PROJECT ASSESSMENTS FOR 8-HOUR OZONE CONFORMITY IN ISOLATED RURAL AREAS

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Jeroen Van Houtte, Ph.D. Candidate
Dr. Douglas Eisinger, Program Manager

Dr. Deb Niemeier, Principal Investigator
Dept. of Civil and Env. Engineering
University of California
One Shields Ave.
Davis, CA 95616

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Mike Brady, Senior Environmental Planner
Air Quality and Conformity Coordination
Division of Transportation Planning, MS-32
1120 N Street
Sacramento, CA 94274
(916) 653-0158

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for isolated rural 8-hour ozone non-attainment areas.

Project Assessments for 8-hour Ozone Conformity in Isolated Rural Areas

Jeroen Van Houtte, Douglas Eisinger, Ph.D. and D.A. Niemeier, P.E., Ph.D.

Jeroen Van Houtte, Ph.D. candidate
Transportation Technology and Policy,
U.C. Davis,
One Shields Avenue,
Davis, CA, 95616,
Phone: (530) 752 7132,
Fax: (530) 752 7872,
jjvanhoutte@ucdavis.edu

Douglas Eisinger, Ph.D. (corresponding author)
Program Manager,
U.C. Davis-Caltrans Air Quality Project,
University of California,
One Shields Ave.,
Davis, CA 95616,
phone: 707-665-9900,
fax: 707-665-9800,
doug@sonomatech.com

D.A. Niemeier, P.E., Ph.D.
Dept. of Civil and Env. Engineering,
University of California,
One Shields Ave.,
Davis, CA 95616,
phone: (530) 752-8918,
fax: (530) 752-7872,
dniemeier@ucdavis.edu

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ABSTRACT

Isolated rural 8-hour ozone non-attainment and maintenance areas (hereafter: rural areas) need to make a conformity determination for regionally significant transportation projects. This paper presents a streamlined method for project analysts charged with completing rural-area 8-hour ozone conformity analyses.

Several analysis options are available to complete rural-area 8-hour ozone conformity determinations. In most circumstances, however, the simplest approach will be for project analysts to use the "no-greater-than-base-year" emissions test to assess whether a project will pass conformity. The no-greater-than-base-year test involves estimating emissions for the base year, 2002 for 8-hour ozone analyses, and comparing emissions that occur during the base year to emissions that occur in future years, assuming the project is completed. If future year emissions are not greater than those estimated for 2002, the project will pass the conformity test.

On-road motor vehicle emissions are projected to decline substantially in future years, due to the replacement of older, higher-polluting vehicles, with newer, cleaner-operating vehicles. Given the substantial forecasted decline in on-road emissions, most projects will have little trouble passing the no-greater-than-base-year emissions test, unless the project results in a substantial increase in regional vehicle miles traveled (VMT).

For the no-greater-than-base-year test, we present a simplified analysis procedure relying on EMFAC (EMFAC is the California motor vehicle emissions model) projections of VMT and making simple assumptions about changes in traffic flow. For analyses where these assumptions are not sufficiently precise, a more detailed procedure is outlined.

INTRODUCTION

This paper presents a method for project analysts charged with completing conformity analyses for projects located in rural 8-hour ozone non-attainment and maintenance areas, as defined in 40 C.F.R. § 93.101. The guide is directed primarily at areas that were in attainment for 1-hour ozone and were subsequently classified as non-attainment for 8-hour ozone. Because rural areas are not required to develop and use a travel demand model (TDM), this paper describes conformity analysis procedures that are not reliant upon use of a TDM; the procedures can also be adapted to areas where TDM results are available.

Following this introduction, an overview is given of the conformity requirements, followed by a step-by-step procedure for simplified project-level rural area conformity analyses. For those cases where the simplified analysis does not suffice, a detailed analysis procedure is also outlined.

This paper helps state and local agencies complete rural-area conformity analyses. The methodologies presented do not constitute official guidance from a regulatory agency. Analysts are encouraged to use the interagency conformity consultation process to ensure the acceptability of this or other analysis methods.

REQUIREMENTS

This section explains the requirements for *rural* area conformity analysis. What triggers a conformity analysis? What needs to be included in an isolated rural area conformity analysis? Which conformity test should be used? Which horizon years should be analyzed? Where should an analyst get VMT and speed data?

What Triggers a Conformity Analysis?

In contrast to metropolitan areas and the more rural areas that surround them ("donut areas"), rural areas need *not* make conformity analyses at fixed time intervals. Rural areas need only submit conformity determinations to the Federal Highway Administration (FHWA)

- prior to federal approval of a non-exempt project that is either federally funded or has a regional impact, or
- after a change in design concept or scope of such a project, or
- when more than three years have elapsed between consecutive major approval steps—see 40 C.F.R. § 93.104 (d) and reference (*1*).

What Needs to Be Included in an Isolated Rural Area Conformity Analysis?

This section describes the information to include in a rural area conformity analysis, based primarily on conformity checklist materials made available by FHWA and the U.S. Environmental Protection Agency (EPA) (*2*). During the research phase of our work, FHWA staff also supplied us with an example rural area 1-hour ozone conformity analysis completed for a project in Cherokee, South Carolina (Roberts, 2005; personal communication). The project analysis was noteworthy because it was done in close consultation with FHWA officials. The federal agency conformity checklist, together with the insights available from the example analysis, help define project-level analysis needs. Project analysts should prepare the following when completing a rural area conformity analysis:

Background Materials that Describe the Project and the Conformity Analysis

- A brief description of the project that requires the analysis, including the reason for the analysis: new project, changed project or three year time lapse (40 C.F.R. § 93.104(d)).
- A paragraph on the non-attainment classification history of each applicable pollutant and precursor in the air basin that the project is in, as well as the boundaries of the air basin (40 C.F.R. § 93.102).
- A reference to the applicable air quality management plan, known as the state implementation plan (SIP), its status, and documentation of compliance with its requirements or those of applicable court orders including but not limited to emission budgets and Transportation Control Measure (TCM) requirements (40 C.F.R. § 93.109 (a,b)).
- Documentation of interagency and public consultation (40 C.F.R. § 93.112).
- In the absence of an adequate SIP budget, identification of the selected emissions test and definition of the baseline and action scenarios (40 C.F.R. § 93.119 (h,i)).
- A description of the analysis process including use of latest planning assumptions (40 C.F.R. § 93.110 (a,b) and guidance (40 C.F.R. § 93.111 and § 93.122 (d)):
    - Forecasting method,
    - Analysis years (40 C.F.R. § 93.118(b,d) and § 93.119 (g)),
    - Data sources,
    - Software used,
    - Assumptions regarding tampering rates and programs, vehicle speeds, VMT mix, inspection and maintenance (I/M) program, vehicle refueling emission controls, which hydrocarbons were modeled (usually reactive organic gases, ROG), fuel volatility, altitude, operation mode fractions, temperatures, basic exhaust emission rates for ROG and oxides of nitrogen (NO_x),
    - Planning assumptions and effect on VMT for:
        - all regionally significant projects and all Federal projects in the air basin (with reason for exemption, if applicable) (40 C.F.R. § 93.122 (a)(1), § 93.126, § 93.127, § 93.128)
        - transit, TCMs and other SIP measures (40 C.F.R. § 93.122 (a)(2-6), § 93.110 (c,d,e,f) and § 93.113(a,d)).

