BY ELECTRONIC MAIL

23 November 2015

Greg Nudd
Eric Stevenson
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA  94109

COMMUNITIES FOR A BETTER ENVIRONMENT

Re: **Supplemental Comment on Air District Staff Proposal, Rules 12-15 and 12-16; Evidence of Localized Bay Area Refinery GHG and $PM_{2.5}$ Emission Impact**

Dear Mssrs. Nudd and Stevenson,

Data the Air District reports elsewhere document a substantial long-term increase in Bay Area refinery emissions of GHG and $PM_{2.5}$ that co-emit from refinery fuel combustion. EIA data show that refined fuels demand cannot explain the reported emissions increase. Peer reviewed science shows that refining lower quality oil contributed to this emissions increase and could further increase emissions from Bay Area refineries if their current, declining, crude oil supply is replaced with bitumen-derived 'tar sands' oil.

Forecasts the Air District reports elsewhere show that Bay Area refinery GHG and $PM_{2.5}$ emissions could further increase. The peer reviewed science shows that Bay Area refinery emissions could greatly exceed even these forecasts if the refiners replace their declining current oil supply with bitumen-derived tar sands oil. In fact, industry reports document plans to replace Bay Area (and California) refiners' declining current oil supplies with that tar sands oil—if the resultant emissions increase is allowed.

Moreover, those industry-reported plans include a major expansion of Bay Area oil train traffic that—since Bay Area refineries cannot process very large amounts of light shale oils efficiently—could be allowed here ***if*** the emissions increase from refining the large amounts of tar sands oil these trains would deliver is allowed.

The foregoing is summarized from CBE's 21 October 2015 comments 1–10.

CBE believes that the Air District Staff has improperly rejected enforceable limits set to current actual emission rates in part because the Staff has not considered adequately, and has not informed the public and its Board about, the data and information summarized above, and the following data and information:

## 11. Bay Area oil refineries contribute to serious PM air pollution impacts.

Analysis the Air District reports elsewhere estimates that air pollution kills ≈ 2,000 to 3,000 Bay Area residents each year, $PM_{2.5}$ causes the "vast majority" of these premature deaths, and health impacts from air pollution cost the region's economy "multiple billions of dollars" each year. (Attachment 4 to CBE's 21 Oct. Comment at pp. 26–27.)

A table from the Air District web site indicating that the region does not attain State ambient air quality standards for $PM_{2.5}$, $PM_{10}$ and ozone, and also remains designated as in "nonattainment" of national ambient air quality standards (NAAQS) for $PM_{2.5}$ and ozone, is appended hereto as Attachment 36.[36] A World Health Organization (WHO) summary of its health-based ambient air PM criteria is appended as Attachment 37.[37] Attachments 36 and 37 show that WHO's health-based ambient air criteria for $PM_{2.5}$ (10 $\mu g/m^3$ annual mean; 25 $\mu g/m^3$ 24-hour mean) are more protective than the NAAQS (12 $\mu g/m^3$ annual mean; 35 $\mu g/m^3$ 24-hour mean).

California Air Resources Board (ARB) data for 24-hour $PM_{2.5}$ air concentrations that exceeded NAAQS and WHO criteria during May 2012–April 2015 at the five nearest $PM_{2.5}$ NAAQS monitors to Bay Area refineries are appended hereto as Attachment 38.[38] The table below summarizes these data. $PM_{2.5}$ exceeded one or both health criteria a total of 156 times at these five monitoring stations collectively on 66 days in this period. $PM_{2.5}$ exceeded the WHO health criterion more frequently than once each 17 days, on average over these three years. On most of these days (40 of 66), criteria were exceeded at multiple locations, and the vast majority of these days (61 of 66), were in winter. These observations are consistent with the accumulation of local emissions in nearby air that the Air District reports elsewhere. Atmospheric conditions that Air District Staff describe in Attachment 4 as "stagnation," which occur most frequently in the Bay Area in winter, trap air pollution close to emission sources, thereby increasing the effect of strong local emission sources that elevates $PM_{2.5}$ air concentrations near these sources.

This evidence demonstrates that the refinery emissions documented in CBE's 21 October 2015 comments 1–10 contribute to a serious air pollution and health problem.

**Ambient air $PM_{2.5}$ concentrations that exceeded the 25 $\mu g/m^3$ World Health Organization (WHO) and 35 $\mu g/m^3$ National Ambient Air Quality Standard (NAAQS) criteria for 24–hour exposures at NAAQS $PM_{2.5}$ monitors nearest to Bay Area refineries, May 2012–Apr 2015.[a]**

