# SAN FRANCISCO URBAN PARTNERSHIP AGREEMENT

# NATIONAL EVALUATION: COST BENEFIT ANALYSIS TEST PLAN

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# NATIONAL EVALUATION: COST BENEFIT ANALYSIS TEST PLAN

By

Battelle Memorial Institute 505 King Ave. Columbus OH 43201

Prepared for United States Department of Transportation Federal Highway Administration (FHWA) Office of Operations 1200 New Jersey Avenue, S.E. Washington, DC 20590

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#### 16. Abstract

This report presents the test plan for collecting and analyzing cost and benefit data for the San Francisco Urban Partnership Agreement (UPA) under the United States Department of Transportation (U.S. DOT) UPA Program. The San Francisco UPA projects focus on reducing congestion by employing strategies consisting of combinations of tolling, transit, telecommuting/alternate commute programs, and technology, also known as the 4 Ts. The national evaluation focuses on the San Francisco UPA projects that deal with parking pricing in downtown San Francisco and supporting technology and telecommuting/TDM projects. The SF*park* parking pricing pilot will implement variable pricing in on-street and garage parking in selected parking zones. Information on parking availability and price will be available by phone, websites, and variable message signs. Outreach events for alternate commute programs will inform the public about the parking pricing and information projects. The Cost Benefit Analysis Test Plan is based on the San Francisco UPA National Evaluation Plan. This test plan describes the cost and benefit data sources, data availability, and possible risks associated with the data. The methods for analyzing the cost and benefit data are discussed. The schedule and responsibilities for collecting, analyzing, and reporting the cost and benefit data are presented.

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# LIST OF ABBREVIATIONS

4Ts	Tolling, transit, telecommuting/travel demand management, and technology
CBA	Cost benefit analysis
СО	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
DOE	Department of Environment
FHWA	Federal Highway Administration
ISP	Information service provider
ITS	Intelligent Transportation System
MTC	Metropolitan Transportation Commission
NO <sub>x</sub>	Nitrogen oxide
PM <sub>2.5</sub>	Particulate matter that is 2.5 micrometers in diameter and smaller
SF CHAMP Model	SFCTA's Travel Demand Forecasting Model
SFCTA	San Francisco County Transportation Authority
SFMTA	San Francisco Municipal Transportation Agency
TDM	Travel demand management
UPA	Urban Partnership Agreement
U.S. DOT	United States Department of Transportation
VMT	Vehicle miles traveled
VOC	Volatile organic compounds

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## 1.0 INTRODUCTION

This report presents the test plan for collecting and analyzing cost and benefit data for the national evaluation of the San Francisco Urban Partnership Agreement (UPA) under the United States Department of Transportation (U.S. DOT) UPA program. The San Francisco UPA is one of several large field deployments around the United States that are receiving U.S. DOT funding and which are intended to demonstrate congestion pricing and supporting strategies. The San Francisco UPA national evaluation will address the four primary U.S. DOT UPA evaluation questions shown in Table 1-1.

Objective Question #1	<ul> <li>How much was congestion reduced in the area impacted by the implementation of the tolling, transit, technology, and telecommuting strategies? It is anticipated that congestion reduction could be measured by one of the following measures, and will vary by site and implementation strategy: <ul> <li>reductions in vehicle trips made during peak/congested periods;</li> <li>reductions in travel times during peak/congested periods;</li> <li>reductions in congestion delay during peak/congested periods; and</li> <li>reductions in the duration of congested periods.</li> </ul> </li> </ul>
Objective Question #2	<ul> <li>What are the associated impacts of implementing the congestion reduction strategies? It is anticipated that impacts will vary by site and that the following measures may be used: <ul> <li>increases in facility throughput during peak/congested periods;</li> <li>increases in transit ridership during peak/congested periods;</li> <li>modal shifts to transit and carpools/vanpools;</li> <li>traveler behavior change (e.g., shifts in time of travel, mode, route, destination, or forgoing trips);</li> <li>operational impacts on parallel systems/routes;</li> <li>environmental impacts;</li> <li>impacts on goods movement; and</li> <li>effects on businesses.</li> </ul> </li> </ul>
Objective Question #3	What are the non-technical success factors with respect to the impacts of outreach, political and community support, and institutional arrangements implemented to manage and guide the implementation?
<b>Objective Question #4</b>	What are the overall costs and benefits of the deployed set of strategies?

Table 1-1. U.S. DOT National Evaluation "Objective Questions"

The questions shown in Table 1-1 will be addressed by carrying out the following ten "evaluation analyses" described in the San Francisco UPA National Evaluation Plan: congestion, pricing, telecommuting/travel demand management (TDM), technology, equity, environmental, goods movement, business impacts, non-technical success factors, and cost benefit. Each of these ten analyses relies upon various evaluation measures of effectiveness.

"Test plans" are the evaluation planning documents that describe how specific data will be collected and processed to yield the evaluation measures of effectiveness required for the various analyses. Whereas evaluation analyses are categorized according to related evaluation questions or types of impacts, for example all equity-related impacts are addressed in the equity analysis, test plans are categorized according to common data types or sources. For example, the Traffic System Data Test Plan collects and processes all of the traffic data required for the national evaluation. In addition to this Cost Benefit Analysis Test Plan, the other nine test plans focus on the following types of data: traffic, parking, transit, telecommuting/TDM, traveler information, surveys and interviews, environmental, content analysis, and exogenous factors.

