

## **STREET PAVING:**

More proactive maintenance could preserve additional city streets within existing funding

A REPORT FROM THE CITY AUDITOR  
July 2006



Office of the City Auditor  
Portland, Oregon

Association of Local Government Auditors'  
2006 Silver Knighton Award Winner for Best Audit





CITY OF  
**PORTLAND, OREGON**

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July 24, 2006

TO: Tom Potter, Mayor  
Sam Adams, Commissioner  
Randy Leonard, Commissioner  
Dan Saltzman, Commissioner  
Erik Sten, Commissioner  
Susan Keil, Director, Portland Office of Transportation

SUBJECT: *Audit – Street Paving: More proactive maintenance could preserve additional city streets within existing funding, Report #324B*

Attached is Report #324B containing the results of our second in a series of audits on Portland's street paving program. This report evaluates the funding of the street preservation program. The audit was included in our annual audit schedule and was conducted in accordance with generally accepted government auditing standards.

As a follow-up to our recommendations, we ask that the Director of the Office of Transportation prepare a status report in one year, detailing steps taken to address the report's recommendations. This status report should be submitted to the Audit Services Division and coordinated through the Commissioner in Charge of Transportation.

We appreciate the cooperation and assistance we received from personnel in the Portland Office of Transportation and the Bureau of Maintenance in conducting this audit.

  
GARY BLACKMER  
City Auditor

Audit Team: Drummond Kahn  
Doug Norman  
Beth Woodward

Attachment



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## STREET PAVING:

### More proactive maintenance could preserve additional city streets within existing funding

**Summary** The backlog of City streets needing repair has grown from 439 miles in 1991 to 597 miles in 2005 (+36 percent). The estimated cost to repair the backlog has more than doubled during this period, increasing to \$93 million in 2005, after adjusting for inflation. In addition, there has been some decline in the overall condition of City streets. In 1991, 62 percent of City streets were rated as “good” or “very good,” a statistic that dropped to 55 percent in 2005. During this 15-year period, the percentage of streets rated as “poor” or “very poor” rose from 14 to 22 percent.

Although the maintenance backlog is growing, our analysis indicates that, even after adjusting for inflation, the City’s Street Preservation expenditures have increased slightly over the past 10 years. In addition, our review of the Street Preservation Program’s work activities indicates the Program has not utilized its resources in the most cost-effective manner. While the Portland Office of Transportation’s (PDOT’s) Pavement Asset Management Plan has a stated purpose that includes “...delivering a street preservation program based on a preventive maintenance strategy,” we found that PDOT is not achieving this purpose. Instead, PDOT’s Street Preservation Program has concentrated its efforts on meeting production goals by repairing streets in poor condition, including short-term fixes of badly deteriorated streets. PDOT has done too little to incorporate proactive preventive maintenance techniques designed to prolong the life of streets in good condition. This reactive approach has resulted in PDOT spending more money to maintain fewer streets, and limits its ability to reduce the repair backlog and improve the overall condition of streets.

According to pavement management experts, the cost of street preservation increases significantly when streets are allowed to deteriorate as they have in the City of Portland. Experts we spoke with indicated that an effective strategy for planning and meeting street preservation needs is an approach called “Remaining Service Life”, or RSL. Instead of focusing solely on its repair backlog, under RSL, the City would proactively identify a combination of treatments it could apply to gain the most years of street life over the entire street system. Many more years of street life can be achieved by applying less costly preventive maintenance treatments such as chip seal, slurry seal, and thin overlays to many streets than can be gained by performing major repairs on a few badly deteriorated streets. A larger number of streets can be maintained with lower cost preventive maintenance than can be achieved by performing major repairs with the same budget.

PDOT also needs to improve its planning and tracking of work activities in a way that more accurately differentiates between preventive maintenance and rehabilitation/reconstruction work. Spending records we obtained from PDOT showed almost no expenditures on rehabilitation and reconstruction; however, we found that a significant portion of work classified as resurfacing by PDOT was actually rehabilitation. We also found that PDOT failed to track some important work activities, such as the number and cost of pothole repairs, which are needed to understand actual street conditions and evaluate maintenance activities. The lack of good tracking of work activities obscures the nature of work performed by PDOT crews and inhibits effective evaluation and planning by managers.

While PDOT could benefit from an influx of funds to address badly deteriorated streets and the need for more preventive maintenance, we believe it could achieve the greatest value for each dollar spent and lower the overall cost of ownership of roads by devoting a higher proportion of its resources to proactive, preventive maintenance work. Experts caution that it may take years for the cost effectiveness and condition of City streets to improve. Nevertheless, in order to reduce the City’s long-term costs and improve the condition of City streets, we recommend that PDOT:

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- Develop a rigorous preventive maintenance program to be applied to newly constructed and resurfaced streets, and other streets in good condition
  - Adopt the RSL approach to planning and budgeting its street preservation program
  - Establish better methods for categorizing and tracking street preservation work activities
  - Evaluate the need for creating a Pavement Engineer position

**Portland's street preservation program**

The City of Portland has \$5.8 billion worth of transportation infrastructure, according to the City's 2005 Asset Status and Condition Report. The largest segment is improved streets, valued at \$3.6 billion, nearly two-thirds of the total transportation infrastructure value. Maintenance and repair of the City's network of over 3,900 lane miles of arterial and local streets is the responsibility of the Street Preservation Program within PDOT's Bureau of Maintenance (BOM). Street

**PDOT paving crew applying a pavement overlay**



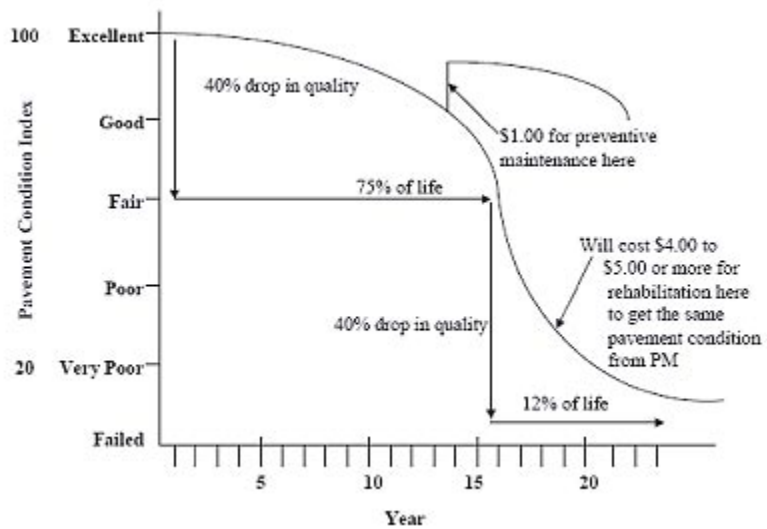
Source: Audit Services Division photo

Preservation is the largest of nine programs within BOM, with over 90 employees and a budget of \$15.2 million in FY 2005-06. Crews in the Street Preservation Program employ a variety of techniques – ranging from sealing cracks and patching holes to base repair and asphalt overlay – to help preserve the condition of City streets.

**Preserving pavement life**

Pavement preservation has been defined as "...a long-term strategy that enhances functional pavement performance using an integrated, cost-effective set of practices that extend pavement life..." (Transportation Research Board of the National Research Council, 2005). Industry experts indicate that the condition of pavement declines slowly at first, but as serious deterioration of pavement structure occurs, the rate of deterioration accelerates, as does the cost of restoring the pavement through rehabilitation or reconstruction. Figure 1 illustrates a typical pavement life cycle and treatments recommended at the various stages of declining street condition.

**Figure 1 Pavement condition life cycle and relative costs of various treatment types**



Source: U.S. Department of Transportation Federal Highway Administration, *Selecting a Preventive Maintenance Treatment for Flexible Pavements*, August 2000, FHWA-IF-00-027, Figure 1.2, page 2, "Typical Variation in Pavement Conditions as a Function of Time"



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**PDOT management systems and reports**

PDOT has adopted a number of management systems and reports recommended by industry experts. The Street Preservation Program values streets as assets and maintains a street inventory, assesses the condition of streets through visual inspection, and has developed methods for identifying and prioritizing streets needing treatment. The Program developed a computerized Pavement Management System in 1983 which it uses to identify and prioritize street repair needs. It has hired a consultant to help with the procurement of a new, upgraded Pavement Management System, and has targeted July 2008 for implementation of the new system.

PDOT has also developed a Pavement Asset Management Plan which reports trends in the value and condition of City streets, the backlog of repair needs, and citizen rating of street condition. The purpose of the plan is to “ensure that the condition of the street network is communicated to stakeholders in a meaningful way while delivering a street preservation program based on a preventive maintenance strategy.”

In addition, PDOT periodically issues The City of Portland Transportation System: Status and Condition Report, which defines the City’s transportation system, summarizes the condition of its component facilities, reports on key operational measures, and summarizes the repair and preservation needs of the system. The Status and Condition Report states, “The condition of the City’s transportation infrastructure has a direct bearing on the long-term financial condition of the Transportation Fund. The City’s asset management goal is to minimize total life cycle cost of asset ownership while maintaining the system in good operating condition.”

