



# Division of Transportation Planning

## Cost-Benefit Analysis of Park & Ride/Intermodal Strategies within the State Highway System in Southern California

### FINAL REPORT



**System Metrics Group, Inc.**



**Division of Transportation Planning**

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November 2013



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## Introduction

This is a critical time to determine how park and ride programs fit with innovative and multi-modal system management strategies. Park and ride program and intermodal facilities are becoming increasingly vital to the goal of improving person throughput and reducing the reliance on single occupant vehicles. The California Department of Transportation (Caltrans) and its key stakeholders have embraced the concept of system management with the knowledge that California cannot build its way out of congestion. Park and ride have the potential to use existing excess parcels, integrate planning and traffic operations strategies, partner with transit agencies, and support carpooling and managed lanes operations.

Innovative management strategies are able to provide greater user benefits at lower cost than traditional capital expansion. For example, the Southern California Association of Governments (SCAG) recently examined the potential of implementing pricing strategies as part of its Express Choices Study and found promising pricing and managed lane options. The Los Angeles County Metropolitan Transportation Authority (Metro) is currently conducting a demonstration of the High Occupancy Toll (HOT) lane concept as part of its Metro Express Lanes pilot program. Managed lane and pricing strategies have the potential to encourage carpooling in addition to their other goals.

The value of park and ride facilities as a whole is widely accepted and encouraged, particularly in California. However, there are few tools and case studies on the quantified assessment of their benefits and costs. The ability to assess the value of park and ride lot development and intermodal facilities improvements is important as many existing facilities are in need of improvement and funds are scarce.

In the past, park and ride lot development projects have “piggy-backed” on other larger capital projects when funds were available. In today’s economic climate, many of these types of projects need to compete with other projects for limited funding. A comprehensive assessment tool can effectively calculate more precisely the relative costs and benefits of constructing new facilities, entering into lease agreements, and estimating the relative worth of relinquishing or retaining existing facilities. The use of an assessment tool provides a better understanding of the cost-benefits associated with existing and planned intermodal strategies and ensures the successful implementation of the most appropriate projects and highest priorities.

Caltrans District 12 (Orange County) led the study to develop a *Cost-Benefit Analysis of Park and Ride/Intermodal Strategies within the State Highway System in Southern California*. Through the study, Caltrans and its partners developed an understanding of evolving innovative strategies, a plan for integrating park and ride lots with these strategies, and a database of information necessary to conduct economic analyses of park and ride lots. While District 12 (Orange County) took the lead in managing



the project, the effort covered all counties in Southern California, including Orange, Los Angeles, Riverside, San Bernardino, Imperial, and San Diego. In addition, other Caltrans districts can benefit from the data collected and tools developed in the study.

As part of the study, the consulting team conducted a literature review on the development and benefits of park and ride lot programs. The team also conducted a survey of park and ride lot stakeholders in Southern California to collect data and gather opinions about issues related to park and ride lots. With this information, the consulting team developed two tools to help Caltrans and its partners evaluate and quantify park and ride operations in California. The first tool allows planners to develop a sketch planning estimate of the costs of building and operating park and ride lots. The second tool can estimate the cost-benefit of new park and ride developments, as well as existing facilities, to identify their effectiveness as part of Caltrans' overall strategy to manage congestion.

The final report provides an overview of the study findings and is organized in the following topic areas:

- Introduction
- Literature Review
- Stakeholder Views
- Cost Estimation Tool
- Cost-Benefit Tool
- Summary and Conclusions.

The appendices provide detailed findings from the literature review, stakeholder interviews, and cost data collection.

## Literature Review

At the beginning of the project, the consulting team conducted a literature review on the development and benefits of park and ride lot programs. The consulting team consulted academic journal articles, reports by the Transportation Research Board (TRB), United States Department of Transportation (USDOT) manuals, park and ride studies conducted by various states and local jurisdictions, as well as California enabling legislation and Caltrans guidelines. The team found that while there are over thirty useful references, a few sources are critical for understanding the development and benefits of park and ride lots:

- Assessing Park-and-Ride Impacts – a literature review conducted by the Caltrans Division of Research and Innovation (DRI) that covers park and ride performance, locations, rider attraction, and planning



- Park and Ride Program Resource Guide – a document produced by the Caltrans Division of Mass Transportation that provides information on the background, design, operations, and funding considerations of park and ride lots
- American Association of State Highway and Transportation Officials (AASHTO) Guide for Park and Ride Facilities – a guidebook that provides a comprehensive background on the types of park and ride lots, their history, park and ride lot design, operations, and finding considerations
- Cost-Effectiveness of Park-and-Ride Lots in the Puget Sound Area – a 1986 study by the Washington State Department of Transportation (WSDOT) of the cost effectiveness of park and ride lot investments
- Victoria Transportation Institute Online Transportation Demand Management (TDM) Encyclopedia – an online reference of TDM strategies (including park and ride lots) and their benefits
- SEStran Park and Ride Strategy – a park and ride strategy developed by the transit authority in South East Scotland that includes an approach to cost-benefit analysis.

The following five subsections provide high-level findings for the primary topic areas. Detailed findings from the literature review can be found in Appendix A.

### Background on Park and Ride Programs

- Although park and ride lots have existed in one form or another since the mid-1920s, the first formal park and ride facilities were developed in the 1970s.
- The AASHTO guide provides a detailed history of park and ride programs. The Caltrans Park and Ride Program Resource Guide also provides extensive information on the background of park and ride programs.
- A key goal of park and ride lots is to increase transportation options and person throughput, while decreasing vehicle trips and air pollution.
- Park and ride lots primarily support other transportation planning and program strategies by encouraging transit, carpool, and vanpool use.
- Close proximity to a major freeway, nearby High Occupancy Vehicle (HOV) access, and frequent transit service are key features for successful park and ride lots.
- Park and ride facilities are part of Caltrans' efforts to promote complete streets.
- The California Highway Design Manual (HDM) notes that park and ride facilities must be considered on all major transportation projects that include new freeways, interchange modifications, lane additions, transit facilities, and HOV lanes.



## Design/Physical Issues

- There are very few references available that provide guidance for the detailed design of park and ride lots.
- The California HDM was updated on May 7, 2012 to include design standards and guidelines for park and ride facilities. The HDM notes that park and ride facilities should be designed as multi-modal facilities and in consultation with local transit providers.
- The primary resource is the AASHTO guide, which most other documents (including the HDM) reference. The New York HDM also has a section on the design of park and ride lots.
- The right location for a park and ride lot depends on the type of facility and the distance to the primary destination market. The AASHTO guide provides a classification and a step-by-step process for selecting sites.
- The Texas Roadway Design Manual provides guidelines on where to locate park and ride lots on freeways.
- The New York HDM provides detailed park and ride lot design specifications.
- Security is a key concern for users of park and ride lots.
- Safety and security is as much a perception as it is real. Security measures should match the perceived need of the site.

## Funding Information

- The Caltrans Park and Ride Program Resource Guide identifies several funding sources for park and ride lot planning as well as federal, state, and local sources that can be used for the capital funding.
- The Caltrans Buspool project identified a few opportunities for public-private partnerships: providing amenities, adopting a project, co-locating on site, imposing developer impact fees, and dedicating private land.
- The “shared-use” park and ride lot has been a successful form of public-private partnership.
- The University of South Florida quantified the impacts in Florida and found that retail centers may benefit from induced or diverted shoppers.
- Miami-Dade Transit operates park and ride lots on private property without formal agreements.
- Some North Carolina communities have ordinances that require some parking spaces at regional shopping centers to be set aside for park and ride.
- Charlotte Area Transit has the ability to review zoning modifications and request park and ride spaces at large developments during rezoning.



- A review of data in the California Transportation Improvement Program System (CTIPS) found that most park and ride projects cost less than \$5 million and are sponsored by a local agency (particularly cities). A “typical” project costs about \$2 million with construction accounting for about two-thirds of the costs. Funding comes from a variety of federal, state, and local sources.

### Cost-Benefit Analysis

- There have been very few formal cost-benefit analyses of park and ride lots. The only two examples found were a 1986 study by the Washington State Department of Transportation (WSDOT) and a recent economic analysis conducted by the regional planning agency in Edinburgh, Scotland to help prepare a park and ride strategy.
- The WSDOT analysis compared the user benefits of park and ride to driving to the same destination.
- The Scottish study compared the user benefits of park and ride to driving as well as to using transit for the whole trip.
- Key benefits include: user benefits, decongestion benefits, changes in transit revenue, and changes in parking costs.
- The WSDOT study found that park and ride lots are effective and cost-effective.

### Other Areas

- The Florida DOT State Park-and-Ride Lot Planning Program classifies park and ride lots based on location.
- AASHTO classifies park and ride lots by function and distance to market.
- Typical operational issues include: safety, lighting, and access to amenities.
- The actual operational issues depend on the type of facility and the level of management.
- Parking management systems (i.e., space monitoring and vehicle detection), intelligent transportation systems (i.e., electronic message signs, electronic fare payment), and priority treatments (i.e., ramp metering/HOV bypass, signal priority, queue bypass) are emerging strategies to improve access to park and ride lots and the utilization of these lots. For example, priority treatments increase the benefits and, therefore, the incentives for park and ride lot users.
- There are several documents and academic papers that discuss alternative techniques to estimating park and ride demand.



## Stakeholder Views

The consulting team conducted a survey of stakeholders to obtain data and gather opinions about a number of issues related to park and ride lots. The team contacted park and ride program coordinators, park and ride lot managers, and rideshare providers within the Southern California Region as well as representatives from Caltrans Headquarters to reflect a variety of opinions. The survey included the following park and ride stakeholders:

- Orange County Transportation Authority (OCTA) – Gary Hewitt
- Caltrans District 7 – Alec Mardirossian
- Caltrans District 8 – Mark Roberts and Sybille Phillips
- Caltrans District 11 – Chris Schmidt and Michael Roy
- Caltrans Headquarters – Scott Sauer
- Los Angeles County Metropolitan Transportation Authority (LACMTA) – Adelaida Felix
- Riverside County Transportation Commission (RCTC) – Jillian Edmiston
- Automobile Club of Southern California (AAA) – Hamid Bahadori.

In general, the consulting team found that stakeholders' primary concerns were related to security, funding, maintenance, and adequate capacity for park and ride lots. Stakeholders' suggestions for addressing security issues ranged from adding security guards, to installing fake CCTV cameras, to using a host program to partner with donation centers to provide better security and maintenance in park and ride lots. While average utilization of Caltrans park and ride lots is approximately 60 percent, some facilities are utilized beyond capacity.

A number of park and ride lots are currently under development in Southern California ranging from expansions of existing park and ride lots to addition of new lots. With regard to maintenance, the consulting team found that Caltrans resurfaces park and ride lots as part of maintenance when funds are available rather than on a set schedule. Funding for capacity expansion or new park and ride lots may be through a Congestion Mitigation and Air Quality (CMAQ) improvement grant, the American Fast Forward/Measure R efforts, or public-private partnership opportunities.

Stakeholders expressed interest in a cost-benefit tool developed as part of this study, but they also emphasized that a demand estimation tool would help them prepare plans for new park and ride facilities. Stakeholders were able to provide information from recent park and ride utilization studies, park and ride cost data, as well as details on contracts for leased park and ride lots. Appendix B contains detailed findings from the stakeholder survey.



## Cost Estimation Tool

As part of the project, the project team developed a sketch planning tool for estimating the initial capital costs and ongoing operating and maintenance costs for park and ride lots. The cost estimation tool was built on cost data provided by stakeholders and information collected during the literature review. The information collected showed that a typical park and ride project costs about \$2 million. Construction accounts for about two-thirds of the cost with funding coming from a variety of federal, state, and local sources.

The cost estimation tool helps planners and park and ride coordinators develop high-level cost estimates for early stages of project development. More detailed estimates should be made during later project study phases and design. The tool uses standard costs from a variety of recent studies. Appendix C describes the sources of all costs used in the tool.

The cost estimation tool is intended to have a similar look and feel to the cost-benefit tool, which is described in the next section. Both tools are modeled after the Caltrans Cal-B/C benefit-cost model, so the user interface should be familiar to many Caltrans planners. Pull-down menus make selections easy and the tool allows users to override estimates as needed. Cost estimates can be computed for four types of park and ride facilities: surface lots, above ground structures, below ground structures, and leased lots.

Like Cal-B/C, the cost estimation tool is arranged as a simple spreadsheet file. The spreadsheet includes six pages:

- Title – introduction page with model contact information
- Instructions – general description of the model and its assumptions as well as step-by-step instructions for using the model
- 1) Inputs – sheet for entering project data and developing high-level cost estimates
- 2) Cost Build-Up – calculation of construction costs using a more detailed “cost build-up” approach
- 3) Cost Results – calculation of project costs for the entire project life-cycle formatted so results can be pasted directly into the accompanying cost-benefit tool
- Parameters – default low, middle, and high cost estimates for different types of park and ride facilities and project elements.

Most users will refer to the pages marked as 1) Inputs, 2) Cost Build-Up, and 3) Cost Results. Exhibit 1 shows an example of the first of these pages – the input sheet. The user starts by entering basic information about the project. The model guides the user into selecting reasonable capital, maintenance, and operating costs for the project. The model provides low, middle, and high estimates



(shown in blue) for each cost item using the park and ride lot information and default values found in the parameters page. These values are intended to be used as a reference as the user enters values selected for each item in the green cells.

Right-of-way costs can vary considerably by the location of the park and ride lot. The tool provides a wide range of potential costs, but site-specific costs should be used when available. The standard land costs used in the tool were obtained from a review of vacant land prices in Southern California using [www.zillow.com](http://www.zillow.com), [www.landwatch.com](http://www.landwatch.com), and right-of-way cost estimates from projects in the 2010 Federal Transportation Improvement Program (FTIP). There will be no right-of-way costs if a project uses available excess parcels.

Construction costs can also vary considerably depending on the type of facility to be built. The cost estimation tool provides two methods for estimating park and ride construction costs. Method 1 uses an average cost per stall, while Method 2 allows the user to build costs up from individual construction components. The user should pick a single construction cost using one or both of these methods. The selected value is entered in the green cell on the inputs page.

To estimate costs using Method 1, the tool uses a look-up table of costs by facility type. These costs come from three separate studies that are described more fully in Appendix C. The tool provides low, middle, and high cost estimates, which are shown on the inputs page. If the user wishes to build-up costs (Method 2), the user must enter information on the cost build-up page. The results are transferred to the inputs page for comparison with the Method 1 estimates.

Exhibit 2 shows an example of the cost build-up page used for Method 2. The page provides predefined construction cost items along with associated unit costs using information from a park and ride lot study in San Joaquin County. The user is able to reference this information while selecting items to be included in cost estimate, such as fencing and lighting. Extra rows are available for the user to define additional items.

The tool also estimates annual operating and maintenance costs as well as preliminary engineering costs. These costs are included on the input page. If a user does not want to build up project costs, the user can refer to only the inputs and cost results pages and skip the cost build up page.

The final life-cycle costs are shown on the cost results page. An example of this page is shown in Exhibit 3. The results are formatted like the cost inputs for the cost-benefit tool, so cost estimates can be pasted directly in the cost-benefit tool.





**Exhibit 1: Cost Estimation Tool Input Sheet**

**Input Sheet**

AGENCY / DISTRICT / DIVISION:

PROJECT TITLE:

EA:

PPWD:

**1A PARK-AND-RIDE LOT INFORMATION**

**Type of Facility**  
Select facility type from list:

**Facility Size**  
Number of Parking Stalls:   
Number of Levels (if multi-level or below ground facility):

**1B PARK-AND-RIDE OPERATING AND MAINTENANCE COSTS** Surface Lot

	Low Est.	Middle Est.	High Est.	User-Selection	Notes
<b>Annual Operating and Maintenance Costs</b>					
Average Annual Oper. or Lease Cost	\$ 16,800	\$ 56,000	\$ 122,500	\$ 43,944	User-input required in green cell

**1C PARK-AND-RIDE CAPITAL COSTS** Surface Lot

	Low Est.	Middle Est.	High Est.	User-Selection	Notes
<b>Right of Way Cost</b>					
Total Acreage Needed	1.12	1.77	2.49	4.00	User-input required in green cell
Land Cost per Acre	\$ 30,000	\$ 500,000	\$ 2,000,000	\$ 45	User-input required in green cell
Right of Way Cost	\$ 33,747	\$ 883,838	\$ 4,981,635	\$ 178	Calculated automatically
<b>Construction Cost</b>					
Method 1-Average Per Stall Cost	\$ 350,000	\$ 1,400,000	\$ 2,940,000		User-input required in green cell
Method 2-Cost Build Up Estimated		\$ 1,754,144			
Method 2-Cost Build Up User-Defined		\$ 1,043,465			
<b>Preliminary Engineering/Design</b>					
PE/Design % of Construction Cost	5.0%	7.5%	10.0%		User-input required in green cell
PE/Design Cost	\$ -	\$ -	\$ -	\$ -	
<b>Total Capital Costs</b>					
Total Capital Costs	\$ 383,747	\$ 2,283,041	\$ 7,921,635	\$ 178	Calculated automatically



Exhibit 2: Construction Cost Build-Up for Method 2

		MATERIAL COST BUILD-UP					
Item Description	Unit	Automatic Estimate			User-Defined Estimate		
		Unit Cost	Units Needed	Cost per Item	Unit Cost	Units Needed	Cost per Item
Traffic Control System	Lump Sum	\$11,161	1.00	\$11,161	\$ 11,161	1.00	\$11,161
Project Funding Identification Sign	Each	\$335	1.00	\$335	\$ 335	1.00	\$335
Clearing & Grubbing	Parking Space	\$972	140.00	\$136,118	\$ 972	75.00	\$72,920
Erosion Control	Parking Space	\$26	140.00	\$3,625	\$ 26	75.00	\$1,942
Temporary Fencing	Linear Foot	\$6	568.40	\$3,172	\$ 6	304.50	\$1,899
Select Fill Material	Cubic Yard	\$78	1,825.60	\$142,624	\$ 78	978.00	\$76,406
Earthwork Excavation	Cubic Yard	\$33	1,487.45	\$48,803	\$ 33	796.85	\$26,680
Aggregate Base	Cubic Yard	\$67	1,879.36	\$125,849	\$ 67	1,006.80	\$67,419
Asphalt Concrete	Ton	\$78	1,110.76	\$86,778	\$ 78	595.05	\$46,488
Concrete Bus Pads	Cubic Yard	\$558	97.00	\$54,129	\$ 558	97.00	\$54,129
Colored Concrete Crosswalk	Cubic Yard	\$614	15.00	\$9,208	\$ 614	8.00	\$4,911
Temporary Pedestrian Access	Lump Sum	\$2,232	1.00	\$2,232	\$ 2,232	1.00	\$2,232
Curbs	Linear Foot	\$22	1,706.82	\$38,098	\$ 22	914.60	\$20,415
Curb & Gutter	Linear Foot	\$39	1,121.74	\$43,818	\$ 39	870.45	\$34,002
Curb Ramps	Each	\$3,906	12.00	\$46,875	\$ 3,906	8.00	\$31,250
Driveways	Each	\$4,464	5.00	\$22,321	\$ 4,464	3.00	\$13,393
Misc. Concrete (Sidewalks)	Square Foot	\$8	16,728.82	\$140,028	\$ 8	8,962.10	\$75,017
12" PVC Pipe, Trench & Back Fill	Linear Foot	\$67	478.80	\$32,062	\$ 67	256.50	\$17,176
Manhole	Each	\$3,906	2.00	\$7,812	\$ 3,906	2.00	\$7,812
Storm Drain Inlet	Each	\$3,348	5.00	\$16,741	\$ 3,348	3.00	\$10,045
Cross Walk and Stop Bar Striping	Linear Foot	\$3	762.08	\$2,126	\$ 3	575.40	\$1,605
Parking Lot Striping	Linear Foot	\$3	2,515.58	\$6,317	\$ 3	1,347.40	\$3,384
Wheel Stops	Each	\$112	29.00	\$3,237	\$ 112	21.00	\$2,344
Parking Lot Marking	Square Foot	\$3	250.04	\$837	\$ 3	133.95	\$448
Sign and Post	Each	\$357	15.00	\$5,357	\$ 357	13.00	\$4,643
Utility Adjustment	Lump Sum	\$12,946	1.00	\$12,946	\$ 10,045	1.00	\$10,045
Site Lighting	Lump Sum	\$798	140.00	\$111,718	\$ 798	75.00	\$59,849
Planting	Lump Sum	\$282	140.00	\$39,439	\$ 282	75.00	\$21,128
Irrigation	Lump Sum	\$106	140.00	\$14,783	\$ 106	75.00	\$7,920
Bus Shelters	Linear Foot	\$22,321	1.00	\$22,321	\$ 22,321	1.00	\$22,321
Fencing	Lump Sum	\$45	400.60	\$17,884	\$ 45	235.50	\$10,513
User Defined 1				\$0			\$0
User Defined 2				\$0			\$0
User Defined 3				\$0			\$0
User Defined 4				\$0			\$0
User Defined 5				\$0			\$0
User Defined 6				\$0			\$0
User Defined 7				\$0			\$0
User Defined 8				\$0			\$0
User Defined 9				\$0			\$0
User Defined 10				\$0			\$0
<b>ESTIMATED SUBTOTAL</b>				<b>\$1,209,754</b>	<b>USER-DEFINED SUBTOTAL</b>		<b>\$719,631</b>



Exhibit 3: Cost Results Sheet

3 PROJECT COSTS (in thousands of dollars)									
Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Year	DIRECT PROJECT COSTS						Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	INITIAL COSTS			SUBSEQUENT COSTS				Constant Dollars	Present Value
	Project Support	R / W	Construction	Maint. / Op.	Rehab.	Mitigation			
<b>Construction Period</b>									
1	\$0	\$0	\$0					\$178	
2								0	
3								0	
4								0	
5								0	
6								0	
7								0	
8								0	
<b>Project Open</b>									
1				\$44				\$43,944	
2				44				43,944	
3				44				43,944	
4				44				43,944	
5				44				43,944	
6				44				43,944	
7				44				43,944	
8				44				43,944	
9				44				43,944	
10				44				43,944	
11				44				43,944	
12				44				43,944	
13				44				43,944	
14				44				43,944	
15				44				43,944	
16				44				43,944	
17				44				43,944	
18				44				43,944	
19				44				43,944	
20				44				43,944	
<b>Total</b>	\$0	\$0	\$0	\$879	\$0	\$0	\$0	\$879,058	



## Cost-Benefit Tool

Using the information collected during the literature review and the stakeholder interviews, the project team developed a cost-benefit spreadsheet tool. The tool provides a method for preparing simple economic analyses for park-and-ride lot projects. Given required input data for a project, the model calculates its life-cycle costs, life-cycle benefits, net present value, benefit/cost ratio, internal rate of return, and payback period.

The cost-benefit tool is intended to be used to prioritize park and ride lot investments, evaluate alternatives, and compete for project funding. The tool can also be used as part of sketch planning. The tool uses a similar structure, formatting, and parameters to the Cal-B/C model, which is the Caltrans standard for benefit-cost analysis. As a result, the cost-benefit tool developed in this study allows Caltrans and its partners to prepare benefit-cost analyses for park and ride lots that are comparable to those calculated for other projects using Cal-B/C.

In the course of the literature review, the project team found two other cost-benefit tools for assessing the benefits of park and ride lots. One tool was developed by the WSDOT to analyze park and ride projects in Washington State. The other was developed in Scotland to assess a series of park and ride investments in metropolitan Edinburgh. The cost-benefit tool calculates benefits similar to the Washington State tool, but incorporates elements from the Scottish tool and, more importantly for Caltrans and its partners, Cal-B/C.

