

This document supports an application by the City of Bakersfield for TIGER funds.

***Cost and Benefits of the Build Alternative
Westside Parkway with the Stockdale/Heath Tie-in and
the SR 58 Connector project***

NAME OF PROJECT

Westside Parkway, Stockdale/Heath Tie-in

AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009

Grants for Transportation Investment Generating Economic Recovery

TIGER DISCRETIONARY GRANTS

SPONSORING ORGANIZATIONS

City of Bakersfield, California Department of Transportation

CONTACT INFORMATION

City of Bakersfield
Public Works Department
1501 Truxtun Avenue, Second Floor
Bakersfield, CA 93301

ADDITIONAL PROJECT INFORMATION

- (i) The City of Bakersfield is proposing to construct a highway project.
- (ii) The project is located in Bakersfield, Kern County, California, which is included in California's 22nd Congressional District.
- (iii) The project is located in an urban area.
- (iv) The City of Bakersfield is seeking \$35 million in TIGER funds.

Cost and Benefits of the Build Alternative: Westside Parkway with the Stockdale/Heath Tie-in and the SR 58 Connector project

The Build Alternative includes Stockdale/Heath Tie-in of the Westside Parkway, the westerly two-mile section of a new eight-mile long east–west freeway through western metropolitan Bakersfield, and the SR 58 Connector project. A complete description of the Build Alternative is provided in Section 4 of the TIGER application.

The Build Alternative also includes the Metropolitan Bakersfield regional transportation improvements network, as adopted in the 2009 City of Bakersfield/County of Kern Transportation Impact Fee program and the Kern Council of Governments regional travel demand model. This section identifies the costs and estimated benefits associated with implementing the Build Alternative. The No-build alternative considered by this analysis is only the 2035 regional transportation improvements network scenario, including the SR 58 Connector and with the Westside Parkway, minus the Stockdale/Heath Tie-in section.

SUMMARY OF BENEFITS

The Build Alternative, which includes Westside Parkway Stockdale/Heath Tie-in, will produce net savings in travel time, crashes and vehicle operating expense. The actual benefits under the Build Alternative are \$13.1 million in 2015 and \$92.3 million in 2035. Collectively, these savings are estimated to total more than \$1.1 billion over the 20-year life cycle of the project, assuming current year dollars. These findings are summarized in Table 9 and sorted by benefit type.

COST ESTIMATES

Cost estimates were developed by Parsons for the project study report. The preliminary cost estimate for the Build Alternative is \$35,000,000 for Westside Parkway Stockdale/Heath Tie-in. Table 1 provides a summary of the capital cost for the Build Alternative.

BENEFITS ESTIMATES

The Build Alternative allows more vehicles to access the Westside Parkway compared with the No Build Alternative, meaning that vehicles traverse fewer miles on arterial streets and more miles on the freeway system. Under the No-build Alternative, traffic cascades across the highway network seeking available capacity; hence, traffic volume impacts are regional in addition to the study area.

Table 1. Capital Cost for Build Alternative (\$ 2008)

ELEMENT	ALTERNATIVE COST
Roadway Items	
Earthwork	\$ 2,500,000
Structural Section	6,639,235
Drainage	920,732
Specialty Items	4,003,625
Traffic Items	946,069
Minor Items	2,820,290
Mobilization	1,500,000
Supplemental Work and Contingencies	3,100,000
Subtotal (rounded)	22,430,000
Structure Items	8,570,049
Right-of-Way Items	0
Engineering and Project Administration	4,000,000
Total (rounded)	\$ 35,000,000

To provide a regional comparison of Westside Parkway/ Centennial Build versus No-build traffic-related impacts, Parsons calculated regional benefits using the Kern COG 2006 Regional Travel Demand Model (Update 1) and STEAM 2.0, a system-wide analysis tool. The Federal Highway Administration (FHWA) introduced the first version of the Surface Transportation Efficiency Analysis Model (STEAM) in 1997. STEAM was the first FHWA impact analysis product to use input directly from the four-step travel demand modeling process for detailed, system wide analysis of alternative transportation investments on regional and corridor levels. FHWA released STEAM 2.0 in 2000 to expand the scope of the model to address environmental justice measures.