The relationship between test plans and evaluation analyses is discussed in Section 1.2. In short, analyses describe the evaluation questions and hypotheses to be investigated and the test plans describe how the data and measures of effectiveness needed to support the evaluation will be collected and processed. Most test plans collect data and provide measures of effectiveness that will be used in multiple analyses and most analyses rely upon data and measures developed through several different test plans.

The remainder of this introduction chapter identifies the San Francisco UPA deployments and elaborates on the relationship between test plans and evaluation analyses. The remainder of the report is divided into three sections. Chapter 2.0 presents the data sources, data availability, and risks associated with the cost and benefit data collected through this test plan. Chapter 3.0 discusses how all of the cost and benefit data will be analyzed and used in the national evaluation. Chapter 4.0 presents the schedule and responsibilities for collecting and analyzing the cost and benefit data.

## 1.1 The San Francisco UPA

San Francisco was selected by the U.S. DOT as an Urban Partner to implement projects aimed at reducing congestion based on four complementary strategies known as the 4Ts: tolling, transit, telecommuting/TDM, and technology. Under contract to the U.S. DOT, a national evaluation team led by Battelle is assessing the impacts of the projects in a comprehensive and systematic manner in San Francisco and other sites. The national evaluation will generate information and produce technology transfer materials to support deployment of the strategies in other metropolitan areas. The national evaluation will also generate findings for use in future Federal policy and program development related to mobility, congestion, and facility pricing.

The San Francisco local UPA partners for the national evaluation consist of three public agencies. Two of the partners represent the City of San Francisco--the San Francisco County Transportation Authority (SFCTA) and the San Francisco Municipal Transportation Agency (SFMTA). The third partner is the Metropolitan Transportation Commission (MTC), the metropolitan planning organization for the Bay Area.

The San Francisco projects are focused on reducing traffic congestion related to parking in downtown San Francisco. Intelligent transportation systems (ITS) technologies underlie many of the San Francisco UPA projects, including those utilizing parking sensors and real-time parking

information. The San Francisco UPA projects that will be evaluated<sup>1</sup> are described briefly below.

**SF***park* **Variable Pricing.** SF*park* is the name given to the parking pricing system to be implemented by SFMTA. The primary goal of SF*park* is to use intelligent parking management technology and techniques, in particular demand-responsive pricing, to manage the on-street and off-street parking supply and demand. SFMTA expects this approach to increase parking availability, reduce the number and duration of vehicle trips and reduce double parking and, thereby, reduce congestion. The parking technologies to be tested include networked parking meters, parking occupancy sensors, and parking information systems. Pricing policies may change over the course of the evaluation period, as SF*park* managers adjust rates in response to demand. Some extensions in times of day/week that meters are operable are also possible pending SFMTA Board actions.

The pilot areas for SF*park* are highlighted in red (or dark lines) in Figure 1-1. The new system will consist of approximately 6,000 metered on-street parking spaces (about one-quarter of the city's total supply) and 12,250 parking spaces in fifteen city-operated garages and one lot. Control areas, highlighted in yellow (or light lines) in Figure 1-1, will be equipped with traffic sensors for monitoring use of the parking supply where variable pricing is not implemented.

To assist travelers in making choices about parking pre-trip and en-route, SFMTA will disseminate parking information in various ways. Strategically placed variable message signs<sup>2</sup> will show parking availability in city-operated garages, and parking availability and pricing information will also be displayed on SFMTA's website and by text messaging to mobile devices.

**511 Upgrades.** The 511 phone and website in the San Francisco Bay Area, operated by MTC, is one of the most advanced in the country, including a variety of multi-modal information. However, at the present time, the parking information on 511 is limited to static information about park and ride lots and rail stations (on the web) and airport parking (on the phone). The planned upgrades will provide parking space availability and pricing information for selected parking facilities in downtown San Francisco by 511 phone and web and by information service providers (ISPs) in the region who receive a feed of 511 data from MTC. MTC will receive a real-time data feed of parking availability for parking garages managed by SFMTA and pricing data for those SFMTA garages, lots, and on-street parking. The user interfaces on 511 phone and website will be enhanced to disseminate the parking information to 511 customers.

<sup>&</sup>lt;sup>1</sup> The Clipper<sup>SM</sup> electronic payment card (formerly known as TransLink<sup>®</sup>) that was to be piloted for parking payment at five SFMTA garages was removed from the national evaluation owing to uncertainty about when it would be deployed.

 $<sup>^{2}</sup>$  The deployment of the variable message signs has been delayed to December 2011, placing them several months behind the other UPA projects. Rather than delay evaluation of the rest of the projects, the decision was made not to include them in the national evaluation.



Figure 1-1. SFpark Pilot and Control Zones

**Expansion of San Francisco Telecommuting and Alternate Commute Programs.** Under the direction of the SFCTA, the telecommuting and alternate commute programs will be undertaken by the City of San Francisco's Department of the Environment (DOE). In support of the SF*park* and 511 enhancements, DOE and SFCTA plans include two activities: promotion of SF*park* at DOE outreach events and promotion of 511 enhancements at outreach events. Through the outreach efforts, downtown workers will be better informed about the UPA initiatives and can better use the parking and information resources available to them.

