MOOSE–WILSON CORRIDOR
ADAPTIVE MANAGEMENT PLAN (DRAFT)

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GLOSSARY OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic for some period less than a year
AASHTO	American Association of State Highway and Transportation Officials
AMP	Adaptive Management Plan (referring to this document)
CRF	Crash Reduction Factor
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
LSR Preserve	Laurance S. Rockefeller Preserve
MOE	Measure of Effectiveness
mph	Miles per hour
MVMT	Million Vehicle Miles Travelled
MWR	Moose–Wilson Road
NPS	National Park Service
PTSF	Percent Time Spent Following
ROD	Record of Decision (for the environmental impact statement)
START	South Teton Area Rapid Transit
vpd	Vehicles per day

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EXECUTIVE SUMMARY

As part of Grand Teton National Park's Transportation Plan, management strategies have been recommended for Moose–Wilson Road. Moose–Wilson Road is a rustic, narrow, two-lane road that connects the park's Granite Canyon Entrance Station with the community of Moose, and goes through some of the best wildlife viewing areas in the park. Management strategies have been recommended because of a group of interdependent challenges and issues that are affecting the road corridor:

- Traffic Growth. Traffic volumes on Moose–Wilson Road doubled between 1988 and 2003, and traffic is projected to continue to grow in the future. While the road operates acceptably from an engineering perspective, park personnel believe that the road is at its capacity from the perspectives of visitor experience and resource protection.

- Connectivity and Compatibility. Some members of the community desire improved mobility on Moose–Wilson Road for bicycle and pedestrian road users. However, the narrow width of the current road generally prevents a solution that would separate bicycles and pedestrians from two-way vehicle traffic. This may discourage use of these alternate modes of travel while jeopardizing the safety of those who choose to use them.

- Sensitive Environment. The Moose–Wilson Road corridor includes wetlands and wildlife habitat that would be impacted both by increased traffic and by changes or major improvements to the road corridor, such as a separated multiuse pathway.

- Access Requirements. Moose–Wilson Road serves a variety of road users, including park visitors, private landowners within the park boundary, emergency responders, park personnel and contractors. Maintaining vehicle access to these road users is at least optimal, and in some cases mandatory.

The park contracted with the Western Transportation Institute at Montana State University to identify approaches for managing Moose–Wilson Road that could be used to address these issues. The goal was to develop a transportation management approach that enhances connectivity, compatibility between users of different modes, and preserves access to key road users (such as emergency responders and private landowners within the park boundary), while keeping traffic volumes at current levels and maintaining the existing footprint of the roadway in order to protect the sensitive environment through which Moose–Wilson Road passes. A Transportation Assessment Report was delivered in 2006 that:

- provided information on unique traffic management strategies used in other national parks,

- identified 34 different potential road management strategies (see Table 3-1 on page 14),

- with the help of park personnel, narrowed management strategies to seven core strategies,

- identified 52 performance measures to evaluate how well strategies meet needs and goals,

- consolidated ratings by park staff of the core strategies against these performance measures, and

- provided an adaptive management framework for implementing core strategies.

Since the 2006 report, several activities have created a need to update the report. Data collection efforts provided better insight into the current condition of travel on Moose–Wilson Road and the magnitude of potential impacts of various strategies. New facilities have been completed including the Laurance S. Rockefeller (LSR) Preserve visitor contact area and a separated non-motorized pathway on a portion of Teton Park Road, which intersects with the northern terminus of Moose–Wilson Road.

This report provides an update to the 2006 report. From the original report, this document contains:

- background on the Moose–Wilson Corridor (Sections 2.1 and 2.2),

- an overview of different potential strategies (Sections 2.3),

- a discussion of how those strategies were reduced to the seven core strategies (Chapter 3),

- a detailed description of the core strategies (Chapter 4),

- how park personnel initially ranked these strategies (Chapter 5), and

- a plan for implementation (Chapter 7).

- In addition to updating these sections in the context of new information, this update includes:

- a summary of the data collected along Moose–Wilson Road (Appendix C), and

- an analysis of potential impacts of the core strategies (Chapter 6), which was made possible by the collection of data that was not available at the time of the 2006 report.

Core Strategies

The research team developed core strategies that could be used to manage the road. These strategies were developed under the constraints of maintaining two-way motor vehicle access on the existing Moose–Wilson Road between Moose and the new LSR Preserve visitor contact area, and between the Granite entry and the Granite Canyon trailhead. Seven core strategies were considered:

- Reversible lanes (Core Strategy A; see Table 4-2 on page 23)

- Northbound only (Core Strategy B; see Table 4-3 on page 24)

- Southbound only (Core Strategy C; see Table 4-4 on page 25)
- Installation of a gate on Moose–Wilson Road restricting through trips (Core Strategy D; see Table 4-5 on page 26)
- Restricting auto access by time of day (Core Strategy E; see Table 4-6 on page 26)
- Restricting auto access from a portion of the road (Core Strategy F; see Table 4-7 on page 27)
- Creating a separate multi-use pathway (Core Strategy G; see Table 4-8 on page 27)

Complementary strategies and various intensity levels were considered as ways to enhance or modify these core strategies. As a result, 80 different strategy combinations were considered as potential management approaches for Moose–Wilson Road.

Performance Measures

To compare core strategies, the research team identified a set of 52 performance measures (see Table 5-1). These performance measures were developed based on a review of park documents and consultation with park personnel. Potential data sources or measurement methods were identified to facilitate subsequent evaluation of the parameters.

The performance measures were grouped under three major goals: enhance visitor experience, preserve the character and integrity of Moose–Wilson Road, and improve management of traffic on Moose–Wilson Road. These goals were divided into a total of 12 objectives (Table ES-1) whose attainment could be assessed in terms of the 52 performance measures. Each strategy was evaluated on each performance measure to determine its potential aggregate effectiveness in achieving each of the 12 objectives. The results of this evaluation are presented in Table ES-1. In viewing the assessments presented in Table ES-1, it is important to note that in many cases they were based on professional judgment rather then a formal structured analysis. Often formal methods and the requisite data needed to employ them were unavailable.

Table ES-1: Assessment of Strategies

Objective		Strategy with Intensity Option													
		Reversible		*1-Way North*		*1-Way South*		*Gate*		*Time of Day*			*Limited Auto*		*Path*
		A0	A1	B0	B1	C0	C1	D0	D1	E0	E1	E2	F0	F1	G0
Goal 1: Enhance visitor experience															
1.1	Visitors usage of MWR	B	C	B	B	B	B	C+	C+	C	C	C	C	C	A
1.2	Visitor access	B	B	B+	B+	C+	C+	B	B	B	B	B	C+	C+	A
1.3	Variety of ways to experience park	C	C	C	C	C	C	C	C	D+	D+	D+	C	C	C
1.4	Visitor safety	C+	C+	B	B	B	B	C+	C+	B	B	B	B	B	B
1.5	Visitor contact opportunities	C	C	C	C	C	C	C	C	C	C	C	C	C	C
1.6	Visitor satisfaction	C+	C	C+	C+	C+	C+	C	C	C	C	C	D+	D+	C
Goal 2: Preserve the character and integrity															
2.1	Support alternative modes	C+	C+	C+	C+	C+	C+	C+	C+	C+	C+	C+	B+	B+	B
2.2	Minimize environmental impacts	B+	B+	B+	B+	B+	B+	B+	B+	A	A	A	A	A	D
2.3	Minimize aesthetic impacts	C+	C+	B+	B+	B+	B+	B+	B+	B	B	B	B+	B+	D
Goal 3: Improve management of traffic															
3.1	Reduce non-park traffic	C	C	C+	C+	C+	C+	A	A	C+	C+	B	A	A	E+
3.2	Preserve access to key road users	C+	C+	C	C	C	C	C+	C+	C	C+	C+	D+	C+	A
3.3	Strategy suitable for future	C	C	C	C+	C	C+	C	C	C	C	C	C	C+	C+

Legend
- A Exceptionally Good
- B Above Average
- C Average
- D Below Average
- E Worst Case

Synopsis of Strategies

A0 – Reversible Flow, Granite Canyon to Death Canyon
A1 – Reversible Flow, Granite Canyon to Death Canyon, with time changes
B0 – One-Way Northbound, Granite Canyon to Death Canyon
B1 – One-Way Northbound, Granite Canyon to Death Canyon; permit some to go southbound
C0 – One-Way Southbound, Granite Canyon to Death Canyon
C1 – One-Way Southbound, Granite Canyon to Death Canyon; permit some to go southbound
D0 – Gate Restriction on Through Traffic
D1 – Gate Restriction on Through Traffic, Permit Additional Vehicles
E0 – Time of Day Restriction, Granite Canyon to Death Canyon
E1 – Time of Day Restriction, Granite Canyon to Death Canyon, permit more vehicles
E2 – Time of Day Restriction, Granite Canyon to Death Canyon, with time changes
F0 – Limited Auto Access, Granite Canyon to Death Canyon
F1 – Limited Auto Access, Granite Canyon to Death Canyon, permit more vehicles
G0 – Separated Pathway

Following this work, park personnel ranked the 52 performance measures to help identify which measures were most critical in evaluating which strategy should be implemented and whether a management strategy has been successful. The 2006 report identified 22 critical performance measures. Based on experience with data collection, three were removed because they proved to be infeasible to measure. The remaining 19 performance measures are shown in Table ES-2.

Table ES-2: Performance Measures to be Evaluated

Goal/Objective	Park Rating
1.3.1. Preserve wildlife viewing opportunities	Most Critical
2.2.1. Preserve wildlife populations in the Moose-Wilson corridor	Most Critical
3.3.1. Minimize confusion and misunderstanding among road and park users	Most Critical
1.3.2. Preserve auto touring opportunities	Very Critical
1.4.1. Maintain or reduce vehicle speeds	Very Critical
1.6.1. Preserve visitor satisfaction ratings among first-time visitors	Very Critical
1.6.2. Preserve visitor satisfaction ratings among non-local visitors	Very Critical
3.1.1. Reduce volume of "commuter" traffic (regular users who do not visit park)	Very Critical
3.1.2. Reduce volume of shortcut traffic (occasional users who do not visit park)	Very Critical
1.1.1. Preserve visitation (not vehicle) levels on Moose-Wilson Road and its sites	Somewhat Critical
1.3.3. Enhance bicycle touring opportunities	Somewhat Critical
1.4.3. Reduce number and severity of vehicle-vehicle collisions	Somewhat Critical
1.4.5. Reduce number and severity of vehicle-bicycle collisions	Somewhat Critical
1.4.7. Reduce number of roadkills	Somewhat Critical
1.5.1. Increase percentage of visitors who go through an entrance station	Somewhat Critical
1.6.3. Preserve visitor satisfaction ratings among local visitors who access the park by auto	Somewhat Critical
1.6.4. Preserve visitor satisfaction ratings among local visitors who access the park by bicycle	Somewhat Critical
2.1.2. Increase mode share of non-auto modes on Moose-Wilson Road (transit or bicycle)	Somewhat Critical
2.1.1. Increase average vehicle occupancy of motor vehicles on Moose-Wilson Road	Not as Critical

Phasing Plan

The 2006 report recommended first implementing a one-way strategy (Strategies A, B or C) with the following considerations:

- The existing road footprint is maintained, and the existing unpaved portion of Moose–Wilson Road remains unpaved
- Two-way vehicle access is maintained between Moose and LSR Preserve, and between the Granite entry and the Granite Canyon trailhead
- One lane of motor vehicle access is provided between LSR Preserve and Granite Canyon trailhead, with the remainder of the existing road set aside for non-motorized road users
- Emergency vehicles would maintain their current access to the road

Initial Implementation

Choosing which one-way strategy to initially implement required collecting and analyzing data to predict the impact of each choice. Based on this analysis, Strategy B, one-way northbound, was determined to be the best one-way strategy. Reasons (see Chapter 6 for more detail) for this recommendation include:

- There is no foreseeable difference in safety between the one-way strategies.
- The fewest number of vehicles will be impacted. Slightly more than half the vehicles are travelling northbound (51.5%). Thus one-way southbound (Strategy C) would impact slightly more vehicles than one-way northbound. Reversible flow (Strategy A) will impact almost twice the number of vehicles than one-way northbound primarily because there is significant flow in both directions mid-day that would be impacted while the one-way direction was being reversed.
- Entrance contact opportunities are the highest because all vehicles will be required to pass the Granite Canyon Entrance Station on the south end.

Future Phasing

Transportation management of Moose–Wilson Road in future years should reflect the evaluation of the performance measures and the level of achievement of management goals. Table 7-2 (see page 51) provides decisive values for each of the critical performance measures. Table 7-3 (see page 53) provides data sources and baseline values for comparison of these performance measures. Evaluation of these performance measures will lead to one of three conclusions, as shown in Figure ES-1:

- monitor, where the strategy succeeds in meeting the park's performance measures, and the park continues to monitor its effectiveness over subsequent seasons;
- improve, where the strategy does not succeed in meeting all of the park's performance measures, but may be modified through the addition, modification or removal of complementary strategies; and
- reject for unacceptable flaw, where there is a negative evaluation outcome that requires adoption of an entirely different management approach (core strategy).

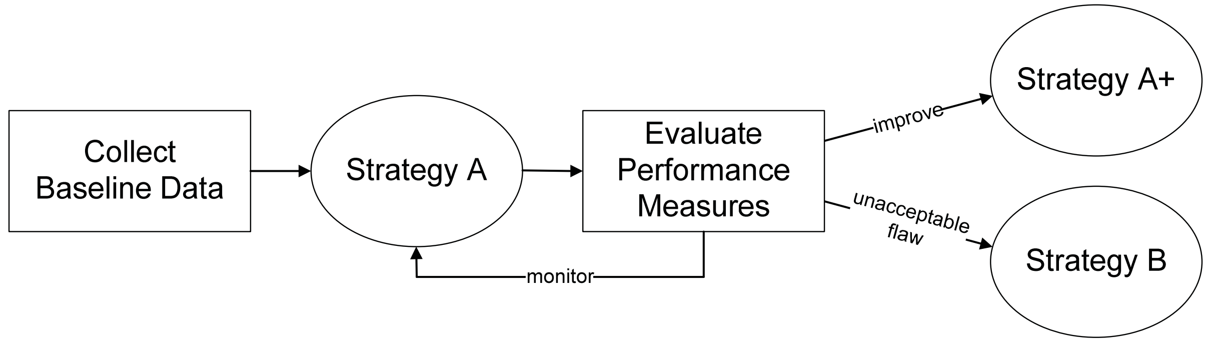


Figure ES-1: Evolution of Traffic Management Strategies Example

This approach may be used to guide implementation of management strategies over time. The report includes flow charts (see Figures 7-2 through 7-5 on pages 56 through 59) that depict this process in greater detail.

External Factors

The best management approach for Moose–Wilson Road may be affected by a variety of external factors including, but not limited to, improvements in the roadway network outside of the park, changing land uses within the park, and regional transit improvements. These factors could be decisive in identifying the best management approach for the road, or could alleviate the need for management of the road at all.

Next Steps

This report does not make a recommendation of whether or not to maintain the status quo. The park should revisit the current situation on Moose–Wilson Road, considering the findings of this report, and determine if a new management strategy is needed. If the status quo is not an acceptable option, the following steps are recommended for the park to proceed with implementation of an adaptive transportation management approach.

- Publicize the transportation management strategy to stakeholders/park users through local outreach and media, as well as the park's web site and similar venues.
- Implement the one-way northbound strategy.
- Evaluate the strategy through data collection efforts after a season of implementation.
- Based on the results of the evaluation, at the conclusion of a season of implementation, maintain, modify or reject the one-way northbound flow strategy.
- Continue to monitor and evaluate management strategies in future years.

1. INTRODUCTION

According to its mission statement, the National Park Service (NPS) exists to "[preserve] unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations" (1). This statement captures well the multiple objectives that parks must balance in their management: protecting resources, while making the resources accessible to be experienced and enjoyed by the public. The enjoyment of these resources by the public entails transportation—getting people to the park and around park sites. Efforts between the 1940s and the 1960s, such as the creation of the Interstate Highway System and the NPS's Mission 66 infrastructure renewal initiative, enabled people to have easier access to national parks by using their vehicles (2). Visitation to national parks consequently grew considerably, as have issues related to resource protection.

The relationship between transportation needs and resource protection has been emphasized in recent years. As noted on the NPS's Alternative Transportation Program web site (3),

> "*The fundamental purpose* of the National Park System is resource preservation. Visitors can experience and learn about their natural and cultural heritage in parks. Most visitors arrive by private auto and, in some cases, this has begun to threaten the very resources parks were created to protect."

Grand Teton National Park in northwestern Wyoming was enlarged to near its present size in 1950, a time when automobile mobility and access was heavily promoted nationwide. Like other parks, Grand Teton has experienced considerable growth in visitation since that time. Like some other parks, this growth in visitation has pushed usage of some of the park's roads to the point that resource protection issues are emerging, such as along Moose–Wilson Road in the southwestern portion of the park. Moose–Wilson Road is a rustic, relatively low-volume road that provides access to several park destinations, and also allows visitors to see some of the best wildlife habitat in the park. The road connects with WY 390 outside of the park, an important component in the broader regional, multimodal transportation network, and a significant tourism corridor. Traffic volumes on the Moose–Wilson Road are currently at levels that are threatening the ability to protect corridor resources and preserve the quality of the visitor experience. Increasing tourism and population growth in the region are expected to make this problem worse. In order to preserve the pristine nature of the corridor, the park looked at management or operational strategies for Moose–Wilson Road as a part of its transportation plan environmental impact statement (EIS) (4), and record of decision (ROD) (5), which are summarized in Chapter 2.

At the time the EIS/ROD was being developed, Grand Teton National Park contracted with the Western Transportation Institute to examine and prioritize transportation management strategies that would be suitable for addressing the challenges on Moose–Wilson Road. The Moose Wilson Corridor Transportation Assessment (6) was submitted in June 2006. The report 1) summarized the research team's understanding of the challenges and issues related to Moose–Wilson Road, 2) presented transportation management strategies to address these challenges and issues, 3) listed performance measures that can be used to guide decisions on strategy implementation, and 4) presented a framework for a phasing plan to implement and evaluate strategies. One primary issue identified in that report was the absence of the data required to evaluate strategies that were considered or attempted. Since the 2006 report, data relating to Moose–Wilson Road has been collected through several efforts (7). These efforts will be further described in Chapter 2.

This document is an update of the June 2006 report and incorporates activities and data collection that have occurred since 2006. Chapter 2 provides an overview of the challenges in managing Moose–Wilson Road and a review of potential traffic strategies attempted in other national parks. Chapter 3 lists the numerous possible strategies identified in the 2006 report and the initial efforts to pare them down to the most feasible strategies. Chapter 4 provides more detail on these most feasible strategies. Chapter 5 provides the initial ranking by Grand Teton Park staff of these strategies. Since this initial ranking, several data collection efforts have occurred. Chapter 6, the main update since 2006, provides details on the potential impacts of the various strategies based on analysis of data collected. Chapter 7 discusses next steps and implementation of management strategies.

2. BACKGROUND

2.1. Project Context

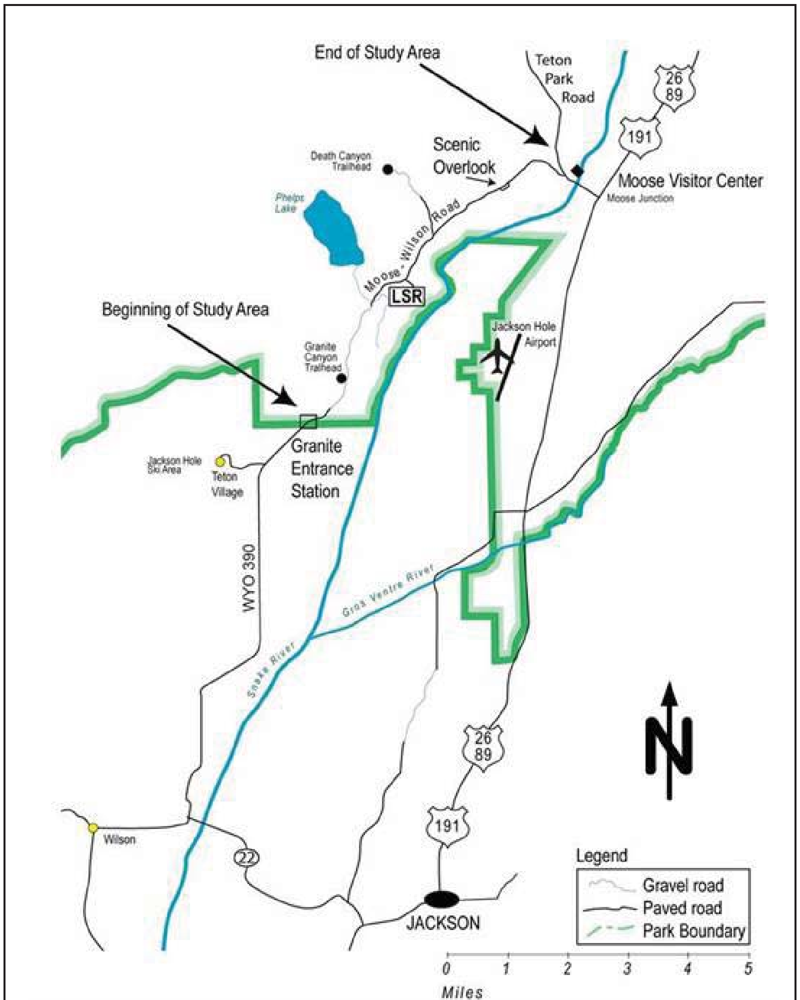


Figure 2-1: Map of Moose–Wilson Road

Moose–Wilson Road is located in the southwestern portion of Grand Teton National Park, and connects WY 390 near the Granite Canyon Entrance Station to Teton Park Road near the Moose Entrance Station. The road provides access to several park features, including the Granite Canyon and Death Canyon trailheads, White Grass Ranch, and the Laurance S. Rockefeller (LSR) Preserve. The road also goes through rich wildlife habitat where bear, moose, elk, deer and other animals may be viewed from the road. As wildlife viewing is one of the two most frequently cited reasons for visiting the park (8,9), Moose–Wilson Road represents a compelling visitor experience in itself.

The road is a two-lane, winding, narrow roadway with a posted speed of 25 mph for much of its length. It currently goes through forested sections and some wetlands. Most of the road is paved, with the exception of the section from the Granite Canyon trailhead to the southern end of the LSR Preserve. The entire road is open to cars and bicycles between May and October. Access by trailers, buses and RVs is restricted due to road geometrics and road surface quality. During the winter, the road is closed between Granite and the south LSR Preserve entrance; however, it is open from the south to the Granite Canyon parking lot and plowed from the north to the south LSR Preserve entrance, to provide access to private lands.

An exploration of transportation management strategies on Moose–Wilson Road is included as a common element of transportation alternatives considered in the park's transportation plan EIS/ROD (5):

> "Over the next several years, the NPS may test a number of different strategies identified in the AMP [Adaptive Management Plan] for managing traffic, as well as pedestrian and bicycle use on the Moose–Wilson Road…. These strategies, if implemented, will be seasonal and/or temporary and will involve segments or portions of the Moose–Wilson Road to provide information to the NPS for developing a long-term solution in conjunction with future long-term planning efforts."

This transportation plan EIS/ROD identified a preferred alternative that included multi-use pathways outside and inside the road corridor ("inside" referring to within the existing footprint of the roadway including cut and fill areas and clear zones). The pathway on Moose–Wilson Road is planned to be inside the road corridor and travel:

> "along the Moose–Wilson Road from the Granite Canyon Entrance Station to the new Laurance S. Rockefeller (LSR) Preserve (a distance of approximately 3.3 miles). The Moose–Wilson pathway will begin at the Granite Canyon Entrance Station and extend to the north end of the unpaved section of road. At that point, the pathway will divert eastward and follow the long-established alignment of the unpaved levee access road to the new LSR Preserve" (5).

This exploration is motivated by several challenges that form the context in which Moose–Wilson Road operates, and how that context may change in the future. These challenges and issues are discussed in the next section.

2.2. Challenges

The research team has identified four broad challenges, listed in no particular order, which are motivating this examination into transportation management strategies on Moose–Wilson Road.

2.2.1. Traffic Growth

To determine the impact of traffic on Moose–Wilson Road, it is important to define the road's capacity. The Highway Capacity Manual (HCM) defines capacity as "the maximum amount of traffic that can be accommodated by a facility while prescribed operational qualities are maintained" (10). Its capacity estimation procedures, used as a standard throughout traffic engineering and highway design, presume high-speed operation of a facility. In the case of two-lane rural highways serving scenic and recreational environments, HCM notes that while these roads should operate reasonably safely, they do not require high-speed operation (10).

Baseline capacity of a two-lane rural highway, before adjusting for factors such as traffic composition, directional split, lane width and grades, is estimated by HCM at 1,600 vehicles per hour in each direction (11). However, these procedures presume a highway that has a posted speed limit of 45 or more miles per hour. As such, any road with operating speeds of 25 to 40 mph would be characterized as being at or near capacity, even if that speed agrees with the posted speed limit. Moreover, the Federal Highway Administration, in documentation supporting its Highway Performance Monitoring System, does not define capacity for unpaved roads (11), and recent research has shown that the level of road roughness can reduce actual highway capacity (12).

Note that although HCM methods may not accurately predict actual capacity, it could be used to compare different strategies. Section 6.3 uses these methods to compare potential impacts of different management strategies. The current capacity using HCM methods is estimated at 318 vehicles per hour.

Because the HCM may not be appropriate for determining capacity on Moose–Wilson Road, the practical capacity may depend on other factors more directly related to the park's values. As stated in the National Park Service Management Policies (2001), "Park roads are generally not intended to provide fast and convenient transportation; rather, they are intended to enhance the quality of a visit, while providing for safe and efficient travel, with minimal or no impacts on natural and cultural resources" (13). Park road design standards put the capacity at 200 vehicles per day for a road the size and type of Moose–Wilson Road. Further information on park road design standards is included in Appendix A. Park personnel agree that traffic volumes are approaching the carrying capacity of the road from visitor experience and wildlife habitat perspectives. Increasing traffic would, therefore, create a level of congestion unacceptable to the park and its mission.

Traffic along Moose–Wilson Road may be broadly categorized into visitors (those who seek to experience the park in some way) and commuters (those who are using Moose–Wilson Road but not to experience the park). Traffic volumes on Moose–Wilson Road show annual average daily traffic (AADT) volumes[3] nearly doubling from 372 in 1988 to 729 in 2003 (14). Current average summer volumes are around 1,200 vehicles per day (vpd). The road sees an average of 1,870 vehicles per day during the peak month (July) with several days over 2,000. Visitation data over the same period is difficult to compare because of a substantial change in counting methodology introduced in 1992 (15). Since 1993, recreational visitation has been relatively static, while non-recreational visitation has increased, as shown in Figure 2-2. Since there have been changing patterns in visitation over that time, it is unclear how much of this growth is from commuters. Anecdotal evidence from park staff indicates that 50 percent of Moose–Wilson Road traffic during the summer months may be commuter-oriented.

[3] These are annual volumes, which include the winter months when a portion of the road is closed to vehicle traffic.

