

AUDIT TEAM

Jim Williamson, CPA, CIA, City Auditor
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**PUBLIC WORKS DEPARTMENT
PAVEMENT MANAGEMENT SYSTEM**

DECEMBER 2, 2014

MAYOR AND CITY COUNCIL

<i>Mick Cornett</i>	<i>Audit Committee, Mayor</i>
<i>James Greiner</i>	<i>Ward 1</i>
<i>Ed Shadid</i>	<i>Ward 2</i>
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<i>Patrick J. Ryan</i>	<i>Ward 8</i>



December 2, 2014

The Mayor and City Council:

The Office of the City Auditor completed an audit of the Public Works Department's pavement management system as of June 30, 2013.

Based upon the result of our audit, we believe that current systems and processes used by the department should be improved in order to optimize the condition of major City streets.

BACKGROUND


- **Citizens desire improved streets.** From FY 2005 through FY 2013 citizen satisfaction with major City streets has lagged other large cities and each year citizens prioritized maintenance of major streets as the City's top priority for emphasis. See Figures 1 and 2.
- **Street infrastructure projects are primarily funded through G.O. Bonds.** A total of \$690 million was authorized for street infrastructure projects in 2000 and 2007. G.O. Bonds were the funding source for approximately 94% of the \$242 million spent on street infrastructure projects from FY 2008 through FY 2013. See Figure 4.
- **Expenditures are primarily directed toward arterial streets.** Approximately 89% of street infrastructure expenditures from FY 2008 through FY 2013 were focused on resurfacing, reconstruction or widening arterial streets. See Figures 5 and 6.
- **Pavement preservation is important to optimizing street conditions.** Repairing streets in poor condition is very costly. A pavement preservation strategy seeks to keep streets above critical condition in good repair to extend their useful life and reduce overall costs. See Figures 7 through 10.
- **A pavement management system is essential to implementing a pavement preservation strategy.** A pavement management system is an organization-wide structure designed to centralize information and decision making. A complete and accurate inventory of street conditions and use of data collection and analysis software are integral components of an effective pavement management system.
- **City pavement activities are fragmented.** Activities related to monitoring, maintenance, resurfacing and reconstruction of roadways are spread across six Public Works Department programs with no one person assigned responsibility for coordinating these activities into a comprehensive pavement management system.

EXECUTIVE SUMMARY: Audit Report 13-02B

RECOMMENDATIONS

- Create a Pavement Management Program and a Pavement Manager position to provide centralized planning, coordination, and monitoring of the City's pavement network. Recommendation 1.
- Use data collection and analysis software to support a comprehensive and centralized pavement management program. Recommendation 2.
- Develop guidelines for street project selection based on a pavement preservation strategy. Recommendation 3.
- Improve the accuracy of the pavement inventory. Recommendations 4 through 7.
- Use percentage of lane miles in good condition as an objective strategic result measure for efforts to address citizen expectations regarding quality of City streets. Recommendation 11.
- Create separate arterial and residential measures for street condition and citizen satisfaction. Recommendation 13.
- Work with the General Services Department to prioritize and coordinate in and out-of-season work on critical machines and support vehicles used in pavement maintenance activities. Recommendation 16.
- Assess the reasonableness of annual targets for pavement maintenance activities. Recommendation 17.
- Maintain complete lists of scheduled pavement maintenance activities and document that street conditions fall within departmental standards prior to performing micro-resurfacing work. Recommendation 18.
- Inspect street projects completed by counties and other municipalities under an inter-local agreement. Recommendation 21.

The content and emphasis of the items in this report have been discussed with appropriate management representatives to assure a complete understanding of the recommendations and observations arising from our audit. Management responses are attached to this report in their entirety.


Jim Williamson
City Auditor

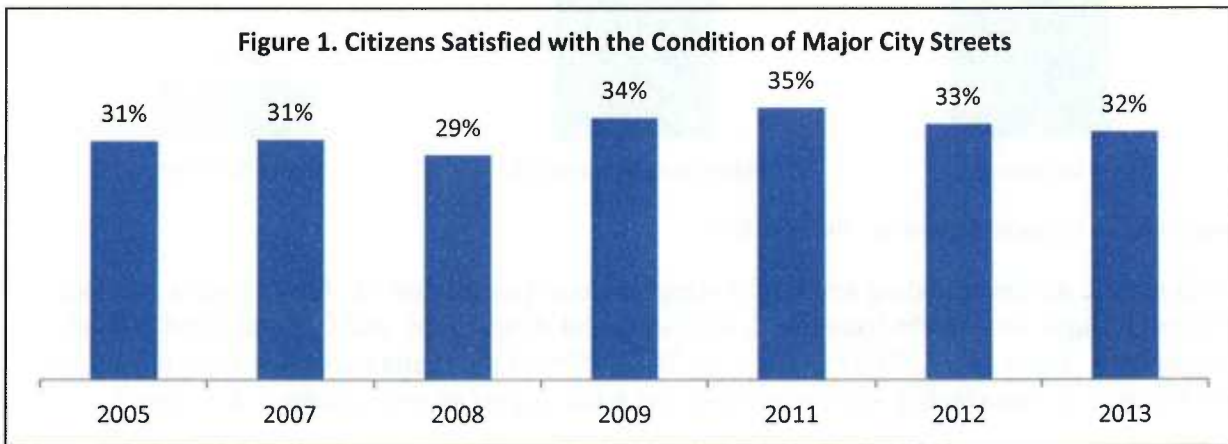

Marilyn J. Dillon
Audit Manager

PUBLIC WORKS DEPARTMENT PAVEMENT MANAGEMENT SYSTEM

AUDIT OBJECTIVE, SCOPE AND METHODOLOGY

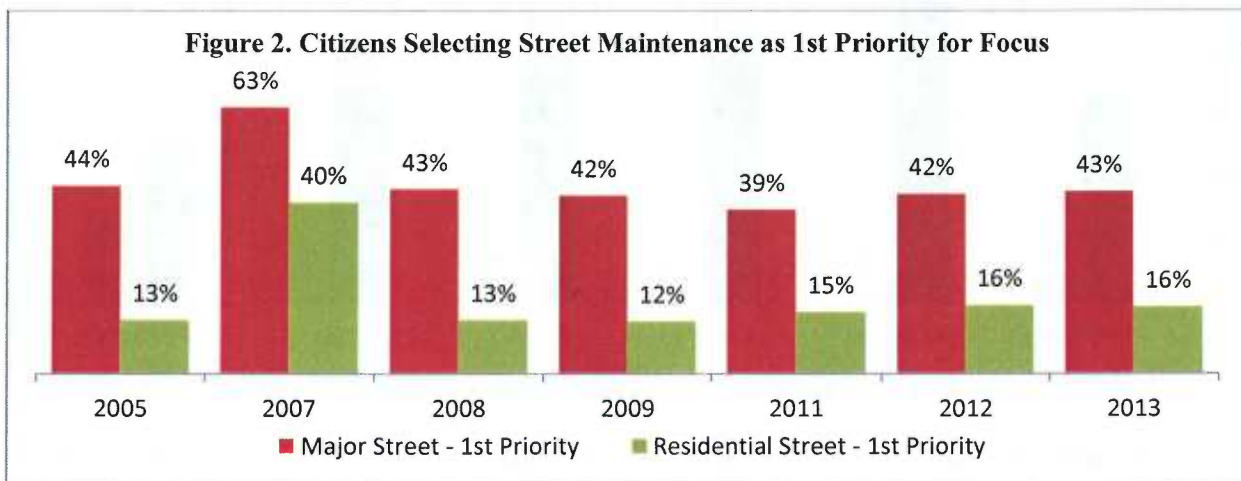
The objective of this audit was an evaluation of the adequacy and effectiveness of the systems and processes used by the Public Works Department to optimize the condition of City streets as of June 30, 2013.

Street condition is an important issue for the citizens of Oklahoma City. Since 2005, citizen satisfaction with the condition of major City streets averaged 32% (Figure 1). As reported in the 2013 survey benchmarks, Oklahoma City ranked 15% below other selected cities with a population greater than 250,000, which had an average of 47% in citizen satisfaction with major streets.



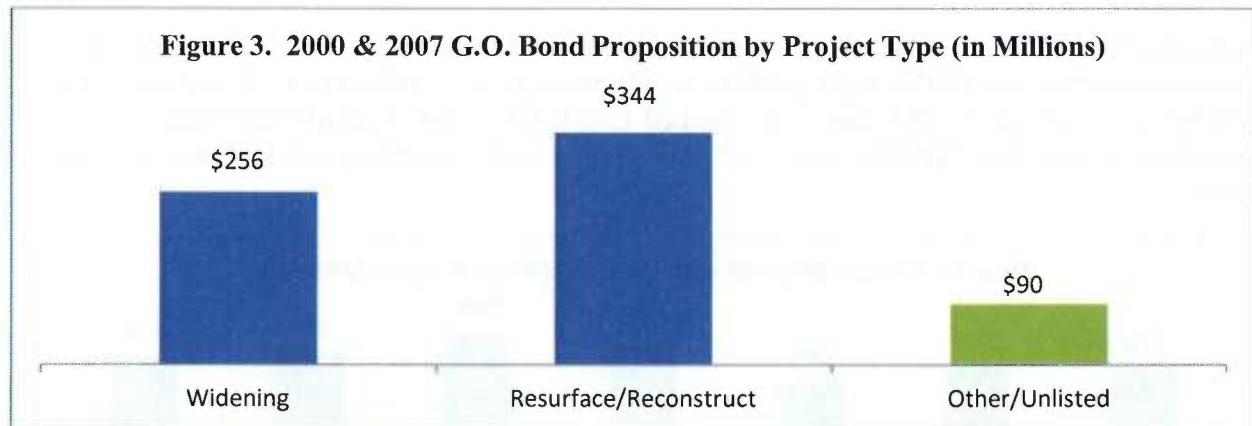
Source: ETC Institute Final Reports 2005 to 2013 Citizen Survey (No survey was conducted in 2006 and 2010).

The citizens of Oklahoma City continue to express concern with the maintenance of City streets. In 2013, 43% of citizens surveyed ranked maintenance of major streets as the number one area to receive the most emphasis over the next three years (Figure 2).



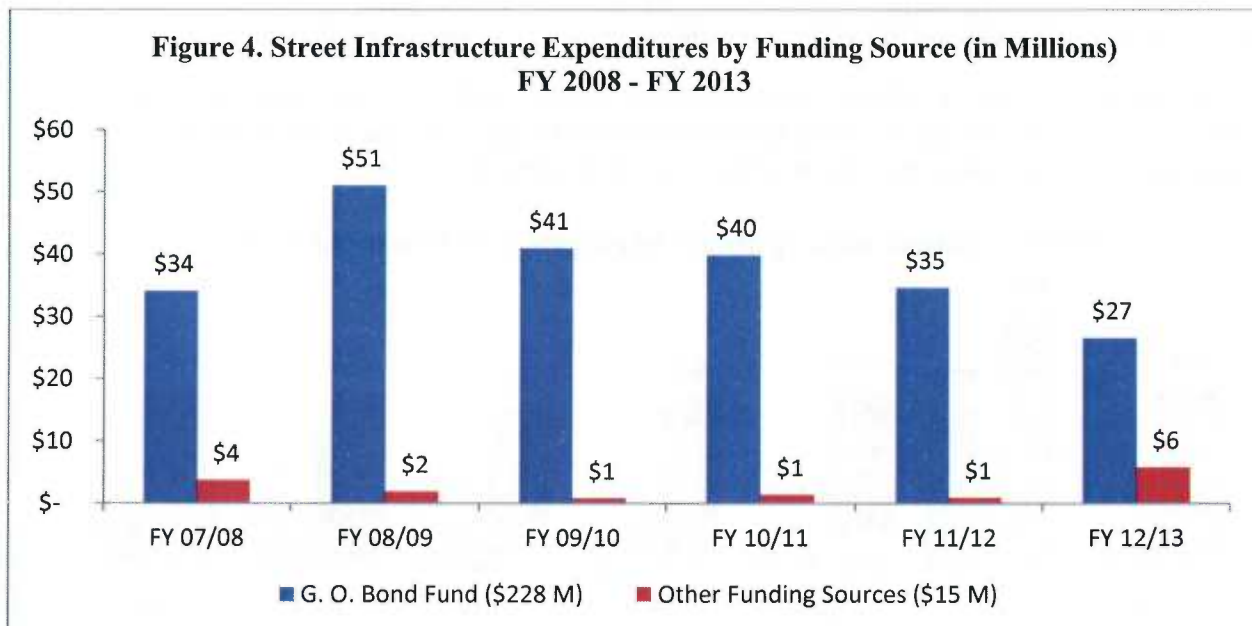
Source: ETC Institute Final Reports 2005 to 2013 Citizen Survey (No survey was conducted in 2006 and 2010).

