Alternatives to Air Quality Modeling for Project Level Conformity

By

T.P. Kear
Vicente J. Garza

Institute of Transportation Studies; University of California, Davis

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Abstract

Approaches that simplify project-level conformity determinations by combining air quality planning, microscale monitoring and project conformity analysis are presented.

Under the Clean Air Act Amendments of 1990, transportation projects may not create, or worsen existing violations of air quality standards. Projects with characteristics that may potentially increase emissions must demonstrate that they will not have a detrimental effect on local air quality. For carbon monoxide, this demonstration is commonly made with dispersion models.

Regional air quality plans map out how a nonattainment area intends to come into compliance with, and maintain air quality standards. Estimates of regional emissions are compared with permissible emission levels, given the area's carrying capacity and air quality standards. Though some of the data relied upon to demonstrate attainment is gathered at microscale-level monitors, localized impacts of future traffic growth at specific intersections and links are not necessarily considered.

A proposal is introduced that places more emphasis on estimation of microscale effects of traffic growth in the air quality planning process. Through incorporation of hot-spot analysis of (or demonstrating that the monitoring network adequately characterizes) each region's "worst" links and intersections a measure is established to which new projects could be compared. This suggests an implicit demonstration of conformity for "lesser" projects. The regulatory framework for this change is outlined and the implications for air quality planning and conformity processes are reviewed.

Introduction

This paper addresses the need to integrate air quality planning and transportation planning. While coordination was mandated under the transportation conformity requirements of the Clean Air Act Amendments of 1990 (CAAA 1990), and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), little has been done to integrate the planning processes. Considering conformity requirements early in the planning process will streamline that process and lead to more consistent results.

The conformity process links together the major elements of air quality and transportation planning. summary, those major elements consist of the following pieces:

- *State implementation plan (SIP) -- (required by the CAAA of 1990)* A plan that lays out how a state will attain the national ambient air quality standards (NAAQS) by the date required in the CAAA of 1990, and how it will implement federal requirements. The SIP must include an attainment demonstration, that shows via modeling and/or ambient monitoring, that the state's approach will bring ambient pollution levels within acceptable limits.
- *Maintenance plan -- (required by the CAAA of 1990)* A demonstration that the state will maintain NAAQS over a ten year period after a region has come into attainment.
- *Transportation Plan* -- (required by ISTEA) The long range plan developed by the regional Metropolitan Planning Organization (MPO), specifying desirable / needed changes to the regional transportation network over a 20 year planning horizon.
- *Transportation Improvement Plan (TIP)* -- (required by ISTEA) The working version of the transportation plan. Specifies all the projects planned to be implemented over the next 3 years. The TIP ranks projects by order of importance and describes the funding mechanisms for each project.
- Project design -- The specifics of individual projects, prepared by the project proponents (typically city, county, and state government).

The transportation conformity requirements are intended to coordinate the SIP, transportation plan, TIP and individual projects to insure that transportation does not create new or worsen existing air quality problems.

History of Transportation Conformity

(adapted from EPA 1993a)

Conformity provisions first appeared in the Clean Air Act Amendments of 1977. Although these provisions did not define conformity, they provided that no Federal department could support any activity which does not conform to a SIP, after the SIP had been approved or promulgated. Conformity was the responsibility of the head of each Federal agency. In addition, no MPO could approve any transportation project, program, or plan which did not conform to a State or Federal implementation plan.

The congressional intent of this section of the 1977 Clean Air Act Amendments was to prevent Federal actions from causing a delay in the attainment or maintenance of the NAAQS. However, no further rulemaking action was taken.

In 1980 the Environmental Protection Agency (EPA) and Federal Department of Transportation (DOT) jointly issued guidance that in nonattainment and maintenance areas, conformity determinations must be documented as a necessary element of all certifications, TIP reviews, and environmental impact statement (EIS) findings. Transportation plans and programs were considered to conform with the SIP if they did not adversely affect the transportation control measures (TCMs) in the SIP, and if they contributed to reasonable progress in implementing those TCMs. A transportation project would conform if it were a TCM from the SIP, came from a conforming TIP, or did not adversely affect the TCMs in the SIP. Conformity was interpreted in the context of TCMs -- the CAAA of 1990 changed that, redefining conformity in terms of regional emission targets (termed "emission budgets") and project by project analysis of estimated ambient pollution levels.

The CAAA of 1990 expand the scope and content of the conformity provisions by defining conformity to an implementation plan to mean (EPA, 1993a):

> "Conformity to the plan's purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards; and that such activities will not (i) cause or contribute to any new violation of any standards in any area; (ii) increase the frequency or severity of any existing violation of any standard in any area; or (iii) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area."

