GRAND CANYON NATIONAL PARK ASSESSMENT REPORT ON TRANSPORTATION ALTERNATIVES

APRIL 1999

FEDERAL TRANSIT ADMINISTRATION
FEDERAL HIGHWAY ADMINISTRATION
WITH
VOLPE NATIONAL TRANSPORTATION SYSTEMS CENTER

U.S. Department
of Transportation
**Federal Highway
Administration
Federal Transit
Administration**

MAY 3 1999

The Honorable Ted Stevens
Chairman, Appropriations Committee
United States Senate
Washington, D.C. 20510

Dear Chairman Stevens:

I am pleased to transmit to you a copy of the enclosed report, "Grand Canyon National Park: Assessment Report on Transportation Alternatives (Assessment Report)." Staff of the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) prepared this report with technical support from the Volpe National Transportation Systems Center in response to a requirement in the fiscal year 1999 U.S. Conference Report for the U.S. Department of Transportation Appropriations Act (HR 105-648). The Conference Report directs FHWA and FTA to "review the transportation alternatives considered by the National Park Service in the Grand Canyon and Yosemite National Parks to determine if all necessary and appropriate transportation planning, development, environmental and alternative analyses have been conducted to support the alternatives selected by the National Park Service."

The Assessment Report is based on a review of the multi-year transportation planning process conducted by the National Park Service, Grand Canyon (GRCA), including a "Life Cycle Cost Analysis" of five rail and bus service alternatives completed in December 1998. Additional technical studies reviewed for this report document the evolution of GRCA's transit system proposal from its origins in the 1995 *General Management Plan* for the Grand Canyon National Park through the evaluation of alternatives for environmental review in compliance with the National Environmental Policy Act (NEPA). In response to the requirements set forth in the Conference Report, the Assessment Report addresses three major subject areas that are essential to the performance of a technically sound transportation alternatives analysis: Transportation Systems, Impacts to the Environment, and Development.

An identical letter is being sent to the Chairman, Appropriations Committee, United States House of Representatives.

Sincerely,

Gordon J. Linton
Administrator – FTA

Kenneth R. Wykle
Administrator – FHWA

Enclosure

MAY 3 1999

U.S. Department
of Transportation
Federal Highway Administration
Federal Transit Administration

The Honorable C.W. Bill Young
Chairman, Appropriations Committee
United States House of Representatives
Washington, D.C. 20510

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REPORT NO. FTA.TPL.99.2

Grand Canyon National Park:
Assessment Report on Transportation Alternatives

April 1999

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Grand Canyon National Park:
Assessment Report on Transportation Alternatives

Executive Summary

This report presents the results of the review by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) of the transportation alternatives analysis conducted for the Grand Canyon National Park by the National Park Service (NPS). The preferred alternative emerging through the NPS' analysis is a light rail system that may be powered either by electricity or diesel engines. The U.S. Congress directed FHWA and FTA to undertake this review in the Conference Report for the fiscal year 1999 U.S. Department of Transportation (DOT) Appropriation Act. In response to the Congressional directive, it is the purpose of the report to "determine if all necessary and appropriate transportation planning, development, environmental and alternative analyses have been conducted to support the alternatives selected by the National Park Service."

Project Description

Heavy traffic volumes on roadways in the Grand Canyon National Park are a significant problem, detracting from visitors' experience of the park as a natural environment and generating unacceptable levels of noise and air pollution. The *General Management Plan (GMP)* for the park, completed in 1995 after four years of planning, public participation, and environmental review, identified transportation as the most significant issue affecting preservation of the park's unique natural resources.

The transportation plan set forth in the *GMP* restricts the use of private vehicles and requires most visitors to use public transit within the South Rim area of the park, which is the destination of approximately 90 percent of visitors to the Grand Canyon. Transit is conceived in the *GMP* as the backbone of a South Rim transportation system that also will encourage movement by foot and bicycle. A system of trails is planned to promote pedestrian and bicycle travel along the canyon rim, complementing transit service and providing new, improved opportunities for experiencing the South Rim's incomparable vistas.

The National Park Service, Grand Canyon (GRCA) has continued to refine the *GMP's* original transportation concept as the proposed transit service has progressed through Draft and Final *Environmental Assessments (EA).* Following the review of bus and rail alternatives in the Draft *EA,* and in response to public comment, a rail system was selected as the preferred alternative for review in the Final *EA*, released in August 1997. As a result of concern as to whether the basic line haul service would best be served by rail or bus, GRCA completed a *Life Cycle Cost Analysis* in December 1998 comparing the line haul rail line to several line haul bus service options. Five alternatives were considered in this analysis:

- Option I- Electric Light Rail
- Option II- Diesel Light Rail

- Option III- 40' Compressed Natural Gas (CNG) Bus
- Option IV- 60' Articulated Bus
- Option V- 60' Articulated Bus on Busway

The analysis did not include a review of planned complementary bus service, which would distribute passengers from stations on the line haul transit service to desired destinations throughout the South Rim area. GRCA's preferred alternative is a three-station, 8.25 mile double-tracked light rail system that would link a new Grand Canyon Transit Center and parking lot outside the park's south entrance to transit stations at two locations within the park: the Canyon View Information Plaza near Mather Point and the Village Transit Center near the Maswik Lodge. Day visitors would not be able to drive their private vehicles into the park at the south entrance, but instead would transfer to the transit system. Visitors with overnight accommodations would continue to drive into the park. East Rim Drive would remain open to through traffic and also would be served by transit buses. The transit system would operate 12 months, 365 days per year, from early morning to late evening and would be supplemented by an overnight taxi service, for a fee.

All of the options considered in the *Life Cycle Cost Analysis* would operate over a similar alignment, linking a parking facility outside the south entrance to the park with the Canyon View Information Plaza and the Village Transit Center. Line haul service provided by each of these options would connect to a multimodal network of shuttle bus services and a system of pedestrian and bicycle "greenways" distributing passengers from the transit stations to points along the canyon rim, the Grand Canyon Village Historic District, and other areas of interest.

<u>**Review of Alternatives Analysis**</u>

This review addresses three major subject areas that are central to the "necessary and appropriate analysis"of transportation alternatives, as directed in the Congressional Conference Report: Transportation Systems, Impacts to the Environment, and Development. FHWA's and FTA's major observations on the alternatives analysis conducted in each of these areas are presented below.

Transportation Systems

Transit is well suited to address the transportation problems on the Grand Canyon's South Rim for several reasons:

- Large numbers of visitors are concentrated within the South Rim area;
- Most visitors travel to a limited number of destinations requiring motor vehicle access;
- Walking and bicycling are important modes of transportation within the park that can complement transit service.

Key criteria considered in DOT's review of the *Life Cycle Cost Analysis* are *capacity, quality of service, and cost.*

Capacity: The principal advantage of the proposed light rail system compared to the other alternatives considered is its higher capacity. A three-car train can carry 500 passengers, versus only 60 passengers in a standard 40 foot bus and 100 passengers in a 60 foot articulated bus. With peak hour (peak season) demand of 4,000 passengers, the substantially higher capacity of light rail should be a significant advantage.

Quality of Service: Smaller fleet size should also contribute to improved reliability for rail service compared to the bus options, although with rail the risk of system failure is greater. Light rail (Options I and II) or busway (Option V) options would have a travel time advantage of a few minutes compared to bus services operated on existing roadways (Options III and IV).

Cost: GRCA's analysis of capital and operating costs is based on reasonable assumptions and generally sound methods. GRCA has estimated that the substantially higher capital cost for light rail, compared to bus alternatives, would be offset by lower operating and maintenance costs. Total costs are comparable for the most cost-effective rail and bus alternatives: Diesel Light Rail (Option II), and Articulated Bus on Busway (Option V). GRCA has estimated net present value costs, discounted at the Office of Management and Budget 7 percent annual rate, to be $242.9 million for the Diesel Light Rail option and $223.7 million for Articulated Bus operated on a Busway.

GRCA is in the process of developing a strategy for financing the transit system through user fees. GRCA is considering the use of "design-build-operate-maintain" procurement, following the transit industry's "DBOM" model. While preliminary analysis suggests that GRCA can generate sufficient revenue through user fees to finance the system, a fully developed financial plan is necessary to determine the feasibility of proposed project financing.

Environment

Criteria guiding the FTA/FHWA review of GRCA's environmental analysis are the degree of positive and negative impacts on *air quality, noise, natural resources, and quality of visitor experience.* The use of transit services by visitors to the South Rim will lower vehicular emissions and noise dramatically, due to a massive reduction in the use of private vehicles. GRCA has not compared different transit system alternatives in terms of air quality and noise impacts. Differences among system types would be minor, however, in comparison to the improvement resulting from the shift of visitors from private vehicles to transit. Electric light rail and CNG buses would have the lowest emissions and greatest air quality benefits.

Quantification of noise impacts would be useful as a basis for developing an effective noise mitigation strategy. It also would be reasonable for GRCA to include allowable emission and noise levels as system design specifications and to seek the most pollution-free and quietest feasible technology.

Development

The primary criteria applied in reviewing GRCA's analysis of development impacts were *consistency with land use plans* and differences in *housing costs* associated with alternative transit systems. The transportation plan for the Grand Canyon has been conceived as part of a broader growth management strategy, which will allow for increasing public access to the park, protection of natural resources, and enhancement of visitor satisfaction. The modest level of development anticipated in conjunction with the proposed transit system is consistent with this vision of the park's future. Locating new employee housing outside the park boundaries would help to maintain the unique natural environment of the South Rim.

Conclusion

The information reviewed for this report provides strong evidence that GRCA has developed its proposal for transit service through a sound and thorough planning process, including a satisfactory analysis of transit alternatives and meaningful public involvement. As part of this process, GRCA has identified a potentially sound strategy for financing the system through user fees. A conclusive determination of the project's financial feasibility, however, will require a basis in a more fully developed financial plan. FTA and FHWA recommend that the final financial plan be completed prior to awarding a DBOM contract for the project.

Grand Canyon National Park:
Assessment Report on Transportation Alternatives

1.0 Introduction

As the number of visitors to the Grand Canyon continues to increase, the park risks becoming a victim of its own resounding success. Growth in attendance has meant increasing traffic congestion on park roadways, intruding upon the visitor's experience of the park's singular natural glory. These ever more frequent traffic jams have brought with them the damaging environmental impacts of noise and air pollution.

Recognizing the increasing severity of traffic congestion and the threat to the environment it presents, in 1991 the National Park Service (NPS) initiated a comprehensive planning process that resulted in the development of a *General Management Plan (GMP)* for the Grand Canyon National Park. The *GMP* provides direction for "the management of resources, visitor use, and general development at the park over a 10- to 15-year period." Central to the vision set forth in the *GMP* is a transportation plan, which identifies public transit as the primary mode of transportation in the South Rim area of the park and restriction of most private vehicles within the park's roadway network.

Following the release of the *GMP* in 1995, the NPS continued to refine the plan's original transportation concept into five specific public transit options. The preferred alternative is a three-station, 8.25-mile double-tracked light rail system to be operated in the South Rim area. The proposed light rail system would provide the central linkage to a multimodal network of shuttle bus services and a system of pedestrian and bicycle "greenways" bordering the canyon rim.

The evolution of the project from the concept in the *GMP* to the current proposal corresponds to specific stages of the Federal environmental review process. The *Draft Environmental Assessment (EA)* released in March 1997 evaluated several alternative bus and rail system concepts. Public response to the *Draft EA* favored the light rail system. Alternative rail alignments were considered in the *Final EA*, released in August 1997. The proposed action alignment, which has since remained essentially unchanged, was projected to have the least adverse impact on archaeological resources and several sites sensitive to noise pollution. The *Finding of No Significant Impact* issued in October 1997 thus is consistent with the choice of light rail as the proposed action. Since that time the GRCA has been working to implement the project. Preliminary plans, technical specifications, and cost estimates have been prepared and a financial plan for funding the project is under development.

In the Conference Report for the fiscal year 1999 U.S. Department of Transportation (DOT) Appropriation Act,[1] the U.S. Congress directed the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) to "review the transportation alternatives considered by the National Park Service in the Grand

[1] U.S. House of Representatives, HR 105-825,Congressional Record, October 19, 1998, p.84

Canyon and Yosemite national parks to determine if all necessary and appropriate transportation planning, development, environmental and alternative analyses have been conducted to support the alternatives selected by the National Park Service." This report, which presents the results of the review by FHWA and FTA of the transportation alternatives analysis conducted by GRCA for the Grand Canyon, has been prepared in fulfillment of the directive in the Conference Report.

1.1 System Overview

The goal of the proposed transit system is to improve access to points of visitor interest and to protect the natural environment within the South Rim area, which is the destination of roughly 90 percent of visitors to the park. The proposed light rail rapid transit service, which emerged as a result of a multi-year planning process including extensive analysis of transportation alternatives, would link a parking lot outside the park's south entrance to transit stations at two locations within the park: the Canyon View Information Plaza near Mather Point and the Village Transit Center near the Maswik Lodge, as shown in Figure 1.1. Day visitors would not be able to drive their private vehicles into the park at the south entrance, but instead would transfer to the transit system. Visitors with overnight accommodations at the lodges or campgrounds would continue to drive into the park, but would not be permitted to use their vehicles for internal circulation. The transit system would operate 12 months, 365 days per year, from early morning to late evening and would be supplemented by an overnight taxi service, for a fee.

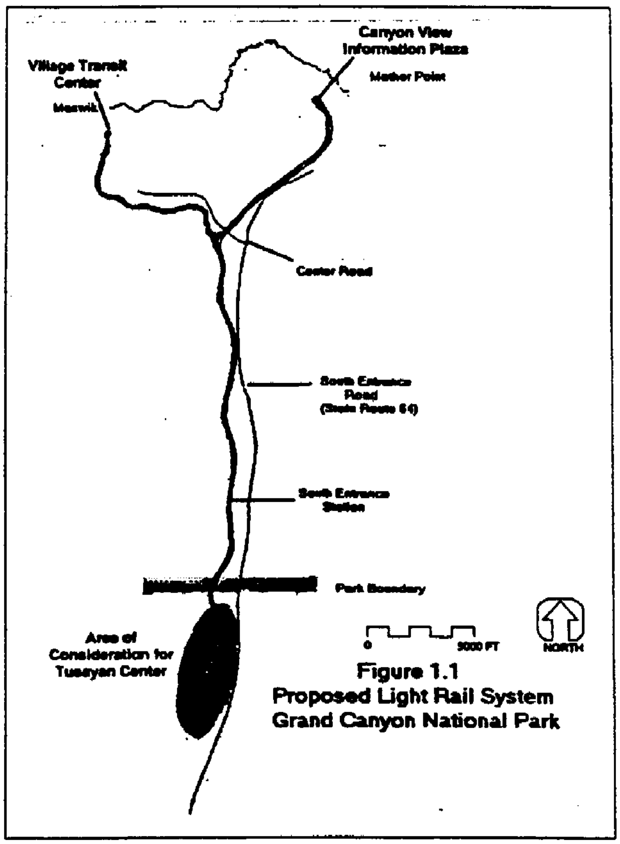


Figure 1.1
Proposed Light Rail System
Grand Canyon National Park

The proposed light rail system would include 18 vehicles and a maintenance facility. Light rail service would be complemented by a system of six bus routes and a fleet of over 50 buses powered by non-polluting alternative fuels, as well as pedestrian and bicycle trails. Shuttle bus stops would be located at each light rail station, from where bus routes would provide circulation within the Grand Canyon Village, and to the east and west rim areas of the park, including the major South Rim trailheads. All transit vehicles would comply with the Americans with Disability Act. Bicycles would be accommodated on board both rail and bus vehicles. A 38-mile Greenway Trail will run along the rim, connecting to the light rail system in a hub at Mather Point. In remote areas, cyclists and pedestrians will mix; within heavily used areas, they will access separate, clearly marked pathways.