Like the Washington State tool, the new Caltrans cost-benefit tool estimates benefits for users traveling to different destinations. The model user defines up to three destinations that serve as proxies for typical travel from the park and ride lot being analyzed. The tool then estimates benefits for four types of park and ride lot users:

- New Transit Riders (users who switch from automobile to express bus)
- Existing Transit Riders (users who switch from local bus to express bus)
- New Carpoolers (users who switch from automobile to carpool)
- Existing Carpoolers (users who switch to a park and ride lot that requires less driving).

Although the cost-benefit tool is similar to the Washington State tool, it contains a number of important enhancements:

- Uses the Cal-B/C framework (i.e., model structure, formatting, benefit types, assumptions, and parameters)
- Estimates the safety, emission, and greenhouse gas benefits of park and ride projects



- Calculates fuel and emissions savings based on vehicle operating speed using the same assumptions as Cal-B/C
- Allows the user to specify a future year when the lot reaches capacity (benefit in earlier years are lower since the lot is not at capacity)
- Includes a space to input no build park and ride lot information, so park and ride lot expansion projects can be analyzed
- Assumes average vehicle occupancy (AVO) is the same for all park and ride lot users rather than forcing the model user to estimate many AVO values
- Calculates benefits for park and ride lot users that switched from another park and ride lot, which is more common in an area with many park and ride lots
- Simplifies the input of travel time information
- Assumes that average transit riders and carpoolers are unwilling to wait more than 10 minutes
- Estimates vehicle-miles traveled (VMT) reductions and the benefits of CO<sup>2</sup> reductions.

Like Cal-B/C, the new park and ride cost-benefit tool estimates four types of user benefits:

- Travel time savings, as people driving alone and taking local transit switch to carpools and express buses that can take managed lanes
- Vehicle operating cost savings, as fewer vehicles on the road due to carpooling and transit usage. It should be noted that private vehicle operating costs become agency costs in the case of transit. These increased costs should be included in the project evaluation if increased transit service is part of the project being assessed.
- Safety benefits, as fewer vehicles on the road and buses being safer than private vehicles
- Emissions benefits, as fewer vehicles on the road and fewer miles driven.

Benefits are estimated for each travel destination using the demand and travel information entered by the model user. The tool does not estimate park and ride lot demand – this information must be estimated outside the model and provided by the model user.

### Model Structure

Similar to Cal-B/C and the cost estimation tool, the cost-benefit tool is arranged as a simple spreadsheet file. The spreadsheet includes 10 pages:

- Title – introduction page with model contact information
- Instructions – general description of the model and its assumptions as well as step-by-step instructions for using the model
- 1) Project Information – sheet for entering project data, park and ride lot information, destination information (e.g., demand, travel times, etc.), and cost information
- 2) Results – summary of cost-benefit results formatted similar to Cal-B/C



- Travel Time – detailed calculation of travel time impacts
- Vehicle Operating Costs – detailed calculation of changes in highway vehicle operating costs and user out-of-pocket costs
- Accidents – detailed calculation of changes in highway accident costs
- Emissions – detailed calculation of changes in vehicle emissions
- Final Calculations – detailed calculation of net present value, internal rate of return, and payback period
- Parameters – economic assumptions, lookup tables, and other model parameters consistent with Cal-B/C.

Most people will use only the pages marked as 1) Project Information and 2) Results. The project information page is used to enter information about the project, while the results page provides the summary of the economic analysis. In addition, users may refer to the instructions page, which contains step-by-step instructions on how to use the model and explanations for the input data required. These instructions can be printed as a reference. Most of the remaining pages (i.e., travel time, vehicle operating costs, accidents, and emissions) contain the detailed calculations of the user benefits. The typical model user will not refer to these pages.

The final calculations page aggregates all of the user benefits into the final estimates of net present value, internal rate of return, and payback period. This page is identical to the one found in Cal-B/C. An advanced user could use this page to assess more than three park and ride destinations, but it is unlikely that users will be able to estimate demands for so many destinations. The parameters page contains the economic assumptions, look-up tables, and other model parameters. This page is identical to the one in Cal-B/C and contains many more parameters than are needed to assess park and ride projects.

### Using the Model

The model user enters data about the project on the project information page. As shown in Exhibit 4, the first three boxes are used to enter information about the park and ride lot, its design, its location, expected demand, and different travel conditions to the likely traveler destinations. In Box 1A, the user enters information about the project and its location. In Box 1B, the user enters information about the number of parking spaces in the lot and the time that it takes to reach capacity. The user can also enter information about bicyclists and pedestrians.

In Box 1C, the model user provides detailed information about the destinations that travelers may want to reach from the park and ride lot. The user can enter data for up to three destinations. Percentages must be entered to distribute the park and ride lot demand to the three destinations and four types of park and ride lot users. In addition, information is required on the travel conditions and average accident rates along typical routes for reaching these destinations.



**Exhibit 4: Project Information Page**

District:  EA:

PROJECT:  PPNO:

<p><b>1A PROJECT DATA</b></p> <p><b>Type of Project</b> Select project type from list <input type="text"/></p> <p><b>Project Location</b> (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural) <input type="text"/></p> <p>Length of Construction Period <input type="text"/> years</p>	<p><b>1C DESTINATION INFORMATION</b></p> <table border="1"> <thead> <tr> <th colspan="2"></th> <th>Dest 1</th> <th>Dest 2</th> <th>Dest 3</th> </tr> </thead> <tbody> <tr> <td colspan="5"><b>Destination Description</b></td> </tr> <tr> <td>Destination Name</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Distance from Park-and-Ride Lot (miles)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Distance to Next Lot (miles)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Parking Cost at Destination (avg \$/day)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="5"><b>Demand for Travel to Destination</b></td> </tr> <tr> <td colspan="2">Percent of Lot Users to Destination</td> <td></td> <td></td> <td></td> </tr> <tr> <td rowspan="4">Distribution (percent)</td> <td>New Transit Riders</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Existing Transit Riders</td> <td></td> <td></td> <td></td> </tr> <tr> <td>New Carpoolers</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Existing Carpoolers</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="5"><b>Highway Travel to Destination</b></td> </tr> <tr> <td colspan="2">HOV Travel Time (in min)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Non-HOV Travel Time (in min)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Accident Rate (per million vehicle-miles)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Percent Fatal Accidents (Pct Fat)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Percent Injury Accidents (Pct Inj)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="5"><b>Transit Travel to Destination</b></td> </tr> <tr> <td rowspan="2">Express Bus</td> <td>Travel Time (in min)</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Average Fare</td> <td></td> <td></td> <td></td> </tr> <tr> <td rowspan="2">Local Bus</td> <td>Headway (in min)</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Travel Time (in min)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Average Fare</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="5"><b>Carpool/Vanpool Travel to Destination</b></td> </tr> <tr> <td colspan="2">Average Carpool Size (people/vehicle)</td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2">Average Carpool Wait Time (in min)</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Dest 1	Dest 2	Dest 3	<b>Destination Description</b>					Destination Name					Distance from Park-and-Ride Lot (miles)					Distance to Next Lot (miles)					Parking Cost at Destination (avg \$/day)					<b>Demand for Travel to Destination</b>					Percent of Lot Users to Destination					Distribution (percent)	New Transit Riders				Existing Transit Riders				New Carpoolers				Existing Carpoolers				<b>Highway Travel to Destination</b>					HOV Travel Time (in min)					Non-HOV Travel Time (in min)					Accident Rate (per million vehicle-miles)					Percent Fatal Accidents (Pct Fat)					Percent Injury Accidents (Pct Inj)					<b>Transit Travel to Destination</b>					Express Bus	Travel Time (in min)				Average Fare				Local Bus	Headway (in min)				Travel Time (in min)				Average Fare					<b>Carpool/Vanpool Travel to Destination</b>					Average Carpool Size (people/vehicle)					Average Carpool Wait Time (in min)				
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As shown in Exhibit 5, the user also enters project cost data on the project information page. Box 1D is formatted the same as the table in the cost estimation tool, so cost estimates can easily be pasted from that tool into the cost-benefit model. The table is identical to the one in Cal-B/C except that it allows the user to enter the residual value of the park and ride project at the end of the life-cycle. The model automatically includes the residual value of the right-of-way in the analysis. This is an important consideration for park and ride lots since the land can be sold at the end of the project life-cycle.

Exhibit 6 shows an example of the cost-benefit tool results page. This page looks identical to the one in Cal-B/C with two exceptions:

- The cost-benefit tool also reports VMT reductions, which are an important goal of park and ride projects.
- The cost-benefit tool includes the residual value benefit of the land.



Exhibit 5: Project Cost Data

PROJECT COSTS (enter costs in thousands of dollars)									
Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Year	DIRECT PROJECT COSTS			SUBSEQUENT COSTS		Mitigation	Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	Project Support	R / W	Construction	Maint. / Op.	Rehab.			Constant Dollars	Present Value
<b>Construction Period</b>									
1				<-- Must enter a cost -->				\$0	\$0
2								0	0
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
<b>Project Open</b>									
1								\$0	\$0
2								0	0
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
9								0	0
10								0	0
11								0	0
12								0	0
13								0	0
14								0	0
15								0	0
16								0	0
17								0	0
18								0	0
19								0	0
20								0	0
<b>Total</b>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

Residual Value in Year 21  
(in thousands of dollars)

\$0

Present Value =  $\frac{\text{Future Value (in Constant Dollars)}}{(1 + \text{Real Discount Rate})^{\text{Year}}}$

Exhibit 6: Cost-Benefit Results Page

District: HQ

PROJECT: Hypothetical Project

EA:   
PPND:

INVESTMENT ANALYSIS			
SUMMARY RESULTS			
Life-Cycle Costs (mil. \$)	\$0.0	ITEMIZED BENEFITS (mil. \$)	
Life-Cycle Benefits (mil. \$)	\$0.0	Travel Time Savings	Average Annual: \$0.0, Total Over 20 Years: \$0.0
Net Present Value (mil. \$)	\$0.0	Veh. Op. Cost Savings	Average Annual: \$0.0, Total Over 20 Years: \$0.0
Benefit / Cost Ratio:	N/A	Accident Cost Savings	Average Annual: \$0.0, Total Over 20 Years: \$0.0
Rate of Return on Investment:	N/A	Emission Cost Savings	Average Annual: \$0.0, Total Over 20 Years: \$0.0
Payback Period:	N/A	Residual Value	\$0.0
		<b>TOTAL BENEFITS</b>	\$0.0
		Person-Hours of Time Saved	0
		VMT Reduction	0
		CO <sub>2</sub> Emissions Saved (tons)	0
		CO <sub>2</sub> Emissions Saved (mil. \$)	\$0.0

Should benefit-cost results include:

- 1) Induced Travel is not considered
- 2) Vehicle Operating Costs? (y/n)
- 3) Accident Costs? (y/n)
- 4) Vehicle Emissions? (y/n)  
includes value for CO<sub>2</sub>e

Y  
Default = Y  
Y  
Default = Y  
Y  
Default = Y



## Summary and Conclusions

This project addressed two missing components in the toolbox for assessing Southern California park and ride projects – cost estimation and cost-benefit analysis. The cost-benefit component is particularly important because park and ride projects must compete with other projects for funding and the benefits of projects need to be demonstrated. Few practical tools exist for assessing the benefits of park and ride projects. Before this project, none were available in California.

### Cost Estimation

The literature review and stakeholder interviews revealed that limited data are available on the costs of developing or improving park and ride facilities. Few agencies keep records on costs specific to park and ride construction elements. This is partly because park and ride lots are commonly built as part of larger roadway projects for which costs are broken down by non-specific items, such as linear feet of fencing or square-feet of asphalt. Costs specific to park and ride facilities are often generalized or approximated as rule-of-thumb costs per square-foot or number of spaces. These costs are not tailored to particular facilities or locations. In addition, much of these rules of thumb cost data are outdated and, therefore, no longer relevant.

The consulting team incorporated the most recent and relevant data found in the literature and stakeholder interviews into the cost estimation tool. Even so, users need to remember that the data are not robust. Good judgment is needed when using the tool to assess the reasonableness of results. Moreover, the data for the tool were compiled from multiple sources and different regions of the country. Cost factors vary, sometimes significantly, from one region to the next. Whenever possible, users should use estimated costs specific to the projects analyzed. Absent such data, the cost estimation tool provides planners and engineers with a range of values suitable for high-level or sketch analysis.

Caltrans and its stakeholders should continue to refine the data in the cost estimation tool by adding cost information as more park and ride projects are built. The accuracy of the tool will improve with additional data, particularly if data can be refined for different regions in California and specific types of park and ride improvements.

### Cost-Benefit Analysis

The cost-benefit tool developed in this project can help Caltrans and its stakeholders estimate the benefits of park and ride projects. As described previously in this report, the benefit estimation includes several components, but the basic architecture and economic assumptions are derived from Cal-B/C. As a result, the key to the benefit estimation is not the calculations in the tool, but rather, the assumptions and demand factors used as inputs.

The most critical components that impact the accuracy of cost-benefit calculations are demand-related factors, such as the expected lot utilization, identification of major destinations served by the lot, and



the relative mix of carpools and transit traveling to major destinations. Users should take care in identifying appropriate assumptions and demand factors. Users are encouraged to test different scenarios using alternative assumptions to check whether the results are reasonable.

The literature review revealed that there are several demand estimation techniques and methods available. Some methods rely on GIS modeling to identify catchment areas, while others use statistical equations. In the case of statistical methods, users should make sure the equations are calibrated to or reasonable for California conditions. In general, model users will be better off consulting individuals with knowledge about specific routes and traffic conditions rather than using uninformed assumptions. A park and ride demand estimation tool specific to Southern California could be very helpful in providing input to the cost-benefit tool. Such a tool would simplify analyses and potentially reduce human error with the assumptions.



# Appendix A: Literature Findings

This appendix provides detailed findings from the literature review that the consulting team conducted at the beginning of the project. The materials are organized by the following primary topics:

- Background on Park and Ride Programs
- Design/Physical Issues
- Funding Information
- Cost-Benefit Analysis
- Other Areas.

The literature review findings are followed by a section that provides a summary abstract for each document and a matrix that identifies the topics covered in each document. A complete bibliography is provided at the end of the appendix.

## Background on Park and Ride Programs

When reviewing the literature, the consulting team considered the following questions about the background of park and ride programs:

- What is the history nationally and in California?
- What are the goals of park and ride programs?
- What is the current enabling legislation?
- How do park and ride lots support other transportation planning and program strategies, such as transit, pricing, and managed lanes?

The consulting team found that the best resources on the background of park and ride programs are:

- AASHTO Guide for Park and Ride Facilities [AASHTO, 2004]
- Caltrans Park and Ride Program Resource Guide 2010 [Caltrans, 2010]
- Preliminary Investigation Assessing Park-and-Ride Impacts [Caltrans, 2010]
- Park and Ride Options for Tompkins County [Ithaca-Tompkins County Transportation Council, 2004].

## History Nationally and In California

According to the AASHTO Guide for Park and Ride Facilities [AASHTO, 2004], park and ride lots have existed in one form or another since the mid-1920s. However, the first formal park and ride facilities in the United States were developed in the early and mid-1970s in response to rising fuel prices. According



to the Caltrans Park and Ride Program Resource Guide [Caltrans, 2010], the first park and ride facility in California opened in Newcastle near I-80 on Ophire Road. The lot opened June 1975 with 35 spaces.

The various federal “TEA” highway bills have helped to promote the development of park and ride lots in the United States [AASHTO, 2004]. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) as well as subsequent actions by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) prioritized multimodal and intermodal projects over those that encouraged continued reliance on the single occupant vehicle in urban areas. This emphasis benefitted park and ride lot development during the years covered by ISTEA (1992 to 1997). The subsequent Transportation Equity Act for the 21st Century (TEA-21), which covered 1998 to 2003, built upon the ISTEA emphasis on intermodal connections. By their design, park and ride facilities support intermodalism and meet the needs of future urban travel markets, while addressing related issues such as congestion mitigation and air quality. The Caltrans Resource Guide [Caltrans, 2010] provides additional background on park and ride lots.

In 2008, Caltrans issued Deputy Directive 64-R1, which established the need to identify opportunities for creating “complete streets” early in system planning and continuing through project delivery, maintenance, and operations. According to the Deputy Directive, “the Department views all transportation improvements as opportunities to improve safety, access, and mobility for all travelers in California and recognizes bicycle, pedestrian, and transit modes as integral elements of the transportation system.” The long-term implementation of the complete streets policy is intended to result in:

- More options for people to go from one place to another
- Less traffic congestion and greenhouse gas emissions
- More walkable communities (with healthier, more active people)
- Fewer barriers for older adults, children, and people with disabilities.

The May 7, 2012 revision to the California Highway Design Manual (HDM) [Caltrans, 2012] includes more references to park and ride lots, especially regarding complete streets. In Topic 905 on park and ride standards and guidelines, the HDM notes that park and ride facilities must be considered for inclusion on all major transportation projects that include new freeways, interchange modifications, lane additions, transit facilities, and HOV lanes. The Caltrans Project Development Procedures Manual provides additional information on the consideration of park and ride lots.

## Goals of Park and Ride Programs

According to the Caltrans Resource Guide [Caltrans, 2010], the goals for Park and Ride lots are to:

- Increase mobility options for travelers
- Increase person throughput on the system



- Decrease the number of vehicle trips
- Decrease greenhouse gas and air pollution associated with transportation
- Decrease congestion on transportation facilities.

In Section 905.2 Site Selection, the California HDM notes that park and ride facilities are typically placed to enhance efforts to reduce congestion and to improve air quality usually associated with other transportation opportunities, such as HOV lanes and transit. Park and ride lots also provide a number of ancillary benefits, such as improving safety by shifting travelers from highways to transit, supporting economic development by providing increased transportation access, and enhancing the quality of life.

### Enabling Legislation

The Caltrans Park and Ride Program Resource Guide provides a background on the enabling legislation that supports park and ride facility development in California. This enabling legislation includes Assembly Bill 32 (Global Warming Solutions Act), Assembly Bill 3034 (Safe, Reliable High Speed Passenger Train Bond Act), and Senate Bill 375 (Sustainable Communities and Climate Protection Act). The California Vehicle Code and the California Streets and Highways Codes also contain provisions related to park and ride lots. For example, the Streets and Highway Codes define what should be included in park and ride lot lease agreements.

In order to construct, maintain, and operate fringe and transportation corridor parking facilities, Caltrans may enter into agreements with other agencies for joint financing. Facilities that cost more than \$250,000 must be included in the Regional Transportation Improvement Program (RTIP) to be funded. In addition, not more than \$2 million of state funds may be appropriated annually for park and ride lots.

### Support Other Strategies

Park and ride lots support other transportation planning and program strategies in several ways. Park and Ride Options for Tompkins County suggests that park and ride lots encourage transit use, such as rail and bus service, as well as increased carpooling and van pooling. Park and ride lots provide convenient transit stops and allow agencies to extend transit service into low-density areas not easily served by transit. Parking at rail stations allows rail to have a greater catchment area without needing ridership to be supported by feeder bus services or walking patrons. Park and ride lots provide a convenient carpool or vanpool collection point, encouraging greater usage of these multiple occupancy modes.

However, park and ride lot conditions and amenities affect lot utilization rates. Users expect lots to be well maintained. Amenities, such as bus shelters and bike lockers, also encourage greater park and ride usage. Safety is a major concern for lot users. Regular law enforcement patrols and safety lighting can help improve the perception of safety and lot utilization. Additional features for successful park and



ride lots include close proximity to major commuting highways, frequent transit access or connections, and close or direct HOV access.

Users are willing to pay to use park and ride lots if these amenities and features are present. If users are already paying to use park and ride lots, these features make them more willing to pay increased fees.

## Design/Physical Issues

When reviewing the literature, the consulting team considered the following questions about the design of park and ride lots and other physical issues:

- Where should park and ride lots be located?
- How should lots be designed?
- What are potential security issues and how can these be addressed in designs?

The consulting team found that the best resources on design and physical issues are:

- AASHTO Guide for Park and Ride Facilities [AASHTO, 2004]
- California Highway Design Manual (HDM), Chapters 630 and 900 [Caltrans, 2012]
- Park and Ride Planning and Design Guidelines [Parsons Brinkerhoff, 1997]
- Texas Roadway Design Manual [TxDOT, 2010]
- New York Highway Design Manual (HDM), Chapter 24 - Mobility Measures [NYSDOT, 1998].

## Park and Ride Lot Location

According to the California HDM [Caltrans, 2012], park and ride facilities are typically sited to enhance efforts to reduce corridor congestion and improve air quality by providing access to other transportation opportunities, such as HOV lanes and transit. The California HDM notes that the specific location and design of a park and ride facility should be determined through detailed analysis of demand and the potential impact of the facility. Several factors should be considered:

- Corridor congestion
- Community values
- Air quality
- Transit operations
- Overall safety
- Multi-modal opportunities

The Metropolitan Planning Organization (MPO) in Martin County, Florida conducted a park and ride study in 2007 [Kimley Horn, 2007]. The final report identifies the characteristics of the most successful



park and ride lots in North America. These characteristics come from the June 23, 2006 edition of the Urban Transportation Monitor and were selected based upon a survey of public transportation agencies.

The key characteristics of the “successful” lots include:

- Near a major commuting highway (no more than 0.3 miles)
- Frequent express bus service
- Long commute distance (at least 13 miles for employment center)
- Other factors (near commuter homes, high-levels of congestion, high downtown parking costs, close to retail shopping centers)
- Medium density land-use
- Available, free parking
- Lighting.

Other amenities, such as restrooms, securities guards, and covered parking, are valuable, but provided less frequently.

The AASHTO Guide [AASHTO, 2004] makes a distinction between the geographic location and the site-specific location for a park and ride lot. The best geographic location for a park and ride lot depends on the type of facility and distance to the primary destination market. As an example of a functional distinction, park-and-pool lots that serve carpool and vanpool riders are typically small and may be an opportunistic or informal lot. The amount of public investment in these lots can be high or low depending on the agreement with the property owner. In contrast, transit centers that provide a park and ride function are integrated with an interchange of local and express transit service. These are in high demand locations and require high public investment. As an example of the distance distinction, remote long-distance lots serve intercity commuters, while peripheral park and ride lots intercept travelers prior to reaching a high-demand activity center, such as a sporting facility or hospital.

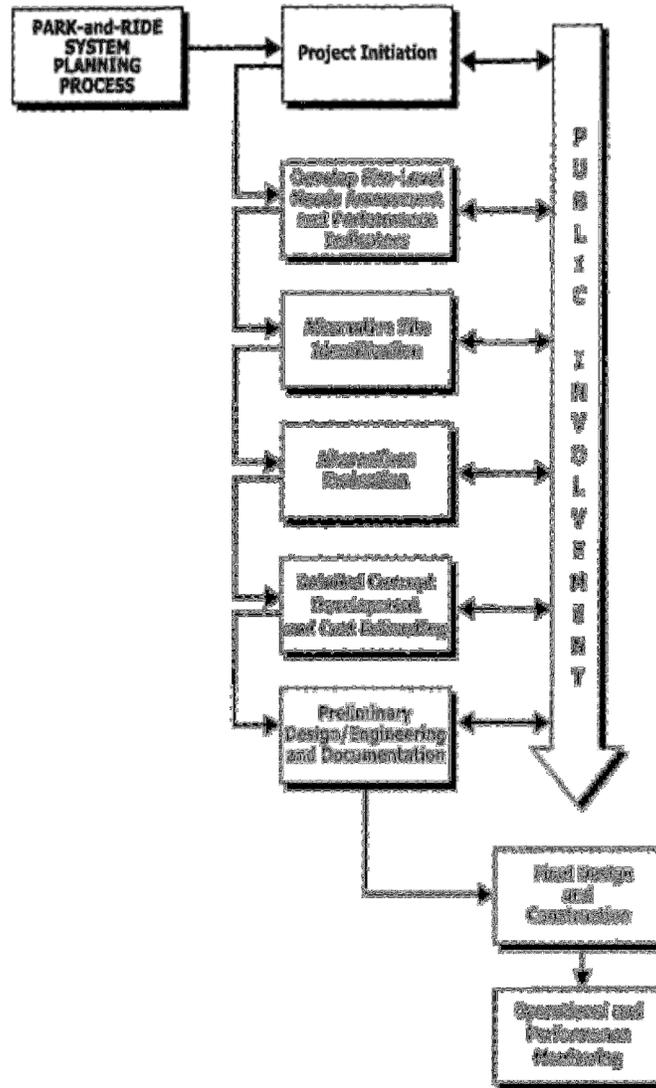
The AASHTO Guide presents a step-by step process for determining park and ride alternatives and the site selection process. The optimum site depends on competing interests and community goals. Factors are evaluated on a site-by-site basis and include the following steps:

- Determination of site availability
- Site evaluation, ranking, and selection from a range of alternatives
- Site-level demand forecasts
- Conceptual site design
- Analysis of location-specific environmental impacts
- Assessing storm water management requirements
- Public involvement program centering around specific site
- Pursuing and securing adequate funding resources

- Preliminary design and engineering.