The Clean Air Act Amendments of 1990 emphasize controlling estimates of emissions from transportation such that they do not surpass the emission budgets set up during the SIP process. The idea is to protect the integrity of the SIP by ensuring that its growth projections are not exceeded without additional measures to counterbalance unforeseen growth.

Recent legislation and court rulings have placed some limitations on where conformity is applicable. The most notable restrictions are:

1. Categorical exemptions built into the conformity regulations themselves for projects that are required to meet critical needs such as safety (40 CFR §51.460, §51.462, §93.134, §93.135).
2. Conformity is only applicable to projects in nonattainment and maintenance areas (P.L. 104-59, 1995).
3. Conformity is only applicable to roadway projects, not marine or rail (EDF v. EPA, 1996).

The next section is a discussion of where conformity determinations are required and how they are made under the current regulations.

Conformity Under the Clean Air Act Amendments of 1990

Conformity determinations are required at each level of the transportation planning process:

- For each new/revised transportation Plan,
- For each new/revised TIP, and
- for each project.

Thus, conformity determinations must be made on two different scales: a regional scale for transportation plans and TIPs, and at the microscale for individual projects; Figure 1. Simplistic Conformity Process, is a process diagram of conformity showing the three places where conformity determinations are required (FHWA, 1995, 40 CFR §51.406, §93.108). The dashed process flow line linking the attainment demonstration to the project level conformity test is the approach that the authors propose in this paper.

Regional determinations are based on emission budgets that are established in the SIP. The plan or TIP conforms if the estimated emissions from the transportation network do not exceed those SIP budgets, and requirements pertaining to model selection and interagency consultation have been fulfilled. The Requirements for regional conformity determinations can be found in 40 CFR §51.412, §51.414, §51.416, §51.418, §51.428, §51.430, §51.436, §51.438, §51.442, §51.444 and the corresponding sections in 40 CFR §93.

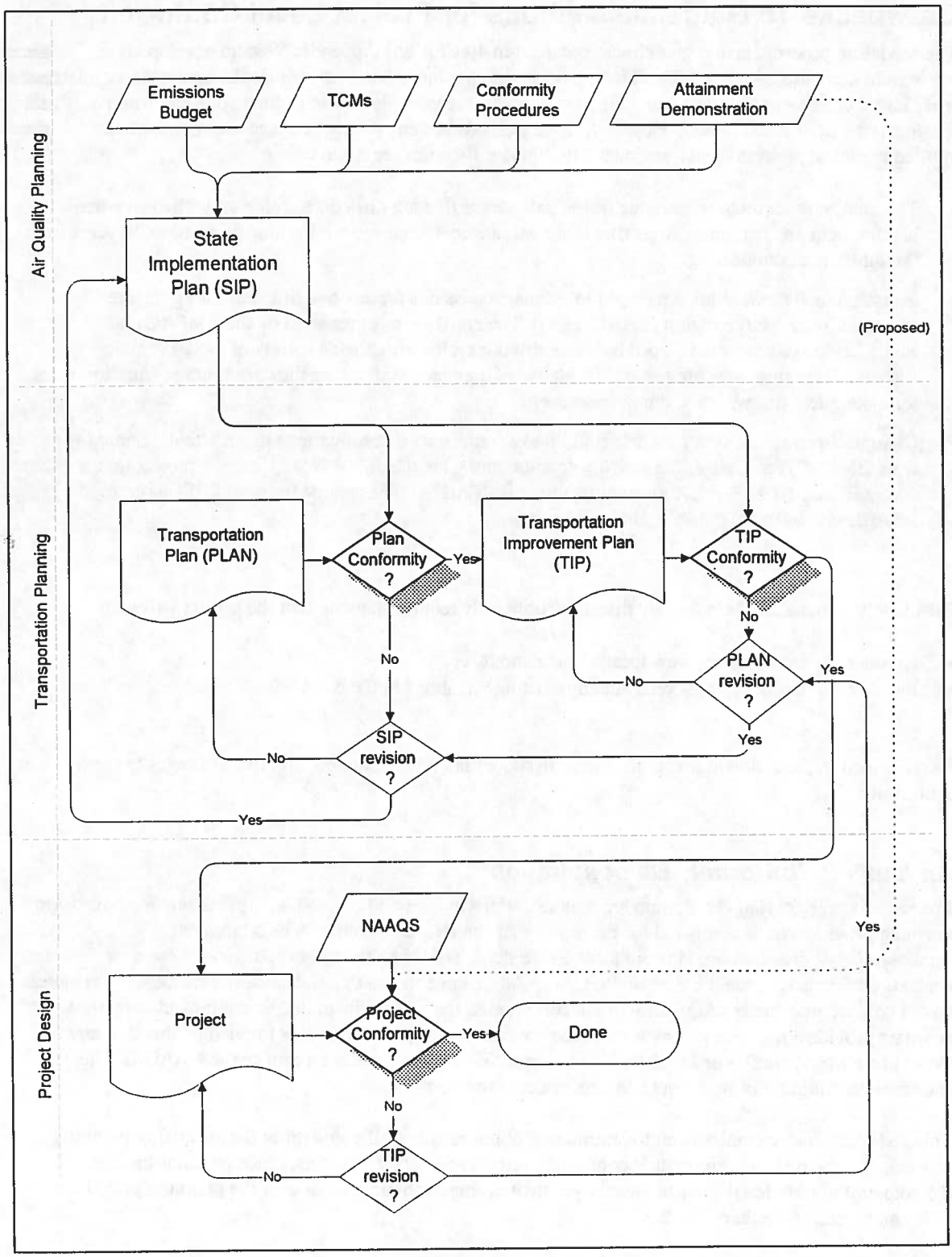
Project level conformity determinations are based on estimates of ambient pollution concentrations in the area substantially effected by the project. Because ozone is not a microscale problem, project level conformity is only an issue in carbon monoxide and PM_{10} (particulate matter smaller than 10 microns in aerodynamic diameter) nonattainment / maintenance areas. In order to demonstrate conformity, the project must not cause or contribute to any new localized violations, or increase the frequency or severity of any existing violations of the National Ambient Air Quality Standards (NAAQS) (40 CFR§51.424).