The GRCA has proposed to issue a concessions contract of up to 20 years that requires the contractor to finance, design, build, operate and maintain the system, following the transit industry's "DBOM" procurement model. The contractor would be reimbursed for capital and operating expenses through a transit fee that will be included in the park's admission fee. GRCA is still studying a number of options for financing the system.

1.2 Review Process and Scope of Report

The review of Grand Canyon transportation alternatives has been coordinated with the work of a multidisciplinary, interagency team composed of representatives from FHWA, FTA, and the U.S. Department of the Interior (DOI), NPS, Grand Canyon National Park (GRCA). The multi-modal team was organized to provide technical support to GRCA in the implementation of its transportation system, in accordance with the provisions of the June 1998 Project Agreement, executed under a Memorandum of Understanding (MOU) signed by the Secretary of Transportation and the Secretary of the Interior in November 1997. The MOU provides for DOT technical assistance to DOI on transportation-related improvements at National Parks. The Project Agreement identifies the scope of activities to be undertaken by the multi-modal GRCA transportation planning effort, including advising GRCA on the application of state-of-the-practice techniques in financial systems, value engineering, technology, public outreach, management oversight, procurement methods, and other aspects of project planning and implementation.

As a product of its multi-year planning process, GRCA prepared a *Life Cycle Cost Analysis* comparing the costs and service characteristics of five rail and bus transit alternatives. The *Life Cycle Cost Analysis* was completed in December 1998. A review by FTA and FHWA of this analysis and related technical studies, including environmental documentation prepared in compliance with the National Environmental Policy Act (NEPA), has provided the basis for this report. In response to the requirements set forth in the Conference Report initiating the review, the report addresses the following three major subject areas that are central to the "necessary and appropriate" analysis of transportation alternatives: Transportation Systems, Impacts to the Environment, and Development.

The final section of the report presents a summary of findings, including information on project financing and implementation, and observations and implications of the alternatives analysis.

2.0 Transportation Planning and Alternatives Analysis

In the GRCA's transportation alternatives analysis, all of the options considered would provide the transit connections (line haul) to the same central destinations and operate on similar routes, i.e, linking the new Grand Canyon Transit Center just north of Tusayan, which is outside the park boundaries at the south entrance, to the Canyon View Information Center at Mather Point on the South Rim and the Village Transit Center near Maswik Lodge, which is adjacent to the historic South Rim village.

2.1 Definition of Alternatives

Five mass transit system alternatives have emerged through GRCA's planning process:

- Option I – Electric Light Rail
- Option II- Diesel Light Rail
- Option III- 40' Compressed Natural Gas (CNG) Bus
- Option IV -60' Articulated Bus
- Option V – 60' Articulated Bus on Busway

These are the options considered in GRCA's *Life Cycle Cost Analysis* (see Appendix A), and represent refinements of alternatives considered previously in planning and environmental studies. The basic characteristics of these options are identified in Table 2.1. More detailed information relevant to transportation planning is presented in Section 2.2.

Table 2.1 Characteristics of Transit Alternatives

	Option I ELECTRIC LIGHT RAIL	**Option II** DIESEL LIGHT RAIL	**Option III** 40' CNG BUS	**Option IV** 60' ARTICULATED BUS	**Option V** 60' ARTICULATED BUS ON BUSWAY
GUIDEWAY/ RIGHT-OF-WAY	8.25-MILE DOUBLE TRACK	8.25-MILE DOUBLE TRACK	EXISTING ROADWAYS: STATE ROUTE 64, CENTER ROAD	EXISTING ROADWAYS: STATE ROUTE 64, CENTER ROAD	9-MILE EXCLUSIVE GUIDEWAY
ALIGNMENT	COUNTER-CLOCK-WISE LOOP	COUNTER-CLOCKWISE LOOP	COUNTER-CLOCKWISE LOOP	COUNTER-CLOCKWISE LOOP	COUNTER - CLOCKWISE LOOP
POWER	ELECTRIC	DIESEL	CNG	DIESEL	DIESEL
SERVICE UNITS	3-CAR TRAINS	3-CAR TRAINS	40' BUS	60' BUS	60' BUS
VEHICLE CAPACITY	175 PASSENGERS	175 PASSENGERS	60 PASSENGERS	100 PASSENGERS	100 PASSENGERS
BOARDING	ACROSS PLATFORM	ACROSS PLATFORM	CURB TO LOW FLOOR VEHICLE	CURB TO LOW FLOOR VEHICLE	CURB TO LOW FLOOR VEHICLE

2.2 Transportation System

Improved transportation is essential to accommodate forecasted growth in the number of visitors to the Grand Canyon in the year 2010 and beyond. The capacity of existing roadways and parking facilities already has been exceeded to the point that for many visitors, locating a parking space has begun to compete with the experience of viewing the breathtaking scenery. Over 5 million people visited the Grand Canyon in 1997, 4 million of whom went to the South Rim. Approximately 75 percent of these visitors used private vehicles within the park boundaries.

Mass transportation is a viable alternative for solving the mobility problems on the Grand Canyon's South Rim, for the following reasons:

- large numbers of visitors are concentrated within the South Rim area;
- most visitors travel to a limited number of destinations within the park that require motor vehicle access;
- walking and biking trails within the park can easily complement transit service.

It is important to note that the *GMP was* adopted in 1995 following extensive public review and comment. It establishes the framework for a transportation system designed to support the protection and effective management of park resources. A transit connection between Tusayan and Mather Point and the complementary bus system is the backbone of a South Rim transportation system that also will encourage movement by foot and bicycle. A system of trails will be developed to promote pedestrian and bicycle travel along the canyon rim, complementing transit service and providing new opportunities to experience the South Rim's incomparable vistas. The *GMP* calls for review of further alternative analyses for providing these transit services and to fully evaluate site-specific planning, design, and environmental factors.

2.2.1 System Configuration

Common to all the transit options considered by GRCA is the requirement that most visitors use the park's transit system instead of private vehicles within the South Rim area. A major new Grand Canyon Transit Center and parking facility would be constructed at the north end of Tusayan, outside the park boundaries at the south entrance to the park. This parking facility would have capacity for approximately 3,500 passenger cars, 130 recreational vehicles, and 70 buses and would connect to a transit station. Tour bus passengers and all other day visitors accessing the park through the south entrance would be required to park at the facility and transfer to mass transit. Overnight guests staying at accommodations within the park would be allowed to drive to near lodgings or campsites, but would use the transit system for in-park transportation. Vehicles entering the South Rim area at the east entrance would have access to South Rim roadways (SR 64) but would be restricted from parking within the South Rim area. These visitors would have to use transit to access Mather Point and the Village. Today, approximately 80 percent of visitors arrive at the park from the south entrance and 20 percent enter from the east.

Transit would link the Grand Canyon Transit Center just north of Tusayan with two destinations: the Canyon View Information Plaza visitor orientation center six miles north of Tusayan and 500 feet from the scenic overlook at Mather Point, and the Village Transit Center near the Maswik Lodge and the existing Grand Canyon Railroad line from Williams, Arizona. In November 1997 the GRCA proposed a light rail system to provide this basic line-haul service supported by complementary bus service on 6 routes. Most recently, because of questions on cost and operations, GRCA also compared the proposed light rail service to three bus alternatives in the *Life Cycle Cost Analysis* completed in December 1998. All of the alternatives considered would serve the same two destinations: Canyon View at Mather Point and the Village Transit Center from the Grand Canyon Transit Center.

In addition to the line-haul service, whether it be rail or bus, a fleet of alternate fuel shuttle buses would provide distribution from Canyon View and the Village Transportation Center near Maswik Lodge to the village, the business center (located between the village and Mather Point) and points along the rim. Greenway pedestrian and bicycle trails also will be designed to feed directly into Canyon View and the Village Transit Center stations.

The alignment of the light rail system would consist of an 8.25-mile double-track "Y" configuration, with trains operating in a counter clockwise loop (Grand Canyon Transit Center to Canyon View to Village Center to Grand Canyon Transit Center). GRCA considered both electric light rail (Option I), powered through an overhead catenary wire, and diesel light rail (Option II) as two separate options in the *Life Cycle Cost Analysis*. Whether electric or diesel, the first segment of the light rail system would parallel the South Entrance Road (State Route 64) between Tusayan and Mather Point. The second segment would connect Mather Point to the Village Transit Center near Maswik Lodge, by back tracking south to Center Road, then running south of and generally parallel to Center Road for two miles to the village. The light rail tracks would cross the park road system at two locations. Bridges would be built to carry road traffic over the tracks. Round trip travel time would take approximately 35 minutes.

GRCA's *Life Cycle Cost Analysis* includes two bus options (Options III and IV) in which the buses would operate primarily on the existing roadways, South Entrance Road and Center Road. The final option included in the *Life Cycle Cost Analysis* consists of a fleet of 60-foot buses operated on a fixed guideway (Option V) along the same general alignment as the light rail system. The bus rolling stock would consist of accessible low-floor buses.

2.2.2 Operational Characteristics and Ridership

High quality service is contingent upon matching the volume and spatial distribution of visitor travel demand with the capacity, configuration, and operating policies of the transit system. Taking into account the variables of travel demand volume and spatial distribution, the South Rim transportation plan was based on the following assumptions:

- A large percentage of the visitors would use mass transportation services within the park, particularly during the peak season.

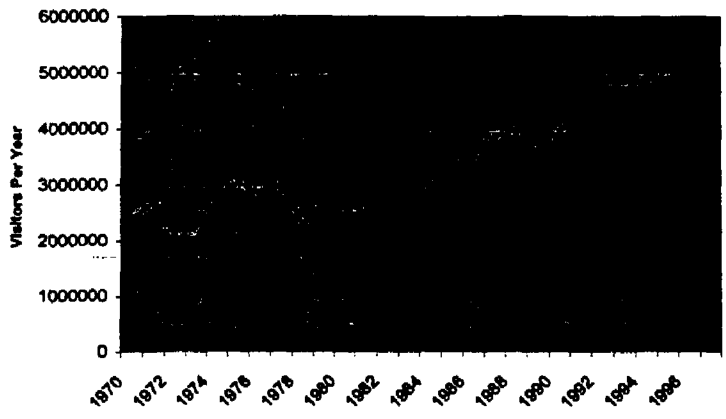
- Most visitors would travel to no more than two locations, at which point they will transfer to transit or use the pedestrian or bicycle trails. Mather Point, in particular, is a desirable initial destination and departure point for first-time visitors.

Both of these assumptions support a relatively high-capacity transit service, such as light rail. A third premise that has been given increased consideration over the course of the planning process is that a dedicated right-of-way would provide for faster and more reliable transit service. Therefore, a light rail system or bus operated on a dedicated fixed guideway would provide a superior level of service to bus operated in mixed traffic on the park's roadways.

Capacity Requirements

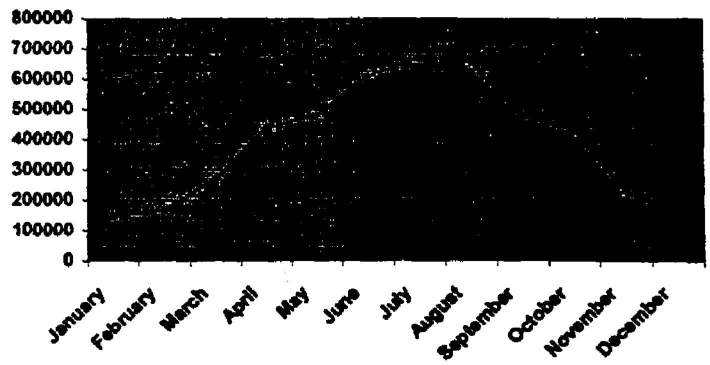
GRCA estimates annual visitation to the park of 6.87 million by the year 2010, assuming an annual rate of growth of approximately 2 percent, which is conservative relative to past experience. While visitation actually declined by almost 8 percent between 1997 and 1998, the number of visitors to the park increased at an average annual rate of approximately 3 percent over the 27-year period between 1970 and 1997 and 6 percent from 1984 through 1997. Growth rates appear to have moderated in the most recent five-year period (see Figure 2.1). As illustrated in the chart, it is not unusual for visitation to fluctuate downward in a single year, although there has been a strong trend of increasing visitation over the last two decades.

Figure 2.1 Grand Canyon National Park Visitation



Seasonal variation in visitation levels is significant. During the peak month of July, approximately 667,000 people visited the park in 1998, which is more than 4 times the number of people visiting the park in January of that year. As shown in Figure 2.2, the majority of annual visitation (70 percent in 1998) occurs in the six-month period from May through October. The peak season, in which monthly visitation is in the range of 600,000-800,000, extends from June through August. In April, May, September, and October, the park attracts 400,000-500,000 visitors. In each of the remaining 5 months, visitation ranges from approximately 150,000-270,000.

Figure 2.2 Grand Canyon National Park Monthly Visitation (1998)



Peak summer demand for transit service in 2010 is estimated to be 31,572 passengers per day, assuming 6.34 million visitors to the South Rim per year (92 percent of the total number of visitors to the park) and 45,000 South Rim visitors on the system design[2] day. This level of demand is high for a single bus route and within the range that would be expected for a high capacity service such as a light rail line, although

[2] The design day is the 10th highest demand day per year.

there are several bus routes in the U.S. serving this many passengers. Examples are located in New York City (Hillside Avenue, Queens and Madison Avenue, Manhattan) and Portland, Oregon (5th and 6th Avenues), where the operating environment and trip purposes obviously are very different from those of the Grand Canyon.

