Alternative Transportation Modes
Feasibility Study

VISITOR TRANSPORTATION SYSTEM ALTERNATIVES

For National Park Units

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Volume I

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This study has been prepared by BRW, Inc., under the direction of the Branch of Transportation, Denver Service Center, National Park Service. The study has been reviewed by the National Park Service and the U.S. Department of Transportation. Appropriate changes have been incorporated based on these reviews. NPS staff have provided assistance, review, and guidance during the course of the study.

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PURPOSE

Section 1050 of the Intermodal Surface Transportation Efficiency Act of 1991, Public Law 102-240, requested that a study be conducted of alternatives for visitor transportation in the national park system. Because of congressional intent and interest, the study used Denali National Park and Preserve and Yellowstone and Yosemite national parks as case study examples. Each of these park units has special transportation problems.

The major purpose of this study, as stated in the 1991 act, is to evaluate the following:

> 1. The economic and technical feasibility, environmental effects, projected costs, and benefits as compared to the costs and benefits of existing transportation systems, and general suitability of transportation modes that would provide efficient and environmentally sound ingress to and egress from national park lands; and
>
> 2. Methods to obtain private capital for the construction of such transportation modes and related infrastructure.

The study included an evaluation of specific alternatives to private vehicle travel in each of the three parks and a comprehensive inventory of transportation technologies that can serve visitor transportation needs within the national park system.

Transportation problems in the national park system are a cause for increasing concern. The issues leading to this study included the following:

- increasing traffic congestion in many park units, indicating a need for alternative transportation modes to enhance resource protection
- potential enhancement of the visitor experience and reduced vehicular congestion with the increased use of visitor transportation systems
- increasing rates of deterioration of park roads from increased traffic and age
- rapidly expanding roadway construction needs

The information presented in this study is intended for use in the initial evaluation and feasibility assessment of transportation alternatives in the national park system. More in-depth engineering and environmental impact analyses of specific conditions will be required to establish cost estimates for specific alternatives in individual park units. The unit costs presented in this report reflect typical conditions, which may not apply to a specific park unit.

PREFACE

The results of the *Alternative Transportation Modes Feasibility Study* are presented in four separate volumes. This volume, Volume I, presents:

- an overview of transportation conditions in the national park system

- guidelines for identifying the most suitable transportation solutions for recreational transportation needs in individual park units,

- a recommended project development approach for implementing visitor transportation systems (VTS) in units of the national park system

- a discussion of the need for definitive National Park Service (NPS) policies regarding alternative transportation modes and increased funding levels for both park roads and visitor transportation systems

- an inventory of transportation technologies that are considered to be appropriate for use in park settings

Volumes II, III, and IV of the study present the results of evaluations of alternative transportation systems for Denali, Yellowstone, and Yosemite national parks, respectively.

Throughout the *Alternative Transportation Modes Feasibility Study*, only those transportation technologies that have been proven in everyday use have been discussed in detail. This volume also identifies emerging technologies that show the greatest promise for future application in the national park system. As these and other new technologies are developed and proven, a broader range of options may be available for use in parks units.

The study has concentrated on transportation within and near parks. The transportation of visitors to park units from remote locations was not considered directly during this study. However, the National Park Service recognizes the value of integrating the planning of transportation systems within the parks with the efforts of surrounding communities to address transportation issues. Visitor transportation systems in the parks must respond to transportation requirements that will vary depending on visitors' means of traveling to the parks.

Undoubtedly, many opportunities will be available to enhance the economic development potential of gateway communities and to reduce the impacts of transportation on park resources by providing innovative transportation systems based in the gateway communities. Such systems could be extensions of or complements to internal visitor transportation systems. A cooperative approach to visitor access and internal park transportation could enhance efforts to preserve regional ecosystems as well as improve the overall quality of visitors' experiences in national parks.

The movement of visitors to and between attractions within parks accounts for the majority of travel within the national park system. Consequently, this study concentrated on the question of how to best serve the transportation needs of visitors. Frequently, the transportation of park service and concessioner employees also is an issue, especially at the larger park units. Specific planning efforts in individual units of the National Park System should explore the opportunity to address both visitor and employee transportation needs with alternative transportation systems. The ability to serve both groups of travelers with a single system will depend to a great extent on the location of employee housing, an issue that is outside the scope of this study.

Transportation planning for national parks is but one element of a complete and systematic planning process that is conducted to determine the future of the nationally significant areas that have been set aside as units of the national park system. As urban planning professionals have recognized that effective land use and transportation decisions cannot be made independently, recreation planners and park planners and managers have increasingly embraced the idea of coordinated planning for resource management, visitor facilities, and transportation systems. Transportation systems in national parks play a crucial role determining the quality of visitors' experiences in the parks and have a strong influence on resource preservation.

In developing transportation alternatives for specific units of the national park system, planners and managers should consider how those alternatives can best support the broader purpose and values of the Park Service and the individual park.

For the purpose of this report the terms park and park unit are defined as all types of units managed by the National Park Service.

Increases in visitation, insufficient funds for park operations, and inadequate resources for needed roadway improvements have strained the National Park Service's ability to fulfill its dual responsibilities of stewardship of park unit resources and provision for visitor enjoyment and learning. Inadequate transportation systems within the nation's park units reduce the quality of visitors' experiences, expose visitors to potentially unsafe conditions, and increase the potential for unacceptable environmental and resource impacts.

TRANSPORTATION FUNDING

With few exceptions, travel by private vehicle is the only means of getting to and moving within NPS units. As a result, some of the most conspicuous problems in units of the National Park System with high visitation levels stem from an inability to accommodate growing volumes of traffic and spiralling demand for visitor parking.

As visitation levels have increased, the Park Service's core operational budget has remained essentially level since 1983.[1] Funding for maintaining park roads and for operating visitor transportation systems must compete with other operating needs for these limited funds.

While operating and maintenance funding has been scarce, an equally serious shortage of roadway improvement funds exists; a 1990 study identified a $1.6 billion backlog of required roadway improvements on the existing system of park roads and a need for $100 million per year to prevent further deterioration of the park road system.[2] Park road funding has consistently been below the level required to maintain park roads in their current condition. As a result, the backlog of needed improvements has grown. Figure ES-1 shows that park road improvement funding of at least $160 million per year will be required beyond 1998 to reverse the trend of worsening NPS road conditions.

NPS VISITOR TRANSPORTATION SYSTEMS

While travel by private vehicle serves most visitor transportation needs, some parks have transportation systems offering an alternative means of access to certain park resources. Since 1971, the number of NPS-managed transportation systems has grown to some 25 systems in 12 parks. Also, vehicular transportation services are provided by concessioners in 23 park units. Some of these systems play a vital role in providing access and circulation within heavily used areas of the parks. For example, the Yosemite Valley shuttle now serves an average of 25,000 passenger boardings daily during the peak summer months and provides vital visitor circulation functions on a year-round basis.

The success of existing visitor transportation systems indicates the potential for an expanded role for transit in addressing transportation needs and resource protection in the nation's parks. Faced with physically and functionally deficient transportation facilities, and recognizing the negative environmental consequences of continued reliance on the private vehicle as the primary means of visitor transportation in some parks, the National Park Service undertook this study to identify alternative transportation modes that might be used in the national park system.

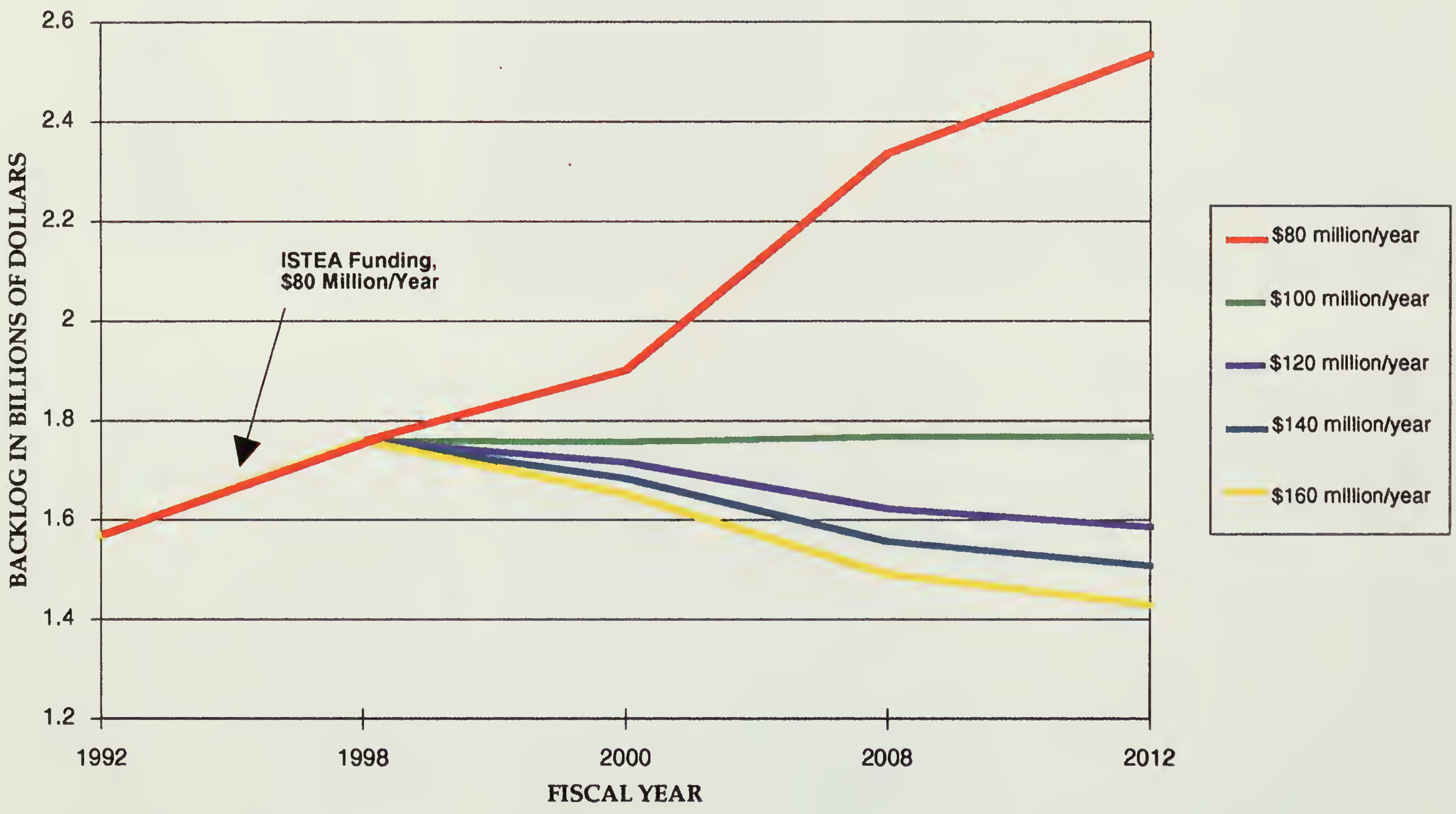
NPS TRANSPORTATION POLICY

This study identified several problems with current NPS transportation policy, planning procedures, and funding:

- There is limited and outdated information on existing roadway conditions, functional deficiencies, and VTS equipment, services, costs, and ridership.

Figure ES-1: Roadway Reconstruction Needs

NPS Public Paved Roads and Parkways



- Although there is overall policy to provide visitor transportation systems in park system units, there are a lack of guidelines for determining the appropriate roles for private vehicles and VTS solutions in meeting transportation needs in the parks. Currently, the tendency is to use transit only to reduce congestion or avoid roadway expansion. VTS solutions offer other potential benefits, including enhanced visitor experiences and reduced impacts on natural and cultural resources.

- Comprehensive VTS planning guidelines that use knowledge gained at park units with VTS systems, and encourage a professional approach to identifying service levels, equipment needs, support facility requirements, and ridership on a multimodal basis are needed.

- The concept of integrated planning for visitor use, NPS and concession facilities, resource preservation, and transportation needs to be embraced.

- Quantitative data on visitor use patterns to support effective transportation planning is lacking.

- There is a need for increased coordination with gateway communities in solving transportation problems and providing for visitor services.

- Guidelines that establish program responsibilities and direction for procuring VTS equipment and services and system monitoring need to be formulated.

- There are limited means of evaluating roadway investment priorities and no method of evaluating VTS requirements based on identified transportation needs.

- Funding is not adequate to support development of visitor transportation systems or maintenance of park roads.

Of all the problems, the lack of a program to provide adequate funding is the single largest obstacle to meeting existing and future transportation needs in park units. A funding source that would afford flexibility in meeting transportation needs at individual parks through a combination of roadways for private vehicular use, visitor transportation systems, bike facilities, pedestrian walkways, and provisions for other appropriate modes of transportation would most effectively meet existing and future needs.

A new NPS visitor transportation program that addresses transportation needs with multimodal solutions is recommended. The elements of a new program would include the following:

- policy guidance
- planning guidelines
- procurement standards
- programming guidelines
- program responsibilities including staffing requirements
- funding
- monitoring and reporting systems

This report provides a framework for the development of an expanded NPS transportation program that would build upon the transportation planning guidelines in NPS-2, the *Planning Process Guideline*.

VISITOR TRANSPORTATION CHARACTERISTICS AND NEEDS

Transportation to and within national park units is distinct from the urban travel patterns that are the focus of most transportation planning efforts. Some of the unique aspects of visitor transportation which need to be considered in planning VTS solutions include:

- the desired character and quality of visitor experiences

- the location, resource carrying capacity, and visitor use capacity of major park features

- the characteristics of visitors, including group size, nationality, age, and participation in organized tour groups

- mode of arrival (auto, recreational vehicle, tour bus, train, air)

- broader travel itinerary (trips through parks versus in and out of the same entrance)

- primary activity (sightseeing, camping, fishing, climbing)

- trip types (sightseeing, access to activities and resources, housekeeping)

Over the past three to four decades, the private vehicle has developed into a travel mode which offers users most of the service characteristics that are desirable for recreational travel. In many park settings, travel by private vehicle is appropriate as the primary means of visitor circulation.

To park visitors, travel by private vehicle becomes less attractive as use becomes concentrated and delays result from congestion due to inadequate roadway capacity and from a lack of convenient parking near park resources. One response to the undesirable consequences of concentrated use is to expand facilities to accommodate the increased demand. However, at some point this approach will begin to conflict with the mandate to preserve park resources in their unaltered state and provide a quality visitor experience. High volumes of private vehicular travel also contribute to poor air quality, an increase in noise levels, and an intrusion of urban conditions into pristine settings.

The development of a visitor transportation system is another potential response to conditions that make unrestrained private vehicular travel undesirable. Mandatory and voluntary systems have been implemented in national park units, as have hybrids between the two extremes.

In using an alternative transportation system, visitors must compromise on some service characteristics, such as convenience, freedom, flexibility, and privacy; but many of these desirable qualities of private vehicular travel are already compromised if travel demand is high enough to cause congestion. Well conceived VTS services can provide much better viewing opportunities (especially for the private vehicle driver whose attention must be focused on the task of driving) and interpretation of the resources being viewed. By alleviating congestion and the frustration resulting from overcrowded parking facilities, a transportation system can result in better service than individual travel in private vehicles. The most important requirement for a system which provides convenient service that can compete with private vehicular transportation is a large enough concentration of potential riders and a convenient, secure, and efficient location to accomplish the required transfer from the private vehicle to the transportation system.

VISITOR TRANSPORTATION SYSTEM PLANNING AND DEVELOPMENT

A VTS planning process for national park units, should provide a clear understanding of the problems to be solved, identify viable alternatives to be considered, evaluate the alternatives against a range of criteria, select a preferred transportation strategy, and develop an implementation plan.

After the planning process has been completed, more detailed alternatives analysis to make specific technology and alignment decisions, preliminary engineering, environmental documentation, final design, and construction and operations plans will need to be undertaken.

A range of implementation strategies can be used to complete the final design and construct visitor transportation systems once preliminary engineering has been completed. A traditional approach would involve completion of final design under NPS supervision and development of several construction bid packages that would be advertised and bid upon individually by construction companies and suppliers. More innovative techniques that combine some or all final design work with construction work into fewer bid packages could also be used. The preferred strategy should be selected after an evaluation of the cost, quality, schedule, risk, and degree of NPS control offered by each approach.

VISITOR TRANSPORTATION SYSTEM TECHNOLOGY OPTIONS

A wide range of transit technologies are available for use in national park system units. This report provides an inventory of transit options organized into the following categories:

- Bus Transit - These systems can use existing park roads, parking areas, and interpretive waysides. They include various buses as well as van conversions and towed trailers.

- Rail Transit Systems - These systems require installation of conventional tracks to guide the vehicles. Technologies appropriate for use in parks included in this category are systems built at-grade, including light rail transit or trolley systems and self-propelled vehicles.

- Guideway Systems - These systems require a specially designed guideway for vehicle support and guidance. These technologies are typically used in systems that are separated from traffic and pedestrians. In parks, these systems would most likely be built on elevated structures. Examples of this category include group rapid transit and people movers. Monorail technology is a variation of group rapid transit or people mover technology.

- Special Purpose Systems - These systems are designed to transport passengers in rough or mountainous terrain and include funiculars, aerial tramways, and cog railroads.

- Waterborne Transit - These options include a variety of small- to medium-sized boats.

- Emerging Technologies - These systems are currently undergoing research and development and show promise for future use in parks. Personal rapid transit is an example of an emerging technology.

The characteristics of transit modes presented in this report will assist park planners and managers in the initial evaluation and feasibility analysis of VTS alternatives. VTS planning at specific park units should consider location and situation-specific conditions that could affect the performance and cost of the alternatives.

VTS options have proven to be effective in meeting specialized visitor transportation needs in park settings. The results of the *Alternative Modes Feasibility Study* at Denali, Yosemite, and Yellowstone, and the results of transportation planning efforts at other park units, indicate that visitor transportation systems can play an expanded role at congested park units and in areas where private vehicular transportation could result in unacceptable resource impacts and visitor experiences.