Ambient pollution levels are generally estimated by the methodologies contained in the modeling guidelines specified by 40 CFR §51, Appendix W. Those methods involve the use of the latest version of either the EMFAC or MOBILE emission factor models coupled with either the CAL3QHC or CALINE4 dispersion models (EPA, 1986; EPA 1993b). These quantitative approaches were not developed to address project level conformity. The next section details some of the shortcomings of these quantitative models and the motivations for developing qualitative methods of demonstrating that a project does not:

- cause or contribute to any new localized violations, or
- increase the frequency or severity of any existing violations of the NAAQS.

Later sections outline methods and theory on which to base qualitative conformity determinations, and how those methods fit into the current conformity regulations.

Figure 1. Simplistic Conformity Process



Drawbacks To Guideline Methods for Project Level Conformity

The modeling procedures and guidelines contained in 40 CFR §51 Appendix W were developed for attainment demonstrations in SIPs. These models are data intensive, and require the analyst to estimate what future conditions will be. The guidelines provide a reasonable way to evaluate projects when only a few locations need to examined. However, those methods become impractical and expensive when applied to all the projects from a regional TIP. Some difficulties are listed below:

- The analyst is required to estimate traffic parameters that are difficult to come up with even when historic data are available Projecting those parameters to analyze a milestone point 10 to 20 years in the future is discomforting.
- Emission models were not developed to estimate emissions for any one link, but for aggregate emissions over a large region (CARB, 1996) The emission rates reported by the EMFAC and MOBILE models were developed based on driving cycles with a wide variety of modal vehicle activity. Emission rates are not representative of a given speed, rather they are average emission rates for a complete trip with a given average speed.
- Changes in emission factor models could make conformity determinations inconsistent. Changing from EMFAC7f to EMFAC7g roughly doubles emissions (CARB, 1995). Hence, a project that was acceptable under EMFAC7f may not be under EMFAC7g. The change from MOBILE5a-h to MOBILE5b will likely have a similar impact.

Fortunately, project level conformity determinations only require showing that the project will not:

- cause or contribute to any new localized violations, or
- increase the frequency or severity of any existing violations of the NAAQS.

As explained in the following sections, the analyst does not need to use quantitative estimates to show conformity.

An Implicit Conformity Demonstration

The authors propose that the attainment demonstrations in SIPs and maintenance plans provide a measure to which projects can be compared for the purpose of showing conformity. The attainment demonstrations, prepared by state and local air agencies, should be the most sophisticated / accurate analysis performed. Once the state and local regulators have shown that the existing facilities in a region do not compromise the NAAQS, or will not compromise them after the projected attainment date, those facilities provide a measure to which proposed projects can be compared. It is implied by this that any lesser project (i.e., similar or lower traffic volume, LOS, etc.) will not compromise the NAAQS. This test is termed an "implicit project level conformity determination".