Current service plans provide for the following daily hours of operation:

- Summer (June-July): 6:00 AM to 10:00 PM (16 hours)
- Shoulder (September-November, March-May): 7:00 AM to 9 PM (14 hours)
- Winter (December-February) 7:00 AM to 8 PM (13 hours)

Applying a peak hour percentage of 13 percent, GRCA projects year 2010 peak hour summer demand of over 4,000 passengers, which seems reasonable based on existing travel patterns, reinforcing the need for high capacity service as provided by rail.

The use of buses to meet peak hour demand in 2010 would require very frequent bus service and a fleet of vehicles—if operating in mixed traffic, 62 standard 40' buses (Option III) or 38 higher-capacity articulated buses (Option IV), including spares (see Table 2.2.) In the case where articulated buses would operate in a dedicated busway (Option V), higher speeds would reduce round trip travel times and buses could be cycled back into service more frequently, reducing the peak hour fleet requirement including spares to 30 vehicles. In comparison, 18 light rail vehicles (LRVs) including spares (Options I and II) would be needed to meet peak hour demand with rail service.

While more frequent service and lower headways generally are regarded as providing higher levels of transit service, the headways necessary to meet peak hour demand with buses would be so low that maintaining reliable service could pose a potential problem. In the case of a regular 40' bus operating in mixed traffic (Option III), 69 bus trips would be required in the peak hour. There are few examples of successful bus operations with headways of less than 1 minute, which would essentially require providing continuous service. The 7 1/2-minute headways planned for the light rail service should be more manageable, especially for a recreational trip, while providing an acceptably high level of passenger service.

Although the frequent headways may pose operational problems in the case of bus service, overall there are several trade-offs between bus and rail from the standpoint of reliability. Less frequent service with fewer vehicles should result in fewer breakdowns and service interruptions, but when breakdowns do occur on a rail system, the consequences tend to be more serious than with a bus system. A bus system with more complicated operational logistics may produce more frequent, but less severe, service interruptions.

Table 2.2
Comparison of Service Characteristics by Alternative

TRANSIT OPTIONS	I ELECTRIC LIGHT RAIL	II DIESEL LIGHT RAIL	III 40' CNG BUS	IV 60' DIESEL ARTICULATED BUS	V 60' DIESEL ARTICULATED BUS ON DEDICATED BUSWAY
Vehicle Capacity (passengers)	175	175	60	100	100
Average Travel Speed (mph)	43	43	31	31	43
Stop Time in Station (minutes)	4	4	4	4	4
Travel Time to Mather Point (minutes)	8.4	8.4	11.6	11.6	8.4
Route Distance (miles)	16.5	16.5	17	17	16.5
Round Trip Travel Time (minutes)	35	35	45	45	35
Transit Round Trips-Year 2010 (Peak Hour)	9*	9*	69	43	43
Vehicles Required**	15	15	52	32	25
Peak Hour Headways-Year 2010	7.5 minutes	7.5 minutes	52 seconds	84 seconds	84 seconds

*Three-vehicle trains
**Does not include spares of normally 20 percent

Travel Patterns

The transportation plan for the South Rim provides for fast and convenient service to two locations—Canyon View Information Plaza at Mather Point and Village Transit Center near Maswik Lodge. These locations would function to a large degree as hubs or departure points for visitors who would then walk, bicycle, or transfer to six bus routes connecting to other destinations along the rim or in the village/education center. Mather Point also serves as a major attraction and is thus a destination in its own right for many visitors. Development of a planned visitor Information Plaza at Mather Point should reinforce its prominence as a visitor destination and gateway to the South Rim. The groundbreaking ceremony for the Canyon View Information Plaza is set for April 23, 1999.

The success of this plan depends on the extent to which the underlying concept conforms to visitors' desired travel patterns. For example, if most visitors do not want to stop at Mather Point, they may find the planned hub configuration less convenient than a more decentralized transit system in which buses would carry passengers directly from Tusayon to dispersed locations along the rim, eliminating the need to transfer to shuttle buses. This alternative concept would have several disadvantages, however, even assuming a broad dispersal of visitor destinations:

- Transit operations would be more complex, more difficult to support at a high level of service, and probably less cost-effective;
- Transfers between bus routes would still be necessary for most visitors;
- Visitors may be confused by the multiplicity of bus routes originating at Tusayan;
- Headways for individual bus routes would inevitably be longer for a dispersed system than the more centralized system proposed.

Transit works best when travel is concentrated to and from a limited number of locations. This is particularly true of a system with fixed guideways, e.g. rail or busway. If the planned system conforms reasonably well to desired travel patterns within the South Rim area, particularly if Canyon View at Mather Point and the Village Transit Center function well as primary destinations and departure points, the proposed light rail service should be well matched to service requirements.

Another important consideration is the nature of travel within the Grand Canyon National Park, in contrast to the customary commuter trip served by transit. Most users will not be familiar with the park's transit system. The ability of first-time users to understand the configuration of the system, in terms of the connections it provides to desired destinations, is paramount. Also, users will most often be traveling with other family or group members and will want to remain with their companions, rather than boarding different vehicles. These factors favor a simple system with fewer, higher-capacity vehicles. Many visitors carry supplies, equipment, and young children and some travel with baby strollers. Level boarding, wide doors, and interior vehicle space thus are significant advantages for system users. Another less tangible but important factor is the compatibility of the service with users' expectations of a recreational experience in a predominantly natural setting. Higher capacity, less frequent and ubiquitous transit operations are likely to better address that service criterion.

Travel Times

With average travel speeds of 43 miles per hour (mph), the guideway options, including light rail (Options I and II) and busway (Option V), would have a modest travel time advantage over buses operating in mixed traffic on existing roadways (Options III and IV), projected to have average operating speeds of 31 mph. At these average speeds, the travel time from Tusayon to Mather Point would be about 8 ½ minutes for the light rail and busway options, and 11 ½ minutes in the case of buses operating on existing roads. This travel time difference, while small, may be beneficial to visitors, who can be expected to want to spend as little time as possible in the confines of a transit vehicle. As noted earlier, reducing round trip travel times also has operational advantages, in that the size of the vehicle fleet can be decreased. Another advantage of operating transit in a dedicated right-of-way is the greater reliability that can be expected due to the elimination of interference from other vehicles.

2.2.3 Capital and Operating Costs

Capital Cost

The components of capital cost for the proposed transit system include expenditures for vehicles, stations, infrastructure, and a maintenance facility. GRCA has prepared detailed estimates of capital costs for each of the transit options considered in the recent *Life Cycle Cost Analysis*. (Itemized capital cost estimates from the life cycle analysis are provided in Appendix A of this report.) These cost estimates in millions of 1998 dollars are summarized in Table 2.3 below.

Table 2.3
Capital Cost Summary*
($ millions)

TRANSIT OPTIONS	I ELECTRIC LIGHT RAIL	II DIESEL LIGHT RAIL	III 40' CNG BUS	IV 60' DIESEL ARTICULATED BUS	V 60' DIESEL ARTICULATED BUS ON DEDICATED BUSWAY
Vehicles	$43.5	$54.3	$27.4	$20.6	$18.3
Infrastructure	$80.3	$38.5	$15.8	$16.0	$18.6
Maintenance Facility	$11.5	$12.4	$17.8	$17.6	$17.2
Contingency	$21.7	$15.3	$8.6	$7.9	$8.5
Total	$157.0	$120.5	$69.6	$62.1	$62.6

*Line haul service only

In the above table, vehicle cost estimates for Options III, IV and V include initial bus purchases in the first year of service, additional bus purchases in 2007 and 2022, and replacement of all original buses in 2017. These capital expenditures are discounted to net present value using the Office of Management and Budget (OMB) 7 percent annual rate. Thus, vehicle purchases in future years have lower net present value costs than vehicles purchased in the early phase of operations.

Infrastructure costs include track/guideway, signal system (rail), construction, road improvements and engineering. Contingency costs were calculated for the GRCA life cycle cost analysis at the rate of 5 percent for rolling stock and 20 percent for infrastructure. The capital costs shown do not include employee housing, which is discussed in Section 2.4, or the circulator bus system and network of pedestrian and bicycle "greenways" common to all the alternatives. The circulator bus system would consist of over 50 alternative fueled buses and a maintenance facility and is estimated to cost $20 million.

Capital cost estimates for all the options include a single major rehabilitation at vehicle half life equal to 30 percent of the initial vehicle cost. Service life is assumed to be 30 years for light rail vehicles and 15 years for buses. While service life is typically several years shorter in urban settings (25 years for rail vehicles and 12 years for buses), the NPS postulates that wear and tear will be less in the Grand Canyon environment, extending vehicle life. Estimated vehicle unit purchase prices are:

- Option I - Electric Light Rail - $2.4 million (per rail car)
- Option II – Diesel Light Rail - $3.0 million (per rail car)
- Option III – 40' CNG Bus - $325,000
- Option IV – 60' Diesel Articulated Bus - $400,000
- Option V – 60' Diesel Articulated Bus operated on Busway - $400,00

These cost estimates for vehicles are consistent with recent purchases by U.S. transit operators, except that in the case of diesel light rail vehicles, there are no U.S. examples based on actual experience. The estimate of $3 million per diesel rail vehicle is above the middle range of prices quoted by European manufacturers. At the upper end of this range is the $3.6 million estimate for a heavier diesel rail vehicle modified to American standards for use in a planned light rail transit system in southern New Jersey.

Infrastructure costs are highest for electric light rail, due to costs associated with providing an electrified guideway and bringing regional electric service to the project site. These costs are estimated at $20.5 million and $17.6 million respectively. Expenses related to electrification would be eliminated in the diesel light rail option and all the bus options. The estimated service life for rail infrastructure is 30 years in the case of the signal system and at least 30 years for the guideway and stations. Excavation, pavement, and other components of busway construction for Option V are estimated to be less costly than preparation of the railbed and laying track for Options I and II. Infrastructure costs for Options III and IV are limited to expenditures for planned roadway upgrades on SR 64 and transit terminals.

Construction of a maintenance facility accounts for a substantial share of capital costs for all the alternatives, particularly among the bus options. These estimates are based on engineering plans, which relate the scale of the facility, particularly in terms of the number of service bays required, to the size of the vehicle fleet. Thus, facility size and capital cost are estimated to be greater for the bus options, which involve the operation of more vehicles than the rail options, despite the fact that rail maintenance is more demanding in terms of machinery and equipment requirements. The service life of the maintenance facility is estimated to be at least 30 years.

Capital costs are substantially higher for rail than for the bus options, due to higher infrastructure and vehicle costs. The cost difference is particularly pronounced for electric light rail infrastructure.

Operating and Maintenance Cost

Operating and maintenance cost estimates for the five options included in the life cycle cost analysis were derived through a two-part process:

1. Total operating and maintenance costs for the year 2010 were estimated using a "bottom up" model based on specification of all labor, equipment, and materials requirements. Labor requirements were specified in terms of the number of each type of employee needed to perform operations, maintenance, engineering, and administrative functions. Direct costs were itemized for office equipment, insurance, utilities, radios, facility maintenance, spare parts inventories, computer support, and staff uniforms and training.

2. Estimates of *unit operating and maintenance costs per vehicle hour* were derived for each option by dividing total operating and maintenance costs (estimated in step 1 above) by the number of option-specific vehicle hours of service needed to accommodate demand in 2010. Unit operating and maintenance costs were then multiplied by estimates of vehicle hours of service for the 30-year time period covered by the analysis: 2002 through 2031.

Table 2.4 below presents a summary of the year 2010 total operating and maintenance cost estimates generated in step 1 of the process.

Table 2.4
Operating and Maintenance Costs
Year 2010
($ millions)

	I ELECTRIC LIGHT RAIL	II DIESEL LIGHT RAIL	III 40' CNG BUS	IV 60' ARTICULATED BUS	V 60' ARTICULATED BUS ON BUSWAY
LABOR*	$6.8	$6.8	$12.4	$8.5	$8.0
**MANAGEMENT AND ADMINISTRATION	$0.9	$0.9	$0.5	$0.4	$0.4
**OPERATIONS	$2.1	$2.1	$8.5	$5.3	$4.8
**MAINTENANCE	$3.2	$3.2	$2.2	$2.0	$2.0
DIRECT COSTS***	$3.6	$2.5	$4.6	$3.4	$3.2
TOTAL	$10.4	$9.3	$17.0	$11.9	$11.1

*Total labor costs include 10 percent contingency factor.
**Management and administration, operations, and maintenance are components of labor costs.
*** Direct costs include 9.5 percent contingency for total operating and maintenance costs.

Labor costs are higher for bus than rail and highest for Option III -- 40' bus -- because more vehicles would be in operation, requiring more drivers. Estimated personnel requirements by option are shown in Table 2.5.

Table 2.5
Personnel Requirements by Option

	I ELECTRIC LIGHT RAIL	II DIESEL LIGHT RAIL	III 40' CNG BUS	IV 60' ARTICULATED BUS	V 60' ARTICULATED BUS ON BUSWAY
DRIVERS	18	18	150	85	75
MECHANICS	49	49	39	35	35
ADMINISTRATION	13	13	8	7	7
OTHER	12	12	17	17	17
TOTAL	92	92	214	144	134

Direct costs exhibit a similar pattern to operations, because the variable component of direct costs (training, uniforms, other staff costs) in the estimation model increases or decreases as a function of the number of employees. The only other significant variation across the options is in management and administration labor costs, where rail costs are higher due to a substantial increase in the number of "ground transportation coordinators."

For the second step in the estimation process, the total operation and maintenance costs shown in Table 2.4 were translated into unit operation and maintenance costs by dividing by the number of vehicle hours of operation for each option, as explained above. The resulting estimates of cost per vehicle hour are shown in Table 2.6.

Table 2.6
Operating and Maintenance Cost Per Vehicle Hour

	I ELECTRIC LIGHT RAIL	II DIESEL LIGHT RAIL	III 40' CNG BUS	IV 60' ARTICULATED BUS	V 60' ARTICULATED BUS ON BUSWAY
COST PER VEHICLE HOUR	$578.08*	$518.43*	$103.42	$123.07	$149.58

*Three-car trains

These estimates are generally consistent with the experience of U.S. transit agencies operating these types of services. Operating and maintenance unit costs range widely among different transit properties, due in part to varying operating conditions, and age and type of equipment in use.

One concern about the method used to derive these unit costs is that the "bottom up" model used in step 1, which does not provide for significant variation in maintenance or administrative costs by vehicle hour, may not be compatible with the development of unit hourly cost estimates. The problem is illustrated by comparing results from step 1 and step 2 of the estimation process for Options IV and V.