The most pressing need with respect to transportation in the nation's parks is a level of funding adequate to reverse the trend of declining physical conditions on park roads and increasing functional deficiencies of roads and VTS services. The preliminary findings of this study indicate an annual funding need of at least $160 million for road improvements and up to $70 million for visitor transportation systems in the national park system. This level of funding would allow the Park Service to begin reducing the backlog of roadway funding needs, reversing the trend toward worsening roadway physical conditions and increasing maintenance costs, and reducing the negative impacts of vehicular travel in some of the more congested parks.

INTRODUCTION

The National Park Service was established on August 25, 1916, with the following charge:

> The service thus established shall promote and regulate the use of the federal areas known as national parks, monuments and reservations...by such means and measures as conform to the fundamental purpose of said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.[3]

Conflict between the dual responsibilities of providing for visitor enjoyment and conserving the unique resources found in the national park units has always existed. In recent years the challenge of balancing stewardship of park resources against the pressure for more public access has become considerably more difficult. Sharp increases in visitation to the park system's 370-plus units, a 25% increase between 1983 and 1990, have strained the Park Service's ability to provide a meaningful and pleasant visitor experience while preserving those special qualities that draw visitors and distinguish units of the national park system from other recreational areas.

With few exceptions, travel by private vehicle is the only means of getting to and moving within national park units. As a result, some of the most conspicuous problems in units of the park system with high visitation levels stem from an inability to accommodate growing volumes of traffic and spiralling demand for visitor parking. In addition, growth in private vehicular traffic has resulted in an increasing need to assign staff to traffic control and enforcement. Continued reliance on the private vehicle as the primary means of transportation also threatens the fragile ecosystems in some high-use areas within the park system.

As visitation levels have increased, the Park Service's core operational budget has remained essentially level since 1983.[4] Funding for maintaining park roads and operating visitor transportation systems must compete with other operating responsibilities for these limited funds.

While operating and maintenance funding has been scarce, an equally serious shortage of roadway improvement funds exists; a 1990 study identified a $1.6 billion backlog of required roadway improvements on the existing system of park roads, and a need for $100 million per year to prevent further deterioration of the park road system.[5]

The Intermodal Surface Transportation Efficiency Act of 1991 provides for an annual expenditure level of approximately $80 million for existing park roads, which results in approximately $60 million in actual roadway construction. This level of funding will not provide the resources needed to meet road system requirements and will result in continuing deterioration of park roads. At the current level of funding, the backlog of needed roadway rehabilitation is projected to reach $2.5 billion by 2010. The proportion of park roads in poor or failed conditions will continue to increase, resulting in unpleasant and unsafe driving conditions for visitors. Routine maintenance costs will increase as roads continue to deteriorate, potentially diverting annual operating funds from other critical needs.

Although park road maintenance and rehabilitation needs are substantial, the physical condition of the park roads is only part of the problem faced by the Park Service. Park road systems do not provide adequate capacity to handle peak season weekend traffic volumes in many high use locations, such as the South Rim of Grand Canyon, Yosemite Valley, and Great Smoky Mountains National Park. Recent trends indicate that the demand for visitation will continue to grow at sites throughout the park system and that the number of parks with serious congestion problems will increase.

Throughout the park service, there is a growing awareness that some park resources and a number of visitor support facilities are reaching their practical carrying capacities. A combination of improved or expanded facilities and visitor use management with careful attention given to resource protection will be required for the Park Service to fulfill the mandate of its enabling legislation in the coming years.

Although travel by private vehicle serves most visitor transportation needs, some parks have visitor transportation systems offering an alternative and, in some cases, the only means of access to certain park resources. The first NPS visitor transportation system was implemented in 1971 at Yosemite National Park. Since then, the number of NPS-managed visitor transportation systems has grown to some 25 systems in 12 parks. Vehicular transportation services are provided by concessioners in 23 park units - ranging from the largest systems in Yosemite National Park, Denali National Park and Preserve, Grand Canyon National Park, and the Monumental Core area of Washington, D.C., to small systems transporting visitors between lodges and other specialized concession activities. A combination of concessioner and NPS-operated services operates on the Denali Park Road.

Waterborne transportation, boat rentals, and river rafting are offered by concessioners in 35 park units. These operations also cover a range of passenger volumes, from the large system at the Statue of Liberty to numerous small launches and boat rental concessions. Waterborne systems provide the only means of visitor access to some park units.

With a few exceptions, the land-based visitor transportation systems operated in the national park system employ buses or converted vans to move passengers over park roads. Some of these systems play a vital role in providing access and circulation within heavily used areas of the parks. For example, the Yosemite Valley Shuttle serves an average of 25,000 passenger boardings daily during the peak summer months and provides visitor circulation functions on a year-round basis.

The success of existing visitor transportation systems indicates the potential for an expanded role for transit in addressing transportation needs in the nation's parks. Faced with physically and functionally deficient transportation facilities, and recognizing the negative environmental consequences of continued reliance on private vehicles as the primary means of visitor transportation in some parks, the National Park Service has undertaken this study to identify alternative transportation modes that may be useful in the national park system. Consideration of the full range of proven and appropriate technologies has been included in this study. Ongoing transit technology research and development activities that may expand the range of potential transportation solutions in the parks also have been identified.

Increasing visitation and a recent history of deferred maintenance and delays of needed repairs to transportation facilities in the parks have created serious transportation problems in the national park system. The poor condition and inadequate capacity of transportation facilities are detrimental to visitors' experiences in the parks and can result in hazardous conditions.

The National Park Service does not have the appropriate policy framework, or adequate program funding to address transportation needs in the nation's parks. A multimodal transportation policy and an accompanying program for identifying, prioritizing, funding, and implementing transportation improvements in park units are needed to address demands that grow more serious each year. Currently, transportation needs are met through an underfunded roadway improvement program, some operating funds of individual park units and, to some degree, the NPS line item construction program.

FEDERAL LANDS HIGHWAY PROGRAM

The worsening condition of road infrastructure in the U.S. has been a subject of national attention. Despite an 83% increase in expenditures on roadway construction nationwide since 1983, improvements have not kept pace with needs. Over the same period, NPS road improvement funding availability and spending have varied widely on a year-to-year basis, but have not increased. The current funding level is lower than the 1984 levels. The result has been steady growth in the backlog of needed repairs to park roads.

Since 1983, funding for rehabilitation of the Park Service's 5,150-mile system of paved primary roads has been provided through the Federal Lands Highway Program administered by the Department of Transportation. Funding levels have fluctuated from $75 million in 1983, to $100 million in each year from 1984 through 1986, to less than $60 million per year from 1987 through 1991. The Intermodal Surface Transportation Efficiency Act provides the Federal Lands Highway Program with about $80 million per year for road improvements in the National Park System through 1997.

Roadway funding allocations are based on a multi-year program of road improvement projects developed at the national level through consultation with NPS regional management.

ROADWAY FUNDING NEEDS

Visits to park units have risen sharply since 1983, but the NPS core operating budget (from which routine roadway maintenance and traffic services are funded) has remained flat in real terms. Road improvement funding has been even more limited, declining since 1983 considering the effects of inflation. Deferred road improvements have placed increasing stress on park operating funds, because roads in poor and failed condition require more frequent maintenance and minor repairs.

Figure 1 shows a forecast of road construction needs at varying levels of annual expenditure. The $80 million annual authorization provided in the Intermodal Surface Transportation Efficiency Act will not allow the Park Service to keep pace with expanding road investment needs, and will result in a 12% increase in the backlog of roadway improvement needs from 1992 to 1998. In order to substantially reduce the backlog below its 1992 level by the year 2012, at least $160 million per year will need to be provided for park road improvements beyond 1997.

Figure 1: Roadway Reconstruction Needs

NPS Public Paved Roads and Parkways

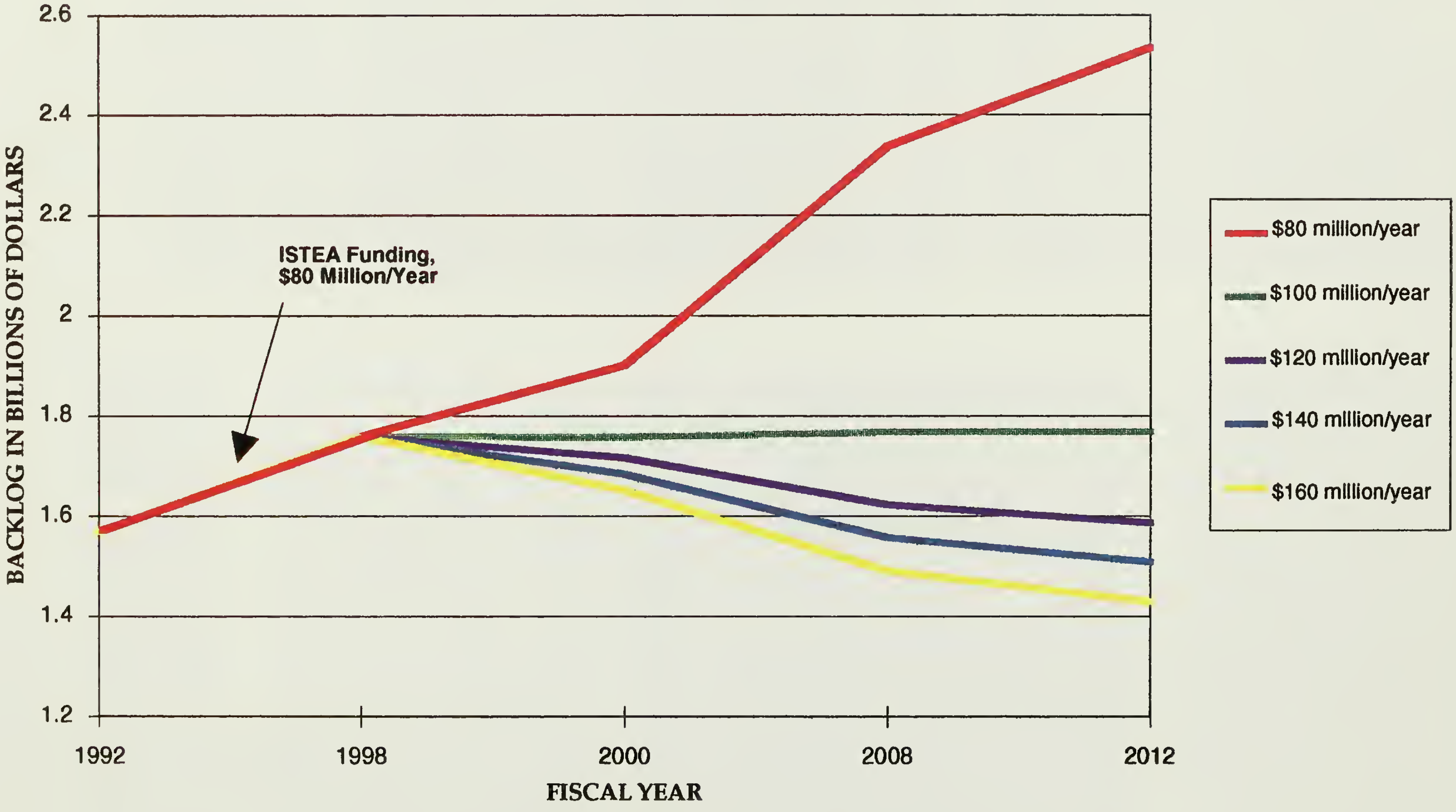


Table 1: Roadway Improvement Expenditures by States and The National Park Service

	Fifty States	Idaho	Nevada	Utah	Average of Three States	National Park Service
Miles of Roads	798,488	5,119	5,220	5,795	5,378	5,150
Annual Highway Construction, Engineering and Administrative Costs (millions)	26,780	120.6	93.5	181.9	132.0	80.0
Expenditure Per Mile of Road	33,540	23,560	17,910	31,390	24,540	15,534

Source: 1991 highway statistics, Federal Highway Administration; NPS Statistics

Visible evidence of the shortfall in road funding is provided by the dramatic increase in the proportion of park roads in poor or failed condition. In 1990 about 33% of the nation's park roads fell into this category, compared to only 18% in 1981. Road failures will continue to increase until funding levels are boosted substantially.

Park road funding has traditionally been lower than that for state-administered roads. Table 1 shows a comparison of 1991 road spending for the nation as a whole and for three western states with road systems of a size similar to that of the National Park Service. The annual spending authorization for park roads provided in the Intermodal Surface Transportation Efficiency Act is less than half the national average expenditure for state road construction on a per-mile basis.

The states of Idaho, Nevada, and Utah have road systems with shares of urban and rural mileage similar to those for park roads and similar total system mileage. Of these three states, only Utah approaches the national average for road improvement expenditures. The average expenditure per roadway mile for these states is nearly 50% higher than the average for roads in the national park system.

The use of the national average of state road investments for park roads would result in a program of more than $160 million per year. To be comparable with highway investments in the selected western states, the NPS share of the Federal Lands Highway Program would need to be $120 million per year.

The forecasts of growth in the roadway improvement backlog and comparative data from state roadway programs suggest that to recover from an extended period of deferred maintenance and delayed roadway construction, the National Park Service should secure annual funding for road improvements of $160 million per year (in constant dollars) for a period of about 10 years, and a continuing funding level of $120 million per year.

The need for roadway improvements is not likely to decline, especially if added emphasis is given to alternative transportation modes for travel in congested park units. Even if alternative transportation modes can play a more important role in serving visitor transportation needs within these units, road improvement and maintenance will be required. In all but a few special cases, rubber-tired transit vehicles are likely to be the most appropriate mode for NPS units. These vehicles will require roads which are structurally equal to or better than those which now serve visitor travel in private vehicles.

EXISTING VTS OPERATIONS

Visitor transportation systems in national park units are operated by the Park Service and by concessioners. The Park Service operates transportation systems in the following 12 park units: Cape Cod National Seashore, Carl Sandburg Home National Historic Site, Denali National Park and Preserve, Dinosaur National Monument, Ft. Matanzas National Monument, Grand Canyon National Park, Harpers Ferry National Historic Park, Kennesaw Mountain National Battlefield Park, Lyndon B. Johnson National Historic Park, North Cascades National Park, Redwoods National Park, and Rocky Mountain National Park. The largest of these systems are at Grand Canyon National Park, which cost $840,000 to operate in 1992, and Denali National Park and Preserve, which cost $1.7 million.

Vehicular transportation services are provided by concessioners in 23 park units. Concessioner systems range from large systems providing general visitor transportation in Yosemite National Park, Denali National Park and Preserve and the Monumental Core area of Washington, D.C., to small systems providing specialized services to a limited number of visitors at other park units. Denali National Park and Preserve is unique in its dependence on two mandatory VTS operations as the primary means of visitor access during certain periods of the year.

Waterborne visitor transportation systems, boat rentals, and river running expeditions are operated by concessioners at 35 park units. The Statue of Liberty ferry system is one of the larger waterborne systems serving a national park unit. Many of the remaining units have very small concession operations offering water transportation or boat rental.

Because of the lack of a servicewide VTS program, consolidated cost and ridership data is not available for NPS or concession VTS operations. Most NPS funding for these systems goes to Denali National Park and Preserve and the West Rim and village shuttles at Grand Canyon National Park.

EXISTING VTS POLICY

Current NPS policy is to provide visitor transportation services (transit systems) within selected park areas wherever such systems are deemed a desirable alternative to the construction of additional roads and parking and support facilities in prime resource areas and where these services will improve the visitor experience.

Chapter 9, Section 9 of the National Park Service *Management Policies* states the following:

> A decision to provide visitor transportation services will be based on a determination that the following criteria are met:
>
> The system is a cost-effective alternative to the construction of additional roads, parking areas and support facilities.
>
> The system will enhance the visitor experience by offering new or improved interpretive opportunities, simplifying travel within the park, or making it easier to see park features.
>
> The system will reduce traffic congestion, noise, air pollution and adverse effects on park resources and values.
>
> The system will conserve energy.
>
> All alternative modes of transportation may be considered conceptually. However, consideration of any mode of transportation that requires the construction of surface or elevated trackage, suspended cables, or advanced technologies will not go beyond a conceptual status without approval from the Director. Considering economic and environmental factors, any mode of transportation other than a system using rubber-tired vehicles operating on existing roads for land transportation or using standard displacement boats for water-borne systems would have to be uniquely advantageous to warrant its use to supplement or replace an existing system.

> The National Park Service will work with other federal and state agencies, local and regional planning bodies, citizen groups and others to promote public transportation systems for park access and circulation and to encourage the use of public transportation wherever feasible.

Regarding accessibility for persons with disabilities, Chapter 9, Section 3 states:

> Transportation systems in parks will have a sufficient percentage of fully accessible vehicles to provide effective service to disabled persons. On existing systems, the necessary vehicles will be provided on a replacement or retrofit basis. Until the transportation system has been made fully accessible, a separate accessible vehicle will be provided or disabled persons will be allowed to drive their personal vehicles on otherwise restricted roadways. No new roads will be developed for the sole purpose of providing disabled access to a given area. However, within the existing road system, efforts will be made to provide for specialized transportation needs. Water transportation systems will be as accessible as the areas being served by the systems. Every effort will be made to provide full access to scenic cruise vessels.

Accessibility to all public facilities and transportation systems is now governed by the Americans with Disabilities Act. The U.S. Department of Transportation has developed regulations and guidelines for transit vehicles and transit facilities and for paratransit services that are complementary to regular fixed-route transit service. The development and operation of transit systems in the national park system will be subject to the Americans with Disabilities Act implementing regulations.

The implementation of VTS operations within the national park system is subject to the provisions of the National Environmental Policy Act (NEPA) and other laws and NPS directives. Options that involve construction or reconstruction require environmental documentation.

CURRENT VTS FUNDING

Existing NPS visitor transportation systems are funded by various means, including user fees, surcharges on other visitor goods and services provided by concessioners, and annual appropriations as part of a park's operating budget. No specific NPS policy currently exists regarding funding of VTS equipment, facilities, or operations, and no program has been established to set aside funds for VTS development.