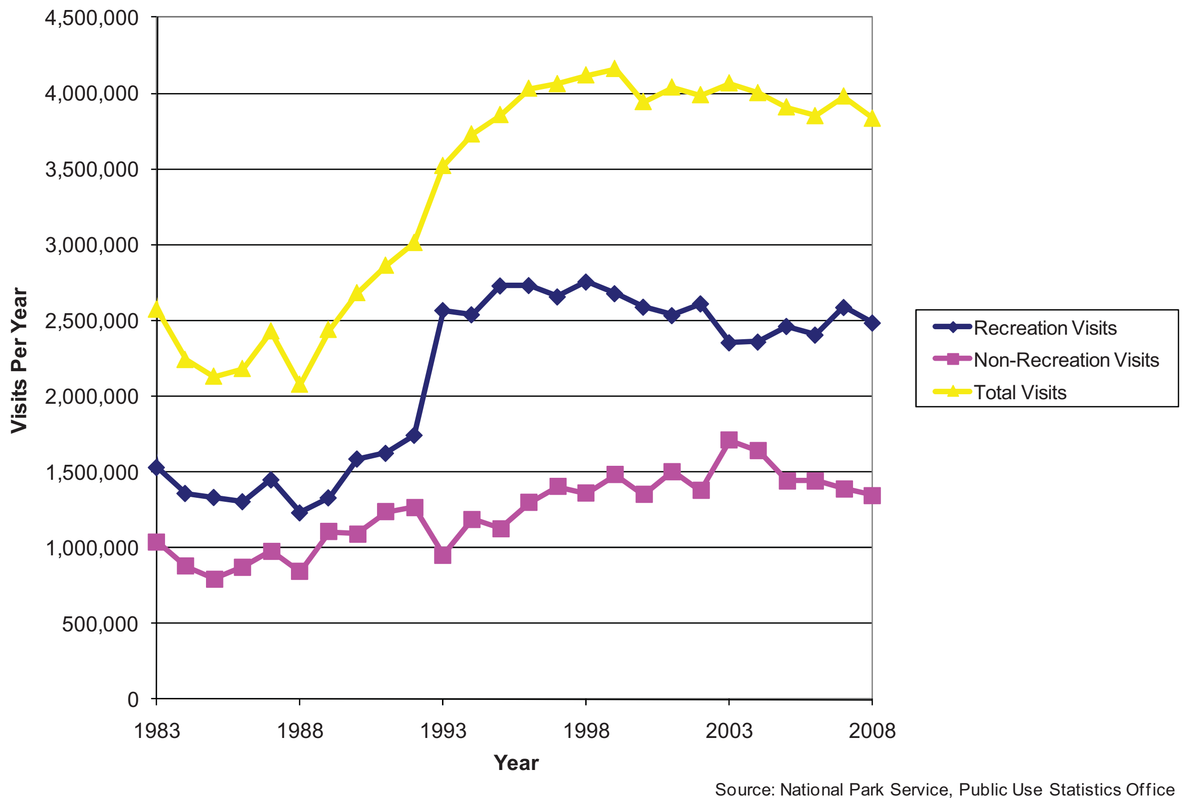
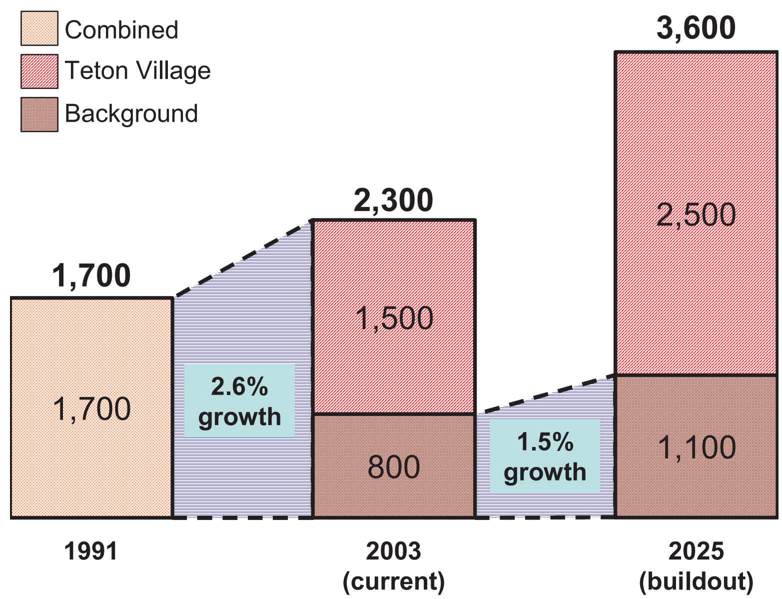


Figure 2-2: Grand Teton National Park Visitation, 1983–2008

There are challenges related to growth outside of the park, through new traffic coming from Teton Village (just south of the Granite Canyon Entrance Station) and general growth in the county. Teton Village's revised master plan includes a full buildout of nearly 6,500 beds and 280,000 square feet of commercial space (16). A traffic impact study prepared by Snake River Associates for the Teton Village Expansion Resort Master Plan assumes that 20 percent of summer traffic entering or leaving Teton Village will be to/from the north (17). Correspondingly, it is assumed that 20 percent of Teton Village traffic uses Moose–Wilson Road to the north. With few access points between Teton Village and the park, this traffic impact would be expected to go on at least the southern part of Moose–Wilson Road. The author of the traffic impact study suggests that this traffic would be park visitors, not cut-through traffic (18).

Traffic volumes forecast for the south end of the park's portion of Moose–Wilson Road in the Teton Village study are shown in Figure 2-3. The portion of the columns labeled Teton Village represents traffic using Moose–Wilson Road through the park; the portion labeled "Background" refers to traffic neither to nor from Teton Village. Both streams of traffic may include a mix of commuters and visitors. Three years are shown: 1991 for historical reference, 2003 as the baseline condition, and 2025 as planned buildout for Teton Village. While traffic from Teton Village is projected to comprise nearly 70 percent of traffic on Moose–Wilson Road by 2025, it should be noted that even without full buildout at Teton Village, forecast traffic volumes for Moose–Wilson Road would increase, based on projected increases in background (i.e., non-Teton Village) traffic.



(Source: 17)

Figure 2-3: Daily Summer Traffic Volumes at South End of Moose–Wilson Road

If Moose–Wilson Road is already at its carrying capacity from a park management perspective, it is clear that further traffic growth will cause the road to operate in an unacceptable condition in the future. According to NPS Management Policies, "When roads are chronically at or near capacity, the use of alternative destination points or transportation systems, or limitations on use, will be considered as alternatives to road expansion" (13). Therefore, discerning the reasons for this traffic growth—increased usage by commuters and/or changing use by visitors—will be critical in ensuring that the road continues to meet the needs of the park.

2.2.2. Connectivity and Compatibility

Of the four objectives in the park's transportation plan EIS, two relate directly to supporting sustainable, non-motorized transportation options such as bicycles (4):

- "Provide improved opportunities for visitors to enjoy the park safely by providing additional travel/recreational options, both motorized and non-motorized," and
- "Reduce and manage the level of traffic and parking congestion at key locations."

The feasibility of these modal options depends on whether there is a viable network for that mode (connectivity) and, when a network is shared between multiple modes, whether those modes are compatible. Currently, no transit service is provided for park visitors along Moose–Wilson Road, partially due to visitors' trip patterns and the geometric constraints of the road. Consequently, current challenges of connectivity and compatibility relate more to non-motorized modes, specifically bicycles.

Currently, bicyclists are permitted on Moose–Wilson Road and share the road with motor vehicle traffic. A separated multiuse (bicycle) pathway exists along WY 390 up to the Granite Canyon Entrance Station (19), so bicycle travelers have network connectivity between Moose and Teton Village, and points further south.

An earlier transportation study recommended separated pathways to enhance the visitor experience and address safety concerns from potential vehicle–bicycle conflicts (cited in 4). Although accidents involving bicycles are rare in Grand Teton National Park, two fatalities resulting from motor vehicles striking bicyclists who were riding on road shoulders elsewhere in the park focused attention on the issue. On Moose–Wilson Road, the limited sight distance and narrow lanes can sometimes reduce drivers' or cyclists' awareness of other vehicles or bicycles, especially when distracted by wildlife near the roadside. At the same time, the slow travel speeds on Moose–Wilson Road may help to mitigate potential crashes. In response to an interest by some members of the community, the park's transportation plan EIS included the evaluation of a separated pathway along the Moose–Wilson Road (4).

While modal connectivity and compatibility support the use of alternative transportation modes along the corridor, it is important to note that existing usage of alternative modes is relatively low. As was mentioned earlier, there is no transit service for park visitors along this corridor. In 2005, two surveys were conducted regarding bicycle entry into Grand Teton National Park. The survey showed that approximately 0.8 percent of vehicles entering through the Granite Canyon Entrance Station were bicycles (20). On average, over the two-week survey period, seven bicycles per day were counted entering the park through Granite. Using a value of 2.5 persons per motor vehicle, 0.3 percent of people entering through Granite were on a bike. The proportion of bicycle traffic was higher at Granite than at the other two park entrance stations. According to an earlier visitor survey, about 4 percent of visitors use bicycles recreationally within the park (8). The difference may be accounted for by visitors who drive into the park and bicycle once within the park. Data collected in 2006 (Appendix C) reveals similar numbers with 1.6 percent of vehicles being bicycles, 2.25 persons per auto, resulting in 0.7 percent of people enter Moose–Wilson Road on bike. The challenge is to provide connectivity and address compatibility issues to ensure equitable access for visitors across all modes.

2.2.3. Sensitive Environment

As was mentioned in the introduction, Moose–Wilson Road provides prime wildlife viewing opportunities in a relatively pristine rural setting. Aspects of the sensitivity of the Moose–Wilson Road environment are described in Chapter 3 of the transportation plan EIS (4):

- Visual and Scenic Quality. Ninety-six percent of visitors have said that scenic views were very or extremely important to their park experience (8). The plan describes Moose–Wilson Road as "known for its natural rural character and potential for viewing wildlife."

- Soil and Vegetation. The Moose–Wilson Road corridor represents "a mosaic of soil and drainage types," which supports a diverse vegetation "comprised of sagebrush shrubland, conifer forest, grassland meadow, riparian/wetland, aspen, and cottonwood." The dominant cover type is lodgepole pine forest.

- Wetlands. The northern part of Moose–Wilson Road is located adjacent to "extensive scrub-shrub and palustrine emergent wetlands."

- Wildlife. Moose–Wilson Road passes through very rich wildlife habitat, with regular sightings of elk, black bear, deer, moose and other animals near the roadway. Areas along Moose–Wilson Road are important for elk calving, which peaks around June 1, and large numbers of elk move through the area each spring and fall. The road also passes through the Granite lynx analysis unit. There are few roadkills along Moose–Wilson Road (21), but this could result from lower vehicle speeds than elsewhere in the park.

Any additional infrastructure could have negative impacts on the sensitive environment along Moose–Wilson Road. Separated multi-use pathways have been considered in the park's transportation plan EIS. The separated pathway under the preferred alternative along Moose–Wilson Road would require removal of 2,150 to 2,900 trees. There are concerns that the unpredictability of pathway users could make it more difficult for some wildlife to adjust to this new use, resulting in additional habitat displacement and fragmentation.

2.2.4. Access Requirements

Moose–Wilson Road provides access to a variety of road users. Maintaining and managing access for these road users is a significant challenge.

From the park's perspective, access for park visitors is of paramount importance. For Moose–Wilson, access relates to accessing the scenic features along the road, as well as accessing park sites. The road currently has few pullouts, so "wildlife jams" often occur when wildlife are spotted near the road. Since the opportunity to see wildlife is a key aspect of the visitor experience, this type of access needs to be considered. There are also popular sites along the road, including Granite Canyon and Death Canyon trailheads. The unpaved parking lots at each location are generally full and overflowing starting at 10 AM on a typical summer day.

Access is also an important consideration in two redeveloped areas along Moose–Wilson Road. The LSR Preserve was officially conveyed to the park on November 5, 2007, and opened to the public on June 22, 2008. The LSR Preserve includes access to hiking trails, a visitor contact station and a small parking lot (capacity of approximately 50 vehicles). White Grass Ranch is being rehabilitated as a satellite location for the park's new historic preservation center, which will attract some seasonal traffic. Neither of these redevelopments is expected to dramatically change traffic patterns within the park over the long-term; however, they will require some level of visitor and staff access.

Grand Teton National Park has some privately owned land within the park boundary, including along the Moose–Wilson Road corridor. These landowners are typically seasonal residents and are estimated to be responsible for less than 1 percent of trips on the road during peak summer months. The park is required to preserve some level of access to these landowners (21). In addition, according to NPS management policies, commercial traffic serving park visitors and park operations may be allowed on Moose–Wilson Road, and superintendents may permit commercial vehicles to use park roads when necessary for access to private lands within or adjacent to a park area to which access is otherwise not available. Providing access to these parties and concessioners, such as those with horse trailers, is a consideration.

Another aspect of access relates to Teton Village. As was indicated earlier, the traffic impact study for expansion of Teton Village shows 20 percent of summer trips going on WY 390 to/from the north—i.e., onto Moose–Wilson Road. The study authors indicated that these trips were primarily for visiting the park as opposed to commuting to/through the park. Teton Village's projected land use consists primarily of lodging, retail and commercial establishments, with some residential development. According to park personnel, one aspect of promotion for Teton Village is that the park is its "backyard"; therefore, those promoters will feel that preserving some level of access will be important from a community and economic development perspective.

Finally, access must be maintained for other users, such as the Army Corps of Engineers for the levees toward the north end, emergency responders, and people with physical disabilities.

2.3. Transportation Management in National Parks

The National Park Service's Transportation Planning Guidebook notes one option for improving access and reducing traffic congestion is to maximize use of the existing road system (22). This is in concert with national efforts that have focused on improving operations of the transportation system, rather than simply reducing congestion by expanding the infrastructure. According to the Federal Highway Administration's Office of Operations web site, "This initiative builds on the thought that we can do more to operate the transportation system so that it performs better to meet customer expectations regardless of the demands placed on it. Better approaches to operations on the transportation network are a viable and effective strategy to help improve traffic flow and meet growing travel demands" (23).

The use of transportation management strategies in national parks has precedent. National Park Service units were examined to provide examples of the strategies being considered for Moose–Wilson Road. Information was collected primarily through telephone interviews and e-mail communication. Specific examples are presented below of the operational strategies of reversible flow, one-way traffic, and limited auto access.

2.3.1. Reversible Flow

Rock Creek Park (Washington, DC)

The Rock Creek and Potomac Parkway runs through Rock Creek Park and practices reversible flow traffic during the week to accommodate commuter traffic. The Parkway is southbound only during the morning (6:45 to 9:45 am) and northbound only during the evening (3:45 to 6:30 pm). At other times (including weekends) the Parkway services both directions of traffic. Bicyclists are not allowed on the Parkway, but can use an adjacent bike and foot trail.

The road was completed in 1935 and within 13 months the road began practicing time-of-day reversible flow. The United States Park Police are responsible for ensuring properly oriented traffic and signage during the reversal episodes.

2.3.2. One-Way Traffic

One-way traffic flow already exists in Grand Teton National Park for a portion of a spur road off of Teton Park Road, from the Leigh and String Lakes trailhead to just north of the South Jenny Lake Junction. According to one park maintenance employee, this partial one-way configuration dates back to the 1960s or earlier. There are numerous other uses of one-way roads in national parks across the country, a few of which are described in this section.

Acadia National Park (Maine)

Many park roads in Acadia are former carriage roads, and are not wide enough to support two-way traffic. Consequently, several roads, such as the east side of the 27-mile Park Loop Road, and a seven-mile section on Schoodic Peninsula, are designated for one-way traffic.

There are 45 miles of unpaved two-way carriage roads in Acadia National Park for non-motorized means of transportation. They were constructed from 1913 to 1940 for horse and buggy use, but are now the preferred paths for mountain bicyclists. While there are no designated bike lanes in the park, the bicycling community is more focused on improving roads outside the park; they are generally satisfied with the bicycling experience in the park. The 27-mile Park Loop Road is a two-lane, one-way route whose current one-way configuration has been in place since 1988; prior to that there were more two-way sections. The southern seven-mile section of Schoodic Peninsula is also two-lane, one-way where the light traffic has unofficially resulted in the right lane being primarily for bicyclists. These one-way sections are also one-way for bicycle traffic.

Great Smoky Mountains National Park (North Carolina, Tennessee)

Cades Cove Loop Road is especially popular among the park’s more than 10 million annual visitors. The Cades Cove area hosts an abundance of wildlife and numerous historic churches and cabins. The one-way loop road is 11 miles long and carries about 3,500 vehicles per day. Due to traffic volumes and scenic opportunities the loop trip can take as long as two to four hours.

Hot Springs National Park (Arkansas)

The Hot Springs Mountain Drive in Hot Springs National Park is a curvy one-way counterclockwise loop road. It was originally two-way, but numerous accidents on the hairpin curves caused planners to alter the road as a wide one-lane, one-way road in the early 1980s. There is no bike lane, but bicyclists may occasionally use the road. There are overlook locations with parking and signage to prevent wrong-way traffic. Gates are used to close the road at night or when hazards occur.

Organ Pipe Cactus National Monument (Arizona)

Ajo Mountain Drive is a 21-mile one-way clockwise loop in Organ Pipe Cactus National Monument. The road was most likely two-way when ranchers developed it in the 1930s. However, under NPS management, the road was converted to a one-lane, one-way route in the early 1970s when visitation increased. Planners have considered reversing the traffic direction so visitors could experience a new viewshed; however, the reversal would be seasonal or bi-seasonal, not time-of-day.

Puerto Blanco Drive is a larger loop (about 60 miles) with two-way traffic at each end and one-way, westbound traffic in the unpaved section between the ends. Similar to Ajo Mountain Drive, the road was likely two-way when ranchers were the primary users, but was converted to one-way in the 1970s. However, the 20-mile southern portion has been two-way since inception in the 1950s. The five-mile northern loop entrance was converted to two-way flow in 2002. By allowing two-way traffic at the ends, visitors don't have to commit to the entire loop; they can drive in, picnic, and exit.

Bicycle use in the park is considered light, with two or three bicyclists per day. Bicyclists are not restricted to traveling one-way on either Ajo Mountain Drive or Puerto Blanco Drive. There is no designated bike lane, but with annual visitation of only 300,000, bicyclists don't contend with heavy traffic.

Valley Forge National Historic Place (Pennsylvania)

The Inner Line and Outer Line Drives are each one-way roads at Valley Forge National Historic Place. The former is a six-mile loop heading south and then back north. Outer Line Drive was originally two-way and several issues were addressed by converting the road to west-bound only traffic. This conversion occurred in the late 1980s, when the road and separated bike pathway were near capacity. Instead of widening the road and pathway, planners opted for one-way traffic flow to slow down travelers (posted speed limit of 15 mph) and reduce commuter traffic. Bicyclists then found the road more desirable and could choose either the road or pathway. Public traffic was found to be very detrimental to the road, causing planners to specifically discourage commuters. The local residents have accepted the change, because they know where to go, while visitors are unaware that the road configuration has changed.

Yellowstone National Park (Idaho, Montana, Wyoming)

Yellowstone National Park officials believe many types of roads are needed in the park. There are several roads that are designed to allow two-way bicycle traffic and one-way automobile traffic, including Old Gardiner Road, Blacktail Plateau Drive, Firehole Lake Drive, Firehole Canyon Drive, and Virginia Cascades. Old Gardiner Road and Blacktail Plateau Drive are unpaved roads that were originally part of the old road alignment. There is not a large bike population visiting Yellowstone; mostly mountain bikers use the roads to access off-road destinations. The road to Bunsen Peak was originally one-way northbound for automobiles, but is now a scenic gravel road only for bicyclists (still one-way) and skiers (traveling either direction).

2.3.3. Limited Auto Access

Denali National Park (Alaska)

To reduce vehicle traffic in environmentally sensitive areas, the park has restricted automobile access beyond the Savage River Check Station at Mile 15 of the park road; only pedestrians, bicyclists, and buses are allowed. Various free and reservation shuttle services are provided to give visitors access to various destinations along the Denali Park Road, going as far as Kantishna at the road's western end. The buses can accommodate some bikes, but bike use is restricted to the roads only; off-road biking and biking on trails are strictly prohibited. Motorists are generally courteous to cyclists and travel slow to discourage throwing up dust.

Gateway National Recreation Area, Jamaica Bay Unit (New York)

In 1996 the Jamaica Bay Unit of Gateway National Recreation Area began restricting vehicle access into the park to address several issues. First of all, the roads were unpaved and were required to remain in this state for historical preservation. Wet weather caused accessibility issues and there was a general increase in traffic (the recreation area is located in an urban area near JFK International Airport). Currently there are gravel parking lots at the entrance with pedestrian, bicycle, and wheelchair access to trails.

Great Smoky Mountains National Park

Great Smoky Mountains National Park's Cade Cove Loop Road (mentioned earlier) is also notable because while most park roads are not suited for safe and enjoyable bicycle riding due to heavy traffic, narrow roads, and steep terrain, Cade Cove Loop Road accommodates bicyclists and pedestrians. The loop is closed to motor vehicles on Wednesday and Saturday mornings until 10 AM from the second week in May until the second-to-last Saturday in September to allow bicyclists and pedestrians to enjoy the scenery.

Zion National Park (Utah)

Popularity of this national park led to high volumes of vehicle traffic in Zion Canyon. Park personnel indicated that there were problems with noise and air pollution that were impacting both the resource and the visitor experience. Starting in 2000, the park restricted vehicle access to the canyon and implemented a shuttle service to preserve visitor access. Private vehicles are not allowed on the Zion Canyon Scenic Drive from early April through the end of October. Free shuttle services are available in two loops: one loop goes to Springdale (the gateway community) and the other goes into the canyon, making eight stops in the park. The annual operating cost of the transit system is about $2.6 million. Bicyclists use the road and an adjacent foot and bike trail. While there is no designated bike lane, bicyclists prefer the road as a transit thoroughfare; they contend with a shuttle about every 10 minutes instead of heavy private vehicle traffic.

3. STRATEGIES: INITIAL CUT

The research team identified strategies that could be used individually or in combination to address the challenges along Moose–Wilson Road. These strategies were described along with a an assessment of the feasibility of their implementation in the short-term in a technical memorandum submitted in January 2006. The feasibilities of these initial mitigations were determined by park personnel on January 18, 2006. Table 3-1 lists these initial mitigations with the assessments of the feasibility of their implementation in the short term, and the expected success.

Table 3-1: Potential Strategies

Strategy / Option Number	Description	Feasibility	
		Implementable Short-Term?	Park Assessment
Status Quo / No Management Strategy		*Yes*	*No*
Remove Paved Surface			
1	Remove pavement from Moose-Wilson; convert to unpaved road with graded bike path	No	No
Educational Improvements / Traveler Information			
1	New wayfinding signage at airport, Teton Village, and each end of MWR to direct traffic away	Yes	Yes
2	New dynamic signage at airport, Teton Village, and each end of MWR to direct traffic away	No	Yes
3	Rangers encourage visitors to use sites other than Moose-Wilson Road	Yes	No
Spot Improvements			
1	Bike/ped detection at key locations	No	No
2	Bicyclists push button to initiate warning	No	No
3	Add pullouts at select locations	No	Yes
Reversible Flow			
1	Gates at Granite Canyon & LSR; reversible direction traffic (by time of day) between gates	Yes	Yes
2	Northbound entry at Granite entry permitted until 10 AM; Southbound entry from Moose permitted after 3 PM		
2-1	Using signage	Yes	Yes
2-2	Using technology	No	Yes
Speed Management / Traffic Calming			
1	Reduce speed limit to 20 mph; add spot enforcement	Yes	No
2	Use striping, bulbouts to narrow lanes, slow vehicles	Yes	Yes
3	Use variable speed limit signs based on weather, congestion	No	No
4	Radar speed trailers at select locations	Yes	No
Directional Auto Access			
1	Gates at Granite Canyon & LSR; one-way traffic between gates		
1-1	Northbound	Yes	Yes
1-2	Southbound	Yes	Yes
2	Gates at Granite entrance & LSR; one-way traffic between gates		
2-1	Northbound	Yes	Yes
2-2	Southbound	Yes	Yes

Table 3-1: Potential Strategies (cont.)

Strategy / Option Number	Description	Feasibility	
		Implementable Short-Term?	Park Assessment
Limited Auto Access			
1	Gates at Granite Canyon & LSR; transit/bike-only access between gates (with access for emergency responders and private landowners within the park boundary)	No	Yes
2	Gates at Granite Canyon & LSR; transit/bike and two-way transponder vehicle-only access between gates		
2-1	Transponders for emergency responders, park vehicles and private landowners within the park boundary	No	Yes
2-2	Transponders for emergency responders, park vehicles, private landowners within the park boundary and non-park residents	No	Yes
2-3	Transponders for emergency responders, park vehicles, private landowners, non-park residents, and users of intermediate sites (e.g. Whitegrass)	No	Yes
3	Gates at Granite Canyon & LSR; bike and two-way transponder vehicle-only access between gates		
3-1	Transponders for emergency responders, park vehicles and private landowners within the park boundary	No	Yes
3-2	Transponders for emergency responders, park vehicles, private landowners within the park boundary and non-park residents	No	Yes
4	Gates at Granite Canyon & LSR; transit/bike only during peak hours of day (10 AM - 7 PM)	No	Yes
5	Use license-plate recognition at Granite and Moose Junction; track/fine vehicles which go between the two in less than a certain amount of time	No	No
6	Gate at LSR prohibiting through traffic except transit and bikes; two-way traffic allowed to gate from each direction	No	Yes
7	Do not permit southbound turns from Teton Park Road onto M-W Road	Yes	No
8	Do not allow northbound right turn onto Teton Park Road to US 26/89/191 south; or northbound US26/89/191 to westbound Teton Park Road to left turn onto M-W Road		
8-1	Using signage	Yes	No
8-2	Using license-plate recognition	No	No
Travel Demand Management			
1	Charge $5 premium for vehicles driving through unpaved section	No	No
2	Charge $5 premium for vehicles with fewer than four passengers	No	No
3	Minimum vehicle occupancy requirements (4.0) for traffic entering through Granite; others must use Granite Canyon or turn around	Yes	No
4	Work with community to establish transit service for visitors to the park	No	Yes
5	Reservation-only access to Moose-Wilson Road	No	No
Pathways			
1	Gates at Granite Canyon & LSR; one-way traffic between gates; add separated pathway at selected locations		
1-1	Northbound	No	Yes
1-2	Southbound	No	Yes
2	Separated pathway at selected locations	No	Yes
Complementary Approaches			
1	Roadway design: 9-foot lane, 9-foot two-way bike path	Yes	Yes
2	Transit touring from Moose to Granite Canyon	No	Yes
3	Hikers shuttle from Moose to Granite Canyon	No	Yes

For comparison purposes, levels of management intensity (i.e., the additional workload required of park personnel to implement a strategy) and operational costs were estimated for each group of strategies. These estimates are based on the guidelines shown in Table 3-2. It should be noted that the management intensity and cost figures may vary within a group of strategies, depending upon the specific technologies or physical treatments utilized. Also, some strategies may have a high upfront (capital or implementation) cost, but a low annual operating cost.

Table 3-2: Definitions for Management Intensity and Operational Costs

Level	Management Intensity	Operational Costs
Low	Unlikely that additional personnel would be needed to operate the strategy, or operations may require weekly or monthly monitoring and/or inputs.	Strategies generally costing from zero to less than $2,500 per year to operate.
Medium/ Moderate	Falls between low and high levels.	Between $2,500 and $10,000 per year to operate.
High	Likely requires the hiring or reassignment of two or more personnel; and daily or hourly monitoring and/or inputs to the system.	At least $10,000 would be spent annually on operations.

The remainder of this chapter reviews these strategies for mitigating the four issues along Moose–Wilson Road - traffic growth, connectivity and compatibility, sensitive environment and access requirements - and explains, where applicable, why a strategy was not considered feasible for further consideration.

3.1. Descriptions of Strategy Groups

3.1.1. Status Quo

This strategy reflects a "do-nothing" approach. However, anticipated traffic growth and the desire for improved compatibility and connectivity between modes may make it difficult to sustain this strategy while preserving the natural and scenic resources of the Moose–Wilson Corridor.

Management Intensity: Low
Cost: Low

3.1.2. Remove Paved Surface

In order to reduce traffic speeds and the appeal of the road to commuters, it was proposed that the majority of the pavement could be removed from those areas of the roadway that are currently paved. A section of approximately four feet in width could be retained as a bikeway. If this strategy succeeded in reducing traffic volume along the roadway, it would address all of the four issues.

Park personnel indicated several problems with this approach. First, there could be erosion between the paved path and the gravel, as well as gravel spilling over onto the pavement which would require maintenance. Second, removal of the pavement would increase maintenance costs and create dust control issues. Third, it was noted that the cost to implement this strategy would be high, and pavement removal would be a difficult strategy to reverse. Consequently, this strategy was not considered for implementation.