This test places more emphasis on the estimation of microscale traffic growth in the air quality planning process. To correctly use an implicit conformity test, the SIP and / or maintenance plan must account for the potential of individual links to have larger than average volume growth over the planning period. This can be done by either:

- detailed modeling efforts, or
- demonstrating that the regional monitoring network adequately represents the worst links and intersections.

In the portions of California recently proposed for redesignation, the second approach was used. That analysis was based on regional rollback calculations and the assumption that the existing monitoring network adequately represents each regions worst links.

Consistency with Current Regulation

The authority/ability for individual MPOs to specify how they will determine project level conformity is not clearly stated in the regulations. In the preamble to the NPRM, EPA proposed to allow project level conformity determinations to be made without a quantitative analysis, if a qualitative demonstration could be made based on consideration of local factors (EPA 1993a). For the final rule, EPA settled on the language in 40 CFR §51.454 & §93.131. That section, which is shown below, requires that the quantitative methods from 40 CFR §51 appendix W be used. Qualitative methods are only applicable to projects that have a level of service (LOS) rating of A, B, or C. -- this is too restrictive, requiring modeling for all projects in regions that design to an LOS rating of D.

However, There is a clause to allow each region to develop their own methodologies. This clause, starting with the word "unless" (emphasis added), allows for regions to determine how they will address project level conformity determinations during SIP development.

40 CFR §51.454 -- Procedures For Determining Localized CO and PM_{10} Concentrations

(a) In the following cases, CO hot-spot analyses must be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR part 51 Appendix W ("Guideline on Air Quality Models (Revised)" (1988), supplement A (1987) and supplement B (1993), EPA publication no. 450/2-78-027R), ***unless***, after the interagency consultation process described in §93.105 and with the approval of the EPA Regional Administrator, these models, data bases, and other requirements are determined to be inappropriate:

The approval and promulgation of the SIP, would serve as the required EPA regional administrators approval. The preceding passage references 40 CFR §51.402, which specifies how each region can incorporate conformity procedures into the SIP. EPA, state and local air agencies, state and federal DOT, and MPOs need to agree on a conformity protocol that identifies methods to be used in making project level conformity determinations. Once agreed upon, that protocol can to be incorporated into the SIP.

40 CFR §51.402 -- Consultation.

(a) General. The implementation plan revision required under §51.396 of this chapter will include procedures for interagency consultation (Federal, State, and local), and resolution of conflicts.

(1) The implementation plan revision will include procedures to be undertaken by MPOs, State departments of transportation, and DOT with State and local air quality agencies and EPA before making conformity determinations, and by State and local air agencies and EPA with MPOs, State departments of transportation, and DOT in developing applicable implementation plans.

(2) Before the implementation plan revision is approved by EPA, MPOs and State departments of transportation before making conformity

determinations must provide reasonable opportunity for consultation with State air agencies, local air quality and transportation agencies, DOT, and EPA, including consultation on the issues described in paragraph (c)(1) of this section.

(b) ...

(c) Interagency consultation procedures: Specific processes. Interagency consultation procedures will also include the following specific processes:

(1) A process involving the MPO, State and local air quality planning agencies, State and local transportation agencies, EPA, and DOT for the following:

(i) Evaluating and choosing a model (or models) and associated methods and assumptions to be used in hot-spot analyses and regional emissions analyses;

The following section provides a template for developing a qualitative protocol. It suggests a conservative procedure for making qualitative conformity determinations. It is a simplified/generalized version of the Transportation Project-Level Carbon Monoxide Protocol developed by U.C. Davis for Caltrans (see Garza et. al., 1996).

Suggested Qualitative Process

The determination of project-level impacts should be carried out according to the Local Analysis flow chart shown in Figure 2 (Adopted from Garza Et. Al., 1996). The suggested process was developed for carbon monoxide (CO); it consists of four levels:

- LEVEL A directs projects to different tests, depending on the federal designation for the area in which the project is situated.
- LEVEL B is simplified build / no build test for projects in nonattainment areas.
- LEVEL C compares projects in nonattainment areas to existing facilities that have demonstrated that they do not contribute to violations of the NAAQS.
- LEVEL D provides a screening procedure for projects in maintenance areas, where it is assumed that all existing facilities have demonstrated that they do not contribute to violations of the NAAQS; hence only a project that is expected to generate ambient pollution levels higher than those existing in the region is routed to quantitative analysis

This approach is based on comparing the proposed projects to existing facilities and/or previous quantitative analysis. The crux of the conformity test is to show that the project does not create new or worsen existing violations of the NAAQS. Conformity can be demonstrated by showing that the impacts of the project are acceptable relative to some project / facility that is known not to compromise the NAAQS.