This process is illustrated in Exhibit A1, which is a graphic included in the AASHTO guide.

**Exhibit A1: AASHTO Site-Specific Alternatives Analysis**



Source: AASHTO, 2004.

## Park and Ride Lot Design

The design of park and ride lots covers both planning and conceptual design as well as the detailed design associated with a specific lot. There is much more information available on planning and conceptual design than for detailed lot design.



The California HDM [Caltrans, 2012] provides primarily conceptual design guidance. In Section 905.3, the HDM states that park and ride facilities should be designed as multi-modal facilities with provisions for pedestrians, bicyclists, transit, single-occupancy vehicles, and multi-occupancy vehicles, as appropriate. The manual notes that the function of the facility should take precedence over form, but that special considerations of safety and security are important for the success of a park and ride lot facility. The initial design of the facility should also take into account the eventual operations and maintenance required. “Appurtenant facilities” can be included as allowed by law, but the need for these additional facilities should be considered early in the project development process with necessary funding and agreements in place.

In Section 636.4(2), the California HDM provides specific guidelines on the use of flexible pavement in park and ride structures. Engineering based on standard traffic projections is not practicable for park and ride facilities due to the unpredictability of traffic. The HDM provides guidelines based on anticipated loads, but site-specific information should be used if it is available. The pavement guidelines provide minimal layer thickness because additional flexible surfacing can be added later, as needed, without significant exposure to traffic.

The AASHTO Guide [AASHTO, 2004] provides an approach that depends on the type of facility:

- Location - Suburban, Remote Long Distance, Local Urban, or Peripheral
- Ownership - Traditional (publically owned), Joint-Use, Leased, or Temporary.

Other considerations for the conceptual design include: the need for strong demand and patronage, integration with the local community, and designs that reduce implementation cost and financial risk.

The Texas Roadway Design Manual [TxDOT, 2010] provides conceptual guidance for planning park and ride lots. The guidance is geared towards freeway lots that serve commuters. The Texas Roadway Design Manual states that park and ride lots should be situated on corridors serving at least 20,000 vehicles per day per lane. In addition, the lots should be located at least 4 to 5 miles from the central business district (CBD), served by transit, and 4 to 5 miles from the next lot on the same corridor. The manual also notes that lots should be located on the right-side of an inbound roadway.

The New York Highway Design Manual [NYSDOT, 1998] is one of the few manuals that provide detailed design guidelines and recommended layouts for lots. Exhibit A2 shows some of the graphics included in the New York Highway Design Manual for park and ride lots. Design elements to be considered include: intermodal connections, community integration, the number of spaces, art and architecture, signing, and geometric elements.

**Exhibit A2: Design Guidelines in New York Highway Design Manual**

Figure 24-22 Recommended Minimum Dimensions for 2.7 m Wide Parking Stalls

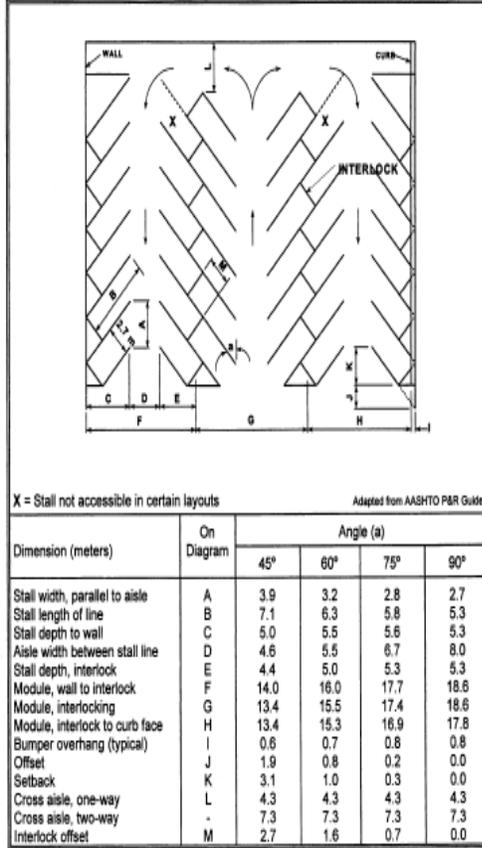


Figure 24-24 On-Line Side Platform Transfer Station

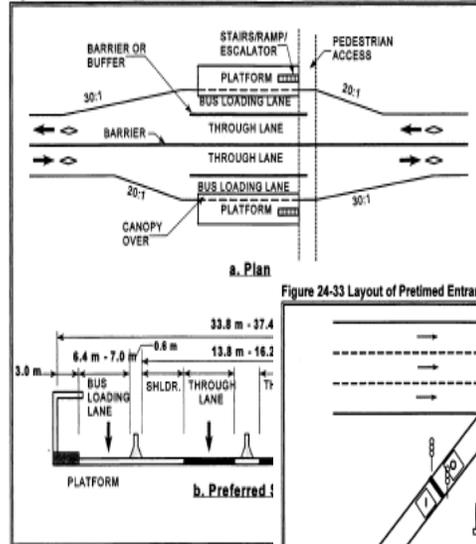
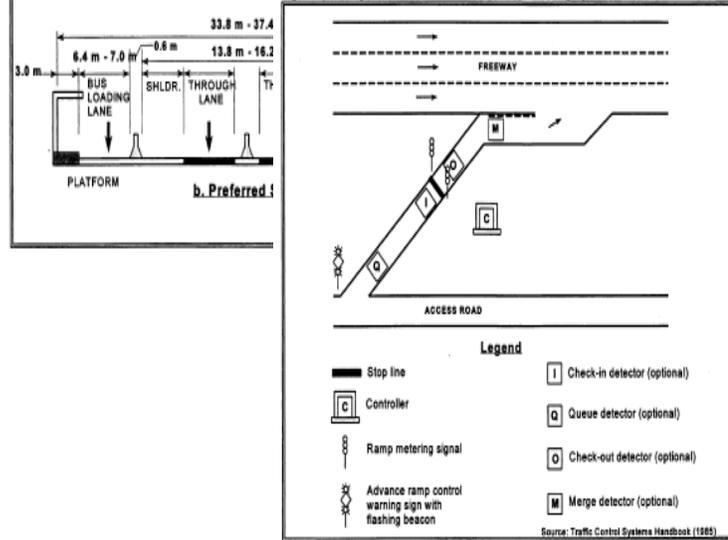


Figure 24-33 Layout of Pretimed Entrance Ramp Metering System



Source: NYSDOT, 1998.

**Security Issues**

The AASHTO Guide [AASHTO, 2004] notes that the provision of a safe and secure environment for park and ride lot users (i.e., patrons, parked vehicles, and transit operators) is absolutely critical to the success of a park and ride lot. However, safety and security is as much a perception as it is real. For example, the frequent and consistent removal of graffiti, broken glass and trash, and overgrown landscaping helps to provide a feeling of security. In addition, an aggressive response to security breaches and other patron concerns can help promote a feeling of security.

The AASHTO Guide notes that security techniques should not be intrusive or create a feeling of imprisonment for patrons. For example, security cameras, emergency telephones, increased lighting levels and hours of operation, the use of white light source for all site lighting, and activity-generating joint uses are preferable to fences and on-site security. Fences and on-site security can make a park and ride lot feel more like a prison. It is important that the security techniques chosen integrate with the surrounding community and match the perceived need of the site. In addition, the lot design should discourage vagrancy.



As part of the California Buspool Project [Nelson Nygaard, 2005], Caltrans conducted a survey of park and ride users in seven Caltrans districts. Caltrans found that the majority of users were satisfied with the park and ride lots and available transit service. Respondents indicated that they were unwilling to pay for improvements, except potentially for service attendants. This addressed respondents' biggest concerns, which were trash and safety.

## Funding Information

When reviewing the literature, the consulting team considered the following questions about the funding of park and ride lots:

- How are park and ride lots currently funded?
- What are the opportunities for public-private partnerships?
- What are some examples of successful public-private partnerships or innovative funding strategies?

The consulting team found that the best resources on funding are:

- Caltrans Park and Ride Program Resource Guide 2010 [Caltrans, 2010]
- Florida Evaluation of Shared Use Park & Ride Impact on Properties [Wambalaba and Goodwill, 2004]
- Martin County Park-and-Ride Study [Kimley Horn, 2007]
- California Park & Ride and HOV Transit Enhancement (Buspool) Project [Nelson Nygaard, 2005].

## Current Funding

The Caltrans Park and Ride Program Resource Guide [Caltrans, 2010] identifies several funding sources for planning and capital costs associated with park and ride lots. The resource guide provides a description of each funding source as well as the applicability of the funding to park and ride lots. The guide identifies the following sources for funding park and ride planning:

- Transportation Planning Grants – Caltrans has competitive grant programs to fund planning studies. Although individual projects cannot be funded, planning grants can be used to study multiple park and ride lots or a system.
- Transportation, Community, and System Preservation (TCSP) Program – This is a federal program that provides funding for considering the relationships among transportation, community, and system preservation and to identify private sector-based initiatives.



The Park and Ride Program Resource Guide also identifies several federal, state, and local sources for capital funding:

- Federal Sources – Federal Transit Administration (FTA) Section 5307 for Large Urban Cities, FTA Section 5309 Capital Investment Program, FTA Section 5311 for Rural and Small Urbanized Areas, Community Development Block Grants (from Housing and Urban Development), Congestion Mitigation and Air Quality (CMAQ) Improvement Program, Regional Surface Transportation Program (RSTP), and Federal Earmarks.
- State Sources – Transportation Development Act (TDA), State Transportation Improvement Program (STIP), State Highway Operation Protection Program (SHOPP), Public Transportation Modernization, Improvement, and Service Enhancement Account of Proposition 1B, and Environmental Enhancement and Mitigation Program (EEMP).
- Local Sources – Regional Transportation Impact Fees, Self-Help Transportation Sales Taxes.

An analysis of recently funded, California park and ride lots completes the funding picture. The consulting team looked at funding data from the California Transportation Improvement Program System (CTIPS). The database is used by Caltrans Transportation Programming to develop the Federal Statewide Transportation Improvement Program (FSTIP). As external users, the consulting team was unable to get direct access to CTIPS. However, on-line reports were available for:

- 2012 State Transportation Improvement Program (STIP)
- 2012 State Highway Operations and Protection Program (SHOPP)
- 2010 Federal Transportation Improvement Program (FTIP).

Since the documents are updated nightly, the team examined reports from a single date – April 15, 2012. The consulting team found that the STIP has only one project that involves a park and ride lot. The project is the Capital Corridor Rail Station in Fairfield and includes the construction of rail station, 300-space park and ride lot, and electric vehicle charging facilities. With such a large scope, the project includes roughly \$40 million in right-of-way, construction, and project engineering costs and is not representative of a “typical” park and ride lot. There were no park and ride lots in the SHOPP.

The FTIP includes 43 park and rides projects and includes much more information on funding. In addition to park and ride projects, there are another 61 projects that involve transit center parking lots, vista points, rail station parking, and truck parking. Some projects combine park and ride lot construction with other activities, such as building transit centers and realigning roads. Like the Fairfield Station, these projects cost more than a typical park and ride lot. However, most projects cost less than \$5 million.



A “typical” project costs about \$2 million with construction costing about two thirds (63 percent) of total project costs. Right-of-way (14 percent) and project engineering (23 percent) comprise the other third of project costs. Most park and ride projects in the FTIP are sponsored by local agencies (particularly cities) and use a combination of funding sources. Federal sources account for 40 percent of the funding, while state and local sources makes up about 30 percent each.

The most common funding sources are:

- Federal: Congestion Mitigation and Air Quality (CMAQ) and Federal Transit Administration (FTA)
- State: Transportation Development Act (TDA) and STIP
- Local: City or County General Funds.

## Public-Private Opportunities

The “shared-use park and ride lot” is one example of using a public-private partnership to provide park and ride facilities. A shared-use lot involves private retail centers, other businesses, churches, or schools making excess parking spaces available to commuters, who can use public transit, carpool, or vanpool to reach their final destinations. AASHTO defines a shared-use park and ride lot as “a parking lot used for a specific activity but also used to accommodate commuter vehicles from the beginning of the morning peak period until the end of the evening peak period” [AASHTO, 2004]. The benefits to public agencies include savings in right-of-way (land acquisition) and facility maintenance costs.

Since churches and schools are non-profit or public agencies, their involvement in shared-use lots is typically not considered to be a public-private partnership. To private-sector, for-profit organizations, the impacts may be positive or negative. Shared-use lots may bring in additional retail customers, but they also increase liability, vandalism and litter. In addition, park and ride lot users occupy spaces that might otherwise have been used by retail shoppers.

The California Buspool Project [Nelson Nygaard, 2005] considered long-term funding strategies for funding park and ride lots and the “buspool” concept (park and ride and HOV improvements that enhance express bus services). These include:

- Pursuing funding from inter-regional transportation improvements – This includes trying to obtain funding from the State Interregional Transportation Improvement Program (IIP) under the notion that the buspool program may not have a clear regional funding priority.
- Developing regional support for the buspool program – This would allow the program to use federal and state funds programmed by Metropolitan Planning organizations (MPOs), such as the federal Surface Transportation Program (STP), Congestion Management Air Quality (CMAQ), Transit Enhancement, and Regional Transit Improvement Program (RTIP) funds. In addition, regional sponsors may be able to use regional funding sources, such as the measure funding.



- Exploring public-private partnerships – The Buspool Project identified three types of partnerships including: 1) private organizations providing amenities (such as landscaping or benches) in return for recognition, 2) local businesses “adopting” a project in return for recognition, 3) businesses (such as a coffee shop) co-locating on the site to provide rental income and enhanced security.

As part of the Buspool Project, an interview with the District 7 park and ride coordinator also indicated the use of a “host” program (not supported by federal policy). That program allows outside individuals to house trailers inside or adjacent to lots. In exchange for this privilege, the private entities monitor the lots and report any crime. Lots that are part of the program are considered to be highly successful.

Other opportunities mentioned in the Buspool report for private sector involvement include developer impact fees, dedication of land, and negotiated mitigation. The report also notes that non-profit organizations may have access to non-transportation sources.

## Successful Strategies

In a “shared-use” park and ride lot, a public or private sector organization makes excess parking spaces available to commuters to use as parking for transit. Several different types of private organizations can be involved, including: retail centers (shopping malls), other businesses, and churches. In addition, schools, which are public organizations, may make lots available for shared use. While schools typically provide their lots free of charge, private organizations may make spaces available to public agencies for free or a charge. Retail centers may benefit from induced or diverted shoppers.

The University of South Florida [Wambalaba and Goodwill, 2004] undertook a study to determine the impact of shared-use arrangements on retail centers in Florida. The research team surveyed users of seven park and ride facilities in Brandon (Hillsborough County), Tampa, Jacksonville, Ft. Lauderdale, Gainesville, and Miami. The majority of surveys came from only two park and ride lots, but users completed surveys at all seven lots. While many park and ride lots are used for commuting to work, the surveys also covered a park and ride lot used for attending football games and another used for visiting the hospital.

As may be expected, the park and ride lots provide reductions in the transit agency costs and congestion. The University of South Florida survey found that roughly 50 percent of park and ride users would have driven all the way to their final destination had the park and ride lot not been available. Commuting and football park and ride users tended to park at the lots frequently, while parking at the lot for the hospital shuttle occurs less frequently, although it is not clear whether this result corresponds to the lower frequency of hospital trips. The lot users also appreciate the availability of the park and ride lots. When asked how beneficial the park and ride lots were, 83.5 percent of respondents reported “very beneficial.”

The survey also provides evidence that park and ride lots benefit the retail centers where they are located. Respondents indicated that they spent \$14.83 to \$25.19 per shopper or \$5.74 to \$10.31 per park and ride user (not every lot user is a shopper) in just the last visit. This translated to average weekly purchases of \$25.06 to \$72.09 per shopper or \$12.17 to \$37.21 per lot user. The highest purchases were made by the football shuttle users followed by the commuters and hospital shuttle users. Many of these purchases were induced (20 percent) or diverted from another retail center (23 percent).

The 2007 Martin Park and Ride Study [Kimley Horn, 2007] provides several examples of shared parking agreements. For example, Miami-Dade Transit (MDT) operates several park and ride lots on private property. There are no formal agreements with the private property owners. The owners allow park and ride users to park for free under “gentleman’s agreements.” Despite the informality in the agreements, the spaces are designated through signage. Exhibit A3 provides an example of a Miami-Dade park and ride lot.

**Exhibit A3: Example of Signage in Informal Miami-Dade Park and Ride Lot**



*Source: Kimley Horn, 2007.*

Portland has over 50 park and ride lots in the metropolitan region [Kimley Horn, 2007]. The transit agency (Tri-Met) has a Tri-Met Park and Ride Policy Report. The policy establishes that Tri Met should use one-time cost reimbursements (such as implementation costs, enhancement cost, or tax breaks) to avoid on-going operating costs for shared park and ride facility. Many of the park and ride lots in Portland are shared through agreements with private landowners, such as churches, schools, businesses, and shopping malls.



The Ohio Department of Transportation (ODOT) has developed a sample park and ride facility agreement for agencies to use in developing shared park and ride facilities. The sample agreement includes a diagram to designate specific spots for park and ride use. The agreement also encourages agencies to pay for park and ride use of private property.

Two communities in North Carolina (Durham and Knightdale) require 5 percent of parking spaces at regional shopping centers to be designated for park and ride use. Charlotte, North Carolina does not have a similar ordinance, but Charlotte Area Transit has the ability to review zoning modifications and often requests the designation of park and ride spaces at large developments during rezoning. The agency often pays private landowners (e.g., \$5 per month) for use of spaces, but sometimes agreements are worked out at no cost [Kimley Horn, 2007].

## Cost-Benefit Analysis

When reviewing the literature, the consulting team considered the following questions about cost-benefit analysis for park and ride lots:

- Has cost-benefit analysis been conducted on park and ride lots in California or other states?
- What is the appropriate analysis approach (e.g., comparing transit to automobile use, measuring convenience benefits to existing transit riders, considering societal or agency benefits)?
- What are some critical benefits to consider?
- What are the results of recent benefit-cost analyses (i.e., highlight data available and results)?

The consulting team found that the best resources on cost-benefit analysis for park and ride lots are:

- SEStran Park and Ride Strategy
- WSDOT Cost Effectiveness of Park-and-Ride Lots in the Puget Sound Area.

## Available Analyses

The consulting team was able to find only two examples of cost-benefit analyses on park and ride lots:

- A 1986 study of the cost effectiveness of park and ride lots in the Puget Sound Area [University of Washington, 1986]
- A 2010 economic analysis of park and ride lots in Scotland [SEStran, 2010].

In 1986, the Washington State Transportation Center at the University of Washington conducted a cost-benefit evaluation of the park and ride system in the Seattle metropolitan area [University of Washington, 1986]. At the time, the park and ride system consisted of 26 park and ride lots. The Washington State Transportation Center conducted a survey of users at each of the 26 lots to determine



the total trip costs incurred in a trip that uses the lot compared to a corresponding trip that does not use the lot. This allowed a build/no-build (or before and after) analysis to be conducted that compares the park and ride lot to an alternative. The costs and benefits of the system were examined with respect to users, the public, and public agencies.

In 2010, the South East of Scotland Transport Partnership (SEStran) developed a regional park and ride strategy for the Edinburgh, Scotland regional area as part of the Regional Transport Strategy [SEStran, 2010]. In developing its strategy, SEStran conducted an extensive inventory of park and ride sites that focused on facilities provided, parking capacity, and public transportation services. SEStran also conducted a detailed analysis of the “catchment area” for existing park and ride lots. The catchment area analysis considered the number of residences within a 15-minute drive of each site as well as the number of jobs accessible by public transit and within a 45-minute commute. In addition, SEStran conducted an economic analysis that provided an economic analysis of the economic benefits associated with the provision of park and ride lots. The analysis was automated into a spreadsheet-based “ready reckoner” that estimates based on travel time and costs differences between auto travel and transit travel.

### Appropriate Approach

The Scottish study of park and ride lots in Edinburgh uses two types of comparisons to make the economic analysis [SEStran, 2010]:

- Park and ride compared to driving all the way to the final destination
- Park and ride compared to using transit for the whole trip.

The underlying assumption is that a park and ride user drives to the lot and takes transit the rest of the way to the final destination. As a result, the alternatives to park and ride are to drive the entire way without stopping at the lot or to take transit the entire way (provided that transit is available from the origin to the destination). The transit option cannot be evaluated if transit does not serve the origin (which may be the case in American park and ride lot transit service).

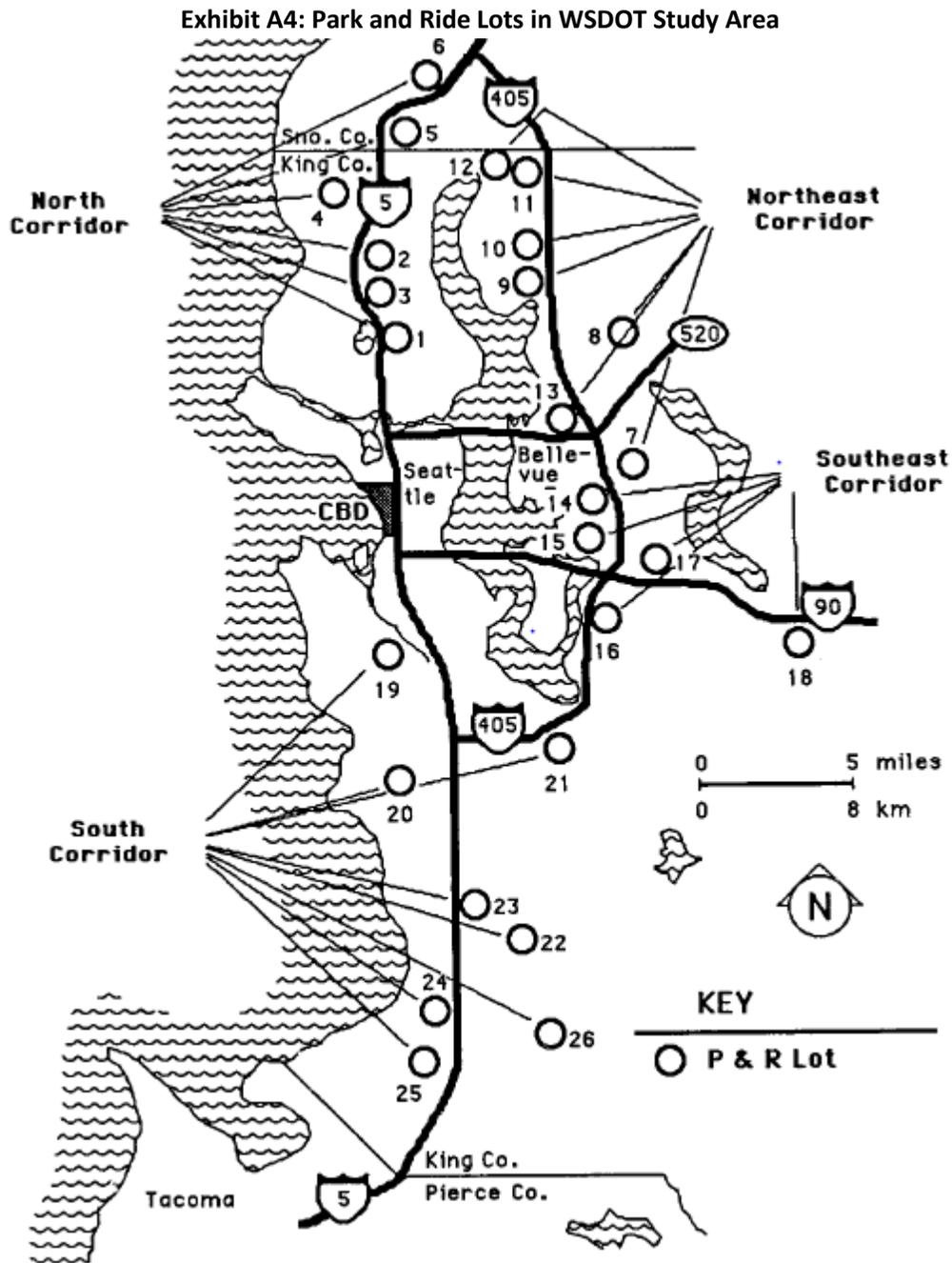
The economic analysis assumes that switching from automobiles use to park and ride lots will reduce variable vehicle operating costs because motorists do not need to drive as far. However, switching to transit will not affect “sunk costs,” such as insurance. To the extent that public transit has a preferred travel lane (e.g., HOV lane) or can avoid congestion, the switch from automobile to transit may save the traveler overall travel time. However, the wait at the park and ride lot could increase travel times. In addition, the use of a park and ride lot may save travelers parking fees at the destination (e.g., in a downtown area). For other travelers (those that remain on the highway), the reduction in vehicles will reduce congestion and travel times. Likewise, increased transit usage will result in higher farebox revenue for transit operators and reduced parking revenues for parking lot operators.