	Step 1-Total O & M Costs	**Step 2- Cost Per Vehicle Hour**
Option IV	$11.9 million	$123.07
Option V	$11.1 million	$149.58

The cost per vehicle hour is estimated to be substantially higher for Option V than for Option IV, because the number of vehicle hours is lower for Option V, even though total costs were somewhat higher for Option IV. Rather than reflecting a genuine difference in the cost of providing an hour of service, this result appears to be more a product of the fact that in step 1, most components of total cost are relatively fixed and did not rise with increases in vehicle hours. The estimates of vehicle costs per hour, therefore, may overstate the difference between Options IV and V.

Total Cost

GRCA compared total costs among the five options under consideration, using the OMB 7 percent discount rate to estimate the 1998 net present value for a 30-year service period. The results of this comparison are shown in Table 2.7 below.

Table 2.7
Total Costs
(Net Present Value)
($millions)

	I ELECTRIC LIGHT RAIL	II DIESEL LIGHT RAIL	III 40' CNG BUS	IV 60' ARTICULATED BUS	V 60' ARTICULATED BUS ON BUSWAY
CAPITAL COSTS	$160.7	$124.2	$78.2	$67.8	$68.0
MAJOR MAINTENANCE COSTS	$8.2	$9.4	$8.0	$6.7	$6.0
ROUTINE O & M COSTS	$121.9	$109.3	$217.2	$157.3	$149.7
TOTAL	$290.8	$242.9	$303.4	$231.9	$223.7

Three of the options—Options II, IV, and V—have comparable costs, which are lower than those for Options I and III. Option III is the most expensive, because of the size of the vehicle fleet and the large numbers of drivers needed to serve anticipated demand with a standard sized bus. Estimated cost for Option II, Diesel Rail, is slightly higher than for Articulated Bus Options (IV and V), but estimated differences in cost for all three of the options are probably within the margin of error for the analysis.

Option V appears to have the lowest cost. While estimated differences in cost among this option and Options II and IV may not be significant, the estimate of Option V unit operating costs per vehicle hour may be too high, as noted earlier. Use of a lower value for operating cost per vehicle hour would lower Option V total costs further. Thus, the cost advantage for Option V may actually be somewhat greater than is suggested in GRCA's life cycle cost analysis.

2.3 Environmental Impacts

Preservation of the environment is a primary purpose of the proposed Grand Canyon transit system. The need for public transit to provide the principal means of circulation in the park emerged through the comprehensive planning process culminating in the 1995 *GMP*. The *GMP* established in concept the transportation plan that has evolved into the current proposed transit system. The environmental impacts associated with implementation of the *GMP* were evaluated in Draft and Final Environmental Impact Statements (EIS), in compliance with requirements of the National Environmental Policy Act (NEPA). The *GMP* was formally adopted following approval of the Record of Decision on the FEIS in August 1995.

In March 1997 GRCA released for public review a Draft Environmental Assessment (EA) for the transportation component of the *GMP*, the *Mather Point Orientation/Transit Center and Transit System*. This document identifies potential environmental impacts for three alternative transit systems and a no action alternative. Two of the transit alternatives considered in the Draft EA would have provided for non-guideway bus systems connecting a gateway parking facility at Tusayan, outside the park boundaries, with a new transit station and visitor information center approximately 500 feet from the South Rim overlook at Mather Point. The third alternative provided for rail service connecting Tusayan to Mather Point and Mather Point to a station at the Maswik Transportation Center to the west, adjacent to the Grand Canyon Village Historic District.

All of the alternatives would also entail the operation of a fleet of approximately 75 alternative fuel shuttle buses on multiple routes connecting the line haul bus or light rail system to dispersed points of interest throughout the park. The EA addressed the potential for impacts to occur in the full range of categories relevant to the affected environment, including air, noise, natural and cultural resources, scenic values, traffic management and park operations. In the case of several categories of impacts, however, including air quality and noise, the EA did not compare the alternative transit systems to one another, but only to the no action alternative.

A Final EA for the *Mather Point Orientation/Transit Center and Transit System* was issued in July 1997. The Final EA designates light rail as the preferred transit alternative, citing the public's expression of support for a rail system in response to the Draft EA. The Final EA provides a comparison of the proposed action, which has as its principal component a rail system in a "Y" configuration essentially the same as that currently being proposed, with two alternate rail alignments and the no action alternative. The two alignments considered as alternatives to the proposed action would traverse the historic Grand Canyon Village Historic District, with instrusive effects on structures, archaeological sites, and noise levels. Public comment supported the selection of the proposed action route alignment, which does not intrude into the village. A Finding of No Significant Impact for the proposed action was issued in October 1997, fulfilling the NEPA requirements for the proposed transit system.

2.3.1 Air Pollution

The EA for the proposed transit system focused on the improvement in air quality that would result from the shift from private automobiles to public transit by park visitors. The EA projects that approximately 26,200 passengers daily will be diverted from automobiles to transit on peak summer demand days in the year 2010, logically producing a major reduction in vehicular emissions within the park. In addition to the shift from automobiles to transit, the prohibition of tour bus parking and idling along the South Rim and throughout most of the park would reduce site-specific air pollution from diesel emissions at scenic overlook areas, including Mather, Yavapai, and

Maricopa Points. Approximately 150 tour buses daily would be eliminated from the South Rim as a result of the park's transit system. In comparison to conditions that would prevail in the absence of the transit system, the operation of approximately 100 trains daily, irrespective of technology, would substantially lower emissions.

What the EA does not address is differences in air quality impacts for bus versus rail, or diesel versus electric light rail vehicles, nor does it quantify the anticipated reduction in emission levels. A light rail system powered by electricity would be free of air pollutants, and superior to a rail or bus system powered by diesel engines, in terms of air quality impacts within the Grand Canyon. Another possible alternative, considered in both the EA and the GRCA's recent life cycle cost analysis, is a system operated with buses powered by compressed natural gas (CNG). Use of CNG as a fuel source would reduce transit emissions to negligible levels, and thus would be advantageous compared to diesel bus or rail operations from an air quality standpoint.

Thus, considering the five options included in GRCA's *Life Cycle Cost Analysis*, the electric light rail and CNG-powered 40-foot bus systems would have the most beneficial air quality impacts. GRCA has not considered the use of alternative fuels such as CNG or liquefied natural gas (LNG) as a power source in its two articulated bus options, citing possible technological problems and the lack of a track record for these vehicles under actual operating conditions. CNG articulated buses currently are not in use in the U.S. and deployment to date in Europe has been minimal.

The EA's perspective remains valid that the air quality impacts of either an electric or diesel light rail transit system would be overwhelmingly positive, compared to a no action or no build scenario. Analysis of emission levels specific to each of the five light rail and bus options included in *Life Cycle Cost Analysis* would be required to determine whether differences in air quality impacts among the options are significant. Such differences will be dwarfed, however, by the improvement associated with shifting most park visitors from automobiles to transit.

2.3.2 Noise and Vibration

According to GRCA, Congress has required the protection and restoration of "natural quiet" in Grand Canyon National Park. Ideally, the park should provide visitors a refuge from the noise of everyday life. Noise levels tend to be low in the park, typical of a largely isolated, natural setting. As a result, very small increases in noise are readily perceived.

As in the case of air quality, the EA does not provide a direct comparison of noise impacts for light rail versus bus operations. GRCA suggests that electric light rail would be quieter than the other options, but has not provided data to support this observation. Noise will be reduced significantly as a result of transit operations, regardless of the technology deployed, due to the massive reduction in automobile use within the park. Noise impacts associated with rail may be more intense but less frequent than in the case of bus alternatives. The Final EA concludes that the proposed action light rail alignment, skirting the Grand Canyon village rather passing through it, would generate lower noise levels in the village than alternative rail alignments, including the routing considered in the Draft EA, which would have passed through the village.

Nevertheless, there are six principal noise receptors that are close enough to the proposed light rail alignment to experience adverse impacts from proposed transit operations:

- South Rim overlook at Mather Point, approximately 500 feet from the proposed light rail station
- Mather Campground
- Trailer park
- Historic Village District
- Maswick Lodge guest accommodations
- Employee housing at Pinyon Park and Coconino Apartments

Sites within 150 feet of light rail operations also may experience noticeable vibration impacts. The first three sites are on the east leg of the proposed transit route and have been adjacent to highway traffic since their development at least 30 years ago. A reduction in automobile traffic would lower noise levels at all of these three sites. In addition, the overlook at Mather Point would benefit from the 0.9-mile road closure and parking lot removal proposed in the adjacent area.

A number of possible mitigation measures can be implemented to limit noise intrusion at sensitive receptor sites:

- Construction of noise barriers at critical locations
- Operating restriction of light rail operating speeds in the vicinity of the campground and trailer park at night
- Increase in nighttime headways
- Relocation of the campsites closest to the transit line.

The system would not be in operation during the hours from 10:00 PM to 6:00 AM, so noise impacts would not be a factor during the time period when quiet is most critical for overnight guests. Moreover, light rail systems typically operate within close proximity of residences in urban areas at acceptable noise levels. As a nature retreat and recreational area, the Grand Canyon environment is more sensitive to noise and has substantially lower ambient noise levels than the urban settings where light rail systems are commonly deployed. Even in the unique setting of the Grand Canyon, however, differences between light rail and bus alternatives are unlikely to be of such magnitude as to dictate the choice between systems, particularly if appropriate mitigation measures are implemented.

2.3.3 Natural Resources: Wildlife and Vegetation

Both the construction and operation of a transit system can disrupt plant and animal life. GRCA has established direction for the protection of the Grand Canyon's natural resources in the 1988 *Management Policies, NPS-77: Natural Resources Management Guideline*, the 1985 *Statement for Management* and the 1995 *General Management Plan*. The Draft EA for the *Mather Point Orientation /Transit Center and Transit System* compares natural resource impacts for several non-guideway bus systems and a rail system, although the alignment of that rail system differs from that currently proposed by the GRCA. The Final EA discloses natural resource impacts for a rail alignment essentially the same as that proposed, however, and combining information from the Draft and Final EAs provides a basis for comparing the proposed rail system alignment with non-guideway bus options.

According to the Draft and Final EAs, the primary natural resource impact of the transit system would be to pinon/juniper forest. The Final EA also discloses impacts to Ponderosa pine woodland. This vegetation provides habitat for mule deer, rock squirrel, golden-mantled ground squirrel, raven, and pinons jay. Both plants and the wildlife communities inhabiting the vegetation would be affected, primarily by removal of the vegetation to accommodate the proposed transit center and, in the case of a rail system, the right-of-way including track. Thus, the magnitude of impacts is directly related to the surface area or footprint occupied by the transit system. While bus guideway options were not addressed specifically in the EAs, it is reasonable to assume that aggregate right-of-way requirements for a bus guideway would be roughly similar to those for rail along a similar alignment.

The Final EA projects that the proposed rail system would affect approximately 95.7 acres, which compares to the Draft EA's projected impact of 34 acres for non-guideway bus systems. The additional 62 acres comprise a minimal part of the total woodland area at the South Rim. The Draft EA notes that there are no threatened or endangered species inhabiting or depending on the area that will be affected by the transit project.

2.3.4 Visitor Impact/Quality of Experience

The Draft EA identifies a number of improvements in the quality of visitors' experiences that are common to all the transit alternatives:

- Removal of private vehicles and tour buses from the South Rim would eliminate the traffic congestion and competition for parking spaces currently encountered by visitors seeking access to scenic overlook points. Many visitors experience long traffic delays and lack of parking at desired destinations. During peak periods, a considerable number of visitors never find parking spaces in the Mather Point overlook area, or they drive off the road to park in landscape along the roadside, damaging vegetation and native animal habitats.
- Greater safety for pedestrians and bicycle riders

- Quieter, cleaner, more natural environment at Mather Point and other overlook points due to the elimination of parking and tour bus idling along the South Rim
- Improved introduction to the park at Mather Point, due to the dramatic visual impression created by natural vegetative screening and the drop in grade between the new orientation center and the overlook point at the rim

The EA acknowledges as a negative impact the need for visitors to wait for transit service, although the wait would be short and often less time consuming than the traffic delays that would be experienced by users of private vehicles in the absence of the transit system. Visual intrusion is another potential negative impact, which is expected to be minor. In the case of a light rail system, natural screening by tall trees and dense forest would diminish any impact on natural scenic views.

The Draft EA also cites the following as advantages of light rail over bus service:

- More spacious vehicles
- Level loading at all stops
- Ability to equip vehicles with interior bike racks
- Ability to equip vehicles with video systems

In-vehicle travel times would be equal for light rail and buses operated over an exclusive guideway. Travel times would be longer, however, for buses operating on existing roadways. Park visitors are likely to view shorter travel times favorably.

As discussed in Section 2.2, wait times would be longer for a light rail system than for buses, due to longer headways. With peak period headways of approximately 7 ½ minutes, however, wait times with light rail nevertheless would be short and are likely to be viewed favorably by most passengers. Thus, the shorter wait times for bus service would not represent a significant advantage over light rail service.

Moreover, the need to run buses on a very frequent schedule, with headways of under 1½ minutes, would have its disadvantages in terms of the character of the visitor's experience. Nearly constant bus movement within view or earshot of the bus route would be a source of constant disturbance to visitors seeking an experience of the natural environment. At each transit station, several buses would be entering, unloading, loading and departing at the same time, which may be suitable for urban transportation, but which may not be suitable for the park setting of the Grand Canyon. Inevitable slippage from a demanding schedule is likely to compound the intense activity and possible disorder at the bus stations. If operated competently, the less frequent and higher-capacity trains are likely to create a more orderly and attractive impression.

GRCA has the perception that rail cars are roomier than buses, and therefore would accommodate visitors with bicycles more readily. Because of their greater capacity, the use of rail cars would reduce the incidence of families and groups needing to separate. Light rail may provide a smoother ride than bus options, which would improve passenger comfort. GRCA also cites the long tradition of train service at the Grand Canyon, dating back to 1901, when the first passenger train reached the South Rim, marking the transition from the frontier age to the era of 20th Century tourism.

2.4 Development

The proposed transit service is an integral part of a growth management strategy aimed at preserving the natural environment of the Grand Canyon and enhancing the experience of park visitors. Development planning is another major component of that strategy. The high volume of visitation at the park creates demand for lodging, restaurants, and other services. Park employees also require a range of physical facilities, including housing.

As the number of visitors to the park rises, so do development pressures. The *GMP* considered a variety of strategies for addressing anticipated growth, including reducing visitation below demand levels. The growth management strategy selected in the *GMP* will provide for an efficient organization of development to accommodate substantial growth in visitation, while preserving the environment and improving park operations. The *GMP* anticipates 6,865,000 Grand Canyon visitors in 2010, an increase of 34 percent above 1997 levels.