| | | 24-hour average $PM_{2.5}$ ambient air data | |
|---|---|---|---|
| Date | NAAQS Monitoring Station | ($\mu g/m^3$) | (health criteria exceeded) |
| 16 November 2012 | Concord–Treat Blvd. | 32.2 | WHO |
| 16 November 2012 | San Rafael | 25.9 | WHO |
| 5 January 2013 | Concord–Treat Blvd. | 27.6 | WHO |
| 5 January 2013 | San Rafael | 28.5 | WHO |
| 5 January 2013 | Vallejo–Tuolumne St. | 28.6 | WHO |
| 15 January 2013 | Vallejo–Tuolumne St. | 26.7 | WHO |
| 16 January 2013 | Oakland–West | 33.2 | WHO |
| 16 January 2013 | San Rafael | 26.3 | WHO |
| 16 January 2013 | Vallejo–Tuolumne St. | 32.8 | WHO |
| 17 January 2013 | Oakland–West | 29.8 | WHO |
| 17 January 2013 | San Rafael | 25.5 | WHO |
| 17 January 2013 | Vallejo–Tuolumne St. | 25.2 | WHO |
| 22 January 2013 | Oakland–West | 28.1 | WHO |
| 22 January 2013 | San Rafael | 26.5 | WHO |
| 23 January 2013 | Concord–Treat Blvd. | 36.2 | WHO and NAAQS |
| 23 January 2013 | Oakland–West | 37.4 | WHO and NAAQS |
| 23 January 2013 | San Pablo–Rumrill Blvd. | 38.7 | WHO and NAAQS |
| 23 January 2013 | San Rafael | 31.5 | WHO |
| 1 February 2013 | Oakland–West | 28.5 | WHO |
| 1 May 2013 | Oakland–West | 27.3 | WHO |
| 1 June 2013 | Oakland–West | 25.1 | WHO |
| 4 July 2013 | Oakland–West | 29.2 | WHO |
| 29 July 2013 | Oakland–West | 29.0 | WHO |
| 30 July 2013 | Oakland–West | 25.9 | WHO |
| 30 July 2013 | San Pablo–Rumrill Blvd. | 31.1 | WHO |
| 30 July 2013 | San Rafael | 26.1 | WHO |
| 30 July 2013 | Vallejo–Tuolumne St. | 26.0 | WHO |
| 24 November 2013 | Vallejo–Tuolumne St. | 31.7 | WHO |
| 25 November 2013 | Oakland–West | 25.7 | WHO |
| 25 November 2013 | San Pablo–Rumrill Blvd. | 25.2 | WHO |
| 25 November 2013 | Vallejo–Tuolumne St. | 29.9 | WHO |
| 27 November 2013 | Oakland–West | 29.1 | WHO |
| 27 November 2013 | San Pablo–Rumrill Blvd. | 25.8 | WHO |
| 5 December 2013 | Vallejo–Tuolumne St. | 26.2 | WHO |
| 12 December 2013 | Oakland–West | 25.7 | WHO |
| 12 December 2013 | San Pablo–Rumrill Blvd. | 25.7 | WHO |
| 13 December 2013 | Oakland–West | 26.9 | WHO |
| 13 December 2013 | Vallejo–Tuolumne St. | 25.2 | WHO |
| 14 December 2013 | Vallejo–Tuolumne St. | 38.0 | WHO and NAAQS |
| 15 December 2013 | Oakland–West | 31.8 | WHO |
| 15 December 2013 | San Pablo–Rumrill Blvd. | 29.8 | WHO |
| 15 December 2013 | San Rafael | 26.5 | WHO |
| 15 December 2013 | Vallejo–Tuolumne St. | 33.7 | WHO |

**Ambient air $PM_{2.5}$ concentrations that exceeded the 25 $\mu g/m^3$ World Health Organization (WHO) and 35 $\mu g/m^3$ National Ambient Air Quality Standard (NAAQS) criteria for 24–hour exposures at NAAQS $PM_{2.5}$ monitors nearest to Bay Area refineries, May 2012–Apr 2015.[a]**
*Continued.*

| Date | NAAQS Monitoring Station | 24-hour average $PM_{2.5}$ ambient air data ($\mu g/m^3$) | (health criteria exceeded) |
|---|---|---|---|
| 16 December 2013 | Oakland–West | 25.7 | WHO |
| 16 December 2013 | Vallejo–Tuolumne St. | 28.8 | WHO |
| 17 December 2013 | Concord–Treat Blvd. | 29.5 | WHO |
| 17 December 2013 | Oakland–West | 42.7 | WHO and NAAQS |
| 17 December 2013 | San Pablo–Rumrill Blvd. | 41.2 | WHO and NAAQS |
| 17 December 2013 | San Rafael | 44.9 | WHO and NAAQS |
| 17 December 2013 | Vallejo–Tuolumne St. | 38.7 | WHO and NAAQS |
| 22 December 2013 | Oakland–West | 25.1 | WHO |
| 22 December 2013 | Vallejo–Tuolumne St. | 31.9 | WHO |
| 23 December 2013 | Oakland–West | 32.5 | WHO |
| 23 December 2013 | San Pablo–Rumrill Blvd. | 31.0 | WHO |
| 23 December 2013 | San Rafael | 32.6 | WHO |
| 23 December 2013 | Vallejo–Tuolumne St. | 39.3 | WHO and NAAQS |
| 24 December 2013 | Oakland–West | 32.2 | WHO |
| 24 December 2013 | San Rafael | 29.0 | WHO |
| 24 December 2013 | Vallejo–Tuolumne St. | 31.3 | WHO |
| 25 December 2013 | Oakland–West | 30.0 | WHO |
| 25 December 2013 | San Pablo–Rumrill Blvd. | 27.4 | WHO |
| 25 December 2013 | Vallejo–Tuolumne St. | 36.5 | WHO and NAAQS |
| 26 December 2013 | Oakland–West | 26.1 | WHO |
| 27 December 2013 | Oakland–West | 29.6 | WHO |
| 30 December 2013 | Concord–Treat Blvd. | 26.3 | WHO |
| 30 December 2013 | Oakland–West | 26.2 | WHO |
| 30 December 2013 | San Pablo–Rumrill Blvd. | 33.3 | WHO |
| 30 December 2013 | San Rafael | 44.4 | WHO and NAAQS |
| 30 December 2013 | Vallejo–Tuolumne St. | 35.5 | WHO |
| 31 December 2013 | Oakland–West | 26.2 | WHO |
| 31 December 2013 | San Pablo–Rumrill Blvd. | 30.4 | WHO |
| 31 December 2013 | San Rafael | 25.7 | WHO |
| 31 December 2013 | Vallejo–Tuolumne St. | 42.6 | WHO and NAAQS |
| 1 January 2014 | Oakland–West | 38.8 | WHO and NAAQS |
| 1 January 2014 | Vallejo–Tuolumne St. | 39.6 | WHO and NAAQS |
| 2 January 2014 | Oakland–West | 25.7 | WHO |
| 3 January 2014 | Oakland–West | 25.7 | WHO |
| 3 January 2014 | Vallejo–Tuolumne St. | 30.7 | WHO |
| 6 January 2014 | Oakland–West | 25.8 | WHO |
| 6 January 2014 | San Pablo–Rumrill Blvd. | 26.4 | WHO |
| 7 January 2014 | Oakland–West | 25.2 | WHO |
| 17 January 2014 | Oakland–West | 33.8 | WHO |
| 17 January 2014 | San Pablo–Rumrill Blvd. | 29.6 | WHO |
| 17 January 2014 | San Rafael | 30.8 | WHO |
| 17 January 2014 | Vallejo–Tuolumne St. | 31.8 | WHO |

