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National Evaluation:
Cost Benefit Analysis Test Plan

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ATLANTA
CONGESTION REDUCTION DEMONSTRATION

NATIONAL EVALUATION:
COST BENEFIT ANALYSIS TEST PLAN

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Prepared for

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16. Abstract

This report presents the test plan for collecting and analyzing cost and benefit data for the Atlanta Congestion Reduction Demonstration (CRD) under the United States Department of Transportation (U.S. DOT) Urban Partnership Agreement (UPA) and CRD Programs. The Atlanta CRD projects include the conversion of lanes for high occupancy vehicles (HOV) on approximately 16-miles of I-85 to high occupancy toll (HOT) lanes along with expansion and enhancement of transit service in that corridor, including new and expanded park-and-ride lots. The Cost Benefit Analysis Test Plan is based on the Atlanta CRD 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 responsibility for collecting, analyzing, and reporting the cost and benefit data are presented.

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LIST OF ABBREVIATIONS

4Ts	Tolling, Transit, Telecommuting, and Technology
AFV	Alternative fuel vehicle
ALPR	Automatic license plate reader
ARC	Atlanta Regional Commission
CAC	Clean Air Campaign
CBA	Cost benefit analysis
CO_2	Carbon dioxide
CRD	Congestion Reduction Demonstration
CVO	Commercial vehicle operator
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
Georgia Tech	Georgia Institute of Technology
GRTA	Georgia Regional Transportation Authority
HOT	High occupancy toll
HOT3+	High occupancy toll lane allowing untolled travel by vehicles with three or more occupants
HOV	High occupancy vehicle
HOV2+	High occupancy vehicle with a minimum of two occupants
HOV3+	High occupancy vehicle with a minimum of three occupants
MARTA	Metropolitan Atlanta Rapid Transit Authority
NO_x	Nitrogen oxide
O&M	Operation and maintenance
$PM_{(2.5)}$	Fine particulate matter
RFID	Radio frequency identification
SOV	Single-occupant vehicle
SRTA	State Road and Tollway Authority
TDM	Travel demand management
UPA	Urban Partnership Agreement
U.S. DOT	United States Department of Transportation
VOC	Volatile organic compounds
VMT	Vehicle miles traveled

1.0 INTRODUCTION

This report presents the test plan for collecting and analyzing cost and benefit data for the national evaluation of the Atlanta Congestion Reduction Demonstration (CRD) under the United States Department of Transportation (U.S. DOT) CRD program. The cost and benefit data will be used in one or more of the evaluation analyses contained in the Atlanta CRD National Evaluation Plan. This plan is one of ten test plans identified in the Atlanta CRD National Evaluation Plan.

The Atlanta CRD 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 Atlanta CRD national evaluation will address the four primary U.S. DOT Urban Partnership Agreement (UPA) evaluation questions shown in Table 1-1.

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

Objective Question #1	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: • reductions in vehicle trips made during peak/congested periods; • reductions in travel times during peak/congested periods; • reductions in congestion delay during peak/congested periods; and • reductions in the duration of congested periods.
Objective Question #2	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: • increases in facility throughput during peak/congested periods; • increases in transit ridership during peak/congested periods; • modal shifts to transit and carpools/vanpools; • traveler behavior change (e.g., shifts in time of travel, mode, route, destination, or forgoing trips); • operational impacts on parallel systems/routes; • equity impacts; • environmental impacts; • impacts on goods movement; and • effects on businesses.
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?
Objective Question #4	What are the overall costs and benefits of the deployed set of strategies?

The questions shown in Table 1-1 will be addressed by carrying out the following 12 "evaluation analyses" described in the Atlanta CRD National Evaluation Plan: congestion, tolling, transit, travel demand management (TDM), technology, safety, equity, environmental, goods movement, business impacts, non-technical success factors, and cost benefit. Each of these 12 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. There are a total of ten test plans for the Atlanta CRD national evaluation. In addition to this Cost Benefit Analysis Test Plan, there are test plans focusing on the following types of data: traffic, tolling, transit, TDM, safety, 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 describes the Atlanta CRD deployments and elaborates on the relationship between test plans and evaluation analyses. The remainder of the report is divided into three sections. Chapter 2 presents the data sources, data availability, and risks associated with the cost and benefit data collected through this test plan. Chapter 3 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 Atlanta CRD

Atlanta was selected by the U.S. DOT to implement projects aimed at reducing congestion based on a combination of 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 Atlanta 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 Atlanta CRD partnership is led by three public agencies—the Georgia Department of Transportation (GDOT), the Georgia Regional Transportation Authority (GRTA), and the State Road and Tollway Authority (SRTA). Other partners include Atlanta Regional Commission (ARC), Georgia Department of Public Safety, Metropolitan Atlanta Rapid Transit Authority

(MARTA), Gwinnett County Government, Clean Air Campaign (CAC), and Georgia Institute of Technology (Georgia Tech).

The Atlanta CRD partners have as a long-term regional goal an integrated system of congestion-priced lanes, enhanced transit service, and advanced technology on 49-miles of I-75, I-85, and I-20. The CRD will establish the first phase of that network on approximately 16 miles of I-85 from I-285 to Old Peachtree Road. The Atlanta CRD projects are described briefly below.

