Refinery Strategy

Board of Directors Special Meeting
November 30, 2015

Eric Stevenson
Director of Meteorology, Measurement and Rules

- Reduce harmful emissions both regionally and within nearby communities

- Perform monitoring to measure impacts and identify potential opportunities to reduce emissions

- Limit emissions and protect health

- Ensure refinery operation changes will not increase health burden and ensure best practices over time

- Develop information over time to implement new regulatory programs

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
REFINERY STRATEGY

REDUCE HARMFUL EMISSIONS → **CONTINUOUS MONITORING** → **LIMIT POLLUTION & PROTECT HEALTH** → **ENSURE BEST PRACTICES**

Reduce Harmful Emissions: The Air District staff is developing a suite of regulations to reduce emissions of criteria pollutants from Bay Area refineries by 20 percent (or as much as feasible) by 2020. The first phase of these regulations will be considered by the Board in December 2015 and will:

- Reduce sulfur dioxide (SO_2) from coke-calcining

- Reduce organic compound and toxic emissions from equipment leaks and cooling towers

- Limit ammonia emissions from fluid catalytic cracking (FCC) units, which will reduce associated formation and emission of fine particulate matter ($PM_{2.5}$)

In mid-2016, the second phase of the strategy will further reduce:

- SO_2 from FCC units and other refinery sources

- $PM_{2.5}$ emissions from FCC units

- Nitrogen oxide (NO_x) emissions from turbines

Continuous Monitoring: Draft Regulation 12, Rule 15, Petroleum Refining Emissions Tracking, will require:

- Continuously updated, state-of-the-art methods be used to calculate and report the total pollution from the refineries every year

- Extensive air quality monitoring to validate those pollution calculations and ensure surrounding communities are not subjected to unhealthy levels of pollution

- Requirements that will use emission inventories and monitoring data to identify potential reductions

- An energy audit identifying potential improvements to reduce GHGs

- New, more protective, Health Risk Assessments be performed to determine the health risk from toxic air pollutants

Limit Pollution & Protect Health: Draft Regulation 12, Rule 16, Petroleum Refining Emissions Limits and Risk Thresholds, will:

- Limit refinery criteria pollutant and toxic emissions to levels that minimize the health burden for the surrounding communities

- Require Health Risk Assessments have updated information every year as new emissions data are received

Ensure Best Practices: Air District staff is developing changes to the Air District permitting regulations to ensure that when refineries modernize or make significant changes to the type of crude oil they use, they will be required to use the best available control technology to reduce smog-forming, toxic, and climate pollutants. Over time, these changes to the permitting regulations will ensure the refineries use best practices and operate as efficiently and cleanly as possible.

REFINERY STRATEGY

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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Reduce Harmful Emissions

- 20% criteria pollutant reductions by 2020

  - Includes four specific refinery emission reduction regulations

  - Additional rulemaking is underway

- 20% reduction in risk by 2020

  - 12-16 sets total risk at 25 in 1 million

  - 12-15 HRA and additional monitoring requirements will aid in identifying sources for further reductions

Reduce Harmful Emissions - Phase I

Title	Pollutant(s)	Amount Reduced	Projected Completion
Rule 9-14: Petroleum Coke Calcining	SO_2	372 tons/year (tpy)	December 2015
Rule 6-5: Fluid Catalytic Cracking Units	Ammonia, PM	TBD	December 2015
Rule 8-18: Equipment Leaks	VOC, toxics, methane	1,227 tpy	December 2015
Rule 11-10: Cooling Towers	VOC, toxics, methane	997 tpy	December 2015

Total Reductions for 2015: **2,596 tons per year or 16%** of total refinery criteria pollutant emissions.

Phase II rulemaking planned for 2016 likely to exceed goal of 20% reductions by 2020.