**Ambient air $PM_{2.5}$ concentrations that exceeded the 25 $\mu g/m^3$ World Health Organization (WHO) and 35 $\mu g/m^3$ National Ambient Air Quality Standard (NAAQS) criteria for 24–hour exposures at NAAQS $PM_{2.5}$ monitors nearest to Bay Area refineries, May 2012–Apr 2015.[a]**
*Continued.*

| | | 24-hour average $PM_{2.5}$ ambient air data | |
|---|---|---|---|
| Date | NAAQS Monitoring Station | ($\mu g/m^3$) | (health criteria exceeded) |
| 19 January 2014 | Oakland–West | 27.2 | WHO |
| 19 January 2014 | San Pablo–Rumrill Blvd. | 25.6 | WHO |
| 20 January 2014 | Oakland–West | 25.5 | WHO |
| 24 January 2014 | Concord–Treat Blvd. | 30.6 | WHO |
| 24 January 2014 | Oakland–West | 30.9 | WHO |
| 24 January 2014 | San Pablo–Rumrill Blvd. | 38.2 | WHO and NAAQS |
| 24 January 2014 | San Rafael | 38.1 | WHO and NAAQS |
| 25 January 2014 | Oakland–West | 25.4 | WHO |
| 6 November 2014 | Vallejo–Tuolumne St. | 29.7 | WHO |
| 27 November 2014 | Concord–Treat Blvd. | 25.1 | WHO |
| 27 November 2014 | Oakland–West | 26.1 | WHO |
| 27 November 2014 | San Pablo–Rumrill Blvd. | 28.2 | WHO |
| 27 November 2014 | San Rafael | 26.8 | WHO |
| 27 November 2014 | Vallejo–Tuolumne St. | 30.9 | WHO |
| 9 December 2014 | Vallejo–Tuolumne St. | 29.5 | WHO |
| 28 December 2014 | Vallejo–Tuolumne St. | 26.9 | WHO |
| 2 January 2015 | San Rafael | 26.7 | WHO |
| 2 January 2015 | Vallejo–Tuolumne St. | 30.2 | WHO |
| 3 January 2015 | Concord–Treat Blvd. | 26.1 | WHO |
| 3 January 2015 | Oakland–West | 33.7 | WHO |
| 3 January 2015 | San Pablo–Rumrill Blvd. | 29.6 | WHO |
| 3 January 2015 | San Rafael | 30.2 | WHO |
| 3 January 2015 | Vallejo–Tuolumne St. | 38.0 | WHO and NAAQS |
| 4 January 2015 | Concord–Treat Blvd. | 27.4 | WHO |
| 4 January 2015 | Oakland–West | 34.8 | WHO |
| 4 January 2015 | San Pablo–Rumrill Blvd. | 32.1 | WHO |
| 4 January 2015 | San Rafael | 31.3 | WHO |
| 4 January 2015 | Vallejo–Tuolumne St. | 32.5 | WHO |
| 5 January 2015 | Oakland–West | 25.8 | WHO |
| 5 January 2015 | San Pablo–Rumrill Blvd. | 26.4 | WHO |
| 5 January 2015 | Vallejo–Tuolumne St. | 28.6 | WHO |
| 6 January 2015 | Oakland–West | 36.1 | WHO and NAAQS |
| 6 January 2015 | San Pablo–Rumrill Blvd. | 26.5 | WHO |
| 6 January 2015 | San Rafael | 27.7 | WHO |
| 6 January 2015 | Vallejo–Tuolumne St. | 28.9 | WHO |
| 7 January 2015 | Oakland–West | 25.2 | WHO |
| 8 January 2015 | Concord–Treat Blvd. | 31.0 | WHO |
| 8 January 2015 | Oakland–West | 38.7 | WHO and NAAQS |
| 8 January 2015 | San Pablo–Rumrill Blvd. | 31.8 | WHO |
| 8 January 2015 | San Rafael | 34.8 | WHO |
| 8 January 2015 | Vallejo–Tuolumne St. | 41.4 | WHO and NAAQS |
| 9 January 2015 | Oakland–West | 29.9 | WHO |

