APPENDIX D: BENEFIT-COST ANALYSIS

CRENSHAW/LAX TRANSIT CORRIDOR PROJECT
Benefit-Cost Analysis

Metro

August 20, 2010

TRANSPORTATION INVESTMENT GENERATING ECONOMIC RECOVERY DISCRETIONARY GRANT (TIGER II) PROGRAM

TIGER II DISCRETIONARY GRANT REQUEST

Submitted by

Los Angeles County Metropolitan Transportation Authority

Project Type:
Multimodal (transit, pedestrian, bicycle, roadway)

Project Location:
Los Angeles County
California

Type of Jurisdiction:
Urban

Congressional Districts:

33rd – Diane Watson
35th – Maxine Waters
36th – Jane Harman

Benefit-Cost Analysis:
Appendix D

BENEFIT-COST ANALYSIS
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I INTRODUCTION & SUMMARY OF KEY FINDINGS

There are four types of quantifiable benefits associated with the Crenshaw/LAX Transit Project:

1. Direct Transit User Benefits. The economic value of changes in consumer surplus (for both existing and new transit riders), due to travel time and cost savings vs. other travel modes. The value of reduced medical costs from increased and regular physical activity associated with walking or biking to/from stations also accrues directly to transit users. Time and cost savings, as well as a measurable improvement in individual health and well-being, represent a valuation of ***Livability***.

2. Indirect User Benefits. The economic value of congestion and accident reduction within the regional street and highway network attributable to a mode shift to transit (***Safety***) and positive impacts to property values brought about by improved accessibility and new development (***Economic Competitiveness***).

3. External/Societal Benefits. The net economic value of reduced environmental pollution and energy use arising from changes in travel behavior to support ***Sustainability***.

4. Transit Operator Benefits. The economic value of more efficient operation and maintenance, including the elimination of duplicative services and facilities. This relates to the concept of ***State of Good Repair***.

The primary results of the economic analysis are summarized in Tables I-1, I-2, and I-3. At a 7% real discount rate, the Present Value (PV) of the project's total benefits is $1,407 million (in 2010 dollars) for the Base Case scenario, including both recurring and one-time benefits. The PV of the project costs is $1,304 million (in 2010 dollars), for a benefit-cost ratio of 1.08. At a 3% discount rate, the PV of the project benefits and costs would be $3,222 million and $2,047 million, respectively, for a benefit-cost ratio of 1.57.

Table I-1 - Summary of Project Benefits - Ongoing (in millions of dollars)

Benefits Category (2010$, in millions)	Total Discounted Value of Benefits (2010-2057, NPV @ 7%)	Total Annual Benefit, 2010$ (forecast year 2035)
Travel Time Savings	308.59	43.58
Travel Cost Savings	121.10	16.71
Parking Cost Saving Benefits	37.26	5.14
Individual User Health Benefits	17.14	0.47
Accident Reduction Savings	135.40	18.68
Vehicle Operating & Auto Ownership Costs	205.85	29.43
Pollution Reduction Benefits	65.90	9.09
Greenhouse Gas Reduction Benefits	32.90	0.74
Transit Operator Benefits	66.58	6.86
Total	**990.72**	**130.70**

Table I-2 - Summary of Project Benefits - Non-Recurring (in millions)

Benefits Category (2010$)	Total Discounted Value of Benefits (2010-2057, NPV @ 7%)	Average Annual Benefit in Millions of Dollars (2018- 2027)
Property Value Increase – New Accessibility	71.86	17.58
Property Value Increase – Developability	359.32	87.9
Total	**431.18**	**105.48**

Table I-3 – Calculation of Benefit-Cost Ratio for Project

Discount Rate	7%	3%
Total Costs	$1,304.72	$2,047.07
Total Benefits	$1,407.15	$3,222.93
Net Present Value (NPV)	$102.43	$1,175.85
Benefit-Cost Ratio	**1.08**	**1.57**

II KEY ANALYTICAL ASSUMPTIONS

Discount Rate

The U.S. Office of Management and Budget (OMB) currently requires U.S. Federal agencies to use a 7% real discount rate to evaluate public investments and regulations. In keeping with this standard, the analysis assumes a discount rate of 7%. An alternate scenario with a discount rate of 3% was also calculated. The benefit-cost ratio with the 3% discount rate is warranted for the Crenshaw/LAX Transit Corridor Project since the alternate use of funds dedicated to the project would be other public expenditures.

Evaluation Period

Benefits and costs are evaluated over the construction and operations period from 2010 through 2057, which includes 40 years of benefits after substantial project completion in 2018, based on the expected useful life of the capital investments.

