

BOARD MEETING DATE: May 1, 2015

AGENDA NO. 29

PROPOSAL: Draft 2016 AQMP White Papers on Particulate Matter Controls and Volatile Organic Compound Controls

SYNOPSIS: Draft white papers have been prepared on particulate matter (PM) controls and volatile organic compound (VOC) controls including the influence of VOCs on ozone and PM_{2.5} formation and recommended approaches to develop their attainment strategies.

COMMITTEE: Mobile Source Committee, April 17, 2015, Reviewed

RECOMMENDED ACTION:
Receive and file.

Barry R. Wallerstein, D.Env.
Executive Officer

BB EC:PF:MK

Background

The SCAQMD is preparing a 2016 Air Quality Management Plan (AQMP) to demonstrate how the region will reduce air pollution to meet federal health-based standards for ground-level ozone and fine particulates (PM_{2.5}). The Plan will focus on demonstrating attainment of the National Ambient Air Quality Standards (NAAQS) for 8-hour ozone (75 parts per billion, set in 2008) and annual PM_{2.5} (12 µg/m³ set in 2012). The Plan will also revise the previously submitted SIPs for the 1979 1-hour ozone, 1997 8-hour ozone, and the 24-hour PM_{2.5} standards.

As part of this process, SCAQMD staff is working closely with stakeholders to prepare a series of 10 white papers on key topics to provide scientific background and policy considerations that will inform the development of the 2016 AQMP. Two draft white papers have been prepared on the role of VOC controls and PM controls in the effort to achieve clean air standards. Based on the technical information such as pollutant formation of PM_{2.5} and ozone, both white papers include prioritized policy recommendations that will serve to shape the control strategy in the 2016 AQMP. The

complete draft VOC and PM white papers are included as attachments to this Board letter.

Staff Recommended Approaches for Control Strategy Development

VOC Controls

Significant decreases in NO_x emissions are needed for attainment of the ozone standard throughout the Basin, regardless the amount of VOC reductions. However, such NO_x reductions may lead to short-term, local increases in ozone in some areas of the western Basin. Based on numerous modeling scenarios, staff is recommending an attainment path for ozone, which calls for heavy NO_x reductions augmented with limited, strategic VOC controls to avoid the potential increase in ozone exposure above the 1997 ozone standard. The following staff recommendations provide a prioritized approach for achieving future VOC reductions:

1. Maximize co-benefits from NO_x, GHG or air toxic controls that produce concurrent VOC reductions.
2. Promote pollution prevention with associated cost savings.
3. Incentivize super-compliant zero- and near-zero VOC materials.
4. Maximize reductions from existing regulations (e.g., enhanced enforcement, remove loopholes, expand reporting programs).
5. Prioritize emission reductions of VOC species that are most reactive for ozone and/or PM_{2.5} formation and that produce concurrent air toxic or GHG benefits
6. Avoid toxicity trade-offs from exempt VOC replacements.
7. Further evaluate the practicality and effectiveness of time and place controls.
8. Continue research on the emissions and chemistry of semi-volatile organic compounds, including Low Vapor Pressure compounds.

Particulate Matter Controls

Several attainment paths can be developed with varying degree of controls among directly emitted PM_{2.5} and PM precursors. Selecting the most efficient path for PM_{2.5} attainment must take into consideration many factors, including the amount of total reductions needed, technology readiness, attainment deadlines, cost-effectiveness, and the relationship with attainment deadlines for other NAAQS pollutants. The following staff recommendations provide a prioritized approach for the development of the PM_{2.5} attainment strategy.

1. Co-benefits from the ozone NO_x strategy
2. Co-benefits from climate change or air toxic control programs
3. Outreach and incentive programs
4. Additional measures for PM_{2.5} attainment
5. Continue research and scientific studies

Public Process

Draft white papers for VOC Controls and PM Controls were released to the public on April 2, 2015, and the working group for each topic met, respectively, on April 14, 2015 and April 16, 2015 to discuss the content. Comments from the working groups, AQMP Advisory Group and other stakeholders will be incorporated into a revised version of the white papers. Staff is providing the Board a presentation on the draft white papers and will return to the Board once the reports are finalized to assist in the development of the 2016 AQMP.

Attachments

- A. VOC Controls White Paper
- B. Particulate Matter Controls White Paper

PRELIMINARY DRAFT



April 2015

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1. Introduction

This document evaluates the need for additional VOC controls to achieve more stringent annual PM_{2.5} and 8-hour ozone standards in the SoCAB. It assesses the role of VOCs in forming ozone and PM_{2.5} to inform policymakers of the most efficient and effective strategies to attain the federal standards that are the subject of the upcoming 2016 AQMP.

The science behind the formation of ozone and particulate matter from VOCs is also summarized. A state-of-the-science numerical modeling system (WRF-CMAQ) is used to estimate the maximum allowable NO_x and VOC emissions that will lead to regional ozone and PM_{2.5} concentrations that meet the federal standards. Given the results of this modeling, the implications of various NO_x and VOC control strategies are analyzed.

2. What are VOCs?

VOCs are chemicals containing carbon that readily evaporate. VOCs are widely used in modern society in fuels, solvents, coatings, cleaning supplies, building products, and many other materials. In addition to evaporation, some VOCs are emitted as a product of combustion processes, such as wood burning or internal combustion engines. Thus, VOCs are emitted from mobile sources such as cars and trucks, and stationary sources such as refineries, chemical plants, and households. Since VOCs evaporate readily, in the absence of appropriate control measures, these compounds will ultimately end up in the atmosphere. Subsequent chemical reactions of VOCs in the atmosphere can form surface level ozone pollution and particulate matter.

Atmospheric scientists classify VOCs into several subcategories. The rate that each specific VOC forms ozone is a function of its unique chemical reactivity, its atmospheric concentration, and the atmospheric concentrations of other chemicals needed for these complex chemical reactions. VOCs that form ozone at extremely slow rates are considered non-reactive and are often classified as “exempt” from current VOC rules and regulations. However, toxicity or other potential adverse environmental impacts from these VOCs should also be considered. The ability for a specific VOC to form particulate matter is dependent on how fast it reacts with other atmospheric compounds and the physical properties of the resulting products.

We can also classify VOCs and their chemical reaction products into three sub-categories dependent on how readily they evaporate. VOCs with high volatility evaporate quickly, but are less likely to contribute to particulate matter, because these compounds generally remain as gases once they evaporate. On the other hand, compounds with lower volatilities evaporate at a slower rate, but are more likely to contribute to particulate matter as they or their reaction products may condense (transition from gas to liquid or solid form) once they are in the atmosphere. Compounds that have a significant fraction of their mass in both the gas and particle-phase in the atmosphere are referred to Semi-Volatile Organic Compounds (SVOCs). Compounds that have most of their mass in the gas-phase, but can transition to the particle phase under certain atmospheric conditions are termed Intermediate Volatility Organic Compounds (IVOCs). While a direct comparison is difficult, low vapor pressure volatile organic compounds (LVP-VOCs), defined under the California Air Resources Board consumer products regulations, fall into the IVOC and SVOC categories. In addition, atmospheric reactions can produce products with drastically different volatilities than the parent compounds.

3. The role of VOCs in ozone formation

Ozone concentrations in the South Coast Air Basin

Ground-level ozone pollution is a powerful oxidant with significant adverse effects on human health. While ozone concentrations within the SoCAB have declined significantly over the past few decades, the SoCAB does not meet federal or state ozone standards. In addition, the recently proposed federal limit of 65-70 ppb will make future attainment even more challenging [1]. In recent years, the significant downward trend in Basin-wide ozone concentrations has begun to level off. Figure 1 details the yearly trend in ozone concentrations and the trend in the number of days that exceed the current federal standard.

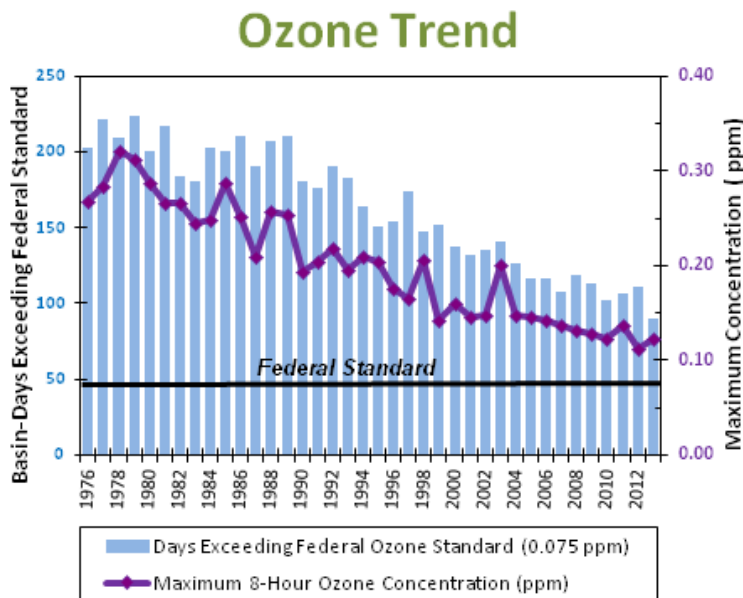


Figure 1: Basin-wide maximum 8-hour ozone concentration and Basin-days exceeding the federal standard.

Certain air quality monitoring stations located in the Inland Empire and the San Bernardino Mountains exceed the federal ozone standard over 60 days per year (Figure 2). Higher local ozone concentrations in these regions can be attributed to the significant upwind NOx and VOC precursor emissions transported by the daily sea-breeze in the summer, local emissions, and the timing of the daily emissions and peak sunlight intensity.

