Dave Yost • Auditor of State

The State of Ohio, Auditor of State

Ohio Department of Transportation Performance Audit June 2015

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Dave Yost • Auditor of State

To the Governor's Office, General Assembly, Director and Staff of the Ohio Department of Transportation, Ohio Taxpayers, and Interested Citizens:

It is my pleasure to present to you this performance audit of the Ohio Department of Transportation (ODOT or the Department). This service to ODOT and to the taxpayers of the state of Ohio is being provided pursuant to Ohio Revised Code § 117.46 and is outlined in the letter of engagement signed March 10, 2015.

This audit includes an objective review and assessment of selected program areas within ODOT in relation to surrounding states, industry standards, and recommended or leading practices. The Ohio Performance Team (OPT) of the Auditor of State's (AOS) office managed the project and conducted the work in accordance with Generally Accepted Government Auditing Standards.

The objectives of this engagement were completed with an eye toward analyzing the Department, its programs, and service delivery processes for efficiency, cost-effectiveness, and customer responsiveness. The scope of the engagement was confined to the area of Fleet Management.

This report has been provided to ODOT and its contents have been discussed with Department leadership, division leadership, program specialists, and other appropriate personnel. The Department is reminded of its responsibilities for public comment, implementation, and reporting related to this performance audit per the requirements outlined under ORC § 117.461 and § 117.462. The Department is also encouraged to use the results of the performance audit as a resource for improving overall operational efficiency as well as service delivery effectiveness.

Sincerely,

Dave Yost

Dave Yost
Auditor of State

June 9, 2015

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I. Engagement Purpose and Scope

Ohio Revised Code (ORC) § 117.46 provides that the Auditor of State (AOS) shall conduct performance audits of at least four state agencies each budget biennium. In consultation with the Governor and the Speaker and Minority Leader of the House of Representatives and the President and Minority Leader of the Senate, the Auditor of State selected the Ohio Department of Transportation (ODOT or the Department) for audit during the fiscal year (FY) 2013-15 Biennium, encompassing FY 2013-14 and FY 2014-15.

Prior to the formal start of the audit, the Ohio Performance Team (OPT) and ODOT engaged in a collaborative planning process which included initial meetings, discussion, and assessments. Based on these planning activities AOS and ODOT signed a letter of engagement, marking the official start of the performance audit, effective March 10, 2015.

The letter of engagement established that the objective of the audit was to review and analyze selected areas of ODOT operations to identify opportunities for improvements to economy, efficiency, and/or effectiveness.

The letter of engagement led to OPT planning and scoping work, in consultation with ODOT, which identified the following scope area: **Fleet Management**

This operational area comprises the scope of the audit as reflected in this report.

Based on the established scope, OPT engaged in supplemental planning activities to develop detailed audit objectives for comprehensive analysis. See **Section VIII: Audit Scope and Objectives Overview** for an overview of this scope area and audit objectives.

II. Performance Audit Overview

The United States Government Accountability Office develops and promulgates Government Auditing Standards that provide a framework for performing high-quality audit work with competence, integrity, objectivity, and independence to provide accountability and to help improve government operations and services. These standards are commonly referred to as generally accepted government auditing standards (GAGAS).

Performance audits are defined as engagements that provide assurance or conclusions based on evaluations of sufficient, appropriate evidence against stated criteria, such as specific requirements, measures, or defined business practices. Performance audits provide objective analysis so that management and those charged with governance and oversight can use the information to improve program performance and operations, reduce costs, facilitate decision making by parties with responsibility to oversee or initiate corrective action, and contribute to public accountability.

OPT conducted this performance audit in accordance with GAGAS. These standards require that OPT plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for findings and conclusions based on the audit objectives. OPT believes that the evidence obtained provides a reasonable basis for our findings and conclusions based on the audit objectives.

III. Methodology

To complete this report, AOS staff worked closely with ODOT staff to gather data and conduct interviews to establish current operating conditions. This data and information was reviewed with staff at multiple levels within ODOT to ensure accuracy and reliability. Where identified, weaknesses in the data obtained are noted within the report where germane to specific assessments.

To complete the assessments, as defined by the audit scope and objectives, OPT identified sources of criteria against which current operating conditions were compared. Though each source of criteria is unique to each individual assessment there were common sources of criteria included across the audit as a whole. These common sources of criteria include: statutory requirements such as contained in ORC or Ohio Administrative Code (OAC), ODOT internal policies and procedures, other State agency policies and procedures, industry standards, and government and private sector leading practices. Although OPT reviewed all sources of criteria to ensure that their use would result in reasonable, appropriate assessments, OPT staff did not conduct the same degree of data reliability assessments as were performed on data and information obtained from ODOT.

The performance audit process involved information sharing with ODOT staff, including preliminary drafts of findings and proposed recommendations related to the identified audit scope and objectives. Status meetings were held throughout the engagement to inform the Department of key issues, and share proposed recommendations to improve or enhance operations. Input from the Department was solicited and considered when assessing the selected areas and framing recommendations. The Department provided verbal and written comments in response to various recommendations, which were taken into consideration during the reporting process. Where warranted, the report was modified based on agency comments.

This audit report contains recommendations that are intended to provide the Department with options to enhance its operational economy, efficiency, and effectiveness. The reader is encouraged to review the recommendations in their entirety.

IV. ODOT Overview

Responsibilities and Mission

ODOT is a cabinet-level Department and, as such, the Director of Transportation (the Director) is appointed by, and serves at the pleasure of, the Governor. As a State agency, ODOT is charged with overseeing the planning, construction, and maintenance of the State's transportation infrastructure. In doing so, ODOT plans, designs, constructs, and maintains the State's network of highways and bridges and provides financial and technical assistance to the State's public transit systems, general aviation airports, and railways.

The Department's mission is "To provide easy movement of people and goods from place to place, we will:

- Take care of what we have;
- Make our system work;
- Improve safety; and
- Enhance capacity."

Specific ODOT duties are outlined in ORC § 5501.03 and include duties to:

- Coordinate and develop, in cooperation with local, regional, state, and federal planning agencies and authorities, comprehensive and balanced state policy and planning to meet present and future needs for adequate transportation facilities in this state, including recommendations for adequate funding of the implementation of such planning;
- Coordinate activities with those of other appropriate state departments, public agencies, and authorities, and enter into any contracts with such departments, agencies, and authorities as may be necessary to carry out its duties, powers, and functions;
- Cooperate with and assist the public utilities commission in the commission's administration of sections 4907.47 to 4907.476 of the Revised Code, particularly with respect to the federal highway administration;
- Cooperate with and assist the Ohio power siting board in the board's administration of Chapter 4906 of the Revised Code;
- Give particular consideration to the development of policy and planning for public transportation facilities, and to the coordination of associated activities.

- Conduct, in cooperation with the Ohio Legislative Service Commission, any studies or comparisons of state traffic laws and local traffic ordinances with model laws and ordinances that may be required to meet program standards adopted by the United States department of transportation pursuant to the "Highway Safety Act of 1966," 80 Stat. 731, U.S.C.A. 401;
- Prepare, print, distribute, and advertise books, maps, pamphlets, and other information that, in the judgment of the director, will inform the public and other governmental departments, agencies, and authorities as to the duties, powers, and functions of the department; and
- Consider technologies for improving safety, mobility, aviation and aviation education, transportation facilities, roadways, including construction techniques and materials to prolong project life, being used or developed by other states that have geographic, geologic, or climatic features similar to this state's, and collaborate with those states in that development.

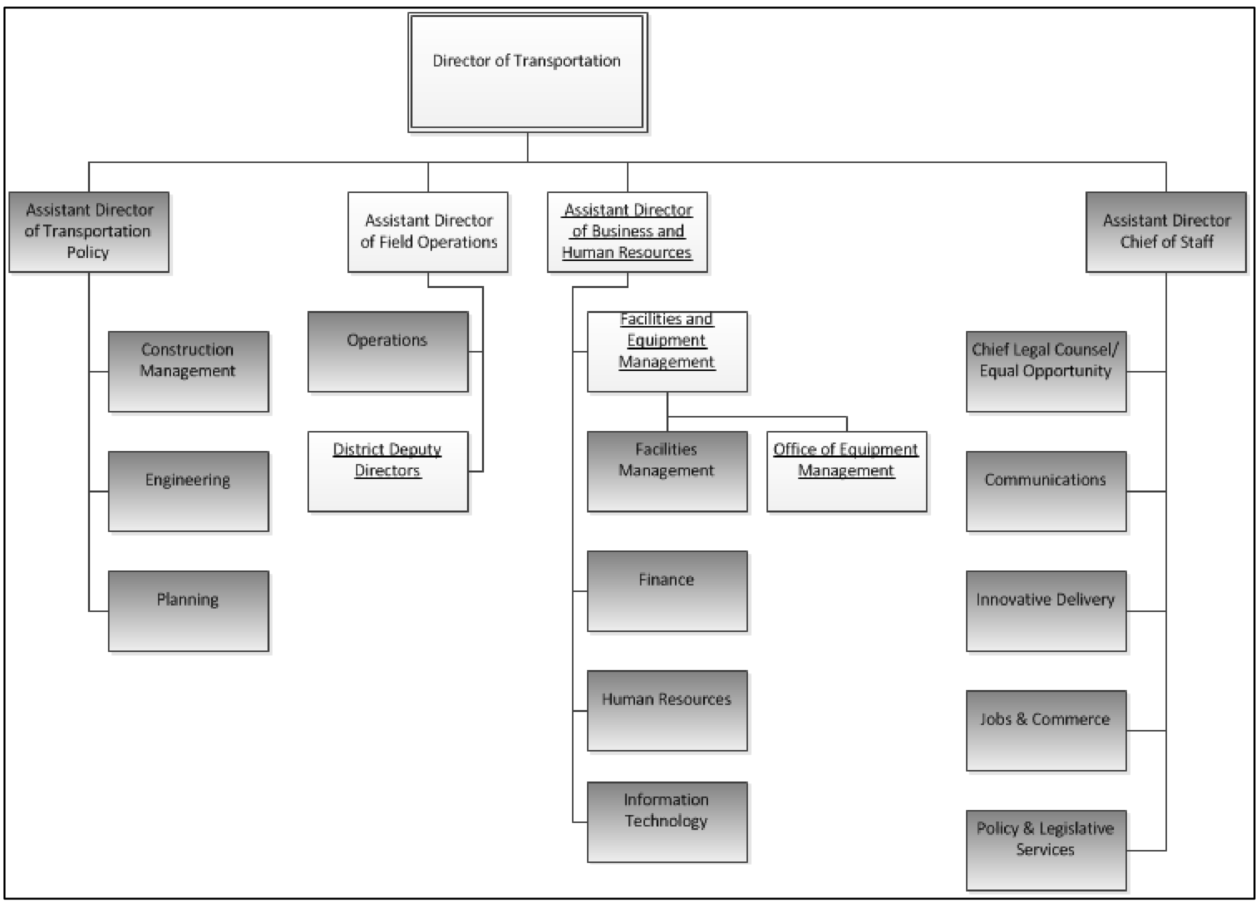
ODOT duties that are most germane to this report are outlined in ORC § 5513.01, which allows the Director of Transportation to purchase supplies and materials, including vehicles, and ORC § 5513.04 which allows the Director to “sell, transfer, or otherwise dispose of any item of personal property that is not needed by the Department of Transportation.”

Organizational Structure

Within ORC Title 55: Roads - Highways - Bridges, ORC § 5501.02 authorizes that, "all duties, powers, and functions conferred by law on the Department of Transportation and the divisions of the Department shall be performed under such rules as the Director of Transportation may prescribe, and shall be under the director's control. The Director shall appoint such employees of the Department as are necessary, and shall prescribe their titles and duties."

ODOT carries out its statutory responsibilities, mission, and mission components through 13 main operating divisions and offices which include: Construction Management, Engineering, Planning, Operations, Facilities and Equipment Management, Finance, Human Resources, Information Technology, Chief Legal Counsel/Equal Opportunity, Communications, Innovative Delivery, Jobs and Commerce, Policy and Legislative Services.

The following graphic illustrates both the basic organizational structure and the leadership hierarchy of the Department. Key to the scope and objectives of this performance audit are the day-to-day responsibilities for fleet management. These roles are specifically within the purview of ODOT's Office of Equipment Management and district deputy directors and assigned staff.



Note: While shaded positions and functional areas are customers and stakeholders of the fleet, underlined positions and functional areas have specific day-to-day operational oversight of the fleet.

Organizational History

Since its formal establishment, ODOT has had a long and varied history and today's Department, both in structure and function, is a product of evolving statutory roles and responsibilities. The first iteration of ODOT was referred to as the Ohio Department of Highways and was established on February 15, 1905 with a budget of $10,000. In 1933, the Department organized the first highway patrol. The Department of Highways grew rapidly during the late 1940s and through the 1950s as an increased emphasis was placed on the construction of the interstate highway system. In 1972 the Department of Highways was dissolved and the modern Department of Transportation was created to facilitate greater coordination between the maintenance and construction of different types of transportation.

The history and organizational change shown here is just a snapshot of the changes that have occurred over time and will likely continue to occur in the future. However, when examining the organizational structure and alignment of responsibilities and functions within the Department, the historically dynamic nature of both should be taken into account.

Staffing and Budgetary Resources

ODOT is Ohio's second largest agency in terms of employees by headcount, with a staff of approximately 5,400 located in 12 districts throughout the state, as well as a Central Office in Columbus, Ohio. ODOT's total appropriated budget for the FY 2015-17 biennium is $2.88 billion for FY 2015-16 and $2.99 billion for FY 2016-17. However, as noted in context of ODOT's table of organization, day-to-day management of the fleet is handled by a portion of staff within ODOT's larger organization. Furthermore, in relation to the Department's total budget, between FY 2009-10 and FY 2013-14 ODOT spent between $16.0 and $18.8 million annually to operate the light fleet, which ODOT defines as passenger vehicles and utility and dump trucks up to 1 ton (i.e., "light dump trucks").[1]

[1] 1 ton dump trucks and 1 ton utility vehicles are larger and heavier than standard passenger vehicles but both trucks are based on a standard, 1 ton pickup truck frame such as a Ford F350 or Chevrolet 3500. Because these vehicles are smaller than the larger dump trucks in ODOT's fleet and also mechanically similar to more traditional pickup trucks, ODOT considers these vehicles to be "light" relative to the larger and more specialized vehicles in the fleet.

V. Summary of Recommendations and Impact

The following table shows performance audit recommendations for **Fleet Management** and total financial implications for this report.

Table V-1: Summary of Section Recommendations and Impact

Report Section	Recommendations	Annual Impact
Fleet Management		
• Blended Biodiesel	**R.1**	$202,475
• Auction Analysis	**R.2**	$126,898
• Fleet Cycling	**R.3**	$1,426,840
Adjusted Impact of Offsetting Recommendations [1]		($126,898)
Adjusted Total Financial Implication		**$1,629,315**

[1] In totaling the financial implications from this report, the financial implication of **R.2** was subtracted from **R.3** because both recommendations assume optimized auction performance and the same vehicles used to calculate **R.2** are also used in **R.3**. However, fully implementing **R.3** is expected to take several years, whereas implementing **R.2** would allow the Department to begin to see improved auction performance immediately.

VI. Audit Results

The performance audit identified recommendations within the scope area of **Fleet Management** and is presented in three separate sections including:

- **Blended Biodiesel:** This section focuses on ODOT's current use of blended biodiesel and analyzes how use of this type of fuel contributes to additional maintenance costs.
- **Auction Analysis:** This section focuses on ODOT's vehicle auctions and analyzes how implementation of leading practices could result in improved asset sale values.
- **Fleet Cycling:** This section focuses on ODOT's vehicle cycling practices and analyzes the financial benefits associated with implementation of leading practices.

Recommendations Overview

Recommendation 1.1 ODOT should work with the General Assembly to eliminate the mandate to use blended biodiesel.

Financial Implication of 1.1 ODOT can reduce unscheduled filter repairs by **$202,475** annually by eliminating the use of blended biodiesel.

