Effectiveness of HOT Lanes On the SR-91 Freeway

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January 8, 1998

SUMMARY

An Orange County Transportation Authority (OCTA)/Parsons study of HOT lanes on the SR-91 west of SR-55, has found them "feasible", in terms of functionality and the maintenance of a target peak hour volume of 1500 vph.

However, the report fails to address the most important question:

> *Does the HOT lane do more good, does it afford greater transportation and environmental benefit than alternative operational modes?*

We take it that the primary objective of freeway operation should be to improve critical peak period transportation not just to provide more income. To this end, this paper evaluates comparative overall performance based on the data developed and methodology used by the study. It finds that the HOT alternative results in significantly more travel-time lost in congestion and CO emissions than either the mixed-flow or HOV2 alternative. As compared to unrestricted mixed-flow operation, the value of the additional time lost in congestion under HOT operation is more than three times the projected HOT net income.

THE STUDY REPORT

The HOT (High-Occupancy Toll-lane) report (the "Report")[1] centered on a proposed lane addition to the SR-91 freeway between SR-55 and the Los Angeles/Orange Country line. It derived detailed vehicular volume projections for four alternative operational modes for the lane:

HOV2, (2 or more person carpools in the lane)
HOV3, (3 or more person carpools in the lane)
HOT3-25, (3 person carpools or toll of 25¢/mile in the lane)
HOT3-33, (3 person carpools or toll of 33¢/mile in the lane)

HOT2 was found unworkable because it resulted in overloading the lane, beyond the target 1500 vph (vehicles per hour) leaving no capacity for peak-hour toll customers.

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1 "HOT Lanes Feasibility Study for State Route 91", (OCTA/Parsons Transportation Group, July 1997).

Under HOT3 operation, using the toll amount as a fine-tuning control[2], the projected traffic volumes were close to the target 1500 vph level. On this basis, the HOT3 concept was declared "feasible".

Total annualized costs of operation and amortization of the HOT infrastructure were estimated at $3-5 million and annual toll revenues at $7-9 million by year 2010.

Projected traffic volumes in unrestricted and restricted lanes under the various operating alternatives (HOV2, HOV3, HOT3-25 and HOT3-33) were derived and given in Tables 2-6 and 2-7 for the years 2000 and 2010.

WHAT'S MISSING

The reason for adding the lanes is — or should be — to

> *provide more transportation capacity, which will relieve congestion, air pollution and energy consumption.*

The comparative performance or effectiveness of the various operational alternatives HOV, HOT, or mixed-flow, should be measured by the extent to which they achieve these fundamental objectives.

But the Report gives no results whatsoever on comparative performance. It concludes HOT is *feasible*, but gives no guidance on whether implementing it would be beneficial or detrimental. The study concentrated on the narrow issue of "lane optimizing" the restricted lane alone, to satisfy an arbitrary 1500 vehicle-per-hour (vph) criterion, without regard to what happens to the other lanes. In effect, the ground rule was, "Never mind how much more or less congestion the mixed-flow lane drivers suffer — nor how much more pollution they may cause because of the HOV lane."

HOT lane operation should be implemented only if it is projected to provide greater ***overall*** transportation benefit than the alternatives. In this context, "overall" means considering the net effect on the entire freeway or corridor, not just the restricted lane. If "lane optimizing" were a valid objective, ultimate performance would be achieved by simply *blocking off the lane* — totally. Then there would be *no* congestion, *no* lost time, and *no* pollution in the lane. Stated this way the fallacy is surely obvious.

DERIVING THE MISSING RESULTS

The starting point for deriving the missing results is the traffic volume data for each alternative operational mode, given in the Report, Tables 2-6 and 2-7. In those tables, the *total* facility volume distributions (for each occupancy class, summed over all lanes) are *identical* between the HOV2 and HOV3 operational modes. This means that using a *consistent* traffic methodology, they would then also be identical for any occupancy threshold and in particular, for HOV1, which is identically the mixed-flow alternative. Consequently, without further assumptions, we can take these totals as the mixed-flow

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[2] Tolls set at 25¢/mile initially, increased to 33¢/mile by year 2010.

volumes that would have been obtained, even though these were not explicitly solved for in the Report.

Given the lane traffic volumes, it is a trivial additional effort to calculate the average congestion delay and average speed using the same "Bureau of Public Roads" methodology used and described in the Report and also used in the recent Major Investment Study. The average speed and volume in turn determines the average emission and energy consumption rates, based on California Air Resources Board EMFAC7G technology. Those computations are carried out in Table2 and Table 3 and explained in detail in the Technical Appendix here.

