

HOUSTON INTELLIGENT TRANSPORTATION SYSTEMS (HITS)

TIGER 2014 Grant Proposal | Benefit-Cost Workbooks



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Assumptions and Results from IDAS:

IDAS provided annual travel time savings for the complete system in the AM Peak (\$1995) =	\$8,391,481
Value of time used by IDAS model to calculate the monetized savings =	\$9.63
Travel Time savings in vehicle hours during AM Peak (for the proposed portion of the HITS project) =	157,722
Travel Time savings in vehicle hours during PM Peak(for the proposed portion of the HITS project) =	220,811
Total Travel Time Savings (From Both AM and PM Peak) =	378,533
Hourly value of TT Savings in 2013 US \$ per person hour =	\$12.98
Number of persons per vehicle (based on travel demand model) =	1
Hourly value of TT Savings in 2013 US \$ per vehicle =	\$12.98
Yearly growth in traffic =	1.5%

Calendar Year	Travel Time Savings (Vehicle Hours)	Monetized value of TT savings (\$2013)	Travel Time Savings with traffic growth (Vehicle Hours)	Monetized value of TT savings with traffic growth (\$2013)
	\$12.98			
2014		\$0	0	\$0
2015	378,533	\$4,913,356	384,211	\$4,987,059
2016	378,533	\$4,913,356	389,974	\$5,061,863
2017	378,533	\$4,913,356	395,824	\$5,137,796
2018	378,533	\$4,913,356	401,761	\$5,214,858
2019	378,533	\$4,913,356	407,787	\$5,293,075
2020	378,533	\$4,913,356	413,904	\$5,372,474
2021	378,533	\$4,913,356	420,113	\$5,453,067
2022	378,533	\$4,913,356	426,414	\$5,534,854
2023	378,533	\$4,913,356	432,811	\$5,617,887
2024	378,533	\$4,913,356	439,303	\$5,702,153
2025	378,533	\$4,913,356	445,892	\$5,787,678
2026	378,533	\$4,913,356	452,581	\$5,874,501
2027	378,533	\$4,913,356	459,369	\$5,962,610
2028	378,533	\$4,913,356	466,260	\$6,052,055
2029	378,533	\$4,913,356	473,254	\$6,142,837
2030	378,533	\$4,913,356	480,353	\$6,234,982
2031	378,533	\$4,913,356	487,558	\$6,328,503
2032	378,533	\$4,913,356	494,871	\$6,423,426
2033	378,533	\$4,913,356	502,294	\$6,519,776
2034	378,533	\$4,913,356	509,829	\$6,617,580

The a.m. peak period represented 2.5 hours from 6:00 a.m. to 8:30 a.m., and the p.m. peak period is 3.5 hours from 3:00 p.m. to 6:30 p.m. It was assumed that most of HITS' benefits occur during the peak periods and that this approach would produce a more conservative estimate of average annual benefits.

Based on project implementation schedule, 100% of annual benefits will be realized in years from 2015 thru 2034.

Assumptions and Results from IDAS:

Annual Accident savings from IDAS for AM peak in \$1995 = \$2,234,943.00
 Annual Accident savings from IDAS for AM peak inflated to
 \$2013 using the BLS's inflation calculator = \$3,416,310.00
 Yearly growth in traffic = 1.50%

Year	Accident savings (\$)		Total Annual Accident Savings (\$2013)	Total Annual Accident Savings with Traffic Growth (\$2013)
	For AM peak	For PM peak		
2014		\$0	\$0	\$0
2015	\$618,352	\$865,693	\$1,484,045	\$1,506,306
2016	\$618,352	\$865,693	\$1,484,045	\$1,528,900
2017	\$618,352	\$865,693	\$1,484,045	\$1,551,834
2018	\$618,352	\$865,693	\$1,484,045	\$1,575,111
2019	\$618,352	\$865,693	\$1,484,045	\$1,598,738
2020	\$618,352	\$865,693	\$1,484,045	\$1,622,719
2021	\$618,352	\$865,693	\$1,484,045	\$1,647,060
2022	\$618,352	\$865,693	\$1,484,045	\$1,671,766
2023	\$618,352	\$865,693	\$1,484,045	\$1,696,842
2024	\$618,352	\$865,693	\$1,484,045	\$1,722,295
2025	\$618,352	\$865,693	\$1,484,045	\$1,748,129
2026	\$618,352	\$865,693	\$1,484,045	\$1,774,351
2027	\$618,352	\$865,693	\$1,484,045	\$1,800,967
2028	\$618,352	\$865,693	\$1,484,045	\$1,827,981
2029	\$618,352	\$865,693	\$1,484,045	\$1,855,401
2030	\$618,352	\$865,693	\$1,484,045	\$1,883,232
2031	\$618,352	\$865,693	\$1,484,045	\$1,911,480
2032	\$618,352	\$865,693	\$1,484,045	\$1,940,152
2033	\$618,352	\$865,693	\$1,484,045	\$1,969,255
2034	\$618,352	\$865,693	\$1,484,045	\$1,998,794