III CALCULATION OF BENEFITS

Reductions in Regional Vehicle Miles Travelled (VMT)

Reductions in annual regional VMT realized as a result of the Crenshaw/LAX Transit Corridor project forms the basis for the calculation of direct and indirect user benefits as well as external/societal benefits, including accident reduction, vehicle operating & auto ownership cost savings, and pollution reduction savings.

As shown in Table III-1, updated regional travel demand estimates from the 2035 regional model (reflecting the new Long Range Transportation Plan) suggest significant reductions in auto travel due to the project both for the immediate study area and for the Los Angeles County region as a whole. For almost all facility types, there is a significant reduction in regional travel with the implementation of the Crenshaw/LAX LRT Project. Regionwide, there is a reduction in VMT of 363,083 whereas in the corridor, there is a reduction of 16,085 miles traveled.

Table III-1 – Reduction in Daily Vehicle Miles Traveled (VMT)

	Regional			Study Area		
	No Build	With Project	Reduction with Project	No Build	With Project	Reduction with Project
Freeways	213,762,876	213,608,844	154,032	1,926,228	1,922,064	4,164
Principal Arterials	51,263,510	51,239,899	23,611	1,214,296	1,208,758	5,538
Minor Arterials	124,327,750	124,154,832	172,918	698,454	694,422	4,032
Major Connectors	48,442,850	48,433,156	9,694	430,684	427,980	2,704
HOV 2+	45,089,494	45,110,163	-20,669	378,646	379,824	-1,178
Freeway ramps	7,315,359	7,291,884	23,474	83,179	82,354	825
HOV 3+	1,709,750	1,709,112	638	0	0	0
Toll Road	8,050,610	8,051,225	-615	0	0	0
Total	**499,962,197**	**499,599,114**	**363,083**	**4,731,487**	**4,715,401**	**16,085**

As shown in Table III-2, using an annualization factor of 305 (days) for highway related impacts, the reductions in VMT are 110 million miles for the region and 4.9 million miles for the study area. These significant reductions have the potential to significantly improve safety benefits to the entire Southern California region as a result of the Crenshaw/LAX project.

Table III-2 - Annual Reductions in VMT, Regionwide and in Study Area

	Daily	Annual
Total Regional Reduction (miles)	363,083	110,740,193
Total Study Area Reduction (miles)	16,085	4,905,986

Ridership

Another critical set of information in the calculation of benefits is ridership. The Los Angeles Regional Travel Demand Model has been updated to reflect recent updates to the Long Range Transportation Plan. This plan includes an extensive expansion of the transit network by 2035. By 2035, the Crenshaw / LAX line will be part of a unified service from Crenshaw / Exposition in the north to Torrance in the south that includes a rail extension called the South Bay Metro Green Line Extension. Table III-3 indicates that the entire line is estimated to have a daily ridership of 27,460 and that the Crenshaw / LAX line alone, the estimated ridership is 21,930.

Table III-3 - Estimated Ridership for the Crenshaw/LAX Transit Corridor

	Daily Ridership by station
Crenshaw / Exposition	6,170
Crenshaw / Martin Luther King Jr.	1,290
Crenshaw / Vernon	-
Crenshaw / Slauson	1,400
Florence / West	1,440
Florence / La Brea	2,020
Aviation / Manchester	2,160
LAX Connection (Aviation / Century)	3,720
Metro Green Line Connection (Mariposa through Marine)	3,730
Total Crenshaw / LAX Line Ridership (Crenshaw / Exposition to Redondo Beach**)	21,930
Total Ridership of Line with South Bay Extension	27,460

Source: LACMTA Travel Demand Model, estimates for 2035 developed in April 2010.

III-A Direct User Benefits

III-A-1 LIVABILITY

Travel Time Savings.

Both existing and new transit users will benefit from substantial travel time savings and increased connectivity throughout LACMTA's Rail network. For passengers transferring between the Expo Line at Crenshaw/Exposition Station and the Metro Green Line at Mariposa, for example, the connection via the new Crenshaw/LAX LRT will be 21.6 minutes shorter than the current bus route.

To convert the reduction in hours travelled by transit users into monetary terms, travel time is typically valued as a percentage of the average wage rate, with different percentages by trip period. Time savings for personal travel (all modes) is valued at 60% of the average wage rate during the peak period, and at 50% during the off-peak period. For this analysis, assumptions for value of time (VOT) estimates, as percentages of the average wage per job, were derived from the Bureau of Economic Analysis, Regional Quarterly Report. In Los Angeles County, the average wage per job was $45,113 (2010 dollars).