**Schedule for the San Francisco UPA Projects.** The projects to be evaluated will go into operation between in mid-2011 and late 2011. SFMTA will be implementing variable pricing in SF*park* zones in mid-2011. At that time real-time parking information will become available via SFMTA's website and text messaging and the MTC 511 phone system. In late 2011 parking information will be available on the 511 website. As the SFMTA and MTC projects are deployed, SFCTA will conduct its expanded outreach and alternate commute program.

## 1.2 San Francisco UPA National Evaluation Plan and the Use of the Cost Benefit Analysis Data

Table 1-2 shows which of the various San Francisco UPA test plans will contribute data to each of the evaluation analyses. The "flow" between test plans is "one way" in the sense that test plans feed data and measures to the analyses rather than the reverse. The solid circles show where data from a given test plan constitutes a major input to an analysis; the open circles show where data from a given test plan constitutes a supporting input to an analysis. Data from the Cost Benefit Analysis Test Plan will be used only in the cost benefit analysis. Table 1-3 presents the cost benefit data elements and the measures of effectiveness and the hypotheses/questions the cost and benefit data will be used to evaluate.

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San Francisco UPA Test Plans	Congestion Analysis	Pricing Analysis	Telecommuting/ TDM Analysis	Technology Analysis	Equity Analysis	Environmental Analysis	Goods Movement Analysis	Business Impact Analysis	Non-Technical Success Factors Analysis	Cost Benefit Analysis
Traffic System Data Test Plan	•				0		0			0
Parking Data Test Plan		•		0	0	0	•	0		
Transit System Data Test Plan	0	•				0				0
Telecommuting/TDM Data Test Plan			•							
Traveler Information Data Test Plan				•						
Surveys and Interviews Test Plan	•	•	•	•	•	0		0	•	0
Environmental Data Test Plan					0	•				0
Content Analysis Test Plan									•	
Cost Benefit Analysis Test Plan										
Exogenous Factors Test Plan	0	0	0	0	0	0	0	0	0	0

 Table 1-2.
 Relationship Among Test Plans and Evaluation Analysis

• — Test Plan Data Constitute a Major Input to the Evaluation Analysis

O — Test Plan Data Constitute a Supporting Input to the Evaluation Analysis

	San Francisco Data Element	Data Source	San Francisco UPA Measure of Effectiveness	San Francisco UPA Hypotheses/ Questions*		
1.1	New investment in the variable parking pricing system	SFMTA				
1.2	O&M costs in the variable parking pricing system	SFMTA				
1.3	Replacement investment in the variable parking pricing system	SFMTA				
2.1	New investment in the regional 511 system	MTC				
2.2	O&M costs in the regional 511 system	МТС				
2.3	Replacement investment in the 511 system	МТС	C TA TA, D Net Benefits			
3.1	Investment in promoting SF <i>park</i> and 511 parking information	SFCTA				
3.2	Investment in promoting SF <i>park</i> and 511 parking information	SFMTA, MTC		SFCBA-1		
3.3	Ongoing investment in promoting SF <i>park</i> and 511 parking information	SFMTA, MTC	Benefit Cost Ratio			
4.1	Commercial vehicle travel time savings	SFCTA				
4.2	Personal vehicle travel time savings	SFCTA				
4.3	Transit rider travel time savings	SFCTA				
5.1	Commercial vehicle operating cost savings	SFCTA				
5.2	Personal vehicle operating cost savings	SFCTA				
5.3	Transit vehicle operating cost savings	SFCTA				
6.1	Reduction in emissions	SFCTA				

### Table 1-3. Cost Benefit Analysis Test Plan Data Elements

\*Listed are acronyms corresponding to hypotheses/questions to be addressed with data from this test plan. An explanation of these acronyms can be found in Appendix A, which contains a compilation of the hypotheses/questions for all the analysis areas from the San Francisco UPA National Evaluation Plan. This page intentionally left blank

# 2.0 DATA SOURCES, AVAILABILITY, AND RISKS

This section describes the cost benefit data sources, data availability, potential risks associated with obtaining the data, and the schedule and responsibility for data collection.

## 2.1 Data Sources

The Cost Benefit Analysis Test Plan will use three major sources of data. The first source is the detailed costs associated with the UPA projects. These data will be provided by SFMCTA, SFMTA, and MTC. The second source is the traffic forecast generated by the SFCTA's Travel Demand Forecasting Model (SF CHAMP Model). The third source will be data from other test plans.

**Cost Data from Participating Agencies.** Cost data will mainly be obtained from government agencies, such as SFMCTA, SFMTA, and MTC, which will make expenditures for the UPA projects. Data include the costs associated with installing/initiating the various projects, the operating and maintenance costs, and the replacement and re-investment costs. Cost data will be collected for the following cost categories:

- Implementation costs:
  - Building the variable parking pricing system in San Francisco
  - Upgrading the regional 511 system to include real-time information regarding parking pricing and availability
  - Promotion of the new parking system
- Operating and maintenance costs:
  - Operating and maintaining the variable parking pricing system
  - Operating and maintaining information on parking in the 511 system
  - Additional cost (if any) for incorporating SF*park* and 511 into San Francisco Department of Environment's alternate commute outreach activities.
- Replacement and re-investment costs for UPA equipment and infrastructure, including:
  - The equipment used in the variable parking pricing system, and
  - The 511 system.