LEVEL A -- Triage Using Area Designation

The local analysis provided in this Protocol recommends slightly different approaches according to the designation of the area in which the project is located, as explained in the following subsections.

Projects In Nonattainment Areas

Projects located in nonattainment areas should proceed to level B, for this qualitative approach, regions that have been proposed for redesignation should be treated as maintenance areas to take advantage of the attainment demonstrations contained in the SIP, maintenance plan, and redesignation request.

Projects In Attainment, Maintenance, Or Unclassified Areas

Projects located in areas that have been proposed for federal redesignation to attainment after the 1990 CAAA must have a Maintenance Plan and should proceed the next section under level A. Projects located in areas designated as attainment when the 1990 CAAA were approved, or in unclassified areas, are not subject to conformity (P.L. 104-59, 1995) and do not require an analysis.

Maintenance Verification

For projects in maintenance areas, project sponsors should contact the local air district to verify continued attainment. Maintenance plans require periodic checks to assure that they have not been compromised. Projects in areas where continued attainment has been verified (or where proposed redesignation is so recent that a review has not yet occurred) should proceed to level D. Projects in areas where continued attainment cannot be verified should proceed to level B.

LEVEL B -- Build / No Build Test For Projects In Nonattainment Areas

A Project in a nonattainment area may be deemed satisfactory if it can be determined that the project does not lead to an increase in ambient pollution levels[1]. Comparison of the "build" and "no build" scenarios according to the criteria set forth below provide a basis for deciding if the changes in ambient pollution concentrations are acceptable:

a. Project does not significantly increase the percentage of vehicles operating in cold start mode. Increasing the number of vehicles operating in cold start mode by as little as 2% should be considered potentially significant.

b. Project does not significantly increase traffic volumes. Increases in traffic volumes in excess of 5% should be considered potentially significant. Increasing the traffic volume by less than 5% may still be potentially significant if there is a corresponding reduction in average speeds.

c. Project improves traffic flow. For uninterrupted roadway segments, higher average speeds (up to 50 mph) should be regarded as an improvement in traffic flow. For intersection segments, higher average speeds and a decrease in average delay should be considered an improvement in traffic flow.

d. Project does not move receptors closer to the traveled way. If receptors are located closer to the traffic lanes, concentrations to which the public are exposed will increase.

The criteria should be applied on an hourly basis for the averaging periods of concern.

LEVEL C -- Implicit Conformity Via the Attainment Plan

Some regions incorporate rigorous analysis of microscale changes in traffic, and ambient pollutant concentrations at characteristic intersections. This analysis, if it shows acceptable ambient pollution

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[1] Analysis of projects in nonattainment areas during the time period prior to federal approval of a region's CO attainment plan are subject to different criteria regarding the acceptability of impacts. Such projects shall be considered satisfactory only if the project sponsor can determine that the project leads to a decrease in emissions.

levels, could be used in an implicit conformity test. Screening criteria are provided in this section for projects involving intersections that may be compared to intersections included in the attainment plan.

Analysis detail and findings

A comparison between intersections can only be made if the following conditions are satisfied:

a. The intersection analysis in the CO attainment plan was performed in sufficient detail to establish CO concentrations.
b. The impacts were acceptable.

Estimating the difference in carbon monoxide concentrations

Carbon monoxide concentrations at an intersection would be lower than those reported for an intersection analyzed in the CO attainment plan if all of the following conditions are satisfied:

a. The receptor locations at the intersection under study are at the same distance or farther from the traveled roadway than the receptor locations used in the intersection in the attainment plan.
b. The two intersection geometries are not significantly different. An example of a significant difference would be a different number of lanes on any of the approach or departure segments.
c. Appropriately assumed meteorology for the intersection under study is the same or worse than the assumed meteorology for the intersection in the attainment plan. Relevant meteorology includes: wind speed, wind direction, temperature and stability class.
d. Traffic lane volumes for all approach and departure segments are lower for the intersection under study than those assumed for the intersection in the attainment plan.
e. Percentages of vehicles operating in cold start mode are the same or lower for the intersection under study compared to those used for the intersection in the attainment plan.
f. Percentage of heavy duty gas trucks in the intersection under study is the same or lower than the percentage used for the intersection in the attainment plan.
g. Average delay and queue length for each approach is the same or smaller for the intersection under study compared to those found in the intersection in the attainment plan.
h. Background concentration in the area where the intersection under study is located is the same or lower than the background concentration used for the intersection in the attainment plan.

