SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Analysis of Fleet Replacement Lifecycle

Project #12-14

Prepared by
Office of the Inspector General

J. Timothy Beirnes, CPA, Inspector General

sfwmd.gov

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

MEMORANDUM

TO: Tommy Strowd, Division Director, Operations, Maintenance and Construction

FROM: J. Timothy Beirnes, Inspector General

DATE: October 4, 2012

SUBJECT: *Report*: Analysis of Fleet Replacement Lifecycle
Project No. 12-14

The subject analysis was performed pursuant to our Fiscal Year 2012 annual audit plan. Our objectives focused primarily on determining how the District's equipment replacement criteria and practices compare to current industry standards and practices. We also focused on determining the point at which it is more cost efficient to replace vehicles and equipment rather than repairing.

Among the methods used for determining the optimum point for replacing vehicles, lifecycle costing is preferred because it results in the most economical cost. Studies show that lifecycle method results in vehicle lives in the range of 9 to 12 years, with the tendency in the 10 to 11 year range. Studies also show that total annual costs tend to decline only marginally after 9 years and should be weighted against many "soft cost" factors; such as, obsolescence, downtime cost, and employee morale, in the replacement decision process. We made several suggestions for your management's consideration.

Please feel free to call me should you have any questions concerning matters discussed in this report.

c: Governing Board Members
Melissa Meeker
Bob Brown
Deena Reppen
Carolyn Ansay
Alex Damian
Joel Arrieta

TABLE OF CONTENTS

BACKGROUND

In accordance with the Office of Inspector General's Fiscal Year 2012 Audit Plan, we conducted an analysis of the District's fleet replacement lifecycle guidelines. District vehicles are tools used to carry out the District's mission. Thus, the primary goals are that the vehicles are safe, reliable, and provide the necessary functionality at an economical cost. The District's current guidelines target vehicle replacement at approximately 12 years or 180,000 miles. The Field Operations Bureau, under the Operations, Maintenance, and Construction Division, oversees vehicle and equipment replacement. The District owns the following vehicles and equipment:

	Number*	
Vehicle Type	**2010**	**2003**[1]
Sedans	27	24
Light Trucks	477	516
Medium & Heavy Trucks	92	69
Tractors	20	20
Heavy Equipment	74	81
Boats	120	140
Trailers	193	253
Total Vehicles	1,003	1,103

*Fleet operations also maintain approximately 150 other pieces of equipment that are not included in the above table; such as, all terrain vehicles, mobile pumps, compressors, and other miscellaneous equipment.

The above table also includes the number of vehicles in the District's fleet in 2003. This comparison reveals that the District manages to fulfill its mission with 100 (9%) fewer vehicles and equipment pieces than in 2003.

[1] Data from the *Audit of the District's Fleet Operations,* Report No. 04-08, issued by the District Office of Inspector General issued February 18, 2005.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our objectives focused on comparing the District's equipment replacement criteria and practices to current industry standards and practices. We also focused on determining the point at which it is more cost efficient to replace vehicles and equipment rather than repairing.

Our methodology entailed researching available public information regarding how companies manage their fleets and the average life at time of replacement. We also researched current trends in fleet lifecycles.

EXECUTIVE SUMMARY

Vehicle manufacturers' improved engineering, technological advancements, and improved workmanship have led to increased vehicle quality and longer useful lives. Consequently, individuals and companies are keeping vehicles longer. The average age of passenger vehicles on the road has increased approximately 2 years over the last decade to 10.8 years in 2011.

Three options are typically used in determining a vehicle's replacement point:

1) Replacement is determined based on established intervals of age and mileage. This method is simple to implement but may not result in the most economical cost because it does not consider variability among vehicles.
2) Replacement is made when repairing exceeds the value of the vehicle. This method is often referred to as the "drive it till it dies" approach, which typically occurs when a major component fails, such as a transmission or engine. Major components tend to start failing on vehicles in the 150,000 to 200,000 miles range.
3) Replacement is based on lifecycle costing analysis. This method considers the point in the vehicle or equipment's life when the sum of all ownership and operating costs reaches a minimum. Typical parameters included in these analyses are depreciation, cost of money, insurance, fuel, and maintenance and repairs.