City leaders continue to stress the importance of infrastructure enhancements, and improvements in street condition support the City Council priority to ‘**Develop a Transportation System That Works for All Citizens**’ within the *Leading for Results* (LFR) performance management system¹. Street condition as a funding priority is reflected in the authorization of \$192 million in General Obligation Bonds in 2000, and the 2007 approval of an additional \$498 million in bonds for street related infrastructure projects. In these bond propositions, projects for resurfacing and reconstruction accounted for 50% of the total proposition; 37% for widening projects; 12% for unlisted projects; and 1% for curb ramps, bike trails, and other items (see Figure 3).



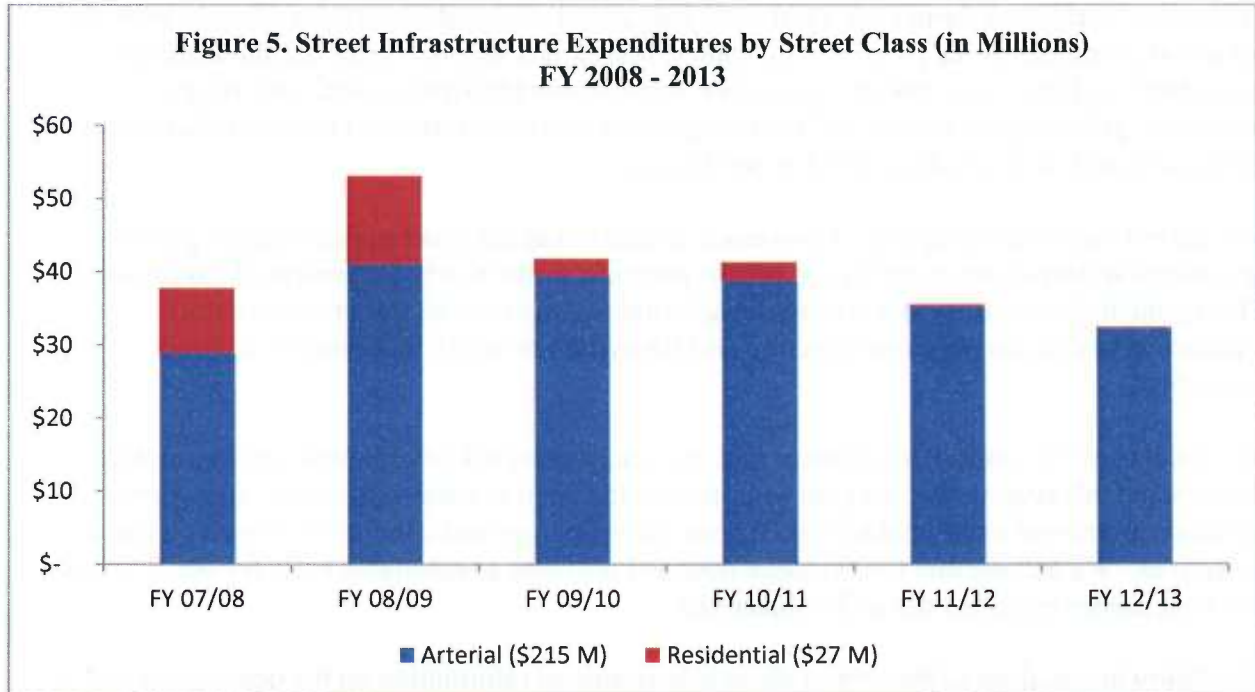
Source: General Obligation Proposition, 2000 and 2007.

Bonds are the primary funding source for street projects (see Figure 4). Other sources include the Capital Improvement Projects Fund, the Street and Alley Fund, and General Fund budget amendments. From July 1, 2007 to June 30, 2013, 89% of the funds expended from all sources were focused on resurfacing, reconstruction, and widening of arterial streets (see Figure 5).



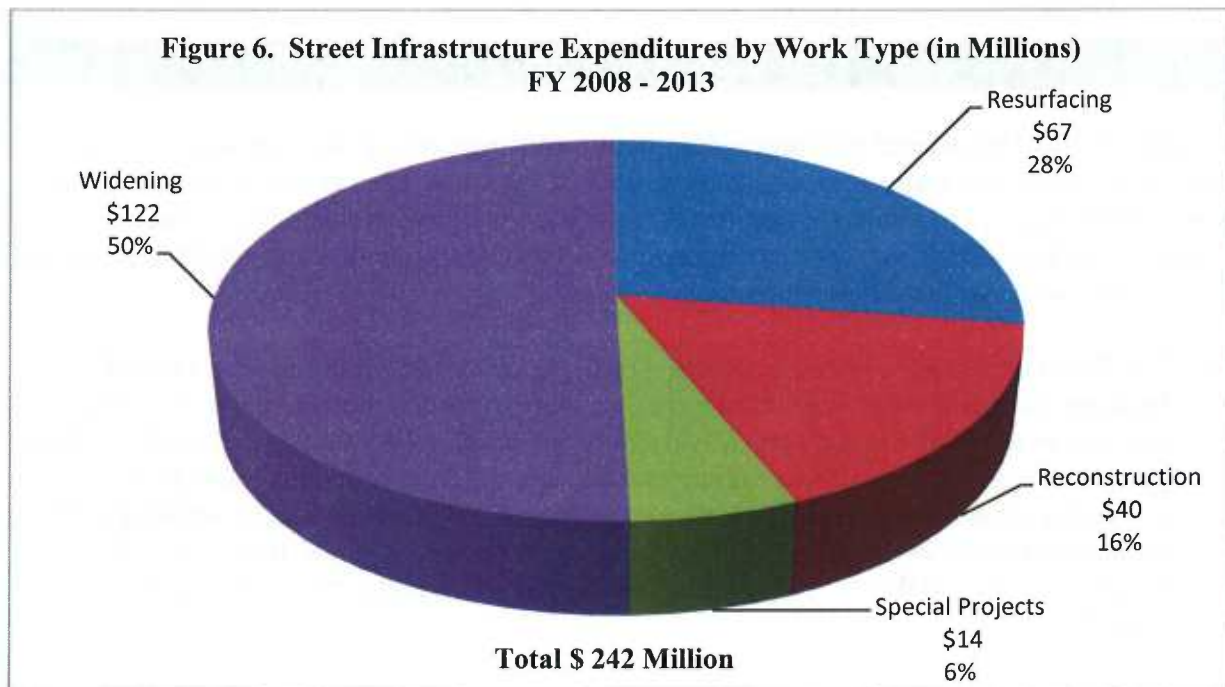
Source: PeopleSoft Financial System. Totals do not include Project 180 expenses from the TIF Fund or Streetscape projects.

¹ FY 14-15 Budget Book



Source: PeopleSoft Financial System. Totals do not include Project 180 expenses from the TIF Fund or Streetscape projects.

The department expended a total of \$242 million dollars for street related projects from July 1, 2007 to June 30, 2013, and widening projects represented 50% of the total (see Figure 6).



Source: PeopleSoft Financial System. Totals do not include Project 180 expenses from the TIF Fund or Streetscape projects. Examples of special projects include the relocation of Interstate 40 and street improvements for The Outlet Shoppes at Interstate 40 and Council Road.

Procedures performed during our audit included compilation and assessment of street projects; review and analysis of the pavement inventory; review and assessment of current management procedures and street maintenance activities; interviews with departmental staff regarding processes, policies, procedures, and controls; review and assessment of current project selection guidelines; and, an analysis of street expenditures.

We did not assess the adequacy of processes related to capital street project design, project specification development, utility cut permit issuance, or the newly implemented Construction Management System (CMS) software. In addition, we did not test the street inventory maintained within the pavement layer of the GIS system to verify inclusion of all street segments.

We conducted this audit in accordance with generally accepted government auditing standards. These standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our audit findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

The following sections of this report provide background information on the department and a review of industry best-practices for an effective pavement management system. This is followed by recommendations intended to provide constructive suggestions for improving the current systems and processes. Included in the body of this report are *management responses* to each recommendation. Appendix A contains the entirety of *management responses* received from the department.

BACKGROUND

The Public Works Department provides infrastructure construction and maintenance, private construction review and inspection, and emergency first response services to the public so they can live, work and play in a safe environment². Services specifically related to pavement maintenance, rehabilitation, reconstruction, and preservation are spread across multiple programs and lines of business within the department.

- The Streets Program within the Streets, Traffic, and Drainage Maintenance Line of Business is responsible for providing roadway repair, reconstruction, and debris removal services to the public so they can travel safely and comfortably throughout the City. Key performance measures in this program that address the condition of city streets are increasing citizen satisfaction with street condition to 50% by 2017 and completing 80% of pothole repairs within 3 days. In addition, the Streets Program also reports LFR measures related to the ‘# of lane miles micro surfaced’ and the ‘# of lane miles chip sealed’.
- The Project Management Program within the Engineering Line of Business is responsible for capital project construction oversight for citizens so they can have improved public

² FY 2015 Public Works Department Strategic Business Plan

facilities completed on time and within program budget. Performance measures include the timely award of capital construction projects including streets, the number of street lane miles constructed, and the percentage of capital projects completed on time.

- The Technical Review and Regulation Program within the Engineering Line of Business provides pavement management, document review, and approval services to the development community, government agencies, and the public so they can proceed with construction projects in a timely manner. Performance measures within this program track private road development work orders and document/plan review for paving projects.
- The Construction Inspection and Construction Quality Program within the Field Services Line of Business provides plan review, materials testing, inspections, and reporting to City staff and the development community so they can provide citizens with infrastructure built and maintained in a timely manner and in accordance with recognized construction standards. Important LFR measures related to street condition include ‘Average PCI rating for City streets’ and ‘# of square miles of residential streets rated [for PCI]’.
- The Data Collection Program within the Traffic Management Line of Business provides services to gather, process, and report traffic information in support of transportation infrastructure improvements including the collection of average daily traffic counts used in pavement project prioritization.
- The Administrative Line of Business includes staff assigned to maintain and update the pavement inventory, which is maintained in the pavement layer of the geographic information system (GIS).

Pavement Condition Index (PCI)

The PCI rating scale is a method for quantifying the condition of roadways developed by the U.S. Army Corps of Engineers and further validated by the U.S. Department of Transportation (DOT) and the American Public Works Association (APWA). PCI is a numerical indicator of the surface condition of pavement based on a detailed survey of specific distresses. Distress types relate to either the structural integrity or the operational condition of the roadway³. Jurisdictions use PCI values as an objective guide to determine maintenance needs; prioritize capital projects; and, monitor the quality of design standards, materials, and maintenance.

The PCI is a scale from zero to 100; with 100 representing a newly constructed pavement and zero representing a failed pavement. As shown in Table 1, the department uses a modified version of the official rating scale from the American Society for Testing and Materials (ASTM) that combines some of the condition bands (see Appendix B for the full ATSM PCI Scale). PCI inspection can be done through a visual walking scan of the roadway or by specially equipped

³ ASTM Standards for Pavement Condition Index; D6433-07

vehicles that utilize automated technology to evaluate road condition. The department utilizes a vendor to conduct a biennial automated inspection of major arterial roadways, and residential streets are inspected manually by two dedicated inspectors in Field Services.

