Bus Lifecycle Cost Model for Federal Land Management Agencies

User's Guide

Introduction

The Bus Lifecycle Cost Model is a spreadsheet-based planning tool that estimates capital, operating, and maintenance costs for various bus types over the full lifecycle of the vehicle. The model is based on a number of operating characteristics, including those related to the routing and frequency of the service. The model is designed to allow users to estimate and compare the total costs of offering different types of bus services over time. The model helps the user:

- Estimate the cost of operating a bus service over the full lifecycle of a vehicle;
- Determine the most cost-efficient bus type(s); and
- Understand the effect of various factors, including route distance, travel time and headway, on cost.

The model is tailored to planning bus service that serves Federal Land Management Agencies (FLMAs), allowing federal public land site planners and partners to estimate the total cost of various Alternative Transportation System (ATS) project alternatives using a systematic approach that is consistent, comparable, defensible, and credible.

The spreadsheet model requires certain inputs from the user and contains default values, which the user can change in accordance with the individual federal public land site's specific circumstances.

The following are the **inputs** to the model:

- Bus type
- Fuel costs
- Service and schedule characteristics
- Driver wages
- Maintenance requirements
- Overhaul decision points
- Infrastructure
- Visitation

The following are the **outputs** of the model:

- Number of buses needed
- Vehicle capacity utilization
- Estimated purchase, operations and maintenance, overhaul, and cumulative costs on a year-to-year basis

Purpose of the User's Guide

The User's Guide is meant to be used in conjunction with the Bus Lifecycle Cost Model to inform the FLMA manager of factors that will affect the estimated cost of the vehicle. The User's Guide is not intended to provide detailed instructions on how the model works. These instructions are included as the initial sheet on the spreadsheet model itself. Rather, the User's Guide describes the assumptions of the model and how default values were chosen. It is these underpinnings by which the model's outputs, and therefore the estimations of lifecycle costs, are calculated.

Considerations for federal public land sites with existing bus service systems

FLMA staff at federal public land sites that have existing transit or bus systems may already be familiar with bus costs, U.S. General Services Administration (GSA) procurement, and scheduling. This model may be most helpful for managers who want to consider a different operating strategy or who want a quick analysis of costs to expand or modify their service.

Considerations for federal public land sites planning a new bus service system

FLMA staff at sites without existing transit or bus systems can use this model as an introduction to bus lifecycle costs and an overview of considerations when instituting a bus service.

Cost Elements

The model includes the cost elements shown in the table below. These represent the basic costs associated with running a transit system. Additional considerations are outlined in the next section.

Cost Element	Included in the model	Not included in the model
Capital	• Bus purchase price • Start up costs • Maintenance facilities and storage • Bus shelters / infrastructure • Fueling stations • Inflation rates	• ITS equipment (outside of start up costs)
Operations	• Site-owned and operated fleet management • Driver wages • Fuel costs • Administrative costs • Marketing costs • Road condition adjustments	• Lease / concessionaire arrangements
Maintenance	• Preventative • Corrective • Mid-cycle overhaul	

Bus Types

This model includes five bus types as default options. These are among the most commonly used bus types in use at federal public land sites.

Vehicle Type	Passengers	Average Purchase Cost	Fuel economy	Life span	Operations/ Maintenance	Manufacturers	Notes
Low-floor, 40 foot, large heavy-duty bus Example	40 (with some standees)	$350,000 (diesel) $500,000 (hybrid)	4 mpg (diesel) 5 mpg (hybrid)	12-year market or 500,000 miles	Propulsion system, engine, axles, transmission, suspension and brakes may need major servicing and / or replacement one or more times over the life of the vehicle	Gillig, Millenium Transit, North American Bus Industries (NABI), New Flyer, Nova Bus, and Orion	Constitute approximately 75% of transit market. Propulsion systems include diesel, gas, CNG, electric, and hybrid systems
Body on frame, 30-40 foot, heavy-duty bus Example	27-30 (with some standees)	$200,000-$250,000 (diesel) $400,000 (hybrid)	5 mpg (diesel) 6 mpg (hybrid)	10-year market or 350,000 miles (some variants as 12-year, 500,000 miles)	Propulsion system, engine, axles, transmission, suspension and brakes may need major servicing and / or replacement one or more times over the life of the vehicle	Blue Bird Corporation, Optima Bus, Supreme Corporation, and Thomas Built	Constitute less than 1% of transit market (only 200-300 units sold annually)
Built on stripped chassis, cutaway, medium-duty bus Example	22-30 (typically no standees)	$75,000 (diesel) $175,000 (hybrid)	7 mpg (diesel) 9 mpg (hybrid)	7-year market or 200,000 miles	Operations and servicing are simpler than for larger transit vehicles	Cable Car Classics, Champion Bus, Eldorado National, Glaval Bus, Goshen Coach, Molly Corporation, Starcraft Automotive Corporation, Startrans, Supreme Corp, and Trolley Enterprises	Constitute just over 2% of transit market. Category can encompass some types of trolleybuses, but these average about $175,000. Operators usually not required to have a CDL.
Full size passenger van Example	12-15 (no standees)	$25,000-$35,000	15 mpg (gasoline)	4-year market or 100,000 miles	Easy to operate and offer significant parts compatibility with other cars and light-duty trucks	Several auto manufacturers offer these vehicles	Approximately 20% of transit vehicles, but transit constitutes less than 0.3% of van market. For smaller fleets, service can be carried out by nearby dealership or garage
School bus Example	40-54 (no standees)	$110,000 (diesel) $200,000 (hybrid)	7 mpg (diesel) 9 mpg (hybrid)	10-12 year market, 350,000-500,000 miles	Usually reduced maintenance costs compared to a transit bus	Blue Bird Corporation, Optima Bus, Supreme Corporation, and Thomas Built	Generally not ADA compliant. Primarily features the same components as vehicles in the 10-year market.

40-Foot, Heavy-Duty Bus (12-year, 500,000 miles)

The 40-foot (40'), heavy-duty bus is the most common bus type employed by transit agencies today, and holds approximately 75% of the transit market. Seating capacity ranges between 39-47 passengers, with additional room for standees. The 40' heavy-duty bus weighs between 33,000 and 40,000 lbs. and features doors at the front and middle of the vehicle. Low-floor options are available for better accessibility. They are designed to last a minimum of 12 years or 500,000 miles and for daily operation and rugged duty cycles; the frame, body, drivetrain and accessory systems are designed to be robust and to withstand the use associated with long, harsh duty cycles and must pass FTA-required Altoona testing[1] for the 12-year, 500,000 mile expected life of the vehicle. For many transit agencies, these buses serve the busiest routes, as they are designed to hold the greatest number of passengers (apart from even larger articulated buses). However, they are also more expensive than the other vehicle types explored in this model, and vehicles may not navigate rugged terrain and narrow roadways well.

40' heavy-duty buses may work best in public land sites which require advanced transit systems, such as those where the majority of visitors are obliged to use a service and buses are expected to be at or near capacity on most runs. The acquisition of multiple vehicles may achieve economies of scale and complementary infrastructure (internal maintenances, storage) present to accommodate larger fleets may assist in keeping variable costs down.