Among the three methods, the lifecycle costing method is preferred because it results in the most economical cost. However, the method is also the most complex to implement and is often as much an art as science. One major assumption implicit in the lifecycle approach is that future maintenance and repair costs can be forecasted with reasonable certainty based on historical maintenance and repair costs. Therefore, judgment is needed in interpreting the results and sensitivity analyses should be made to evaluate the impact of changes in assumptions. The optimal replacement time is rarely a precise moment, but more closely resembles a window.

The two costs that change the most over a vehicle's life are depreciation and repairs. Depreciation cost is very high over the early years of a vehicle's life, losing about half its value in the first three years alone. Repair costs are usually covered under factory warranties for the first three years or more; however, repair costs increase with vehicle age and tend to rise dramatically after 150,000 miles.

One study[2] concluded that the optimum life cycle results in the range of 9 to 12 years based on various simulation models; however, the tendency was in the 10 to 11 year range. The study also showed that total annual costs tend to decline only marginally after 9 years. Based on the results of this study, extending the District's target life beyond 9 years may only provide marginal cost savings. Vehicle life cycle tends to follow the economic concept of marginal utility. Such minimal saving should be weighed against the many "soft cost" factors such as obsolescence, downtime cost, and employee morale.

We made several suggestions for management's consideration at the end of this report.

[2] University of Minnesota, Center for Transportation Studies

TRENDS IN VEHICLE USEFUL LIFE

The average light vehicle lasts about 13 years and 145,000 miles when it is taken out of service and scrapped. However, this includes accident vehicles taken out of service prematurely. According to Consumers Report, the average vehicle will last about 150,000 miles; however, a properly maintained vehicle can last until 200,000 miles. Historically reliable models may last even longer.

Americans are keeping cars and light trucks longer. The average age of passenger vehicles on the road has increased approximately 2 years over the last decade, from 8.9 years in 2001 to 10.8 years in 2011 as shown in Table 1. This trend is due to manufacturers' continuously increasing vehicle quality through improved engineering, technological advances, and improved workmanship. The trend has also been influenced by economic conditions as individuals and businesses stretch budget dollars for their transportation needs. However, as shown in Table 1, the trend for keeping vehicles on the road longer was well established before the economic challenges triggered by the financial crisis of 2008.

Average Age of Passenger Cars and Light Trucks			
Year	Passenger Cars	Light Trucks	Total Light Vehicles
1995	8.4	8.3	8.4
1996	8.5	8.3	8.5
1997	8.7	8.5	8.6
1998	8.9	8.5	8.8
1999	9.1	8.5	8.8
2000	9.1	8.4	8.9
2001	9.3	8.4	8.9
2002	9.4	8.4	9.0
2003	9.6	8.5	9.1
2004	9.8	8.6	9.4
2005	10.1	8.7	9.5
2006	10.3	8.9	9.7
2007	10.4	9.0	9.8
2008	10.6	9.3	10.0
2009	10.8	9.8	10.3
2010	11.0	10.1	10.6
2011	11.1	10.4	10.8

Table 1

Source: Polk
(note figures are from July 1 each year)

Americans have also managed to find ways to provide their transportation needs with fewer vehicles. The number of vehicles in operation in 2011 is slightly less than five years ago although the country's population has grown by approximately 12 million people, or 4.1%, over the same period (per U.S. Census Bureau data), as shown in Table 2.

Passenger Cars and Light Trucks Vehicles in Operation	
Year	Volume
2000	205,279,196
2001	209,199,497
2002	213,540,009
2003	218,375,207
2004	224,982,194
2005	231,986,557
2006	237,084,889
2007	240,912,739
2008	242,081,704
2009	241,509,108
2010	240,012,476
2011	240,504,646

Table 2

Source: Polk
(note figures are from July 1 each year)

As companies continue to find ways to get the most out of their fleet vehicles and technology continues to evolve, replacement cycles are increasingly extended. Budget constraints have encouraged more fleets to be creative with cost-cutting strategies. Some companies have adopted a wait-and-see strategy where individual vehicles are replaced only when necessary or when safety concerns arise. Some companies are also streamlining their fleets by having drivers share vehicles or redefining employee job functions. The table on page 1 shows that the District's trend has also been to reduce its fleet size in recent years.