Table 2-1 provides a cost reporting scheme with detailed cost categories by type of project and by reporting agency.<sup>3</sup> The costs to be considered in the cost benefit analysis should only include those annual expenditures through July 2021 (10 years of operation) incurred as a result of implementing the UPA projects and allocated to those UPA projects. In other words, only the marginal costs should be recorded and reported as the costs of the UPA projects. For instance, suppose that MTC currently operating 511 without the parking information has an annual operation budget of \$1 million. Further, suppose that with the investment in parking information from the UPA projects, MTC's annual operational budget for 511 increases to \$1.5 million. For the purpose of reporting the costs for the cost benefit analysis, only the newly increased costs of \$0.5 million should be reported. Any savings in operation costs would be reported as a negative cost.

<sup>&</sup>lt;sup>3</sup> To convert these future year marginal costs to year 2010 dollars a real discount rate of 7 percent will be used (based on guidance from <u>http://www.whitehouse.gov/omb/assets/a94/a094.pdf</u> (page 9) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).

Major	jor Reporting Major Cost Year <sup>(*)</sup>				r <sup>(*)</sup>			
Data Element	Agency	Category	Cost Sub-category		2010	2011	2012	 2021
1. Variab	le Parking P	ricing System						
1.1	SFMTA	Implementation Costs	All costs required to design and build the new parking pricing system. Includes capital costs (sensors, meters, communications equipment, others) as well as engineering design and planning, construction labor, management, other.					
1.2	SFMTA	Operation and Maintenance Costs	Marginal cost of operating and maintaining the new pricing system. Includes: <i>General:</i> account set-up, equipment O&M, hardware and software maintenance, banking, oversight, labor. <i>Collections:</i> Account management, communication, payment processing, labor. <i>Compliance:</i> Enforcement, violation processing, dispute resolution, labor.					
1.3	SFMTA	Reinvestment Costs	Marginal cost of replacement equipment. Includes parking pricing equipment, computer upgrades / replacement, labor.					
2. Regio	nal 511 Syste	em						
2.1	МТС	Implementation Costs	All costs required to design and build the enhanced parking pricing portion of the 511 system. Includes computer hardware and software, labor, other.					
2.2	MTC	Operation and Maintenance Costs	Marginal cost of operating and maintaining the enhanced parking pricing features of the 511 system. Includes repair, maintenance, and labor.					
2.3	MTC	Reinvestment Costs	Marginal cost of replacement equipment for parking pricing on the 511 system. Includes computer upgrades / replacement, labor.					

### Table 2-1. Cost Reporting Scheme for the UPA Projects

Major	Reporting	Major Cost	Cost Sub-category		Year <sup>(*)</sup>						
Data Element	Agency	Category			2010	2011	2012		2021		
3. Invest	ment in Pron										
3.1	SFCTA	Implementation	Investment in promoting SF <i>park</i> and 511 parking information in SFDOE outreach program								
3.2	SFMTA and MTC	Implementation	Investment in promoting SF <i>park</i> and 511 parking information								
3.3	SFMTA and MTC	Operation Costs	Ongoing investment in promoting SF <i>park</i> and 511 parking information								
(*) The sha	aded cells indi	cate that cost data	most likely do not need to be collected for those yea	ars.		· · · · · · · · · · · · · · · · · · ·					

## Table 2-1. Cost Reporting Scheme for the UPA Projects (Continued)

Major	Reporting	Major Renefit	Benefit Sub-category		Year <sup>(*)</sup>					
Data Element	Agency	Category			2010	2011	2012		2021	
4. Travel	4. Travel Time Benefits									
4.1	SFCTA	Commercial Vehicle Travel Time Savings	Includes travel time saved by commercial vehicles for the 10 year period post- implementation of the parking pricing system.							
4.2	SFCTA	Personal Vehicle Travel Time Savings	Includes travel time saved by personal vehicles for the 10 year period post-implementation of the parking pricing system.							
4.3	SFCTA	Transit Rider Travel Time Savings	Includes travel time saved by transit riders for the 10 year period post-implementation of the parking pricing system.							
5. Vehicl	e Operating	Cost Savings								
5.1	SFCTA	Commercial Vehicle Operating Cost Savings	Includes both the fuel savings (minus taxes) and other operating cost savings for commercial vehicles due to congestion reduction.							
5.2	SFCTA	Personal Vehicle Operating Cost Savings	Includes both the fuel savings (minus taxes) and other operating cost savings for personal vehicles due to congestion reduction.							
5.3	SFCTA	Transit Vehicle Operating Cost Savings	Includes both the fuel savings (minus taxes) and other operating cost savings for transit vehicles due to congestion reduction.							
6. Air Quality Improvements										
6.1	SFCTA	Reduction in emissions	Value of reduced carbon dioxide ( $CO_2$ ), nitrogen oxide ( $NO_x$ ), particulate matter that is 2.5 micrometers in diameter and smaller ( $PM_{2.5}$ ), and volatile organic compounds (VOC).							
(*) The shaded cells indicate that cost data most likely do not need to be collected for those years.										