COMPARATIVE PERFORMANCE RESULTS SUMMARY

The main results are summarized here in Table 1, in terms of overall person-hours of congestion lost time, and overall Carbon Monoxide (CO) emissions, tons/year, expressed as a percentage relative to the mixed Flow alternative (defined as 100%), ranked from best to worst:

Table 1 Overall Benefits Comparison of Alternatives For year 2010

Op. Mode	Congestion-Lost Time	CO Emissions	Restricted Lane Volume Vehicles/hour
Mixed-flow (best)	100.0%	100.0%	2320
HOV2	100.1%	104.4%	1922
HOT3-25	122.1%	110.4%	1940
HOT3-33	150.4%	124.7%	1500
HOV3 (worst)	277.1%	173.4%	194

In brief summary, the preferred HOT3-33 operational mode is projected to produce 50% more overall congestion lost time, and 25% more CO emissions than the mixed flow alternative.

The last column in this comparison gives the projected traffic volumes in the restricted lane. The interesting point made here is that the benefits ranking are essentially inverse to the restricted lane volume rankings; the more restricted the special lane, the worse the overall congestion and air quality impacts. The greatest congestion and air quality benefits are found for the mixed-flow case, no restriction at all.

The expected benefits of HOT lane operation stem from the plausible *hypothesis* that the restricted lanes can be made better without significant ill effects on the rest of the freeway. However, objective analysis in the recent OCTA MIS study, in EI studies by OCTA and CALTRANS in Orange County, in analytic studies at the Institute for Transportation Studies, UCI Berkeley, and finally here in the extended HOT study, all have shown this *hypothesis* is generally false[3]. In all of these studies, whenever one lane

[3] "Best Evidence on HOV Effectiveness", AJM Engineering, August 23, 1998. Online at <http://home.earthlink.net/~malli/HOV.html>

has been restricted to provide more nearly free-flow in it, the adverse effect on the *other* lanes, of the added traffic imposed on them, has *more* than nullified any advantage in the restricted lane alone, so that the net effect on the freeway as a whole is counterproductive. Lane *emptiness* turns out to be almost always the dominant factor, even when, as in the case of HOV2, it may not be obvious to most travelers.

CONCLUSIONS

1. HOT lanes should be implemented only if they can be expected to provide greater fundamental transportation benefits: less travel-time wasted in congestion, and less polluting emissions than the alternative operational modes.
2. The OCTA study found HOT lanes *feasible*, but showed no comparison of fundamental benefits of the alternatives — no reason why HOT should be preferred over any other alternative, HOV2, HOV3, or mixed Flow.
3. The anticipated benefits of HOT lane operation like HOV operation, stem from the initially plausible *hypothesis* that by using congestion pricing to maintain the restricted lane volume at a near free-flow condition of about 1500 vph, the restricted lanes can be made better without significant ill effects on the rest of the freeway. However, in every known instance where comparative overall benefits have been evaluated, this hypothesis turns out to be false; the ill-effects on the unrestricted lanes outweigh the benefits in the restricted lane[3].
4. Because of the relationship between emissions and speed, freeing up the restricted lane at the price of slowing down the mixed-flow lane is almost always a lose-lose proposition. HOV and mixed-flow cars *both* create *more* pollution than they would under mixed flow operation. (See the discussion of Figure 1 in the Appendix)
5. Based on year 2010 projections, HOT3-33 operation of the facility would result in 50% more congestion-lost time, and 25% more CO emissions, than mixed-flow (Table 1).
6. The Report found HOV3 -33 (33 ¢/mile toll) necessary in order to meet the arbitrary target of 1500 vph in the peak period. However, HOV3-25 would afford 28% less congestion lost time and 15% less CO emissions (Table 1). One must then ask, which is the more important fundamental objective, maintaining 1500 vph in the HOT lane, or minimizing congestion and pollution?
7. Comparing HOV alternatives and mixed-flow (HOV1+) alternatives, unrestricted mixed-flow is best in all respects (Table 1). However, the differences between mixed-flow and HOV2 are insignificantly small. Bear in mind that this is only for terribly highly congested peak period, 2010 conditions and happens because HOV2 and mixed-flow lanes are approaching equal super-saturation. At off-peak hours the mixed-flow advantage would be more apparent. Contrary to the popular wisdom, HOV3 operation is a distant worst choice under all conditions (Table1). Ironically, HOV lanes are usually at their best, (least disbenefit) when, as here in the case of HOV2, they are equally congested as the mixed-flow lanes, not affording any time-saving or carpooling incentive, and not working at all as intended.