Continuous Monitoring

Regulation 12, Rule 15 Elements

- Annual emissions inventories to determine emissions

- Fence line and community monitoring

- Crude oil composition characteristics used in future for permitting decisions

- Health Risk Assessments (HRAs) used to limit risk in nearby communities

- Energy audits used to develop Information for future regulatory action

Regulation 12, Rule 16

- Risk limit - 25 in 1 million using HRA required in 12-15
  - Future rule changes will likely incorporate this limit for all Bay Area facilities
  - Update information yearly to ensure changes don't negatively impact heath
- Implement refinery- wide criteria pollutant limits based on Potential To Emit (PTE) and National Ambient Air Quality Standards (NAAQS)

Ensure Best Practices

- Crude slate modifications trigger permitting review

  - Engineering review of criteria pollutants, GHG and TACs

- Best Available Control Technology (BACT) for criteria pollutants, GHG and TACs

  - New Source Review for all affected systems

Current Proposals Towards 20% Reductions

- Regulation 9, Rule 14 addresses largest SO_2 source in the Bay Area

- Regulation 6, Rule 5 first step towards reducing PM from FCCUs

- Regulation 8, Rule 18 reduces VOC emissions from leaks

- Regulation 11, Rule 10 applies current standards to all cooling towers and identifies leaks earlier
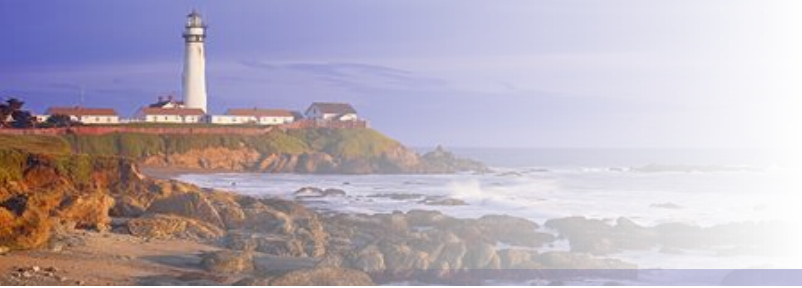
Next Steps

- Presentations by WSPA and CBE

- Consider public comments and input

- Bring 12-15 and 12-16 to the Board for consideration in December

- Bring new and modified regulations in the Phase I of the 20% reduction by 2020 package to the Board for consideration in December

- Continue rule development and enact changes to permitting regulations and additional items in Phase II of the 20% by 2020 package

