

# A Review of “Competent Engineering Estimates” Under California VC 21655.5

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California VC 21655.5 requires that

*Prior to establishing (an HOV lane) competent engineering estimates shall be made of the effect of the lanes on safety, congestion and capacity.*

The statement of legislative intent further states

*It is the intent of the Legislature in amending this section to stimulate and encourage the development of ways and means of relieving traffic congestion on California highways and, at the same time, to encourage individual citizens to pool their vehicular resources and thereby conserve fuel and lessen emission of air pollutants.*

Clearly it was the intent of the legislature that HOV operation should improve overall traffic congestion, environmental impacts and safety as compared to GP (General-Purpose, or Mixed-Flow, or unrestricted) operation of the lane. The requirement reflects the intent to invoke the best engineering understanding and judgement to insure that these benefits would in fact occur.

That intent has been massively frustrated by Caltrans. Engineering estimates for the most part have not been made, and on the few occasions where they have been made, the estimates have reflected rote recitation of a standard pro-forma cookbook spreadsheet rather than actual calculations of traffic and carpooling modal shift for the conditions of application. Further, for the most part, they have not compared HOV operation to unrestricted (mixed-flow or general-purpose) operation of the same physical facility.

In 1998, through the offices of Assemblyman McClintock, I requested *all* the “competent engineering estimates” that had been prepared from inception of the requirement through 1998. Based upon the number of such facilities existing, Caltrans initially estimated that there should be 80 or 90 such reports. Ultimately they were able to identify and provide only nine.

It is not clear whether such estimates were ever done for the other 90% of the cases. However, the nine cases that were provided constitute a damning indictment of the competency of the process. The attached spreadsheet summarizes the nine reports in terms of six criteria that are each necessary (but not sufficient) characteristics of a competent engineering estimate of HOV Lane (HOVL) effectiveness. Failure to pass any criterion is indicated by the bolding of the response for that entry. The significance of the various columns are as follows.

## **Criterion 1. Makes Traffic Redistribution Projections**

The projected traffic redistribution among the lanes is at the heart of any benefit calculation. Two of the nine cases (the bottom two) don’t even purport to make any traffic projections or relative benefit estimates, only seven (referred to here as “the seven”) gave any traffic results whatsoever.

**Criterion 2. Compares HOV to GP as *operational* alternatives for the same physical freeway.**

Clearly the legislative intent was to determine whether HOV operation of a lane was more beneficial than regular, mixed-flow, not whether *adding a lane* was beneficial (of *course* it always is, no matter how inefficiently operated. Adding even a fraction of a lane capacity can only help). But, unfortunately the wording of the legislative requirement permits a much narrower legalistic interpretation, that is, compare the *prebuild* mixed-flow condition with the *bundled* alternative of (build a new lane *and* operate it as HOV). Every one of the seven reports took advantage of this loophole and avoided comparing HOV and MF as operational alternatives for the same physical freeway lanes.

This is rationalized as realistic in view of the Caltrans policy since the ill-fated Santa Monica diamond lane experiment, that all new HOV lanes in California have been bundled with the building of a new lane. The sole rationale for that policy is to avoid giving the public an opportunity to make a simple A-B comparison of HOV vs. MF operation. So the question of relative effectiveness of HOV vs. Mixed-Flow lane operational alternatives of a given remains un-addressed and unanswered, both in practice and in the Caltrans “competent engineering estimates” under VC 21655.5. Six of the seven reports failed this test.

**Criterion 3. Estimation Methodology Documented.**

All of the seven included one of more spreadsheets, in identical format (a Caltrans HOV branch pro-forma standard), comparing vehicle volumes, person volumes, Level-Of-Service (a measure of freedom from congestion) and safety in each lane in existing pre-build (presumably measured), and estimated post-build states. These estimates could have been arrived at in many ways ranging from comprehensive traffic planning models, the method of choice of the US DOT for major investment studies, to baseless guesses contrived to support an a priori conclusion. Documentation of the method actually used to obtain these estimates is an essential component of a credible engineering estimate. Not one of the seven estimate reports explains *how* the estimates were arrived at. Other discrepancies discussed under the remaining criteria strongly suggest that whatever methodology was used was invalid. All of the seven reports failed this test.