**Objectives, scope, and methodology**

Because of the City’s deteriorating street conditions and the growing backlog of streets needing repair, we undertook an analysis of historical Street Preservation funding and expenditures to determine if the Program has utilized its resources in an economic manner. We wanted to determine if the City’s pattern of spending on street preservation was reasonable and cost effective, compared to spending strategies recommended by pavement preservation experts.

We obtained detailed expenditure data from PDOT, including expenditures made on slurry seal, pothole repair and patching, resurfacing, rehabilitation, and reconstruction. We also obtained historical data on the inventory of streets, miles of streets treated, the street maintenance backlog, and the condition of streets. We attempted to obtain 15 years of historical data; however, because some information for earlier years was not readily available from PDOT, some of the charts presented in this report go back only 10 years. We interviewed Street Preservation staff responsible for developing the annual paving and slurry seal lists and identified the criteria used for selecting streets for preservation work. We also interviewed Street Preservation managers about funding, tracking of work activities, and related issues.

We interviewed street preservation experts, including representatives from the National Center for Pavement Preservation (NCPP), the U.S. Department of Transportation's Federal Highway Administration (FHWA), and the American Association of State Highway and Transportation Officials (AASHTO), to learn of options available for optimizing the use of limited street preservation dollars. We also reviewed professional literature, including *The ABCs of Pavement Preservation*; *Pavement Management Guide: Executive Summary Report*; *Rough Ride Ahead*; *Best Practices Handbook on Asphalt Pavement Maintenance*; *Local Agency Pavement Management Application Guide*; *Optimal Timing of Pavement Preventive Maintenance Treatment Applications*; *Pavement Management: A Guide for Local Officials*; *Transportation Asset Management in Australia, Canada, England, and New Zealand*; the *Pavement Preservation Toolbox* prepared by the Foundation for Pavement Preservation; and other materials.

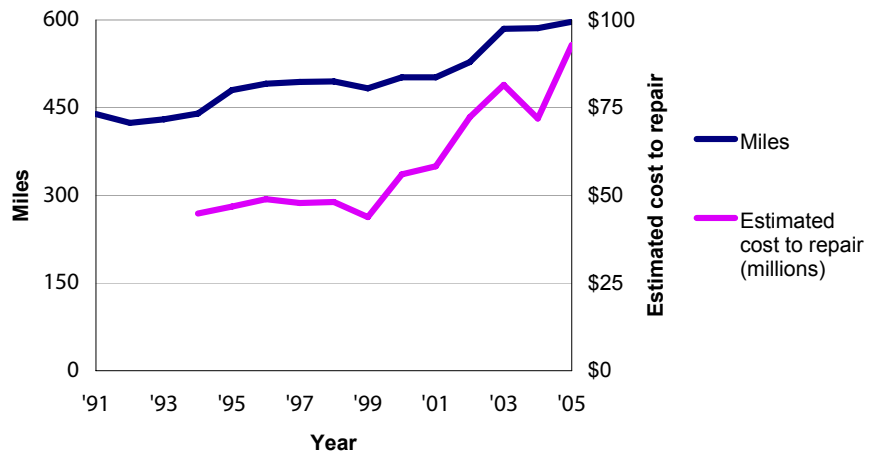
During our research we learned that terminology in the pavement preservation industry varies among jurisdictions and researchers. Because such inconsistencies affect the interpretation of studies of pavement preservation, the FHWA prepared a memorandum in September 2005 to clarify consensus definitions. Our use of preservation

terminology in this report (see Appendix A for a Glossary of Terms) is consistent with the FHWA guidelines, attached as Appendix B. We conducted our work in accordance with generally accepted government auditing standards.

**Rise in maintenance backlog and some decline in street condition**

The backlog of streets needing repair has grown significantly, from 439 miles in 1991 to 597 miles in 2005. After adjusting for inflation, the estimated cost to make all identified repairs in the backlog has more than doubled since 1994, growing from \$44.8 million to \$92.9 million. (See Figure 2.)

**Figure 2 Miles\* and value\*\* of Portland’s street maintenance backlog 1991 - 2005 (adjusted for inflation)**



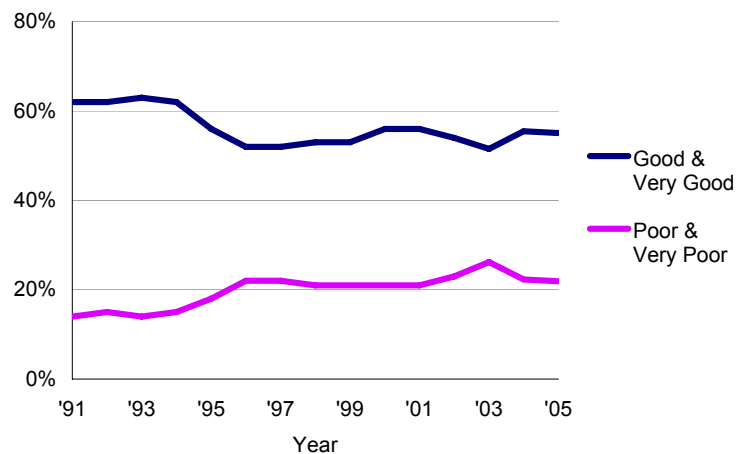
Source: PDOT Backlog Summary reports

\*28 feet equivalent miles

\*\*PDOT’s estimated cost to repair the entire backlog, adjusted to 2005 dollars using the Consumer Price Index for all urban consumers (CPI-U). PDOT managers told us that mandated stormwater regulations have contributed significantly to the growth in the value of the backlog because of their impact on costs related to street design and reconstruction.

Street Preservation personnel perform visual inspections to determine the condition of City streets and identify specific defects requiring treatment. As shown in Figure 3, the condition of City streets has declined over the past 15 years, although the condition has remained relatively static over the past 10 years. In 1991, 62 percent of City streets were rated as good or very good by Street Preservation personnel, compared to 55 percent in 2005. The percentage of streets rated as poor or very poor increased from 14 percent in 1991 to 22 percent in 2005. PDOT managers told us that many of the streets annexed from Multnomah County in the 1980s and 1990s were in poor condition. These annexations may have contributed to the rise in PDOT’s repair backlog as well as to the decline in the overall condition of City streets.

**Figure 3** Percent of streets in “good / very good” and “poor / very poor” condition, 1991 through 2005



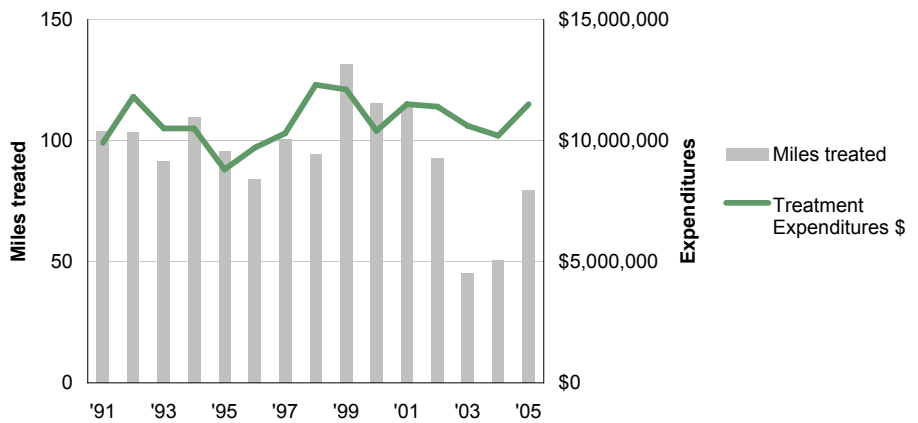
Source: PDOT records

**Fewer miles of streets treated**

There has been a significant decline in the number of miles of streets treated by the Street Preservation Program over the past 15 years. In FY 1990-91, the Program treated 103.9 total miles of streets compared to only 45.3 miles in FY 2002-03 (-56 percent) and 79.3 miles in FY 2004-05 (-24 percent). This has occurred despite a 13 percent

growth in the City's inventory of improved streets during the same period. On the other hand, total dollars spent on the treatment of streets, after adjusting for inflation, increased by 16 percent since FY 1990-91, from \$9.9 to \$11.5 million. (See Figure 4.)

**Figure 4 Treatment miles\* and expenditures \*\*  
FY 1990-91 through FY 2004-05**



Source: PDOT records

\*28 feet equivalent miles

\*\*Expenditures adjusted to FY 2004-05 dollars using CPI-U

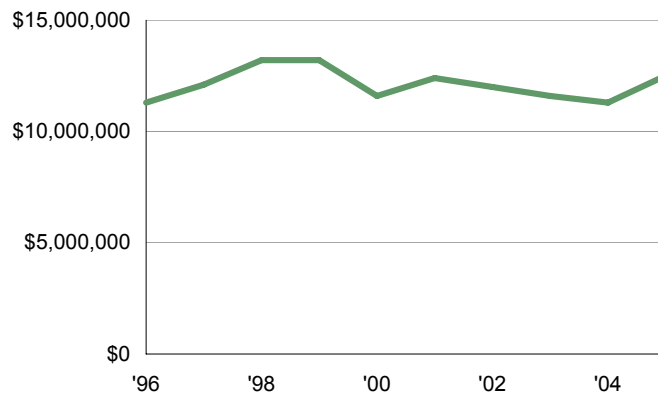
PDOT managers told us that miles treated in FY 2002-03 and FY 2003-04 declined in part because of the concentration of street treatment in the downtown area, which is more difficult and time consuming due to increased traffic and the need for access to downtown businesses. Managers also stated that the elimination of the slurry seal program during these same years contributed significantly to the reduction in the number of miles treated.