Management Intensity: Low
Cost: Medium (initial cost to remove pavement could be considerable, however)

3.1.3. Educational Improvements/Traveler Information

The primary focus of strategies in this group would be to use signage and other sources of information to try to reduce the traffic volume on Moose–Wilson Road. Signage at Teton Village could direct travelers to the airport via WY 22 and US Route 191. Further, park rangers could direct traffic away from Moose–Wilson Road by highlighting other areas of the park to visitors. This approach, if it reduced traffic, would address three of the four issues, but would not likely improve connectivity and compatibility.

Park personnel felt that signage strategies could be appropriate, though not sufficient to meet the park's objectives in managing the road. The option of rangers directing visitor traffic away from the road was considered to be infeasible, since visitors want to see Moose–Wilson Road and the scenery and wildlife viewing opportunities it offers.

Management Intensity: Low–Moderate
Cost: Low (depending upon information outlets)

3.1.4. Spot Improvements

Several strategies could be implemented at only selected segments along the roadway. These improvements, as noted in Table 3-1, deal primarily with bicycle mobility and parking issues. In general, these spot improvements could help connectivity without limiting access; however, they would not address traffic growth or the sensitivity of the surrounding environment. Park personnel indicated that strategies D-1 (bike–pedestrian detection) and D-2 (bike warning button) in particular would not be consistent with the designed visitor experience. Strategy D-3 (additional pullouts) was considered feasible.

Management Intensity: Low
Cost: Low–Moderate (depending upon technologies used)

3.1.5. Reversible Flow

Reversible flow solutions are generally used to manage access to a site based on directional flows during different times of the day. For example, at a beach location there may be a considerable amount of travel to the beach in the morning and from the beach in the afternoon/evening. If Moose–Wilson Road traffic is heavily directional by time of day, the road could be designated as one-way northbound in the morning, and one-way southbound in the evening. In addition, these flows could be managed at several areas along the roadway, depending upon where traffic-control devices (gates, etc.) are placed.

These strategies could reduce traffic growth on the roadway, thus preserving the environment. Though reversible lanes would provide more room in the roadway for bicyclists, this strategy in and of itself does not address the entire issue of connectivity and compatibility. Further, depending upon how the flow of traffic is managed, access to certain areas along Moose–Wilson Road may be reduced.

Management Intensity: Moderate–High
Cost: Moderate–High (depending upon technologies used)

3.1.6. Speed Management/Traffic Calming

In an effort to reduce the number of "commuters" who use the roadway, which may reduce the increase in traffic volume, several speed management or traffic calming strategies could be implemented. These strategies include both physical changes to the roadway as well as intelligent transportation solutions, such as dynamic message signs. These strategies could reduce roadway speed, leading to a reduction in traffic volume (i.e., reduced number of commuters due to higher travel times), therefore protecting the environment. These strategies would not restrict access along the road, which is also an advantage. However, these strategies would not improve bicycle network connectivity and compatibility between modes.

Park personnel were skeptical over the potential for these strategies to succeed in reducing speed, thereby reducing traffic volumes. First, it was felt that high speeds along Moose–Wilson Road do not represent an issue by itself. Further, resources for enforcing speed along Moose–Wilson Road are limited, and it was felt that locals would continue to travel at customary speeds regardless of signage.

Management Intensity: Low–Moderate (depending upon the need for enforcement)
Cost: Low–Moderate (depending upon technologies used)

3.1.7. Directional Auto Access

These strategies focus on managing the directional flow of the traffic along Moose–Wilson Road. The specific strategies under this group vary in where directional flows begin and end, and whether traffic flows northbound or southbound. By managing the directional flow of the traffic, it is possible that traffic volumes would be reduced, leading to better protection of the environment while preserving access for certain groups (e.g., private landowners within the park boundary). Also, a portion of the existing roadway space may be reserved for non-motorized users, promoting bicycle network connectivity and compatibility.

Management Intensity: Low–High (depending upon specific strategies used)
Cost: Low–High (depending upon specific strategies/technologies used)

3.1.8. Limited Auto Access

These strategies focus on limiting access to certain areas along Moose–Wilson Road. Gates or other traffic control devices could be placed at one or several locations along the road to prohibit or limit auto access. For example, private landowners within the park boundary or park vehicles may have a transponder that would allow them access through a gate, while commuters and visitors are restricted from access. Variations on this theme include where to place gates, and whether access is permitted to certain vehicles (groups of people).

By limiting auto access, there is also the likelihood that transit services or other ridesharing options would be introduced. It is doubtful that transit could be introduced immediately, so some of these strategies are for future years. By limiting auto access, traffic growth and environmental issues are addressed. Depending upon where access restrictions (gates) are placed, access for private landowners within the park boundary and others may be affected. Finally, by limiting auto access, bicycle mobility should be improved; however, that may only occur in those segments of the roadway where vehicles are prohibited.

Park personnel rated most of these options to be feasible for consideration, with the exception of H-5 (measure travel times and track/fine commuting-type vehicles), H-7 (restrict a turning movement) and H-8 (restrict more turning movements). H-5 was rejected because the approach was believed to carry a connotation of privilege and inequity, while H-7 and H-8 were rejected as being unworkable and easily avoided, especially by commuters.

Management Intensity: Low–High (depending upon specific strategies used)
Cost: Low–High (depending upon specific strategies, technologies used)

3.1.9. Travel Demand Management

Travel demand management, also known as TDM, looks at methods to reduce the demand for a particular roadway or groups of roads. Strategies in this group focus on encouraging higher vehicle occupancy (i.e., more efficient use of vehicles on the road), ridesharing, transit, and a fee structure to reduce traffic on Moose–Wilson Road.

In order to reduce commuter or other through traffic, a gate could be established along the road so that someone wanting to make a through trip would have to pay a fee (I-1). This fee could be levied on all vehicles traveling through or only on those vehicles with fewer than four occupants (I-2). A minimum vehicle-occupancy requirement (I-3) could encourage visitors to use transit, while likely discouraging commuters. Transit service (I-4) serving park sites, as well as connecting to adjacent land uses such as Teton Village and the airport, could help to reduce commuter traffic on Moose–Wilson Road. Finally, the park could adopt a reservation-access approach to Moose–Wilson Road (I-5), an approach that has been used in other national parks such as Denali and Mesa Verde.

All of the strategies in this group focus on reducing the demand of travelers to use the Moose–Wilson Road. Therefore, traffic volumes should decrease, leading to better protection of the environment along the roadway. Access would not be limited, and exceptions for the fees could be made for private landowners within the park boundary. Finally, if demand for the roadway was sufficiently reduced, there could be improved connectivity for bicyclists and improved compatibility between modes.

While these options have some appeal, all except the transit option were rejected by the park as infeasible. The fee alternatives are not consistent with National Park Service policies, and the vehicle occupancy requirement can have a connotation of privilege and inequality. The reservation approach was deemed acceptable in parks like Denali and Mesa Verde, which are more destination-oriented, as opposed to Moose–Wilson Road, which is often used more as a travel route than a destination in and of itself.

Management Intensity: Low–Moderate (depending upon specific strategies used)
Cost: Low–Moderate (depending upon specific strategies, technologies used)

3.1.10. Pathways

These strategies focus on developing a separate pathway for bicycles and pedestrians along sections of Moose–Wilson Road. Some gates could be installed to limit auto access as well. As noted by park staff, adding a separate pathway is an expensive strategy with high impacts to resources. While adding gates to limit auto access would alleviate some traffic volume and related environmental concerns, adding a separate pathway would certainly have an impact on the environment. Finally, depending upon whether or not gates were installed, access restriction could be an issue.

Management Intensity: Low (once established)
Cost: High (based on adding a separate pathway for bikes and pedestrians)

3.1.11. Complementary Approaches

In the process of identifying strategies, the research team identified complementary approaches that would likely be used in conjunction with other strategies previously mentioned. This would include re-striping the road to allow for a bicycle lane (if one-way traffic was implemented), and adding transit tour services and/or a shuttle for hikers. These strategies would only occur if the directional flow of traffic was modified, or if auto access was limited along all or certain sections of the Moose–Wilson Road.

Management Intensity: Low (once established)
Cost: High (based on adding a separate pathway for bikes and pedestrians)

3.2. Strategy Review

A summary of each strategy group based on its ability to address the primary issues along Moose–Wilson Road is presented in Table 3-3. Using this high-level view, it can be seen that no strategy group by itself will fully address the four issues identified in Chapter 2 with respect to Moose–Wilson Road. However, there may be groupings of strategies that could accomplish this.

Table 3-3: Issues-Strategies Matrix

Strategies \ Issues	Traffic Growth	Compatibility and Connectivity	Sensitive Environment	Access Requirements
Status Quo	▪	▪	▪	●
Removed Paved Surface	○	●	○	●
Educational Improvements/ Traveler Information	○	○	○	●
Spot Improvements	○	▪	○	●
Reversible Flow	○	○	○	○
Speed Management / Traffic Calming	○	▪	○	●
Directional Auto Access	○	●	○	○
Limited Auto Access	●	●	●	○
Travel Demand Management	○	○	○	●
Pathways	▪	●	▪	●
Complementary Approaches	○	○	○	○

Legend:
▪ – Does not address this issue at all
○ – Could partially address this issue
● – Addresses this issue

As discussed throughout this chapter, several strategies were removed from consideration because of their limited feasibility (determined primarily during the meeting held on January 18, 2006). From the initial list, seven core strategies were chosen for further evaluation:

A. Reversible Flow
B. One-Way Northbound
C. One-Way Southbound
D. Gate Restrictions to Through Traffic
E. Time-of-Day Restrictions
F. Limited Auto Access
G. Separated Pathway

These seven strategies are further discussed in Chapter 4 (detailed description of strategies), Chapter 5 (initial ranking by park personnel), and Chapter 6 (analytical evaluation of these strategies).

4. CORE STRATEGY DESCRIPTIONS

The research team identified seven distinct, mutually independent core strategies that were accepted by park personnel as technically feasible to address the four issues along Moose-Wilson Road—traffic growth, connectivity and compatibility, sensitive environment and access requirements. These are listed in Table 4-1.

Table 4-1: List of Core Strategies

Core	Title
A	Reversible Flow
B	One-Way Northbound
C	One-Way Southbound
D	Gate Restrictions to Through Traffic
E	Time of Day Restriction
F	Limited Auto Access
G	Separated Pathway

Each of the core strategies maintains two-way vehicle access between LSR Preserve and Moose (to ensure good access to the new LSR Preserve), and between the Granite entry and the Granite Canyon trailhead parking area (to maintain access for private landowners within the park boundary).

This section will describe each of these core strategies, discuss how they respond to the challenges identified in the Moose–Wilson Road corridor, and what elements and options are part of the strategy. Options are discussed in terms of different levels of intensity for a particular strategy implementation.

4.1. Reversible Flow (Strategy A)

Initial anecdotal evidence suggested that traffic on Moose–Wilson Road is directional, with northbound favored in the morning and southbound favored in the afternoon and evening. Therefore, the least restrictive option from a vehicle access standpoint would be to keep the flow of traffic open only in the direction that most people want to go at a given time.

This core strategy would adopt reversible flow between the Granite Canyon trailhead and LSR Preserve. The road between these points would be divided by pavement marking with one lane for motor vehicle traffic and the remainder of the road as a non-motorized pathway. The pathway portion of the roadway would permit two-way bicycle and pedestrian traffic. Emergency vehicles would continue to have unrestricted access on the road, being able to go in either direction at any time. To ensure that sufficient time is allowed for changing signage and that vehicles are not "caught" going the wrong way, there would be an interval of time when that section of road would be closed to vehicles coming through. For illustration purposes, it is assumed that the reversible flow section would have northbound traffic from 4 AM to 12 PM, and southbound traffic from 2 PM to 2 AM.

Specific elements of this strategy are shown in Table 4-2. Note that the time limits when traffic is permitted in either direction may be adjusted to make this strategy more or less intense in how much vehicle traffic may be redirected away from Moose–Wilson Road.

Table 4-2: Elements in Reversible Flow Strategy

Element	Intensity Options
Install gates at Granite Canyon trailhead and LSR Preserve access	
Allow northbound only traffic from 4 AM to 12 PM; southbound only from 2 PM to 2 AM	Change time limits
Stripe pavement to indicate 9-foot bike path and 9-foot driving lane, with emergency vehicles permitted in bicycle lane	
Add signage at Granite entrance and Moose junction indicating reversible flow restrictions	
Add signage at access points indicating reversible flow restrictions	
Modify shoulders to discourage parking in some areas and support it in others	

4.2. One-Way Northbound (Strategy B)

An operationally simpler alternative than reversible lanes is to implement one-way vehicle traffic flow between the Granite Canyon trailhead and LSR Preserve. This core strategy would adopt northbound only flow between those two locations. Visitors would be able to enter the park from the south through the Granite Canyon Entrance Station and continue on to Moose and other destinations, whereas vehicles could not travel the entire length of Moose–Wilson Road from Moose to the Granite Canyon Entrance Station. As was true with reversible flow, pavement markings would be used to separate the roadway into a lane that would be used by northbound motor vehicles, and a narrower lane that would be available as a pathway for bicycles and pedestrians.

While one-way operations may be adopted in either direction, northbound has a couple of advantages over southbound operations. First, southbound-only access would require modification of the Granite entry station, so that park entrance fees would be collected or verified as vehicles leave the park. Second, southbound-only access might raise issues of access for park visitors originating from Teton Village.

The impacts of this alternative on vehicle traffic levels are unclear, as this may make Granite a de facto park entrance for many visitors, and visitors who wish to see Moose–Wilson Road may continue to do so, increasing northbound traffic volumes above current levels.

Elements for this strategy are shown in Table 4-3. As was true under the reversible flow strategy, emergency vehicles would be permitted contraflow (i.e., southbound) access on Moose–Wilson Road. This strategy could be adjusted by allowing other road users, such as park operations, to go southbound. These exceptions would clearly need to be limited to preserve the safety and security of road users.

Table 4-3: Elements in One-Way Northbound Strategy

Element	Intensity Options
Install gates at Granite Canyon trailhead and LSR Preserve access	
Permit northbound-only vehicle traffic, except for emergency vehicles	Allow other vehicles, such as park operations, to go southbound
Stripe pavement to indicate 9-foot bike path and 9-foot driving lane, with emergency vehicles permitted in bicycle lane	
Add signage at Granite entrance and Moose junction indicating one-way restrictions	
Add signage at access points indicating one-way flow	
Modify shoulders to discourage parking in some areas and support it in others	

4.3. One-Way Southbound (Strategy C)

This strategy would have southbound-only operations on Moose–Wilson Road between LSR Preserve and the Granite Canyon trailhead parking area. Vehicles entering the park through the Granite Canyon Entrance Station would only be able to get as far as the Granite Canyon trailhead parking area, although bicycles and pedestrians would be able to continue on to Moose on the existing roadway. Vehicles would be able to proceed from Moose through the Granite Canyon Entrance Station to leave the park. Like Strategies A and B, pavement markings would be used to designate a portion of the roadway's width for one-way southbound motor vehicle traffic, with the remainder of the width available for two-way bicycle and pedestrian traffic.

Elements for this core strategy are shown in Table 4-4. Allowing contraflow (i.e., northbound) operations for more road users would be a way to lessen the vehicle access restrictions associated with this strategy.

Table 4-4: Elements in One-Way Southbound Strategy

Element	Intensity Options
Install gates at Granite Canyon trailhead and LSR Preserve access	
Permit southbound-only vehicle traffic, except for emergency vehicles	Allow other vehicles, such as park operations, to go northbound
Stripe pavement to indicate 9-foot bike path and 9-foot driving lane, with emergency vehicles permitted in bicycle lane	
Add signage at Granite entrance and Moose junction indicating one-way restrictions	
Add signage at access points indicating one-way flow	
Modify shoulders to discourage parking in some areas and support it in others	

4.4. Gate Restriction on Through Traffic (Strategy D)

A more aggressive approach in restricting traffic, beyond allowing through trips in only one direction at a time, would be to prohibit private vehicle traffic from driving the length of Moose–Wilson Road. This would be done by installing a single gate somewhere on Moose–Wilson Road, perhaps in the vicinity of the LSR Preserve, to prohibit through traffic. Two-way vehicle access would be permitted up to the gate from either direction. Through the use of transponders, certain vehicles, such as emergency responders, could be allowed access through the gate. Transponder availability could be extended to other road users (e.g., park operations and private landowners within the park boundary) in order to provide fewer restrictions on vehicle traffic. This alternative has some flexibility in that the gate may be opened to permit through trips during lower traffic volume periods.

Unlike Strategies A, B and C, this approach would not set aside a pathway within the existing roadbed for bicycles and pedestrians. By eliminating most through trips, however, it is presumed that both vehicle traffic volumes and speeds would decrease, providing greater security for non-motorized users of the road.

Elements for this core strategy are shown in Table 4-5.

Table 4-5: Elements in Gate Restriction on Through Traffic Strategy

Element	Intensity Options
Install single gate along Moose-Wilson Road, perhaps in vicinity of LSR Preserve.	
Prohibit vehicles to go through gate except for emergency responders, park operations and transit.[1]	Extend access to other vehicles, such as construction vehicles and private landowners within the park
Add signage at Granite entrance and Moose junction indicating closure to through traffic except for authorized vehicles	

[1] – This would most easily be accomplished through the use of transponders.

4.5. Time-of-Day Restriction (Strategy E)

A yet more aggressive approach in restricting traffic would be to prohibit motor vehicle traffic (except for emergency vehicles) from going between LSR Preserve and Granite Canyon trailhead during certain times of the day. This would be accomplished with two gates, one just south of LSR Preserve and one just north of Granite Canyon. During these times, the road would be accessible to emergency vehicles, transit service (should it become available), bicycles and pedestrians. Since many road users—both visitors and commuters—currently use Moose–Wilson Road as a through route, this core strategy should help reduce overall traffic on the road.

Elements for this strategy are shown in Table 4-6. Like Strategy D, the intensity could be modified by allowing other road users to have access to the road at any time of day.

Table 4-6: Elements in Time of Day Restriction Strategy

Element	Intensity Options
Install gates at Granite Canyon trailhead and LSR Preserve access	
Do not allow vehicle access between gates between 10 AM and 7 PM, except for emergency vehicles, transit and park operations[1]	Extend access to other vehicles, such as construction vehicles or private landowners within the park
Add signage at Granite entrance and Moose junction indicating time-of-day restrictions	

[1] – This would most easily be accomplished through the use of transponders.

4.6. Limited Auto Access (Strategy F)

The most aggressive approach to reducing vehicle volumes on Moose–Wilson Road would be to restrict certain portions of the road from private vehicle access, regardless of time of day. This can be seen as an extension of the time-of-day restriction (Strategy E). This strategy would use two gates to restrict access, with access only permitted for vehicles equipped with transponders, such as emergency responders, private landowners within the park boundary, park transit and NPS vehicles. These users, along with bicycles and pedestrians, would be permitted to use the entirety of Moose–Wilson Road.

Elements for this core strategy are shown in Table 4-7.

Table 4-7: Elements in Limited Auto Access Strategy

Element	Intensity Options
Install gates at Granite Canyon trailhead and LSR Preserve access	
Do not allow vehicle access between gates, except for emergency vehicles, transit and park operations[1]	Extend access to other vehicles, such as construction vehicles or private landowners within the park
Add signage at Granite entrance and Moose junction indicating auto access restrictions	
Add signage at exits at access points indicating auto access restrictions	

[1] – This would most easily be accomplished through the use of transponders.

4.7. Separated Pathway (Strategy G)

The seventh core strategy differs substantially from the other six in that it seeks to address connectivity and compatibility challenges by creating a separate pathway for bicycles and pedestrians over sections of Moose–Wilson Road. This would improve connectivity and compatibility for bicycles and pedestrians using the corridor. However, by creating a new 10-foot-wide separated pathway in the corridor—the width recommended according to guidelines produced by the American Association of State Highway and Transportation Officials (AASHTO) (24)—this strategy would have an impact on the sensitive environment that the other strategies do not. Apart from other solutions, this approach would not address growth in vehicle traffic volumes. This strategy would also have higher construction costs than the other strategies.

Elements for this core strategy are shown in Table 4-8.

Table 4-8: Elements in Separated Pathway Strategy

Element	Intensity Options
Construct separated pathway parallel to Moose–Wilson Road, connecting existing pathway at Granite entrance to Moose	
Add signage at Granite entrance and Moose junction directing bicycles and pedestrians to use pathway	

4.8. Relationship to Challenges

The core strategies described in this section are designed to address all four general challenges/issues related to Moose–Wilson Road described in Chapter 2: traffic growth, connectivity and compatibility, sensitive environment, and access requirements. As such, it is important to see how these core strategies address these challenges.

4.8.1. Traffic Growth

The ability of Moose–Wilson Road to handle future traffic growth depends on demand and supply (capacity). How these seven core strategies address this challenge is shown in Figure 4-1. Strategies A through F generally represent increasing levels of motor vehicle access restriction in order to manage vehicle demand while maintaining the existing road prism. Strategy G would increase the capacity of the corridor by adding a separated pathway to parts of Moose–Wilson Road. Apart from a major change in mode choice from auto to bicycle/pedestrian, Strategy G would not address forecast growth in traffic volumes.

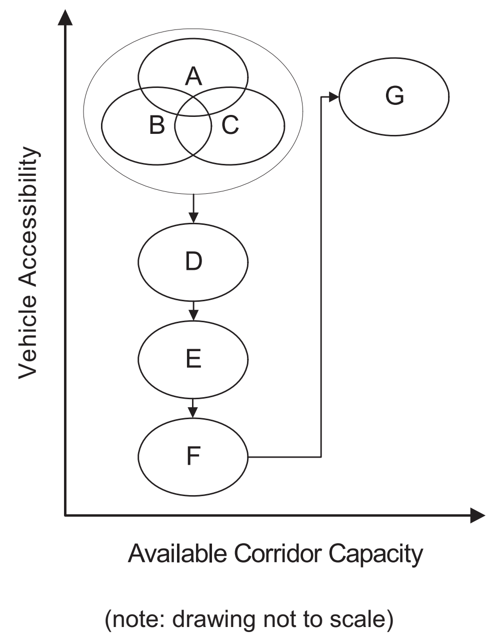


Figure 4-1: Vehicle Accessibility and Corridor Capacity for Strategies

4.8.2. Connectivity and Compatibility

The strategies adopt varying approaches for addressing connectivity and compatibility between modes. Regarding use of the Moose–Wilson Road corridor by bicycles, Strategies A, B and C provide a designated lane within the existing right-of-way between LSR Preserve and the Granite Canyon trailhead to promote network connectivity. Strategies A through F all seek to promote compatibility by reducing vehicle volumes, and therefore the exposure of bicycles to conflict with vehicles. Strategy G represents a best case scenario for bicycle and pedestrian connectivity and compatibility, as these road users would be protected from any conflicts with vehicles for the entire length of the road.

There is currently no transit service oriented toward visitors on Moose–Wilson Road. All strategies are designed to permit network connectivity for transit service, if it is offered in the future. However, the road's geometry and design will limit which transit vehicle options are operationally feasible in the future.

4.8.3. Sensitive Environment

Preserving the character and integrity of Moose–Wilson Road is the primary motivation behind this project's examination of transportation management strategies. Accordingly, a premium value is placed on those strategies that have minimal effect on the existing road environment. Of the seven core strategies considered, Strategies A through F all stay within the existing prism of the roadway. Some spot improvements may be necessary (for example, infrastructure elements like gates), but these impacts will be confined to the roadway and its immediate proximity. Strategy G, the separated pathway alternative, would essentially open up a second road within the Moose–Wilson Corridor, with significant consequences to the Moose–Wilson environment as highlighted in Chapter 2 and elaborated in the park's transportation plan EIS/ROD (4,5).

4.8.4. Access Requirements

Each of the core strategies maintains access to all sites along Moose–Wilson Road for all road users, including visitors, emergency responders, park operations, and private landowners within the park boundary. To maintain access, visitors (and some other road users) may need to adjust their travel patterns, by deciding to visit the road from a different direction, at different times of day, or possibly using a different mode. Access for emergency responders, for the most part, is maintained at current levels. Access for other groups, such as private landowners within the park boundary and park service vehicles, may be easily modified within each core strategy.

4.9. Complementary Strategies

There were many strategies identified in Chapter 3 that may complement the core strategies listed in the previous chapter. Table 4-9 lists these core strategies, and indicates for which strategy they could serve as effective complements.

Table 4-9: List of Complementary Strategies

		Core Strategy						
		A	B	C	D	E	F	G
Strategy	Description	Reversible Flow	One-Way Northbound	One-Way Southbound	Gate Restriction on Through Traffic	Time of Day Restriction	Limited Auto Access	Separated Pathways
1	Static signage to discourage commuter use of MWR							✓
2	Dynamic signage to discourage commuter use of MWR	✓	✓	✓				
3	Add pullouts at select locations	✓	✓	✓				
4	Radar speed trailers at select locations	✓	✓	✓				✓
5	Reduce speed limit to 20 mph; add spot enforcement	✓	✓	✓				✓
6	Use striping, bulbouts to narrow lanes	✓	✓	✓				✓
7	Transponder-only access between gates				✓	✓	✓	
8	Work with community to establish transit service for visitors to the park	✓	✓	✓	✓	✓	✓	
9	Establish transit service for visitors in the park	✓	✓	✓	✓	✓	✓	

The complementary strategies listed in Table 4-9 could be combined with the seven core strategies, each having different intensity options (the general framework shown in Figure 4-2), for a list of 80 resulting detailed management strategies for possible implementation.

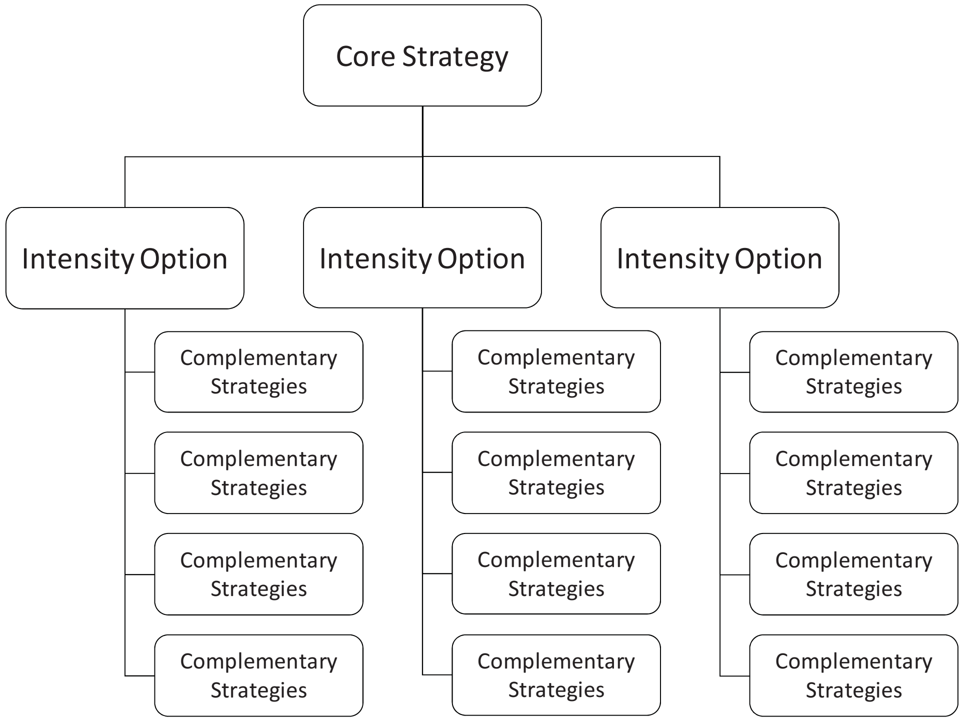


Figure 4-2: Hierarchy of Core Strategies, Intensity and Complementary Strategies

5. INITIAL RANKING BY PARK STAFF

Performance measures are used to describe a particular value or characteristic designated to measure input, output, outcome, efficiency, or effectiveness (25). In the context of this project, the research team identified 52 performance measures for assessing the success of transportation management strategies on Moose–Wilson Road. These performance measures, grouped into 12 objectives and three goals (enhance the visitor experience, preserve the character and integrity, and improve management of traffic on Moose–Wilson Road) were developed based on a review of park documents and in consultation with park personnel. The performance measures are listed in Table 5-1.