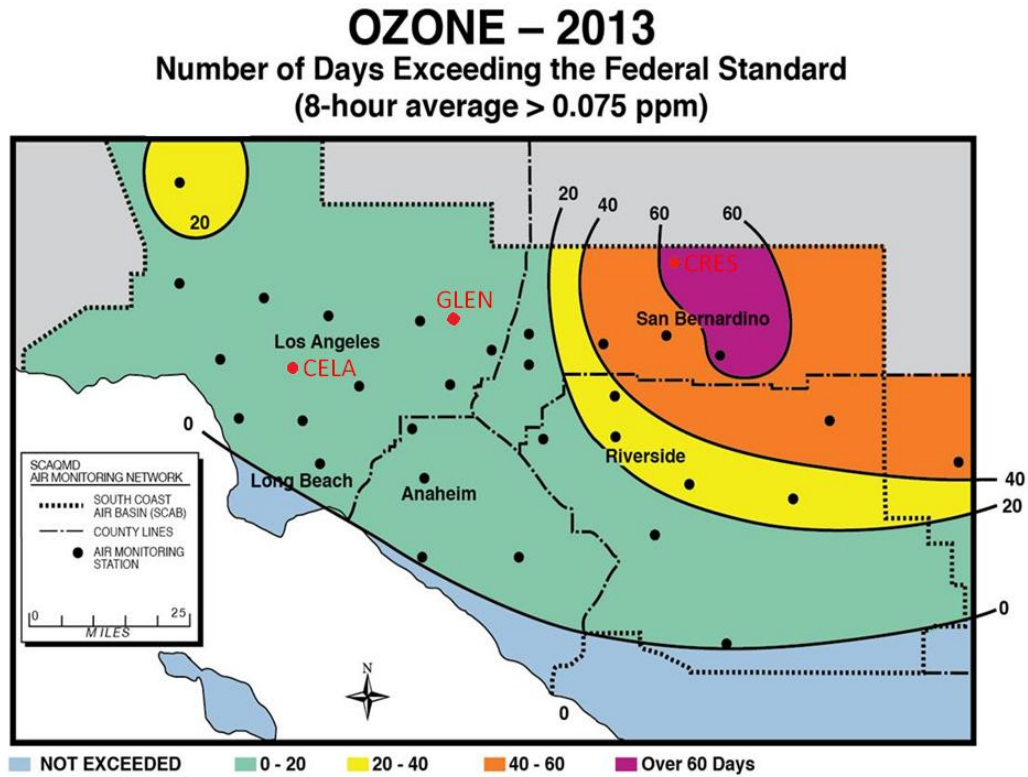


Figure 2: Spatial distribution of ozone exceedances in the SoCAB. Central Los Angeles (CELA), Glendora (GLEN), and Crestline (CRES) are highlighted.

How do VOCs form ozone?

Ozone (O₃) is not emitted directly into the atmosphere; it is formed in the atmosphere by reaction of VOCs with oxides of nitrogen (NO_x) in the presence of sunlight. NO_x is generated from combustion processes and is emitted in large quantities within the South Coast Air Basin (SoCAB). The chemical reactions that form ozone are highly complex and depend not only on NO_x and VOC levels, but also on the ratio of VOC to NO_x concentrations. NO_x emissions can even reduce ozone concentrations in the immediate vicinity of an emission source, but will contribute to ozone formation downwind.

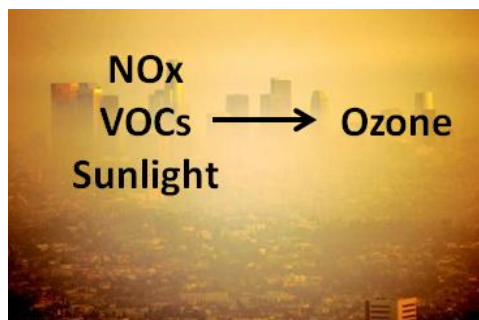


Figure 3: Recipe for ozone production

A decrease in ambient VOC concentrations generally leads to a decrease in ozone. However, because of the complex chemistry involved, a decrease in NO_x concentrations may lead to a

decrease or an increase in ambient ozone depending on the local VOC concentration. This complex dependence on NO_x and VOC concentrations leads to interesting policy implications, which can be explored using comprehensive air quality models.

4. How do VOCs form particulate matter?

The South Coast Air Basin does not currently meet federal and state standards for PM_{2.5}, particles with diameters less than 2.5 μm (Figure 4). These particles consist of a myriad of different chemical compounds in both solid and liquid form. While some PM_{2.5} is emitted directly from sources, the majority of ambient PM_{2.5} is formed from chemical reactions and processes in the atmosphere. These small particles are particularly dangerous due to their ability to penetrate deep into the lungs. Many studies have linked inhalation of PM to serious adverse respiratory and cardiovascular affects. In order to develop an effective control strategy, one must consider the composition and by extension, the sources of PM_{2.5} in the Basin. In the Basin, approximately 30-50% of the PM_{2.5} mass is composed of organic compounds. The remaining fraction consists of elemental carbon, metals, dust, inorganic sulfate, inorganic nitrate, ammonium, and chloride. The organic fraction, known as organic aerosol (OA), is composed of a complex mixture of organic chemicals that may continue to evolve as it ages in the atmosphere.

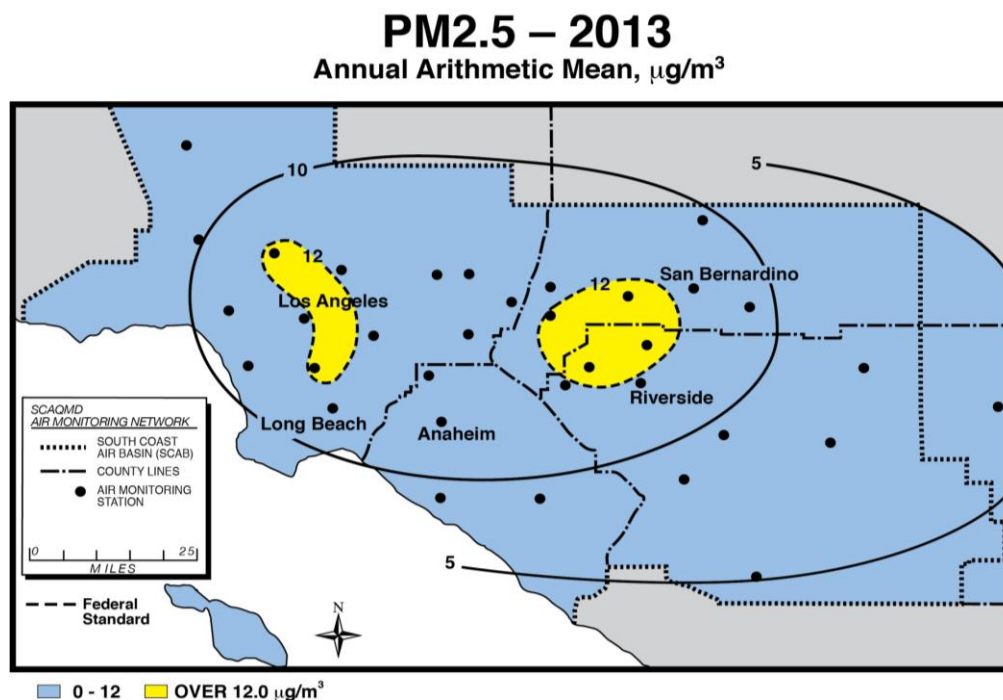


Figure 4: Spatial distribution of PM_{2.5} concentrations in the SoCAB

Different chemical reactions are responsible for the formation of ozone and OA from gaseous organic compounds. Since both ozone and PM_{2.5} formation are largely dominated by atmospheric reactions, we must consider the potential for a gaseous organic compound to contribute to both ozone and PM_{2.5} levels. Organic compounds with large ozone formation potentials may or may not contribute significantly to PM_{2.5} mass. Similarly, many gaseous

organic compounds classified as VOCs, IVOCs, or SVOCs that contribute to OA may or may not play a role in the formation of ozone [5].

5. Ozone Control Modeling Analysis

The Community Multiscale Air Quality (CMAQ) model has been used to investigate the resulting O₃ concentrations with various levels of VOC and NO_x emissions under different control strategies. The CMAQ model, which is the U.S. EPA recommended regulatory model, is considered the preeminent, state-of-the-science air quality model for analyzing air quality improvement strategies. Since ozone concentrations are a complex function of both NO_x and VOCs concentrations, we use a three-dimensional plot to visualize this dependency. The Empirical Kinetics Modeling Approach (EKMA) ozone “isopleths” diagrams illustrate the outcomes of this complicated chemistry.

The ozone isopleth diagram in Figure 5 illustrates how 8-hr ozone concentrations in Crestline (the monitoring station currently with the most ozone exceedances in the Basin) respond to decreases in total Basin-wide anthropogenic VOC and NO_x emissions beyond the existing adopted rules and regulations. The corresponding ozone isopleths diagram for Central Los Angeles is presented in Figure 6. Estimated VOC and NO_x emissions following the continued implementation of adopted rules and regulations in the 2023 timeframe are defined by the upper-right corner of the plot. The federal ozone standard is met within the yellow and green regions of the diagram (corresponding to Air Quality Index levels and colors). Three paths are illustrated on both isopleths diagrams to highlight the potential effects of different control strategies and to aid in policy discussions. Path C illustrates the impact of a control scenario that attains the ozone standards with only additional NO_x reductions beyond what is required in current rules. In this scenario, additional VOC reductions beyond current requirements are not applied. A control scenario focusing solely on additional VOC control is shown with Path A. A hypothetical control scenario where additional (beyond scheduled reductions) NO_x and VOC reductions occur at the same rate is illustrated with Path B. This is provided as an example of the results of a control strategy emphasizing VOC and NO_x reductions equally.

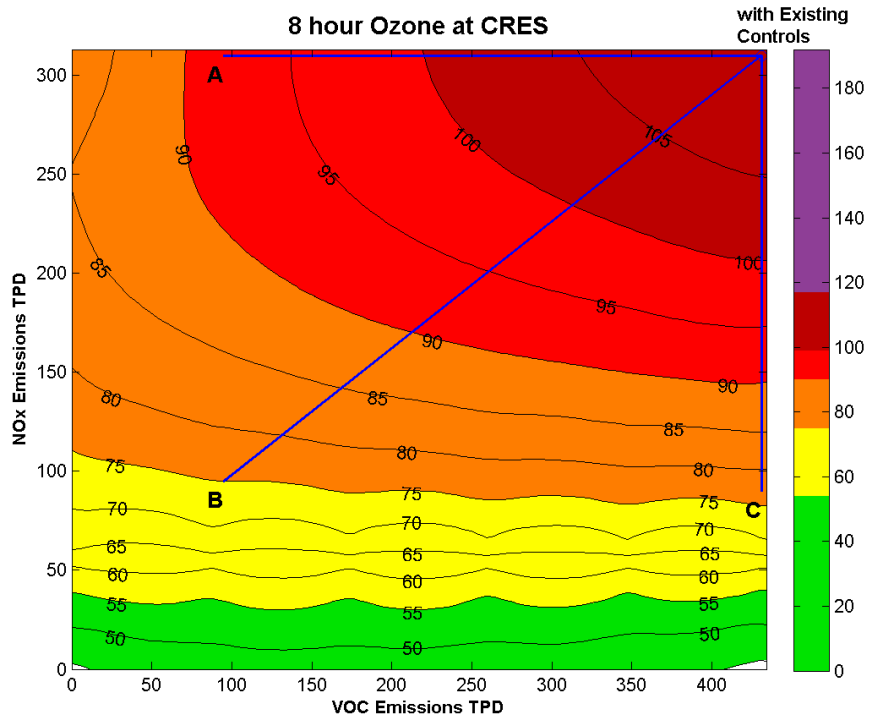


Figure 5: EKMA ozone isopleths diagram showing 8-hr ozone isopleth at Crestline. The color shading corresponds to the air quality index (AQI) color code. This analysis is based on the emissions inventory used for the 2012 AQMP using CMAQ version 4.7.