**Funding of street preservation remains steady**

PDOT states in its Financial Forecast 2006-2011 that funding for infrastructure maintenance has been below sustainable levels for several years, and that the growth in the repair backlog and decline in street conditions is due to funding shortages. Our analysis indicates that

Street Preservation expenditures have been relatively steady over the past ten years, increasing from \$11.3 million in FY 1995-96 to \$12.5 million in FY 2004-05 (+11 percent), after adjusting for inflation (see Figure 5).

**Figure 5 Street preservation program expenditures\*  
FY 1995-96 through FY 2004-05 (adjusted for inflation)\*\***



Source: City Financial Records

\* Recycling centers were moved out of the Street Preservation Program in FY 2003-04, and recycling center expenditures in earlier years are excluded for consistency

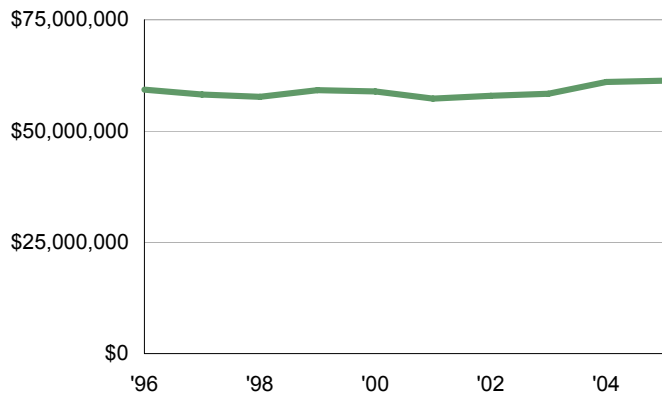
\*\* Expenditures adjusted to FY 2004-05 dollars using CPI-U. PDOT calculated a 4 percent increase in expenditures (\$12.0 million to \$12.5 million) over 10 years by applying the Oregon Highway Construction Cost Trend to Street Preservation's asphalt expenditures. However, our review of asphalt prices paid by PDOT over this same period indicates PDOT's cost of asphalt actually increased at a lower rate than the CPI-U. Our overall conclusion that Street Preservation expenditures have remained relatively steady is valid regardless of which inflation factor is applied to historical expenditures.

PDOT states that the primary source of its discretionary revenue – the State Highway Trust Fund – has not kept pace with inflation. The main component of the Highway Trust Fund is the State gas tax, which has not been indexed to inflation and has not been increased since 1993. Nevertheless, PDOT's General Transportation Revenues (GTR) comprised of unrestricted funds (including the State gas tax revenues) available for discretionary purposes have also remained

steady over the past 10 years, increasing from \$59.3 million in FY 1995-96 to \$61.3 million in FY 2004-05 (+3 percent), after adjusting for inflation. (See Figure 6.)

PDOT managers told us that although General Transportation Revenues have remained relatively steady over the past 10 years, the portion truly available for discretionary expenditures has declined significantly over this same period. Central interagency requirements have grown much faster than the rate of inflation, and the ongoing operational requirements of new major transportation initiatives, such as the Portland Streetcar and the multi-space Smartmeters, have significantly reduced discretionary funds. A reduction in General Fund support of Street Lighting operations has also negatively impacted the availability of discretionary dollars, according to PDOT managers.

**Figure 6 PDOT general transportation revenues\*  
FY 1995-96 through FY 2004-05 (adjusted for inflation)**



Source: PDOT Financial staff

\* Adjusted to FY 2004-05 dollars using CPI-U

**PDOT's street preservation practices are not cost effective**

Our review of professional literature and interviews with street preservation experts indicate that the most cost effective approach to preserving a street system is to incorporate a proactive preventive maintenance program. Experts indicate that the cost of street preservation is much less when preventive maintenance is used to extend the life of streets in good condition than when resources are used primarily to repair deteriorated streets. Our analysis of PDOT's street preservation practices – including methods for selecting streets for treatment and historical spending patterns – shows that PDOT has been operating in a reactive manner to street deterioration and has not incorporated preventive maintenance in a systematic way.

PDOT states in its Pavement Asset Management Plan that it intends to deliver "...a street preservation program based on a preventive maintenance strategy." In addition, our interviews with Street Preservation Program managers and staff indicate that they understand the theoretical value of preventive maintenance. However, these managers also believe they must choose streets in poor or very poor condition for maintenance over streets in fair or good condition. As a result, PDOT is devoting the majority of its street preservation resources to repairing streets it has rated in poor or very poor condition and is doing little to preserve the life of streets in good condition. In turn, the lifetime cost of streets, or the cost of ownership, will be much higher to the City and its taxpayers. We believe this approach has limited PDOT's ability to reduce the repair backlog and improve the overall condition of streets.

While PDOT's Pavement Management System provides Street Preservation managers and staff with good information on the condition and needs of the City's street system, decisions regarding which streets to treat and what treatments to apply appear to preclude preventive maintenance. Streets are not considered for treatment by Street Preservation staff until defects are sufficiently visible to be rated, and then scored high enough to be included in the backlog. Local streets in very good condition and arterial streets in good condition are excluded by design. We have prepared a detailed description of the process Street Preservation staff undergo each year in developing their "annual paving list" (see Appendix C). In addition,



**Figure 7 Criteria for selecting streets for paving and other treatment: City of Portland vs. industry experts**

| <b>Approx. Priority</b> | <b>City of Portland Street Preservation</b>  | <b>Industry Experts</b>   |
|-------------------------|--|---|
| 1                       | Select from streets rated, in backlog  | Protect streets in good condition   |
| 2                       | Include streets selected but not paved in previous years   | Maximize asset years (lane-mile years of remaining service life)  |
| 3                       | Exclude streets with pending utility cut conflicts   | Apply variety of treatments from preventive maintenance to reconstruction, to maintain optimal distribution of asset years. |
| 4                       | Provide district equity (pave in all parts of City)  |   |
| 5                       | Choose longest continuous projects in PMS score in "poor condition" range  |   |
| 6                       | Select quantity matching equipment and crew capacity (50 lane miles)   |   |
| <b>Cost</b>             | Achieve lowest cost rehabilitation - slurry instead of pave local streets, short-term fix instead of wait to reconstruct | Achieve lowest cost over time   |
| <b>Plan</b>             | Plan annual schedule 6 months to 1 year ahead  | Plans years ahead - know what needs are coming up   |

Source: Audit Services Division interviews and research

we have compared the criteria PDOT staff uses to select streets for paving and other treatments to criteria recommended by experts. As shown in Figure 7, PDOT's list of criteria does not include preventive maintenance, whereas industry experts give preventive maintenance the highest priority.

**PDOT spending more on rehabilitation and repair than on prevention**

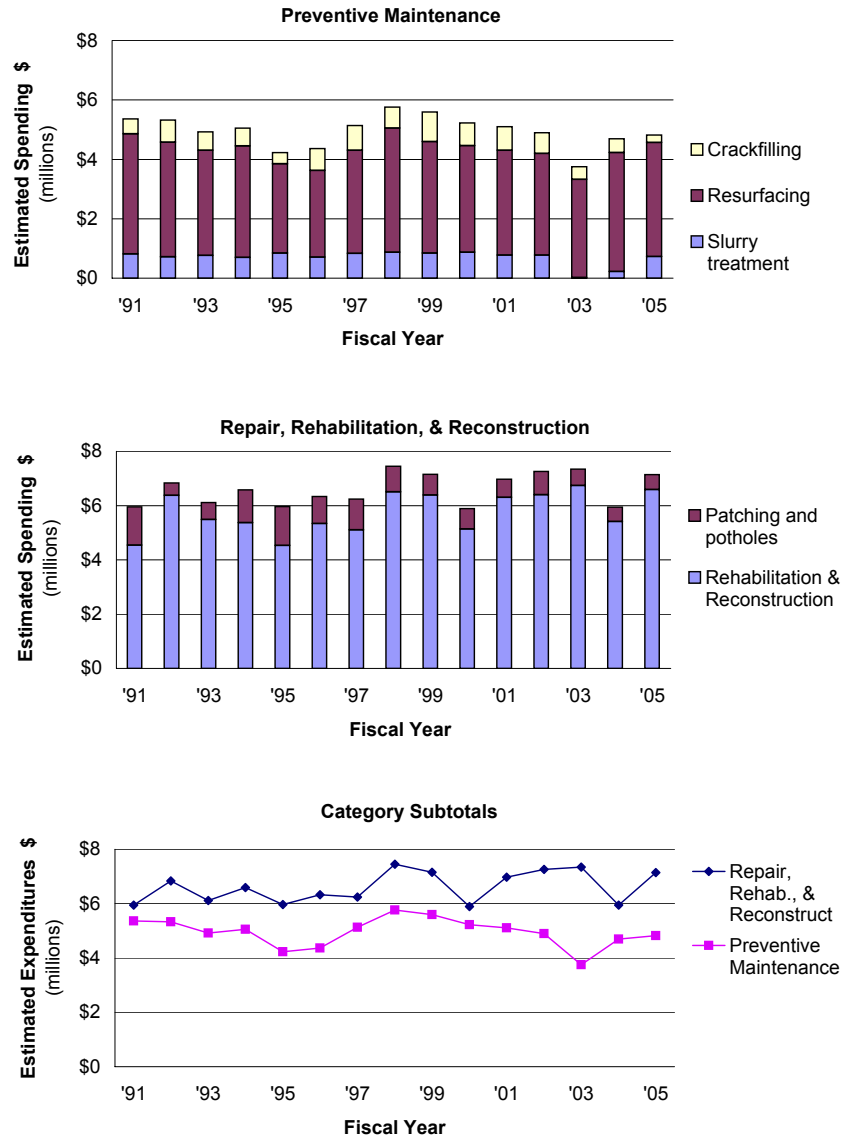
PDOT reports in various documents that it has spent little or no funds on rehabilitation and reconstruction over the past 15 years; however, we found that PDOT's break-out of street treatment expenditures was not accurate. Based on our interviews with Street Preservation personnel and industry experts, we have revised the break-out of PDOT's pavement treatment expenditures. Our analysis, as illustrated in Figure 8, shows that the majority of treatment dollars have been spent on the repair and rehabilitation of deteriorated streets, while much less has been spent on preventive maintenance techniques such as slurry seal. Crack-filling can be preventive, and is included in preventive here. However, crack-filling is also rehabilitation, depending on the cause of cracking.