Table 2 reports measures of effectiveness computed with STEAM 2.0, based on travel demand forecast input from the Kern COG regional travel model. Monetized benefits and costs are reported below along with assumptions used in the STEAM 2.0 computations.

The data reported in Table 2 indicates that vehicle miles traveled (VMT) increases with the Build Alternative as motorists are willing to travel further to reduce overall travel time. Hydrocarbon (HC) emissions decrease with increasing speed to 55–60 mph, and then rise. Fewer HC emissions result due to higher speeds on the freeway system compared with parallel arterial streets. Like hydrocarbons, carbon monoxide (CO) emissions decrease with increasing speeds to 45–50 miles per hour, and then increase thereafter. Nitrogen oxides (NO_x) emissions also decline with speed increases to 25 mph, but increase thereafter. Hence, the Build Alternative produces higher amounts of CO and NO_x emissions compared with the No Build Condition. Build Alternative benefits are most noticeable in reduced crashes, reduced fuel consumption, and reduced greenhouse gas emissions; in addition to travel time savings.

TRAVEL TIME SAVINGS

Vehicle hours of travel were computed for each link in the highway system. Highway link travel speeds and volumes were output directly from the Kern COG 2006 Regional Travel Demand Model TP+ software to STEAM 2.0 using a custom design interface. This program interface is now available for use with any Kern COG Model/STEAM 2.0 application.

Table 2. Westside Parkway Stockdale/Heath Tie-in: Project Measures of Effectiveness

	2015			2035		
	BASE	BUILD	CHANGE	BASE	BUILD	CHANGE
1. Travel Demand						
VMT (million VMT/year)	12,840.4	12,851.8	11.4	20,281.5	20,379.8	98.3
Travel time (million person hours/year)	451.03	450.51	-0.53	690.58	686.11	-4.47
2. Tons of Emissions (tons/year)						
VMT Related Emissions						
HC	8,238.5	8,235.2	-3.3	12,771.3	12,753.8	-17.6
CO	25,428.3	25,418.4	-9.9	39,222.7	39,287.4	64.7
NO _x	4,384.2	4,391.3	7.1	6,854.3	6,948.0	93.8
PM ₁₀	333.4	333.7	0.3	518.6	520.9	2.3
Cold start emissions		No change			No change	
3. Greenhouse Gas Emissions						
Btu energy consumption (100 billion Btu/year)	689.6	689.1	-0.5	1,061.5	1,060.6	-0.9
CO ₂ emissions (1,000 tons/year)	5,378.9	5,374.7	-4.1	8,279.7	8,272.6	-7.1
4. Accidents						
Fatalities	148.8	148.4	-0.4	229.9	227.0	-2.9
Injuries	24,385.6	24,331.9	-53.7	37,838.4	37,461.3	-377.1
Property damage only	33,268.1	33,223.2	-44.9	51,952.3	51,664.7	-287.6
5. Fuel Consumption						
Gallons (1,000 gallons/year)	547,916.4	547,485.4	-431.0	843,492.2	842,728.8	-763.4

Source: Parsons (based on STEAM 2.0)

Consistent with U.S. Department of Transportation guidance for the valuation of travel time in economic analysis, Parsons assumed local personal travel to be valued at 50 percent of the local median wage rate. Business travel by truck and bus drivers was valued at 100 percent of the mean wage for these occupations, plus fringe benefits. Kern County's mean wage for all occupations was reported by the State of California Employment Development Department to be \$18.00 per hour for the third quarter of 2008; hence a value of time equal to \$9.00 per hour was used for local personal travel. The state reported that heavy and tractor trailer truck drivers residing in Kern County earned \$17.64 per hour on average in the third quarter of 2008. A fringe benefit rate of 50 percent of the mean wage was assumed by Parsons for bus and truck drivers. The corresponding value of time for these business travelers was thus estimated to be \$26.47 per hour.¹

Computation of benefits also took vehicle occupancy into account for local personal travel. Based on the Kern COG model, the average daily vehicle occupancy for all trip purposes in Kern County is estimated to be 1.44 persons per vehicle. While this average occupancy may be lower or higher during peak periods, the average rate was assumed for the benefits calculation for lack of better data.