High Occupancy Toll (HOT) Lanes on I-85. As the first phase of a regional integrated system of congestion-priced lanes, the existing high occupancy vehicle (HOV) lanes will be converted to dynamically-priced HOT lanes, called Express Lanes, on approximately 16 miles of I-85 from Chamblee Tucker Road, just south of I-285, to just north of Old Peachtree Road in Gwinnett County. The Express Lanes are depicted in Figure 1-1. The occupancy requirement for using the Express Lanes toll-free will change from the two or more people on the current HOV lanes (HOV2+) to three or more people (HOT3+) and registration will also be required. Registered toll-exempt vehicles include vehicles with three or more people, motorcycles, alternative fuel vehicles (AFV) with GA AFV license plates (but not hybrids), transit, and emergency vehicles. Pre-registered vehicles with less than three occupants will be allowed on the Express Lanes by paying a toll. The lanes will operate with seven entry and exit points in the northbound direction and six in the southbound direction. Tolling will occur 24 hours a day and seven days a week in four southbound sections and five northbound sections. GDOT is responsible for the construction in the HOV to HOT conversion. SRTA will operate the tolling portion of the system.

Transit Enhancements. A total of 36 new buses will be added to the commuter bus fleet on the I-85 corridor, with 20 buses added in 2010 and 16 more in 2011. The expanded fleet will enable five new routes to operate on the corridor, the first of which began in August of 2010. GRTA will purchase the buses. GRTA is also responsible for the CRD-funded park-and-ride lot enhancements. These include three new lots—Mall of Georgia, Hamilton Mill, and Hebron Baptist, Dacula—and one expanded lot at I-985/GA 20. The Mall of Georgia lot was the first to open in August of 2010 with 750 leased spaces until the permanent lot opens at that location. Opening in June 2011 are 400 new leased spaces at Hebron Baptist, Dacula. Scheduled for July 2011 is the expansion of the I-985/GA 20 lot, which will add 384 spaces to the 347 that already exist today. The Hamilton Mill lot is scheduled to open in August 2011 with 918 spaces. In addition to the CRD-funded park and ride lots, the evaluation will include two other lots that are not funded by the CRD but could be impacted. These include the Discover Mills and Indian Trail Park and Ride Lots.