The purchase of capital equipment for VTS operations is funded in a similarly diverse manner. In Yosemite National Park, the Park Service owns the vehicles that are operated by the park concessioner. The equipment used in the major VTS operations is aging and will need replacement within the next few years. Systems with acute equipment replacement needs include the West Rim shuttle system at Grand Canyon and the Yosemite Valley shuttle system.

VTS PROGRAM NEEDS

Visitor transportation systems play a vital role in visitor access and circulation at several park units, including Grand Canyon, Denali, and Yosemite.

At the Grand Canyon, an aging vehicle fleet, visitation growth, and a need to reduce the impact of private vehicle use have all been considered in estimates of VTS investment needs. As much as $34 million in capital improvements and equipment funding and $6.3 million in annual operating and maintenance resources will be needed to meet projected visitor demand at Grand Canyon.

The *Alternate Modes Feasibility Study* for Denali, Yellowstone, and Yosemite has identified viable VTS options for each park. For Denali National Park and Preserve, identified alternatives range from $21 million to more than $480 million in capital costs and from $0.7 million to $4.2 million in annual operating costs.

The *General Management Plan* (GMP) for Yosemite calls for a major reduction in automobile traffic in the congested Yosemite Valley. The already overcrowded system of shuttle buses serving Valley visitors will be called upon to carry substantially more visitor trips over longer distances if the GMP goals are to be achieved. VTS capital investments ranging from $31.6 million to $460 million will be required, depending on whether a fixed guideway alternative is implemented in Yosemite Valley. Operating costs between $5 million and $8 million per year can be expected. The present system of funding Yosemite VTS operations through surcharges on concession goods and services places an inordinate amount of the burden for paying for VTS operations on overnight visitors. If day use visitor traffic to the valley is transferred to a visitor transportation system, the cost may be too high and the inequities too great to continue to use surcharges as the only method of funding the transit system.

Several VTS options have been identified at Yellowstone National Park during this study. As with the other parks, substantial investments in vehicles and facilities would be required to bring new systems into operation at Yellowstone, along with a commitment to fund ongoing operation and maintenance expenses.

Ongoing transportation studies in other park units indicate that investments in VTS options will be justified in an increasing number of areas. Considering the ongoing major needs at Denali, Grand Canyon, and Yosemite, the VTS system enhancements and expansions identified in this and other studies for these three parks, and a variety of potential projects at other parks, servicewide annualized capital and operating costs of VTS systems could amount to $70 million. Annualized funding requirements will be even higher if the most costly fixed guideway transit solutions are chosen at Denali, Yosemite, or Yellowstone.

NPS TRANSPORTATION PROGRAM ISSUES

The Park Service is unable to adequately address existing transportation needs or respond to the demands associated with increasing visitation and a growing need to better manage visitor use of and movement within parks. Problems with the current situation include the following:

- There is limited and outdated information on existing roadway conditions, functional deficiencies, and VTS equipment, services, costs, and ridership.

- Although there is overall policy to provide visitor transportation systems in park system units, there are a lack of guidelines for determining the appropriate roles for private vehicles and VTS solutions in meeting transportation needs in the parks. Currently, the tendency is to use transit only to reduce congestion or avoid roadway expansion. VTS solutions offer other potential benefits, including enhanced visitor experiences and reduced impacts on natural and cultural resources.

- Comprehensive VTS planning guidelines that use knowledge gained at park units with VTS systems, and encourage a professional approach to identifying service levels, equipment needs, support facility requirements, and ridership on a multimodal basis are needed.

- The concept of integrated planning for visitor use, NPS and concession facilities, resource preservation, and transportation needs to be embraced.

- Quantitative data on visitor use patterns to support effective transportation planning is lacking.

- There is a need for increased coordination with gateway communities in solving transportation problems and providing for visitor services.

- Guidelines that establish program responsibilities and direction for procuring VTS equipment and services and system monitoring need to be formulated.

- There are limited means of evaluating roadway investment priorities and no method of evaluating VTS requirements based on identified transportation needs.

- Funding is not adequate to support development of visitor transportation systems or maintenance of park roads.

Of all the problems, the lack of a program to provide adequate funding is the largest obstacle to meeting existing and future transportation needs in park units. A funding source that would afford flexibility in meeting transportation needs at individual parks through a combination of roadways for private vehicle use, visitor transportation systems, bike facilities, pedestrian walkways, and provisions for other appropriate modes of transportation would most effectively meet present and future needs.

ELEMENTS OF A NEW NPS TRANSPORTATION PROGRAM

This section provides an outline of a multi-modal visitor transportation program for the National Park Service. The elements of such a program should include:

- monitoring and reporting systems
- policy guidance
- planning guidelines
- procurement standards
- programming guidelines
- program responsibilities
- funding

Monitoring and Reporting Systems

The Intermodal Surface Transportation Efficiency Act mandates the development of pavement, bridge, and safety management systems for the roads under NPS jurisdiction. These systems will provide the initial elements of a comprehensive data base on the physical condition of park roads. In urban areas, companion data bases addressing the functional adequacy of roadway systems, known as congestion management systems, are being developed. These systems could provide a model for a NPS management system for congested roadways. The NPS congestion management system could focus on those parks with high visitation levels and congestion or visitor management problems.

For VTS operations, a centralized source of information would assist the Park Service in determining the cost-effectiveness of existing systems and provide a planning data base to support the assessment of new or expanded systems. The data base would ideally cover NPS- and concession-operated systems, and include information on the VTS route(s), service levels offered, equipment used, support facilities required, ridership attracted, operating and maintenance costs, labor force, equipment and facility costs, sources of funding, and visitor acceptance.

Policy Guidance

Transportation policies that approach the requirement for park access and circulation from a multimodal perspective are needed to guide planning efforts at individual park units and to support the development of criteria for prioritizing transportation investments. Transportation policy for parks should recognize that transportation decisions could influence visitor use management, resource protection and other NPS objectives. NPS policy should identify multimodal transportation planning as an integral part of the planning process, beginning with the general management plans and extending through all planning and design efforts. Transportation should be recognized as one of the most influential determinants of visitors' park experiences and a major factor affecting park resources. A critical policy issue to be addressed is how to provide funding for the necessary capital investments and operating subsidies associated with future transportation systems for park units.

Planning Guidelines

The VTS planning process outlined later in this report and existing NPS transportation planning guidelines in the *Planning Process Guideline* (NPS-2) can serve as a starting point for a servicewide guide to evaluating transportation options at individual park units. Methods to compare the relative merits of a visitor transportation system and private vehicle transportation alternatives would need to be defined to provide a truly comprehensive transportation planning guideline.

Procurement Standards and Implementation Guidelines

Procurement policies for VTS equipment and services that support clear, performance-based specifications for equipment and services while providing for competition among bidders should be developed. The potential role of the private sector in the design, construction, equipment procurement, and operation of both transportation systems and vehicular transportation facilities (such as parking areas) should be explored in developing the policies. Procedures that result in comprehensive, well-defined system requirements are mandatory. Criteria for selecting delivery methods for individual projects should be defined, giving particular attention to the issues of cost, risk, project flexibility, and quality control.

Programming Guidelines

A method is needed to compare the relative merits of transportation proposals competing for funding. Issues to consider in prioritizing funding allocations include life-cycle cost impacts and cost-effectiveness, environmental impacts, resource preservation benefits and impacts, subsidy requirements, impact on visitor experience, sustainable design principles, and public acceptance. A model for comparing projects in different environments and serving varying transportation functions is provided by the Federal Transit Administration's process for evaluating major federal capital investments in transit.[6]

Program Responsibilities

The responsibilities of the various parts of the NPS organization in identifying, planning, designing, programming, implementing, and operating transportation systems improvements need to be defined. Staffing requirements need to be identified for all elements of an expanded VTS program. The relationship between the Park Service and other federal agencies and between the federal government, local and state agencies, and the private sector, (as represented by concessioners, contractors, and others) should be delineated.

Funding

The preliminary findings of this study indicate an annual funding need of at least $230 million for road improvements and visitor transportation systems in the national park system. This level of funding would allow the Park Service to begin to reduce the backlog of roadway improvement needs, reverse the trend toward worsening roadway physical conditions and increasing maintenance costs, and to reduce the negative impacts of vehicular travel in some of the more congested parks in the system. Potential sources of funds include park entrance fees, direct user charges (for visitor transportation systems), surcharges on other goods and services, Intermodal Surface Transportation Efficiency Act funding through the Federal Lands Highway Program, the private sector, and NPS appropriations.

The funding program should recognize the potential for visitor resistance to direct user charges that would be levied in addition to park entrance fees. Funding options will be affected by the current policy of returning entrance fees collected at park units to the general fund. This policy limits direct use of entrance fees to pay for the cost of transportation systems in the parks. The program needs to consider equity in developing visitor-generated revenues, the stability of the funding source, the impact of transportation investments on other costs and revenues, and the relationship between private sector benefits from transportation investments (*e.g.*, concessioners) and private sector funding contributions.

It would be difficult to develop a visitor transportation system alternative that could be wholly funded through user fees and private sector contributions. At the same time, NPS investments in road improvements are not supported by a specific revenues directly generated by visitors who drive through parks. Direct and indirect subsidies will be required for any solution to transportation needs in an individual park. The need for and potential sources of subsidies should be one element of the evaluation of transportation alternatives. Each alternative for improving transportation in parks must be evaluated against a broad set of criteria which recognize the value of investments that contribute to the mission of the Park Service to provide for visitor enjoyment and preserve the resources of the parks for enjoyment by future generations.

This chapter identifies some of the most important characteristics of recreational travel and the unique requirements that travel to and within national park units places on the transportation system. Planning for new and improved VTS services in the national park system requires a thorough understanding of the general characteristics presented here, as well as information on the individual patterns of visitor use and travel at specific park units.

RECREATIONAL TRAVEL CHARACTERISTICS

Transportation planning for urban areas has traditionally involved forecasting travel demand based on the location of residences and activity centers and the propensity for people or vehicles to move between them. Mostly, people travel to be able to work, shop, or do other things; they do not travel for the sake of travel alone. In fact, travel forecasting models used by urban transportation planners assume that people will seek ways to accomplish their daily activities with the least amount of travel.

Another traditional assumption made in urban transportation planning and in planning for rural roads, is that demand for travel is seen as something over which the planner or manager has no control but must respond to by providing transportation facilities. Recent policy directives in the Clean Air Act Amendments of 1990 and the Intermodal Surface Transportation Efficiency Act require that planners and managers seek ways of reducing and managing travel demand, rather than planning for the continual expansion of the transportation system to meet an ever growing demand for travel. In response to these requirements, transportation planning practice has begun to consider ways in which travel demand can be influenced by strategic land use decisions and other innovative measures. Measures to reduce the need for travel, change the time of travel and make travel more efficient are being developed and tested.

Recreational travel is similar to and yet distinct from urban travel. In many cases the demand for recreational travel is derived from a desire to undertake a specific activity (traveling to a beach to swim). However, many recreational trips or portions of trips are made partially to experience the pleasure of travel itself. The sense of discovery and adventure are very important elements of the experience of driving through an unfamiliar national park unit and visitors are willing to take longer and more circuitous routes than they would for the simple purpose of getting from one place to another.

In most cases, planning for recreational travel has paralleled urban transportation planning in the treatment of demand as something to respond to rather than something which can be managed or controlled. Just as urban planners recognize the need to integrate the process of planning for land uses and the transportation systems serving those uses, park planners and managers acknowledge the value of coordinating resource and visitor facilities planning with visitor transportation planning. Facility design and location decisions, visitor trip planning information strategies, reservation systems for the use of overtaxed resources, and other means are being explored in many park settings in an effort to better manage the flow of visitors.

There also is a growing realization that many park unit resources have a finite carrying capacity. Unrestrained growth in visitation cannot always be accommodated without detrimental impacts to park resources and the quality of visitors' experiences. Some park units, notably Yosemite National Park, have established limits of visitation to specific park areas as part of the general management plan. Other park units are researching visitor use patterns and the impacts of visitor use on resources, with the aim of establishing visitation targets and visitor management strategies. Concepts being considered include planning of special activities and improved visitor information to encourage more even distribution of visitors throughout parks to reduce visitation peaks at individual sites.

Recreational travel demand patterns are distinct from urban conditions in other important ways. Peak use typically occurs on weekends, especially at park units serving regional recreation demands. Remote park units may not have weekend visitation peaks to the same degree, but day-by-day use patterns are still of interest. Seasonal use variations affect nearly all parks, with many parks closing some or all facilities for a portion of the year. The wide variation in visitation and visitor transportation needs make efficient use of capital facilities and equipment more difficult. At the same time, the summer visitation peaks coincide with the traditional availability of temporary labor at reasonable rates, making labor-intensive transportation solutions more attractive than they otherwise would be. In recent years, however, temporary labor has been more difficult to obtain, and providing employee housing has become burdensome, reducing the relative attractiveness of labor-intensive solutions to visitor transportation needs.

Most park visitors are unfamiliar with park roads and the locations of major attractions and visitor services, since many visitor journeys will be first-time experiences. Park visitors need and want more information than urban travelers, and it may therefore be possible to more effectively manage recreational travel demand within park units than in other settings.

VTS planning needs to consider several factors which are not normally encountered in typical situations. Some of these factors include:

- the characteristics of visitors, including group size, nationality, age, and participation in organized tour groups

- mode of arrival (auto, recreational vehicle, tour bus, train, air)

- broader travel itineraries (trips through parks versus in and out of the same entrance)

- primary activity (sightseeing, camping, fishing, climbing)

- trip types (sightseeing, access to activities and resources, housekeeping)

Several trends are influencing visitor service needs and visitor transportation in major parks. These trends include the aging of the population, a growing share of visitation by foreign visitors, growth in tour bus travel to parks, and growth in the use of self-contained recreational vehicles. Even passenger rail service, which played a crucial role in the early access to and development of national parks, is making a comeback.

Inadequate structural conditions, lane widths, and curve radii are some of the problems being encountered on park roads as a result of the increasing share of visitors who travel to park units in tour buses or large recreational vehicles. Visitor facilities that were designed to accommodate dispersed arrival and departure times are also being strained by the increasing share of arriving and departing visitors in large groups.

TRANSPORTATION SERVICE NEEDS IN THE PARKS

From a visitor's viewpoint, an ideal transportation system would have the following service qualities:

- be easy to access, with well-designed transitions from the visitor's private vehicle to the visitor transportation system

- offer secure locations for parking private vehicles with adequate visitor support facilities, information systems, and orientation services

- provide access to locations visitors want to visit

- be convenient, allowing visitors to travel when they want with a reasonable wait period

- be comfortable, providing pleasant surroundings and adequate room for sitting or standing, as appropriate

- allow some degree of freedom in setting travel paths and schedules

- provide flexibility to change travel plans;

- have reasonable costs and be affordable to use

- not require separate payment from park entrance fees, except in special cases

- be adaptable in accommodating recreational equipment

- afford good visibility from the vehicle

- provide interpretation and an opportunity for learning about park resources

- be safe, providing appropriate protection from danger, the elements, and accidents

- provide privacy, as reflected in freedom from crowding and opportunity to experience resources on individual terms

- provide an experience consistent with visitor's expectations and park values

- be simple in concept so visitors can understand how to use the system

- provide clear, concise information about the VTS service and the park resources it serves

- accommodate needs of all visitors including visitors with disabilities, visitors who do not speak English, and other users with special needs

Over the past three to four decades, the private vehicle has developed into a travel mode that offers its users most of the service characteristics that are desirable for recreational travel. In many park settings, travel by private vehicle is appropriate as the primary means of visitor circulation.

To park visitors, travel by private vehicle becomes less attractive as use becomes concentrated and delays result from congestion due to inadequate roadway capacity or shortages of convenient parking. One response to the undesirable consequences of concentrated use is to expand facilities to accommodate the increased demand. However, at some point this approach will begin to conflict with the mandate to preserve park resources in their unaltered state. High volumes of private vehicle travel also contribute to poor air quality, an increase in noise, and an intrusion into pristine settings.

A second response to vehicle congestion is to limit or manage access through traffic controls and reservation and information systems. Such controls have been only partially effective for the following reasons. First, the limits have been based on avoiding a total breakdown in visitor movements or *gridlock*. The traffic conditions that trigger restrictions are generally beyond the limit of what would normally be considered desirable in the environment of a national park unit. Second, limits based on traffic carrying capacity are frustrating for those who are denied access. The frustration results from a lack of advance information to allow visitors to avoid the overcrowded conditions.

The development of a visitor transportation system is another potential response to conditions which make unrestrained private vehicle travel undesirable. Mandatory and voluntary systems have been implemented in national park units, as have hybrids between the two extremes.

In using an alternative transportation system, visitors must compromise on some service characteristics, such as convenience, freedom, flexibility and privacy; however, many of these desirable qualities of private vehicle travel are already compromised if travel demand is high enough to cause congestion. Well conceived VTS services can provide much better viewing opportunities (especially for the private vehicle driver whose attention must be focused on driving) and interpretation of the resources being viewed. By alleviating congestion and the frustration resulting from overcrowded parking facilities, a visitor transportation system can result in better transportation service than individual travel in private vehicles. The most important requirement for a system that provides convenient service and can compete with private vehicle transportation is a large enough concentration of potential riders and a convenient, secure, and efficient location to accomplish the required transfer from the private vehicle to the visitor transportation system.

Although visitor transportation systems offer the benefits described above, these systems are only one element of a comprehensive system. Visitor use management methods may also be needed for resource protection and visitor enjoyment.