The a.m. peak period represented 2.5 hours from 6:00 a.m. to 8:30 a.m., and the p.m. peak period is 3.5 hours from 3:00 p.m. to 6:30 p.m. It was assumed that most of HITS' benefits occur during the peak periods and that this approach would produce a more conservative estimate of average annual benefits.

Based on project implementation schedule, 100% of annual benefits will be realized in years from 2015 thru 2034.

Assumptions for Calculating Emissions Benefits:

Emission and fuel consumption benefits calculated for this project assume that travel time saved with HITS project is the amount of time that vehicle engines are not running and as such not emitting pollutants in the air. However we did not find any factors that could be directly applied to calculate total emission savings, instead we converted the travel time saved to an equivalent number of miles traveled by using a reasonable average speed of traffic during AM and PM peak periods on the arterial network.

Assuming average travel speed of all vehicles = 20mph

Year	Vehicle Hours saved	Equivalent VMT	Emission Factors (g/mi) ¹			Gasoline Consumption (Gal/mile)	Emissions Increase (Metric Tons / Year)			Gasoline saved (Gallons)	Value of Emissions (\$2013 / Metric Ton)			Average Price of gasoline (\$/gal) ²	Emission Costs					NPV of CO2 Benefits at 3% SCC
	Cell E from TT savings	Cell F3	VOC	NOx	CO2		VOC	NOx	CO2		VOC	NOx	CO2		VOC	NOx	Fuel	Total w/o CO2 (for BCA)	CO2	
		20	1.034	0.693	368.40	0.04					\$1,999	\$7,877		\$3.374						
2014	0	0					0	0	0	0			\$44		\$0	\$0	\$0	\$0	\$0	\$0
2015	384,211	7,684,220					8	5	2,831	318,818			\$45		\$15,883	\$41,946	\$1,075,693	\$57,829	\$127,389	\$123,679
2016	389,974	7,799,480					8	5	2,873	323,600			\$46		\$16,121	\$42,575	\$1,091,828	\$58,697	\$132,173	\$124,586
2017	395,824	7,916,480					8	5	2,916	328,455			\$47		\$16,363	\$43,214	\$1,108,206	\$59,577	\$137,072	\$125,441
2018	401,761	8,035,220					8	6	2,960	333,381			\$49		\$16,609	\$43,862	\$1,124,828	\$60,471	\$145,049	\$128,874
2019	407,787	8,155,740					8	6	3,005	338,382			\$51		\$16,858	\$44,520	\$1,141,700	\$61,378	\$153,233	\$132,180
2020	413,904	8,278,080					9	6	3,050	343,458			\$52		\$17,111	\$45,188	\$1,158,826	\$62,299	\$158,582	\$132,810
2021	420,113	8,402,260					9	6	3,095	348,610			\$52		\$17,367	\$45,866	\$1,176,209	\$63,233	\$160,960	\$130,876
2022	426,414	8,528,280					9	6	3,142	353,838			\$54		\$17,628	\$46,554	\$1,193,851	\$64,182	\$169,658	\$133,930
2023	432,811	8,656,220					9	6	3,189	359,147			\$55		\$17,892	\$47,252	\$1,211,761	\$65,144	\$175,392	\$134,424
2024	439,303	8,786,060					9	6	3,237	364,534			\$56		\$18,160	\$47,961	\$1,229,936	\$66,121	\$181,260	\$134,874
2025	445,892	8,917,840					9	6	3,285	370,001			\$57		\$18,433	\$48,680	\$1,248,384	\$67,113	\$187,264	\$135,283
2026	452,581	9,051,620					9	6	3,335	375,552			\$58		\$18,709	\$49,411	\$1,267,111	\$68,120	\$193,408	\$135,652
2027	459,369	9,187,380					9	6	3,385	381,184			\$60		\$18,990	\$50,152	\$1,286,116	\$69,142	\$203,078	\$138,286
2028	466,260	9,325,200					10	6	3,435	386,903			\$61		\$19,275	\$50,904	\$1,305,409	\$70,179	\$209,560	\$138,544
2029	473,254	9,465,080					10	7	3,487	392,706			\$62		\$19,564	\$51,668	\$1,324,991	\$71,232	\$216,190	\$138,764
2030	480,353	9,607,060					10	7	3,539	398,597			\$63		\$19,857	\$52,443	\$1,344,866	\$72,300	\$222,972	\$138,949
2031	487,558	9,751,160					10	7	3,592	404,576			\$63		\$20,155	\$53,229	\$1,365,038	\$73,385	\$226,317	\$136,925
2032	494,871	9,897,420					10	7	3,646	410,644			\$65		\$20,458	\$54,028	\$1,385,513	\$74,485	\$237,004	\$139,215
2033	502,294	10,045,880					10	7	3,701	416,804			\$66		\$20,764	\$54,838	\$1,406,295	\$75,603	\$244,260	\$139,298
2034	509,829	10,196,580					11	7	3,756	423,056			\$67		\$21,076	\$55,661	\$1,427,391	\$76,737	\$251,680	\$139,349