Recommendation 1.2: ODOT should adopt leading practices to optimize cost recovered through vehicle and equipment auctions.

Financial Implication 1.2: Achieving results similar to those of DAS will improve residuals for common vehicles by **$126,898** annually.

Recommendation 1.3: ODOT should adopt optimized fleet cycling guidelines that promote the most financially efficient operation of the fleet. Specific guidelines include:

- **4 Years and 48,000 Miles – Passenger Cars, 1/4 Ton SUVs, and 1 Ton Pickup Trucks;**
- **5 Years and 60,000 Miles – 1/2 Ton SUVs, 1/2 Ton Pickup Trucks, and 3/4 Ton Pickup Trucks;**
- **6 Years and 72,000 Miles – Minivans and 1 Ton Passenger Vans;**
- **7 Years and 84,000 Miles – Cargo Vans;**
- **10 Years and 100,000 Miles – Light Dump Trucks; and**
- **11 Years and 132,000 Miles –Utility Trucks (3/4 and 1 Ton).**

Further, each vehicle approaching these parameters should be thoroughly reviewed on a cost-per-mile basis to determine whether or not it is more cost effective to retain or replace. Finally, vehicles nearing the end of service life should be promptly salvaged to capture maximum residual value.

Financial Implication 1.3: Each year the proposed cycling models are fully in place, ODOT could save **$1,426,840** in reduced operating costs and increased salvage values.

See **Section IX: Abbreviated Terms and Acronyms** for a list of acronyms used throughout this report.

VII. Fleet Management Background

The Ohio Department of Transportation (ODOT or the Department) holds a fleet of 4,718 vehicles that are used to support various aspects of statewide operations.[2] ODOT's fleet management authority is delegated from the Ohio Department of Administrative Services (DAS) in accordance with Ohio Revised Code (ORC) § 125.832(G) because ODOT holds over 100 vehicles and also has a DAS-certified fleet manager. ODOT's fleet is managed by the Office of Equipment Management (OEM) in cooperation with district managers (at the direction of district deputy directors). OEM works with district managers to develop fleet policies and procedures (e.g., utilization expectations, replacement criteria, record keeping, etc.) that are consistent with DAS policies as well as relevant ORC and Ohio Administrative Code (OAC) sections. District managers, in turn, are responsible for executing the policies established by OEM as well as communicating district specific fleet concerns with OEM.

ODOT's operational responsibilities include the construction and maintenance of the State's transportation infrastructure including state routes and interstate highways. ODOT's complex array of responsibilities necessitates a large and varied fleet. General use vehicles typically include pickup trucks ranging from 1/2 ton to 1 ton as well as passenger sedans, minivans, and SUVs. In addition, the Department also operates more specialized vehicles such as heavy dump trucks which are used mainly for snow and ice controls and utility trucks which are used to support various maintenance and construction activities.

Table 1-1 shows the count and percent distribution of all vehicles by type for fiscal year-to-date (FYTD) 2014-15. Additionally, the cumulative percentage provides context for the concentration of the distribution of vehicles by type. This type of overview demonstrates that, although ODOT's fleet is large, the majority of units are heavily concentrated within just a few vehicle types. While this table shows all vehicles in ODOT's inventory to provide full perspective, the scope of this audit is focused specifically light vehicles such as passenger vehicles, pickup trucks, utility trucks, and light dump trucks.

[2] This count includes active vehicles as of March 2015, but excludes vehicles that have been selected for auction as well as equipment such as back hoes, tractors, skid steer loader, etc.

Table 1-1: ODOT Active Vehicles FYTD 2014-15

Type	Description	Count of Unit	% of Total	Cumulative %
254	Dump Truck, 25,000-35,000 GVW [1]	1,137	24.1%	24.1%
221	Pickup, 1/2 Ton	1,102	23.4%	47.5%
256	Dump Truck, Tandem Axle	600	12.7%	60.2%
222	Pickup, 3/4 Ton	407	8.6%	68.8%
101	Sedan, Standard	343	7.3%	76.1%
223	Pickup, 1 Ton	208	4.4%	80.5%
253	Dump Truck, 10,000-24,999 GVW	140	3.0%	83.5%
213	Utility Truck 1 Ton	122	2.6%	86.1%
330	Bucket, Aerial, Hyd. Mtd.	91	1.9%	88.0%
201	Van, Mini, Passenger	80	1.7%	89.7%
214	Utility Truck 3/4 Ton And Over	66	1.4%	91.1%
231	Stake, 1 Ton, Standard	66	1.4%	92.5%
203	Van, Cargo	61	1.3%	93.8%
233	Stake, 1 1/2 & Over, Standard	56	1.2%	95.0%
262	Truck Tractor, Over 50,000 GVW	49	1.0%	96.0%
132	1/4 Ton, 4 Wheel Drive	47	1.0%	97.0%
234	Stake, 1 1/2 & 2 Ton, W/Lift gate	42	0.9%	97.9%
232	Stake, 1 Ton, W/Lift gate	31	0.7%	98.6%
204	Van, 1 Ton, 12-15 Passenger	28	0.6%	99.2%
133	Pass. Vehicle 1/2 Ton All Terrain	20	0.4%	99.6%
202	Van, 3/4 Ton, 8-12 Passenger	9	0.2%	99.8%
258	Stake Truck, Multi-Use	5	0.1%	99.9%
242	Wrecker	3	<0.1%	≈100.0%
241	Welder, Truck	3	<0.1%	≈100.0%
113	Station Wagon, Carry/All	2	<0.1%	100.0%
Total Active Vehicles		**4,718**	**100.0%**	**N/A**

Source: OEM
Note 1: ODOT active vehicle count is as of March 2015.
Note 2: Shading represents vehicle types that cumulatively account for more than 80.0 percent of the active fleet.
[1] GVW stands for gross vehicle weight and refers to the weight of the vehicle including a full load at maximum capacity.

As shown in **Table 1-1**, six types of vehicles account for over 80 percent of the total fleet. These six vehicle types include:

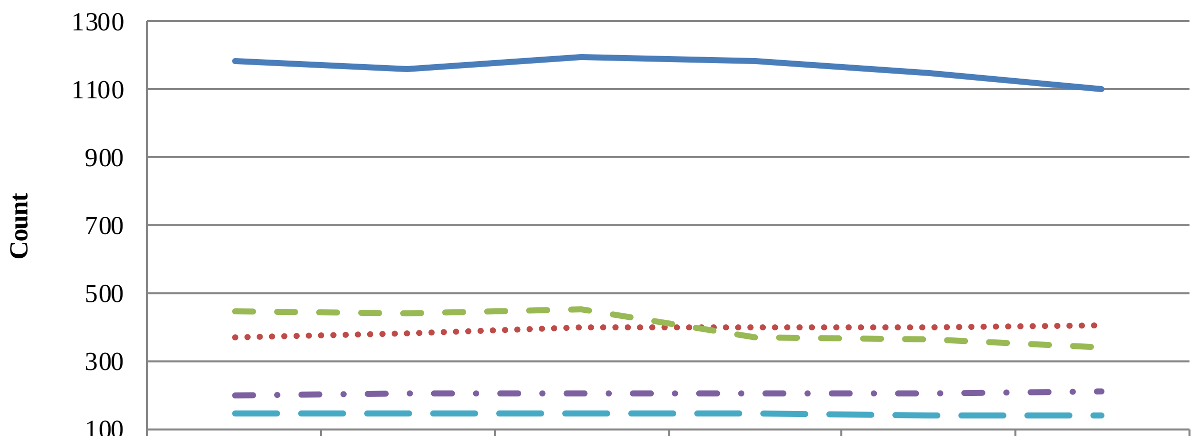
- **Type 254, Heavy Dump Trucks –** These are used primarily for snow and ice control and account for 1,137 total units or 24.1 percent of the active fleet.
- **Type 221, 1/2 Ton Pickup Trucks –** These are widely used for a variety of applications across the Department and account for 1,102 total units, or 23.4 percent of the active fleet.
- **Type 256, Tandem Axle Dump Trucks –** These are larger than type 254 vehicles. They are used for both snow and ice control and construction and maintenance functions and account for 600 total units or 12.7 percent of the active fleet.
- **Type 222, 3/4 Ton Pickup Trucks –** These are widely used for general construction and maintenance activities, and account for 407 total units or 8.6 percent of the active fleet.

- **Type 101, Passenger Sedans –** These are used for general transportation and account for 343 total units or 7.3 percent of the active fleet.
- **Type 223, 1 Ton Pickup Trucks –** These are used to support maintenance and construction operations and account for 208 total units or 4.4 percent of the active fleet.

Over the past five fiscal years ODOT has taken action to reduce its inventory of light vehicles based on age, mileage, and utilization criteria. In total, the Department has decreased its inventory of light vehicles from 2,839 in FY 2009-10 to 2,633 as of FYTD 2014-15, a decrease of 206 units or 7.3 percent.

Chart 1-1 shows an example of the changes over time in five common types of vehicles which are included in the audit scope. This chart demonstrates that ODOT's fleet has changed by highlighting the generally downward trend in the ownership for passenger sedans, 1/2 ton pickup trucks, 3/4 ton pickup trucks (though only a slight decrease), while also showing that 1 ton pickup trucks and light dump trucks have remained relatively stable over the same time period.

Chart 1-1: Example Ownership Trends FY 2009-10 to FYTD 2014-15[1]



	2010	2011	2012	2013	2014	2015
221	1185	1157	1192	1182	1150	1102
222	370	384	397	399	398	407
101	445	440	451	372	361	343
223	201	205	206	205	207	208
253	144	146	148	146	139	140

Source: OEM

Note: The following vehicle types are included in this chart: 1/2 ton pickup trucks (221s), 3/4 ton pickup trucks (222s), passenger sedans (101s), 1 ton pickup trucks (223s), and light dump trucks (253s).

[1] The vehicle count for each year is based on the count of unique equipment numbers for each vehicle type for each fiscal year. These counts represent a snapshot in time and overall inventory levels can vary throughout the year as new vehicles are purchased and older vehicles are cycled out.

As shown in **Chart 1-1**, passenger sedans (type 101) and 1/2 ton pickup trucks (type 221) have decreased the most between FY 2009-10 and FYTD 2014-15. ODOT has reduced the inventory of passenger sedans by 102 units, or 22.9 percent, while 1/2 ton pickup trucks have been reduced by 83 units, or 7.0 percent.

1. Blended Biodiesel

Section Overview

This section focuses on ODOT's current use of blended biodiesel and analyzes how use of this type of fuel contributes to additional maintenance costs. In a prior performance audit, OPT reported on the direct costs incurred due to the purchase of blended biodiesel as a result of the legislative mandate. This section takes a closer look at the financial cost of the mandate by analyzing a portion of the maintenance costs that are incurred due to the use of blended biodiesel.

During the course of this audit, ODOT submitted a FY 2016-18 biennium budget to the General Assembly that eliminated the biodiesel requirement from ORC § 125.834. The General Assembly approved this language and the Governor signed the transportation bill on April 1, 2015. With the elimination of the mandate, ODOT plans to completely discontinue the use of blended biodiesel by the end of FY 2015-16.

Recommendation Overview

Recommendation 1.1 ODOT should work with the General Assembly to eliminate the mandate to use blended biodiesel.

Financial Implication of 1.1 ODOT can reduce unscheduled filter repairs by **$202,475** annually by eliminating the use of blended biodiesel.

Background

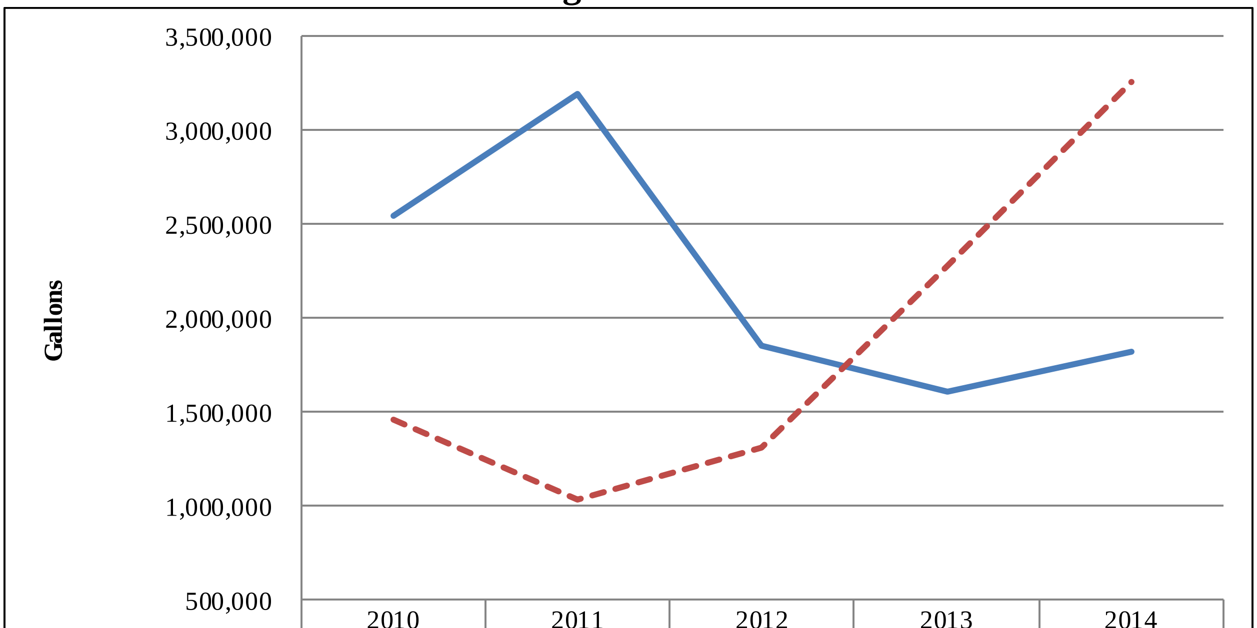
ORC § 125.834(C) requires DAS to purchase, at minimum, one million gallons per year of blended biodiesel, beginning in FY 2006-07 and to increase the amount of blended biodiesel purchased by at least 100,000 gallons per year. ORC § 125.831(C) defines blended biodiesel as a product that is 80 percent petroleum diesel and 20 percent biodiesel, this blend is commonly referred to as B20. As the state agency with the most diesel vehicles, ODOT is responsible for an overwhelming majority of mandated State biodiesel usage. For example, the DAS established goal for blended biodiesel usage in FYTD 2014-15 was 928,426 gallons as of April of 2015. ODOT used 927,734 gallons during the same time period, which is equal to over 99.0 percent of all the blended biodiesel used by State agencies. Prior to FY 2011-12, ODOT focused on using biodiesel extensively and routinely far exceeded the mandated amount.

ODOT leadership and staff report that use of blended biodiesel has historically led to increases in vehicle breakdowns and maintenance expenses. Department staff also noted that during cold weather blended biodiesel can "gel" and cause fuel filters to become clogged. Clogged fuel filters lead to vehicle breakdowns, unscheduled fuel filter replacements, and additional maintenance expense. In addition, ODOT staff also report that fuel storage tanks used for blended biodiesel also require more frequent cleaning and filter replacement and also are more expensive to operate.

Concerns regarding higher maintenance cost associated with the use of blended biodiesel have also been recognized with the energy industry. In a report titled *Recent Research to Address Technical Barriers to Increased Use of Biodiesel* (National Renewable Energy Laboratory, 2005), researchers found biodiesel can increase the cost of maintenance by up to 28.0 percent, and the cost increase can be attributed to extra fuel filter and fuel injector maintenance.

Chart 1-2 shows the amount of regular diesel and blended biodiesel purchased by ODOT from FY 2009-10 to FY 2013-14.

Chart 1-2: Diesel Purchasing Trends FY 2009-10 to FY2013-14



	2010	2011	2012	2013	2014
Biodiesel	2,541,522	3,195,972	1,851,540	1,613,985	1,826,659
Regular Diesel	1,457,407	1,036,153	1,317,259	2,282,878	3,254,397

Source: OEM and DAS, Office of Fleet Management
Note: Regular diesel excludes dyed diesel; a fuel type which is used only for off-road equipment.