If the switch occurs from public transit only to a combination of automobile and transit using the park and ride lot, the economic analysis assumes that the switch will lead to increased automobile operating costs, reduced transit fares associated with shorter transit trips, and shorter overall travel times. For other travelers, the use of an automobile in combination with transit will increase traffic volumes, but the additional traffic does not change travel times if the increase occurs on mostly uncongested roads.

The WSDOT study compared the alternative of using the park and ride lot and transit to driving only [University of Washington, 1986]. In order to determine travel alternatives and costs, the study team conducted a user survey of park and ride lot users. Exhibit A4 shows the location of the park and ride lots included in the WSDOT study area.

Although the study area included 26 park and ride lots, the study team focused on only the 11 lots in the north and southeast corridors because they represented the extreme conditions. The north corridor was fully developed and had a high utilization rate. The south east corridor was newly developing and had the lowest utilization rate. Travel costs were estimated using a 1972 Keeler-Small model designed for the San Francisco Bay Area. As with the Scottish study, the WSDOT study examined both user benefits and public agency benefits.



Source: University of Washington, 1986.

### Critical Benefits

The Scottish study considers several types of user and public agency benefits [SEStran, 2010]. **User benefits** consist of the savings in generalized cost for commuting and other trip purposes. In the “switching from automobile” scenario, the generalized costs are estimated by comparing the travel time, driving costs and parking costs with the travel times and cost of park and ride. In the “switching



from transit” scenario, the generalized costs are estimated by comparing the travel time, driving costs and parking costs with the travel times and costs of using transit for the entire trip.

Other critical benefits in the Scottish study include:

- **Decongestion Benefits** – based on assumed proportions in non-free flow conditions (dependent on length of journey) and proportions of people switching from automobiles
- **Change in Transit Revenue** – balance of increased fares from automobile switchers and reduced fares from transit switchers
- **Change in Parking Revenues (in downtown)** – split between private and public sector (provided that there is a combination of private and municipal lots).

As shown in exhibit A5, the WSDOT study considered similar benefits in its economic analysis [University of Washington, 1986].

**Exhibit A5: Public and Private Trip Cost Components in WSDOT Study**

Component	Study Value
<b>Time Costs</b>	
• In-vehicle time	1/3 wage rate
• Out-of-vehicle time	2.5 x in-vehicle cost
<b>Public Costs</b>	
• Provision and maintenance of roadway	Peak Period; Bus 2.49 x auto
• Traffic congestion impact on road users	Time, Fuel, Main.
• Other government provided services (planning, police, etc.)	Keeler-Small
• Environmental (noise and air pollution)	Keeler-Small
<b>Automobile Costs</b>	
• Ownership and operating (less fuel and accident)	FHWA, AAA, Hertz
• Fuel	• • •
• Accident	• • •
<b>Parking Costs</b>	
• Provision of P&R lot parking	Actual Construction & O/M Costs
• Parking at destination	Reported on survey
<b>Transit Costs</b>	
• All costs involved in providing transit service (less user fare)	Metro model
• User fare	Actual fare

Source: University of Washington, 1986.

## Results of Analyses

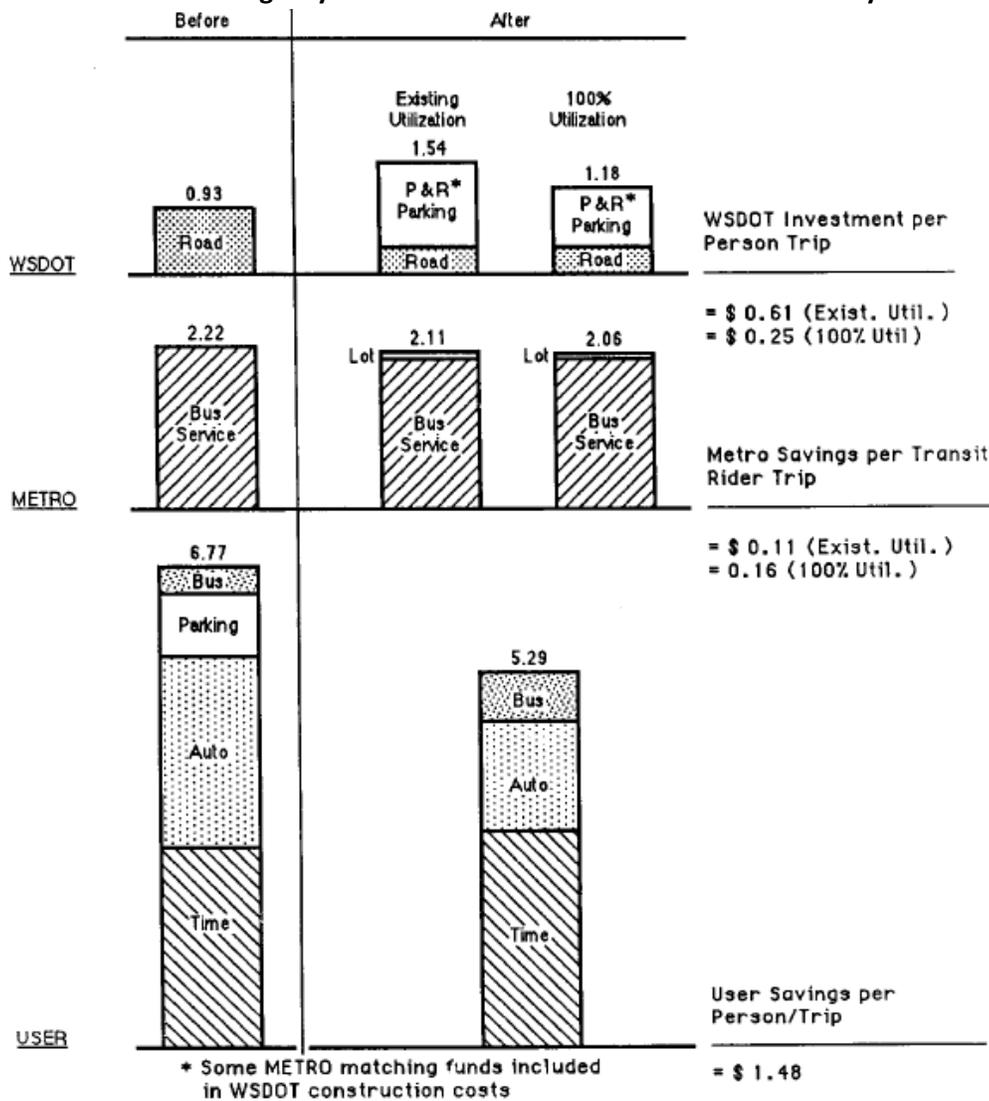
The Scottish model was run for individual park and ride lots. However, the results are not provided in the Park and Ride Strategy Study [SEStran, 2010].



The WSDOT study found that park and ride lots are cost-effective and cost-beneficial [University of Washington, 1986]. While the park and ride lots increased travel times 13.3 percent compared to the previous mode and increased person- miles traveled (PMT) by 3.9 percent, the lots decreased accidents by 35.5 percent and reduced energy consumption by 21.3 percent. In addition, the park and ride lots saved users automobile operating costs and parking fees. Although the park and ride lots increased costs for WSDOT (cost of providing park and ride lots), they reduced costs for the users and the transit agency (METRO).

Exhibit A6 summarizes findings from the WSDOT study.

**Exhibit A6: Agency and User Costs and Benefits in WSDOT Study**



Source: University of Washington, 1986.



## Other Areas

When reviewing the literature, the consulting team also considered questions related to miscellaneous aspects of park and ride lots:

- What are the different types of park and ride lots?
- What are operational issues associated with park and ride lots?
- What are recommended maintenance requirements?
- What are emerging issues and strategies?
- What are appropriate techniques for park and ride demand estimation?

The consulting team found that the best resources to answer these questions are:

- AASHTO Guide for Park and Ride Facilities [AASHTO, 2004]
- Smart Parking Management Field Test: A Bay Area Rapid Transit (BART) District Parking Demonstration [UC PATH, 2008]
- Evaluation of Transit Applications of Advanced Parking Management System [RITA, 2008].

## Types of Park and Ride Lots

The Florida Department of Transportation (FDOT) State Park-and-Ride Lot Program Planning Manual identifies five different types of park and ride lots on the basis of their location:

- Urban Corridor
- HOV Corridor
- Peripheral
- Urban Fringe
- Remote [Kimley Horn, 2007].

The AASHTO guide [AASHTO, 2010] provides a more detailed classification by function and distance to destination market. Exhibits A7 and A8 show these classifications and how they affect the characteristics of park and ride lots and the level of public involvement in their funding and operation.



**Exhibit A7: Park and Ride Classification by Function**

Facility Type	Function	Characteristics	Public Investment
Informal Park-and-Ride Lots	Access to transit stop	Motorists park on-street or in an adjacent property	None
Opportunistic or Joint-Use Lots	Access to transit, carpooling, vanpooling	Shared use with church, theater, shopping mall, special events center, or use of surplus right-of-way	High or low depending on agreement with property owner
Park-and-Pool Lots	Carpool and vanpool formation	Typically small; may be opportunistic lot	High or low depending on agreement with property owner
Suburban Park-and-Ride Lots	Collect potential transit patrons in suburban areas for line-haul express transit service	Located at outer edges of urban landscape; private auto as collect/distribute mode, transit (bus, rail) as line-haul mode	Usually public investment, but opportunities for joint development and multi-use facility are high
Transit Centers (Intermodal)	Park-and-ride function integrated with center where interchange of local and express transit takes place	In high demand locations; offers patrons a much higher degree of travel services, route choices, and destination alternatives	High public investment but image of permanence can generate opportunities for private investment
Satellite Parking Facilities	Provides inexpensive alternative to on-site parking within an activity center	Placed at the edge of an activity center (e.g., central business district, sports complex, airport); may not offer benefits of lower VMT and emissions compared to facilities located at trip origin	Potentially low if operated privately under free market system

Source: AASHTO, 2004.

**Exhibit A8: Park and Ride Classification by Distance to Destination**

Facility Type	Distance From Primary Destination	Characteristics	Public Investment
Suburban Park-and-Ride Lots	6 to 50 km (4 to 30 mi)	Intermodal or change-of-mode service provided	Tend to be publicly funded but offer opportunities for joint ventures or privatization
Remote Long-Distance Lots	65 to 130 km (40 to 80 mi)	Intercity commuters served	Typically publicly funded
Local Urban Park-and-Ride Lots	2 to 7 km (1 to 4 mi)	Fills gap between suburban market and central business district; informal, shared use, or opportunistic	Often publicly funded, but provide opportunities for private operation
Peripheral Park-and-Ride Lots	Located at edge or periphery of primary destination	Intercept travelers prior to activity center; satellite park-and-ride lot	Opportunities for private investment; public investment should be carefully evaluated

Source: AASHTO, 2004.

## Operational Issues



According to AASHTO, the operational issues associated with park and ride lots depend on the type of facility [AASHTO, 2004]. AASHTO defines a lot that also serves transit as an “intermodal facility.” A DOT-owned lot has less complicated operational issues than an intermodal facility with transit. For example, a DOT-owned lot has issues related to lighting, gates, and access to amenities, but the provision of spaces for transit stops is not an issue as it is with an intermodal facility.

Operational issues also depend on the level of management. In recent years, there has been a move to more high-tech lot management. Parking management systems provide real-time space monitoring and vehicle detection. Coupled with intelligent transportation systems, such as electronic message signs, parking management systems can provide greater patron satisfaction. The level of on-site security management (e.g., closed-circuit televisions, guards, and staff) also impacts the complexity of operations.

## Maintenance Requirements

The AASHTO guide [AASHTO, 2004] provides a list of general maintenance activities that should be considered in the operation of park and ride lots:

- Periodic inspection
- Landscaping
- Sweeping/trash pickup
- Traffic control devices (signs/markings)
- Restroom and building maintenance
- Pavement repair
- Information systems
- Lighting
- Site furnishing
- Security/gates.

The type of site (new or existing), method of performing maintenance, and site location will determine the level of maintenance required. A sound maintenance program should be planned well ahead of a new park and ride facility being placed into operation. A sound program includes adequate funding, staffing, and scheduling. In addition, planners should determine the cost and agency responsible for maintenance early in the planning stages. Cost estimation can be difficult because the costs associated with maintenance activities are not well-documented.

## Emerging Issues and Strategies

The AASHTO guide discusses emerging issues and strategies in the following areas:



- Access management, including issues such as access and driveway spacing, corner clearance, and driveway to intersection
- Priority treatments, such as ramp meter or HOV bypasses, traffic signal priority, and queue bypasses
- Signage, including guide signs, facility signs, sign board location, and placement
- Intelligent Transportation Systems (ITS), such as electronic fare payment and traveler information
- Performance monitoring.

A number of recent studies have explored the use of advanced parking management systems and ITS technologies. For example, the New Jersey Department of Transportation explored technical solutions to overcrowded park and ride facilities in a 2007 research report [NJDOT, 2007]. The report covers automated systems, such as space monitoring, payment systems, and reservation systems. The Federal Transit Administration (FTA) has produced an evaluation of transit applications for advanced parking management systems [RITA, 2008].

The Bay Area Rapid Transit District (BART) recently conducted a smart parking demonstration. The demonstration included parking management (i.e., fee for parking, reservation, and security) as well as ITS (e.g., advanced parking spaces and traveler information). The smart parking project showed that parking management can improve access to transit and increase ridership. The program attracted new users – 49 percent of respondents to a survey indicated they would not have used BART if smart parking were not available. The program also increased BART’s mode share, reduced total vehicle-miles traveled, and reduced average commuting times [UC PATH, 2008].

The BART demonstration was considered successful. The study produced lessons for incorporating improvements in future deployments. Exhibit A9 shows user perceived strengths and weaknesses of the parking system. There are now five additional demonstration locations on COASTER trains to San Diego.

**Exhibit A9: Top Five Perceived Strengths and Weaknesses of BART Smart Parking**

<b>Strengths</b>	<b>n=177</b>
I have more confidence that a parking spot will be available when I need it.	16.0%
I can park closer to the station.	12.2%
I have a better idea of how long it will take me to find a parking spot.	10.7%
I can leave my home for work at a later time.	9.8%
I feel safer parking in the smart parking lot.	8.7%
<b>Weaknesses</b>	<b>n=177</b>
The cost of smart parking is too high.	13.3%
Smart parking spaces have already filled.	12.8%
The cost of BART is too high.	10.9%
My personal work schedule varies some days.	8.9%
I don't think the smart parking space will be there when I arrive at the lot.	8.5%

Note that respondents could choose more than one answer.

Source: UC PATH, 2008.

## Demand Estimation

The AASHTO guide describes two techniques for estimating park and ride demand [AASHTO, 2004]. The first technique was developed by the Institute of Transportation Engineers (ITE). This technique estimates demand as a direct function of peak-period traffic on adjacent travel facilities for commuters already passing the park and ride location as part of their usual travel routes. Exhibit A10 shows the ITE approach.

### Exhibit A10: ITE Park and Ride Demand Estimation

$$\text{Demand} = a (\text{Peak}) + b (\text{Prime})$$

where:

**Peak** = Total peak-period traffic on adjacent facilities (including the prime facility);

**Prime** = Peak-period traffic on the prime facility; and

**a, b** = Diversion factors for total traffic and prime facility traffic, respectively.

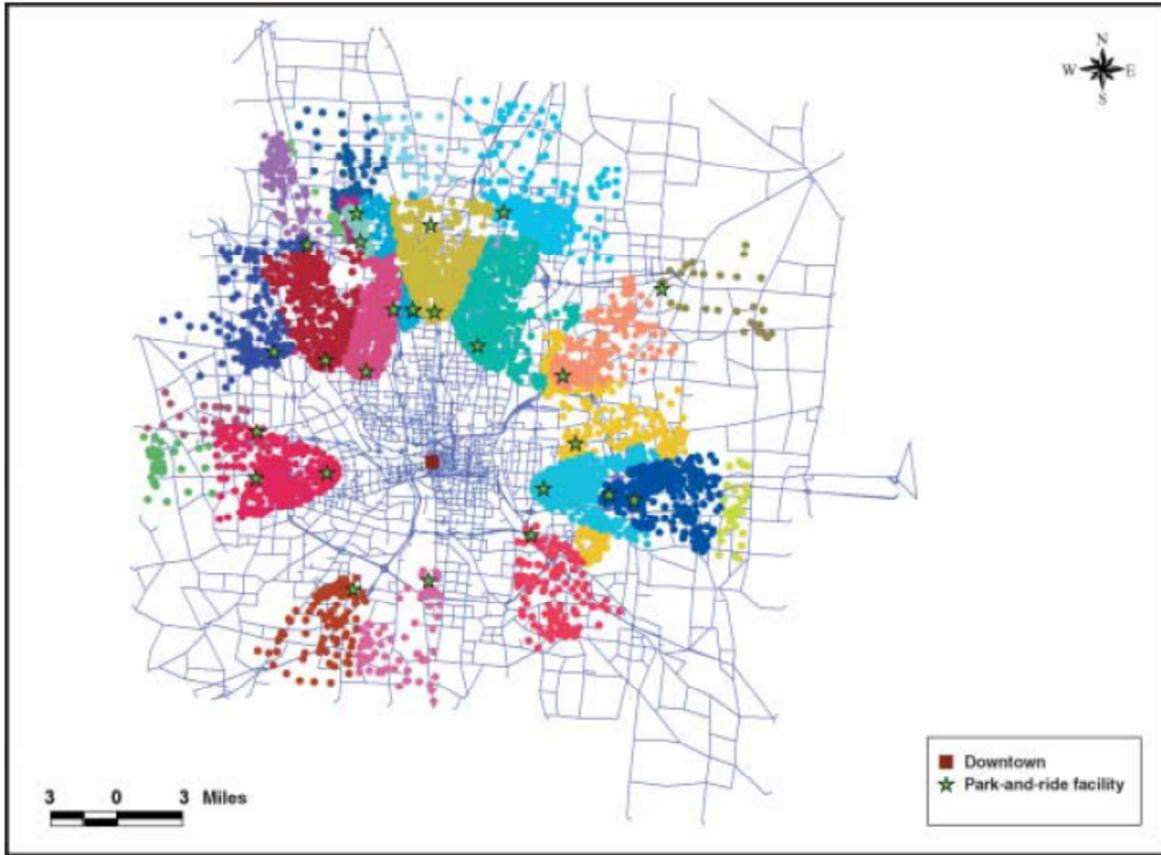
*Source: AASHTO, 2004.*

King County Metro in Seattle uses a more complicated approach. After studying demand characteristics at 31 park and ride lots in its service area, Metro developed five model equations. These equations consider the following factors:

- Service area population
- Distance to CBD
- Number of buses AM peak
- Optimal travel time to CBD
- Distance to other lots
- Availability of midday service.

Researchers at the Ohio State University (OSU) developed an alternative approach for identifying park and ride lot market areas [Farhan and Murray, 2005]. Current approaches generally fall into three broad categories: methods that assume a geometric market area, methods based on travel cost comparisons across modes, and methods identifying current or past users. The Farhan and Murray approach uses a GIS-based system to account for facility accessibility and user travel direction. As shown in the example for Columbus, Ohio (see Exhibit A11), the approach allows catchment areas to be assessed using visual markers.

### Exhibit A11: Park and Ride Market Area Visualization



Source: Farhan and Murray, 2005.

## Summaries

This section provides summaries of the documents reviewed as part of this compilation. Although most documents cover more than one topic, the consulting team has assigned each document to one of the five topic areas for categorization in the summary section:

- Background on Park and Ride Programs
- Design/Physical Issues
- Funding Information
- Cost-Benefit Analysis
- Other Areas.

The matrix found on the next four pages provides references to all of the topics that the documents cover. The "further research" column indicates documents that merit further review throughout this study. The titles in red are subset indicating documents especially valuable for information on a particular topic area.