Calculations Detailing Analysis Results

- VMT projections
- Input and results of EMFAC or MOBILE modeling.

Conclusion—Conformity finding and summary of results:

- A table showing the reference and projected emissions (40 C.F.R. § 93.109 (l)), see illustration in Table 1.

- Conformity finding with (40 C.F.R. § 93.118(a,c,e)) or without applicable SIP budget (40 C.F.R. § 93.119).

Note that this outline does not include particulate matter (PM) or carbon monoxide (CO) hot spot analysis documentation; PM and CO hot spot analyses are required in PM and CO nonattainment and maintenance areas.

TABLE 1. Illustration of Project Emissions that Would Pass a Conformity Test.

Scenario	ROG [TPD]	NO_x [TPD]
Reference (e.g. base-year 2002, no-build or budget)	2.18	3.05
Action, build, horizon analysis year 1 (e.g., 2008)	1.82	2.77
Action, build, further horizon analysis years …(e.g., 2018)	0.99	1.54

Data in the table are for illustration only. TPD means tons per day.

Which Test to Use

The test to use depends on the presence of an emission budget. The emission budget is the preferred reference for conformity testing. In the absence of such a budget, one must use either base year 2002, or the horizon-year no-build scenario, or both.

Situations Where Emission Budgets Have Been Established

Over time, most nonattainment areas will become subject to a SIP. SIPs establish allowable emissions, and identify and make commitments to needed emission controls. Once an area has a SIP that establishes allowable on-road mobile source emissions, EPA reviews the allowable emissions to ensure they are based on adequate information. Once EPA finds the allowable emission levels to be adequate, they become “emissions budgets” for the purpose of completing transportation conformity analyses. Thus, areas that have SIPs in place generally have obvious conformity analysis goals in the form of specific emission limits, or budgets. If the area has an emissions budget and meets the budget test, no other tests are required. Also, for years after those covered by the latest SIP with adequate vehicle emissions budgets, any one of several tests can be used to demonstrate conformity (*3*).

Situations Where Emission Budgets Have Not Yet Been Established

In the period prior to the development and adoption of SIPs, other conformity tests are used to determine whether transportation projects, plans, and programs conform to air quality goals. Since newly designated 8-hour ozone areas (rural or not) typically will not have an EPA-approved adequate SIP emissions budget until at least three years after the area was first designated to be a nonattainment region, conformity analyses in these areas must rely on tests other than use of an emissions budget. If the ozone non-attainment area is classified as marginal or below, the area can choose to use a regional emissions analysis based on either the “baseline/action” test (also known as “build/no-build”) or the “no-greater-than-base-year” test. Federal Regulations define the base year for 8-hour ozone areas as 2002. For comparison, 1990 was the base year for 1-hour ozone conformity assessments (40 C.F.R. § 93.119 (b)). If the area is classified as moderate or above, both tests ("build/no-build" and "no-greater-than-base-year") must be met.