The resulting time travel savings of the build alternative improvements are estimated to be approximately \$4,986,400 annually in 2015 and \$42,685,300 annually in 2035, assuming current year dollars.

CRASH BENEFITS

The frequency of accident occurrence is typically lower on freeways and expressways when compared to other types of regional roads and city streets. To compute benefits associated with the Build Alternative

¹ Benefits for heavy and tractor-trailer truck trips are under-reported, as the Kern COG model commingles auto and truck trips in the internal-external and external-external trip matrices. Auto value of time is assumed for internal-external and external-external trips.

versus the No-build alternative, the number of vehicle miles traveled over the highway system was computed for each alternative, using the Kern COG Model and STEAM 2.0.

Rates of crash occurrences resulting in fatalities, personal injuries, and property damage only were obtained from the California Highway Patrol, California Department of Transportation for Year 2004. Statewide rates listed in Table 3 are for state owned facilities, and do not include the majority of urban arterial, local and collector streets.

Table 3. California Crash Rates on State Highways (2004)*

FUNCTIONAL CLASSIFICATION	PDO CRASH RATE	INJURY CRASH RATE	FATAL CRASH RATE
All	100.90	61.96	1.13

Source: California Highway Patrol, California Department of Transportation

*Crash rates per 100 million vehicle miles.

To develop a more comprehensive set of crash occurrence rates, statewide data available from the Nevada Department of Transportation was obtained and benchmarked to match California crash rates for similar type facilities (interstate rural, interstate urban, urban principal arterial, and principal arterial urban). The resulting crash rates used for the STEAM 2.0 calculation of benefits are listed in Table 4.

Table 4. California Crash Rates by Functional Roadway Classification*

FUNCTIONAL CLASSIFICATION	PDO CRASH RATE	INJURY CRASH RATE	FATAL CRASH RATE
Interstate urban	179.14	103.52	0.52
Other urban freeways and expressways	129.76	76.27	0.49
Urban principal arterials	341.59	272.07	1.72
Urban minor arterials	288.20	243.14	1.79
Urban collector streets	185.94	149.69	0.91
Urban local streets	212.89	113.04	0.65

Source: Parsons, based on Caltrans 2004 and Nevada Department of Transportation 2002 data.

*Crash rates per 100 million vehicle miles.

The values of loss associated with accidents were obtained from the National Safety Council and a 1991 Urban Institute/FHWA study. Periodically, the National Safety Council estimates the average cost of fatal and non-fatal injuries due to motor vehicle crashes. These estimates are made using a comprehensive or willingness to pay method. After adjusting the Urban Institute/FHWA estimate to Year 2005 using the gross domestic product deflator, a value of \$7,948 per reported PDO accident was derived. Taking inflation into account, these estimates of accident costs compare favorably with values used in four computerized benefit-cost models, as reported in Table 5.

There are two categories of accident cost reductions, internal and external. The build alternative provides a combined accident cost savings of \$8,427,200 annually in Year 2015 and \$59,642,600 annually in Year 2035, assuming current year dollars.

STEAM 2.0 calculates separate internal and external accident costs. Internal accident costs are defined as costs inflicted upon and perceived by transportation facility users. External costs are defined as costs

inflicted on users, but not perceived by users. Table 6 identifies the breakdown of these accident cost assumptions.