Study Name	Background	Design	Funding	Cost-Benefit	Other	Further Research
<b>Background on Park and Ride Programs</b>						
<i>Metrolink Station Parking Management Study</i>	X	X	X		X	Yes
<i>Assessing Park-and-Ride Impacts</i>	X	X	X	X		Yes
<i>Caltrans Park &amp; Ride and HOV Transit Enhancement Project</i>	X		X			Yes
<i>Commercial Vehicle Parking in California: Exploratory Evaluation of the Problem and Solutions</i>					X	No
<i>State Park &amp; Ride Lot Program: Planning Manual</i>	X	X	X	X		Yes
<i>Park-and-Ride/Fringe Parking</i>	X			X		Yes
<i>Vanpool Programs: Implementing Commuter Benefits Under the Commuter Choice Leadership Initiative</i>					X	No
<i>Response of Regional Rail Park-and-Ride Users to Parking Price Changes: Systemwide Results and a Detailed Study of Two Stations</i>	X					No
<i>Federal-Aid Highway Program Guidance on High Occupancy Vehicle (HOV) Lanes</i>	X					No
<i>Mitigating Traffic Congestion the Role of Demand Side Strategies</i>	X					No
<i>Park-and-Ride Study</i>	X	X	X			Yes
<i>Park and Ride Options for Tompkins County</i>	X	X	X	X		Yes
<i>Park N Ride Atkins</i>				X		Yes
<i>Park and Ride Program Resource Guide 2010</i>	X	X	X	X		Yes
<i>Park and Ride Program Resource Guide 2009</i>	X	X	X	X		Yes
<i>Parking Policy for Transit-Oriented Development: Lessons for Cities, Transit Agencies, and Developers</i>			X			Yes
<i>Public Transit in California: Existing Conditions and Current Practices</i>	X		X	X		No
<i>Advanced Parking Management Systems: A Cross-Cutting Study; Taking the Stress Out of Parking</i>	X	X				Yes
<i>Park-and-Ride/Pool: Traveler Response to Transportation System Changes</i>	X	X			X	Yes



Study Name	Background	Design	Funding	Cost-Benefit	Other	Further Research
<b>Design/Physical Issues</b>						
<i>Park and Ride Planning and Design Guidelines</i>		X				Yes
<i>Guide for Park and Ride Facilities</i>	X	X	X		X	Yes
<i>California Highway Design Manual (HDM)</i>		X				Yes
<i>Collier County Park &amp; Ride Site Identification Study</i>	X	X				Yes
<i>Fort Worth Park – and – Ride Development Study</i>		X				Yes
<i>Freeway Bus Station Area Development: Critical Evaluation and Design Guidelines</i>		X		X		Yes
<i>Intermodal Facilities and Rest Areas</i>		X				No
<i>Statewide Transit-Oriented Development (TOD) Study Factors for Success in California Special Report Parking and TOD: Challenges and Opportunities</i>		X	X			No
<i>Study of Park-and-Ride Facilities and Their Use in the San Francisco Bay Area of California</i>		X		X		Yes
<i>Facility Location Methodology for Optimal Placement of Park-and-Ride Facilities</i>		X				Yes
<i>Concept of Operations for the I-15 Corridor in San Diego, California</i>		X				Yes
<i>Concept of Operations for the I-394 Corridor in Minneapolis, Minnesota</i>		X				Yes
<i>Highway Design Manual, Chapter 24—Mobility Measures, Revision 32</i>		X				Yes
<i>Roadway Design Manual, Chapter 7, Miscellaneous Design Elements; Section 4: Parking</i>		X				Yes
<i>Optimal Location of Park and Ride Facility</i>		X		X		Yes
<i>Evaluation of Transit Applications of Advanced Parking Management Systems—Final Evaluation Report</i>		X			X	Yes
<i>Parking for Transit-Oriented Development</i>		X			X	Yes



Study Name	Background	Design	Funding	Cost-Benefit	Other	Further Research
<b>Funding Information</b>						
<i>Evaluation of Shared Use Park &amp; Ride Impact on Properties</i>			X			Yes
<i>Evaluation Of Shared Use Park and Ride Impact on Properties - Summary</i>			X			Yes
<b>Cost-Benefit Analysis</b>						
<i>Parking Planning and Costs</i>			X	X		Yes
<i>Cost Effectiveness of Park-and-Ride Lots in the Puget Sound Area</i>	X			X		Yes
<i>Park &amp; Ride Strategy</i>	X	X		X		Yes
<i>Guide to Calculating Mobility</i>						Yes
<i>The Cost of Driving and the Savings from Reduced Vehicle Use</i>				X		Yes
<i>Park and Ride: Convenient Parking For Transit Users</i>		X		X		Yes
<i>Transit and Congestion Pricing: A Primer</i>				X		Yes
<i>Locating and Pricing Park-and-Ride Facilities in a Linear Monocentric City with Deterministic Mode Choice</i>	X			X		Yes
<b>Other Areas</b>						
<i>Houston Managed Lanes Case Study: The Evolution of the Houston HOV</i>		X			X	Yes
<i>OCTA Go Local Program - Park and Ride Metrolink Shuttle</i>				X	X	Yes
<i>Metro Orange Line Mode Shift Study and Greenhouse Gas Emissions Analysis</i>				X	X	Yes
<i>Park and Ride: Lessons from the UK</i>					X	No
<i>Cellular Automaton Simulation of Vehicle Dynamics in Park-and-Ride</i>					X	Yes
<i>Concepts for Coordinating Freeways and Transit in Multimodal Corridors</i>					X	No
<i>Siting park-and-ride facilities using a multi-objective spatial optimization</i>					X	Yes
<i>Integrating Bicycling and Public Transport in North America</i>					X	No
<i>Smart Parking Management Field Test: A Bay Area Rapid Transit (BART) District Parking Demonstration; Final Report</i>	X				X	Yes
<i>A GIS-based planning approach to locating urban rail terminals</i>					X	Yes



Study Name	Background	Design	Funding	Cost-Benefit	Other	Further Research
<b>Funding Information</b>						
<i>Park and Ride: Characteristics and Demand Forecasting</i>					X	Yes
<i>Modeling Effect of Travel Time Uncertainty and Traffic Information on Technical Solutions to Overcrowded Park and Ride Facilities</i>		X		X	X	Yes



## Background on Park and Ride Programs

**Metrolink Station Parking Management Study.** For SCAG by IBI Group. September 27, 2011.

Keywords: Strategy, Management, Overview

This is a PowerPoint presentation that provides an overview of managing parking facilities. The study reviews case studies from the US and Canada in terms of parking pricing, parking operations, parking technology, access mode, and land-use. It also assesses potential improvements at Metrolink park and ride lots and the applicability of the case studies to Metrolink. There may be an accompanying report that provides study findings.

**Assessing Park-and-Ride Impacts.** By CTC & Associates LLC for Division of Mass Transportation, Caltrans. June 2, 2010. Keywords: Performance Measurement, Location Analysis, Literature Review

This report (called a “Preliminary Investigation”) is essentially a literature review that considers relatively recent research and publications in online and print sources from the National Cooperative Highway Research Program (NCHRP), other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related research. The review covers six topic areas:

- Measuring and Improving the Performance of Existing Park-and-Rides.
- Locating Park-and-Ride Lots for Maximum Benefit.
- Attracting Park-and-Ride Users.
- Park-and-Ride Planning Documents.
- Informal Survey of State Practice.
- Projects in Process.

The report includes a summary of findings, brief summaries of each report reviewed and bibliographical citations. The report also identifies several “gaps in findings:”

- The 2004 AASHTO publication Guide for Park-and-Ride Facilities provides the basics of park and ride planning and design. However, with the exception of a Florida DOT planning manual, state departments of transportation do not provide detailed park and ride planning guidance.
- While modeling is extensively used to manage traffic, it is not used as often to manage park and ride lots. However, there are signs that modeling is becoming more common for locating and managing park and ride facilities.
- Few studies address vehicle movements within park and ride facilities. This lack of research data makes it difficult for park and ride facility managers to forecast demand and evaluate alternative designs.
- There are few surveys of park and ride users that can help identify the features and amenities most preferred by users.



**Caltrans Park & Ride and HOV Transit Enhancement Project.** By Nelson/Nygaard for Division of Mass Transportation, Caltrans. July 2005. Keywords: Overview, Usage, Surveys

This study looked at an opportunity that involves maximizing transit vehicle utilization at the state's extensive park and ride and High-Occupancy Vehicle (HOV) system. There are 367 park and ride lots and 1061 HOV lane miles spread throughout the state. The California BusPool Project was created to identify potential park and ride and HOV improvements that would enhance express bus services in the State's metropolitan areas. The document is organized into the following sections: Background and Objective, Approach and Work Flow, Document Review, Outreach Activities, Evaluation Criteria, park and ride Survey, Needs Assessment, Evaluation and Prioritization of Improvements, 10-Year Master Plan, and Marketing the Program. This document is relevant in the following areas: background, surveys, and evaluation.

**Commercial Vehicle Parking in California: Exploratory Evaluation of the Problem and Solutions.** Rodier, Caroline J. Shaheen, Susan A. Allen, Denise A. Dix, Brenda. California PATH Research Report. March 2010. Keywords: Commercial Vehicle Travel, Truck Parking, ITS

This report provides a summary of the relevant legislation history on truck parking in the United States. The report also describes the current shortage of truck parking in California and its impact on congestion, safety, air quality, public health, and trucking productivity. Stakeholder interviews and surveys of truck drivers were conducted. The researchers provide lessons learned from the interviews and surveys as well as parking guidance for automobiles. This is followed by an evaluation of alternatives to address the truck parking problem, including expanded capacity, improved information, and installation of anti-idling technology. Finally, the federally funded Truck Parking Initiative in California is described.

**State Park & Ride Lot Program: Planning Manual,** Florida Department of Transportation, September 1996. <http://www.dot.state.fl.us/transit/Pages/StateParkandRideLotPlanningManual.pdf>.  
Keywords: Site Selection, Planning, Economic Impact

First published in 1989 and revised in 1996, this detailed planning manual for park and ride lots includes information on:

- Planning process
- Site selection (system and project levels)
- Estimating demand and facility size
- Impact assessments
- Economic analysis and project
- Project justification
- Conceptual design considerations
- Promotion
- Planning ancillary services
- Evaluating performance of existing facilities
- Program performance evaluations
- Private participation.



Two related documents provide additional details or updated information:

- Park and Ride Lot Program, Procedure Topic No. 725-030-002-f, Florida Department of Transportation, May 14, 2001. <http://www2.dot.state.fl.us/proceduraldocuments/procedures/bin/725030002.pdf>

This document describes the procedures applicable to the planning, implementation, promotion, maintenance and monitoring of park and ride facilities by the Florida Department of Transportation (DOT).

- Update of FDOT State Park & Ride Lot Program Planning Manual: Chapters 3, 4 and 6, Florida Department of Transportation, April 2001. <http://www.dot.state.fl.us/transit/Pages/StateParkandRideUpdatestoChapter34and6.pdf>

This is a limited revision to the Florida DOT park and ride manual. The update covers chapters on site selection, demand and facility size estimation, and economic analysis and project justification.

**Park-and-Ride/Fringe Parking. EPA Transportation policy.** Keywords: Cost, Air Quality, Overview

This report describes the United States Environmental Protection Agency (EPA) guidelines related to park-and-ride facilities. The report discusses successes of existing systems, impacts on air quality and transportation, and typical costs.

**Vanpool Programs: Implementing Commuter Benefits Under the Commuter Choice Leadership Initiative.** By Michael Grant and Lisa Ecola of ICF Consulting for EPA's Office of Transportation and Air Quality. September 2001. Keywords: Employer Benefits, Tax, Costs

This document describes the concept of vanpooling and its expected benefits. Vanpooling brings together seven to fifteen commuters in one vehicle, typically a van. One person drives and maintains the van, while riders split expenses. In some cases, companies own and operate the vanpool, offering employees the chance to ride at a reduced rate as a work benefit. The primary benefits of vanpooling depend on the market segment. In areas with high occupancy vehicle lanes, vanpools allow commuters to use these lanes to bypass traffic jams, providing potentially significant time savings. For long-distance commuters, vanpools provide a relaxing way to travel, since the passengers have time to read, work, or sleep. For employers facing a parking shortage, vanpooling can reduce the cost of building additional parking facilities.

**Response of Regional Rail Park-and-Ride Users to Parking Price Changes: Systemwide Results and a Roadway Design Manual, Chapter 7, Miscellaneous Design Elements; Section 4: Parking,** Texas Department of Transportation, March 2010. See page 225 of the PDF at <http://onlinemanuals.txdot.gov/txdotmanuals/rdw/rdw.pdf>. Keywords: BART, Surveys

This study investigated traveler response to the introduction of parking user fees at heavily patronized park and ride lots at San Francisco Bay Area Rapid Transit (BART) stations. Researchers conducted detailed research at two stations using mail and license plate surveys and focus groups. Results indicate modest overall effects from the price increase. The increased availability of parking resulting from new



reserved spaces and the introduction of fees made parking available later in the day and pushed back morning arrival times. New, higher-fee, daily reserved spaces were more popular than the monthly reserved spaces they replaced. Researchers concluded that “as long as service, cleanliness, security, and convenience are maintained or improved for parkers, as other access modes are also supported and improved, most riders appear more than willing to pay the new fees.”

**Federal-Aid Highway Program Guidance on High Occupancy Vehicle (HOV) Lanes.** August 2008.

Keywords: HOV, Federal

High Occupancy Vehicle (HOV) facilities have proven to be effective enhancements to the transportation system in many metropolitan areas. These facilities are most appropriate and are most needed along corridors with high levels of demand and traffic congestion. In these situations, HOV facilities can provide the travel times saving and improved travel time reliability necessary to encourage commuters to change from driving alone to using transit services, vanpools, and carpools. HOV lanes work best where significant roadway congestion occurs during the peak periods and where HOV-support facilities, such as park and ride lots, are available. Experience with HOV lanes from around the country has shown a positive relationship between ridership and travel time savings. This suggests that travelers' willingness to carpool or ride on buses that use HOV lanes grows when congestion gets worse.

**Mitigating Traffic Congestion the Role of Demand Side Strategies.** By The Association for Commuter Transportation, UrbanTrans Consultants, Parsons Brinckerhoff, ESTC for Office of Transportation Management, Office of Operations, Federal Highway Administration. October 2004.

Keywords: Demand Estimation, Strategy, Applications, Case Studies

This report outlines a framework for understanding the potential demand-side strategies. It also provides a series of brief and in-depth case studies that illustrate where and how these strategies work best. The document is organized around five primary sections:

- The Demand-Side Framework – The broad framework for understanding demand-side strategies, their impact on traveler choices, and the varied settings where they are applied.
- Summary of Case Study Experience – A review of the case studies collected and key lessons learned from the case study exploration.
- Conclusions and Future Developments – A summary of concluding thoughts from the publication as a whole and highlights of important future developments.
- Additional Resources and References – A collection of organizations, publications and internet resources, along with citations from this publication.
- The Case Studies – In-depth case studies of over 25 examples of demand-side programs underway across the country.

**Park-and-Ride Study.** By Kimley-Horn and Associates, Inc. for Martin Metropolitan Planning Organization. May 2007. Keywords: Survey, Background, Demand

This study identified areas of Martin County for potential implementation of park-and-ride lots based on an evaluation of the potential demand for these locations. Transportation planning analyses conducted for this purpose included: reviewing travel patterns from prior studies, and conducting a mail-back/internet survey to assist in evaluating the park-and-ride needs of the community.



**Park and Ride Options for Tompkins County.** By Fernando de Aragón for Ithaca-Tompkins County Transportation Council. August 5, 2004. Keywords: Review, Pros and Cons, Background

This paper presents the concept of park and ride as a component of the transportation system and describes how it can be used in Tompkins County, New York. The paper describes the advantages and disadvantages of park and ride lots. These are based mostly on the experience of other urban areas as described in a variety of professional and academic reports. The author presents his own ideas and opinions of how park and ride strategies could be adapted for Tompkins County. This is intended to serve as a starting point for discussion on the implementation of a Tompkins County park and ride program.

**Park N Ride Atkins.** Institute for Transport Studies, University of Leeds. Viewed September 27, 2011. Keywords: Impact

This is an excerpt from a larger document. This section presents case studies to demonstrate the empirical evidence of the use of park and ride programs as policy instruments. The section includes a summary of an Atkins report containing analysis of several sites in the United Kingdom. It also presents a re-evaluation by Parkhurst (2000) of park and ride case studies prepared by Atkins. The section also includes information on international park and ride programs.

**Park and Ride Program Resource Guide 2010.** Caltrans. 2010. Keywords: Guide, Right of Way, Planning, Design, Funding, Performance

This report is a resource guide on park and ride programs for Caltrans planners and engineers. The guide has eight chapters: How to Build a Park and Ride Lot; Mission, Goals, Values, and the Mobility Pyramid; Director's Policies and Deputy Directives; Park and Ride Division Guidelines; Park and Ride Related Laws and Legislation; Park and Ride Funding; Performance Analysis and Research; and Park and Ride Issues. The first chapter provides a rough outline of the requirements for building a park and ride facility. The second and third chapters provide support for park and ride activities approved by Caltrans. The fourth chapter identifies roles and responsibilities for individual divisions regarding the Park and Ride Program. The fifth chapter provides legal and legislative support for park and ride lots. The sixth chapter summarizes the potential funding sources available for park and ride improvements. The seventh chapter provides information regarding park and ride project analysis methods.

**Park and Ride Program Resource Guide 2009.** Caltrans. 2009. Keywords: Guide, Right of Way, Planning, Design, Funding, Performance

This is an earlier draft of the above document.

**Parking Policy for Transit-Oriented Development: Lessons for Cities, Transit Agencies, and Developers.** Willson, Richard. Journal of Public Transportation, Vol. 8, No. 5, 2005. Keywords: Parking Supply, Pricing, Right of Way

Parking policy is an important element of transit-oriented development (TOD). It shapes travel behavior, community design, and development economics. Parking policy can also improve the performance of both rail transit and TOD. This article is based on the study of residential TODs, office



TODs, and joint development of transit agency station parking in California. The research includes surveys of travel behavior, station area characteristics, parking supply, interviews with real estate developers, and studies of replacement parking issues at joint development sites. Research results show that TOD parking supply and pricing policy seldom are structured to support transit ridership goals. Policy recommendations for improving parking policy for TODs are offered to transit agencies, cities, and developers.

**Public Transit in California: Existing Conditions and Current Practices.** Curry, Melanie. Malinoff, Aaron. Shiu, Justin. California Department of Transportation Statewide Transit Strategic Plan Resource paper. Keywords: Background

This report provides an overview of current transit practices in California. A chapter on park and ride facilities provides some general background information for park and ride facilities in California.

**Advanced Parking Management Systems: A Cross-Cutting Study; Taking the Stress Out of Parking.** FHWA, Report No. FHWA-JPO-07-011, January 2007. [http://ntl.bts.gov/lib/jpodocs/repts\\_te/14318\\_files/14318.pdf](http://ntl.bts.gov/lib/jpodocs/repts_te/14318_files/14318.pdf). Keywords: Management, Advanced Parking Management Systems, Benefits

This study examines advanced parking management systems (APMSs) in three venues: airports, central business districts and transit park and ride locations. The systems examined in this study provide directional and space availability information to patrons as they proceed to the parking facility. Among the case studies included in the report is an examination of the Chicago Metra park and ride. Specific benefits found in visits to sites with APMSs include reduced frustration, increased venue accessibility, increased facility occupancy and improved traffic flow.

**Park-and-Ride/Pool: Traveler Response to Transportation System Changes.** Turnbull, Katherine F. Pratt, Richard H. Evans, IV, John E. Et al. for the Federal Transit Administration in Cooperation with the Transit Development Corporation. 2004. Keywords: HOV, Pricing, Land Use

This paper is one chapter in larger volume. The chapter covers travel demand and related aspects of providing and supporting park-and-ride and park-and-pool facilities. Park-and-ride facilities and associated transit services along with park-and-pool facilities formalize and support the option of mixed-mode travel. They facilitate a number of mixed-mode combinations including, the use of a low-occupancy mode, most often driving alone, where travel densities are low and high-occupancy modes are inconvenient. It allows the transfer to a high-occupancy mode — rail transit, bus, vanpools, or carpools — where travel densities become higher and more supportive of high-occupancy mode efficiencies. Park-and-ride and park and-pool facilities range from multi-story parking garages with customer amenities to simple surface parking lots. They may vary in purpose from serving a major intermodal transportation center to simply facilitating carpools.

## Design/Physical Issues

**Park and Ride Planning and Design Guidelines.** Spillar, Robert J. Parsons Brinkerhoff Quade & Douglas, Inc. October 1997. Keywords: Planning, Development, Design, Architecture

This guide is divided into six primary chapters. Chapter 1 is an outline for the following chapters. Chapter 2 describes park-and-ride nomenclature to assist in the classification of facilities for planning



purposes. Chapter 3 describes a sound planning process that is fundamental to the development of a successful park-and-ride program. Chapter 4 discusses how a park-and-ride facility can in a manner that promotes safety, mobility, and efficiency. Chapter 5 discusses the range of design options that exist for individual park-and-ride facilities. Chapter 6 describes how art can be integrated into a park-and-ride facility through sound concepts of landscape and architectural design. In this way, the park-and-ride lot can become more than “just another parking facility.”

**Guide for Park and Ride Facilities.** Task Force on Public Transportation Facilities Design, Published by American Association of State Highway and Transportation Officials. October 2004. Keywords: Definition, Planning, Operations, Maintenance, Design, Signage, Guidance

AASHTO developed this report to provide planning and design guidelines for the development of park-and-ride facilities. The guide assimilates reliable methods for selecting optimum locations for park-and-ride facilities in terms of maximizing demand and promoting community integration. It also synthesizes design techniques used by a number of agencies with active park-and-ride programs. The result is a collection of design concepts that may be useful to planners, engineers, and policy makers in design efficient park and ride lots that are integrated into the community fabric.

**California Highway Design Manual, Chapters 630 and 900.** Caltrans, Division of Design. May 7, 2012. Keywords: Site Selection, Design, Pavement

The California Highway Design Manual (HDM) is prepared by the Caltrans Division of Design to establish uniform policies and procedures when carrying out State highway design functions. The latest revision to the HDM was made in May 7, 2012. As part of this revision, Caltrans added guidelines related to the design of park and ride facilities. Chapter 630 covers the application of flexible pavement. Section 636.4(2) provides guidelines for pavement layer thickness in park and ride facilities. The section notes that layer thicknesses can be minimal since flexible surfacing can be added later without much exposure to traffic. Chapter 900 deals with landscape architecture issues. Topic 905 provides standards and guidelines specific to park and ride facilities. The guidelines reference the AASHTO Publication “Guide for Park and Ride Facilities” (2004). They also provide brief site selection guidelines and key design features and facilities.

**Collier County Park & Ride Site Identification Study.** By Center for Urban Transportation Research College of Engineering, University of South Florida for Collier County. November 2005. Keywords: Site Selection, Planning

The Center for Urban Transportation Research (CUTR) at the University of South Florida (USF) was contracted to provide Collier County with a plan identifying sites suitable for development of informal and formal park-and-ride facilities. This report is separated into four sections. The first section identifies primary transportation corridors including major roads and the fixed-route public transit networks provided by Collier Area Transit (CAT) and Lee County Transit (LeeTran). In the second section, specific potential park-and-ride sites are identified. The third section looks more closely at site plan development and general “rule-of-thumb” costs. Finally, the fourth section describes and provides examples of interlocal agreements used for establishing park-and-ride facilities by other transit systems.

**Fort Worth Park – and – Ride Development Study.** Transportation Department North Central Texas Council of Governments. June 2008. Keywords: Site Selection, Model, Performance



This study documents a recommended system of future park-and-ride fixed facilities within or adjacent to the Fort Worth Transportation Authority's member city area. The study contains details on how each location performed in terms of bus ridership and parking utilization. Recommendations for proposed park-and-ride locations area also provided.

**Freeway Bus Station Area Development: Critical Evaluation and Design Guidelines.** Banerjee, Tridib. Bahl, Deepak. Rabbani, Shahab. Mamgain, Abhishek. Agarwal, Sukriti. Yu, Haiyan. School of Policy, Planning, and Development, University of Southern California for METRANS Transportation Center. July 1, 2005. Keywords: Design, User Perception.

Transit centers can serve as destinations that accommodate a diversity of uses and activities that promote transit ridership. Their location, quality of design, supporting amenities, and other development attributes can influence ridership. This project uses Harbor Transitway as a case study to assess the place-based qualities of freeway transit centers with respect to amenity mix, appearance, access, comfort, convenience, security, business development opportunities, and pedestrian and park-and-ride linkages. In addition, the researchers identify transit user needs and perceived gaps in services through surveys and interviews to develop broad performance measures of station area interface with the neighborhood and transit user needs.

The research suggests that Harbor Transitway station areas are not used efficiently or effectively. Some of the major problems cited by transit users include: irregularity in bus service, inconvenient bus transfers, insufficient public amenities, lack of public art, narrow sidewalks, unsafe crosswalks, high noise levels, poor station area maintenance, insufficient lighting, and perceptions of insecurity of waiting alone at the station. To increase transit ridership, the researchers make design recommendations and suggest strategies to improve the linkage between land use, transportation, and surrounding communities.

**Intermodal Facilities and Rest Areas.** Mass Highway. 2006 Edition. Keywords: Design, Site Selection

This chapter is from the Massachusetts Highway Design Manual. The chapter describes design considerations for Park & Ride/Transit Centers and Rest Areas/Tourist Information Centers. Park and Ride lots provide a collection point for travelers to transfer between the automobile mode and transit, or between the single occupant vehicle (SOV) and high occupancy vehicle modes. Other modes potentially supported by a Park and Ride facility include pedestrian, bicycle, paratransit, intercity bus transit, airport service, and intercity and commuter rail. In addition to the services offered at park-and-ride lots, transit centers tend to offer a higher degree of travel services, route choices, and mode choices.