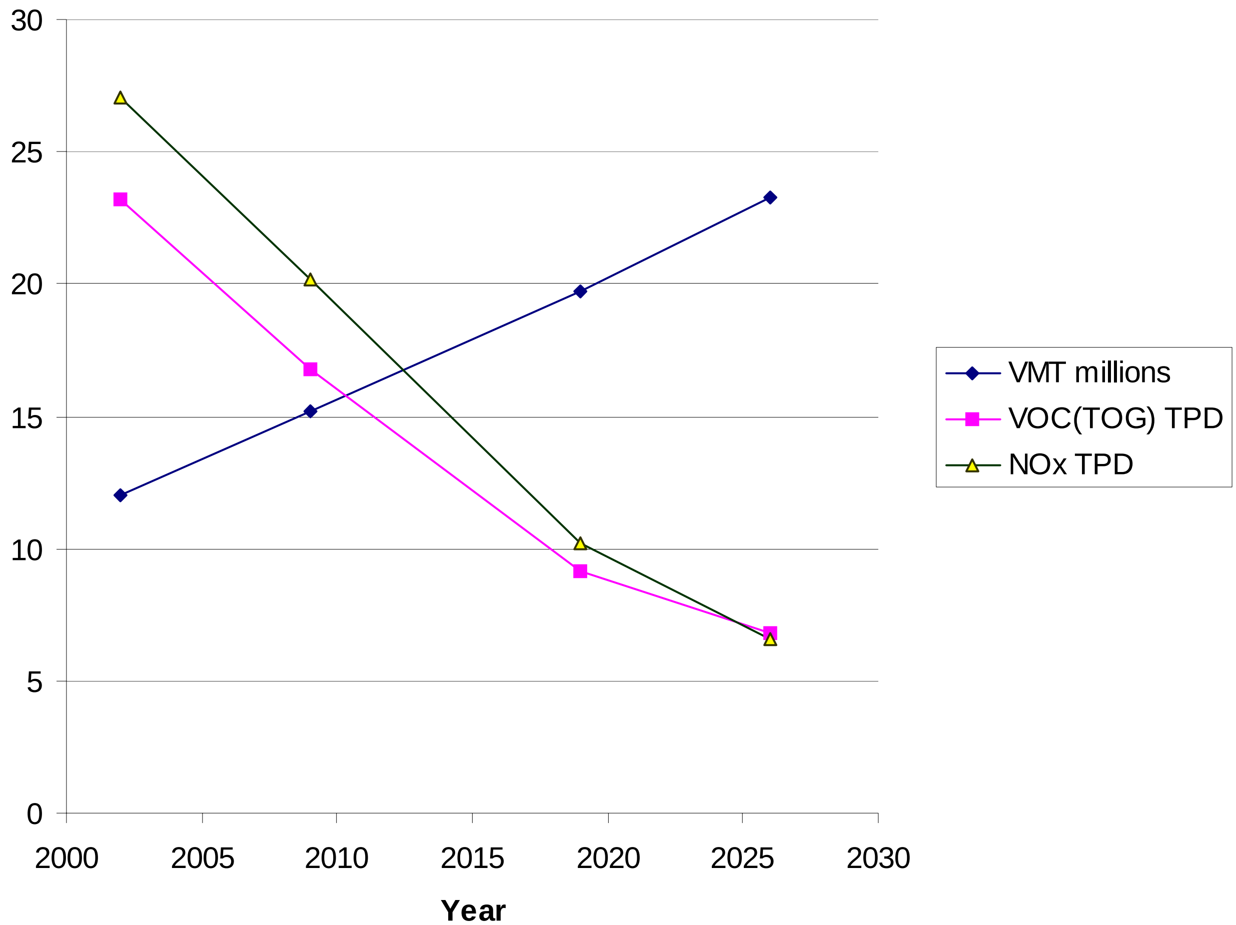


FIGURE 1. Declining on-road emissions, and increasing VMT, for California Mountain Counties, as predicted by EMFAC2002 with default settings.

In most cases, the no-greater-than-base-year test is easier to meet than the build/no-build test. The removal of older vehicles with higher emissions, in favor of newer, cleaner vehicles, dramatically reduces fleet-average emission factors. To illustrate this, Figure 1 provides EMFAC results for the California Mountain Counties air basin (a nine county region). As illustrated by Figure 1, fleet turnover means that on-road emissions decline substantially over time, despite forecasted VMT growth. In some circumstances, even if a project passes a no-greater-than-base-year test, stakeholder groups may want to understand build/no-build analysis results to assess individual project impacts.

Which Forecast Analysis Horizon Years to Test

Based on transportation conformity requirements, the first horizon year should be no later than five years after the year in which the conformity determination is being made and subsequent horizon years should not be more than 10 years apart(40 CFR 93.119[g]). While not required, it can be helpful to include the attainment year as a horizon year. The attainment dates for 8-hour ozone are listed in Table 2. For example, in California, each of the 8-hour ozone rural nonattainment regions is classified under Subpart 1 of the Clean Air Act (*4*). If there is a transportation plan applicable to the region, the last year of the transportation plan must be a horizon year. If, however, agreement can be reached in the interagency consulting process, and certain criteria are met, federal legislation (the "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users," or SAFETEA-LU) does allow analysts to limit the horizon alternatively to the longest of three options: ten years, or the last year applicable to an emission budget, or the year after completion of a project (*5*).

TABLE 2. Attainment Dates for 8-Hour Ozone.

Classification	Attainment dates
Severe 17	06/2021
Serious	06/2013
Moderate	06/2010
Marginal	06/2007
Subpart 1*	06/2009
Marginal Early Action Compact	12/2007
Subpart 1* Early Action Compact	12/2007

Source: (6)

**Subpart 1 is the classification for areas that were in attainment under the 1-hr ozone standard* (40 C.F.R. § 51.902).

Which Data Are Needed for a Test?

The conformity test requires a comparison of two emission inventory scenarios from either EMFAC (BURDEN), for California analyses, or MOBILE for analyses outside California. The approved versions for latest planning assumptions are MOBILE6.2 and EMFAC2002 (as of mid-2006). Most input values (including countywide VMT and speed profiles) have defaults in EMFAC for California, or can be obtained from the highway performance monitoring system (HPMS) (*7,8*).

MOBILE6.2 allows VMT to be specified for several road classifications (*9*). FHWA has published methods to estimate VMT for each of the MOBILE6.2 classifications (*10*).

EMFAC uses 13 average speed bins to differentiate driving activity; the model does not differentiate emissions by facility (freeway, arterial, local road) (*11*).

VMT adjustments called for by FHWA are already accounted for in the EMFAC model. Based on EMFAC technical documentation (*12*), EMFAC default VMT is perhaps more accurate than HPMS data, and EMFAC is more conservative than HPMS, meaning that it forecasts higher rates of VMT growth (see Amador County example in Table 3).

TABLE 3. VMT Estimates by EMFAC and HPMS for Amador County.

YEAR	EMFAC VMT	Compared to 2002	HPMS* VMT	Compared to 2002
2000	1,148,788	0.911	988,000	0.916
2002	1,260,686	1.000	1,078,440	1.000
2004	1,393,315	1.105	1,151,270	1.068
2009	1,671,041	1.326	1,355,358	1.257
2019	2,188,334	1.736	1,763,533	1.635
2026	2,707,262	2.147	2,049,255	1.900

** For forecasting based on HPMS, the average annual increase was calculated (40,818 VMT) based on 2000-2004 data and was assumed to be constant over the time horizon.*

Rural areas without TDM tools must develop a non-modeled estimate of project-specific VMT impacts. One approach for estimating such impacts is provided by Norowzi and Hyder (*13*). They estimate project-specific VMT based on historic VMT growth rates, and estimate project impacts as being proportional to additional lane miles [Equation 1]:

$$VMT_{build\ ,\ forecast} = VMT_{nobuild\ ,\ forecast} + VMT_{baseyear} \times \frac{LaneMiles_{added}}{LaneMiles_{baseyear}} . \qquad [1]$$

Where:

$VMT_{build,forecast}$ = the forecast VMT for the scenario in which the project is built;
$VMT_{nobuild,forecast}$ = the standard forecast VMT for the scenario in which the project is not built;
$VMT_{baseyear}$ = the estimated VMT for the base year, 2002;
$LaneMiles_{baseyear}$ = the estimated number of lane miles for the base year;
$LaneMiles_{added}$ = the actual number of lane miles to be created by the project.

Norowzi and Hyder use HPMS data for base-year and forecast VMT as well as base-year lane miles. In California, however, it may be more accurate to use EMFAC forecasts for VMT. Alternatively, some growth-factor-based forecast methods could be used. The VMT forecasting methodology may need to be resolved in interagency consulting.

PROCEDURES

We outline two methods to demonstrate conformity in rural 8-hour ozone areas. The first method is a simplified conformity analysis (SCA). The SCA approach reduces modeling needs where little doubt exists that the project meets conformity requirements. The second method is a more detailed conformity analysis procedure appropriate for those projects where conformity is less obvious. The SCA procedure is designed to use conservative assumptions, so any project which passes the SCA will also pass the more detailed analysis. Projects that fail the SCA, on the other hand, may pass the more detailed analysis. While the SCA is designed to assess against the 2002 base year, the procedure can also be used to assess against SIP emissions budgets.