Fuel Considerations: 40' heavy-duty transit buses are available in various configurations and to suit the following fuel types: gasoline and gasoline-hybrid, clean diesel and diesel-hybrid, all electric and natural gas (both compressed (CNG) or liquefied (LNG) systems are available). Fuel types and configurations are best decided on a case-by-case basis depending on fuel availability and site goals and resources. Average fuel economy is dependent on duty cycle, and typically average around 4 miles per gallon (MPG), with hybrid-drive buses achieving a roughly 30% improvement in fuel economy.

Capital Costs: 40' heavy-duty buses average between $300,000-$350,000 for non-hybrid models. Advanced propulsion systems (gas and diesel hybrids) can cost upwards of $500,000, and all-electric options are limited and expensive ($1,000,000 - $1,500,000) and still in early stages of deployment at the time of this report. This model assumes a base purchase price of $300,000 for diesel and $500,000 for diesel-hybrid buses. Other capital cost considerations include fueling facilities and maintenance facility / depot construction, which are a significant investment for consideration, particularly for larger fleets.

Operations and Maintenance: The frame, body, electrical components and other major components are designed to last for the full 12-year service life; components such as the propulsion system, engine, axles, transmission, suspension and brakes will need major servicing and / or replacement one or more times over the life of the vehicle. In a public lands context, these are typically carried out on a continuous basis as individual components break down. The model uses a cost-per-mile estimate for maintenance of $1.00.

30-40 Foot, Heavy-Duty Bus (10-year, 350,000 miles)

The body-on-frame, 30-40' heavy-duty bus makes up only 1% of the transit market; however, it is most popular in demand-response and shuttle applications (airport shuttle, etc.). Seating capacity ranges from 22-30 depending on configuration, with additional room for standees. They are designed to last a minimum of 10 years and 350,000 miles with some variants holding the same 12-year, 500,000 mile minimum life expectancy of their 40' heavy-duty counterparts. They are designed to withstand daily use and rugged duty cycles and must pass Altoona testing for their expected life segment. Their robust construction results in significantly higher purchase pricing compared to the built-on-stripped-chassis or "cutaway" medium-duty vehicles of similar passenger capacity; however, in addition to their higher specification build quality, they are available in low-floor configuration providing for easier accessibility.

[1] The Altoona Bus Research and Testing Center. Penn State University. http://altoonabustest.com/.

The 30-40' heavy-duty bus may work best at federal public land sites which require advanced transit systems while operating on smaller and more rugged roadways.

Fuel Considerations: 30-40' heavy-duty transit buses are available in various configurations and to suit the following fuel types: gasoline and gasoline-hybrid, clean diesel and diesel-hybrid. Fuel types and configurations are best decided on a case-by-case basis depending on fuel availability and site goals and resources. Average fuel economy is dependent on duty-cycle, and typically average around 5 MPG, with hybrid-drive buses achieving a roughly 30% improvement in fuel economy.

Capital Costs: 30-40' heavy-duty buses average around $250,000 for non-hybrid models. Advanced propulsion systems (gas and diesel hybrids) can cost upwards of $400,000, and all-electric options are limited and expensive ($1,000,000+) and still in early stages of deployment at the time of this report[2]. Other capital cost considerations include fueling facilities and maintenance facility / depot construction, which are a significant investment for consideration, particularly for larger fleets.

Operations and Maintenance: The frame, body, electrical components and other major components are designed to last for the full 10 to 12-year service life, components such as the propulsion system, engine, axles, transmission, suspension and brakes will need major servicing and / or replacement one or more times over the life of the vehicle. In a public lands context, these are typically carried out on a continuous basis as individual components break down. The model uses a cost-per-mile estimate for maintenance of $1.00.

Medium-Duty "Cutaway" Bus (7-year, 200,000 miles)

Medium-Duty "Cutaway" buses are built on a multi-purpose frame to leverage economies of scale with production volumes. They feature a "box" on top of a universal frame, cab and drivetrain. Seating capacity ranges from 22-30 depending on configuration, typically without additional room for standees. They are designed to last a minimum of 7 years and 200,000 miles. They are designed to withstand daily use and typical "light transit" duty cycles, and must pass Altoona testing for their expected life segment. Their built-on-stripped-chassis construction results in significantly lower purchase pricing compared to the purpose built medium and heavy-duty vehicles of similar passenger capacity. An ideal vehicle for federal public land sites that desire an affordable vehicle for interpretive tours and light transit or "shuttle" duties, the "cutaway" style vehicle offers significant passenger capacity at a modest price. Due to their high-floor construction, these vehicles fare well on tight, small roads with elevation changes and in modest unpaved environments.

Fuel Considerations: Medium-duty "cutaway" style shuttle buses are available in various configurations (typically built to order) and to suit the following fuel types: gasoline and gasoline-hybrid, clean diesel and diesel-hybrid. Fuel types and configurations are best decided on a case-by-case basis depending on fuel availability and site goals and resources. Average fuel economy is dependent on duty-cycle, and typically average around 5 MPG, with hybrid-drive buses achieving a roughly 30% improvement in fuel economy.

Capital Costs: Medium-duty "cutaway" shuttle buses average around $125,000 for non-hybrid models (stripped, basic versions can be found for closer to $100,000). Advanced propulsion systems (gas and diesel hybrids) can cost upwards of $175,000. Pricing largely depends on desired features, drivetrains and level of options. Other capital cost considerations include fueling facilities and maintenance facility / depot construction, which are a significant investment for consideration, particularly for larger fleets.

Operations and Maintenance: The frame, body, electrical components and other major components are designed to last for the full 7-year service life. Major components including the propulsion system (engine, transmission) and the frame and body of the vehicle will most likely last the 7-year life span of the vehicle.

[2] This market segment is currently unavailable for purchase through the General Services Administration (GSA)'s AutoChoice program; however, as requests for 30-40' "transit" type heavy-duty buses have increased, the GSA anticipates availability at some point in 2012.

If major components such as the engine were to fail prior to this 7-year life, it would be cost-prohibitive to repair or replace them versus buying a new vehicle. Brakes, tires, and suspension may need periodic replacement and servicing throughout the vehicle life, and in a public lands context, these minor component repairs are typically carried out on a continuous basis as individual components break down. The model uses a cost-per-mile estimate for maintenance of $1.00.

Full Size Passenger Van (4-year, 100,000 miles)

Full size passenger vans are not dissimilar from those available on the consumer market for home or commercial use. Available to carry up to 15 passengers, full-size passenger vans are a flexible solution for federal public land sites requiring occasional transport of small visitor groups. Often a full size passenger van will be used to augment an existing, larger vehicle; or to provide ADA accessibility should a larger vehicle lack ADA accessibility or equipment. They are not designed for long life and high mileage and are amortized over a 4-year and 100,000-mile lifetime; however may last much longer if use is low and they are properly stored and maintained. A full size passenger van is an ideal vehicle for very small, narrow roadways or if the federal public land site desires a multi-use vehicle available to staff for various needs in addition to its passenger transportation duties.