TRANSPORTATION SYSTEM CHARACTERISTICS

Transportation planning for national park units must consider the need to preserve park resources and respect the needs of nonusers. In each park, the planning process should strive to develop a transportation system which meets the need for visitor movement while sustaining the special values of the park. A visitor transportation system functioning as an integral part of an overall park transportation system would have the following characteristics:

- be consistent with the desired character and quality of visitor experience
- be able to serve a level of visitation and visitor circulation consistent with the Park Service's obligation to provide for visitor enjoyment and resource protection
- have minimal impact on the natural and cultural environment of the park and provide opportunities to reduce negative environmental impacts associated with visitation
- provide a balance between transportation capacity and the carrying capacity of individual park resources, considering both physical impacts to resources and the quality of visitors' experiences
- provide an ability to manage visitor use patterns to enhance visitor experience and control visitor impacts on resources
- have little impact on visitors who are nonusers, including visual effects, noise, and air quality
- allow for the safe and efficient flow of visitor and other traffic not served by the visitor transportation system
- have acceptable impacts on existing and planned visitor facilities and have support facility requirements that can be met within the park
- be cost-effective and affordable with respect to construction, maintenance, and operations;
- have well-conceived construction, operation and maintenance plans, with clear responsibilities among the Park Service, other public agencies, and the private sector
- have acceptable impacts on park operations, considering the transportation benefits of the system
- be feasible to construct and operate, considering energy requirements, physical constraints, climate, and other location-specific factors
- be consistent with park management policies and development plans and the principals of sustainable design
- be acceptable to the public, environmental groups, and other concerned entities

Park management and resource protection objectives will, in many instances, be most cost-effectively achieved with a well-conceived private vehicle transportation solution. At low to moderate visitation levels, existing park roads and parking facilities can accommodate the movement of visitors with minimal negative impacts on the quality of the visitor experience or on the natural environment. Conditions that favor consideration of a visitor transportation system include:

- high visitation levels which frequently lead to congested conditions on existing facilities

- opportunities to substantially reduce the environmental impacts associated with the current system for serving visitor movement

- physical constraints which limit the ability to provide for private vehicular access and/or parking

- especially sensitive park resources or environmental conditions which call for more control of visitor movements than is possible with private vehicular transportation

- a visitation and/or access pattern that results in many trips entering and exiting an area at a single location

The transportation planning and development process for an individual park should seek to develop an overall transportation system solution that meets visitor transportation service needs, possesses characteristics which fit within the park environment, and is affordable and cost-effective in delivering service to visitors. The following chapter describes an approach to transportation system development for national park units which is designed to yield effective transportation solutions to transportation problems in a park environment.

TRANSPORTATION PLANNING FOR NATIONAL PARKS

Transportation planning for parks and recreation areas presents unique challenges. The visitor use patterns and travel demand characteristics to be served are as diverse as the resources within the national park system. Seasonal variations and weekend travel peaks have substantial impacts on the overall cost-effectiveness of solutions that involve major capital investment in equipment, structures and facilities. Sensitivity to environmental impacts is probably greater in units of the national park system than in any other setting, requiring careful study of all aspects of the interaction among the transportation system, the park resources served by the system, and the experience of the parks by transportation systems users and nonusers.

In developing long-range plans for transportation as well as for visitor facilities and resource management, the Park Service must respond to the views of a multitude of interests, including the environmental community, gateway communities, the travel industry, and a variety of user groups.

The planning process for parks must continually seek an appropriate balance between visitor access and enjoyment and resource protection. The challenge of the Park Service's dual responsibility is multiplied in an environment of limited funding and staff resources. It will benefit both visitors and park resources to broaden the scope of implementation responsibilities for innovative transportation solutions and to draw in the communities and private sector interests that depend on the success of the Park Service in accomplishing its mission.

Figure 2 outlines a generalized approach to planning for visitor transportation in park units. As much as possible, transportation planning should be included within the general management plan planning process as identified in the *Planning Process Guideline* (NPS-2). The following five steps will lead to an initial assessment of the feasibility of VTS options, and the preliminary selection of a preferred alternative or set of promising alternatives:

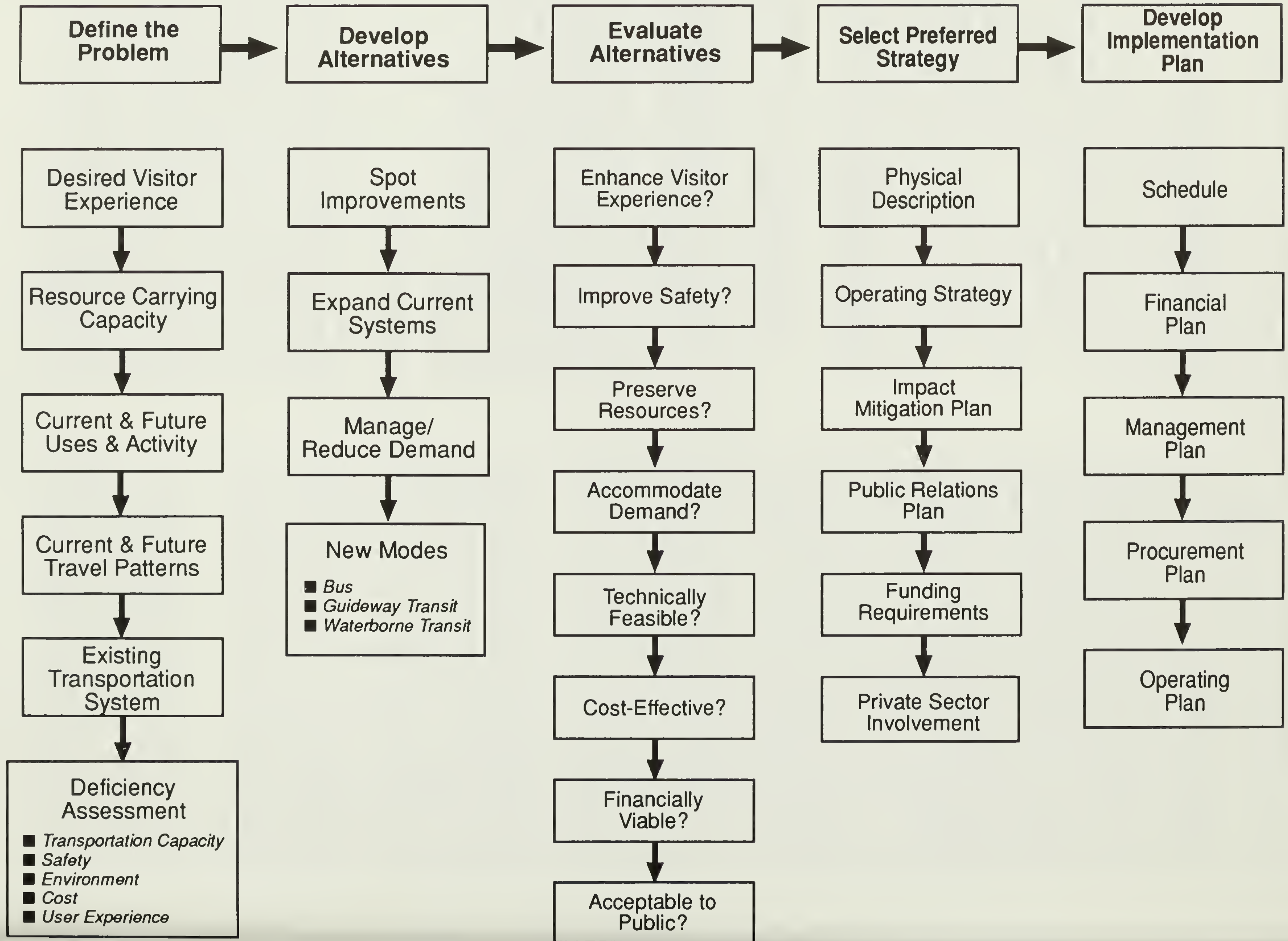
- Development of a well-defined understanding of the transportation problems to be solved.
- Development of alternative solutions, ranging from short-term, low cost measures to major investments in new transportation systems.
- Evaluation of the alternatives against a range of appropriate criteria.
- Selection of a preferred strategy or small set of promising strategies.
- Preparation of a program management plan that defines work tasks and responsibilities for implementation of the preferred strategy.

The study steps described in this section would be followed by more detailed engineering and environmental studies if the recommended action requires construction or a significant change in park management or visitor use. The next section outlines the steps required to implement VTS projects identified during the initial planning effort.

Problem Definition

A clear understanding of the transportation problems to be solved is crucial to developing effective transportation solutions in any setting. The desired nature of the visitor experience, the physical and social carrying capacity of park resources, and the resulting patterns of park resource and visitor facility use determine the need for visitor movement. Existing visitation characteristics should be carefully observed. Future visitation expectations should be estimated based on current conditions and on an understanding of resource carrying capacities, park management objectives and growth trends

Figure 2: Planning Process for Visitor Transportation Systems



in the sectors of the population which generate recreational use.

The coordination of broader park management planning, visitor facility planning, and resource protection efforts with transportation system planning is crucial to the development of alternative systems that will be attractive to users while fitting into the park environment. The interpretive goals of the park should be considered in the definition of the transportation problem. High-technology transit solutions may provide effective transportation service but in some settings may clash with park values and the physical setting of the park.

Some of the aspects of visitor use that are especially important to consider in determining the demand for visitor transportation include:

- seasonal variations
- day-to-day variations
- hourly visitation patterns
- peak activity in comparison with average activity
- visitor travel patterns
- visitor characteristics (age, group size, disabilities, etc.)
- length of stay
- overnight accommodations
- arrival mode

Along with transportation demand, the availability of transportation facilities and services determines the quality of transportation service in parks. Existing roadways, parking facilities, and visitor transportation systems should be inventoried to determine their ability to accommodate the existing and projected demand for visitor travel.

Aspects of the existing transportation system which should be examined include:

- transportation capacity, defined as the maximum demand which can be served at an acceptable level of service

- safety, as reflected in accident history

- quality of service, as reflected in the amount of delay or degree of congestion

- cost, considering costs to the user and costs to the owner and operator

- environmental impact, including air quality, habitat disturbance, and effects on wildlife and other park resources

- user experience, including comfort, convenience, crowding, impact on the character of the park, visual impact, noise, and other factors

The shortcomings of the existing transportation systems as well as future conditions should be determined in developing a concise, well grounded statement of the problem. If well crafted, the problem definition will play an invaluable role in defining effective alternatives and in focussing the evaluation of alternatives on the most important issues.

Alternatives Development

A full range of viable options for addressing the identified transportation problems should be explored, including better management of existing transportation facilities, managing or reducing the demand for visitor travel, low-cost spot improvements, expanding the existing transportation system (if growth in visitation needs to be accommodated), and developing alternative transportation modes. Transportation planners and park unit managers are increasingly recognizing the potential to manage existing transportation resources better and to influence travel behavior with incentives and disincentives. Opportunities to address identified problems with management strategies should be considered in every VTS planning study.

The technology advancements associated with Intelligent Vehicle Highway Systems (IVHS) offer the potential for new strategies to manage visitor movement and visitor use of parks. Advanced Traveller Information Systems (ATIS) can be used to communicate the use of park attractions, the availability of parking, and even the best routing for visitors traveling to specific destinations. Advanced Traffic Management Systems (ATMS) can be used to manage roadway facilities to maximize efficiency. One example of an ATMS application - reversible lanes - can be controlled electronically to respond to traffic demand patterns. In the future, entrance fee collection using automated toll collection equipment may be possible. IVHS technology can also make transit operations more efficient and effective, allowing close management of vehicle movements and providing real-time schedule information to potential passengers by applying global positioning satellite (GPS) and other vehicle location technologies.

As in the definition of the problem, coordination between transportation and broader planning activities is crucial in the development of alternatives. In some instances, moving or changing the use of visitor facilities that generate high volumes of travel may be a viable alternative to expanded transportation capacity.

Equally important to a fair evaluation of alternatives is a complete definition of other facility improvements and operating practices required to implement each alternative successfully. For example, some visitor transportation systems may tend to concentrate users in groups. Visitor support facilities such as restrooms and food service areas may need to be redesigned to accommodate concentrated use patterns. Different strategies for protecting fragile resources may be required for new visitation patterns associated with alternative transportation systems.

Finally, it is important to resist the tendency to make the alternatives as similar to one another as possible across one or more characteristics. Each option should be designed to take maximum advantage of its particular strengths and to compensate for its weaknesses. The choice among alternatives can then be based on a comparative evaluation of the full range of differences among the options.

Alternatives Evaluation

The evaluation of the various alternatives should be designed to answer the following questions, in order of priority:

- Is the alternative effective in solving the identified transportation problem(s)?

- Is the solution cost-effective and affordable, considering the likely availability of implementation and operational and maintenance funding?

- Is the alternative acceptable in terms of its impacts on and potential for enhancement of park resources, the environment, and the experience of visitors?

Specific evaluation criteria will need to be developed for each situation, responding to unique needs and constraints within individual parks. Criteria should cover at least the following subject areas:

- visitor experience
- safety
- resource carrying capacity
- environmental and resource impact
- impacts to visitor facilities and concessioner operations
- transportation capacity
- travel convenience
- visitor management
- technical feasibility
- consistency with adopted plans
- cost, operating and capital
- cost-effectiveness
- financial viability
- public acceptance

Life-cycle costing for VTS alternatives should recognize unique circumstances within the park, such as seasonal operations, peak versus average daily conditions, and unique circumstances regarding energy sources, labor rates, and other factors.

Selection of a Preferred Strategy

It is desirable to provided some *feedback* from the evaluation of alternative transportation improvements to the definition of the alternatives. Undesirable characteristics of an option may be eliminated by refining its physical or operational characteristics. Each alternative should be refined to the extent possible to take best advantage of the strengths that are revealed in the initial evaluation.

A screening process that eliminates the poorest options early may facilitate the decision-making process. Alternatives that are not effective in addressing the identified transportation problem should be discarded early, as should alternatives that are not affordable, or which have a high ratio of costs to benefits. Fatal-flaw analysis can be used to identify options which have unacceptable impacts to critical resources. Decisionmakers should be ready to accept the need for more in-depth study of a limited number of the best alternatives if the differences among the best options are slight. Through a process of successive *narrowing* of the alternatives, a preferred strategy for addressing visitor transportation needs can be identified.

The product of the selection process is a project definition for the selected option or range of options. The primary elements of the project definition are:

- physical description, including travel mode, alignment, facility sizes and locations, and vehicle descriptions

- operating strategy, describing the function of the system, the general operating characteristics, variations by hour, day, or season, and special opportunities for interpretation

- an impact mitigation and resource enhancement plan, identifying strategies to limit resource and environmental impacts and enhance the positive elements of the system

- funding requirements, including operating and maintenance costs and capital costs

- ridership projections, including totals and ridership patterns

Depending on the alternatives selected, the level of detail appropriate for inclusion in the system description may vary. For example, if an automated people-mover solution is selected, it will generally not be possible to determine the specific technology or vehicle characteristics. This is because these automated systems are best procured using a competitive bidding process in which the various suppliers respond to a performance specification applied to a specific route and set of stations.

PROJECT DEVELOPMENT APPROACH

After identifying feasible and potentially cost-effective VTS solutions to transportation problems within a park unit, a series of steps are required to identify the best solution for the park unit and to make the project a reality. This chapter provides an outline of a recommended process for the planning, design, and environmental compliance work needed to implement a new or expanded transportation system within a park.

The process is modelled after the major capital investment planning process used by the Federal Transit Administration to plan and establish priorities for investments in transit systems for urban areas. The process described here would be used for VTS options involving the construction of fixed facilities. Solutions that involve running buses over existing park roads and using existing parking facilities could be implemented through a more streamlined process. Even for bus-based transportation systems, a consistent, centralized process for planning service and procuring the necessary buses and operating resources is recommended.

Individual park units are currently developing VTS services without the benefit of the knowledge gained in parks that have been operating similar systems for years. Too often, a lack of adequate formal service planning results in wasted resources and poor service to visitors. In contrast to the isolated basis on which park units plan transit services, the urban transit industry has a large network of formal and informal communication. Transit professionals and decision-makers share their success stories and their failures with one another, helping others to make good decisions and avoid unnecessary expenses.

For more capital-intensive VTS alternatives, a sequence of studies incorporating increasing levels of project detail is recommended to define the project and secure funding commitments. Decision points should be included between steps to allow decision-makers to review the costs, benefits, and impacts of the proposed project prior to committing more resources to the design effort. The steps described here could form the basis for a servicewide policy for VTS development and an approach to assessing the relative priority of projects competing for limited funds.

The recommended steps include:

- alternatives analysis
- preliminary engineering, environmental documentation
- final design, procurement, construction and operation

A VTS solution identified during the feasibility study stage that only involved buses operating on existing park roads would most likely skip the first step, require a simplified second step involving developing performance specifications for the proposed service, and proceed immediately to the procurement process for vehicles and service.

A major decision facing the Park Service in developing servicewide VTS solutions is the role of the Park Service in relation to ownership, management, and operation of the transit system. Possible owners of the fixed facilities and vehicles include the Park Service, the park concessioner, or a third party. A combination of ownership responsibilities may be appropriate, with the Park Service owning fixed facilities and the private sector owning vehicles. The Park Service could accept management responsibilities for the system, or management could be contracted to the private sector. Similarly, the employees required to operate the system could be NPS staff or they could be hired by a private sector operator. Ownership and management decisions would normally be made once a detailed definition of the service and facilities needed to operate the system was made in the second step of the VTS development process. The final step would then be undertaken in a way which supports the selected ownership and management approach.

ALTERNATIVES ANALYSIS

This initial stage of the VTS implementation process includes compiling information on existing topography, soils, environmental baseline conditions, and other material to support the conceptual design of each alternative and the preliminary assessment of the environmental effects of each alternative.

Visitor use projections would be developed and conceptual cost estimates would be compared to identify the most cost-effective options. The environmental impacts and benefits of the construction and operation of each alternative would be estimated and compared, along with assessments of each alternative's contribution to visitors' experiences of the park and the achievement of park objectives.