A Simplified Conformity Analysis Procedure

The SCA approach is premised on the idea that projects have to increase regional VMT by substantial margins to result in future-year regional emissions that exceed those from 2002. The reasons for this are as follows:

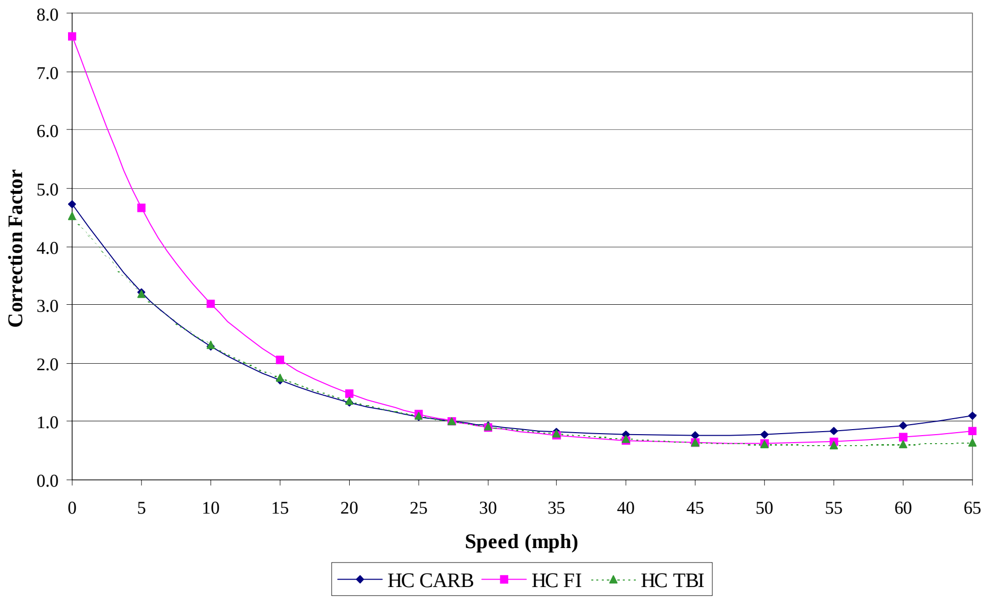
- Over time, per-vehicle and total fleet emissions are forecasted to drop substantially, despite increased VMT, as illustrated by Figure 1.
- Due to the overwhelming reduction in forecasted fleet emissions, total "no-build" fleet emissions will be below base year emissions.
- Even if, in a "build" scenario, a project increases VMT, the VMT change is unlikely to overcome the substantial emission reductions taking place at the regional level.

As an illustration, assume no-build fleet emissions drop 50% between 2002 and 2015. A 50% emissions drop over this time scale is roughly consistent with Figure 1. Further assume that regional travel conditions (congestion and travel speeds) remain about the same regardless of whether a project is built. What this means is that g/mi emissions can be scaled linearly with VMT, since all VMT is assumed to have the same average g/mi emissions. In this illustration, the 2015 "build" scenario would need to double the 2015 "no-build" regional VMT, before regional emissions in the build case exceeded 2002 base year conditions. Projects that have more modest regional VMT impacts would not result in emissions that exceed base year levels.

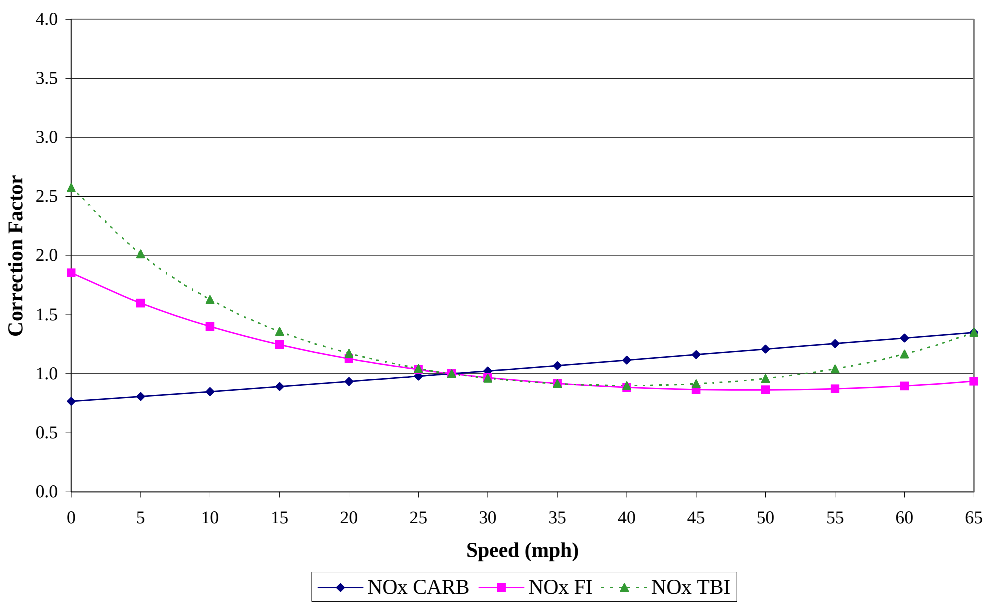
Note that EPA discourages use of VMT comparisons that do not also take into consideration variables that affect per-mile emission factors such as travel speeds, fuels, inspection and maintenance or other technological factors (*14*). The SCA, therefore, accounts for important travel speed changes (congestion effects) and uses data embedded in existing models such as EMFAC to account for changes in fleet technology over time, as well as implementation of control programs specific to the region of study.

The simplified approach is an environmentally conservative analysis approach, meaning that it likely overestimates emissions associated with projects. The reason is that the approach does not give credit for any congestion-relieving benefits associated with building projects. The approach accounts for VMT changes associated with projects, but it assumes that travel conditions (congestion levels) remain approximately the same with or without the project. In reality, projects typically alleviate stop-and-go and congested conditions. There is a substantial body of evidence dating at least to the 1990s in the U.S., and more recently in Europe and elsewhere, documenting that g/mi NO_x and ROG emission rates are reduced by improved travel conditions—more free-flow operations; less stop-and-go (*15,16,17*). The simplified approach merely scales emissions directly to VMT changes, without adjusting for any g/mi emission rate improvements that might occur.