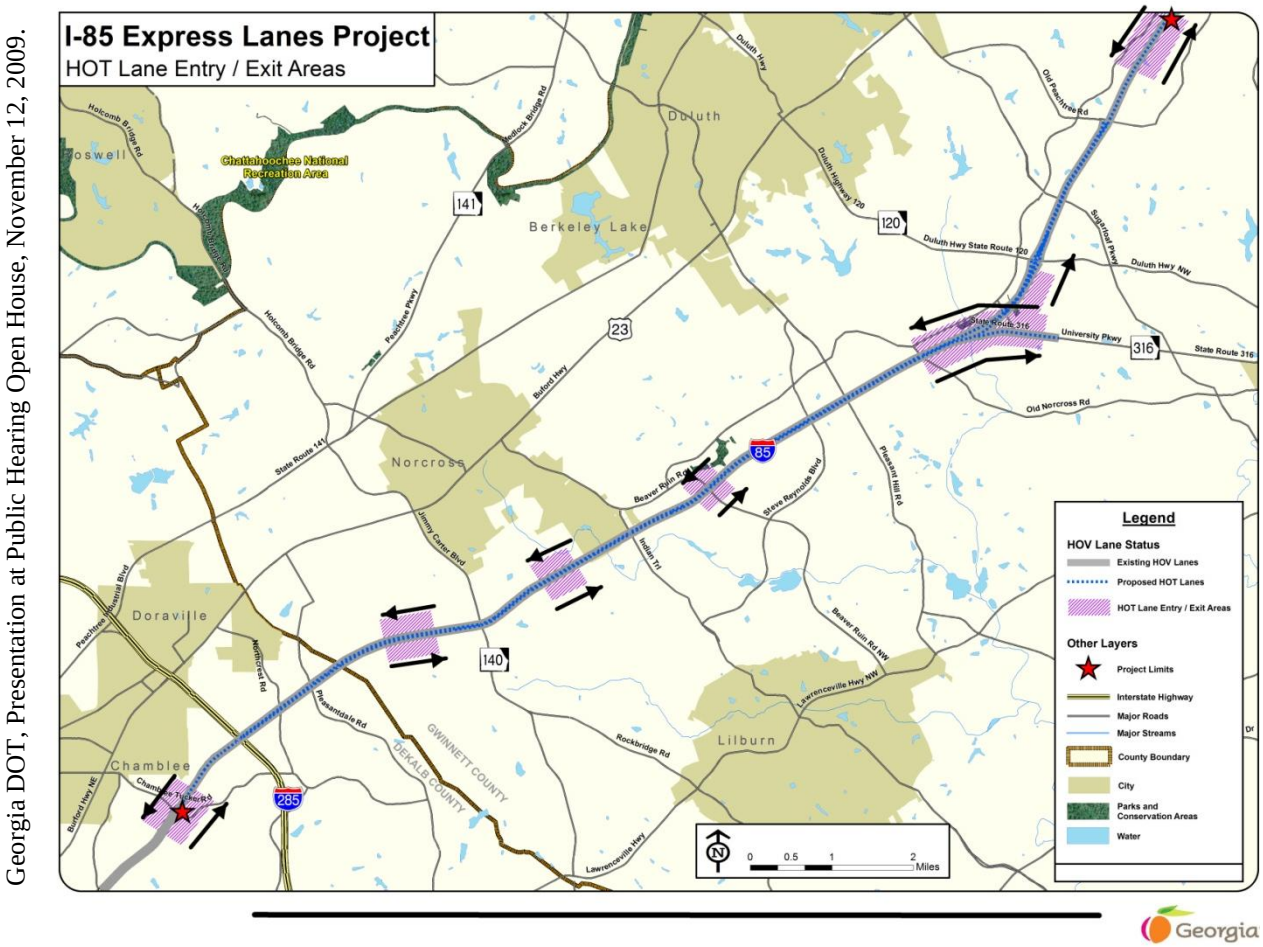

Figure 1-1. I-85 HOV to HOT Conversion Project

Automated Enforcement Systems. A gantry-controlled access system for the Express Lanes will consist of approximately 35 overhead gantries or existing structures placed in the median. Readers equipped with radio frequency identification (RFID) will read transponders, and cameras will collect images of vehicle license plates. This information will be used to identify toll violators. Mobile automatic license plate readers (ALPR) camera systems installed in enforcement vehicles will aid police officers with visual occupancy verification of vehicles using the Express Lane. Enforcement officials will be provided with an audible or visual alert if a license plate matches the database of registered HOT3+ users to prompt a visual inspection for vehicle occupancy compliance. Officers will upload a list of occupancy violations written during a shift to the Express Lanes back-office system.

Carpooling Outreach. To support the CRD projects, the Clean Air Campaign will undertake public outreach to increase the number of 3 person carpools in the I-85 Express Lanes corridor. Their efforts will focus on converting existing 2-person to 3-person carpools and on creating 3-person carpools from single-occupant vehicle (SOV) drivers. CAC will use existing carpooler databases to identify and contact 2-person carpoolers. In conjunction with SRTA, CAC will identify SOV commuters who travel in the I-85 Express Lanes and encourage carpool

formation. SOV drivers will also be targeted through outreach to employers in the I-85 corridor and to employers outside the corridor who may have employees who use the I-85 corridor.

Schedule for the Atlanta CRD Projects. The projects to be evaluated go into operation between August 2010 and July 2012. Table 1-2 presents the dates at which each of the Atlanta CRD projects are expected to be in operation.

Table 1-2. CRD Project Schedules

Projects	Operational Date
Express Lanes on I-85	September 2011
5 New Bus Routes	August 2010 – July 2012
Park-and-Ride Lots	August 2010 – August 2011
Automated Enforcement	September 2011
Carpooling Outreach	Spring 2011 – Winter 2012

1.2 Atlanta National Evaluation Plan and the Use of Cost Benefit Data

Table 1-3 shows which of the various Atlanta CRD 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. As shown in Table 1-3, the Cost Benefit Analysis Test Plan provides major input to the cost benefit analysis (CBA). Table 1-4 includes a summary of the cost benefit data elements, the measures of effectiveness and the hypotheses/questions the cost and benefit data will be used to evaluate.

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Table 1-3. Relationships Among Test Plans and Evaluation Analyses

Atlanta CRD Test Plans	Congestion Analysis	Tolling Analysis	Transit Analysis	TDM Analysis	Technology Analysis	Safety Analysis	Equity Analysis	Environmental Analysis	Goods Movement Analysis	Business Impact Analysis	Non-Technical Success Factors Analysis	Cost Benefit Analysis
Traffic System Data Test Plan	●	●		○	○	○		●	●			○
Tolling Data Test Plan		●					○		●			○
Transit System Data Test Plan			●				○	○				○
TDM Data Test Plan		○		●			○	○		○		○
Safety Data Test Plan					●	●						○
Surveys and Interviews Test Plan	○	○	●	●		○	●	○	○	○	●	○
Environmental Data Test Plan							○	●				○
Content Analysis Test Plan											●	
Cost Benefit Analysis Test Plan												●
Exogenous Factors Test Plan	○	○	○	○	○	○	○	○	○	○	○	○

● — Major Input ○ — Supporting Input

Table 1-4. Cost Benefit Analysis Test Plan Data Elements

Atlanta Data Element	Data Source	Atlanta CRD Measure of Effectiveness	Atlanta CRD Hypotheses/ Questions*
1.1 New investment in park and ride lots	GRTA	Net Benefits Benefit Cost Ratio	AtlCBA-1
1.2 Operation and maintenance (O&M) costs for the park and ride lots	GRTA		
2.1 New investment in the tolling system for the Express Lanes	GDOT		
2.2 Maintenance costs for the tolling system for the Express Lanes	GDOT		
2.3 Operations costs for the tolling system for the Express Lanes	SRTA		
2.4 Replacement costs for the tolling system for the Express Lanes	GDOT		
3.1 Operations costs for promoting HOV3+ on the new Express Lanes	CAC		
4.1 Investment in new buses and transit routes	GRTA		
4.2 O&M costs for the new buses and transit routes	GRTA		
5.1 Commercial vehicle travel time savings	ARC		
5.2 Personal vehicle travel time savings	ARC		
5.3 Transit rider travel time savings	ARC		
6.1 Commercial vehicle operating cost savings	ARC		
6.2 Personal vehicle operating cost savings	ARC		
6.3 Transit vehicle operating cost savings	ARC		
7.1 Reduction in emissions	ARC		
8.1 Reduction in crashes	ARC & GDOT		

*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 Atlanta CRD National Evaluation Plan.