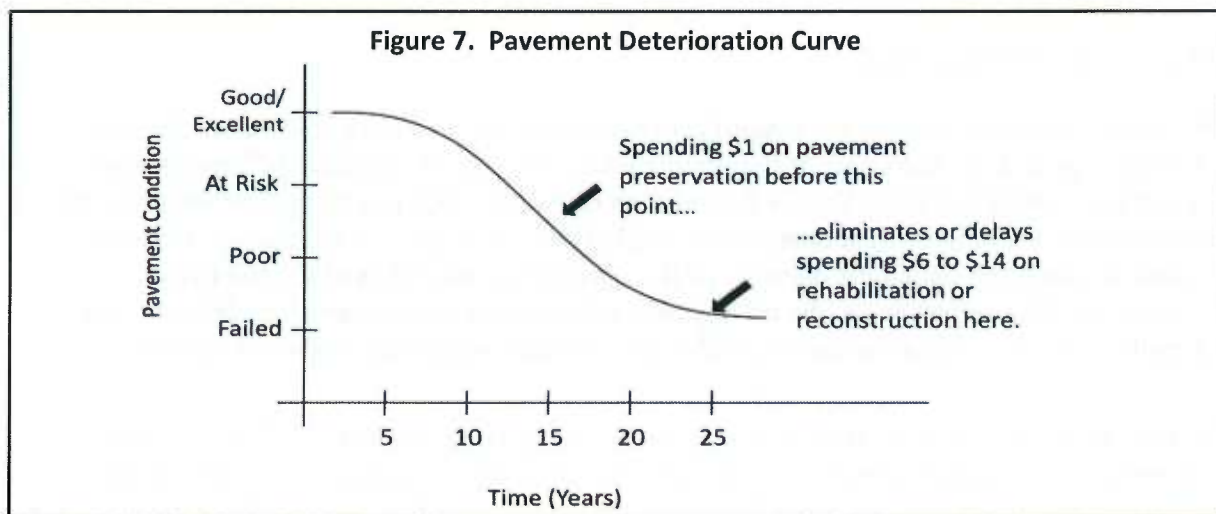
Table 1. Public Works Department Pavement Condition Index (PCI) Rating Scale

Category	PCI Score	Description and Required Work
Excellent	100-85	No repairs needed
Very Good	71-85	Pavement eligible for micro-resurfacing
Good	61-70	Base in acceptable condition, eligible for a ¾ inch asphalt overlay
Fair	51-60	Requires minor repairs to the base and a ¾ inch asphalt overlay
Poor	41-50	Pavement requires some base repairs and a 2 inch asphalt overlay
Very Poor	35-40	Requires major base repair, curb/gutters, and a 2 inch asphalt overlay
Failed	0-35	Pavement requires complete reconstruction

Adapted from GIS Mapping Services information at www.okc.gov and departmental provided information.

Pavement Lifecycle and Pavement Preservation

Paved roadways represent one of the largest assets of the City. Typical asphalt pavements have a useful life of 10-20 years, depending on design, structure, traffic volume/weight, and climate⁴. Industry experts agree that pavement condition declines slowly following initial construction then the pavement reaches a critical point where deterioration and repair costs begin accelerating at a rapid rate. The Pavement Preservation Foundation reports that investing \$1 on pavement preservation activities can eliminate or delay spending \$6 to \$14 on rehabilitation/reconstruction, which is required when the roadway is allowed to deteriorate⁵.

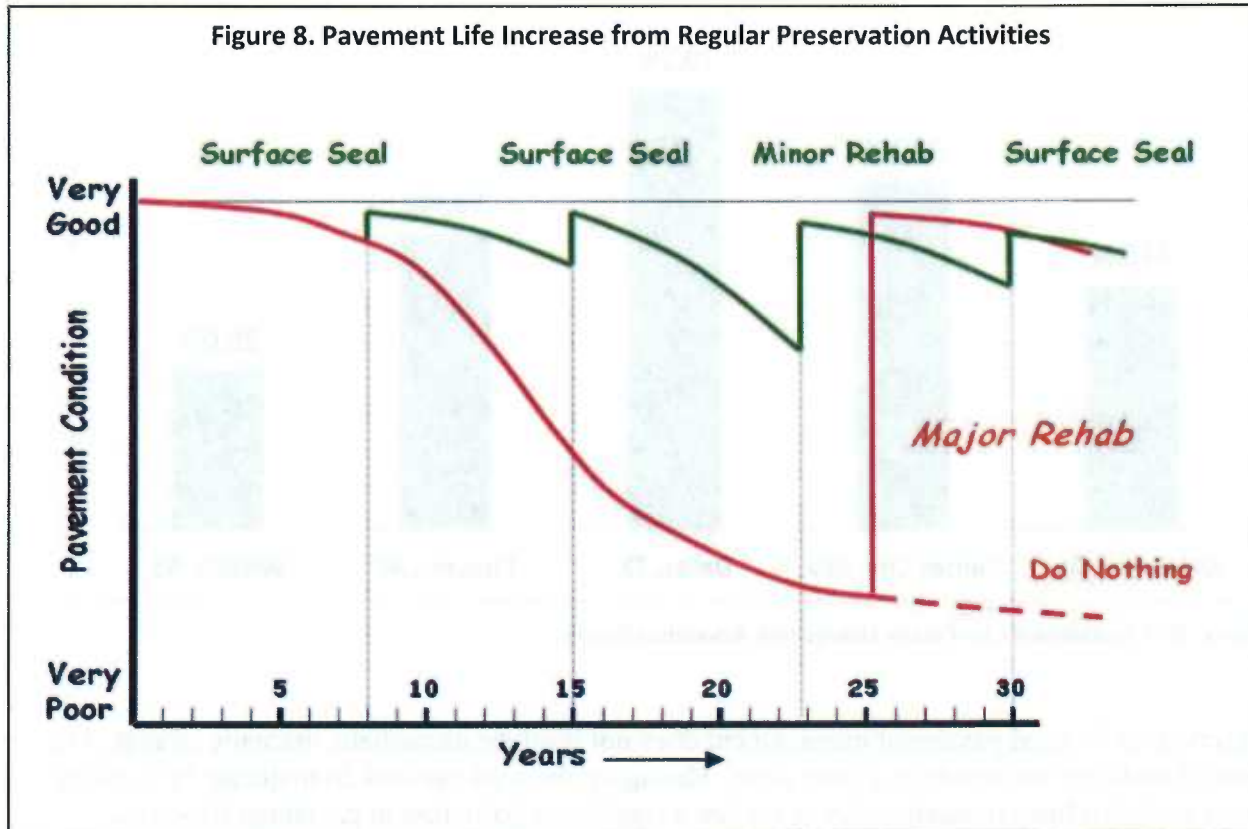


Source: National Center for Pavement Preservation (National cost averages as of 2001).

⁴ Pavement Maintenance (2012). Tennessee Public Works Institute

⁵ ASHTO & TRIP (2009). Report, *Rough Roads Ahead*

As shown in Figure 8, preservation activities on pavement in good condition can extend the useful life of the pavement significantly at a much lower cost. Simply put, a network of roadways in good condition costs less, making a pavement management system critical to overall asset management.



Adapted from *The Hole Story* (2011). Report, American Public Works Association.

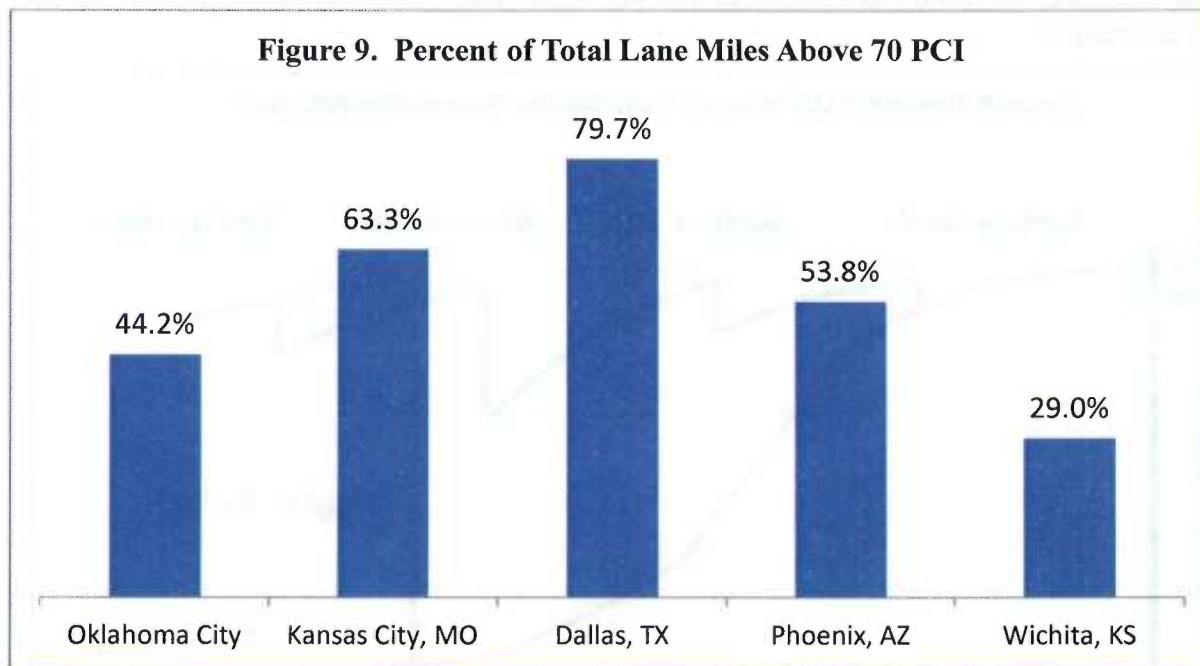
Citizens also experience increased costs associated with road networks in poor condition. Driving on a roadway in disrepair accelerates vehicle deterioration and depreciation, requires more frequent vehicle maintenance, and reduces gas mileage. In a 2010 survey of 20 urban regions with a population of 500,000 or more, Oklahoma City ranked seventh in annual vehicle operating costs at \$662, which is \$260 greater than the national average⁶.

Many communities mistakenly adopt a ‘worst first’ strategy to address pavement condition. This strategy spends limited funding to fix or replace streets in poor condition. In contrast, a proactively-focused pavement preservation strategy seeks to keep streets above a critical PCI in good condition to extend their useful life and reduce overall costs⁷. Results from a 2011 survey by the International City-County Management Association (ICMA) indicate that Oklahoma City lags behind most other selected cities in this measure of overall street condition, with 44.2% of total lane miles above critical PCI (see Figure 9). Pavement preservation is not a one-size fits all

⁶ TRIP (2010). Report, *Hold the Wheel Steady: America’s Roughest Rides*

⁷ United States Department of Transportation, Research and Innovative Technology Administration. National Transportation Library. Retrieved from <http://ntl.bts.gov/>

solution. According to the Transportation Research Board, each municipality must tailor their pavement management system to preserve road conditions in the most cost-effective manner⁸.



Source: 2011 International City-County Management Association Survey.

Preservation focused pavement management does not produce immediate, dramatic change; but benefits and cost savings accrue over time. Managing the road network to maintain PCI values above critical allows municipalities to realize a significant reduction in pavement life-cycle costs. For example, two identical roadways each costing \$500,000 were studied over the life of the roadway. The first location received regular maintenance at a cost of \$140,000, which increased the useful life of the roadway an additional 18 years. The second location received no maintenance and required \$480,000 for full reconstruction at the end of its useful life⁹. Regular maintenance deferred the need to spend an additional \$340,000 for nearly 20 years.