It is possible, in theory, that a project could worsen travel conditions for some of the VMT occurring in the region. In those instances, g/mi emission rates would be expected to increase for the affected VMT. Additionally, trip-based speed correction factors (SCFs) for some pollutants and vehicle technology groups suggest that increased average trip speeds, especially above 50 mph, modestly increase g/mi emissions (*18*). Figure 2 illustrates hydrocarbon and NO_x light-duty vehicle (LDV) SCFs from EMFAC2002. As indicated by Figure 2, as average trip speeds increase to 50 mph, g/mi emissions decrease substantially. As average trip speeds increase above 50 mph, late-model LDV g/mi emissions increase slightly.



2a. Hydrocarbon SCFs.



2b. NO_x SCFs.

CARB is carbureted; FI is multi-port fuel injected (late-model LDVs); TBI is throttle body injected. The on-road LDV fleet is comprised primarily of late-model (FI) vehicles.

Source: Reproduced from the California Air Resources Board's EMFAC Technical Support Document (http://arbis.arb.ca.gov/msei/onroad/downloads/tsd/Speed_Correction_Factors.doc).

FIGURE 2. LDV speed correction factors included in EMFAC2002.

In Figure 2, SCFs represent trips of various average speeds, rather than link-level travel conditions. However, the SCFs illustrate the important relationship between stop-and-go conditions (represented by low travel speeds) and increased emissions. Later in this section we present an analytical approach to address situations where projects might result in increased congestion.

The SCA approach ratios future-year emissions to base year (2002) emissions, and then correlates those emission changes to allowable VMT changes. The steps to complete the SCA are reasonably straightforward and should prove adequate in many applications; the steps are briefly noted below, and described in further detail later in this discussion:

- Step SCA1: Define horizon years.
- Step SCA2: Estimate Horizon Year Emissions as a Percent of 2002
- Step SCA3: Adjust horizon year emissions for project-related VMT.
- Step SCA4: Document conformity, if result of SCA3 is smaller than 2002 emissions.

SCA1: Horizon Years

Since transportation ROG and NO_x emission forecasts generally exhibit a downward trend representing cleaner vehicle technologies penetrating the vehicle population (see Figures 1 and 3), the most critical ozone analysis horizon year for rural areas can be expected to be the year after project completion. This should be supplemented with the attainment year, the last year of the transportation plan and any additional years needed to ensure that the horizon years and the base year are not spaced more than 10 years apart as described above.

1) Select the year after project completion.
2) Select the attainment year.
3) If the area is included in a transportation plan, select the last year of that plan.
4) If there are more than ten years between selected horizon years, select additional analysis years to ensure analyses no more than 10 years apart.

SCA2: Estimate Horizon Year Emissions as a Percent of 2002 Emissions

The simplified method tests whether future year emissions have declined enough to compensate for any extra VMT that might occur due to the project. This step compares horizon year "no-build" emissions to base-year (2002) emissions. For example, assume an Amador County, California project analysis involving a 2009 horizon year. The 2002 base year NO_x emissions and 2009 NO_x no-build emissions are 3.05 tpd and 2.61 tpd respectively (EMFAC 2002). In this example, 2009 NO_x emissions are 86% of the 2002 value.

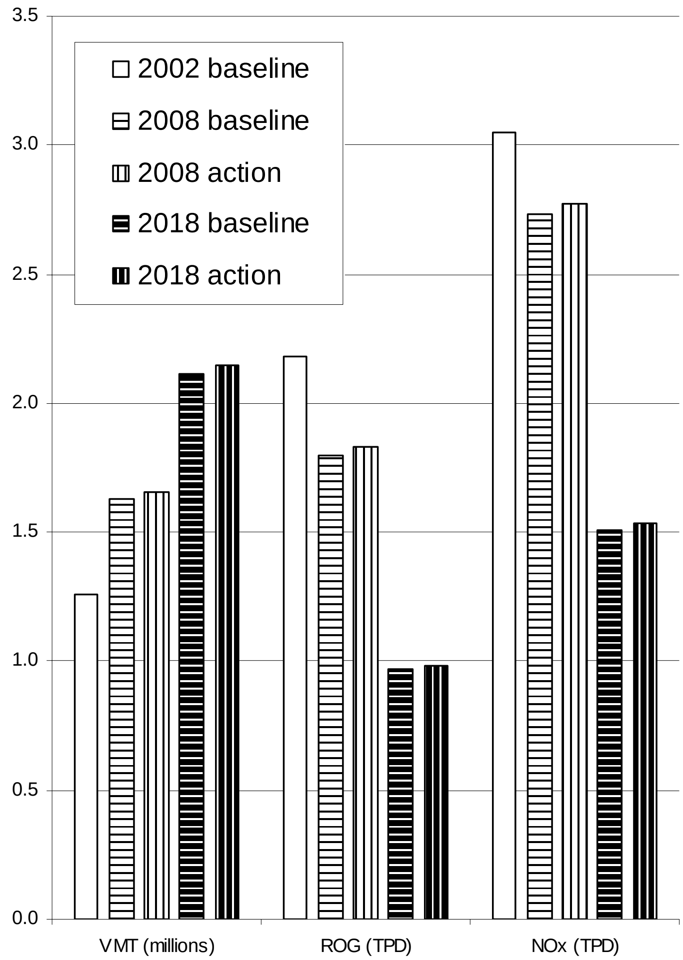


FIGURE 3. Project emissions are negligible compared to changes in default emissions over time. Baseline data are the EMFAC2002 projections for Amador County. Action data are taken from 22 mile project example discussed in the text.

SCA3: Adjust Horizon-Year Emissions for Project-Related VMT

The simplified method correlates emissions directly with VMT. Therefore, the next step involves estimating how the project affects county-level horizon year VMT. If an estimate of the project contribution to county VMT in the horizon years does not yet exist from a travel demand model or other source, Norowzi and Hyder's method of estimating an increase in VMT proportional to the increase in lane miles can be used as described above. To scale emissions to horizon year "build" VMT conditions, multiply the "horizon year emissions as percent of the base year" from step SCA2 by the percent change in VMT due to the project. For example, assume a project in Amador County increased county-level VMT by 1.6%. From our example in SCA2, we saw that year 2009 NO_x emissions in Amador County were 86% of the year 2002 value. We scale the 86% value to reflect the 1.6% increase in VMT due to the project $(1.016 \times 86\%)$, obtaining a value of 87%.