1 <http://www.epa.gov/otaq/consumer/420f08024.pdf>

2 http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epm0_pte_r30_dpg&f=a

Based on project implementation schedule, 100% of annual benefits will be realized in years from 2015 thru 2034.

Baseline Benefit-Cost Analysis Worksheet

Year	Cost		Total Cost Undiscounted	Total Cost Discounted to 7%	Total Cost Discounted to 3%	Livability	Safety	Sustainability		Total Benefits - Excluding reduction in Carbon	Benefits Discount to 2013 at 7% - Excluding reduction in Carbon	Benefits Discount to 2013 at 3% - Excluding reduction in Carbon	Sustainability - Reduction in Carbon	Total Benefits Discount to 2014 at 7%	Total Benefits Discount to 2014 at 3%
	System Components and Integration	O&M Costs*				Annual Travel Time Savings from HITS	Safety Benefit from HITS due to Incident Management	Air Pollution Benefits excluding CO2	Fuel Saving Benefits				NPV of CO2 Benefits at 3% SCC		
2014	\$20,944,859.00	\$0	\$20,944,859	\$20,944,859	\$20,944,859	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2015		\$162,500	\$162,500	\$151,869	\$157,767	\$4,987,059	\$1,506,306	\$57,829	\$1,075,693	\$7,626,887	\$7,127,932	\$7,404,745	\$123,679	\$7,251,610	\$7,528,423
2016		\$167,375	\$167,375	\$146,192	\$157,767	\$5,061,863	\$1,528,900	\$58,697	\$1,091,828	\$7,741,287	\$6,761,540	\$7,296,906	\$124,586	\$6,886,126	\$7,421,491
2017		\$172,396	\$172,396	\$140,727	\$157,767	\$5,137,796	\$1,551,834	\$59,577	\$1,108,206	\$7,857,413	\$6,413,990	\$7,190,646	\$125,441	\$6,539,430	\$7,316,087
2018		\$177,568	\$177,568	\$135,466	\$157,767	\$5,214,858	\$1,575,111	\$60,471	\$1,124,828	\$7,975,268	\$6,084,294	\$7,085,922	\$128,874	\$6,213,168	\$7,214,796
2019		\$182,895	\$182,895	\$130,402	\$157,767	\$5,293,075	\$1,598,738	\$61,378	\$1,141,700	\$8,094,891	\$5,771,545	\$6,982,724	\$132,180	\$5,903,726	\$7,114,904
2020		\$188,382	\$188,382	\$125,527	\$157,767	\$5,372,474	\$1,622,719	\$62,299	\$1,158,826	\$8,216,317	\$5,474,879	\$6,881,036	\$132,810	\$5,607,689	\$7,013,846
2021		\$194,033	\$194,033	\$120,834	\$157,767	\$5,453,067	\$1,647,060	\$63,233	\$1,176,209	\$8,339,569	\$5,193,465	\$6,780,833	\$130,876	\$5,324,340	\$6,911,708
