

Rocky Mountain National Park
Intelligent Transportation System
Evaluation Plan



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July 2011

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GLOSSARY OF ABBREVIATIONS

CDOT	Colorado Department of Transportation
CO ₂	Carbon Dioxide
CFLHD	Central Federal Lands Highway Division
DMS	Dynamic Message Sign
HAR	Highway Advisory Radio
ITS	Intelligent Transportation System
NPS	National Park Service
ROMO	Rocky Mountain National Park
TRIPTAC	Paul S. Sarbanes Transit in Parks Technical Assistance Center
WTI	Western Transportation Institute

1 INTRODUCTION

Rocky Mountain National Park (ROMO) has maintained a consistent level of visitation over the last few years, approximately 3 million annual visitors (1). About 40% of these visitors come from the “front range.” The “front range” includes residents of Denver, Fort Collins, and their surrounding suburbs. Visitation is concentrated during the peak summer season. Concentrated visitation results in serious congestion in ROMO and its gateway community of Estes Park, Colorado. In an effort to reduce congestion and improve visitor experience, a pilot Intelligent Transportation System (ITS) composed of Dynamic Message Signs (DMS) and Highway Advisory Radio (HAR) will be implemented during the summer of 2011. A more in-depth discussion of the system and its implementation can be found in the Rocky Mountain National Park Dynamic Message Sign/Highway Advisory Radio Operations Plan (2).

This document presents a plan for evaluating the effectiveness of the ITS in achieving the project goals. The goals, objectives, performance measures and data sources are discussed in the next section. The subsequent section discusses the specific data collection needs defined for this evaluation. The final section describes how the data will be utilized in the analysis.

2 GOALS, OBJECTIVES, & PERFORMANCE MEASURES

This project was initiated to help alleviate congestion along the Bear Lake Road corridor in Rocky Mountain National Park (ROMO). Central Federal Lands Highway Division (CFLHD), working in collaboration with ROMO, recommended pursuing this project as an interim solution, until the long-term planning effort from the 2010 Paul S. Sarbanes Transit in Parks grant is complete. Contacts for the partners involved in the study can be found in Appendix A.

The goals of the ITS pilot study for ROMO are to:

- Shift visitors' travel mode from private vehicles to shuttle buses,
- Quantify the reductions in emissions pollution as a result of the mode shift,
- Intercept visitors east of their arrival to the Town of Estes Park,
- Peak spread the arrival of people and vehicles into ROMO using an "Insider's Tip" on the HAR,
- Improve the visitor experience through better dissemination of traveler information,
- Successfully collaborate with the Town of Estes Park, the Colorado Department of Transportation (CDOT), and CFLHD,
- Introduce ROMO to ITS Systems, and
- Select ITS devices easy to operate and maintain.

To help determine whether the goals of the project have been achieved, the technical assistance team has established objectives and performance measures for each goal. The following sections identify each goal, the supporting objectives and performance measures, and the data source that will be utilized to analyze whether the goal is achieved.

Table 1: Goal One

GOAL: Shift visitors' travel mode from private vehicles to shuttle buses		
1		OBJECTIVE: Increase daily ridership of shuttles when the 2011 ITS system is operable as compared to the periods when the ITS is not operable
		PERFORMANCE MEASURE: Predicted daily ridership counts when the ITS is and is not operable
2		OBJECTIVE: Demonstrate that the 2011 ITS system has influenced visitors to utilize the shuttle system
	A	PERFORMANCE MEASURE: Percent of survey users influenced by the DMS/HAR to utilize the shuttles
	B	PERFORMANCE MEASURE: Percent of survey users that learned about the shuttles through the DMS/HAR
DATA SOURCE: Ridership counts, traffic counts, entrance station counts, DMS & HAR logs, user survey, weather events, event data		

Table 2: Goal Two

GOAL: Quantify the reductions in emissions pollution as a result of the mode shift
OBJECTIVE: Reduce the carbon dioxide (CO ₂) emissions during the 2011 ITS deployment
PERFORMANCE MEASURE: Amount of CO ₂ reduction during the 2011 ITS deployment
DATA SOURCE: Traffic counts, fleet observations

Table 3: Goal Three

GOAL: Intercept visitors east of their arrival to the Town of Estes Park	
OBJECTIVE: Increase usage of the new park-and-ride lot in the Town of Estes Park during the 2011 ITS deployment	
A	PERFORMANCE MEASURE: Silver Route ridership counts with and without ITS
B	PERFORMANCE MEASURE: Occupancy of the Estes Park Park-and-Ride lot with and without ITS
C	PERFORMANCE MEASURE: Percent of survey users influenced by the DMS/HAR to utilize the Silver Route
DATA SOURCE: Ridership counts, traffic counts, entrance station counts, DMS & HAR logs, user survey, weather events, event data	

Table 4: Goal Four

GOAL: Peak spread the arrival of people and vehicles into ROMO using an “Insider’s Tip” on the HAR	
OBJECTIVE: Delay the arrival of some visitors to ROMO by providing an “Insider’s Tip,” which tells visitors the best time to visit to avoid congestion, in the HAR message	
A	PERFORMANCE MEASURE: Percent of survey respondents that delayed their visit to ROMO due to the “Insider’s Tip” on the HAR*
B	PERFORMANCE MEASURE: Opinions of stakeholders on the effectiveness of the “Insider’s Tip” to persuade visitors to delay their visit to ROMO*
DATA SOURCE: DMS & HAR logs, user survey, stakeholder survey	

*Utilizing the “Insider’s Tip” is not recommended on days where afternoon thunderstorms are expected.

Table 5: Goal Five

GOAL: Improve the visitor experience through better dissemination of traveler information
OBJECTIVE: Document a statistical correlation between a positive visitor experience and utilization of the information from the 2011 ITS
PERFORMANCE MEASURE: Visitor rating of visitor experience and use of 2011 ITS
DATA SOURCE: User survey

Table 6: Goal Six

GOAL: Successfully collaborate with the Town of Estes Park, CDOT, and CFLHD
OBJECTIVE: <ul style="list-style-type: none"> • Show support from stakeholders in the Town of Estes Park for the 2011 and future ITS • Show support from CDOT for the 2011 and future ITS on the corridor to ROMO • Show support from CFLHD for the 2011 ITS deployment
PERFORMANCE MEASURE: Stakeholder opinions on the benefits of collaboration, challenges experienced while collaborating, satisfaction with 2011 ITS deployment, effectiveness of DMS/HAR to affect driver behavior, and support for future ITS deployments
DATA SOURCE: Stakeholder survey

Table 7: Goal Seven

GOAL: Introduce ROMO to ITS Systems
OBJECTIVE: Introduce ROMO employees to the use of ITS by implementing DMS/HAR during the summer of 2011
PERFORMANCE MEASURE: Entries on the DMS and HAR logs showing the equipment was implemented and utilized
DATA SOURCE: DMS & HAR logs