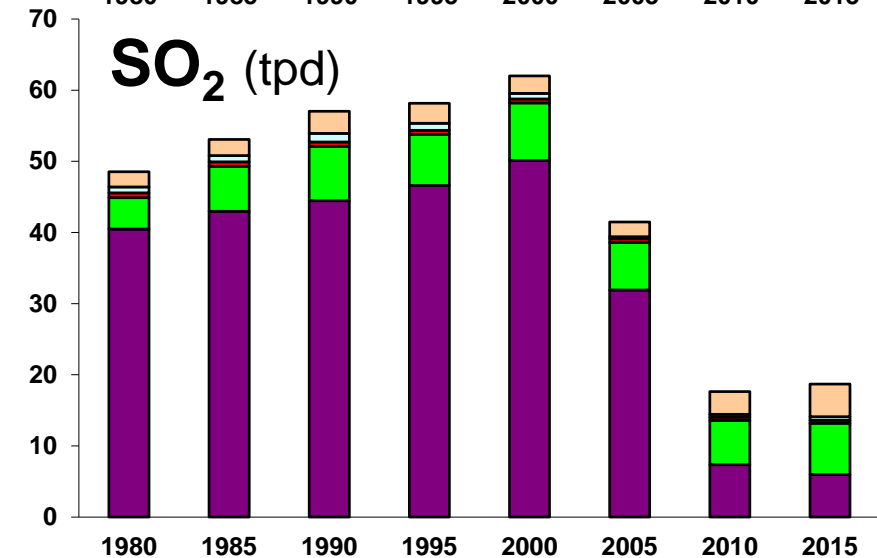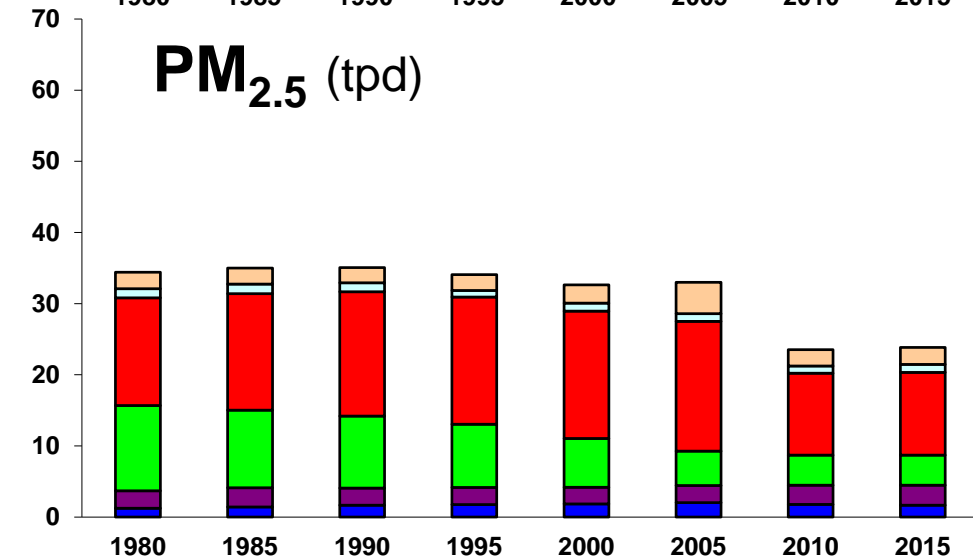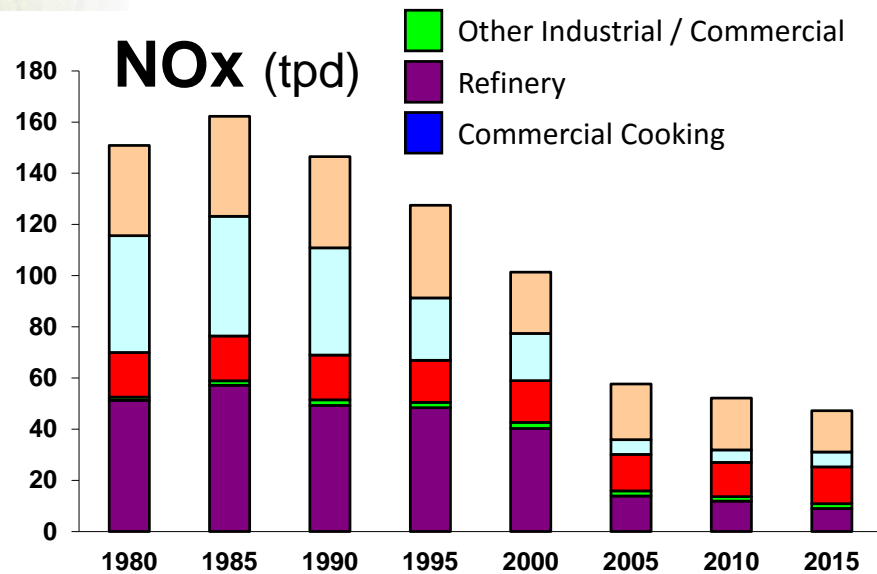