MEMORANDUM

TO: Parisa Fatehi-Weeks, Public Advocates

FROM: Alex Karner and Deb Niemeier, Department of Civil and Environmental Engineering, UC Davis

DATE: May 24, 2012

RE: Alternative scenarios, affordable housing, and vehicle-miles traveled in the Bay Area

A. Introduction

Under SB 375, California's metropolitan planning organizations (MPOs) must reduce per capita greenhouse gas (GHG) emissions, primarily by coordinating transportation and land use planning in an effort to pair compact growth with high quality transit. This coordination is embodied in the sustainable communities strategy – a new component of the regional transportation plan that provides not only a vision for the future transportation system but also signals the kinds of land uses needed to achieve reductions in vehicle-miles traveled (VMT).

The potential for gentrification and displacement to occur in urban spaces simultaneous with the pursuit of otherwise laudable environmental goals is now well-documented.[1] Recent work has identified ways in which the process of gentrification and the demographic changes it elicits actually work against environmental goals. These studies consistently find evidence of growing affluence in neighborhoods that receive improved transit service, including increasing proportions of college graduates, rising median incomes, higher automobile ownership, and reduced transit mode share.[2] The research on racial demographic effects is more mixed, with some studies concluding that local transit investments lead to a reduction in proportions of people of color,[3] and others finding no evidence of changing racial demographics.[4] As one example, an analysis of Canada's three largest cities found that while gentrification was associated with increases in non-motorized mode share, it was also associated with decreases in public transit and carpool use. Most problematically, the mode share for "auto as driver" was also associated positively with gentrification.[5] Taken together, these studies suggest that merely producing dense, mixed use developments well-served by transit is not enough to reach the policy goals of reducing VMT and thus GHG emissions.

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[1] Sarah Dooling, "Ecological Gentrification: A Research Agenda Exploring Justice in the City," *International Journal of Urban and Regional Research* 33, no. 3 (2009); Noah Quastel, "Political Ecologies of Gentrification," *Urban Geography* 30, no. 7 (2009).

[2] Matthew E. Kahn, "Gentrification Trends in New Transit-Oriented Communities: Evidence from 14 Cities That Expanded and Built Rail Transit Systems," *Real Estate Economics* 35, no. 2 (2007); Stephanie Pollack, Barry Bluestone, and Chase Billingham, "Maintaining Diversity in America's Transit-Rich Neighborhoods," (Dukakis Center for Urban and Regional Policy, 2010); Kara S. Luckey, "Assessing the Effectiveness of Approaches to the Allocation of Low-Income Housing Tax Credits in Proximity to Rail Transit" (paper presented at the 91st Annual Meeting of the Transportation Research Board, Washington, DC, 2012).

[3] ———, "Approaches to the Allocation of LIHTCs".

[4] Pollack, Bluestone, and Billingham, "Maintaining Diversity."

[5] Martin Danyluk and David Ley, "Modalities of the New Middle Class: Ideology and Behaviour in the Journey to Work from Gentrified Neighbourhoods in Canada," *Urban Studies* 44, no. 11 (2007).

As part of its equity analysis for the current regional plan update, known as *Plan Bay Area*, the Metropolitan Transportation Commission (MTC) reports that there will be substantial displacement pressures on "communities of concern" in the Bay Area in future years.[6] Specifically, MTC's analysis identifies concentrations of overburdened renters in traffic analysis zones (TAZs)[7] where greater than 15% of housing units are occupied by renters paying more than 50% of their income on housing. TAZs that meet these thresholds and are projected to grow by more than 30% by 2035 are considered at risk of increased displacement pressure. The MTC analysis results show that 30% to 40% of the base year's overburdened renters in communities of concern are at risk compared to 7% to 10% in the remainder of the region.

MTC has also identified that the proposed transportation investment and land use strategies get only part of the way toward the 2035 GHG emissions reduction goal. There is a five percentage point gap remaining that MTC is proposing to address through a series of transportation policy measures. Despite MTC's own analysis on displacement risk, discussions around bridging this gap have focused almost exclusively on achieving additional per capita GHG reductions through policy initiatives like the promotion of electric vehicles.[8] In focusing on vehicle technology, MTC overlooks an important opportunity: affordable housing can be an effective tool for meeting GHG emissions reductions while simultaneously meeting a number of other objectives by reducing other VMT-related externalities including congestion costs, deaths and injuries from collisions, and public health costs like obesity.