The planning process for the *GMP* identified three problem areas for which solutions might be found beyond the park's boundaries: 1) transportation staging; 2) expansion of employee housing, and 3) expansion of community facilities. From the park perspective, the need for these facilities is clear. Transportation is the single biggest issue in the *GMP*. Housing is both in poor quality and in short supply. Community facilities, such as school buildings and places of worship serving park employees, are inadequate.

2.4.1 Planned Future Development

Land use is a major issue both within and beyond the park boundaries. The *GMP* designates limited areas in the park for development, preserving over 90 percent as being suitable for wilderness. Transportation and other facilities included in the *GMP* are confined to areas that already are considered "disturbed" as a result of existing development. Housing for Grand Canyon employees currently is provided within the park, in the area south of the village.

New South Rim development proposed in the *GMP* includes:

- transportation system linking Tusayan and Mather Point
- orientation/transit center at Mather Point
- bicycle and pedestrian trail network
- shuttle bus system, including shelters
- housing

- continuation of visitor services such as hotels, restaurants, and gift shops
- maintenance facility near junction of Center and South Entrance Roads
- transit station and transfer center at Maswick
- Heritage Education Campus (rehabilitation of existing historic buildings)
- replacement structures to accommodate functions displaced by Heritage Education Campus

A development project planned since the *GMP* is the realignment of the Highway 64 interchange near Mather Point to accommodate through traffic. An existing parking lot at Mather Point would be removed.

Outside the park boundaries, the *GMP* identifies the need for construction of a transportation staging area and parking lot north of Tusayan to serve transit users. The *GMP* also establishes as a principle of its growth management strategy the siting of new housing and other development outside the boundaries of the park. Tusayan has a number of motels, restaurants and other commercial facilities catering to tourists. In 1993, Coconino County formed the Tusayan Planning Committee to develop a plan that would guide land use decisions in Tusayan.

2.4.2 Accommodating Growth Beyond the Park Boundaries

As an outgrowth of the *GMP,* GRCA has worked cooperatively with the Forest Service (FS), Coconino County, and the Northern Arizona Council of Governments in planning for the Tusayan area. A Draft EIS for *Tusayan Growth* was released for public and agency review, addressing alternative proposals for land use in the area near the park's south entrance. The DEIS considers two possible approaches by which the community of Tusayan, which is surrounded by forest lands, could grow and solve some of the park's problems: 1) exchange of a large parcel of Federal land adjacent to Tusayan for privately-owned properties scattered throughout a section of the Kaibab National Forest 2) purchase of Kaibab National Forest lands through the Townsite Act, which requires payment of fair market value and use of the purchased lands for "municipal purposes" only. In either case, a transportation staging area for the park transit system would be constructed by the park's selected transit provider on Kaibab National Forest lands. Any private or municipal development of housing or community service facilities would occur adjacent to the transportation staging area and the existing community of Tusayan.

In the first of the above options, the lands adjacent to the transportation staging area would be developed in a mix of commercial, residential, and community facilities to serve the needs of park employees and tourists. A private developer has designed a master-planned community that includes hotels, restaurants, retail shops, an educational facility, and employee housing and community facilities. The transportation staging area on adjacent Federal land will be an important adjunct to this development.

In the second of the options considered in the Tusayan Growth EIS, there would be no land exchange and no new master-planned community. Owners of existing businesses have expressed support for locating the transportation staging area adjacent to their properties.

A Supplement to the Draft EIS was issued in June 1998 and contained three new alternatives for improving transportation, housing, community facilites and visitor services outside the park boundaries. A decision on the Final EIS is expected this summer. While the proposal for private development is highly controversial, the planned transportation staging area is not. Accordingly, the NPS and FS hope that construction of the transportation staging area on Federal land can proceed without restraint.

2.4.3 Transit Alternatives

The transit service proposed for the Grand Canyon would create the need for new employee housing and related community and commercial services. This development potentially could be located either within or outside the park boundaries, if a plan is approved for additional development in the Tusayan area. Employees at the Grand Canyon face special challenges in finding housing. Because the park is in a remote setting where development is constrained by water supply, housing generally is not available in the private market at reasonable commuting distances. Thus, the GRCA must provide for employee housing and associated services.

Table 2.8 shows the number and cost of new housing units at $50,000 required for each of the five transit options.

Table 2.8
Transit Employee Housing Needs

	OPTION I ELECTRIC LIGHT RAIL	OPTION II DIESEL LIGHT RAIL	OPTION III 40' CNG BUS	OPTION IV 60' ARTICULATED BUS	OPTION V 60' ARTICULATED BUS
HOUSING UNITS	74	74	171	115	109
COST	$3,700,000	$3,700,000	$8,550,000	$5,750,000	$5,450,000

The need for new housing is lowest with the light rail options. Employee housing requirements would be 47 percent higher for Option V, 55 percent higher for Option IV, and over 130 percent higher for Option III. The need to provide housing for transit employees could be addressed with less impact to the park if a plan for development in the Tusayan area is approved.

3.0 Summary

This section summarizes the technical review of the Grand Canyon transportation alternatives analysis presented in the previous section. This analysis provided the basis for GRCA's designation of light rail as the preferred alternative. Information also is presented on the financing plan and current schedule for implementation of the proposed transit system. The report then concludes with a summary of FTA's and FHWA's observations on the analysis of transit system alternatives.

3.1 Evaluation

Transit service in Grand Canyon National Park should provide a convenient, comfortable, and reliable means of transporting visitors to points of interest on the South Rim. Quality of service is always a critical criterion in evaluating transportation services. In addition, the Grand Canyon is a setting of unusual environmental sensitivity. While transit is often perceived as a solution to urban transportation problems, the purpose of implementing new transportation service in the Grand Canyon is to preserve its essential natural character and the quality of experience enjoyed by its visitors. Thus, environmental issues--always a factor in transportation planning--are particularly important in this special context. Similarly, land use and development impacts are a major concern affecting the natural environment, park operations, the quality of visitor experiences, and cost.

3.1.1 Transportation System

Key transportation system evaluation criteria include ***Operational Characteristics*** (Capacity, Spatial Coverage, Reliability), ***Quality of Service*** (Travel Times, Wait Times, Convenience, Comfort, Ease of Use, System Comprehensibility), and ***Cost***.

Operational Characteristics: The key difference among the five options considered by GRCA in the life-cycle cost analysis is the higher *capacity* of the proposed light rail system compared to bus alternatives. A three-car train can carry 500 passengers, versus only 60 passengers in a standard 40' bus and 100 passengers in a 60' articulated bus. With peak hour (peak season) demand of 4,000 passengers, the substantially higher capacity of light rail should be a clear advantage. Lower fleet size should also contribute to improved *reliability* for light rail vehicles compared to buses, although with rail the risk of system failure is greater.

The configuration of the proposed fixed route system would provide high quality service to two key destination points, Canyon View at Mather Point and Village Center near Maswik Lodge, with multimodal connections (shuttle bus, walk, and bicycle) to other points of interest. This configuration corresponds to visitor travel patterns in the South Rim area, providing appropriate and reasonably convenient *spatial coverage.*

Quality of Service: *Travel times* between the Grand Canyon Transit Center and the Canyon View Information Plaza would be nearly 30 percent shorter for transit services operated in a dedicated right-of-way (light rail or busway) than for buses operated in mixed traffic on existing roadways. The travel time savings for the light rail and busway options would be approximately 3 minutes between Tusayan and Mather Point. *Wait times* would be slightly shorter with buses than a light rail service, although it may be difficult to attain the frequency of bus departures necessary to accommodate peak hour demand, and delays would extend wait times, especially since most users would not be familiar with the system. Light rail headways of 7½ minutes should be attainable, resulting in short wait times that visitors are likely to perceive as *convenient*. User *comfort* will depend largely on the specific vehicles chosen, although light rail may provide a smoother ride than bus.

Cost: Capital costs are substantially higher for light rail than for bus. However, in order to provide the same ridership capacity with the bus service as the rail, the bus system would require a larger fleet size. Therefore, it would cost twice as much to staff and maintain a bus fleet as a rail system.

Considering both the capital and operating costs, the investment is comparable for bus and rail. GRCA has estimated net present value total costs to be $242.9 million for the Diesel Light Rail option and $223.7 million for Articulated Bus operated on a designated Busway.

3.1.2 Impacts to the Environment

Proposed transportation plans at the Grand Canyon National Park have been the subject of extensive environmental review through an EIS for the *GMP* and an EA for the South Rim transit system proposal. The principal relevant categories of potential environmental impacts are ***Air Quality, Noise and Vibration, Natural Resources,*** and ***Quality of Visitor Experience***, as described below.

Air Quality: The use of transit services by visitors would significantly lower vehicular emissions, due to a major reduction in the use of private vehicles within the South Rim area. Although GRCA did not compare different transit system alternatives in terms of air quality impacts, the differences among system types would be relatively small compared to the benefit resulting from the reduced use of private vehicles. Electric light rail and CNG buses would release the lowest levels of emissions and result in the greatest air quality benefits.

Noise: As with air quality, the impact of restricting the use of private vehicles in the South Rim would be overwhelmingly positive. Mitigation techniques can reduce transit-related noise at individual receptors. Vibration impacts from light rail operations may be perceptible at sites within 150 feet of rail lines. Bus operations would produce no vibration impacts.

Natural Resources: Transit systems with guideways, including light rail and buses operated on busways, would disturb more acreage than bus systems operated on existing roadways. The difference in impact—62 acres—is modest relative to the resource. No threatened or endangered species would be affected.

Quality of Visitor Experience: GRCA's transportation plan would improve the visitor's experience of the Grand Canyon, chiefly by eliminating traffic congestion from South Rim roadways and the stress associated with finding scarce parking spaces. Overall reductions in emissions and noise levels, as well as reinforcement of walking and bicycling as modes of transportation, should produce a more tranquil atmosphere conducive to the appreciation of nature.

3.1.3 Development

The unique natural environment in and surrounding the Grand Canyon National Park is highly sensitive to development impacts. Transportation facilities can have profound impacts on land development. Crucial development considerations addressed in this assessment are the proposed transit system's ***Consistency with Land Use Plans*** and ***Housing Cost*** for transit system employees.

Consistency with Land Use Plans: The transportation plan for the Grand Canyon has been conceived as part of a broader growth management strategy, which would allow for increasing park visitation, protection of natural resources, and enhancement of visitor satisfaction. The modest level of development anticipated in conjunction with the proposed transit system would be consistent with this vision of the park's future. Locating new employee housing outside the park boundaries would help to maintain the unique natural environment of the South Rim.

Housing Cost: As a result of the lack of a significant private housing market in the vicinity of the park, GRCA must provide housing for its new employees. Bus options would impose higher housing costs than light rail, because more employees would be required to operate a bus-based system. The cost difference above light rail ranges from $3.1 million for an articulated bus system operated on busways, to $4.9 million for a service operated with 40' buses.

3.2 Financing

GRCA currently is analyzing potential financing mechanisms and means of reducing project costs, as the basis for developing a financial plan. The system would most likely be operated as a private concession under contract. GRCA is evaluating the use of "design-build-operate-maintenance"(DBOM) procurement through concessions law, which would provide for financing of the system by a concessioner. GRCA would pay the concessioner from the funds collected through the park admissions fee. Payment to the concessioner would be at a pre-determined per mile or per hour rate, established through a competitive bidding process. Thus, the concessioner would bill the GRCA on a regular basis for an amount equal to the number of miles or hours operated multiplied by the agreed upon fee per unit of service provided.

The most recent precedent for charging and retaining user fees at national parks was established through the Recreational Fee Demonstration Program, authorized in 1996 and amended in 1997. Individual parks participating in the demonstration have been allowed to retain up to 80 percent of the entrance fees collected on-site. The Parks Omnibus Act of 1998 allows the NPS to charge user fees specifically for transportation services operated under contract at national parks.

GRCA is in the process of determining a fee structure that will provide the revenue necessary to cover the cost of the transit system. This analysis incorporates the following assumptions, which are subject to revision as financial planning progresses:

- 75% debt / 25% equity financing
- interest rate on debt of 6.4 %
- contractor's rate of return on equity of 20 percent
- system capital cost of $155 million
- first year operating and maintenance cost of $13.8 million

GRCA currently projects that the first year of operations would cost $30.4 million.

Over 75 percent of visitors to the Grand Canyon stay for only 1 or 2 days. Proposals under consideration would establish either a single set of fees for the purchase of a 7-day pass, or a more complicated fee structure in which visitors would have the option of purchasing a pass for either 7 days or a shorter stay of probably 1 or 2 days. The GRCA is considering whether Golden Eagle, Golden Age, and Golden Access pass holders would pay reduced fees or no fees at all.

Depending on the fee structure chosen, GRCA expects entrance charges, including a transit fee, to be in the range of $12-$15 per adult and $7- $11 per child age 6-16. At these rates, the cost of a typical family consisting of two adults and one child between the ages of 6 and 16 would be $8 – $21 higher than with the current entrance fee of $20 per car. While this would be a significant increase, for most families, it would not represent a substantial increase in the total cost of a trip to the Grand Canyon. The most recent entrance fee increase did not have a significant effect on park attendance, indicating that there is considerable inelasticity of demand based on entrance fees. Therefore, visitation probably would not decrease appreciably in response to the fee increase. Charging user fees at the levels under consideration represents a reasonable approach to meeting system costs. Further development of financial plans is necessary to determine the viability of specific financing strategies.

3.3 Implementation Plan and Schedule

GRCA's Implementation Plan provides for development of the proposed light rail system over a period of 3 1/2 years. The plan identifies seven major project components: Tusayan Parking Area and Roads, Light Rail Guideway & Stations, Grade Separated Overpasses, Light Rail Maintenance Facility, Light Rail Vehicle Procurement, and Bus Procurement. Work on all of the components is to be initiated concurrently following the Notice to Proceed. The component expected to require the longest implementation time is Light Rail Vehicle Procurement. The schedule depends on the timing of permission to proceed with procurement.

While the schedule is fast-paced compared to typical light rail construction projects in urban settings, the projected timeframe is very ambitious but may be feasible given the less complicated construction environment at the Grand Canyon. It is suggested that GRCA conduct a constructability analysis to confirm the schedule. The ability to procure a relatively small order of 18 light rail transit vehicles (LRTs) in 24 months is very problematic. GRCA should explore the possibility of a joint procurement with another LRT property.