The relationship between the physical capacity for transporting visitors and the carrying capacity of park resources is an extremely important element of the evaluation of the alternatives. Carrying capacity should be considered from the perspective of physical damage to natural and cultural resources and from the viewpoint of visitor experience. The contribution of each transportation alternative to the unique character of the visitors' experiences in the park should be important considerations in the choice among the available options. The need for, feasibility of, and acceptability of improvements to manage visitors in areas of concentrated use should be considered as an integral part of the evaluation of alternatives.

Plan and profile drawings would be developed for any rail or other fixed-guideway alternatives, needed roadway improvements would be identified for bus alternatives, and a detailed operating plan and definition of fleet requirements would be developed for each alternative. The location, size, and type of visitor facilities, vehicle storage, maintenance facilities, and other features would be specified and conceptual layouts would be produced. Operational tests of alternative transit vehicles could be undertaken to identify the most appropriate models for use in the specific environment of the park.

The product of this step in the process would be a definition of the preferred alternative for the park, a more definitive cost estimate for the system, identification of environmental issues, and a preliminary financing plan. This information could be used to compare proposed improvements at each park with other servicewide needs to develop priorities for NPS funding allocations.

Depending on the alternative selected to address visitor transportation needs, additional design and environmental compliance work might be required. The following sections describe the work needed to implement fixed guideway systems as well as those tasks that would be required to develop a bus-based visitor transportation system.

PRELIMINARY ENGINEERING AND ENVIRONMENTAL DOCUMENTATION

In this step of the process, the design of the proposed improvements would be developed in more detail to confirm the alignment, profile, requirements for structures, and the location and design of fixed facilities. Approximately 30% of the design work needed to produce construction contract documents would be completed at this stage of the project.

Performance specifications would be prepared for the equipment needed to operate the transportation system. If the selected VTS strategy involves operating buses on existing park roads, a performance specification for the required vehicles and a detailed operating plan for the proposed transit service would be prepared.

The greater level of detail available at this stage of the design process would allow environmental impacts of the proposed improvement to be determined with confidence, and would permit mitigation measures to be identified and included in the design. An environmental impact statement or environmental assessment would be prepared, as required by NPS policy and environmental law. Cost estimates prepared at this stage would have a greater level of confidence and could be used as a basis of a final decision on proceeding with the project.

FINAL DESIGN, CONSTRUCTION, OPERATIONS

At this stage of the project development process, a number of options would be available to move the project forward if the necessary funding is available. Enough project definition would now be in place to allow all or portions of the project to be turned over to a contractor or set of contractors, if that approach offers significant advantages with respect to cost or implementation time. The implementation strategy could follow one of four models:

- traditional model
- design-build model
- turnkey model
- super-turnkey model

Aspects of each implementation model would apply to VTS alternatives using buses alone, as well as to alternatives involving the construction of fixed facilities and/or guideways.

Traditional Project Implementation

The traditional approach to developing public works projects has involved separating the final design and construction tasks from one another. Construction documents and detailed equipment specifications for all elements of the project are prepared under the direction of the project owner. The project is split into packages, and competitive bids are taken for constructed facilities and for equipment items. In some cases, a single, all-encompassing general contract is bid, but more often several individual elements of the project are bid separately. The owner or a representative of the owner is then responsible for coordinating the work of the individual contractors.

Design-Build

The design-build model for project development involves splitting the project into distinct packages at the completion of preliminary engineering. Competitive bids are taken for (1) the completion of final design and construction of fixed facilities based on the preliminary engineering design and (2) for the design and manufacture of equipment based on performance specifications. This approach potentially allows the contractors to contribute to the design process, identifying cost-saving design changes. This approach also internalizes any conflicts between the design intent and any unexpected conditions which are revealed during construction within a single contracting entity. The owner is still responsible for coordinating the activities of the different contractors to deliver a completed project.

Turnkey

The turnkey contracting model involves taking competitive bids on a single contract package, which includes the final design, construction, and fabrication of all the elements necessary to deliver the completed project. The turnkey contract also may include operating the completed project for a specified number of years. The presumed advantage of this approach is that a single point of responsibility is identified for delivering a completed, successful project. The contractor may be able to reduce the total cost of the project by more effectively coordinating the design and construction aspects of the project and by applying private sector management techniques to the project. The costs of design and program changes will be more readily apparent under the turnkey approach, perhaps resulting in fewer changes.

The risk of coordinating the elements of the project is removed from the owner and placed on the contractor. The owner should expect to pay a premium to the contractor for accepting risk which would otherwise be the owner's responsibility.

Turnkey contracts usually are based on a firm fixed price for which the contractor agrees to deliver the finished project. While risk is transferred to the contractor, the owner gives up a good deal of control over the process in this model.

Super-Turnkey

The super-turnkey model can be used if the contractor has a potential ownership interest in all or portions of the system. Within the national park system, the development of fixed facilities within park units by concessioners is a form of super-turnkey project implementation. In the case of a VTS project, a park concessioner could undertake the project on a super-turnkey basis. The concessioner could retain ownership of the system for a specified number of years and have the rights to operate the system, collecting fares and using the system to support other concession services. The Park Service could share in system revenues through provisions in the super-turnkey contract. Alternatively, the Park Service could agree to subsidize the concessioner operation of the system to keep user costs low.

Summary

The turnkey and super-turnkey project implementation concepts have received a great deal of interest in the last few years. Transit proposals involving these innovative approaches include systems in Houston, the Twin Cities, Newark and Honolulu; however, a transit project has yet to be successfully completed using the turnkey or super-turnkey approach.

Each of the available approaches has advantages and drawbacks. At the feasibility study stage, it is not necessary to identify a preferred approach. If a VTS project proceeds into preliminary engineering, a formal evaluation of the available implementation strategies should be made. Factors to consider in choosing an approach include the cost of the project, the degree of risk and liability and the way in which risk is shared among the parties, the degree of control that the Park Service can exercise over the project, the time schedule for completion of the project, the quality of the resulting system, the ability of the Park Service to manage the project, and other factors specific to the individual park.

FUNDING OPTIONS

The potential funding sources for VTS improvements in units of the national park system include annual appropriations as part of a park's operating budget (as at Denali National Park and Preserve), surcharges on visitor goods and services provided by a concessioner (as at Yosemite National Park), funds from the Federal Lands Highway Program provided by Intermodal Surface Transportation Efficiency Act, a new and as yet undefined NPS program for transportation systems, park visitors (in the form of entrance fees or fares), and the private sector. The private sector's involvement would be predicated on the potential to recover their investment through user charges and/or subsidies.

The annualized costs of individual VTS alternatives evaluated in Denali National Park and Preserve and Yosemite and Yellowstone National Parks as part of this study range from $6 million to more than $50 million. This compares to an existing servicewide funding level of about $80 million per year for road improvements.

A servicewide program for VTS funding does not exist within the Park Service and data on servicewide spending for VTS services is not available. The annual operating costs for the few major visitor transportation systems in park units are in the range of $1 to $2 million per system. The costs associated with replacing the aging vehicle fleets in existing transportation systems are not reflected in the annual expenditures.

Currently, a servicewide policy regarding visitor transportation system development and funding is not in place. The need for such a policy is evident from the results of studies at Denali, Yosemite and Yellowstone. The funding required to support any of the proposed alternatives is beyond the current resources of these parks.

The movement of visitors is one of the most critical aspects of the management of the nation's park units. This study and other ongoing work in the parks have identified the importance of the NPS role in planning for and managing visitor use. Visitor transportation systems offer a means to control visitor movements while enhancing the interpretation of park resources and enjoyment of the visitors. The existing lack of a formal program for planning, designing, evaluating, prioritizing, and funding VTS services in the National Park System severely limits the Park Service's ability to respond to critical transportation and resource protection problems in the nation's parks.

OVERVIEW

To assist planners and NPS managers in the identification of appropriate alternatives as part of the VTS planning process, this chapter contains an inventory of proven transportation systems that may be appropriate for use in a national park setting. Transportation systems providing very high speed or very high capacity service are not included, since these systems are designed to serve travel demand patterns that are not found in the national park system. Average peak season visitation at the most heavily visited park units is between 20,000 and 30,000 per day. High-capacity urban systems can serve that many passengers per hour during peak travel periods.

The transportation systems described here have been organized into six categories:

- Bus Transit - These systems can use existing or improved park roads. They include various buses as well as van conversions and towed trailers.

- Rail Transit Systems - These systems require installing conventional tracks to guide the vehicles. Technologies appropriate for use in parks included in this category are systems built at-grade, including light rail transit or trolley systems and self-propelled vehicles.

- Guideway Systems - These systems require a specially designed guideway for vehicle support and guidance. These technologies are typically used in systems which are separated from traffic and pedestrians. In parks, these systems would most likely be built on elevated structures. Examples of this category include group rapid transit and people movers. Monorail technology is a variation of group rapid transit or people-mover technology.

- Special Purpose Systems - These systems are designed to transport passengers in rough or mountainous terrain and include funiculars, aerial tramways, and cog railroads.

- Waterborne Transit - These options include a variety of small- to medium-sized boats.

- Emerging Technologies - These systems are currently undergoing research and development and show promise of being available for use in parks. Personal rapid transit is an example of an emerging technology.

A brief introduction is provided for each category, spelling out the primary characteristics of transit technologies that fall within that category. Individual entries are provided for each specific visitor transportation technology.

Many of the transportation modes described in this inventory would require modifications for application in a national park setting. Depending on the type of visitor trip being served, some seating capacity might need to be removed to provide space for camping equipment or other gear. Also, special modifications to improve viewing opportunities could be desirable in some settings. The conventional transit buses operating in Yosemite Valley, modified to include skylights and removable side windows, exemplify this type of modification. The costs of these park-specific modifications are not included in the cost ranges noted for each technology. The range of operating costs per vehicle mile include labor costs.

Park units with highly seasonal visitation patterns may be adequately served by used transit equipment, rebuilt after service in urban transportation systems. This report does not address used vehicles, although the physical and operational characteristics of used equipment would be similar to those of the new vehicles addressed in this inventory.

BUS TRANSIT

Buses are rubber-tired vehicles designed to operate in mixed traffic on ordinary roadways. Bus transit is by far the most common type of public transportation in the world today. Bus systems of some form exist in virtually every urban area in the country and in a number of national park units. Buses can operate on fixed routes according to published schedules, or may be dispatched individually to pick up passengers on a demand-responsive basis.

Buses have three major advantages that account for their predominance as a transit technology. First, they do not require a large investment in construction and maintenance of new infrastructure since they can use existing roadways. Second, they offer unequaled routing flexibility. Third, buses can serve a very wide range of passenger demand levels by using small to very large vehicles.

Perhaps the greatest drawbacks of bus transit are the high labor cost per passenger carried, especially in areas with high ridership, and the emission of pollutants which are particularly objectionable in a national park setting. Most large buses are currently powered by diesel engines. However, a variety of alternative fuel technologies, including methanol, compressed natural gas, liquified natural gas, and propane are now available. An older technology still in use in several cities is the electric trolley bus which draws its power from overhead wires, thereby avoiding emission of pollutants. Battery buses are available, but have low passenger capacities and short operating ranges.

Although buses typically operate in mixed traffic, several cities have built exclusive busways that exclude other vehicles. On such facilities, buses can provide faster service by bypassing congestion. The Park Service has restricted private vehicular travel on some existing roadways and provided a mandatory transportation system for visitor access. Examples include West Rim Drive at the Grand Canyon, the Quarry access road at Dinosaur during the summer months, and the east end of Yosemite Valley year-round.

Bus transit encompasses a wide variety of vehicles, ranging from converted vans to double-deck and articulated transit buses. School buses, motor coaches, and power unit/trailer combinations represent variations from the traditional urban transit vehicle. Other technological innovations include automatic vehicle location systems, automated demand-responsive dispatching, transit operations software, electronic ticketing, and automated fare payment.

Currently, buses and other rubber-tired vehicles are the most common form of land-based transit service operating in national park units. In park settings, standard bus technology offers good contact between the driver or a guide and passengers.

VANS AND VAN CONVERSIONS

Converted vans are a versatile form of bus transit used to transport small- to medium-sized groups. They are used for short-haul transportation around airports and other activity centers and for longer-distance travel to resorts from urban areas. Most versions of these vehicles are best suited to point-to-point travel with a minimum amount of passenger on and off movements, due to their lower ceilings and limited interior space.

Advantages

Small size encourages frequent service.

Usable for both fixed-route and demand-responsive service.

Variety of features for disabled and other passenger amenities.

Low initial cost.

Highly maneuverable.

Low axle weights reduce need for road upgrades.

Wide variety of fuel types available.

Large number of suppliers in active market.

Ready supply of operators and mechanics in most areas.

Able to operate on most park roads.

Disadvantages

Small size may cause need for numerous vehicles and drivers in cases of moderate to high demand.

Small size may result in congestion from large number of vehicles during peak periods.

Small size results in higher labor costs per passenger.

Difficult for passengers to move to and from doors.

Relatively less durable than transit buses.

Exhaust and noise from internal combustion engine may be objectionable.

Physical Data

Length	15 to 25.5 feet
Width	7.7 feet
Height	9.3 feet
Weight	9,000 to 12,000 lbs.
Power Source	Gasoline, diesel, methanol, compressed natural gas, liquified natural gas, propane, battery

Operating Data

Top Speed	60 mph
Maximum Grade	15%
Turn Radius	20 to 25 feet
Passengers:	
Seated	16 to 25
Total	16 to 25
Fuel Consumption	10 to 12 mpg

Economic Data

Vehicle Cost	$25,000 to $50,000
Estimated Life	5 years
	100,000 to 200,000 miles
Operating Cost	$2.00 to $2.50 per vehicle mile

Note: Battery versions have limited range

SCHOOL BUS


SCHOOL BUS
BLUE BIRD


SCHOOL BUS
STOP
DO NOT PASS WHEN SIGNALS FLASHING

SCHOOL BUS

School buses offer a cost-effective solution to seasonal visitor travel. Where private contractors provide school transportation, idle school buses may be available for lease during the summer. School buses are used to provide VTS service at Denali National Park and Preserve. Being designed for school children, these buses provide less comfortable seating than other vehicles. Buses based on school bus design may be purchased for permanent use at a park unit with modifications to better accommodate adults. School bus seat modifications can also be made quite easily for easier access and more room.

Advantages

Available for low cost chartering during school recesses.

Ideal for transporting children to recreational destinations.

Low-cost design offers an alternative to more expensive transit buses.

Variety of sizes available.

Large number of suppliers in active market.

Ready supply of operators and mechanics in most areas.

Low axle weights reduce need for road upgrades.

Able to operate on most park roads.

Disadvantages

Not comfortable for adult passengers.

Poor operating performance.

High entry steps.

Generally unsuitable for steep grades.

Narrow doors make entry and exit slow.

Small windows.

Exhaust and noise from internal combustion engine may be objectionable.

Physical Data

Length	17 to 38 feet
Width	8.0 feet
Height	9.5 to 10.3 feet
Weight	25,500 to 32,000 lbs.
Power Source	Diesel, gasoline

Economic Data

Vehicle Cost	$70,000 to $120,000
Estimated Life	8 to 10 years, 300,000 to 500,000 miles
Operating Cost	$2.00 to $2.75 per vehicle mile

Operating Data

Top Speed	60 mph
Maximum Grade	15%
Turn Radius	39 feet
Passengers:	
Seated	24 to 45 (adults)
Total	24 to 45 (adults)
Fuel Consumption	8 to 10 mpg

SMALL TRANSIT BUS

SMALL TRANSIT BUS

These buses are used in urban areas with lower ridership levels where large urban transit buses are not justified. They offer better maneuverability than conventional buses and somewhat lower initial costs. On a per-passenger basis, these models are generally more expensive than larger buses. These buses are durable, having been designed for repetitive start and stop operation. These buses offer all the advantages of their larger counterparts in accommodating on and off movements of passengers and providing room for standees.

Advantages

Lower initial cost than standard transit bus.

Variety of seating arrangements.

Special features available for riders with disabilities.

Maneuverable on narrow roads and tight curves.

Can be modified to provide improved viewing opportunities.

Can be used in alternative service during off-peak seasons.

Ready supply of operators and mechanics in most areas.

Large number of suppliers in active market.

Lower axle weights reduce need for road upgrades.

Durable, with 10- to 12- year life of full-time use.

Active research underway for low-emissions diesel and alternative fuels.

Disadvantages

Lower capacity requires many units if demand is high.

Small size results in higher operating cost per passenger than standard transit bus.

High initial cost compared to school buses and vans.

Exhaust and noise from internal combustion engine may be objectionable.

Physical Data

Length	22.3 to 31.6 feet
Width	8 feet
Height	9.2 to 11 feet
Weight	15,000 to 25,000 lbs.
Power source	Diesel, methanol, liquified natural gas, compressed natural gas, battery

Economic Data

Vehicle Cost	$125,000 to $185,000
Estimated Life	12 to 15 years, 500,000 to 1,000,000 miles
Operating Cost	$2.20 to $2.70 per vehicle mile

Note: Battery versions have limited range

Operating Data

Top Speed	60 mph
Maximum Grade	15%
Turn Radius	30 feet
Passengers:	
Seated	27
Total	45
Fuel Consumption	4 to 7 mpg (diesel)

CONVENTIONAL TRANSIT BUS

CONVENTIONAL TRANSIT BUS

Conventional transit buses are currently used for the NPS Yosemite Valley shuttle. These large buses are useful in areas of high-volume, short-to-medium distance travel. The design of these buses provides for efficient loading and unloading in areas with frequent stops and complex visitor travel patterns. Typical designs provide grab bars for numerous standees. Conventional transit buses require 11- to 12-foot lane widths for comfortable operation.

Advantages

Widely available for purchase or lease. Numerous suppliers in active market.

Active bus rebuilding and used vehicle market.

Can be used on a variety of existing roads.

Designed for efficient loading and unloading.

Variety of seating arrangements.

Ready supply of operators and mechanics in most locations.

Active research underway for low-emissions diesel and alternative fuels.

Can be used in alternative service during off-peak seasons.