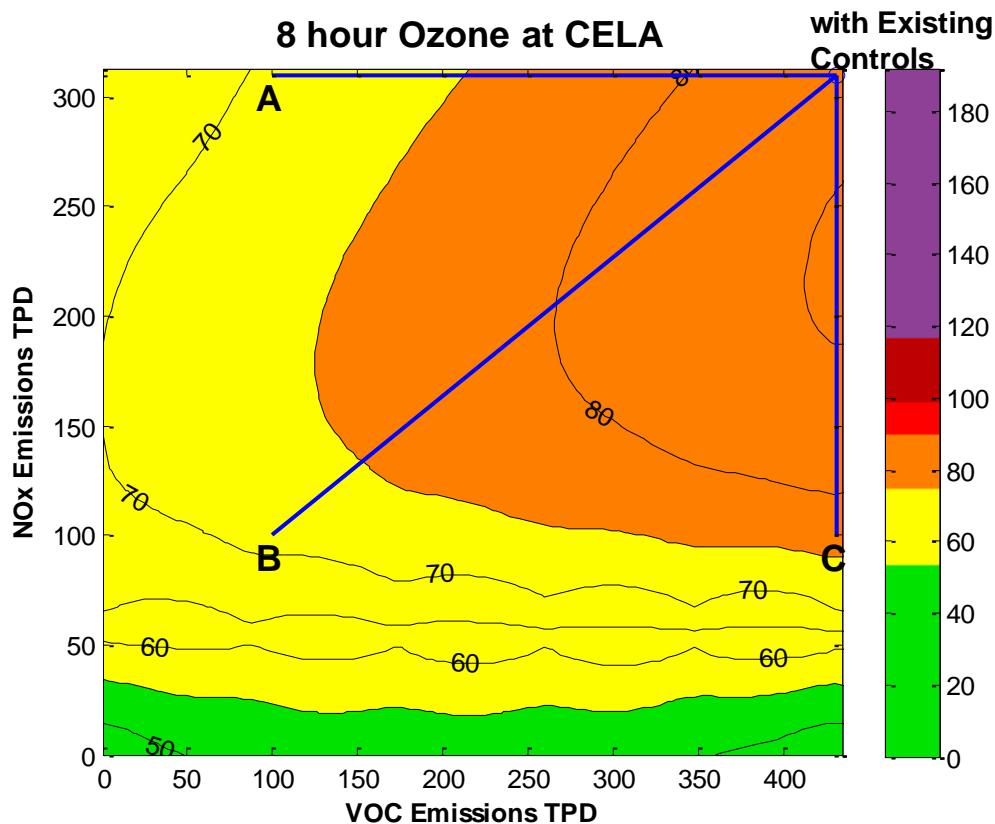


Figure 6: EKMA ozone isopleths diagram showing 8-hr ozone isopleth at Central Los Angeles. The color shading corresponds to the air quality index (AQI) color code. This analysis is based on the emissions inventory used for the 2012 AQMP using CMAQ version 4.7.

It is necessary to understand how ozone concentrations evolve during each of these three control paths at the Crestline and Central L.A. monitoring locations (Figure 7).

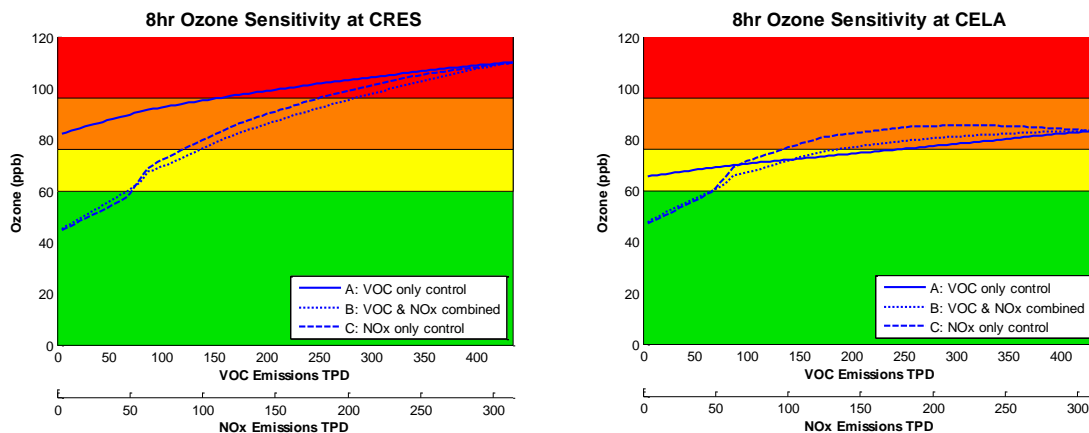


Figure 7: Ozone concentrations at Crestline and Central Los Angeles predicted to occur as a result of the specific control strategies (path A, B, and C) marked in Figure 5 and 7.

While the VOC heavy control strategy (Path A from right to left) reaches attainment in CELA with the minimum amount of emissions reductions, this strategy will not lead to attainment in CRES, and thus the Basin, even with zero anthropogenic VOC emissions. Therefore, additional NO_x reductions are required to achieve the ozone standards for both sites.

Not only is the achievable endpoint different in each of the scenarios, the ozone concentrations predicted to occur along the path to attainment are also quite different. Moving from right to left in these figures along Path C, the NO_x heavy control strategy suggests that approximately an additional 200 TPD of NO_x reductions beyond current regulations is required to attain the federal ozone standard. If NO_x is reduced without additional VOC reductions beyond what is projected from current rules, as illustrated in Figure 8 there could be up to a 2 ppb increase in ozone in certain parts of the western Basin surrounding central LA along the path to attainment. Figure 9 shows the area that would be above the 1997 ozone standard of 80 ppb and how much the potential ozone exposure increase would be. The population potentially subject to this effect is estimated to be a few million. It should be noted that this increased ozone phenomenon attributable to a pure NO_x reduction strategy is temporary and exists only along the path to attain the 80 ppb standard, but does not occur with additional NO_x reductions designed to attain the more stringent 75 ppb or the future proposed standard (65 to 70 ppb).

Additional Reductions Beyond Existing Controls

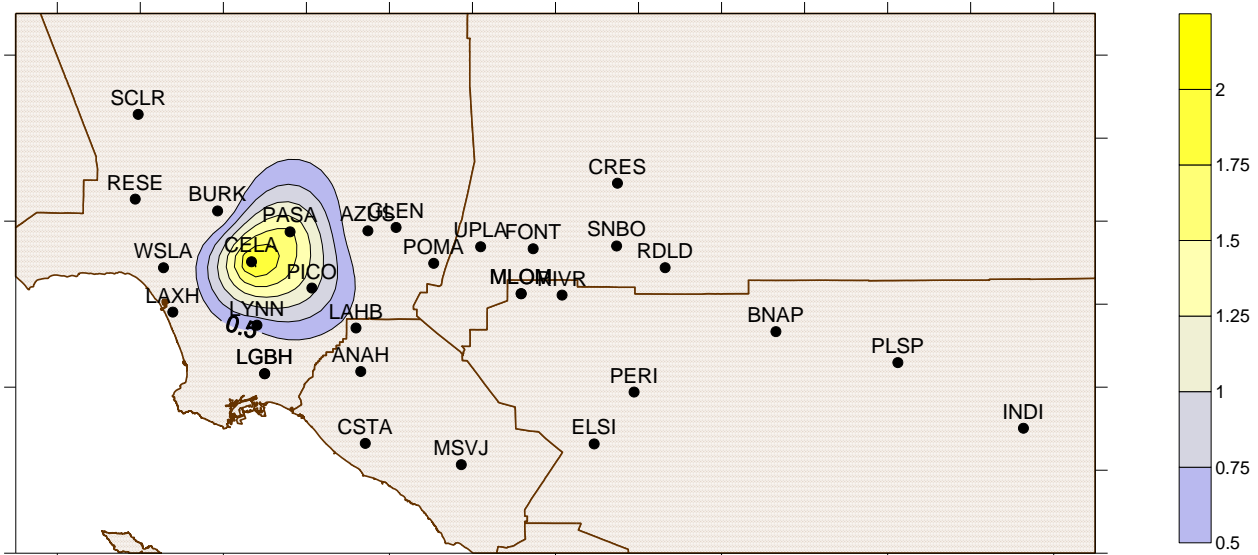


Figure 8: Maximum increase in ozone along the path to attainment with a pure NO_x control strategy

6. Consideration of “Path to Clean Air” Scenarios

There are different paths to achieve ozone and PM_{2.5} standards based on various levels of control among the precursor pollutants. The total magnitude of reductions required, technology readiness, cost-effectiveness, economic impacts, attainment deadlines, and the interaction with other attainment deadlines for other pollutants are all critical considerations in developing an overall multi-pollutant control strategy. Complex atmospheric chemistry and the non-uniform spatial distribution of both sources and the resulting ambient concentrations requires a comprehensive analysis that ensures not only that ozone and PM_{2.5} concentrations meet standards in all areas, but that unintended exposure increases in specific areas are avoided if at all possible. Furthermore, concurrent reductions of other pollutants such as air toxics and greenhouse gases should also be considered in optimizing a path to meeting multiple standards, objectives, and deadlines.

NOx-Only Control Strategy (Path C)

As demonstrated above, a NOx-only approach without new VOC controls provides a potential path to ozone attainment for both stations that minimizes the overall tons of emissions reductions needed and has commensurate benefits for PM_{2.5}. Many of the currently available technologies needed for NOx reductions have air toxics and greenhouse gas co-benefits and vice-versa. Reducing NOx emissions will also mitigate adverse health effects associated with inhalation of locally elevated concentrations of NO₂, another criteria pollutant. However, this NOx-only (path C) approach leads to increased ozone concentrations and exposure in the more densely populated areas of the western Basin in the short-term. Consequently, a certain portion of the Basin's population would experience worse ozone air quality at levels above federal standards in the interim years under a NOx only approach. This approach requires an additional NOx reduction beyond adopted regulations of approximately 65-75% to attain the federal ozone standards. While a reduction of this magnitude is challenging and will require significant investments, zero- and near zero- NOx emission reduction technologies are currently available and in limited use and can potentially be widely deployed in the next 10 to 20 years.