Within commercial fleets, the long-term trend in vehicle life cycling has been a gradual increase in the service life of vehicles since 2007. However, more recent industry data has shown significant lengthening of cycles. Improved quality and vehicle dependability have reduced the risk of extending the replacement cycle.

Another industry trend is right sizing vehicles for the job. Employee job functions are being reassessed to determine if a smaller more fuel efficient vehicle provides sufficient utility to perform the job junction. Vehicle utilization is also being evaluated and whether certain vehicles can be shared, or more fully shared, with other employees. Also, older vehicles are considered for possible secondary uses.

REPLACEMENT CYCLE METHODS

Following are three options that may be used in determining when to replace a vehicle:

- Replace at established intervals based on age and mileage.
- Replace when the cost to repair exceeds the vehicle's value.
- Determine the optimum replacement point that results in the lowest total cost over the vehicle's life.

These three options are discussed in the following sections.

Replace at Established Intervals

Established interval replacement is based on establishing guidelines by vehicle class based on age or mileage. Under this method a vehicle is replaced when it reaches its target age or mileage. Currently, the District uses the established interval approach with a target guideline of 12 years or 180,000 miles. Individual vehicle's maintenance and repair costs are also monitored to identify those that that begin to significantly exceed the average cost within its vehicle category.

The advantage of the interval replacement method is its simplicity of implementation as it removes subjectivity and judgment from the replacement decision process. The disadvantage is that it may not result in the most economical cost because it does not consider variability of conditions among vehicles; for example, some models are historically more reliable and durable and can usually be driven longer without incurring major repairs compared to less reliable models. Consequently, some less reliable vehicles may be kept in service longer than they should thereby incurring costly repairs while others may be removed from service although they may have several years of functional service life left without incurring major repairs.

Replace When Repairing Exceeds Value

Replacing when repairing exceeds value approach keeps the vehicle in operation until it requires a major repair that exceeds the value of the vehicle. Typically, this occurs when a major component fails such as a transmission or engine. Transmissions typically cost between $2,000 and $4,000 and the cost of an engine often exceeds $5,000.

Once a major component fails, the vehicle usually has little resale value as they are often sold for salvage. Selling the vehicle "as is" is generally preferable to repairing because the cost of the repair is usually not completely recoverable when selling the vehicle. If the major repair is performed, the investment is best realized through keeping the vehicle in service and extending its replacement target.

Repair costs tend to start increasing dramatically at about 150,000 miles. The best time to sell a unit is just before a major breakdown; however, the challenge lies in pinpointing when it will occur and is the major disadvantage to the replace when repairing exceeds value approach.

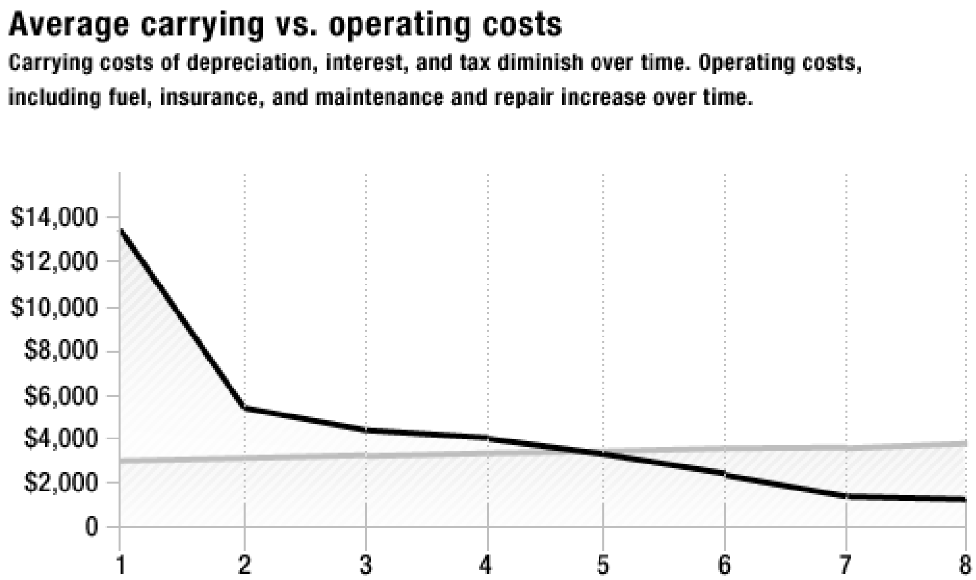
Life Cycle Costing

One of the most important considerations in developing a fleet replacement program is understanding the concept of lifecycle costs. As vehicles age certain costs such as maintenance and repairs tend to increase while other costs such as depreciation tend to decrease. When the sum of these and all other ownership and operating costs reaches a minimum, the economic life is reached. Quantifying and analyzing these costs is known as economic lifecycle analysis.