Fuel Considerations: Full size passenger vans are available with gasoline engines and in some cases, diesel engines. The extra cost of a diesel engine for this application is often considered unnecessary and provides only modest fuel economy improvements. Typically the cargo van equivalent vehicles would provide for a stronger case to be equipped with a diesel engine, as one can more easily handle increased hauling capacity.

Capital Costs: Full size passenger vans average around $25,000 for gasoline versions, and are available with two- or four-wheel drive; the latter an attractive option if winter weather driving is required, or operation along unpaved and rough roads.

Operations and Maintenance: The frame, body, electrical components and other major components are designed to last for 4 years or 100,000 miles. If major component such as the engine were to fail prior to this 4-year life, it would be cost-prohibitive to repair or replace such a major component versus buying a new vehicle. Brakes, tires, and suspension may need periodic replacement and servicing throughout the vehicle life, and in a public lands context, these minor component repairs are typically carried out on a continuous basis as individual components break down. The model uses a cost-per-mile estimate for maintenance of $0.60.

School Bus (10-year, 350,000 miles)

The school bus market are vehicles that share engines, drivetrains and other major components with vehicles such as the 30-40’ heavy-duty transit buses, often featuring a V6 diesel engine due to the lower weight of a school bus versus a transit-oriented counterpart. Seating capacity ranges from 40-54 adults depending on model and configuration, with no room for standees. They are designed to last a minimum of 10-years and 350,000 miles. They are designed to withstand daily use and must pass Altoona testing for their expected life segment. Their construction is often of a very basic nature, with simple seats and few amenities and results in significantly lower purchase pricing compared to their transit-oriented counterparts. School buses may work best at public land sites that place a premium on passenger capacity (shuttle systems) while operating on roadways that are unsuitable for low-floor, transit buses.

Fuel Considerations: School buses are available in various configurations (front engine, rear engine, various lengths) and to suit the following fuel types: gasoline and gasoline-hybrid, clean diesel and diesel-hybrid. Fuel types and configurations are best decided on a case-by-case basis depending on fuel availability and site goals and resources. Average fuel economy is dependent on duty cycle, and typically average around 7 MPG, with hybrid-drive buses achieving a roughly 30% improvement in fuel economy.

Capital Costs: Non-hybrid school buses average around $110,000, though advanced propulsion systems (gas and diesel hybrids) can cost upwards of $200,000. Other capital cost considerations include fueling facilities and maintenance facility / depot construction, which are a significant investment for consideration, particularly for larger fleets.

Operations and Maintenance: The frame, body, electrical components and other major components are designed to last for the full 10-year service life; components such as the propulsion system, engine, axles, transmission, suspension and brakes will need major servicing and / or replacement one or more times over the life of the vehicle. Reliability of school buses may be greater than heavy-duty transit buses due to the lack of accessory systems and optional equipment. In a public lands context, the maintenance for school buses is typically carried out on a continuous basis as individual components break down. The model uses a cost-per-mile estimate for maintenance of $1.00.

Primary influences on depreciation and vehicle life expectancy

The value of a transit vehicle will decrease over time as it is subjected to use. Many characteristics of both vehicles and service types factor into the rate of depreciation. This section describes which aspects of vehicle operations, including service environment and fleet characteristics, most influence vehicle depreciation and life expectancy.

The three indicators that constitute the major determinants of the life expectancy of a vehicle are Vehicle Miles Traveled (VMT), Vehicle Hours Traveled, and maintenance and rehabilitation practices. The methods by which operators manage their vehicles will result in different maintenance and operating costs over the vehicle lifecycle. Many of the outputs of the bus model are predicated on these indicators.

Vehicle Miles Traveled (VMT)

Vehicle life expectancies correlate with annual mileage totals -- the higher the annual mileage total, the shorter the lifespan of the vehicle. Vehicles that achieve higher annual mileage figures are more likely to accrue higher maintenance costs over their lifecycle. This is due to the accelerated deterioration and increasing operations costs over time, as higher mileage vehicles tend to consume more fuel on a per mile basis. The average annual mileage across all of the nation's transit vehicles is nearly 37,000 miles.[3]

Vehicle Hours Traveled

Higher vehicle hours traveled figures correlate with shorter vehicle life expectancies. This measure is commonly gauged as vehicle operating speed, an easier figure to calculate than vehicle hours traveled over a period of time. Lower vehicle operating speeds indicate heavier duty-cycles, with more frequent starts and stops for a vehicle. This can cause wear and tear on many vehicle components, such as drive trains and brakes. The range of average vehicle operating speeds for 12-year transit buses runs between eight and 20 miles per hour, with an average of roughly 13 miles per hour.[4]

Maintenance and Rehabilitation Practices

There are two standard approaches to maintenance of transit vehicles. Many of the nation's high ridership bus operators conduct preventative maintenance on their buses. This practice, when applied to vehicles with a 12-year life expectancy, consists of taking the vehicle out of service at six or seven years of age and performing a "mid-life overhaul." This overhaul generally entails replacing the engine, transmission, and many other of the vehicles components. This affords additional years of service life to the vehicle, and may be carried out again at more advanced stages.[5]

Developing a comprehensive annual or semi-annual preventative maintenance inspection program should be a pivotal part of any FLMA's maintenance strategy. A robust preventative maintenance strategy can help identify areas requiring maintenance before they break, allowing replacements to be scheduled with other servicing.

Corrective maintenance, which is standard practice for smaller transit operators similar in scale to operations at federal public land sites, involves repairing and replacing vehicle components on an as-needed basis. This is typically an ongoing process, with opportunities to repair or replace multiple components carried out when appropriate. This corrective maintenance is employed until such time when

[3] Federal Transit Administration. *Useful Life of Transit Buses and Vans.* http://www.fta.dot.gov/documents/Useful_Life_of_Buses_Final_Report_4-26-07_rv1.pdf.
[4] Ibid.
[5] Ibid.

the costs of repair outweigh the benefits of continued utilization of the vehicle, in which case the vehicle is generally retired.[6]

Operations in an FLMA context are often confined to a corrective maintenance strategy, as resources required for conducting mid-life overhauls of vehicle fleets may be unavailable. Additionally, corrective maintenance can be carried out on any vehicle type, whereas preventative maintenance is a practice for longer-lasting 12-year vehicle fleets common of larger transit agencies. Neither approach is correlated with lower or higher vehicle life expectancies. Each operator must adopt the technique most suitable to them, based on funds available and the intensity with which the fleet vehicles are utilized.