If the project increases congestion in any part of the region, the analysis must adjust for that. A separate section below describes how to account for adverse effect on per-mile emission factors.

SCA4: Document Conformity, if Result of SCA3 is Not Greater Than 2002 Emissions

If, for each horizon year, ROG and NO_x results from step SCA3 are not greater than 100%, meaning they are not greater than 100% of 2002 year emissions, the project meets the no-greater-than-base-year test and conforms. Project analysts should document the results and the assumptions used to derive them. Another way to describe the test is with these equations:

$$\frac{HY_{no-build}}{BY} \times 100 = HY_{percent} ; \quad [2]$$

$$HY_{percent} \times (1 + VMT_{project}) = HY_{build} . \quad [3]$$

Where:
$HY_{no\text{-}build}$ = horizon year no-build emissions;
BY = base year (2002) emissions;
$HY_{percent}$ = horizon year emissions as a percent of base year emissions;
$VMT_{project}$ = build vs. no-build percent change in county-wide VMT;
HY_{build} = horizon year build emissions as a percent of base year emissions.

And, conformity is demonstrated if

$$HY_{build} \leq 100\% . \quad [4]$$

If horizon-year build emissions are greater than 100% (more than 2002 emissions), the result may be due to the lack of accounting for improvements in traffic flow in this simplified procedure. The detailed procedure (described below) should then be followed.

Example Analysis Using Amador County, California

Project Description A project to add 22 lane miles in Amador County is scheduled to be completed in 2008; no travel demand model or VMT estimates are available to estimate what VMT changes will occur in the build scenario. The project is not projected to have negative impacts on traffic flow. (We have purposely hypothesized an unusually large project to illustrate that, even assuming an unusual amount of new lane miles added, the no-greater-than-base-year test will typically be easy to pass.)

SCA1 We use horizon years 2009 and 2018. We select 2009 since it is the year following project completion and is also the attainment deadline; we select 2018 since it is less than 10 years out and shows the long-term trend of mobile emissions. Thus, our analysis will cover the years 2002, 2009, and 2018.

SCA2 Estimate the ROG and NO_x emissions for the specified county and horizon years using EMFAC, and divide by the 2002 values; results are shown in Table 4:

TABLE 4. ROG and NO_x Horizon Year Emissions as a Percent of 2002 Values.

Pollutant	2002 Emissions [tpd]	2009 Emissions [tpd]	2018 Emissions [tpd]	2009 Emissions [% of 2002]	2018 Emissions [% of 2002]
ROG	2.18	1.69	0.97	77.5%	44.5%
NO_x	3.05	2.61	1.51	85.6%	49.5%

SCA3 Calculate the county-wide VMT increase due to the project. In this example, we lack project-specific data and use Norowzi and Hyder's formula. According to a 2004 HPMS report (*7*), Amador County has 669.29 centerline miles of maintained roads, including roads maintained by cities, the county, and state, the Bureau of Indian Affairs and the U.S. Forest Service. This method assumes that the county average VMT per mile of road is constant. For some projects it may be reasonable to assume that the VMT per mile of road should only be averaged for certain categories of roads. For illustration purposes, the example uses the total centerline miles without any adjustments. As can be observed in the same HPMS report, it is reasonable to assume that lane miles are approximately twice the centerline miles in rural areas: 1338.58 for Amador County. Using lane miles as a proxy, we estimate the build to no-build VMT ratio to be

$$\frac{1338.58+22}{1338.58}=1.016 \qquad [5]$$

or, a 1.6% increase in regional VMT. This value is the same for both horizon years. We now use the 1.6% estimated increase in VMT to adjust the emissions from step SCA2, as illustrated in Table 5.

TABLE 5. Horizon Year Emissions Scaled to Reflect Build Scenario Increased VMT.

Year	Pollutant	No-Build Emissions as % of 2002 Values[a]	Build Scenario % Increase in County VMT	Emissions Scaled to Reflect Increased VMT[b]
2009	ROG	77.5%	1.6%	78.7%
2009	NOx	85.6%	1.6%	87.0%
2018	ROG	44.5%	1.6%	45.2%
2018	NOx	49.5%	1.6%	50.3%

a From Table 4.

*b No-build emissions as % of 2002 values * (1+ % increase in VMT)*

SCA4 All horizon year emissions, adjusted for project contribution to VMT, are not greater than 100% of base-year emissions. The project conforms.

Note that the simplified method relies on the no-greater-than-base-year test. A simplified analysis that scales emissions to VMT will fail a build/no-build test whenever a project increases VMT, since the test would not account for reduced emissions due to traffic flow improvements.

Accounting for Congestion Effects When Completing Simplified Analyses

Description of the Analytical Approach Under some circumstances it is possible that a completed project could worsen traffic flow and cause increased emissions. This discussion provides an analytical method to account for such conditions.

Assume that, in the Amador County example used above, the project negatively affected traffic flow. The question arises, "Would the project conform?" The answer is derived by adjusting horizon-year "build" emissions to account for increased emissions due to congestion. We call these increased emissions the "congestion effect."

We estimate the congestion effect by relating emissions to vehicle speeds. The methodology is premised on the understanding that vehicles emit more per mile during slower, stop-and-go driving conditions, compared to higher-speed free-flow traffic conditions. The EMFAC model includes speed correction factors (SCFs) that adjust fleet emissions depending upon the average speed for the vehicle trips assumed to be taking place (*18*). This methodology employs the assumptions embedded in the EMFAC model to approximate the impact of speed, as a surrogate for travel conditions, on emissions.

The congestion effect is estimated as a function of the fraction of VMT adversely affected (travel conditions worsened) by the project and a conservative estimate of the change in emission factor due to increased congestion. This change can be expressed as the ratio of the emission factor for the more congested build scenario to the less congested no-build scenario. An upper bound for this can be found by assuming, for example, that all affected traffic was at optimal speed (from an emissions viewpoint) in the no-build scenario, and at the worst-case conditions (again, from an emissions viewpoint) in the build scenario.

Based on the information included in EMFAC, and an assumption that current and future vehicle fleets are predominantly comprised of later-model fuel-injected vehicles, we assume that optimal travel conditions are around 50 mph, and worst-case stop-and-go conditions occur when speeds drop to approximately 2.5 mph. Based on the SCFs in the EMFAC documentation, worst-case travel conditions are associated with emissions that are several multiples of optimal conditions. If traffic conditions deteriorate from 50 mph to 2.5 mph, EMFAC estimates that fleet-average g/mi NO_x and ROG emissions will increase by factors of 2.6 and 10, respectively.