The remainder of this memo uses travel modeling data produced by MTC to quantify differences in travel behavior by income categories. We argue that equitable housing distributions that provide options for residents of different income levels can be an effective VMT reduction strategy.

B. Income, automobile ownership and VMT

The Association of Bay Area Governments (ABAG) has noted that residents of affordable housing drive less and own fewer cars than those who do not live in affordable housing.[9] Precisely how much less they drive can be identified with the travel demand modeling data developed for the alternative *Plan Bay Area* scenarios using low-income status as a proxy for affordable housing residence.[10] Table 1 shows vehicle ownership and VMT per capita at the household level when looking at income effects for both 2005 and future years. Consistent with SB 375, all future scenarios suggest that households, on average, will own fewer vehicles and

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[6] MTC, "Plan Bay Area Equity Analysis Overview and Equity Analysis Scorecard," http://www.onebayarea.org/pdf/EquityAnalysisOverview.pdf.

[7] A unit of geography used to model travel approximately equivalent to a census tract.

[8] See discussion at the May 11, 2012 joint meeting of the MTC Planning Committee and the ABAG Administrative Committee. Out of $685 million budgeted to help MTC reach its 2035 GHG emissions reduction target, 60% is directed at electric vehicle subsidization.

[9] Association of Bay Area Governments, "Myths & Facts About Affordable and High-Density Housing," http://www.abag.ca.gov/services/finance/fan/housingmyths2.htm.

[10] Five alternative scenarios were designed for Plan Bay Area comprising two transportation investment scenarios paired with two land use scenarios. The first two, Initial vision and Core capacity, assume unlimited resources for housing development in the Bay Area. The latter three are based upon realistic planning assumptions regarding the total amount of housing growth that can be accommodated in the region. Each varies slightly in precisely where growth is located. Further information is available at: http://www.onebayarea.org/pdf/ScenarioAnalysisOverview.pdf.

that VMT per capita across all income groups will decline. However, as expected, we find that vehicle ownership and VMT per capita increases as household incomes increase.

Table 1 Comparison of modeled scenarios – Automobile ownership and VMT per capita by income.

	Income quintile 1 (< 26,000)[a]	Income quintile 2 (26,000 – 52,000)	Income quintile 3 (52,000 – 80,000)	Income quintile 4 (80,000 – 124,000)	Income quintile 5 (> 124,000)
	Average vehicles per household				
Base year, 2005	1.010	1.533	1.821	2.10	2.15
Initial vision	0.947	1.447	1.738	2.01	2.09
Core capacity	0.917	1.445	1.742	2.01	2.08
Focused growth	0.948	1.493	1.795	2.06	2.11
Constrained core capacity	0.942	1.487	1.790	2.06	2.11
Outward growth	0.988	1.521	1.815	2.08	2.12
	Average VMT per capita				
Base year, 2005	8.78	13.27	17.13	19.15	19.65
Initial vision	8.09	12.18	15.40	17.30	18.20
Core capacity	7.91	12.22	15.48	17.26	17.99
Focused growth	7.76	11.94	15.07	17.02	17.83
Constrained core capacity	7.69	11.84	14.98	16.95	17.83
Outward growth	8.07	12.24	15.35	17.27	18.00

[a]Quintile bounds are calculated for each scenario, so the values that define each category are approximate.

The empirical evidence of gentrification discussed earlier suggests that median income levels and vehicle ownership are likely to rise in areas where transit service improves, and these increases have been linked to increasing risk of gentrification and displacement.[11] In future years, MTC has identified that transit service improvements will be focused largely on priority development areas (PDAs) – those areas targeted to receive streamlined environmental review for housing projects with densities conducive to frequent transit service. Using data provided by MTC, we classified 195 TAZs as being part of a PDA and compared the median incomes for PDA and non-PDA areas.[12] Table 2 shows that median income across the PDAs increase faster than in the non-PDAs and faster than the entire region from the base year to each of the future year scenarios. The results are consistent with MTC's equity analysis: PDAs will likely experience gentrification and increasing displacement risk as *Plan Bay Area* is implemented.

[11] Pollack, Bluestone, and Billingham, "Maintaining Diversity."

[12] A TAZ was considered to be part of a PDA if greater than 50% of its area overlapped part a PDA classified as "planned" and "final" in the GIS layer (according to the attributes PlanStatus and ABAGStatus, respectively).