Table 5. Accident Cost Estimates

ACCIDENT TYPE	CSI* (\$ 1993)	StratBENCOST** (\$ 1996)	STEAM† (\$ 1997)	RAILDEC‡ (\$ 1997)	KERN COUNTY¶ (\$ 2005)
Fatality	\$3,325,095	\$3,521,359	\$2,726,350	\$3,613,137	\$4,250,901
Injury	\$ 7,890	\$ 83,848	\$ 59,718	\$ 86,033	\$ 95,803
PDO	\$ 5,651	\$ 5,806	\$ 3,322	\$ 5,957	\$ 7,948

* Cambridge Systematics, Inc. (CSI), Approaches for Developing Nationwide Estimates of Congestion Delay, Accidents, Emissions, and Noise Impacts: Interim Report, 1995.

** NCHRP Project 2-18(3), Development of an Innovative Highway User Cost Estimation Procedure. Midrange of costs reported.

† FHWA, Surface Transportation Efficiency Analysis Model, 1997. Total of internal and external costs.

‡ Companion to StratBENCOST which estimates the reduction in accident costs as the change in highway accidents between the base and alternative (rail) case. StratBENCOST values inflated by 2.6 percent for all accident types.

¶ Parsons, based on California Life-Cycle Benefit/Cost Analysis Model, Technical Supplement to User's Guide.

Table 6. Accident Cost Assumptions for STEAM (\$ 2005)

ACCIDENT TYPE	INTERNAL COST	EXTERNAL COST	TOTAL COST
Fatality	\$3,613,266	\$637,635	\$4,250,901
Injury	\$ 81,433	\$ 14,370	\$ 95,803
PDO	\$ 6,756	\$ 1,192	\$ 7,948

Source: Parsons

MOTOR VEHICLE EMISSIONS AND COSTS

Motor vehicle emissions were calculated for the emissions listed in Table 7. Rates of motor vehicle emissions were obtained from the California Life-Cycle Benefit/Cost Analysis Model for carbon monoxide, nitrogen oxides, and fine particulates assuming a vehicle model year of 2020. The source of these emission rates is the California Air Resources Board EMFAC 2002 v 2.2, April 23, 2003 model. STEAM 2.0's default values for hydrocarbon emissions were also used in the analysis. These rates assume a Year 2010 vehicle model year and are based on the EPA's Mobil 5a model results.

Table 7. Vehicle Pollution Emissions

EMISSION	DESCRIPTION	SOURCE	HARMFUL EFFECTS	SCALE
Carbon monoxide (CO)	A toxic gas that undermines blood's ability to carry oxygen	Engine	Human health, climate change	Very local
Nitrogen oxides (NO _x)	Various compounds; some are toxic, all contribute to ozone.	Engine	Human health, ozone precursor	Regional
Fine particulates (PM ₁₀)	Inhalable particles consisting of bits of fuel and carbon	Diesel engines and other sources	Human health, aesthetics	Local and regional
Hydrocarbons (HC)	Unburned fuel; forms ozone	Fuel production and engines	Human health, ozone precursor	Regional

Monetary values for CO, PM₁₀ and NO_x emissions were obtained from research by Donald McCubbin and Mark Delucchi reported in “The Social Cost of Health Effects of Motor-Vehicle Use in the United States,” as updated for use in the California Life-Cycle Benefit/Cost Analysis Model. Values reported for the Los Angeles/South Coast air basin (see Table 8) were used for the evaluation of benefits.

Table 8. Health Cost of Motor Vehicle Emissions (\$/ton)

EMISSION		VALUE
Carbon monoxide	CO	\$ 127
Fine particulates	PM ₁₀	\$422,985
Nitrogen oxides	NO _x	\$ 51,635
Hydrocarbons	HC	\$ 7,407

Source: Parsons, based on California Life-Cycle Benefit/Cost Analysis Model, Technical Supplement to User's Guide

The health cost of HC emissions was taken from a second source that also valued NO_x.² These values were indexed to the Cal B/C values to estimate the per ton cost of HC.