This figure is divided by the number of working hours per year (2,080) to calculate the average hourly wage, with the percentages above applied to yield the hourly VOT estimates shown in Table III-4.

Historically, wages and salaries have increased, on average, at a higher annual rate than general price inflation. Between 1970 and 2010, per capita personal incomes in Los Angeles County grew at an inflation-adjusted average annual rate of 0.62%, roughly the same as for the State of California as a whole (Source: Bureau of Economic Analysis). Based on the historical trends for real wages, the VOT derived from them are also assumed to grow by 0.62% per year from 2010 forward over the project evaluation period.

Table III-4 - Calculation of Annual Travel Time Savings (based on 2035 ridership and escalated 2035 VOT)

	Reduction in Hours Travelled	Hourly VOT	Total VOT
Peak Period	6,169	$ 15.18	$ 93,656
Non-Peak Period	3,634	$ 12.64	$ 45,934
Total Daily	9,803		$ 139,590
Total Annual	3,026,758	$14.40	**$43,584,836**

Travel Cost Savings for Inbound LAX Passengers

The calculation of the reduction in parking costs captures the savings achieved by LAX passengers who would have otherwise incurred a charge to park their vehicle at the airport on outbound trips. A comprehensive estimate of travel cost savings for transit users should also include inbound LAX passengers, primarily tourists or business travelers, who are induced to use public transit for their mobility needs on short-term visits and therefore diverted from more expensive travel modes such as taxi or rental cars. Since the regional travel demand model does not account for airport passengers and tourists in its estimates, it is appropriate to calculate the benefit for reduced costs separately, which is reflected in Table III-5.

The travel cost savings would represent the difference between the cost of transit fares and the cost of taxi fares and/or rental cars. In the 2006 travel survey of airport passengers, the mode share of taxis and rental cars was 10.4% and 9.0%, respectively. The diversion rate from taxis and rental cars is expected to be minor – 4% and 1% of all trips, respectively. During 2009, the last year for which statistics are available, the annual number of passenger trips was 56,520,843. As shown in the table below, total annual savings are projected to be $16.7 million.

Table III-5 - Calculation of Annual Cost Savings from Inbound LAX Passengers Choosing Transit

Estimated Annual Trips Originating at LAX Airport*	**56,520,843**		
	Taxi	**Rental Car**	**Total**
Share of Passengers Using Mode*	10.40%	9.00%	
Annual Trips by Mode	5,878,168	5,086,876	10,965,044
Diversion Rate from Non-Transit Travel Mode	4.00%	1.00%	
Trips Diverted-Outbound	235,127	50,869	109,650
% involving roundtrip fare savings*	35%	n/a	
Additional Trips Diverted	82,294	n/a	
Total Trips Diverted	317,421	50,869	
Average Cost Savings Per Trip	$35.00	$50.00	
Average Overnight Stay (days)	n/a	2.2	
Total Average Cost Savings Per Trip	$35.00	$110.00	
Total Annual Savings	$11,109,737	$5,595,563	**$16,705,300**

Parking Cost Savings

The reduction in parking costs attributable to the Crenshaw/LAX Transit Project counts new transit riders who would have otherwise incurred the cost of parking at trip destinations both along the Crenshaw/LAX Transit Corridor and beyond via connecting transit lines. These trip destinations include two travel zones with paid parking, primarily LAX Airport and Downtown Los Angeles. The average daily prices for parking are based on a study conducted by the City of Los Angeles for the Downtown Central Business District in 2003, as well as informal surveys of private parking operators in these zones.

Because a transfer to the Expo Line is required at the Crenshaw/Expo Station for downtown destinations, the number of daily trips undertaken on Crenshaw/LAX LRT ending in this zone is estimated to be low, based on the competitiveness of travel times between transit and auto. Only a small fraction of the total daily ridership is therefore anticipated to divert from auto and benefit from parking cost savings in the downtown area. For the LAX Airport area, a higher percentage of riders, including local residents and business travelers who do not ordinarily use transit for work-related trips, are expected to be diverted from auto.

As shown in Table III-6, the total annual savings from avoided parking costs amounts to $5,139,893 in the horizon year, 2035. This discussion and estimate focuses only on direct parking cost savings accrued by users and ignores the indirect savings gained by employers who would provide parking spaces at a free or subsidized cost parking to their employees.