A project is considered satisfactory if it meets the above criteria.

LEVEL D -- Implicit Conformity in Maintenance Areas

In maintenance and proposed maintenance areas, the project sponsor is primarily concerned with intersections where air quality may be getting worse. There is more flexibility built into the suggested conformity determination process in maintenance areas than there was in nonattainment areas. Every intersection and link in a maintenance area has demonstrated that it does not compromise the NAAQS, therefore any existing facility can serve as a measure to use in the implicit conformity test.

Projects that are likely to worsen air quality

Because the region has been shown to not violate the NAAQS, only those projects that are likely to worsen air quality necessitate further analysis. The following criteria should be used to determine whether a project is likely to worsen air quality in the area substantially effected by the project. This is identical to the build no build test in level B.

a. The project significantly increases the percentage of vehicles operating in cold start mode. Increasing the number of vehicles operating in cold start mode by as little as 2% should be considered potentially significant.

b. The project significantly increases traffic volumes. Increases in traffic volumes in excess of 5% should be considered potentially significant. Increasing the traffic volume by less than 5% may still be potentially significant if there is also a reduction in average speeds.

c. The project worsens traffic flow. For uninterrupted roadway segments, a reduction in average speeds (within a range of 3 to 50 mph) should be regarded as worsening traffic flow. For intersection segments, a reduction in average speed or an increase in average delay should be considered as worsening traffic flow.

d. Project does not move receptors closer to the traveled way. If receptors are located closer to the traffic lanes, concentrations to which the public are exposed will increase.

The criteria should be applied on an hourly basis for the averaging periods of concern. Note that it may be easier to "screen out" a project by proceeding directly to the next subsection; the analyst is encouraged to look ahead at the criteria given therein.

Projects suspected of resulting in higher CO concentrations than those existing within the region at the time of attainment demonstration

Projects potentially creating CO concentrations higher than those existing within the region at the time of attainment demonstration should proceed to the next subsection. If the project does not have the potential to create ambient concentrations higher than those accounted for in the attainment demonstration, then no further analysis is needed. This test compares the project to existing facilities that have already demonstrated that they do not compromise the NAAQS.

Project sponsors may use the following criteria to determine the potential existence of higher CO concentrations in the region. Select one of the worst locations in the region having a similar configuration and compare it to the "build" scenario of the location under study according to the following conditions:

a. The receptors at the location under study are at the same distance or farther from the traveled roadway than the receptors at the location where attainment has been demonstrated.

b. The roadway geometry of the two locations is not significantly different. An example of a significant difference would be a larger number of lanes at the location under study compared to the location where attainment has been demonstrated.

c. Expected worst-case meteorology at the location under study is the same or better than the worst-case meteorology at the location where attainment has been demonstrated. Relevant meteorological variables include: wind speed, wind direction, temperature and stability class.

d. Traffic lane volumes at the location under study are the same or lower than those at the location where attainment has been demonstrated.

e. Percentages of vehicles operating in cold start mode at the location under study are the same or lower than those at the location where attainment has been demonstrated.

f. Percentage of heavy duty gas trucks at the location under study is the same or lower than the percentage at the location where attainment has been demonstrated.

g. For projects involving intersections, average delay and queue length for each approach is the same or smaller for the intersection under study compared to those found in the intersection where attainment has been demonstrated.

h. Background concentration at the location under study is the same or lower than the background concentration at the location where attainment has been demonstrated.

If all of the above conditions are satisfied there is no reason to expect higher concentrations at the location under study.

Projects that involve signalized intersections at LOS E, or F

Projects that are likely to worsen air quality at signalized intersections having a level of service E, or F, represent a potential for a CO violation and need a quantitative analysis.

Projects that result in worsening of signalized intersection LOS to E, or F

Projects that would lead to worsening the level of service of a signalized intersection to E, or F, represent a potential for a CO violation and require a quantitative analysis. For example, a project that would change the level of service of a signalized intersection from D to E would require a quantitative analysis.

Other reasons causing adverse air quality impacts

Under certain special conditions, there still may be cause for concern about the air quality impacts of the project even if no further analysis was required according to the above criteria. These conditions require that the project sponsor(s), in consultation with the MPO and the local Air District, determine the potential air quality impacts of the particular project being reviewed. Examples of such special conditions include:

a. Urban street canyons

b. High percentage of heavy duty gas trucks in the vehicle mix (for example, in manufacturing or industrial areas)

c. High percentage of vehicles operating in cold start mode coupled with high traffic volumes

d. Locations near a significant stationary source of CO

e. Locations with high background CO concentrations

A quantitative analysis is required if it is determined that the project has the potential to negatively affect air quality even in a CO attainment area.