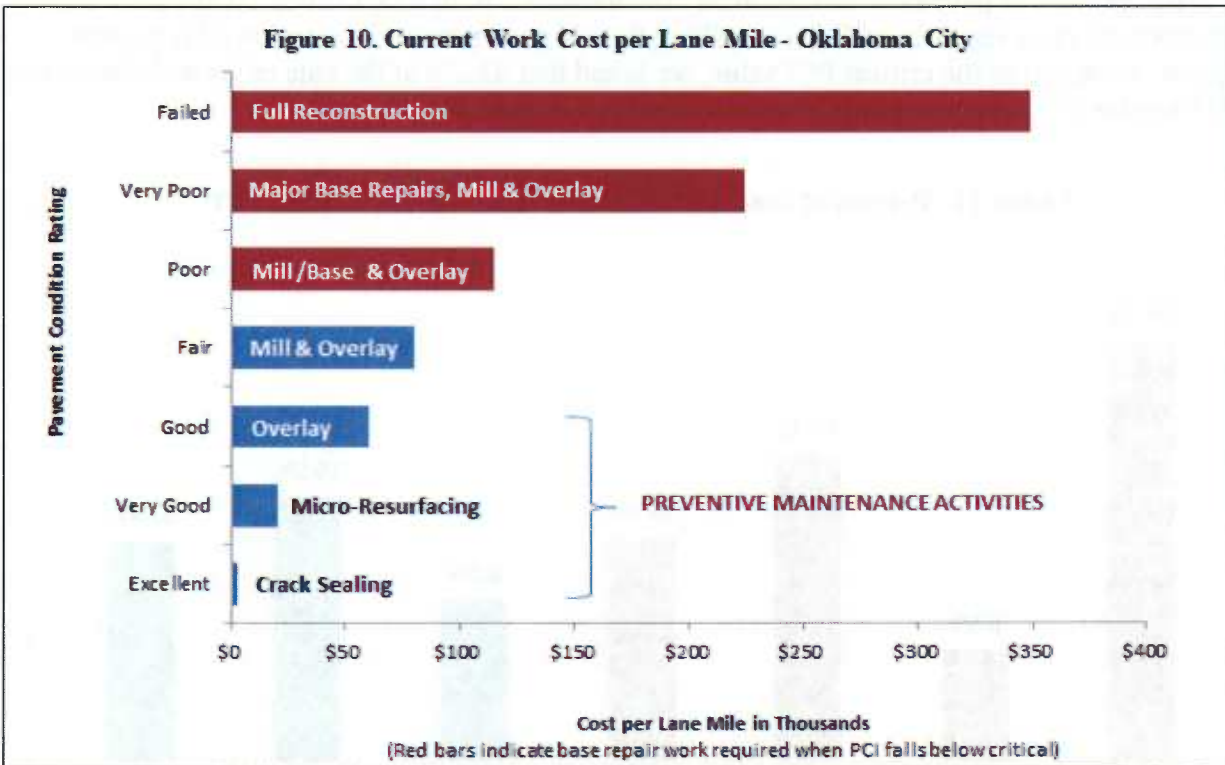
Percentage of total lane miles above critical PCI is an important industry measure of pavement management effectiveness¹⁰. When the PCI of a road reaches 60, the pavement requires base layer repair in addition to milling the old pavement surface and overlaying with asphalt¹¹. Using departmental costing information, we found a significant cost variance between preventive activities and reactive activities on roads with PCI values below critical (see Figure 10).

⁸ Galehouse, et al., (2003). Report, *Principles of Pavement Preservation*, Transportation Research Board, National Research Council, Washington, DC

⁹ Galehouse, et al., (2003).

¹⁰ International City-County Management Association, Survey Standard Guidelines.

¹¹ See Table 1 and Appendix B.



Adapted from costing information provided by the department.

RESULTS OF WORK PERFORMED

Current systems and processes used by the department should be improved in order to optimize the condition of major City streets.

Pavement Management Systems (PMS)

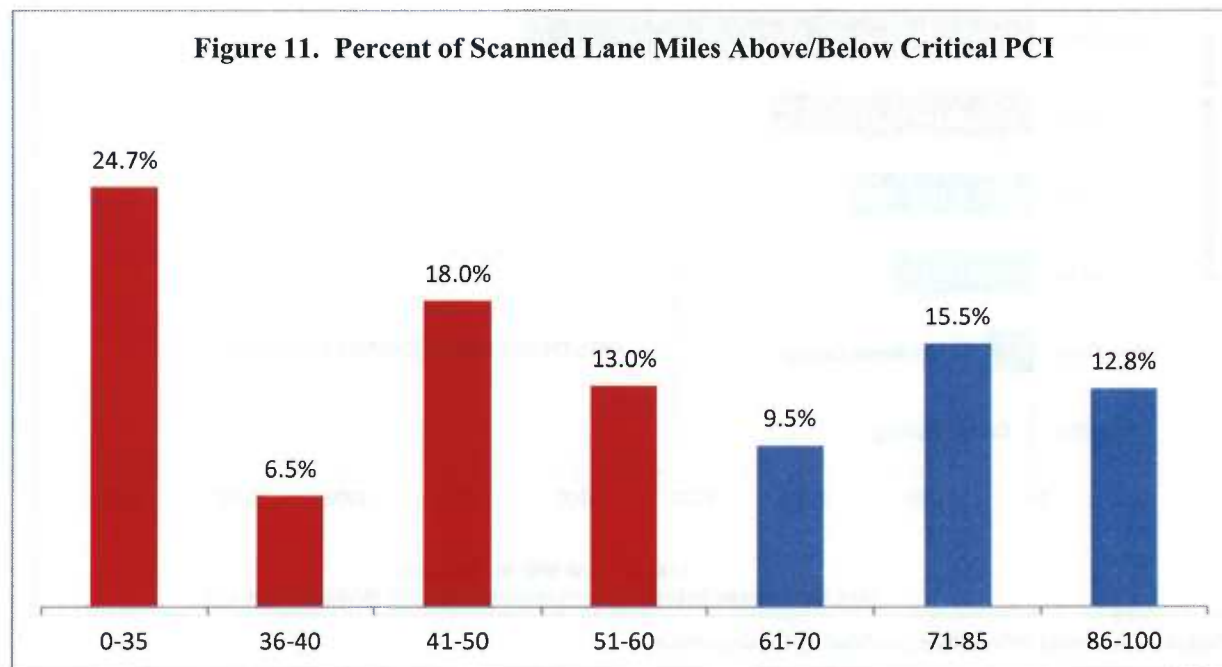
A PMS is an organization-wide management structure designed to preserve the condition of the pavement network. The objective is to centralize information and develop decision making criteria to maximize available funding, improve condition, and apply “the right treatment on the right road at the right time”¹². According to the Center for Transportation Studies at the University of Minnesota, conducting repairs or maintenance activities inappropriate to the PCI value can accelerate the rate of pavement distress development, which reduces the effective useful life of the pavement and increases overall costs¹³. The goal of a properly managed PMS is to increase the number of lane miles on the high end of the PCI scale to avoid more costly rehabilitation or reconstruction¹⁴.

¹² Galehouse, et al., (2003).

¹³ Johnson (2000). *Best Practices on Asphalt Pavement Maintenance*, Center for Transportation Studies, University of Minnesota

¹⁴ US DOT, Federal Highway Administration (2007). Report, *Asset Management Overview*.

As stated previously, the percentage of total lane miles above critical PCI is an important industry measure of pavement management effectiveness. With a PCI below 60, the pavement requires base layer repair in addition to milling the old pavement surface and overlaying with asphalt. Using 60 as the critical PCI value, we found that 62.2% of the lane miles included in the 2013 vendor PCI scan had a rating below critical (see Figure 11).



Source: 2013 Vendor Automated Scan PCI Values. Red bars indicate base repair work required when PCI falls below critical.

Fragmentation and Decentralization

Industry recommendations for effective pavement management include the need to centralize oversight of the road network including planned maintenance activities, scheduling of capital rehabilitation and reconstruction projects, and the development of a comprehensive strategy to improve road condition¹⁵. The Federal Highway Administration and other pavement industry leaders encourage the use of a strategic and systematic process to maintain and preserve roadways throughout their life cycle¹⁶. By utilizing a PMS, the road network is managed as an integrated whole with clearly defined terminology and work definitions¹⁷.

A review of the Public Works Department organizational chart and strategic business plan reveals that activities related to monitoring, maintenance, resurfacing, and reconstruction of roadways are spread across the Administrative Line of Business and five other departmental programs with no one person assigned responsibility for coordinating these activities into a comprehensive pavement management program. Without a coordinated structure for pavement management, resource allocation and completed street projects may not optimally improve road condition, address City Council priorities, and increase citizen satisfaction.

¹⁵ Galehouse, et al., (2003).

¹⁶ AASHTO & TRIP (2009).

¹⁷ US DOT/FHA (2007).

For example, in a sample of 38 lane miles of capital road projects completed between July 1, 2010 and March 31, 2013, we found that 8 lanes miles (20.8%) have post-completion PCI values that indicate the work performed was not effective in raising the PCI value. Currently, the department does not have staff responsible for identifying and investigating these anomalies (i.e., repairs inappropriate for the current road condition, poor quality workmanship, incorrect PCI values, inventory data entry errors, etc.).

In addition, to coordinating street-related activities carried out by various department programs, a Pavement Manager could enhance resource allocation decision making, ensure planned work is appropriate for the current PCI value of roadways, and play an important role in objectively selecting street projects in future General Obligation Bond propositions to allocate the appropriate level of funding to various work types (micro-resurfacing, resurfacing, reconstruction).

Recommendation 1

Public Works management should create a Pavement Management Program and a Pavement Manager position to provide centralized planning, coordination, and monitoring of the City's pavement network. Ideally, the Pavement Manager should be an industry professional, trained in the use of appropriate software and planning tools with extensive experience managing a large pavement network.

Management Response 1

Management agrees with the recommendation. The need for an employee to lead a Pavement Management Program to coordinate the different departmental programs affecting the quality of city streets is needed. Currently, the Civil Engineer IV in the Paving and Resurfacing Section is responsible for numerous activities including management of the street resurfacing program which includes GO Bond resurfacing, fund-balance resurfacing and coordination of City-County agreements. As part of the FY 2015-16 budget process, a thorough evaluation of the organization and staffing levels in the Engineering Division will be completed. Following this evaluation, Public Works will request an additional position to focus on the Pavement Management Program. If a new position is approved in the FY 2015-16 budget, this recommendation will be completed by September 30, 2015.

Tools and Software

Data collection and analysis is a critical component for a successful pavement management program¹⁸. In 1995, the federal government passed The Intermodal Surface Transportation Efficiency Act to encourage states and municipalities to use software systems in an overall

¹⁸ Reid (2004). Report, *Learning What Software Variables to Evaluate When Selecting a Pavement Management Software Program*. American Public Works Association (APWA).

pavement management strategy¹⁹. Several programs exist to meet this objective including the MicroPaver software system developed by the U. S. Army Corps of Engineers. Because the Public Works Department already possesses a software license for the most recent version of MicroPaver purchased through the APWA, we focused our audit analysis on the capabilities and applicability of this software to support a pavement management program in Oklahoma City.

MicroPaver offers a full-featured, pavement inventory that can be linked and integrated directly into the City's existing Geographic Information System (GIS). In addition, the software can model future condition, store historical maintenance and repair records, calculate PCI based on distress data, develop scenarios based on available funding, and produce priority ranked lists for suggested repairs based on the analysis²⁰. MicroPaver can be customized through user-defined fields, produce detailed reports on past and future pavement condition, automatically update surface types based on work history information, and provides companion add-ons that allow for field PCI inspections and storing of digital image files. A license for MicroPaver is available from Colorado State University for \$795 per year and the integrated field inspection software add-on is \$299. This amount allows for three users and full technical support. In addition, the university offers a week-long, in-depth training seminar for \$1,799 per person.

Currently, the department uses the software to calculate and verify PCI values but does not utilize the software for scenario analysis or modeling future condition. MicroPaver is not connected to the City's GIS system and has not been updated with historical maintenance repair information. In addition, the vendor conducting the biennial automated PCI data collection is not required to submit detailed distress data in a format suitable for automatic upload and use with MicroPaver.

Utilizing pavement management software would provide objective information on projected future pavement conditions that could be used to plan work, select projects for future General Obligation Bond propositions, and allocate the appropriate level of funding to various work types (micro-resurfacing, resurfacing, reconstruction).

Recommendation 2

Public Works management should utilize the MicroPaver software system to support a comprehensive and centralized pavement management program. In addition, the department should utilize vendor provided support and training available for MicroPaver through Colorado State University. In support of the software, historical information regarding the date of last major maintenance and/or reconstruction should be entered into the GIS system, the GIS system should be linked to MicroPaver, and the automated PCI scan vendor should be required to supply PCI distress information in a compatible format with distress data at the detailed segment level.

Management Response 2

Management agrees with the recommendation. In order to run scenario analysis and modeling

¹⁹ Ibid.

²⁰ MicroPaver Software Description. Colorado State University.

of future street conditions for the entire City of Oklahoma City street inventory, additional staff and computer aided software will be required. The Public Works Department is prepared to evaluate different pavement management software systems, including MicroPaver. Staff will be responsible for data entry of all maintenance and date constructed information into the paving management software. The next contract for automated street inspection during FY 2015 will include submission of the paving condition database as a deliverable. Funding for the procurement of a pavement management software, additional staff and staff training will be requested in the FY 2015-16 operating budget.

Street Project Selection

Doing the right work at the right time is a crucial element of effective pavement management. Properly timed road work can increase the useful life of roadways significantly (see Appendix C). Prioritizing work using an objective system is important to avoid the increased costs associated with major rehabilitation and reconstruction. A strategic decision making structure provides the best return for each dollar invested, improves citizen satisfaction, and reduces life-cycle costs²¹. Industry studies show that the development of decision trees and written project selection criteria provides the most cost-effective method to plan future road work when the agency uses projected future condition data obtained from pavement management software²².