Table 8: Goal Eight

GOAL: Select ITS devices easy to operate and maintain	
1	OBJECTIVE: Allow ROMO remote access to the DMS for the 2011 ITS
	PERFORMANCE MEASURE: Acknowledgment by stakeholders that rented equipment allowed ROMO to remotely access and change messages on all of the DMS
2	OBJECTIVE: Allow ROMO remote access to the HAR for the 2011 ITS
	PERFORMANCE MEASURE: Acknowledgment by stakeholders that rented equipment allowed ROMO to remotely access and change any messages on all of the HAR
3	OBJECTIVE: ROMO staff spends less than 4 hours to apply for the temporary FCC license for the 2011 ITS
	PERFORMANCE MEASURE: Amount of time spent to complete the FCC license for the 2011 ITS
4	OBJECTIVE: ROMO has no perceived difficulty in operating DMS and HAR
	PERFORMANCE MEASURE: Stakeholder opinions on ease or difficulty of DMS and HAR operations and maintenance
DATA SOURCE: DMS & HAR logs, stakeholder survey	

3 DATA COLLECTION

The effectiveness of implementing the ITS will be evaluated both quantitatively and qualitatively. Quantitative data that will be collected includes shuttle ridership, user surveys, traffic, entrance station counts, and fleet observations. Qualitative data that will be collected includes the frequency and types of DMS and HAR messages, stakeholder surveys, the occurrence of special events, and weather data. Table 9 summarizes how the technical assistance team will use these data pieces to assess progress towards the goals.

Table 9: Data Use in Goals

	Goal One	Goal Two	Goal Three	Goal Four	Goal Five	Goal Six	Goal Seven	Goal Eight
Ridership Counts	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					
Traffic Counts	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					
Entrance Station Counts	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					
Fleet Observations		<input checked="" type="checkbox"/>						
DMS&HAR Logs	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
User Survey	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			
Stakeholder Survey				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Weather Events	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					
Event Data	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					

3.1 Ridership Counts

To perform the evaluation analysis, the technical assistance team will need shuttle ridership data from the Hiker, Bear Lake, Moraine Park, Silver, Shopper (Blue and Red Routes), and Brown (Campground) Shuttles. The team requests ridership data for both 2010 and 2011 for all routes; however, only ridership data from 2011 will be available for the Silver Route, which is new in 2011.

For the Silver and Hiker Shuttles, the team requests more detailed data, including boardings and alightings for each stop, on each run, for each day that the shuttles operate. For the Bear Lake, Moraine Park, Shopper, and Brown Shuttles, only daily ridership totals are requested. Table 10 summarizes the 2010 ridership data. It can be found disaggregated by day in Appendix B.

Table 10: 2010 Monthly Ridership Totals

	Hiker	Bear Lake	Moraine Park	Blue	Red	Brown
May	n/a*	4,294	807	n/a*	n/a*	n/a*
June	945	53,228	7,217	807	409	708
July	8,448	131,534	14,805	6,177	3,440	6,059
August	7,575	103,787	11,350	3,388	2,453	4,969
September	2,073	56,801	5,957	598	395	580
October	177	16,627	927	n/a*	n/a*	n/a*
TOTAL	19,218	361,977	40,256	10,970	6,697	12,316

*This shuttle did not run during these months in 2010.

Ridership data will play a part in the analysis of Goals One, Two, and Three.

The TRIPTAC staff is requesting that ROMO provide 2011 ridership data on a weekly basis from June through September 25th. Access to ridership data during the ITS implementation will allow the TRIPTAC to analyze if the system is performing as expected, and will potentially enable changes and improvements during the implementation stage.

3.2 Traffic Counts

A total of twelve traffic counters will be utilized for the evaluation of the ITS pilot study. The data collected from the traffic counters will be utilized in the analysis of Goals One, Two, and Three.

3.2.1 Responsibility

CFLHD has agreed to supply, deploy, and maintain the traffic counters. Maintenance of the traffic counters includes charging the batteries and downloading the data. After the data has been downloaded, CFLHD will disseminate the collected traffic counter information to the TRIPTAC for analysis.

3.2.2 Equipment

CFLHD owns NC-97 and NC-200 Portable Traffic Analyzer Counters by Quixote Transportation Technology, Inc. The NC-97 traffic counter is shown in Figure 1. The NC-200 traffic counters are similar to the NC-97s, except that they are smaller.



Figure 1: Traffic Counter (left) and Traffic Counter Deployed (right)ⁱ

Both generations of traffic counters have magnetic sensors capable of one-direction, one-lane counts classified by time of day, vehicle length, and speed bins. They should not be placed near locations where vehicles are turning as they may over or under-count vehicles. The traffic counters are placed in the middle of the travel lane and drilled into the asphalt to ensure that they are not displaced from their installation location.

The traffic counters can be programmed to start and stop at specified times, can record counts in 15-minute or hourly bins, and have batteries that can last for approximately two weeks (14 days) before they need to be recharged.

3.2.3 Deployment Timeframe

The traffic counters will be deployed during specified periods from June 24, 2011 through September 27, 2011; however, maintenance of the traffic counters, as discussed above, must occur approximately every 14 days. To allow enough time for traveling to/from the sites (CFLHD is located in Denver, which is about an hour and a half from Estes Park), charging of the batteries, and downloading information, maintenance periods will generally occur over several days. However, CFLHD is expecting to receive newly purchased traffic counters by August 9th. Therefore, the removal and installation of traffic counters will occur on the same day after August 9th.

The traffic counters will be deployed during six different periods, including:

- June 24, 2011 through July 5, 2011,
- July 7, 2011 through July 22, 2011,
- July 27, 2011 through August 9, 2011,
- August 9, 2011 through August 23, 2011,
- August 23, 2011 through September 6, 2011,
- September 6, 2011 through September 20, 2011, and
- September 20, 2011 through September 27, 2011.

ⁱⁱ Photos provided by CFLHD

These deployment periods, along with the ITS deployment periods, are identified by month in Figure 2 through Figure 5. The days on which the traffic counters will be installed and removed are indicated with text. The days over which the traffic counters remain in the field are indicated by a black stripe. A “Change Period,” signified by a day highlighted in yellow, is a day on which changes are scheduled for the ITS set-up (e.g., on July 14 the remaining ITS is being installed).