**Ambient air $PM_{2.5}$ concentrations that exceeded the 25 μg/m$^3$ World Health Organization (WHO) and 35 μg/m$^3$ National Ambient Air Quality Standard (NAAQS) criteria for 24–hour exposures at NAAQS $PM_{2.5}$ monitors nearest to Bay Area refineries, May 2012–Apr 2015.**[a] *Continued.*

| Date | NAAQS Monitoring Station | 24-hour average $PM_{2.5}$ ambient air data (μg/m$^3$) | (health criteria exceeded) |
|---|---|---|---|
| 9 January 2015 | Vallejo–Tuolumne St. | 29.5 | WHO |
| 10 January 2015 | Vallejo–Tuolumne St. | 29.7 | WHO |
| 11 January 2015 | Vallejo–Tuolumne St. | 27.0 | WHO |
| 14 January 2015 | Concord–Treat Blvd. | 28.3 | WHO |
| 14 January 2015 | San Pablo–Rumrill Blvd. | 31.7 | WHO |
| 14 January 2015 | San Rafael | 35.1 | WHO |
| 14 January 2015 | Vallejo–Tuolumne St. | 39.1 | WHO and NAAQS |
| 15 January 2015 | Concord–Treat Blvd. | 29.6 | WHO |
| 15 January 2015 | Oakland–West | 36.1 | WHO and NAAQS |
| 15 January 2015 | San Pablo–Rumrill Blvd. | 33.2 | WHO |
| 15 January 2015 | San Rafael | 36.3 | WHO and NAAQS |
| 15 January 2015 | Vallejo–Tuolumne St. | 31.9 | WHO |
| 16 January 2015 | Concord–Treat Blvd. | 28.1 | WHO |
| 16 January 2015 | Oakland–West | 32.9 | WHO |
| 16 January 2015 | San Pablo–Rumrill Blvd. | 31.6 | WHO |
| 16 January 2015 | San Rafael | 36.0 | WHO and NAAQS |
| 16 January 2015 | Vallejo–Tuolumne St. | 30.7 | WHO |
| 23 January 2015 | Vallejo–Tuolumne St. | 29.4 | WHO |
| 24 January 2015 | San Rafael | 30.5 | WHO |
| 24 January 2015 | Vallejo–Tuolumne St. | 28.2 | WHO |
| 26 January 2015 | Vallejo–Tuolumne St. | 25.1 | WHO |
| 28 January 2015 | Vallejo–Tuolumne St. | 26.1 | WHO |
| 1 February 2015 | Vallejo–Tuolumne St. | 32.6 | WHO |
| 2 February 2015 | Oakland–West | 26.7 | WHO |
| 2 February 2015 | San Rafael | 29.5 | WHO |
| 2 February 2015 | Vallejo–Tuolumne St. | 32.0 | WHO |
| 4 February 2015 | Concord–Treat Blvd. | 25.6 | WHO |
| 4 February 2015 | San Pablo–Rumrill Blvd. | 26.2 | WHO |
| 4 February 2015 | San Rafael | 31.0 | WHO |

[a] Data from California Air Resources Board; www.arb.ca.gov/adam/weekly/weekly2.php; *see* Attachment 38. San Pablo and W. Oakland stations began reporting data on December 12th and 18th, 2012, respectively.

## 12. Bay Area oil refineries cause disparately greater PM emissions locally.

As stated, strong local emission sources elevate $PM_{2.5}$ air concentrations locally, especially during stagnant atmospheric conditions that trap emissions near their sources. A report by former ARB advisors that found oil refineries are 11 of the worst 15 major industrial GHG co-pollutant emitters in California, as ranked by population-weighted PM emission burden at 2.5 miles from the facilities, is appended hereto as Attachment 39.[39]

Areal refinery source strength—emissions per area (e.g., mile$^2$) within a given boundary around the source—was calculated from Air District data for the same range of boundary distances assessed in Attachment 39, and compared with the average for *all* emission sources within the Bay Area as a whole, as detailed in Attachment 40.[40] The table below shows areal source strengths for $PM_{2.5}$ and the $PM_{2.5}$ precursors $NO_x$ and $SO_2$. For example, the Bay Area average $PM_{2.5}$ source strength (3.19 annual t/mile$^2$) is based on 17,885 tons emitted by all sources in the Bay Area divided by its area (5,600 miles$^2$); the refineries source strength at the 0.5 miles boundary (250 t/mile$^2$) is based on 985 tons emitted by refineries divided by 3.93 miles$^2$, their collective 0.5-mile-radius area. These source strengths are averages: air emission plumes vary in direction and concentration.

**Areal refinery emission source strength at 0.5–6 miles, in emissions per square mile and as a percentage of the regional average for all sources in the Bay Area Air District.**[a]

| Pollutant Emission | Bay Area Sources | Areal Boundary | Areal source strength at boundary (avg.): Annual tons/mile$^2$ | % of Bay Area avg. |
|---|---|---|---|---|
| $PM_{2.5}$ | All sources | AQMD jurisdiction | 3.19 | — |
| $PM_{2.5}$ | Oil refineries | 0.5 miles radius | 250 | ≈ 7,800% |
| $PM_{2.5}$ | Oil refineries | 2.5 miles radius | 10.0 | ≈ 310% |
| $PM_{2.5}$ | Oil refineries | 6.0 miles radius | 1.74 | ≈ 54% |
| $NO_x$ | All sources | AQMD jurisdiction | 22.6 | — |
| $NO_x$ | Oil refineries | 0.5 miles radius | 1,080 | ≈ 4,800% |
| $NO_x$ | Oil refineries | 2.5 miles radius | 43.4 | ≈ 190% |
| $NO_x$ | Oil refineries | 6.0 miles radius | 7.54 | ≈ 33% |
| $SO_2$ | All sources | AQMD jurisdiction | 1.89 | — |
| $SO_2$ | Oil refineries | 0.5 miles radius | 1,380 | ≈ 73,000% |
| $SO_2$ | Oil refineries | 2.5 miles radius | 55.3 | ≈ 2,900% |
| $SO_2$ | Oil refineries | 6.0 miles radius | 9.60 | ≈ 510% |

[a] Based on reported emissions and area within boundary: Emissions from BAAQMD inventories; refinery boundary distances after Pastor et al., 2010; jurisdiction area from BAAQMD. *See* Attachment 40 for details.