VOC-Only Control Strategy (Path A)

A VOC heavy control strategy without additional NOx controls, illustrated by path A in Figure 6, will not lead to attainment of the ozone standards for the eastern Basin, even in the absence of any man-made VOC emissions. This control strategy avoids a short-term increase in ozone inherent in the NOx-only strategy, however, it will not be possible to achieve the ozone standards by reducing VOCs alone. Furthermore, zero- and near zero-VOC technologies for many of the major VOC emitting categories (e.g. consumer products) may take many years for reformulation and market penetration, and are thus less mature than current low NOx technologies.

Combined NOx and VOC Control Strategies

A VOC and NOx combined strategy would require greater combined tons of reductions with greater associated compliance costs than a single pollutant approach. However, a combined strategy will aid in mitigating short-term increases in ozone in certain areas while potentially providing additional benefits for PM_{2.5}, toxics, and greenhouse gases. Note that Path B in the above figures is provided only as an example, and a combined control strategy could lie anywhere between path A and path C that still reaches ozone attainment.

For example, Figure 10 adds two additional emissions reduction scenarios to the Central L.A ozone isopleths in Figure 7. Path D provides just enough additional VOC control (30 - 40 tons per day) to avoid any increases in ozone exposure above the 2023 attainment target of 84.5 ppb (this standard has been revoked, but the 2023 target remains with U.S. EPA's anti-backsliding provisions). Another policy option is Path E, which includes enough early VOC reductions to avoid any increases in ozone exposure in the western Basin. This would require approximately 100 tons per day of additional VOC controls, and for those controls to be timed to occur before the bulk of the NOx controls. In any case, the choice of the optimal path should consider multiple policy goals, including public health, cost-effectiveness, and economic impacts.

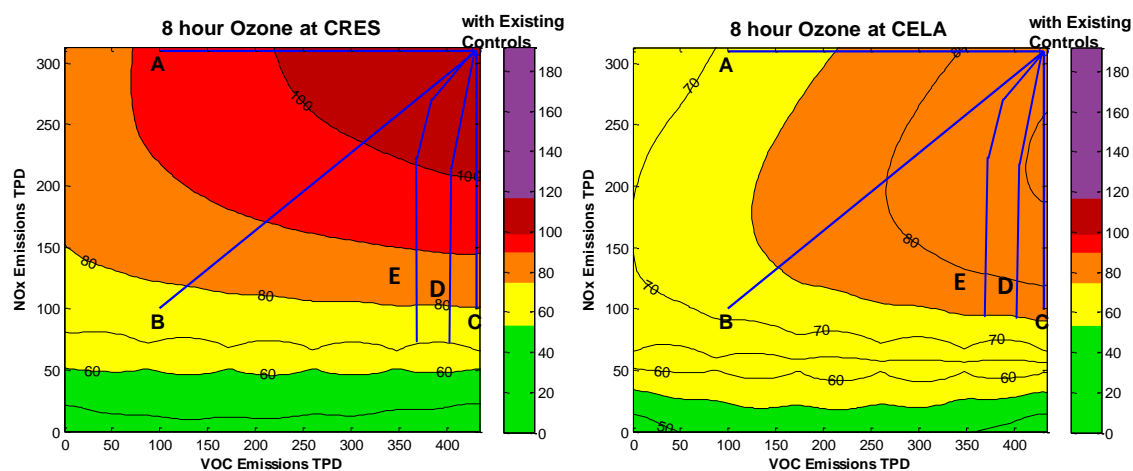


Figure 10: Additional emissions reduction options (Paths D and E) mitigating ozone increases in the western Basin (CELA)

Recommendations- NOx-Heavy Controls with Strategic and Tiered VOC Reductions

Given the availability of technology, climate and PM_{2.5} objectives, a desire to minimize control costs, and the lack of a viable path to attainment with VOC reductions only, a NOx heavy approach with modest VOC controls as shown in Path D is preferred. It is the same path that was taken by both the 2007 and 2012 AQMPs that focuses primarily on NOx reductions, but is augmented with modest VOC reductions to mitigate the higher ozone exposures along the path to attainment. According to this analysis, approximately 200 tons per day of NOx would be needed by 2023, and mitigating the interim ozone increases would require about 30 to 40 tons per day, or less than 10 percent of total anthropogenic VOC emissions beyond the existing adopted rules and regulations. Once the 84.5 ppb level is reached, these or additional VOC reductions would not be needed to avoid increases in ozone exposure. It should be noted that Path D would also result in concurrent PM_{2.5} reductions throughout the entire air basin which are needed to address the current PM_{2.5} annual standard of 12 µg/m³.

These additional VOC reductions will help to mitigate the increase in ozone in the western Basin inherent in this NOx heavy control strategy. Therefore, a control strategy that continues to focus on NOx reductions, with additional strategic and cost-effective VOC reductions, is the most desirable way to minimize the general public's exposure to unhealthy ozone pollution not only in the target attainment year, but also during the course of the control effort. The next section discusses a prioritized strategy to achieve cost-effective VOC reductions that maximize co-benefits and emphasize non-regulatory approaches.

Note that this analysis is based on the results of analyses conducted for the 2012 AQMP. This analysis will be repeated for the 2016 AQMP with an updated emissions inventory and new attainment demonstration modeling methods from the US Environmental Protection Agency, following the same approach and rationale outlined above. The general findings of the control pathways outlined above is not expected to change, but the amount of reductions needed will be refined to reflect the latest planning assumptions and methodologies.

7. Tiered Approach to VOC Reductions

Based on the above analysis of the overall path to attainment and the role VOCs play in the ozone control program, a strategy that continues to focus on significant NO_x reductions but includes meaningful VOC reductions where appropriate is recommended. In order of priority, the following potential strategy considerations are designed to achieve VOC reductions in a cost-effective and targeted fashion considering the co-benefits from and to other air quality objectives:

1. *Maximize co-benefits from NO_x, GHG or air toxic controls that produce concurrent VOC reductions*

Certain zero- or near-zero NO_x technologies would also lead to VOC reductions. Given the continued NO_x heavy strategy, policies should promote technologies with these additional VOC co-benefits. For example, electric and hydrogen fuel cell vehicles, efficiency measures, or VMT reductions produce both NO_x and VOC reductions; many of these strategies also avoid evaporative losses associated with traditional fuels like gasoline. Similarly, control technologies for GHG or air toxics may also produce concurrent VOC reductions. The 2016 AQMP will aim to better integrate and quantify these VOC reductions into the attainment plan.

2. *Promote pollution prevention at the source with associated cost savings*

Reducing waste at the source is an efficient and effective way to reduce emissions. This strategy could involve the implementation of more robust leak detection and repair (LDAR) programs, including Smart LDAR using advanced infrared or optical technologies. This approach can lead to cost savings as less product is lost through fugitive emissions. In other cases, this approach could reduce the use of VOC containing products and/or the reliance on after-treatment control technology. This also can lead to cost savings. Examples of this are incentives and programs promoting the use of higher transfer efficiency spray painting equipment.

3. *Incentivize super-compliant-zero- and near-zero VOC materials, especially during peak ozone season*

Super-compliant zero and near-zero VOC materials eliminate or drastically reduce emissions during the use of these products. There are several product categories where these materials perform as well as traditional products and are widely available in the market. Incentives to promote the use of super-compliant products containing no or little VOC during ozone season could reduce ozone concentrations when exceedances are typically experienced.

4. *Maximize reductions from existing regulations via enhanced enforcement actions, removal of potential regulatory loopholes, and expanded reporting programs.*

Enhanced enforcement and the tightening of regulatory exemptions that may be used as loopholes in lieu of compliant technologies can lead to reduced emissions. Additionally, recent sales and emissions reporting programs have led to increased understanding of the VOC inventory, incentivized clean technology through fee structures, and better focused

future enforcement and regulatory actions. These enhancements not only ensure that the reductions assumed in the AQMP are actually occurring, but also allow the plan to capture market trends and compliance margins that go beyond the regulatory requirements.

5. *Prioritize emission reductions of the VOC species that are most reactive for ozone and/or PM_{2.5} formation and that produce concurrent air toxic or GHG benefits*

The California Air Resources Board has an active reactivity program to investigate the scientific and policy implications of reactivity-based regulations. Reducing emissions of the most reactive species, considering ozone and PM_{2.5} formation along with enforceability, toxicity, and climate impacts, may be an efficient method to reduce ambient ozone and PM_{2.5} concentrations, achieve multiple environmental and health benefits, while minimizing market disruptions.

6. *Avoid toxicity trade-offs from exempt VOC replacements*

In recent years more and more manufacturers are formulating their compliant products using exempt VOCs, which are VOCs that do not contribute significantly to ozone formation. However, sometimes these compounds may have or be suspected of having health impacts. Their associated potential toxic risks, in comparison with existing products, are a complex issue in terms of how they are being used by workers or the general public and associated work practices to reduce exposure. In some cases, health impacts may involve different health end points (acute vs. chronic or cancer risks) than existing formulations. SCAQMD staff held a one-day technical symposium on this very issue to solicit inputs from experts in the field with no clear conclusions. Emerging from this and other discussions, is a policy debate as to whether we should treat new chemicals as “innocent until proven guilty” (i.e., not toxic until a risk factor is formally assigned by a health agency). In light of the amount of VOC reductions needed for attainment and other available VOC control opportunities, a precautionary approach is recommended that avoids regulatory VOC reductions that could potentially increase the use of more chemicals that are known or suspected to be toxic until it can be demonstrated that they would not create more toxic risks for workers or the public than the compounds they are replacing.

7. *Further evaluation of the practicality and effectiveness for time and place controls*

Most ozone exceedances occur during the months of May through September (the “ozone season”) when higher ambient temperatures and stronger solar intensities accelerate ozone formation rates. In addition, during the ozone season, higher temperatures increase the volatility of organic compounds, leading to accelerated evaporation and larger emissions of precursor compounds. In contrast, PM_{2.5} concentrations are typically highest during the winter months when stagnant weather and temperature inversions trap emissions close to the ground. The implications of controlling ozone and PM_{2.5} sources differently based on location and season can be evaluated further through modeling exercises.