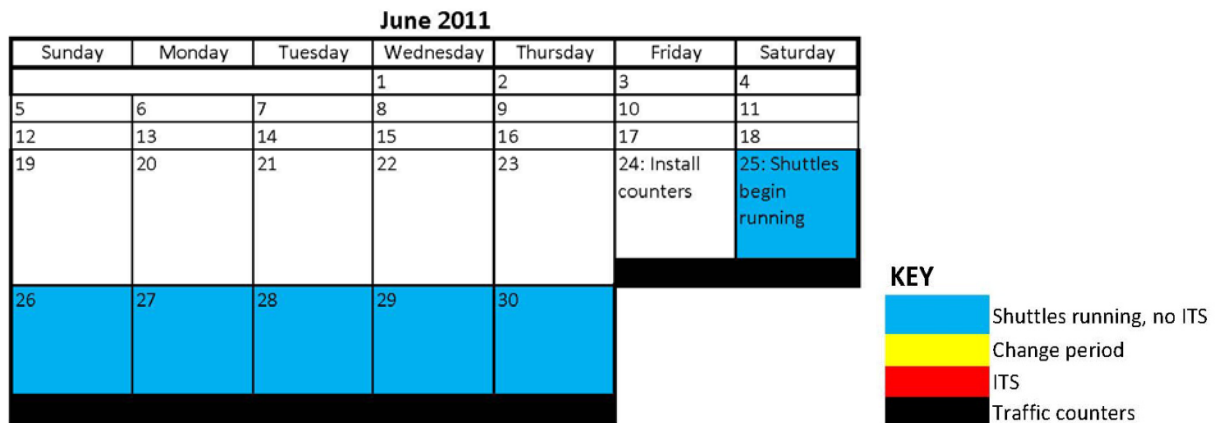


Figure 2: June ITS and Traffic Counter Deployment

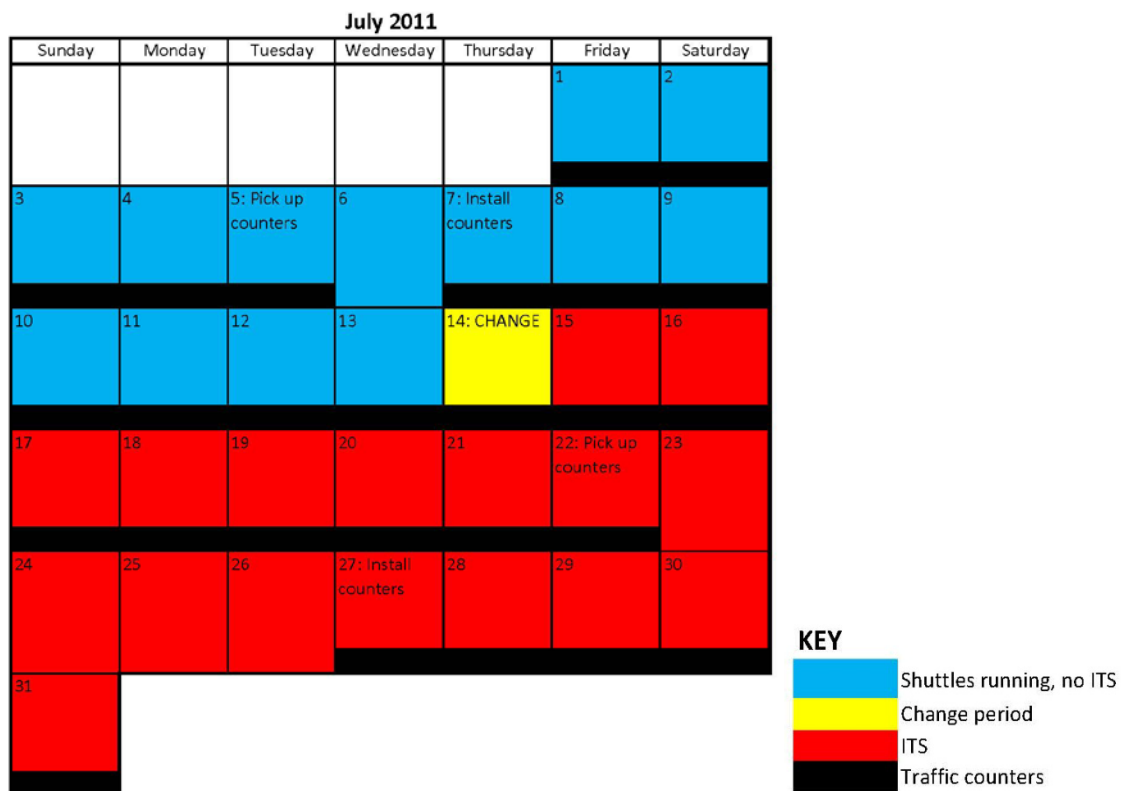


Figure 3: July ITS and Traffic Counter Deployment

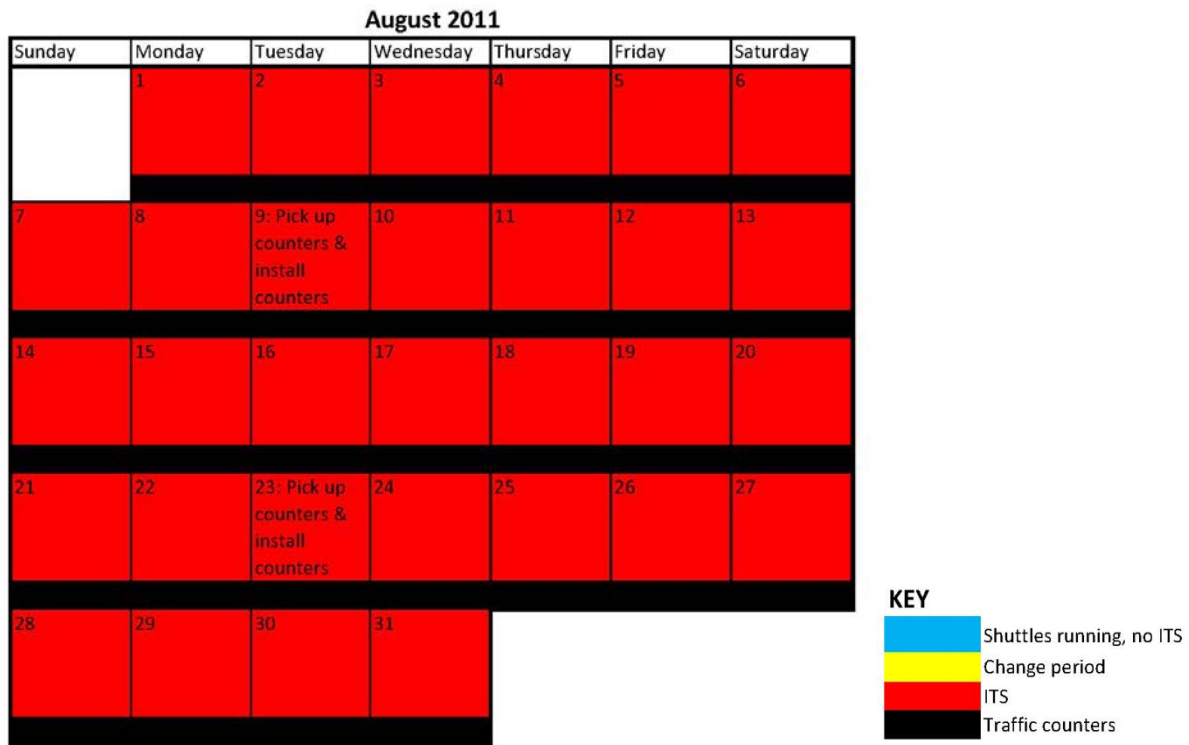


Figure 4: August ITS and Traffic Counter Deployment

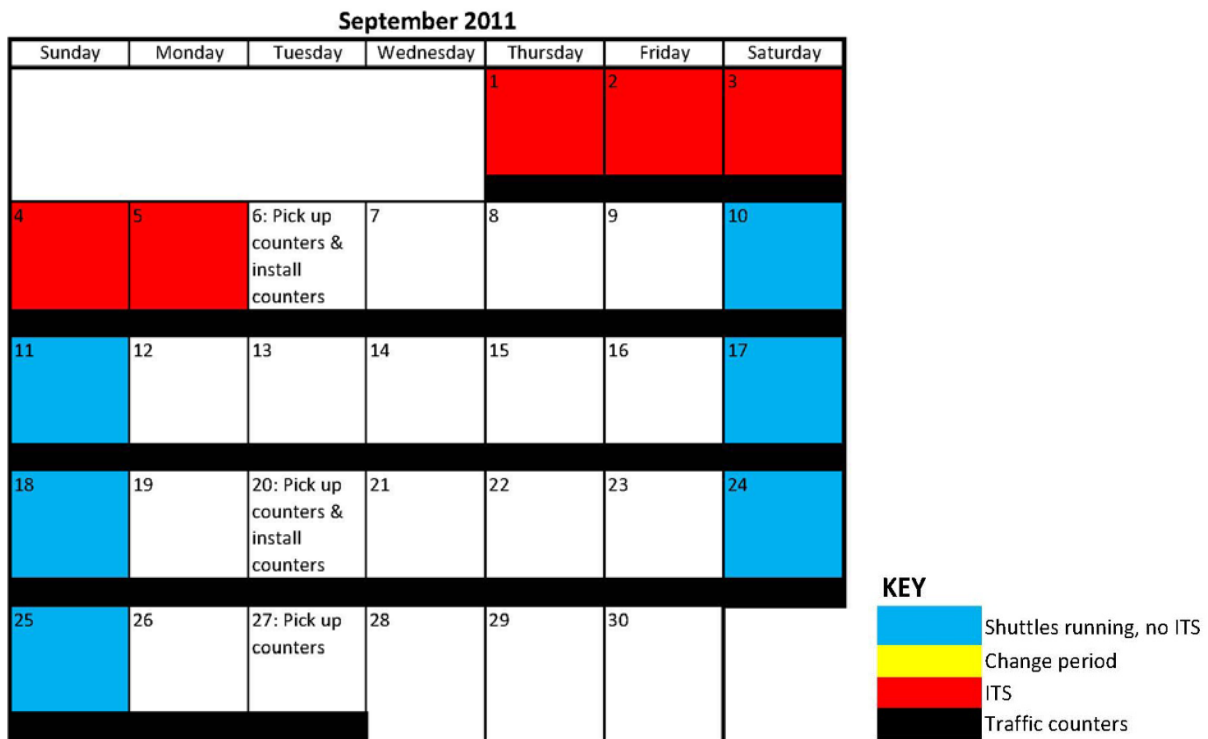


Figure 5: September ITS and Traffic Counter Deployment

3.2.4 Deployment Locations

The twelve traffic counters will be dispersed among four main locations: the Estes Park Park-and-Ride, the Estes Park School Parking Lot, the Bear Lake Park-and-Ride, and the Beaver Meadows Entrance to ROMO. The traffic counters will be placed at the Estes Park and the Bear Lake Park-and-Rides to estimate the occupancy of each lot. Traffic counters will be placed at the Estes Park School Parking Lot located near the Estes Park Park-and-Ride because the school parking lot will be utilized as the temporary park-and-ride during events. The traffic counters will be placed at the Beaver Meadows Entrance station along the same stretch where the National Park Service (NPS) counter is