**Statewide Transit-Oriented Development (TOD) Study Factors for Success in California Special Report Parking and TOD: Challenges and Opportunities.** By Parsons Brinckerhoff for California Department of Transportation. February 2002. Keywords: Design, Site Selection, Planning

This is a special report intended to provide information to local jurisdictions, transit agencies, developers, financial institutions, and others as they develop and implement parking standards and programs for transit-oriented developments (TODs) in California. It provides an overview of available information on the extent to which parking for various types of land uses may be reduced in the vicinity



of major transit stations. It is one of a series of reports produced for the California Department of Transportation, Division of Mass Transportation's Statewide Transit-Oriented Development Study. This report is not intended to be an exhaustive source of information on TOD parking issues.

**Study of Park-and-Ride Facilities and Their Use in the San Francisco Bay Area of California.** Shirgaokar, Manish. Deakin, Elizabeth. Transportation Research Record: Journal of the Transportation Research Board, Volume 1927 / 2005: 46-54. Keywords: Planning, Survey

Park-and-ride lots are important support facilities for transit and ridesharing in the San Francisco Bay Area of California. The authors designed and carried out the region's first large-scale, detailed study of park-and-ride facilities and users. Three Bay Area Rapid Transit (rail) station parking lots were also surveyed. The user survey results showed that almost all the parking users were commuters; at the freeway lots, half were transit users and the remainder were organized and casual carpoolers. Most drove alone to the park-and-ride lot and made long trips to work, many more than 30 mi one way. Users had concerns about lot security, the lack of lighting, and the quality of transit services offered. Analysis of focus group data determined that schedule adherence rather than frequency was the cause of most concerns. Participants expressed a willingness to pay for parking that was fenced, security patrolled, and lighted, with shelters for waiting. Together, the surveys and focus groups have provided insights into ways to improve the park-and-ride lots and the services offered there, as well as on how travelers view transit and carpooling options. The results provide a sound basis for planning improvements.

**Facility Location Methodology for Optimal Placement of Park-and-Ride Facilities,** Jhael Isa, Satish V. Ukkusuri, Kien Doan, Wilfredo Fernando Yushimito, TRB 89th Annual Meeting Compendium of Papers DVD, Paper #10-3301, 2010. Citation at <http://tris.trb.org/view.aspx?id=911000>  
Keywords: Location, Site Selection

The authors describe a methodology for locating park and ride facilities that takes qualitative measures that affect the accessibility and connectivity of park and ride facilities and compiles them into quantitative analytical techniques. Measures of effectiveness were created to account for effects of emissions, congestion, connectivity, accessibility and demand. The results demonstrate the interrelationship between different objectives to obtain an optimal set of park and ride sites. The model applied to the New York City area to illustrate results in a complex urban environment that could be replicated in other cities.

**Concept of Operations for the I-15 Corridor in San Diego, California,** U.S. DOT RITA, Report No. FHWAJPO-08-009, March 31, 2008. [http://ntl.bts.gov/lib/30000/30300/30311/14395\\_files/14395.pdf](http://ntl.bts.gov/lib/30000/30300/30311/14395_files/14395.pdf)  
Keywords: ICM, Integrated Corridor Management, Concept of Operations, Con Ops, I-15, San Diego, Freeway, Arterial, Transit, Intelligent Transportation Systems, ITS, HOT, Managed Lanes, 511, ATIS

This project is one of three Concept of Operations (ConOps) developed in connection with the U.S. DOT's Integrated Corridor Management (ICM) Initiative. This document provides an overview of the San Diego region's ICM System (ICMS) concept to be deployed along the I-15 corridor and including the cities of San Diego, Poway and Escondido. It describes current operations in the corridor, explains how they will function in the near term once the ICMS concept is operational, and identifies current and future responsibilities of San Diego regional stakeholders.



Page 95 of the document provides the vision statement for the I-15 ICMS transportation corridor: “To facilitate HOV use, travelers will be able to use Park and Ride facilities equipped with smart parking technologies at BRT stations along the corridor, and buses will have efficient access from the BRT stations to the Managed Lanes through DARs. The Managed Lanes, while also promoting HOV use, will serve multiple modes of transportation and operate as limited-access lanes in which carpools, vanpools, and buses have first priority and travel free of charge. Single occupancy vehicles will be able to legally use these lanes by paying a fee and physically gain access to them from general purpose lanes through ingress-egress points. The Managed Lanes will maintain free-flow conditions, and the volume of traffic will be controlled by regulating the toll fee through dynamic variable pricing.”

**Concept of Operations for the I-394 Corridor in Minneapolis, Minnesota**, U.S. DOT RITA, Report No. FHWAJPO-08-006, March 31, 2008. [http://ntl.bts.gov/lib/30000/30300/30310/14392\\_files/14392.pdf](http://ntl.bts.gov/lib/30000/30300/30310/14392_files/14392.pdf)  
Keywords: Design

This is the Concept of Operations (ConOps) for the I-394 Corridor that serves the residents of Hennepin County, MN. This corridor is served by a combination of three interrelated networks—a freeway network, a series of arterial highways and a transit system operated by three transit agencies. The document discusses the design of park-and-ride facilities in Minnesota.

**Highway Design Manual, Chapter 24—Mobility Measures, Revision 32**, New York State Department of Transportation, May 4, 1998.  
[https://www.nysdot.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt\\_24.pdf](https://www.nysdot.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_24.pdf)  
Keywords: Design, Signage

This is an excerpt from the New York State Department of Transportation Highway Design Manual. Page 73 of the excerpt (Section 24.3, Commuter Transfer Facilities), addresses site selection; interior lot layout; pavement and shoulders; drainage and snow removal; signing and pavement markings; lighting; furnishings; landscape development; security; and maintenance and operation. Shared-use and park-and-pool lots are also addressed.

**Roadway Design Manual, Chapter 7, Miscellaneous Design Elements; Section 4: Parking**, Texas Department of Transportation, March 2010. See page 225 of the PDF at <http://onlinemanuals.txdot.gov/txdotmanuals/rdw/rdw.pdf>. Keywords: Design

This is a section of the Texas Roadway Design Manual. This section includes location criteria and design features for typical park and ride lots.

**Optimal Location of Park and Ride Facility**, Xiaoning Zhang, Haijun Huang, International Conference on Transportation Engineering 2007: 2753-2758. Citation at <http://cedb.asce.org/cgi/WWWdisplay.cgi?157981> Keywords: Location, Site Selection, Traffic Patterns

This paper investigates the optimal location of a park-and-ride facility in a traffic corridor with a transit line and a freeway that connects a city center and a suburban area. With a fixed-point iterative calculating method, the researchers are able to determine the traffic pattern in equilibrium and cutting points of mode selection simultaneously. The optimal location of the park-and-ride facility is chosen by minimizing the system travel expense.



**Evaluation of Transit Applications of Advanced Parking Management Systems—Final Evaluation Report**, U.S. DOT Research and Innovative Technology Administration (RITA), Report No. FHWA-JPO-08-052, May 9, 2008. <http://ntl.bts.gov/lib/30000/30500/30588/14432.pdf>. Keywords: Evaluation, Transit, Intelligent Transportation Systems, ITS, Parking Management Systems, Real-Time Traveler Information, Evaluation, Customer Satisfaction

This study provides an evaluation of advance parking information systems applied to transit systems in Chicago and suburban Washington, DC. The study documents quantified system impacts in terms of parking utilization, transit ridership and mode choice, traffic circulation within and between transit park and ride lots, and customer satisfaction. It also includes a review of institutional issues that includes organizational and institutional challenges encountered by the project stakeholders throughout the course of deployment and operation of the systems. Researchers conducted passenger surveys of transit riders and staff interviews, and gathered data on transit ridership and archived system data on in and out counts at the lots. Study results indicate that it is unclear whether the parking management systems increased parking utilization or transit ridership, or whether they reduced circulation within and between park and ride lots.

**Parking for Transit-Oriented Development**, Jeffrey Tumlin, Adam Millard-Ball, 2006 ITE Annual Meeting and Exhibit Compendium of Technical Papers, 2006. Citation at <http://tris.trb.org/view.aspx?id=793228> Keywords: Design, Highways, Planning and Forecasting, Public Transportation, Terminals and Facilities

This paper describes how Transit Oriented Development (TOD) requires a different parking approach than conventional development. Investing in TOD rather than in subsidized park-and-ride lots may produce higher ridership and higher revenue for transit agencies. TOD projects have inherently lower parking demand than conventional development, so municipalities should adjust their parking requirements to take advantage of more transit accessible locations. This paper offers case studies of transit agencies and municipalities that have taken innovative approaches to parking at TODs and examines how these strategies have helped achieve local economic development, transit ridership and quality of life goals.

## Funding Information

**Evaluation of Shared Use Park & Ride Impact on Properties**. Wambalaba, Francis. Goodwill, Julie. National Center for Transit Research at the Center for Urban Transportation Research, University of South Florida. April, 2004. Keywords: Benefits, Analysis, Survey, Use, Retail Impacts

The purpose of this study is to document the economic benefit of shared use park and ride facilities located at retail centers in Florida. Transit agencies usually perceive shared use park and ride as mutually beneficial to both the transit agency through savings in land and development costs and to park and ride providers through an increase in customer base and sales. In contrast, park and ride providers may hold negative perceptions about shared-use park and ride and feel that allowing a shared-use park and ride on their property will bring problems such as increased liability, vandalism, and litter, as well as occupy spaces that might have been used by potential shoppers. The study documents whether the presence of a “Shared Use Park & Ride” has influence on shopping behavior patterns, whether it generates revenues for park and ride providers, and whether it generates ridership for transit



service providers. The study finds that shared-use park and ride facilities have positive benefits for both the transit agency and retail shopping centers.

**Evaluation of Shared Use Park and Ride Impact on Properties -Summary.** Francis Wambalaba, Ph.D., of the Center for Urban Transportation, Research at the University of South Florida. April 2004. Keywords: Benefits, Analysis, Survey, Use, Retail Impacts

This document provides a summary of the findings from the above study and report.

**Sacramento Regional Transit District Five Year Capital Improvement Plan FY 2010 – FY 2014.**  
Keywords: Projects

The Five Year Capital Improvement Plan (CIP) represents the culmination of the Sacramento Regional Transit District’s efforts to plan and prioritize capital activities from FY 2010 to FY 2014 and beyond. The projects in the CIP are consistent with RT’s adopted Vision, Strategic Plan, and with the region’s currently approved Metropolitan Transportation Plan. The plan places an emphasis on ensuring safety, regulatory compliance, a “state of good repair” for the District’s current assets; completing transit expansion projects identified in Measure A Renewal; and providing for modest system enhancement/improvement projects – particularly projects that significantly enhance customer service or provide opportunities for greater system efficiency/revenue generation. In addition, this document provides early information for proposed projects beyond the five-year window. Some of the projects in this document are in relation to park-and-ride facilities.

## Cost-Benefit Analysis

**Parking Planning and Costs.** For Southern California Association of Governments by Walker Parking Consultants. September 27, 2011. Keywords: Costs, Benefits, Financial, Overview

This is a PowerPoint presentation that provides an overview for planning and costs associated with parking.

**Cost Effectiveness of Park-and-Ride Lots in the Puget Sound Area.** For Washington DOT by Wellander, Chris A., Washington State Transportation Center University of Washington, Washington State Department of Transportation – Joe Bell. October 1986. Keywords: Costs, Cost-Benefit

This report provides the results of a cost effectiveness evaluation and a cost-benefit analysis on park-and-ride system in the Seattle metropolitan area. Costs and benefits of the system were examined with respect to the user, the community at large, and the public agencies responsible for providing for the community’s transportation needs. A user survey was conducted at all 26 lots. Using the survey data, a model was developed to calculate the total incurred trip costs of both the park-and-ride trip and a corresponding trip not involving the park-and-ride lot. These trip costs were compared in a “before” and “after” analysis. In addition, the park-and-ride system was analyzed for its effect on the following transportation system measures of effectiveness: travel time, person-miles traveled (PMT), vehicle-miles traveled (VMT), traffic volumes, vehicle emissions, accidents, and energy consumption.

General results indicated that the park-and-ride system in the Seattle area is cost effective. The average park-and-ride trip was estimated to be 11.6 percent less expensive than the corresponding average



previous trip by another mode. Results also indicated that the lots have a slightly negative impact on travel time and PMT (i.e., these measures have increased), but VMT, traffic volumes, accidents, vehicle emissions, and energy consumption have all been reduced.

**Park & Ride Strategy.** SEStran South east of Scotland Transport Partnership. Keywords: Economic Impact, Cost-Benefit, Site Selection

This report describes the development of a park and ride strategy for South East Scotland (i.e., the Edinburgh metropolitan area) by the regional planning agency. While preparing the park and ride strategy, SEStran developed a spreadsheet-based benefit-cost model to estimate the benefits of particular park and ride lots. The model compares use of the park and ride lot with drive only and transit only alternatives. The model also considers benefits from the perspective of users, society, and the transit agency.

**Guide to Calculating Mobility Management Benefits.** Litman, Todd. Victoria Transport Policy Institute. March 11, 2011. Keywords: Cost, Savings

Mobility Management (also called Transportation Demand Management or TDM) consists of various policies and programs that change travel behavior in order to increase transport system efficiency. It includes strategies that improved travel options, incentives to use the most efficient option for each trip, and more accessible land use patterns. Mobility management can provide various economic, social and environmental benefits. Conventional transportation evaluation practices tend to overlook and undervalue many of these benefits. More comprehensive analysis tends to support more mobility management implementation, and can help optimize mobility management policies and programs. This guide provides guidance for comprehensive mobility management evaluation. Examples illustrate how such analysis can be applied in particular situations.

**The Cost of Driving and the Savings from Reduced Vehicle Use.** TDM Encyclopedia Victoria Transport Policy Institute. May 9, 2010. Keywords: Cost-Benefit

The Victoria Transportation Policy Institute provides an online encyclopedia of Transportation Demand Management (TDM) strategies and their benefits. This section discusses the costs associated with vehicle usage, including parking costs.

**Park and Ride: Convenient Parking For Transit Users.** TDM Encyclopedia Victoria Transport Policy Institute. January 26, 2010. Keywords: Cost-Benefit, Impact

This is another section of the Victoria Transportation Policy Institute provides an online encyclopedia of Transportation Demand Management (TDM) strategies and their benefits. This section describes the characteristics and benefits of park and ride lots. According to the encyclopedia, park and ride consists of parking facilities at transit stations, bus stops and highway onramps, particularly at the urban fringe, to facilitate transit and rideshare use. Some park and ride lots also include bicycle parking. Parking is generally free or relatively cheaper than in urban centers.



**Transit and Congestion Pricing: A Primer**, FHWA, Report No. FHWA-HOP-09-015, April 2009. <http://www.ops.fhwa.dot.gov/publications/fhwahop09015/fhwahop09015.pdf>. Keywords: Congestion Pricing

This report reviews the potential impacts that congestion pricing may have on public transit. Key lessons learned from United States and international experiences with congestion pricing include this from page 21 of the report: “Insufficient development of park-and-ride facilities has greatly limited transit’s involvement in the domestic pricing deployments. If mode shift is a project goal, properly sited parking must be developed to accommodate increased transit demand.”

**Locating and Pricing Park-and-Ride Facilities in a Linear Monocentric City with Deterministic Mode Choice**, Judith Y. T. Wang, Hai Yang, Robin Lindsey, Transportation Research Part B: Methodological, Vol. 38, No. 8, September 2004: 709-731. Citation at <http://tris.trb.org/view.aspx?id=704714> Keywords: Design, Economics, Planning and Forecasting, Public Transportation, Railroads, Terminals and Facilities, Economic Analysis, Location, Mode Choice, Optimization, Travel Demand

This paper investigates the optimal location and pricing of a park and ride facility in a linear city with a highway and rail line that can be accessed at all points along the travel corridor, with all trips directed to the city center. In the paper’s conclusion, the authors note that use of a model similar to the one in the study found that a single cordon toll can be an effective tool for congestion pricing, suggesting that park and ride facilities may lose much of their value if congestion pricing eventually becomes widespread. The authors acknowledge that most cities will not apply such pricing in the near future, and park and ride facilities remain a “fertile topic for research.”

## Other Areas

**Houston Managed Lanes Case Study: The Evolution of the Houston HOV System**. Turnbull, Katherine F. Texas Transportation Institute The Texas A&M University System College Station, Texas for FHWA.

This study describes the development, operation, and use of the High Occupancy Vehicle (HOV) system in the Houston area and its evolution toward managed lanes. The institutional arrangements and the factors influencing the development of the system are also summarized. A good deal of information is available in other documents on the use of the Houston HOV lanes. This report provides an overview of the development and use of the HOV system and the institutional arrangements that have helped foster the evolution of the system. The report also describes issues typically associated with HOV facilities and managed lanes to assist transportation professionals interested in considering HOV and managed lanes.

**OCTA Go Local Program - Park and Ride Metrolink Shuttle**. By The Solis Group, Patti Post & Associates for City of Lake Forest/City of Laguna Hills. June 23, 2008. Keywords: Analysis, Survey, Route Planning

The report describes the results of a transit needs assessment study conducted as part of the Orange County Transportation Authority (OCTA) Go Local program. The report examines a proposed shuttle service from two park and ride lots to the Irvine Metrolink station. The study included an identification of existing transit services and facilities available to local residents and businesses. It also involved conducting public outreach with residents, commuters, and business with respect to transit demand, as



well as soliciting input from stakeholder groups including major Homeowners Associations and the Chamber of Commerce. The recommended shuttle service is intended to improve the use of transit to access Metrolink stations.

**Metro Orange Line Mode Shift Study and Greenhouse Gas Emissions Analysis.** By ICF International, Fehr and Peers for Los Angeles County Metropolitan Transportation Authority. June 2011. Keywords: Bicycle, Emissions

This study examines the mode shift and greenhouse gas impacts of constructing the proposed Metro Orange Line as an integrated transportation system that includes transit, bicycle and pedestrian models. This report provides information on bicycle usage and park and ride trip distances. The report includes counts focused on bicycles and pedestrians on the bike path, counts of bicyclists on the busway and a survey that focused on bicyclists and park-and-ride drivers. The count and survey methodology was designed to develop preliminary estimates of the potential mode shift, VMT, and GHG emissions reduction benefits attributable to Metro Orange Line bicycle facilities by documenting and describing the travel behavior of system users. These bicycle facilities include the Metro Orange Line Bike Path, station bicycle storage, and bike racks on the Metro Orange Line bus.

**Park and Ride: Lessons from the UK Experience,** Stuart Daniel Meek, Stephen Ison, Marcus Paul Enoch, TRB 87th Annual Meeting Compendium of Papers DVD, Paper #08-0730, 2008. Citation at <http://tris.trb.org/view.aspx?id=847642>. Keywords: Administration and Management, Economics, Planning and Forecasting, Policy, Public Transportation

This report summarizes 40 years of experience with park and ride facilities in the United Kingdom. Park and ride lots were initially placed in medium-size historic centers experiencing traffic congestion and having limited opportunity for expanding infrastructure to the urban core. With encouragement from the national level, park and rides are applied in many more settings today. In this paper, the authors conclude that although park and ride facilities are popular among motorists, their presence has also attracted users of existing public transport services and has generated additional trips, resulting in a counterproductive effect. For park and rides to be successful, the authors recommend that they be implemented in tandem with other supply-side measures and used with rigorous restraint measures that discourage automobile use.

**Cellular Automaton Simulation of Vehicle Dynamics in Park-and-Ride Facilities,** Langston Lai, Amer S. Shalaby, TRB 86th Annual Meeting Compendium of Papers CD-ROM, Paper #07-1755, 2007. Citation at <http://tris.trb.org/view.aspx?id=801852>. Keywords: Planning, Impacts, Design

The authors note that while there are relatively few studies that address vehicle movements within park and ride facilities, a thorough understanding of vehicle dynamics could assist transportation planners in forecasting demand and making objective evaluations of alternative park and ride designs. In this study, researchers developed a microscopic park and ride simulation model using the cellular automata (CA) approach. The park and ride model simulates a variety of driver actions such as surveying the environment, making parking choice decisions, and steering and controlling vehicles. Researchers compare current lot design with a slightly modified design using the Kipling Station South lot in Toronto to illustrate how the model evaluates different design layouts. Using the model, a modified design proposed to address bottleneck problems at entrance gate areas was found to reduce average queuing time by 37 percent.



**Concepts for Coordinating Freeways and Transit in Multimodal Corridors**, Christopher Erin Ferrell, Michael Carroll, Herbert S. Levinson, TRB 89th Annual Meeting Compendium of Papers DVD, Paper #10-3618, 2010. Citation at <http://tris.trb.org/view.aspx?id=911183>. Keywords: Planning, Demand, Highways, Multimodal Transportation, Public transit, Transportation Corridors

This paper introduces two key concepts to clarify the relationship between the auto and transit modes of travel along corridors. The first is corridor orientation, which broadly covers the degree to which a corridor is designed or has developed to encourage travel patterns by either auto or transit. This includes consideration of the access conditions, provision for park and ride or kiss-and-ride, land use along the corridor, and the corridor's placement geographically in the region. The second concept is multimodal coordination, which is either complementary or supplementary:

- Complementary coordination occurs where the transit and a freeway facility sustain different travel markets, activity patterns and land uses within a defined corridor.
- Supplementary coordination occurs when the transit capacity provides additional support to the markets, activity patterns and land uses that are typically supported by the freeway.

Preliminary research for this project, which was funded under TCRP H-36, Reinventing the Interstate: A "New Paradigm" for Multimodal Transportation Facilities, suggests that the more complementary a freeway and transit corridor is, the more total patrons (freeway and transit) the corridor facilities will carry, while supplementary designed facilities carry fewer total passengers.

**Siting Park-and-Ride Facilities Using a Multi-objective Spatial Optimization Model**, Bilal Farhan, Alan T. Murray, Computers & Operations Research, Vol. 35, No. 2, February 2008: 445-456. Citation at doi:10.1016/j.cor.2006.03.009. Keywords: Planning, Site Selection, Location, Demand Estimation

This research focuses on three major modeling concerns that must be addressed when siting park and ride facilities: covering as much potential demand as possible, locating park and ride facilities as close as possible to major roadways, and siting these facilities in the context of an existing system. Existing models do not permit simultaneous analysis of these factors. This paper presents a model for integrating these considerations and applies the model for finding a compromise siting configuration for park and ride facilities in Columbus, OH, from many available alternatives. Application results show how the inherent trade-offs when siting park and ride facilities—for example, maximizing coverage of park and ride users and siting park and ride facilities as close as possible to major roadways—can be quantified and used in the siting analysis. The authors note that extensions of the model could address facility capacities, site costs, and regional spacing.

**Integrating Bicycling and Public Transport in North America**, John Pucher, Ralph Buehler, Journal of Public Transportation, Vol. 12, No. 3, 2009: 79-104. <http://www.nctr.usf.edu/jpt/pdf/JPT12-3Pucher.pdf>. Keywords: Bicycle, Public Transit

This article describes current approaches to integrating bicycling and public transit with case studies focused on bike-transit integration in six large American cities (San Francisco; Portland, OR; Minneapolis; Chicago; Washington, D.C.; and New York) and two Canadian cities (Vancouver and Toronto).



From the article's conclusion:

"Paradoxically, bike-and-ride can become problematic where it is most successful. Capacity problems are most likely to arise in cities with well-used public transport and high levels of cycling. That is why the European approach to bike-and-ride has favored the provision of ample, sheltered, secure bike parking at transit stops instead of accommodating bikes on transit vehicles. Similarly, in North American cities with overcrowding of rail vehicles during rush hours, the focus should probably be on providing improved bike parking at rail stations. Not only is more parking needed, but it should be of higher quality, with more sheltered and secure spaces. Major transit terminals should include multi-service bike stations, such as those in northern Europe. Similar to the concept of "complete streets," an appropriate goal of transit systems in North America should be to provide "complete stations," which fully accommodate the needs of cyclists."