This chapter presents how the various combinations of core strategies, intensity options and complementary strategies (referred to as detailed management strategies) introduced in Chapter 4 were ranked by park staff based on these specific performance measures.

5.1. Assessment of Strategies

The detailed management strategies were assessed according to the performance measures in order to more clearly see the relative strengths and weaknesses of each core strategy. The 52 performance measures were applied to each of the 80 detailed management strategies and rated by park personnel on a 1-to-5 scale, with 1 representing the worst case value, and 5 representing the best case value. It is important to note that in many cases rankings were based on professional judgment rather then a formal structured analysis. For simplicity, rankings for these detailed strategies and performance measures were aggregated into the 14 strategy bundles and 12 objectives, as shown in Table 5-2. The 14 strategies represent a specific core strategy and intensity option, combining all complementary strategies for this option. The 12 objectives combine all of the performance measures that fall under that objective. The method for this aggregation was as follows:

- For a given core strategy with intensity option, the score for each performance measure, was calculated as the average of the maximum and minimum rating across all possible complementary strategies. This resulted in a matrix consisting of values for each of 52 performance measures on 14 strategies (composed of the seven core strategies with different intensity options).
- After this aggregation, the scores of performance measures for each strategy were averaged for each objective. For a listing of which of the 52 performance measures map to the 12 objectives in Table 5-2, refer to Table 5-1.
- The numbers were then converted to a letter grade with A representing a best ranking of 5 and E representing a worst ranking of 1.

Table 5-1: Goals, Objectives, and Performance Measures

Goal 1: Enhance visitor experience

1.1. Preserve visitors' usage of Moose-Wilson Road
- *1.1.1. Preserve visitation (not vehicle) levels on Moose-Wilson Road and its sites*

1.2. Preserve visitor access to the variety of natural, cultural, recreational and educational opportunities available in the park and on Moose-Wilson Road
- *1.2.1. …to Death Canyon / White Grass Ranch from south*
- *1.2.2. …to Death Canyon / White Grass Ranch from north*
- *1.2.3. …to Granite Canyon from south*
- *1.2.4. …to Granite Canyon from north*
- *1.2.5. …to LSR Preserve from south*
- *1.2.6. …to LSR Preserve from north*
- *1.2.7. …to Moose Visitor Center from south*

1.3. Preserve a variety of ways to experience the park
- *1.3.1. Preserve wildlife viewing opportunities*
- *1.3.2. Preserve auto touring opportunities*
- *1.3.3. Enhance bicycle touring opportunities*
- *1.3.4. Enhance transit touring (i.e. guided interpretation) opportunities*
- *1.3.5. Enhance transit shuttle (i.e. circulation) opportunities*

1.4. Improve visitor safety
- *1.4.1. Maintain or reduce vehicle speeds*
- *1.4.2. Reduce vehicle-vehicle conflicts*
- *1.4.3. Reduce number and severity of vehicle-vehicle collisions*
- *1.4.4. Reduce vehicle-bicycle conflicts*
- *1.4.5. Reduce number and severity of vehicle-bicycle collisions*
- *1.4.6. Reduce number of conflicts between road/pathway users and wildlife*
- *1.4.7. Reduce number of roadkills*

1.5. Enhance visitor contact opportunities
- *1.5.1. Increase percentage of visitors who go through an entrance station*

1.6. Preserve visitor satisfaction
- *1.6.1. Preserve visitor satisfaction ratings among first-time visitors*
- *1.6.2. Preserve visitor satisfaction ratings among non-local visitors*
- *1.6.3. Preserve visitor satisfaction ratings among local visitors who access the park by auto*
- *1.6.4. Preserve visitor satisfaction ratings among local visitors who access the park by bicycle*

Goal 2: Preserve the character and integrity of Moose-Wilson

2.1. Support alternative modes of transportation on Moose-Wilson Road
- *2.1.1. Increase average vehicle occupancy of motor vehicles on Moose-Wilson Road*
- *2.1.2. Increase mode share of non-auto modes on Moose-Wilson Road (transit or bicycle)*

2.2. Minimize corridor environment impacts
- *2.2.1. Preserve wildlife populations in the Moose-Wilson corridor*
- *2.2.2. Preserve wildlife habitat*

2.3. Minimize corridor aesthetic impacts
- *2.3.1. Maintain existing paved footprint*
- *2.3.2. Minimize striping and signage requirements*
- *2.3.3. Minimize visible built features (e.g. new gates, solar panels)*

Goal 3: Improve management of traffic on Moose-Wilson Road

3.1. Reduce non-park traffic on Moose-Wilson Road
- *3.1.1. Reduce volume of "commuter" traffic (regular users who do not visit park)*
- *3.1.2. Reduce volume of shortcut traffic (occasional users who do not visit park)*

3.2. Preserve access to key road users
- *3.2.1. Preserve access for park maintenance and operations*
- *3.2.2. Preserve access for emergency responders*
- *3.2.3. Preserve access for in-holders*
- *3.2.4. Preserve access for construction activities at White Grass*
- *3.2.5. Preserve access for commercial operations*
- *3.2.6. Preserve access for park employees*
- *3.2.7. Preserve access for other users (e.g. Army Corps of Engineers)*

3.3. Implement a strategy suitable for the future
- *3.3.1. Minimize confusion and misunderstanding among road and park users*
- *3.3.2. Utilize proven methods and technologies*
- *3.3.3. Minimize strategy complexity (e.g. requiring approval authority and/or partnerships)*
- *3.3.4. Minimize construction activity required to implement strategy*
- *3.3.5. Minimize management intensity*
- *3.3.6. Minimize financial commitment – park operations*
- *3.3.7. Maximize opportunity to obtain funding from sources outside of Grand Teton NP*
- *3.3.8. Provide basis for scalability to address future traffic growth*
- *3.3.9. Pursue strategies that are easy to terminate as needed*
- *3.3.10. Provide continuity with the Jackson Hole Community Pathways network*
- *3.3.11. Preserve future opportunities in roadway for transit utilization*

Table 5-2: Assessment of Strategies

		Strategy with Intensity Option													
		Reversible		1-Way North		1-Way South		Gate		Time of Day			Limited Auto		Path
Objective		A0	A1	B0	B1	C0	C1	D0	D1	E0	E1	E2	F0	F1	G0
Goal 1: Enhance visitor experience															
1.1	Visitors usage of MWR	B	C	B	B	B	B	C+	C+	C	C	C	C	C	A
1.2	Visitor access	B	B	B+	B+	C+	C+	B	B	B	B	B	C+	C+	A
1.3	Variety of ways to experience park	C	C	C	C	C	C	C	C	D+	D+	D+	C	C	C
1.4	Visitor safety	C+	C+	B	B	B	B	C+	C+	B	B	B	B	B	B
1.5	Visitor contact opportunities	C	C	C	C	C	C	C	C	C	C	C	C	C	C
1.6	Visitor satisfaction	C+	C	C+	C+	C+	C+	C	C	C	C	C	D+	D+	C
Goal 2: Preserve the character and integrity															
2.1	Support alternative modes	C+	C+	C+	C+	C+	C+	C+	C+	C+	C+	C+	B+	B+	B
2.2	Minimize environmental impacts	B+	B+	B+	B+	B+	B+	B+	B+	A	A	A	A	A	D
2.3	Minimize aesthetic impacts	C+	C+	B+	B+	B+	B+	B+	B+	B	B	B	B+	B+	D
Goal 3: Improve management of traffic															
3.1	Reduce non-park traffic	C	C	C+	C+	C+	C+	A	A	C+	C+	B	A	A	E+
3.2	Preserve access to key road users	C+	C+	C	C	C	C	C+	C+	C	C+	C+	D+	C+	A
3.3	Strategy suitable for future	C	C	C	C+	C	C+	C	C	C	C	C	C	C+	C+

Legend
- A Exceptionally Good
- B Above Average
- C Average
- D Below Average
- E Worst Case

Synopsis of Strategies

A0 – Reversible Flow, Granite Canyon to Death Canyon
A1 – Reversible Flow, Granite Canyon to Death Canyon, with time changes
B0 – One-Way Northbound, Granite Canyon to Death Canyon
B1 – One-Way Northbound, Granite Canyon to Death Canyon; permit some to go southbound
C0 – One-Way Southbound, Granite Canyon to Death Canyon
C1 – One-Way Southbound, Granite Canyon to Death Canyon; permit some to go southbound
D0 – Gate Restriction on Through Traffic
D1 – Gate Restriction on Through Traffic, Permit Additional Vehicles
E0 – Time of Day Restriction, Granite Canyon to Death Canyon
E1 – Time of Day Restriction, Granite Canyon to Death Canyon, permit more vehicles
E2 – Time of Day Restriction, Granite Canyon to Death Canyon, with time changes
F0 – Limited Auto Access, Granite Canyon to Death Canyon
F1 – Limited Auto Access, Granite Canyon to Death Canyon, permit more vehicles
G0 – Separated Pathway

Because of these averaging processes, Table 5-2 does not indicate the “best” management strategy as the one with the most A’s or the fewest E’s. It is expected that different levels of importance would be placed on individual performance measures within a given objective, and that different weighting may be placed on different objectives, which would likely influence which management strategy would be preferred for meeting the objectives for the road. Table 5-2 does indicate, however, some ways of distinguishing the relative characteristics of the core strategies.

- Strategies A through D tend to score average to above average on all the objectives. Core Strategies B and C would have better effects on safety by providing pavement markings to separate motor vehicles from bicycles and pedestrians, while Core Strategy D would be very effective in reducing non-park-related traffic by prohibiting through traffic.

- Strategies E and F would succeed in removing traffic from the road and mitigating environmental impacts; however, they would likely have negative impacts on visitor satisfaction.

- Strategy G rates well on numerous objectives, but is the worst among the core strategies on environmental and aesthetic impacts, and would do nothing (by itself) to reduce non-park traffic using the road.

5.2. Summary

Based on this initial ranking by park staff, it is clear that each core strategy has its own strengths and weaknesses. This initial ranking could be used to prioritize and select a strategy, keeping in mind that these rankings were completed in 2006 when little data was available. Chapter 6 estimates potential impacts of various strategies based on data collected from 2006 to 2008.

6. ANALYSIS OF POTENTIAL IMPACTS

The actual impacts of a particular management strategy, as determined by the performance measures in Appendix B, cannot be truly known unless baseline data is collected, the strategy is implemented, and follow-up data is collected and compared with the baseline. The details of this approach are discussed in Chapter 7. Baseline data was collected in 2006, with some data collection activities continuing in subsequent years. Appendix C summarizes the baseline data that have been collected, which include traffic data (volumes, temporal distributions, directionality, and speeds) mode splits, visitor satisfaction and incident reports. This chapter makes use of this baseline data to shed further light on how the core strategies may perform in realizing the various management objects.

This chapter provides estimates of the following potential impacts:

- Safety improvements (objective 1.4) are estimated using the current number of reported crashes by crash type and predicting the potential for reduction by implementing a given strategy.

- Certain management strategies will require vehicles to re-route. The number of vehicles impacted and potential delay caused by rerouting is estimated for each management strategy. Although delay is not specifically listed in the performance measures, it has a potential impact on auto touring opportunities (performance measure 1.3.2) and visitor satisfaction (objective 1.6).

    - This delay could provide an incentive for commuter vehicles to reroute and avoid Moose–Wilson Road (objective 3.1). An exact value is not estimated for this impact, but is generally discussed in terms of order of magnitude.

- The percentage of time a vehicle is forced to follow a slower moving vehicle (known as percent time spent following [PTSF]) is also estimated as a potential factor affecting visitor satisfaction (objective 1.6).

    - Break points for changes in the amount of traffic are also determined for specific thresholds of PTSF. Not only is this helpful for comparing potential mitigation strategies, it may provide insight into when (in terms of increases in visitation) a mitigation strategy might be warranted.

- By their functional form, strategies can be compared by their impact on access to locations (objective 1.2), access for specific activities (objective 1.3), access by key users (objective 3.2), environment and esthetics (objectives 2.2 and 2.3), pathway continuity (performance measure 3.3.10), entrance contact opportunities (objective 1.5), and bicycle opportunities (performance measures 1.3.3 and 1.6.4).

A few objectives were not directly considered in this analysis. It is difficult to know, for example, how much certain strategies will impact total visitation on Moose–Wilson Road (objective 1.1) and mode shift (objective 2.1). Implementation suitability (objective 3.3) should be based on the rankings by park personnel in Chapter 5.

This chapter provides a brief discussion and results of the analysis. For a more detailed discussion of the assumptions and calculations refer to Appendix D. Strategies were only evaluated in terms of the core strategy and not in terms of detailed management strategies of different intensity options and compatible strategies. These core strategies, previously described in Chapter 4, are:

A. Reversible Flow
B. One-Way Northbound
C. One-Way Southbound
D. Gate Restrictions to Through Traffic
E. Time-of-Day Restrictions
F. Limited Auto Access
G. Separated Pathway

6.1. Safety

One important objective of any management strategy is to preserve and improve visitor safety (Objective 1.4). This section analyzes the safety issues under current conditions and with different traffic management strategies.

6.1.1. General Geometric Considerations

Based on the Guide for the Development of Bicycle Facilities (24), the minimum width of a bike lane should be 4 feet for roadways with no curb and gutter. A Policy on Geometric Design of Highways and Streets (26) sets the range of travel lane widths at between 9 feet and 12 feet. Existing pavement width on Moose–Wilson Road is about 20 feet. No striping exists to delineate the travel lane and shoulder. In order to meet the minimum design standard, it is assumed to be a 9-foot width travel lane and 1-foot width shoulder (Figure 6-1). Drivers share the lane with non-motorized visitors (e.g., bicyclists) who, in this case, are exposed to a relatively higher risk of crashes with vehicles.

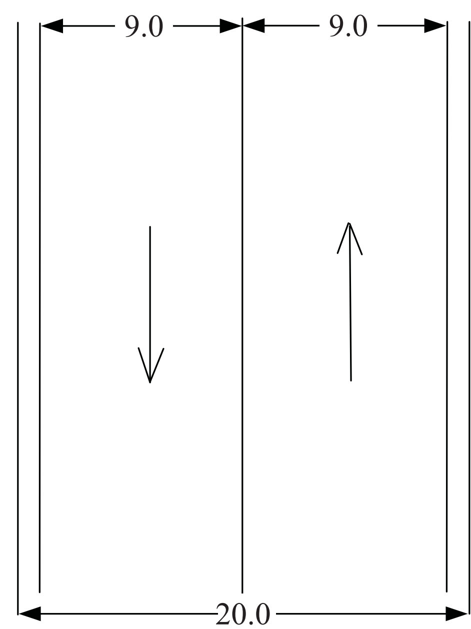


Figure 6-1: Current Roadway Layout

One-way traffic control on the road section allows two possible scenarios (Figure 6-2). In the first scenario, vehicles travel in the middle of the road with bike lanes on each side, which also function as shoulders.

The second scenario combines two bike lanes to one side of the roadway. The dimension of travel lanes is shown in the right figure. There is 1-foot buffer zone between bike path and driving lane and a 1-foot shoulder.

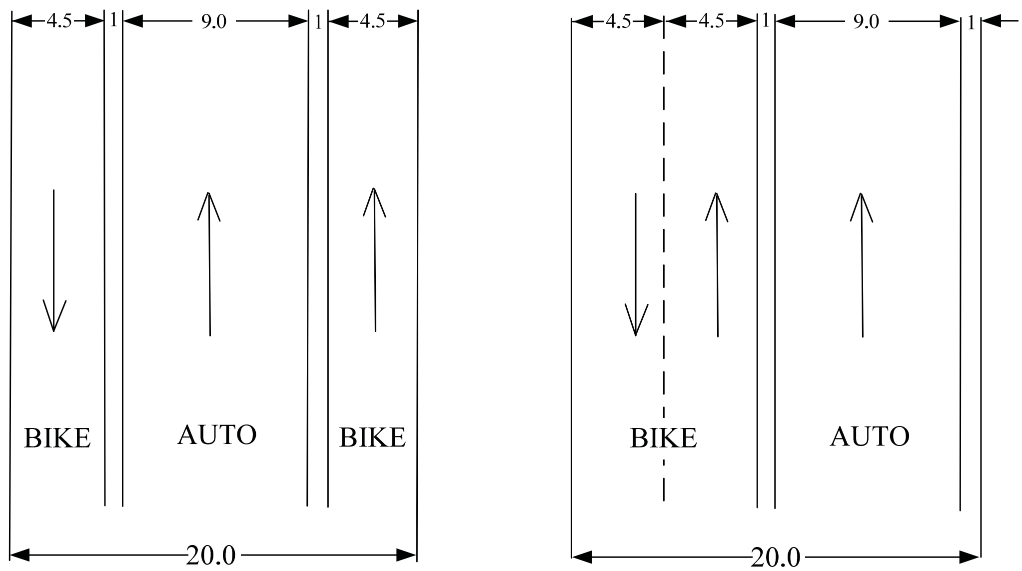


Figure 6-2: Optional Roadway Layouts

Both scenarios improve safety by separating auto and bicycle traffic into different lanes, but they do not eliminate the potential for vehicle-bicycle conflicts as the lanes are adjacent to each other. The second scenario almost eliminates this potential for conflict for cyclists traveling in the opposite direction to the auto traffic, which makes the second scenario better than the first one. Striping the entire length of the roadway to delineate the bike lanes may not be aesthetically pleasing. Note, however, that without the channelization provided by striping it is difficult to say which scenario visitors will use.

6.1.2. Collisions

The potential impact of various traffic management strategies on different collision types are summarized in Table 6-1.

Table 6-1: Potential Safety Impact of Strategies

Strategy		Type of Collision			
		Single-vehicle, Run-off-the-road	Two-vehicle Collisions	Animal Vehicle Collisions	Bicycle–Vehicle Collision
A: Reversible Flow		↑ or ↓	↓↓	?	↓
B: One-way North		↑ or ↓	↓↓	?	↓
C: One-way South		↑ or ↓	↓↓	?	↓
D: Gate restriction		--	--	--	--
E: Time of Day	Peak	↓↓	↓↓	↓↓	↓↓
	Off-peak	--	--	--	--
F: Limited Auto Access		↓↓	↓↓	↓↓	↓↓
G: Pathway		--	--	--	↓↓

↑ Possible increase
-- Unchanged
↓ Possible decrease
↓↓ Eliminate
? Unknown

Strategies A, B, and C, resulting in one-way traffic, would likely cause a near elimination of two-vehicle collisions. Single-vehicle run-off-the-road crashes could increase or decrease. Without the fear of meeting an approaching vehicle, drivers may increase their speeds, resulting in more run-off-the-road crashes. Run-off-the-road crashes could decrease because there is more road width for the vehicles to maneuver. As noted previously, the lane width would likely remain at nine feet to allow bicycle lanes, but the bicycle lane could act as an increased shoulder width so long as bicycle traffic remains low. The effect, if any, of these strategies on animal-vehicle collisions is unclear. If a strategy has an effect on the overall volume of traffic on Moose–Wilson Road a proportional change animal-vehicle collisions might be expected. Bicycle collisions will likely decrease as the strategies allow for bicycle lanes.

Strategy D has no impact on crashes, assuming the same amount of traffic will travel the road in both directions. Strategy D could result in lower traffic volumes due to the inconvenience of rerouting, which would result in fewer crashes.

Strategy E would have no impact on crashes during the time of day vehicles are not restricted. Strategy E would essentially eliminate crashes on the segment of Moose–Wilson Road when it is closed to vehicles, as would Strategy F.

Strategy G (separated pathway) totally separates non-motorists from vehicles and should eliminate all bicycle–vehicle collisions.

A further analysis was done to quantify the possible impacts of various management strategies on the number of collisions along Moose–Wilson Road. Currently there is an average of 3.9

crashes per year on Moose–Wilson Road (see Appendix C for more details). The distribution of these crashes by type is shown in Table 6-2. Almost all of the crashes reported on Moose–Wilson Road were property damage only. One bicycle–vehicle crash in a five year period reported minor injuries.

For possible increases or decreases, crash reduction factors (CRFs) can be used to estimate the potential percent reduction in a certain crash type for a certain change in operations or geometry of a roadway. Crash reduction factors are developed based on previous before-after studies where operational or geometric changes were implemented. CRFs are taken from the Federal Highway Administration's Desktop Reference for Crash Reduction Factors (27).

Elimination of a certain crash type would clearly result in a CRF of 100 percent. For strategy E, this 100 percent reduction would be applied to the 68 percent of the traffic that occurs during the time of day when the road would be closed (see Appendix D).

As discussed above, one-way strategies could impact run-off-road crashes positively or negatively. No single CRF is directly applicable to run-off-the-road crashes for a change from two-lane and two-way operation to one-lane and one-way. A CRF for run-off-the-road crashes is 12 percent for every additional two feet of lane width. Although specific to run-off-the-road crashes, this factor is for all roadway types and may not be appropriate, particularly since the lane width is not actually increasing. Paved, rural, low-volume, two-lane roadways have a 16 percent CRF for widening nine-foot lanes and 13 percent for widening one-foot shoulders (12 percent for unpaved road shoulder widening). This is for all crash types, not just run-off-road. Converting a to one-way traffic results in a 43 percent CRF for all crash types. This is for any type of roadway and most studies are from urban areas. A large portion of the 43 percent CRF could be due to elimination of two-vehicle collisions. Based on these considerations, a CRF for run-off-the-road crashes is selected at 13 percent for this analysis. Finding a CRF for bicycle crashes is much more straightforward. Adding bicycle lanes results in a CRF of 36 percent. The resulting number of crashes for each strategy is shown in Table 6-2.

Table 6-2: Possible Number of Crashes per Year

Strategy	Single-vehicle, Run-off-the-road	Two-vehicle Collisions	Animal Vehicle Collisions	Bicycle–Vehicle Collision	Total
Current (Do Nothing)	2.2	1.0	0.5	0.2	3.9
A: Reversible Flow	1.9	0	0.5	0.1	2.5
B: One-way North	1.9	0	0.5	0.1	2.5
C: One-way South	1.9	0	0.5	0.1	2.5
D: Gate restriction	2.2	1.0	0.5	0.2	3.9
E: Time of Day	0.7	0.3	0.2	0.1	1.3
F: Limited Auto Access	0	0	0	0	0
G: Pathway	2.2	1.0	0.5	0.0	3.7

Moose–Wilson Road is currently a relatively safe road compared to the national average crash rate (see Appendix C). All strategies could improve safety by reducing the number of collisions. One-way strategies (A, B, and C) are estimated to have some reduction in collisions. Larger reductions could be realized when the road is closed some or all of the time (Strategies E and F).

6.2. Rerouting and Delay

Vehicle access and time-of-day restrictions associated with certain management strategies require visitors to change their travel plans, including choosing alternative routes, using other travel modes and/or traveling at other times of day. The magnitude of inconvenience caused by these changes in travel plans is not explicitly listed as a performance measure, but could have an impact on visitor satisfaction (Objective 1.6). This section estimates the magnitude of inconvenience in terms of the number of vehicles that would be impacted and the additional travel time required should they choose to reroute.

Table 6-3 describes the options visitors have to maintain access to attractions on Moose–Wilson Road under different management strategies. For example, with Strategy G (a separated pathway) a visitor can access any part of Moose–Wilson Road at any time, from either direction, and by any mode, and thus would not have to change their time, route, or mode. Under reversible flow (Strategy A), a visitor can still access the area by auto, but may have to change the route (if desiring to travel against the direction of the one-way flow) or travel at another time when the one-way flow is in the desired direction. Because all strategies allow full access by bicycle, changing mode can allow access for any restriction.

Table 6-3: Comparisons of Strategy Impacts on Travel Plans

	May Require Change in		
	Route	Time	Mode
A: Reversible Flow	×	×	×
B: One-way North	×		×
C: One-way South	×		×
D: Gate restriction	×		×
E: Time of Day	×	×	×
F: Limited Auto Access	×		×
G: Pathway			

Assuming all visitors re-route, a negative impact of the management strategies is the increased travel time needed to take a lengthy detour. Based on traffic data previously collected (Appendix C) and assumptions about travel decisions (Appendix D) travel time delay estimates were developed based on the number of vehicles that would have to re-route and the total additional travel time required for the re-routing.

Table 6-4: Estimated Daily Impacts on Auto Travel Time Delay

	Total Delay (hours)	Vehicles Impacted	Impact per Vehicle (min)
A: Reversible Flow	180	400	26
B: One-way North	120	260	28
C: One-way South	130	280	27
D: Gate restriction	490	620	47
E: Time of Day*	330	420	47
F: Limited Auto Access	490	620	47
G: Pathway	0	0	0

*based on 9 hours of closure

Strategy A is estimated to cause 180 hours of delay in one day with 400 vehicles impacted. It allows peak direction traffic flow to use the road at the peak time. However, in order to ensure that no vehicles are caught going the wrong way, there should be two hours when the road is closed to vehicles entering either direction in order to clear the vehicles currently on the road. Therefore, there is no great travel time delay saving for this strategy. Strategy B causes less delay than Strategy C because northbound traffic is a little heavier than southbound traffic. Strategy D and Strategy F cause the same total travel time delay in one day, because under these strategies travelers could not access LSR Preserve from Granite Canyon Entrance Station, but would have to enter from the north end at Moose. The impact per vehicle of Strategy E is the same as Strategies D and F. The proportion of vehicles impacted depends on the duration of the closure. Traffic is consistently high from 10 AM to 7 PM, which accounts for 68 percent of the daily traffic. Strategy G would set no restrictions on vehicle access and would cause no delay. The impact per vehicle is much less for the one-way strategies because these typically impact only one portion of the trip, either going to Moose–Wilson Road or returning from Moose–Wilson Road, but not both. A gate restriction often affects both portions of the trip.

6.2.1. Commuter Traffic

"Commuter" traffic or drivers seeking shortcuts can be assumed to take the shortest path to their destination. Although re-routing impacts discussed above are considered negative, those vehicles impacted that are commuters would totally avoid Moose–Wilson Road and result in the benefit of removing commuter traffic (objective 3.1).

6.3. Percent Time Spent Following

Level of service (LOS) refers to the quality of service of the transportation infrastructure. The transportation LOS system uses the letters A through F, with A referring to free flow traffic and F referring to total breakdown. In this case, F means more traffic than can move on the roadway even if the traffic is packed as tightly as possible. E is often considered an unacceptable LOS. For a two-way, two-lane, scenic highway, the level of service is defined in terms of percentage time spent following (PTSF), except for LOS F which is defined as the maximum theoretical traffic. PTSF is the aggregate percentage of time that drivers spend in queues and unable to pass.

The Highway Capacity Manual (10) directional segment analysis was used to determine the traffic thresholds for different levels of service. The results of the analysis (two-way traffic) are presented in Table 6-5. The analysis assumed a) the entire road was a no-passing zone, b) a directional split during peak hour is the same as existing (67/33), c) a default peak hour factor of 0.88, d) no heavy trucks, e) level grades and f) a design speed of 45 miles per hour. The Highway Capacity Manual provides factors for determining PTSF for design speeds as low as 45 mph. Because the design speed on Moose–Wilson Road is lower (posted speed is 25 to 35 mph), the results should be interpreted with caution. Note that on this roadway, LOS A is never attainable.

The current peak hour volume is about 120 vehicles per hour (80 travelling northbound and 40 travelling southbound) resulting in an estimated 65 PTSF corresponding to a LOS of C.

Table 6-5: Breakpoints of Percent Time Spent Following for Two-way Traffic

LOS	PTSF (%)	Two-Way Hourly Volume (vph)
A	≤40	--
B	40-55	≤ 48
C	55-70	48-170
D	70-85	170-318
E	85-100	318-2112
F	>100	>2112

Several of the management strategies are based on one-way traffic, reducing the total capacity of the roadway. Calculated one-way peak traffic volume thresholds are shown in Table 6-6. As mentioned previously the current peak hour volume is about 120 vehicles with 80 vehicles in the dominant direction and 40 vehicles travelling in the opposing direction. If the management option included one-way traffic in the dominant direction, the 40 vehicles would either not travel on Moose–Wilson Road, or would reroute so they could travel in the permitted direction. If the one-way management strategy causes the vehicles to not travel on Moose–Wilson Road, the resulting volume of 80 vehicles maintains a LOS of C. If, however, the 40 vehicles rerouted and the one-way volume was 120 vehicles per hour, the PTSF would be 71 percent with the corresponding LOS degrading to D.