Review of the table reveals substantial refinery source strength at all distances compared. This is true for $PM_{2.5}$, $NO_x$ and $SO_2$. The areal source strength of Bay Area refineries for these pollutants ranges from ≈ 48–730 *times* the Bay Area average for all sources at 0.5 miles, to ≈ 2–29 *times* this average at 2.5 miles, to 33–510% of the Bay Area average at six miles away from refineries. Note that these values are roughly additive—for example, the 33% value for refineries in the table represents an average total source strength that is ≈ 133% of the Bay Area average. Thus, all the data shown in the table indicate that refineries contribute significantly to locally elevated emissions.

This evidence demonstrates that the refineries cause a disparately severe local $PM_{2.5}$ air pollution emission impact.

**13. Bay Area refinery emissions contribute substantially to disparately greater PM pollution of the ambient air locally.**

A 2012 paper showing that refineries affect the PM trace element chemistry of urban ambient PM 2–8 kilometers downwind is appended hereto as Attachment 41.[41] A 2010 paper showing that metalliferous ultra-fine particulate matter (UFPM) emissions from refineries and other industries can alter atmospheric chemistry over "whole towns and cities" is appended hereto as Attachment 42.[42] A 2012 paper showing that emissions from oil refining and other industries are the main cause of UFPM air pollution episodes in Huelva, Spain is appended hereto as Attachment 43.[43] The analyses of refinery air pollution outside the Bay Area that is reported in attachments 41–43 further support the chemical "fingerprinting" analysis linking locally elevated ambient $PM_{2.5}$ to a Bay Area refinery source that is reported below.

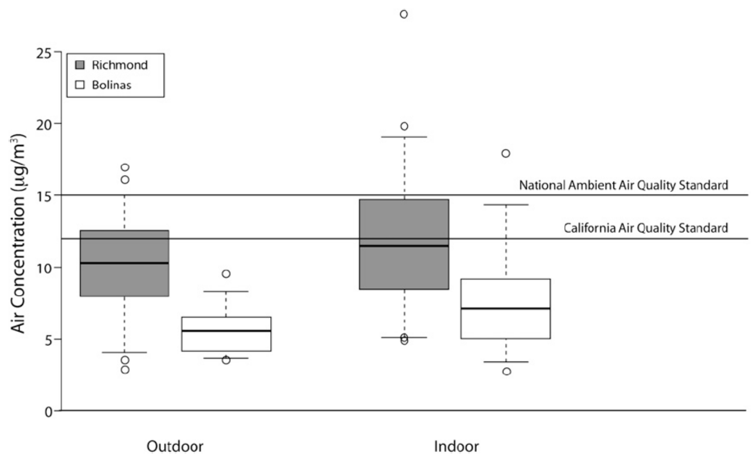
A 2009 paper that, among other things, documents locally elevated ambient air $PM_{2.5}$ levels in communities near the Chevron Richmond refinery, and shows by chemical "fingerprinting" that heavy oil combustion at the refinery and port account for this elevated air pollution, is appended hereto as Attachment 44.[44] A 2005 report that documents a statistically significant link between episodic emissions from Bay Area refineries and elevated $SO_2$ and $H_2S$ ambient air levels at regional monitors, and even higher air levels at closer-in fence line monitors is appended hereto as Attachment 45.[45] A 2006 Air District Staff report documenting air dispersion modeling that corroborates the localized impacts shown in Attachment 45 is appended hereto as Attachment 46.[46] A 2013 report on the 6 August 2012 catastrophic pipe failure and refinery fire at Richmond indicating that ≈ 15,000 residents sought emergency medical care following exposures to the massive PM plume from this fire is appended hereto as Attachment 47.[47]

The evidence in attachments 36–47 strongly supports the conclusion that Bay Area refineries contribute substantially to disparately severe local $PM_{2.5}$ air pollution.

**14. Ambient air data alone may underestimate the severity of refinery impacts because refinery emissions penetrate indoor environments.**

The most uniquely important data and information reported in Attachment 44 is from intensive multi-pollutant monitoring of ***indoor*** household air at 50 Bay Area sites, including 40 sites near the Richmond refinery and ten control sites in Bolinas. Analysis of the resultant data showed that outdoor air pollution, including the elevated local air pollution that was caused by the refinery and port, penetrated indoors.

Moreover, some important air pollutants reached higher air concentrations indoors than outdoors—and reached higher indoor air concentrations in the refinery-impacted sites than in the control sites. This effect is illustrated for $PM_{2.5}$ in the chart entitled "Figure 1" in Attachment 44 that is excerpted below.




*Note.* Solid lines are medians; boxes are interquartile ranges; vertical lines are 5th and 95th percentiles; circles are extreme data points below the 5th percentile and above the 95th percentile; and horizontal dotted lines represent annual federal and state ambient air quality standards for $PM_{2.5}$.