According to departmental management, the City prioritizes projects based on the PCI value, the average daily traffic count, citizen complaints, and input from the City Council. We examined all budget amendment funded street projects from FY 2011-2012 and FY 2012-2013, and a sample of street projects funded from unlisted G.O. Bond funds, the CIP Fund, and the Street & Alley Fund during the period July 1, 2010 through June 30, 2013. Of the 153.8 lane miles, we found 53.9 lane miles (35%) did not receive work that was consistent with the current PCI listed in the pavement inventory system at the time the project was selected.

We also analyzed the department's *unfunded project lists by ward* to evaluate project selection and the given priority of the projects based on current PCI values. The *unfunded project lists by ward* contains two columns related to the project priority. The first column ranks the project on a high/medium/low scale and the second column ranks the projects numerically. Our analysis did not support the use of objective criteria for numerical priority assignments and we noted that some high/medium/low priority rankings did not coincide with the numerical priority. Further, not all projects on each list were assigned a numerical priority; and we noted projects for road segments with low average daily traffic counts that were prioritized ahead of other arterial streets that carry significantly more vehicles per day.

Recommendation 3

Public Works management should develop written guidelines and standardized criteria for street

²¹ US DOT/FHA (2007). Ibid.

²² Sharaf (1998). Report, *A Procedure to Determine Critical Preventive Maintenance Timing*. 4th International Conference on Managing Pavements

project selection based on industry best practices regarding PCI and a ‘preservation first’ strategy. These guidelines and criteria would support final decision making once the required work based on PCI condition is identified using the prediction modeling and scenario analysis options in MicroPaver. Written criteria should also address other, non-quantitative, project selection considerations such as traffic counts, safety concerns, projections of future development in the area, joint project agreements, funding sources, and potential widening needs.

Management Response 3

Management agrees with the recommendation. Written guidelines and standardized criteria for street project selection will be developed by Public Works Engineering staff. Projects included in the 2007 Bond Program must be completed in accordance with the bond proposition language. This may or may not coincide with the pavement treatment recommendations based on the current PCI rating. The guidelines and criteria document will be completed by March 30, 2015.

Pavement Inventory Accuracy

An accurate and complete pavement inventory is crucial to support decision making and for proper functioning of the MicroPaver software. As noted previously, detailed inventory records and pavement condition data collection are integral parts to an overall approach to pavement management. According to the American Public Works Association (APWA), pavement condition distress data must be collected each year using a consistent methodology²³. Inventory information stored in the *pavement layer* of the City’s GIS system must be accurate, consistent, and current. We noted several areas for improvement with regard to the accuracy of the street inventory information.

Functional Street Classification

Within a street inventory, each roadway segment is assigned a functional classification that outlines the major use of the roadway and provides information regarding the amount of daily traffic. In 2008, the City Council adopted the *Functional Classification Plan* that outlined eight street classifications and provided definitions for each (see Appendix D). We found that these classifications are not being used within the street inventory maintained in the *pavement layer* of the City’s GIS system.

The pavement layer has 22 different classifications that may not be entered correctly and do not have formal definitions to facilitate consistent use. For example, a ‘Private’ classification would indicate the road segment is outside the City’s maintenance responsibility and funds should not be used to rate the road for PCI, but we found 12 ‘Private’ classed street records with a maintenance history listed and 26 additional ‘Private’ classed street records with a PCI rating.

²³ Reid (2004). Ibid.

Recommendation 4

Public Works management should review the 22 street classification fields being used currently in the GIS-Pavement Layer for ongoing need and develop a matrix to align GIS-Pavement Layer classifications with the eight classifications defined in the Functional Classification Plan adopted by the City Council in 2008, related departmental LFR measures, and the classification values available in the MicroPaver software.

Management Response 4

Management agrees with recommendation. However, the Public Works Department does not manage street classifications. Street classifications are provided by the Development Services Department and the Functional Classification Plan was completed by the Planning Department. The Public Works Department will review the 22 street classifications currently being utilized in the GIS system, and staff will work reduce the total number of classifications that are required for the successful management of the pavement management program. These changes will be completed upon the procurement of the pavement management software, but not later than September 30, 2015.

System Interfacing, Standardization and Logic Checks for Inventory Accuracy

One aspect of an accurate and properly updated pavement inventory is the ability to interface information from multiple systems to maintain the historical work records, update street classifications, notate planned work, track expenditures, and monitor maintenance or repair project timeliness. We noted multiple instances of inconsistencies and/or inaccuracies in the pavement inventory as of April 23, 2013.

Some of the inconsistencies and inaccuracies noted were:

- Of the 262.9 lane miles of chip sealing and micro-resurfacing work completed from July 1, 2010 through March 31, 2013, 90.4 lane miles (34.4%) were not noted correctly in the *last maintenance* field
- An additional 28 chip seal work orders and 17 micro-resurfacing work orders were noted as complete in the street inventory, but no work had been started on these road segments as of March 31, 2013
- Of the 32 residential crack sealing work orders completed in CityWorks from July 1, 2010 through March 31, 2013, only six (18.8%) were recorded in the *last maintenance* field of the inventory
- Of the 664 street segment records tested for capital repairs or reconstruction work, 10.4% contained an error in the *last maintenance* field
- Of the 69 records tested for maintenance notations, three records (4.3%) did not list a date for the maintenance
- Of the seven records tested for average daily traffic count accuracy, two were noted on the wrong street inventory record and three were suspect due to inconsistencies in the

- beginning and ending descriptors and/or the street segment name
- Divided boulevard streets throughout the City are not entered in the street inventory consistently. Some segments of the roadway may contain two records (one for the northbound side of the street and one for the southbound side), while other divided roadways are represented by only one record per segment lane mile with no differentiation between the two sides of the median
- Inaccuracies exist in the *lanes* (number of lanes per road) field. Despite the presence of multiple roadways in the City with four lanes and a middle turn lane, we could find no records in the street inventory notated as five lane roads
- Of the 13,712 individual street segment records classified as City responsibility, 408 (3%) were missing data in one or more fields (see Appendix E for details)

One possible reason for these inaccuracies and inconsistencies is the lack of a unique identifying number in departmental databases, project lists, and companion systems (i.e.: CityWorks or the Construction Management System) that are used to provide information for updating the street inventory records in GIS. Each street segment record in the *pavement layer* of the City's GIS system has a unique identifying number (Facility ID) that is not being used across all departmental systems and data repositories. Use of this Facility ID would provide a linking mechanism for automatic information uploads to GIS and act as a control mechanism to reduce the data entry errors resulting from manual information input.

A second explanation for data inaccuracy or inconsistency is the lack of a formal policy to standardize naming conventions across all departmental systems that contain information about the street inventory or work being performed on streets. We found inconsistencies in information entry in the *last maintenance* field with seven different ways to note widening work, four different ways to note chip sealing, four different ways to note reconstruction, and 11 ways to note resurfacing work. In addition, the *street name* field is inconsistent across multiple segments of the same roadway. Using a sample of six known divided/boulevard-type streets in the downtown and midtown area, we tested 23.7 lane miles and found 14.4 (60.8%) had inconsistencies in the *street name* field that were related to naming conventions as well as inconsistent representation of the northbound/southbound or eastbound/westbound sides of the divided/boulevard roadway.

Finally, the department does not perform yearly logic-based field relationship testing to verify inventory accuracy and identify inconsistencies in information. We tested the relationship between entries in the *surface type* field, the *rank/classification* field, the *PCI* value field, and the *last maintenance* field. Filtering the pavement inventory by gravel or dirt surface type, we found three of the 306 street segment records with a gravel surface were noted as receiving G.O. Bond resurfacing. According to departmental staff, G.O. Bond money is not spent to resurface gravel roadways. We also found 17 of the 306 gravel surface segment records were noted as arterial streets, and five of the 17 gravel surface, arterial class streets were noted as a dead end. The functional classification plan (Appendix D) defines an arterial as carrying moderate to high traffic flows and designed to facilitate traffic distribution in more densely populated areas. This definition is incongruent with a gravel-surfaced, dead-end street. Further, out of 59 street segment records with a dirt surface, we found that 12 records had a PCI value. The PCI scale is not designed for use with dirt surfaces.

Recommendation 5

Public Works management should use a unique identifying number (Facility ID) to unite the information concerning each street segment in the GIS-Pavement layer (master street inventory) with all departmental systems, G. O. Bond propositions, City Council documents, databases, and software systems. This would facilitate the accurate upload, updating, and tracking of information related to pavement management.

Management Response 5

Management disagrees with the recommendation. Public Works discussed this recommendation with the Information Technology Department and there are technical challenges in implementing the request. The pavement layer of the GIS System is generally broken into the longest segment possible, up to 1 mile. The streets layer is broken at every intersection. If the data was formatted in this way, the same Facility ID cannot be assigned to both the pavement segment and the street segment. A non-CityWorks related ID could be established, but this would require a major restructuring of the GIS streets layer, which would affect CityWorks, 911CAD, and other systems.

The Public Works Department will further evaluate a method to better organize the GIS data in a way that provides for reduced errors, and provides better coordination of the various projects completed. Following the identification of the new method, changes will be completed by March 31, 2015.

Auditor's Comment 5

The Information Technology Department confirmed to the Office of the City Auditor that use of a unique identifying number would require reconfiguration of departmental systems.

Recommendation 6

There are formal guidelines for naming conventions in the Street and Address layers of the GIS system. Public Works management should adopt these standardized naming conventions for street name designators (Drive, Avenue, Boulevard, etc.), street directional indicators (north, south, east, west), maintenance descriptors (micro-resurfacing, mill/overlay, etc.), and other repetitive fields within the Pavement Layer. These naming conventions should be used across all street-related software systems.

Management Response 6

Management both agrees and disagrees with the recommendation. The Public Works Department is not responsible for naming of streets. Street names are developed by the Development Services Department and the data is entered into the GIS system by the Information Technology Department which includes street name designators (Drive, Avenue, Boulevard, etc.). However, the Public Works Department is prepared to ensure the street

directional indicators (north, south, east and west) are accurate in the GIS pavement layer. These same naming conventions will also be utilized in the pavement management software, once selected, and the corrections/changes will be made no later than September 30, 2015.

Auditor's Comment 6

While Public Works is not responsible for naming streets, Public Works staff is responsible for GIS pavement layer data entry. Consistent data entry is important to sorting and compiling data for management reporting purposes.

Recommendation 7

Public Works management should institute yearly, logic-based data checks to verify the accuracy and completeness of the GIS-Pavement layer (master street inventory). Responsibility for making data corrections should be assigned to specific positions within the department.

Management Response 7

Management agrees with the recommendation. The responsibility for data verification is already assigned to the Public Works GIS Analyst. Public Works will work with the Information Technology Department to develop reports that will be used to run quality control checks on the GIS pavement layer. The quality control reports will be completed by March 30, 2015.

Leading for Results Reporting

We reviewed the department's strategic objectives and program performance measures related to pavement management activities for reporting accuracy, measure relevance, and measure definitions.

Measure Definition and Reporting Accuracy

Evaluation of appropriate measure definition and reporting accuracy was complicated by the lack of measure details provided within the *Leading for Results* (LFR) application. The LFR application provides a 'measure details' area that allows management to outline the measure formula, describe the source of underlying data used for reporting, explain how the measure is tracked, and how targets were developed. Of the 18 measures within our audit scope, 12 measures (66.7%) had not been completed with measure details.

The department uses values generated by the Crystal Reports application to report LFR performance measures in the Streets Program. Crystal Reports queries the CityWorks system for closed work orders. From July 1, 2010 through March 31, 2013, we were unable to recreate the reported LFR values based on closed work orders for "# of potholes filled", the "# of lane miles micro-resurfaced", and the "# of lane miles chip sealed".

For example, monthly differences between pothole totals from CityWorks and the amount reported in the LFR application for the “# of potholes filled” ranged from -16 to 8,554. Yearly lane mile totals from CityWorks were higher (by 2 to 8 lane miles) than the amount reported in the LFR application for the “# of lane miles micro-resurfaced”. We were able to recreate the yearly total lane miles reported in FY 10-11 for the “# of lane miles chip sealed”, but the reported totals for FY 11-12 and FY 12-13 thru March were 8.5 and 6.6 lane miles higher, respectively, than the lane miles represented by closed work orders in CityWorks.