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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 data drawn from three major sources. The first source is the detailed costs associated with the CRD projects. These data will be provided by the agencies that implement, operate and maintain the CRD projects, which include GDOT, GRTA and SRTA. The second source is the forecasts generated by Atlanta Regional Commission's Travel Demand Model (ARC Model), which will provide all of the benefits data used in the cost benefit calculations. The third source is data collected through other test plans, which will be used to calibrate the ARC model to observed, post-deployment year one national evaluation findings. Consistent with standard practice, the cost benefit analysis will consider a 10-year timeframe, comparing "with CRD projects" to "without CRD projects" scenarios. Thus, in addition to observed/actual costs and benefits, forecasted costs and benefits will also be required. Year one of the 10-year analysis period will be September 2011 to August 2012 since most of the CRD projects, including the I-85 Express Lanes, are scheduled to be operational by September 2011. Data from each of the three major data sources are described below.

Cost Data from Participating Agencies. Cost data will mainly be obtained from state and local government agencies participating in the CRD. Data include the implementation costs associated with 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.
  - Equipment and installation of gantries for the Express Lanes tolling system
  - Automated enforcement technologies for the Express Lanes
  - Transit expansion, including purchase of 36 new buses
  - Park-and-ride lot additions and expansion
- Operating and maintenance costs.
  - Operating and maintaining the expanded transit services
  - Operating and maintaining the new and expanded park-and-ride lots
  - Operating and maintaining the tolling system
  - Compliance costs for enforcing the toll facilities
  - Carpooling outreach
- Replacement and re-investment costs for CRD equipment and infrastructure, including the tolling system, the new transit buses, and the park-and-ride lots.

Table 2-1 provides a cost reporting scheme with detailed cost categories by type of project and by reporting agency.[1] Benefits are listed in Table 2-2. The costs to be considered in the cost benefit analysis should only include those annual expenditures up to August of 2021 incurred as

[1] 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 http://www.whitehouse.gov/omb/assets/a94/a094.pdf (page 9) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).

a result of implementing the CRD projects along I-85 and allocated to those I-85 CRD projects. Although additional CRD funds are allocated to transit activities outside of the I-85 corridor, the national evaluation is focused only on the impact (costs and benefits) along the I-85 corridor. In other words, only the marginal costs should be recorded and reported as the costs of the CRD projects. For instance, suppose that GRTA currently operates a bus fleet on the I-85 corridor with an annual operation budget of $1 million. Further, suppose that with the investment from the CRD projects, GRTA's annual operational budget for the bus fleet along the I-85 corridor 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. Another example would be the tolling customer service center. The costs of this service center will be allocated to all toll facilities it services. These will include the GA 400 Toll Road along with the I-85 Express Lanes and any additional tolling facilities that are planned to open by 2021. For example, if the annual cost of the service center was $3 million and one-third of the costs of this center could be attributed to I-85 Express Lanes then a cost of $1 million would be attributed to this cost element of the CRD for that year.

ARC's Travel Demand Model. This model will provide all of the benefits data related to congestion reduction resulting from the I-85 CRD projects. The model will be run using 2010 and 2020 traffic, area, and network data for two scenarios in each of those years:

1. Assuming none of the Atlanta CRD projects were implemented
2. With all of the Atlanta CRD projects along the I-85 corridor implemented as planned with the model calibrated to correspond to first year results as found in the test plans listed below.

Both scenarios will include other planned (non-CRD) projects for the area. A comparison of the two scenarios will provide the benefits data listed in Table 2-2 (including travel time savings, change in vehicle operating costs, and changes in health benefits due to reduced emissions). Changes in crashes will be obtained from the Safety Data Test Plan that examines actual changes in traffic along the I-85 corridor. These benefits will then be converted to monetary terms based on the standard values noted in Section 3.0. Benefits in intermediate years will be assumed to change uniformly (linearly) from year 1 to year 10.

Other Atlanta CRD Test Plans. Another important source of data for the cost benefit analysis is the other test plans. The data from the test plans include both pre- and post-deployment and will be used to validate (or calibrate) the ARC model. These data are critical since the benefits calculation relies on the ARC model's estimate of future traffic conditions for the 10 years following deployment of the CRD projects in 2011. Therefore, proper calibration of year one model results to observed data 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 vehicle miles-traveled (VMT), vehicle occupancy rates, number of vehicles, and travel times. Data for both personal vehicles and commercial vehicles will be needed.
- Transit System Data Test Plan – Data will focus on the change in transit travel time and the number of transit riders along the I-85 corridor.

- Environmental Data Test Plan – Data will focus on the change in (1) emissions from vehicles, including ozone precursors (specifically volatile organic compounds [VOC] and nitrogen oxide [NO_x]), greenhouse gas (CO_2) and fine particulate matter ($PM_{2.5}$), and (2) fuel consumption.
- Safety Data Test Plan – Data will include the number and severity of crashes along I-85.

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

- Toll Revenues (from the Tolling Data Test Plan): Tolls collected from vehicles paying to use the Express Lanes.
- Mode Shifting Data (from the Transit System Data Test Plan and Surveys and Interviews Test Plan): Number of people changing from driving to riding transit.
- Telecommuting Condition Data (from the TDM Data Test Plan and Surveys and Interviews Test Plan): Number of people changing from driving to telecommuting.