Lifecycle analysis can be applied in three ways as a management tool. First, the analysis can be used to develop guidelines by vehicle class based on age or mileage replacement criteria before vehicles go into service. Second, the analysis can be used to assess individual vehicles after they have been in service to determine whether they should continue in service for another year or be replaced. Third, the analysis can be applied to evaluate the economics of major rebuilding programs for larger trucks and equipment units to assess whether it is more cost effective to rebuild the unit and extend its life or replace it with a new one. The typical parameters included in these analyses are the following:

- Depreciation
- Cost of Money
- Insurance
- Fuel
- Maintenance and Repairs

In determining the optimum point in time to replace a vehicle, total cost of ownership is divided into two groups: 1) ownership costs tied to the vehicle purchase, and 2) operating costs associated with ongoing driving expenses. Ownership costs are those relatively fixed cost due to purchasing and owning a vehicle; such as, age depreciation, and insurance. Operating costs are associated with the ongoing driving expenses including fuel, maintenance, repairs, and mileage depreciation. Ownership costs diminish significantly over time while operating costs rise slightly, primarily due to increasing maintenance and repair costs as illustrated in the following graph:

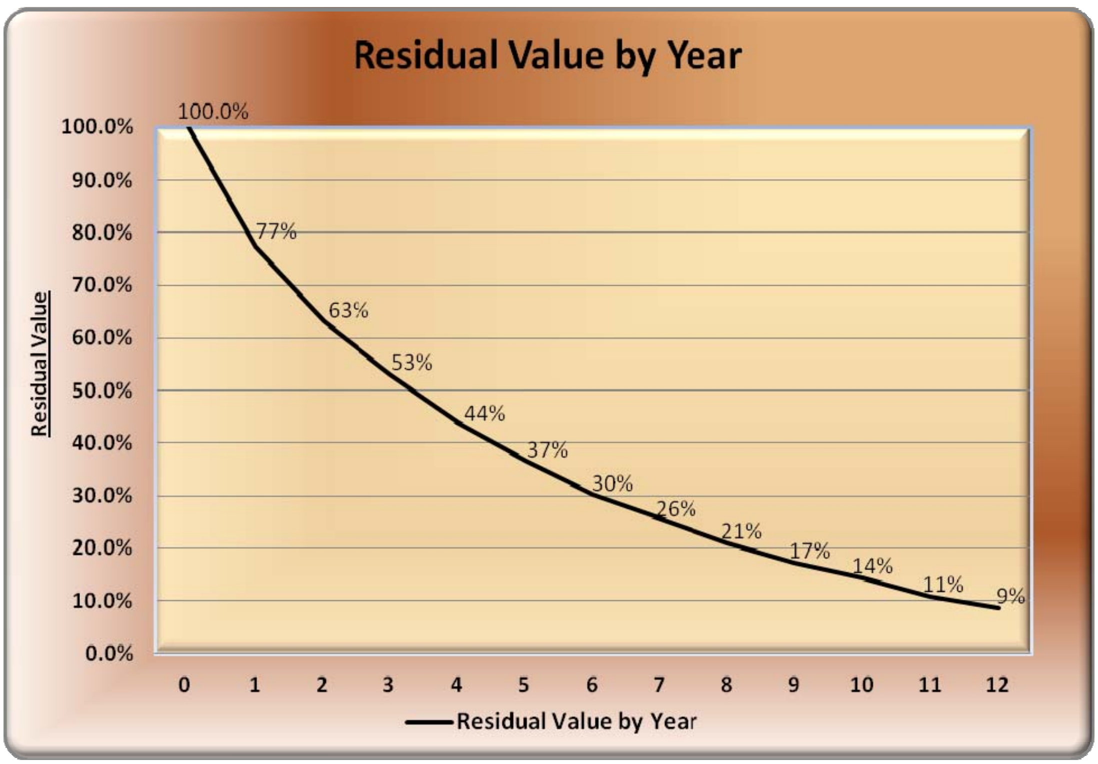


Still, on average, operating costs are less than carrying costs until a vehicle is about five years old. Depreciation is the biggest reason cars cost so much to own during the first few years. It makes up almost 60% of the cost in the first year alone. Insurance cost is relatively fixed over the vehicle life but tends to be slightly higher for a new vehicle and declines slightly over time as the value of the vehicle declines. Fuel is directly correlated to the amount of miles the vehicle is driven. These cost categories are more fully discussed in the following sections.