Table 2 Median income, 2000$.

	PDAs	Non-PDAs	Entire region
Base year, 2005	43,800	68,200	65,000
Initial vision	48,000	67,000	64,400
Core capacity	50,000	68,000	65,000
Focused growth	48,310	68,000	65,000
Constrained core capacity	48,600	68,000	65,000
Outward growth	48,200	68,010	65,200

The gentrification literature discussed in the introduction also suggests that new residents in gentrifying areas will be less likely to take transit and more likely to own greater numbers of automobiles than previous residents. We can test this prediction by comparing low-income households to all other households in PDAs and non-PDA TAZs in terms of VMT per capita (Table 3). As we might expect, VMT per capita decreases from the base year when compared to each forecast scenario for both low-income and all other households. That is, households in PDAs have substantially lower VMT per capita than the rest of the region in both the base and forecast years. The critical aspect to this analysis, however, is that the rate at which low-income households reduce VMT per capita is slightly higher than all other households in both PDAs and non-PDAs in all future year scenarios (final row of Table 3). Automobile ownership results show similar, across the board reductions for PDAs, with low-income households owning fewer automobiles than all other households in both PDAs and the remainder of the region. Locating residents in PDAs is clearly an important strategy for achieving SB 375's GHG targets, but the future year non-low income households generally do not reduce driving or automobile ownership as much as low-income households.

Table 3 Comparison of modeled scenarios – VMT per capita.

	VMT per capita (PDAs)		VMT per capita (other TAZs)	
	Low-income households[a]	All other households	Low-income households[a]	All other households
Base year, 2005	5.51	11.04	9.54	18.72
Initial vision	5.11	10.23	8.70	17.29
Core capacity	4.78	9.87	8.54	17.20
Focused growth	4.88	9.96	8.42	16.85
Constrained core capacity	4.94	9.89	8.40	16.82
Outward growth	5.07	10.26	8.64	17.05
	Average reduction relative to 2005 (%)			
	10.0	9.0	10.5	9.0

[a]Low-income households classified according to the US Census definition[13] based on household size and income threshold. Consistent with MTC practice, 200% of the threshold is used.

One caveat is that these results may not fully represent market dynamics that will result from improved transit service, since the allocations of different household types by income are established prior to running the travel model. In addition, representations of travel behavior are

[13] US Census Bureau, "Poverty Data - Poverty Thresholds," http://www.census.gov/hhes/www/poverty/data/threshld/index.html.

based upon cross-sectional analysis sometimes extending as far back as 1990.[14] The gentrification literature argues that subsequent "waves" of gentrifying individuals bring with them different travel behaviors; these behaviors would tend to transcend classification based upon income alone to include difficult-to-quantify properties such as politics, ideologies and values.[15] Later waves are potentially less inclined to reduce automobile ownership and VMT than are earlier waves. These factors are generally not included in a travel demand model. For this reason, the travel model results might underestimate the VMT per capita and automobile ownership figures expected to result in future years in gentrifying, transit rich areas.

C. Links between affordable housing and VMT

It seems self-evident that affordable housing should not just be placed anywhere. More equitable distributions of housing can be expected to lead to lower VMT per capita based on the land uses likely to surround mixed income communities and also because of the relationships between VMT and income noted above. We can quantify the equitability of a housing distribution using the Gini coefficient. The Gini coefficient is a well-accepted measure of population inequality which varies from a perfectly equal distribution of some good (zero) to a perfect concentration of that good with one individual or group (one).[16] Those TAZs with more equitable housing distributions (where there are equal numbers of each household type by income) will have Gini coefficients closer to zero, while those with inequitable distributions will have Gini coefficients closer to one.

Table 4 summarizes the VMT per capita for each future year scenario and the base year according to quintiles of the Gini coefficient calculated at the household level.[17] Each column represents the average VMT per capita for households representing 20% of the total in each scenario. Housing distributions become increasingly inequitable moving from left to right in the table. The results clearly indicate that TAZs with more equitable housing distributions have lower VMT per capita. Further analysis reveals that the TAZs with the highest Gini coefficients (most inequitable) disproportionately represent households in the highest income groups. For the initial vision scenario, the TAZs with the most inequitable housing distributions (i.e. Gini quintile 5) had an average of 51% of total households in the highest income category and only 10% in the lowest income category. TAZs that had the most equitable housing distributions (i.e. Gini quintile 1) had an average of 23% of households in the highest income category and 20% in the lowest.