The LFR inconsistencies may be caused by the inaccurate entry of dates into CityWorks and/or including duplicate or cancelled work orders in measure value calculations. When a work order is created in CityWorks, the initiated date is assigned automatically. Subsequent entry of dates for ‘actual work start date’ and ‘actual work completed date’ are entered manually. The system has no entry masks or field rules that prevent staff from manually entering a date prior to the date the work order was initiated. In addition, there is no mask or field rules to prevent manual entry of a work completed date that occurs prior to the manually entered work start date. Currently, all work orders in the CityWorks system are marked as ‘closed/completed’. There is no distinction between work orders that were completed and those that must be cancelled due to duplication or incorrect information.

Recommendation 8

Public Works management should direct program and/or line of business managers to complete the specific LFR ‘measure details’ information within the LFR application to outline the measure value formulas, the source of underlying data being reported, how the measure is tracked, how measure values are aggregated, how measures are reported, and how the measure targets were developed. In addition, the department should investigate the accuracy of the Crystal Reports query that is used to report Streets Program LFR measures to verify accuracy for “# of potholes filled”, “# of lane miles micro-resurfaced”, and “# of lane miles chip sealed”.

Management Response 8

Management agrees with the recommendation. The Streets, Traffic and Drainage Maintenance Division (STDM) met with the Office of Management and Budget in June 2014 and reviewed each measure in the Leading for Results (LFR) database. The database program for extracting the LFR data from CityWorks is Crystal Reports XI for ESRI. The STDM Quality Control Coordinator has access to this program and will review the data to ensure accuracy in reporting. In addition, Public Works staff as part of the annual review of LFR strategic business plan measures and reporting will re-evaluate the measure details and identify any logic or errors that may be caused during reporting. This review and re-evaluation will be completed by December 31, 2014.

Recommendation 9

Public Works management should work with staff to reduce data entry errors related to work order dates within the CityWorks system. In addition, staff should meet with the Information

Technology Department to develop data entry mask rules that will prevent: (1) the work start date from preceding the date the work order was initiated and (2) the work completed date from preceding the work start date or the work order initiation date. These errors could be influencing problems with the Crystal Report query discussed under Recommendation 8.

Management Response 9

Management agrees with the recommendation. Staff was advised by the Information Technology Department in September 2012, that a change to the software was not possible and data entry mask rules could not be implemented. However, additional investigation will be completed to address records with errors. Based on the amount of work orders that would have to be back loaded, it is not advantageous at this time to make all historical corrections due to the volume of work orders already completed. Public Works will coordinate with the Information Technology Department to reduce any errors identified in the system and to avoid future data entry errors by December 31, 2014.

Recommendation 10

Public Works management should work with the Information Technology Department and Street Program staff to mark duplicate, incorrect, or cancelled work orders in the CityWorks system in a way that distinguishes them from completed or closed work orders. These errors could be influencing problems with the Crystal Report query discussed under Recommendation 8.

Management Response 10

Management agrees with the recommendation. A procedure is currently in place for closing duplicate work orders. The custom field that identifies the work order by number on the duplicate is entered as a "0", and there would be also zero cost associated with the work order. Also since there would be a "0" in this field, the duplicate work order would not be counted. As an extra precaution, the LFR Crystal Report query was updated on June 25, 2014 to exclude work orders with zero cost. The Quality Control Coordinator has tested the procedure, but due to the volume of work, it is not practical at this time to make historical edits. Future work orders will be checked and will be eliminated as they are identified.

Identification of Service Gaps and Strategic Results

The Public Works Department strategic business plan uses citizen satisfaction as the **strategic result** measure of success in addressing street condition. Although survey results are quantifiable and citizen satisfaction with street conditions is critical, ratings of satisfaction from citizens are subjective and do not provide an objective measure of the effectiveness of departmental efforts to improve the City's pavement network.

In addition, the department has no measures within the current strategic business plan to identify service and performance gaps related to street condition and pavement preservation. Reporting the percentage of total lane miles in the street network that have a PCI value above a critical threshold provides a clearer picture of the overall condition of streets than reporting an average PCI, since averages can be skewed by extremely high or low numbers. In addition, reporting the total number of lane miles requiring major maintenance that are unfunded and/or the dollar amount of unfunded major repair needs would allow the department to quantify funding shortfalls to facilitate long-term planning and identify service gaps.

Recommendation 11

Public Works management should use the percentage of total lane miles above critical PCI as an objective **strategic result** measure for departmental efforts to address the issue of ‘condition of streets’ outlined in the department’s strategic business plan. See Recommendation 13 for a discussion of arterial versus residential street condition reporting.

Management Response 11

Management agrees with the recommendation. Data for the measurement is readily available within the Pavement Management System. Public Works will work with the Office of Management and Budget to add this measure as part of the next Strategic Business Plan update by March 31, 2015.

Recommendation 12

Public Works management should establish an LFR measure for unfunded repair needs using the number of lane miles and/or the related dollar amount required for arterial streets below critical PCI. This would provide a means to identify and communicate gaps in funding required to address the ‘condition of streets’ issue outlined in the department’s strategic business plan. See Recommendation 13 for a discussion of arterial versus residential street condition reporting.

Management Response 12

Management agrees with the recommendation. Data for the number of arterial street lane miles below critical PCI is currently available. The cost to improve those lane miles is available and will be revised periodically based on changes in material pricing and bids received by the City on projects. The Public Works Department will work with the Office of Management and Budget to incorporate the new measures into the Strategic Business Plan by March 31, 2015.

Performance Measures for Arterial Streets

The department has two program measures ‘Average PCI of City streets’ and ‘% of citizens satisfied with the condition of City streets’ that are reported as an average of residential and arterial streets. We analyzed expenditures for capital projects and preventive maintenance segregated by arterial and residential street classification.

In terms of capital street projects for resurfacing and reconstruction, arterial streets account for 87.2% of expenditures from July 1, 2007 through June 30, 2013 (see Figure 5). In addition, there is less emphasis on maintaining complete and up-to-date PCI ratings for residential streets. We found that 9.6% of residential street lane miles in the pavement inventory have a PCI older than January of 2010, and the pavement inventory shows that an additional 2.4% of the residential street lane miles have never been rated for PCI as of April 23, 2013.

Residential preventive street maintenance is limited to crack sealing. Crack sealing of residential streets accounts for 3% of the street maintenance expenditures from July 1, 2010 through March 31, 2013. In contrast, micro-resurfacing, chip sealing, and crack sealing of arterial streets compromised the remaining 97% of the \$6.8 million expended on preventive maintenance activities during the period.

Citizens also prioritize the condition of major arterial streets over residential streets (see Figure 2). Between 2005 and 2013, citizens ranked maintenance of major arterial streets as their first priority for focus and arterials were prioritized significantly ahead of residential street maintenance each survey year.

Recommendation 13

Public Works management should create separate arterial and residential measures for street condition and citizen satisfaction based on formal definitions of the road classifications (see Recommendation 4). This will better represent the focus of departmental efforts and citizen priorities. See recommendations 11 and 12 regarding street condition measures.

Management Response 13

Management disagrees with the unrated street methodology, but agrees with the recommendation for the remaining items. In the analysis performed in August 2014, 0.9% of all streets had not been rated. Of the 0.9%, a PCI rating would only be available for approximately 0.4% due to some streets being closed and other streets being mistaken for driveways or private streets. Overall, PCI ratings do not exist for approximately 134 out of 19,000 paving segments. Many of these are in new neighborhoods that Field Services has not yet inspected, or they are very small segments (less than 500 feet), that do not represent the condition of the overall road. The 134 segments have been noted and will be provided to Field Services to be completed in the next inspection cycle. In addition, the pavement inspection application has been changed to highlight the oldest inspections, alerting Field Services inspectors where they should inspect first.

The Public Works Department will work with the Office of Management and Budget to add the new measures to the Strategic Business Plan. The measures will be updated annually, but no later than March 31, 2015.

Misleading Performance Measure Name

We were unable to recreate the reported values for the result measure ‘% of pothole repairs completed in three 3 days’. Subsequent analysis determined that the department is not reporting the number of individual pothole repairs for this measure, but rather the values represent the number of pothole **work orders** completed in 3 days. We found that work orders initiated from July 1, 2010 through March 31, 2013 represented a broad range, from a single pothole repair per work order to another work order covering 1,328 individual pothole repairs. These discrepancies result in an ill-defined measure that may result in misleading reporting regarding the timeliness of pothole repairs.

Recommendation 14

Public Works management should update the measure name for ‘% of pothole repairs completed in 3 days’ to reflect the actual data reported. If the measure will continue to be based on work order completion, the department should establish a reasonable range for the number of potholes included on each work order to prevent large variances from unreasonably skewing performance measurement.

Management Response 14

Management agrees with the recommendation. The measure name was updated in June 2014 following a review with the Office of Management and Budget. The measure now reflects the actual data being reported.

Street Maintenance/Streets Program

We reviewed the operations of Streets Program activities related to pavement management and maintenance activities to prolong the useful life of City streets.

Chip Seal Work Order Types

During the course of our analysis, we found that chip sealing is divided into two main types: chip seal overlays and full-depth chip sealing. A chip seal overlay involves the application of a single layer of asphalt binder and aggregate to a prepared road surface²⁴. In contrast, full-depth chip sealing involves removal of the existing road surface and repair of the base layer prior to the application of two layers of asphalt binder and aggregate.

Work order types in the CityWorks system do not distinguish between these types of work, despite significant differences in cost and the amount of work required. Currently, the only way to determine whether the work performed was a simple overlay or a full-depth chip seal is a detailed analysis of the work order materials list. This lack of distinction prevents staff from querying the work order system to update the last maintenance field in the street inventory.

²⁴ International Slurry Seal Association (2012). *Recommended Performance Guideline for Chip Seal*, Report A165.

Recommendation 15

Public Works management should work with the Information Technology Department and Street Program staff to develop work order types that distinguish between full-depth chip seal projects and chip seal overlay projects due to the significant cost/work required differences, and to provide management more flexibility in reporting, monitoring productivity, and updating maintenance entries in the street inventory.

Management Response 15

Management agrees with the recommendation. Changes have already been made and the use of the revised work order types became effective on July 1, 2014.

Vehicle Maintenance

Pavement maintenance activities including chip sealing and micro-resurfacing have a limited work season due to industry standards regarding the proper ambient temperature and precipitation level required for project success. The Streets Program has one micro-resurfacing machine and limited back-up machines for critical chip sealing equipment. The department does not have a Service Level Agreement with the General Services Department to coordinate and prioritize maintenance on these critical machines and related support vehicles during the work season (April to September).

Significant time delays for routine vehicle maintenance during the work season may prevent performance of these important street maintenance activities at targeted levels. For example, we found 104 work orders for **routine preventive maintenance** on critical vehicles during the work season with an average of 9.75 days of vehicle down time per work order during the period of July 1, 2010 to March 31, 2013.

Recommendation 16

Public Works management should work with the General Services Department to prioritize and coordinate in and out-of-season work on critical Streets Program machines and support vehicles to better position staff to meet performance targets related to street maintenance activities.

Management Response 16

Management agrees with the recommendation. The Streets, Traffic and Drainage Maintenance Division has a long term commitment from the General Services Department regarding equipment maintenance priorities for Public Works equipment. Public Works staff will work with General Services to develop an interdepartmental memorandum of understanding regarding equipment maintenance priorities and schedules by March 31, 2015.

Maintenance Activity LFR Targets and Project Lists

Currently, the annual lists for micro-resurfacing and chip sealing projects are developed based on the LFR targets for each activity. From July 1, 2010 to March 31, 2013, productivity in micro-resurfacing did not reach the annual target of 100 lane miles; and productivity in chip sealing only reached the annual target of 40 lane miles in one of the reporting periods (see Table 2).

Table 2. Leading for Results Performance Reporting Versus Targets – Streets Program

Measure Name	FY 10/11	FY 11/12	FY 12/13	Target FY 12/13
# of lane miles micro-resurfaced	67	81	61	100
# of lane miles chip sealed	26	55	28	40

LFR measure performance and the associated measure targets are intended to provide information to management, direct decision making, and establish goals. According to the LFR methodology, targets should be reasonable, achievable goals that aid management in determining service delivery trends and future budgetary needs²⁵.