<u>Depreciation</u>

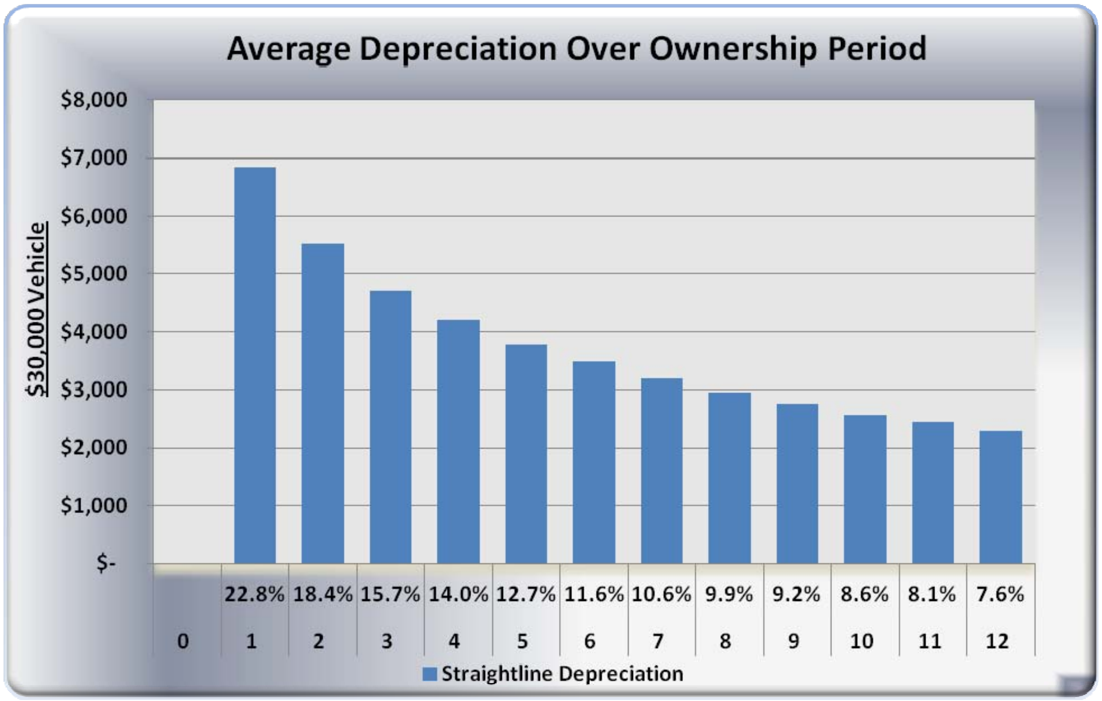
Depreciation cost over the ownership period of a vehicle is the price paid for the vehicle, plus any acquisition costs to place it in service, minus the resale value (net of any selling expenses). Depreciation comprises two components; utility and prestige value. The utility component (the usefulness of the vehicle) is based entirely on mileage – a vehicle loses utility value with every mile driven. The other component, new-vehicle prestige, drops dramatically at delivery. Prestige value continues to drop quickly throughout the first two years, and by years four and five virtually no prestige value remains. For the balance of the vehicle life, depreciation is based solely on the amount of utility left in the vehicle.

Depreciation is the largest cost of owning a vehicle during the first six years of ownership. Vehicles typically lose about 70% of their original value over the first six years of life but will lose only about 20% over the following six years (years 7 through 12). This trend is illustrated in the following graph:



Thus, the depreciation expense over the first six years for a $30,000 vehicle is about $21,000 and about $6,000 over years 7 through 12. While maintenance and repair costs will increase over the second six year period they typically are less than the difference in the depreciation between the two periods (i.e. $15,000).