located to obtain daily traffic counts because the NPS traffic counter only provides monthly counts. Figure 6 through Figure 9 show the physical locations of the traffic counters at each of the four main locations. The locations of the traffic counters themselves are identified with red or white circles.

3.2.4.1 Estes Park Park-and-Ride Lot

As shown in Figure 6, a total of six traffic counters are planned to be deployed at the Estes Park Park-and-Ride lot. Three traffic counters are needed for both the 4th Street and Manford Avenue access roads. One traffic counter will be placed at the entrance of each access road. Two counters will be needed for the exit of each access road to accommodate the dual turn lanes.

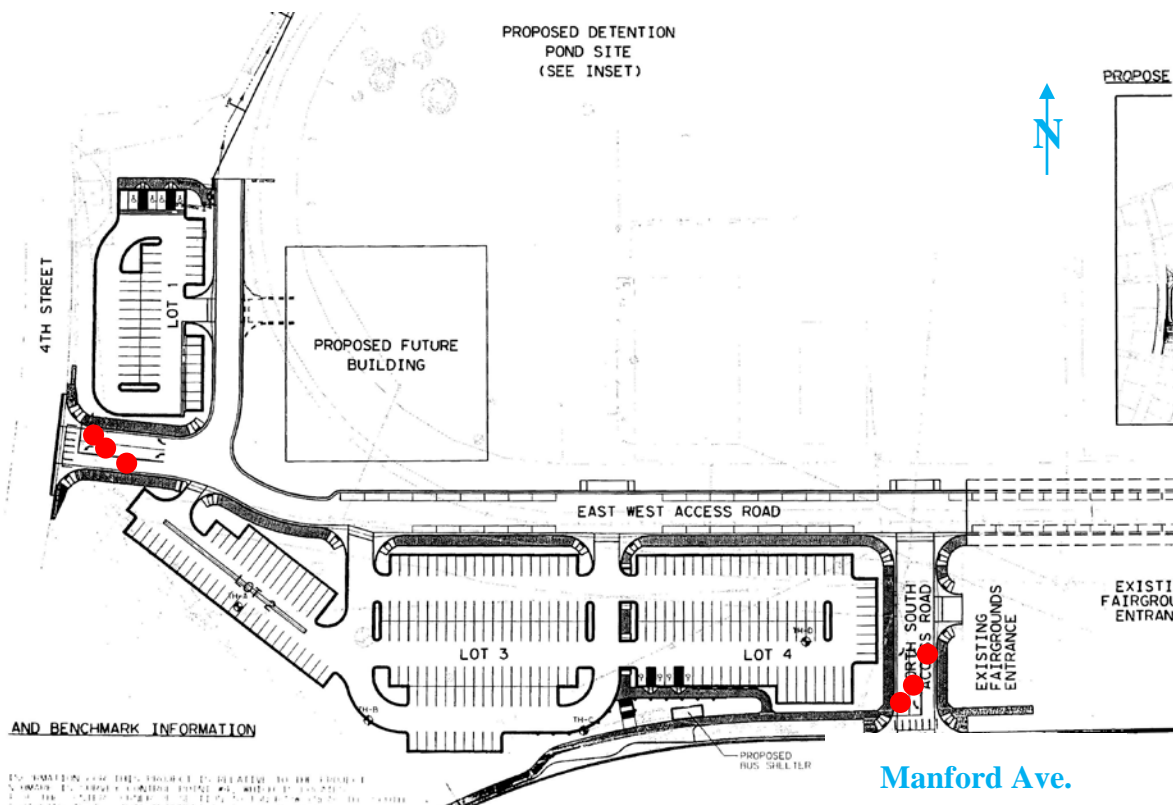


Figure 6: Traffic Counter Locations at Estes Park Park-and-Rideⁱⁱ

ⁱⁱ Figure taken from plans courtesy of the Town of Estes Park

3.2.4.2 Estes Park School Parking Lot

Figure 7 shows traffic counters located within the school parking lot. Only three counters are needed because there is a one-way street in the eastbound direction.