Can be modified to provide improved viewing opportunities.

Low-floor models available from some manufacturers to speed boarding process (see next page).

Ready supply of operators and mechanics in most areas.

Durable, with 10- to 12-year life of full-time use.

Disadvantages

Relatively high initial cost. New vehicles may not be cost-effective in seasonal use.

May not be cost-effective for low to moderate passenger volumes.

Exhaust and noise from internal combustion engine may be objectionable.

Noisy, if special modifications not made, especially in hilly terrain.

May be viewed as out-of-character in rustic settings.

High axle loads require structurally sound roads.

Large size not suited to some narrow park roads.

Not as comfortable as tour bus for long-distance travel.

Physical Data

Length	30 to 40 feet
Width	8.0 to 8.5 feet
Height	10 to 11 feet
Gross Weight	35,000 to 40,000 lbs
Power Source	Diesel, methanol, liquified natural gas, compressed natural gas, battery

Economic Data

Initial Cost	$150,000 to $200,000
Estimated Life	500,000 to 1,000,000 miles
Operating Cost	$2.35 to $2.85 per vehicle mile

Note: Battery versions have limited range.

Operating Data

Top Speed	60 mph
Maximum Grade	15%
Turning Radius	35 to 45 feet
Passengers	
Seated	40 to 48
Total	65 to 75
Fuel Consump.	3 to 5 mpg (diesel)

LOW FLOOR TRANSIT BUS

LOW FLOOR TRANSIT BUS

Low floor transit buses are based on airport apron buses frequently used in Europe. These large buses are useful for high-volume, short distance travel. The multiple wide doors and low floor design of these buses offer very efficient loading and unloading in areas with frequent stops and high volumes of simultaneous boarding and alighting movements. A good example of the application of these buses in the United States is the 16th Street Mall shuttle system in Denver. Typical designs provide few seats and a clear floor area for numerous standees. These buses require lane widths similar to those needed for conventional transit buses.

Advantages

Multiple doors allow very efficient loading and unloading.

Variety of seating arrangements.

Ready supply of operators and mechanics in most locations.

Active research underway for low-emissions diesel and alternative fuels. Battery versions proven in regular service for short routes.

Provide improved viewing opportunities.

Durable, with 10 to 12 year life of full-time use.

Modifications to reduce noise proven in service.

Disadvantages

Few suppliers. Typically a custom order, which increases costs.

Higher initial cost than conventional bus.

May not be cost-effective for low to moderate passenger volumes.

Exhaust and noise from internal combustion engine may be objectionable.

Wheel wells and engine compartment reduce floor area available for passengers.

May be viewed as out-of-character in rustic settings.

High axle loads require structurally sound roads.

Large size not suited to some narrow park roads.

Requires paved surface due to low clearance.

Not able to operate on moderate to steep grades.

Not appropriate for long-distance travel.

Physical Data

Length	40 to 45 feet
Width	8.5 to 9 feet
Height	9 to 10 feet
Gross Weight	45,000 to 60,000 lbs
Power Source	Diesel, methanol, liquified natural gas, compressed natural gas, battery

Economic Data

Initial Cost	$300,000 to $400,000
Estimated Life	500,000 to 1,000,000 miles
Operating Cost	$2.50 to $3.00 per mile

Note: Battery versions have limited range

Operating Data

Top Speed	35 mph
Maximum Grade	4% to 6%
Turning Radius	40 to 50 feet
Passengers	
Seated	10 to 15
Total	70 to 80
Fuel Consump.	2 to 4 mpg (diesel)

ARTICULATED TRANSIT BUS

ARTICULATED TRANSIT BUS

These buses can carry large numbers of passengers while operating on most streets. They are most useful in areas of high demand. Most models have multiple wide doors for easy loading and unloading. First introduced to the United States in the late 1970s, these buses have been very successful in serving heavily traveled corridors.

Advantages

High capacity per driver reduces labor costs.

Fewer vehicles needed with high ridership.

Multiple wide doors speed loading and unloading.

Ready supply of mechanics and operators in most locations.

Durable, with 10- to 12-year life of full-time use.

Active research underway for low emissions diesel and alternative fuels.

Can be modified to provide improved viewing opportunities.

Disadvantages

Relatively high initial cost.

May not be cost-effective in seasonal use.

High initial cost.

Not suited to low ridership periods or areas.

Requires special driver training for safety.

Relatively few manufacturers.

Requires long straight area for passenger loading and unloading.

More complex mechanically than standard buses.

Requires large area for service and maintenance.

Large size may be incompatible with park environment.

Noise and exhaust from internal combustion engine may be objectionable.

Physical Data

Length	56 to 60.5 feet
Width	8.0 to 10.0 feet
Height	10.0 to 12.1 feet
Weight	49,500 to 56,500 lbs.
Power Source	Diesel, methanol, liquified natural gas, compressed natural gas

Economic Data

Vehicle Cost	$290,000 to $325,000
Estimated Life	500,000 to 1,000,000 miles
Operating Cost	$2.60 to $3.10 per vehicle mile

Operating Data

Top Speed	55 mph
Maximum Grade	10%
Turn Radius	45 feet
Passengers:	
Seated	69
Total	90 to 110
Fuel Consumption	2 to 4 mpg diesel

DOUBLE-DECKER BUS

DOUBLE-DECKER BUSES

These large buses are designed to comfortably accommodate large numbers of riders. Double-deckers are not appropriate for areas with many on and off movements. These buses are best suited to medium to long-distance runs, where their large size can significantly reduce per-passenger operating costs.

Advantages

Attractive transportation for recreational situations.

High capacity per driver reduces labor costs.

Reduces number of buses needed when ridership is heavy.

Good viewing opportunities, especially from second level.

Ready supply of operators and mechanics in most areas.

Good passenger comfort.

Proven in a variety of recreational settings.

Durable, with 10 to 12 year life of full-time use.

Disadvantages

Relatively high initial cost.

May not be cost-effective in seasonal use.

Operation is inefficient when ridership is low.

Slow loading and unloading.

Not suitable for steep grades or restricted clearances.

High capital and maintenance costs.

High axle loads require structurally sound roads.

Noise and exhaust from internal combustion engines may be objectionable.

Large size may be incompatible with park environment.

Physical Data

Length	26 to 39.5 feet
Width	7.5 to 8.2 feet
Height	13 to 14.5 feet
Weight	50,000 lbs.
Power Source	Diesel, alternative fuels in development

Economic Data

Vehicle Cost	$400,000 to $420,000
Estimated Life	10-15 years (new) 6-8 years (reconditioned)
Operating Cost	$2.60 to $3.10 per vehicle mile

Operating Data

Top Speed	60 mph
Maximum Grade	15%
Turn Radius	29 to 30 feet
Passengers	
Seated	60 to 83
Total	60 to 83
Fuel Consumption	2 to 4 mpg

MOTOR COACHES

These buses are designed for long-distance, high speed travel. They are currently used by group tours as a primary means of reaching park units. Concession operators are using buses of this type to provide tours within parks. Motor coaches provide high levels of passenger comfort. They are not designed for use in areas with high volumes of on and off movement.

Advantages

High level of passenger amenities.

Comfortable for long-distance travel.

Large number of suppliers in active market.

Active rebuilding and used bus market.

Suitable for travel to and from as well as within park units.

Can be used in alternative service in off-peak seasons.

High floor enhances viewing.

Capable of sustained high speed operation.

Smaller sizes available for use on narrow roads.

Durable, with life of 15 years or more in full-time use.

Ready supply of operators and mechanics in most areas.

Large storage area for luggage/equipment.

Disadvantages

Relatively high initial cost.

May not be cost effective in seasonal use.

Not designed for frequent stops or short-distance service.

Slow loading and unloading.

Requires costly alterations for disabled riders.

Low capacity for size.

Noise and exhaust from internal combustion engines may be objectionable.

Large size may be incompatible with park environment.

Physical Data

Length	40 feet
Width	8.0 to 8.5 feet
Height	11.1 to 11.7 feet
Weight	35,000 to 44,000 lbs.
Power Source	Diesel

Economic Data

Vehicle Cost	$250,000 to $275,000
Estimated Life	15 years or more
Operating Cost	$2.20 to $2.70 per vehicle mile

Operating Data

Top Speed	60 mph
Maximum Grade	15%
Turn radius	41 feet
Passengers:	
Seated	53
Total	53
Fuel Consumption	5 to 10 mpg

POWER UNIT/TRAILER COMBINATION

POWER UNIT/TRAILER COMBINATION

These specialized units, which use a tractor to pull one or multiple trailer units, have proven to be useful for short-distance travel in amusement parks, ski areas, and other controlled environments. To operate effectively, an exclusive, paved roadway is needed. Various designs are available, including vehicles modeled after trains and other unique vehicles. Heavy duty models are also available at a higher unit cost.

Advantages

High capacity per driver.

Entertaining for short guided tours.

Appealing to children.

Highly maneuverable for size.

Easy loading and unloading.

Ready supply of operators and mechanics in most areas.

Disadvantages

Few suppliers.

Not suitable for highway use or long-distance travel.

Slow speed.

High initial cost. May not be cost-effective in seasonal use.

Cannot reverse.

Need paved road for adequate traction.

More complex mechanically than standard buses.

Not appropriate for steep terrain.

Noise and exhaust from internal combustion engine may be objectionable.

Physical Data

Length:	
Power Unit	11 to 20 feet
Trailer	20 to 30 feet
Width	6.0 to 8.0 feet
Height	5.0 to 8.0 feet
Weight	6,000 lbs./axle
Power Source	Diesel, gasoline

Economic Data

Vehicle Cost	\$40,000 to \$100,000 (power unit) \$15,000 to \$70,000 (per trailer)
Estimated Life	5 to 10 years
Operating Cost	\$2.75 to \$3.25 per vehicle mile

Operating Data

Top Speed	25 mph
Maximum Grade	10%
Turn Radius	20 to 30 feet
Passengers (per unit):	
Seated	20 to 35
Total	50 to 70
Fuel Consumption	3 to 5 mpg

COMMUTER TRAMS

COMMUTER TRAMS

Vehicles of this type have been proven in daily use on the West Rim of the Grand Canyon. Offering similar advantages to the power unit/trailer combination, these vehicles are well-suited to many recreational travel situations. They employ a small to medium-sized vehicle similar to a bus which pulls one or more unpowered trailers.

Advantages

High capacity per driver.

Entertaining for short guided tours.

Highly maneuverable for size.

Easy loading and unloading.

Ready supply of operators and mechanics in most areas.

Disadvantages

Not suitable for highway use or long-distance travel.

Slow speed.

High initial cost. May not be cost-effective in seasonal use.

No alternative uses.

Cannot reverse.

Need paved road for adequate traction.

Not as durable as standard buses.

More complex mechanically than standard buses.

Not suitable for steep terrain.

Noise and exhaust from internal combustion engine may be objectionable.

Physical Data

Length	
Power Unit	25 feet
Trailer	25 feet
Width	7.7 to 8 feet
Height	9.3 to 10 feet
Weight	18,000 lbs/trailer
Power Source	Diesel, gasoline

Economic Data

Vehicle Cost:	
Power Unit	$30,000 to $60,000
Trailer	$10,000 to $30,000
Estimated Life	10 to 12 years
Operating Cost	$2.75 to $3.25 per vehicle mile

Operating Data

Top Speed	20 to 35 mph
Maximum Grade	15%
Turn Radius	26 to 30 feet
Passengers (per unit):	
Seated	15 to 35
Total	20 to 40
Fuel Consumption	5 to 7 mpg

RAIL TRANSIT

Rail transit includes a broad range of transit technologies which operate over steel rails. Rail transit technologies appropriate for use in a national park include light rail and self-propelled rail. These modes may be powered by electricity, diesel fuel, or alternate fuels. Light rail transit (LRT) and self propelled rail cars can operate in a number of settings, ranging from tracks laid in pavement, permitting mixed-traffic operation, to totally exclusive right-of-way, allowing service that is uninterrupted by other traffic.

Most LRT vehicles use electrical power supplied by an overhead wire. The overhead power source makes LRT operation possible in a wide variety of environments. Some historic trolley versions of light rail transit use on-board diesel generators to supply power to the electric motors. LRT vehicles can operate at high speeds on grade-separated alignments or at lower speeds with frequent stops and grade-crossings. Cars can be operated singly or in trains of two to four vehicles. Since 1980, light rail transit has gained popularity as an urban transit mode with seven new systems in operation and at least two under construction in the United States. In addition, several historic trolley systems have been implemented over the last decade. A historic trolley operates in the Lowell National Historic Park in Lowell, Massachusetts. A variation of light rail transit is operated in the mountains of Switzerland, employing a single, electrically powered vehicle which pulls trailer cars.

Self-propelled transit rail cars can be operated alone or in trains, but do not require a locomotive. They use standard railroad tracks. Power is either generated on the vehicle or received from an adjacent electric power source such as a third rail or overhead wire. In contrast to light rail transit, self-propelled rail typically operates as commuter rail in a suburban or rural environment. Rail diesel cars (RDC) and electric motive units (EMU) represent the most common types of these vehicles. The RDC version of this technology is evaluated in this report.

Rail transit is most applicable to travel corridors and activity centers in park units with high volumes of passengers. Because they can be operated in trains, rail vehicles can carry large passenger volumes at a lower labor cost per passenger than bus transit. Rail systems can be designed to blend in with the surrounding environment, and electric vehicles are non-polluting at their point of use.

By comparison with other fixed guideway modes, at-grade rail transit is inexpensive to construct, and frequent station stops can be provided at a reasonable cost. Tracks can be laid within existing roadway rights-of-way; however, a number of park roads have limited roadway corridor widths that may require additional right-of-way particularly along sections of existing roads that have steep grades and sharp curves.

Accessibility for riders with disabilities is an issue at low-platform stations. Low-floor cars have been developed to allow access from sidewalk level. Alternatively, ramps or other devices must be provided to permit access for the mobility impaired to high-floor vehicles.

High-capacity rail vehicles can be designed to operate along alignments through restricted rights-of-way, including bridges and tunnels. For an electrically powered system, the availability of adequate electric power and distribution systems is critical. Electric power sources are limited in many park units; additional electric transmission lines may need to be installed for this mode.

Self-propelled rail cars, like buses, can use fuels that have been developed as alternatives to diesel.

LIGHT RAIL TRANSIT

LIGHT RAIL TRANSIT

Light rail transit operates in 14 urban areas in the United States, and at a national park service unit in Lowell, Massachusetts. Light rail transit features electrically propelled rail cars, operated singly or in short trains, using an overhead wire as the power source. Two LRT vehicle types are in service: single unit vehicles, which can be coupled to provide greater capacity, and articulated vehicles, which are useful where higher vehicle passenger capacity must be maintained in areas of short radius curves. Historic trolleys are a variation of light rail transit which offer passenger entertainment value along with many of the transportation advantages of standard light rail. The Lowell system is a short historic trolley route. Restored vintage trolleys and replica models are available at costs below those for standard vehicles.

Advantages

High capacity.

Can be connected in trains.

Quiet, nonpolluting.

Tracks can be crossed by pedestrian and vehicular traffic and by wildlife.

Flexible low-cost design compared to other fixed guideway modes.

Easily recognized routes and boarding points.

Standard equipment, wide range of suppliers, proven in U.S. operation.

Simple switching allows multiple routing options.

Easy loading, unloading, adaptable for disabled access, flexible seating arrangements.

High vehicle capacity reduces operating costs in high-demand areas.

Disadvantages

Overhead wires and supporting poles may be considered visually intrusive.

Requires high voltage power supply, substations, and electrical distribution system which may not be available in remote areas.

High initial cost for track, electrification, and vehicles compared to bus options.

Relatively difficult to change routes and boarding points in response to varying demand.

Difficult to implement in areas with steep grades.

Requires specialized maintenance facilities and skilled personnel.

Right-of-way maintenance costs higher than for buses due to overhead wire, tracks, and switches.

Physical Data

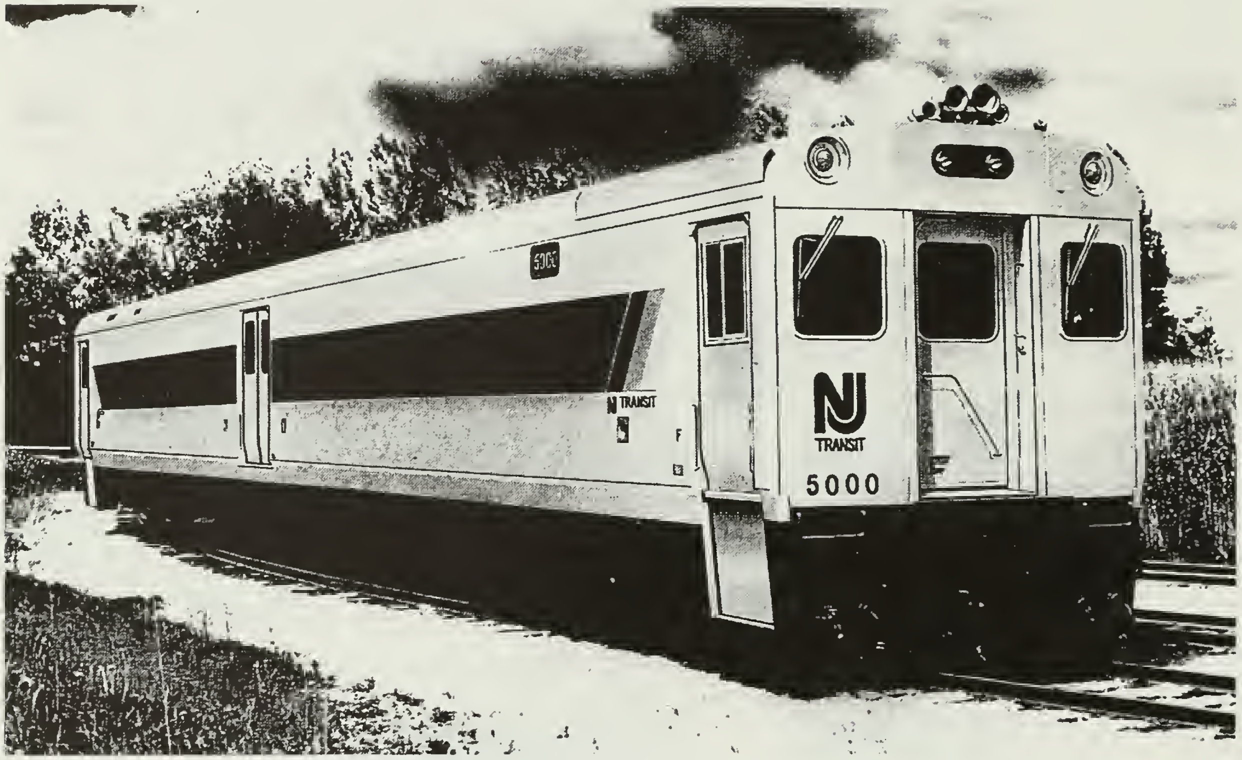
Length	50 to 114 feet
Width	7.5 to 9.2 feet
Right of Way:	
Single	16 to 25 feet
Double	22 to 35 feet
Height	10.8 to 12.5 feet

Economic Data

Initial Cost ($M):	
Vehicle	$1.5 to $2.5/vehicle
Guideway/Station	$10 to $25 M/mi
Estimated Life	25 to 30 years
Operating Costs	$5.00 to $10.00 per vehicle mile

Operating Data

Top Speed	35 to 55 mph
Maximum grade	4% to 10%
Minimum curve radius	34 to 82 feet
Passengers:	
Seated	46 to 88
Total	70 to 160
Power Requirement	400 to 1500 kilowatts at 600 to 750 volts, DC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SELF-PROPELLED RAIL TRANSIT

Self-propelled rail transit cars employ on-board diesel engines to generate power. They offer high capacity, but do not require the installation of overhead wires. They were operated for many years in suburban commuter rail service in eastern cities.