As shown in **Chart 1-2**, ODOT decreased the amount of blended biodiesel purchased during the last three complete fiscal years. This decrease in the use of blended biodiesel can be attributed to the aforementioned maintenance issues. ODOT leadership noted that district managers have been granted more operational leeway in recent years with regard to the use of blended biodiesel and some districts have completely switched back to traditional diesel. Overall, the use of blended biodiesel has declined from 75.5 percent of all diesel fuel in FY 2009-10 to just 36.0 percent in FY 2013-14.

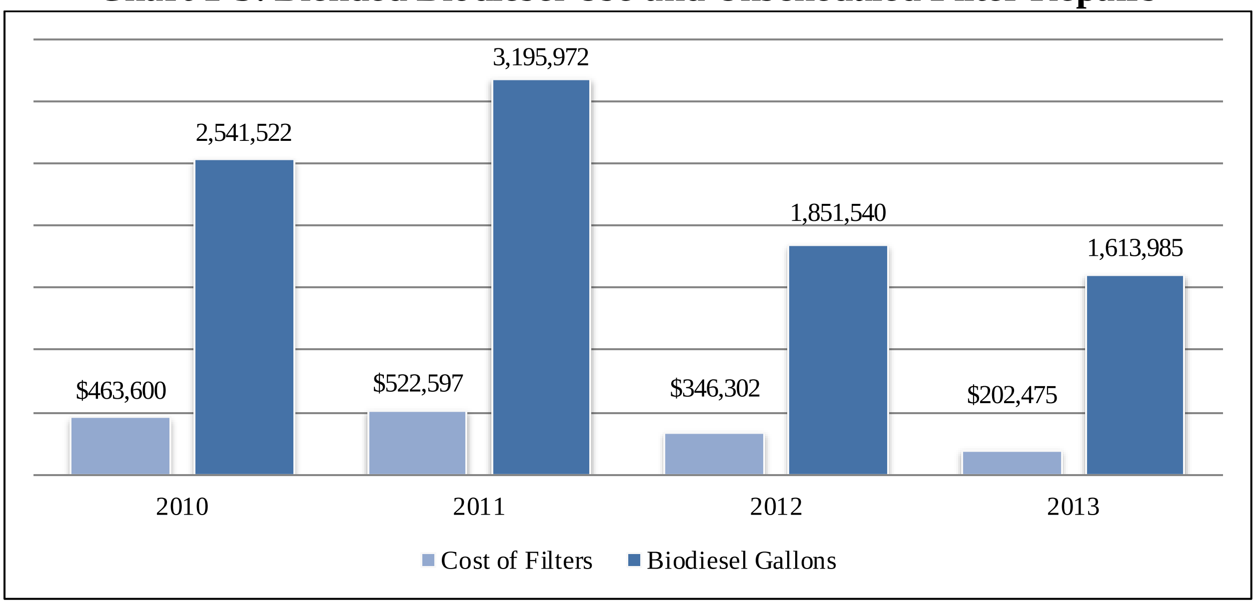
Methodology

An assessment of the maintenance cost of blended biodiesel was requested by ODOT leadership due to internal reports of increased, unplanned maintenance cost related to the use of blended biodiesel. Specifically, Department staff had reported unscheduled fuel filter maintenance as well as a need to replace fuel filters at more frequent intervals due to the use of blended biodiesel. Initial maintenance data was collected and analysis was performed to assess the validity of initial claims. This preliminary analysis led to a focus on the cost associated with unscheduled fuel filter maintenance on large dump trucks. Data for unscheduled fuel filter repairs or replacements was gathered from ODOT's equipment management system (EMS) for FY 2009-10 through FY 2012-13.[3] The cost of unscheduled filter replacements was gathered for each year and compared to the amount of blended biodiesel purchased.

Analysis

Chart 1-3 shows the amount of biodiesel purchased by ODOT from FY 2009-10 to FY 2012-13 compared to the cost of unscheduled filter repairs over the same time period. This analysis demonstrates the relationship between the two factors in that as the amount of blended biodiesel use fluctuates the cost of unscheduled filter repairs also fluctuates. Specifically, as the amount of blended biodiesel use decreased during the last two fiscal years available for analysis the cost of unscheduled filter repairs also decreased.

Chart 1-3: Blended Biodiesel Use and Unscheduled Filter Repairs



Source: OEM

Note: Analysis was limited to the two most common types of diesel trucks in ODOT's inventory, type 254 and type 256 dump trucks. However, these two vehicle types account for 1,737 units or 92.3 percent of all vehicles that use blended biodiesel.

[3] Data for FY 2013-14 was requested, but was unavailable for use in this analysis due to the Department's transitioning of data from EMS to a new management information system.

As shown in **Chart 1-3**, ODOT expended between $463,600 and $202,475 on unscheduled fuel filter repairs from FY 2009-10 to FY 2012-13. With an inventory of 1,737 trucks, unscheduled filter repairs per truck ranged from a high of $300.86 in FY 2010-11 to a low of $116.57 per truck in FY 2012-13. The additional cost of unscheduled filter repairs likely underestimates the full cost of using blended biodiesel because filter issues can disrupt operations, especially during winter months. ODOT tracks the cost of labor associated with the maintenance activities but the Department does not track operational delays that could result from having to find an additional vehicle or the cost of a driver having to wait while a filter is replaced.

One factor that can contribute to additional maintenance expenses with biodiesel could be the legal requirement to use B20. Washington State varies the biodiesel blend based on the season, switching between B20 in the summer and B10, which is 10 percent biodiesel, in the winter. Missouri reports that maintenance issues with biodiesel were mitigated when the state switched to regular diesel during the winter. New Hampshire and Nebraska, which both have winters similar to Ohio, use B5 and B2, respectively, and both states report no major maintenance issues. Researchers have found that low percentage biodiesel mixtures may be the optimum type of biodiesel in most circumstances (Xue, Grift, & Hansen, 2011).[4]

Conclusion

ODOT's use of blended biodiesel is linked to the increase in unscheduled fuel filter replacements and additional maintenance costs. Furthermore, research and other states' practices identifies that the year-round use of B20 blended biodiesel is sub-optimal from a maintenance, operation, and cost standpoint.

Recommendation 1.1 ODOT should work with the General Assembly to eliminate the mandate to use blended biodiesel.

Financial Implication of 1.1 ODOT can reduce unscheduled filter repairs by **$202,475** annually by eliminating the use of blended biodiesel.

[4] Xue, J., Grift, T. E., & Hansen, A. C. (2011). Effects of biodiesel on engine performances and emissions. Renewable and Sustainable Energy Review, 1098-1116.

2. Auction Analysis

Section Overview

This section focuses on ODOT's vehicle auctions and analyzes how implementation of leading practices could result in improved asset sale values.

Recommendation Overview

Recommendation 1.2: ODOT should adopt leading practices to optimize cost recovered through vehicle and equipment auctions.

Financial Implication 1.2: Achieving results similar to those of DAS will reduce the cost of ownership for common vehicles by **$126,898** annually.

Background

ORC § 125.02 identifies DAS as the authority over purchasing supplies for all cabinet-level agencies. In accordance with this requirement, ODOT purchases new vehicles through DAS, at state contract prices, which are typically below the manufacturers' suggested retail prices. Other agencies with large fleets, such as the Ohio Department of Natural Resources (ODNR), send vehicles to auction through DAS. ODOT does not use DAS, but instead auctions surplus vehicles itself. ODOT's authority to conduct auctions separate from DAS is derived from ORC § 5513.04, which allows the Director of Transportation to "sell or transfer any structure, machinery, tools, equipment, parts, material, office furniture, or supplies unfit for use or not needed by the Department of Transportation."

ODOT vehicles that have reached the end of the expected lifecycle are sold via an online auction website. The auction website is maintained by a third-party vendor and the vendor charges 7.5 percent of each vehicle's sale price as a fee for service. Services provided by the vendor include: photographing vehicles and uploading pictures to the auction website, administering the auction, and collecting money from the buyers.

Table 3-1 shows the annual count of vehicles salvaged as well as the average age and average final odometer reading for the three most common vehicle types in ODOT's inventory. This table demonstrates that the number of vehicles salvaged has increased during the last five complete fiscal years.

Table 1-2: Example Salvage Vehicles FY 2009-10 to FY 2013-14

Type	Count	Avg. Age at Salvage	Avg. Final Odometer
Passenger Sedans			
FY 2009-10	3	11.0	133,278
FY 2010-11	30	11.2	143,493
FY 2011-12	24	11.7	143,888
FY 2012-13	91	11.7	137,864
FY 2013-14	36	10.5	131,566
Average	**37**	**11.2**	**155,917**
1/2 Ton Pickup Trucks			
FY 2009-10	18	11.4	139,749
FY 2010-11	52	11.9	153,531
FY 2011-12	71	13.3	152,646
FY 2012-13	116	13.1	161,922
FY 2013-14	75	12.7	155,259
Average	**66**	**12.5**	**163,214**
3/4 Ton Pickup Trucks			
FY 2009-10	7	9.3	129,276
FY 2010-11	7	14.3	147,883
FY 2011-12	8	12.9	147,119
FY 2012-13	34	13.9	175,736
FY 2013-14	18	12.3	165,877
Average	**15**	**12.5**	**153,178**

Source: OEM

As shown in **Table 1-2**, the number of vehicles salvaged for each of these three vehicle types generally increased each year from FY 2009-10 through FY 2013-14 as ODOT focused on reducing the size of the fleet. At that same time the average age and average odometer at salvage also generally declined as ODOT continues to focus on improving the cost effectiveness of fleet management. For example, Department leadership identified that in moving toward a 90,000 miles at salvage goal for passenger sedans it should reach an average of 120,000 miles per vehicle within the next two years.

Methodology

Data for this section was taken from ODOT auctions from FY 2009-10 to FY 2013-14 and DAS auctions of vehicles previously owned by ODNR from FY 2008-09 to FY 2012-13.ODNR was used as a reference because ODNR and ODOT each operate large fleets at multiple statewide locations. Both agencies also operate a mix of passenger sedans, SUVs, minivans, 1/2 ton pickup trucks, and 3/4 ton pickup trucks. For each vehicle, the actual price obtained at auction was compared to the National Auto Dealers Association (NADA) average trade-in value of a vehicle of identical make, model, age, and mileage. NADA was used as a source because it is considered an industry standard and is recommended by DAS, Office of Fleet Management as a resource for judging the value of used vehicles. The relationship between the auction value and NADA represents a 'capture rate'. The capture rate of ODOT auctions was then compared to the capture rate of DAS auctions to determine if opportunities exist to improve financial performance.

Analysis

Table 1-3 shows the NADA average trade-in value capture rate experienced by ODOT and DAS auctions for three common types of vehicles. NADA values are an industry benchmark of the expected trade-in values. As such, the difference between the capture rate experienced by ODOT and DAS represents an opportunity to capture more residual dollars on each vehicle. Increasing the residual value also works to reduce the overall cost of ownership for a given vehicle.

Table 1-3: ODOT and DAS Auction Capture Rates Comparisons

Vehicle Type	ODOT Capture Rate	DAS Capture Rate	Difference
Passenger Sedans	73.7%	144.4%	(70.7%)
1/2 Ton Pickup Trucks	40.8%	79.8%	(39.0%)
3/4 Ton Pickup Trucks	37.7%	56.4%	(18.7%)

Source: OEM and DAS, Office of Fleet Management

Note: Capture rates are expressed as the average percentage of the estimated NADA trade-in value obtained in each vehicle sale.

As shown in **Table 1-3**, ODOT's online auctions consistently under-perform relative to DAS' centralized, live auctions for similar age and mileage vehicles. The Department's underperformance ranges from as low as 18.7 percentage points below the DAS average for 3/4 ton pickup trucks to as high as 70.7 percentage points below the DAS average for passenger sedans and 39.0 percent for 1/2 ton pickup trucks.

As previously noted, a key difference in this comparison is the two auction methods; online and decentralized versus live and centralized. These differences are consistent with academic research on auction strategies. For example, in *Towards a competitive arousal model of decision-making: A study of auction fever in live and Internet auctions* (Ku, Malhotra, & Murnighan, 2005), researchers found that a psychological phenomenon causes participants in live auctions to bid more for the same commodity when compared to bidders in online auctions.[5] This explanation fits with the observed auction results from live DAS auctions when compared to ODOT's online system. Other factors that may contribute to DAS auction performance include:

- **Location:** DAS is located in Columbus, Ohio which is the largest population center in the State. As such, there is a large potential customer base with easy access to the auction. In the publication, *2014 Used Car Market Report* (Manhiem, 2014), Manhiem consulting found auction locations can have a significant impact on the price of vehicle sold.
- **Number of Vehicles:** DAS is able to handle up to 240 vehicles per auction and typically holds auctions only when the maximum number of vehicles are available. This leads to a larger auction with a greater variety of vehicles that may attract a larger group of

[5] Ku, G., Malhotra, D., & Murnighan, J. K. (2005). Towards a Competitive Arousal Model of Decision-Making: A Study of Auction Fever in Live and Internet Auctions. *Organizational Behavior and Human Decision Processes*, 89-103

potential buyers. In contrast, ODOT holds auctions, generally on a district-by-district basis with a smaller number of available vehicles. For example, District 8, which covers much of the Cincinnati metropolitan area, holds auctions with just 20 vehicles. ODOT leadership believes that the Department could generate more interest in auctions by waiting until more vehicles have been collected or by consolidating district auctions into regional auctions held near or in larger metro areas.

- **Reserve Price:** Researchers have discovered that setting a reserve price can increase the revenue received at auctions (Reily, 2006).[6] DAS typically sets a reserve price of 60.0 percent of NADA value.[7] In contrast, ODOT typically starts vehicles bidding at $100, regardless of the NADA value.

Table 1-4 shows district-to-district auction value variation for the most common vehicle types sold over the last five complete fiscal years. This type of analysis helps to further illustrate the impact that low volume or poor location at some districts has on the overall ODOT average capture rate.

Table 1-4: District Capture Rate Performance FY 2009-10 to FY 2013-14 [1]

Vehicle Type	Avg. Capture Rate [2]	Districts Below Avg.	Districts Above Avg.
Passenger Sedans	73.7%	1,2,3,4,5,6,11	7,8,9,10,22
1/2 Ton Pickup Trucks	40.8%	1,2,3,4,6,7,11	5,8,12,22
3/4 Ton Pickup Trucks	37.7%	2,3,6,12	1,4,7,8,10,11

Source: OEM and DAS
Note: District 22 is the ODOT Central Office in Columbus, Ohio.
[1] Districts that do not appear in an analysis for a particular type either sold no vehicles of that type during the timeframe in question or sold so few vehicles that a useful analysis could not be conducted.
[2] This is the ODOT average percentage of NADA trade-in value captured for each vehicle type.

As shown in **Table 1-4**, districts such as 2, 3, and 6 consistently underperform when it comes to capture rates; whereas districts 7, 10, and 22 perform well with some vehicles.[8] District 8 captures above average residuals for each of the three major vehicle types. This suggests that ODOT might be able to improve auction performance by either adopting practices from high performing districts or by shifting vehicles to better performing districts.