8. Conduct further studies related to VOCs

Over the years, knowledge of the VOC emissions inventory, speciation profiles, and reactivity has improved significantly. Several topics should be further investigated to build a stronger scientific-basis for future VOC control programs. These include optical remote sensing technologies that allow for the detection of emissions in locations where traditional monitoring techniques are not practical. Such fence-line systems could enhance the accuracy of emissions inventories, provide an alarm system in the case of process disruptions, and offer opportunities for real-time feedback for process and emissions control to the facility operator. Furthermore, ongoing and future studies of emissions, evaporation rates, ambient concentrations, ozone formation, and PM_{2.5} formation from SVOCs, IVOCs, and LVP-VOCs will help determine if controlling these compounds could assist the attainment strategies for ozone and PM_{2.5}.

8. Conclusions

While air quality has improved considerably in the SoCAB over the past few decades, further emission reductions must be made to attain the federal standards for ozone and PM_{2.5}. The analysis herein indicates that a NO_x-heavy strategy accompanied by modest VOC reductions will help to avoid temporary increases in ozone concentrations in the western side of the Basin. This finding reaffirms the previous NO_x-heavy SIP strategies to meet both PM_{2.5} and ozone standards, but recognizes that VOC reductions can be given a lower priority. To this end, a strategic VOC control program is recommended for the 2016 AQMP to first maximize co-benefits of NO_x, GHG, and air toxic controls, followed by controls that could create a win-win, “business case” for the affected entities, incentives for super-compliant products, while ensuring and capturing benefits from implementation of existing rules. When additional VOC controls are still needed, it is recommended to prioritize controls that will produce co-benefits for air toxics, GHGs, with a focus on VOC species that are most reactive in ozone and/or PM_{2.5} formation.

9. References

1. E.P.A., *National Ambient Air Quality Standards for Ozone: A Proposed Rule by the Environmental Protection Agency*. 2014.
2. Hayes, P.L., et al., *Organic aerosol composition and sources in Pasadena, California, during the 2010 CalNex campaign*. *Journal of Geophysical Research: Atmospheres*, 2013. 118(16): p. 9233-9257.
3. Seinfeld, J.H. and S.N. Pandis, *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*. 2012: Wiley.
4. Parrish, D., *Synthesis of Policy Relevant Findings from the California Research at the Nexus of Air Quality and Climate Change 2010 Field Study*, in *Final Report to the Research Division of the California Air Resources Board*. 2014.
5. Gentner, D.R., et al., *Chemical Composition of Gas-Phase Organic Carbon Emissions from Motor Vehicles and Implications for Ozone Production*. *Environmental Science & Technology*, 2013. 47(20): p. 11837-11848.

PRELIMINARY DRAFT



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LIST OF ACRONYMS AND ABBREVIATIONS

AQMP	Air Quality Management Plan
Basin	South Coast Air Basin
BC	Black Carbon
CAA	Clean Air Act
CARB	California Air Resources Board
CMAQ	Community Multi-scale Air Quality model
DPM	Diesel Particulate Matter
EC	Elemental Carbon
GHG	Greenhouse Gas
MATES	Multiple Air Toxics Exposure Study
NAAQS	National Ambient Air Quality Standards
NH ₃	Ammonia
NO _x	Nitrogen Oxides
OC	Organic Carbon
PM	Particulate Matter
PM _{2.5}	Particulate Matter with a dynamic diameter less than or equal to 2.5 microns
PM ₁₀	Particulate Matter with a dynamic diameter less than or equal to 10 microns
ppm	Parts per million
RACM	Reasonably Available Control Measure
RACT	Reasonably Available Control Technology
RECLAIM	REgional CLean Air Incentives Market
SCAQMD	South Coast Air Quality Management District
SIP	Standard Implementation Plan
SOA	Secondary Organic Aerosol
SO _x	Sulfur Oxides
SVOC	Semi-Volatile Organic Compound
U.S. EPA	United States Environmental Protection Agency
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
µg/m ³	Micrograms per cubic meter
µm	Micrometers

Preface

The purpose of this 2016 Air Quality Management Plan (AQMP) White Paper on Particulate Matter (PM White Paper) is to provide background technical information and present the policy challenges associated with attaining the National Ambient Air Quality Standards (NAAQS) for fine particulate matter (PM_{2.5}), with a focus on the newly adopted federal annual PM_{2.5} standard of 12 micrograms per cubic meter (µg/m³). Annual PM_{2.5} concentrations continue to decrease and the South Coast Air Basin (Basin) is projected to be near attainment of the new annual PM_{2.5} standard once the ozone attainment strategy is fully implemented, but further actions may be needed to ensure attainment. Several scientific and policy issues will be described, including the roles of directly emitted PM_{2.5} emissions and PM_{2.5} precursor gases, and the PM_{2.5} co-benefits from the ozone control program. Key to the policy discussion is the potential need for additional measures for PM_{2.5} given that the attainment strategy cannot rely on the “black box” advanced technology emissions reductions that are used to demonstrate attainment of the ozone standard under federal Clean Air Act (CAA) Section 182(e)(5). Even though the NO_x reductions for the ozone strategy will have significant PM_{2.5} benefits, only specific measures adopted at the time of the 2016 AQMP submittal can be credited towards the PM_{2.5} attainment demonstration. This PM White Paper will address these issues as well as the science behind PM_{2.5} formation, followed by potential PM_{2.5} control approaches including seasonal, episodic or geographically-focused controls.

1. Introduction

The Basin has experienced remarkable improvement in air quality since the 1970's as a direct result of a comprehensive, multi-year strategy of reducing air pollution from all sources. Yet the Basin is still not in attainment of current federal and state air quality standards and, in fact, is still the worst in the nation for ozone. Currently, the Basin is not attaining federal ozone standards or the federal annual and 24-hour fine particulate matter (PM_{2.5}) standards.

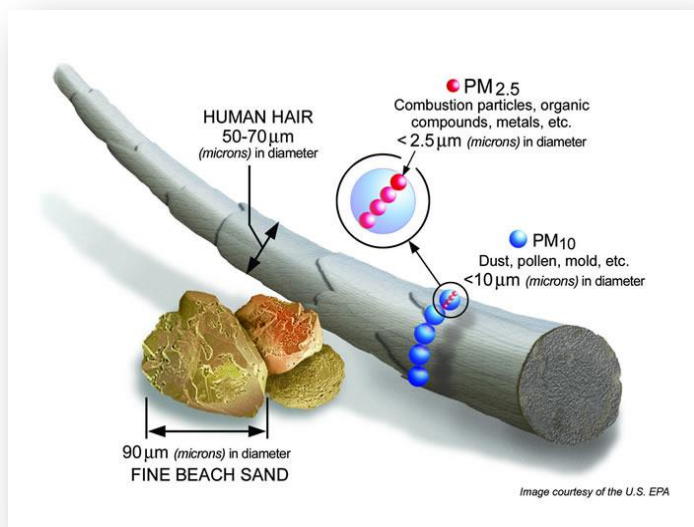
While the 2012 AQMP was designed to bring the Basin into attainment with the 24-hour PM_{2.5} standard by 2015, with additional measures to address the 1997 8-hour ozone standard by 2023, the primary focus of the 2016 AQMP will be to demonstrate attainment of the 2008 ozone standard by 2032 and the annual PM_{2.5} standard by the 2021-2025 timeframe. Attaining the federal ozone standard will have the added benefit of emission reductions that will further improve PM_{2.5} levels.

The purpose of this 2016 AQMP PM White Paper is to provide background technical information and present the policy challenges associated with attaining PM air quality standards. The focus will be primarily on the newly adopted federal annual PM_{2.5} standard of 12 µg/m³, but some emission control measures that can be implemented sooner will help to ensure attainment of the 24-hour PM_{2.5} standard of 35 µg/m³. This PM White Paper will describe the scientific basis of PM_{2.5} formation including the major sources of direct PM_{2.5} and PM_{2.5} precursor gases. The PM reduction co-benefits from ozone control programs and climate change strategies will also be described. Finally, potential strategies for further PM_{2.5} control will be considered.

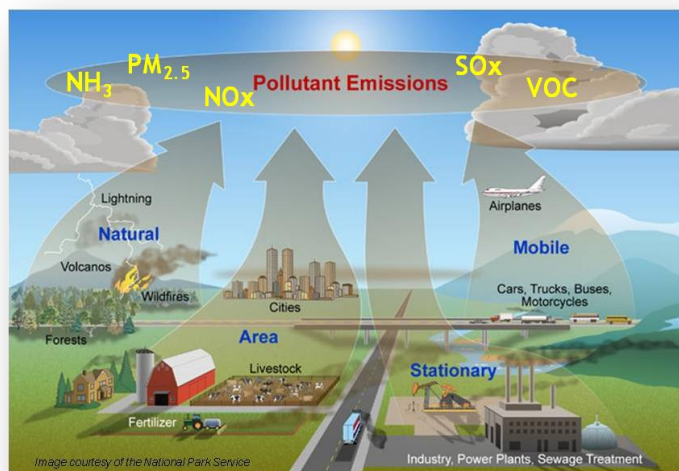
2. Background

PM_{2.5} and Precursors

Particulate matter (PM), also known as particle pollution, is a complex mixture of microscopic solid and liquid particles suspended in air. Particles of concern are classified into two categories: Inhalable coarse particles (PM_{10-2.5}) and fine particles (PM_{2.5}). Inhalable coarse particles are generally created by mechanical or natural processes, such as grinding, sanding, sea spray, windblown dust, and soil. Coarse particles have sizes larger than 2.5 micrometers (μm) and smaller than 10 μm in diameter. Fine particles, such as those found in smoke and haze, are 2.5 μm in diameter or smaller, and are generally



formed by combustion processes or by chemical reactions that occur in the atmosphere. PM_{2.5} is of primary concern because it, once inhaled, can travel deeply into the respiratory tract, reaching the lungs. Scientific studies have linked increases in daily PM_{2.5} exposure with increased respiratory and cardiovascular hospital admissions, emergency department visits, and even deaths. Studies also suggest that long-term exposure to PM_{2.5} may be associated with increased rates of chronic bronchitis, reduced lung function and increased mortality from lung cancer and heart disease. People with breathing and heart problems, children, and the elderly may be particularly sensitive to PM_{2.5}. Recently, an additional particle category known as ultrafine particles (often defined as particles less than 0.1 μm) has been studied and found to have distinct chemical and toxicological properties. However, given that there are no ambient standards for ultrafine particles, and that the purpose of this white paper is to address fine particle standards, issues related to ultrafine and coarse particles are beyond the scope of this discussion.