8. By the year 2010, "lane optimized" HOT3-33 (33¢/mile toll) operation of SR-91 west would result in 7 million more congestion lost person-hours per year than mixed-flow operation. The value of this wasted time, about $71 million per year — more than three times as much as the expected toll revenue — must be counted as part of the cost of HOT3, operation. Drivers, as a class, would have to pay the $9 million tolls to use roads they have already more than paid for in highway user fees[4]. In addition, they would have to endure some $71 million worth of unnecessary congestion lost time and some 340 tons/yr of unnecessary CO emissions.

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[4] Mallinckrodt, "Highway Subsidies", DHS Transportation Forum, January, 1996.

TECHNICAL APPENDIX
DERIVATION DETAILS

In all cases, the total freeway was taken as four lanes in each direction. The fundamental inputs to the derivation here are the projected year 2010 traffic volumes taken directly from the Report, for each of two ***lane-types:***

Three Mainline or mixed-flow lanes, plus
One Restricted, HOV or HOT lane

for each of three ***occupancy classes***

Drive alone,
2 person carpool, and
3 person carpool)

for each of four ***operational modes***

HOV2
HOV3
HOT3 @ 25¢/mile toll
HOT3 @ 33¢/mile toll

Table 2 derives the basic emission and energy consumption rates per vehicle. The bold, italicized entries in columns C,F, I, and L, are the traffic volume data, taken from the OCTA report, tables 2-6 and 2-7. Notice that the total volume distributions for "All lanes" in rows 29-32 are identical between the HOV2 and HOV3 cases. Using a consistent traffic methodology, they would then also be identical for any occupancy threshold and in particular, for HOV1, which is the mixed-flow alternative. Consequently, without further assumptions, we can take these totals as the mixed-flow volumes even though these were not explicitly derived in the Report.

Given the projected traffic volumes, it is a relatively trivial matter to derive the travel-time lost in congestion, the speeds, and emissions for the unrestricted and restricted lanes and overall. Tables 3a and 3b are spreadsheets for years 2000 and 2010, deriving the per-unit (per hour, per mile of freeway) total-travel-time lost in congestion (person-hr/mile/hr), and CO emissions (gm/mile/hr) factors for each operational mode. All the traffic volume data and methodology is identical to that found and used in the HOT study (except for emissions which were not treated there).

The geographic scheme of the derivation spreadsheets 3a and 3b is this: The four (or five for year 2010) major three-column groups represent the four (or five) applicable operational modes. Within each such operational mode-group the three major row - groups represent mainline, restricted lane (if any), and overall freeway lanes. The cell derivation within each such row-column group, all follow the same pattern which will be described for the first row and first column group, (Mainline lanes, HOV 2 mode), as follows.

All quantities are per mile of freeway and per hour of duration. The bolded numbers in column C rows 9-12 are the traffic volumes from the Report, Tables 2-6 and 2-7.

The next subgroup, cells C-13 to C 17 derive the basic unit time delay and emission factors as follows: Travel -time estimation is based on the Bureau of Public Roads (BPR) formula as given in the OCTA Report Appendix, page A-4

$$T = T_0(1 + 0.15(V/C)^4)$$

where

T = Congested travel-time
T_0 = Free-flow travel-time. Taking the unit distance to be one mile at nominal 60 mph, T_0 = 1 minute per mile
V = traffic volume, vehicles per hour per lane
C = nominal lane capacity, vehicles per hour per lane
= 1500 vph for freeway lanes.

This is the same algorithm used in the OCTAM model in the recently completed MIS study.

For the present purposes we are interested only in the *excess* congested travel time, given by subtracting off the free-flow part of the travel time (the "1" inside the parentheses) thus:

$$\boxed{TC = T_0(0.15(V/C)^4)} \qquad 1)$$

where TC is the travel-time lost in congestion (minutes per mile).