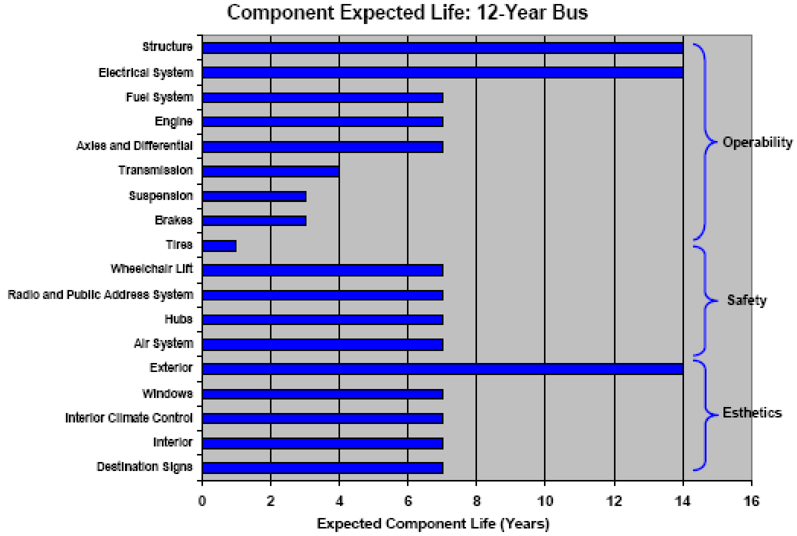
Vehicle Components and Service Environment

Buses are assembled from various components, each of which plays a different role in making a vehicle operable. Although these elements do function together as a whole, each component is fundamentally unique. The useful life of each bus component varies according to the operating conditions to which it is subjected. Whereas some parts are designed to last throughout the life of the vehicle, others will need to be replaced one or more times.

The following chart details the expected lifespans of various bus components in a 12-year vehicle:[7]

Figure 6-1

Component Expected Life: 12-Year Bus



As evidenced above, many of the vehicle components are not designed to last the useful life of the vehicle. These instances should not be assumed to only occur at the points depicted in the chart. The deterioration of some bus components is directly tied to use, such as the propulsion system and brakes. As services at many federal public land sites may be operated less frequently than in typical transit contexts, the need for repair or replacement may occur at later junctures of vehicle life.

Vehicle structure is undoubtedly the most important vehicle component. While most other components can be replaced as needed, deterioration or failure of the structure of the vehicle essentially defines the end of a vehicle's useful life. This is because the structure constitutes the backbone of the vehicle. All other vehicle components are attached to the vehicle's structure. In order to replace the vehicle's

[6] Ibid.
[7] Ibid.

structure, all other components would need to be removed and then reassembled, which would be a costly and arduous measure.[8]

Generally speaking, vehicles of shorter life expectancies (4-year, 7-year, and less commonly 10-year vehicles) will not require replacements of many of the components indicated above, with the exception of more heavily used parts such as tires and brakes. Most of the vehicle components are expected to last the life of the vehicle, and overhaul of these systems at that point would produce little utility to the operator.

The intensity of use that a vehicle experiences over time will influence the level of maintenance vehicle components will require, and ultimately the useful life of the vehicle. As noted in an earlier section, vehicle miles traveled and vehicle hours traveled are two of the three key determinants for vehicle life expectancy. These figures are determined by the operating characteristics of the vehicle in service, such as daily span of service, annual span of service, frequency of service, distances of routes traveled, average operating speeds, and non-service operating time. Buses running over long distances at greater frequencies accrue higher mileage figures, which contributes to deterioration of vehicle components.

Additionally, lower vehicle operating speeds are indicative of more frequent starts and stops, producing similar results. Greater passenger use of a vehicle, such as through high ridership, high passenger load rates, and increased presence of equipment (such as hiking gear) are also associated with vehicle wear. The environment within which a transit service operates can also greatly impact the effectiveness and useful life of vehicles and vehicle components. Local climate conditions can cause components to wear at faster rates, especially in suboptimal colder weather. For instance, salt used on roads can cause corrosion of various components, including the vehicle structure. Challenging terrain and poor road conditions can also increase attrition of components.

Vehicle Use and Fleet Characteristics

The composition of transit operator fleets influences the attention needed for maintenance efforts. The types of vehicles in use, as well as their age and historical use, are strong indicators of vehicle life expectancies and maintenance costs. The methods in which operators employ the vehicles in their fleet can also accelerate or delay the rate of deterioration.

The type of vehicle influences its value as it ages. The FTA defines five different transit vehicle types according to physical characteristics (length, weight), capacity, and cost.[9]

Comparison of Vehicle Types in FTA's Five Service-life categories

Category	Typical Characteristics				Minimum Life (Whichever comes first)	
	Length	Approx. GVW	Seats	Average Cost	Years	Miles
Heavy-Duty Large Bus	35 to 48 ft and 60 ft artic.	33,000 to 40,000	27 to 40	$325,000 to over $600,000	12	500,000
Heavy-Duty Small Bus	30 ft	26,000 to 33,000	26 to 35	$200,000 to $325,000	10	350,000
Medium-Duty and Purpose-Built Bus	30 ft	16,000 to 26,000	22 to 30	$75,000 to $175,000	7	200,000
Light-Duty Mid-Sized Bus	20 to 30 ft	10,000 to 16,000	16 to 25	$50,000 to $65,000	5	150,000
Light-Duty Small Bus, Cutaways, and Modified Van	16 to 28 ft	6,000 to 14,000	8 to 22	$30,000 to $40,000	4	100,000

These categories can assist FLMAs in estimating the minimum service life of a vehicle, measured in both years in use and mileage accrued.

[8] Ibid.
[9] Ibid.

The vehicle types included in the model roughly correspond to some, but not all, of these categories. They are detailed more extensively in an earlier section.

It is important to note that the minimum lives of vehicles, as defined by FTA, are not approximations of expected service lives. It has been noted that many transit vehicles in use are in operation beyond these figures, especially if they have been subjected to efficient maintenance practices. For example, the average retirement age for a 12-year vehicle in the FTA study was 15.1 years.[10] In an FLMA context, where vehicles are likely to see less overall use than in traditional transit services, vehicles may remain in service use well beyond the minimum life as defined by FTA.

Transit operators generally modify the intensity of vehicle use based on the timing of maintenance activities. In fleets consisting of two or more vehicles, it is common to rotate vehicles between light and heavy service loads in order to even out intensity of use. This cycling can occur over the course of a service season or throughout the lifespan of vehicles, as older vehicles are placed on routes with lighter demands. In many instances, the operator will purchase a spare vehicle in case other vehicles in service malfunction. It may be prudent to cycle this vehicle into larger service operations on occasion.

Another consideration which strongly affects ongoing maintenance costs is the sharing of transit vehicles across multiple entities over different service seasons. Many federal public land sites lend vehicles to (or lease from) other tourist sites with disparate service seasons, enabling revenue generation at a time when vehicles would otherwise be dormant. While this type of arrangement is commonly seen as beneficial for all parties, this external vehicle use contributes to accelerated deterioration and may accelerate the failure of vehicle components. It is sensible to incorporate the impact of extended use into the cost considerations of these arrangements.

[10] Ibid.

Bus Lifecycle Cost Model Inputs

The model provides default values for many key inputs. These default values are rough estimates and can be changed manually by the user. Users of the model should perform their own independent research of cost inputs to achieve greater accuracy in the model. This section identifies the inputs to the model and their default values and ranges. Also included is a description of some of the tradeoffs associated with operating a bus service in a federal public lands context, and how the default values may change as a result.

Vehicle Purchase Cost

The following are estimates of vehicle purchase costs for the five bus types in the model, including designations for diesel and hybrid buses where applicable.