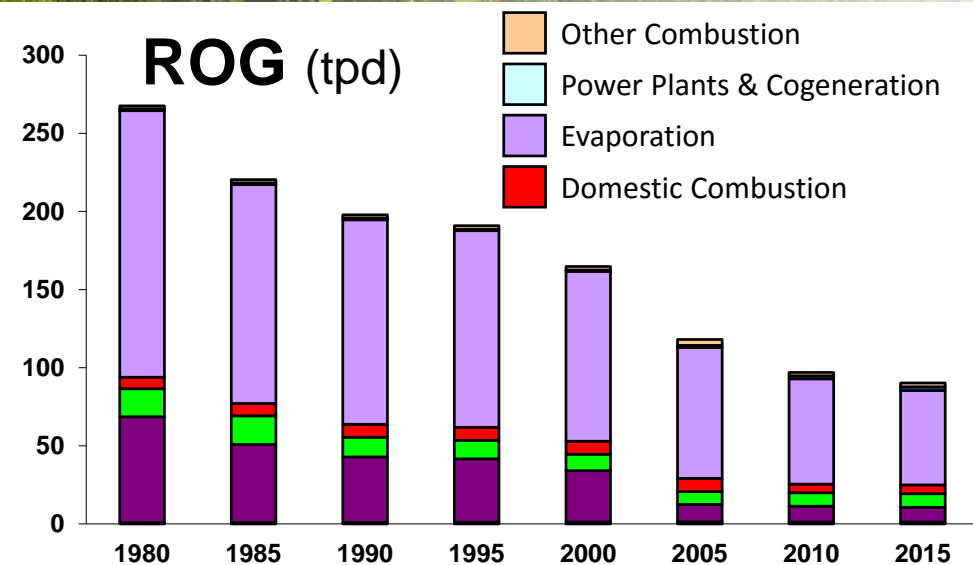- Bring Phase II and permitting rules to Board for consideration in early 2016
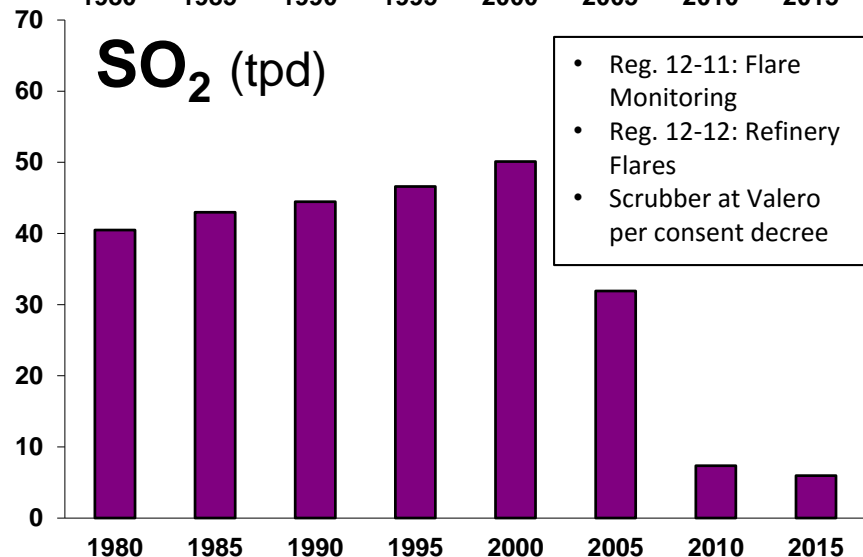