**Smart Parking Management Field Test: A Bay Area Rapid Transit (BART) District Parking Demonstration; Final Report**, Caroline J. Rodier, Susan A. Shaheen, Charlene Kemmerer, California PATH Program, Institute of Transportation Studies, University of California, Berkeley, Report No. UCD-ITS-RR-08-32, June 2008. PDF available for download at [http://pubs.its.ucdavis.edu/publication\\_detail.php?id=1237](http://pubs.its.ucdavis.edu/publication_detail.php?id=1237). Keywords: Parking Management, Travel Behavior, Intelligent Transportation Systems

This report presents an evaluation of the first transit-based smart parking project in the United States at the San Francisco BART district station in Oakland, CA. The authors broadly define "smart parking" as the use of advanced technologies to help motorists locate, reserve and pay for parking. Launched in December 2004, the project used a survey to identify participants' demographic attributes, response to the service and changes in travel patterns. Since the 2004 project launch, two other transit-based smart parking systems have been implemented at Metro stations in Montgomery County, MD, and at three Metro stations in Chicago. Analysis of the user response indicated:

- Most respondents used smart parking to travel to their on-site work location one to three days per month.
- Most respondents used the advanced reservation service via phone or Internet to access the smart parking system.
- Thirty-seven percent of respondents had seen one or more of the changeable message signs with smart parking information, but only 32 percent of those used this information to decide whether to continue driving or take BART instead.

In terms of changes in travel patterns, survey results indicated:

- Increases in BART modal share and reductions in drive-alone mode share.
- Reductions in carpooling and bus modes.
- Increased driving to the BART station.
- Decreased average commute time.
- Reduction in total vehicle miles traveled.



Researchers also noted that the majority of participants continued to use the service when fees were implemented, and commented that the revenues obtained from the smart parking system may provide the funds needed to expand BART station parking facilities and allow for further ridership expansion.

**A GIS-Based Approach for Delineating Market Areas for Park and Ride Facilities**, Bilal Farhan, Alan T. Murray, *Transactions in GIS*, Vol. 9, No. 2, 2005: 91-108. <http://cura.osu.edu/research/publications/data/farhan-murray2005.pdf>. Keywords: Planning, Site Selection, Demand Estimation

Current approaches for identifying park and ride market areas fall into three broad categories: methods that assume a geometric shape for the market area, methods based on travel cost comparison between travel modes and methods identifying current or past users. This paper develops an alternative to these methods—a GIS-based approach for delineating market areas for park and ride facilities. The new approach simultaneously accounts for park and ride facility accessibility and user travel direction. A visual comparison among the market areas proposed by the model showed that the accessibility and travel direction approach is more realistic than other approaches used to identify market area.

**Park and Ride: Characteristics and Demand Forecasting**, Land Transport New Zealand, Research Report 328, September 2007. <http://www.nzta.govt.nz/resources/research/reports/328/docs/328.pdf>. Keywords: Demand Estimation

This report examines the characteristics of park and ride usage and suggests demand modeling methodologies based on these characteristics for changes in demand at existing sites, and estimation of demand at new sites. It reviews New Zealand and international evidence on the nature of park and ride usage and the factors that influence it. The report then examines potential park and ride modeling methodologies and identifies the most appropriate models for New Zealand.

**Modeling Effect of Travel Time Uncertainty and Traffic Information on Use of Park-and-Ride Facilities**, Ilona Bos, Dick Ettema, Eric Molin, *Transportation Research Record*, Vol. 1898, 2004: 37-44. Citation at <http://dx.doi.org/10.3141/1898-05>. Keywords: Modeling, Demand Estimation

The authors present an approach to determine the effect of travel time uncertainty and traffic information on mode choice in general and on the potential patronage of park and ride facilities in particular. Simulations using a park and ride facility in the Netherlands suggest that providing travelers with travel time information increases the patronage of park and ride facilities. The authors conclude that this is because automobile use is avoided during heavy congestion. However, the effect of providing information is limited when compared with other factors, such as the quality of the park and ride option in terms of travel time, facilities, and costs.

**Technical Solutions to Overcrowded Park and Ride Facilities**, New Jersey Department of Transportation, FHWA, Report No. FHWA-NJ-2007-011, May 2007. <http://www.nj.gov/transportation/refdata/research/reports/FHWA-NJ-2007-011.pdf>. Keywords: Intelligent Transportation Systems, Parking Information, Parking Monitoring, Parking Reservation

The goals of this project were to improve the operation and efficiency of the New Jersey park and ride system and identify potential technological solutions that could address the issue of anticipated demand for park and ride parking. Results include:



- A summary of parking monitoring and guidance systems and recommendations that include a cost analysis of three technologies used in a typical parking installation—magnetometer, video image processing and inductive loop detectors.
- A prototype parking information and reservation system through the web and cell phone that includes a parking reservation algorithm and solution methodology, a web-based parking reservation system and a cell phone-based parking reservation and information system. The establishment of a web- and cell phone based parking information and reservation system is recommended as the main technology to efficiently allocate the parking spaces from overcrowded to underutilized park and ride facilities.
- A prototype park and ride intermodal transportation planning model that, if fully developed and calibrated, has the capability to analyze travel patterns in an intermodal network that includes park and ride facilities. The model estimates changes in the network travel patterns that result from different information provided to travelers, alternative pricing and operating policies, changes in transit and park and ride systems, and future increases in travel demand. Potential uses of the model include measuring the effect of changing the location of park and ride facilities and evaluating the potential consolidation of multiple park and ride facilities within a geographical area to one facility.



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## Appendix B: Stakeholder Surveys

This appendix provides detailed findings from interviews that the consulting team conducted with park and ride program coordinators, park and ride lot managers, and rideshare providers within the Southern California Region as well as representatives from Caltrans Headquarters. The materials and stakeholder responses are organized into the following primary topics:

- Data and Analysis
- General Issues
- Lot Utilization
- Intermodal Strategies
- Operations and Maintenance
- Security
- Outreach
- Benefit/Cost Tool
- Other.

Prior to conducting the interviews, the consulting team developed a brief questionnaire that covered a number of topics related to planning, operating, and maintaining park and ride lots. Before each interview, the team sent a stakeholder a copy of the questionnaire. The interviews were conducted over the phone, but several stakeholders chose to provide written answers to the questionnaire as well.

In general, the consulting team found that stakeholders' primary concerns were related to security, funding, maintenance, and adequate capacity for park and ride lots. Stakeholders were able to provide information from recent park and ride utilization studies, park and ride cost data, as well as details on contracts for leased park and ride lots. Stakeholders also expressed interest in a cost-benefit tool developed as part of this study, but they also emphasized that a demand estimation tool would help them prepare plans for new park and ride facilities.

### Data and Analysis

As part of the interviews, the consulting team asked stakeholders to provide data on park and ride construction and maintenance costs. Stakeholders were also asked about benefit-cost analysis recently conducted and current plans to improve or develop new park and ride lots. With regard to maintenance costs, the consulting team found that Caltrans resurfaces park and ride lots as part of maintenance when funds are available rather than on a set schedule. While specific maintenance resurfacing costs are not available, general annual maintenance costs per parking space was estimated to be approximately \$55 based on older maintenance data. Stakeholders did not know of any benefit-cost analyses conducted for park and ride lots in Southern California. The Caltrans Bus Pool Project was



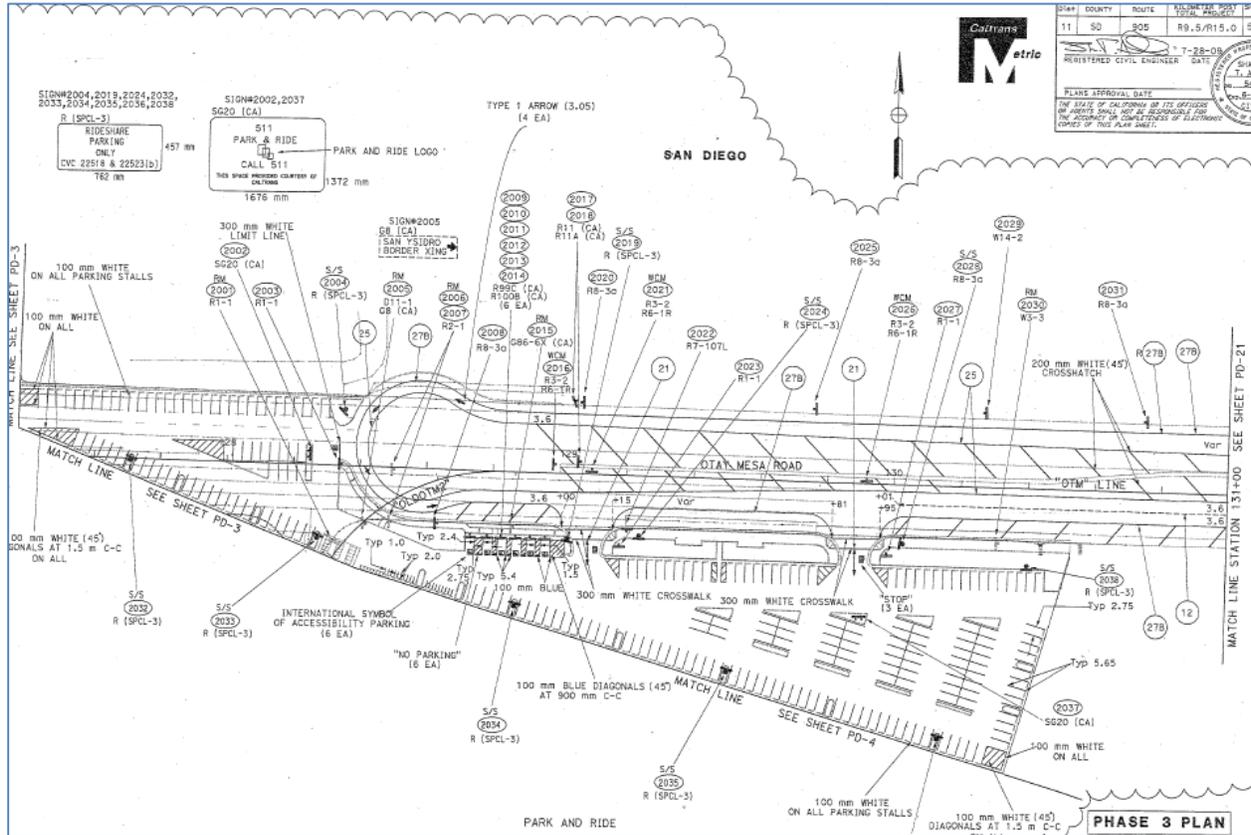
cited as an analysis that rates park and ride lots into priority categories that could help Caltrans determine which lots should be improved first to receive the greatest benefit to the system. A Draft BCA document prepared by Barbara Gossett in 2009 provided guidance to determine a parcel's potential as a park and ride lot, quantify the economic benefits, and quantify the non-economic benefits of a potential park and ride lot.

LACMTA has information on construction costs in its parking 2012 Parking Utilization and Site Assessment: Metro Rail, Orange Line, and Silver Line Stations study. According to this June 2012 study, costs vary from the least expensive surface lots to the most expensive subterranean structures. While surface lot costs are estimated at \$4,000 per space (not including land costs), "barebones" structured costs are \$15,000 plus per space in addition to land cost or other costs such as retaining walls. Subterranean "barebones" spaces escalate the cost to \$30,000 per space on the first level and to \$55,000 per space by the third subterranean level.

Caltrans District 12 provided cost data for three Park and Ride projects involving lot resurfacing and striping that ranged from \$60 per space at the Good Shepherd lot, to \$380 per space at the Irvine Light of Christ lot, to \$4,000 per space at the Lincoln Avenue lot. District 12 also shared construction costs for a proposed new Lincoln Park and Ride Lot on northbound SR-55 at Lincoln and Nohl Ranch Road that a total project cost of \$1 to \$2.5 million for 100 spaces. This cost reflects Caltrans owned excess land that has already been graded and includes improvements to adjacent streets and other park and ride components such as bike racks, striping, signage, etc. A proposed project to expand on the Camarillo Station Park and Ride lot servicing Amtrak, Metrolink, and Ventura Intercity Service Transit Authority buses showed a project cost of almost \$6 million for 200 spaces. In general, construction costs for a surface park and ride lot, including land costs, averages around \$10,000 per space.

Exhibit B1 shows a sample park and ride lot project that is slated for completion in early 2013 plan as part of the SR-905 project in San Diego. This surface lot is designed for 240 parking spaces with a total cost of approximately \$465,000.

Exhibit B1: SR-905 Park & Ride Plan



The consulting team inquired about leased park and ride lots. While some Caltrans districts lease park and ride lots, District 11 San Diego does not. The district has shared-use agreements with some churches and commercial centers that do not charge the State any money. In contrast, RCTC leases all of its park and ride spaces. Contracts are renewed every year or every other year. The leases vary between \$5 and \$15 per space per month for RCTC facilities depending on the park and ride location. Caltrans District 12 also leases park and ride spaces but did not provide leasing cost information.

The presence of parking structures can drive park and ride lot costs. Of Caltrans park and ride facilities, only the District 12 park and ride spaces leased in the South Coast Plaza are located inside a parking structure. However, Metrolink stations do have parking structures. RCTC has negotiated with Metrolink to allow park and ride customers to park on the surface and top level of structures in Riverside County if parking is available.

A number of park and ride lots are currently under development in Southern California. Caltrans is constructing a park and ride lot as part of the sbX Rapid Transit Project in the City of San Bernardino. The lot is located within a portion of the Kendall Drive Interchange near I-215. Completion is slated for 2014. OCTA also plans to expand the Goldenwest Transportation Center with additional parking spaces. This second project is currently in design. Caltrans District 12 has a Project Initiation Document (PID)



prepared for the proposed new Lincoln park and ride lot at Lincoln and Nohl Ranch Road along with a minor program maintenance project to resurface and add five spaces to the existing Lincoln lot. While the City of Temecula has plans to build a future park and ride lot, it is currently looking for funding or public-private partnership opportunities.

## General Issues

The consulting team asked stakeholders to identify the most pressing issues and their thoughts or suggestions on addressing those issues. They were also asked to describe their involvement in the design of new lots or improvements. In addition, stakeholders provided information on park and ride demand by explaining any lot losses and identifying areas or subregions where locals have asked for park and ride lots.

Stakeholders cited three main concerns – security, maintenance and funding for maintenance, and demand exceeding capacity for park and ride lots. Due to limited resources, Caltrans District 7 is in the process of relinquishing park and ride lots to LACMTA. Caltrans District 8 would like to relinquish its facilities as well to a local jurisdiction or the County Transportation Commission. Currently, OCTA is exploring private partnerships and revenue generation at its lots to offset operating costs. Another funding idea, being considered by District 11, is to partner with local agencies to install solar panels on facilities to charge electric vehicles and sell electricity to power companies. The recently approved Caltrans Deputy Directive (DD)-104 mentions this solar panel concept.

The stakeholders provided several suggestions for addressing security issues. The most common are to add security guards or install fake CCTV cameras. A more unusual approach involves finding a mixed use. District 11 has agreements with three donation centers (i.e., AMVETS, Goodwill, and the Salvation Army) to operate collection sites at 14 park and ride lots. These donation centers operate between 8:30 a.m. and 6:00 p.m. District 12 also has agreement with a Goodwill donation center at one of its locations. The centers help provide light maintenance and some security by having a person on-site during those hours of operation. The constant presence of someone onsite is thought to provide a greater sense of security and encourage park and ride lot usage.

The stakeholders interviewed have not been involved in the design of new lots or improvements. However, they cited the American Association of State Highway and Transportation Officials (AASHTO) Park and Ride Guide and the 1980 Highway Design Manual guideline for park and ride lots as appropriate design guidelines to follow.

South Bay cities in District 11, including Chula Vista, National City, Spring Valley, and cities along SR-54 have requested additional park and ride facilities. North Orange County has requested for park and ride lots in District 12. For the RCTC region, additional facilities have been requested for Murrieta and West Corona areas. Currently, Caltrans (District 7 and District 8) has leasing agreements coming due for its



park and ride lots. Caltrans Districts 7 and 8 do not plan to renew these leases due to budget cutbacks. This will result in the loss of capacity in the region's park and ride system.

## Lot Utilization

The consulting team asked stakeholders about park and ride utilization rates. In general, the stakeholders perform utilization surveys every year or every other year. Stakeholders provided utilization data for Caltrans Districts 7, 8, 11, and 12 facilities as well as regional facilities operated by LACMTA and RCTC. Park and ride utilization varies from no usage to exceeding capacity, in some case vehicles parked in unmarked areas, depending on the location. Average utilization is around 60 percent. The various park and ride utilization study results are summarized below.

### District 7 Park & Ride Utilization Study (2011)

- Caltrans District 7 has 49 State-owned park and ride facilities with a total of 10,768 spaces.
- Utilization ranges from 2 percent to over 100 percent.
- Average utilization for the facilities is 58 percent.
- The most underutilized facility is the Rosecrans facility with 342 spaces and 2-percent utilization.
- The most utilized facility is at the Newhall-East Lot facility with 32 spaces with over 65 vehicles parked with the overflow parked in unmarked or non-designated areas.
- The facility with the most spaces (I-5 Termination facility with 1,630 spaces) has 100-percent utilization.
- Caltrans District 7 also leases 366 spaces with average utilization of 88 percent. Many of these leases are due to expire by the end of 2013.

### District 8 Park & Ride Utilization Study (2011)

- Caltrans District 8 has 25 park and ride facilities for a total of 4,397 spaces. These facilities are State owned or leased, County or City owned, or managed through joint use.
- Utilization ranges from 7 percent to over 100 percent.
- Average utilization for the facilities is 57 percent.
- The most underutilized facility is the I-210 and Beech Avenue facility with 150 spaces and 7-percent utilization.
- The most utilized facility is the US-395 at Joshua Street facility with 150 spaces and over 210 vehicles parked with the overflow parked in unmarked or non-designated areas.
- The facility with the most spaces (Montclair Transcenter with 1,700 spaces) has 40-percent utilization.
- Four leased facilities were not renewed and not counted in the 2011 study.



### District 11 Park & Ride Utilization Study (2011)

- Caltrans District 11 has 64 park and ride facilities for a total of 3,709 spaces. These facilities are State owned, privately owned, or County owned.
- Utilization ranges from 2 percent to over 100 percent.
- Average utilization for the facilities is 57 percent.
- The most underutilized facility is Park and Ride Lot #57 at Stoney Creek with 132 spaces and 2-percent utilization.
- The most utilized facility is Park and Ride Lot #7 at Sorrento Valley Road with 50 spaces and over 60 vehicles parked with the overflow parked in unmarked or non-designated areas.
- The facility with the most spaces (Park and Ride Lot #54 at Via Rho Parkway with 215 spaces) has 33-percent utilization.
- Fourteen of the park and ride lots have donation centers operated by Goodwill, AMVETS, or the Salvation Army.

### District 12 Park & Ride Utilization Study (2012)

- Caltrans District 12 has 11 park and ride facilities for a total of 817 spaces. These facilities are State owned or privately owned.
- Utilization ranges from 15 percent to over 100 percent.
- Average utilization for the facilities is 62 percent.
- The most underutilized facility is the Saddleback Valley Community Church facility in Lake Forest with 62 spaces and 15-percent utilization.
- The most utilized facility and also the facility with the most spaces is the Jeffrey Road facility with 225 spaces and 230 vehicles parked.

### LACMTA Parking Utilization and Site Assessment: Metro Rail, Orange Line and Silver Line Stations (June 2012)

- This report focuses on parking utilization at Metro rail stations as well as Orange and Silver Line facilities (approximately 20,000 spaces).
- Many of the parking lots along the Green Line and at the El Monte Transit Center are currently owned by Caltrans and maintained by Metro. These lots are expected to be transferred to Metro ownership in the near future.
- The most underutilized facility is the Imperial/Wilmington facility near the Blue Line with 63 spaces and no users.
- The most utilized facilities are near the Green Line at the Norwalk and Lakewood facilities with 1,605 spaces and 447 spaces respectively. Both locations have over 100-percent utilization rates.



Exhibit B2 shows a map of the LACMTA Metro Rail system for the Blue, Green, Red, Purple, and Gold Lines. There are 32 park and ride locations that serve the five metro rail lines with a total of over 13,000 parking spaces. Orange and Silver Lines are bus rapid transit lines served by 13 park and ride stations and a total of 6,700 spaces. Exhibit B3 shows a sample of the parking utilization for the Green Line park and ride facilities in 2007, 2008, and 2011. Parking utilization statistics are also available for the other Metro Rail, Silver, and Orange Lines.