Another way to look at depreciation is the average annual depreciation cost of owning a vehicle over a certain number of years; for example; the depreciation cost for replacing a vehicle every year is about 30% (30% ÷ 1), whereas replacing the vehicle after six years the average drops to about 11.67% (70% ÷ 6). The average drops to 7.6% over a 12-year ownership period. This is illustrated in the following graph for a vehicle with an original cost of $30,000:



As shown in the above graph, although the straight line depreciation rate continues to decline each year, in the latter years there is a diminishing rate of saving for each year the vehicle is kept in service. Since the cost of a new vehicle will usually be higher than the original cost of the vehicle to be replaced, replacement decisions should be based on the projected depreciation cost of the new vehicle and not the original cost of the vehicle to be replaced.

Cost of Money

The cost of money is the interest rate that would be paid if capital were borrowed to acquire the asset. If the investor's own funds are used to acquire the asset the cost of money is the interest that could be earned if the amount invested in an asset was instead invested in a risk-free security such as U.S. Treasury Bills. This is also referred to as opportunity cost since it is the opportunity forgone as a result of using the funds to purchase the asset. The District usually purchases vehicles with its own funds. Currently, the risk-free rate of return is very low - less than 1%; therefore, under current conditions the Cost of Money factor in a life cycle analysis will have minimal affect on the results; for example, the July 2012 30-day average yield was 0.31% for participants in the State Board of Administration of Florida Local Government Investment Pool. This is one of the investment options used for investing District cash.

Insurance

Insurance is a relatively fixed cost; however, the cost of insuring a new vehicle is generally slightly higher during the first few years of ownership. The reason for this is that a new vehicle carries a higher value making it a greater risk in the event of an accident. However, reduced liability due to added safety features in new vehicles, are tending to offset much of the increased collision risk. Safety features are increasingly included even in basic trim models. Thus, the difference in insurance cost is not that significant to the decision making process. It should be noted that the District self insures its fleet.

Fuel

Fuel cost is a variable operating expense as it is directly related to the number of miles driven. However, fuel expense can vary significantly due to wide fluctuations in fuel prices, which are unpredictable. However, fuel costs can be estimates based on averages over time and price trends. Fuel costs factors should include assumptions that the average price will continue to increase over time.

Vehicle replacement decisions should also factor in the improvements in fuel economy provided in new vehicles. Manufacturers continue to incorporate technological advancements into new vehicle that have improved fuel efficiency while maintaining or increasing horsepower. The high cost of fuel has made increasing fuel economy a high priority for vehicle manufacturers. Federal standards also mandate that manufacturers achieve certain average minimum miles per gallon benchmarks in future years. According to Bureau of Transportation statistics the average fuel efficiency of U.S. Light Duty Trucks (i.e. < 8,500 lbs GVWR) increased about 3 mpg over the past decade, which equates to about a 15% improvement. (A significant portion of the District fleet is Light Duty Trucks.) A 3 MPG improvement in fuel economy saves about $600 to $700 per year (assuming 15,000 miles per year and current gas prices of about $3.75 per gallon). Additionally, a vehicle's fuel efficiency tends to decline slightly for older vehicles due to engine ware.

Maintenance and Repairs

Preventive maintenance is critical to maximizing a vehicle's useful life. Missing even one oil change can shorten an engine's life span. The District's fleet operation uses a computerized information management system (SAP) to monitor and document the preventive maintenance and repairs of its fleet. Maintenance costs typically include fluids, filters, belts, hoses, batteries, brakes, sparkplugs, and other components that are not intended to last the life of the vehicle. Repairs, on the other hand, are those components that fail prematurely, such as alternators, air compressors, transmissions, and other components that are intended to last the life of the vehicle. Vehicle repair costs are generally covered under manufacturers warranties for the first few years of ownership (typically 3 to 5 years). Repair costs tend to increase as a vehicle ages and begins to offset some of the depreciation savings from keeping a vehicle longer. Repair costs are generally manageable until a major component fails, such as a transmission or engine. Major components begin failing between 150,000 and 200,000 miles. Vehicles have minimal resale value once a major component fails as the cost often exceeds the vehicle's value. Such vehicles are often removed from service and sold for salvage. Vehicle condition is the most significant factor that affects resale value in older higher mileage vehicles.