2022		\$199,855	\$199,855	\$116,317	\$157,767	\$5,534,854	\$1,671,766	\$64,182	\$1,193,851	\$8,464,652	\$4,926,504	\$6,682,074	\$133,930	\$5,060,434	\$6,816,004
2023		\$205,850	\$205,850	\$111,969	\$157,767	\$5,617,887	\$1,696,842	\$65,144	\$1,211,761	\$8,591,634	\$4,673,279	\$6,584,772	\$134,424	\$4,807,703	\$6,719,195
2024		\$212,026	\$212,026	\$107,783	\$157,767	\$5,702,153	\$1,722,295	\$66,121	\$1,229,936	\$8,720,506	\$4,433,063	\$6,488,875	\$134,874	\$4,567,937	\$6,623,750
2025		\$218,386	\$218,386	\$103,754	\$157,767	\$5,787,678	\$1,748,129	\$67,113	\$1,248,384	\$8,851,304	\$4,205,191	\$6,394,371	\$135,283	\$4,340,474	\$6,529,654
2026		\$224,938	\$224,938	\$99,875	\$157,767	\$5,874,501	\$1,774,351	\$68,120	\$1,267,111	\$8,984,084	\$3,989,041	\$6,301,256	\$135,652	\$4,124,693	\$6,436,908
2027		\$231,686	\$231,686	\$96,142	\$157,767	\$5,962,610	\$1,800,967	\$69,142	\$1,286,116	\$9,118,834	\$3,783,992	\$6,209,483	\$138,286	\$3,922,278	\$6,347,769
2028		\$238,637	\$238,637	\$92,547	\$157,767	\$6,052,055	\$1,827,981	\$70,179	\$1,305,409	\$9,255,624	\$3,589,491	\$6,119,058	\$138,544	\$3,728,034	\$6,257,601
2029		\$245,796	\$245,796	\$89,088	\$157,767	\$6,142,837	\$1,855,401	\$71,232	\$1,324,991	\$9,394,460	\$3,404,985	\$6,029,946	\$138,764	\$3,543,749	\$6,168,711
2030		\$253,170	\$253,170	\$85,757	\$157,767	\$6,234,982	\$1,883,232	\$72,300	\$1,344,866	\$9,535,380	\$3,229,963	\$5,942,134	\$138,949	\$3,368,912	\$6,081,082
2031		\$260,765	\$260,765	\$82,551	\$157,767	\$6,328,503	\$1,911,480	\$73,385	\$1,365,038	\$9,678,406	\$3,063,935	\$5,855,595	\$136,925	\$3,200,861	\$5,992,520
2032		\$268,588	\$268,588	\$79,465	\$157,767	\$6,423,426	\$1,940,152	\$74,485	\$1,385,513	\$9,823,576	\$2,906,442	\$5,770,315	\$139,215	\$3,045,656	\$5,909,530
2033		\$276,645	\$276,645	\$76,495	\$157,767	\$6,519,776	\$1,969,255	\$75,603	\$1,406,295	\$9,970,929	\$2,757,045	\$5,686,281	\$139,298	\$2,896,343	\$5,825,579
2034		\$284,945	\$284,945	\$73,635	\$157,767	\$6,617,580	\$1,998,794	\$76,737	\$1,427,391	\$10,120,502	\$2,615,330	\$5,603,477	\$139,349	\$2,754,679	\$5,742,826
Total			\$25,311,295	\$23,111,254	\$24,100,199	\$115,319,032	\$34,831,313	\$1,337,226	\$24,873,953	\$176,361,523	\$90,405,905	\$129,290,448	\$2,681,937	\$93,087,843	\$131,972,386