**PDOT doing expensive, short-term repairs on badly deteriorated streets**

Because Street Preservation personnel do not consider streets for treatment until defects are frequent or severe enough to require repair, and because less deteriorated streets compete for treatment with very deteriorated streets, some repairs are not only late, but inadequate. For example, work done on Division Street in 2003 – costing \$192,902 – and on Lombard Street in 2004 – costing \$462,000 – were decisions to use short-term fixes on severe defects in order to address other pressing needs. Division Street needed repair of the base aggregate or complete reconstruction. Instead, Street Preservation personnel decided to grind and repave, without significant base repair. Many miles of defects classified as “Rehabilitation” disappeared from the backlog summary in that year, but that portion of Division will reappear in the backlog within just a few years.

Lombard Street was in “very poor” condition and also ranked very highly for treatment. It had not been treated for 17 years although it carried exceptionally heavy truck traffic. Street Preservation personnel performed a similar short-term fix on Lombard rather than full rehabilitation or reconstruction needed to restore the street to full strength. The work on both Division and Lombard involved relatively high expenditures on repairs that were partly wasted because new pavement was placed on a base that needed more repair, in a high traffic volume area.

**Figure 8 Estimated spending on various street treatment categories FY 1990-91 through FY 2004-05 (adjusted for inflation)\***



Source: Auditor interviews and analysis of PDOT financial records

NOTE: Not all crackfilling, resurfacing, and slurry treatment can be considered preventive, therefore preventive maintenance estimated may exceed actual preventive maintenance.

\* Expenditures adjusted to FY 2004-05 dollars using CPI-U.

Plans for Southeast 39th Avenue during FY 2005-06 provide another example. A section of Southeast 39th was rehabilitated using all of Street Preservation's annual funds allocated for contract work. However, Street Preservation staff had earlier listed it among its proposed in-house repair projects, and had begun partial rehabilitation work. Due to concerns about meeting ORS 279C.305 requirements regarding achieving least cost in public improvements, rehabilitation was completed under contract.

The above decisions have contributed to increasing the backlog by applying resources to repair a few miles of streets. These resources could have been used more efficiently to preserve many more miles of streets in good condition, keeping them off of the backlog list. The City of Portland is not alone in this regard. Experts state that cities often believe they are compelled to spend resources on worst case repairs rather than on prevention. As more streets become severely deteriorated, repairs become more costly, further reducing funds that might be used for prevention, while the miles of streets needing maintenance increases. Money spent on severely deteriorated streets does not add as much service life as the same amount of money spent earlier in the pavement deterioration process. Pavement that is repaired inadequately, regardless of the reason and regardless of surface appearance, will not last as long as it would if structural needs are addressed. Problems will recur sooner and will need to again be addressed, costing more in the long run.

**Slurry seal used to patch, not protect**

According to PDOT, slurry seal has been its first choice of treatment for local streets, although local streets in poor or very poor condition are eventually repaved, usually in conjunction with nearby asphalt paving work on arterials. Slurry seal and other thin treatments are widely used in other jurisdictions as preventive maintenance on flexible pavement. When applied to pavement in good condition, slurry seal restores the surface, extending pavement service life by three to seven years, depending on traffic levels.

In Portland, however, slurry seal is considered only after streets have developed defects such as cracking, sufficient to put them on the backlog list. In addition, it is not used at all on Portland's arterial

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streets. As in paving decisions, backlog candidates for slurry seal treatment compete for limited dollars, and streets selected for slurry seal are often in poor condition. Personnel making these decisions believe that limited base repair followed by patching, crack sealing and slurry seal is a cost effective alternative to paving. However, such expenditures are not likely to keep a street off the backlog for very long.

PDOT's practice of not applying slurry seal to arterial streets runs counter to what street preservation experts told us. They said it is even more important to apply preventive maintenance techniques such as slurry seal to arterials because they bear a much greater traffic load than local streets. In fact, arterial streets represent 79 percent of the value of the backlog of street repairs (\$73.1 million of a total \$92.9 million) identified by PDOT. In addition, PDOT has been reducing the slurry seal program and is considering eliminating the program altogether. In FY 2002-03 the slurry seal program was halted for nearly two years, and the program is slated to be cut in half in FY 2006-07.

**Preventive  
maintenance  
recommended  
by national street  
preservation experts**

Industry experts indicate that the most cost effective way to maintain streets in good condition is to intervene early in the life of a street with relatively low-cost preventive maintenance techniques, such as chip seal, slurry seal, and thin overlays. When a street is allowed to deteriorate, it requires significantly more expensive rehabilitation and reconstruction to extend its life. A report prepared for the 2005 annual meeting of the Transportation Research Board emphasizes the importance of preventive maintenance:

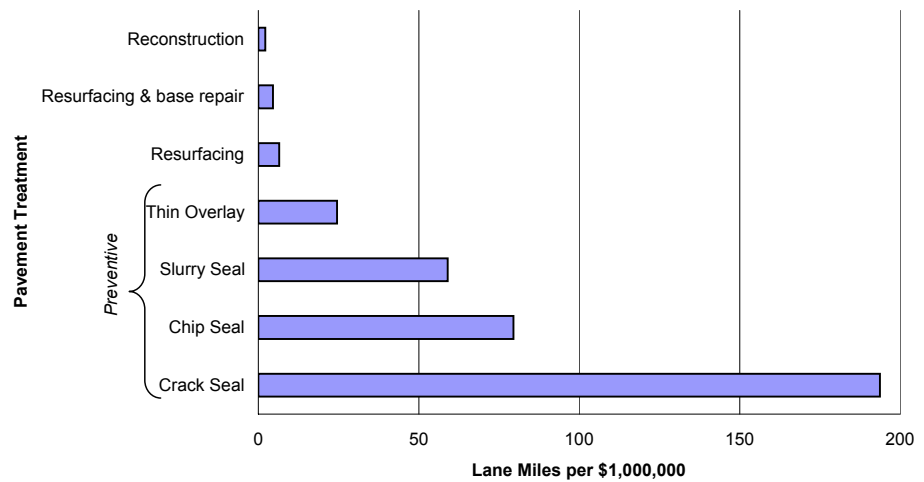
“Budget constraints are making it more and more difficult to maintain our highway infrastructure. A sound pavement preservation program can reduce costs while improving the overall quality of our pavement network if preventive maintenance treatments are applied before corrective maintenance is needed....As the demands on limited highway budgets increase, it becomes more important to make the best use of available funds. The traditional maintenance approach focusing on corrective maintenance or “worst

first” does not serve today’s needs for pavement quality and budget management...When applied early, preventive maintenance treatments used as part of a sound pavement preservation strategy will cost less than the reconstruction and rehabilitation of highways that are allowed to deteriorate.”

(“Preventive Maintenance Treatment Performance at 14 Years” prepared for the 2005 Annual Meeting of the Transportation Research Board, Page 2)

An analysis of the long term performance of preventive maintenance treatments, prepared for the Transportation Research Board, provides some insight into the magnitude of potential savings available through application of preventive maintenance techniques – shown as thin overlays, slurry seal, chip seal, and crack seal in Figure 9 – compared to the higher costs associated with resurfacing, rehabili-

**Figure 9 Number of lane miles that can be treated with \$1 million using various treatment types\***



Source: Based on annualized cost per lane mile and average life gained by various treatment types, available in a 2005 report to the Transportation Research Board by Galehouse, Larry; King, Helen; Leach, David; Moulthrop, Jim; and Ballou, Bill; “Preventive Maintenance Treatment Performance at 14 Years,” 2005, p. 19.