Figure 7: Traffic Counter Location at Estes Park School Parking Lot (3)

3.2.4.3 Beaver Meadows Entrance

Figure 8 shows a traffic counter to the west of the Beaver Meadows Entrance station. As identified in the figure, a traffic counter is only needed for traffic heading west into ROMO.



Figure 8: Traffic Counter Location at the Beaver Meadows Entrance (3)

3.2.4.4 Bear Lake Park-and-Ride Lot

Figure 9 shows the entrance to the Bear Lake Park-and-Ride lot. As indicated in the figure, two counters are needed: one for traffic entering the park-and-ride lot and one for traffic exiting the park-and-ride lot.

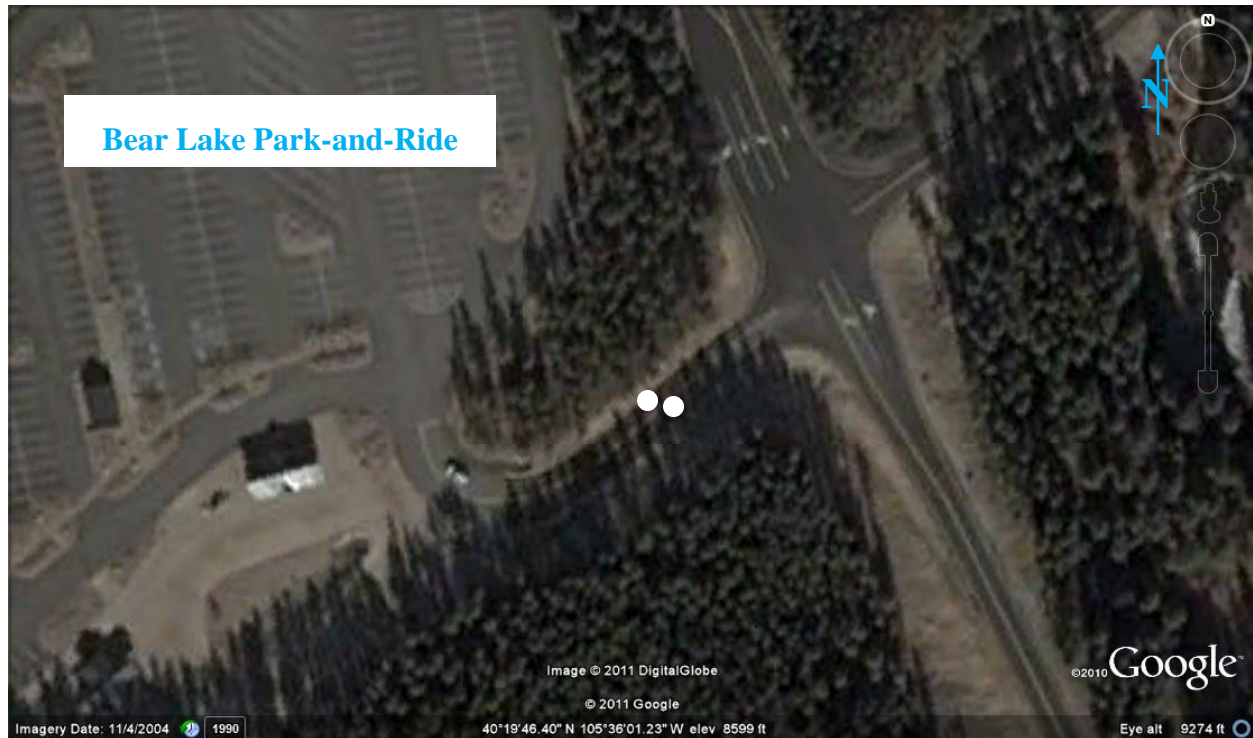


Figure 9: Traffic Counter Location at the Bear Lake Park-and-Ride Lot (3)

3.3 Entrance Station Counts

The Beaver Meadows Entrance Station count data will be used for analyzing Goals One and Three. Data from 2008-2011 will be utilized. This data was and will be obtained from the NPS Stats website (4). The data available at present is shown in Table 11.

Table 11: Traffic Counts at Beaver Meadows Entrance Station (4)

	April	May	June	July	August	September	October	November
2008	12,846	32,421	41,301	99,466	89,386	78,381	40,650	13,750
2009	11,716	41,176	74,387	104,859	92,618	79,340	33,088	13,080
2010	14,565	33,615	76,245	108,614	98,128	83,970	45,968	13,728
2011	15,034	31,010	89,667	TBD	TBD	TBD	TBD	TBD

*TBD = To be determined

3.4 Fleet Observations

Fleet Observations are needed for Goal Two. Fleet Observations are the proportion of passenger cars and light trucks using the Estes Park Park-and-Ride. Fleet Observations are necessary because the miles per gallon associated with these two groups of vehicles are different. Passenger cars are assumed to achieve 23.9 mpg whereas light trucks are assumed to achieve 17.4 mpg according to the values obtained from MOBILE (5). Several observations will be made at varying times which count the total number of passenger cars and light trucks, respectively, in the Estes Park Park-and-Ride.

3.5 DMS & HAR Logs

ROMO is responsible for recording the frequency and type of DMS and HAR messages, which will be studied to identify the periods that can be used for comparison. Appendix C contains both the DMS and HAR log forms. The information recorded on the logs will be utilized when analyzing the effectiveness of Goals One, Two, Three, Four, Seven, and Eight. The use of this information in seven of the eight goals illustrates the importance of this data piece. An in-depth discussion of how the information recorded on the log sheets will be utilized in the analysis can be found in the Analysis section (Section 4).

3.6 Survey

Two surveys will be performed: a user and stakeholder survey.

3.6.1 User Survey

The purpose of the user survey is to collect data about the DMS and HAR, including whether or not the respondents see the devices, their perception of the devices, and if the devices influence their travel plans. The data collected from the user surveys will be utilized in the analysis of Goals One, Two, Three, Four, and Five. Surveys will be administered at three locations: on the Silver Shuttle, at the Estes Park Visitor Center, and at Bond Park (located just west of the Estes Park Town Hall). Multiple locations have been chosen so that both shuttle riders and non-shuttle riders will be surveyed. Surveying at the Bear Lake Trailhead would be preferable; however, restrictions on surveying within ROMO require that an alternative location be chosen. There will be four survey instruments used:

1. An on-site survey for shuttle riders
2. An on-site survey for non-shuttle riders
3. A form for visitors requesting not to be surveyed
4. A mail survey that will be sent to homes

The survey instruments will be tested on July 15 by a TRIPTAC representative. The survey will then be conducted from July 27 through August 9, administered by members of the TRIPTAC and volunteers from the Estes Park Convention and Visitors Bureau. A representative of the TRIPTAC, from the University of Maine, will be training volunteers from the Town of Estes Park Convention and Visitors Bureau on July 26, 2011.

Survey participants will be selected as follows.