Default Values:
$300,000 – 40' Heavy-Duty Diesel Bus[11]
$500,000 – 40' Heavy-Duty Diesel Hybrid Bus[12]
$110,000 – 40-passenger School Bus Diesel[13]
$200,000 – 40-passenger School Bus Diesel Hybrid[14]
$250,000 – 30'-40' Medium Duty Diesel Bus (Estimated)
$400,000 – Medium Duty Diesel Hybrid Bus (Estimated)
$125,000 – Medium-Duty 'Cutaway' Diesel Shuttle[15]
$175,000 – Medium-Duty 'Cutaway' Diesel Hybrid Shuttle[16]
$25,000 – Full-Size Passenger Van – Gasoline[17]

Operations Costs

Operating costs in this model reflect only those directly attributed to drivers and administrative personnel, whose responsibilities may include dispatching, scheduling, and management of operators. Separate parts of the model account for both fuel costs and maintenance costs.

The primary operating cost for running a bus at a federal public land site is labor. According to the Bureau of Labor and Statistics, as of May 2010 the average wage for transit and intercity bus drivers was $17.82 per hour.[18] The middle 50% earned between $12.72 and $22.97 per hour.[19] Evidence suggests these wages vary significantly according to location.

These wages are exclusive of the fringe benefits afforded to drivers. The 2010 Fact Book issued by the American Public Transportation Association (APTA) quantifies the added cost of fringe benefits, which typically includes paid leave, health and life insurance, contributions to retirement plans, social security, and workmen's compensation. APTA found that fringe benefits equate to roughly 67% of wages.[20]

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[11] Hybridcenter.org. *Hybrid Watchdog: Hybrid Transit Buses. Are They Really Green?* http://www.hybridcenter.org/hybrid-transit-buses.html.
[12] Ibid.
[13] GSA. *Buses*. http://www.gsa.gov/portal/content/101293. Note that an account is required to view vehicles.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] American Public Transportation Association. *U.S. Average New Vehicle Costs for 2009 and 2010 Vehicles By Type.* http://www.apta.com/resources/aboutpt/Documents/table22_vehcosttransitlength2010.pdf, p. 1-2.
[18] U.S. Department of Labor. Bureau of Labor Statistics. *Occupational Employment and Wages, May 2010.* http://www.bls.gov/oes/current/oes533021.htm#nat.
[19] Ibid.
[20] American Public Transportation Association. *2010 Public Transportation Fact Book.* http://www.apta.com/resources/statistics/Documents/FactBook/APTA_2010_Fact_Book.pdf, p. 21, 26, 30.

The average wage of $17.82 per hour combined with the estimated benefits of $11.94 per hour yields an overall hourly driver cost of $29.76. The default value for hourly driver cost has been rounded up to $30.00.

Default Value: $30.00/hour

Range: $20.00/hour to $40.00/hour

The average yearly salary for all operations employees, including administrative personnel, is $38,574. This is similar to the average yearly salary for only bus drivers ($37,060), so for the purposes of the model it is assumed that the hourly cost for administrative personnel is the same as for drivers.[21][22]

Public Lands Perspective: Federal public land sites tend to operate under different business models than a traditional transit agency. First, they will have a much smaller number of bus operators, perhaps as few as one or two people. Some federal public land sites use FLMA staff to operate buses. Vehicles with passenger loads over 15 passengers require a driver to have a Commercial Driver's License.[23] Second, wages are extremely location-specific and will vary based on geographic location and the prevailing wages in the region within which the federal public land site is situated. Perhaps most notably, driver costs will vary depending on whether the driver is an official staff member of the site, or whether they are an outside contractor. Wages for services operated in-house may be folded into the annual salary of either an existing or new hire. Outside contractors will generally have a cost premium to procure their services, including the costs incurred to access the site each day. These contractors may be paid on an hourly basis, but one that may be higher than the default $30.00 per hour amount.

Local Conditions (infrastructure quality, weather impacts)

Local environmental factors and road conditions within public lands vary wildly, from smooth pavement to treacherous unpaved roads, from seaside beach environments to mountains and muddy terrain. Variations in local environments and local road conditions greatly impact both fuel economy and maintenance costs of vehicle fleets greatly. The unmodified default values assumed in this model reflect good condition, paved road surfaces. High altitude, gravel road surfaces and other factors may reduce fuel economy by as much as 20-27%, and research into the impact of road conditions on operations and maintenance (O&M) costs have shown poor road conditions, excessive dirt, mud or seaside operations may increase overall O&M costs by as much as two to four times when compared to operating vehicles along flat, smooth pavement in a 'clean' environment. The default values in the model correspond to operations within public lands on roadways in reasonable condition and in a 'typical' environment, free of excessive dirt, mud, and sand or salt. The model conservatively associates a 100% cost-increase with the worst-case scenario conditions. While road construction, paving materials selection, and overall road conditions vary from site to site, this model accounts for these adverse operating conditions through a separate Local Condition Factor, which provides **four** alternative road quality categories, with each category impacting overall fleet fuel economy and O&M costs based on a self-assigned road condition evaluation. The cost increase for a worst-case condition scenario is represented conservatively as 100 percent.

Default Value: 1.0

Range: 1.0 to 2.0

[21] Ibid.
[22] U.S. Department of Labor. Bureau of Labor Statistics. *Occupational Employment and Wages, May 2010.* http://www.bls.gov/oes/current/oes533021.htm#nat.
[23] U.S. Department of Transportation. Federal Motor Carrier Safety Administration. *Commercial Driver's License Program (CDL/CDLIS).* http://www.fmcsa.dot.gov/registration-licensing/cdl/cdl.htm.

The value associated with each local condition category is factored into fuel economy calculations and O&M calculations which are based off annual vehicle miles traveled (VMT).

- Good conditions (paved roads, 'clean' environment) carry a default value of 1.0
- Fair conditions (paved or good condition dirt / gravel roads with mild dirt/dust/salt) carries a value of 1.25
- Poor conditions (poor pavement or gravel / dirt roads and dirt/dust/salt requiring frequent cleanings) carry a value of 1.5
- Bad conditions (bumpy / rutted roads with dirt/dust/salt requiring frequent cleanings) carry a value of 2.0

Public Lands Perspective: Federal public land sites tend to maintain paved and unpaved roads rather well; however, road and other local conditions vary by site, geographic location and depend on the local environment. Many sites have unpaved roads, which even when maintained properly can impact the fuel economy and maintenance costs associated with vehicles traveling on the roads. Other sites may operate in high dust/dirt/salt (seaside) environments, which require more frequent cleaning during the maintenance process. Still other sites may experience heavy use during colder months when snow and ice are prevalent, which leads to an increase in traffic accidents and potential damage to the roadway infrastructure. These factors are important when considering or planning for transportation to, from or within a federal public land site, particularly with regard to operations and maintenance costs.

Inflation Rate

Guidance from the Federal Highway Administration and the Federal Transit Administration suggests that absent state and/or local data, an annual inflation rate of 4% is acceptable.[24] Other resources, such as one developed in 2010 as an ITS project resource, has an estimate of 3%.[25] It is also suggested that the Consumer Price Index (CPI) is a useful resource. For the 12-month period concluding in July 2011, the CPI was 3.6% overall and 2.9% for transportation services.[26] Based on this research, a default value of 3.0% is selected.