\* Exact costs of each treatment would vary in the City of Portland, as would the number of miles that could be treated by each treatment type. Nevertheless, preventive maintenance allows street departments to treat more miles than more expensive rehabilitation and reconstruction.

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tation, and reconstruction. It is clear from this data that Portland could preserve many more miles of streets by applying preventive maintenance techniques instead of more expensive rehabilitative work.

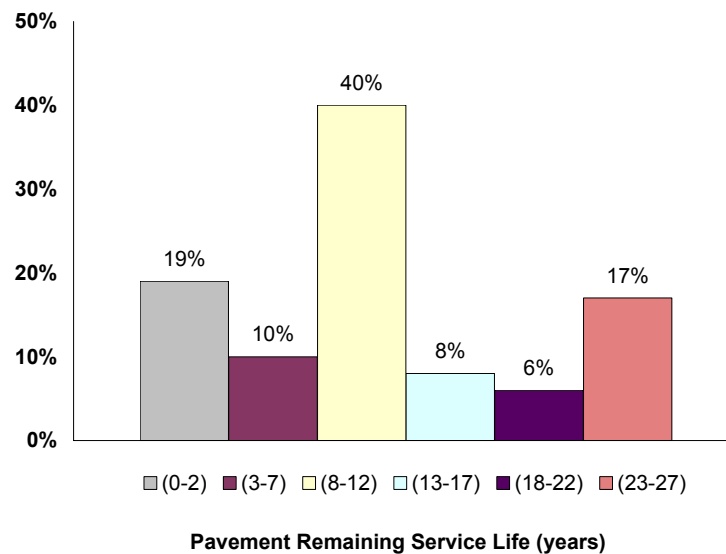
**“Remaining service life” evaluation also recommended by experts**

City Street Preservation managers we interviewed agree that they are doing too little preventive maintenance and would like to do more. To help them move in this direction, we believe they should consider adopting a planning and budgeting approach that will help them focus on the most cost effective street surface treatments. Representatives of the National Center for Pavement Preservation recommend the use of a network approach to managing street preservation – “Remaining Service Life,” or RSL. Using RSL, a combination of treatments is selected in proportions that would deliver the maximum lane mile years of remaining service life for the overall pavement network.

RSL is an approach for planning cost-effective street preservation and optimal street preservation budgets years in advance, rather than reacting annually to street conditions, by predicting treatment needs based on locally determined deterioration and treatment variables. The City of Portland currently has 3,949 lane miles in the street system to maintain. If no work were done for a year, the system would then have 3,949 fewer lane mile years of remaining service life in it than it does today. This means that to avoid losing value, at least 3,949 lane mile years need to be restored annually through preservation or reconstruction. Preventive maintenance treatments such as slurry seal and thin overlays performed on streets that are still in good condition can add many more lane mile years of service life than can be added by the same amount of money spent on structural resurfacing or other forms of rehabilitation, as shown in Figure 9.

To use RSL, the City would need to estimate years of remaining service life for each segment of street, and then calculate remaining service life for its entire 3,949 lane miles. Figure 10 is a hypothetical example of a distribution of remaining service life that is typical for most cities. Categories of remaining service life are not distributed evenly in this example, so cost and methods of treatment needed would vary significantly over time. In this example, 19 percent of the streets will need reconstruction within one or two years, while less than 25 percent are in sufficiently good condition to benefit from the most cost effective preventive treatments.

**Figure 10 Example of remaining service life distribution in a typical pavement network (not Portland)**

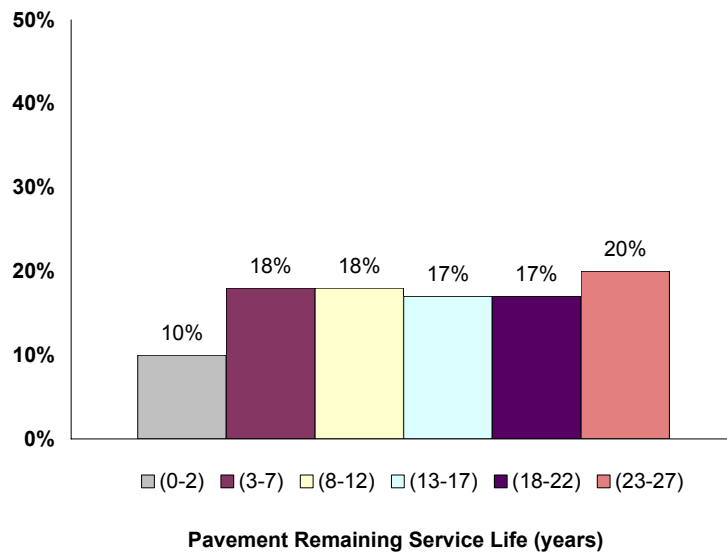


Source: Galehouse, Larry, "Strategic Planning for Pavement Preventive Maintenance: Michigan DOT 'Mix of Fixes' Program," in Pavement Preservation Compendium, 2003, FHWA -IF-03-21



A city with such a distribution might want to spend all of its available maintenance budget on streets near failure. However, to achieve a more efficient distribution of pavement remaining service life categories, it should protect its streets in good condition while performing rehabilitation and reconstruction on streets that are nearer to failure. Figure 11 illustrates the optimal distribution of categories of service life that is achievable using RSL.

**Figure 11 Optimal condition for distribution of pavement remaining service life (not Portland)**



Source: O'Doherty, John, National Center for Pavement Preservation, presentation on Pavement Preservation to Transportation Research Board Meeting, January 2006

It would likely take years for PDOT to achieve an optimal distribution of remaining service life in its street network. It could do so by spending more funds on extending the life of pavements in good condition, while continuing to rehabilitate and restore other streets. Figure 12 shows the estimated extension of pavement life for different treatments, reported by five sources. Research in this field is ongoing, and experts have told us that cities need to determine the

**Figure 12 Years of pavement life gained through various preventive treatments**

| 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                                   |
| Microsurfacing                        | 3 to 9                                   |
| Thin (1.5") hot mix                   | 5 to 10                                  |
| Hot-mix overlay (1.5"), after milling | 2 to 12                                  |

Sources:

Minnesota Technology Transfer Center, *Best Practices Handbook on Asphalt Pavement Maintenance*, 2000; p. 17

Hicks, Gary, P.E.; Seeds, P.E., Stephen; Peshkin, P.E., David; *Selecting a Preventive Maintenance Treatment for Flexible Pavements*, 2000, FHWA-IF-00-027, p. 9

Galehouse, Larry; King, Helen; Leach, David; Moulthrop, Jim; and Ballou, Bill; *Preventive Maintenance Treatment Performance at 14 Years*, 2005, p. 19.

Galehouse, Larry, "Strategic Planning for Pavement Preventive Maintenance," in *Pavement Preservation Compendium*, 2003, FHWA-IF-03-21, p. 8.

Perkins, D.G.; Hoerner, T.E., and Zimmerman, K.A.; *Optimal Timing of Pavement Preventive Maintenance Treatment Applications*, National Cooperative Highway Research Program Report 523, 2004, p. 10-13.

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best treatments locally because the value of treatments depends on many variables including local climate, treatment quality, and especially traffic type and volume.

**Tracking of work activities and related costs are incomplete and inaccurate**

We asked PDOT for a breakdown of expenditures for the various street surface treatments, including slurry seal, pothole repairs, preservation overlays, structural overlays, rehabilitation, and reconstruction; however, not all this information is tracked by PDOT, and the allocation of work among the various treatment categories was not entirely accurate. For example, PDOT records show that no funds were spent on reconstruction and rehabilitation from FY 1991-92 through FY 2001-02. However, Street Preservation staff told us that much of the street resurfacing crews perform is structural resurfacing which, according to guidelines issued by the Federal Highway Administration, is rehabilitation. Street Preservation staff also stated that base repair work listed as resurfacing in PDOT spending records is also rehabilitation.

In tracking the cost of work activities, PDOT has not adequately segregated preventive maintenance from rehabilitation and reconstruction work. For example, its tracking of street treatment expenditures does not differentiate between structural overlays and preservation overlays. Whereas a preservation overlay represents a thin layer of asphalt and is considered preventive maintenance, a structural overlay improves a street's structural durability or capacity and is thus considered rehabilitation.

We also found PDOT has not differentiated between arterial streets and local streets in its tracking of expenditures. The difference between an arterial street and a local street is significant in terms of their maintenance needs, and we believe PDOT should isolate arterial and local streets in its tracking of street treatment work and associated expenditures. Also, PDOT is not tracking the number or cost of pothole repairs, which are an indication of advanced pavement deterioration. Information on the number, cost, and location of pothole repairs would provide useful information on the condition and needs of specific street segments.