3.4 Observations

The transportation plan developed by the GRCA is necessary to address the Grand Canyon's increasingly severe traffic problems. The basic transportation service concept defined in the *GMP* and its translation into a specific transit system proposal appear to be based on sound planning practices, including the analysis of potential transit alternatives. Comments follow on aspects of the alternatives analysis concerning *transportation, impacts to the environment*, and *development.*

3.4.1 Transportation

- The principal advantage of the proposed light rail system compared to the other alternatives considered is its higher capacity. Peak hour demand of over 4,000 passengers can be accommodated more readily on 9 hourly 3-car trains than in 40 to 70 buses.

- The operation of fewer, higher-capacity vehicles should foster reliable operations and maintenance efficiency. These advantages, however, depend on the quality of equipment in use and the competence of operators, mechanics, and system managers. A rail system is less forgiving of mechanical problems and breakdowns when they do occur and the risk of system failure is higher. A bus system with more complicated operational logistics may produce more frequent, but less severe, service interruptions.

- The travel time advantage for light rail or busway options would be tangible but smaller than is typical of urban transportation systems, because most private vehicles would be eliminated from the area's roadways. Providing a dedicated right-of-way should result in some improvement in schedule adherence.

- While some visitors may find it inconvenient to transfer between the line haul transit service and connecting shuttle buses, the advantages of the proposed system configuration appear to outweigh potential disadvantages. The transit system would provide good spatial coverage to points of interest throughout the South Rim. The transportation plan underlying the proposed transit service thus represents a sound approach to meeting circulation needs within the South Rim area.

- The analysis of capital and operating costs is based on reasonable assumptions and generally sound methods. Vehicle capital cost estimates are consistent with price data reported by U.S. transit agencies. Estimates of other capital cost components are based on technical analysis conducted at a level of detail appropriate to transit alternatives analysis.

- GRCA has estimated that the substantially higher capital cost for light rail, compared to bus alternatives, would be offset by lower operating and maintenance costs. Estimated total net present value costs of the Diesel Light Rail service alternative are comparable to the estimated cost for Articulated Bus service alternatives, although costs for an Electric Light Rail system would be higher.

- Estimates of unit operating and maintenance costs for one of the Articulated Bus options may be too high. If a lower value of unit operating and maintenance costs were determined to be more appropriate for this option, its total cost would be reduced. In that case, Articulated Bus on Busway would be the lowest-cost option, but the relative cost advantage over Diesel Light Rail probably still would not be large enough to be decisive.

- There are several additional issues that could possibly affect the cost estimates to some degree:

    - Facility capital costs may be too dependent on vehicle fleet size, raising bus capital costs.
    - Several incorrect estimates of vehicle hours were used in the first stage of the operating cost estimation process. The errors did not exceed 10 percent, however, and as noted before, the model used for this part of the analysis was relatively insensitive to variations in vehicle hours. The errors, therefore, probably did not affect the unit cost estimates.
    - Contingency factors on operating and maintenance costs may be too high. A 10 percent contingency cost is incorporated in labor costs to cover factors such as turnover, extended leave, and training. In addition, a 9.5 percent contingency factor is applied to total labor and other costs, yielding an effective 20 percent contingency factor for the labor component of operating and maintenance costs. The result is to boost the share of operating costs as a component of total costs. This works to the disadvantage of the bus options, which already have higher operating costs than rail.

These issues are unlikely to have a major effect on the analysis conclusions, however, including the ranking of the transportation options in terms of cost.

- GRCA is in the process of developing a strategy for financing the transit system through user fees. A fully developed financial plan is necessary to determine the feasibility of proposed project financing.

3.4.2 Impacts to the Environment

- Environmental impacts have been considered in a succession of review cycles as the project has progressed from a broad strategy in the *GMP* to a specific transit system proposal. The approved EA for the transit system identifies rail service as the proposed action.

- The environmental review process established to the satisfaction of review agencies that the impact of the transit service concept would be of marked benefit to the environment of the Grand Canyon, due to the dramatic reduction in automobile use within the park. This conclusion is well founded and valid irrespective of the equipment or means of propulsion selected for system operations.

- Notwithstanding the indisputable environmental benefits of transit as an alternative to private vehicles, there remains the potential for differences in impacts among bus and rail alternatives and equipment powered by electric, diesel, and alternative fuels. GRCA has not attempted to quantify and compare emission levels for transit alternatives. While an electric light rail system would produce lower levels of air pollution than either a rail or bus system powered by diesel fuel, this benefit is unlikely to be of sufficient magnitude to outweigh the cost advantages of other alternatives. CNG buses also would reduce air pollution somewhat relative to diesel-powered vehicles, but at the cost of significant operational disadvantages. GRCA should undertake an emissions analysis for the various vehicle types for each option.

- Noise impacts, similarly, are unlikely to vary to such an extent as to determine the choice among transit alternatives. Quantification of noise impacts would be useful as a basis for developing an effective noise mitigation strategy. It also would be reasonable for GRCA to include allowable emission and noise levels as system design specifications and to seek the most pollution-free and quietest feasible technology. Once a particular LRV has been decided upon, GRCA should obtain noise data at various operating speeds and plot noise contours near sensitive noise receptors (e.g. campgrounds) to fully analyze potential impacts.

- Users may find light rail service, which would operate at higher capacities and lower frequencies than bus alternatives, to be more compatible with their expectations of recreational travel and less pervasive in its impact on their experience of the park.

3.4.3 Development

- The proposed transit system would impose modest development impacts on the Grand Canyon and its environs. This development was envisioned in *GMP*, which sets forth a growth management strategy designed to protect the environment. The *GMP* proposes that most future residential and commercial development be located outside the park boundaries.

- Employee housing costs for 74 to 116 units would be in the range of $3.7 million - $5.8 million for the light rail and articulated bus alternatives. A system operated with standard 40' buses would require more employees, generating greater demands for employee housing. Thus, employee housing costs are estimated to be higher for this alternative, on the order of $8.6 million. While the objective of reducing the need for employee housing is legitimate, differences among the light rail and articulated bus options are not large enough to merit substantial weight in determining the choice of transit system.

3.5 Review Process

The FTA and FHWA have performed the review of the Grand Canyon alternatives analysis following a process similar to that used in FTA's review of applications by local transit properties for Federal funding under the Section 5309 New Starts program. As with the financial assessments performed for New Starts projects, FTA has reviewed the proposed Grand Canyon transit system in terms of expected ridership and system characteristics, cost, benefits, and revenues. It is the purpose of this review, as summarized in this report, to assess the feasibility of the project and to develop appropriate recommendations for increasing the prospects for its success. It is not the intention of the DOT to impose its judgment regarding the selection or design of the transit system on prospective local grantees, in the case of FTA's New Starts program, or on the National Park Service, in the case of this review.

As noted earlier in this report, FTA and FHWA have been working with GRCA over the past year in a multidisciplinary effort supporting the advanced stages of project planning. In response to FTA and FHWA comments on earlier GRCA projections of project costs, GRCA developed the project to the 30 percent design stage and revised its cost estimates accordingly. These cost estimates served as a basis for this review. FTA and FHWA encourage GRCA to continue development of transit station plans to the 100 percent design stage to provide a greater level of confidence and address remaining questions regarding station design costs.

The information reviewed for this report provides strong evidence that GRCA has developed its proposal for transit service through a sound and thorough planning process, including a satisfactory analysis of transit alternatives and meaningful public involvement. As part of this process, GRCA has identified a potentially sound strategy for financing the system through user fees. A conclusive determination of the project's financial feasibility, however, will require a basis in a more fully developed financial plan. FTA and FHWA recommend that the final financial plan be completed prior to awarding a DBOM contract for the project.

Appendix A

Grand Canyon National Park Transit System Life Cycle Cost Analysis

Part I- Capital Cost Estimates, All Options

Part II-Operating and Maintenance Cost Estimates, Option II-Diesel Light Rail and Option V- 60 Foot Articulated Bus on Busway

Part III-Cost Estimate Summary (Net Present Value), Option II-Diesel Light Rail and Option V – 60 Foot Articulated Bus on Busway

Grand Canyon National Park
Life Cycle Cost Analysis
Robert Peccia & Associates

OPTION I
Electric Light Rail System
Initial Capital Cost Estimate

Component	Unit	#	Unit Cost	SubTotal Cost	Total Cost
Light Rail Vehicle (Electric)*	vehicle	18	$2,400,000	$43,200,000	
High Rail Trucks	vehicle	2	$140,000	$280,000	$43,480,000
Sub Grade & Track	single lane, mi	19.25	-	$16,300,000	
Excavation	cy.	265,276	$5	$1,326,380	$17,626,380
Signal System	dual lane, mi	8.25		$11,419,000	$11,419,000
Electrification		1	-	$20,500,000	$20,500,000
Electric Service to Site		1	-	$17,600,000	$17,600,000
Stations (platforms)	station	3	$815,000	$2,445,000	$2,445,000
Maintenance Facility		1	$7,500,000	$7,500,000	
- Rail Barn	per veh.	9	-	$3,000,000	
- Wash & Vac. Station		1	$1,000,000	$1,000,000	
- Paving (asph & base)	sq. ft.	5,000	$1.5	$7,500	$11,507,500
Employee Housing	dwelling	74	$50,000	$3,700,000	$3,700,000
Three Overpasses		1	$2,007,816.0	$2,007,816	$2,007,816
Sub Total					$130,285,696
Contingencies-Rolling Stock		10%	ng stock only)		$4,348,000
Contingencies-Infrastructure		20%	ng stock only)		$17,361,139
Engineering-Infrastructure		10%	ng stock only)		$8,680,570
Light Rail System Total					**$160,675,405**

* LRV Train Cars - No additional vehicle purchase required.

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Grand Canyon National Park
Life Cycle Cost Analysis
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OPTION II
Diesel Light Rail System
Initial Capital Cost Estimate

Component	Unit	#	Unit Cost	SubTotal Cost	Total Cost
Light Rail Vehicle (Diesel)*	vehicle	18	$3,000,000	$54,000,000	
High Rail Trucks	vehicle	2	$140,000	$280,000	$54,280,000
Sub Grade & Track	single lane, mi	19.25	-	$16,300,000	
Excavation	cy.	265,276	$5	$1,326,380	$17,626,380
Signal System	dual lane, mi	8.25		$11,419,000	$11,419,000
Stations (platforms)	station	3	$815,000	$2,445,000	$2,445,000
Diesel LRV Maint. Facility		1	$7,500,000	$7,500,000	
- Rail Barn	per veh.	9	-	$3,000,000	
- Diesel Refueling Station		1	$880,000	$880,000	
- Wash & Vac. Station		1	$1,000,000	$1,000,000	
- Paving (asph & base)	sq. ft.	5,000	$1.5	$7,500	$12,387,500
Employee Housing	dwelling	74	$50,000	$3,700,000	$3,700,000
Three Overpasses		1	$2,007,816	$2,007,816	$2,007,816
Sub Total					$103,865,696
Contingencies-Rolling Stock		10% ng stock only)			$5,428,000
Contingencies-Infrastructure		20% ng stock only)			$9,917,139
Engineering-Infrastructure		10% ng stock only)			$4,958,570
Light Rail System Total					**$124,169,405**

* LRV Train Cars - No additional vehicle purchase required.

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Grand Canyon National Park
Life Cycle Cost Analysis
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OPTION III
40' CNG, Low-floor Transit Bus
Initial Capital Cost Estimate

Component	Unit	#	Unit Cost	SubTotal Cost	Total Cost
New 40' CNG, Low-floor Bus	vehicle	58	$325,000	$18,850,000	$18,850,000
Bus Maintenance Facility		1	$12,000,000	$12,000,000	
- Bus Barn	per veh.	62	-	$2,300,000	
- Refueling Station		1	$3,000,000	$3,000,000	
- Wash & Vac Station		1	$350,000	$350,000	
- Paving (asph & base)	sq. ft.	115,000	$1.5	$172,500	$17,822,500
Stations (platforms)	station	3	$500,000	$1,500,000	$1,500,000
Employee Housing	dwelling	171	$50,000	$8,550,000	$8,550,000
Upgrade Existing Roadways		1	$10,500,000	$10,500,000	$10,500,000
Sub Total					$57,222,500
Contingencies-Rolling Stock	5% ng stock only)				$942,500
Contingencies-Infrastructure	20% ng stock only)				$7,674,500
Engineering-Infrastructure	10% ng stock only)				$3,837,250
Transit Bus System Total					**$69,676,750**

* 40' CNG Bus - Additional bus purchases: yr. 2007 +4 buses.

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Grand Canyon National Park
Life Cycle Cost Analysis
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OPTION IV
60' Diesel, Low-floor Articulated Transit Bus
Initial Capital Cost Estimate

Component	Unit	#	Unit Cost	SubTotal Cost	Total Cost
New 60' Diesel, Lo-flr, Artic Bu	vehicle	35	$400,000	$14,000,000	$14,000,000
Bus Maintenance Facility		1	$12,000,000	$12,000,000	
- Bus Barn	per veh.	38	-	$2,120,000	
- ~~Refueling~~ Station		1	~~$3,000,000~~	~~$3,000,000~~	
- Wash & Vac Station		1	$350,000	$350,000	
- Paving (asph & base)	sq. ft.	106,000	$1.5	$159,000	$17,629,000
Stations (platforms)	station	3	$650,000	$1,950,000	$1,950,000
Employee Housing	dwelling	115	$50,000	$5,750,000	$5,750,000
Upgrade Existing Roadways		1	$10,500,000	$10,500,000	$10,500,000
Sub Total					$49,829,000
Contingencies-Rolling Stock	5% ng stock only)				$700,000
Contingencies-Infrastructure	20% ng stock only)				$7,165,800
Engineering-Infrastructure	10% ng stock only)				$3,582,900
Transit Bus System Total					**$61,277,700**

* 60' Articulated Bus - Additional bus purchases: yr. 2007 +3 buses.