*. Estimated O&M Costs of the currently installed and funded components. The Baseline system is expected to operational by 2015 requiring O&M budgets. O&M costs were grown by 3% per year.

Baseline Benefit-Cost Analysis Summary

Discount Rate	Total Cost	Total Benefits	Benefit - Cost Ratio
0%	\$25,311,295	\$179,043,461	7.1
3%	\$24,100,199	\$131,972,386	5.5
7%	\$23,111,254	\$93,087,843	4

Assumptions and Results from IDAS:

IDAS provided annual travel time savings for the complete system in the AM Peak (\$1995) =	\$8,391,481
Value of time used by IDAS model to calculate the monetized savings =	\$9.63
Travel Time savings in vehicle hours during AM Peak (for the proposed portion of the HITS project) =	713,668
Travel Time savings in vehicle hours during PM Peak(for the proposed portion of the HITS project) =	999,135
Total Travel Time Savings (From Both AM and PM Peak) =	1,712,803
Hourly value of TT Savings in 2013 US \$ per person hour =	\$12.98
Number of persons per vehicle (based on travel demand model) =	1
Hourly value of TT Savings in 2013 US \$ per vehicle =	\$12.98
Yearly growth in traffic =	1.5%

Calendar Year	Travel Time Savings (Vehicle Hours)	Monetized value of TT savings (\$2013)	Travel Time Savings with traffic growth (Vehicle Hours)	Monetized value of TT savings with traffic growth (\$2013)
	\$12.98			
2014				
2015	513,841	\$6,669,656	521,549	\$6,769,706
2016	1,027,682	\$13,339,311	1,058,744	\$13,742,497
2017	1,712,803	\$22,232,186	1,791,041	\$23,247,712
2018	1,712,803	\$22,232,186	1,817,907	\$23,596,433
2019	1,712,803	\$22,232,186	1,845,175	\$23,950,372
2020	1,712,803	\$22,232,186	1,872,853	\$24,309,632
2021	1,712,803	\$22,232,186	1,900,946	\$24,674,279
2022	1,712,803	\$22,232,186	1,929,460	\$25,044,391
2023	1,712,803	\$22,232,186	1,958,402	\$25,420,058
2024	1,712,803	\$22,232,186	1,987,778	\$25,801,358
2025	1,712,803	\$22,232,186	2,017,595	\$26,188,383
2026	1,712,803	\$22,232,186	2,047,859	\$26,581,210
2027	1,712,803	\$22,232,186	2,078,577	\$26,979,929
2028	1,712,803	\$22,232,186	2,109,755	\$27,384,620
2029	1,712,803	\$22,232,186	2,141,401	\$27,795,385
2030	1,712,803	\$22,232,186	2,173,523	\$28,212,329
2031	1,712,803	\$22,232,186	2,206,125	\$28,635,503
2032	1,712,803	\$22,232,186	2,239,217	\$29,065,037
2033	1,712,803	\$22,232,186	2,272,805	\$29,501,009
2034	1,712,803	\$22,232,186	2,306,898	\$29,943,536
2035	1,712,803	\$22,232,186	2,341,501	\$30,392,683
2036	1,712,803	\$22,232,186	2,376,624	\$30,848,580

The a.m. peak period represented 2.5 hours from 6:00 a.m. to 8:30 a.m., and the p.m. peak period is 3.5 hours from 3:00 p.m. to 6:30 p.m. It was assumed that most of HITS' benefits occur during the peak periods and that this approach would produce a more conservative estimate of average annual benefits.

Based on project implementation schedule, \$0 benefits will be realized in year 2014, 30% of total annual benefits will be realized in 2015, 60% of total annual benefits will be realized in 2016, and 100% of annual benefits will be realized in years from 2017 thru 2036.

Assumptions and Results from IDAS:

Annual Accident savings from IDAS for AM peak in \$1995 = \$2,234,943.00
 Annual Accident savings from IDAS for AM peak inflated to
 \$2013 using the BLS's inflation calculator = \$3,416,310.00
 Yearly growth in traffic = 1.50%

Year	Accident savings (\$)		Total Annual Accident Savings (\$2013)	Total Annual Accident Savings with Traffic Growth (\$2013)
	For AM peak	For PM peak		
2014			\$0.00	
2015	\$839,387	\$1,175,142	\$2,014,530	\$2,044,748
2016	\$1,678,775	\$2,350,285	\$4,029,059	\$4,150,838
2017	\$2,797,958	\$3,917,141	\$6,715,099	\$7,021,834
2018	\$2,797,958	\$3,917,141	\$6,715,099	\$7,127,161
2019	\$2,797,958	\$3,917,141	\$6,715,099	\$7,234,069
2020	\$2,797,958	\$3,917,141	\$6,715,099	\$7,342,580
2021	\$2,797,958	\$3,917,141	\$6,715,099	\$7,452,718
2022	\$2,797,958	\$3,917,141	\$6,715,099	\$7,564,509
2023	\$2,797,958	\$3,917,141	\$6,715,099	\$7,677,977
2024	\$2,797,958	\$3,917,141	\$6,715,099	\$7,793,146
2025	\$2,797,958	\$3,917,141	\$6,715,099	\$7,910,044
2026	\$2,797,958	\$3,917,141	\$6,715,099	\$8,028,694
2027	\$2,797,958	\$3,917,141	\$6,715,099	\$8,149,125
2028	\$2,797,958	\$3,917,141	\$6,715,099	\$8,271,362
2029	\$2,797,958	\$3,917,141	\$6,715,099	\$8,395,432
2030	\$2,797,958	\$3,917,141	\$6,715,099	\$8,521,364
2031	\$2,797,958	\$3,917,141	\$6,715,099	\$8,649,184
2032	\$2,797,958	\$3,917,141	\$6,715,099	\$8,778,922
2033	\$2,797,958	\$3,917,141	\$6,715,099	\$8,910,606
2034	\$2,797,958	\$3,917,141	\$6,715,099	\$9,044,265
2035	\$2,797,958	\$3,917,141	\$6,715,099	\$9,179,929
2036	\$2,797,958	\$3,917,141	\$6,715,099	\$9,317,628

The a.m. peak period represented 2.5 hours from 6:00 a.m. to 8:30 a.m., and the p.m. peak period is 3.5 hours from 3:00 p.m. to 6:30 p.m. It was assumed that most of HITS' benefits occur during the peak periods and that this approach would produce a more conservative estimate of average annual benefits.