- For shuttle riders – surveys will be administered on the shuttle as it returns to the park-and-ride lot. One person per party will be requested to participate.
- For non-shuttle riders – the location for administering surveys will be alternated daily between the Estes Park Visitor Center and Bond Park. At these locations, survey administrators will ask every 12th visitor to participate.

All identified visitors must be 18 years of age or older. The on-site survey is expected to take 5 minutes or less. Example questions include:

- Did you tune in to the highway advisory radio during this trip?

- How would you rate your experiences related to travel (i.e. driving, navigating, parking) within Rocky Mountain National Park and/or the Town of Estes Park?
- How strongly do you agree or disagree with the following statements about how your travel plans were influenced based on the information provided on the highway advisory radio?
 - The information influenced me to use the shuttle
 - This information influenced me to use the park-and-ride lot
 - I decided to visit certain attractions within the park *later* in the day based on the information
- How did the price of gasoline influence your decision to use a shuttle?
 - It did not influence my decision to use a shuttle
 - It somewhat influenced my decision to use a shuttle
 - It completely influenced my decision to use a shuttle

3.6.2 Stakeholder Survey

The data collected from the stakeholder surveys will be utilized in the analysis of Goals Four, Six, and Eight. The purpose of the stakeholder survey is to collect qualitative data related to stakeholders' perceptions of the DMS and HAR, including ease of use and effect on congestion.

The stakeholder survey will be conducted over the phone both before and after the ITS implementation. The stakeholders to be included in the survey include representatives from:

- Rocky Mountain National Park (ROMO),
- Colorado Department of Transportation (CDOT),
- Town of Estes Park (e.g., town staff, shuttle drivers, show owners, visitor center staff, etc), and
- Central Federal Lands Highway Division (CFLHD).

Example questions for the stakeholder survey include:

- How do you believe the DMS and HAR affected driver behavior?
- How would you rate the ease or difficulty of device operations?
- Explain the benefits of collaborating with the other stakeholders.
- Explain any difficulties encountered in the operation and maintenance of the devices.
- What suggested changes do you have if the ITS pilot continues in future years?

3.7 Weather Events

Weather has been reported by ROMO employees as a significant factor affecting visitation. In particular, afternoon thunderstorms have been reported to result in an influx of visitors leaving the Park at the same time. Therefore, the presence of rain in the afternoon, as recorded by a weather station in Estes Park, CO will be incorporated into the prediction model for ridership. The weather data is published on Weather Underground.ⁱⁱⁱ The weather station is called The

ⁱⁱⁱ<http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KCOESTES2&month=7&day=7&year=2010>

Reserve or KCOESTES2. It is located at 40°23'22" N, 105°29'57" W. Figure 10 through Figure 12 depict the type of rainfall distributions that were recorded in 2010. A review of the 2010 data will be performed to determine qualitative ratings with which to categorize the subsequent plots shown in the figures.

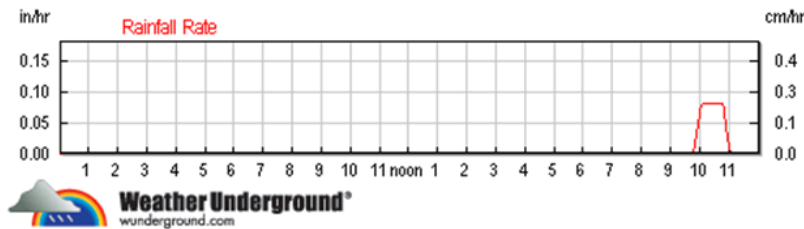


Figure 10: Rainfall Rate for July 6, 2010

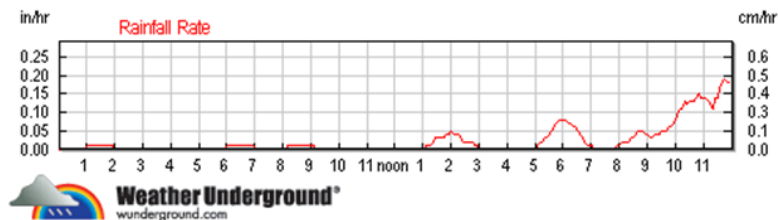


Figure 11: Rainfall Rate for July 7, 2010

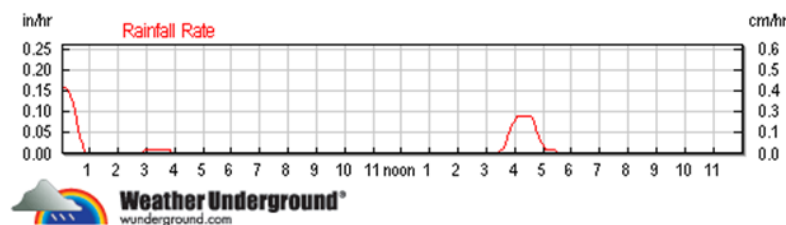


Figure 12: Rainfall Rate for July 8, 2010

3.8 Event Data

The Estes Park Park-and-Ride lot may be utilized over the summer by attendees of events at the Fairgrounds. The following were events identified which may affect the Estes Park Park-and-Ride:

- Rooftop Rodeo, July 12-17, 2011,
- Hunter Jumper Shows, July 27-31, 2011,
- Hunter Jumper Shows, August 3-7, 2011,
- Hunter Jumper Shows, August 10-14, 2011, and
- Senior Professional Rodeo, August 19-20, 2011.

The events only occur in July and August. These times periods are identified in the following two figures. The days highlighted in red and blue indicate those with and without ITS, respectively. The day on which the ITS is being installed is indicated in yellow.

July 2011

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7	8	9
10	11	12	13	14: CHANGE	15	16
		Rooftop Rodeo				
17	18	19	20	21	22	23
24	25	26	27	28	29	30
		Hunter Jumper Horse Shows				
31						

Figure 13: July Events Potentially Using the Park-and-Ride

August 2011

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
			Hunter Jumper Horse Shows			
7	8	9	10	11	12	13
			Hunter Jumper Horse Shows			
14	15	16	17	18	19	20
				Senior Professional Rodeo		
21	22	23	24	25	26	27
28	29	30	31			

Figure 14: Rainfall Rate for July 8, 2010

4 ANALYSIS

This section discusses how the data will be used in the analysis.

4.1 Goal One: Mode Shift

Goal One focuses on identifying if visitors have changed their mode of travel from private vehicles to the shuttles as a result of the information provided by the intelligent transportation system devices. Two approaches will be utilized to determine if a travel mode shift has been achieved: a statistical model and a survey instrument.

First, a statistical model will be developed that predicts the daily ridership of the Silver Route. The model will be based on characteristics that may include an indicator variable for ITS operation (determined from the DMS and HAR logs), the month, the day of the week, the presence of a holiday, the presence of an event, whether or not the event traffic has been directed to utilize the park-and-ride, traffic counts, monthly entrance counts, and weather. The statistical model will be utilized to predict the ridership had the ITS not been in operation. If a mode shift is achieved as a result of the ITS, the Silver Route ridership will increase during the periods with ITS, as compared to periods without it (taking into account all of the aforementioned variables). As the Silver Route is a new service, there is no 2010 data. Therefore, a ridership model may be developed for the Hiker Shuttle, because both 2010 and 2011 data would be available for use in the model. Additionally, the overall ridership in 2011 will be compared to 2010 for the Bear Lake, Moraine Park, and Shopper Shuttles to determine if significant differences in ridership are observed.