**Need for pavement engineer**

PDOT's 2006 Pavement Asset Management Plan indicates that a Pavement Engineer is needed to support the Street Preservation Program. Program managers told us they lack adequate technical expertise and that a Pavement Engineer could help them make better plans and decisions regarding street preservation. When these managers need to resolve a problem during asphalt pavement construction, such as insufficient density, they currently obtain assistance from one of their asphalt supplier's technical staff. Streets represent the City's most valuable transportation asset – worth in excess of \$3.6 billion. We agree it makes sense to add a Pavement Engineer to assist in planning and decision-making regarding the construction and maintenance of City streets. A Pavement Engineer could help with the design and development of the Program's new Pavement Management System.

**Conclusions and recommendations**

PDOT has established a number of commendable systems and reports for managing its Street Preservation Program. However, the Program is clearly focused on patching and repairing severely deteriorated streets and is not considering the cost effectiveness of its street preservation work. While PDOT points to a shortage of resources as the cause for the declining condition of City streets, we believe the failure to enact a proactive preventive maintenance strategy has limited its ability to address the repair backlog and improve the overall condition of streets. Street preservation experts state that when there are limited resources, it is even more important to avoid the 'worst first' philosophy and make optimal use of available resources by applying preventive maintenance as part of a sound pavement preservation strategy.

The longer PDOT continues down the path of focusing primarily on the backlog of street repair needs, the faster City streets will deteriorate and the higher the overall cost of streets will become. We believe PDOT needs to chart a new course that will allow it to become more proactive and less reactive in its efforts to preserve City streets. It can do so by devoting more resources to preventive maintenance and fewer resources to costly short-term fixes of deteriorated streets.

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We have not determined an ideal funding level for PDOT's Street Preservation Program given the current condition of City streets. The Program could benefit from an influx of funds to address badly deteriorated streets and the need for more preventive maintenance. Regardless of the level of funding, however, we believe PDOT could achieve the greatest value for each dollar spent and lower the overall cost of ownership of roads by devoting a higher proportion of its resources to proactive, preventive maintenance work.

While the rate of deterioration can be curtailed, street preservation experts caution that it may take years for the cost effectiveness and the condition of streets to improve. Nevertheless, in order to reduce the City's long-term costs and improve the condition of City streets, we recommend that PDOT:

- 1. Develop a proactive preventive maintenance program to be applied to newly constructed and resurfaced streets, and other streets in good condition.**

To transition from a reactive mode to a strategy that incorporates proactive preventive maintenance, experts recommend one of two approaches. The first approach is to build preventive maintenance into the design of streets; that is, a schedule is established before actual construction or rehabilitation work begins, and money is set aside for preventive maintenance. Another option is to commit a certain percentage of pavement funds to preventive maintenance, and to use those funds only for preventive maintenance activities, even during times of budget constraints. We also recommend that PDOT re-evaluate its decision to cut, and possibly eliminate, the slurry seal program. We believe an appropriate type of slurry seal, or other preservation treatment, should be utilized to extend the life of arterial, as well as local, streets.

- 2. Adopt the RSL approach to planning and budgeting the street preservation program.**

While the backlog of street repairs requires attention, we believe it makes sense to adopt a more inclusive and cost

effective approach for preserving City streets, such as RSL, which focuses on the most cost effective means of extending the life of City streets. In doing so, PDOT will need to ensure that its new Pavement Management System incorporates such an approach, and include preventive maintenance as an integral part of its street preservation strategy.

**3. Establish better procedures for categorizing and tracking street preservation work activities.**

PDOT needs to segregate structural overlays from preservation overlays, as well as arterial streets from local streets, in tracking work activities and their associated costs. It also needs to do a better job of distinguishing preventive maintenance from rehabilitation and reconstruction work. In addition, PDOT needs to begin tracking the number, location, timing, and cost of pothole repairs.

**4. Evaluate the need to establish a Pavement Engineer position.**

PDOT needs to have the expertise of an engineer who specializes in pavement design and maintenance. We believe it makes sense to establish a Pavement Engineer position within PDOT to assist in decision making regarding all phases of pavement design and maintenance. With the new Pavement Management System under development, the involvement of a Pavement Engineer is essential to gain full value for the City.

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## APPENDICES





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## APPENDIX A: Glossary of Terms

The following definitions reflect the use of these terms in this report. Although generally agreed upon, they may differ from usage in other reports.

### **28-foot equivalent mile**

A unit of pavement surface measure equal to the area of one mile of pavement 28 feet wide, the width of a typical two lane street with parking on each side.

### **backlog**

The streets maintained by the City of Portland that are known to be in fair, poor, or very poor condition, through visual rating by PDOT Street Preservation staff and Pavement Management System processing.

### **Backlog Summary**

Backlog streets classified by the Pavement Management System software into categories of treatment suggested by the same system, based on visual rating by PDOT Street Preservation staff.

### **chip seal**

A preventive maintenance treatment for asphalt pavement, chip seal is a high viscosity surface coat of asphalt emulsion with rock chips rolled into it.

### **failure**

Unacceptable pavement condition in which reconstruction is the only practical means of extending use

**lane-mile-year**

A unit of value of pavement as an asset, in terms of an area one lane wide by one mile long with one year of service life. For example, a 2-lane road 5 miles long estimated to have 10 remaining years of service life could be valued as 100 lane mile years.

**mile (as a measure of pavement)**

PDOT uses three different pavement measures based on miles. These are:

*28-ft equivalent mile*—an area equivalent to one mile of pavement 28 feet wide, which is the width of a typical two lane street with parking on each side.

*lane mile*—an area equivalent to one mile of pavement one lane wide.

*centerline mile*—a measure of street length without regard to the number of lanes, along the centerline.

**optimal timing**

“As it relates to preventive maintenance [optimal timing] is defined as the time at which the greatest improvement in performance (over doing nothing) is realized at the lowest cost.” NCHRP Report 523, p. 62

**pavement preservation**

“...a program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations.” FHWA Memorandum on Pavement Preservation Definitions, September 12, 2005

**pavement reconstruction**

“...is the replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure.... Reconstruction is required when a pavement has either failed or has become functionally obsolete.” FHWA Memorandum on Pavement Preservation Definitions, September 12, 2005

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**pavement rehabilitation**

"...structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capacity. Rehabilitation techniques include restoration treatments and structural overlays." FHWA Memorandum on Pavement Preservation Definitions, September 12, 2005

**preventive maintenance**

"a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity)." FHWA Memorandum on Pavement Preservation Definitions, September 12, 2005

Preventive maintenance, unlike corrective maintenance, is cyclic in nature. It is intended to stop some distresses before they occur and to slow the development of other types of distresses. (WSDOT p. 5-1)

**preservation overlay**

A term used in Portland to mean a layer of asphalt concrete, typically 1.5" to 2.0" thick, placed over an existing asphalt street to improve the quality of pavement. Preservation Overlay is one category of PMS-prescribed treatment based on PMS analysis of street ratings.

**remaining service life**

The amount of time from the present until, without intervening treatment, failure of a street is predicted.

**slurry seal**

A mixture of asphalt emulsion, fine mineral aggregate and water proportioned, mixed and spread primarily on asphalt concrete pavement for maintenance purposes.

**thin overlay**

A layer of asphalt approximately 1.5 inches thick placed and compacted over existing asphalt pavement to extend its service life.



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## APPENDIX B:

Federal Highway Administration memorandum:  
"Pavement Preservation Definitions"





# Memorandum

Subject: **ACTION**: Pavement Preservation Definitions

Date: September 12, 2005

*(Original Signed by David R. Geiger, P.E.)*

From: David R. Geiger, P.E.  
Director, Office of Asset Management

Reply to  
Attn. of: HIAM-20

To: Associate Administrators  
Directors of Field Services  
Resource Center Director and Operations Manager  
Division Administrators  
Federal Lands Highway Division Engineers

As a follow-up to our Preventive Maintenance memorandum of October 8, 2004, it has come to our attention that there are differences about how pavement preservation terminology is being interpreted among local and State transportation agencies (STAs). This can cause inconsistency relating to how the preservation programs are applied and their effectiveness measured. Based on those questions and a review of literature, we are issuing this guidance to provide clarification to pavement preservation definitions.

Pavement preservation represents a proactive approach in maintaining our existing highways. It enables STAs to reduce costly, time consuming rehabilitation and reconstruction projects and the associated traffic disruptions. With timely preservation we can provide the traveling public with improved safety and mobility, reduced congestion, and smoother, longer lasting pavements. This is the true goal of pavement preservation, a goal in which the FHWA, through its partnership with States, local agencies, industry organizations, and other interested stakeholders, is committed to achieve.

A Pavement Preservation program consists primarily of three components: preventive maintenance, minor rehabilitation (non structural), and some routine maintenance activities as seen in figure 1.

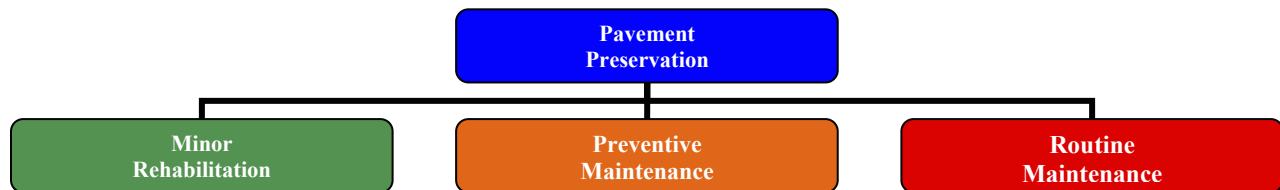


Figure 1: Components of Pavement Preservation



An effective pavement preservation program can benefit STAs by preserving investment on the NHS and other Federal-aid roadways, enhancing pavement performance, ensuring cost-effectiveness, extending pavement life, reducing user delays, and providing improved safety and mobility.