Exhibit B2: Metro Rail Map

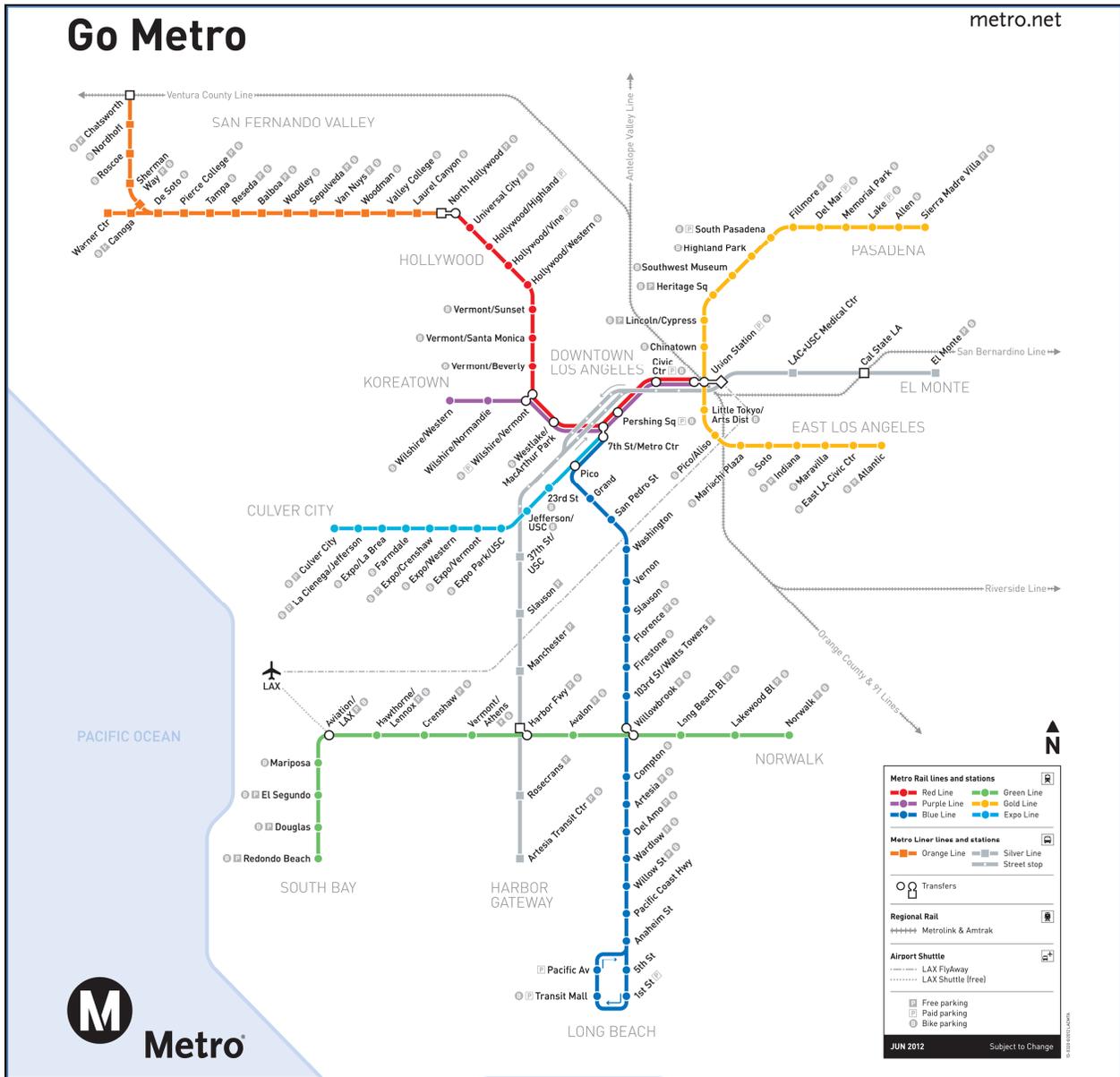


Exhibit B3: Sample Parking Utilization for Metro Green Line Park and Ride Facilities

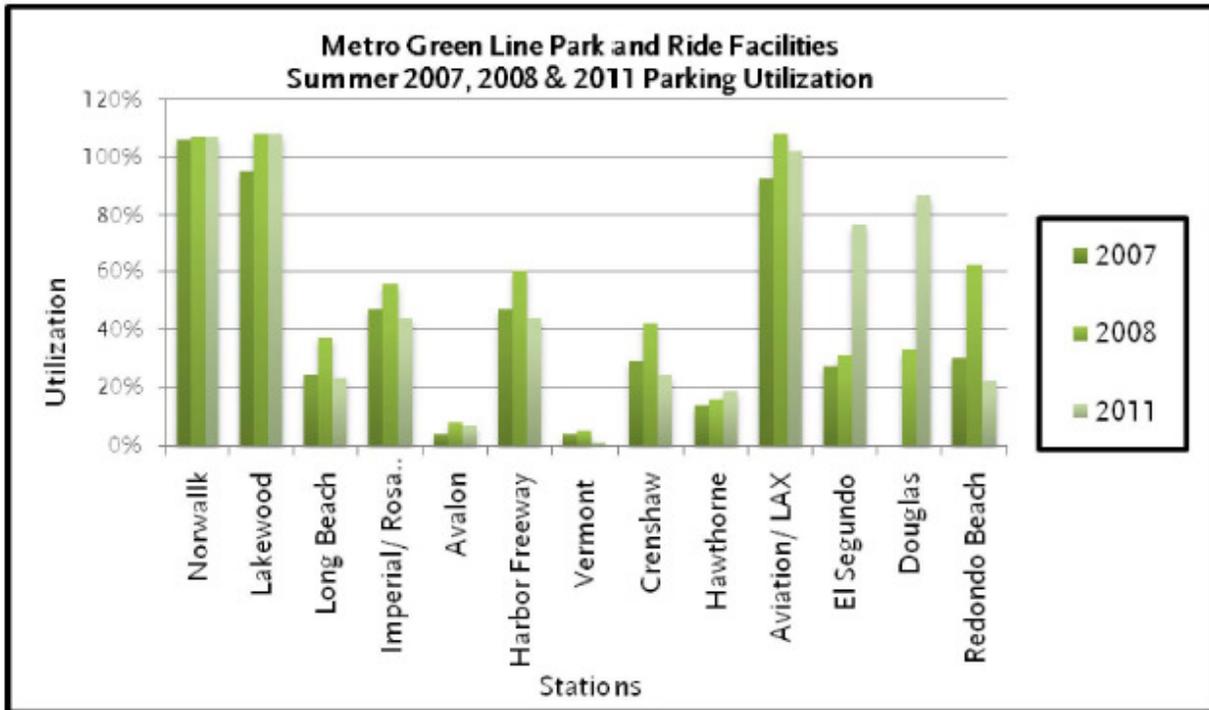
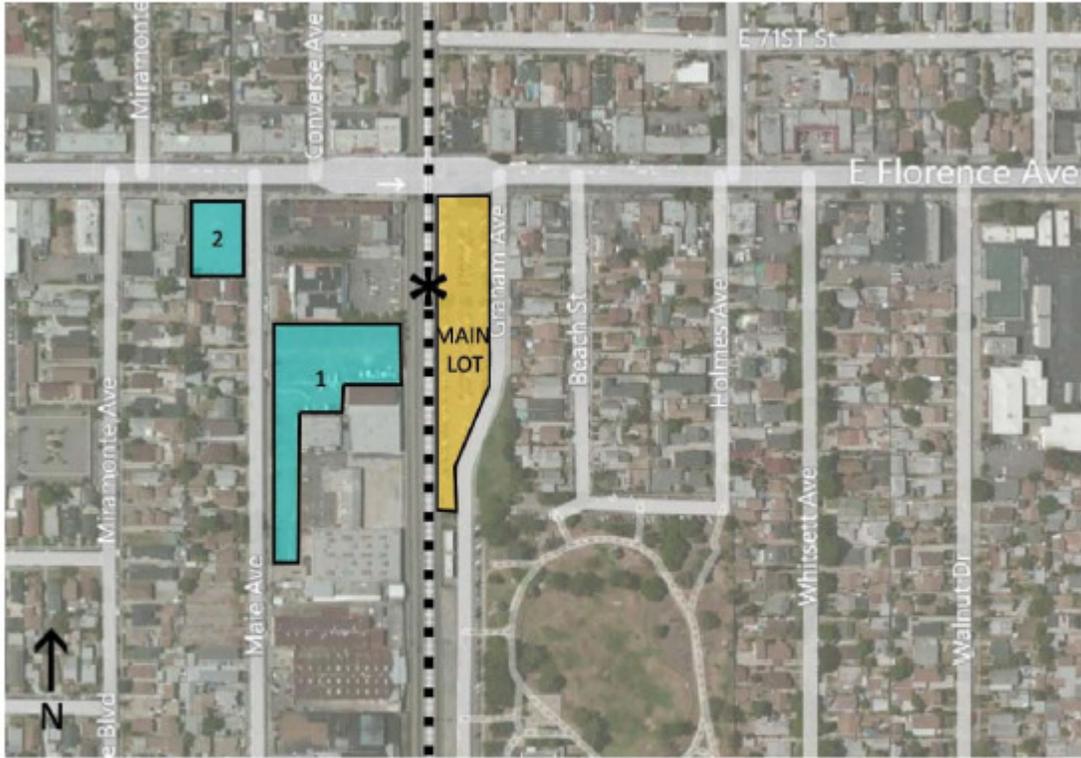


Exhibit B4 shows an example of the parking and site assessment for the Florence Station conducted as part of the utilization study. This location currently has a park and ride lot with 103 free parking spaces and 12 spaces converted to reserve paid parking spaces. However, utilization surveys from 2007 to 2011 shows that all free parking spaces were fully utilized and 50 percent of the reserved paid parking spaces were utilized. The study recommends several public parking facilities that can be considered for park and ride if demand calls for transit parking at this location. Parking and site assessments are also conducted for other metro stations that identify potential parking needs and options for park and ride locations.

**Exhibit B4: Sample Parking and Site Assessment at Florence Station**



Map 4-8

**LEGEND**

- \* = Florence Station
- = Park and Ride
- = Potential Parking Location
- ■ ■ ■ = Blue Line

For the 884 spaces at RCTC-operated park and ride lots, average utilization is approximately 80 percent. In response to consulting team questions, RCTC provided lease location and contract details for each of their park and ride lots. Exhibit B5 includes a complete list of these locations along with the cost per space, number of spaces, and contract periods.



**Exhibit B5: RCTC Park and Ride Contracts for FY 12/13**

Park and Ride Name & Location	Contract Details
Canyon Community Church of the Nazarene 1504 Taber Street Corona, CA 92881	#06-41-534-06 July 1, 2012 - June 30, 2013 \$5/space, 75 spaces \$4,500
Corona Friends Church 1220 W. Ontario Avenue Corona, CA 92882	#08-41-071-04 July 1, 2012 - June 30, 2013 \$7/space, 56 spaces \$4,704
Elsinore Naval and Military School 15891 Grand Avenue Lake Elsinore, CA 92530	#06-41-538-06 July 1, 2012 - June 30, 2013 \$10/space, 71 spaces \$8,520
Hope Lutheran Church 29141 Vallejo Avenue Temecula, CA 92592	#07-41-162-05 July 1, 2012 - June 30, 2013 \$6.50/space, 76 spaces \$5,928
Lake Elsinore Outlets 17600 Collier Avenue Lake Elsinore, CA 92530	#08-41-098-02 July 1, 2012 - June 30, 2014 \$15/space, 156 spaces \$56,160
Living Truth Christian Fellowship Church 1114 W. Ontario Avenue Corona, CA 92882	#08-41-040-03 July 1, 2011 - June 30, 2013 \$7/space, 70 spaces \$11,760
Mt. San Jacinto College 1499 N. State Street San Jacinto, CA 92583	#11-41-038-01 January 1, 2012 - June 30, 2013 \$8/space, 27 spaces \$3,888
Orchard Christian Fellowship 42101 Moraga Road Temecula, CA 92591	#08-41-088-04 January 1, 2012 - June 30, 2013 \$10/space, 65 spaces \$11,700
Revival Christian Fellowship 29220 Scott Road Menifee, CA 92584	#06-41-537-06 July 1, 2012- June 30, 2013 \$7/space, 50 spaces \$4,200
United Methodist Church 42690 Margarita Road Temecula, CA 92592	#05-41-935-09 July 1, 2012 - June 30, 2013 \$10/space, 71 spaces \$8,520

Stakeholders also detailed expansion plans. Caltrans District 11 plans to expand the park and ride lot on excess Caltrans right-of-way near the I-15 and SR-395 Interchange through a Congestion Mitigation and Air Quality (CMAQ) improvement grant. Caltrans District 12 plans to expand the existing Lincoln park



and ride lot by five additional spaces including resurfacing the entire lot and updating the lighting. OCTA plans to expand capacity at the Goldenwest Transportation Center. RCTC is also interested in increasing capacity at the Lake Elsinore location. LACMTA plans to add approximately 17,000 new spaces, 6,200 associated with the construction and completion of the Expo Line (Phases 1 and 2) and the Gold Line Foothill Extensions. Additional parking spaces (10,000 or more) are associated with America Fast Forward/Measure R efforts and other transportation projects throughout the region.

## Intermodal Strategies

The consulting team asked stakeholders about intermodal strategies at park and ride lots. Strategies discussed include improving the connectivity of parking with a transit/HOV facility and facilitating pedestrian or bicycle connections. Stakeholders also discussed the potential for transit agencies to modify or adjust their routes, schedules, or service to accommodate new park and ride facilities.

Stakeholders identified several lots that they thought had the best connectivity between parking and transit/HOV facility use:

- Green Line/Route 105 park and ride lots in Los Angeles County
- Jeffrey Road, Lincoln Avenue, and San Juan Capistrano lots in Orange County
- SR-91 Main Street lot in Corona in Riverside County
- I-15 lots in San Diego County.

These lots were singled out due to the availability of HOV facilities near the park and ride facilities. The stakeholders noted that lots not currently connected to transit may have a good potential to improve connectivity between parking use and transit/HOV facility use.

Stakeholders identified several potential improvements to get better usage of park and ride lots and neighboring transit services and HOV facility. For example, higher residential density and mixed-use developments along transit corridors can improve transit use. Security enhancements and maintenance may encourage greater lot usage, while developing a more robust outreach rideshare/ridematch tool could help encourage commuter usage. However, the provision of more transit and HOV facilities might make transit or vanpooling more advantageous than carpooling.

The stakeholders were unable to identify any park and ride lots with pedestrian or bicycle connections. Caltrans District 8 suggested that the consulting team review a Southern California Association of Governments (SCAG) study of the Metrolink system that may relate to pedestrian and bicycle connections. AAA suggested that bicycle lockers, rather than bicycle racks, must be available at park and ride lots to promote bicycle usage.



Caltrans District 11 provided an example where transit agencies were willing to modify routes to accommodate new park and ride facilities, but they were unable to do so. When the San Diego Region was planning the I-15 Bus Rapid routes, the two transit operators in San Diego tried modifying routes to use the new park and ride lots. Ultimately, they were unsuccessful due to a lack of funding and adequate right of way. Caltrans District 12 believes that with the proper planning and analysis, most transit agencies would be willing to modify their routes to accommodate new park and ride facilities.

## Operations and Maintenance

The consulting team asked stakeholders about the operations and maintenance involved with park and ride lots as well as program coordination. Lease agreements are in effect for District 7, District 8, District 12, and RCTC park and ride facilities. District 11 does not have leasing agreements. It has shared-used agreements with retail center and church groups to share the use of their parking facilities. These agreements are done out of a “sense of community or civic duty.” Parking utilization counts are conducted yearly to every other year. Violations are generally not seen as a big problem.

The major concern expressed by stakeholders about maintenance is the lack of funding. There is no regular schedule for maintaining the park and ride lots. Maintenance is done when funding is available. For Caltrans park and ride lots, the Caltrans Division of Maintenance gets an allocation for park and ride through the High Occupancy Vehicle (HOV) program, however, all of the stakeholders interviewed stated that funding is not adequate. Having the donation centers host some park and ride lots in San Diego helps with minor maintenance and the reporting of violators. Caltrans District 11 has also been trying to promote adoption of Park and Ride lots similar to the Adopt-A-Highway Program. However, this promotion has been unsuccessful so far. OCTA lots must be maintained and patrolled for security; however, OCTA does not have funding dedicated to maintenance of park and ride lots.

Exhibit B6 shows an example of a park and ride lot at the Del Amo Station that is well maintained and has 100 percent utilization throughout the three study years in the LACMTA study. Exhibit B7 shows an example of underutilized lots at the Hawthorne Station (South East Lot, North East Lot, and North West Lot) that have maintenance issues such as litter, poorly maintained landscaping, faded striping, broken fencing, and a homeless person living at one of the lots. Although the smallest lot (North West Lot with 46 spaces) has 100 percent utilization, poor maintenance and safety concerns at these locations result in overall low usage by commuters (averaging less than 20 percent over the three study years). Clearly, having well maintained park and ride lots help promote the usage and continued usage of these facilities.

**Exhibit B6: Park and Ride Lot Conditions at Del Amo Station**



**Exhibit B7: Park and Ride Lot Conditions at Hawthorne Station**



Figure 5-16. There is extensive litter in all three parking lots.



Figure 5-17. There is at least one homeless person living at one of the lots.



Figure 5 -18 and Figure 5 -19. Landscaping is poorly maintained throughout all three lots.



## Security

The consulting team asked stakeholders which lots could use better security and what could be done to improve safety. The stakeholders indicated that all park and ride lots could use better security. Suggested improvements include having CCTVs with direct connections to the police, better lighting, clear fencing, “mobile cafés” during the morning commute, fake CCTVs, or “hosting” by donation centers or recreation vehicle (RV) residents to help with minor maintenance and security. During the winter months, lighting is especially important since days are shorter and commutes may start or end at night. District 11 representative wanted to emphasize that he believes that the security issues such as occasional break-ins is often blown out of proportion and may not be major problem for the District. None of the Caltrans, OCTA, or RCTC operated park and ride lots have CCTV cameras. Only Metrolink parking facilities have CCTV cameras.

The consulting team asked the stakeholders for their thoughts about a concept of providing secured lots with fees for usage. Under this strategy, registered carpoolers could park for free with Radio-Frequency Identification (RFID) tags. The stakeholder indicated that adoption of such a strategy would need to be a regional policy decision. If such a policy were pursued, fees should be minimal. However, they also noted that a secure lot program with fees would be burdensome if Caltrans were to administer it due to the lack of funding.

## Outreach

The consulting team asked stakeholders what additional marketing or advertising is necessary to attract potential users to park and ride lots. Stakeholders from both RCTC and Caltrans District 8 felt that the existing [www.ie511.org](http://www.ie511.org) website is the key marketing tool for the regional park and ride lot system. Other County Transportation Commissions (CTCs), such as OCTA and LACMTA, have websites promoting the use of the park and ride system for vanpool and riding sharing. AAA promotes vanpool and carpooling programs within its own organization. AAA also periodically publishes topics related to carpooling in its monthly *Westways* magazine.

When asked about efforts to gauge park and ride user attitudes, the stakeholders indicated no park and ride user surveys have been conducted within the last five years. Although Caltrans is expected to have quarterly meetings with all park and ride districts in attendance, they have occurred less frequently in practice. The last meeting was held in Caltrans District 7 with all park and ride districts in attendance. Additionally, County Transportation Commissions have been meeting with some Caltrans park and ride coordinators to share ideas for promoting the lots.



## Cost-Benefit Tool

The consulting team asked stakeholders about the usefulness of a cost-benefit tool for the park and ride program. Most stakeholders felt that a park and ride cost-benefit tool would help secure funding by quantifying the benefits to the region. Important benefits to quantify include congestion reduction and air quality improvement.

Caltrans District 11 feared that a cost-benefit tool could help or hurt the park and ride program, depending on the results produced. The district indicated that a greater issue is demand estimation. It is hard to justify spending money on spaces without knowing exactly how many people will use the facility. District 11 stakeholders thought that a parking demand model would be a good companion tool, since determining usage would help to justify the cost. District 11 provided the *San Diego Regional Park & Ride Study Working Paper #2 Demand Analysis, Site Identification, Evaluation, and Selection*, July 1994 as an example of a demand analysis procedure used for estimating future park and ride demand at specific locations within San Diego County. OCTA also felt that a demand tool would complement a cost-benefit tool when planning new facilities.

Caltrans Headquarters recommends developing a cost-benefit tool that allows the user to estimate benefits and costs appropriate to each agency. The tool would need to have flexibility, so the user could turn features on and off according to the role of the user's agency in park and ride. For example, Caltrans may be asked to provide right of way rather than sponsoring construction of a particular lot. The cost-benefit tool needs to allow for the analysis of different scenarios and different levels of participation.

AAA was not sure whether a cost-benefit tool would be useful. Cost data differs considerably by park and ride lot. In addition, the appropriate base for comparing benefits is not easy to identify.

Others noted that a cost-benefit tool would be very helpful in deciding which park and ride lots to fund. Funding decisions can be political, but objective analysis can help inform the process, and that a cost-benefit tool would help to make tradeoffs in park and ride investments.

## Other

The consulting team also asked stakeholders about hosting programs, unique features of its park and ride programs, public-private partnership opportunities, and miscellaneous ideas for improving park and ride lots. Caltrans District 12 has a unique program on their leased lots to issue a limited number of permits to park in these lots. As an example of one idea offered to improving park and ride lots, a district is considering adding electric vehicle chargers that can charge cars in 20 minutes to park and ride lots.



Host programs partner with companies or RV residents to work or live part time or full time on the park and ride lot. While some districts were not familiar with host programs, District 11 uses a host program to partner with three donation centers to provide better security and maintenance in park and ride lots. District 12 has a host program with a Goodwill donation center at its San Juan Capistrano park and ride lot. Similarly, District 7 has an agreement with an RV resident that lives onsite and helps with light maintenance and security at one lot. Districts that use host programs say that onsite hosts give the commuters a sense of security that can encourage more park and ride usage. Some districts also have shared-use programs, which typically involve property owners making their parking lots available to commuters for parking personal vehicles so they can access public transit or use a carpool/vanpool to travel to their final destinations.

In some districts, public-private partnerships are being explored, while others already partner with local businesses, churches, and schools. The most successful shared parking programs are with churches, since they often have large lots not used throughout the week. In addition, church lots are generally well maintained and give the impression of better security. Since park and ride lots serve a small group of people, AAA noted that it would be difficult to entice private companies since very little money is to be made. The Adopt- a-Park-and-Ride program is also a public-private partnership opportunity that is being implemented by Caltrans District 11. Stakeholders noted that Senate Bill (SB) 415 will make relinquishment of park and ride lots easier for Caltrans. Relinquishment may lead to more public-private partnerships. Additionally, an Assembly Bill (AB) 2583 is being implemented that would require the Department of General Services (DGS) and Caltrans to develop and implement advanced technology vehicle parking incentive programs in specified public parking facilities with 50 spaces or more and specified park and ride lots to incentivize the purchase and use of alternatively fueled vehicles. This bill only applies to Caltrans owned and operated park and ride lots, not leased lots.



## Appendix C: Cost Data and Sources

This appendix provides information on the sources of default cost data used in the cost estimation tool.

The exhibit on the next page shows the cost data found on the parameters page. The first four rows provide the cost defaults used to estimate park and ride construction costs using an average cost per stall (Method 1). The costs vary by facility type and come from three sources:

- New York City Park & Ride Study conducted for the New York State Department of Transportation by Rensselaer Polytechnic Institute in January 2012
- Riverside County Transportation Commission (RCTC) Contract Lease Rates, which are listed in the 2012 Federal Transportation Improvement Program (FTIP)
- San Joaquin Council of Governments Park-and-Ride Lot Master Plan Study prepared in October 31, 2007 by DKS Associates.

The detailed cost information used to build up construction costs by item (Method 2) come from Table 10 of the San Joaquin Council of Governments Park-and-Ride Lot Master Plan Study.

The exhibit on the next page also shows right of way, preliminary engineering, and annual operating and maintenance costs. Right of way land costs were obtained from a review of vacant land prices in Southern California using [www.zillow.com](http://www.zillow.com), [www.landwatch.com](http://www.landwatch.com), and right of way cost estimates from the 2010 FTIP. Preliminary engineering and design costs are from the Valley Metro Regional Public Transportation Authority: RPTA Park and Ride Reprioritization Study. Although this study estimates costs for Maricopa County, Arizona (Metropolitan Phoenix), the cost estimation tool estimates preliminary engineering and design costs as a percentage of construction costs to approximate costs in Southern California. Typical maintenance and operation costs were collected from the Orange County Transportation Authority (OCTA) as part of the stakeholder survey, which is described in Appendix B.

All costs are updated to 2012 dollars. Users should change the default values in the cost estimation tool as more up-to-date information becomes available.



**Exhibit C1: Range of Construction, Right of Way, Preliminary Engineering, and Annual Operating and Maintenance Costs (and Data Source)**

Type of Facility	CONSTRUCTION COST ESTIMATES PER PARKING STALL (2012\$/stall)				SQUARE FOOTAGE ESTIMATES PER PARKING STALL (SqFt/Stall)				Square Feet Needed			Square Acreage Needed		
	Low	Middle	High	Source(s)	Low	Middle	High	Source(s)	Low	Middle	High	Low	Middle	High
Above Ground Multi-Level Structure	\$ 9,000	\$ 16,000	\$ 46,000	New York City Park and Ride Study	280	350	400	New York City Park and Ride Study	39,200	49,000	56,000	0.90	1.12	1.29
Below Ground	\$ 30,000	\$ 53,000	\$ 76,000	New York City Park and Ride Study	280	350	400	New York City Park and Ride Study	39,200	49,000	56,000	0.90	1.12	1.29
Leased Lot	\$ 5.00	\$ 8.55	\$ 15.00	Riverside County Transportation Commission (RCTC) Contract Lease Rates, 2012 FTIP	350	550	775		49,000	77,000	108,500	1.12	1.77	2.49
Surface Lot	\$ 2,500	\$ 10,000	\$ 21,000	San Joaquin Council of Governments Park-and-Ride Lot Master Plan Study	350	550	775		49,000	77,000	108,500	1.12	1.77	2.49

Element	Low	Middle	High	Source(s)
Right of Way Average Land Cost per Acre (US 2012 Dollars)	\$ 30,000	\$ 500,000	\$ 2,000,000	Review of vacant land prices in Southern California using www.zillow.com, www.landwatch.com, and from right of way cost estimates from the 2010 FTIP
Preliminary Engineering/Design Cost as a % of Construction Cost	5.00%	7.50%	10.00%	Valley Metro Regional Public Transportation Authority: RPTA Park and Ride Reprioritization Study
Average Annual Maintenance and Operations Costs per Parking Stall (US 2012 Dollars)	\$ 120	\$ 400	\$ 875	Based on maintenance and operations estimates from the Orange County Transportation Authority. Typical ranges are 10-30% of Total Construction Costs according to Park & Ride Stakeholder Survey for District 12 Project