ODOT does not have a practice of analyzing historical auction performance and District 8 was unable to identify specific practices that could be contributing to above average performance. One factor that could influence the auction outcomes could be the number of potential buyers within close geographic proximity to the auction site.[9] Although the auction is held online, potential buyers are permitted to visit the ODOT garage and inspect vehicles before the bidding begins. Also, buyers are responsible for transporting the vehicles after the auction ends. For this

[6] Reily, D. H. (2006). Field Experiments on the Effects of Reserve Prices in Auctions: More Magic on the Internet. The RAND Journal of Economics, 37(1), 195-211.
[7] Though DAS typically uses a 60.0 percent reserve price, the auctioneer is given leeway to adjust the reserve price down based on vehicle age, mileage, condition, and/or other factors.
[8] District 22 is the ODOT Central Office which encompasses Columbus and the surrounding metropolitan area.
[9] District populations reflect the sum of the population of each county within a given district's purview. County populations are from the U.S. Census Bureau.

reason, the number of potential buyers within the district could impact the auction price. In the case of passenger sedans, three out of the five high performing districts, or 60.0 percent, are districts which each have a combined population of over 1 million residents.[10] For 1/2 ton pickup trucks, three out of four high performing districts, or 75.0 percent, have populations in excess of 1 million residents. The results of 3/4 ton pickup truck auctions are more mixed, which may be attributed to the fact that 3/4 ton pickup trucks are a more specialized type of vehicle. Overall, this analysis demonstrates that the demand for used vehicles may not be equal in all districts and there could be opportunities to improve auction performance by measuring auction outcomes and shifting used vehicles in such a way as to take advantage of local demand.

Table 1-5 shows the potential financial impact from improving ODOT's auction performance to achieve results similar to those achieved by DAS. This table uses data from FY 2013-14 (see **Table 1-2**) as a baseline for expected age and mileage at time of salvage, as well as an expectation of the number of vehicles salvaged per year.

Table 1-5: Financial Impact of Improving Auction Performance

Vehicle Type	Count	Expected Residual Value[1]	Potential Residual Value[2]	Difference	Improved Residual
1/2 Ton Pickup Trucks	75	$1,174	$2,293	$1,119	$83,925
Passenger Sedans	36	$1,280	$2,509	$1,229	$44,244
3/4 Ton Pickup Trucks	18	$1,009	$1,510	$501	$9,018
				Improved Residual Value	**$137,187**
				Net Additional Residual Less Auction Fees[3]	**$126,898**

Source: OEM and DAS, Office of Fleet Management
[1] This is the expected residual value based on ODOT's historical auction performance.
[2] This is the potential residual value if ODOT can match DAS auction performance.
[3] The vendor charges a 7.5 percent service fee of the vehicle price for each unit sold.

As shown in **Table 1-5**, even without drastic improvements in fleet cycling, the Department can increase the residual values and, conversely, decrease the cost of ownership for common vehicles by optimizing auction practices. In doing so, the Department could capture an additional **$126,898** annually by optimizing vehicle auctions for the three most common vehicle types.

Achieving the results shown in **Table 1-5** will require the Department to implement practices used by DAS and recognized by industry standards. ODOT should work with district managers to find appropriate approaches to auction optimization. Strategies that could be tested include:

- **Track Auction Performance –** The Department does not measure the value of vehicles sold at auction relative to industry benchmarks such as NADA or Kelley Blue Book. Better knowledge regarding district-by-district performance relative to industry benchmarks will assist in identifying best practices and also understanding varying demands for used vehicles.
- **Hold Regional Live Auctions –** The Department should pilot a program to combine multiple districts' salvaged inventory into a District near a large metro area (e.g.

[10] This assumes that District 22 has relatively easy access to the population of Franklin County, which the US Census Bureau estimated to be 1.2 million for 2014.

Columbus, Cincinnati, etc.) and conduct a live auction using the practices employed by DAS including setting a reserve price using an industry benchmark such as NADA.

Conclusion

ODOT's vehicle auctions underperform recognized benchmarks for similar vehicle types. The Department can improve auction performance and increase the residual value of older vehicles by adopting leading auction practices such as those used by DAS.

Recommendation 1.2: ODOT should adopt leading practices to optimize cost recovered through vehicle and equipment auctions.

Financial Implication 1.2: As shown in **Table 1-5**, achieving results similar to those of DAS will increase cost recovery for common vehicles by **$126,898** annually.

Additional Consideration

Research has shown that a so-called "buy it now" feature on an online auction can increase the speed and value of a sale (Leszczyc, Qiu, & He, 2008).[11] The Department should pilot the use of buy it now in the current online auction system. The buy it now price could be based on an industry benchmark such as the NADA average trade-in value.

[11] Leszczyc, P. P., Qiu, C., & He, Y. (2008). A Reference Price Effect of Buy-now Prices in Internet Auctions. *Latin American Advances in Consumer Research, 2*(59).

3. Fleet Cycling

Section Overview

This section focuses on ODOT's vehicle cycling practices and analyzes the financial benefits associated with implementation of leading practices.

Recommendation Overview

Recommendation 1.3: ODOT should adopt optimized fleet cycling guidelines that promote the most financially efficient operation of the fleet. Specific guidelines include:

- **4 Years and 48,000 Miles – Passenger Cars, 1/4 Ton SUVs, and 1 Ton Pickup Trucks;**
- **5 Years and 60,000 Miles – 1/2 Ton SUVs, 1/2 Ton Pickup Trucks, and 3/4 Ton Pickup Trucks;**
- **6 Years and 72,000 Miles – Minivans and 1 Ton Passenger Vans;**
- **7 Years and 84,000 Miles – Cargo Vans;**
- **10 Years and 100,000 Miles – Light Dump Trucks; and**
- **11 Years and 132,000 Miles –Utility Trucks (3/4 and 1 Ton).**

Further, each vehicle approaching these parameters should be thoroughly reviewed on a cost-per-mile basis to determine whether or not it is more cost effective to retain or replace. Finally, vehicles nearing the end of service life should be promptly salvaged to capture maximum residual value.

Financial Implication 1.3: Each year the proposed cycling models are fully in place, ODOT could save **$1,426,840** in reduced operating costs and increased salvage values.

Background

A vehicle's lifecycle represents the age and mileage at which the vehicle is expected to have exceeded its useful life. For the purposes of this report exceeding useful life is defined as moving beyond the point at which the cost to own and operate the vehicle exceeds the residual value of the vehicle. Fleet managers commonly set lifecycle parameters based on generalized expectations for each class and type of vehicles, but actual replacement decisions are based on individual vehicle-specific data.

ODOT's current lifecycle expectation for light vehicles is based on DAS recommended practices of 6 years and/or 90,000 miles.[12] However, ODOT leadership is concerned that a single guideline may not be optimized for a fleet of such size, composition, and operational complexity (see **Table 1-1**). Further, ODOT performs most maintenance in house, whereas most other state

[12] For the purposes of this audit, light vehicles include passenger vehicles, pickup trucks, utility trucks, and 1 ton "light" dump trucks.

agencies use commercial vendors. ODOT also has utilization standards of 12,000 miles per year, which means that it will take at least 8 years for vehicles to hit at least 90,000 miles. For this reason, the Department requested an analysis of its light vehicle cycling practice to determine the optimum fleet cycling procedure to minimize the cost of ownership while balancing unique operational needs.

Table 1-6 shows ODOT's total fleet operating cost by vehicle type for FY 2009-10 to FY 2013-14. This type of overview helps to demonstrate that even a relatively small reduction in overall fleet costs can result in substantial savings.

Table 1-6: Operating Expense by Vehicle Type FY 2009-10 to FY 2013-14 [1]

Vehicle Type	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
1/2 Ton Pickup Trucks	$5,712,350	$5,995,278	$6,804,044	$6,566,493	$6,493,301
3/4 Ton Pickup Trucks	$2,579,500	$3,077,890	$3,473,885	$3,370,244	$3,134,704
1 Ton Pickup Trucks	$1,461,544	$1,718,231	$1,753,810	$1,894,202	$1,958,296
Passenger Sedans	$1,776,869	$1,818,384	$1,798,086	$1,420,373	$1,341,204
Light Dump Trucks	$1,350,814	$1,525,342	$1,631,894	$1,545,648	$1,499,980
1 Ton Utility Trucks	$1,010,385	$1,184,069	$1,117,231	$1,141,551	$1,100,898
3/4 Ton Utility Trucks	$485,560	$488,437	$462,856	$498,398	$691,262
Cargo Vans	$455,809	$548,255	$508,027	$473,853	$414,206
Minivans	$508,277	$528,618	$502,777	$392,207	$351,729
1 Ton Passenger Vans	$322,586	$368,400	$330,155	$249,028	$194,502
1/4 Ton SUVs	$123,655	$173,737	$213,760	$176,229	$264,808
1/2 Ton SUVs	$129,910	$103,106	$116,978	$118,541	$136,493
3/4 Ton Passenger Vans	$43,844	$32,742	$51,686	$53,795	$52,585
Grand Total	**$15,961,102**	**$17,562,489**	**$18,765,189**	**$17,900,562**	**$17,633,969**

Source: OEM
[1] Fleet operating expense includes all maintenance and fuel costs.

As shown in **Table 1-6**, ODOT historically spent between $16.0 and $18.8 million annually to operate the light fleet. Furthermore, as Department leadership has focused on managing the fleet in a more efficient and effective manner, especially over the last three fiscal years, total operating expenses have declined by $1.1 million. This reduction has been largely accomplished through reduction of the inventory of older; more costly vehicles (see **Chart 1-1**).

As previously noted, 1/2 ton pickup trucks are the most common type of light vehicles in the fleet; 1,102 units as of March 2015 (see **Table 1-1**). The second most common type of light vehicles are 3/4 ton pickup trucks with 407 units. The third most common type of light vehicles are passenger sedans with 343 units. The fourth most common type of light vehicles are 1 ton pickup trucks with 208 units. As shown in **Table 1-6**, total expense generally correlates to number of vehicles with the exception of 1 ton pickup trucks. However, large trucks are expected to have a higher overall operating cost, largely due to lower fuel economy, relative to other light vehicles such as passenger sedans.

Methodology

Data for this section was obtained from ODOT's Equipment Management System (EMS) for all light vehicle types for FY 2009-10 to FY 2013-14. These vehicle types were selected for analysis based on a cursory evaluation of the current inventory as well as with input from ODOT leadership. Specific data points were collected on an individual vehicle basis and included costs for: vehicle purchase, maintenance and repair labor, maintenance and repair parts, fuel, and overhead. This data was then analyzed for three common types of light vehicles (passenger sedans, 1/2 ton pickup trucks, and 3/4 ton pickup trucks) to assess trends in fleet composition and the impact that high mileage vehicles have on service activity needs and cost. Finally, data was aggregated by vehicle type and used to calculate the current average annual cost of ownership and average annual cost per mile (CPM).[13] This analysis reflects an in-depth review of ODOT's unique operational needs and past performance. As such, the results shown here should not be viewed as a reflection on DAS's more generalized guidelines or on other State agencies that operate fleets of varying sizes, compositions, and operational demands.

Analysis

Table 1-7 shows service activities, including maintenance and repair, for passenger sedans that occurred during FY 2013-14. The purpose of this overview is to demonstrate how service activities generally increase in both frequency and cost as a vehicle ages.[14] As such, this table includes only the top 20 most common types of service activity and the data is divided into 12,000 mile increments because ODOT's utilization expectation is 12,000 miles per year. Service occurrences per vehicle and average cost per service occurrence are both instrumental in demonstrating the increased activity and cost as a vehicle ages and accumulates mileage.

[13] 3/4 ton passenger vans (type 202) were excluded from analysis because the inventory of this type of van is so small that a reliable sample size of operating costs was not possible to obtain.
[14] As ODOT reduces its inventory of extremely high mileage vehicles the data points on service occurrences begin to represent fewer total occurrences that are typically more costly.

Table 1-7: Passenger Sedan Service Activities FY 2013-14 [1]

Odometer Range	Service Occurrences	Avg. Service Occurrences per Vehicle	% of Total Services Occurrences	Cumulative Percentage	Avg. Cost per Service Occurrence
0-12,000	13	0.9	0.7%	0.7%	$74.12
12,001-24,000	49	2.9	2.5%	3.1%	$142.15
24,001-36,000	135	4.7	6.8%	9.9%	$134.00
36,001-46,000	119	5.2	6.0%	15.9%	$159.63
48,001-60,000	126	5.0	6.4%	22.3%	$171.79
60,001-72,000	150	5.6	7.6%	29.9%	$173.84
72,001-84,000	84	6.0	4.2%	34.1%	$154.88
84,001-96,000	234	5.3	11.8%	45.9%	$170.91
96,001-108,000	208	6.7	10.5%	56.4%	$184.10
108,001-120,000	173	5.6	8.7%	65.1%	$169.11
120,001-132,000	190	5.8	9.6%	74.7%	$180.62
132,001-144,000	154	6.2	7.8%	82.5%	$205.82
144,001-156,000	130	6.5	6.6%	89.0%	$196.91
156,001-168,000	115	7.7	5.8%	94.8%	$224.84
168,001-180,000	61	8.7	3.1%	97.9%	$204.12
180,001-192,000	29	7.3	1.5%	99.3%	$130.02
192,001 or more	13	6.5	0.7%	100.0%	$197.93

Source: OEM

Note: This analysis focuses only on the top 20 most common maintenance and repair activities for passenger sedans as these are the most likely to commonly occur across this sub-section of the light fleet.

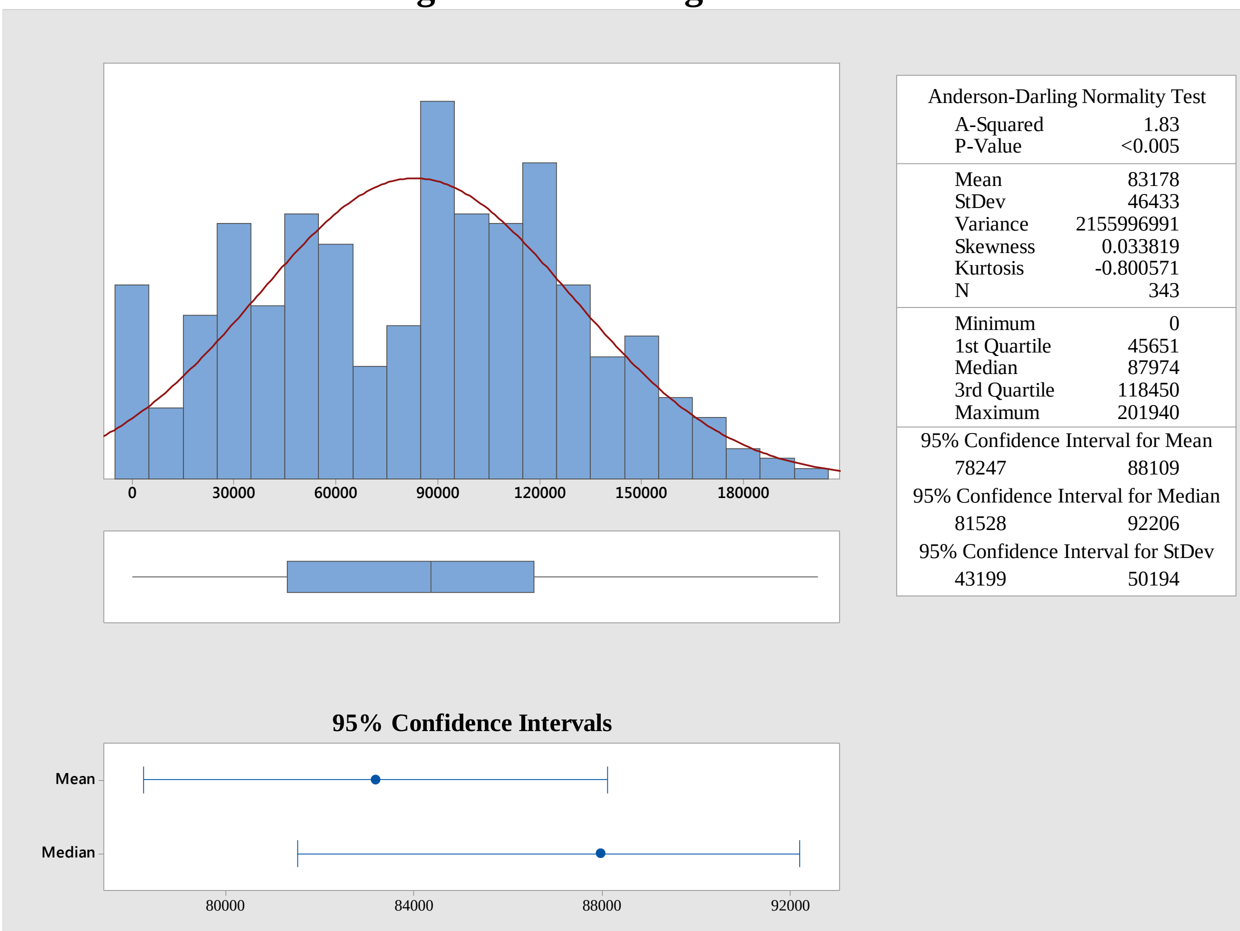
[1] The top 20 repair activities for passenger sedans include: E Inspection (a standard inspection after routine maintenance); Test Drive (after repair or routine maintenance); F Inspection (a standard inspection after repair); Tire Repair or Replacement (with a used tire); Brake Inspection or Troubleshooting; Parts Pick-up/Research or Ordering; New Tire/Replacement; Windshield Wiper/Washer System; Scope/Analysis/Diagnostic; Inspection/Safety; Battery Replacement; Battery Charging or Cleaning; Rotors/Drums; Deliver/Pickup Equipment; Electrical Troubleshooting; Electrical Instruments/Gauges/Meters/Speedometer; Brakes/Pads/Shoes/Replacement; Computer/Sensor Repair or Replace; Travel To or From Repair Site; and Brake Reline/Replace/Complete Brake Job.