#### Table 2-2. Benefit Reporting Scheme for the UPA Projects

**SFCTA's San Francisco Travel Demand Forecasting Model (SF CHAMP model).** Data from the other test plans (discussed below) can provide data needed for benefits from the UPA projects in year one. However, for a more accurate estimate of benefits further into the future, the SF CHAMP model will be used. The model will be run for two scenarios:

- 1. Assuming none of the San Francisco UPA projects were implemented
- 2. With all of the San Francisco UPA projects implemented as planned with the model calibrated to correspond to first year results as found in the test plans listed below.

Each scenario will be run for (1) the first year after UPA implementation and (2) ten years after UPA implementation. A comparison of the two scenarios will provide some of the benefits data listed in Table 2-2 for years 1 and 10. These benefits will then be converted to monetary terms based on the standard values noted in Section 3.0.

**Other San Francisco UPA Test Plans.** The third source is data from other test plans and includes both pre- and post-deployment data that will be used both to estimate benefits and to validate (or calibrate) SF CHAMP. These data are critical since the benefits calculation relies on the SF CHAMP model's estimate of future traffic conditions for 10 years into the future. Therefore, proper calibration of year one model results to actual findings from the test plans is an essential initial step in benefit calculation. The data from other test plans that will be used for model calibration include:

- Traffic System Data Test Plan Data will include travel speeds, vehicle occupancy rates, and number of vehicles on roads within the parking management districts. These data can be used to estimate vehicle operating cost changes.
- Transit System Data Test Plan Data will include transit travel time and the number of transit riders. These data can be used to estimate change in transit use and transit travel times. As described in the test plan, transit travel times will be used as a proxy for travel time of all vehicles.
- Environmental Data Test Plan Data will include emissions based on vehicle miles traveled (VMT) from vehicles searching for parking spots. These data can be used to calculate the change in emissions.

Three additional benefit categories will be documented in the cost benefit report but not monetized and will not be included in the net benefit calculation. These benefits will be quantified as discussed below:

- Traffic System Data Test Plan The change in travel time reliability (as measured by travel speeds) will be estimated.
- Transit System Data Test Plan and Survey and Interview Test Plan Number of people changing from driving to riding transit. Also, he change in travel time reliability (as measured by difference between peak and off-peak travel times) will be estimated.
- Surveys and Interviews Test Plan Number of people changing from driving to telecommuting.

### 2.2 Data Availability

SFMTA, SFCTA, and MTC will provide the cost data. The cost data from these agencies should cover the pre- and post-deployment time periods. The operating and maintenance costs and the replacement and re-investment costs need to cover a 10-year time period after the San Francisco UPA projects are operational. Agency staff will need to develop forecasts of these costs using their normal budgeting methods. SFCTA will provide travel demand forecasts from their SF CHAMP model. Other data needed for the cost benefit analysis will be obtained from the other test plans and SFCTA's SF CHAMP model. The national evaluation team has discussed use of the model for the evaluation with SFCTA staff, who has confirmed their availability to make the model runs.

### 2.3 Potential Risks

There do not appear to be any significant risks associated with obtaining cost information from the sources outlined previously. Potential issues may arise during the data collection process, however. Examples of possible concerns include delays in gathering data, inconsistency or duplication in the data, inability to accurately separate costs related to the new parking pricing system from other costs, and cost accounting methods. To address potential issues with obtaining cost information, Battelle team members will work with partnership agency staff to initiate the data request early in the evaluation process and follow up with any specific questions.

The largest risk is the difficulty in estimating future year benefits from the UPA projects. Preferably, year one benefits would be estimated based on data from the SF CHAMP model runs. Alternatively, year one benefits can be obtained by monetizing changes measured in actual field data from the first year of UPA operations as outlined in the various test plans. Ideally, both methods would result in the same benefits as the model should be calibrated to match year one results.

Predicting the future is inherently risky, but in this case the SF CHAMP model may not be able to accurately capture the change in driving behavior caused by the UPA projects. For example, the model cannot capture the reduced parking search times – which will represent a significant portion of the benefits from these UPA projects. Battelle team members will work with the SFCTA staff to review the model output as compared to the data collected as part of the test plans. This would likely focus on comparing the model predictions for post-deployment year one versus the real world traffic and travel condition data in year one. Also, SFCTA will need empirical parking data (the entire SF*park* data) from SFMTA to calibrate the model. In the event the model results are inaccurate, SFCTA would determine if the model can be calibrated to reflect the observed data or if the model simply cannot account for all aspects of the impacts of the UPA projects. If the model can be accurately calibrated, then it will be used to estimate future year changes in:

- total travel time of personal vehicles,
- total travel time of transit riders,
- total travel time for commercial vehicles,
- total user costs based on amount of travel
- amount of travel (VMT) by speed on the different roadways,

- total parking fees paid, and
- number of travelers using each mode.

If the SF CHAMP model cannot be calibrated to observed year one data or cannot capture the changes in driving behavior due to the UPA projects then the fall-back approach will be to multiply the observed year one benefits by 10 to represent the 10 years of operational benefits. In theory this would represent a conservative estimate of benefits since many key benefits of the UPA projects would increase over time given the expected continued increase in regional traffic volumes and health care costs (which will equate to greater benefits associated with emissions reductions).