**FIGURE 1—Levels of fine particulate matter ($PM_{2.5}$) in homes in Richmond and Bolinas, CA: 2006.**
***Excerpted from Brody et al., Attachment 44. (NAAQS shown revised in 2012 to 12 $\mu g/m^3$ per Att. 36.)***

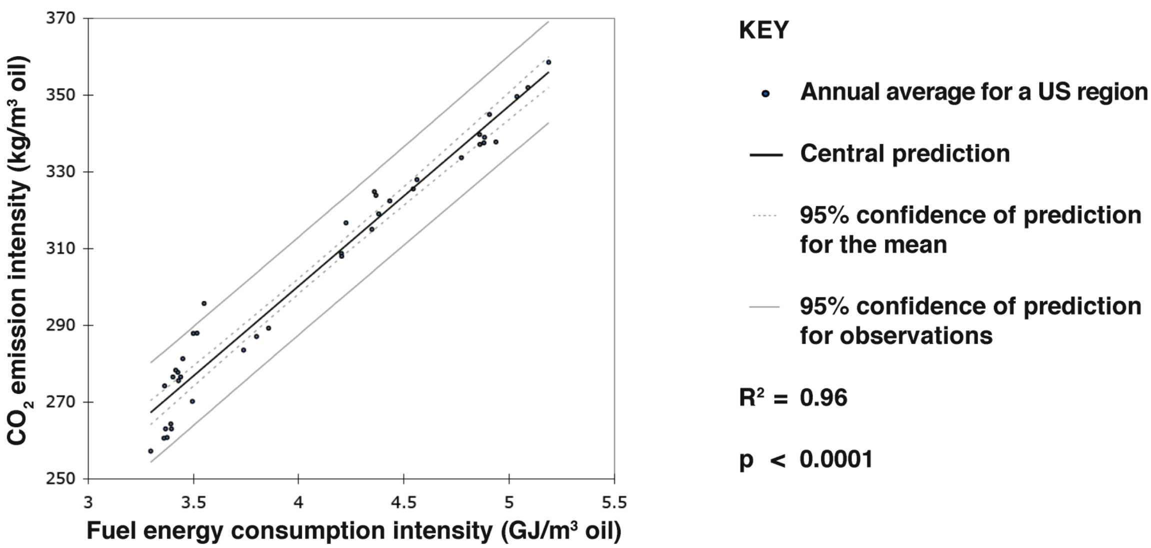
As shown in the chart, indoor air levels of $PM_{2.5}$ exceeded the State's ambient air quality standard at nearly half of the refinery-impacted sites, and exceeded 10 $\mu g/m^3$, the annual average health criterion set by WHO, at more than half of the refinery-impacted sites. This finding is based on the measurements reported in Attachment 44, which were taken in the summer months. Bay Area $PM_{2.5}$ levels are well known to be generally lower in summer and higher in winter, so these summertime data may underestimate actual indoor exposures. In any case, this evidence for indoor $PM_{2.5}$ air pollution levels even higher than the levels outdoors is especially important because people on average spend most (≈ 90%) of our time indoors. But ambient air, by definition, is outdoor air. Thus, this evidence of indoor $PM_{2.5}$ air concentrations that are higher than outdoor $PM_{2.5}$ air concentrations at refinery-impacted Bay Area sites indicates that ambient air data alone may underestimate the localized health impacts of refinery emissions here.

### 15. Increasing refinery GHG emissions would increase unregulated local health hazards from toxic GHG co-pollutant emissions.

Attachments 4, 6, 42, and 43 demonstrate that refineries emit environmentally significant amounts of UFPM that—compared with coarser PM—carries higher concentrations of toxins, penetrates deeper into the lungs, bloodstream, and cells to deliver those toxins, is more abundant and concentrated near its sources, and may in fact be even more toxic.

PM co-emits along with GHGs from Bay Area refinery combustion sources, and refinery PM emissions generally increase along with GHG emissions, as shown by comments 1–6 and attachments 1–20. Attachments 6, 42, and 43 further confirm the co-emission of UFPM with other PM from refineries. Indeed, basic engineering and combustion principles dictate that, like other ubiquitous fossil fuel combustion products, UFPM, $PM_{2.5}$, $PM_{10}$ and $CO_2$ will co-emit from oil refinery combustion sources. Current industry plans would increase those emissions through a switch to processing tar sands oil that would further increase the energy intensity and fuel combustion intensity of Bay Area refineries, as documented by comments 1–9 and attachments 1–33.

A statistical analysis report on a comparison of actual, observed fuel combustion energy intensity and GHG emission intensity data from operating refineries across 97% of the U.S. industry over ten years is appended hereto as Attachment 48.[48] The data analyzed are from Attachment 13. The analysis finds a strong, positive, quantitatively predictable relationship between $CO_2$ the emission intensities and fuel energy consumption intensities of refineries. This finding is illustrated in the chart below.




**Increase in average refinery $CO_2$ emission intensity with increasing refinery fuel energy consumption intensity across four U.S. regions and ten years. *Source:* Attachment 48.**

Bay Area refinery emissions of UFPM are unregulated because, as the Air District Staff admits, its industrial PM emission monitoring and control requirements are set up to "measure the mass of particles" only, and "UFPM is negligible on a mass basis." (*See* Attachment 4 at 104.) Moreover, "hot spot" impacts from other types of refinery PM emissions are unregulated. An appendix to the Office of Environmental Health Hazard Assessment's guidance showing that (except for PM from diesel and gasoline engines), the State Air Toxics Hot Spots Program does *not* require refinery PM emissions to be quantified for health risk assessment is appended hereto as Attachment 49.[49]

In sum, the evidence in attachments 1–49 shows that unregulated local toxicity hazards from $PM_{2.5}$ and UFPM emissions could increase if further increased refinery GHG emissions are allowed. Strong evidence supports the conclusion that enabling refinery GHG emissions to further increase could result in a worsening of disparately severe, localized toxic hazards from increased refinery emissions of GHG co-pollutants.