Table 6-6: Breakpoints of Percent Time Spent Following for One-way Traffic

LOS	PTSF (%)	One-Way Hourly Volume (vph)
A	≤40	--
B	40-55	≤ 32
C	55-70	32-114
D	70-85	114-252
E	85-100	252-1408
F	>100	>1408

It is difficult to know how management strategies will affect traveler choices (i.e., whether a traveler will still travel on Moose–Wilson Road even if changing route or time of travel is required, or if the traveler will avoid Moose–Wilson Road altogether). If vehicles reroute, one-way strategies (A, B and C) could create a degraded level of service in terms of PTSF, but still possibly within acceptable levels (i.e., worst case is PTSF of 70 to 85 percent).

6.4. Functional Attributes

Unlike values estimated for safety, delay and PTSF, this section summarizes the performance measures that lend themselves to a yes/no value based on the functional form of the mitigation. The following impacts are summarized:

- access to locations (objective 1.2),
- access for specific activities (objective 1.3),
- access by key users (objective 3.2),
- environment and esthetics (objectives 2.2 and 2.3),
- pathway continuity (performance measure 3.3.10),
- entrance contact opportunities (objective 1.5), and
- bicycle opportunities (performance measures 1.3.3 and 1.6.4)

6.4.1. Access to Location

Table 6-7 indicates the access provided to particular destinations from the north and/or south end of the roadway for auto visitors. All strategies provide emergency responders with unlimited access from both ends of the road. Depending on the intensity option, the access limitations may not apply to park operations, construction vehicles, or private landowners within the park. The intensity option may allow transit vehicles to have access through the gates (Strategies D, E and F), but transit vehicles should not be allowed to go against the flow of traffic for one-way operations (Strategies A, B and C). Note that two strategies (Strategy A, reversible flow, and Strategy E time-of-day restriction) allow vehicle access but only for certain times of day.

Table 6-7: Preserving Auto Access to Locations for Different Strategies (Objective 1.2)

Preserve Access to…	Strategy						
	A	B	C	D	E	F	G
Death Canyon/White Grass Ranch from South	P	Y	N	N	P	N	Y
Death Canyon/White Grass Ranch from North	Y	Y	Y	Y	Y	Y	Y
Granite Canyon from South	Y	Y	Y	Y	Y	Y	Y
Granite Canyon from North	P	N	Y	N	P	N	Y
LSR Preserve from South	P	Y	N	N	P	N	Y
LSR Preserve from North	Y	Y	Y	Y	Y	Y	Y
Moose Visitor Center from South	P	Y	N	N	P	N	Y

Y = maintains auto access
P = maintains partial auto access (for certain times of day)
N = maintains no auto access for certain locations and directions

6.4.2. Access for Specific Activities

Objective 1.3 is to maintain a variety of ways to experience the park. Management strategy impacts on auto touring opportunities were discussed in the previous section. Bicycle touring opportunities are discussed later. Management strategies do not directly create transit touring opportunities, but there are potential implications of management strategies on transit operations.

High ridership can enhance transit touring and shuttle opportunities and preserve and encourage future opportunities for transit utilization, while low ridership cannot. Strategies D, E and F, depending on the intensity option, can allow for transit vehicles to travel the entire roadway, when personal vehicles cannot. Providing this access advantage could motivate visitors to change modes, resulting in higher ridership. Strategies A, B and C require transit vehicles to operate alongside personal vehicles, eliminating the aforementioned advantage.

Higher ridership on public transit also allows more visitors to access Moose–Wilson Road within the existing road capacity (more people per vehicle). No transit service exists along Moose–Wilson Road currently. For detailed information about the feasibility of transit operation, refer to Grand Teton National Park Draft Public Transportation Feasibility Study (28).

6.4.3. Access for Key User Groups

Management strategies impact key user groups differently as summarized in Table 6-8. Emergency vehicles, for example, have full access under any management strategy. That is, they can reach any portion of Moose–Wilson Road from any direction during any part of the day (denoted as Y). Some management strategies have different intensity options that could allow full access for certain user groups (denoted as I). Other management strategies, regardless of the intensity option, limit access by certain user groups (denoted as N).

Table 6-8: Preserve Access for Key Road Users (Objective 3.2)

	Strategy						
User Group	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Park Maintenance and Operations	N	I	I	I	I	I	Y
Emergency Responders	Y	Y	Y	Y	Y	Y	Y
Private Landowners within Park	N	N	N	I	I	I	Y
Construction Activities at White Grass	N	N	N	I	I	I	Y
Commercial Operations	N	N	N	I	I	I	Y
Park Employees	N	N	N	I	I	I	Y
Other Users (e.g., Army Corps of Engineers)	N	N	N	I	I	I	Y

Y = maintains full access in both directions
I = full access depends on intensity option
N = Access limited for certain locations, directions and/or times

6.4.4. Environment and Aesthetics

The environmental and aesthetic impacts (Objectives 2.2 and 2.3) of implementation of the various core strategies are summarized in Table 6-9. Some strategies fully meet the aesthetic and environmental performance measures, while others may not. For those that do not fully meet a specific measure, the exact magnitude of the impact is difficult to assess and may depend on the exact design and intensity option.

Table 6-9: Strategy Impacts on Wildlife Habitat and Corridor Aesthetic

	Strategy						
Performance Measure	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Preserve Wildlife Habitat	Y	Y	Y	Y	Y	Y	N
Maintain Existing Paved Footprint	Y	Y	Y	Y	Y	Y	N
Minimize Striping and Signage	N	N	N	N	N	N	N
Minimize Visible Built Features	N	N	N	N	N	N	N

Y = fully meets objective
N = may not fully meet objective

Creating a separated pathway will lead to loss of wildlife habitat, while other strategies do not. All strategies need to stripe the pavement or add signage to restrict traffic except Strategy G, which only adds signage at the entrance to direct non-motorists to use the pathway.

Human activities have an impact on wildlife. The interaction between humans and wildlife occurs when human beings come in contact with wildlife either intentionally or unintentionally. Due to unclear changes in visitation and traffic flow characteristics, it is difficult to estimate the change in wildlife population (performance measure 2.2.1) that would occur under the different management strategies.

6.4.5. Pathway Continuity

Strategy G includes creating a new separated pathway and increasing the continuity of non-motorist infrastructure (objective 3.3.10), while other strategies do not meet this objective.

6.4.6. Entrance Contact Opportunities

Currently southbound traffic on Moose–Wilson Road can travel the roadway without stopping at an entrance station. One-way traffic northbound (Strategy B, and to some extent Strategy A) can force traffic to stop at the Granite Canyon Entrance Station, increasing the contact opportunities. Strategy C requires moving the entrance station to the Moose Entrance to manage the traffic, which can enhance visitor contact opportunities as well.

6.4.7. Bicycle Opportunities

All of the traffic management strategies preserve bicycle touring opportunities (performance measures 1.3.3 and 1.6.4). Some strategies provide more space for cyclists by restricting vehicle access and possibly re-striping the roadway. Table 6-10 contrasts the space available for non-motorists under different strategies.

Table 6-10: Comparisons of Strategy Impacts on Space for Non-Motorists

Strategy		No. of Auto Travel Lanes	Lane Width for Non-Motorists
Do Nothing		2	1 ft each side
A: Reversible flow		1	9-ft
B: One-way Northbound		1	9-ft
C: One-way Southbound		1	9-ft
D: Gate Restriction on Through Traffic		2	1 ft each side
E: Time of Day Restriction	Peak	0	20 ft
	Off Peak	2	1 ft each side
F: Limited Auto Access (the whole day)		0	20 ft
G: Separated Pathway		2	10 ft

6.5. Strategy Impacts Summary

Based on the estimated impacts presented in this chapter, some concluding observations are offered below for each core strategy. In reading these remarks it is important to understand, the actual impact of a particular strategy cannot truly be known until the strategy is implemented and impacts measured.

Considering the strategies with one-way traffic flow (A, B, and C), one-way northbound, Strategy B is the preferred option. It has the least impact on vehicles in terms of rerouting and delay. It has an expected safety impact similar to the other one-way options. All visitors entering Moose–Wilson Road will have to pass the Granite Canyon Entrance Station. It requires less management effort and has lower potential for confused motorists than reversible flow (Strategy A). If a one-way management strategy is considered, northbound one-way should be implemented.

When comparing Strategy B (one-way northbound) with the remaining options (Strategies D, E, F and G), different strategies rise to the top depending on the relative priority of the objective being pursued.

From a safety perspective, most strategies have minimal impact. Considering that Moose–Wilson Road is relatively safe, even closing the road for all or part of the day (Strategies E and F) results in reducing only a few crashes per year.

In regards to inconveniencing motorists through rerouting and delay, a time-of-day restriction (Strategy E) has less impact than continuous closed gates (Strategies D and F). The total impact of Strategy E on inconveniencing motorists could be adjusted depending on the hours of closure, to the point that it could have less overall impact than Strategy B.

One-way traffic (Strategy B) could have a negative impact on the level of service in terms of percent time spent following if vehicles are rerouted. Although the northbound capacity is the same, the southbound capacity of the roadway is zero.

If a pathway is not installed, Strategy B allows for a designated pathway on the existing pavement. A separated pathway (Strategy G) provides the most comfort and safety for non-motorized visitors.

All strategies have some impact on the built features (signing, striping, gates). Strategy G has the most environmental impact with reduced wildlife habitat.

7. PHASING PLAN

Earlier chapters have presented various transportation management strategies that could be employed along Moose–Wilson Road, along with criteria (i.e., performance measures) that may be used to measure their effectiveness. This chapter integrates this information into a phasing plan that recommends an order for strategies to be implemented, and identifies values for measures of effectiveness that, if not met, would lead to a change in the transportation management strategy.

The phasing plan, as outlined in the 2006 Moose–Wilson Corridor Transportation Assessment Report, involves: 1) collecting baseline data; 2) using the baseline data to determine which strategy to implement; 3) implementing the strategy chosen; 4) collecting post-implementation data; and 5) annually revisiting the strategy to determine a) if alternative intensity options should be used, b) if any complementary strategies should be employed, or c) if another strategy should be implemented.

7.1. Order of Strategy Implementation

As illustrated in Figure 7-1, the strategies may be related to each other in terms of the level of vehicle access they provide and the level of corridor capacity. Strategies A through F, in general, involve increasing restrictions on vehicle access on Moose–Wilson Road while maintaining the same physical roadway capacity. Strategy G, which calls for separated multiuse pathways, is alone among the core strategies in expanding the capacity of the corridor.

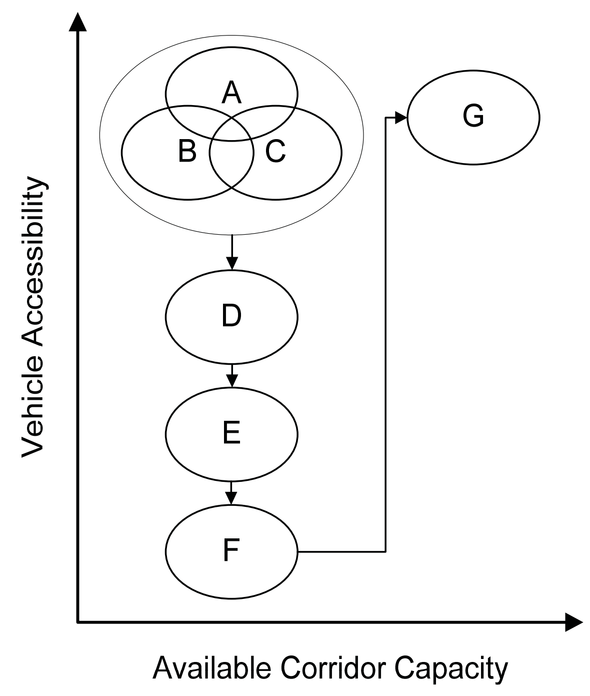


Figure 7-1: Relationship Between Strategies

Since a large number of trips on Moose–Wilson Road are through trips—by both park visitors and non-park road users—the least restrictive approaches would be those that allow some through trips to continue throughout the day. These approaches would be found among Strategies A, B and C (Reversible Flow, One-Way Northbound and One-Way Southbound, respectively). Of the one-way strategies, Northbound (Strategy B) should be implemented because it has the least impact on rerouting vehicles, has no apparent safety disadvantage, and provides the highest level of visitor contact through the Granite Canyon Entrance Station (refer to Chapter 6 for more details).

A chronological approach is recommended that would select a core strategy (starting with the least restrictive), and modifying it with complementary strategies and intensity levels as needed to manage its effects. There may come a point, however, when a strategy has unacceptable flaws from a performance measure standpoint. At that time, the decision would be made to advance to the next core strategy.

The approach to transitioning between core strategies over time is depicted in Figure 7-1. Strategies A through F generally represent increasing limitations on visitor vehicle access to Moose–Wilson Road. Strategy G, the only strategy that considers separated multiuse pathways, would be considered only if all other core strategies prove to be unsuccessful in meeting park objectives. The primary reason for the pathways alternative to be considered last is that it would increase the paved cross-section of the Moose–Wilson Road corridor, which would be considered an unacceptable flaw in this strategy because of its impact on park resources.

7.2. Performance Measures

To conserve on data collection costs during evaluation, the 52 performance measures in Appendix B were reduced to the most critical, as ranked by park personnel (Table 7-1). Note that the performance measures identified in the 2006 report included conflicts, or close calls, in addition to collisions. Based on experience from the baseline data collection, these conflicts proved difficult to accurately collect and have been removed from the list of critical performance measures.

Table 7-1: Critical Performance Measures to be Evaluated

Goal/Objective	Park Rating
1.3.1. Preserve wildlife viewing opportunities	Most Critical
2.2.1. Preserve wildlife populations in the Moose-Wilson corridor	Most Critical
3.3.1. Minimize confusion and misunderstanding among road and park users	Most Critical
1.3.2. Preserve auto touring opportunities	Very Critical
1.4.1. Maintain or reduce vehicle speeds	Very Critical
1.6.1. Preserve visitor satisfaction ratings among first-time visitors	Very Critical
1.6.2. Preserve visitor satisfaction ratings among non-local visitors	Very Critical
3.1.1. Reduce volume of “commuter” traffic (regular users who do not visit park)	Very Critical
3.1.2. Reduce volume of shortcut traffic (occasional users who do not visit park)	Very Critical
1.1.1. Preserve visitation (not vehicle) levels on Moose-Wilson Road and its sites	Somewhat Critical
1.3.3. Enhance bicycle touring opportunities	Somewhat Critical
1.4.3. Reduce number and severity of vehicle-vehicle collisions	Somewhat Critical
1.4.5. Reduce number and severity of vehicle-bicycle collisions	Somewhat Critical
1.4.7. Reduce number of roadkills	Somewhat Critical
1.5.1. Increase percentage of visitors who go through an entrance station	Somewhat Critical
1.6.3. Preserve visitor satisfaction ratings among local visitors who access the park by auto	Somewhat Critical
1.6.4. Preserve visitor satisfaction ratings among local visitors who access the park by bicycle	Somewhat Critical
2.1.2. Increase mode share of non-auto modes on Moose-Wilson Road (transit or bicycle)	Somewhat Critical
2.1.1. Increase average vehicle occupancy of motor vehicles on Moose-Wilson Road	Not as Critical

The determination of when a core strategy should be modified and when it should be abandoned in favor of a different strategy depends on the values of the critical performance measures. This section identifies the performance measure values that would constitute an unacceptable flaw in the implemented strategy and require improvement to the current transportation management approach. This section presents flow charts that show how these performance measures may be used to guide selection/modification of transportation management strategies into the future. Finally, this section mentions external factors that may affect the phasing plan.

7.2.1. Critical Performance Measures

For each of the 19 critical performance measures in Table 7-1, three thresholds are indicated in Table 7-2 corresponding to three possible actions that will be triggered based on their assessed value/condition: a) performance acceptable, continue to monitor; b) performance unacceptable, modify strategy and continue to monitor; and c) performance sufficiently unacceptable (flawed) that a new strategy should be implemented. These thresholds are called decisive values, as they are the values that are recommended to be used to drive decisions on which transportation management strategy should be implemented. The decisive values for each critical performance measure are shown in Table 7-2.

To a large extent, Table 7-2 provides general guidelines rather than specific values for many of the performance measures. While all of these performance measures may be quantifiable, it is uncertain in almost all cases what numeric values should be considered “decisive.” Park personnel who have had experience interacting with Grand Teton visitors over a number of years would ultimately need to define those decisive values. Moreover, the reasons behind any changes in values would need to be investigated to determine to what extent deterioration in visitor satisfaction or the visitor experience is the result of the transportation management strategy.

It should be noted that not all of the performance measures have decisive values corresponding to an outcome of “unacceptable flaw.” This means that even though they are important from the perspective of meeting park goals and assessing strategy effectiveness, those performance measures will not, by themselves, determine that a specific core strategy should be abandoned. Moreover, a performance measure yielding an “unacceptable flaw” value will need to be investigated to ensure that this value is attributable to the transportation management strategy.

Table 7-2: Decisive Values for Critical Performance Measures

Goal/Objective		Performance Measure	Action Based on Performance Measure Value: Monitor, If…	Improve, If…	Unacceptable Flaw, If…
Safety					
1.4.1.	Maintain or reduce vehicle speeds	Average vehicle speed on Moose-Wilson Road	No change or decrease	Increase	>10 mph increase
1.4.3.	Reduce number and severity of vehicle-vehicle collisions	Number of collisions in a year	No change or decrease	1/yr increase	2/yr increase
1.4.5.	Reduce number and severity of vehicle-bicycle collisions	Number of collisions in a year	No change or decrease	1/yr increase	2/yr increase
Visitor Experience					
1.1.1.	Preserve visitation (not vehicle) levels on Moose-Wilson Road and its sites	Amount of visitor traffic on Moose-Wilson Road and its sites	No change or increase	Significant decrease	
1.3.1	Preserve wildlife viewing opportunities	Percentage of visitors who access Moose-Wilson Road to see wildlife	No change or increase	Significant decrease	
1.3.2	Preserve auto touring opportunities	Percentage of visitors who were satisfied with auto touring opportunities in park	No change or increase	Significant decrease	
1.3.3	Enhance bicycle touring opportunities	Percentage of visitors who were satisfied with bicycle touring opportunities in park	No change or increase	Significant decrease	
1.5.1	Increase percentage of visitors who go through an entrance station	Percentage of visitors who go through an entrance station	No change or increase	Significant decrease	
1.6.1.	Preserve visitor satisfaction ratings among first-time visitors	Percent of first-time visitors who accessed Moose-Wilson Road and were satisfied with their visit	No change in satisfaction levels	Significant increase in visitor dissatisfaction	
1.6.2.	Preserve visitor satisfaction ratings among non-local visitors	Percent of non-local visitors (first-time or repeat) who accessed Moose-Wilson Road and were satisfied with their visit	No change in satisfaction levels	Significant increase in visitor dissatisfaction	
1.6.3.	Preserve visitor satisfaction ratings among local visitors who access the park by auto	Percent of local visitors who accessed Moose-Wilson Road by car and were satisfied with their visit	No change in satisfaction levels	Significant increase in visitor dissatisfaction	
1.6.4.	Preserve visitor satisfaction ratings among local visitors who access the park by bicycle	Percent of local visitors who accessed Moose-Wilson Road by bicycle and were satisfied with their visit	No change in satisfaction levels	Significant increase in visitor dissatisfaction	
3.3.1.	Minimize confusion and misunderstanding among road and park users	Percent of visitors who express confusion about traffic management on the road	Few visitors are confused	Majority are confused	
		The number of complaints received by park personnel	Few or no complaints	A high number of complaints to park personnel	
Road Stewardship					
1.4.7.	Reduce number of roadkills	Number of large mammal roadkill removed from Moose-Wilson Road	0-1 / year	2-3 / year	> 3 / year
2.1.1.	Increase average vehicle occupancy of motor vehicles on Moose-Wilson Road	Average vehicle occupancy of motor vehicles on Moose-Wilson Road	No change	Decrease	
2.1.2.	Increase mode share of non-auto modes on Moose-Wilson Road (transit or bicycle)	Percent of visitors using Moose-Wilson Road with transit or bicycle	No change	Decrease	
2.2.1.	Preserve wildlife populations in the Moose-Wilson corridor	(1)	(1)	(1)	
3.1.1.	Reduce volume of “commuter” traffic (regular users who do not visit park)	Number of "commuters" using Moose-Wilson Road per day	Decrease	No change or slight increase	Large increase
3.1.2.	Reduce volume of shortcut traffic (occasional users who do not visit park)	Number of vehicles per day using Moose-Wilson Road as shortcut	Decrease	No change or slight increase	Large increase

(1) - To be determined by park wildlife and resource management personnel

Definitions:
Monitor - The strategy succeeds in meeting the park’s performance measures; the park would continue to monitor strategy effectiveness
Improve - The strategy does not meet all of the park’s performance measures, so complementary strategies are used to improve it
Unacceptable Flaw - The strategy has an outcome that is considered unacceptable to a level that the core strategy needs to be abandoned

These critical performance measures may be grouped into three areas: safety, visitor experience, and road stewardship. Each group is discussed in turn below.

Safety

Three of the critical performance measures deal explicitly with safety. Crashes are an ultimate measure of roadway safety; consequently, increases in crashes that can be attributed to the transportation management approach—whether between vehicles (1.4.3) or between vehicles and bicycles (1.4.5)—would likely be an unacceptable flaw. However, crashes are an extreme (and generally rare) instance of a road safety failure; there are more subtle levels of safety failure that may be measured and that could also indicate the need for improvement. Increases in vehicle speed (performance measure 1.4.1) will tend to increase the likelihood and severity of crashes. Vehicle speed is especially critical for accidents involving unprotected road users, including bicyclists and pedestrians.

Visitor Experience

Ten of the critical performance measures are concerned with visitor experience. It should be noted that none of these measures have decisive values in the "unacceptable flaw" range. However, any or all of them may lead to improvements in a current transportation management strategy. If the improvements are not possible within the current core strategy, these performance measures could ultimately lead to implementation of a new core strategy.

Road Stewardship

Finally, as Moose-Wilson Road and its surrounding area are considered a valuable park resource, it is important to consider how this resource is being managed and protected. Six performance measures deal with this question: four of these address how the road is currently used (commuter traffic, shortcut traffic, alternative mode use, and vehicle occupancy), and two are concerned with impacts on wildlife (wildlife population and roadkills).

7.2.2. Measuring Performance

When Moose–Wilson Road is evaluated to determine if a change in strategy is needed, data for the critical performance measures should be collected. Data sources include traffic counters, incident reports, complaint history, manual counts of mode and occupancy, and visitor surveys. As noted in Table 7-1, impacts on wildlife population are difficult to measure. This performance measure should result from discussions with park biologists if there is a general sense that the management strategy is impacting wildlife populations.

Baseline data has been collected for current conditions and baseline values of the performance measures have been determined, as presented in Table 7-3. Automatic traffic counters (road tubes) were used to collect information on traffic volumes and speeds. Incident reports were reviewed to identify the number of vehicle only and vehicle–bicycle collisions. The severity (i.e., if someone was injured or killed) of these collisions was also be noted. Park personnel were asked if there were any records of public complaints regarding Moose–Wilson Road. This included informal discussions with interpretive staff regarding public complaints. Automatic traffic counters cannot reliably record bicycle traffic, and are unable to determine the number of people in a vehicle. As such, manual mode and occupancy counts were completed. A visitor survey targeting users of Moose–Wilson Road was conducted to determine visitor satisfaction as well as the visitor's primary purpose of travelling on Moose–Wilson Road. For more detail on the source of the baseline data, refer to Appendix C.

Table 7-3: Data Sources for Performance Measures

Objective	Data Source	Current Value
Safety		
1.4.1. Maintain or reduce vehicle speeds	Traffic counters	Ave. Speed = 21 to 35 85^{th} % Speed = 25 to 40
1.4.3. Reduce number and severity of vehicle collisions	Incident reports	3.9 collisions per year (no injury/fatality)
1.4.5. Reduce number and severity of vehicle–bicycle collisions	Incident reports	0.2 collisions per year (all injury)
Visitor Experience		
1.1.1. Preserve visitation (not vehicle) levels on Moose–Wilson Road	Manual counts	2,770 people per day
1.3.1. Preserve wildlife viewing opportunities	Survey	21% summer 26% fall
1.3.2. Preserve auto touring opportunities	Traffic counts	1,200 ADT
1.3.3. Enhance bicycle touring opportunities	Manual counts	20 bicycle ADT
1.5.1. Increase percentage of visitors who go through an entrance station	Traffic counters	51.5% northbound
1.6.1. Preserve visitor satisfaction ratings among first-time visitors	Survey	Satisfaction: 4.3 out of 5, 3.7 w/ poor gravel
1.6.2. Preserve visitor satisfaction ratings among non-local visitors	Survey	Satisfaction: 4.3 out of 5, 3.8 w/ poor gravel
1.6.3. Preserve visitor satisfaction ratings among local visitors who access park by auto	Survey	Satisfaction: 4.3 out of 5, 3.8 w/ poor gravel
1.6.4. Preserve visitor satisfaction ratings among local visitors who access park by bicycle	Survey	Satisfaction: 4.3 out of 5, 4.7 w/ poor gravel
3.3.1. Minimize confusion	Complaints	Minimal complaints
Road Stewardship		
1.4.6. Reduce number of roadkills	Incident reports	0.5 reported collisions per year
2.1.1. Increase average vehicle occupancy of motor vehicles	Manual counts	2.25 people per vehicle
2.1.2. Increase mode share of non-auto modes	Manual counts	1.6% bicycle, no transit
2.2.1. Preserve wildlife populations	Interview with park biologist	
3.1.1. Reduce volume of "commuter" traffic 3.1.2. Reduce volume of shortcut traffic	Survey (through trips)	38% in summer 22% in fall

7.2.3. Future Strategy Selection

After Strategy B is implemented for a season, the performance measures should be evaluated to determine one of the following actions:

- Monitor- If the strategy succeeds in meeting the park's performance measures, the park should continue to monitor its effectiveness over subsequent seasons.

- Improve- If the strategy does not succeed in meeting all of the park's performance measures, but may be modified through the addition, modification or removal of complementary strategies, the park should implement such modifications and monitor over subsequent seasons to see if the they are successful.

- reject for unacceptable flaw- If there is a negative evaluation outcome that shows the current strategy to be unacceptable even with changes to intensity options or complementary strategies, the park should adopt an entirely different management approach (core strategy).

The first question will be whether any of the performance measures have a value that would be characterized as an unacceptable flaw. If so, that core strategy will no longer be considered. The next core strategy to be considered would be the one that would be expected to have the next least impact on reducing vehicle traffic on Moose–Wilson Road (based on available data).

If there are no unacceptable flaws, the next question will be whether there is a need to improve the implementation. Improvement would be considered when one or more of the 19 critical performance measures listed in Table 7-2 scores in the “Improve” category. There are potentially limitless combinations of improvements that could be added to a given core strategy. For the purposes of this phasing plan, the first modifications would focus on adding complementary strategies, and then on changing the strategy intensity as needed. Complementary strategies for these core strategies include options such as enhancing roadway signage/marking, implementing speed reduction measures, and adding transit. Changing the strategy intensity for these strategies might include, for example, extending the limits of the one-lane section. It is proposed that multiple improvements to a strategy could be adopted in a given season. This will ensure that no more time is devoted to an ultimately unsatisfactory transportation management approach than is necessary.

If no improvements are deemed necessary, the transportation management strategy will be kept in place without changes for another season. Further evaluation will be conducted the following year to ensure that there is no unacceptable deterioration in any of the performance measures as usage patterns of Grand Teton National Park in general, and Moose–Wilson Road in particular, continue to change.

The decision flow chart for Strategy B is shown in Figure 7-2. The flow chart provides a logical process for considering complementary strategies and intensity options based on the annual review of performance measures. If the decision is made to add transit as a complementary strategy to a given core strategy, it would likely not make sense to remove that service in the event the core strategy is changed.