Table III-6 – Calculation of Annual Parking Cost Savings

	Downtown CBD	LAX Airport	Total
Estimated Daily Trips Ending in Paid Parking Zones	1,693	798	
Diversion Rate from Auto Travel	30.00%	60.00%	
Trips Diverted Daily	508	479	
Annualization Factor	255	365	
Total Annual Trips Diverted	129,513	174,762	304,275
Average Daily Cost Savings Per Trip	$10.00	$10.00	
Average Parking Duration (days)	1.0	2.2	
Total Average Cost Savings Per Trip	$10.00	$22.00	
Total Annual Savings	$1,295,129	$3,844,764	**$5,139,893**

Source: Downtown CBD Parking Study, City of Los Angeles

User Health Benefits

A number of studies have examined the relationship between community health and the built environment. While the root factors behind weight-related diseases are complex, a broad scientific consensus has emerged pointing to the prevalence of auto travel in American cities—and consequent lack of opportunities for routine daily exercise via walking or biking—as a contributing factor in increased body fat percentages, incidences of obesity, and chronic medical conditions such as diabetes and high blood pressure.

The Center for Disease Control recommends that adults average at least 22 minutes in moderate daily physical activity, such as brisk walking, to stay fit and healthy. Overall, fewer than half of American adults achieve this target, but most public transportation users meet this target while walking to and from transit stations. In multivariate analysis, rail users, minorities, people in households earning <$15,000 a year, and people in high-density urban areas are more likely to spend ≥30 minutes walking to and from transit daily.

In a study published in the August 2010 issue of the *American Journal of Preventive Medicine*, the use of transit by patrons of a new LRT system in Charlotte, North Carolina was associated with an average -1.18 reduction in Body Mass Index (or an average weight loss of 6.45 lbs per person) compared to non-LRT users in the same area over a 12-18 month follow-up period. Over time, these users also reduce their odds of becoming obese by 81%.

Concurrently, new research by the journal *Health Affairs* shows medical spending averages $1,400 more a year for an obese person than for a person of normal weight. Even modest amounts of physical activity can reduce annual medical costs by $500 for people under 60, and by as much as $750 for people over 60, for those who are not necessarily overweight or obese.

Lower-income communities in South Los Angeles, including some of the neighborhoods served by the Crenshaw/LAX LRT alignment, suffer disproportionately from obesity and weight-related illnesses, with 30% of the adult population considered clinically obese compared to the Countywide average of 20.9%. The introduction of a new LRT system into the heart of these communities is likely to improve health outcomes, with significant, quantifiable benefits to individual users.

It is possible to estimate the number of Crenshaw/LAX LRT users who are induced to meet targets for minimum levels of daily recommended physical activity (RPA), and thereby quantify the health benefits attributable to the Project. Such benefits accrue only to users who regularly and consistently meet the RPA target through their commute, namely those undertaking work-related trips multiple times per week. For this calculation, the number of work-related *trips* derived from the ridership totals must be divided by a factor of two to yield the equivalent number of *users*. This takes into account the likelihood of roundtrip travel by the same user who therefore undertakes two daily trips on the Crenshaw/LAX LRT Line.

Personal/leisure trips must be netted out of this calculation because, although these riders may also gain health benefits from physical activity associated with public transit, their frequency of use is difficult to establish, and consistent daily exercise is necessary for a user to be reasonably classified as "physically active." Table III-7 summarizes the calculation of transit users meeting the recommended RPA levels.

Table III-7 - Calculation of Transit Users Meeting Recommended Physical Activity (RPA) Levels

Total Average Daily Boardings	**21,930**
% work-related trips (likely to involve frequent users 4x or more/week)	55%
Daily Work-Related Boardings	12,062
Conversion to Number of Users	6,031
% new transit users (induced & diverted from auto)	30%
New, Frequent Users Meeting RPA Threshold	1,809
60 yrs or older (11%)	199
less than 60 yrs (89%)	1,610

Because the increase in medical costs has historically outpaced inflation, a 4% annual escalator has been applied to the reduction in medical expenses per user, with the benefit of $500 for those under 60 rising to $684, and the benefit of $750 for those over 60 rising to $1,026 in current dollars (2010$) by year 2018, when the LRT Line is scheduled to open for service.

As shown in Table III-8, the value of improved health outcomes attributable to HSR, achieved in tandem with the development of new walkable, transit-oriented communities, would total approximately $1.0 million in reduced medical costs in the opening year of the Project, escalating to over $2.5 million annually by 2035.

Table III-8 - Calculation of Annual User Health Benefits

Year		**<60 yrs**	**60+ yrs**	**Benefit ($/yr)**
2018	Number of Users	1,271	157	$1,031,185
	Medical Costs	$684	$1,026	
2035	Number of Users	1,610	199	$2,544,184
	Medical Costs	$1,332	$1,999	

Vehicle Operating & Ownership Cost Savings.