Figure 2. Conceptual Qualitative Project Level Conformity Analysis

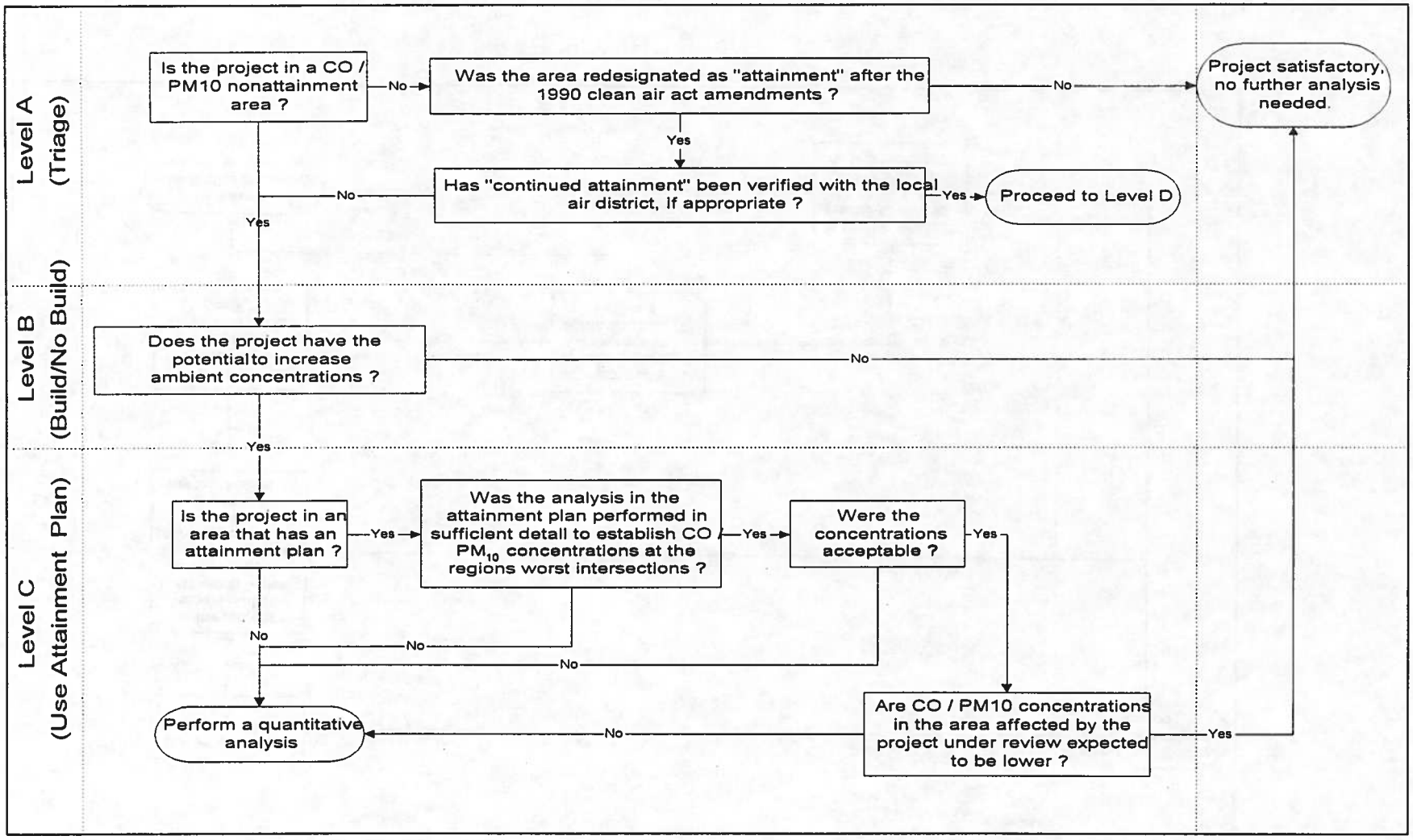
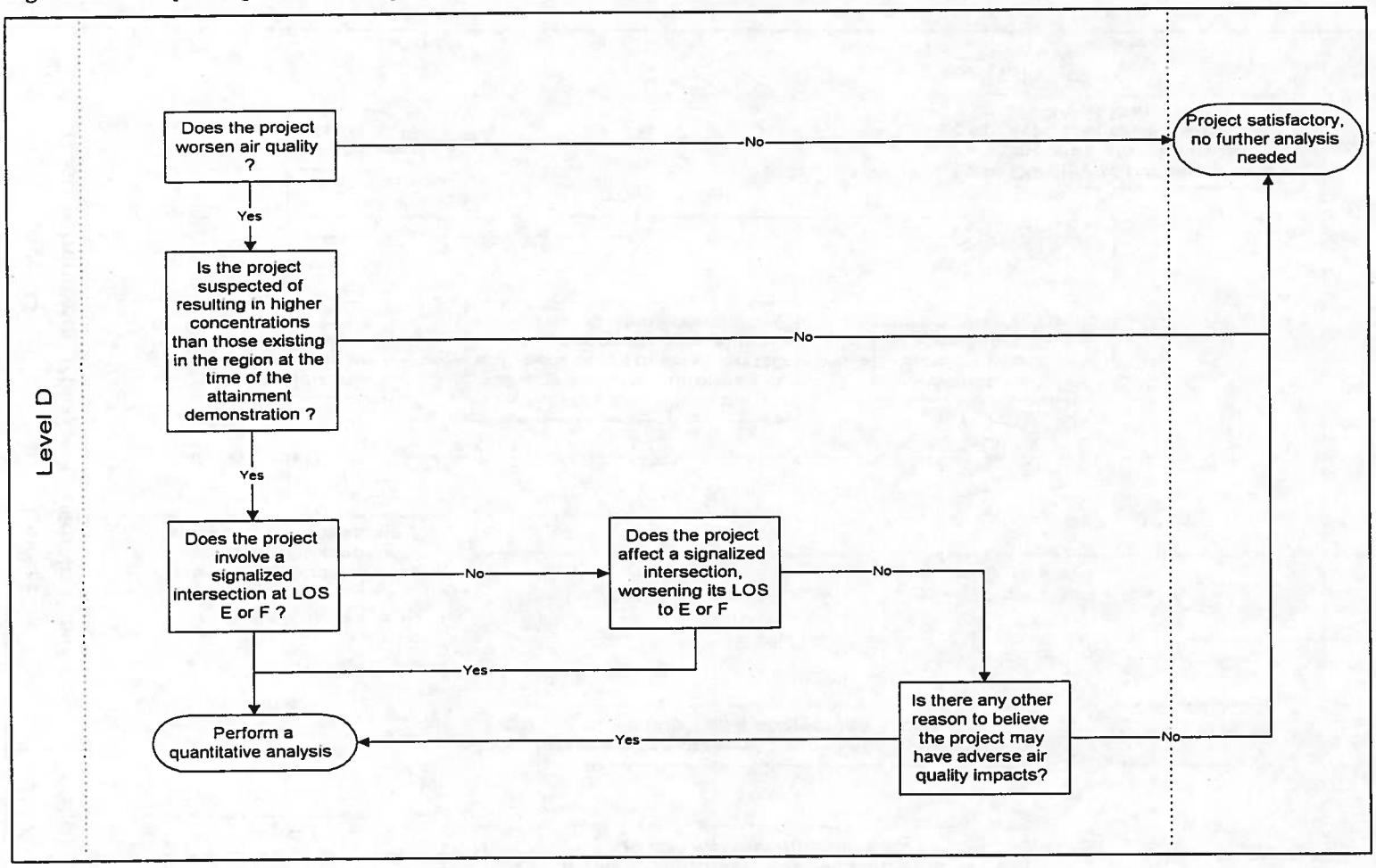


Figure 2. Conceptual Qualitative Project Level Conformity Analysis (continued)



Conclusion

It is possible to demonstrate project level conformity, without undergoing the expense of analytical modeling, by using the Implicit Conformity Test. This test provides a useful tool to quickly show conformity for lesser projects, and leaves more resources available to analyze projects that pose a real threat to the national ambient air quality standards and state implementation plans (SIPs).

Because the test relies upon the attainment demonstrations prepared as part of the air quality planning process, new emphasis will be placed on those attainment demonstrations. It is important that these attainment demonstrations take into account the microscale effects of traffic growth. Misrepresenting those microscale impacts will compromise any conformity determination that relies on the attainment demonstration.

To take full advantage of the Implicit Conformity Test, better integration of the SIP process and transportation planning process needs to take place. The test may only be applicable to a fraction of each regions transportation projects if it is not incorporated into the conformity procedures included in the SIP.

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