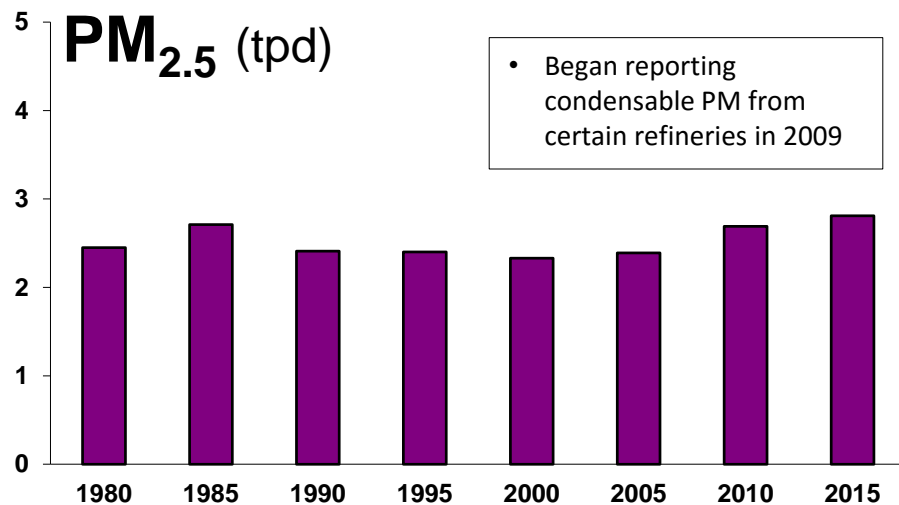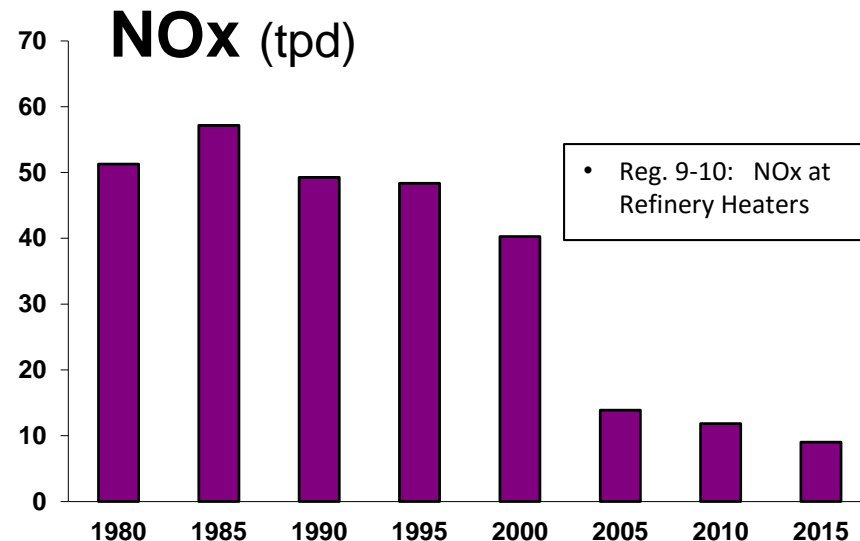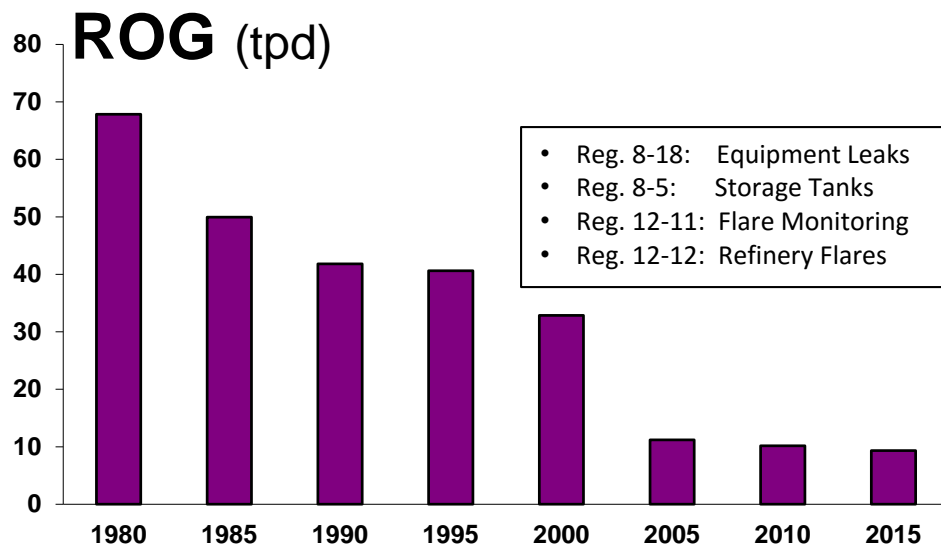
Goals Achieved