Default: 3.0%

Range: 2.5%-4.0%

Maintenance Costs

Maintenance costs reflect those costs which are directly related to keeping a transit vehicle in a state of good repair as it accumulates VMT and VHT over time.

Estimates of typical maintenance costs for buses varied greatly in cited reports, owing to methodologies used in calculating figures and a stronger focus on traditional, urban-oriented transit services. The default value here does not incorporate fuel costs, unlike many estimates cited in reports. Integrating fuel costs can inflate maintenance costs by roughly $1.00/mile. Fuel costs are not included in the $/mile maintenance costs within the model.

The primary report used in developing this figure was the University of South Florida's National Center for Transit Research's *Bus Size Evaluation Tool (BSeT)*. This model examined both large (≥ 40 feet) and small (<40 feet) buses and found that each feature average maintenance costs of roughly $1.25/mile. This figure is roughly split between $0.42-$0.52/mile for labor costs and $0.73-$0.84/mile for parts costs.

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[24] Federal Highway Administration. *Financial Planning and Fiscal Constraint for Transportation Plans and Programs Questions & Answers*. http://www.fhwa.dot.gov/planning/guidfinconstr_qa.htm.
[25] Kimley-Horn and Associates, Inc. *Intelligent Transportation System Strategic Deployment Plan Update Final Cost Estimate Report.* http://www.campo-nc.us/ITS-SDP/5-Cost%20Estimate/Final-Cost-Estimate-Report.pdf, p. 2.
[26] U.S. Department of Labor. Bureau of Labor Statistics. *Consumer Price Index Summary.* http://www.bls.gov/news.release/cpi.nr0.htm.

A number of other reports were reviewed as a basis for developing the model's bus maintenance costs. The Metropolitan Transportation Authority's *Selected Aspects of Bus Fleet Maintenance* found that transit buses in mid-sized cities and rural environments, akin to a shuttle service at a federal public land site, featured much reduced maintenance costs over transit services in large cities. The National Renewable Energy Laboratory's *In-Use Performance Comparison of Hybrid Electric, CNG, and Diesel Buses at New York City Transit* found a maintenance cost range of $0.75-$1.41/mile for various hybrid and CNG buses. The *MSBO School Bus Maintenance Cost Template* discovered a range of $1.21-$1.35/mile for maintenance of school buses.

Based on the background research conducted, the model assumes a default value of $1.00/mile in maintenance costs for all vehicle types except for a passenger van. Maintenance costs can vary significantly, however, based on the nature of the service being operated by the respective FLMA.

Due to factors such as lighter weight loads, maintenance costs for passenger vans are considerably lower than for conventional buses. The Urban Land Institute's *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions* report found a $0.60/mile cost for all passenger vehicles, with which many passenger vans share components.

Default Value: $1.00/mile for all vehicle types, with the exception of $0.60/mile for passenger vans.

Range: $0.75-$1.25/mile for all vehicle types, with the exception of $0.60-$0.75/mile for passenger vans.

Public Lands Perspective: The impact of maintenance costs on total operating expenditures is heavily dependent on the maintenance procedures undertaken by the federal public land site. Sites operating systems with large fleets are more likely to invest in an on-site maintenance staff, along with facilities for conducting repairs. Although this may require a large upfront investment, cost savings will be achieved over time, and turnaround on repairs should occur more quickly. Conversely, federal public land sites with smaller fleets may decide to utilize an off-site facility to conduct repairs. While this avoids the investment of hiring staff and constructing maintenance facilities, repairs will typically cost more on a per-site basis, turnaround may be slower, and there will be added costs in transporting vehicles to and from the maintenance site. For those services operated much like a traditional transit agency, with frequent service and high levels of usage, costs may be lower, closer to $0.75/mile. For other services that may have an interpretive component and therefore incur a lot of idling time, the cost may be closer to $1.25/mile.

Fuel Economy

Fuel economy will vary significantly by type of vehicle and type of fuel. The majority of vehicles operating on public lands will use diesel fuel; however, some may be hybrid buses and will generally achieve a 20-30% improvement.

Default Values:
4 miles per gallon (MPG) – 40' Heavy-Duty Diesel Bus[27]
5 MPG – 40' Heavy-Duty Diesel Hybrid Bus[28]
7 MPG* – 40-passenger School Bus Diesel[29]
9 MPG* – 40-passenger School Bus Diesel Hybrid[30]
5 MPG – 30'-40' Medium-Duty Diesel Bus (Estimated)
6.5 MPG – 30'-40' Medium-Duty Diesel Hybrid Bus (Estimated)
7 MPG - Medium-Duty 'Cutaway' Diesel Shuttle[31]

[27] Federal Transit Administration. *Transit Bus Life Cycle Cost and Year 2007 Emissions Estimation.* http://www.proterra.com/images/WVU_FinalReport.pdf, p. 11.
[28] Ibid.
[29] GSA. *Buses*. http://www.gsa.gov/portal/content/101293. Note that an account is required to view vehicles.
[30] Ibid.

9 MPG - Medium-Duty ‘Cutaway’ Diesel Hybrid Shuttle[32]
14 MPG - Full-Size Passenger Van – Gasoline[33]

*Note: the fuel economy figures for school buses, as defined above, are from average fuel economy figures. The greater fuel economy compared to a heavy-duty transit vehicle is attributable to two main factors: lighter weight, and higher-speed duty cycles (suburban transport) which have fewer stops and starts than their transit-bus counterparts.

Public Lands Perspective: The fuel efficiency of buses on federal lands will be impacted by the characteristics of the service being operated, such as number and frequency of stops, and idling time. Federal public land sites may experience reduced fuel economy when buses navigate traverse terrains with steep inclines.

Engine and Transmission Overhauls

The model includes a “trigger” at 250,000 miles traveled, which results in the inclusion of costs for an engine and transmission overhaul. For passenger vans, the anticipated useful life of 100,000 miles assumes no major overhauls, and that the vehicle will be decommissioned at the end of its life due to the low residual value of the vehicle (i.e. it would not be financially justifiable to overhaul a small passenger van versus purchasing a new replacement vehicle). Costs associated with medium- and heavy-duty vehicles’ major overhauls are as follows:

Engine Overhaul Costs:[34]

- Heavy-Duty (30’-40’) Bus
    - Diesel / Biodiesel: $20,000
    - Diesel-Hybrid: $15,000
- Medium-Duty (Shuttle / Cutaway)
    - Diesel / Biodiesel: $15,000
    - Diesel-Hybrid: $15,000

Transmission Overhaul Cost: $10,500 (non-hybrid), $31,300 (hybrid)[35]

Other Factors: Modern “Clean Diesel” vehicles are equipped with advanced diesel emissions systems and a diesel particulate filter (DPF). Heavy-duty diesel vehicles built since 2010 are equipped with DPF and replacement intervals are still difficult to estimate. Some manufacturers cover this system under an extended warranty and recommend annual DPF cleaning, which can range from $300-$1000 depending on the vehicle’s exhaust system design and ease of access to the DPF for removal and cleaning. Engine overhaul costs for diesel-hybrids in heavy-duty buses are significantly less due to their use of less expensive medium-duty engines, instead of the heavy-duty diesel engines (typically a heavy-duty V8) installed in non-hybrid diesel buses. Conversely, the transmission systems utilized in hybrid-drive buses are not rebuildable and must be removed and replaced with a remanufactured unit from the manufacturer. Diesel-hybrids in the medium-duty class and school buses are equipped with similar engines as their non-hybrid counterparts, typically a V6 diesel.