Advantages

High capacity.

Can be connected in trains.

Tracks can be crossed by pedestrians, vehicles, and wildlife.

Does not require electric power.

Flexible, low-cost design compared to other fixed-guideway modes.

High vehicle capacity reduces operating costs in high demand areas.

Suitable for long-distance travel in rural areas.

Easily recognized routes and boarding points.

High level of passenger comfort.

Simple switching allows multiple routing options.

Disadvantages

No models meeting U.S. rail standards are currently available.

High initial cost for vehicles and for track.

Difficult to implement in areas with steep grades.

Requires specialized maintenance facilities and skilled personnel.

Noise and diesel exhaust may be intrusive in park environment.

Relatively difficult to change routes and boarding points in response to varying demand.

Right-of-way maintenance costs higher than for buses due to tracks and switches.

Less efficient loading and unloading than light rail transit.

Requires high-level platform for disabled boarding.

Physical Data

Length	75 to 85 feet
Width	12.5 to 15.7 feet
Right of Way:	
Single	16 to 25 feet
Double	22 to 35 feet
Height	10.5 feet

Economic Data

Initial Cost ($M):	
Vehicle	$1.5 to $3.0
Guideway Station	$8.0 to $20 M/mi
Estimated Life	30 years
Operating Cost	$6.00 to $12.00 per vehicle mile

Operating Data

Top Speed	55 mph
Maximum Grade	5% to 10%
Minimum Curve Radius	90 feet
Passengers:	
Seated	90 to 150
Total	90 to 150
Fuel	Diesel

GROUP RAPID TRANSIT

Group rapid transit (GRT) is defined as a transit mode in which unmanned vehicles operate on specially designed fixed guideways. The guideways must be fully grade separated from all motorized and nonmotorized traffic. They can be elevated, in a tunnel, or on a fenced at-grade right-of-way. Vehicles receive power through an electrified contact rail contained within the guideway, can be operated singly or in trains, and may run on either steel wheels or rubber tires.

Existing GRT systems, like LRT systems, operate along fixed routes with fixed station stops. Vehicle capacities can range up to that of a standard transit bus. In the United States, most GRT applications provide circulation within airports, amusement parks, urban downtowns, and business/residential communities. Several line-haul GRT urban transit systems operate in Europe and Canada.

The chief drawback of automated vehicle operation is the need for full grade separation, resulting in high construction costs. Most GRT applications are elevated, which could be visually disruptive in a park setting. On the other hand, GRT systems can substantially reduce labor requirements and, as a result, operating costs in areas with high passenger demand. The fully separated guideway also allows short headways and rapid response to fluctuations in demand. Group rapid transit is especially suitable for relatively compact areas in which travel demand is high, walking distances are excessive, and use of private vehicles is either impractical or incompatible with the desired environment. Central control of the system operating conditions is both a requirement and an advantage of GRT systems.

Unlike light rail transit, which is a generic technology with equipment available from numerous suppliers, most GRT systems are proprietary. Several GRT technologies exist, but each must be purchased as a complete system from the vendor who developed it. This limits the flexibility of a client in designing a system that best meets their needs. On the other hand, each proprietor has its own advantages and disadvantages which permits a ready comparison of distinct technological packages. Once a system is installed, all additional vehicles or line extensions must be acquired from the original vendor.

GRT systems currently in operation include monorails and people movers. Automated versions of people movers are also referred to as automated guideway transit (AGT).

PEOPLE MOVERS

People movers have been proven in daily operation in airports, activity centers, and downtown areas. Examples of this technology providing line-haul rapid transit service exist in Canada and Europe. People-mover systems employing rubber tires and steel wheels have been successfully implemented. Automated operation allows headways between vehicles to vary in response to demand. These systems are most appropriate for short-to-medium-distance travel.

Advantages

Quiet, non-polluting.

Short headways due to automation.

Grade separation allows superior speed and reliability.

Easily recognized routes and boarding points.

Can respond to demand fluctuations without large standby force.

Novelty value may attract visitors.

Low labor cost per rider in high demand areas.

Elevated lines provide excellent viewing opportunities.

Allows free movement of pedestrians and wildlife if elevated.

Proven in downtown and airport applications worldwide.

Disadvantages

Very high initial cost for guideway and vehicles.

Inflexible routes.

Elevated guideway may be visually intrusive in sensitive areas.

Requires specialized maintenance facilities and skilled personnel.

Requires high-voltage electric power which may not be available in remote areas.

May be incompatible with rustic or wilderness environments.

Elevated stations are large and complex, requiring elevators for visitors with disabilities.

Limited opportunity for informal stops.

Proprietary technologies limit choices when system expansions or modifications are required.

Right-of-way maintenance cost very high due to specialized equipment.

Physical Data

Length	11.8 to 45.0 feet
Width	5.2 to 9.2 feet
Right of Way:	
Single	8 to 16 feet
Double	16 to 35 feet
Station	33 to 60 feet
Height	7.7 to 11.2 feet
Power Source	Electric current

Economic Data

Initial Cost ($M):	
Vehicles	$0.85 to $1.5
Guideway/Station	$20 to $80/mi
Estimated Life	20 to 25 years
Operating Cost	$10 to $15 per vehicle mile

Operating Data

Top Speed	50 mph
Maximum Grade	5% to 10%
Minimum Curve Radius	26 to 180 feet
Passengers:	
Seated	8 to 68
Total	57 to 124
Power Requirement	150 to 500 kilowatts at 600 to 750 volts DC

MONORAIL

MONORAIL

Monorail is a variation of group rapid transit which employs a single, relatively slender beam to support the transit vehicles. Vehicles either straddle the beam or are suspended from it. Monorail examples in the United States include systems at Disneyland in California, Disney World in Florida, and downtown Seattle. Small monorail systems have been implemented at expositions and other recreational areas. Monorail's design allows the guideway to be smaller, lighter, less obtrusive, and potentially less expensive than other elevated transit systems. Like people movers, monorail systems must be fully protected from pedestrian and wildlife crossings.

Advantages

Quiet, non-polluting.

Vehicles operable manually or automatically.

Grade separation allows superior speed and reliability.

Easily recognized routes and boarding points.

Smaller guideway is less obtrusive than other elevated systems.

Novelty value may attract visitors.

Elevated guideway offers excellent viewing opportunities.

Allows free movement of pedestrians and wildlife.

Low labor cost per rider in high demand areas.

Proven in amusement park settings.

Disadvantages

Very high capital cost for guideway and vehicles.

Inflexible route.

Elevated guideway may be visually intrusive in sensitive areas.

Requires specialized maintenance facilities and skilled personnel.

Requires high-voltage electric power, which may not be available in remote areas.

Relatively cumbersome switches, requiring large area.

Elevated stations are large and complex, requiring elevators for visitors with disabilities.

May be incompatible with rustic or wilderness environments.

Proprietary technologies limit choices when system expansions or modifications are required.

Limited opportunity for informal stops.

Right-of-way maintenance cost very high due to specialized equipment.

Physical Data

Length	28.8 to 102.6 feet
Width	8.2 to 9.5 feet
Right of Way:	
Single	8 to 16 feet
Double	16 to 35 feet
Station	33 to 60 feet
Height	9.5 to 16.7 feet
Weight	18,990 to 114,600 lb.
Power Source	Electric current

Economic Data

Initial Cost ($M):	
Vehicles	$0.9 to $1.5
Guideway/Station	$20 to $50 per mile
Estimated Life	30 years
Operating Cost	$10.00 to $15.00 per vehicle mile

Operating Data

Top Speed	45 to 56 mph
Maximum Grade	6.0%
Minimum Curve Radius	225 feet
Passengers:	
Seated	240
Total	240
Power Requirement	150 to 500 kW at 600 to 750 volts, DC

SPECIAL PURPOSE TRANSIT

Several specialized transit technologies have been devised for areas with special needs or constraints that are not well served by traditional bus or rail systems. Characteristics associated with such technologies include steep grades, mountainous terrain, and potential disruption to wetlands or other sensitive environments. In some cases, tourist attractions have used these systems to capitalize on the novelty value of an exotic transportation mode. This technology category includes aerial cable systems, cog railways, and funiculars.

Gondolas and reversible tramways are the principal types of aerial cable system. Such operations, most often seen in ski areas, transport people individually or in small groups. Larger aerial cable systems provide line-haul transportation at activity centers. These systems employ larger vehicles and often provide transportation across geographical barriers such as lakes, in cases where a bridge is undesirable. An urban application of an aerial tramway connects Manhattan with Roosevelt Island, New York.

Cog railways or rack railways were initially implemented to allow conventional trains to ascend steep grades, enabling passengers to make a through trip rather than transfer to a funicular or aerial cable system. While typically used in mountainous areas on nonmainline railways, rack sections can be used on a railway whenever a steep grade may occur and with other rail modes. Some systems apply a combination of cog and normal rail adhesion technology.

Funiculars or inclined railways have typically been implemented to provide access between points of significantly different elevation or along steep hills. They represent the most efficient means of ascending steep slopes over short distances. Funiculars have been implemented in parks and in urban areas to facilitate pedestrian movements. In the United States, funiculars have operated successfully in cities such as Pittsburgh, Chattanooga, and Dubuque.

FUNICULARS

FUNICULARS

Funiculars or inclined planes function as inclined elevators, providing access over steep slopes. Some funicular systems carry vehicles along with passengers. This technology involves site specific design and the development of customized equipment. Its application in the parks would be limited to short travel between activity areas to viewpoints.

Advantages

Provides access up very steep slopes.

No off-line maintenance required.

All-weather operation.

Operation can be fully automated.

Disadvantages

Site-specific guideway design.

Applicable only to short-distance travel.

Relatively low passenger capacity.

Relatively low speed.

High capital cost for vehicles and guideway.

Few suppliers.

Physical Data

Length	45.9 to 101.7 feet
Width	7.5 to 8.33 feet
Right of Way:	
Double	15 to 30 feet
Height	9.5 to 11.8 feet
Weight	23,400 to 66,100 lb.
Power Source	Cable propulsion

Economic Data

Initial Cost ($M):	
Vehicle	$0.4 to $1.0
Guideway	$4.2 to $6.9/mile
Estimated Life	30 years
Operating Cost ($/hr)	$37 to $107/hour

Operating Data

Top Speed	1.6 to 23 mph
Maximum Grade	13% to 188%
Minimum Curve Radius	1,047 to 1,640 feet (horizontal)
Total Passengers	20 to 200
Power Requirement	Electric current or diesel engine

AERIAL TRAMWAYS

AERIAL TRAMWAYS

Aerial tramways provide a cost-effective means of accessing rugged, mountainous terrain. Typically used at ski resorts and at tourist attractions, tramways provide novelty appeal as well as transportation service. Tramways may also be used to cross physical barriers, such as rivers, lakes, or canyons. An urban transport application of this technology provides service to Roosevelt Island in New York City.

Advantages

Marginal impact on surface environment.

Does not form a barrier to wildlife movement.

Little or no pollution.

Simple, safe operation.

Well suited to steep slopes or topographical barriers.

Relatively low initial cost, compared to fixed-guideway technologies.

Recreational appeal.

Spectacular viewing opportunities in appropriate terrain.

Allows management of visitor movement and interpretive opportunities.

Disadvantages

Visual impact of towers may be objectionable at close range.

Turnaround facilities are complicated.

Limited and inflexible route networks.

Straight-line travel only, unless multiple systems are used.

Reduced speed at support points.

Limited system lengths due to lower tension exerted on cable for acceleration as distance increases.

Line branching is not possible; passengers must transfer.

Passengers may feel crowded in large groups.

Physical Data

Length	9.8 to 30 feet
Width	8.7 to 13.8 ft.
Right of Way	
Horizontal	23 to 50 feet
Vertical	40 feet
Height	8.5 to 9.8 feet
Weight	4,400 to 19,850 lbs.
Power Source	Cable propulsion

Economic Data

Initial Cost ($M):	
Vehicles & Equipment	$3.2 to $4.2/mile
Terminals/Towers	$5.9 to $9.6/mile
Estimated Life	15 to 20 years
Operating Cost	$0.32 to $2.43 per passenger mile

Operating Data

Top Speed	13 to 27 mph
Maximum Grade	16% to 90%
Minimum Curve Radius	Tangent only
Passengers:	
Total	60 to 150
Power Requirement	200 to 1,750 kW

GONDOLAS

GONDOLAS

Gondolas are similar to aerial tramways, but employ many small cabins on a continuous cable. Gondola cabins typically accommodate four to eight passengers. Gondola systems offer more privacy than tramways, but they have reduced potential for on-board interpretation. Boarding and exiting are difficult, because the cabins keep moving during the boarding process. Access for visitors with disabilities is difficult with this technology.

Advantages

Marginal impact on surface environment.

Does not form a barrier to wildlife movement.

Little or no pollution.

Relatively low initial cost.

Relatively simple operations and maintenance.

Recreational appeal.

More privacy than tramway.

Spectacular viewing in appropriate terrain.

Disadvantages

Visual impact of towers may be objectionable at close range.

Usually straight line operations only.

Tricky loading and unloading on nonstop operations, the alternative being stop and go travel.

Line branching is not possible, passengers must transfer.

Limited system length.

Physical Data

Length	5.6 to 7.8 feet
Width	4.2 to 7.4 feet
Right of Way:	
Horizontal	32 to 38 feet
Vertical	8 feet
Height	5.8 to 8.0 feet
Weight	700 to 4,100 lbs.
Power Source	Cable propulsion

Economic Data

Initial Cost:	
Vehicles	$10,000-$20,000
Stations	$0.4 to $0.7 M
Towers/Equipment($M)	$1.05/mile
Estimated Life	30 years
Operating Cost	$0.11 to 0.77 per passenger mile

Operating Data

Top Speed	11 to 14 mph
Maximum Grade	60% 103%
Minimum Curve Radius	Tangent Only
Passengers:	
Total	4 to 24
Power Requirement	200 to 1750 kW

COG RAILWAYS

Cog rail technology was developed to allow conventional trains to negotiate steep slopes in mountainous terrain. Cog rail vehicles can be powered by diesel engines, as on Pikes Peak in Colorado, or by electricity, as on the Swiss Mountain Railway system in Europe. Railway lines can employ cog or rack propulsion on steep sections and standard adhesion propulsion on the remainder of the line.

Advantages

High capacity.

Able to negotiate steep slopes.

Technology in use for many years.

Electric versions quiet and non-polluting.

Can use rack propulsion on steep grades and conventional propulsion elsewhere.

Suitable for long distance operation.

Easily recognized routes and boarding points.

Provides a high level of passenger comfort.

Large vehicles serve high passenger volumes.

Consistent with mountain and wilderness character.

Relatively easy loading and unloading.

Disadvantages

Few suppliers.

Relatively slow operation on rack sections.

High initial cost for track, vehicles and electrification.

Electrical versions require availability of power and supporting infrastructure.

Noise and exhaust from diesel versions may be objectionable.

Wires for electrified version may be considered visually intrusive.

Requires high platform for disabled users to board.

Relatively difficult to change routes and boarding points in response to varying demand.

Requires specialized maintenance facilities and skilled personnel.

Right-of-way maintenance costs higher than for buses due to track, switches, and overhead wire.

Physical Data

Length:	
Single	50 to 55 feet
Double	100 to 125 feet
Width	9.7 feet
Right of Way:	
Double	26 feet
Height	12 to 13 feet
Power Source	Diesel, electric

Economic Data

Initial Cost:	
Guideway ($M)	$2.5 to $10/mile
Vehicles ($M)	$4.5 to $5.5
Estimated Life	30 years
Operating Cost	$6.00 to $12.00 per vehicle mile

Operating Data

Top Speed	22 to 50 mph
Maximum Grade	12.5% to 25%
Minimum Curve Radius	262 to 328 feet
Passengers:	
Seated	122
Total	200
Power Requirement	800-2,000 kW (electric propulsion)

WATERBORNE TRANSIT

Waterborne transportation systems can provide economical, fast, and pleasant travel through lakes, rivers, and other bodies of water. At some national park units, such as the Glen Canyon National Recreation Area, marine vessels are the primary mode of transportation for visitors. A variety of marine vessel technologies currently operate worldwide. The type of vessel used depends on the type of water body, passenger capacity requirements, length of the trip, depth of the waterway, width of the channel, and docking requirements and accommodations. The U.S. Coast Guard enforces safety regulations for marine vessels in public service.