**16. Additional evidence supports past increases in refinery emission rates.**

On Friday 20 November 2015, one working day before the Monday 23 November 2015 deadline for this comment, the Air District Staff provided to CBE two pages of charts and tables that are appended hereto in their entirety as Attachment 50.[50] Attachment 50 suggests a continuing increase in PM emissions in 2014, and a slight decrease in GHG emissions from 2008–2014 (it estimates GHG emissions in 2008 that *exceed all estimated and forecast* annual refinery emissions the Air District had reported from through *2026* in Attachment 1). However, Attachment 50 provides no detailed supporting data, and, crucially, it omits *any* information on historic emissions before 2007.

Attachment 50 shows increased PM emissions from Chevron's Fluid Catalytic Cracking (FCC) Unit starting in 2009, and increased PM emissions from Shell and Tesoro cooling towers starting in 2014. Air District Staff indicated that these cooling tower emissions are estimated from unmonitored leaks in aging or inadequately leak-proofed equipment.[50] Such unmonitored leaks in aging or poorly maintained cooling towers may be expected to increase over time—and other evidence the Air District has reported elsewhere shows that the Chevron Richmond refinery FCC emissions have increased since 1999.

Excerpts from Air District Authority to Construct, Emission Inventory, and Annual Source Update files for the Chevron Richmond Refinery FCC Unit are appended hereto as Attachment 51.[51] Following Chevron's rebuild and expansion of the FCC, its oil feed and coke burn rates increased substantially, and its PM emissions increased by ≈ 28%, from 1999–2009. (Attachment 51.) These FCC oil feed, FCC coke burn, and FCC $PM_{2.5}$ emission increments are consistent with the impacts of switching to lower quality crude feeds in the U.S. refining industry that are described in Attachment 18.

A report showing that refinery process expansions to refine lower quality crude increased California refinery GHG emissions by ≈ 3 million metric tons/year from 1995–2007 is appended hereto as Attachment 52.[52] A table of refinery GHG emissions reported by the ARB, and separately, estimated from Petroleum Industry Information Act (PIIRA) fuel use data compiled for the analysis in Attachment 16 and the emission factors in Attachment 13, is appended hereto as Attachment 53.[53] These PIIRA data suggest that between the three-year periods 1990–1992 and 2007–2009, statewide refinery GHG emissions increased by ≈ 3.7 million metric tons/year; and the ARB data suggest that between 1990–1992 and 2011–2013, statewide refinery emissions increased by ≈ 2.1 million metric tons/year. (Absolute values of ARB estimates should not be compared to those of PIIRA estimates due to differences in estimation methods; *see* Attachment 53.)

Attachments 51–53 document additional evidence that processing and feedstock changes contributed to increased refinery GHG and PM emissions over the multi-decade period from the 1990s to the present, consistent with the Air District's formally reported data in attachments 1–5 and CBE's comments 1–2. However, omitting *any* information on historic emissions before 2007, the Air District Staff's newly disclosed Attachment 50 presents an incomplete and inaccurate view of historic refinery emission trends.

**Conclusion**

Data the Air District reports elsewhere document a substantial long-term increase in Bay Area refinery emissions of GHG and $PM_{2.5}$ that co-emit from refinery fuel combustion. (Additional evidence that is reported elsewhere by the Air District and others and is reviewed in Comment 16 directly above further supports this finding.) Peer reviewed science shows that refining lower quality oil contributed to this emissions increase and could further increase emissions from Bay Area refineries if their current, declining, crude oil supply is replaced with bitumen-derived 'tar sands' oil.

Forecasts the Air District reports elsewhere show that Bay Area refinery GHG and $PM_{2.5}$ emissions could further increase. The peer reviewed science shows that Bay Area refinery emissions could greatly exceed even these forecasts if the refiners replace their declining current oil supply with bitumen-derived tar sands oil. In fact, industry reports document plans to replace Bay Area (and California) refiners' declining current oil supplies with that tar sands oil—if the resultant emissions increase is allowed.

Moreover, those industry-reported plans include a major expansion of Bay Area oil train traffic that—since Bay Area refineries cannot process very large amounts of light shale oils efficiently—could be allowed here ***if*** the emissions increase from refining the large amounts of tar sands oil these trains would deliver is allowed.

Bay Area oil refineries cause serious PM air pollution impacts, disparately greater PM emissions locally, and disparately severe PM pollution of the ambient air locally. But ambient air data alone may underestimate the severity of these impacts since refinery emissions penetrate indoor environments. Increasing refinery GHG emissions would increase unregulated local health hazards from toxic GHG co-pollutant emissions.

A safeguard against further increasing refinery emissions is needed without further delay. The Air District, however, proposes no such safeguard that is specific, enforceable upon adoption, and would apply to refineries facility-wide. Therefore, given the absence of any other such safeguard proposal, CBE's September 2015 proposal for limits set to current facility emission rates, and the community-proposed moratorium on permits for projects to enable lower quality oil, should be considered favorably in your revisions.

Respectfully submitted,

Greg Karras
Senior Scientist

Copy: Ken Alex, Office of the Governor
John Gioia, Stationary Source Committee Chair
Air District Board members
Richard Corey, Air Resources Board
Jack Broadbent, Air Pollution Control Officer
Interested organizations and individuals

Attachments—*see* attachments list herein below.

**Attachments List (*see CBE's 21 October comments for attachments 1–35*).**

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[36] Attachment 36. *Air Quality Standards and Attainment Status;* annotated table accessed on 17 November 2015 from the BAAQMD web site; Bay Area Air Quality Management District: San Francisco, CA.

[37] Attachment 37. *WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide, Global Update 2005: Summary of Risk Assessment;* World Health Organization: Geneva, Switzerland. 2006.