Table 2-1. Cost Reporting Scheme for the CRD Projects

Data Element	Reporting Agency	Data Sub-Element	Cost Sub-category	Year(*)					
				2010	2011	2012	2013	…	2021
1. *Park-and-Ride Lots (Mall of Georgia, Hamilton Mill, I-985/GA 20)*									
1.1	GRTA	Implementation Costs	All costs required to design and build the new Hamilton Mill and expand the I-985/GA-20 parking lots. Includes capital costs, engineering design and planning, construction labor, management, other. Notes: 1. Mall of Georgia and Hebron Baptist Dacula are leased lots. 2. Subtract salvage value.						
1.2	GRTA	Operation and Maintenance Costs	Marginal cost of repair, maintenance, operations, labor, etc. of the Mall of Georgia, Hamilton Mill, Hebron Baptist Dacula and I-985/GA 20 lots.						
2. *I-85 Express Lanes Tolling System*									
2.1	GDOT	Implementation Costs	All costs required to design and build the new tolling system on the I-85 Express Lanes. Includes electronic toll collection and digital video audit system equipment, automated gantries, computer hardware and software, labor. Also includes education and outreach costs associated with the environmental review and construction. Also includes construction costs to convert the HOV lane to a HOT lane.						
2.2	SRTA	Maintenance Costs	Cost of maintaining the new tolling system attributable to I-85. Includes toll, violation, and gantry equipment maintenance, hardware and software maintenance.						
2.3	SRTA	Operations Costs	Cost of operating the tolling system attributable to I-85. Items such as banking, oversight, labor, education, outreach. *Collections:* Account management, communication, payment processing, and labor. *Compliance:* Enforcement (both electronic and added law enforcement costs), violation processing, dispute resolution, labor.						

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

Data Element	Reporting Agency	Data Sub-Element	Cost Sub-category	Year(*)					
				2010	2011	2012	2013	…	2021
2.4	SRTA	Reinvestment Costs	Cost of replacement equipment for the tolling system. Includes computer upgrades / replacement, labor.						
3. *Carpooling and Transit Usage*									
3.1	CAC	Operation Costs	All costs required to operate the campaign to increase HOV 3+ use on the I-85 Express Lanes. This will include contacting HOV2s, advertising, outreach, etc.						
4. *New Buses and Bus Routes*									
4.1	GRTA	Implementation Costs	All costs required to purchase the new buses and begin the five new transit routes along I-85 (411, 413, 414, 416 and 417). Includes purchase price of the buses and any labor for route development. Note 1: subtract salvage value. Note 2: Downtown transit improvements are scheduled for after this evaluation period and are not included.						
4.2	GRTA	Maintenance Costs	Marginal cost of repair, maintenance, labor, etc. of the 36 new buses and the 5 new routes along I-85.						

* The shaded cells indicate that, given the CRD project deployment schedule, cost data most likely do not need to be collected for those years.

Table 2-2. Benefit Reporting Scheme for the CRD Projects

Major Data Element	Reporting Agency	Major Benefit Category	Benefit Sub-category	Year(*) 2010	2011	2012	2013	…	2021
5. *Travel Time Benefits*									
5.1	ARC	Commercial Vehicle Travel Time Savings	Includes travel time saved by commercial vehicles						
5.2	ARC	Personal Vehicle Travel Time Savings	Includes travel time saved by personal vehicles						
5.3	ARC	Transit Rider Travel Time Savings	Includes travel time saved by transit riders.						
6. *Vehicle Operating Cost Savings*									
6.1	ARC	Commercial Vehicle Operating Cost Savings	Includes both the fuel savings (minus taxes) and other operating cost savings for commercial vehicles due to congestion reduction.						
6.2	ARC	Personal Vehicle Operating Cost Savings	Includes both the fuel savings (minus taxes) and other operating cost savings for personal vehicles due to congestion reduction.						
6.3	ARC	Transit Vehicle Operating Cost Savings	Includes both the fuel savings (minus taxes) and other operating cost savings for transit vehicles due to congestion reduction.						
7. *Air Quality Improvements*									
7.1	ARC	Reduction in Emissions	Monetized value of reduced ozone precursors, (specifically VOC and NO_x), greenhouse gas (CO_2) and fine particulate matter ($PM_{2.5}$,).						
8. *Safety Improvements*									
8.1	ARC & GDOT	Reduction in Crashes	Monetized value of reduced crashes. Fatality, injury, or property damage only.						

(*) The shaded cells indicate that cost data most likely do not need to be collected for those years.
All benefits are for the 10-year period post-implementation of the CRD projects.

2.2 Data Availability

GDOT, GRTA, SRTA and CAC 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 Atlanta CRD projects are completed (September 2011 to August 2021). Agency staff will need to develop forecasts of these costs using their normal budgeting methods. Other data needed for the cost benefit analysis will be available from the other test plans and ARC's travel demand model.

2.3 Potential Risks

There do not appear to be any significant risks associated with obtaining cost information from the sources outlined previously. Other potential issues may arise during the data collection process, including delays in gathering data, inconsistency or duplication in the data, inability to accurately separate costs related to the new CRD projects 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 one specific potential risk is if the ARC travel demand forecast model can correctly estimate the impact of the new restrictions (raising free high occupancy lane use from two occupants to three occupants) and new allowances (SOV travel allowed for a toll) on the I-85 Express Lanes, the dynamic pricing on the Express Lanes, and the new and expanded park and ride lots and the other transit improvements causing mode, time-of-day and route shifting. There is a risk that the traffic forecast generated by the model may not fully capture travelers' behavior changes (including using new routes, modes and traveling at different times of day) due to CRD projects. To address the possible concerns with the travel demand forecast model, Battelle team members will work with the ARC, SRTA and GDOT staff to compare the year one model output to the observed year one data collected through the various national evaluation test plans. In the event the model results are inaccurate, it will be necessary for ARC to calibrate the model so that it accurately reproduces observed year one data. In effect, it will be telling the model what impacts the CRD projects are having on travel in year one and relying on the model to distribute these effects network wide and over the 10-year analysis period.