If the one-way options do not satisfy the critical performance measures—through having one or more performance measures characterized as an unacceptable flaw, or having one or more performance measures that are scored as requiring improvement, while no further improvement is seen possible—then the next core strategy is to install a gate to restrict through traffic except for permitted vehicles (Core Strategy D). The flow chart for this core strategy is shown in Figure 7-3 (page 57).

If Core Strategy D is ultimately unsuccessful, the next core strategy would include time-of-day restrictions on access to portions of Moose–Wilson Road (Core Strategy E). The flow chart for Core Strategy E is shown in Figure 7-4 (page 58).

If Core Strategy E is ultimately unsuccessful, the park would consider Core Strategy F. The flow chart for Core Strategy F is shown in Figure 7-5 (page 59). This flow chart differs from others in what happens if an unacceptable flaw or inability to improve the core strategy is attained. For the other core strategy, this condition would lead to an automatic consideration of the next core strategy. Such a rule would mean that the next strategy to be implemented would be Core Strategy G (Pathways). Because of the impact of Core Strategy G on the sensitive environment of the Moose–Wilson Road and the irreversible nature of construction of a pathway, it is recommended that all other strategies be reconsidered before implementing the pathways alternative.

Core Strategy G, which adds a separated multiuse pathway to the Moose–Wilson Road corridor, differs from all other core strategies in that it expands the capacity of the roadway corridor. It would allow the existing road to continue to support two directions of private vehicle traffic at all times, while providing for improved connectivity for users of non-motorized modes. This approach differs from the other core strategies in that it is technically not a management strategy working within the confines of the existing right-of-way, but rather a construction and expansion strategy. It also differs from other core strategies in that it is essentially irreversible.

Implementation of Core Strategy G would reflect a conclusion that all transportation management strategies have failed to address all four issues of traffic growth, connectivity and compatibility, sensitive environment and access requirements on Moose–Wilson Road. However, it should be noted that while Core Strategy G will resolve connectivity and compatibility issues, it would not address issues related to traffic growth. Consequently, it may be necessary even with a separated multiuse pathway to adopt other transportation management strategies (for example, adding transit or restricting through traffic).

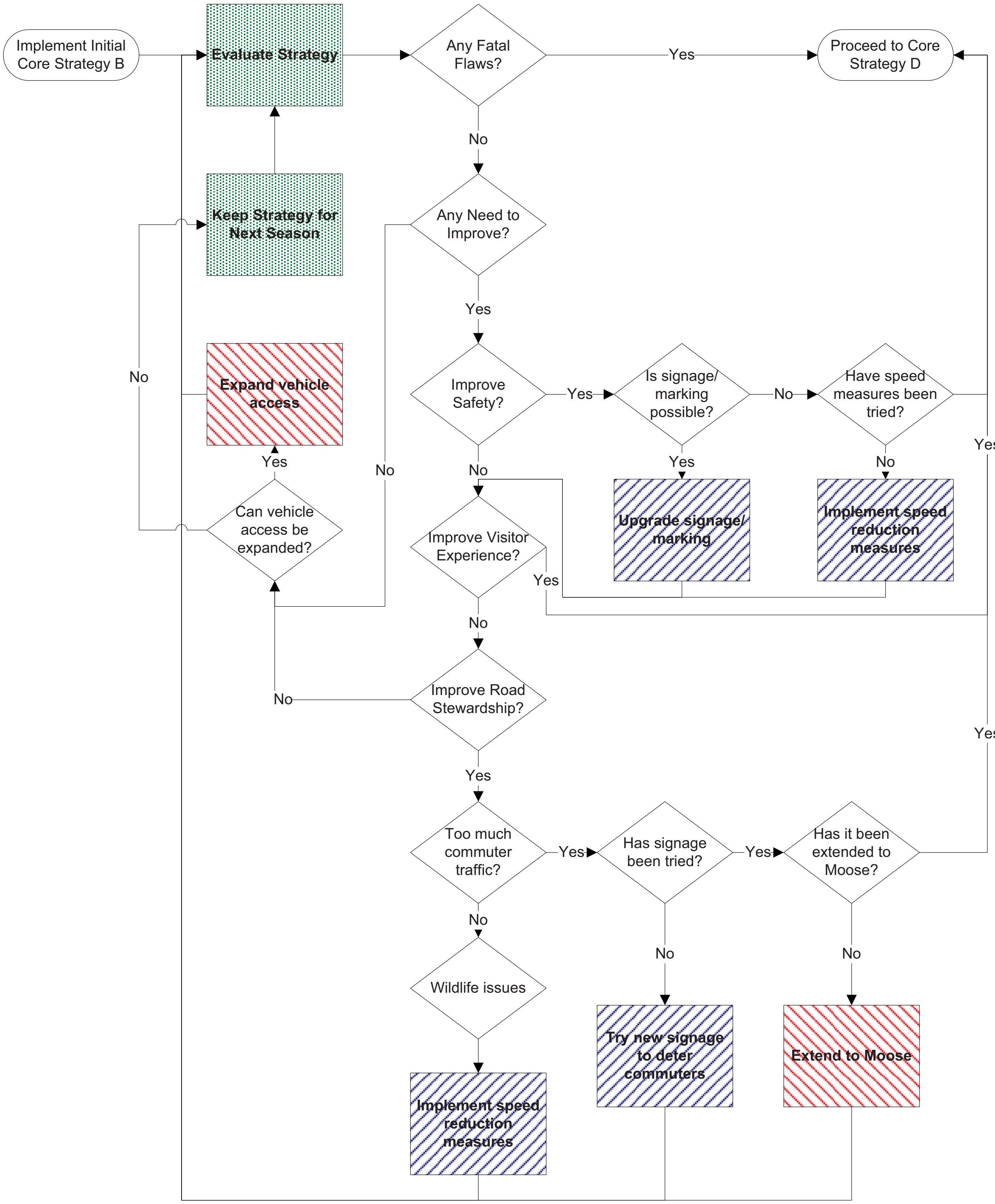


Figure 7-2: Flow Chart for Core Strategies B

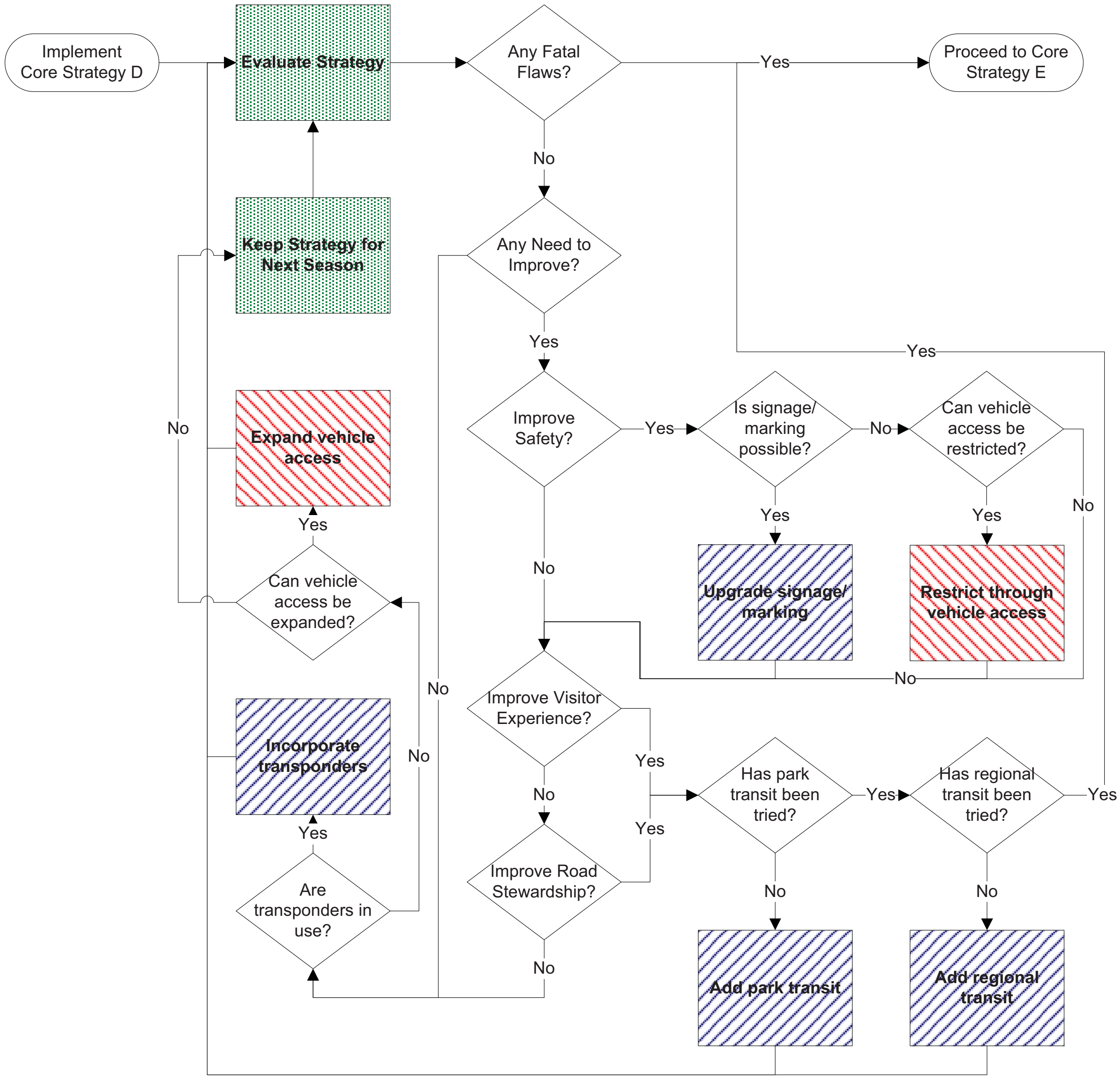


Figure 7-3: Flow Chart for Core Strategy D

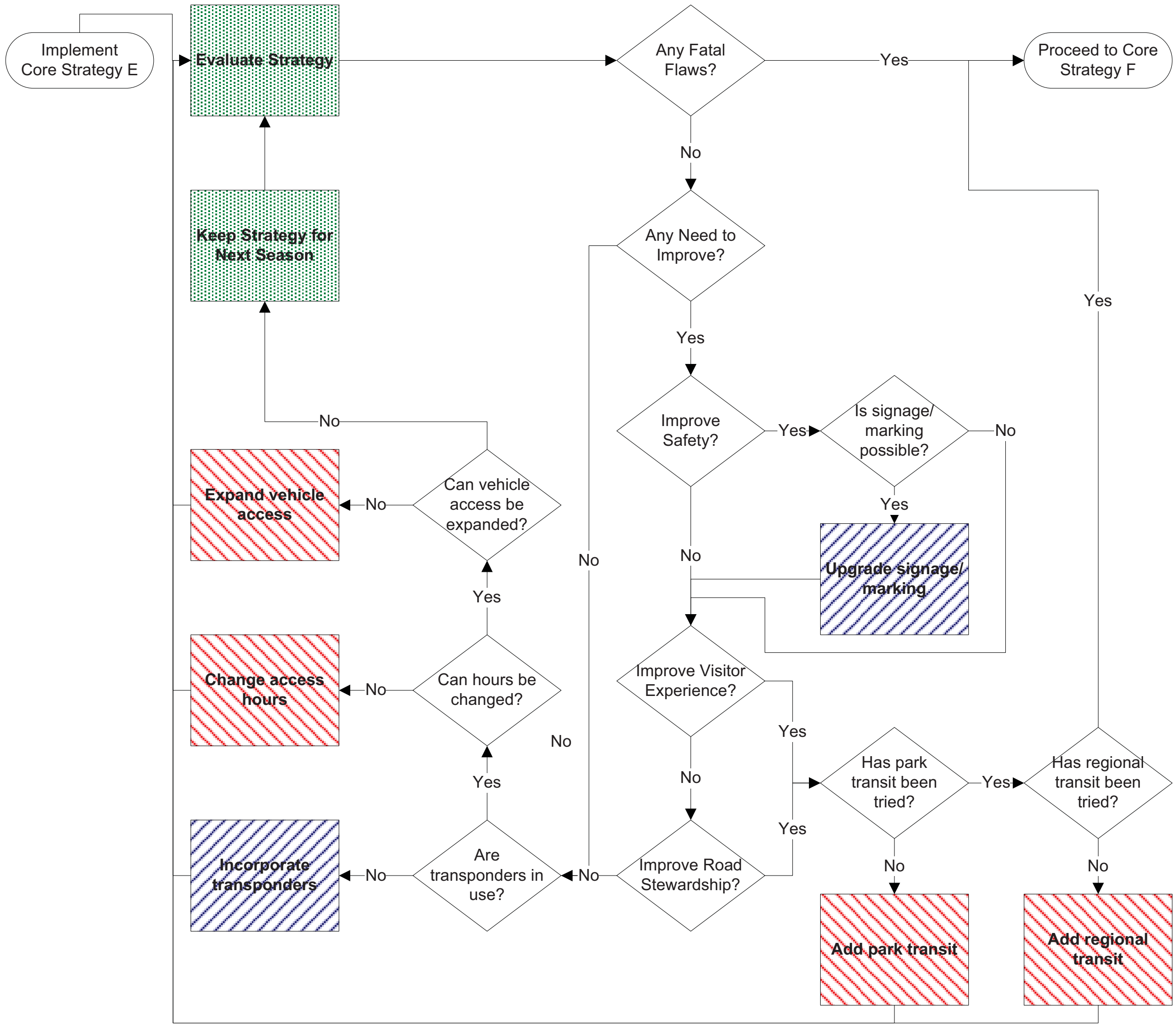


Figure 7-4: Flow Chart for Core Strategy E

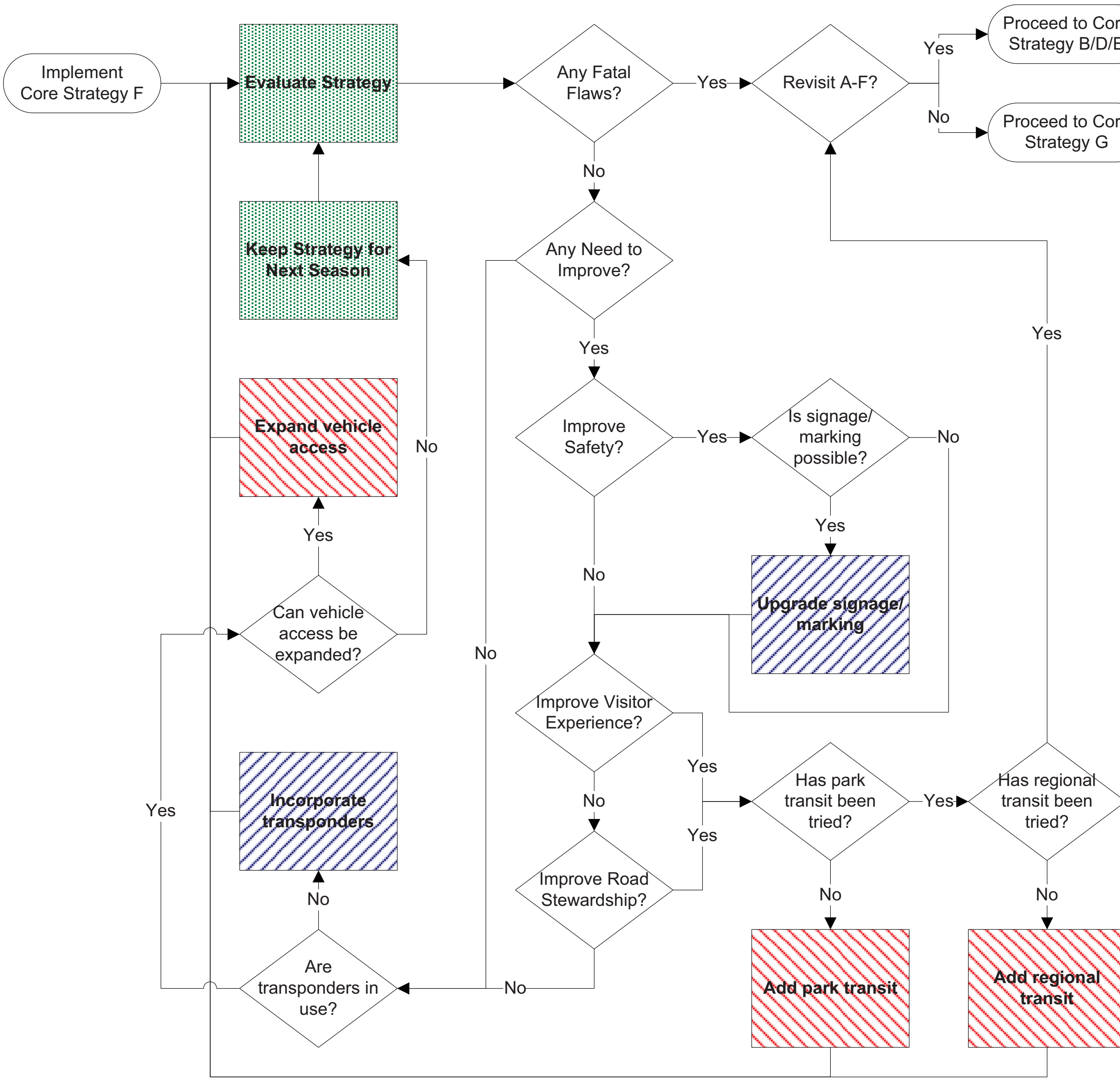


Figure 7-5: Flow Chart for Core Strategy F

7.2.4. Scheduling of Core Strategies

It is recommended that a strategy be allowed a full season (through the end of the peak visitor season in early September) of implementation before any decision is made to abandon the strategy. This is recommended for the following reasons.

- Both visitation levels and visitation patterns may change throughout a season. Understanding how these levels and patterns change over a season in response to a given strategy may lead to information that can help fine-tune a strategy to improve how it meets the critical performance measures.

- All strategies might change when or how motor vehicles could travel on Moose–Wilson Road. Accordingly, it will be necessary to get information out to visitors well before they arrive at the park. Changing a transportation management approach during the middle of a season could adversely affect the visitor experience for many out-of-state visitors, while creating major increased cost in new public information distribution campaigns (e.g., park maps).

- Some strategies require installation of infrastructure (e.g., gates). Accomplishing this during the busy season would be disruptive at a time when road usage is at its maximum. Therefore, construction activities would be recommended only before the peak visitation starts (April–May) or after it ends (late September or October).

- Implementation of transit service would require extensive ramp-up time for vehicle acquisition, creation of maintenance facilities, route planning, design and construction of transit stops, and other factors. Adding transit service to the park coordinated with existing transit services in the region would relieve some of these factors, while creating other difficulties relating to institutional cooperation and funding. Therefore, the decision to add transit service could not be implemented quickly, while the decision to remove transit service could result in considerable costs.

Some complementary strategies, such as adding signage or enhancing speed management strategies, may be implemented relatively easily during a season. In fact, it may be appropriate to do these complementary strategies during a season so that a strategy that is clearly not meeting the performance measures may be improved with the hope of meeting them. It should be recognized, however, that the effects of these strategies will be harder to calculate when visitation patterns are changing at the same time.

7.2.5. External Factors

External factors may emerge over time that could substantially affect the assumptions underlying the phasing plan, and consequently the recommendations for the preferred transportation management strategy. As these factors emerge, it will be important for park personnel to assess whether these have any material impact on the need for and nature of transportation management strategies for Moose–Wilson Road. This section cites three such external factors.

Improved Roadway Connectivity Outside the Park

Anecdotally, it is believed that traffic volumes on Moose–Wilson Road are at a critical level, in part due to commuter traffic, which may be broadly defined as travelers who use Moose–Wilson Road but are not interested in experiencing the park or accessing destinations within the boundaries of the park. These vehicles likely use Moose–Wilson Road because it is the shortest route in time or distance. If a new road opened up outside the park that could improve highway network connectivity, this may remove much of the commute and "shortcut" traffic from Moose–Wilson Road in the park. These alternatives include Snake River crossings at Sagebrush Drive or Spring Creek Road, both south of the park. If such an alternative is built, it would provide a shorter route for traffic between Teton Village and the airport, for example, and perhaps other origin–destination patterns as well. This road, although outside the park, could provide traffic relief for Moose–Wilson Road within the park. Construction of such a road is outside of the park's control, but could have significant beneficial impacts on Moose–Wilson Road.

Evolving Park Land Uses

The LSR Preserve and the new Moose Visitor Center are both open to the public. Both of these may affect use patterns and traffic along the Moose–Wilson Road and Teton Park Road near Moose, although the degree to which this will occur is unknown. It is anticipated that the LSR Preserve may attract substantial numbers of visitors, although parking will only be available for 55 cars and management of the area could influence visitor numbers. In addition, the development of a system of multi-use pathways as described in the park's transportation plan EIS/ROD could also affect visitor use patterns and activities, such as attracting increased numbers of bicyclists.

Regional Transit Improvements

South Teton Area Rapid Transit (START) provides transit service to Jackson and Teton Village. Service could be extended in the future to provide better access to sites within the park boundaries, such as the airport[4]; or even service that could help park visitors, such as service between Moose Visitor Center and either Jackson or Teton Village.[5] If such service were implemented, this could affect usage of Moose–Wilson Road. This also could provide some opportunities for the park to explore greater use of transit service in the park, including along Moose–Wilson Road.

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[4] Transit service to the airport is currently provided by Alltrans; any new service would likely involve establishing agreements between Alltrans, the Jackson Hole Airport Authority and the new transit provider.

[5] Any transit service that uses Moose–Wilson Road would need to consider the geometric and pavement constraints of the existing road when vehicle size and capacity are considered.

8. SUMMARY AND NEXT STEPS

The purpose of this report is to present transportation management strategies that can be used to address the challenges of traffic growth and to promote connectivity and compatibility of modes on Moose–Wilson Road, while working within the constraints of the road corridor's sensitive environment and satisfying access requirements. The report presents a number of strategies, which are reduced and grouped into seven core strategies. These strategies were ranked by park personnel against a series of performance measures, which were developed to correspond to park management goals for the road. This report provides estimates of potential impacts of core strategies. One-way northbound (Strategy B) is identified as the best one-way flow alternative. Finally, these strategies and performance measures are integrated to develop a phasing plan that guides transportation management approaches on Moose–Wilson Road for the indefinite future.

This report does not make a recommendation of whether or not to maintain the status quo. The park should revisit the current situation on Moose–Wilson Road, considering the findings of this report, and determine if a new management strategy is needed. If the status quo is not an acceptable option, the park should proceed with implementation of the framework outlined in this report. The following steps are recommended:

- Publicize the transportation management strategy to both local stakeholders and park users through local outreach and media, as well as to national park users through the park's web site and similar venues.
- Implement the one-way northbound strategy.
- Evaluate the strategy through data collection efforts after a season of implementation.
- At the conclusion of a season of implementation, maintain, modify or abandon the one-way northbound flow based on the results of the evaluation.
- Continue to monitor and evaluate management strategies in future years.

APPENDIX A: PARK ROAD STANDARDS

According to the National Park Service's 1984 *Park Road Standards,* which replaced a 1968 document by the same name, there are seven primary road classifications for the purposes of road design (29):

- Class I – Principal Park Road/Rural Parkway. Roads that constitute the main access route, circulatory tour, or thoroughfare for park visitors.

- Class II – Connector Park Road. Roads that provide access within a park to areas of scenic, scientific, recreational or cultural interest, such as overlooks, campgrounds, etc.

- Class III – Special Purpose Park Road. Roads that provide circulation within public use areas, such as campgrounds, picnic areas, visitor center complexes, concessioner facilities, etc. These roads generally serve low-speed traffic and are often designed for one-way circulation.

- Class IV – Primitive Park Road. Roads that provide circulation through remote areas and/or access to primitive campgrounds and undeveloped areas. These roads frequently have no minimum design standards, and their use may be limited to specially equipped vehicles.

- Class V – Administrative Access Road. All public roads intended for access to administrative developments or structures such as park offices, employee quarters, or utility areas.

- Class VI – Restricted Road. All roads normally closed to the public, including patrol roads, truck trails, and other similar roads.

- Class VII – Urban Parkway. These facilities serve high volumes of park and non-park related traffic and are restricted, limited-access facilities in an urban area. This category of roads primarily encompasses the major parkways that serve as gateways to our nation's capital. Other park roads or portions thereof, however, may be included in this category.

Table A-1 and A-2 show design standards relevant to the Moose–Wilson Road in Grand Teton National Park. *Park Road Standards* has more information regarding sight distance, road curvature, road alignment and other factors important in laying down a road. However, since Moose–Wilson Road already exists, these standards have been omitted in this report.

Table A-1: Typical Design Speeds for Park Roads

Functional Classification	Design Volume Vehicles/Day	Terrain: Flat Preferred	Flat Min	Rolling Preferred	Rolling Min	Mountain Preferred	Mountain Min
I - Principal Park Road and Rural Parkway	< 200	40	30	35	25	30	20
	200-400	50	40	40	30	30	20
	400-1,000	50	40	40	30	35	25
	1,000-4,000	55	45	45	35	40	30
	4,000-8,000	60	50	50	40	40	30
	> 8,000	60	50	60	50	50	40
II - Connector, IIII - Special Purpose, V - Administrative, or VI - Restricted	< 400	30	15	30	15	30	15
	400-1,000	35	20	35	20	30	15
	1,000-4,000	40	25	40	25	35	20
	> 4,000	40	25	40	25	40	25
VII - Urban Parkway	< 4,000	55	45	45	40	45	40
	4,000-8,000	60	50	50	40	45	40
	> 8,000	65	55	60	50	50	40

(Source: 29)

Table A-2: Minimum Roadway Cross-Section Requirements

Average Daily Traffic	No. of Lanes	Lane Width (ft.)*	Shoulder Width (ft./side)	Lane Surface Type(s)
< 50	2	8	1	Dirt / Gravel / Paved
50-200	2	9	1	Dirt / Gravel / Paved
200-400	2	9	2	Gravel / Paved
400-1,000	2	10	3	Paved
1,000-4,000	2	11	3	Paved
4,000-8,000	2	11	4	Paved
> 8,000	4	12	8 **	Paved

* Widening of traffic lanes should be provided on the inside of sharp curves. Where tour buses are allowed or the proportion of recreational vehicles exceeds 5 percent of the design volume, an additional foot of lane width shall be considered, not to exceed 12 feet.