Based on project implementation schedule, \$0 benefits will be realized in year 2014, 30% of total annual benefits will be realized in 2015, 60% of total annual benefits will be realized in 2016, and 100% of annual benefits will be realized in years from 2017 thru 2036.

Assumptions for Calculating Emissions Benefits:

Emission and fuel consumption benefits calculated for this project assume that travel time saved with HITS project is the amount of time that vehicle engines are not running and as such not emitting pollutants in the air. However we did not find any factors that could be directly applied to calculate total emission savings, instead we converted the travel time saved to an equivalent number of miles traveled by using a reasonable average speed of traffic during AM and PM peak periods on the arterial network.

Assuming average travel speed of all vehicles = 20mph

Year	Vehicle Hours saved	Equivalent VMT	Emission Factors (g/mi) ¹			Gasoline Consumption (Gal/mile)	Emissions Increase (Metric Tons / Year)			Gasoline saved (Gallons)	Value of Emissions (\$2013 / Metric Ton)			Average Price of gasoline (\$/gal) ²	Emission Costs					NPV of CO2 Benefits at 3% SCC
	Cell E from TT savings	Cell F3	VOC	NOx	CO2		VOC	NOx	CO2		VOC	NOx	CO2		VOC	NOx	Fuel	Total w/o CO2 (for BCA)	CO2	
		20	1.034	0.693	368.40	0.04					\$1,999	\$7,877		\$3.374						
2014													\$44							
2015	521,549	10,430,980					11	7	3,843	432,781			\$45	\$21,560	\$56,940	\$1,460,204	\$78,501	\$172,925	\$167,888	
2016	1,058,744	21,174,880					22	15	7,801	878,546			\$46	\$43,768	\$115,589	\$2,964,213	\$159,356	\$358,838	\$338,239	
2017	1,791,041	35,820,820					37	25	13,196	1,486,206			\$47	\$74,040	\$195,537	\$5,014,458	\$269,578	\$620,230	\$567,599	
2018	1,817,907	36,358,140					38	25	13,394	1,508,499			\$49	\$75,151	\$198,470	\$5,089,676	\$273,621	\$656,323	\$583,134	
2019	1,845,175	36,903,500					38	26	13,595	1,531,126			\$51	\$76,278	\$201,447	\$5,166,020	\$277,726	\$693,358	\$598,096	
2020	1,872,853	37,457,060					39	26	13,799	1,554,093			\$52	\$77,422	\$204,469	\$5,243,511	\$281,892	\$717,557	\$600,943	
2021	1,900,946	38,018,920					39	26	14,006	1,577,405			\$52	\$78,584	\$207,536	\$5,322,164	\$286,120	\$728,321	\$592,191	
2022	1,929,460	38,589,200					40	27	14,216	1,601,066			\$54	\$79,763	\$210,649	\$5,401,996	\$290,412	\$767,678	\$606,012	
2023	1,958,402	39,168,040					40	27	14,430	1,625,082			\$55	\$80,959	\$213,809	\$5,483,027	\$294,768	\$793,623	\$608,246	
2024	1,987,778	39,755,560					41	28	14,646	1,649,458			\$56	\$82,173	\$217,016	\$5,565,272	\$299,189	\$820,173	\$610,286	
2025	2,017,595	40,351,900					42	28	14,866	1,674,200			\$57	\$83,406	\$220,271	\$5,648,752	\$303,677	\$847,341	\$612,138	
2026	2,047,859	40,957,180					42	28	15,089	1,699,313			\$58	\$84,657	\$223,575	\$5,733,483	\$308,233	\$875,140	\$613,806	
2027	2,078,577	41,571,540					43	29	15,315	1,724,803			\$60	\$85,927	\$226,929	\$5,819,486	\$312,856	\$918,897	\$625,724	
2028	2,109,755	42,195,100					44	29	15,545	1,750,675			\$61	\$87,216	\$230,333	\$5,906,776	\$317,549	\$948,225	\$626,889	
2029	2,141,401	42,828,020					44	30	15,778	1,776,935			\$62	\$88,524	\$233,788	\$5,995,377	\$322,312	\$978,226	\$627,886	
2030	2,173,523	43,470,460					45	30	16,015	1,803,589			\$63	\$89,852	\$237,295	\$6,085,311	\$327,147	\$1,008,915	\$628,722	
2031	2,206,125	44,122,500					46	31	16,255	1,830,643			\$63	\$91,200	\$240,854	\$6,176,588	\$332,054	\$1,024,048	\$619,566	
2032	2,239,217	44,784,340					46	31	16,499	1,858,102			\$65	\$92,568	\$244,467	\$6,269,237	\$337,035	\$1,072,406	\$629,925	
2033	2,272,805	45,456,100					47	32	16,746	1,885,974			\$66	\$93,956	\$248,134	\$6,363,275	\$342,090	\$1,105,238	\$630,302	
2034	2,306,898	46,137,960					48	32	16,997	1,914,264			\$67	\$95,366	\$251,856	\$6,458,727	\$347,222	\$1,138,814	\$630,534	
2035	2,341,501	46,830,020					48	32	17,252	1,942,978			\$68	\$96,796	\$255,634	\$6,555,606	\$352,430	\$1,173,148	\$630,625	
2036	2,376,624	47,532,480					49	33	17,511	1,972,123			\$69	\$98,248	\$259,468	\$6,653,942	\$357,716	\$1,208,257	\$630,580	