If the ARC model cannot be made to reproduce observed year one data, the fall-back approach will be to manually monetize observed year one benefits and then multiply those observed year one benefits by 10 to represent the 10 years of operational benefits. Note that there could be a significant ramp-up period where many travelers are changing their behavior due to the CRD projects. If this does happen, then the time-frame after the ramp-up period will be used as representative of impact of the CRD projects for years 2 through 10. In theory this would represent a conservative estimate of benefits since many key benefits of the CRD 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). The data analysis procedures discussed in Chapter 3 assume that the ARC model will be capable of providing the forecasted data.

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3.0 DATA ANALYSIS

This chapter describes how the data described in Chapter 2 will be used to develop the net benefits of the Atlanta CRD deployment.

The cost benefit analysis timeframe will begin with the first expenses incurred and end after 10 full years of operation in August 2021. The 10-year timeframe was selected since many aspects of all CRDs and UPAs are technology- or pricing-related. Both technology and pricing systems have relatively short life spans. For example, the three U.S pricing systems that have been open long term (10+ years) have changed considerably in their relatively short life-spans:

- SR-91 Express Lanes: changed ownership, changed charging of HOV3+ (twice), and significantly changed pricing
- 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.

The few items with useful lives longer than 10 years, such as a park and ride lot, will be accounted for by including their salvage value at the 10 year point.

Within this evaluation time frame, the cost benefit analysis will estimate and compare net benefits and costs between two scenarios—without implementation of the Atlanta CRD projects and with implementation of the Atlanta CRD projects (including only those projects along the I-85 corridor and excluding the downtown transit improvements which are scheduled for construction too late to be included). All costs and benefits will be calculated in real terms (dollars) based on discount factors discussed below.

The basic procedure for calculating the net benefit is to monetize the benefits experienced by travelers due to the I-85 CRD projects and then subtract the costs incurred by the Atlanta CRD projects along I-85. The major components outlined below briefly describe how the net benefit will be calculated. Note that, as discussed in Section 2.3, the model results will be calibrated using observed data collected as part of the national evaluation test plans. The calibrated model will then be used to estimate 10 years of post-deployment benefits for travel time savings, vehicle operating cost savings, and emissions benefits. Safety benefits will be obtained through observations of changes in the number and severity of crashes. The values shown below 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 cost benefit 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:
    - ARC's travel demand model will provide the amount of travel time saved associated with travel in personal vehicles. This amount of time will be converted to a monetary value using standard values of time supplied by the FHWA in Table 4 from http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf. The value of time for the year 2000 was $11.20 based on local travel, weighted by the average of both business and other 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.

  - ARC's travel demand 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.
  - ARC's travel demand 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 http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf. 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, fuel efficiencies under different driving speeds, and miles traveled. ARC's travel demand model can provide disaggregate information on vehicle travel distance under different driving speeds as well as some portion of distance-based vehicle operating costs experienced by drivers. The non-fuel costs rely on average repair and maintenance costs (identified by the U.S. DOT) and miles traveled. For fuel cost savings, the cost of fuel (minus taxes) for 2011 will be obtained from actual values as supplied by the U.S. Energy Information Administration on their website: http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_r1z_w.htm. Future year estimates for fuel prices 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_Final_Rule_MY2011_FRIA.pdf).

  Table 3-1 presents future year gas prices based on that document.

Table 3-1. Future Year Gas Prices

Year	Forecast Gasoline Price Excluding Taxes (2007 $/gallon)
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

- **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). 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/CAFE_Final_Rule_MY2011_FRIA.pdf, Table VIII-5).

  Future year values are taken from the Highway Economic Requirements System documentation. ARC's travel demand model will supply the change in emissions amounts for: ozone precursors (specifically volatile organic compounds [VOC] and nitrogen oxide [NO_x]), greenhouse gas (CO_2) and fine particulate matter ($PM_{2.5}$,). These values will be provided for the 10-year timeframe of the analysis. The total value of this change will be calculated using the values in Table 3-2 and Table 3-3 multiplied by the emissions amounts.

Table 3-2. Current Values of Reduced Emissions

Pollutant	Cost (2007 $)
CO	$ -
VOC	$1,700 per ton
CO_2	$21 per metric ton[2]
NO_X	$4,000 per ton
$PM_{2.5}$	$168,000 per ton
SO_2	$16,000 per ton

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

Pollutant	Cost in 2015	Cost in 2020
CO	$ -	$ -
VOC	$1,200 per ton	$1,300 per ton
CO_2	$24 per metric ton[2]	$26 per metric ton[2]
NO_X	$4,900 per ton	$5,300 per ton
$PM_{2.5}$	$270,000 per ton	$290,000 per ton
SO_2	$28,000 per ton	$31,000 per ton

- **Safety benefits from the improvement in safety conditions.** Reduced vehicle miles of travel and reduced congestion can both lead to a reduction in crashes. The computation of the safety benefits depends on the number of crashes by crash severity levels and the cost associated with each crash. The number and severity of crashes will be provided by the Safety Data Test Plan. The Safety Data Test Plan relies primarily on actual reported crashes before and after the implementation of the CRD projects. The cost of a crash, by crash severity, will be estimated using guidance for the National Highway Traffic Safety Administration (e-mail correspondence with DOT) as shown in Table 3-4, with the value of a statistical life equal to $6 million in year 2009 dollars. For this CBA the final column values (comprehensive cost of crash avoidance) will be used.