In terms of vehicle operating costs, shifting from driving to transit reduces overall vehicle miles traveled, which provides savings in the marginal costs of auto travel (fuel, maintenance and tires). Based on a fuel price of $2.60 per gallon, as of late 2009, the American Automobile

Association (AAA) estimates the variable, out-of-pocket cost for fuel, maintenance and tires at $0.1674 per mile (2010 dollars).

New transit may also encourage some users to own fewer vehicles. Ten percent of the reduction in VMT is generally attributable to reductions in vehicle ownership, resulting in user savings on the full cost of auto ownership, including insurance, license, registration & taxes, depreciation, and finance charges, estimated at $0.566 per mile (2010 dollars). Table III-9 summarizes the calculated annual vehicle and ownership cost savings based on these assumptions. As shown in the table, the total cost savings is approximately $23.0 million.

Table III-9 - Calculation of Annual Vehicle Operating & Ownership Cost Savings

	Vehicle Operation	Ownership	Total
Annual Reduction in VMT	99,666,174	11,074,019	110,740,193
% of total VMT reduction	90%	10%	100%
Cost savings per mile	$0.1674	$0.5660	
Total	$16,684,117	$6,267,895	**$22,952,012**

Source: AAA, http://www.aaaexchange.com/Assets/Files/201048935480.Driving%20Costs%202010.pdf

III-B Indirect Benefits

III-B-1 SAFETY

Accident Reduction Safety Benefits.

Reductions in VMT lower the incidence of traffic accidents. The cost savings from reducing the number of accidents include direct savings (e.g., reduced personal medical expenses, lost wages, and lower individual insurance premiums) as well as significant avoided costs to society (e.g., second party medical and litigation fees, emergency response costs, incident congestion costs, and litigation costs). The value of all such benefits – both direct and societal – could also be approximated by the cost of service disruptions to other travelers, emergency response costs to the region, medical costs, litigation costs, vehicle damages, and economic productivity loss due to workers inactivity.

Accident rates are essential to estimating the impact of this reduction in automobile travel and are summarized in Table III-10. In 2008, the last year for which accident statistics are available, transportation system users in the State of California experienced 3,113 fatal collisions (with 3,401 persons killed), 170,496 injury collisions (with 241,873 persons injured), and 278,986 collisions only involving damage to personal property. With 325.8 billion vehicle miles traveled statewide that year, rates of accidents and accident outcomes are calculated per 100 million VMT.

Table III-10 - Accident Rates for the State of California

	Total for 2008	Rate per 100 million VMT
Motor Vehicle Miles of Travel	325,750,000,000	
Fatal Collisions	3,113	0.96
Persons Killed	3,401	1.04
Injury Collisions	170,496	52.34
Persons Injured	241,873	74.25
Property Damage Collisions	278,986	85.64

Source: 2008 Annual Report of Fatal and Injury Motor Vehicle Traffic Collisions
Statewide Integrated Traffic Records System
State of California

As mentioned above, economic loss is not the only potential savings realized. The value of traffic safety improvements should reflect society's "willingness to pay" to avoid injury costs associated with automobile hazards. This is known as the comprehensive cost concept. Comprehensive costs of motor vehicle crashes also include a measure of the value of lost quality of life which was obtained through empirical studies of what people actually pay to reduce their safety and health risks. The National Safety Council compiles both the actual direct economic cost and the "comprehensive economic cost of avoidance" for by accident type and injury type. The safety savings can be significant. In 2008, the savings associated with an avoided death is $4.2 million while the savings associated with an avoided injury is close to $165,000.

Table III-11 - Dollar Value of Accidents by Event

Accident Severity		Historical Calculable Cost	Comprehensive Economic Cost of Avoidance
Fatality Accidents	Death	$ 1,300,000	$ 4,200,000
Injury Accidents	Nonfatal Disabling Injury	$ 63,500	* $ 165,322
	Incapacitating Injury (Class A)	$ 67,200	$ 214,200
	Non-incapacitating Injury (Class B)	$ 21,800	$ 54,700
	Possible Injury (Class C)	$ 12,300	$ 26,000
Property Damage	Property Damage Crash	$ 8,300	$ 2,400

Source: National Safety Council 2008
*Estimated based on an average scaling rate

Table III-12 applies these safety savings to the actual reductions in vehicle miles traveled regionally. As shown in the table, the Crenshaw / LAX project is found to benefit the region by more than $18.6 million per year.