[38] Attachment 38. *Weekly Listing: National 24-Hour PM2.5 Averages;* data reported by CARB for 24-hour average $PM_{2.5}$ concentrations in ambient air, during ten-week periods from May 2012 through April 2015 when a 24-hour average exceeded NAAQS and WHO criteria, at the five NAAQS monitors nearest to Bay Area oil refineries. California Air Resources Board: Sacramento, CA. Data accessed 16 November 2015 from: www.arb.ca.gov/adam/weekly/weekly2.php.

[39] Attachment 39. Pastor et al., 2010. *Minding the Climate Gap: What's at Stake if California's Climate Law isn't Done Right and Right Away;* USC Program for Environmental and Regional Equity: Los Angeles, CA.

[40] Attachment 40. *Areal Refinery Source Strength Calculation Details;* Annotated tables based on BAAQMD data for 2010 emissions and jurisdictional data and the range of refinery source boundary distances from Attachment 39. Includes calculation details and results for $PM_{2.5}$ and precursors (NOx and $SO_2$) emissions. CBE, 2015. One page.

[41] Attachment 41. Celo et al., 2012. Concentration and Source Origin of Lanthanoids in the Canadian Atmospheric Particulate Matter: A Case Study. *Atmospheric Pollution Research* **3:** 270–278. DOI: 10.5049/APR.2012.030.

[42] Attachment 42. Moreno et al., 2010. Variations in Vanadium, Nickel and Lanthanoid Element Concentrations in Urban Air. *Science of the Total Environment* **408:** 4569–4579. DOI: 10.1016/j.scitotenv.2010.06.016.

[43] Attachment 43. Fernández-Comacho et al., 2012. Ultrafine Particle and Fine Trace Metal (As, Cd, Cu, Pb and Zn) Pollution Episodes Induced by Industrial Emissions in Huelva, SW Spain. *Atmospheric Environment* **61:** 507–517; http://dx.doi.org/10.1016/j.atmosenv.2012.08.003.

[44] Attachment 44. Brody et al., 2009. Linking Exposure Assessment Science with Policy Objectives for Environmental Justice and Breast Cancer Advocacy: The Northern California Household Exposure Study. *American Journal of Public Health* **99**(S3): S600–S609. DOI: 10.2105/AJPH.2008.149088 (Attachment includes Errata corrections).

[45] Attachment 45. Karras and Hernandez, 2005. *Flaring Hot Spots: Assessment of Episodic Local Air Pollution Associated with Oil Refinery Flaring Using Sulfur as a Tracer;* A CBE report. Communities for a Better Environment (CBE): Oakland and Huntington Park, CA. July 2005.

[46] Attachment 46. Ezersky and Walsh, 2006. *Staff Report, Proposed Amendments to Regulation 12, Miscellaneous Standards of Performance, Rule 12, Flares at Petroleum Refineries;* Bay Area Air Quality Management District: San Francisco, CA. See esp. "Current Flare Emission Estimate" section at pages 6–8.

[47] Attachment 47. *Interim Investigation Report, Chevron Richmond Refinery Fire: Chevron Richmond Refinery; Richmond, California, August 6, 2012;* U.S. Chemical Safety and Hazard Investigation Board: Washington, D.C. Adopted 19 April 2013.

[48] Attachment 48. *Statistical Analysis Report on Comparison of Actual Refinery Fuel Combustion Energy Intensity versus Actual Refinery $CO_2$ Emission Intensity Observed Across 975 of the U.S. Refining Industry: Annual Observations From 1999–2008;* Analysis of data from Attachment 13 (Karras, 2010) by Communities for a Better Environment (CBE). Excel file: includes data, regression, normality test results.

[49] Attachment 49. *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments Appendix A;* California Office of Environmental Health Hazard Assessment: Sacramento, CA. February 2015. Note that the only PM emissions included in Appendix A-I, the detailed list of substances required to be quantified for HRAs, are PM emissions from diesel engine (p. A-8) and gasoline engine (p. A-10) exhaust, and note 9 to the listings further confirms this limitation (p. A-34): refinery PM emissions, which are not diesel or gasoline exhaust emissions, are excluded. Section 3.1 of the OEHHA Guidance Manual states that the list of "emitted substances that are addressed in a health risk assessment (HRA) … is contained in … Appendix A of this document."

[50] Attachment 50. Unreferenced charts and tables labeled as summarizing matter emissions during 2007–2014 and GHG emissions during 2008–2014 from Bay Area refineries that CBE received on 20 November 2014 from the Bay Area Air Quality Management District in a meeting attended by G. Karras and R. Lin of CBE and G. Nudd and E. Stevenson of the Air District, among others. Two untitled pages.

[51] Attachment 51. *Excerpts from Bay Area Air Quality Management District Files regarding the Chevron Richmond Refinery Fluid Catalytic Cracking Unit (FCCU, S-4285);* excerpts include: (1) A summary of unit activity and emission changes from 1999–2009; (2) AQMD and Chevron reports on an FCC expansion; (3) Current FCC emission factor data; (4) Annual Source Update FCC data for 1999; and (5) Emission Inventory FCC data for 2009.

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[52] Attachment 52. Karras, May and Lee, 2008. *Increasing GHG Emissions from Dirty Crude, Analysis of publicly available data for one of the oil refining processes expanding for more contaminated oil in California: Hydrogen Steam Reforming;* A CBE Report. Communities for a Better Environment (CBE). 8 December 2008.

[53] Attachment 53. *Historic Refinery GHG Data Comparison: Preliminary Comparison of Estimates for Total $CO_2e$ Emissions from Refining in California;* Compilation of Air Resources Board, Petroleum Industry Information Reporting Act, and Union of Concerned Scientists data. Data compiled by Communities for a Better Environment (CBE) for technical assistance analysis for the work presented in Attachment 16, and this comment. One-page table including data, calculations, references and notes.