One strategy used to reduce repair cost over the life of the vehicle is to purchase vehicles that have historically proven to be reliable. Vehicles with better reliability reputations tend to last longer and provide lower total operating cost. Reliability can significantly affect the cost of maintenance and repairs over the vehicle's life, especially during the latter years. Thus, maintenance and repair costs can vary widely among fleet vehicles.

Other Replacement Considerations

Obsolescence Cost

Technological advancement should also be considered in vehicle replacement decisions. Manufacturers continue to add technological advancements to vehicles that improve fuel economy, improved emissions, added safety equipment, and reduced maintenance requirements. Safety features, such as traction and stability control, ABS brakes, tire pressure indicators, and side airbags, are increasingly becoming standard equipment even on base models. Safety features reduce accidents and protect occupants. Additionally, manufacturers are providing longer warranties on some models as they continue to improve reliability. Quantifying obsolescence is not easy but can be the deciding factor on how long to keep vehicles. Quantifying obsolescence requires judgment and can involve age and experience factors, manufacturers input, and safety factors.

Downtime Costs

As a vehicle ages, breakdowns will increase. In addition to the cost of repairing the vehicle there may be other costs such as towing expense and possible vehicle rental cost (or mileage allowance for use of personal vehicle) while the repairs are performed. In addition there is the cost of lost staff productivity, which is not reflected in fleet management costs. Productive time may be lost due to:

- Waiting to be towed.
- Arranging for temporary use of another vehicle.
- Administrative time arranging for the repairs.
- Returning to the shop to pick up the vehicle after repairs are complete.

Downtime cost parameters should be included in a life cycle cost analysis. Downtime cost generally includes the loaded rate of the work crew and the cost of a spare vehicle. Towing cost may also be incurred for broken down vehicles.

Market Conditions

Market values of used vehicles also fluctuate based on changes in supply and demand. When the demand for used vehicles is high it may make economic sense to replace a vehicle sooner. Additionally, available manufacturer price incentives should be considered in the replacement decision (i.e., rebates, etc.). Values of used vehicles tend to be higher during periods of economic distress. The most generous manufacturer price incentives are also generally widely available during such economic periods. Also, in the fall, when the new models are introduced, incentives are usually widely available on prior year model closeouts.