Technologies applicable to the National Park Service include mono-hull, catamarans, and in limited cases, hydrofoils. Air cushion vehicles are not considered appropriate in park unit environments because of their very high noise levels.

Specific advantages and disadvantages of using water transport systems depend on the site-specific conditions and the type of marine vessel used. Site considerations include land availability, automobile/pedestrian access, depth of existing waterway, and cost efficiency comparison with other transportation systems such as bridges, roadways, and vehicular transit. Marine vessels are most appropriate when a water route is more direct or more cost-effective than a land route or necessary where the primary user resource is not accessible by land.

MONO-HULL VESSELS

MONO-HULL VESSELS

Mono-hull or conventional displacement vessels are the most common vessels used in boat transportation. A wide variety of sizes are available and in use in tour and shuttle-oriented applications worldwide. These vessels are constructed of steel or aluminum. Mono-hull vessels are somewhat slow and cumbersome compared to other marine vessels.

Advantages

Excellent recreational appeal.

Very reliable operation.

Good potential for alternative uses during off-season periods.

No special operating requirements for crew.

Excellent management control of marine park visitation.

Inexpensive, compared to other large vessels.

Wide variety of suppliers in an active market.

Disadvantages

Large size creates crowding of docks.

Deep draft may require dredging.

Relatively low operating speeds.

Long headways may be inconvenient.

High cost for terminal facilities.

Physical Data

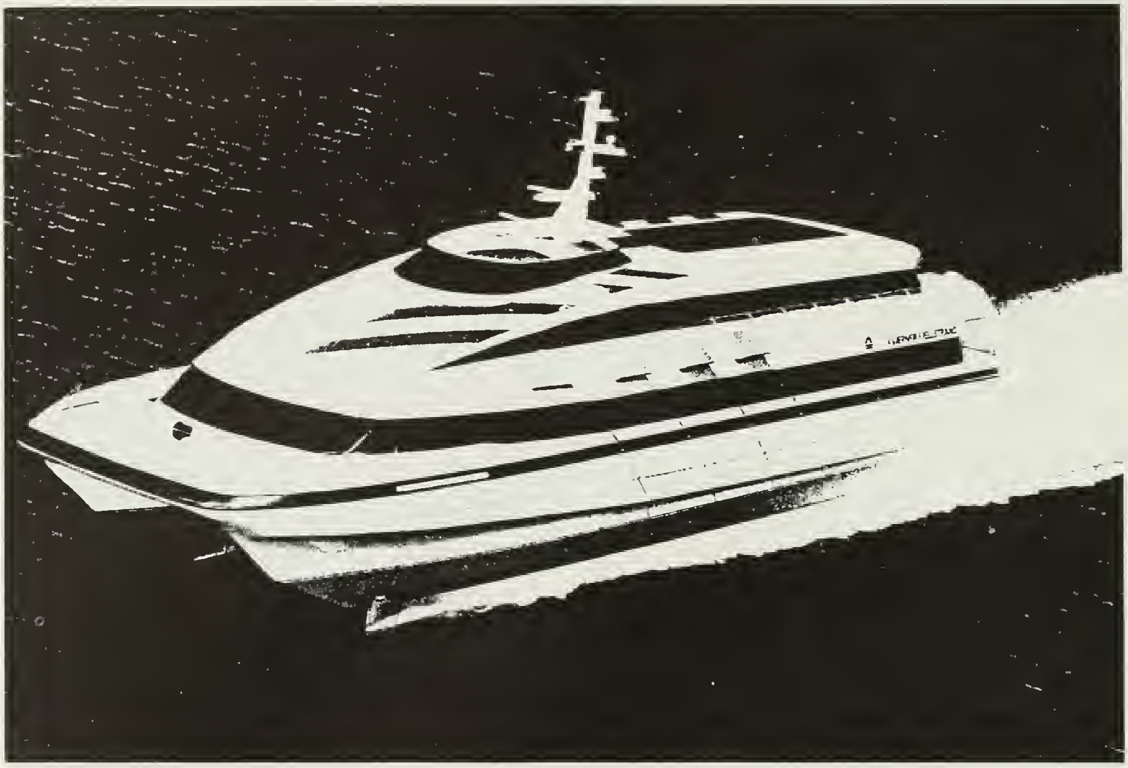
Length	85 to 169 feet
Beam	14 to 34.3 feet
Draft	6.5 to 7.8 feet
Power Source	Diesel

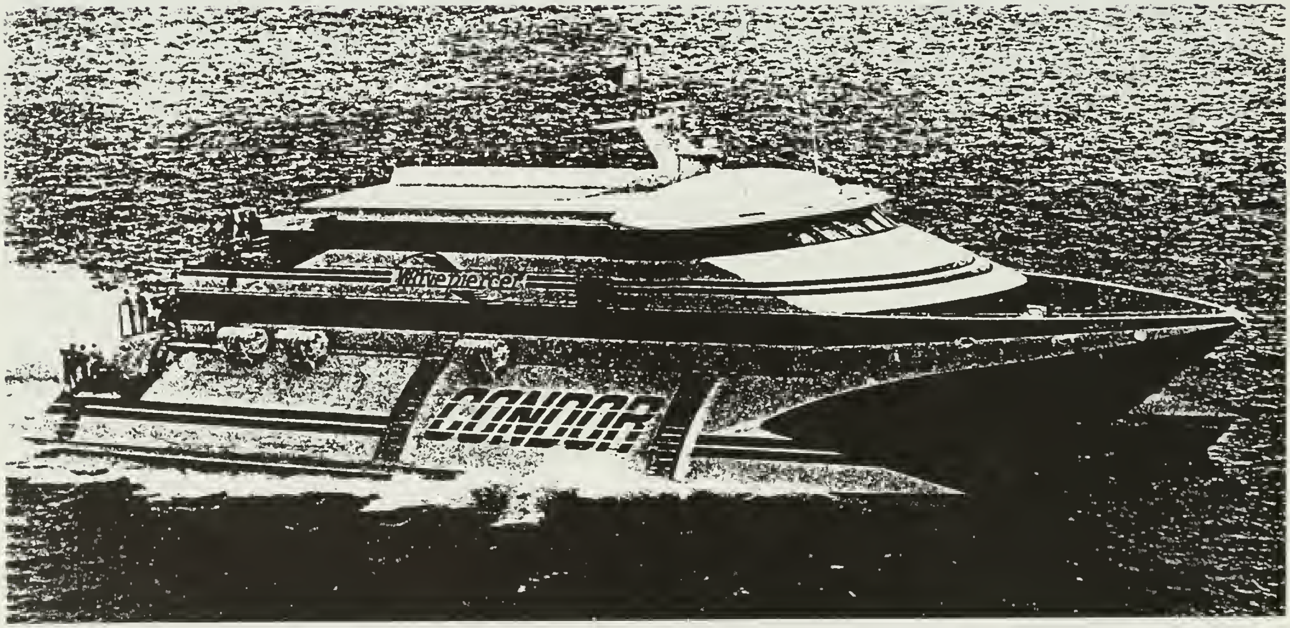
Economic Data

Vehicle Cost ($M)	$0.6 to $2
Estimated Life	20 years
Operating Cost	$250/hour

Operating Data

Top Speed	17 to 26 mph
Passengers	50 to 750
Fuel Consumption	35 gallons/hour
Range	65 to 69 hours

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CATAMARANS

Catamarans are dual hull vessels with a deck between the hulls. These vessels are typically built of aluminum to reduce weight and increase speed. Catamarans are stable in rough water and offer excellent passenger service.

Advantages

High operating speed.

Good sea-going stability.

Good visibility from elevated deck.

Shallow draft.

Large deck surface.

Excellent management control of marine park visitation.

Disadvantages

Width may require widening of channels.

Limited number of suppliers.

Large size creates crowding of docks.

High cost for terminal facilities.

Long headways may be inconvenient.

Physical Data

Length	65 to 100 feet
Beam	25 to 32 feet
Draft	3 to 5 feet
Power Source	Diesel

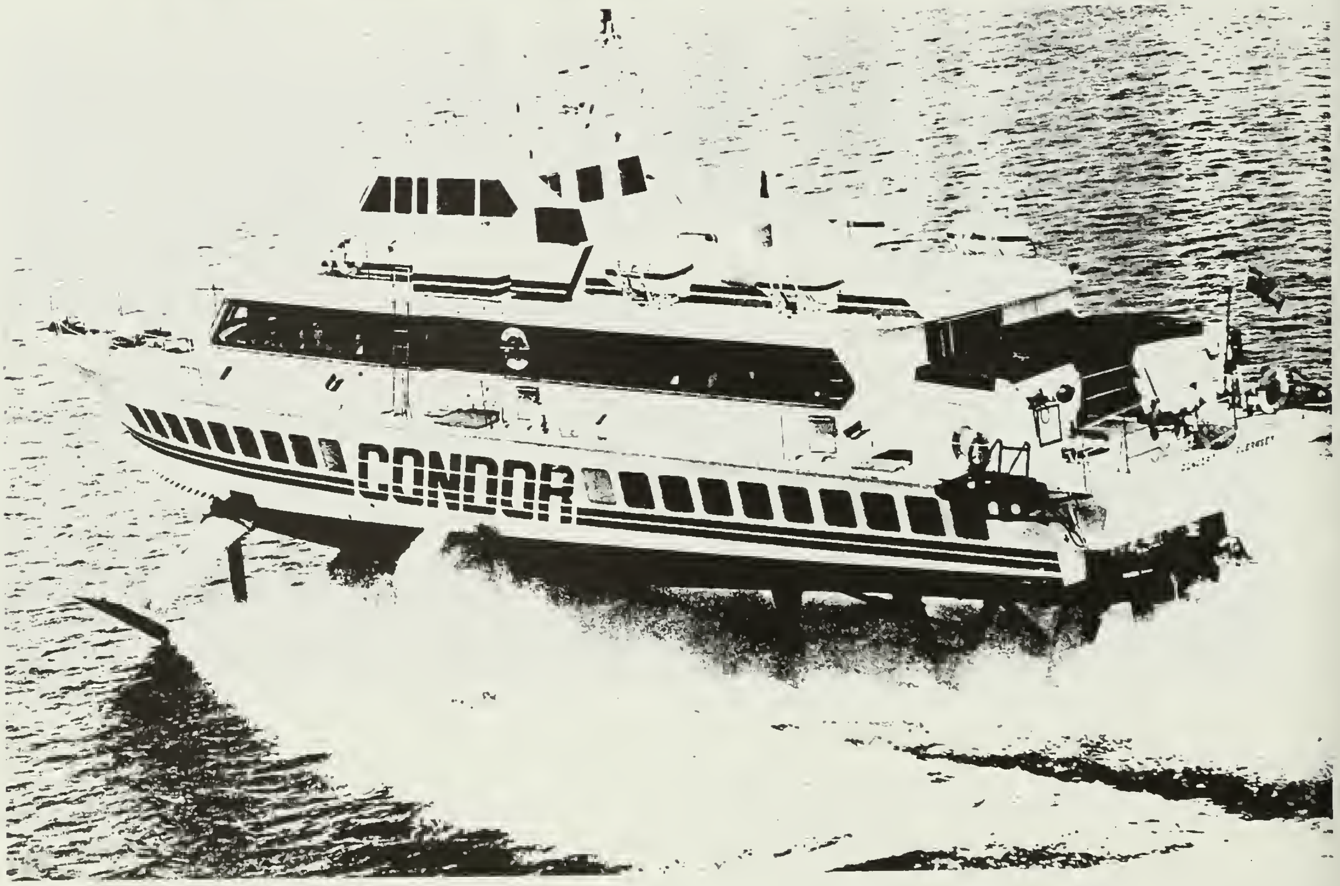
Economic Data

Vehicle cost ($M)	$2.1
Estimated Life	20 years
Operating Cost	$250/hour

Operating Data

Average Speed	34 mph
Passengers	50 to 500
Fuel Consumption	35 gallons/hour
Range	20 to 22 hours

HYDROFOILS



HYDROFOILS

Hydrofoils travel above the water surface on metal struts called foils. The underwater foils are operated hydraulically to lift the hull out of the water at high speed. These vessels are expensive and require deep channels. They are most useful for point-to-point, long-distance travel, where the hydrofoil's high speed can be used to its best advantage. Hydrofoils are susceptible to damage from floating debris.

Advantages

High operating speed.

Good sea-going stability.

Excellent management control of marine park visitation.

Disadvantages

Deep draft may require dredging.

High noise levels.

Submerged foils prone to damage.

Requires specialized crew.

Poor visibility from interior due to hull spray and incline.

Limited number of suppliers.

High cost for terminal facilities.

Long headways may be inconvenient.

Physical Data

Length	40 to 120 feet
Beam	15 to 50 feet
Draft:	
Foil-borne	4 to 8 feet
Foils Submerged	8 to 12 feet
Power Source	Diesel and gasoline

Operating Data

Top Speed	45 to 51 mph
Passengers	50 to 200
Fuel Consumption	50 to 500 gallons/hour
Range	2 to 5 hours

Economic Data

Vehicle Cost ($M)	$0.7 to $13
Estimated Life	10 to 15 years
Operating Cost	$350 to $3,000 /hour

EMERGING TECHNOLOGIES

A number of alternative and innovative technologies have been developed in recent years. Some have been tested, but most have not yet been implemented in regular service. These new technologies include personal rapid transit (PRT), magnetic levitation (Maglev) systems, and suspended light rail.

Personal rapid transit is a form of automated guideway transit that operates in a demand-responsive mode. PRT stations are located off-line, allowing vehicles to use or bypass stations as required. Vehicles are dispatched to stations in response to requests for service, and to transport an individual or small group non-stop from origin to destination. Accordingly, vehicles are small, typically accommodating three passengers. The small vehicles permit small guideways, and stations can be spaced close together without affecting average speed. The PRT concept is most applicable to a relatively dense network of guideways covering an area, rather than a single guideway providing service along a linear corridor. In the latter case, Personal rapid transit offers little advantage over a more conventional GRT system.

Personal rapid transit is being developed primarily for urban and suburban applications, with a view to providing service comparable to private automobiles. Personal rapid transit has been made possible by advances in automation technology, but it is not yet an available, proven mode. Like other GRT systems, PRT systems must be fully grade separated, and guideways are usually elevated.

Magnetic levitation has received significant attention recently as an alternative groundborne high speed transportation technology. Although it is touted as a high-speed intercity mode capable of competing with aviation, maglev is also adaptable to smaller, lower speed systems that provide local transportation within activity centers. Magnetic levitation can generally be implemented with vehicles and in environments comparable to other rail modes.

Suspended light rail is a version of monorail technology which uses cable suspension systems to support a very light guideway beam from which vehicles are suspended. Three U.S. demonstration projects, funded through the Intermodal Surface Transportation Efficiency Act are underway. No operating examples of this technology exist at this time.

A technology overview is provided for the PRT technology on the following page. Magnetic levitation and suspended light rail provide alternative means of vehicle support and guidance for the GRT technologies that were discussed earlier in this report.


TWA

PERSONAL RAPID TRANSIT

Personal rapid transit is a concept which is intended to provide direct point-to-point transit service to individuals and small parties. The small vehicle size and advanced propulsion system are intended to reduce the size and cost of the required guideway system. An automated control system would route vehicles directly to passengers' selected destinations without stops, providing a level of service competitive with private vehicle travel. The PRT concept is most applicable to areas with multiple trip origins and destinations which cannot be served with a simple linear transit system. The PRT technology has yet to be proven in actual operation.

Advantages

Flexible passenger capacity.

Private point-to-point transportation.

Light weight, small vehicles and guideways.

Quiet, non-polluting.

Short walking distances.

Readily responds to unforeseen fluctuations in demand.

Novelty value may attract riders.

Automation reduces labor costs.

Designed to compete directly with private vehicle travel.

Short headways due to automation.

Grade separation allows uninterrupted operation.

Allows free movement of pedestrians and wildlife.

Disadvantages

High initial cost.

Requires almost as many vehicles as existing automobiles.

Extensive elevated network required.

Technology is not yet mature.

Requires electric power supply and distribution system, which may not be available in remote areas.

Requires specialized maintenance facilities and skilled personnel.

Cannot operate without a sophisticated, reliable dispatching and routing system for vehicles.

Elevated guideways may be visually intrusive.

Complex stations required, with elevators for visitors with disabilities.

May be incompatible with rustic or wilderness environments.

Physical Data

Length	8 to 9 feet
Width	4-5 feet
Right of Way:	
One-way	6.6 feet
Two-way	11.5 feet
Height	5 to 6 feet
Weight	1,100 lb.
Power Source	Electric current

Economic Data

Initial Cost ($M):	
Vehicles	$0.08
Guideway	$4/mile
Stations	$0.5 each
Estimated Life	20 to 25 years
Operating Cost	$0.20 to $2.00/passenger-mile

Operating Data

Top Speed	25 to 45 mph
Maximum Grade	15 percent
Minimum Curve Radius	36 to 110 feet
Passengers	3
Power Requirement	600 Vdc

Notes:

1. *National Parks for the 21st Century, The Vail Agenda,* National Park Service, Washington Office, 1991.

2. *Park Roads and Parkways, Assessment of Conditions and Funding Options,* Federal Highway Administration, 1990.

3. 1916 organic act that established the National Park Service *(16 USC 1 et seq).*

4. *National Parks for the 21st Century, The Vail Agenda,* National Park Service, Washington Office, 1991.

5. *Park Roads and Parkways, Assessment of Conditions and Funding Options,* Federal Highway Administration, 1990

6. *Procedures and Technical Methods for Transit Project Planning,* Federal Transit Administration, 1990.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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