1 <http://www.epa.gov/otaq/consumer/420f08024.pdf>

2 http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=p&s=emm_epm0_pte_r30_dpg&f=a

Based on project implementation schedule, \$0 benefits will be realized in year 2014, 30% of total annual benefits will be realized in 2015, 60% of total annual benefits will be realized in 2016, and 100% of annual benefits will be realized in years from 2017 thru 2036.

TIGER Funded Benefit-Cost Analysis Worksheet

Year	Cost		Total Cost Undiscounted	Total Cost Discounted to 7%	Total Cost Discounted to 3%	Livability	Safety	Sustainability		Total Benefits - Excluding reduction in Carbon	Benefits Discount to 2013 at 7% - Excluding reduction in Carbon	Benefits Discount to 2013 at 3% - Excluding reduction in Carbon	Sustainability - Reduction in Carbon	Total Benefits Discount to 2014 at 7%	Total Benefits Discount to 2014 at 3%
	System Components and Integration	O&M Costs ¹				Annual Travel Time Savings from HITS	Safety Benefit from HITS due to Incident Management	Air Pollution Benefits excluding CO2	Fuel Saving Benefits				NPV of CO2 Benefits at 3% SCC		
2014	\$24,096,050.00	\$0	\$24,096,050	\$24,096,050	\$24,096,050	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2015		\$277,500	\$277,500	\$259,346	\$269,417	\$6,769,706	\$2,044,748	\$78,501	\$1,460,204	\$10,353,159	\$9,675,850	\$10,051,611	\$167,888	\$9,843,738	\$10,219,499
2016		\$277,500	\$277,500	\$242,379	\$261,570	\$13,742,497	\$4,150,838	\$159,356	\$2,964,213	\$21,016,905	\$18,356,979	\$19,810,449	\$338,239	\$18,695,218	\$20,148,688
2017		\$277,500	\$277,500	\$226,523	\$253,952	\$23,247,712	\$7,021,834	\$269,578	\$5,014,458	\$35,553,582	\$29,022,314	\$32,536,564	\$567,599	\$29,589,912	\$33,104,163
2018		\$285,825	\$285,825	\$218,055	\$253,952	\$23,596,433	\$7,127,161	\$273,621	\$5,089,676	\$36,086,892	\$27,530,517	\$32,062,736	\$583,134	\$28,113,651	\$32,645,870
2019		\$294,400	\$294,400	\$209,903	\$253,952	\$23,950,372	\$7,234,069	\$277,726	\$5,166,020	\$36,628,186	\$26,115,390	\$31,595,795	\$598,096	\$26,713,487	\$32,193,891
2020		\$303,232	\$303,232	\$202,056	\$253,952	\$24,309,632	\$7,342,580	\$281,892	\$5,243,511	\$37,177,615	\$24,773,014	\$31,135,667	\$600,943	\$25,373,958	\$31,736,610
2021		\$312,329	\$312,329	\$194,503	\$253,952	\$24,674,279	\$7,452,718	\$286,120	\$5,322,164	\$37,735,282	\$23,499,637	\$30,682,237	\$592,191	\$24,091,828	\$31,274,429
2022		\$321,699	\$321,699	\$187,231	\$253,952	\$25,044,391	\$7,564,509	\$290,412	\$5,401,996	\$38,301,308	\$22,291,710	\$30,235,406	\$606,012	\$22,897,722	\$30,841,418
2023		\$331,350	\$331,350	\$180,232	\$253,952	\$25,420,058	\$7,677,977	\$294,768	\$5,483,027	\$38,875,830	\$21,145,875	\$29,795,086	\$608,246	\$21,754,121	\$30,403,332