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## 3.0 DATA ANALYSIS

The cost benefit analysis timeframe will begin with the first expenses incurred and end after 10 full years of operation. Within this evaluation time frame, the cost benefit analysis will estimate and compare net benefits and costs between two scenarios—without implementation of the San Francisco UPA projects and with implementation of the San Francisco UPA projects. All costs and benefits will be calculated in real terms (dollars) based on discount factors discussed below.

The 10-year timeframe was selected since many aspects of all UPAs are technology or pricing related. Both technology and pricing systems have relatively short life spans. For example, three pricing systems in the U.S. that have been open for a long time (10+ years) have changed considerably in their relatively short life-spans:

- SR-91 Express Lanes: changed ownership, changed charging of HOVC3+ (twice), and changed pricing by a tremendous amount
- I-15 San Diego HOT Lane: changes in length, number of lanes, and pricing system
- Lee County Variable Priced Bridges: went from two-directional tolling to one-way tolling.

If any items in the UPA projects have useful lives longer than 10 years, they will be accounted for by including their salvage value at the 10 year point.

The basic procedure for calculating the net benefit is to monetize the benefits experienced by travelers due to the UPA projects and then subtract the costs incurred by the San Francisco UPA projects. Described briefly below is how the net benefit will be calculated for major components. The values shown are the most recent available at the time this test plan was developed. If there are updates to the reference documents at the time of the benefit cost calculation (in late 2012) the updated values will be used.

- Travel time savings resulting from improvement in traffic conditions experienced by drivers and transit riders. The following details the computation:
  - The SF CHAMP model will provide the amount of travel time saved in a personal vehicle. This amount of time will be converted to a monetary value using standard values of time supplied by the FHWA in <a href="http://ostpxweb.dot.gov/policy/Data/VOTrevision1\_2-11-03.pdf">http://ostpxweb.dot.gov/policy/Data/VOTrevision1\_2-11-03.pdf</a>. In Table 4 of that report, the value of time for the year 2000 was \$11.20 for local travel, using a weighted average of both business and personal travel. This was based on the median household income in the year 2000 (\$42,148) and will be adjusted for future values of time using actual and predicted median household incomes for 2010 and future years.
  - The SF CHAMP model will provide the amount of travel time saved for transit riders. Again, these time savings will be converted to monetary units using standard values of time supplied by the FHWA and are the same as those for travel in personal vehicles discussed above.

- The SF CHAMP model will provide the amount of travel time saved for commercial vehicles. Again, these time savings will be converted to monetary units using standard values of time supplied by the FHWA in <a href="http://ostpxweb.dot.gov/policy/Data/VOTrevision1\_2-11-03.pdf">http://ostpxweb.dot.gov/policy/Data/VOTrevision1\_2-11-03.pdf</a>. In Table 4 of that report, the value of time for truck drivers of \$18.10 will be used. This figure was derived using the median weekly earnings of full-time truck drivers for the year 2000 (\$564) divided by average weekly hours for full-time operators in transportation and material moving occupations (45.7 hours per week) plus total benefits (\$5.80). Current year (2010) and future year values of time will be adjusted using updated values of those figures.
- Vehicle operating cost savings experienced by drivers as a result of the reduction in congestion. The vehicle operating cost savings include two components: fuel costs and non-fuel costs, which include "wear-and-tear" costs. The computation of fuel cost reduction depends on fuel prices in the local area, fuel efficiencies under different driving speeds, and miles traveled. The SF CHAMP model can provide link-based information on vehicle travel distance under different driving speeds. The national evaluation team will then use reasonable estimates of the San Francisco fleet fuel efficiency by speed (supplied by the Emission Factors or EMFAC model used in California) to estimate fuel used. The non-fuel costs rely on average repair and maintenance costs (as identified by the U.S. DOT) and miles traveled and can be supplied by the SF CHAMP model. For fuel cost savings, the cost of fuel (minus taxes) will be obtained from Table VIII-4, page VIII-21 in the following document:

Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks," Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009

(http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE\_Fin al\_Rule\_MY2011\_FRIA.pdf). Table 3-1 presents future year gas prices based on that document.

Year	Forecast Gasoline Price Excluding Taxes (2007 \$/gallon)
2011	2.529
2012	2.558
2013	2.611
2014	2.668
2015	2.688
2016	2.736
2017	2.801
2018	2.846
2019	2.909
2020	2.975

Table 3-1.	Future	Year	Gas	Prices
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 Improvement in air quality – The benefits from the improved environment depend on emission rate per mile traveled and the dollar cost per ton of emission. The current year value per ton was derived from Environmental Protection Agency estimates of the value of health and welfare-related damages (incurred or avoided) and are recommended for use in current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30479). (See Table 3-2.) The values are found in the report: "Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks," Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009 (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CA FE Final Rule MY2011 FRIA.pdf.

Future year values are taken from the Highway Economic Requirements System documentation. (See Table 3-3.)