[2] The CO_2 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

Table 3-4. Unit Costs for Police-Reported Injury Scale (KABCO) (2008 $)

Police-Reported Injury		Economic Cost		Comprehensive Cost*	
		Crashworthiness	Crash Avoidance	Crashworthiness	Crash Avoidance
O	No Injury	$68,185	$74,129	$198,819	$204,764
C	Possible Injury	$109,001	$115,088	$300,950	$307,037
B	Non Incapacitating	$263,973	$273,270	$732,628	$741,925
A	Incapacitating	$1,663,924	$1,701,826	$4,740,561	$4,778,463
K	Killed	$1,248,086	$1,272,912	$6,314,875	$6,339,701
U	Injury Severity Unknown	$100,776	$102,832	$291,925	$293,982

*Based on $6.0 million value of a statistical life

- **Implementation costs, operating and maintenance costs, and replacement and re-investment 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 webpages http://www.whitehouse.gov/omb/assets/a94/a094.pdf (page 9) and http://www.whitehouse.gov/sites/default/files/omb/assets/omb/circulars/a004/a-4.pdf (page 33) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).
- **Salvage value.** Two items that will be purchased under this CRD have useful lives longer than the 10-year evaluation timeframe. Therefore, the salvage value of the items at the end of year 10 should be subtracted from their initial cost. The methodology is outlined at http://www.dot.state.mn.us/planning/program/benefitcost.html and is calculated as follows:

$$\text{Salvage Value} = \frac{(1+r)^n \times \left[\left(\frac{(1+r)^L - 1}{r(1+r)^L}\right) - \left(\frac{(1+r)^n - 1}{r(1+r)^n}\right)\right]}{\left(\frac{(1+r)^L - 1}{r(1+r)^L}\right)}$$

Where r = the discount rate (0.07)

n = number of years in the analysis period (10)

L = useful life of the asset

The two CRD investments to which salvage values will be applied are:

- **Park and Ride Lots.** This includes one new lot (Hamilton Mill) and one expanded lot (at I-985 and GA 20). It does not include the new lots at the Mall of Georgia and at Hebron Baptist Dacula since those will be leased by GRTA. These two lots will cost $8,345,000 to build. A park and ride lot has a useful life (L) of 40 years and, using the above formula, will have a salvage value of 93% * $8,345,000 = $7,761,000 in 2021.

- **The Transit Buses.** The buses have a useful life of 12 years and will therefore have a salvage value of 22.8 percent or $109,000 in the year 2021. Note, discussions with GRTA indicated that the agency often sells these $480,000 over-the-road-coaches after 12 years of use for $50,000 to $150,000. Therefore, the estimate here of $109,000 after 10 years appears reasonable.

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.

Another item of interest, mode shifts, will be calculated but is not part of the cost benefit analysis. This includes shifting between driving alone, riding transit, telecommuting and carpooling.

Two other items that will not be included in the benefit cost analysis are the Express Lanes tolls and any construction impacts. Toll revenue is a transfer of wealth (from the traveler to the toll authority) 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 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, a new rail line, hospital, etc.) would be the subject of a separate benefit cost analysis. Construction impacts on current travelers are expected to be minimal (for example, the gantries that will be used for tolling should not cause delays to travelers) and not worth including in this analysis.

4.0 SCHEDULE AND RESPONSIBILITY

The schedule for collecting data for the cost benefit analysis is shown in Table 4-1. The schedule is based on the deployment schedule for the Atlanta CRD projects. The cost benefit analysis will be initiated prior to deployment of the Atlanta CRD projects and will be completed after the Express Lanes on I-85 has been in operation for one year. Operation of the Express Lanes is scheduled to begin in September 2011. Note, this will mean data from the new Cedars Road Park and Ride Lot will not be included due to its construction scheduled for mid-2012. As indicated in Table 4-1, data will be collected periodically, tied to CRD deployment milestones.

Table 4-1. Cost Benefit Data Collection Schedule

Data Category	Reporting Schedule
Costs	
• Implementation Costs (data elements 1.1, 2.1 and 4.1)	Upon Completion of Installation: 1.1 P&R Lots: – I-85/GA 20: July 2011 – Hamilton Mill: July 2011 2.1 – I-85 Tolling: September 2011 4.1 – Transit Improvements along I-85: Early 2012
• Operation and Maintenance Costs (data elements 1.2, 2.2, 2.3, 3.1 and 4.2)	Report for each data element after fiscal year end books completed: 1.2 – P&R Lots, GRTA: September 2010, 2011, 2012 2.2 – I-85 Tolling System, SRTA: September 2011, 2012 2.3 – I-85 Tolling System, SRTA: September 2011, 2012 3.1 – Carpooling, CAC: September 2010, 2011, 2012 4.2 – Transit Improvements, GRTA: September 2010, 2011, 2012
• Reinvestment Costs (data element 2.4)	Estimate by each agency regarding future reinvestment costs near the end of CRD evaluation: 2.4 – I-85 Tolling System, SRTA: November 2012
Benefits	
• Travel Time Savings (data elements 5.1, 5.2, and 5.3)	Future year travel time savings from the (recalibrated) ARC travel demand model: November 2012
• Vehicle Operating Cost Savings (data elements 6.1, 6.2, and 6.3)	Future year cost savings from the (recalibrated) ARC travel demand model: November 2012
• Reduction in Emissions (data element 7.1)	Future year emissions changes from the (recalibrated) ARC travel demand model: November 2012
• Reduction in costs associated with vehicle crashes (data element 8.1)	Future year crash reductions from observations as part of the safety evaluation plan: November 2012