As shown in **Table 1-7**, the average cost per service occurrence ranged from a low of $74.12 during the first 12,000 miles to a high of $224.84 for vehicles between 156,001 and 168,000 miles. In addition, the average service occurrences per vehicle ranged from a low of 0.9 occurrences during the first 12,000 miles to a high of 8.7 for vehicles between 168,001 and 180,000. Finally, more than half of all common service activities were performed on passenger sedans with more than 96,000 miles. As previously noted, light vehicles are generally expected to remain in service for 90,000 miles. As such, passenger sedans with mileage between 84,001 and 96,000 miles could be considered to have reached pre-established lifecycle expectations and be subject to increased operational scrutiny. However, ODOT continues to operate these older, higher mileage vehicles as the Department incrementally phases them out in favor of a newer, more cost-effective fleet. In FY 2013-14, passenger sedans with fewer than 96,000 miles received an average of 4.7 service occurrences per year with a median cost of $157.26 per occurrence. In contrast, vehicles beyond the typical lifecycle expectation received an average of 6.4 service occurrences per year with a median cost of $196.61 per occurrence.

In addition to the direct costs shown in **Table 1-7**, there could be additional service costs that are currently not captured. For example, ODOT records maintenance cost including parts, labor, and overhead. However, the Department does not have a system to record operational delays and/or downtime that result from vehicles being unavailable due to service activities. Taking this into account, it is realistic to assume that each quantified service occurrence also includes an additional real but uncaptured opportunity cost of productivity.

Chart 1-4 shows the distribution of total mileage for passenger sedans in ODOT's fleet as of the end of FY 2013-14. This type of overview helps to illustrate not only how heavily weighted toward older vehicles the current group of passenger sedans is, but also the difficulty that ODOT faces in seeking to avoid cost while still heavily relying on operating less cost-effective vehicles.

Chart 1-4: Passenger Sedan Mileage Distribution FY 2013-14



Source: OEM
Note: Mileage is as of June 30, 2014, which is the end of the last full fiscal year.

As shown in **Chart 1-4**, approximately half the passenger sedans in the Department's inventory at the close of FY 2013-14 were close to or already over ODOT's lifecycle expectation of 90,000 miles. The median mileage for the Department's passenger sedans was 87,874 miles while the average was 83,178 miles. **Chart 1-4**, taken into account alongside the data shown in **Table 1-7**, suggests that ODOT has been and will continue to spend money on common service activities that would be avoidable if the Department replaced passenger sedans in accordance with existing lifecycle expectations. Specifically, if the Department had removed passenger sedans from active service prior to reaching 96,000 miles, it would have avoided at least $407,020 in maintenance expenses in just FY 2013-14.

Table 1-8 shows service activities, including maintenance and repair, for 1/2 ton pickup trucks that occurred during FY 2013-14. Similar to **Table 1-7**, this table focuses on the top 20 service activity types and presents the data in 12,000 mile increments commensurate with annual utilization expectations.

Table 1-8: 1/2 Ton Pickup Truck Service Activities FY 2013-14 [1]

Odometer Range	Service Occurrences	Avg. Service Occurrences per Vehicle	% of Total Services Occurrences	Cumulative Percentage	Avg. Cost per Service Occurrence
0-12,000	116	1.5	2.0%	2.0%	$133.34
12,001-24,000	218	2.7	3.7%	5.7%	$153.58
24,001-36,000	323	4.0	5.5%	11.1%	$188.53
36,001-46,000	394	4.5	6.7%	17.8%	$197.25
48,001-60,000	252	4.5	4.3%	22.1%	$204.26
60,001-72,000	226	5.4	3.8%	25.9%	$193.55
72,001-84,000	366	4.9	6.2%	32.1%	$214.08
84,001-96,000	500	5.7	8.5%	40.6%	$195.11
96,001-108,000	507	5.8	8.6%	49.2%	$201.95
108,001-120,000	528	6.4	9.0%	58.1%	$183.75
120,001-132,000	500	5.6	8.5%	66.6%	$199.23
132,001-144,000	614	6.1	10.4%	77.0%	$196.82
144,001-156,000	412	6.9	7.0%	84.0%	$176.80
156,001-168,000	386	6.5	6.5%	90.6%	$181.91
168,001-180,000	211	5.7	3.6%	94.1%	$173.59
180,001-192,000	96	6.4	1.6%	95.8%	$186.92
192,001 or more	250	7.1	4.2%	100.0%	$184.69

Source: OEM

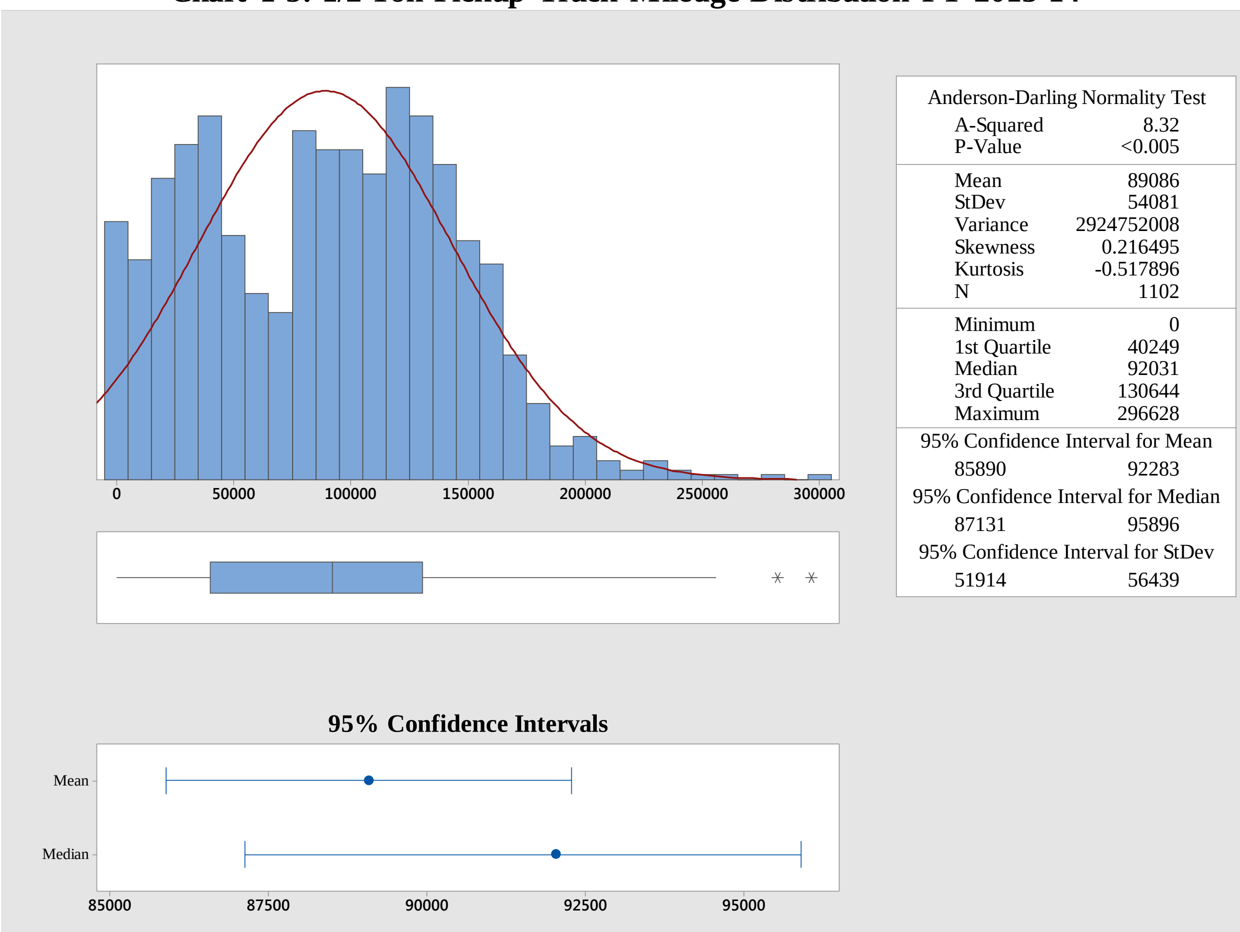
[1] The top 20 service activities for 1/2 ton pickup trucks include: E inspection (this is a standard inspection after routine maintenance); Test Drive (after repair or routine maintenance); F inspection (this is a standard inspection after repair); Parts Pick-Up/Research or Ordering; Tire/Repair/Replace with Used; Tire/Replacement with New; Brake Troubleshooting or Adjustment; Lighting System; Scope/Analysis/Diagnostic; Electrical Troubleshooting; Strobe Light/Install/Remove/Replace; Brakes, Pads, Shoes, Replace; Windshield Wipers/Washer System; Travel to/from Repair Site or County; Battery Replacement; Safety Inspection; Rotors/Drums/Turned or Replaced; Deliver/Pickup Equipment from Vendor/Batter Charging or Cleaning; Wire Replace/Rewire.

As shown in **Table 1-8**, repair activities become relatively more common and relatively more expensive as a vehicle increases in mileage. For example, the average cost per service occurrence ranged from a low of $133.34 during the first 12,000 miles to a high of $214.08 for vehicles between 72,001 and 84,000 miles. In addition, the average service occurrences per vehicle ranged from a low of 1.5 occurrences during the first 12,000 miles to a high of 7.1 for vehicles with more than 192,000 miles. Finally, approximately half of all common service activities were performed on 1/2 ton pickup trucks with more than 96,000 miles.

As previously noted, and consistent with passenger sedans, light vehicles are generally expected to remain in service for 90,000 miles. As such, 1/2 ton pickup trucks with mileage between 84,001 and 96,000 miles could be considered to have reached pre-established lifecycle expectations and be subject to increased operational scrutiny. However, ODOT continues to operate these older, higher mileage vehicles as the Department incrementally phases them out in favor of a newer, more cost-effective fleet. In FY 2013-14, 1/2 ton pickup trucks with fewer than 96,000 miles received an average of 4.1 service occurrences per year with a median cost of $194.33 per occurrence. In contrast, vehicles beyond the typical lifecycle expectation received an average of 6.2 service occurrences per year with a median cost of $184.69 per occurrence. This translates into a service cost of $796.75 per vehicle with fewer than 96,000 miles and $1145.10 for vehicle with in excess of 96,000 miles.

Chart 1-5 shows the distribution of total mileage for 1/2 ton pickup trucks in ODOT's fleet as of the end of FY 2013-14.

Chart 1-5: 1/2 Ton Pickup Truck Mileage Distribution FY 2013-14



Source: OEM
Note: Mileage is as of June 30, 2014, which is the end of the last full fiscal year.

As shows in **Chart 1-5**, more than half of the 1/2 ton pickup trucks in the Department's inventory at the close of FY 2013-14 were close to or already over ODOT's lifecycle expectation of 90,000 miles. The median mileage for the Department's 1/2 ton pickup trucks was 92,031 miles while the average was 89,086 miles. **Chart 1-5**, taken into account alongside the data shown in **Table 1-8**, suggests that ODOT has been and will continue to spend money on common service activities that would be avoidable if the Department replaced 1/2 ton pickup trucks in accordance with existing lifecycle expectations. Specifically, if the Department had removed 1/2 ton pickup trucks from active service prior to reaching 96,000 miles, it would have avoided at least $663,678 in expenses in just FY 2013-14.

Table 1-9 shows service activities, including maintenance and repair, for 3/4 ton pickup trucks that occurred during FY 2013-14. Similar to **Table 1-7** and **Table 1-8**, this table focuses on the top 20 service activity types and presents the data in 12,000 mile increments commensurate with annual utilization expectations.

Table 1-9: 3/4 Ton Pickup Truck Service Activities FY 2013-14 [1]

Odometer Range	Service Occurrences	Avg. Service Occurrences per Vehicle	% of Total Services Occurrences	Cumulative Percentage	Avg. Cost per Service Occurrence
0-12,000	80	3.2	3.4%	3.4%	$714.29[2]
12,001-24,000	72	3.3	3.1%	6.5%	$245.59
24,001-36,000	90	4.7	3.9%	10.4%	$189.54
36,001-46,000	80	4.4	3.4%	13.9%	$264.33
48,001-60,000	90	6.4	3.9%	17.7%	$194.49
60,001-72,000	64	5.3	2.8%	20.5%	$235.29
72,001-84,000	52	7.4	2.2%	22.7%	$336.43
84,001-96,000	163	5.6	7.0%	29.7%	$215.54
96,001-108,000	137	6.0	5.9%	35.6%	$224.77
108,001-120,000	220	6.1	9.5%	45.1%	$244.12
120,001-132,000	272	6.2	11.7%	56.8%	$243.30
132,001-144,000	208	5.5	9.0%	65.7%	$248.63
144,001-156,000	212	5.9	9.1%	74.9%	$218.53
156,001-168,000	190	5.3	8.2%	83.0%	$226.39
168,001-180,000	85	4.5	3.7%	86.7%	$267.74
180,001-192,000	93	6.2	4.0%	90.7%	$284.83
192,001 or more	216	5.8	9.3%	100.0%	$244.66

Source: OEM

[1] The top 20 service activities for 3/4 ton pickup trucks include: E inspection (this is a standard inspection after routine maintenance); Parts Pick-up/Research or Ordering; F Inspection (this is a standard inspection after repair); Tire/Repair/Replace with Used; Tire/Replacement with New; Test drive (after repair or routine maintenance); Lighting System; Electrical Troubleshooting; Brake/Troubleshoot/Adjust and Inspection; Misc/Repair; Travel to/from Repair Site or County; Scope/Analysis/Diagnostic; Deliver/Pickup Equipment from Vendor; Wire Replace/Rewire; Battery/Replace; Batter Charging, Cleaning; Brakes/Pads/Shoes, Replacement; Troubleshoot Engine; Windshield Wipers/Washer System.