Table III-12 - Calculation of Annual Comprehensive Safety Savings

	Accident Outcomes by Type per 100 million VMT	Total Annual Reduction in Accident Outcomes	Comprehensive Economic Cost of Avoidance	Total Comprehensive Safety Savings due to the Project
Fatalities	1.04	1.2	$ 4,200,000	$4,855,979
Injuries (Non-Fatal)	74.25	82.2	$ 165,322	$13,593,751
Property Damage Only Accidents	85.64	94.8	$ 2,400	$227,622
Total Annual Safety Benefit				**$18,677,351**

III-B-2 ECONOMIC COMPETITIVENESS

Property Value Benefit

One of the important benefits of the Crenshaw/LAX LRT transit project is its ability to transform the neighborhoods and districts it passes through with economic development. The lack of visibility and accessibility has hindered the development potential of many districts that once thrived in the streetcar era, such as downtown Inglewood (Market Street) and Leimert Park Village. Traditional commercial businesses along Crenshaw Boulevard have experienced economic decline since the removal of the streetcars in the 1950s and the subsequent development of the regional freeway system, which either bisected or bypassed these communities. The Crenshaw/LAX project has the potential to improve the economic development opportunities through increased property values.

Property values are affected by a transit investment in two primary ways – through improved accessibility and through improvements to the "developability" of parcels. The "accessibility" effect represents the across-the-board increase in land values for properties situated in close proximity to transit stations, whether or not the redevelopment potential is ultimately realized through improvements to the land.

Many studies have already documented the impacts of rail on property values. A review of academic literature indicates accessibility premiums ranging between 3% and 40%. (Diaz, *Impacts of Rail Transit on Property Values*, American Public Transportation Association, 1999.) Enhanced accessibility may ultimately translate into higher rents and property values for the level of development that already exists.

An even more significant and relevant effect on property values in the corridor is the "developability effect." Many of the properties in the corridor, especially in commercial zones, have been rendered undevelopable or otherwise unable to reach their development potential based on their lack of accessibility compared to the level of proximity these properties originally had to the streetcar and railway system of the Los Angeles Railway and the Pacific Electric Railway when first developed. Communities along the Crenshaw corridor and in Inglewood suffered the dismantling of that system and the resultant loss of accessibility and shrinkage of market size along the corridor. Furthermore, the expansion of the freeway system bypassed these communities resulting in development following the more visible and accessible sites along

the freeway. Essentially, commercial development throughout the corridor has been limited and ad hoc.

The introduction of new accessibility raises the properties in the corridor (especially commercial and industrial properties) to a new level of prominence and desirability for redevelopment. Underutilized properties may now be able to be developed because there is a new customer base in the form of commuters arriving and departing from the adjacent stations. Furthermore, new transit enables new types of development, not previously contemplated or even possible for the corridor. New types of development may be entitled contingent on changes in land use and zoning. These uses include mixed use and higher intensities of both housing and commercial development. The opportunity for redevelopment is highlighted by the significant presence of redevelopment zones and enterprise zones (a State Program) in the corridor. The five redevelopment zones and one enterprise zone present in the area are shown in Table III-13.

Table III-13 - Redevelopment Areas and Enterprise Zones

	City	Establishment	Size	Dominant Uses
Mid-City Corridors	Los Angeles	1995	76 acres within the influence area of the project	Commercial
Crenshaw	Los Angeles	1984, expanded in 1994	Originally 54 acres, expanded to 152 in 1994.	Commercial
Crenshaw/Slauson	Los Angeles	1994	262 acres	Commercial / Industrial
In-Town	Inglewood	1970 (amended six times: 1974, 1980, 1986, 1994, 1996, 2002)		Commercial (office / retail)
North Inglewood Industrial Park	Inglewood	1973 (amended 1986, 1994, 1996)	154 acres	Industrial
La Cienega	Inglewood	1973 (amended 6 times, 1976, 1988, 1991, 1994, 2002)		Industrial
LAX-Area State Enterprise Zone	Los Angeles	2004, expanded in 2010	1,078 acres	Industrial / commercial (airport-related office and parking)

In calculating the impact of both increased accessibility and developability, it is appropriate to focus exclusively on the commercial and industrial land within the station areas. While residential land would likely increase in value due to accessibility, developability impacts on residential land is limited due to the relative stability of land uses and zoning codes. There are a total of 89 acres of commercially-zoned property within ½ mile of the stations and a total of 204 acres of industrially-zoned property. A review of land values in the corridor suggests an average value of land within the corridor of $6 million per acre. Scaling factors are developed to determine the accessibility and developability benefits.