**Criterion 4. Estimation of AVO dependency on HOV lane time saving.**

The Average Vehicle Occupancy (AVO) in the several lanes under both GP and HOV operation is critical in determining effectiveness. One valid way of estimating AVO is to solve for the amount of carpooling as determined by the HOV time saving, the HOV time saving in turn determined by the speed in each lane, in turn determined by the traffic volume in each lane, in turn determined by the amount of carpooling. This is a fairly complex modeling issue but competent models of each of the above processes and of their integration in an overall system are widely available. There may be other ways of validly solving for AVO but I don't know of any. Guessing based on other HOV experience is not a valid procedure.

The following two criteria point to two specific serious contradictions of well understood behavior of AVO, which strongly suggest that valid AVO estimation procedures were not used in any of the example cases.

**Criterion 5. AVO in the LOV lanes is Less than Pre-Build.**

The LOVLs (Low Occupancy Vehicle Lanes of a freeway with HOVL) typically display a reduced Average Vehicle Occupancy, (AVO) typically 1.02 to 1.05 as opposed to typically, 1.15 to 1.20 for a freeway as a whole. The reason is simple. If as intended the HOVL is carrying fewer vehicles at higher speed, most existing or “ambient” carpools will divert from the LOVLs to the HOVL to take advantage of its better speed. This leaves the AVO of the LOVLs “depleted” by essentially the same amount that it “enriches” the AVO of the HOVL.

Since the standard “competent estimates” spreadsheet provides both vehicle- and person-count estimates for each lane, it is possible to infer from them the assumed Average Vehicle Occupancy (AVO). Doing so, five of the seven estimate cases have post build AVO in the LOVLs, all greater than 1.14, a clearly erroneous result indicative of faulty and naïve methodology.

In three of those cases the AVO was identical at exactly 1.15, an unlikely coincidence suggesting that the result was not derived by any means but copied from a pro-forma standard. The direction of this error is, of course, such as to overestimate the overall person carrying capacity of the freeway with HOV lane.

Five of the seven reports failed this test.

**Criterion 6.**

Four of the seven estimate cases had AVO of the LOVLs identical to pre-build AVO. This is an impossible contradiction of basic understanding of HOV dynamics as described above and indicates a naïve erroneous methodology. Four of the seven reports failed this test.

**SUMMARY**

The legislative intent of VC 21655.5 has been frustrated in the following ways:

1. None of the respondent studies addressed, much less answered, the issue of comparative benefits of HOV vs GP operational alternatives for the same freeway of the same number of lanes.
  2. None of the respondent studies explained their methodology for arriving at the estimates presented, making it impossible for a knowledgeable third party to check or duplicate the results.
  3. There were numerous cases of results contradictory to the most rudimentary understanding of HOV lane performance.
  4. In my opinion not one of the nine respondent studies was either responsive to the intent of VC21655.5 or competent by the basic criteria set forth above.
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.This following spreadsheet documents the critique of the nine reports provided as response to the requirements of VC 21655.5

### COMPETENT ENGINEERING ESTIMATES

ID	Date	Description	Date	Corporate Author	District	VALIDITY CRITERIA					
						1 Makes Traffic Redistribution Projections	2 Compares HOV vs GP as operational alternatives for same number of lanes.	3 Estimate Methodology Documented	4 Valid Estimation of AVO	5 AVO in LOVL less than Pre Build	6 LOV AVO different from PreBuild AVO
		<b>Mistake is</b>				<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>&gt;1.05</b>	<b>N</b>
1	12/90	SR-57 I-5 TO LA CTY LINE	12/90	Caltrans	12	Y	N	N	N	1.15	N
2	12/90	SR-91, SR-57 to Magnolia	12/90	Caltrans	12	Y	N	N	N	1.15	Y
3	2/91	I-5	2/91	Caltrans	12	Y	N	N	N	1.15	N
4	12/92	SR-405, SR101 to To Rt 5	11/92	Caltrans	7	Y	N	N	N	1.2,1.3	N
5	3/98	Carquinas Bridge	3/98	Caltrans	4	Y	N	N	N	1.21	Y
6	9/94	I-105 Transitway	10/91	Caltrans	7	Y	N	N	N	1.00	Y
7	12/93	SR-605 N of Telegraph to Rt 10	12/93	Alpha	7	Y	Y	Part	N	1.0-1.9	Y/N
8	4/90	I-405 I-5 to SR-605	4/90	Caltrans	7	N	N	N		NA	NA
9	7/97	I-605 from I-405 to LA Cty Line	7/97	Caltrans	12	N	NA			NA	NA

Bolds denote error