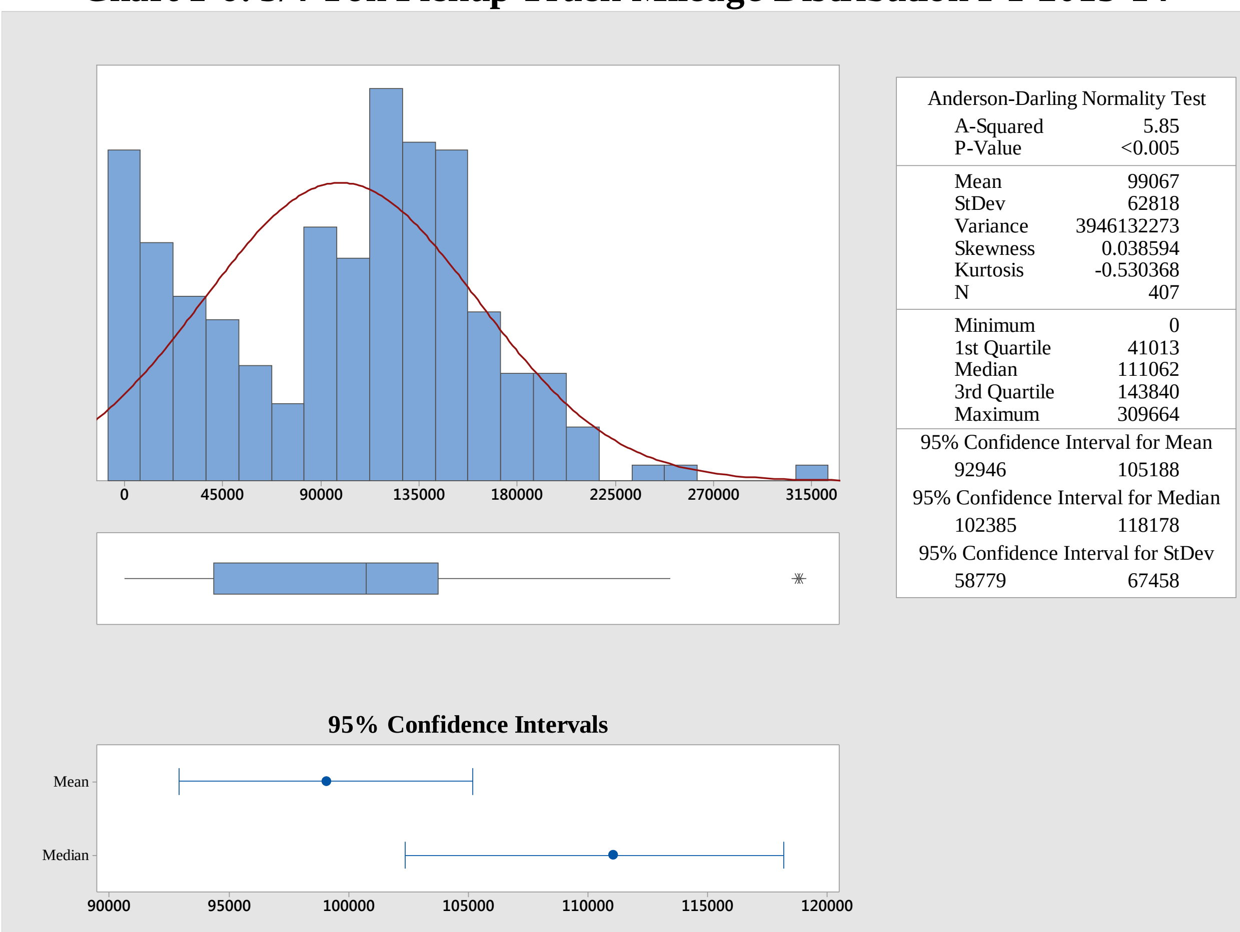
[2] This high cost at an early stage is due to the cost of installing strobe lights on brand new units.

As shown in **Table 1-9**, repair activities become generally more common and relatively more expensive as a vehicle increases in mileage. For example, the average cost per service occurrence ranged from a low of $189.54 for vehicles between 24,001 and 36,000 miles to a high of $336.43 for vehicles between 72,001 and 84,000 miles. In addition, the average service occurrences per vehicle ranged from a low of 3.2 occurrences during the first 12,000 miles to a high of 7.4 for vehicles between 72,001 and 84,000 miles. Finally, approximately half of all common service activities were performed on 3/4 ton pickup trucks with more than 120,000 miles.

As previously noted, and consistent with passenger sedans and 1/2 ton pickup trucks, light vehicles are generally expected to remain in service for 90,000 miles. As such, 3/4 ton pickup trucks with mileage between 84,001 and 96,000 miles could be considered to have reached pre-established lifecycle expectations and be subject to increased operational scrutiny. However, ODOT continues to operate these older, higher mileage vehicles as the Department incrementally phases them out in favor of a newer, more cost-effective fleet. In FY 2013-14, 3/4 ton pickup trucks with fewer than 96,000 miles received an average of 4.8 service occurrences per year with a median cost of $240.44 per occurrence. In contrast, vehicles beyond the typical lifecycle expectation received an average of 6.5 service occurrences per year with a median cost of $244.12 per occurrence.

Chart 1-6 shows the distribution of total mileage for 3/4 ton pickup trucks in ODOT's fleet as of the end of FY 2013-14.

Chart 1-6: 3/4 Ton Pickup Truck Mileage Distribution FY 2013-14



Source: OEM
Note: Mileage is as of June 30, 2014, which is the end of the last full fiscal year.

As shown in **Chart 1-6**, more than half of the 3/4 ton pickup trucks in the Departments inventory at the close of FY 2013-14 were close to or already over ODOT's lifecycle expectation of 90,000 miles. The median mileage for the Department's 3/4 ton pickup trucks was 111,062 miles while the average was 99,067 miles. **Chart 1-6**, taken into account alongside the data shown in **Table 1-9**, suggests that ODOT has been and will continue to spend money on common service activities that would be avoidable if the Department replaced 3/4 ton pickup trucks in accordance with existing lifecycle expectations. Specifically, if the Department had removed 3/4 ton pickup trucks from active service prior to reaching 96,000 miles, it would have avoided at least $393,829 in repair expenses in just FY 2013-14.

In addition to inevitable service activities associated with operating a generally older fleet there are also instances of costly repairs being performed when otherwise the financially optimal decision would be to dispose of the vehicle.

In a publication titled *Federal Vehicle Fleets*, The Government Accountability Office (GAO) recommends that vehicles should be replaced about the time that maintenance and repair expenses exceed the vehicle's auction value (GAO, 2013). DAS does not have written guidelines to determine whether it is more appropriate to repair or replace a vehicle, but staff within the Office of Fleet Management note that repairs in excess of either $1,000 and/or approximately 50.0 percent of a vehicle's residual value are carefully reviewed, and, when possible, the vehicle is replaced instead of being repaired.

Table 1-10 shows examples of the five most expensive repairs, by vehicle type, performed on vehicles that were beyond the Department's 90,000 mile lifecycle expectation during FY 2013-14. In contrast with common service activities quantified in **Table 1-7**, **Table 1-8,** and **Table 1-9** above, these repairs are typically less frequent, but much more costly. This type of analysis further illustrates the financial risk associated with keeping vehicles beyond the 90,000 mile lifecycle expectation as well as lack of a uniform policy on how to deal with service activities for such vehicles.

Table 1-10: 5 Most Expensive Repairs on High Mileage Vehicles FY 2013-14

Repair Focus	Mileage at Repair	Repair Cost	Vehicle Value at Repair[1]	Difference	% Difference
Passenger Sedans					
Transmission	192,853	$2,638	$725	$1,913	263.8%
Electrical	144,638	$2,864	$1,025	$1,839	179.4%
Heater	175,431	$1,711	$725	$986	136.0%
Air Conditioning	160,337	$1,842	$913	$930	101.9%
Exhaust System	160,337	$1,494	$725	$769	106.1%
1/2 Ton Pickup Trucks					
Engine	139,699	$19,724	$3,808	$15,916	417.9%
Body	134,563	$8,986	$3,808	$5,178	136.0%
Engine	150,375	$7,187	$2,875	$4,312	150.0%
Engine	150,375	$7,187	$2,875	$4,312	150.0%
Engine	160,082	$5,001	$2,300	$2,701	117.5%
3/4 Ton Pickup Trucks					
Body	157,743	$17,262	$2,675	$14,587	545.3%
Body	125,833	$13,967	$5,108	$8,859	173.4%
Body	179,657	$7,662	$2,350	$5,312	226.0%
Engine	137,013	$9,150	$4,142	$5,008	120.9%
Engine	118,244	$9,698	$5,767	$3,931	68.2%

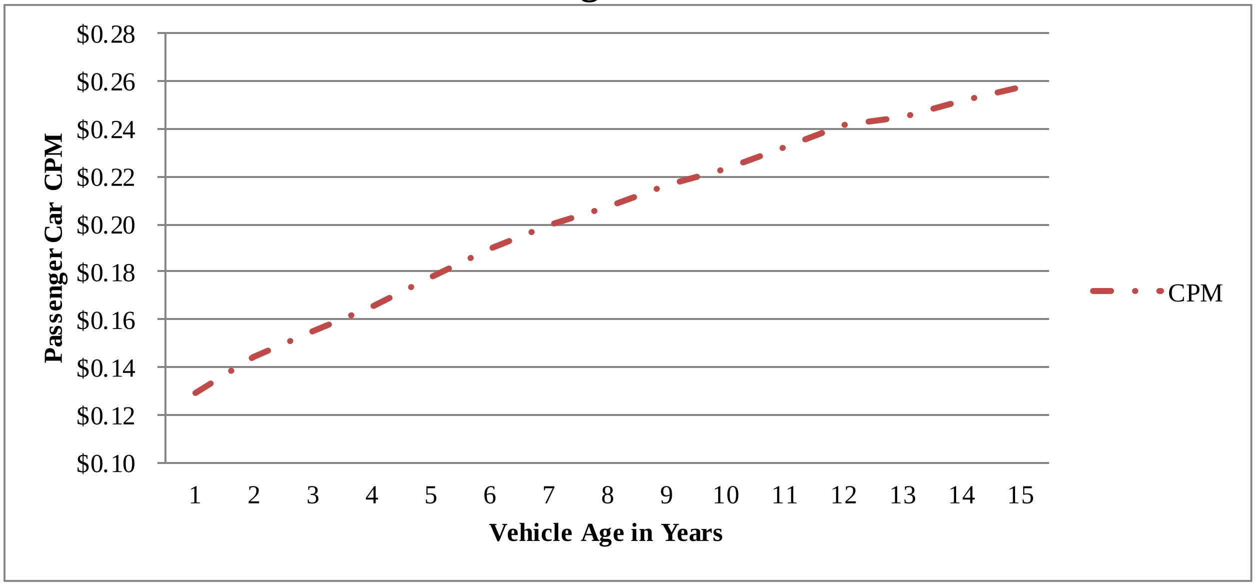
Source: OEM

[1] NADA average trade-in values were used to be consistent with other analyses in this report although the NADA 'rough' trade-in value may have been more appropriate given the condition and age of the vehicles in question; however, NADA rough trade is always lower than average trade-in and would therefore further exasperate the difference between the repair and vehicle cost.

As shown in **Table 1-10**, there are multiple examples from FY 2013-14 where ODOT spent in excess of 100.0 percent, and even as much as 545.3 percent, of a vehicle's value for repairs. Taking into account just the 15 repair activities analyzed here and totaling the per vehicle f=difference between the repair cost and the vehicle value at repair the Department spent a combined total of $76,553 on repairs in excess of the residual value of the vehicles. ODOT leadership and OEM staff noted that currently the residual value of a vehicle does not play into decisions about repairs because obtaining a new vehicle can take up to 18 months and districts need to return vehicles to service as soon as possible.

Chart 1-7 shows the cost per mile (CPM) for passenger sedans from FY 2009-10 to FY 2013-14. The CPM shown here uses cost for maintenance and repair parts, labor, and overhead as well as fuel cost to calculate the average cost of operation for each mile driven. This type of overview further demonstrates how the cost of operating a vehicle increases over time as mileage increases.

Chart 1-7: Passenger Sedan CPM Trends



Source: OEM
Note: CPM includes the cost of parts, labor, fuel, and overhead, but does not include depreciation. In addition, CPM has been normalized based on a 12,000 mile per year utilization expectation.

As shown in **Chart 1-7** the cost of operating a passenger sedan increases in a relatively predictable, steady pace with each year of operation. Each 12,000 miles of operation adds approximately $.01 in CPM which translates into an additional $120 in operating cost per year.

Table 1-11 below provides additional context to show how the cost of operations increase throughout the life of the vehicle. This table shows operating costs in 3 year, 36,000 mile increments. This table shows how changes in cost per mile can result in additional annual operating costs.

Table 1-11: Passenger Sedan Operating Cost Trends

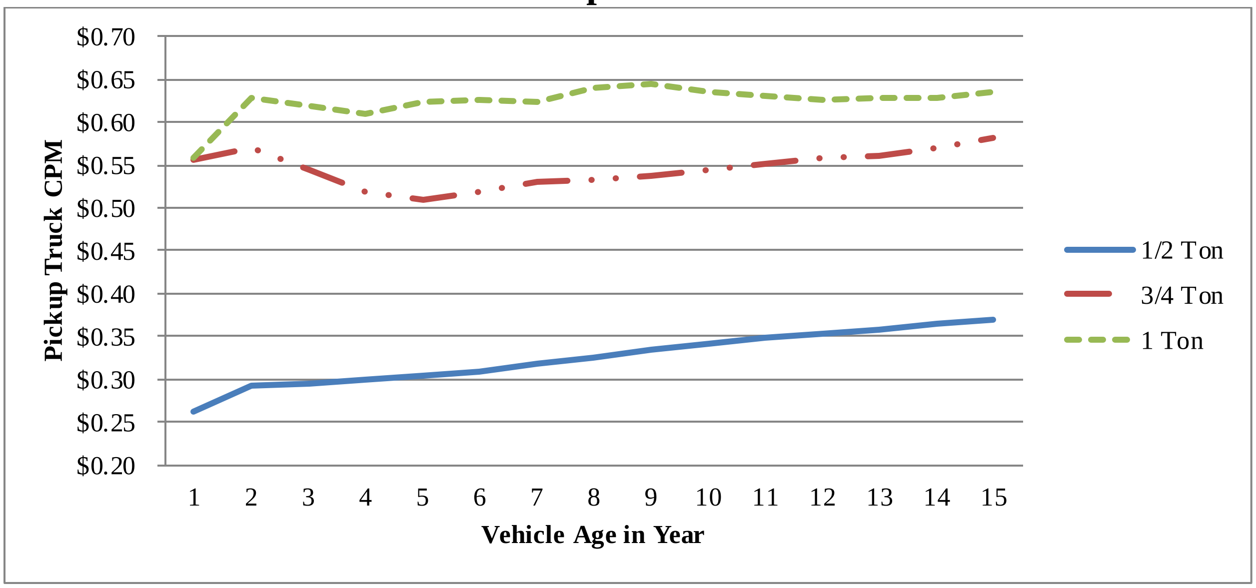
Years	1 to 3	3 to 6	6 to 9	9 to 12	12 to 15
Mileage Range	**0-36,000**	**36,000-72,000**	**72,000-108,000**	**108,000-144,000**	**144,000-180,000**
3 Yr. Increase	$435.15	$637.76	$508.75	$628.39	($173.77)
Annual % Increase[1]	11.4%	9.0%	5.7%	6.0%	(4.2%)
				First Year Cost	$1,916
				Final Year Cost	$3,952
				Average Annual % Increase	7.1%

Source: OEM
[1] Average annual increase is calculated using 0 to 12,000 miles as a baseline. The baseline total cost is subtracted from the total cost for years one through three to isolate the cost increase over and above the baseline. Finally, the cost increase is divided by two to account for the average annual increase over and above the baseline.

As shown in **Table 1-11**, annual operating costs increase, by an average of 11.4 percent per year between the first and third full year of operation, from a base cost $1,915.71 at the end of the first full year to $2,350.86 at the end of the third full year. Between 36,000 and 72,000 miles, operating costs increase by an average of 9.0 percent per year, from $2,350.86 to $2,988.62. The rate of increase slows to 5.7 percent per year from 72,000 to 108,000 miles and increases again slightly to 6.0 percent per year from 108,000 to 144,000 miles. In total, the annual operating cost of a passenger sedan increases by $2,036.28 per year over 180,000 miles, an increase of 106.3 percent. On average, passenger sedan CPM increases by 7.1 percent over a 15 year or 180,000 mile lifecycle. The large increases during the first six full years of operation suggest that the optimal lifecycle is most likely within that range.