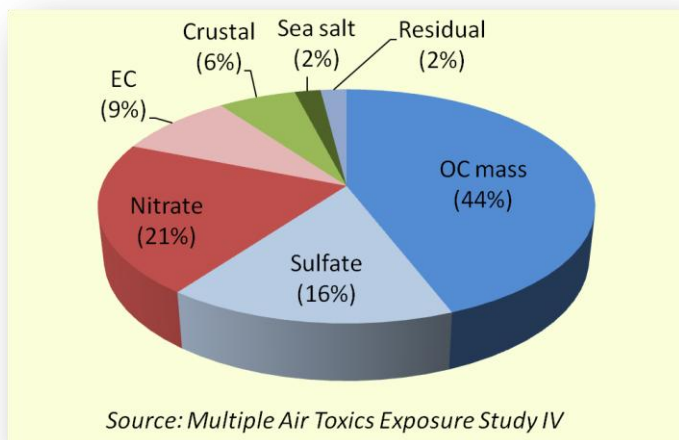


PM in the atmosphere can be categorized as either primary or secondary particles. Primary particles are directly emitted PM from sources, such as construction sites, unpaved roads, sea salt, abrasion, fuel combustion, cooking, or fires. Secondary particles are formed in complex chemical reactions that occur in the atmosphere, often aided by sunlight (known as photochemical reactions). In these reactions, precursor gases, such as volatile organic compounds (VOCs), sulfur oxides (SO_x),

ammonia (NH₃), and nitrogen oxides (NO_x), are transformed into solid or liquid products that contribute to ambient PM levels. NO_x and SO_x will combine with ammonia to form ammonium sulfate or ammonium nitrate salts, which are generally solids at ambient temperatures and can dissolve into water-containing particles. VOCs react with atmospheric oxidants, producing products with lower volatility that condense and form secondary organic aerosol (SOA), another component of PM. Many combustion processes emit both primary PM and precursor gases that ultimately form PM in the atmosphere. For example, in processes such as motor-vehicle gasoline combustion¹ and wood burning², SOA produced by oxidation of the emitted VOCs can exceed the amount of emitted primary organic PM_{2.5}.

“A large portion of PM_{2.5} in the Basin is formed from precursor gases of anthropogenic origin.”

Secondary particles make up the majority of ambient PM_{2.5} in the Basin. Basin-wide average ambient PM_{2.5} speciation profiles³ measured during the recent Multiple Air Toxics Exposure Study (MATES) IV show that the Basin’s PM_{2.5} mass was comprised of four major chemical components: organic carbon (OC), ammonium nitrate, ammonium sulfates, and elemental carbon (EC) with smaller fractions of crustal particles, sea salt, and other trace elements. Elemental carbon (EC), which is similar to the short-lived climate forcing species



¹ Gordon, T.D., et al. Secondary Organic Aerosol Formation Exceeds Primary Particulate Matter Emissions for Light-Duty Gasoline Vehicles, *Atmos. Chem. Phys.* 2014, 14, 4661-4678.

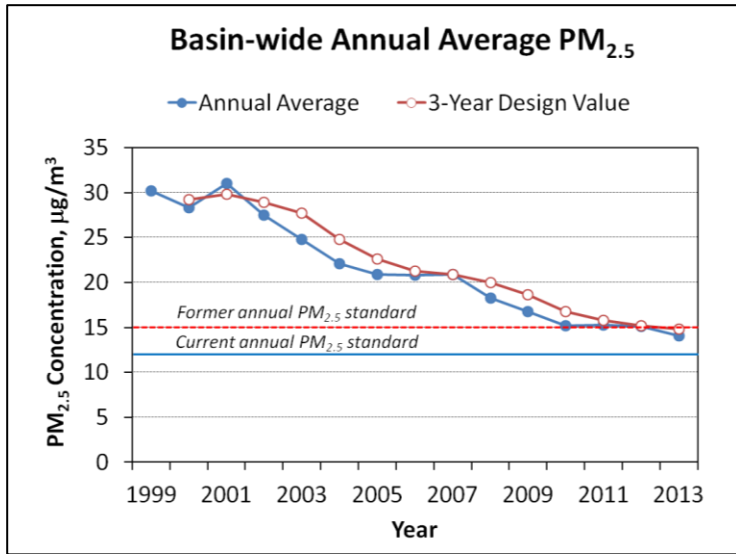
² Hennigan, C.J., et al. Chemical and physical transformations of organic aerosol from the photo-oxidation of open biomass burning emissions in an environmental chamber, *Atmos. Chem. Phys.* 2011, 11, 7669-7686.

³ SCAQMD, Draft Multiple Air Toxics Exposure Study IV, October 3, 2014.

Black Carbon (BC), is an important component of directly emitted PM_{2.5} from internal combustion engines, especially diesel engines. The OC mass portion includes both primary and secondary particle material.

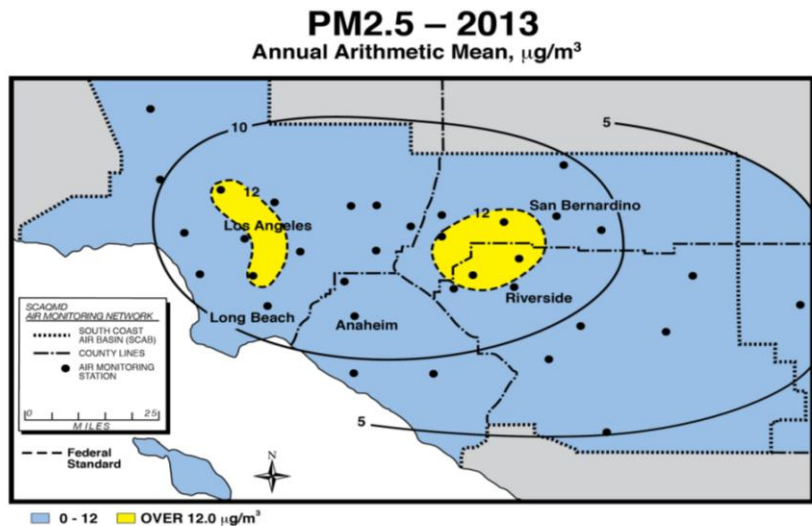
Trends in PM_{2.5} Levels

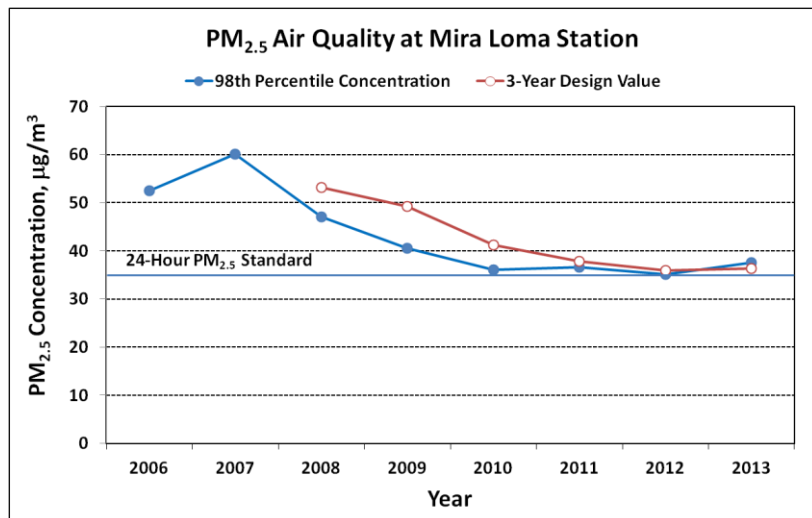
The levels of PM_{2.5} in the Basin have been continually improving since measurements and standards were initiated in the late 1990s. These improvements occurred over a period of significant growth in the Basin’s population, vehicle miles traveled (VMT) and economic activity, and are directly attributable to the region’s air quality control program.



Based on measurement data through 2013, no air monitoring station in the Basin violated the previous 1997 federal annual PM_{2.5} standard (15 µg/m³ for three years), and in December of 2014, U.S. Environmental Protection Agency (U.S. EPA) proposed a clean data determination finding that the Basin has met the 1997 PM_{2.5} standards. This is based on the form of the federal standard, known as the *design value*, which is the 3-year average of the annual PM_{2.5} average, calculated by station.

However, exceedances still occur above the new 2012 annual PM_{2.5} standard of 12 µg/m³ in the San Bernardino and Riverside County metropolitan areas, with the highest levels in Mira Loma. Los Angeles County also exceeded the new PM_{2.5} standard in the Central Los Angeles and East San Fernando Valley areas in 2013. This new standard requires additional reductions of direct PM_{2.5} and PM_{2.5} precursor gases in order to meet the annual PM_{2.5} standard by the 2021-2025 statutory timeframe.



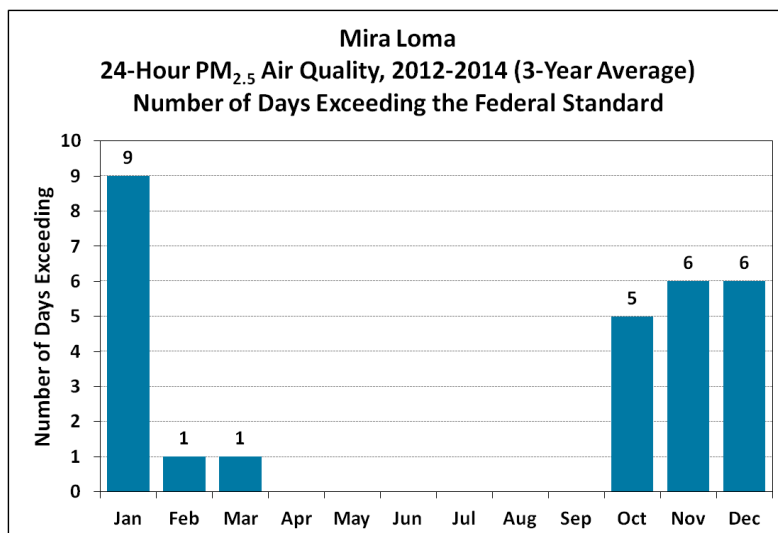


Despite significant progress, the Basin remains in nonattainment for the current 24-hour PM_{2.5} federal standard of 35 µg/m³. As of 2013, the 24-hour PM_{2.5} *design value* (in this case, the 3-year average of annual 98th percentile of the monitored 24-hour concentrations by station), exceeds the federal 24-hour PM_{2.5} standard at only one air monitoring station in Mira Loma in northwestern Riverside County. The 2012 AQMP projected attainment of the 24-

hour PM_{2.5} standard by the end of 2014. However, preliminary monitoring data through June of 2014 indicates that attainment of this standard is not likely to be achieved, largely because of the unanticipated air quality impacts of the severe drought conditions in California. The lack of winter storms and associated rainfall leads to dryer and thus more emissive ground surfaces as well as reduced cleansing and dilution of atmospheric particles. The drought has not only affected PM_{2.5} levels in Southern California; many areas across the state have experienced this reversal in long-term downward trends of PM_{2.5} levels.