Motor vehicle emissions increase based on the higher speeds offered by the Build Alternative. The additional cost of emissions is \$452,100 in 2015 and \$5,681,500 in 2035, assuming current year dollars.

VEHICLE OPERATING COSTS

Vehicle operating costs were calculated for the no-build alternative and Westside Parkway Stockdale Heath Tie-in Build alternative using estimates of vehicle miles traveled produced by the Kern COG 2006 Regional Travel Demand Model and STEAM 2.0. STEAM 2.0 calculates fuel consumption per gallon based on average link speeds and vehicle miles traveled per link.

Default values for the fuel consumption rates used in STEAM come from the ITE “Transportation Planning Handbook,” 1992. However, these rates were derived from a study published by Caltrans in 1983. Non-fuel volatile organic compounds are taken from a USDOT publication, “Characteristics of Urban Transportation Supply,” 1992, and are converted to 1997 dollars. These costs originated in the American Automobile Association publication, “Your Driving Costs.”

For the evaluation of benefits, fuel consumption was based on estimates of average fuel consumption for the Year 2000 obtained from the California Air Resources Board’s Motor Vehicle Emission Inventory models which are used in the California Life-Cycle Benefit/Cost Analysis Model.

The price-per-gallon of regular grade gasoline was assumed to be \$3.04 per gallon based on prices prevailing in Bakersfield in early July 2009. STEAM 2.0 separates fuel costs into tax and non-tax components, using the tax portion to compute “revenue transfers.” The tax rate per gallon of gasoline was assumed to be 58.0 cents per gallon. Truck fuel costs were assumed to be \$2.31 per gallon for the non-tax portion and \$0.57 for the tax component.

Non-fuel costs for vehicle maintenance and tire expense were assumed to be \$0.061 per mile for automobiles based on Center for Transportation Analysis, Department of Energy statistics for calendar year 2004, and \$0.121 per mile for trucks. The STEAM 2.0 model does not include mileage-based depreciation.

² Gunnar Linberg, Benefit-Cost Analysis in a Multimodal Planning Process, "Exploring the Application of Benefit-Cost Methodologies to Transportation Decision Making," May 1995, Tampa, Florida.

The initial opening year (2015) of the Build Alternative provides operating cost savings due to the avoidance of stop-and-go travel on arterial streets. However, as the network is completed, more people are travelling greater distances to access the freeway system. The resulting estimated vehicle operating cost of the Build Alternative improvements are reduced by \$371,700 annually in 2015 and increased by \$3,836,900 annually in 2035, assuming current year dollars. Revenue transfers and fuel taxes not collected as a result of these benefits amount to \$250,000 in 2015 and \$445,900 annually in 2035.

SUMMARY OF BENEFITS

The Build Alternative will produce net savings in travel time, crashes and vehicle operating expense. The actual benefits under the Build Alternative are \$13.1 million in 2015 and \$92.3 million in 2035. Collectively, these savings are estimated to total more than \$1.1 billion over the 20-year life cycle of the project, assuming current year dollars. These findings are summarized in Table 9 and sorted by benefit type.

Table 9. Summary of Westside Parkway Stockdale/Heath Tie-in Benefits *(Based on STEAM 2.0)*

BENEFIT TYPE	BUILD ALTERNATIVE BENEFITS	
	2015	2035
User Benefits		
In-vehicle travel time	\$ 4,986,400	\$42,685,300
Fuel costs	1,067,700	2,065,600
Non-fuel operating costs	(696,000)	(5,902,500)
Internal accident costs	7,351,200	52,038,700
Revenue Transfers	(250,500)	(445,900)
Reduction in External Costs		
Emissions	(452,100)	(5,681,500)
Global warming	14,800	25,300
Noise	(7,600)	(84,300)
Accident	1,076,000	7,603,900
Other mileage based	0	0
Total Benefits (\$/year in 2015 and 2035)	\$13,089,700	\$92,304,700

Source: Parsons