Chart 1-8 shows CPM for pickup trucks (1/2, 3/4, and 1 ton) from FY 2009-10 to FY 2013-14. Similar to Chart 1-6, the CPM shown here uses cost for maintenance and repair parts, labor, and overhead as well as fuel cost to calculate the average cost of operation for each mile driven. This chart also shows that different sizes and types of trucks have different cost curves and may therefore benefit from different cycling models.

Chart 1-8: Pickup Truck CPM Trends



Source: OEM

Note: CPM includes the cost of parts, labor, fuel, and overhead, but does not include depreciation. In addition, CPM has been normalized based on a 12,000 mile per year utilization expectation.

As shown in **Chart 1-8**, 1/2 ton pickup trucks follow a CPM escalation pattern that is similar to passenger sedans.

Table 1-12 provides additional context by showing how CPM can contribute to additional annual operating costs.

Table 1-12: Pickup Truck Operating Cost Trends

Years	1 to 3	3 to 6	6 to 9	9 to 12	12 to 15
Mileage Range	**0-36,000**	**36,000-72,000**	**72,000-108,000**	**108,000-144,000**	**144,000-180,000**
1/2 Ton Pickup					
3 Yr. Increase	$479.52	$317.09	$990.79	$688.82	$736.82
Annual % Increase[1]	7.6%	2.9%	8.4%	-0.4%	15.1%
3/4 Ton Pickup					
3 Yr. Increase	($792.14)	$832.82	$156.24	$885.53	$885.53
Annual % Increase	(5.9)	4.7%	0.8%	4.3%	11.9%
1 Ton Pickup					
3 Yr. Increase	$531.73	$533.78	$553.19	($1,373.44)	$1,568.49
Annual % Increase	4.0%	2.5%	2.4%	(5.5%)	22.6%
			1/2 Ton	**3/4 Ton**	**1 Ton**
First Year Cost			$3,153	$6,681	$6,693
Final Year Cost			$5,614	$8,685	$8,506
Average Annual % Increase			5.2%	2.0%	1.8%

Source: OEM

[1]Average annual increase is calculated using 0 to 12,000 miles as a baseline. The baseline total cost is subtracted from the total cost for years one through three to isolate the cost increase over and above the baseline. Finally, the cost increase is divided by two to account for the average annual increase over and above the baseline.

As shown in **Table 1-12**, 1/2 ton pickup trucks follow a CPM escalation pattern that is similar to passenger sedans. Between the first and third full year in operation, operating costs increase by an average of 7.6 percent per year.[15]. The rate of operating cost increase slows to 2.9 percent annually between 36,000 and 72,000 miles, before increasing again to 8.4 percent between 72,000 and 108,000. In total, operating costs increase by $1,724.00 per year, from $3,153.12 during the first 12,000 miles to $5,613.94 per year between 168,000 and 180,000 miles, a 78.0 percent increase. This analysis suggests that the best opportunities to reduce operating costs occur during one of the two fastest rates of increase periods; either between 12,000 and 36,000 miles or between 72,000 and 108,000 miles. For practical purposes, the optimum lifecycle is likely within the range of 72,000 to 108,000 miles.

Operating costs for 3/4 ton pickup trucks follows a different pattern than 1/2 ton pickup trucks and passenger sedans. Operating costs decrease by an average of 5.9 percent per year during the first three full years of operation, from a baseline of $6,681.16 during the first full year to $5,889.02 during the third full year of operation. During the next three years (i.e., 36,000 to 72,000 miles) of operations, costs increase from $5,889.02 to $6,721,84, an $832.82 or 14.1 percent increase. In total, operating costs increase by 30.0 percent or $2,003.56 per year over the course of 180,000 miles, with the fastest annual increase in costs occurring between 36,000 and

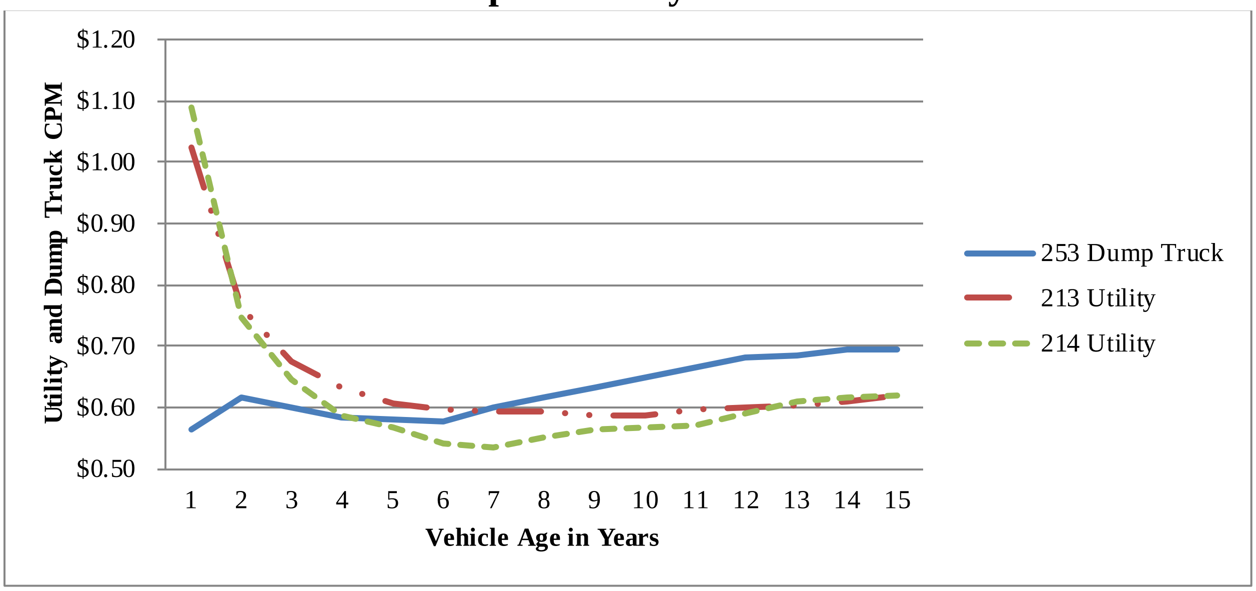
[15] Costs assume ODOT will meet the established utilization goal of 12,000 miles per year for each full year of operation.

72,000 miles. Similar to 1/2 ton pickup trucks, this period of rapid operating cost increase indicates that that the optimum lifecycle is likely within the range of 36,000 to 72,000 miles.

Operating costs for 1 ton pickup trucks follows a pattern that is similar to 1/2 ton pickup trucks. For example, operating costs increase by an average of 4.0 percent per year during the first three full years of operation, from a baseline of $6,692.67 at the end of the first full year to a $7,224.39 by the end of the third full year, a 7.9 percent increase. In total, operating costs increase by $1,817.74 or 1.8 percent per year over the course of the 180,000 miles. The relatively flat cost increase for the first 144,000 miles suggests that decisions about 1 ton truck lifecycles may be more dependent on depreciation costs as opposed to maintenance and operating expenses.

Chart 1-9 shows CPM for light dump trucks and utility trucks (3/4 and 1 ton) from FY 2009-10 to FY 2013-14. Similar to **Chart 1-7** and **Chart 1-8**, the CPM shown here uses cost for maintenance and repair parts, labor, and overhead as well as fuel cost to calculate the average cost of operation for each mile driven. This chart shows that utility vehicles follow a different cost curve when compared to more standard vehicles whereas light dump trucks follow a cost pattern that is similar to 1 ton pickup trucks.

Chart 1-9: Dump and Utility Truck CPM Trends



Source: OEM

Note: CPM includes the cost of parts, labor, fuel, and overhead, but does not include depreciation. In addition, CPM for utility trucks (3/4 and 1 ton) has been normalized based on a 12,000 mile per year utilization expectation. CPM for light dump trucks has been normalized based on a 10,000 mile per year utilization expectation.

As shown on **Chart 1-9**, utility tucks are more expensive during the first 12,000 miles of operation; this is because utility trucks often require a retrofit for special equipment, such as tool boxes, welders, etc. early in the lifecycle. While both utility truck types are most expensive during the first 12,000 miles of service, 3/4 ton utility trucks more quickly revert to a more standard cost curve.

Table 1-13 shows the annual operating costs for 1 ton and 3/4 ton utility trucks. The table shows operating costs in 3 year, 36,000 mile increments. This table adds additional context to the information presented in **Chart 1-9** by demonstrating how small changes in CPM can translate into additional, annual operating costs.

Table 1-13: Utility Truck Operating Cost Trends

Years	**1 to 3**	**3 to 6**	**6 to 9**	**9 to 12**	**12 to 15**
Mileage Range	**0-36,000**	**36,000-72,000**	**72,000-108,000**	**108,000-144,000**	**144,000-180,000**
1 Ton Utility Truck					
3 Yr. Increase	($117.76)	$636.19	$61.86	$1,411.41	$1,081.24
Annual % Increase[1]	(1.0%)	3.6%	0.3%	7.1%	13.5%
3/4 Ton Utility Truck					
Mileage Range	$400.62	($382.48)	$3,116.12	$1,528.40	($1,758.26)
3 Yr. Increase	8.2%	(2.4%)	21.1%	6.3%	(18.4%)
				1 Ton Utility	**3/4 Ton Utility**
			First Year Cost	$6,044	$4,894
			Final Year Cost	$9,117	$7,798
			Average Annual % Increase	3.4%	4.0%

Source: OEM

[1] Average annual increase is calculated using 0 to 12,000 miles as a baseline. The baseline total cost is subtracted from the total cost for years one through three to isolate the cost increase over and above the baseline. Finally, the cost increase is divided by two to account for the average annual increase over and above the baseline.

As shown in **Table 1-13**, costs for the operation of 1 ton utility trucks decrease by an average of 1.0 percent during the first three full years of operations, from a baseline of $6,043.87 to $5,926.11, a $117.76 or 1.9 percent total decrease. In total, the annual cost of maintenance and operations for 1 ton utility trucks increases from $6,043.87 during the first 12,000 miles to $9,116.81after the 15th year of operations, a $3,072.94 or 50.8 percent increase over a 180,000 miles lifecycle. The annual cost of operations for 3/4 ton utility trucks increases from $4,894.09 during the first full year of operations to $7,798.48 at the end of the 15th year of operations. In total, the annual cost of operations for 3/4 ton utility trucks increases by $2,904.39 or 59.3 percent over an 180,000 or 15 year lifecycle. For 1 ton utility trucks, the fastest increase is between 36,000 and 72,000 miles, when vehicle operating costs increase by 10.7 percent, whereas 3/4 ton utility trucks operating costs increase the most, 21.1 percent, between 72,000 and 108,000 miles. This suggests that cycling 1 ton utility trucks could occur between 36,000 and 72,000 miles to have the greatest impact on reducing costs and 3/4 ton utility trucks could be cycled between 72,000 and 108,000 for the greatest financial impact.

Table 1-14 shows how 1 ton dump truck operating costs increase. This table provides additional context to the data presented in **Chart 1-9** by showing how changes in CPM can result in additional annual operating costs.

Table 1-14: Light Dump Trucks Operating Cost Trends

Years	1 to 3	3 to 6	6 to 9	9 to 12	12 to 15
Mileage Range	**0-30,000**	**30,000-60,000**	**60,000-90,000**	**90,000-120,000**	**120,000-150,000**
3 Yr. Increase	$98.46	$34.31	$1,966.44	$688.82	($1,576.64)
Annual % Increase[1]	1.7%	0.2%	11.4%	3.0%	(18.7%)
				First Year Cost	$5,639.84
				Final Year Cost	$6,851.23
				Average Annual % Increase	1.4%

Source: OEM
[1] Average annual increase is calculated using 0 to 12,000 miles as a baseline. The baseline total cost is subtracted from the total cost for years one through three to isolate the cost increase over and above the baseline. Finally, the cost increase is divided by two to account for the average annual increase over and above the baseline.

As shown in **Table 1-14**, light dump trucks experience a cost curve that is similar to 1 ton pickup trucks. A typical light dump truck consists of a cab and chassis based on a standard 1 ton pickup truck body, such as Chevrolet 3500 series or a Ford F350. Dump beds are added either at the factory or by a third party vendor.[16] Light dump trucks are used less frequently than standard pickup trucks, and for that reason ODOT expects to use them 10,000 miles per year and expects units to remain in inventory until 120,000 miles. At the end of the first year of the operation, a light dump truck requires an average of $5,639.84 in maintenance and operating costs, which increases to $5,738.30 during over the next two full years of operations, which is a 1.7 percent annual increase in operating costs. The annual cost of operations decrease at a slower rate during the next 30,000 miles, from $5,738.30 to $5,772.61, between 30,000 and 60,000 miles, a 0.2 percent annual increase. The rate of increase in the annual costs of operations increase between 60,000 and 90,000 miles, from $5,772.61 to $7,739.05, which is an annual increase of 11.4 percent per year, assuming 10,000 miles per year of utilization. In total, over a 15 year or 150,000 mile lifecycle the annual cost of operations for light dump trucks increases from $5,639.84 per year to $6,851.23 per year, an increase of $1,211.39 or an average annual increase of 1.4 percent. The rapid increase in operations costs between 60,000 and 90,000 miles suggests that, in order to minimize maintenance expenses, the optimum lifecycle for light dump trucks may be between 60,000 and 90,000 miles.

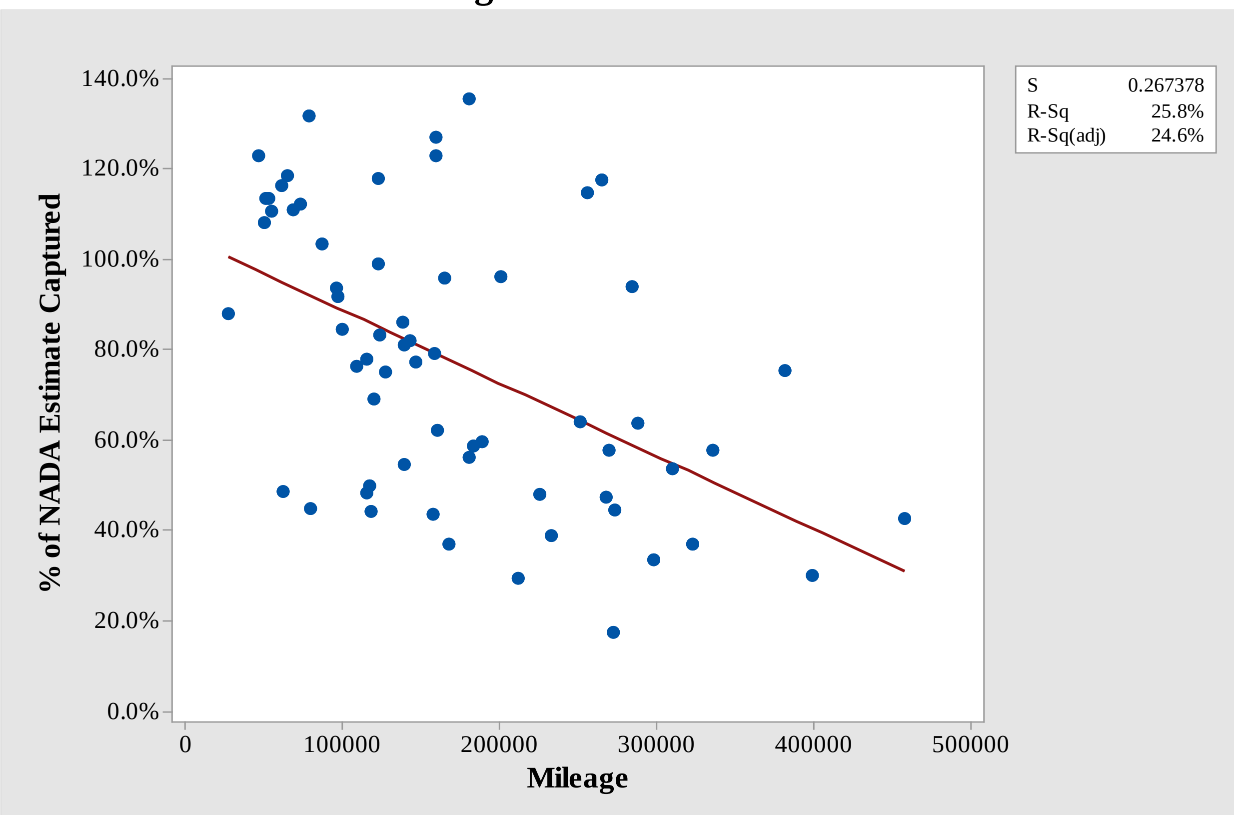
A significant factor influencing total cost of ownership, in addition to vehicle purchase and operating cost is residual value when the vehicle reaches the end of its useful life. Automotive Fleet, a commercial fleet management trade publication, in an article titled, *The Ongoing Used-Vehicle Shortage Favors a Short-Cycling Replacement Strategy* (Automotive Fleet, 2011), notes that fleet costs are influenced by both the age and mileage of the vehicle, and that shorter fleet cycles have the advantage of decreasing the cost of maintenance as well as creating a situation where the vehicle will be worth more on the used market, which can offset the cost of purchasing

[16] The cost of adding the dump bed is reflected in either the initial purchase price or in maintenance and repair costs during the first year depending on whether or not the dump bed is installed by the manufacturer or by ODOT staff.

a new vehicle. Similarly, in the *2014 Used Car Market Report (*Manhiem, 2014), analyses shows that used vehicles that are from three to six model years old are relatively less common than vehicles that are seven or more model years old. The lack of vehicles within this age range points to what could be an opportunity for increased ability to capture residual value on relatively newer vehicles in the used market.