The observed change in VMT and speeds will be used in the Environmental Test Plan to estimate the change in emissions amounts (CO,  $CO_2$ ,  $NO_X$ ,  $PM_{2.5}$ , and VOC) for year one. This will be multiplied by 10 to represent the 10 year life of the UPA projects. The total value of this change will then be calculated using the values in Table 3-2 and 3-3 multiplied by the emissions amounts.

Pollutant	Cost (2007 \$)
CO <sub>2</sub>	\$21 per metric ton <sup>4</sup>
NO <sub>X</sub>	\$4,000 per ton
PM <sub>2.5</sub>	\$168,000 per ton
VOC	\$1,700 per ton

 Table 3-2.
 Current Values of Reduced Emissions

Pollutant	Cost in 2015	Cost in 2020
CO <sub>2</sub>	\$24 per metric ton <sup>3</sup>	\$26 per metric ton <sup>3</sup>
NO <sub>X</sub>	\$4,900 per ton	\$5,300 per ton

\$290,000 per ton

\$1,300 per ton

\$270,000 per ton

\$1,200 per ton

Table 3-3. Future Values of Reduced Emissions (in 2007 \$)

<sup>4</sup> The CO<sub>2</sub> estimates are based on figures from "SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866" http://www1.eere.energy.gov/buildings/appliance\_standards/commercial/pdfs/sem\_finalrule\_appendix15a.pdf

 $PM_{2.5}$ 

VOC

- Implementation costs, operating and maintenance costs, and replacement and reinvestment costs (see Table 2-1). The costs under each of the major categories will be summed for the purpose of calculating the total cost. To convert all costs to 2010 dollars a real discount rate of 7 percent will be used (based on guidance from the websites <u>http://www.whitehouse.gov/omb/assets/a94/a094.pdf</u> (page 9) and <u>http://www.whitehouse.gov/sites/default/files/omb/assets/omb/circulars/a004/a-4.pdf</u> (page 33) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).
- Salvage values. No equipment for this UPA project had significant value after the 10-year analysis period. Therefore, no salvage values will be included.

For the last step, the net benefit will be calculated by summing the benefits and then subtracting all costs in year 2010 dollars using a real discount rate of 7 percent.

Several other items of interest, but not part of the cost benefit analysis (CBA), will be calculated:

- Change in parking fees paid This is the difference in parking fees paid by travelers after the implementation of the UPA projects. The SF CHAMP model can provide disaggregate data on parking fees paid by trip purpose. Also, the Parking Data Test Plan will collect this information for the first year of operations. Parking revenue is a transfer of wealth (from the traveler to the government) and, as such, is not a net societal cost or benefit and is not in the equation. This analysis is focused on the net societal benefits and costs of tolling, transit, technology and telecommuting/TDM. It is assumed that the tolls collected are put to good use (and are thus a transfer of wealth and not simply a waste). What is done with those toll revenues (for example, improved parking and increased transit service) would be the subject of a separate benefit cost analysis.
- Improvement in travel time reliability (as measured by travel speeds and difference between peak and off-peak travel times) – There are certainly benefits from improved travel time reliability, particularly from the reduced searching for parking. However, the United States does not have a standard method of incorporating them into the CBA and the SF CHAMP model is not able to account for the time spent searching for parking. Therefore, reductions in travel time variability, as developed by the SF CHAMP model and/or from the Parking Data Test Plan, will be reported but not included in the CBA as we expect them to be incomplete and not readily monetized.
- Mode Shifting Data Number of people changing from driving to riding transit or telecommuting.

## 4.0 SCHEDULE AND RESPONSIBILITY

The schedule for conducting the cost benefit analysis is shown in Table 4-1. The schedule is based on the overall San Francisco UPA project schedule. The cost benefit analysis will be initiated prior to deployment of the San Francisco UPA projects and will be completed after all the projects are in operation. The local partners will be responsible for providing public agency cost information, the forecasts from the regional transportation model, and, via other test plans, a range of other data that will be used in the cost benefit analysis. Staff from SFCTA will run the regional travel forecast model to compute travel time savings, vehicle operating cost savings, and emissions reductions. Using those results, and FHWA guidance on the monetary value of each of those items, the net benefit of the UPA projects will be calculated.

Data Category	Reporting Schedule			
Costs				
<ul> <li>Implementation Costs (major data elements 1.1, 2.1, 3.1 and 3.2)</li> </ul>	<ul> <li>Upon Completion of Installation:</li> <li>1.1 – Parking Pricing System: Mid-2011</li> <li>2.1 – 511 System: Mid- to Late 2011</li> <li>3.1 – Promotion of System (SFCTA): Mid- 2011</li> <li>3.2 – Promotion of System (SFMTA and MTC): Mid-2011</li> </ul>			
<ul> <li>Operation and Maintenance Costs (major data elements 1.2, 2.2, and 3.3)</li> </ul>	<ul> <li>Report for each data element after fiscal year end books completed:</li> <li>1.2 – SFMTA: September 2010, 2011</li> <li>2.2 – MTC: September 2010, 2011, 2012</li> <li>3.3 – SFMTA &amp; MTC: September 2011, 2012</li> </ul>			
Reinvestment Costs     (major data elements 1.3 and 2.3)	Estimate by each agency on future reinvestment costs near the end of UPA evaluation: Spring 2012			
Benefits				
Travel Time Savings     (major data elements 5.1, 5.2, and 5.3)	Future year travel time savings from the (recalibrated) SF CHAMP model: Fall 2012			
<ul> <li>Vehicle Operating Cost Savings (major data elements 6.1, 6.2, and 6.3)</li> </ul>	Future year cost savings from the (recalibrated) SF CHAMP model: Fall 2012			
Reduction in Emissions     (major data element 7.1)	Future year emissions reductions from the (recalibrated) SF CHAMP model: Fall 2012			