Second, a survey instrument will be utilized to extract information about the shuttle users. In particular, the shuttle users will be asked if the DMS/HAR system influenced them to utilize the shuttle. They will also be asked if they learned about the Silver Route through the DMS/HAR system.

4.2 Goal Two: Emissions Pollution

Goal Two was identified with the intent of quantifying reductions in emissions attributable to the installation of the Estes Park Park-and-Ride. In particular, this analysis will focus on the effects based on the influence of the pilot ITS. The calculations will involve determining the lbs of CO₂ reduced as a result of the ITS directing visitors to the Estes Park Park-and-Ride. The following is the equation that will be utilized:

$$\text{lbs of CO}_2 \text{ reduced} = (19.4 \text{ lbs of CO}_2/\text{gallon of gasoline}) * (1/\text{mpg}) * (\text{VMT}),$$

where:

19.4 lbs of CO₂/gallon of gasoline was obtained from the U.S. Environmental Protection Agency website (5),

mpg represents the miles per gallon of the fleet parking in the Estes Park Park-and-Ride lot during the ITS installation, and

VMT will be determined by multiplying the number of displaced vehicles by the distance in miles that it takes to get from the Estes Park Park-and-Ride to the Bear Lake Park-and-Ride.

4.3 Goal Three: Visitor Intercept

Goal Three has three performance measures to determine if the objective associated with the goal has been achieved. The first performance measure (Silver Route ridership counts with and without ITS) will be evaluated using the same analysis as described for Goal One. The second performance measure (occupancy of the Estes Park Park-and-Ride lot with and without ITS) makes use of the traffic counters placed at the entrance and exits to both the Bear Lake and Estes Park Park-and-Ride lots. With this information, the occupancy of the park-and-ride lot over time can be calculated as described in Goal Two. However, since this goal's intent is to determine if the visitors have been intercepted east of their arrival to Estes Park, looking at the occupancy of the Bear Lake Park-and-Ride is intended to determine if the availability of the Estes Park Park-and-Ride has contributed to a reduction in occupancy of the Bear Lake Park-and-Ride, which would support this goal.

Again, the use of the park-and-ride lot for events will have to be considered. For this goal, the mean of the average occupancy for each day with the ITS will be compared to the mean of the average occupancy for days without the ITS. The average occupancy will be calculated by summing the occupancy over the time blocks in the course of a day and dividing by the total number of time periods. The mean of the resulting values for days with and without ITS will be calculated, respectively. A statistical test, like a t-test, will be utilized to compare whether or not the means of the two samples can be considered statistically significantly different. The t-test assumes a normal distribution; this assumption will have to be tested. Based on the proposed collection periods for the traffic counters, a total of forty-nine and twenty-four days with and without the ITS, respectively, can be utilized. The test will have to take into account the differences in days during which data is collected and whether or not the variances of the samples are similar.

The third performance measure for this goal (percent of survey users influenced by the DMS/HAR to utilize the Silver Route) will be measured based on the user survey responses. Users will be asked to indicate if the ITS influenced their decision to use the Silver Route. The percent of survey participants who respond positively supports this goal.

4.4 Goal Four: Peak Spread

Goal Four is dependent upon the utilization of the "Insider's Tip," which recommends that visitors arrive at ROMO in the afternoon rather than the morning. It is *not* recommended that ROMO utilize the "Insider's Tip" on days when afternoon thunderstorms are expected. Therefore, the DMS & HAR logs will need to be reviewed to determine which days the "Insider's Tip" message was utilized. Technical assistance team members will analyze the results of the user survey for those days if there are sufficient days on which the "Insider's Tip" was disseminated. A statistical test, like the t-test, can be utilized to test the means of the ratings for the statement "I decided to visit certain attractions within the park *later* in the day based on the information," for days with and without this message.

In addition to using the user's survey, the stakeholder survey will be reviewed. Stakeholders will be asked before and after their experience with the ITS for their opinion on whether or not the information broadcast over the HAR has influenced visitors to come to the park in the afternoon instead of the morning.

4.5 Goal Five: Improve Traveler Information

The effectiveness of Goal Five is evaluated through the surveys of shuttle and non-shuttle users with questions such as:

- Rate how strongly you agree or disagree with the statement, “The signs were in a good location.”
- How did you learn about the Fairgrounds Silver Route shuttle?
- How strongly do you agree or disagree with the following statements about the highway advisory radio?
 - The information was accurate
 - The information saved me time
 - I was able to get around easier with the information
 - I would plan to use this information if visiting again
 - The information was useful to me and/or my group
 - The information helped me avoid traffic congestion
 - I needed more information

In addition, respondents of the user survey are asked, “How would you rate your overall experience visiting Rocky Mountain National Park and/or the Town of Estes Park?” and “How would you rate your experiences related to travel (i.e. driving, navigating, parking) within Rocky Mountain National Park and/or the Town of Estes Park?” They were given the choices of “Very Good, Good, Average, Poor and Very Poor.” Respondents who indicated that they tuned into the highway advisory radio during the trip will be grouped and compared to those who had not tuned into the highway advisory radio. The average rating for these two questions, respectively, will be compared between the two groups. However, these tests can only be performed if the sample sizes are sufficiently large.

4.6 Goal Six: Successful Collaboration

Goal Six will be measured through the stakeholder survey. Stakeholders will be asked about their support for the ITS pilot, their satisfaction with the ITS pilot, their collaboration with other partners, and their continuing support for ITS in the future. The stakeholder survey will be performed before and after the project to test whether or not their opinions have changed as a result of the implementation of the ITS pilot.

4.7 Goal Seven: Successful Deployment

The success of Goal Seven will be measured based on whether or not the ITS is deployed during summer of 2011. If the ITS is deployed, then Goal Seven will have been fulfilled. The DMS & HAR logs will be utilized to support this goal.

4.8 Goal Eight: Simple Operations

The success of Goal Eight will depend largely on the equipment utilized during the pilot ITS. Vendors were identified that had equipment that could be turned on and off remotely. However, the technical assistance team will need to confirm whether or not such devices were selected, deployed into the field, and operating properly. This can be accomplished by reviewing the specifications of the devices deployed and the DMS & HAR logs, which contain a column

allowing the equipment operators to log whether or not they accessed the device (HAR or DMS) remotely.

To identify the amount of time expended to obtain the FCC license, the stakeholder survey will ask ROMO representatives for this information. In addition, questions will be included on the stakeholder survey to gather opinions on the ease of ITS operation. For example, some questions that may be asked include:

- Do you anticipate any difficulty operating the DMS/HAR?
- Up to this point in the project, how would you describe the ease or difficulty of preparing for the implementation of the ITS?