In the Report, there is no restriction on the range of applicability of equation 1. In fact, the data of the Report, Tables 2-6 and 2-7 developed using this relation, shows volumes as much as 3029 vph per lane, well beyond a reasonable maximum expectation of 2000 to 2200 vph per lane. This may be viewed at first glance as an apparent contradiction. However, bear in mind that the effects of different freeway capacity restriction choices may be felt over an overflow corridor of several miles width surrounding the freeway. Any study of overall congestion effects should consider these overall corridor impacts. When equation 1 is viewed as an expression of freeway speed as a function of freeway volume demand some of which may in fact be handled by the sidestreets, the contradiction disappears and the extended relation is of exactly the kind needed to treat such effects.

Cell C-13 is the Volume/Capacity ratio given by the subtotal traffic immediately above divided by the total capacity for the 3 mainline lanes, {=6931/(1500*3)= }1.540.

Then in cell C14, Equation 1 above gives average congested time-delay, TC, {=0.15*(1.540)^4= } 0.844 (minute/mile). From this follows the average speed, in cell C-15, {=60/(1+0.844)=} 32.5 mph.

The average travel times found for mainline and special lanes, is summed over all persons (= no. of vehicles in each occupancy class times occupancy) to give total travel-time, (person-hrs/mile of freeway/hr of operation) a direct measure of effective overall congestion in cell E-32..

The CARB MVEI7G program (EMFAC7G technology) was used to estimate fleet weighted average emission factors for the Southern California Air Basin, running emissions burdens, and fuel consumption for year 2010 fleet mix, (1976-2010), light duty automobiles, summertime, 75° F ambient, with catalyst, and standard maintenance options. This results in a table of fleet average emissions rate, gm/mile as a function of average speed. Simple analytic fits were then derived for these average Emission Factors. For CO, the only component treated here, the analytic fit is

$$F_{gm/vmt} = \frac{1}{(k0 + k1 * S + k2 * S^2 + k3 * S^3)}$$

where S is average traffic speed, mph.

F is the emissions rate, gm per vehicle-mile traveled.
k0 = 0.043455649
k1 = 0.009944462
k2 = 0.000370178
k3 = -7.5558E-6

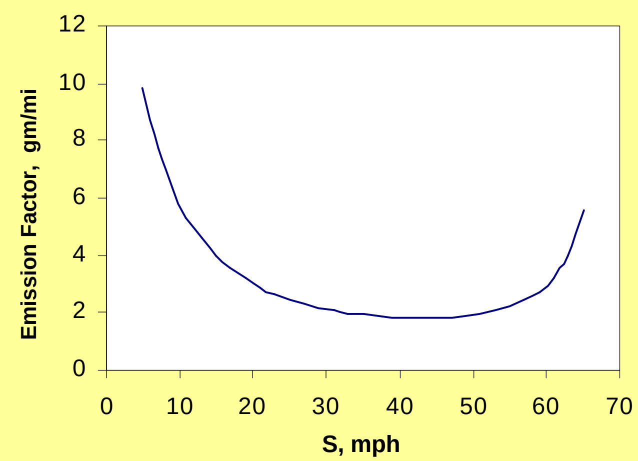

Figure 1. CO Emissons vs. Average Speed

The resulting Emissions Factor, F, in cell C-16, is plotted in Figure 1 here. This figure explains why the tradeoff of worse flow in the unrestricted lanes for better flow in the restricted is almost always unfavorable overall. Emissions and fuel consumption are minimized in the vicinity of 35-50 mph and increase sharply at higher or lower speeds. If the initial average speed is in the order of 40 mph (LOS D or E), speeding up the preference-lane to more than optimum at the cost of slowing down the mixed-flow lanes to less than optimum may cause increased emissions in *both* — a lose-lose proposition.

The computation is carried out separately for the unrestricted and restricted lanes, multiplied by the respective vehicle volumes, and summed for a total system emission in gm/mile of freeway, per hour of operation, in cell C-33..

Column D is the person volume, given by vehicle volume times class-occupancy. For example cell D-10, {= 566 * 2=} 1132. Column E is the congestive time-delay, for example, cell E-10 {=1132 * 0.844/60 =} 7.96 person-hours (per mile of freeway per hour of duration). Here the quantity 0.844 is the congestive per unit time delay given in cell C-14.