Public Lands Perspective: Major overhauls typically occur near the end of a vehicle’s useful life. It is anticipated that the majority of federal public land sites will not see high VMT totals for their vehicle fleets, and thus will likely not perform a major overhaul within the vehicle’s useful life (12-years, FTA standard useful life).

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[31] Ibid.
[32] Ibid.
[33] Fueleconomy.gov. *2011 Most and Least Fuel Efficient Trucks, Vans, and SUVs.* http://www.fueleconomy.gov/feg/bestworstEPAtrucks.htm.
[34] Transit Cooperative Research Program Report 123*. Assessment of Hybrid-Electric Transit Bus Technology*. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_132.pdf, p. 27.
[35] This model assumes hybrid-transmissions are non-rebuildable and are removed and replaced with manufacturer’s remanufactured transmissions as referenced in TCRP Report 123 (same as above).

Battery Pack Replacement

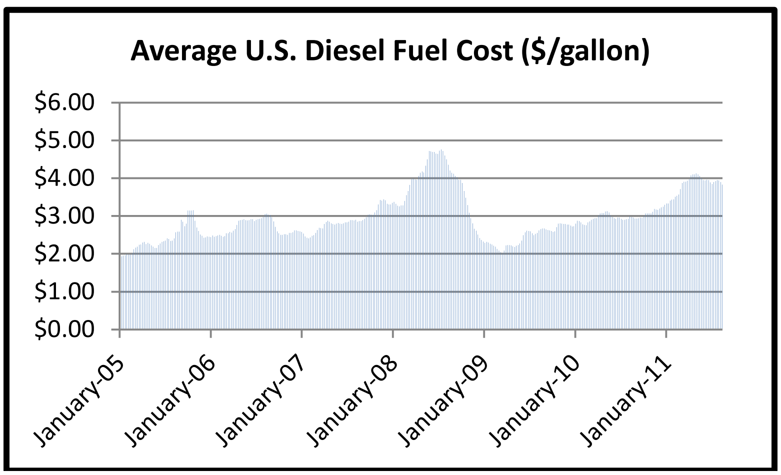
The hybrid model assumes a 6-year service life for battery pack systems equipped in hybrid vehicles. The service life is not dependent on VMT, and 6-year replacement intervals is the industry standard. It is assumed that replacement of the battery packs costs $27,500 for all hybrid vehicles; however, battery pack systems on smaller hybrid vehicles may be less expensive.

Fuel Cost

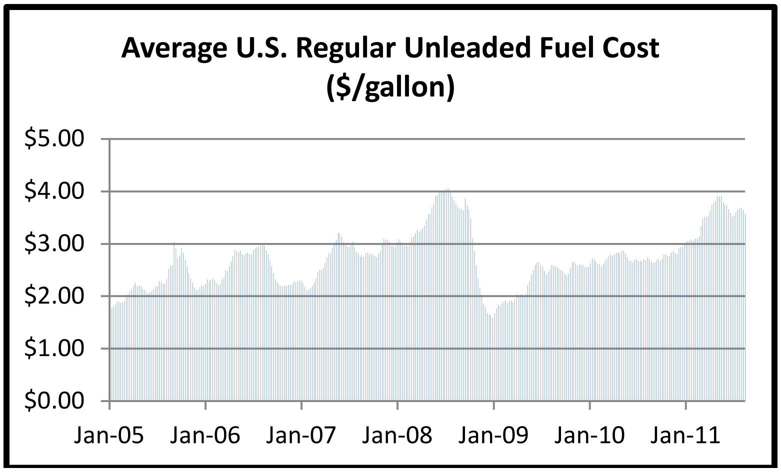
The majority of buses at federal public land sites will run on diesel fuel, though this is changing as alternative fuel sources become more readily available. Vans will likely operate on regular unleaded fuel. Some sites may operate vehicles on special blends.

Fuel prices for both diesel and regular unleaded gasoline are extremely volatile. From 2008 to early 2011, for example, the price of both has oscillated and has even increased by as much as 100% over lows set in late 2008.

Updated fuel information is always available from the U.S. Energy Information Administration.[36] The following two charts show trends in both diesel and regular unleaded fuel costs from 2005 through August 2011:[37]



[36] U.S. Energy Information Administration. *Gasoline and Diesel Fuel Update.* http://www.eia.gov/oog/info/gdu/gasdiesel.asp.
[37] Ibid.



Default Value: $4.00/gallon for diesel; $3.50/gallon for regular unleaded

Range: $3.00-$5.00/gallon for diesel; $2.50-$4.50/gallon for regular unleaded

Public Lands Perspective: In the case of public lands, fuel costs may depend on the distance operators may have to travel to get their transit vehicles fuel. Also, each state has its own gas tax that can dramatically affect the cost of fuel from one state to the next.

Fueling Infrastructure

Fueling costs in this model assume existing on-site fueling infrastructure or nearby local fueling availability. In order to facilitate on-site fueling should existing infrastructure not exist, an above-ground fully-contained fuel tank system with dispenser is recommended. A self-contained fuel dispensary system is a cost-effective and relatively straightforward 'solution' to remote on-site fueling in sensitive environments. With tanks above-ground, many regulations governing in-ground fuel tanks can be avoided, while staying under 10,000 gallons of overall storage capacity typically eases concerns from state and local authorities. Local regulations should always be consulted prior to consideration.
A quote for such a system was provided to the Volpe Center in July of 2010 for consideration at a proposed maintenance facility on Cape Cod. A 10,000 gallon dual tank system (two 5,000 gallon tanks to accommodate gasoline and diesel fueling) with ventilation, dispensing equipment, management software, etc. was quoted at $89,772 plus $4500 for delivery. Tank system costs and local delivery options may vary.

Default: $100,000 for both a gasoline and diesel tank

Range: $85,000-$110,000 for both a gasoline and diesel tank

Public Lands Perspective: Federal public land sites tend to operate within protected areas and remote locations. Local fueling may be miles away or further, and may not facilitate certain fuel options like higher-concentration blends of ethanol (gasoline) or biodiesel which may be desirable for federal public land sites wishing to mitigate their local environmental impact. On-site, above-ground fueling facilities such as the system noted above can offer convenient, local fueling and enable the public lands' agencies to have greater control over what fuel types power their vehicle fleets. While delivery and setup charges may vary, a comprehensive system to enable on-site refueling of gasoline and diesel should cost roughly $100,000 and offer the fueling capacity to support small- to medium-sized fleets.

Vehicle Maintenance Facility

For small bus fleets such as those likely to be operated in most federal lands, the vehicle maintenance bays can be multi-function.[38] The minimum size assumed for such a vehicle maintenance facility is one bus bay with an adjacent shop and parts storage area and a small office. The minimum requirement is nearly 2,500 square feet for the building. This facility could reasonably accommodate a fleet of at least 5 buses.