Table 4-1. Cost Benefit Data Collection Schedule

To summarize, the responsibility for this test plan includes:

- SFMTA, SFCTA, and MTC will provide the cost information on the San Francisco UPA projects. Battelle team members will simply add these costs to develop the total cost of the UPA projects.
- For the data needed from other test plans, the local partners will provide the data and national evaluation team will share the required data for the cost benefit analysis.
- SFCTA personnel will run the regional travel forecast model for four scenarios: year 1 with and without the UPA projects and year 10 with and without the UPA projects. SFCTA personnel will compare their model to the observed first year results as supplied by Battelle team members. If the model results are inaccurate, SFCTA personnel will attempt to recalibrate and rerun the model to reflect observed results. Based on these results:
  - If the SFCTA SF CHAMP model can accurately reflect the changes in travel caused by the UPA projects then the model will be used to supply a long term (10 year) estimate of travel time savings, vehicle miles traveled on links at different speeds, parking fees paid, user costs based on VMT, and the number of travelers of each mode.
  - If the model cannot be used then observed year one data for the above items will be used as an estimate for the impact of the UPA projects for each of the 10 years. Emissions reductions will be based on observed year one data in either case.
- Battelle team members will convert those estimates (travel time savings, VMT by speed, and emissions reductions) to dollar values. The summation of these dollar values are the total benefits of the UPA projects.

## APPENDIX A – COMPILATION OF HYPOTHESIS/QUESTIONS FROM THE SAN FRANCISCO UPA NATIONAL EVALUATION PLAN

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question	
Congestion	SFCong-1	The deployment of SF <i>park</i> and the 511 improvements will reduce traffic congestion on selected travel routes in the downtown area	
	SFCong-2	Travelers will perceive that congestion has been reduced	
Pricing	SFPricing-1	Parking pricing will increase parking availability	
	SFPricing-2	Parking pricing will lead to reduced search time and variability	
	SFPricing-3	Parking pricing will reduce double parking	
	SFPricing-4	Parking pricing will shorten the duration of the average on-street parking session	
	SFPricing-5	Parking pricing will improve reliability and speed of public transit	
	SFPricing-6	Parking pricing will cause a shift to other routes, modes, and other parking garages	
Telecommuting/	SFTele/TDM-1	TDM events will increase the demand for information about SF park and 511 enhancements	
TDM	SFTele/TDM-2	SF park and 511 enhancements will increase effectiveness of TDM program	
	SFTele/TDM-3	Distribution of UPA-related information at events will influence parking program awareness and behavior change	
Technology	SFTech-1	Implementing advance parking technology will improve agency ability to manage parking	
	SFTech-2	Improving the dissemination of parking information via 511 phone, websites, and text messaging, will reduce parking search times	
Equity	SFEquity-1	What are the direct social effects (parking fees, travel times, adaptation costs) for various transportation system user groups?	
	SFEquity-2	What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?	
	SFEquity-3	Are there any differential impacts on certain socioeconomic groups?	
	SFEquity-4	How does reinvestment of parking pricing revenues impact various transportation system users?	

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Environmental	SFEnv-1	SF <i>park</i> will improve air quality by reducing parking search times and shifting trips from car to transit
	SFEnv-2	The public will perceive an improvement in air quality resulting from SF park
	SFEnv-3	SF <i>park</i> will reduce fuel consumption by reducing parking search times and shifting trips from car to transit
Goods	SFGoods-1	CVO double parking will decrease in the SF park areas.
Movement	SFGoods-2	CVO double parking fines will decrease in the SF park areas.
	SFGoods-3	Parking availability, including loading and freight zones, will increase in the SF park areas.
	SFGoods-4	Travel times will decrease in the SF park areas for CVOs and other vehicles.
Business	SFBusiness-1	Sales will increase in the SF <i>park</i> areas.
	SFBusiness-2	Overall travel to access retail and similar businesses will increase in the SF park areas.
Non-Technical	SFNonTech-1	What role did factors related to "people" play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners)
	SFNonTech-2	What role did factors related to "process" play in the success of the deployment? Process (forums including stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on nature of the problem)
	SFNonTech-3	What role did factors related to "structures" play in the success of the deployment? Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures)
	SFNonTech-4	What role did factors related to "media" play in the success of the deployment? Media (media coverage, public education)
	SFNonTech-5	What role did factors related to "competencies" play in the success of the deployment? Competencies (cutting across the preceding areas: persuasion, getting grants, doing research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)
	SFNonTech-6	Does the public support the UPA/CRD strategies as effective and appropriate ways to reduce congestion?
Cost Benefit	SFCBA-1	What is the net benefit (benefits minus costs) of the UPA/CRD strategies?

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U.S. Department of Transportation ITS Joint Program Office-HOIT 1200 New Jersey Avenue, SE Washington, DC 20590

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