It is FHWA's goal to support the development and conduct of effective pavement preservation programs. As indicated above, pavement preservation is a combination of different strategies which, when taken together, achieve a single goal. It is useful to clarify the distinctions between the various types of maintenance activities, especially in the sense of why they would or would not be considered preservation.

For a treatment to be considered pavement preservation, one must consider its intended purpose. As shown in Table 1 below, the distinctive characteristics of pavement preservation activities are that they restore the function of the existing system and extend its service life, not increase its capacity or strength.

| <b>Pavement Preservation Guidelines</b> |                                   |                          |                          |                     |                               |
|---|-----------------------------------|--------------------------|--------------------------|---------------------|-------------------------------|
|   | <b>Type of Activity</b>           | <b>Increase Capacity</b> | <b>Increase Strength</b> | <b>Reduce Aging</b> | <b>Restore Serviceability</b> |
|   | New Construction                  | X                        | X                        | X                   | X                             |
|   | Reconstruction                    | X                        | X                        | X                   | X                             |
|   | Major (Heavy) Rehabilitation      |                          | X                        | X                   | X                             |
|   | Structural Overlay                |                          | X                        | X                   | X                             |
|   | Minor (Light) Rehabilitation      |                          |                          | X                   | X                             |
| <b>Pavement Preservation</b>            | Preventive Maintenance            |                          |                          | X                   | X                             |
|   | Routine Maintenance               |                          |                          |                     | X                             |
|   | Corrective (Reactive) Maintenance |                          |                          |                     | X                             |
|   | Catastrophic Maintenance          |                          |                          |                     | X                             |

*Table 1- Pavement Preservation Guidelines*

### **Definitions for Pavement Maintenance Terminology**

**Pavement Preservation** is “a program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations.”

*Source: FHWA Pavement Preservation Expert Task Group*

An effective pavement preservation program will address pavements while they are still in good condition and before the onset of serious damage. By applying a cost-effective treatment at the



right time, the pavement is restored almost to its original condition. The cumulative effect of systematic, successive preservation treatments is to postpone costly rehabilitation and reconstruction. During the life of a pavement, the cumulative discount value of the series of pavement preservation treatments is substantially less than the discounted value of the more extensive, higher cost of reconstruction and generally more economical than the cost of major rehabilitation. Additionally, performing a series of successive pavement preservation treatments during the life of a pavement is less disruptive to uniform traffic flow than the long closures normally associated with reconstruction projects.

**Preventive Maintenance** is “a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity).” *Source: AASHTO Standing Committee on Highways, 1997*

Preventive maintenance is typically applied to pavements in good condition having significant remaining service life. As a major component of pavement preservation, preventive maintenance is a strategy of extending the service life by applying cost-effective treatments to the surface or near-surface of structurally sound pavements. Examples of preventive treatments include asphalt crack sealing, chip sealing, slurry or micro-surfacing, thin and ultra-thin hot-mix asphalt overlay, concrete joint sealing, diamond grinding, dowel-bar retrofit, and isolated, partial and/or full-depth concrete repairs to restore functionality of the slab; e.g., edge spalls, or corner breaks.

**Pavement Rehabilitation** consists of “structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capacity. Rehabilitation techniques include restoration treatments and structural overlays.” *Source: AASHTO Highway Subcommittee on Maintenance*

Rehabilitation projects extend the life of existing pavement structures either by restoring existing structural capacity through the elimination of age-related, environmental cracking of embrittled pavement surface or by increasing pavement thickness to strengthen existing pavement sections to accommodate existing or projected traffic loading conditions. Two sub-categories result from these distinctions, which are directly related to the restoration or increase of structural capacity.

*Minor rehabilitation* consists of non-structural enhancements made to the existing pavement sections to eliminate age-related, top-down surface cracking that develop in flexible pavements due to environmental exposure. Because of the non-structural nature of minor rehabilitation techniques, these types of rehabilitation techniques are placed in the category of pavement preservation.

*Major rehabilitation* “consists of structural enhancements that both extend the service life of an existing pavement and/or improve its load-carrying capability.” *Source: AASHTO Highway Subcommittee on Maintenance Definition*

**Routine Maintenance** “consists of work that is planned and performed on a routine basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service.” *Source: AASHTO Highway Subcommittee on Maintenance*

Routine maintenance consists of day-to-day activities that are scheduled by maintenance personnel to maintain and preserve the condition of the highway system at a satisfactory level of service. Examples of pavement-related routine maintenance activities include cleaning of roadside ditches and structures, maintenance of pavement markings and crack filling, pothole patching and isolated overlays. Crack filling is another routine maintenance activity which consists of placing a generally, bituminous material into “non-working” cracks to substantially reduce water infiltration and reinforce adjacent top-down cracks. Depending on the timing of application, the nature of the distress, and the type of activity, certain routine maintenance activities may be classified as preservation. Routine Maintenance activities are often “in-house” or agency-performed and are not normally eligible for Federal-aid funding.

Other activities in pavement repair are an important aspect of a STA’s construction and maintenance program, although they are outside the realm of pavement preservation:

**Corrective Maintenance** activities are performed in response to the development of a deficiency or deficiencies that negatively impact the safe, efficient operations of the facility and future integrity of the pavement section. Corrective maintenance activities are generally reactive, not proactive, and performed to restore a pavement to an acceptable level of service due to unforeseen conditions. Activities such as pothole repair, patching of localized pavement deterioration, e.g. edge failures and/or grade separations along the shoulders, are considered examples of corrective maintenance of flexible pavements. Examples for rigid pavements might consist of joint replacement or full width and depth slab replacement at isolated locations.

**Catastrophic Maintenance** describes work activities generally necessary to return a roadway facility back to a minimum level of service while a permanent restoration is being designed and scheduled. Examples of situations requiring catastrophic pavement maintenance activities include concrete pavement blow-ups, road washouts, avalanches, or rockslides.

**Pavement Reconstruction** is the replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure. Reconstruction usually requires the complete removal and replacement of the existing pavement structure. Reconstruction may utilize either new or recycled materials incorporated into the materials used for the reconstruction of the complete pavement section. Reconstruction is required when a pavement has either failed or has become functionally obsolete.

If you need technical support or further guidance in the pavement preservation area, please contact Christopher Newman in the FHWA Office of Asset Management at (202) 366-2023 or via e-mail at [Christopher.Newman@fhwa.dot.gov](mailto:Christopher.Newman@fhwa.dot.gov).

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## APPENDIX C:

### Description of PDOT’s process for selecting streets to treat

Street Preservation personnel perform visual ratings on arterial streets every two years and on local streets every four years, collecting data on the types and severity of pavement defects. The data is entered into the Pavement Management System, which assigns a score to each street segment based on the most recent visual rating. Scores range from 0 for segments with no defects to 670 for segments that have completely deteriorated, as shown below. After Street Preservation crews pave a road, its rating is re-set to 0.

#### PDOT’s scale for rating street condition

|           |           |
|-----------|-----------|
| 0 - 5     | Very Good |
| 5 - 45    | Good      |
| 50 - 95   | Fair      |
| 100 - 245 | Poor      |
| 245 - 670 | Very Poor |

Source: PDOT staff and reports

The maintenance backlog is comprised of street segments that are determined to contain defects and, therefore, are in need of treatment. The backlog includes arterial streets with scores of 115 or higher and local streets with scores of 45 or higher. A “Backlog Summary” is produced that lists streets in need of treatment, as prescribed by the Pavement Management System based on defect data

and type of street (e.g., local versus arterial, flexible pavement versus concrete). Streets are sorted in the “Backlog Summary” not based on score, but according to treatment category – slurry seal, preservation overlay, structural overlay, rehabilitation, and reconstruction. For example, the Pavement Management System may recommend a Preservation Overlay for a street scored as high as 555 (very poor condition) or as low as 70 (fair condition). Slurry is recommended and used only for local streets, which explains why local streets with lower scores are included in the backlog.

Street Preservation personnel select streets for paving using various Pavement Management System reports that list categories of arterial street segments in the backlog either in order of priority by highest score first, or alphabetically. These “design list” reports include PMS-recommended overlay thickness and area in square yards. Treatment projects are proposed by combining selections from the lists. The proposed paving list is prepared many months before each paving season to allow time to revisit streets proposed for treatment, to refine project limits, and to allow time to coordinate with utilities and other City bureaus that may be planning work in the same streets. The list includes up to twice the 50 lane miles that Street Preservation paves in each fiscal year, so that at least 50 lane miles of paving candidates will be available after conflicts become known or arise later. Some local streets adjacent to candidate arterials may also be included.