The per unit (per mile of freeway per hour of operation) delay and emissions rates found in Tables 3 are scaled to overall freeway per year in Table 4. Multiplying by the duration of congestion (assumed 3 hours in each direction) and length of system (12 miles) gives total person-hours of travel-time lost in congestion. Further multiplying by an assumed value of time, $10 per hour, gives the effective dollar value of total travel-time lost in congestion

TABLE 3a   Performance Comparison of HOT Alternatives in year 2000
Ref: HOT Lanes Feasibility Study, July 1997, Table 2-6

		C	D	E	F	G	H	I	J	K	L	M	N
		HOV2 lane & 3 MF lanes			**HOV3 lane & 3 MF lanes**			**HOT3-25 lane + 3 MF lanes**			**4 MF lanes**		
8	**Mainline Lanes**	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr
9	DA	***6254***	6254	87.99	***6254***	6254	205.19	***5277***	5277	91.51	***6254***	6254	70.33
10	2	***566***	1132	15.93	***2200***	4400	144.36	***1944***	3888	67.43	***2200***	4400	49.48
11	3+	***111***	333	4.69	***111***	333	10.93	***82***	246	4.27	***284***	852	9.58
12	Subtotal	***6931***	7719	108.60	***8565***	10987	360.48	***7303***	9411	163.20	***8738***	11506	129.39
13	V/C	1.540			1.903			1.623			1.456		
14	min/mi	0.844			1.969			1.041			0.675		
15	mph	32.5			20.2			29.4			35.8		
16	CO, gm/mi/veh	2.006			3.000			2.156			1.896		
17	CO, gm/mi	13900.1			25698.6			15744.9			16567.5		
18	**Carpool Lane**	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr			
19	DA	***0***	0	0.00	***0***	0	0.00	***1081***	1081	3.29			
20	2	***1634***	3268	17.21	***0***	0	0.00	***289***	578	1.76			
21	3+	***173***	519	2.73	***173***	519	0.00	***206***	618	1.88			
22	Subtotal	***1807***	3787	19.94	***173***	519	0.00	***1576***	2277	6.94			
23	V/C	1.205			0.115			1.051					
24	min/mi	0.316			0.000			0.183					
25	mph	45.6			60.0			50.7					
26	CO, gm/mi/veh	1.817			2.935			1.945					
27	CO, gm/mi	3284.0			507.7			3065.1					
28	**All Lanes**	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr
29	DA	***6254***	6254	87.99	***6254***	6254	205.19	***6358***	6358	94.81	***6254***	6254	70.33
30	2	***2200***	4400	33.13	***2200***	4400	144.36	***2233***	4466	69.19	***2200***	4400	49.48
31	3+	***284***	852	7.42	***284***	852	10.93	***288***	864	6.15	***284***	852	9.58
32	Subtotal	***8738***	11506	128.54	***8738***	11506	360.48	***8879***	11688	170.14	***8738***	11506	129.39
33	CO, gm/mi	17184.2			26206.3			18809.9			16567.5		

Bold italic vph numbers are from source reference   All quantities per hour, per directional mile of freeway

BPR FORMULA: TC = D * (0.15 +(V/C)^4), min/mi
C=1500 vph/ln
V = Volume, veh/hr/ln
CO Emission Factor: F=1/(KK0 + KK1*S + KK2*S^2 + KK3*S^3)   gm/veh-mi
S = Average Speed, mph