** Would only apply, as appropriate, to urban parkways

(Source: 29)

APPENDIX B: PERFORMANCE MEASURES

Goal 1: Enhance visitor experience

1.1. Preserve visitors' usage of Moose-Wilson Road
- *1.1.1. Preserve visitation (not vehicle) levels on Moose-Wilson Road and its sites*

1.2. Preserve visitor access to the variety of natural, cultural, recreational and educational opportunities available in the park and on Moose-Wilson Road
- *1.2.1. …to Death Canyon / White Grass Ranch from south*
- *1.2.2. …to Death Canyon / White Grass Ranch from north*
- *1.2.3. …to Granite Canyon from south*
- *1.2.4. …to Granite Canyon from north*
- *1.2.5. …to LSR Preserve from south*
- *1.2.6. …to LSR Preserve from north*
- *1.2.7. …to Moose Visitor Center from south*

1.3. Preserve a variety of ways to experience the park
- *1.3.1. Preserve wildlife viewing opportunities*
- *1.3.2. Preserve auto touring opportunities*
- *1.3.3. Enhance bicycle touring opportunities*
- *1.3.4. Enhance transit touring (i.e. guided interpretation) opportunities*
- *1.3.5. Enhance transit shuttle (i.e. circulation) opportunities*

1.4. Improve visitor safety
- *1.4.1. Maintain or reduce vehicle speeds*
- *1.4.2. Reduce vehicle-vehicle conflicts*
- *1.4.3. Reduce number and severity of vehicle-vehicle collisions*
- *1.4.4. Reduce vehicle-bicycle conflicts*
- *1.4.5. Reduce number and severity of vehicle-bicycle collisions*
- *1.4.6. Reduce number of conflicts between road/pathway users and wildlife*
- *1.4.7. Reduce number of roadkills*

1.5. Enhance visitor contact opportunities
- *1.5.1. Increase percentage of visitors who go through an entrance station*

1.6. Preserve visitor satisfaction
- *1.6.1. Preserve visitor satisfaction ratings among first-time visitors*
- *1.6.2. Preserve visitor satisfaction ratings among non-local visitors*
- *1.6.3. Preserve visitor satisfaction ratings among local visitors who access the park by auto*
- *1.6.4. Preserve visitor satisfaction ratings among local visitors who access the park by bicycle*

Goal 2: Preserve the character and integrity of Moose-Wilson

2.1. Support alternative modes of transportation on Moose-Wilson Road
- *2.1.1. Increase average vehicle occupancy of motor vehicles on Moose-Wilson Road*
- *2.1.2. Increase mode share of non-auto modes on Moose-Wilson Road (transit or bicycle)*

2.2. Minimize corridor environment impacts
- *2.2.1. Preserve wildlife populations in the Moose-Wilson corridor*
- *2.2.2. Preserve wildlife habitat*

2.3. Minimize corridor aesthetic impacts
- *2.3.1. Maintain existing paved footprint*
- *2.3.2. Minimize striping and signage requirements*
- *2.3.3. Minimize visible built features (e.g. new gates, solar panels)*

Goal 3: Improve management of traffic on Moose-Wilson Road

3.1. Reduce non-park traffic on Moose-Wilson Road
- *3.1.1. Reduce volume of "commuter" traffic (regular users who do not visit park)*
- *3.1.2. Reduce volume of shortcut traffic (occasional users who do not visit park)*

3.2. Preserve access to key road users
- *3.2.1. Preserve access for park maintenance and operations*
- *3.2.2. Preserve access for emergency responders*
- *3.2.3. Preserve access for in-holders*
- *3.2.4. Preserve access for construction activities at White Grass*
- *3.2.5. Preserve access for commercial operations*
- *3.2.6. Preserve access for park employees*
- *3.2.7. Preserve access for other users (e.g. Army Corps of Engineers)*

3.3. Implement a strategy suitable for the future
- *3.3.1. Minimize confusion and misunderstanding among road and park users*
- *3.3.2. Utilize proven methods and technologies*
- *3.3.3. Minimize strategy complexity (e.g. requiring approval authority and/or partnerships)*
- *3.3.4. Minimize construction activity required to implement strategy*
- *3.3.5. Minimize management intensity*
- *3.3.6. Minimize financial commitment – park operations*
- *3.3.7. Maximize opportunity to obtain funding from sources outside of Grand Teton NP*
- *3.3.8. Provide basis for scalability to address future traffic growth*
- *3.3.9. Pursue strategies that are easy to terminate as needed*
- *3.3.10. Provide continuity with the Jackson Hole Community Pathways network*
- *3.3.11. Preserve future opportunities in roadway for transit utilization*

APPENDIX C: MOOSE–WILSON ROAD DATA COLLECTION

Starting in 2006, data has been collected along Moose–Wilson Road. This chapter summarizes the data collected, which includes traffic volume, speed, mode split, vehicle occupancy, visitor satisfaction, and crashes.

Traffic Data Collection Methods

Traffic counts were collected automatically with pneumatic road tubes for summer seasons from 2006 to 2008. The exact dates for each year are shown in Table C-1.

Table C-1: Traffic Data Collection Dates

Year	Beginning	Ending
2006	June 1st	October 30th
2007	May 1st	October 3rd
2008	May 16th	October 8th

The five locations at which traffic counts were made are shown in Figure C-1 as Counters 1, 2, 3, 4, and 5. Counter 3 was not installed until 2008, when the LSR Preserve was open to the public. Hereafter, the counter results are referred to by the following counter numbers (from north to south):

1. North end of Moose–Wilson Road, just north of Saw Mill Ponds overlook
2. Death Canyon Road access
3. LSR Preserve Road
4. North of the gravel road
5. South end of Moose–Wilson Road, north of Poker Flats access

These traffic counts provide the number of vehicles that pass a point in the roadway over a given time interval (e.g., vehicles per hour), and are often referred to as vehicle flow or volume. The volumes were collected by direction (i.e., northbound and southbound). Vehicle speed and class were also collected.

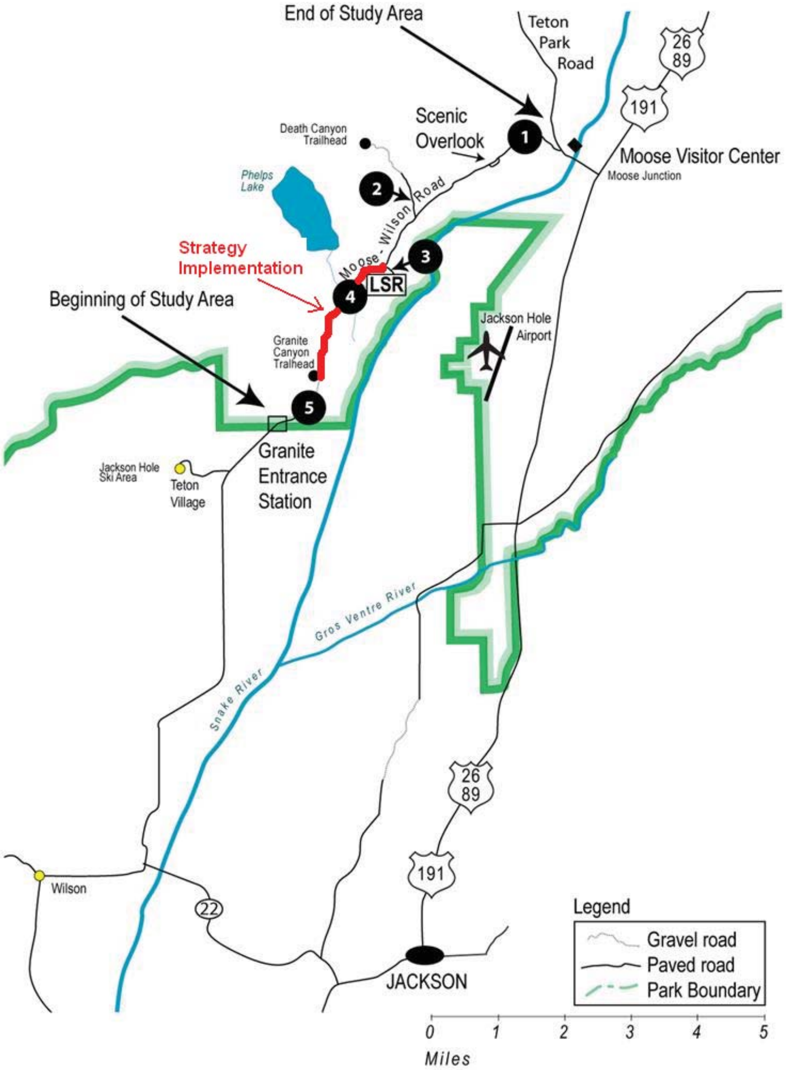


Figure C-1: Road Tube Locations

Daily Vehicle Counts

The available daily vehicle counts by location are shown in Figures C-2 trough C-6. The traffic counters generally show the same trend in traffic volume through time, independent of their location. Counts from the three sites along the main road (counters 1, 4, and 5) gradually increase in early summer, peaking at more than 2,000 vehicles per day in early August, after which they begin to decrease.

There is a small peak in mid-May. Whether the small May peak occurs in a given year depends on the weather conditions. The south part of Teton Park Road is closed to traffic and only allows hikers and cyclists to enter in mid-May. If there is no snow in May, more people will travel through Moose–Wilson Road to enjoy hiking and biking on Teton Park Road.

In reviewing the data it was noted that a few specific weekends had peaks in the traffic flow. These weekends included Independence Day weekend, Labor Day weekend, peak Fall color (late September), and Murie Chocolate Moose Festival (mid October).

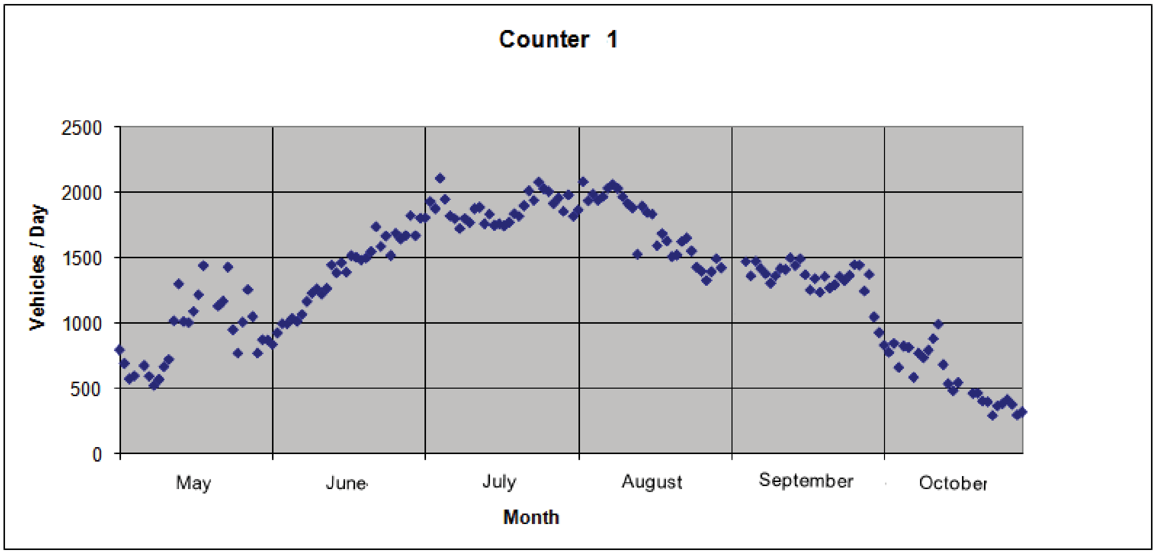


Figure C-2: Daily Vehicle Counts – Counter 1

The three sites along the main road have similar daily traffic counts. The average daily flow is almost the same for counter 5 and counter 4, suggesting that very few vehicles turn around between these counters (for example, at Granite Trailhead). However, the daily counts at counter 1 are on average higher than the counts at counter 4 (about 9 percent higher on weekdays and 5 percent on weekends), indicating slightly higher traffic on the north end of Moose–Wilson Road.

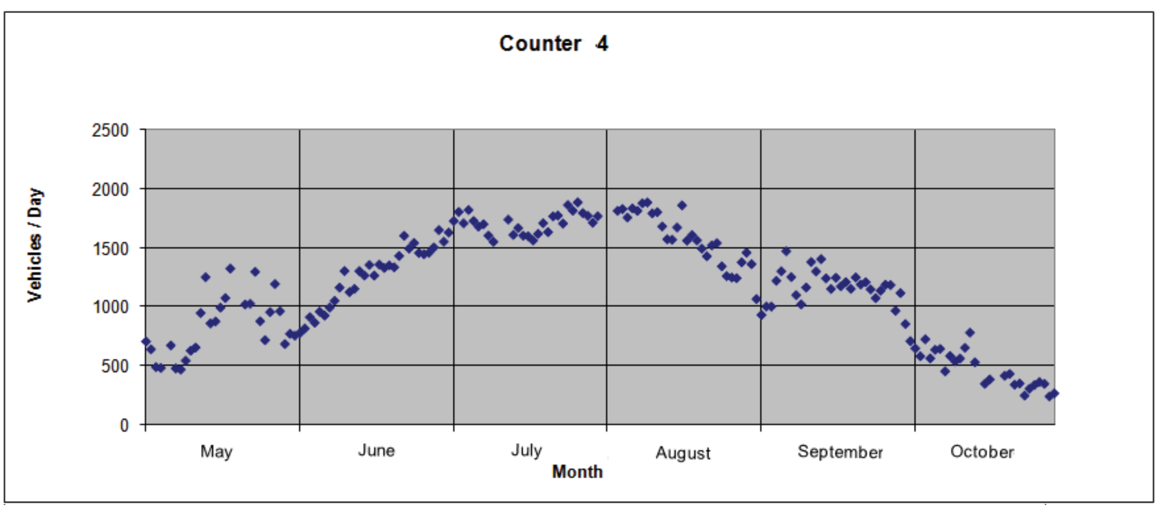


Figure C-3: Daily Vehicle Counts – Counter 4

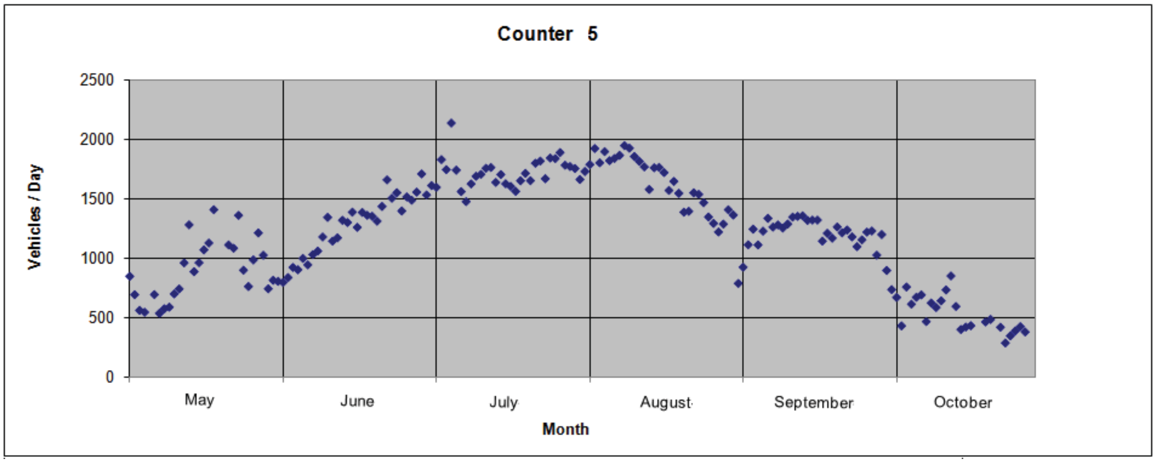


Figure C-4: Daily Vehicle Counts – Counter 5

Traffic flows on Death Canyon Road (counter 2), shown in Figure C-5, are much lower than those on Moose–Wilson Road. The general trend in the traffic flow is similar to the main roadway, with a peak flow in July at a value of approximately 284 vehicles per day.

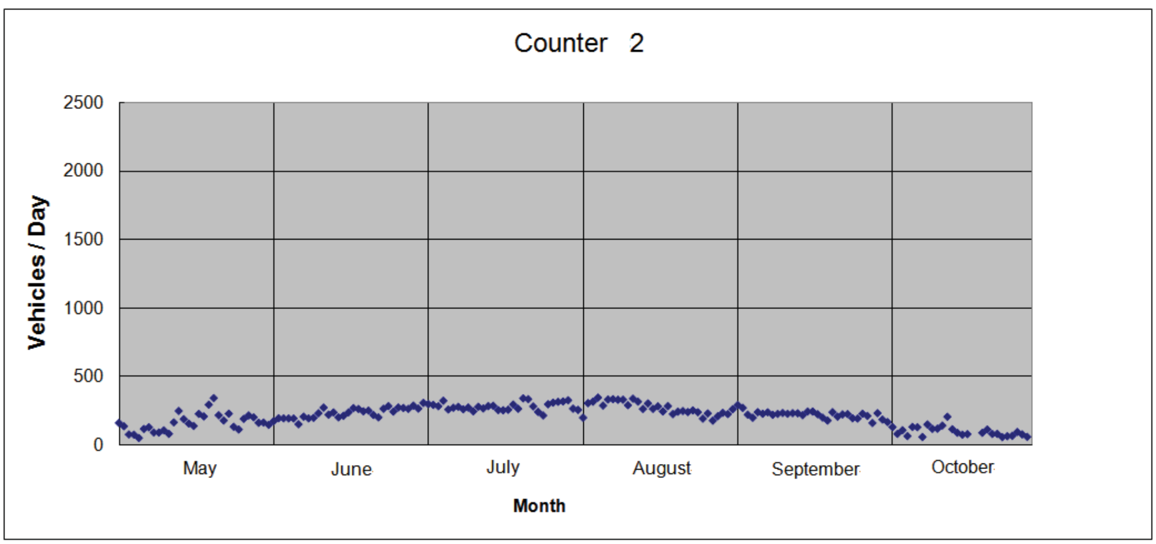


Figure C-5: Daily Vehicle Counts – Counter 2

For traffic to the LSR Preserve (counter 3) only a portion of the 2008 data was available due to technical problems with the counter (Figure C-6). Based on the existing data, traffic flows from and to LSR Preserve are much lower than those on Moose–Wilson Road, with a peak flow in September at an average value of approximately 640 vehicles per day.

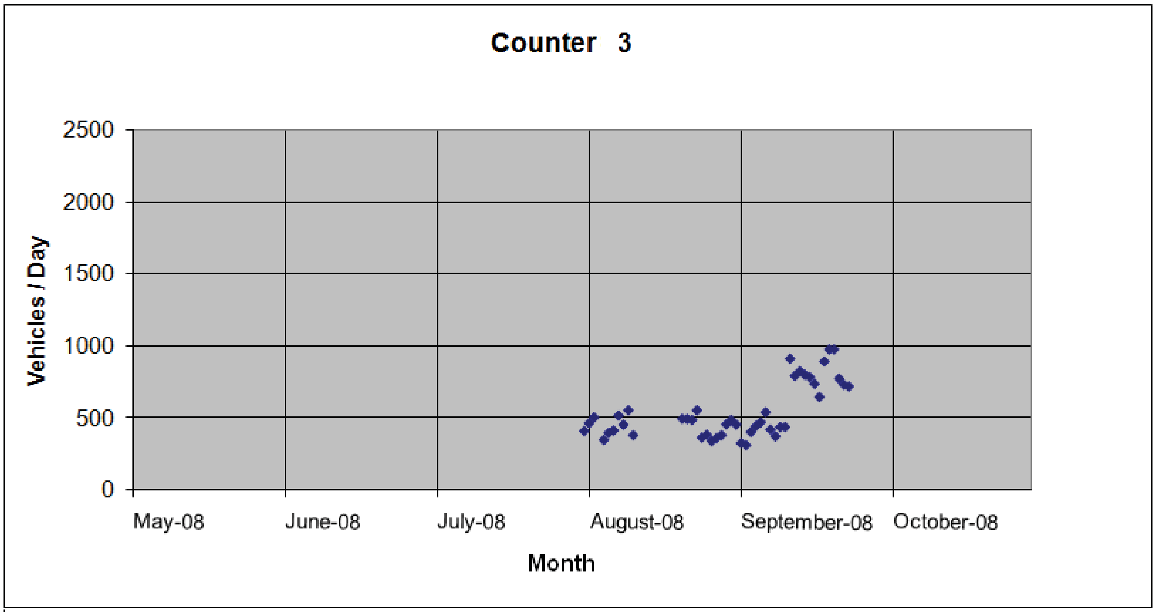


Figure C-6: Daily Vehicle Counts – Counter 3

Averaging across the three counters on Moose–Wilson Road (counters 1, 4, and 5), the average daily traffic for the months of May to October was 1,200 vehicles per day. This can be broken out by month (Table C-2).

Table C-2: Average Daily Traffic by Month

Month	2006	2007	2008	Average
May	--	938	715	827
June	1,175	1,311	1,381	1,289
July	1,668	1,740	1,870	1,759
August	1,616	1,695	1,770	1,695
September	1,110	1,267	1,355	1,244
October	385	--	--	385
May-October	1,193	1,390	1,418	1,200

Traffic Volume Directional Split

When considering the directional split of daily traffic, 51.5 percent of the vehicles are travelling northbound on Moose–Wilson Road. There is no significant difference in the daily split from year to year, or comparing weekend and weekday.

When considering the peak hour (as opposed to the average across the entire day), the directional split is higher. The late-morning peak favors the northbound direction (68 percent of the traffic) and the afternoon peak favors the southbound direction (66 percent of the traffic). On average the peak hour has 67 percent of the traffic in the dominant direction.

Table C-3: Average Peak Hour Directional Split

Peak Hour	Northbound	Southbound
11:00-12:00	68%	32%
16:00-17:00	34%	66%

Hourly Flow Distribution

Average hourly traffic flows for weekdays are shown in Figure C-7 and on weekends in Figure C-8 by direction. The same general trend occurs at all counter locations. Northbound traffic peaks mid-morning at around 11 AM, at a value of 75 vehicles per hour on weekdays and 85 vehicles per hour on the weekend. Southbound traffic peaks in the late afternoon at 4 PM, at a value of 71 vehicles per hour on the weekday and 83 vehicles per hour on weekends. The data in Figures C-7 and C-8 further supports the observation that predominantly "through" traffic travels on Moose–Wilson Road.

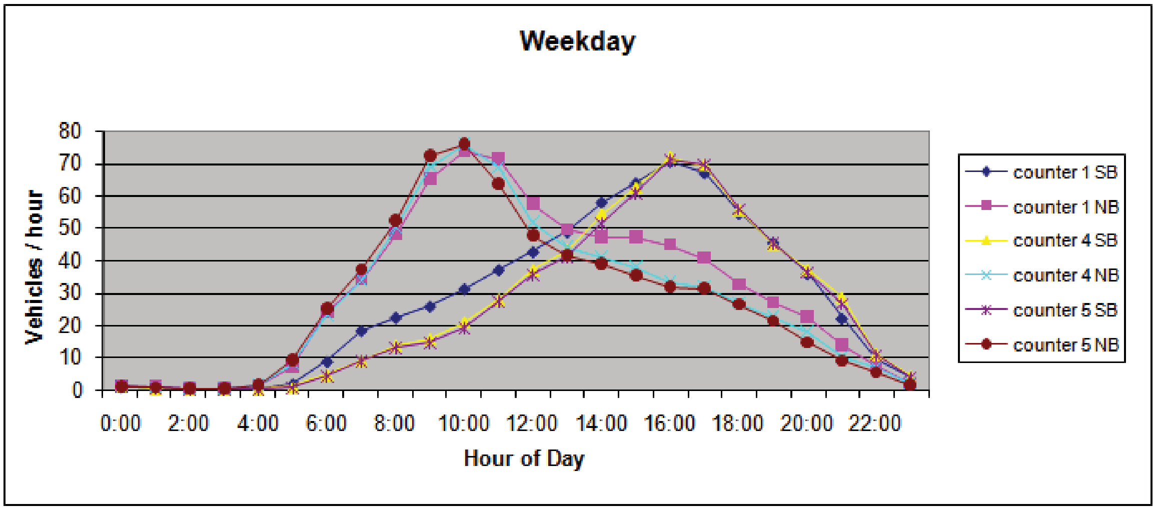


Figure C-7: Hourly Flow Weekday

Weekend hourly traffic distributions (Figure C-8) are similar to the weekday distributions, except that traffic levels are slightly lower on weekends during the early morning hours (6-8AM).

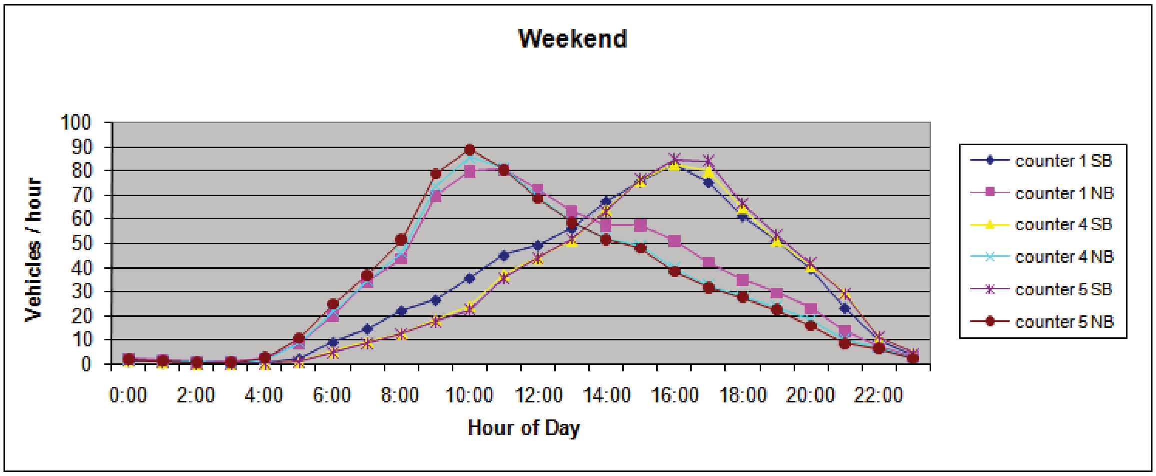


Figure C-8: Hourly Flow Weekend

Hourly flows from Death Canyon Road (counter 2, not shown) follow a similar pattern but on a much smaller scale than on Moose–Wilson Road. Volumes in the northbound direction peaked at 12 vehicles per hour at 11 AM. Volumes in the southbound direction peaked at 12 vehicles per hour at 3 PM. Since vehicles going into Death Canyon Road must come out, it was possible to estimate from the data that the average time a vehicle spends on Death Canyon Road is a little less than two hours and the total number of vehicles on the road at any one time (i.e., they were seen entering, but had not exited yet) peaked at about 21 vehicles around 11 AM.

Hourly flows from LSR Preserve (counter 3, not shown) follow a similar pattern but on a much smaller scale than Moose–Wilson Road. Volumes into LSR Preserve peaked at 31 vehicles per hour at 11 AM. Volumes out of LSR Preserve peaked at 39 vehicles per hour at 2 PM.

Daily Two-Way Traffic by Day of Week

The average daily two-way traffic volume for each section was calculated by the day of the week and is shown in Figure C-9. Traffic levels are fairly uniform across each of two periods each week, namely Monday through Wednesday, and Thursday through Sunday. Traffic later in the week (Thursday through Sunday) is 16 percent greater than earlier in the week. The heaviest traffic day is Sunday.

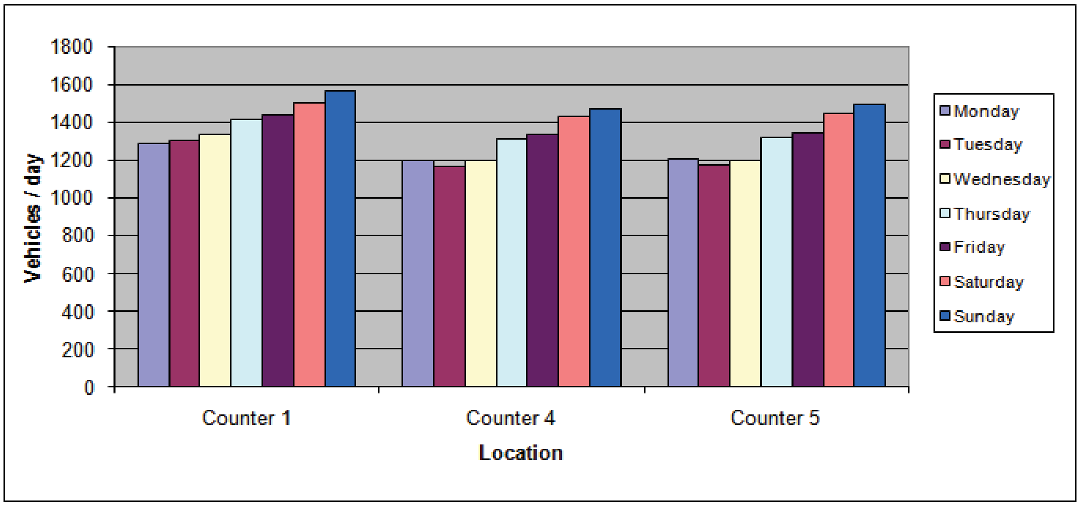


Figure C-9: Daily Two-Way Traffic by Day of Week

Average Speeds

Average speeds and 85th percentile speeds were determined for each location (Table C-4). The 85th percentile speed calculation is one of several methods used for setting posted speed limits. The counters were intentionally placed on straight road segments where speeds are likely to be higher to ensure more accurate counts; therefore, the actual average speeds for the larger roadway section may be slightly lower. Counter 4 is in a short straight stretch between curves; counters 1 and 5 are on longer straight segments, which accounts for the higher speeds when compared to counter 4. Notice that the southbound speeds are typically higher.