Recommendation 17

Public Works management should review the annual LFR targets for micro-resurfacing and chip sealing to ensure annual targets are reasonable given current operating capacity. In addition, the department should consider separate measures/targets for chip seal overlays and full-depth chip seal projects given the significant variance in time and expenditures discussed in Recommendation 14

Management Response 17

Management agrees with the recommendation. The target for micro-resurfacing has been revised from 100 lane miles to 80 lane miles beginning in FY 2015. The Public Works Department will work with the Office of Management and Budget to add new annual targets and measures for chip seal overlay and full-depth chip seal to the Strategic Business Plan by March 31, 2015.

Maintenance Project Lists

We noted that the lists for micro-resurfacing and chip sealing projects are not maintained on a perpetual running list that carries over from year-to-year. Given that the list is developed from LFR targets and these targets are not met (see Recommendation 17), multiple projects during a given year are not completed. During analysis of project lists for the 2010 to 2013 calendar year

²⁵ Leading for Results Facilitator Training Materials

work seasons, we found 2 micro-resurfacing projects and 13 chip seal projects that were not completed and did not carry over to the following year's list.

In addition, we noted that no personnel are assigned to verify the PCI of a roadway prior to micro-resurfacing. Micro-resurfacing is only effective on a roadway in good condition with a PCI rating of 71 - 85²⁶. Allowing for a PCI between 66 and 91, we found 41.6% of the 214.4 total lane miles micro-resurfaced between July 1, 2010 and March 31, 2013 had an inventory PCI value outside the recommended range, and we found an additional 2.8% of micro-resurfaced lane miles that had no PCI value recorded in the pavement inventory.

Recommendation 18

Public Works management should maintain perpetual running lists for micro-resurfacing and chip sealing projects; and a staff member within the Streets Program should be assigned to document that the current PCI of the roadway falls within departmental standards and industry guidelines prior to performing micro-resurfacing work.

Management Response 18

Management agrees with the recommendation. The Streets, Traffic and Drainage Maintenance Division maintains a list for both micro-resurfaced and chip seal projects. Projects that are scheduled, but not completed during a construction season are carried over to the next season. Both lists are reviewed by the Public Works Director prior to the commencement of work. The Public Works Department will complete a review of the PCI rating for those streets identified for micro-resurfacing prior to beginning with the review prior to the beginning of the 2015 construction season and in successive years.

Accounting for Material Expenses

During our analysis of expenditures in the Streets Program from July 1, 2010 to June 30, 2013, we found \$230,000 of material expenses related to micro-resurfacing that were not coded to the appropriate account code in PeopleSoft. In addition, the department did not segregate \$832,000 of expenses for materials used in joint county resurfacing projects from those used by City crews. Inaccurately recording and/or inadequately segregating expenses could impact budgetary planning and tracking of operating costs.

Recommendation 19

Appropriate expense codes should be used when purchasing street maintenance materials. In addition, expense codes should be created to record material purchases for joint City-County projects separate from materials used by City crews.

²⁶ Per Departmental standards and the National Center for Asphalt Technology.

Management Response 19

Management agrees with the recommendation. The current list of accounts contains separate accounting codes for micro-resurfacing materials (53040047) and chip seal materials (53040048). The Streets, Traffic and Drainage Maintenance Division will immediately begin using these accounts for future purchases.

Joint City-County agreements are developed by the Engineering Division and approved by the City Council. Public Works will work with the Accounting Services Division to add an account code that can be used for these types of agreements. The new account code will be used on all future agreements beginning in January 2015.

Entry of Daily Work Orders

Within the Streets Program, work crews submit daily work reports that are entered into the CityWorks system. If corrections are needed or missing information is noted on the daily report, staff may enter the partially correct information and then return the original report to the crew supervisor for correction. No system is in place to document what portions of the information were entered into CityWorks, track what information was required that necessitated the return, or verify that the original daily report was returned for entry completion. This creates opportunities for duplicate entry and lost documents. In a sampling of seven chip seal and six micro-resurfacing work orders from the period of July 1, 2010 to June 30, 2013, we found 85 data entry errors and/or duplicate entries related to recording of the completed daily work reports.

Recommendation 20

Public Works management should develop a system that retains the original daily work report in the Streets Program office with a notation on the information needed and return a copy of the report to the supervisors for correction. In addition, staff should use a ‘tickler’ file or other tracking mechanism to verify that copies sent out for corrections or additional information are returned timely and are entered into the CityWorks system.

Management Response 20

Management agrees with the recommendation. Work orders containing errors will be returned to the appropriate Unit Operations Supervisor for correction. In addition, since the work orders issued to crews are in paper format, a quality control system will be developed to ensure the correction is made in the event the paper copy is not returned. This will allow the Unit Operations Supervisor to audit and identify reoccurring issues with work orders and address them with the appropriate Field Operations Supervisor beginning January 1, 2015.

Other Issues

During the course of our audit fieldwork, we identified other pavement management policy and procedural issues.

Quality Control and Contract Administration

Inter-local agreements governing joint street projects with counties and other municipalities specify that projects, where 100% of labor is performed by these entities, must be inspected by City staff within 5 days of completion. Searching the files for 32 projects specific to inter-local work that were completed between July 1, 2010 and June 30, 2013, we found no inspection reports. In addition, departmental staff responsible for inspecting street projects stated that they do not inspect inter-local work.

Recommendation 21

Street projects being completed under an inter-local agreement should be inspected by City staff as outlined in the terms of the agreement. In addition, inspection records should be maintained in the archived project files with other project-related information.

Management Response 21

Management agrees with the recommendation. Effective immediately, Public Works Field Services will inspect all City-County agreement locations and material tickets prior to making final payment of the claim to the County.

Citizen Complaints and Inquiries

Citizen contacts, complaints, and inquiries related to street condition are maintained in Microsoft Outlook task streams. The current system cannot be searched with ease due to duplicate, non-linked task streams for the same location and non-standardized naming conventions. An analysis of these email task streams for calendar year 2011, 2012, and 2013 found that the current tracking system results in multiple email streams and requires staff response to multiple, overlapping email threads related to the same location. In addition, there is no accurate way for management to track the number of complaints on a specific location for use in project selection or develop a broad overview of the complaint/inquiry response timeliness.

Recommendation 22

Public Works management should develop a searchable system to track citizen complaints and inquiries concerning street conditions. The department could modify the current system being used for drainage complaints or work with the Action Center to use the existing Accela system.

Management Response 22

Management agrees with the recommendation. Public Works currently tracks citizen complaints and City Council requests using the public folders in Microsoft Outlook. However, the use of public folders will not be supported in the next upgrade of Outlook, requiring a new solution for tracking all citizen complaints.

Public Works receives complaints, from several different sources. Complaints are received from citizens, Council Support, the Mayor's Office, and City Manager's Office. Often times the same complaint is received from each office which contributes to the volume and the Public Works Department's ability to effectively manage the complaints. A new solution which will create a document library in Microsoft SharePoint that will accept these requests is being developed. Once completed Public Works staff will advise City Council support, the Mayor's Office, and City Manager's Office to forward complaint based email messages to the new SharePoint library. The new complaint-tracking solution will begin no later than January 1, 2015.

Collection of Average Daily Traffic Counts

The Traffic Data Collection Program is responsible for collecting average daily traffic (ADT) counts. These values are used by departmental management as one of the criteria to prioritize street projects and maintenance. The majority of municipalities utilize short-term data collection using the 'coverage count' method to take readings every two to three years. Using this method, readings are taken in the same location, collection occurs over a two-week period, and at the same time of year for each subsequent measurement²⁷. This provides ADT counts that are comparable between locations and years.

Traffic Data Collection Program management receives a list of locations each year from the Association of Central Oklahoma Governments for traffic counts and may receive specific count requests from management or members of the City Council. We found that the department does not have standardized procedures or written policies that outline the location of the collection device, the number of days the device is left in place, or the time of year when counts are collected. The ADT counts reported in the street inventory are non-standardized and may not be comparable between locations and/or years.

Recommendation 23

Public Works management should develop a policy/procedure manual to standardize collection of ADT counts.

²⁷ FHWA Traffic Monitoring Guide

Management Response 23

Management agrees with the recommendation. However, the Traffic Management Division is neither equipped nor staffed to gather traffic data in the manner described in the recommendation. With a staff of two (2) full-time personnel and an inventory of 75 road-tube type traffic counters, it is not possible to gather traffic data over a two week period for the more than 800 requested traffic counts. ACOG typically does not provide the City with the list of locations to be counted until August of each year, with the due date for all counts being June the following year. In 2014, the traffic count location list was not received until September, which provided additional challenges to City staff.

The Traffic Management Division will develop a data collection standard and operating policy and procedure by December 31, 2014.

Expenditure Approvals

According to the Municipal Code, expenditures in excess of \$25,000 require City Council approval. During the course of our audit, we found that departmental staff became aware of a failure to secure City Council expenditure approval for a 2005 joint county street project estimated at \$80,000. In 2006, the purchase order amount was increased to \$148,361 without City Council approval. Upon discovery of the oversight in 2010, staff did not secure retroactive approval and went on to pay an invoice totaling \$1,641. The total cost of the project paid without securing City Council approval was \$150,002.

Recommendation 24

Municipal Code requirements regarding City Council expenditure approvals on street projects should be followed.

Management Response 24

Management agrees with the recommendation.

Appendix A – Management's Responses

(See Next Page)



MEMORANDUM

The City of
OKLAHOMA CITY

TO: Jim Williamson
City Auditor

THROUGH: James D. Couch *JDC*
City Manager

FROM: Eric J. Wenger, P.E., Director *EW*
Public Works / City Engineer

DATE: November 12, 2014

SUBJECT: Audit 13-02 – Public Works Department – Pavement Management System



Included below are Management's response to the comments and recommendations in the Pavement Management System Audit report. The Public Works Department appreciates the review and recommendations, and many areas were identified that can be enhanced and improved. As it relates to citizens satisfaction ratings, Public Works feels that Oklahoma City would be ranked higher if the comparison was limited to cities with a similar number of lane miles and land area instead of population. With more than 620 square miles of area and more than 8,000 lane miles of streets, Oklahoma City faces many challenges not experienced by other cities. Regardless of Public Works agrees that street condition is the top priority, but a comparison using population rather than lane miles and land area would be more meaningful.

Recommendation 1

Management agrees with the recommendation. The need for an employee to lead a Pavement Management Program to coordinate the different departmental programs affecting the quality of city streets is needed. Currently, the Civil Engineer IV in the Paving and Resurfacing Section is responsible for numerous activities including management of the street resurfacing program which includes GO Bond resurfacing, fund-balance resurfacing and coordination of City-County agreements. As part of the FY 2015-16 budget process, a thorough evaluation of the organization and staffing levels in the Engineering Division will be completed. Following this evaluation, Public Works will request an additional position to focus on the Pavement Management Program. If a new position is approved in the FY 2015-16 budget, this recommendation will be completed by September 30, 2015.

Recommendation 2

Management agrees with the recommendation. In order to run scenario analysis and modeling of future street conditions for the entire City of Oklahoma City street inventory, additional staff and computer aided software will be required. The Public Works Department is prepared to evaluate different pavement management software systems, including MicroPaver. Staff will be responsible for data entry of all maintenance and date constructed

information into the paving management software. The next contract for automated street inspection during FY 2015 will include submission of the paving condition database as a deliverable. Funding for the procurement of a pavement management software, additional staff and staff training will be requested in the FY 2015-16 operating budget.

Recommendation 3

Management agrees with the recommendation. Written guidelines and standardized criteria for street project selection will be developed by Public Works Engineering staff. Projects included in the 2007 Bond Program must be completed in accordance with the bond proposition language. This may or may not coincide with the pavement treatment recommendations based on the current PCI rating. The guidelines and criteria document will be completed by March 30, 2015.

Recommendation 4

Management agrees with recommendation. However, the Public Works Department does not manage street classifications. Street classifications are provided by the Development Services Department and the Functional Classification Plan was completed by the Planning Department. The Public Works Department will review the 22 street classifications currently being utilized in the GIS system, and staff will work reduce the total number of classifications that are required for the the successful management of the pavement management program. These changes will be completed upon the procurement of the pavement management software, but not later than September 30, 2015.

Recommendation 5

Management disagrees with the recommendation. Public Works discussed this recommendation with the Information Technology Department and there are technical challenges in implementing the request. The pavement layer of the GIS System is generally broken into the longest segment possible, up to 1 mile. The streets layer is broken at every intersection. If the data was formatted in this way, the same Facility ID cannot be assigned to both the pavement segment and the street segment. A non-CityWorks related ID could be established, but this would require a major restructuring of the GIS streets layer, which would affect CityWorks, 911CAD, and other systems.