In addition, a recent court decision has compelled U.S. EPA to implement PM_{2.5} standards according to the federal CAA, Title 1, Part D, Subpart 4 (hereafter “Subpart 4”) planning requirements specific to PM₁₀, rather than the general pollutant planning requirements (Subpart 1). Subpart 4 provides for attainment by 2015, with potential extensions. In February 2015, the South Coast Air Quality Management District (SCAQMD) Governing Board approved a Supplement to the 2012 AQMP 24-hour PM_{2.5} SIP for the Basin to comply with Subpart 4 and target attainment in 2015. The Governing Board also directed SCAQMD staff to bring forward early action measures for PM_{2.5} to ensure progress towards attainment under continuing drought conditions. The Supplement was subsequently approved by California Air Resources Board (CARB) and has been submitted to U.S. EPA for consideration.

While ozone concentrations peak in the summer months, PM levels can be high at anytime of the year, but are typically higher in winter months. These higher winter values are specifically influenced by wintertime temperature inversions and stagnant conditions that reduce atmospheric dilution and trap emissions near ground level.



Furthermore, sources such as wood burning have increased emissions during colder weather. Consistent with U.S. EPA guidance, seasonal, episodic, or geographical controls that focus on bringing the Mira Loma station into compliance can continue to be considered as a method to bring the Basin into attainment.

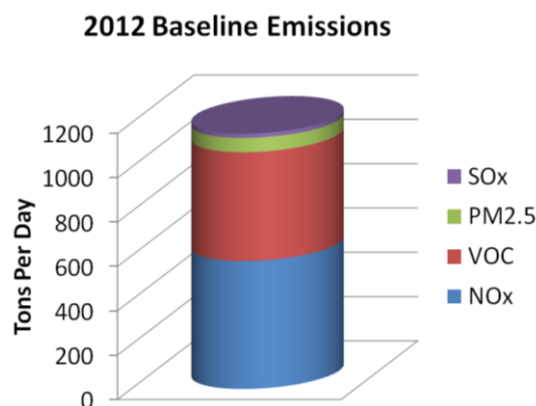
3. Assessing Future Control Strategies

Emission Sources of PM_{2.5}

As mentioned above, most PM_{2.5} in the Basin is formed in the atmosphere, and thus a full picture of the sources of PM_{2.5} must also consider precursor gases. Based on the emissions inventory for 2012, there were 578 tons of NO_x emissions per day, 491 tons of VOC emissions, 65 tons of directly emitted PM_{2.5} emissions, and 19 tons of SO_x emissions. The Top 10 emission sources of direct PM_{2.5} and its precursor gases are contained in Appendix A.

“Trucks are the No. 1 source of NO_x emissions that form both ground-level ozone and PM_{2.5} in the atmosphere.”

On-road and off-road vehicles emit more than 80% of the total NO_x emissions combined. Consumer products solvent evaporation was the single largest contributor to VOC emissions. Mobile (on- and off-road) sources collectively emit more than half of the total VOC emissions. Transportation sources, such as ships, commercial boats, and aircraft, account for more than one-third of the total SO_x emissions. RECLAIM SO_x sources emit another one-third of the SO_x emissions, and service and commercial processes and passenger cars are next largest contributing source categories.



Commercial cooking is the largest emission source of directly emitted PM_{2.5}, followed by residential fuel combustion and paved road dust. These top sources are largely uncontrolled sources of directly emitted PM_{2.5}. The content of particles emitted from commercial cooking, the majority of which comes from under-fired charbroiling of meat, are almost all organic carbon⁴, and studies have shown that commercial meat-cooking contributes more than 20% of the PM_{2.5} organic carbon fraction in Los Angeles air.⁵ Residential fuel combustion is the second largest emission source of directly emitted PM_{2.5}, mostly in the form of wood stove and fireplace wood burning.

⁴ McDonald, J.D. et al. Emissions from charbroiling and grilling of chicken and beef. JAWMA, 2003, 53, 185-194.

⁵ Norbeck, J. *Standardized Test Kitchen and Screening Tools Evaluation for South Coast Air Quality Management District Proposed Rule 1138*; Prepared under Contract No. S-C95073 for the South Coast Air Quality Management District, El Monte, CA, by CE-CERT: University of California, Riverside, CA, 1997.

Control Effectiveness

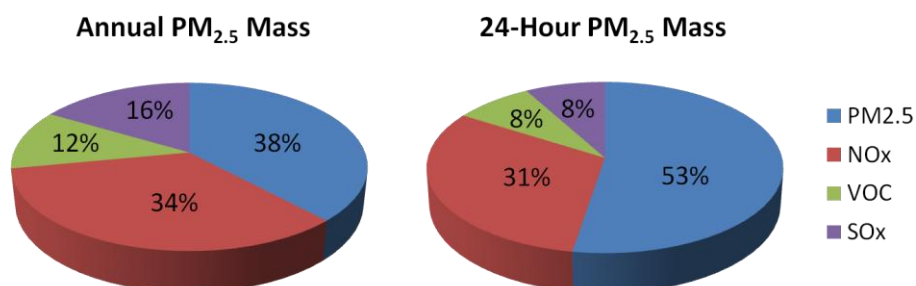
In the SCAQMD’s 2012 AQMP, a detailed computer air quality model (CMAQ v4.7.1) was used to estimate the regional reductions of ambient PM_{2.5} concentrations that result from reductions in PM precursor emissions. On a ton-per-ton basis, primary PM_{2.5} and SO_x emissions controls were found to be the most effective in reducing PM_{2.5} mass concentrations, compared to NO_x emissions controls. VOC emissions reductions had the lowest effect on reducing annual PM_{2.5} mass concentration. As shown, this comparative effectiveness of emissions reductions is different for the 24-hour PM_{2.5} standard, and may also change with season and location in the Basin.

Comparative Effectiveness of Reductions To Achieve Federal PM _{2.5} Air Quality Standards				
	NO _x	SO _x	VOCs	PM _{2.5}
Annual PM _{2.5} Standard	1	15	0.4	10
24-hour PM _{2.5} Standard	1	8	0.3	15

However, the CMAQ model, while state-of-the-art, has been shown to significantly underestimate SOA formation from VOCs⁶. Future versions of CMAQ will strive to eliminate this under prediction as additional SOA formation processes are better understood and incorporated in the model.

Using 2012 emissions inventories weighted by the relative effectiveness factors, contributions of precursor emissions to achieving both annual and 24-hour PM_{2.5} standards were estimated. For example, while SO_x has a higher relative effectiveness factor than NO_x, total emissions of NO_x are much greater than those of SO_x. Therefore, as shown in the charts below, NO_x and PM_{2.5} contribute more to PM_{2.5} levels than SO_x or VOC. As shown, controls of NO_x emissions will make a significant contribution to reducing annual PM_{2.5} mass concentrations, and thus meeting the federal annual PM_{2.5} standard.

Weighted Contributions of Precursor Emissions (2012)



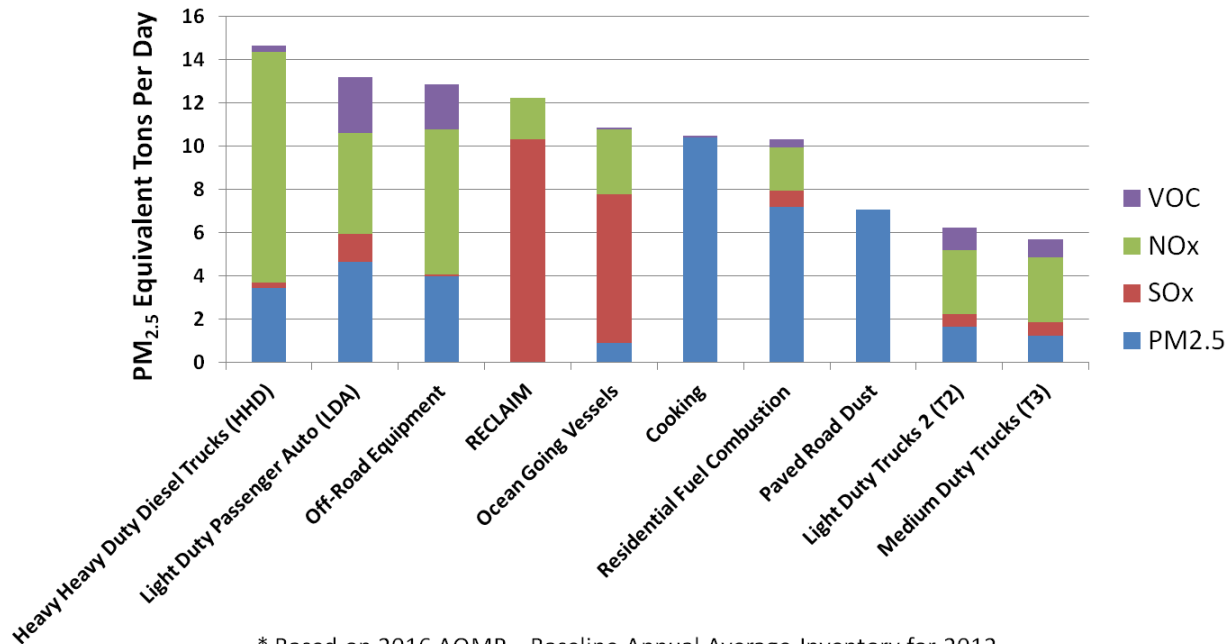
Attaining the ozone standards requires significant reductions in emissions of NO_x well above and beyond those resulting from current rules, programs, and commercially available

⁶ Carlton, A.G., et al. Model Representation of Secondary Organic Aerosol in CMAQ v4.7, *Environ. Sci. Technol.* 2010, 44, 8553-8560

technologies. Most of these additional reductions now rely on the development of new control techniques or improvement of existing control technologies, also known as “black box” measures, as authorized under Section 182(e)(5) of the federal CAA. These “black box” measures, if implemented successfully, will not only allow attainment of the ozone standards, but will also provide significant help in reaching PM_{2.5} standards. In fact, if NO_x emissions reductions designed to meet the former ozone standard in 2023 are achieved, PM_{2.5} levels in the Basin are projected to be very near, if not meeting, the current 2012 federal annual PM_{2.5} standard of 12 µg/m³ by that time. However, attainment of the PM_{2.5} standard may not rely on Section 182(e)(5) measures.