Table C-4: Average Speeds

Location	Mean Speed (mph)	Standard Deviation (mph)	85th Percentile Speed (mph)	Posted Speed (mph)
Counter 1 SB	35.1	8.9	39.2	35
Counter 1 NB	31.8	8.6	35.6	35
Counter 2 SB	27.5	9.0	32.3	25
Counter 2 NB	25.6	8.8	30.3	25
Counter 3 SB	20.7	6.9	21.5	25
Counter 3 NB	19.5	6.9	21.0	25
Counter 4 SB	22.5	7.2	26.0	25
Counter 4 NB	21.2	7.3	24.8	25
Counter 5 SB	32.1	8.0	35.4	35
Counter 5 NB	32.5	9.2	35.9	35

Vehicle Classification and Mode Choice

Types of vehicles and modes using Moose–Wilson Road were collected with automatic traffic counters, manual counts and records kept by staff at the Granite Canyon Entrance Station.

The automatic traffic counters classify vehicles by the distance between axles. Bicycles may be captured by automatic traffic counters and classified as motorcycles, but tests conducted showed that many bicycles were not counted by the automatic counters.

Vehicle types, as determined by the traffic counters, did not vary significantly at the different locations. For traffic counters 1, 2, 4, and 5, the average composition of the traffic stream by vehicle type is shown in Figure C-10.

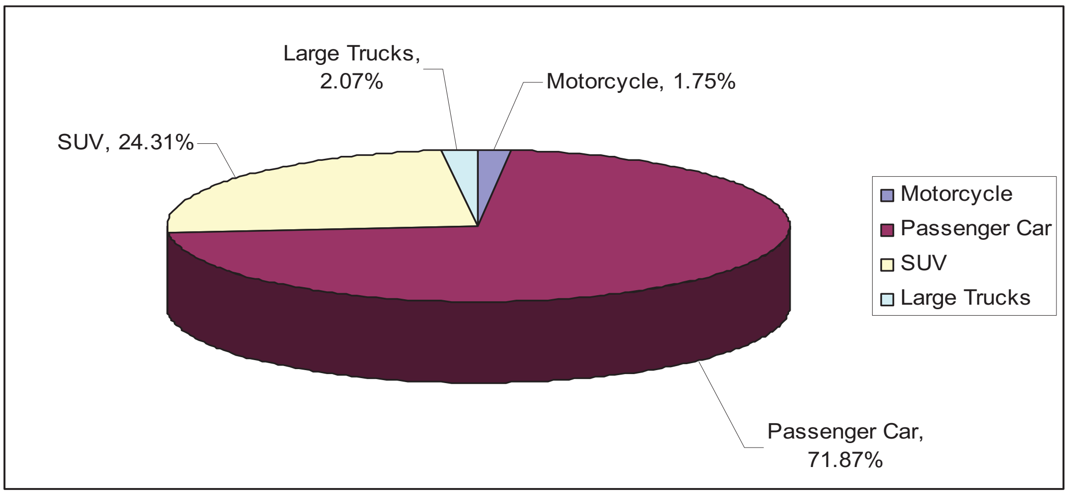


Figure C-10: Traffic by Vehicle Classification

Manual counts conducted in 2006 collected data about vehicle type and mode use. Modes were categorized as hiker/pedestrian, bicycle, motorcycle, taxi, vehicle with different occupancy (Table C-5). The data was collected over 66.1 hours, allowing the calculation of an hourly flow rate. The category of taxi also included tour buses, such as the science school vans.

Based on the collected data, no discernible trends were found in the mix of modes on Moose–Wilson Road relative to morning versus afternoon, weekend versus weekday or northbound versus southbound. Bicycles, hikers, motorcycles and taxis account for a small portion of the traffic on Moose–Wilson Road. In the summer of 2006, taxis traveling through the park were charged fees at entrance stations by the park, which may have had an effect on the number of taxis traveling on Moose–Wilson Road.

Table C-5: Mode Split on Moose–Wilson Road

Mode	Total Count	Percent	Flow (veh/hr)
All	2,425	100.0%	36.7
Bicycle	39	1.6%	0.6
Hiker	4	0.2%	0.1
Motorcycle	41	1.7%	0.6
Taxi 1 person	10	0.4%	0.2
Taxi 2 person	6	0.2%	0.1
Taxi 3+ person	14	0.6%	0.2
All Taxis	30	1.2%	0.5
Car 1 person	525	21.6%	7.9
Car 2 person	1,082	44.6%	16.4
Car 3 person	258	10.6%	3.9
Car 4+ person	427	17.6%	6.5
All Cars	2,292	94.5%	34.7
Other	19	0.8%	0.3

Vehicle occupancy of different modes was determined from this data. Taxi occupancy was 2.13 persons per vehicle. Car occupancy was 2.26 persons per vehicle. Average vehicle occupancy was 2.25 persons per vehicle. Using the occupancy and bicycle counts, ADT of 1,200 can be converted to 2,770 people (20 people by bicycle).

Throughout the season, park employees at the Granite Canyon Entrance Station kept a daily count of bicycles that entered the park through this entrance station. The counts were not validated for accuracy, but could be indicative. Several daily totals were tracked including:

- the total number of bicycles on the road,
- the total number of bicycles attached to private vehicles that entered, and
- the total number of bicyclists that entered as a part of a commercial tour.

The average daily totals, by month, of bicycles in the three categories are shown in Figure C-11. The lines show the value for the single biggest day for that month. For the season, the average number of bicyclists entering on their own power (i.e., not attached to a car or with a commercial tour) was 8.7 per day. There were more bicycles on weekends (average 11.3 per day) than weekdays (average 7.6 per day), with as many as 30 in one weekend day. The number of bicycles that were attached to cars entering Moose–Wilson Road averaged 16.7 per day, with very little variation between weekday and weekend. There were as many as 56 bicycles attached to cars entering in one day. There were only 12 days where there were commercial bike tours with an average of five bicyclists for those 12 days.

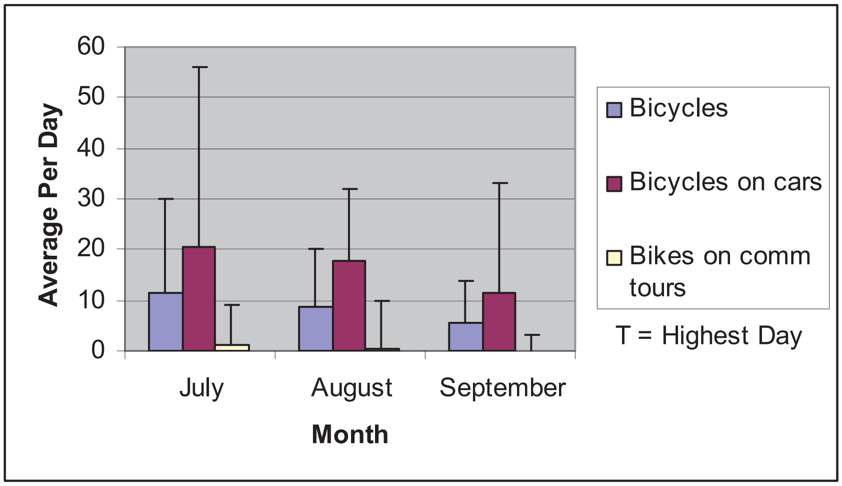
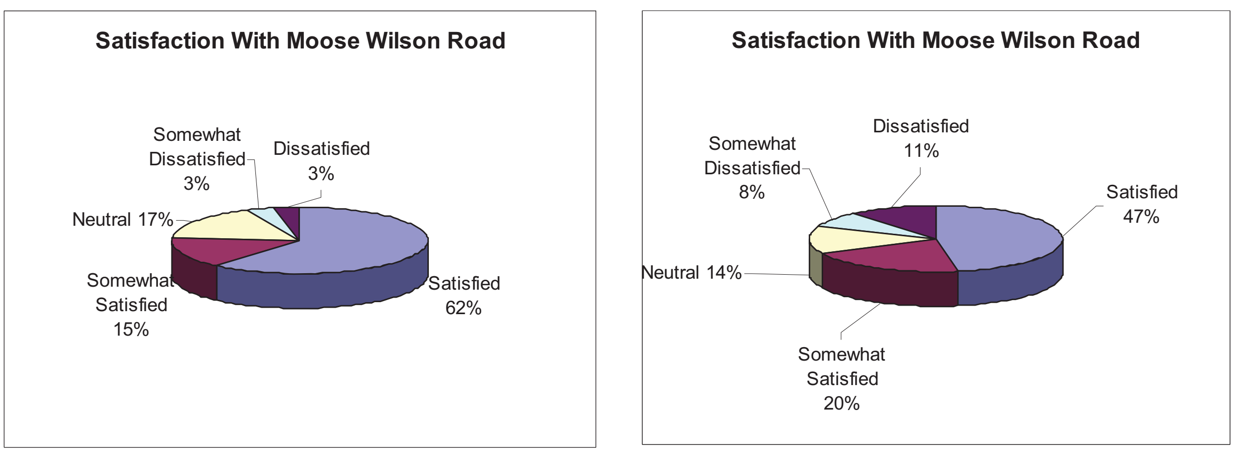


Figure C-11: Bicycles Entering Granite Station

Visitor Satisfaction

A survey of visitors on Moose–Wilson Road was conducted during August and October in 2006. Visitors reported their satisfaction with Moose–Wilson Road (Figure C-12). Note that during the October data collection period, the gravel section was heavily washboarded and is likely the primary cause for the lower satisfaction rating.



August **October**

Figure C-12: Visitor Satisfaction with Moose–Wilson Road

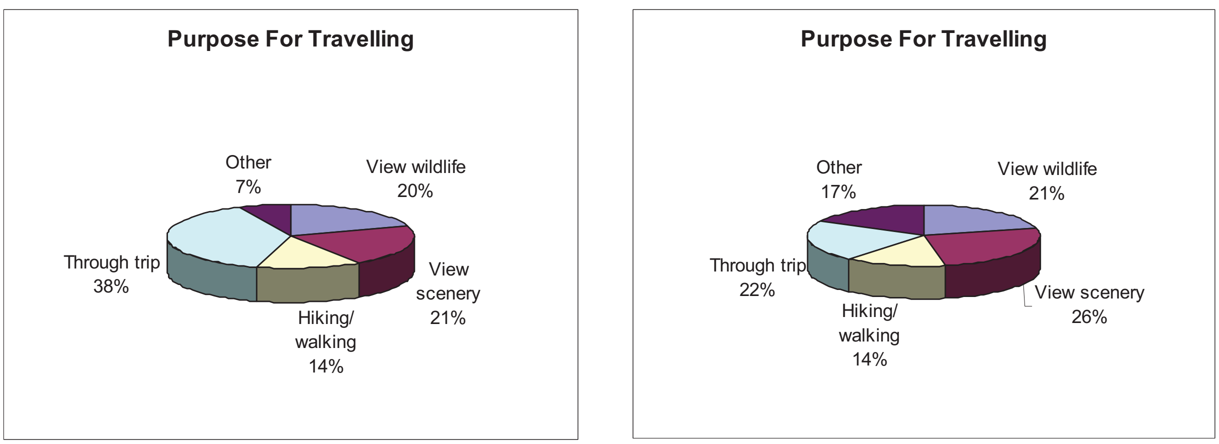
A satisfaction score could be calculated by assigning values of 1 (dissatisfied) to 5 (satisfied) and weighting the proportion of visitors in each category. Satisfaction ratings for local, non-local, first time, auto and bicycle visitors are shown in Table C-6. All categories have a good sample size (greater than 30) except for bicycle, which included survey responses for 11 in August and 7 in October. This small sample size yields less confidence in results and precludes separating bicycle users by local/non-local.

Table C-6: Satisfaction Ratings by Visitor Type

Visitor Type	August Satisfaction (gravel in good condition)	October Satisfaction (gravel in poor condition)
Local	4.3	3.8
Non-Local	4.3	3.8
First Time	4.3	3.7
Auto	4.3	3.8
Bicycle	4.3	4.7
All	4.3	3.8

Visitor Characteristics

From the same survey that measured visitor satisfaction, visitor characteristics are also identified. Of interest is the purpose of travelling. Twenty percent of visitors were primarily interested in viewing wildlife. Through trips (commuters and short-cut travelers) ranged from 22 to 38 percent. The difference is likely due to fewer visitors staying at Teton Village in October.



August **October**

Figure C-13: Visitor Purpose for Travelling

Number of Crashes

By reviewing incident reports for 2001 to 2006, there were 23 vehicle crashes in six years (about four per year). Other than the one bicycle–vehicle crash, which resulted in minor injuries, all crashes were property damage only (i.e., no injuries or fatalities). The types of crashes are shown in Table C-7. By distributing the unknown crashes proportionally across the other types, the annual crashes by type were estimated and shown as “adjusted annual” crash frequencies.

Table C-7: Crash Data on Moose–Wilson Road

Crash Type	Frequency	Percentage	Adjusted Annual
Single-vehicle, Run-off-the-road	9	39	2.2
Two-vehicle Collisions	4	17	1.0
Animal–Vehicle Collisions	2	9	0.5
Bicycle–Vehicle Collision	1	4	0.2
Unknown or Other Types	7	30	n/a

Seventeen crashes (74 percent) were in the months of June to October. From the traffic counts, there is an estimated 1.5 million vehicle miles traveled along Moose–Wilson Road during these summer months This translates to a rate of 1.9 crashes per million vehicle miles traveled (MVMT). This rate is slightly below the national average of 2.0 crashes per MVMT (30). With only one injury related crash in six years, the rate is 0.11 injury crashes per MVMT, much lower than the national average of 0.57. Moose–Wilson Road appears to be a relatively safe roadway.

APPENDIX D: TRAVEL TIME DELAY ESTIMATION

Section 6.2 provides a summary, for each core strategy, of the number of vehicles that would have to reroute to visit Moose–Wilson Road and the additional travel time required to reroute. This section provides the detailed assumptions, data, and calculations behind the travel time delay estimations in Section 6.2.

Assumptions were made, along with existing data, to determine the routes currently used by visitors travelling on Moose–Wilson Road. If a management strategy requires a vehicle to reroute in order to still visit a destination on Moose–Wilson Road, values for number of vehicles that would have to reroute and the additional travel time can then be determined.

These estimates have the broad assumption that all vehicles that currently visit Moose–Wilson Road would continue to do so even if it required significant additional travel time to reroute. In actuality, commuter and short-cut vehicles, for which the core strategy would require additional travel time to visit Moose–Wilson Road, would likely select a route that would totally avoid Moose–Wilson Road. Removing commuter and short-cut vehicles is considered a positive outcome (Objective 3.1). Also, some visitors may choose to not visit Moose–Wilson Road at all because of the additional inconvenience caused by the management strategy. This is considered a negative impact of reduced visitation (Objective 1.1). The actual amount of reduced visitation is difficult to estimate, but can be somewhat captured by the magnitude of the inconvenience in terms of rerouting delays.

The ADT from May to October in 2006, 2007, and 2008 was 1,200 vehicles per day with a directional split of 582 southbound vehicles and 618 northbound vehicles per day.

There are four main trip origins: Yellowstone Nation Park, Teton Village, Wilson, and Jackson. For simplicity, it is assumed that visitors make a round-trip ultimately ending where their trip started. The 2006 visitor survey shows that 12 percent of visitors entered Moose–Wilson Road from Yellowstone National Park. It is assumed that the trip origins for the remaining visitors are evenly split among the other three sites (Table D-1).

Table D-1: Trip Origins from Four Sites

Trip Origin	Percentage	Source or Assumption
Yellowstone National Park	12%	Survey
Teton Village	30%	Average Split
Wilson	29%	Average Split
Jackson	29%	Average Split

Google Maps provides the travel time between different trip origins and park entrances under the free flow speed. Table D-2 shows path, route length and travel time between the trip origins and the entrances to Moose–Wilson Road. Note these travel paths do not include Moose–Wilson Road.

Table D-2: Travel Time between Entrance and Trip Origin

Trip Origin	Entrance Location	Path	Route Length	Travel Time	Travel Time Difference
Yellowstone[1]	Moose	Moose	0 mi	0 min	45 min
	Granite	WY 390, WY22, US89, Teton Park Rd	26 mi	45 min	
Teton Village	Moose	WY 390, WY22, US89, Teton Park Rd	25 mi	45 min	39 min
	Granite	Moose–Wilson Road	2 mi	6 min	
Wilson	Moose	WY 22, US89, Teton Park Rd	22 mi	26 min	4 min
	Granite	WY 22, WY 390	9 mi	22 min	
Jackson	Moose	WY 22, US 89, Teton Park Rd	13 mi	16 min	12 min
	Granite	WY 22, WY 390	13 mi	28 min	

[1] Visitors from Yellowstone National Park usually enter Moose–Wilson Road via Moose, travel times for trips originating at Yellowstone are calculated form Moose.

Source: www.google.com/maps

The difference in travel time to the two different entrances to Moose–Wilson Road, for a given origin, indicates the additional travel time needed if a visitor was required to reroute and enter Moose–Wilson Road from the other entrance (and similarly the additional travel time for detours requiring the vehicle to leave Moose–Wilson Road from the other exit).

There are several scenic attractions along Moose–Wilson Road. It is difficult to know the exact destinations of all visitors. In order to simplify the calculation, it is assumed that the destination of all visitors is LSR Preserve, which is located at the center of the study segment (the travel times from the two entrances to LSR Preserve are the same, 8 minutes).

If a visitor starts and ends their trip at Wilson, the travel time is similar to either entrance site (22 minutes to Granite Canyon Entrance Station and 26 minutes to the entrance at Moose). There is a greater difference between travel times to entrances for trips originating at Yellowstone National Park. Because of the larger differences for trips originating at Yellowstone National Park and Teton Village, it is assumed that all trips enter and exit through the closest end of Moose–Wilson Road. For trips originating at Wilson or Jackson, there are four possible combinations of entrance/exit pairs: 1) Granite Canyon Entrance Station for both entering and exiting; 2) Moose for both entering and exiting; 3) Granite Canyon Entrance Station for entering and Moose for exiting; and 4) Moose Entrance for entering and Granite for exiting. For trips originating at Wilson and Jackson it is assumed that visitors are equally probable to use any of these four options. Table D-3 shows the percentages of visitors using different routes to visit Moose–Wilson Road.

Table D-3: Trip Path Breakdown by Trip Origin

Trip Origin	Entering from	Exiting to	Percentage
Yellowstone	Moose	Moose	100%×12%=12%
Teton Village	Granite	Granite	100%×30%=30%
Wilson	Granite	Granite	25%×29%=7.25%
Wilson	Moose	Moose	25%×29%=7.25%
Wilson	Granite	Moose	25%×29%=7.25%
Wilson	Moose	Granite	25%×29%=7.25%
Jackson	Granite	Granite	25%×29%=7.25%
Jackson	Moose	Moose	25%×29%=7.25%
Jackson	Granite	Moose	25%×29%=7.25%
Jackson	Moose	Granite	25%×29%=7.25%

Though these assumptions do not necessarily represent the real condition, they allow quantitative results that can indicate the comparative impacts of different strategies on travel time delay. Traffic management strategies will be used on the road section between Granite Canyon Trailhead and LSR Preserve. The travel time delay and number of vehicles impacted are calculated for each strategy in the following section.

Do Nothing

There is no travel delay. No vehicles have to detour.

Strategy A: Reversible Flow

A typical hourly flow distribution is shown in Figure D-1. If the park considers enacting a reversible flow option as a traffic management strategy, the optimal time to make the switch is between 12 and 2 PM.

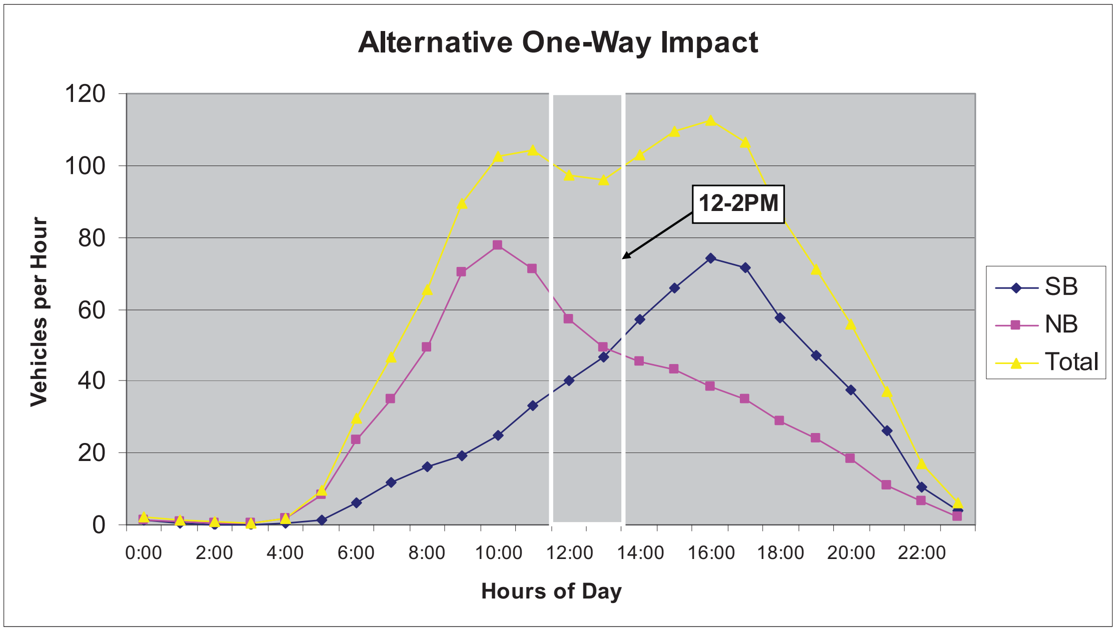


Figure D-1: Typical Hourly Flow Distribution

While the direction of one-way flow is being switched, the roadway ends should be closed in both directions for a period of time to allow vehicles to clear the roadway. The time of total closure is assumed to be noon to 2 PM and midnight to 2 AM. The percentage of daily traffic on Moose–Wilson Road during these times is shown in Table D-4 (the impacted proportions are italicized).

Table D-4: Traffic Distribution Based on Time of Day and Direction

Time of Day and Control	Southbound	Northbound
2am-12pm: One-way NB Traffic	*17%*	48%
2pm-12am: One-way SB Traffic	69%	*36%*
12-2 (am and pm) Closed	*14%*	*16%*
Total	100%	100%

- Total Delay = (17% + 14%) × Total Delay of Strategy B + (36% + 16%) × Total Delay of Strategy C + 0.5 × (14% + 16%) × Total Delay of Strategy F = 31% × 7147 + 52% × 7589 + 15% × 29472 = 10583 min/day

- Number of Vehicles Impacted = (17% + 14%) × SB Traffic + (36% + 16%) × NB Traffic + 0.5 × (14% + 16%) × Total Traffic = 31% × 259 + 52% × 275 + 15% × 621= 316 vehicles

Strategy B: One-way Northbound

Southbound traffic volume, which would need to reroute, is 582 vehicles/day. The routes that are impacted are shown in Table D-5.

Table D-5: Travel Time Delay Calculation of Strategy B

Trip Origin	Entering from	Exiting to	Percentage	Delay (min)	
				Going To	Coming Back
Yellowstone	Moose	Moose	12%	No impacts	No impacts
Teton Village	Granite	Granite	30%	No impacts	45-6
Wilson	Granite	Granite	7.25%	No impacts	26-22
	Moose	Moose	7.25%	No impacts	No impacts
	Granite	Moose	7.25%	No impacts	No impacts
	Moose	Granite	7.25%	No impacts	26-22
Jackson	Granite	Granite	7.25%	No impacts	Saving time
	Moose	Moose	7.25%	No impacts	No impacts
	Granite	Moose	7.25%	No impacts	No impacts
	Moose	Granite	7.25%	No impacts	Saving time

- Total Delay = 582 × {[12% × 0] + [30% × (45-6)] + [7.25% × (26-22) + 7.25% × 0+7.25% × 0 + 7.25% × (26-22)] + [7.25% × 0 + 7.25% × 0 + 7.25% × 0 + 7.25% × 0]} = 7,147 min/day

- Number of Vehicles Impacted = 582 × (30% + 7.25% + 7.25%) = 259 vehicles

Strategy C: One-way Southbound

Northbound traffic volume, which would need to reroute, is 618 vehicles/day. The routes that are impacted are shown in Table D-6.

Table D-6: Travel Time Delay Calculation for Strategy C

Trip Origin	Entering from	Exiting to	Percentage	Delay (min)	
				Going To	Coming Back
Yellowstone	Moose	Moose	12%	No impacts	No impacts
Teton Village	Granite	Granite	30%	45-6	No impacts
Wilson	Granite	Granite	7.25%	26-22	No impacts
	Moose	Moose	7.25%	No impacts	No impacts
	Granite	Moose	7.25%	26-22	No impacts
	Moose	Granite	7.25%	No impacts	No impacts
Jackson	Granite	Granite	7.25%	Saving time	No impacts
	Moose	Moose	7.25%	No impacts	No impacts
	Granite	Moose	7.25%	Saving time	No impacts
	Moose	Granite	7.25%	No impacts	No impacts

- Total Delay = 618 × {[12% × 0] + [30% × (45-6)] + [7.25% × (26-22) + 7.25% × 0 + 7.25% × (26-22) + 7.25% × 0] + [7.25% × 0 + 7.25% × 0 + 7.25% × 0 + 7.25% × 0]} = 7,589 min/day

- Number of Vehicles Impacted = 618 × (30% + 7.25% + 7.25%) = 275 vehicles

Strategy D: Gate Restriction on Through Traffic

A gate would be installed to the south of LSR Preserve access. Vehicles could reach LSR Preserve from the north end (Moose Entrance), but not from the south end (Granite Entrance). The routes that are impacted are shown in Table D-7.

Table D-7: Travel Time Delay Calculation for Strategy D

Trip Origin	Entering from	Exiting to	Percentage	Delay(min)	
				Going To	Coming Back
Yellowstone	Moose	Moose	12%	No impacts	No impacts
Teton Village	Granite	Granite	30%	45-6	45-6
Wilson	Granite	Granite	7.25%	26-22	26-22
	Moose	Moose	7.25%	No impacts	No impacts
	Granite	Moose	7.25%	26-22	No impacts
	Moose	Granite	7.25%	No impacts	26-22
Jackson	Granite	Granite	7.25%	Saving time	Saving time
	Moose	Moose	7.25%	No impacts	No impacts
	Granite	Moose	7.25%	Saving time	No impacts
	Moose	Granite	7.25%	No impacts	Saving time

- Total Delay = 1,200 × {[12% × 0] + [30% × (45-6) × 2] + [7.25% × (26-22) × 2 + 7.25% × 0 + 7.25% × (26-22) + 7.25% × (26-22)] + [7.25% × 0 + 7.25% × 0 + 7.25% × 0 + 7.25% × 0]} = 29,472 min/day

- Number of Vehicles Impacted = 1200 × (30% + 7.25% + 7.25% + 7.25%) = 621 vehicles

Strategy E: Time of Day Restriction (from 10 am to 7 pm)

The amount of traffic affected depends on the times the road is closed. Note from Figure D-1 above that total traffic remains high for most of the day. As shown in Table D-8, about 68 percent of the vehicles travel between 10 AM and 7 PM on Moose–Wilson Road.

Table D-8: Traffic Distribution Based on Time of Day from 2006 to 2008

	2006	2007	2008
10am~7pm	812	942	999
24 hour	1,199	1,401	1,456
Percentage	67.8%	67.2%	68.6%
Average	67.9%		

Strategy E has the same impact per vehicle as Strategies D and F, but only impacts 68 percent of the vehicles.

- Total Delay = 68% × Total Delay of Strategy F = 68% × 29472 = 20,041 min/day
- Number of Vehicles Impacted = 68% × 621 = 422 vehicles

Strategy F: Limited Auto Access

The unpaved road section would be closed. Vehicles could reach LSR Preserve from the north end (Moose Entrance), but not from the south end (Granite Entrance). Therefore, the delay of Strategy F is the same as the delay of Strategy D.

Strategy G: Separated Pathway

No vehicles will be affected by this strategy.

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