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Grand Canyon National Park
Life Cycle Cost Analysis
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OPTION V
60' Diesel, Low-floor Articulated Transit Bus
With Dedicated Busway
Initial Capital Cost Estimate

Component	Unit	#	Unit Cost	SubTotal Cost	Total Cost
New 60' Diesel, Lo-flr, Artic Bu	vehicle	30	$400,000	$12,000,000	$12,000,000
Bus Maintenance Facility		1	$12,000,000	$12,000,000	
- Bus Barn	per veh.	30	-	$1,675,000	
- Refueling Station		1	$3,000,000	$3,000,000	
- Wash & Vac Station		1	$350,000	$350,000	
- Paving (asph & base)	sq. ft.	106,000	$1.50	$159,000	$17,184,000
Stations (platforms)	station	3	$650,000	$1,950,000	$1,950,000
Dedicated Busway:					
- Base Course & Pavement	sq. ft.	2,787,840	$3.00	$8,363,520	
- Excavation	cu. yd.	270,000	$5.00	$1,350,000	
- Drainage		1	$400,000	$400,000	
- Other Construction Costs		1	$2,428,380	$2,428,380	$12,541,900
Employee Housing	dwelling	109	$50,000	$5,450,000	$5,450,000
Three Overpasses		1	$2,007,816	$2,007,816	$2,007,816
Sub Total					$51,133,716
Contingencies-Rolling Stock	5% ng stock only)				$600,000
Contingencies-Infrastructure	20% ng stock only)				$7,826,743
Engineering-Infrastructure	10% ng stock only)				$3,913,372
Transit Bus System Total					**$63,473,831**

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OPTION II
Diesel Light Rail System
Site-Specific O & M Cost Estimate

	Basic Input Parameters				Seasonal Input Parameters																
Year	Round Trip Distance (miles)	Travel Tim (min.)*	Train Capacity**	Train O&M*** Cost/Hour	Season	Est. Pk. Hr Demand (rides/hr)	Daily Hours of Operation	Equiv. Pk. Hr. Utiliz.	Days per Season	Route Capacity /veh./hour	# Active Trains Required (no rndg.)	Trains [illegible] (rounded)	[illegible] Units (active + spares)	Train Rnd Trips per hour	Train Miles per hour	Train Hrs. per day of Operation	Train Miles per day	Train Hrs. per Season of Operation	Train Miles per Season	O&M Costs per Season	Annual O&M Costs
2002	16.5	35	525	$518.43	Summer	3,531	16	0.75	153	900	3.9	[illegible]	[illegible]	7	113.1	48.0	1357.7	7,344	207,730	$3,807,350	$6,899,484
					Shoulder	2,428	14	0.79	122		2.7	[illegible]		5	84.9	33.2	938.5	4,048	114,499	$2,098,584	
					Winter	988	13	0.81	91		1.1	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2003	16.5	35	525	$518.43	Summer	3,609	16	0.75	153	900	4.0	[illegible]	[illegible]	7	113.4	48.1	1361.1	7,362	208,250	$3,816,868	$6,909,003
					Shoulder	2,483	14	0.79	122		2.8	[illegible]		5	84.9	33.2	938.5	4,048	114,499	$2,098,584	
					Winter	1,015	13	0.81	91		1.1	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2004	16.5	35	525	$518.43	Summer	3,687	16	0.75	153	900	4.1	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$7,851,322
					Shoulder	2,537	14	0.79	122		2.8	[illegible]		5	84.9	33.2	938.5	4,048	114,499	$2,098,584	
					Winter	1,041	13	0.81	91		1.2	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2005	16.5	35	525	$518.43	Summer	3,765	16	0.75	153	900	4.2	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$7,851,322
					Shoulder	2,592	14	0.79	122		2.9	[illegible]		5	84.9	33.2	938.5	4,048	114,499	$2,098,584	
					Winter	1,068	13	0.81	91		1.2	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2006	16.5	35	525	$518.43	Summer	3,842	16	0.75	153	900	4.3	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$7,851,322
					Shoulder	2,646	14	0.79	122		2.9	[illegible]		5	84.9	33.2	938.5	4,048	114,499	$2,098,584	
					Winter	1,095	13	0.81	91		1.2	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2007	16.5	35	525	$518.43	Summer	3,920	16	0.75	153	900	4.4	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$7,852,099
					Shoulder	2,701	14	0.79	122		3.0	[illegible]		5	84.9	33.2	938.9	4,049	114,542	$2,099,361	
					Winter	1,121	13	0.81	91		1.2	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2008	16.5	35	525	$518.43	Summer	3,998	16	0.75	153	900	4.4	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	2,755	14	0.79	122		3.1	[illegible]		7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,148	13	0.81	91		1.3	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2009	16.5	35	525	$518.43	Summer	4,075	16	0.75	153	900	4.5	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	2,810	14	0.79	122		3.1	[illegible]		7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,174	13	0.81	91		1.3	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2010	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	2,864	14	0.79	122		3.2	[illegible]		7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,201	13	0.81	91		1.3	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2011	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	2,921	14	0.79	122		3.2	[illegible]		7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,225	13	0.81	91		1.4	[illegible]		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2012	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[illegible]	[illegible]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	2,980	14	0.79	122		3.3	[illegible]		7	113.1	44.2	1251.4	5,397	152,666	$2[illegible]12	
					Winter	1,250	13	0.81	91		1.4	[illegible]		3	56.6	21.1	595.7	1,916	54,208	[illegible]0	

2013	1	35	525	$518.43	Summer	4,153	16	0.75	153	900	-.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,039	14	0.79	122		3.4	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,275	13	0.81	91		1.4	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2014	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,100	14	0.79	122		3.4	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,300	13	0.81	91		1.4	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2015	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,162	14	0.79	122		3.5	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,326	13	0.81	91		1.5	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2016	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,225	14	0.79	122		3.6	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,353	13	0.81	91		1.5	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2017	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,290	14	0.79	122		3.7	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,380	13	0.81	91		1.5	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2018	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,356	14	0.79	122		3.7	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,407	13	0.81	91		1.6	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2019	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,423	14	0.79	122		3.8	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,435	13	0.81	91		1.6	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2020	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,491	14	0.79	122		3.9	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,464	13	0.81	91		1.6	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2021	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,550,850
					Shoulder	3,561	14	0.79	122		4.0	[redacted]	7	113.1	44.2	1251.4	5,397	152,666	$2,798,112	
					Winter	1,493	13	0.81	91		1.7	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2022	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$8,575,722
					Shoulder	3,632	14	0.79	122		4.0	[redacted]	7	114.1	44.6	1262.5	5,445	154,023	$2,822,984	
					Winter	1,523	13	0.81	91		1.7	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2023	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	3,705	14	0.79	122		4.1	[redacted]	9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,554	13	0.81	91		1.7	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2024	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	3,779	14	0.79	122		4.2	[redacted]	9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,585	13	0.81	91		1.8	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2025	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	3,855	14	0.79	122		4.3	[redacted]	9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,616	13	0.81	91		1.8	[redacted]	3	56.6	21.1	595.7	1,916	54,208	$993,550	
2026	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	[redacted]	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378

					Shoulder	3,932	14	0.79	122		4.4	5		9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,649	13	0.81	91		1.8	2		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2027	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	5	16	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	4,010	14	0.79	122		4.5	5		9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,682	13	0.81	91		1.9	2		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2028	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	5	16	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	4,090	14	0.79	122		4.5	5		9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,715	13	0.81	91		1.9	2		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2029	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	5	16	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	4,153	14	0.79	122		4.6	5		9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,750	13	0.81	91		1.9	2		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2030	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	5	16	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,250,378
					Shoulder	4,153	14	0.79	122		4.6	5		9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,785	13	0.81	91		2.0	2		3	56.6	21.1	595.7	1,916	54,208	$993,550	
2031	16.5	35	525	$518.43	Summer	4,153	16	0.75	153	900	4.6	5	16	9	141.4	60.0	1697.1	9,180	259,663	$4,759,187	$9,261,417
					Shoulder	4,153	14	0.79	122		4.6	5		9	141.4	55.3	1564.2	6,747	190,832	$3,497,640	
					Winter	1,820	13	0.81	91		2.0	2		3	57.2	21.3	602.3	1,938	54,811	$1,004,590	
Total																					##########

Notes:

A maximum cap is assumed for light rail peak hour demand, based on the estimated summer demand in the year 2010.

System assumptions: 3-unit trains, 3 stops on route, 7-min. headway between trains.

* Travel time includes stops.

** Train capacity includes seated plus standing passengers.

*** O&M costs are shown in current dollars, with no provision for inflation. Based on regional O&M costs estimated using factors from LRT properties west of the Mississippi. O&M costs were applied to a bottom-up estimate of the site-specific operation

Equivalent Peak Hour Utilization is estimated based on: summer - 8 hrs.@100% & 8 hrs.@50% utilization; shoulder - 8 hrs.@100% & 8 hrs.@50% utilization; winter - 8 hrs.@100% & 8 hrs.@50% utilization.

fccomp1.wk4 revised 12/16/98

OPTION II
Diesel Light Rail System
Cost Estimate Summary
Based on Site Specific O&M Cost Estimates

Component	Initial Cost Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016
Capital Costs	###########	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Routine O&M Costs*	$6,899,484	$6,909,003	$7,851,322	$7,851,322	$7,851,322	$7,852,099	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850
Major Maint. Upgrade Costs:															
- Train Maint. Facility	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
- DMU Fleet Vehicles	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
- Signal System Upgrade	$0	$0	$0	$0	$0	$0	$0	$0	$2,283,800	$0	$0	$0	$0	$0	$0
- Geometric Car Track Chec	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pavement Maintenance:															
- Maint. Facility Pvmt.	$0	$0	$0	$0	$1,147	$0	$0	$0	$0	$1,147	$0	$0	$0	$0	$2,843
Major Maint. Cost Total	$0	$0	$0	$0	$1,147	$0	$0	$0	$2,283,800	$1,147	$0	$0	$0	$0	$2,843

* Light Rail O&M based on annual cost per hour. Based on regional O&M costs estimated using factors from LRT properties west of the Mississippi. The O&M costs were applied to a bottom-up estimate of the site-specific operation proposed for use at the Gr

Cost Summary**

Component	Initial Cost Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016
Capital Costs	###########	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Routine O&M Costs	$6,899,484	$6,909,003	$7,851,322	$7,851,322	$7,851,322	$7,852,099	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850
Major Maintenance Costs	$0	$0	$0	$0	$1,147	$0	$0	$0	$2,283,800	$1,147	$0	$0	$0	$0	$2,843
Total Costs by Year	###########	$6,909,003	$7,851,322	$7,851,322	$7,852,469	$7,852,099	$8,550,850	$8,550,850	$10,834,650	$8,551,997	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,553,693

** All costs are shown in 1998 dollars, with no adjustment for inflation or interest.

Net Present Value Cost Summary***

Component	NPV Year 2002
Capital Costs	###########
Routine O&M Costs	###########
Major Maintenance Costs	$9,419,592
Total Costs (NPV)	###########

*** Costs shown represent Net Present Value, calculated using an annual discount rate of 7% for all future year expenditures.

sumcomp1.wk4 revised 12/22/98

Annual Cost Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2023	Year 2024	Year 2025	Year 2026	Year 2027	Year 2028	Year 2029	Year 2030	Year 2031	30-Year Totals
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$124,169,405
$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,575,722	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,261,417	$256,766,615
$2,250,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,250,000
$16,200,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$16,200,000
$2,283,800	$0	$0	$0	$0	$0	$0	$0	$2,283,800	$0	$0	$0	$0	$0	$0	$6,851,400
$250,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$250,000
$0	$0	$0	$0	$1,147	$0	$0	$0	$0	$1,147	$0	$0	$0	$0	$0	$7,431
$20,983,800	$0	$0	$0	$1,147	$0	$0	$0	$2,283,800	$1,147	$0	$0	$0	$0	$0	$25,558,831

Annual Cost Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2023	Year 2024	Year 2025	Year 2026	Year 2027	Year 2028	Year 2029	Year 2030	Year 2031	30-Year Totals
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$124,169,405
$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,550,850	$8,575,722	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,261,417	$256,766,615
$20,983,800	$0	$0	$0	$1,147	$0	$0	$0	$2,283,800	$1,147	$0	$0	$0	$0	$0	$25,558,831
$29,534,650	$8,550,850	$8,550,850	$8,550,850	$8,551,997	$8,575,722	$9,250,378	$9,250,378	$11,534,178	$9,251,525	$9,250,378	$9,250,378	$9,250,378	$9,250,378	$9,261,417	$406,494,851

OP V
60' Diesel, Low-floor Articulated Bus - with Dedicated Busway
Site-Specific O & M Cost Estimate