With land values increasing anywhere from 3% to 40% as a result of enhanced accessibility, the mid-point of this range, 20%, was used for this calculation. A review of the property values in

similar districts characterized by an intensity and type of development comparable to the long-term potential of the Crenshaw/LAX Corridor suggests a doubling of current property values (100% increase) directly attributable to the transit investment. Because not all commercial and industrial land will be redeveloped in the corridor, this analysis assumes that only 50% of the 293 acres within a ½-mile radius of the station areas will actually benefit from the increase in property value associated with full-scale redevelopment. As shown in Table III-14, overall, a one-time property value increase of $1,054.8 million is estimated to be realized within a ten year period after the implementation of the project in 2018, for an average annual increase of $105.5 million between 2018 and 2027.

Table III-14 - Calculation of Developability and Accessibility Property Value Benefits for Industrial and Commercial Land in the Crenshaw Corridor

	Developability	Accessibility	
Total Acreage of Land Within ½ Mile Station Radius	293		
% of Land Area Projected to be Redeveloped Over 10 Years Post-Project Completion	50%	50%	% of Land Area Projected to Retain Existing Level of Development
Total Acreage Projected to be Redeveloped	146.5	146.5	Total Acreage with Existing Level of Development, but Enhanced Accessibility
Existing Value of Land per Acre	$6,000,000	$6,000,000	Existing Value of Land per Acre
Change in Land Value per Acre	+100%	+20%	Change in Land Value per Acre
Total Increase in Land Value	$ 879,000,000	$ 175,800,000	Total Increase in Land Value
Grand Total	**$1,054,800,000**		

III-C External/Societal Benefits

III-C-1 SUSTAINABILITY

Reduced Pollution.

The Crenshaw/LAX Transit Project will generate environmental benefits by reducing a number of specific air pollutants associated with automobile travel, including tailpipe emissions such as carbon monoxide and nitrous oxides, and other compounds such as $PM_{2.5}$ and PM_{10} emitted from the contact between vehicle tires and road pavement. The state-of-the-practice typically quantifies these externalities on a cost per metric ton basis. The calculation of metric tons is derived from the amount of each pollutant type emitted per VMT and is summarized in Table III-15.

Table III-15 - Calculation of Pollution Externality Values Associated with Reduced Regional VMT

Pollutant Type	Grams Emitted Per VMT	Conversion to Metric Tons	Annual Reduction (Metric Tons per Year)	Value of Reduction of Pollutant per Metric Ton	Annual Value of Pollutant Reduction Benefit
Carbon Dioxide (CO_2)	272.38	0.000600495	66,498.9		
Carbon Monoxide (CO)	9.00	$1.98416E^{-05}$	2,197.3	$ 1,007	$2,212,559
Nitrogen Oxides (NO_x)	0.87	$1.91802E^{-06}$	212.4	$ 7,092	$1,506,261
$PM_{2.5}$	0.3975	$8.76337E^{-07}$	97.0	$ 36,420	$3,534,400
PM_{10}	1.59	$3.50535E^{-06}$	388.2	$ 4,735	$1,838,060
Total					**$9,091,280**

Sources: Energy Information Administration, Environmental Protection Agency, Federal Highway Administration.

Reduced Greenhouse Gas Emissions.

The modal switch from auto to rail will also contribute to reductions in greenhouse gas (GHG) emissions. This benefit can be calculated both in terms of metric tons of carbon dioxide (CO_2) based on the reduction in regional VMT and then monetized based on the social cost of carbon (SCC), which estimates the damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Based solely on the reduction in regional VMT, the Crenshaw/LAX Transit Corridor Project would remove nearly 66,500 metric tons of CO_2 emissions annually from the atmosphere by 2035, as shown in Table III-15 above. The quantification of this reduction must take into account a range of SCC values developed by the U.S. Government Interagency Working Group for use in regulatory analyses, and shown in Table III-16.

Table III-16 - Social Cost of CO_2, 2010-2050 (in 2007 dollars)

	5%	3%	2.5%	3%
Year	Avg	Avg	Avg	95th
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50	100
2035	11.2	36	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65	136.2

Source: U.S. Government, Interagency Working Group on the Social Cost of Carbon, Appendix 15A

Three values are based on the average SCC across models and socio-economic and emissions scenarios at the 2.5, 3, and 5 percent discount rates. The fourth value is included to represent the higher than-expected economic impacts from climate change.