More detailed analysis of the emissions categories contributing to ambient PM_{2.5} mass, using the weighting factors for precursors described above, shows what emission sources could be prioritized for a focused and cost-effective PM control program. Area sources, such as commercial cooking, residential fuel combustion, and paved road dust are major contributors to ambient PM_{2.5}, primarily through direct PM_{2.5} emissions. Mobile sources, both on-road and off-road, are also significant sources of PM_{2.5}, both through direct PM_{2.5} emissions but also precursors such as NO_x.

Emissions Categories Contributing to Annual PM_{2.5} Mass



* Based on 2016 AQMP – Baseline Annual Average Inventory for 2012

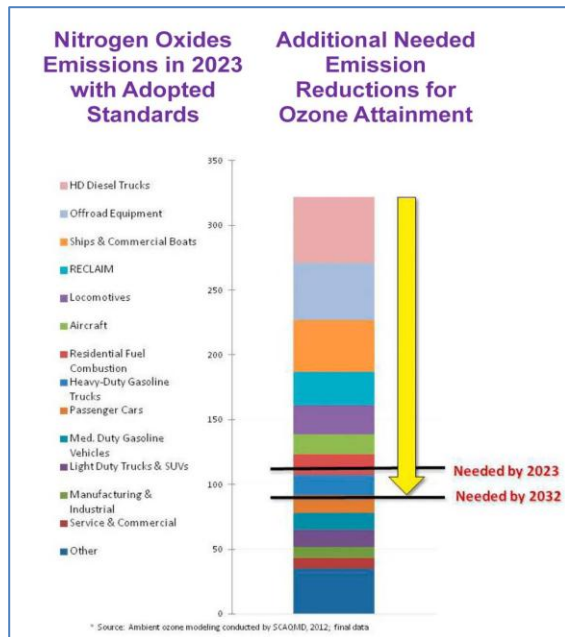
4. Recommendations - Path to PM_{2.5} Attainment in the 2016 AQMP

Control Strategy

Through the 2007 and 2012 AQMPs, it was demonstrated that the previous control strategies employed for the PM₁₀ and 1-hour ozone SIPs also benefited PM_{2.5} and 8-hour ozone reductions. Taking the same multi-pollutant approach to assess strategies for the 2016 AQMP suggests that a heavy NO_x strategy is the most efficient approach for the reduction of fine particulate matter because NO_x reductions are needed anyway for the 1-hour and 1997 8-hour ozone standards with approximately the same timeframe for the federal annual PM_{2.5} attainment demonstration. The PM_{2.5} strategy can be further augmented with targeted and cost-effective directly emitted PM_{2.5} and SO_x controls when needed if NO_x controls from other control programs are insufficient, not timely, or do not materialize.

Based on the above discussion, several attainment paths can be developed with varying degree of controls among directly emitted PM_{2.5} and PM precursors. Selecting the most efficient path for PM_{2.5} attainment takes into consideration many factors, such as the amount of total reductions needed, technology readiness, attainment deadlines, and the inter-relationship with other NAAQS pollutants such that the control strategy does not need to make drastic mid-term adjustments, thus minimizing potential control costs. The following sections describe the staff recommendations for a prioritized approach in the development of a PM_{2.5} attainment strategy.

1) Co-Benefits from the Ozone NO_x Strategy



Many of the most significant direct PM_{2.5} and PM_{2.5} precursor emission sources are already well controlled, but additional reductions from implementation of adopted control measures from the 2007 and 2012 AQMPs may still not be adequate for attainment of the new federal annual PM_{2.5} standard. PM_{2.5} levels will be further reduced from the additional NO_x emissions reductions needed for the ozone control strategy. The 2012 AQMP specifies approximately another 200 tons per day of NO_x reductions needed to meet the 1-hour and 1997 8-hour ozone standards by 2023 and 2024, respectively. This is within the timeframe of 2012 annual PM_{2.5} standard attainment deadline of 2021-2025. Preliminary projections suggest that without any additional PM controls, but with the ozone NO_x strategy alone, the Basin's annual PM_{2.5} design value would be the very near the standard of 12 µg/m³ in 2023.

Given the goal of developing the most efficient and cost-effective path to meeting all clean air standards, and given that these NO_x reductions are needed for ozone attainment anyway, the most desirable path is to control NO_x emissions, not only from stationary and area sources, but

more so from mobile sources that fall under state and federal jurisdiction. Significant reductions are needed from on-road vehicles, off-road engines, ships, and locomotives to achieve the necessary NO_x reductions to meet the federal ozone standards. The 2016 AQMP will capture the anticipated NO_x reductions from the ozone plan, as well as anticipated concurrent reductions of VOCs, SO_x, and directly emitted PM_{2.5} from zero tailpipe emission technologies or efficiency measures that reduce vehicle trips/vehicle miles traveled.

2) Co-Benefits from Climate Change or Air Toxic Control Programs

SCAQMD staff recognizes, to the extent available under the U.S. EPA's PM_{2.5} implementation rule, that there are several near-term measures that are being pursued by CARB under the AB 32 Scoping Plan, such as reductions in short-lived climate forcers such as BC. Comprised of microscopic particles emitted from incomplete combustion of biomass, wood, and fossil fuels, BC is a major contributor to global climate change and also a primary component of diesel particulate matter (DPM). Cutting BC emissions would immediately result in reduction of the rate of warming, as well as PM_{2.5} benefits. Identifying the most promising control measures or mitigation options to address BC emissions reductions in the areas of stationary and mobile sources, residential wood combustion, and open biomass burning will provide climate change as well as PM_{2.5} benefits in the near term.

Air toxic control programs reducing DPM or toxic metals would also contribute to PM_{2.5} reductions. Despite significant decreases in air toxics exposure over the past couple of decades, the recent SCAQMD MATES IV results continue to show unacceptably high risk of exposure to DPM, representing two-thirds of the overall air toxic cancer risk. This result emphasizes that continuous efforts towards reducing DPM emissions are needed at local, state, and federal levels and via cooperation with the ports, airports, and other stakeholders. Alternative fueled vehicles with significant zero emission miles traveled, along with coordinated land use and transportation planning with the goal of reducing VMT, will contribute to reduction of DPM, GHG, as well as NO_x emissions. Toxic metals emitted from industrial processes can cause risks to public health and the environment. SCAQMD will continue to develop new rules or amend existing rules by strengthening requirements to reduce toxic metal emissions and exposure from various metal industry sources. These measures, although not developed for SIP purposes, will achieve concurrent reductions in directly emitted PM_{2.5} and should be quantified and credited toward needed SIP reductions.

3) Outreach and Incentive Programs

Other programs supporting PM control measure implementation are also important to ensure expected emission reductions are being realized. These programs include outreach and incentive programs. SCAQMD staff utilizes a variety of tools to raise public awareness and understanding of the significance and health effects of particle pollution and thus, the importance of PM controls to protect public health. Enhanced public outreach should continue to be pursued by various means, including targeted and focused communications campaigns, community workshops, educational brochures and videos, and other digital media formats.

Incentive funding for stationary sources can be pursued and best applied where controls are cost-effective, but not necessarily affordable by the affected sources, especially when controls are

considered for smaller businesses. Such incentive funds can be used to subsidize low-emitting equipment purchases either by businesses or the public. Funding for such incentive programs can originate from state and federal grants, penalties collected from industry, and other sources.

4) Additional Measures for PM_{2.5} Attainment

Since the federal CAA does not allow for reliance on future technologies (i.e., “black box,” Section 182(e)(5) measures) in the PM_{2.5} attainment plan, portions of NO_x controls that are part of the ozone attainment strategy may be not eligible for inclusion as SIP measures for PM_{2.5} purposes. For this reason, additional measures to ensure attainment will need to be evaluated and implemented where needed. Suggested control concepts based on the Reasonably Available Control Technology (RACT) or Reasonably Available Control Measure (RACM) analysis for PM_{2.5} and its precursors as part of the 2016 AQMP will be evaluated for their feasibility and applicability for this air basin. Any additional measures needed to meet the RACT/RACM requirements will be further developed for inclusion in the 2016 AQMP.

Based on the PM_{2.5} formation potentials described above, if additional reductions are still needed for timely PM_{2.5} attainment demonstration, additional SO_x and/or direct PM_{2.5} measures should be first priority. Examples of such measures can be found in Appendix B.

In developing the PM_{2.5} strategy, geographic, seasonal, and episodic controls should also be considered as they minimize compliance costs while targeting emissions reductions when and where they are needed. Examples of these measures are contained in Appendix C. Such targeted measures will have even greater benefits for avoiding exceedances of the 24-hour PM_{2.5} standard given that the exceedances are episodic and occur almost exclusively in the colder months. As attainment deadlines for the 24-hour standard are imminent, PM_{2.5} measures arising from the 2016 AQMP development process that can help to ensure timely attainment of the 24-hour PM_{2.5} standard should be developed and adopted as early action measures, parallel to the 2016 AQMP development.

Continuing Research and Scientific Studies

Continuing research and scientific studies are needed to better quantify organic compounds and their contribution to PM_{2.5} formation. In the Basin, approximately 30-50% of the PM_{2.5} mass is composed of organic compounds. However, the organic component of PM_{2.5} in the Basin needs further study as certain semi-volatile organic compounds (SVOC) have not been historically inventoried, controlled or incorporated in regional air quality modeling. Continuing research and scientific studies are required to better quantify SVOC emissions and their contribution to PM_{2.5} formation.

The role of ammonia emissions will also be examined further in the 2016 AQMP modeling analysis. Some areas within the Basin may be saturated with ammonia now or in the future relative to SO_x and NO_x, and thus modest ammonia controls may have little effect. Other areas may show that ammonia controls are effective in reducing ambient PM_{2.5}. Even if large ammonia reductions may have benefits, it may not be feasible given the nature of the sources.

Summary

The 2016 AQMP modeling analysis and attainment demonstration analysis will provide refinement to the analysis described above, but it is clear that an integrated approach to multiple air quality challenges will minimize control costs while achieving multiple goals. It is clear that a NO_x-heavy control strategy will not only provide for attainment of the ozone standards, but also provide significant co-benefits for the reduction of fine particulate matter. Concurrent targeted, strategic, and timely reductions in directly emitted PM_{2.5} and precursors can ensure meeting the federal annual and 24-hour PM_{2.5} standards by the attainment deadlines.