To the extent that median incomes rise in PDAs and similarly transit rich areas in the urban core in forecast years, VMT per capita is likely to increase. Maintaining and improving the equitability of the housing distribution is one method that MPOs can use to ensure that per capita VMT remains as low as possible. These results indicate that developing more equitable distributions of affordable housing should be included alongside other methods proposed by MTC to meet its SB 375-mandated GHG reduction target.

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[14] MTC, "Travel Model Development: Calibration and Validation (Draft)," (Oakland, CA: Metropolitan Transportation Commission, 2011).
[15] Danyluk and Ley, "Modalities of the New Middle Class: Ideology and Behaviour in the Journey to Work from Gentrified Neighbourhoods in Canada," 2197-98.
[16] World Bank, "Poverty Analysis - Measuring Inequality," http://go.worldbank.org/3SLYUTVY00.
[17] Quantities of housing types in each of four income categories based on ABAG modeling are used as input into MTC's travel model for future years. Observed data on income distribution are used for the base year.

Table 4 VMT per capita by scenario and Gini coefficient quintile.

Increasingly inequitable housing distribution →

	Gini quintile 1	Gini quintile 2	Gini quintile 3	Gini quintile 4	Gini quintile 5
Base year, 2005	14.91	15.10	15.10	17.50	19.03
Initial vision	12.98	13.71	14.35	15.40	18.10
Core capacity	13.11	13.34	14.25	15.66	17.88
Focused growth	12.73	13.22	14.30	15.11	17.59
Constrained core capacity	12.66	13.25	13.93	15.12	17.66
Outward growth	12.85	13.65	14.25	15.70	17.77

One could argue that the differences identified in Table 4 are entirely the result of income effects. We would expect the same results if low-income housing units are disproportionately concentrated in TAZs with low Gini coefficients. To check this hypothesis, we estimated a preliminary spatial autoregressive error model of the logarithm of total VMT at the TAZ level. The modeling results are located in the appendix. The independent variables include, among others, the total number of housing units in the lowest two income categories; this allows us to estimate the effect of affordable housing provision on total VMT (and thus GHG emissions). The interpretation of the estimated coefficient on affordable housing shown in the appendix is that a one percent increase in housing units occupied by the lowest income groups is associated with a 0.07 percent decrease in TAZ-level VMT, all else equal. Said another way, the provision of affordable housing within a TAZ has a high probability of being independent of the income level within that same TAZ and the other variables included in the model. This result suggests that an equitable housing distribution results in lower VMT.

D. Conclusion

This memo and MTC's own analysis indicate that gentrification and displacement of low-income residents are likely outcomes in areas expected to receive transit investments over the course of *Plan Bay Area*. We present evidence correlating inequitable housing distributions with higher VMT, suggesting that investment in affordable housing can help to meet SB 375's GHG reduction goals while mitigating the risk of gentrification and displacement. Additional transportation policies proposed to achieve GHG targets should not be myopically focused on transportation technology. Strategies such as affordable housing provision can help to meet SB 375's goals while mitigating other transportation externalities.

E. References

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Appendix

The travel data used to estimate the model shown in Table A 1 were obtained from MTC. Demographic data were also assembled from the 2005-2009 American Community Survey maintained by the US Census.

Table A 1 Spatial error model on the logarithm of total TAZ-level VMT for the 2005 base year.

Variable	Coefficient estimate	Standard error[a]
log(median income)	0.01700	0.00354***
log(housing units in the lowest two income categories)	-0.0647	0.00815***
log(total people of color)	-0.01859	0.00861*
log(total zero vehicle households)	-0.0240	0.00448***
log(total workers)	0.0985	0.01340***
log(total population)	0.993	0.01870***
log(total acreage)	0.0370	0.00519***
Peak transit accessibility[b]	-0.0371	0.00315***
Peak non-motorized accessibility[b]	-0.0475	0.00351***
Lambda (spatial error term)	0.1258	0.00256***
Number of observations = 1441		
Pseudo R^2 (Nagelkerke) = 0.96		

[a]Significance is indicated by the following convention: $p < 0.001$ ***, $p < 0.01$ **, $p < 0.05$ *

[b]Transit and non-motorized accessibilities are outputs from the travel demand model and are in relative units. They are included merely as controls.