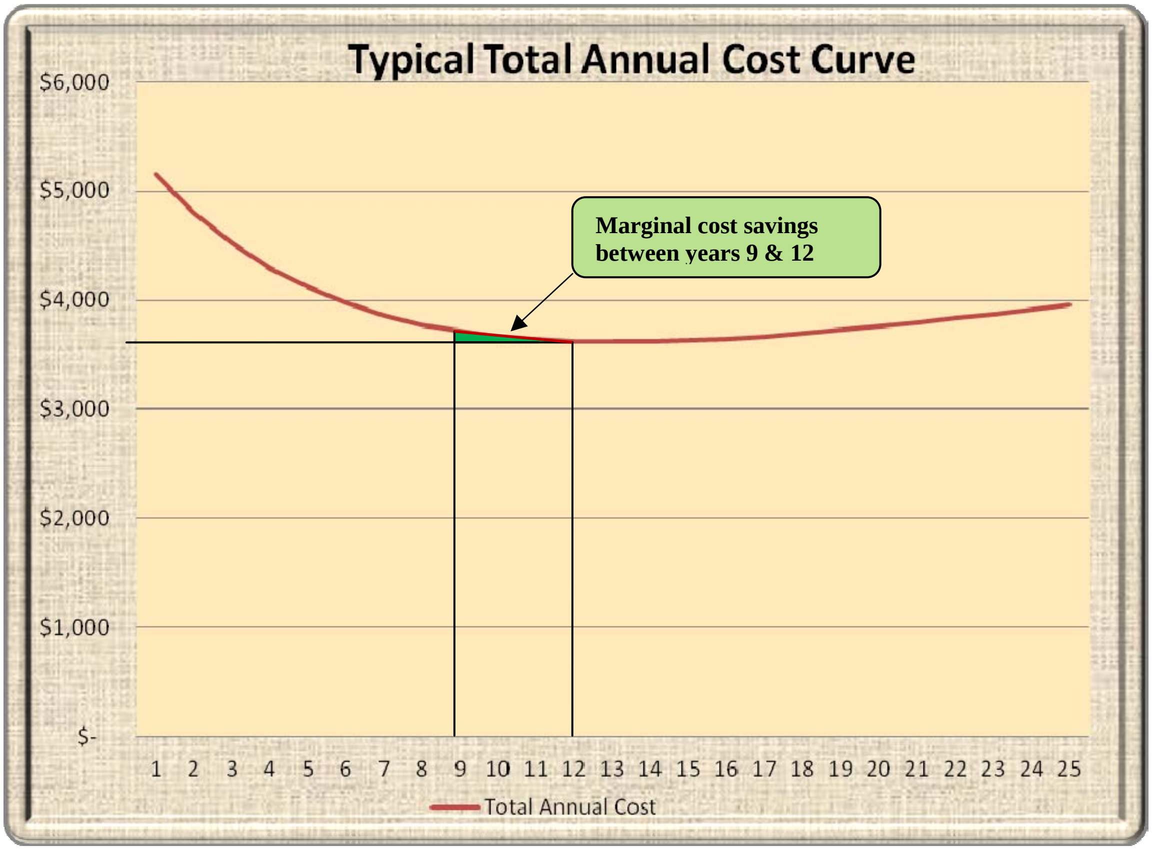
Other Factors

Following are other factors that should be considered in vehicle replacement decisions.

- Replacement must also factor in the cost of removing District emblems from old vehicles and adding them to new vehicles.
- Right sizing the fleet size and vehicle sizes to met organizational needs
- Potential impact on the District's image should also be considered if vehicles begin to look unsightly.
- Employee morale and satisfaction may be affected since employees tend to have less initiative to care for older vehicles.

Applying Lifecycle Costing

The total cost curve tends to become asymptotic, or flattened as a vehicle ages. Stated otherwise, total cost of ownership declines each year of operation but the amount of decline decreases with each year until it nearly resembles a straight line, and then begins sloping gradually upward. One study we found determined that the lowest cost of ownership results from keeping a vehicle for 17 years. However, the study also showed that total ownership cost declines very little after 9 or 10 years (assuming 12,000 miles per year). Another study; performed by the University of Minnesota, Center for Transportation Studies, concluded that the optimum life cycle results in the range of 9 to 12 years based on various simulation models, with the tendency to be in the 10 to 11 year range. Further, this study also showed that total annual costs tend to decline only marginally after 9 years. Thus, the law of diminishing return of extending a vehicle's life beyond 9 years should be weighed against the many benefits of a new vehicle. This is illustrated in the following graph[3]:



One major assumptions implicit in the lifecycle approach is that future maintenance costs can be forecasted on the basis of historical maintenance costs. Therefore, judgment is needed in interpreting the results and sensitivity analyses should be made to evaluate the impact of changes in assumptions. Moreover, historical trending of vehicle maintenance costs versus age tends to understate the true maintenance costs of older vehicles, since highly problematic vehicles typically have been already culled from the fleet. Also older vehicles tend to be reassigned to less intensive use and major repairs may be postponed or not done at all. Hence, it should be noted that lifecycle analysis is

[3] Based on data extracted from a University of Minnesota, Center for Transportation Studies, report.

as much of an art as it is a science. The optimal replacement time is rarely a precise moment, but more closely resembles a window. Where that optimal window falls in a vehicle service life can vary throughout the District due to varying demands placed on vehicles; for example, off-road use is more stressful on vehicles than on-road driving.

A lifecycle cost approach also requires a procurement process other than lowest bid because the vehicles with the lowest lifecycle cost may not be the vehicle with the lowest purchase price.

CONSIDERATIONS

1. Consider implementing a lifecycle costing approach to determining the most economical replacement point for vehicles and heavy equipment.
2. If the District continues to use the age and and mileage target method with target guidelines of 12 years and 180,000 miles, we recommend performing an annual physical condition assessment of vehicles at least 10 years or older, or exceed 150,000 miles. These can be performed when the vehicle is brought in for routine maintenance
3. Consider the feasibility of purchasing used vehicles 1 to 3 years old to reduce the new vehicle prestige depreciation cost.
4. Consider incorporating historical vehicle reliability into the vehicle procurement process.
5. When possible reassign older vehicles to less intensive uses, which can help extend the replacement cycle.