	Basic Input Parameters				Seasonal Input Parameters																
Year	Round Trip Distance (miles)	Travel Tim (min.)*	Bus Capacity**	Bus O&M*** Cost/Hour	Season	Est. Pk. Hr Demand (rides/hr)	Daily Hours of Operation	Equiv. Pk. Hr. Utiliz.	Days per Season	Route Capacity /veh./hour	# Active Req[redacted] (no mdg.)	[redacted]	[redacted]	Bus Rnd Trips per hour	Bus Miles per hour	Bus Hours per day of Operation	Bus Miles per day	Bus Hours per Season of Operation	Bus Miles per Season	O&M Costs per Season	Annual O&M Costs
2002	17	35	100	$149.58	Summer	3,531	16	0.75	153	171	20.6	[redacted]	[redacted]	36	612.0	252.0	7,344.0	38,556	1,123,632	$5,767,206	$9,654,668
					Shoulder	2,428	14	0.79	122		14.2	[redacted]	[redacted]	26	437.1	165.9	4,834.8	20,240	589,846	$3,027,469	
					Winter	988	13	0.81	91		5.8	[redacted]	[redacted]	10	174.9	63.2	1,841.2	5,749	167,553	$859,992	
2003	17	35	100	$149.58	Summer	3,609	16	0.75	153	171	21.1	[redacted]	[redacted]	38	641.1	264.0	7,693.7	40,392	1,177,138	$6,041,835	$9,929,297
					Shoulder	2,483	14	0.79	122		14.5	[redacted]	[redacted]	26	437.1	165.9	4,834.8	20,240	589,846	$3,027,469	
					Winter	1,015	13	0.81	91		5.9	[redacted]	[redacted]	10	174.9	63.2	1,841.2	5,749	167,553	$859,992	
2004	17	35	100	$149.58	Summer	3,687	16	0.75	153	171	21.5	[redacted]	[redacted]	38	641.1	264.0	7,693.7	40,392	1,177,138	$6,041,835	$10,032,094
					Shoulder	2,537	14	0.79	122		14.8	[redacted]	[redacted]	25	431.3	163.7	4,770.1	19,969	581,948	$2,986,935	
					Winter	1,041	13	0.81	91		6.1	[redacted]	[redacted]	12	204.0	73.7	2,148.1	6,708	195,479	$1,003,324	
2005	17	35	100	$149.58	Summer	3,765	16	0.75	153	171	22.0	[redacted]	[redacted]	38	641.1	264.0	7,693.7	40,392	1,177,138	$6,041,835	$10,274,460
					Shoulder	2,592	14	0.79	122		15.1	[redacted]	[redacted]	27	466.3	177.0	5,157.1	21,589	629,169	$3,229,301	
					Winter	1,068	13	0.81	91		6.2	[redacted]	[redacted]	12	204.0	73.7	2,148.1	6,708	195,479	$1,003,324	
2006	17	35	100	$149.58	Summer	3,842	16	0.75	153	171	22.4	[redacted]	[redacted]	39	670.3	276.0	8,043.4	42,228	1,230,645	$6,316,464	$10,549,089
					Shoulder	2,646	14	0.79	122		15.4	[redacted]	[redacted]	27	466.3	177.0	5,157.1	21,589	629,169	$3,229,301	
					Winter	1,095	13	0.81	91		6.4	[redacted]	[redacted]	12	204.0	73.7	2,148.1	6,708	195,479	$1,003,324	
2007	17	35	100	$149.58	Summer	3,920	16	0.75	153	171	22.9	[redacted]	[redacted]	39	670.3	276.0	8,043.4	42,228	1,230,645	$6,316,464	$10,549,089
					Shoulder	2,701	14	0.79	122		15.8	[redacted]	[redacted]	27	466.3	177.0	5,157.1	21,589	629,169	$3,229,301	
					Winter	1,121	13	0.81	91		6.5	[redacted]	[redacted]	12	204.0	73.7	2,148.1	6,708	195,479	$1,003,324	
2008	17	35	100	$149.58	Summer	3,998	16	0.75	153	171	23.3	[redacted]	[redacted]	41	699.4	288.0	8,393.1	44,064	1,284,151	$6,591,093	$11,025,549
					Shoulder	2,755	14	0.79	122		16.1	[redacted]	[redacted]	29	495.4	188.0	5,479.4	22,938	668,492	$3,431,132	
					Winter	1,148	13	0.81	91		6.7	[redacted]	[redacted]	12	204.0	73.7	2,148.1	6,708	195,479	$1,003,324	
2009	17	35	100	$149.58	Summer	4,075	16	0.75	153	171	23.8	[redacted]	[redacted]	41	699.4	288.0	8,393.1	44,064	1,284,151	$6,591,093	$11,025,549
					Shoulder	2,810	14	0.79	122		16.4	[redacted]	[redacted]	29	495.4	188.0	5,479.4	22,938	668,492	$3,431,132	
					Winter	1,174	13	0.81	91		6.8	[redacted]	[redacted]	12	204.0	73.7	2,148.1	6,708	195,479	$1,003,324	
2010	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,301,014
					Shoulder	2,864	14	0.79	122		16.7	[redacted]	[redacted]	29	495.4	188.0	5,479.4	22,938	668,492	$3,431,132	
					Winter	1,201	13	0.81	91		7.0	[redacted]	[redacted]	12	204.2	73.8	2,149.9	6,713	195,642	$1,004,160	
2011	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,451,415
					Shoulder	2,921	14	0.79	122		17.0	[redacted]	[redacted]	29	496.6	188.5	5,492.1	22,991	670,032	$3,439,037	
					Winter	1,225	13	0.81	91		7.1	[redacted]	[redacted]	14	233.1	84.2	2,455.0	7,666	223,404	$1,146,656	
2012	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,645,341
					Shoulder	2,980	14	0.79	122		17.4	[redacted]	[redacted]	31	524.6	199.1	5,801.8	24,288	707,815	$3,632,963	
					Winter	1,250	13	0.81	91		7.3	[redacted]	[redacted]	14	233.1	84.2	2,455.0	7,666	223,404	$1,146,656	
2013	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,645,341
					Shoulder	3,039	14	0.79	122		17.7	[redacted]	[redacted]	31	524.6	199.1	5,801.8	24,288	707,815	$3,632,963	
					Winter	1,275	13	0.81	91		7.4	[redacted]	[redacted]	14	233.1	84.2	2,455.0	7,666	223,404	$1,146,656	

2014	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,847,173
					Shoulder	3,100	14	0.79	122		18.1		33	553.7	210.1	6,124.1	25,637	747,138	$3,834,794	
					Winter	1,300	13	0.81	91		7.6		14	233.1	84.2	2,455.0	7,666	223,404	$1,146,656	
2015	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,847,173
					Shoulder	3,162	14	0.79	122		18.4		33	553.7	210.1	6,124.1	25,637	747,138	$3,834,794	
					Winter	1,326	13	0.81	91		7.7		14	233.1	84.2	2,455.0	7,666	223,404	$1,146,656	
2016	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$11,847,173
					Shoulder	3,225	14	0.79	122		18.8		33	553.7	210.1	6,124.1	25,637	747,138	$3,834,794	
					Winter	1,353	13	0.81	91		7.9		14	233.1	84.2	2,455.0	7,666	223,404	$1,146,656	
2017	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,192,336
					Shoulder	3,290	14	0.79	122		19.2		34	582.9	221.2	6,446.4	26,986	786,461	$4,036,626	
					Winter	1,380	13	0.81	91		8.1		15	262.3	94.8	2,761.9	8,624	251,330	$1,289,988	
2018	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,192,336
					Shoulder	3,356	14	0.79	122		19.6		34	582.9	221.2	6,446.4	26,986	786,461	$4,036,626	
					Winter	1,407	13	0.81	91		8.2		15	262.3	94.8	2,761.9	8,624	251,330	$1,289,988	
2019	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,192,336
					Shoulder	3,423	14	0.79	122		20.0		34	582.9	221.2	6,446.4	26,986	786,461	$4,036,626	
					Winter	1,435	13	0.81	91		8.4		15	262.3	94.8	2,761.9	8,624	251,330	$1,289,988	
2020	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,394,167
					Shoulder	3,491	14	0.79	122		20.4		36	612.0	232.3	6,768.7	28,336	825,784	$4,238,457	
					Winter	1,464	13	0.81	91		8.5		15	262.3	94.8	2,761.9	8,624	251,330	$1,289,988	
2021	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,394,167
					Shoulder	3,561	14	0.79	122		20.8		36	612.0	232.3	6,768.7	28,336	825,784	$4,238,457	
					Winter	1,493	13	0.81	91		8.7		15	262.3	94.8	2,761.9	8,624	251,330	$1,289,988	
2022	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,595,999
					Shoulder	3,632	14	0.79	122		21.2		38	641.1	243.3	7,091.0	29,685	865,107	$4,440,288	
					Winter	1,523	13	0.81	91		8.9		15	262.3	94.8	2,761.9	8,624	251,330	$1,289,988	
2023	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,739,331
					Shoulder	3,705	14	0.79	122		21.6		38	641.1	243.3	7,091.0	29,685	865,107	$4,440,288	
					Winter	1,554	13	0.81	91		9.1		17	291.4	105.3	3,068.7	9,582	279,256	$1,433,320	
2024	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,748,245
					Shoulder	3,779	14	0.79	122		22.0		38	642.4	243.8	7,105.3	29,745	866,844	$4,449,202	
					Winter	1,585	13	0.81	91		9.2		17	291.4	105.3	3,068.7	9,582	279,256	$1,433,320	
2025	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,941,162
					Shoulder	3,855	14	0.79	122		22.5		39	670.3	254.4	7,413.4	31,034	904,430	$4,642,120	
					Winter	1,616	13	0.81	91		9.4		17	291.4	105.3	3,068.7	9,582	279,256	$1,433,320	
2026	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$12,941,162
					Shoulder	3,932	14	0.79	122		22.9		39	670.3	254.4	7,413.4	31,034	904,430	$4,642,120	
					Winter	1,649	13	0.81	91		9.6		17	291.4	105.3	3,068.7	9,582	279,256	$1,433,320	
2027	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$13,115,999
					Shoulder	4,010	14	0.79	122		23.4		41	699.4	265.4	7,735.7	32,384	943,753	$4,843,951	
					Winter	1,682	13	0.81	91		9.8		17	285.9	103.3	3,010.9	9,402	273,996	$1,406,326	
2028	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$13,143,591
					Shoulder	4,090	14	0.79	122		23.9		41	699.4	265.4	7,735.7	32,384	943,753	$4,843,951	
					Winter	1,715	13	0.81	91		10.0		17	291.6	105.3	3,070.0	9,586	279,372	$1,433,918	

2029	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$13,488,157
					Shoulder	4,153	14	0.79	122		24.2	[redacted]	43	728.6	276.5	8,058.0	33,733	983,076	$5,045,782	
					Winter	1,750	13	0.81	91		10.2	[redacted]	19	320.6	115.8	3,375.6	10,541	307,181	$1,576,652	
2030	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$13,488,157
					Shoulder	4,153	14	0.79	122		24.2	[redacted]	43	728.6	276.5	8,058.0	33,733	983,076	$5,045,782	
					Winter	1,785	13	0.81	91		10.4	[redacted]	19	320.6	115.8	3,375.6	10,541	307,181	$1,576,652	
2031	17	35	100	$149.58	Summer	4,153	16	0.75	153	171	24.2	[redacted]	43	728.6	300.0	8,742.9	45,900	1,337,657	$6,865,722	$13,488,157
					Shoulder	4,153	14	0.79	122		24.2	[redacted]	43	728.6	276.5	8,058.0	33,733	983,076	$5,045,782	
					Winter	1,820	13	0.81	91		10.6	[redacted]	19	320.6	115.8	3,375.6	10,541	307,181	$1,576,652	
Total																				###########

Notes:

A maximum cap is assumed for transit system peak hour demand, based on the estimated summer demand in the year 2010.

System assumptions: 3 stops on route, 1-10-min. headway between buses.

* Travel time includes stops.

** Bus capacity includes seated plus standing passengers.

*** O&M costs are shown in current dollars, with no provision for inflation. Based on regional O&M costs estimated using factors from transit bus properties consisting of 25-800 buses in the southwestern region of the U.S. The O&M costs were applied to a bottom-up estimate of the site-specific operation proposed for use at the Grand Canyon.

Equivalent Peak Hour Utilization is estimated based on: summer - 8 hrs.@100% & 8 hrs.@50% utilization; shoulder - 8 hrs.@100% & 6 hrs.@50% utilization; winter - 8 hrs.@100% & 5 hrs.@50% utilization.

ftcomp3.wk4 revised 12/18/98

OPTION V
60' Diesel, Low-floor Articulated Transit Bus - With Dedicated Busway
Cost Estimate Summary
Based on Site-Specific O&M Cost Estimates

Component	Initial Cost Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016
Capital Cost Total*	$63,473,831	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Routine O&M Cost Total**	$9,654,668	$9,929,297	$10,032,094	$10,274,460	$10,549,089	$10,549,089	$11,025,549	$11,025,549	$11,301,014	$11,451,415	$11,645,341	$11,645,341	$11,847,173	$11,847,173	$11,847,173
Transit Bus System:															
- Bus Maintenance Facility	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
- Transit Fleet Vehicles	$0	$0	$0	$0	$0	$0	$0	$3,600,000	$0	$0	$0	$0	$0	$0	$0
Pavement Maintenance:															
- Bus Route Roads	$0	$0	$0	$0	$574,464	$0	$0	$0	$0	$574,464	$0	$0	$0	$0	$1,426,185
- Maint. Facility Pvmt.	$0	$0	$0	$0	$24,325	$0	$0	$0	$0	$24,325	$0	$0	$0	$0	$60,240
Major Maint. Cost Total	$0	$0	$0	$0	$598,789	$0	$0	$3,600,000	$0	$598,789	$0	$0	$0	$0	$1,486,425

* Additional 60' articulated bus purchases: yr. 2007 +3 buses; bus replacement schedule: yr. 2017 +35 buses, yr. 2022 +3 buses.

** Transit Bus O&M based on annual cost per hour. Based on regional O&M costs estimated using factors from transit bus properties consisting of 25-600 buses in the southwestern region of the U.S.

The O&M costs were applied to a bottom-up estimate of the site-specific operation proposed for use at the Grand Canyon.

Cost Summary**

Component	Initial Cost Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016
Capital Costs	$63,473,831	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Routine O&M Costs	$9,654,668	$9,929,297	$10,032,094	$10,274,460	$10,549,089	$10,549,089	$11,025,549	$11,025,549	$11,301,014	$11,451,415	$11,645,341	$11,645,341	$11,847,173	$11,847,173	$11,847,173
Major Maintenance Costs	$0	$0	$0	$0	$598,789	$0	$0	$3,600,000	$0	$598,789	$0	$0	$0	$0	$1,486,425
Total Costs by Year	$73,128,499	$9,929,297	$10,032,094	$10,274,460	$11,147,878	$10,549,089	$11,025,549	$14,625,549	$11,301,014	$12,050,204	$11,645,341	$11,645,341	$11,847,173	$11,847,173	$13,333,598

** All costs are shown in 1996 dollars, with no adjustment for inflation or interest.

Net Present Value Cost Summary***

Component	NPV Year 2002
Capital Costs	$68,040,651
Routine O&M Costs	###########
Major Maintenance Costs	$6,001,868
Total Costs (NPV)	###########

*** Costs shown represent Net Present Value, calculated using an annual discount rate of 7% for all future year expenditures.

sumcomp3.wk4 revised 12/22/98

Annual Cost Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2023	Year 2024	Year 2025	Year 2026	Year 2027	Year 2028	Year 2029	Year 2030	Year 2031	30-Year Totals
$12,600,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$76,073,831
$12,192,336	$12,192,336	$12,192,336	$12,394,167	$12,394,167	$12,595,999	$12,739,331	$12,748,245	$12,941,162	$12,941,162	$13,115,999	$13,143,591	$13,488,157	$13,488,157	$13,488,157	$356,679,727
$3,600,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,600,000
$0	$0	$0	$0	$0	$0	$0	$3,600,000	$0	$0	$0	$0	$0	$0	$0	$7,200,000
$0	$0	$0	$0	$574,464	$0	$0	$0	$0	$574,464	$0	$0	$0	$0	$0	$3,724,041
$0	$0	$0	$0	$24,325	$0	$0	$0	$0	$24,325	$0	$0	$0	$0	$0	$157,540
$3,600,000	$0	$0	$0	$598,789	$0	$0	$3,600,000	$0	$598,789	$0	$0	$0	$0	$0	$14,681,581

Annual Cost Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2023	Year 2024	Year 2025	Year 2026	Year 2027	Year 2028	Year 2029	Year 2030	Year 2031	30-Year Totals
$12,600,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$76,073,831
$12,192,336	$12,192,336	$12,192,336	$12,394,167	$12,394,167	$12,595,999	$12,739,331	$12,748,245	$12,941,162	$12,941,162	$13,115,999	$13,143,591	$13,488,157	$13,488,157	$13,488,157	$356,679,727
$3,600,000	$0	$0	$0	$598,789	$0	$0	$3,600,000	$0	$598,789	$0	$0	$0	$0	$0	$14,681,581
$28,392,336	$12,192,336	$12,192,336	$12,394,167	$12,992,956	$12,595,999	$12,739,331	$16,348,245	$12,941,162	$13,539,951	$13,115,999	$13,143,591	$13,488,157	$13,488,157	$13,488,157	$447,435,139

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