The Public Works Department will further evaluate a method to better organize the GIS data in a way that provides for reduced errors, and provides better coordination of the various projects completed. Following the identification of the new method, changes will be completed by March 31, 2015.

Recommendation 6

Management both agrees and disagrees with the recommendation. The Public Works Department is not responsible for naming of streets. Street names are developed by the Development Services Department and the data is entered into the GIS system by the Information Technology Department which includes street name designators (Drive, Avenue, Boulevard, etc.). However, the Public Works Department is prepared to ensure the street directional indicators (north, south, east and west) are accurate in the GIS pavement layer. These same naming conventions will also be utilized in the pavement management software, once selected, and the corrections/changes will be made no later than September 30, 2015.

Recommendation 7

Management agrees with the recommendation. The responsibility for data verification is already assigned to the Public Works GIS Analyst. Public Works will work with the Information Technology Department to develop reports that will be used to run quality control checks on the GIS pavement layer. The quality control reports will be completed by March 30, 2015.

Recommendation 8

Management agrees with the recommendation. The Streets, Traffic and Drainage Maintenance Division (STDM) met with the Office of Management and Budget in June 2014 and reviewed each measure in the Leading for Results (LFR) database. The database program for extracting the LFR data from Cityworks is Crystal Reports XI for ESRI. The STDM Quality Control Coordinator has access to this program and will review the data to ensure accuracy in reporting. In addition, Public Works staff as part of the annual review of LFR strategic business plan measures and reporting will re-evaluate the measure details and identify and logic or errors that may be caused during reporting. This review and re-evaluation will be completed by December 31, 2014.

Recommendation 9

Management agrees with the recommendation. Staff was advised by the Informational Technology Department in September 2012, that a change to the software was not possible and data entry mask rules could not be implemented. However, additional investigation will be completed to address records with errors. Based on the amount of work orders that would have to be back loaded, it is not advantageous at this time to make all historical corrections due to the volume of work orders already completed. Public Works will coordinate with the Information Technology Department to reduce any errors identified in the system and to avoid future data entry errors by December 31, 2014.

Recommendation 10

Management agrees with the recommendation. A procedure is currently in place for closing duplicate work orders. The custom field that identifies the work order by number on the duplicate is entered as a "0", and there would be also zero cost associated with the work order. Also since there would be a "0" in this field, the duplicate work order would not be counted. As an extra precaution, the LFR Crystal Report query was updated on June 25, 2014 to exclude work orders with zero cost. The Quality Control Coordinator has tested the procedure, but due to the volume of work, it is not practical at this time to make historical edits. Future work orders will be checked and will be eliminated as they are identified.

Recommendation 11

Management agrees with the recommendation. Data for the measurement is readily available within the Pavement Management System. Public Works will work with the Office of Management and Budget to add this measure as part of the next Strategic Business Plan update by March 31, 2015.

Recommendation 12

Management agrees with the recommendation. Data for the number of arterial street lane miles below critical PCI is currently available. The cost to improve those lane miles is

available and will be revised periodically based on changes in material pricing and bids received by the City on projects. The Public Works Department will work with the Office of Management and Budget to incorporate the new measures into the Strategic Business Plan by March 31, 2015.

Recommendation 13

Management disagrees with the unrated street methodology, but agrees with the recommendation for the remaining items. In the analysis performed in August 2014, 0.9% of all streets had not been rated. Of the 0.9%, a PCI rating would only be available for approximately 0.4% due to some streets being closed and other streets being mistaken for driveways or private streets. Overall, PCI ratings do not exist for approximately 134 out of 19,000 paving segments. Many of these are in new neighborhoods that Field Services has not yet inspected, or they are very small segments (less than 500 feet), that do not represent the condition of the overall road. The 134 segments have been noted and will be provided to Field Services to be completed in the next inspection cycle. In addition, the pavement inspection application has been changed to highlight the oldest inspections, alerting Field Services inspectors where they should inspect first.

The Public Works Department will work with the Office of Management and Budget to add the new measures to the Strategic Business Plan. The measures will be updated annually, but no later than March 31, 2015.

Recommendation 14

Management agrees with the recommendation. The measure name was updated in June 2014 following a review with the Office of Management and Budget. The measure now reflects the actual data being reported.

Recommendation 15

Management agrees with the recommendation. Changes have already been made and the use of the revised work order types became effective on July 1, 2014.

Recommendation 16

Management agrees with the recommendation. The Streets, Traffic and Drainage Maintenance Division has a long term commitment from the General Services Department regarding equipment maintenance priorities for Public Works equipment. Public Works staff will work with General Services to develop an interdepartmental memorandum of understanding regarding equipment maintenance priorities and schedules by March 31, 2015.

Recommendation 17

Management agrees with the recommendation. The target for micro-resurfacing has been revised from 100 lane miles to 80 lane miles beginning in FY 2015. The Public Works Department will work with the Office of Management and Budget to add new annual targets and measures for chip seal overlay and full-depth chip seal to the Strategic Business Plan by March 31, 2015.

Recommendation 18

Management agrees with the recommendation. The Streets, Traffic and Drainage Maintenance Division maintains a list for both micro-resurfaced and chip seal projects. Projects that are scheduled, but not completed during a construction season are carried over to the next season. Both lists are reviewed by the Public Works Director prior to the commencement of work. The Public Works Department will complete a review of the PCI rating for those streets identified for micro-resurfacing prior to beginning with the review prior to the beginning of the 2015 construction season and in successive years.

Recommendation 19

Management agrees with the recommendation. The current list of accounts contains separate accounting codes for micro-resurfacing materials (53040047) and chip seal materials (53040048). The Streets, Traffic and Drainage Maintenance Division will immediately begin using these accounts for future purchases.

Joint City-County agreements are developed by the Engineering Division and approved by the City Council. Public Works will work with the Accounting Services Division to add an account code that can be used for these types of agreements. The new account code will be used on all future agreements beginning in January 2015.

Recommendation 20

Management agrees with the recommendation. Work orders containing errors will be returned to the appropriate Unit Operations Supervisor for correction. In addition, since the work orders issued to crews are in paper format, a quality control system will be developed to ensure the correction is made in the event the paper copy is not returned. This will allow the Unit Operations Supervisor to audit and identify reoccurring issues with work orders and address them with the appropriate Field Operations Supervisor beginning January 1, 2015.

Recommendation 21

Management agrees with the recommendation. Effective immediately, Public Works Field Services will inspect all City-County agreement locations and material tickets prior to making final payment of the claim to the County.

Recommendation 22

Management agrees with the recommendation. Public Works currently tracks citizen complaints and City Council requests using the public folders in Microsoft Outlook. However, the use of public folders will not be supported in the next upgrade of Outlook, requiring a new solution for tracking all citizen complaints.

Public Works receives complaints, from several different sources. Complaints are received from citizens, Council Support, the Mayor's Office, and City Manager's Office. Often times the same complaint is received from each office which contributes to the volume and the Public Works Department's ability to effectively manage the complaints. A new solution which will create a document library in Microsoft SharePoint that will accept these requests is being developed. Once completed Public Works staff will advise City Council support, the Mayor's Office, and City Manager's Office to forward complaint based email messages to the

new SharePoint library. The new complaint-tracking solution will begin no later than January 1, 2015.

Recommendation 23

Management agrees with the recommendation. However, the Traffic Management Division is neither equipped nor staffed to gather traffic data in the manner described in the recommendation. With a staff of two (2) full-time personnel and an inventory of 75 road-tube type traffic counters, it is not possible to gather traffic data over a two week period for the more than 800 requested traffic counts. ACOG typically does not provide the City with the list of locations to be counted until August of each year, with the due date for all counts being June the following year. In 2014, the traffic count location list was not received until September, which provided additional challenges to City staff.

The Traffic Management Division will develop a data collection standard and operating policy and procedure by December 31, 2014.

Recommendation 24

Management agrees with the recommendation.

Should you require an electronic copy of the responses please contact Assistant Public Works Director Paul Bronson at 297-2123.

Appendix B – ASTM Pavement Condition Index (PCI) Rating Scale

Rating	PCI Score	Description
Good	100-85	Pavements are newly constructed or resurfaced and have few, if any, signs of distress
Satisfactory	84-70	Pavements require mostly preventive maintenance and have only low levels of distress, such as minor cracks or spalling, which occur when the top layer of asphalt begins to peel or flake off because of water permeation
Fair	69-55	Pavements at the low end of this range have significant levels of distress and may require a combination of rehabilitation and preventive maintenance to keep them from deteriorating rapidly
Poor	54-41	Pavement has deteriorated and requires immediate attention, including rehabilitative work. Ride quality is significantly inferior to better pavement categories
Very Poor	40-26	Pavements have extensive amounts of distress and require major rehabilitation or reconstruction. Significant impacts to the speed and flow of traffic
Serious	25-11	Pavements need reconstruction and are extremely rough and difficult to drive
Failed	10-0	

Adapted from ASTM D6433-07 – Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.

Appendix C – Treatment Impacts on Pavement Useful Life

Treatment	Estimated Pavement Life Extension, Years
Crack Filling	2 to 6
Fog Seal *	1 to 4
Seal Coat *	3 to 6
Chip Seal	3 to 7
Double Chip Seal	7 to 10
Slurry Seal *	3 to 7
Micro-Resurfacing	3 to 9
Thin Hot-Mix Asphalt Overlay (1.5") **	5 to 10
Hot-Mix Asphalt Overlay (1.5"), after milling **	2 to 12

* Treatment not currently used by the City of Oklahoma City

** The City of Oklahoma City currently uses an average 2" asphalt overlay

Sources:

Minnesota Technology Transfer Center (2000), *Best Practices Handbook on Asphalt Pavement Maintenance*.
 Hicks, et al., (2000), *Selecting a Preventive Maintenance Treatment for Flexible Pavements*, FHWA-IF-00-027.
 Galehouse, et al., (2005) *Preventive Maintenance Treatment Performance at 14 Years*.
 Galehouse, (2003). "Strategic Planning for Pavement Preventive Maintenance" in *Pavement Preservation Compendium*.
 Perkins, et al., (2004). *Optimal Timing of Preventive Maintenance Treatment Applications*, National Cooperative Highway Research Program Report 523.

Appendix D – Comparison of Functional Classification Plan with GIS Street Inventory

GIS Master Street Inventory	Functional Class Plan	Description from Functional Class Plan
Alley		
Closed		
Collector	Collector	Moderate to low ADT levels, penetrate neighborhoods to circulate traffic between larger streets and local neighborhood streets, can be in commercial or industrial areas
Emergency Access		
Expressway	Expressways	Fully divided regional traffic generator with a high ADT level and partial access to abutting areas
Freeway	Highways	No access to abutting areas, divided with continuous regional access
Future		
Industrial		
Local	Local	Low ADT levels, only in neighborhoods, not designed to carry high traffic volumes or accommodate thru traffic or industrial type transports (i.e. semis, large cargo vans, etc.)
Local Collector		
Major Arterial	Major Arterial	Moderate to high ADT levels, do not penetrate neighborhoods, emphasis on mobility and traffic distribution
Major Collector		
Median		
Minor Arterial	Minor Arterial	Moderate ADT levels, augments the major network, do not penetrate neighborhoods but offer more access to abutting areas than a major arterial
Outside City Limits		
Private		
Proposed		
Ramp		
Rural Arterial	Rural Arterial	Serves non-urban areas with moderate to high ADT levels, do not penetrate neighborhoods, may also be a state highway
Scenic Route	Scenic Route	Only for access to recreational areas. Do not carry high traffic volumes or commercial traffic.
Vacated		
Virtual		

Source: OCA compilation of information in the Arc-GIS system and the 2008 Functional Class Plan

Appendix E – Detail of Missing Data in Street Inventory (Pavement Layer GIS)

Of the 13,712 street segment records in the inventory provided by the department, our audit revealed the following related to missing data:

- Street Name Field – Two records with no entry
- Beginning Description Field – 34 records with no entry
- End Description Field – 43 records with no entry
- Surface Type Field – Four records with no entry
- PCI Date Field – 71 records with no entry
- Number of Lanes Field – 254 records with no entry
- Lane Miles – 254 records with no entry