Street Preservation personnel state that the preferred range for paving streets is 165 to 180, which they believe represents the optimal part of the pavement life cycle curve shown in Figure 1 on page 3. As shown in the above table, this range represents streets in poor condition. Criteria used by Street Preservation personnel in proposing streets for paving, in approximate order of priority are: 1) streets selected but not paved in the previous year or years, 2) equity among districts of the City, 3) project length, for efficient production, and 4) score assigned by the PMS.

The paving list does not show the type of paving treatment that is planned for each project. Street Preservation personnel determine

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the extent of work needed – such as adding an overlay, grinding and constructing the base then adding overlay, or beginning with base repair work – during field visits after the proposed list has been distributed to utilities and other agencies for coordinating conflicts with other planned utility work. Staff then incorporate information received about conflicts and distributes a second proposed list, the “Paving Candidate’s Conflicts List.” The City requires replacement of five feet of asphalt pavement on each side of a trench cut into an arterial travel lane when the cut occurs within five years of paving. Utilities may avoid the added replacement cost by notifying staff about conflicts. Maintenance on some streets has been delayed for several years due to conflicts with utility cuts.

A similar process is used to develop the annual proposed slurry list for local streets. Street Preservation personnel begin with the Pavement Management System reports and build projects by selecting continuous segments to facilitate meeting production goals. Scores considered right for slurry treatment are lower than those for paving – in the low to mid-100s – although streets requiring base repair are sometimes included. In such cases, slurry is applied over the patched street. PDOT does not need to coordinate with utilities on its work on local streets. Trench cuts on local streets are typically part of residential improvements, which are subject to frequent change.



# RESPONSES TO THE AUDIT







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CITY OF

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**PORTLAND, OREGON**

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OFFICE OF PUBLIC UTILITIES

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**Sam Adams, Commissioner**  
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July 14, 2006

Gary Blackmer  
City Auditor  
1221 SW 4<sup>th</sup> Ave.  
Portland, OR 97204

Dear Auditor Blackmer:

Thank you for providing me with the chance to share my response to the recently completed audit on Bureau of Maintenance (BOM) pavement policies and practices originating from the city's Audit Services Division. I have found the report, on the whole, to be very well done and insightful. I appreciate the independent work from the Audit Services Division that the audit represents.

As the Commissioner-in-Charge of the Portland office of Transportation (PDOT), of which the BOM is a part, I am responsible for overseeing the building and maintenance of Portland's transportation infrastructure. Upon being given the duty of managing the PDOT roughly a year ago, I began scrutinizing their operations and began a process that will eventually institutionalize Asset Lifecycle Management within the agency. The goal of Asset Lifecycle Management, basically, is to ensure that PDOT spends the right amount of money on the right maintenance projects of the right assets at the right time. Essentially, making sure that PDOT uses its limited resources in the most rational way possible with the goal of lowering the long-term costs of maintaining Portland's valuable and indispensable transportation infrastructure.

In light of this process already underway, I welcome your audit and its findings. This independent analysis of PDOT's practices provides me with more important information that will help ensure that the agency is managed in the most effective way possible, giving the taxpayers the most "bang for their buck."

In your report, you pointed out that there exists a gap between the optimal amount of funds needed to maintain Portland's infrastructure as effectively as possible and the actual amount of funds that are currently at PDOT's disposal. I agree with this assessment and appreciate the unambiguity with which it was stated in the report. For PDOT to increase its preventative maintenance, some way to bridge this funding gap must be found.

While this audit does not paint a full picture of all of the work being done at PDOT and BOM, it does provide an important snapshot of several specific practices that must be corrected or improved within the agency. I look forward to working with you and your staff at the Auditor's Office to make certain that PDOT is in full compliance with all applicable state and federal laws, as well as to ensure that PDOT provides the citizens of Portland with the best and most cost-effective transportation services possible.

Best,

A handwritten signature in black ink, appearing to read 'S.A. Adams', with a stylized flourish at the end.

Sam Adams  
Portland City Commissioner

Cc: Portland City Council  
Sue Keil, Director, PDOT  
Sam Irving, Director, BOM  
John Rist, Business Operations Division Manager, PDOT  
Liane Welch, Street Preservation Division Manager, BOM

Sam  
Adams  
Commissioner

July 14, 2006

Susan D.  
Keil  
Director

Gary Blackmer  
City Auditor  
1221 SW 4<sup>th</sup> Avenue  
Portland OR 97204

Eileen  
Argentina  
System  
Management

Dear Mr. Blackmer:

Don  
Gardner  
Engineering &  
Development

The Portland Office of Transportation is pleased to respond to the audit of our street preservation efforts. I appreciate the independent review and work of the Audit Services Division. In our efforts to maintain and improve Portland's transportation system, it is important to use best practices to ensure the lowest life cycle costs for the preservation of our transportation system.

Sam M.  
Irving, Jr.  
Maintenance

The audit makes recommendations for improvements, which PDOT supports. As you know, PDOT is:

John  
Rist  
Business  
Services

- Evaluating and modifying, as appropriate, how we manage the entire life cycle of transportation assets.
- Implementing the adopted work plan of the Pavement Asset Team, which includes resolving new pavement management issues as they are identified.
- Replacing our legacy Pavement Management System, which will enhance our ability to target future pavement preservation investments and improve reporting. We will align PDOT's practice and terminology with industry standards through the new System.
- Hiring a Pavement Engineer or an expert in Pavement Management to support the Street Preservation Program.

Paul  
Smith  
Planning

In essence, these efforts will improve our ability to apply the right treatment at the right time on the right streets.

We concur with your assessment that additional funds are needed to address badly deteriorated streets and that more preventative maintenance should be done. We remain concerned that rising energy prices will impact the cost of the street preservation service. Our office anticipates a 68% increase in asphalt prices between 2005 and 2007.

We also realize the importance of devoting a greater proportion of resources to examining a greater portion of our resources to proactive, preventive maintenance work. However, we recognize the streets targeted for repair may shift as our partners and City Council identify street priorities that support other initiatives. We will continue to involve transportation stakeholders as we identify service choices and consider alternative funding modes.

We agree with the Auditors that different street treatments may be needed in a proactive preventative maintenance program. While we are not in complete agreement with all of the

treatments suggested in the report, new technologies and materials have come on the market, and PDOT will evaluate these treatments.

The audit report expressed concern about the decision to implement short-term fixes on N. Division and N. Lombard Streets. Distress characteristics on these streets indicated that either full rehabilitation or reconstruction was needed to restore the streets to full strength. We understand full well that this is not the ideal solution if adequate funding and time were available. As PDOT transitions to conducting more preventative maintenance, we anticipate similar needs to perform some street rehabilitation to prevent imminent failures.

Not recognized in the audit are fleet management costs. We continue to work with CityFleet to affect timely preventative maintenance of our fleet, correct replacement cycles to reflect actual use, and shorten the procurement process. These are critical factors in achieving street preservation efficiency and effectiveness.

PDOT takes a multi-year view in developing the paving list. We coordinate street preservation needs and other work in the Right-of-Way, including the City's multi-year Capital Improvement (CIP) and utility relocation. This is done on a 5-7 year horizon to preserve our investment in street treatments and minimize activities that cut into the street surface within a 5-year period of its completion.

The audit relies heavily on federal highway sources and costs per mile as the benchmark for Portland's urban streets. We understand the use of federal research and state highway data are meant to be generally instructive and not indicative of specific Portland pavement management strategies or costs per mile of treatment. With that understanding, there are significant differences between highways and urban streets in terms of design and management standards and, as a result, the proper treatment. We have attached a list of significant differences (Attachment A) which inform proper treatment decisions.

I appreciate the thorough review of our street preservation efforts. PDOT is making every effort to implement the changes already underway as well as those suggested by the audit.

Sincerely,



Susan D. Keil  
Director

Cc: City Council  
Sam Irving, Director, BOM  
John Rist, Business Operations Division Manager, PDOT  
Liane Welch, Street Preservation Division Manager, BOM

## **Attachment A Highways vs. Urban Streets**

### **Highways**

- Promote high speed travel
- Completely divided- no left turn lanes

### **Urban Streets:**

- Separate turning lanes
- Underground utilities- gas, water, sewers, electric, fiber optics, manhole covers
- Storm grates
- Provisions for Multi-modal travel including bike and pedestrian travel:
  - Striped bike lanes
  - Pedestrian crossings at intersections and mid-block
  - Medians and curb extensions to enhance pedestrian crossings
- Short blocks
- Cul-de-sacs
- Driveways
- On-street parking
- Street trees- trim as necessary
- Landscaping strips and other traffic control devices
- Traffic control
- Buried traffic signal wiring/ loops
- Existing light rail and streetcar tracks
- Abandoned and buried rail tracks





**Audit Services Division  
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*Street Paving: More proactive maintenance could preserve additional city streets within existing funding*

Report #324B, July 2006

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**Other recent audit reports:**

*Portland Development Commission: Economic development efforts effective, but improvements needed to measure and manage future success (#322, June 2006)*

*Street Paving: City needs to demonstrate least cost (#324A, May 2006)*

*Partial Day Leave for exempt employees: Clarification would improve policy (#327, May 2006)*

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