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APPENDIX B: 2010 RIDERSHIP**2010 Hiker Shuttle Ridership**

	June	July	August	September	October
1	-	230	351	83	-
2	-	191	256	113	117
3	-	351	359	164	60
4	-	277	285	295	-
5	-	304	397	495	-
6	-	156	370	177	-
7	-	129	373	-	-
8	-	211	333	-	-
9	-	144	235	-	-
10	-	265	298	-	-
11	-	290	219	88	-
12	-	203	201	80	-
13	-	285	222	-	-
14	-	168	434	-	-
15	-	236	433	-	-
16	-	238	155	-	-
17	-	343	238	-	-
18	-	248	226	78	-
19	-	282	109	100	-
20	-	340	233	-	-
21	-	168	290	-	-
22	-	270	169	-	-
23	-	288	168	-	-
24	-	349	175	-	-
25	-	315	136	317	-
26	197	465	161	83	-
27	240	351	150	-	-
28	184	308	210	-	-
29	200	232	190	-	-
30	124	354	103	-	-
31	-	457	96	-	-
TOTAL	945	8448	7575	2073	177

2010 Bear Lake Shuttle Ridership

	May	June	July	August	September	October
1	-	-	3023	4126	906	1336
2	-	-	2828	4247	957	3979
3	-	-	5284	4402	1508	2666
4	-	-	4252	4004	4611	987
5	-	1931	5149	4295	6104	1103
6	-	2362	3726	4965	2603	-
7	-	-	1974	5722	1152	-
8	-	-	3422	4965	782	-
9	-	-	4168	3055	1196	2273
10	-	-	5150	4794	1098	697
11	-	-	4384	4028	2286	529
12	-	379	4090	3416	1674	-
13	-	494	4240	3678	1147	-
14	-	1010	3918	5861	1397	-
15	-	1904	4516	4606	1175	-
16	-	1818	4125	3173	1243	2015
17	-	1684	5530	3286	1740	1042
18	-	2406	4240	2926	3358	-
19	-	4245	3233	1598	3021	-
20	-	3604	4292	3333	1592	-
21	-	2784	3761	4786	1722	-
22	-	2934	3818	3484	539	-
23	-	2809	4223	1370	850	-
24	-	2696	5019	1233	1987	-
25	-	3345	5039	1751	5196	-
26	-	4081	4841	1602	3030	-
27	-	3683	4874	2098	1273	-
28	-	2963	4592	2730	983	-
29	1406	2915	3850	2503	766	-
30	1753	3181	4602	888	905	-
31	1135	-	5371	862	-	-
TOTAL	4294	53228	131534	103787	56801	16627

2010 Moraine Park Shuttle Ridership

	May	June	July	August	September	October
1	-	-	435	338	158	104
2	-	-	275	431	137	177
3	-	-	598	574	198	150
4	-	-	422	528	477	82
5	-	327	448	563	645	51
6	-	247	359	561	291	-
7	-	-	380	644	110	-
8	-	-	463	347	169	-
9	-	-	389	277	183	138
10	-	-	672	552	149	60
11	-	-	357	544	276	44
12	-	104	419	324	138	-
13	-	97	423	407	159	-
14	-	148	519	627	249	-
15	-	309	517	416	173	-
16	-	281	345	339	161	64
17	-	479	691	389	150	57
18	-	350	435	377	258	-
19	-	484	455	235	193	-
20	-	285	532	337	160	-
21	-	319	381	460	193	-
22	-	417	604	270	119	-
23	-	478	508	154	88	-
24	-	367	608	172	134	-
25	-	570	472	158	398	-
26	-	600	546	191	152	-
27	-	309	424	196	101	-
28	-	310	535	387	94	-
29	302	373	449	235	105	-
30	340	363	511	150	139	-
31	165	-	633	167	-	-
TOTAL	807	7217	14805	11350	5957	927

2010 Blue Shuttle Ridership

	June	July	August	September	October
1	-	137	174	-	-
2	-	132	121	-	-
3	-	271	119	-	-
4	-	708	106	231	-
5	-	279	95	286	-
6	-	217	135	81	-
7	-	138	160	-	-
8	-	197	172	-	-
9	-	116	123	-	-
10	-	235	136	-	-
11	-	237	116	-	-
12	-	166	111	-	-
13	-	124	149	-	-
14	-	181	149	-	-
15	-	155	153	-	-
16	-	155	77	-	-
17	-	211	111	-	-
18	-	218	101	-	-
19	-	146	111	-	-
20	-	158	78	-	-
21	-	122	173	-	-
22	-	166	107	-	-
23	-	209	96	-	-
24	-	207	83	-	-
25	-	285	43	-	-
26	176	150	75	-	-
27	191	149	108	-	-
28	111	206	96	-	-
29	201	131	110	-	-
30	128	190	-	-	-
31	-	181	-	-	-
TOTAL	807	6177	3388	598	0

2010 Red Shuttle Ridership

	June	July	August	September	October
1	-	41	75	-	-
2	-	66	90	-	-
3	-	138	84	-	-
4	-	299	43	170	-
5	-	94	67	128	-
6	-	172	101	97	-
7	-	135	115	-	-
8	-	126	116	-	-
9	-	68	98	-	-
10	-	73	72	-	-
11	-	122	96	-	-
12	-	88	79	-	-
13	-	117	123	-	-
14	-	76	151	-	-
15	-	86	91	-	-
16	-	177	90	-	-
17	-	159	64	-	-
18	-	78	65	-	-
19	-	141	65	-	-
20	-	75	69	-	-
21	-	105	121	-	-
22	-	107	85	-	-
23	-	149	68	-	-
24	-	93	63	-	-
25	-	112	45	-	-
26	73	98	46	-	-
27	106	80	114	-	-
28	104	85	87	-	-
29	71	92	70	-	-
30	55	66	-	-	-
31	-	122	-	-	-
TOTAL	409	3440	2453	395	0

2010 Brown Shuttle Ridership

	June	July	August	September	October
1	-	143	162	-	-
2	-	116	132	-	-
3	-	266	125	-	-
4	-	289	171	272	-
5	-	112	243	259	-
6	-	122	306	49	-
7	-	137	258	-	-
8	-	181	181	-	-
9	-	175	158	-	-
10	-	300	195	-	-
11	-	127	205	-	-
12	-	140	184	-	-
13	-	111	198	-	-
14	-	228	282	-	-
15	-	230	135	-	-
16	-	226	132	-	-
17	-	305	103	-	-
18	-	195	203	-	-
19	-	165	194	-	-
20	-	218	160	-	-
21	-	179	267	-	-
22	-	235	130	-	-
23	-	276	140	-	-
24	-	172	96	-	-
25	-	189	167	-	-
26	181	172	114	-	-
27	170	152	124	-	-
28	144	150	125	-	-
29	101	189	79	-	-
30	112	212	-	-	-
31	-	347	-	-	-
TOTAL	708	6059	4969	580	0

APPENDIX C: LOG FORMS**DMS Message Log**

Date	Organization Changing Message	Location (Community, Pinyon Trl, or Lyons)	Time Message On (i.e. 10am)	Time Message Off (i.e. 10am)	Accessed Remotely (yes or no)	Message Number (if not pre-approved message, type out entire message)

[illegible]

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