The benefits from reduced (or costs from increased) emissions in any future year can be estimated by multiplying the change in emissions in that year by the SCC value appropriate for that year. Therefore, to conform to the 2035 base year of the Regional Travel Demand model in LACMTA's Long Range Transportation Plan, the SCC values for that year are applied to the CO_2 emissions reduction calculation and are summarized in Table III-17:

Table III-17 - Calculation of Annual CO2 Emissions Reduction Benefit Using Range of SCC Values

	(metric tons)		
Discount Rate	**2035 CO_2 values**	**Reduction in CO_2**	**Annual Value of Pollutant Reduction Benefit**
5%	$11.20	66,498.9	$744,788
3%	$36.00		$2,393,960
2.5%	$54.20		$3,604,240
3% (95th percentile value)	$109.70		$7,294,929

III-D Transit Operator Benefits

III-D-1 STATE OF GOOD REPAIR

LACMTA's current capacity of maintenance and service facilities (MSF) is limited. With each new line, new maintenance capacity is required to store and service light rail vehicles. The Crenshaw / LAX corridor project will include one additional full service maintenance and services facility in the southwestern portion of the regional transit network. As such, it provides important new maintenance capacity for both the Crenshaw/LAX line and to the existing Metro Green Line and potentially for future extensions of the Metro Green Line. Importantly, this new maintenance facility will expand the capability of heavy vehicle maintenance.

Currently, only one facility within LACMTA's system is capable of performing heavy-duty vehicle maintenance, Division 11 in the City of Carson which is more than 14 miles away from the Crenshaw/LAX line. One more heavy-duty maintenance facility will reduce pressure and capacity constraints upon the individual facility as well as reduce the transportation time for vehicles from both the Crenshaw/LAX line and the Metro Green Line to such a facility, thereby improving the maintainability for both of these lines in particular. The benefit of State of Good Repair can be calculated using reduced deadhead time and mileage to the maintenance facility across the system. A full service maintenance facility will reduce deadhead mileage to the heavy-duty maintenance facility by 14 miles for vehicles on the Crenshaw/LAX line and by 7 miles for vehicles on the Metro Green Line.

Reduced Systemwide Annual O&M Costs

The elimination of duplicative bus service and facilities along the Crenshaw/LAX LRT Corridor will yield annual savings of approximately $6.05 million. The cost savings consists primarily of anticipated reductions in service hours on parallel routes operated by LACMTA and municipal transportation agencies ($5.95 million). LACMTA also currently holds a ground lease on a 2.0-acre property near LAX, known as Terminal 27 that is used as a bus storage facility. At an average annual cost of $95,000 under the existing five-year contract (2010-2015), this lease is assumed to be terminated since it will be unnecessary once the light rail line is operational.

IV ECONOMIC COSTS AND ASSUMPTIONS INCLUDED IN THE EVALUATION

The B/C analysis uses project costs that have been estimated by LACMTA on an annual basis, expressed in 2010 dollars.

IV-A Initial Project Investment Costs

Initial project investment costs include engineering and design, construction, acquisition of right-of-way, vehicles, other capital investments, and contingency factors. The costs are treated as upfront costs coinciding with the actual project expenditures on a pay-as-you-go basis. This approach excludes financing costs from long-term borrowing as part of the investment expenditures subject to present value calculations.

IV-B Annual Operating and Maintenance Costs

The annual cost of operating and maintaining the proposed rail investments is included in the analysis. Operation and maintenance activities apply to several assets, including rolling stock, stations, track, and support facilities. Additional incremental agency expenses are also included. The costs include regular and ramp-up O&M expenses beginning in 2018 and continuing through the end of the evaluation period.

Ridership and transit benefits are projected to exhibit real growth of 1.4% per year through the benefit evaluation period from 2018 through 2057. The annual O&M costs are estimated by LACMTA through FY 2040 in YOE dollars. The opening 2018 year estimate of $47.1 million for O&M costs was adjusted to 2010 dollars using a cumulative inflation coefficient of 1.27, consistent with LACMTA's assumptions. LACMTA's policy is to contain its O&M unit costs so that any year-over-year increases will not exceed the rate of annual inflation. For the purposes of this analysis, however, we have included a component of real growth in O&M costs, with an annual escalation rate of 0.5% beyond inflation applied over the entirety of the analysis period (2010-2057).

IV-C Replacement Costs and Major Rehabilitation

Several types of initial asset investments will need to be replaced or rehabilitated during the evaluation period. To account for these costs, the analysis includes rehabilitation/replacement schedules associated with regular asset life cycles. Rail vehicles are, for example, replaced every 30 years at a cost of 100% of the initial expense.