We can now use these multipliers (2.6 for NO_x and 10 for ROG) to account for the congestion effect. The basic approach is to identify what fraction of VMT is forecast to be adversely affected by the project, and to multiply the emissions associated with that VMT by the worst-case congestion effect multiplier.

Example Analysis Accounting for the Congestion Effect To illustrate accounting for the congestion effect, we build on the example in the previous section and start at SCA2:

SCA2 As in the previous example, we identify ROG and NO_x emissions for Amador County, for the 2009 and 2018 horizon years (using EMFAC); we then divide by the 2002 values, and scale to reflect the increased VMT from the project. Results are shown in Table 4 from the example above.

SCA3 In addition, however, we assume, as an illustration, that 2% of all VMT in the county is negatively affected by the project. We can calculate an upper bound to the congestion effect by using the congestion effect multiplier with the affected VMT, as illustrated in Table 6.

TABLE 6. ROG and NO_x Horizon Year Emissions, Corrected for Congestion Effect.

Pollutant	2009 Emissions from Table 5	2018 Emissions from Table 5	Multiplier for Affected VMT	% of VMT Adversely Affected	2009 Corrected % of 2002 Values[a]	2018 Corrected % of 2002 Values[a]
ROG	78.7%	45.2%	10	2%	92.9%	53.3%
NO_x	87.0%	50.3%	2.6	2%	89.8%	51.9%

*a % VMT affected * multiplier * original % of 2002 values) + ((1 - % VMT affected) * original % of 2002 values.*

Note that the factor for the congestion effect upper bound can be calculated as:

$$CE = (1 - x) + (x \times SCF) \qquad [6]$$

Where *CE* is the congestion effect multiplier to be applied to the horizon year emissions scaled to reflect "build" VMT conditions, *x* is the percent of VMT in the county negatively affected by the project, and *SCF* is an upper bound multiplier based on the EMFAC SCFs for ROG and NO_x.

SCA4 In this example, all horizon year emissions are lower than 100% of base-year emissions, and the project conforms.

To account for increased congestion, equations [7]-[8] must replace equation [4] above.

$$HY_{build} \times CE = HY_{build-congestion} \qquad [7]$$

Where:

CE = congestion effect

$HY_{build\text{-}congestion}$ = horizon year build emissions as a percent of base year emissions, after accounting for congestion effect

And, conformity is demonstrated if

$$HY_{build-congestion} \leq 100\% . \qquad [8]$$

Shortcut: Maximum Allowable VMT

For projects without a congestion effect, an analyst can screen projects without running through the calculation steps described in this method. Analysts can simply compare the projected VMT increase associated with the "build" scenario, to the maximum allowable VMT. If the projected VMT increase is not greater than the maximum allowable increase, the project is found to conform.

The maximum allowable increase in VMT is calculated as follows:

1) Obtain the ratio of no-build ROG and NOx emissions in 2002 over no-build emissions in each horizon year.

2) For each horizon year, select the lowest of both the ROG and NOx ratios, representing the precursor pollutant that is reduced the least in the no-build scenario.

3) The allowable increase in VMT equals the percentage that 2002 emissions are higher than those of the horizon year for the selected precursor.

Note, however, that the shortcut approach described above is only valid if the project does not worsen congestion, and therefore emissions, for some portion of the region's VMT.

The Amador County example can be used to illustrate this abbreviated analysis method. Based on Table-4 NO_x emissions data, from 2002 to 2009 the county can increase VMT up to 17% over current estimates, and still keep emissions below 2002 values. The Amador County project results in a 1.6% increase in regional VMT, a number far less than the 17% allowed. The project is therefore in conformity with the no-greater-than-base-year test. ROG emissions are projected to decrease more than NO_x and need not be considered.