2024		\$341,290	\$341,290	\$173,495	\$253,952	\$25,801,358	\$7,793,146	\$299,189	\$5,565,272	\$39,458,966	\$20,058,937	\$29,361,176	\$610,286	\$20,669,223	\$29,971,462
2025		\$351,529	\$351,529	\$167,009	\$253,952	\$26,188,383	\$7,910,044	\$303,677	\$5,648,752	\$40,050,856	\$19,027,873	\$28,933,591	\$612,138	\$19,640,011	\$29,545,728
2026		\$362,075	\$362,075	\$160,765	\$253,952	\$26,581,210	\$8,028,694	\$308,233	\$5,733,483	\$40,651,620	\$18,049,805	\$28,512,228	\$613,806	\$18,663,611	\$29,126,034
2027		\$372,937	\$372,937	\$154,756	\$253,952	\$26,979,929	\$8,149,125	\$312,856	\$5,819,486	\$41,261,396	\$17,122,013	\$28,097,003	\$625,724	\$17,747,737	\$28,722,728
2028		\$384,125	\$384,125	\$148,970	\$253,952	\$27,384,620	\$8,271,362	\$317,549	\$5,906,776	\$41,880,307	\$16,241,905	\$27,687,817	\$626,889	\$16,868,794	\$28,314,705
2029		\$395,649	\$395,649	\$143,401	\$253,952	\$27,795,385	\$8,395,432	\$322,312	\$5,995,377	\$42,508,506	\$15,407,039	\$27,284,593	\$627,886	\$16,034,925	\$27,912,479
2030		\$407,518	\$407,518	\$138,040	\$253,952	\$28,212,329	\$8,521,364	\$327,147	\$6,085,311	\$43,146,150	\$14,615,094	\$26,887,254	\$628,722	\$15,243,816	\$27,515,976
2031		\$419,744	\$419,744	\$132,880	\$253,952	\$28,635,503	\$8,649,184	\$332,054	\$6,176,588	\$43,793,328	\$13,863,846	\$26,495,684	\$619,566	\$14,483,412	\$27,115,250
2032		\$432,336	\$432,336	\$127,913	\$253,952	\$29,065,037	\$8,778,922	\$337,035	\$6,269,237	\$44,450,230	\$13,151,219	\$26,109,826	\$629,925	\$13,781,145	\$26,739,751
2033		\$445,306	\$445,306	\$123,131	\$253,952	\$29,501,009	\$8,910,606	\$342,090	\$6,363,275	\$45,116,980	\$12,475,221	\$25,729,583	\$630,302	\$13,105,523	\$26,359,885
2034		\$458,665	\$458,665	\$118,528	\$253,952	\$29,943,536	\$9,044,265	\$347,222	\$6,458,727	\$45,793,749	\$11,833,975	\$25,354,889	\$630,534	\$12,464,509	\$25,985,422
2035		\$472,425	\$472,425	\$114,097	\$253,952	\$30,392,683	\$9,179,929	\$352,430	\$6,555,606	\$46,480,648	\$11,225,685	\$24,985,639	\$630,625	\$11,856,310	\$25,616,264
2036		\$486,598	\$486,598	\$109,832	\$253,952	\$30,848,580	\$9,317,628	\$357,716	\$6,653,942	\$47,177,866	\$10,648,665	\$24,621,774	\$630,580	\$11,279,245	\$25,252,354
Total			\$32,107,579	\$27,829,094	\$29,706,074	\$558,084,640	\$168,566,135	\$6,471,483	\$120,377,103	\$853,499,361	\$396,132,564	\$597,966,608	\$12,779,331	\$408,911,895	\$610,745,939

1. O&M cost were grown by 3% per year starting in 2018, the second full year when the project will be fully operational.

TIGER Funded Benefit-Cost Analysis Summary

Discount Rate	Total Cost	Total Benefits	Benefit - Cost Ratio
0%	\$32,107,579	\$866,278,692	27.0
3%	\$29,706,074	\$610,745,939	20.6
7%	\$27,829,094	\$408,911,895	14.7