Chart 1-10 shows a summary correlation analysis of the relationship between vehicle mileage and estimated NADA trade-in value capture rate for 60 utility tucks and 1/2 ton pickup trucks sold through Richie Bros.[17] Auctioneers during 2015. The horizontal values are the vehicle mileage and the vertical values are the percent of NADA average trade-in captured at auction.

Chart 1-10: Mileage as a Predictor of Residual Values



Source: Richie Bros. Auctioneers and NADA

As shown in **Chart 1-10**, as mileage decreases, NADA average trade-in values become a more reliable estimator of a vehicle's actual value obtained at auction. Further, vehicle mileage explains 24.6 percent of the observed variance in NADA trade-in value capture rates for the 60 vehicles analyzed. A more narrow analysis of the 18 vehicles with mileage below 100,000 miles shows that 16 of the 18, or 88.8 percent, obtained values of at least 90 percent of NADA estimated residual values. Continuing with this sub-set of 18 vehicles, 13, or 72.2 percent,

[17] Richie Brothers was selected for comparison because they sell a large number of vehicles from state governments from all over the United States.

obtained values that matched or exceeded 100.0 percent of the NADA trade-in value. This analysis reaffirms the advantage of removing vehicles from a fleet sooner, because it shows that prices are both higher and more predictable at a lower mileage. Decreased variability in residual values able to be captured at market also offer the advantage of stabilizing a portion of the funding necessary to purchase replacement vehicles for those that are being cycled out.

Table 1-15 shows the financial impact of implementing optimized vehicle cycling for each type of light vehicle. This analysis first shows the current state lifecycle expectation, CPM, and total cost for each light vehicle in the ODOT inventory. The analysis then uses the identified, optimized lifecycle to calculate a CPM and lifecycle cost in a future, optimized state.

Table 1-15: Optimized Vehicle Lifecycles [1]

Current State			
Vehicle Type	**Expected Lifecycle [2]**	**Lifecycle CPM**	**Lifecycle Cost**
Passenger Sedans	8 Yrs./96,000 Mi.	$0.3478	$33,390
1/4 Ton SUVs	8 Yrs./96,000 Mi.	$0.5133	$49,281
1/2 Ton SUVs	8 Yrs./96,000 Mi.	$0.5347	$51,332
Minivans	8 Yrs./96,000 Mi.	$0.4237	$40,673
Cargo Vans	10 Yrs./120,000 Mi.	$0.5362	$64,349
1 Ton Passenger Vans	8 Yrs./96,000 Mi.	$0.4979	$47,794
1 Ton Utility Trucks	10 Yrs./120,000 Mi.	$0.7859	$94,302
3/4 Ton Utility Trucks	10 Yrs./120,000 Mi.	$0.7749	$92,987
1/2 Ton Pickup Trucks	8 Yrs./96,000 Mi.	$0.5303	$50,904
3/4 Ton Pickup Trucks	8 Yrs./96,000 Mi.	$0.7351	$70,570
1 Ton Pickup Trucks	8 Yrs./96,000 Mi.	$0.8693	$83,449
Light Dump Truck	10 Yrs./120,000 Mi.	$0.9369	$112,423
Optimized State			
Vehicle Type	**Optimized Lifecycle**	**Lifecycle CPM**	**Lifecycle Cost**
Passenger Sedans	4 Yrs./48,000 Mi.	$0.3184	$15,281
1/4 Ton SUVs	4 Yrs./48,000 Mi.	$0.4596	$22,059
1/2 Ton SUVs	5 Yrs./60,000 Mi.	$0.4822	$28,932
Minivans	6 Yrs./72,000 Mi.	$0.3285	$23,650
Cargo Vans	7 Yrs./84,000 Mi.	$0.5250	$44,102
1 Ton Passenger Vans	6 Yrs./72,000 Mi.	$0.4904	$35,309
1 Ton Utility Trucks [3]	11 Yrs./132,000 Mi.	$0.7816	$103,169
3/4 Ton Utility Trucks	11 Yrs./132,000 Mi.	$0.7509	$99,114
1/2 Ton Pickup Trucks	5 Yrs./60,000 Mi.	$0.4836	$29,015
3/4 Ton Pickup Trucks	5 Yrs./60,000 Mi.	$0.6816	$40,897
1 Ton Pickup Trucks	4 Yrs./48,000 Mi.	$0.7710	$37,008
Light Dump Trucks	10 Yrs./100,000 Mi.	$0.9285	$92,845

Source: OEM

[1] All costs in this table assume that the Department will achieve the established utilization standard for each vehicle type in each year of operations. Sub-optimal utilization can negatively impact the annual CPM estimates shown here.

[2] The current expected lifecycle for most light vehicles is based on an annual utilization of 12,000 miles per year. Because the Department has a 90,000 mile lifecycle expectation, it will take 8 years to reach this mileage.

[3] Savings from 1 ton utility trucks will come exclusively from improved auction performance.

As shown in **Table 1-15**, ODOT can reduce overall vehicle operating expenses for each type of light vehicle through the adoption of optimized vehicle lifecycles expectations. In addition to cost savings, instituting a shorter fleet cycle is also likely to decrease the type of service incidents described on **Table 1-7**, **Table 1-8**, and **Table 1-9**. Each service incident may include an uncaptured cost due to operational delays related to having to temporarily remove a vehicle from service while it is being repaired. For this reason, a shorter fleet cycle may result in additional operational efficiencies, in addition to lower costs per mile.

Table 1-16 shows the financial implications of ODOT instituting the fleet cycling model listed on **Table 1-15**. This table shows the current cost per mile, the optimized cost per mile, per vehicle savings, and an annual savings estimate based on the number of vehicles of the type in the fleet. This table shows that ODOT can significantly reduce fleet costs by introducing optimized fleet cycles.

Table 1-16: Total Savings from Improved Fleet Cycling

Vehicle Type	Count of Vehicles	Current CPM	Optimized CPM	Per Vehicle Difference	Annual Savings
Passenger Sedans	343	$0.3478	$0.3184	$353.36	$121,051
1/4 Ton SUVs	47	$0.5133	$0.4596	$645.45	$30,336
1/2 Ton SUVs	20	$0.5347	$0.4822	$630.11	$12,602
Minivans	80	$0.4237	$0.3285	$1,142.47	$91,397
Cargo Vans	61	$0.5362	$0.5250	$134.62	$8,212
1 Ton Passenger Vans	28	$0.4979	$0.4904	$89.42	$2,504
1 Ton Utility Trucks	122	$0.7859	$0.7816	$51.51	$6,285
3/4 Ton Utility Trucks	66	$0.7749	$0.7509	$288.32	$19,029
1/2 Ton Pickup Trucks	1,102	$0.5303	$0.4836	$559.95	$616,061
3/4 Ton Pickup Trucks	407	$0.7351	$0.6816	$641.80	$261,211
1 Ton Pickup Trucks	208	$0.8693	$0.7710	$1,178.97	$245,225
Light Dump Trucks	140	$0.9369	$0.9285	$84.12	$11,777
				Total Financial Impact	**$1,426,840**

Source: OEM and OPT analysis

As shown in **Table 1-16**, ODOT can save a total of **$1,426,840** by implementing the fleet cycling plan recommended in **Table 1-15**. The largest per vehicle savings will come from 1 ton pickup trucks, which will see a $0.0983 decrease in CPM. 1/2 ton pickup trucks are the vehicles that will see the largest annual financial impact, with a savings of $616,061 annually. Overall, a $1.4 million reduction in fleet operating costs will reduce fleet maintenance and operation expenditures by approximately 7.9 percent.[18]

[18] This is based on the $17.6 million maintenance expenditures for FY 2013-14 shown in **Table 1-6**.

Conclusion

ODOT's practice of holding light vehicles well past 100,000 miles results in additional operating cost that could be avoided through improved fleet cycling practices. The Department can reduce the overall cost of vehicle operations by adopting an optimized vehicle lifecycle for each light vehicle type.

Recommendation 1.3: ODOT should adopt optimized fleet cycling guidelines that promote the most financially efficient operation of the fleet. Specific guidelines include:

- **4 Years and 48,000 Miles – Passenger Cars, 1/4 Ton SUVs, and 1 Ton Pickup Trucks;**
- **5 Years and 60,000 Miles – 1/2 Ton SUVs, 1/2 Ton Pickup Trucks, and 3/4 Ton Pickup Trucks;**
- **6 Years and 72,000 Miles – Minivans and 1 Ton Passenger Vans;**
- **7 Years and 84,000 Miles – Cargo Vans;**
- **10 Years and 100,000 Miles – Light Dump Trucks; and**
- **11 Years and 132,000 Miles –Utility Trucks (3/4 and 1 Ton).**

Further, each vehicle approaching these parameters should be thoroughly reviewed on a cost-per-mile basis to determine whether or not it is more cost effective to retain or replace. Finally, vehicles nearing the end of service life should be promptly salvaged to capture maximum residual value.

Financial Implication 1.3: Each year the proposed cycling models are fully in place, ODOT could save **$1,426,840** in reduced operating costs and increased salvage values.

Additional Consideration

Implementing this recommendation, and thus achieving the full optimized results, can reasonably be expected to take several years as ODOT gradually implements improved cycles for each vehicle class. In planning out the implementation of this recommendation the Department should consider that the biggest financial and operational returns will come from improving the cycling of vehicles that are most crucial to key operations. Taking this into account the Department could reasonably focus on improving the cycling of 1/2 and 3/4 ton pickup trucks first because those vehicles are among the most widely and heavily used across the Department.

VIII. Audit Scope and Objectives Overview

Generally accepted government auditing standards require that a performance audit be planned and performed so as to obtain sufficient, appropriate evidence to provide a reasonable basis for findings and conclusions based on audit objectives. Objectives are what the audit is intended to accomplish and can be thought of as questions about the program that the auditors seek to answer based on evidence obtained and assessed against criteria.

AOS and ODOT signed a letter of engagement effective March 10, 2015. The original letter of engagement led to OPT planning and scoping work, in consultation with ODOT, which identified the single scope area of **Fleet Management**.

Based on the agreed upon scope, OPT developed objectives designed to identify improvements to economy, efficiency, and/or effectiveness. **Table VIII-1** shows the objectives assessed in this performance audit and references the corresponding recommendation(s) when applicable.

Table VIII-1: Audit Objectives and Recommendations

Objective	Recommendation(s)
Fleet Management	
What opportunities exist for ODOT to improve its light vehicle fleet management efficiency and/or effectiveness in relation to industry standards and/or leading practices?	**R.2 and R.3**
Identify, what, if any additional maintenance and repair cost is associated with the mandated use of biodiesel. If applicable, what opportunities exist to decrease to the cost of compliance or improve the efficiency and/or effectiveness of operations based on industry standards and/or leading practices?	**R.1**

IX. Abbreviated Terms and Acronyms

AOS - Auditor of State
CPM - Cost Per Mile
DAS - Ohio Department of Administrative Services
EMS - Equipment Management System
FY - Fiscal Year
FYTD - Fiscal Year-To-Date
GAGAS - Generally Accepted Government Auditing Standards
GAO - Government Accountability Office
NADA - National Auto Dealers Association
OAC - Ohio Administrative Code
ODNR - Ohio Department of Natural Resources
ODOT or the Department - Ohio Department of Transportation
OPT - Ohio Performance Team
ORC - Ohio Revised Code
The Director - The Director of Transportation

X. ODOT Response

The letter that follows is ODOT's official response to the performance audit. Throughout the audit process, staff met with Department officials to ensure substantial agreement on the factual information presented in the report. When the Department disagreed with information contained in the report and provided supporting documentation, revisions were made to the audit report.

Division of Facilities & Equipment Management
Office of Equipment Management
ODOT Performance Audit Response
JUN 2015

The Division of Facilities and Equipment Management, Office of Equipment Management (OEM), would like to thank Auditor Dave Yost and his staff for partnering with ODOT to conduct the *Ohio Department of Transportation Performance Audit – June 2015* (Audit Report). The thorough and concise Audit Report makes common sense recommendations regarding the use of biodiesel alternative fuel, how to improve ODOT's auction process to get the biggest return on our fleet once it has hit its useful life, and proper fleet cycling in order to reduce repair costs and receive maximum value at disposal.

ODOT appreciates the dedication of Scott Anderson, Director of the Ohio Performance Team (OPT) and his team to help ODOT improve its processes, increase efficiencies and effectiveness, and invest the public's gas tax wisely. Special recognition is accorded to Brent Grace, Senior Performance Analyst - Project Manager – OPT, and Zach Kromer, Performance Project Manager - OPT for outstanding work regarding this project. It is planned that the recommendations made in the Audit Report will be implemented in a series of initiatives in SFY 2016 and SFY 2017.

ODOT proposed in its 2016-2017 Biennium Budget to eliminate the requirement to use B-20 Biodiesel fuel in its diesel fleet. Since the inception of the biodiesel requirement in 2007, ODOT has paid an increased cost per gallon of biodiesel amounting to $7.8 million. Also, the unscheduled filter repairs have totaled in excess of $202,000 annually during that same time period. The Transportation Budget Bill was signed by Governor Kasich on April 1, 2015 and will become law on July 1, 2015.

ODOT will partner with the Department of Administrative Services (DAS) to optimize cost recovery through vehicle and equipment auctions. ODOT will establish a series of Pilot Programs employing National Automotive Dealers Association (NADA) and/or Kelly Bluebook (Bluebook) vehicle value benchmarks to set minimum bid prices. ODOT will explore the concept of Regional Auctions and other additional leading practices to ensure top dollar from ODOT's auctions.

ODOT will revamp its vehicle and equipment cycling practices to make sure that vehicle life cycles are optimized. An analysis of ODOT's current state and future state utilization standards could mean a $1.4 million saving in repair costs when the fleet cycling optimization is realized. Cost per Mile (CPM) to operate ODOT's Fleet increase as the fleet increases with age. Mileage is also a predictor of residual value and how much money ODOT can expect to receive per each vehicle through auction. ODOT will thoroughly investigate the cost of downtime and delays on its fleet.

ODOT will implement within its EIMS a replacement analysis tool that will flag repairs on high mileage vehicles. If the repair estimate exceeds the NADA and/or Bluebook value, the repair will not be made.

Once again ODOT would like to acknowledge the partnership with the Auditor's Ohio Performance Team (OPT) throughout the Performance Audit. ODOT looks forward to future engagements with the OPT on mutually agreed on process improvements.

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