CO Emission Factors Coefficients

KK0	0.0434556	
KK1	0.0099445	(Calif. EMFAC7G)
KK2	0.0003702	
KK3	-7.56E-06	

TABLE 3b Performance Comparison of HOT Alternatives in year 2010

Ref: HOT Lanes Feasibility Study, July 1997, Table 2-7

		C	D	E	F	G	H	I	J	K	L	M	N	P	Q
	Operational Mode:	**HOV2 lane & 3 MF lanes**			**HOV3 lane & 3 MF lanes**			**HOT3-25 lane & 3 MF lanes**			**HOT3-33 lane & 3MF lanes**			**4 MF lanes**	
8	**Mainline Lanes**	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	persons	ps-hr
9	DA	***6335***	6335	113.27	***6335***	6335	263.34	***5051***	5051	99.64	***5396***	5396	133.54	6335	90.67
10	2	***804***	1608	28.75	***2532***	5064	210.51	***2283***	4566	90.07	***2378***	4756	117.70	5064	72.48
11	3+	***220***	660	11.80	***220***	660	27.44	***208***	624	12.31	***208***	624	15.44	1242	17.78
12	Subtotal	***7359***	8603	153.82	***9087***	12059	501.28	***7542***	10241	202.01	***7982***	10776	266.68	12641	180.92
13	V/C	1.635			2.019			1.676			1.774				
14	Delay, min/mi	1.073			2.494			1.184			1.485				
15	mph	28.9			17.2			27.5			24.1				
16	CO, gm/mi/veh	2.182			3.507			2.276			2.544				
17	CO, gm/mi	16059.8			31871.7			17162.3			20308.8				
18	**Carpool Lanes**	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr		
19	DA	***0***	0	0.00	***0***	0	0.00	***1371***	1371	9.59	***1026***	1026	2.57		
20	2	***1728***	3456	23.29	***0***	0	0.00	***380***	760	5.32	***285***	570	1.43		
21	3+	***194***	582	3.92	***194***	582	0.00	***189***	567	3.97	***189***	567	1.42		
22	Subtotal	***1922***	4038	27.21	***194***	582	0.00	***1940***	2698	18.87	***1500***	2163	5.41		
23	V/C	1.281			0.129			1.293			1.000				
24	Delay, min/mi	0.404			0.000			0.420			0.150				
25	mph	42.7			60.0			42.3			52.2				
26	CO, gm/mi/veh	1.803			2.934			1.803			2.013				
27	CO, gm/mi	3464.4			569.3			3498.3			3018.9				
28	**All Lanes**	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	veh	persons	ps-hr	persons	ps-hr
29	DA	***6335***	6335	113.27	***6335***	6335	263.34	***6422***	6422	109.23	***6422***	6422	136.10	6335	90.67
30	2	***2532***	5064	52.04	***2532***	5064	210.51	***2663***	5326	95.38	***2663***	5326	119.13	5064	72.48
31	3*	***414***	1242	15.72	***414***	1242	27.44	***397***	1191	16.28	***397***	1191	16.86	1242	17.78
32	Total	***9281***	12641	181.03	***9281***	12641	501.28	***9482***	12939	220.88	***9482***	12939	272.09	12641	180.92
33	Total CO, gm/mi	19524.3			32441.0			20660.6			23327.7				

Bold italic vph numbers are from source reference

All quantities per hour, per directional mile of freeway unless otherwise noted

BPR FORMULA: TC = D * (0.15 +(V/C)^4), min/mi
C=1500 vph/ln
V = Volume, veh/hr/ln
CO Emission Factor: F=1/(KK0 + KK1*S + KK2*S^2 + KK3*S^3) gm/veh-mi
S = Average Speed, mph

CO Emission Factors Coefficients

KK0	0.0434556
KK1	0.0099445
KK2	0.0003702
KK3	-7.56E-06

TABLE 4. Comparison of HOT Alternatives
Total Lost-Time in Congestion and Total CO Emissions

		Year 2000				Year 2010				
		MF	HOV2	HOT3	HOV3	MF	HOV2	HOT3@25	HOT3@33	HOV3
Lost Time in Congestion	ps-hr/mi/hr	129.39	128.54	170.14	360.48	180.92	181.03	220.88	272.09	501.28
Multiplier (below)		0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
Lost time/yr in whole 12 mi	mill hr/yr	2.89	2.87	3.80	8.05	4.038	4.041	4.93	6.07	11.19
Cost of lost time	$mill/yr	28.9	28.7	38.0	80.5	40.382	40.406	49.3	60.7	111.9
Lost time re MF		0.00	-0.02	0.91	5.16	0.000	0.002	0.89	2.03	7.15
Cost re MF	$mill/yr	0.00	-0.19	9.10	51.58	0.000	0.024	8.92	20.35	71.50
%re MF	%	100.0%	99.3%	131.5%	278.6%	100.0%	100.1%	122.1%	150.4%	277.1%
CO Emissions	gm/hr/mi	16567.5	17184.2	18809.9	26206.3	18710.1	19524.3	20660.6	23327.7	32441.0
Multiplier (below)		0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246
Per year in whole 12 mile	tons/yr	407.7	422.9	462.9	644.9	460.4	480.5	508.4	574.1	798.3
Per year, rleative to MF		0.0	15.2	55.2	237.2	0.0	20.0	48.0	113.6	337.9
% re HOT3	%	100.0%	103.7%	113.5%	158.2%	100.0%	104.4%	110.4%	124.7%	173.4%

Multiplying factor assumptions

	Time	Emissions
Equiv pk-hr/day, either dirctn.	6	6
Equiv day/yr	310	310
Total Length of fwy, mi	12	12
million$/$	1.00E-06	
ton/gm		1.1025E-06
Factor	0.022	0.0246
Value of Time, $/hr	10	

END