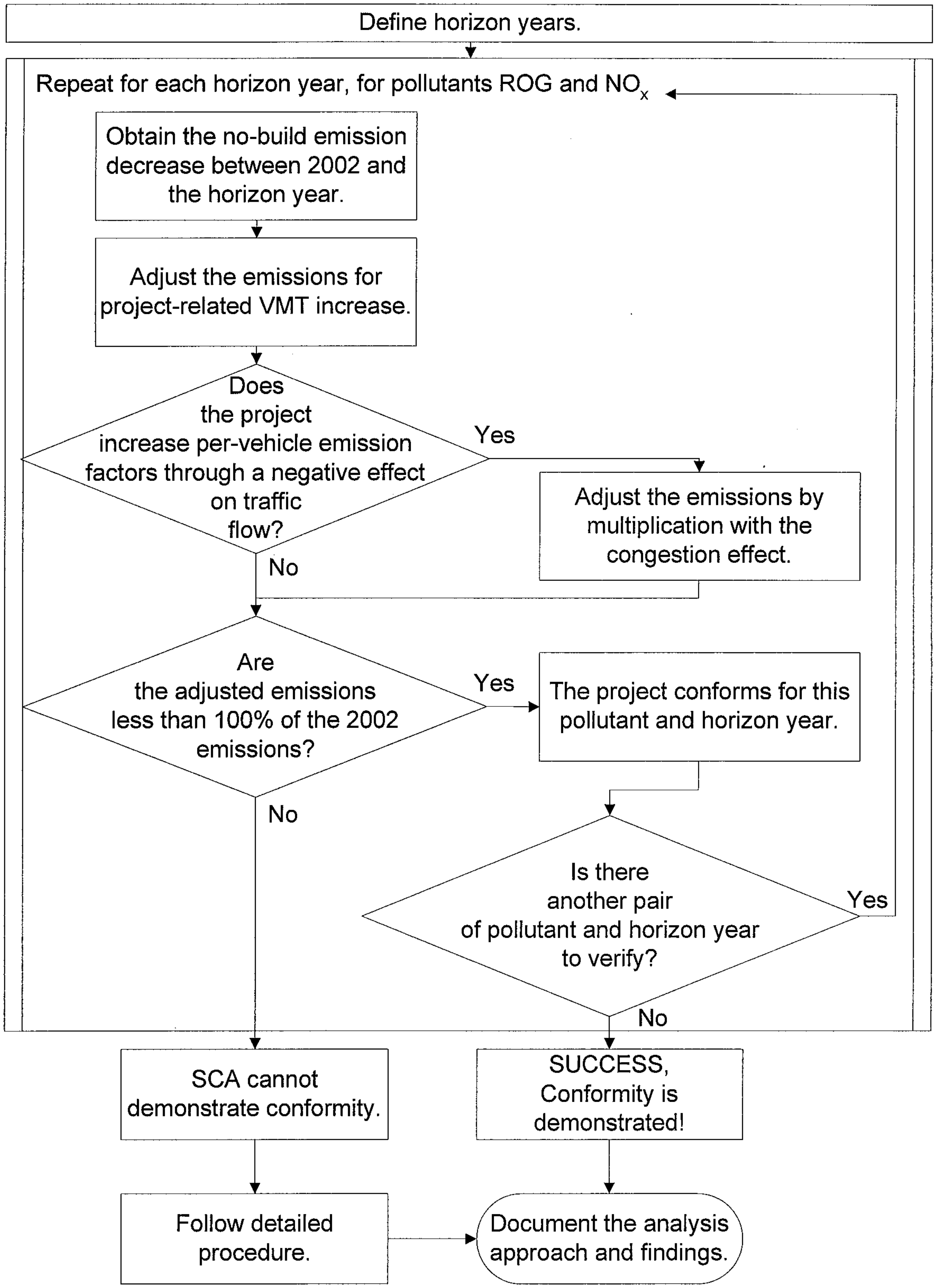


FIGURE 4. Flowchart of the simplified conformity analysis (SCA) using the no-greater-than-base-year test.

Detailed conformity procedure for no-greater-than-base-year test

There may be circumstances where the simplified conformity analysis procedure is inadequate or needs to be supplemented. For example, a project may fail the SCA test but, in the real world, reduce emissions by reducing congestion. Under such a circumstance, a more detailed project assessment would be necessary to identify in greater detail the expected project impacts. This section presents a summary of the analysis steps to complete to perform more detailed project-level assessments. The analysis can be completed with or without a TDM. Detailed analyses consist of: obtaining base year VMT, adjusting VMT based on HPMS data, completing optional further VMT adjustments, assigning the data to speed bins, classifying VMT by vehicle type and age (optional), forecasting VMT and emissions and comparing horizon-year with base-year emissions. Table 7 summarizes the detailed procedure.

TABLE 7. Detailed Conformity Procedure Summary.*

Step	With Travel Demand Model	Without Travel Demand Model
Base Year VMT	Obtain **VMT by road functional class** from the model for the base year.	Obtain base-year VMT by road functional class from HPMS (*19*) or EMFAC
	Compare VMT with HPMS (*19)* data for each road functional class. The transportation conformity rule (*14*) requires that the **modeled VMT be scaled to match HPMS VMT**. The scale factors of the base year must be applied to the forecast years. If local roads are not modeled, they can be scaled from collectors or total VMT, or with additional GIS* analysis at the TAZ* level.	HPMS local road VMT estimates for a single rural county are often not very statistically significant. In this step, the statistical significance of local road VMT estimates is increased. More significant data that can be used instead are the statewide ratio of local road to collector VMT. Alternatively, if the statewide data are expected to be too different from the rural area, use data only from similar counties over multiple years or from local traffic counts and a detailed local road inventory.
Other VMT Adjust -ment	OPTIONAL: disaggregate VMT by hour of day, account for trip lengths that do not cover entire link length, provide additional detail on external trips, adjust VMT to account for seasonal traffic changes	Same as with TDM.
Speed Bin Assign ment	Verify the **speed bin assignments** produced by the model and adjust with observed speeds; use a separate formula—e.g. BPR (*20*)—or lookup tables if necessary.	Estimate speed bin assignments by functional class using observed speeds, speed limits, the HERS (*8*) model, the TTI (*21*) method or the BPR (20) formula if aggregate volume and capacity can be estimated with sufficient accuracy.
VMT by type	OPTIONAL: Verify the applicability of the default **VMT mix by vehicle type** and engine type (gasoline v. diesel) and substitute with local data from vehicle registration or traffic count if appropriate.	Same as with TDM.

(Table 7 continued on next page)

TABLE 7. Detailed Conformity Procedure Summary (concluded).

Step	With Travel Demand Model	Without Travel Demand Model
VMT by age	OPTIONAL: Verify the applicability of the default VMT mix by age and substitute with local data from vehicle registration if appropriate.	Same as with TDM.
M6 Class	MOBILE6 only: Assign road functional classes to MOBILE6 classes: Freeway Ramps, Freeways, Arterials and Local Roads. Verify if the default urban assignment of 8% of freeway VMT to freeway ramps is appropriate and adjust if necessary.	Same as with TDM.
Fore-cast	Obtain VMT from the model, accounting for the proposed action, for each horizon year with all the adjustments done for the base year.	Forecast VMT for horizon years with a single estimated growth factor based on historical growth and/or economic and demographic projections. Alternatively, use a regression analysis on historical data for each functional road class with optional adjustments for roads whose classification changes during the forecasted time span. Alternatively, interstate VMT can be forecast using a separate linear projection or corridor-based analysis. With empirical evidence of declining growth, a decay function may be applied to the growth factor.
Emis-sions	Run MOBILE6 or EMFAC for base year and each horizon year, accounting for I/M* effects as appropriate.	Same as with TDM.
Check	Verify that emissions for each horizon year do not exceed those of the base year.	Same as with TDM.

**Acronyms* not used in text: GIS: Geographic Information System, I/M: inspection and maintenance, TAZ: Traffic Analysis Zone. Analysts should review EPA and FHWA guidance for more detailed information.

SUMMARY

Until SIPs are submitted and emissions budgets are found to be adequate, rural areas classified marginal or "subpart 1" can choose between the no-greater-than-base-year test and the build/no-build test to complete 8-hr ozone conformity analyses. The no-greater-than-base-year test is the easiest to meet. This paper presents a simplified conformity analysis approach for no-greater-than-base-year project assessments. The SCA linearly scales emissions to account for project-specific VMT changes and congestion impacts. "Build" scenario results are compared to 2002 base year values. The SCA is environmentally conservative; it does not consider whether projects relieve congestion and reduce g/mi emission rates. Similarly, the approach is conservative in that it includes a worst-case analysis methodology to account for increased congestion, for instances where some VMT is adversely affected by project operations.

In all cases, once analyses have been completed, project analysts should suitably document the results for inclusion in environmental impact reports. If a project is located in a PM or CO nonattainment or maintenance area, project-level PM or CO hotspot analyses are required. U.C. Davis has prepared protocols to complete hotspot assessments, and these are available from U.C. Davis, Caltrans, or FHWA.

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