The responsibility for this test plan includes:

- GDOT, SRTA, GRTA and the CAC will provide the cost information on the Atlanta CRD projects along I-85. National evaluation team members will sum these costs to develop the total cost of the I-85 CRD projects.
- ARC will run its regional travel forecast model to generate the travel forecasts for the 10-year post-deployment time frame. ARC will compare the model output to the observed year one post-deployment results developed by the national evaluation team. If the model results are inaccurate, ARC will recalibrate and rerun the model to reflect observed results. Using the model, the local partners will supply a long term (10 year) estimate of travel time savings, vehicle operating cost reductions, and emissions reductions caused by the CRD projects.
- The national evaluation team will convert the above estimates (change in travel time savings, vehicle operating cost changes, emissions changes and crash changes) to dollar values using the most recent values from sources noted in section 3.0. The summation of these dollar values are the total benefits of the CRD projects.

APPENDIX A – COMPILATION OF HYPOTHESIS/QUESTIONS FROM ATLANTA CRD NATIONAL EVALUATION PLAN

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Congestion	AtlCong-1	Converting the I-85 HOV lanes to HOT operations will improve travel time and average travel speeds on both the general purpose and high occupancy lanes on I-85
	AtlCong-2	Converting the I-85 HOV lanes to HOT operations will improve travel time reliability and reduce variability on both the general purpose and high occupancy lanes on I-85
	AtlCong-3	Deploying the CRD improvements will result in more vehicles and persons being served on I-85
	AtlCong-4	Implementing the CRD improvements in the I-85 corridor will reduce the spatial and temporal extent of congestion
	AtlCong-5	As a result of the CRD improvements, the perception of travelers is that congestion has been reduced in the I-85 corridor
Pricing	AtlTolling-1	Tolling will increase vehicular throughput on I-85 Express Lanes and improve travel reliability
	AtlTolling-2	What changes in usage will occur as a result of the conversion of the HOV2+ lanes to HOT3+ lanes?
	AtlTolling-3	How much will travelers utilize the I-85 Express Lanes system?
	AtlTolling-4	Variable pricing on the I-85 Express Lanes will regulate vehicular access so as to improve the operation of the lanes
Transit	AtlTransit-1	Atlanta CRD project will enhance transit performance in the I-85 corridor
	AtlTransit-2	Atlanta CRD project will increase ridership and facilitate a mode shift to transit within the I-85 corridor
	AtlTransit-3	Increased ridership / mode shift to transit will contribute to congestion mitigation within the I-85 corridor
	AtlTransit-4	What was the relative contribution of each Atlanta CRD project element to increased ridership and/or mode shift to transit within the I-85 corridor?

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
TDM	AtlTDM-1	Promotion of commute alternatives removes trips and vehicle miles traveled (VMT) from I-85
	AtlTDM-2	CAC incentives support formation of 3+ carpools and vanpools on I-85
	AtlTDM-3	What was the relative contribution of the Atlanta CRD TDM initiatives on reducing I-85 vehicle trips/VMT?
Technology	AtlTech-1	Using advanced technology to enhance enforcement will reduce the rate and type of violators in the corridor
Safety	AtlSafety-1	The collective impacts of CRD improvements will be safety neutral or safety positive
	AtlSafety-2	Gantry-controlled access technology will reduce incidents related to violations for crossing the double white line
	AtlSafety-3	Tolling strategies that entail unfamiliar signage will not adversely affect highway safety
Equity	AtlEquity-1	What are the direct social effects (travel times, tolls, and adaptation costs) for various transportation system user groups from tolling and other CRD strategies?
	AtlEquity-2	What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?
	AtlEquity-3	Are there any differential environmental impacts on certain socio-economic groups?
	AtlEquity-4	How does reinvestment of toll revenues impact various transportation system users?
Environmental	AtlEnv-1	What are the impacts of the Express Lanes project in the I-85 corridor on air quality?
	AtlEnv-2	What are the impacts on energy consumption?
Goods Movement	AtlGoods-1	Commercial vehicle operators (CVOs) will experience reduced travel time by reduced congestion on general purpose lanes
	AtlGoods-2	Operators with light-duty trucks will prefer to use Express Lanes to general purpose lanes for faster travel times
	AtlGoods-3	Operators delivering goods will perceive the net benefit of tolling strategies (e.g., benefits such as faster service and greater customer satisfaction outweigh higher operating costs due to tolls)
	AtlGoods-4	Operators report changing operational decisions due to use of Express Lanes (e.g., changing delivery times)

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Business	AtlBusiness-1	What is the impact of the strategies on employers? e.g., employee satisfaction with commute and increased employment-shed to downtown/mid-town Atlanta
	AtlBusiness-2	What is the impact of the strategies on businesses that rely on customers accessing their stores, such as retail and similar establishments?
	AtlBusiness-3	How are businesses that are particularly impacted by transportation costs affected (e.g., taxis, couriers, distributors, tradesmen)?
Non-Technical	AtlNonTech-1	What role did factors related to “people” play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners)
	AtlNonTech-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)
	AtlNonTech-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)
	AtlNonTech-4	What role did factors related to “media” play in the success of the deployment? Media (media coverage, public education)
	AtlNonTech-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)
	AtlNonTech-6	Does the public support the UPA/CRD strategies as effective and appropriate ways to reduce congestion?
Cost Benefit	AtlCBA-1	What is the net benefit (benefits minus costs) of the Atlanta CRD projects?

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