At Mount Rainier National Park, the cost of a maintenance building and associated equipment was $130 per square foot.[39] For a feasibility analysis of a vehicle maintenance facility at Cape Cod National Seashore a significantly higher cost estimate of over $500 per square foot was used for a much larger facility capable of servicing 25-35 vehicles. This facility was equipped with such items as a vehicle lift and washer area. This high per-square-foot cost can also be attributed to the unique construction practices and permitting processes required on Cape Cod due to the geographic properties of the area.[40]

For the purposes of this model a default value of $300 per square foot was chosen, which would result in an estimated cost of $750,000 for a 2,500 square foot building. However, there is clearly much variation in cost associated with the particular type of facility under consideration and the amenities within.

In addition, outdoor vehicle storage space requires 10.5-foot wide lanes with enough length to accommodate the fleet. A unit of the assumed vehicle length plus 5.0 feet is used to determine the length of the vehicle storage lanes.[41] At Mount Rainier, paved vehicle storage areas cost $10 per square foot. This model assumes a slightly higher cost of $15 per square foot, taking into account the significant cost differences among federal public land sites. Assuming a 40-foot bus, each bus required roughly 500 square at a cost of $7,500 per bus.

Default Value: $750,000 for building and one bus bay to accommodate up to 5 buses; additional $7,500 per bus for outdoor storage.

Range: $400,000-$800,000 for building and one bus bay; additional $300,000-$500,000 per bus bay; additional $5,000-$10,000 per bus for outdoor storage.

Public Lands Perspective: This is a major cost undertaking for a federal public land site. Some sites will contract operations of their transit system, and the contractor will be responsible for a vehicle maintenance facility. For federal public land sites with smaller fleets it will generally be in the FLMA's best interests to pay for maintenance to be conducted off-site. For larger sites it may be worth the up-front investment in a maintenance facility to be able to perform all maintenance on-site, especially if the federal public land site is particularly remote with few qualified mechanics in the area. Federal public land sites in especially remote areas may need to construct a facility for themselves due to the lack of outside assistance within a reasonable distance. For those federal public land sites situated in areas with harsh weather conditions, the investment in outdoor storage may be worthwhile.

Bus Stops and Shelters

[38] Federal Transit Administration. *Federal Lands Alternative Transportation Systems Study: Summary of National ATS Needs.* http://www.fta.dot.gov/documents/3039_study.pdf.
[39] Ibid.
[40] National Park Service. *Cape Cod National Seashore: Satellite Vehicle Maintenance Facility Feasibility Study.* http://ntl.bts.gov/lib/35000/35700/35794/CACO_satellite_vehicle_maint_study_final-508.pdf.
[41] Federal Transit Administration. *Federal Lands Alternative Transportation Systems Study: Summary of National ATS Needs.* http://www.fta.dot.gov/documents/3039_study.pdf.

Design and construction of simple bus stops may require only minor repairs to sidewalks and the installation of a post and sign. Evidence from a bus stop manufacturer and also the transit authority in Baltimore suggests that a traditional bus stop costs anywhere from $7,000-$12,000.[42][43]

Enhanced bus stops may include lighted shelters, a bench, trash can and branded pylons, the corresponding trenching to provide electricity, permits, replacing and fixing portions of sidewalks and installing signs and posts. These can cost over $30,000 per stop solely for construction, ignoring any design costs.

Default value: $10,000/stop

Range: $5,000-$30,000/stop

Public Lands Perspective: Public lands units can generally avoid the costly expenses of enhanced bus stops, but at a minimum should consider a bench and a covered awning. This will not only improve the visitor experience, but will also guard against lightning and other hazards.

Start Up Costs

Start up costs include staff time for vehicle procurement, training, and initial marketing. Initial marketing may only include a route map and schedule. Marketing costs will be higher in the first year of operations, when visitors have no knowledge of the service. Optional costs of Intelligent Transportation Systems (ITS) deployments and dispatch equipment should also be considered. A default value of $15,000 has been selected for the first year of service.

Default: $15,000 (only for first year of service)

Range: $5,000-$25,000

Public Lands Perspective: Start up costs will vary depending on the skill sets of site staff and the amount of effort needed for initial marketing of the service. Those sites operating their own system will need to determine whether or not a Commercial Driver's License (CDL) is required, and what the costs would be to train for and ultimately obtain them.

Marketing

Marketing typically includes website development, route maps development and printing, and some additional print advertising. Increasingly, social media outlets are being utilized to generate awareness of alternative transportation systems. Based on anecdotal evidence, a default value of $5,000 is used in the model.

Default: $5,000 per year

Range: $5,000-$50,000 per year

Public Lands Perspective: Federal public land sites that depend on any revenue generated by a bus service, or those that are instituting a service to reduce congestion or solve other access-related issues at the federal public land sites may be more inclined to market their system aggressively.

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[42] Maryland MTA. *Comparison of Capital Costs for Fixed-Route Bus Stop Improvements to Paratransit Operating Cost.* http://www.ilru.org/html/training/webcasts/handouts/2007/12-12-MG/Busstopimpovements.doc.
[43] Wesoff, Eric. *Solar Bus Shelters From GoGreenSolar: A lot of High-tech Solar is Coming to a Street Corner Near You.* http://www.greentechmedia.com/articles/read/solar-bus-shelters-from-gogreensolar/.

Insurance

DOI-owned and operated vehicles do not need insurance coverage, as the federal government is self-insured and government employees are covered under workers' compensation.

Although the model does not consider concessionaire agreements, it is important for sites to recognize that concessionaires operating in on federal lands do need to purchase insurance for their vehicles. It is common for concessionaire-owned vehicles to carry jurisdictional (State) insurance requirements. The Federal Government requires all vehicles purchased with Federal funds to be insured and that all operating entities carry liability insurance. Government counsel should review specific requirements for vehicle insurance coverage including liability. Rates may vary according to vehicle type, fuel, use, and location. Insurance rates for vehicles used at monuments and sites in urban areas are likely to be higher than those deployed in rural areas. Liability rates for high-capacity transport vehicles are likely to be very expensive.

A default value of $0 is used in the model, based on the assumption that the federal public land site owns and operates the vehicle itself and therefore both the vehicle and its operators are already insured. However, the option is available to increase this default value for special circumstances

Default: $0

Additional References

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Wyatt, R.J., 'The Effect of Road Design and Maintenance on Vehicle Operating Costs-Field Research in Brazil,' *Transportation Research Record 702*, 1979.

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14. ABSTRACT

The Bus Lifecycle Cost Model is a spreadsheet-based planning tool that estimates capital, operating, and maintenance costs for various bus types over the full lifecycle of the vehicle. The model is based on a number of operating characteristics, including those related to the routing and frequency of the service. The model is designed to allow users to estimate and compare the total costs of offering different types of bus services over time. The model is tailored to planning bus service that serves Federal Land Management Agencies (FLMAs), allowing federal public land site planners and partners to estimate the total cost of various Alternative Transportation System (ATS) project alternatives using a systematic approach that is consistent, comparable, defensible, and credible.

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