- Limits set on risk and criteria pollutants

- Additional information collected to inform future emissions reductions for risk, criteria and GHG pollutants

- Achieves 16% emissions reduction with currently proposed rules

- Sets the stage for future rule making

  - Additional reduction measures to reach 20% reduction goal

  - Permitting changes will include GHG requirements

  - Permitting changes will include crude slate change review to ensure no emissions increases or use of BACT

  - Inform potential GHG rulemaking and monitor Cap-and-Trade progress

Stationary Source Emission Trends 1980-2015

Refinery Emission Trends 1980-2015 and Main Causes of Changes

ROG (tpd)

- Reg. 8-18: Equipment Leaks
- Reg. 8-5: Storage Tanks
- Reg. 12-11: Flare Monitoring
- Reg. 12-12: Refinery Flares

NOx (tpd)

- Reg. 9-10: NOx at Refinery Heaters

PM$_{2.5}$ (tpd)

- Began reporting condensable PM from certain refineries in 2009

SO$_2$ (tpd)

- Reg. 12-11: Flare Monitoring
- Reg. 12-12: Refinery Flares
- Scrubber at Valero per consent decree

Bay Area GHG Forecasts

GHG Emissions & Projections (Relative to 1990) with Committed & Expected Policies
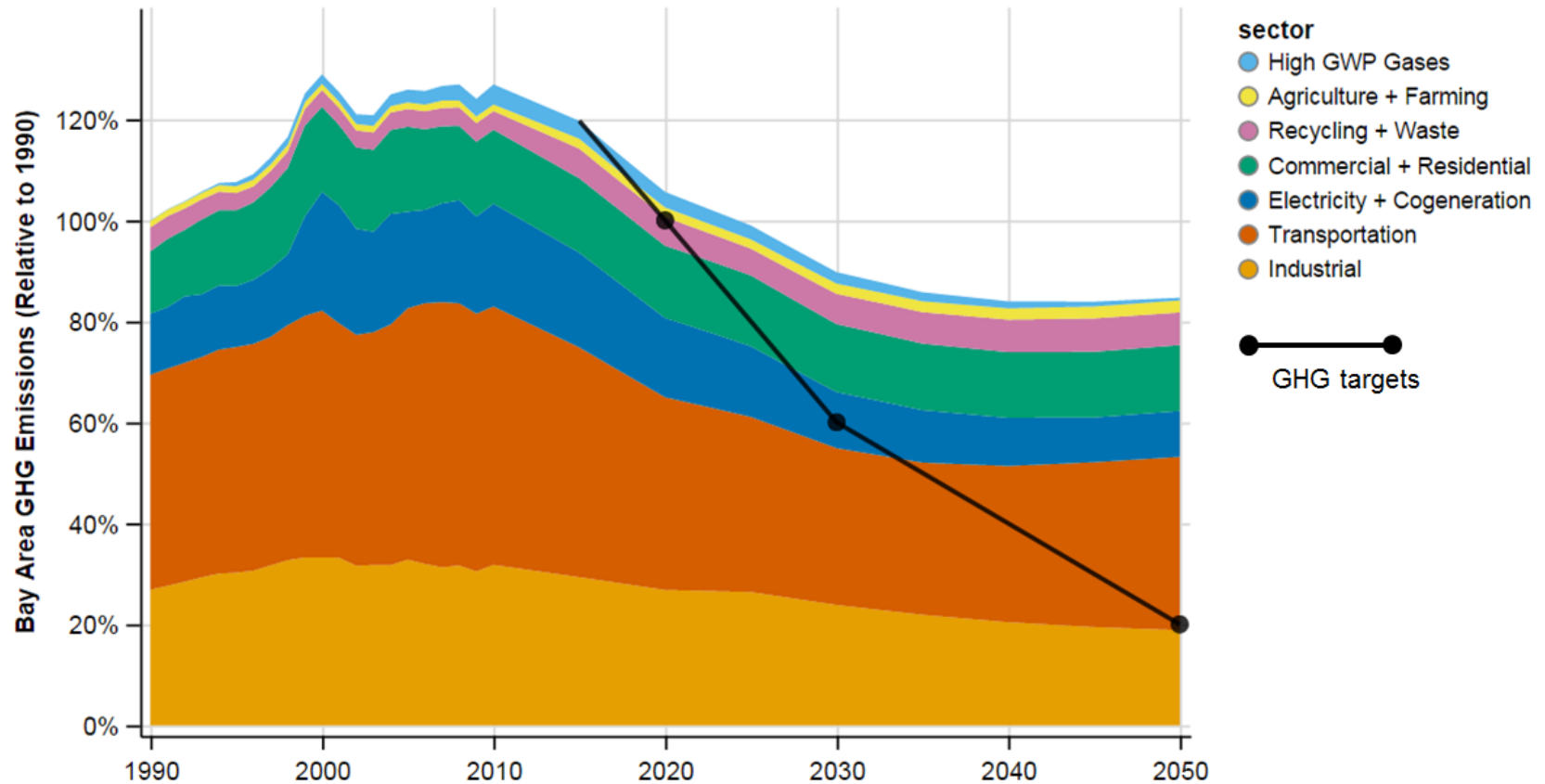
Oil companies plan a switch to tar sands oil—inherently 'dirtier' oil that threatens our health, safety, and climate with potentially huge increases in air pollution and explosion hazards from their oil trains and refineries when they deliver and process this extreme oil.

We can stop this with emission limits that simply cap their refinery emissions _before_ they switch to inherently 'dirtier' grades of oil.

Communities Presentation
30 November 2015 AQMD Special Board Meeting
by Greg Karras, Senior Scientist
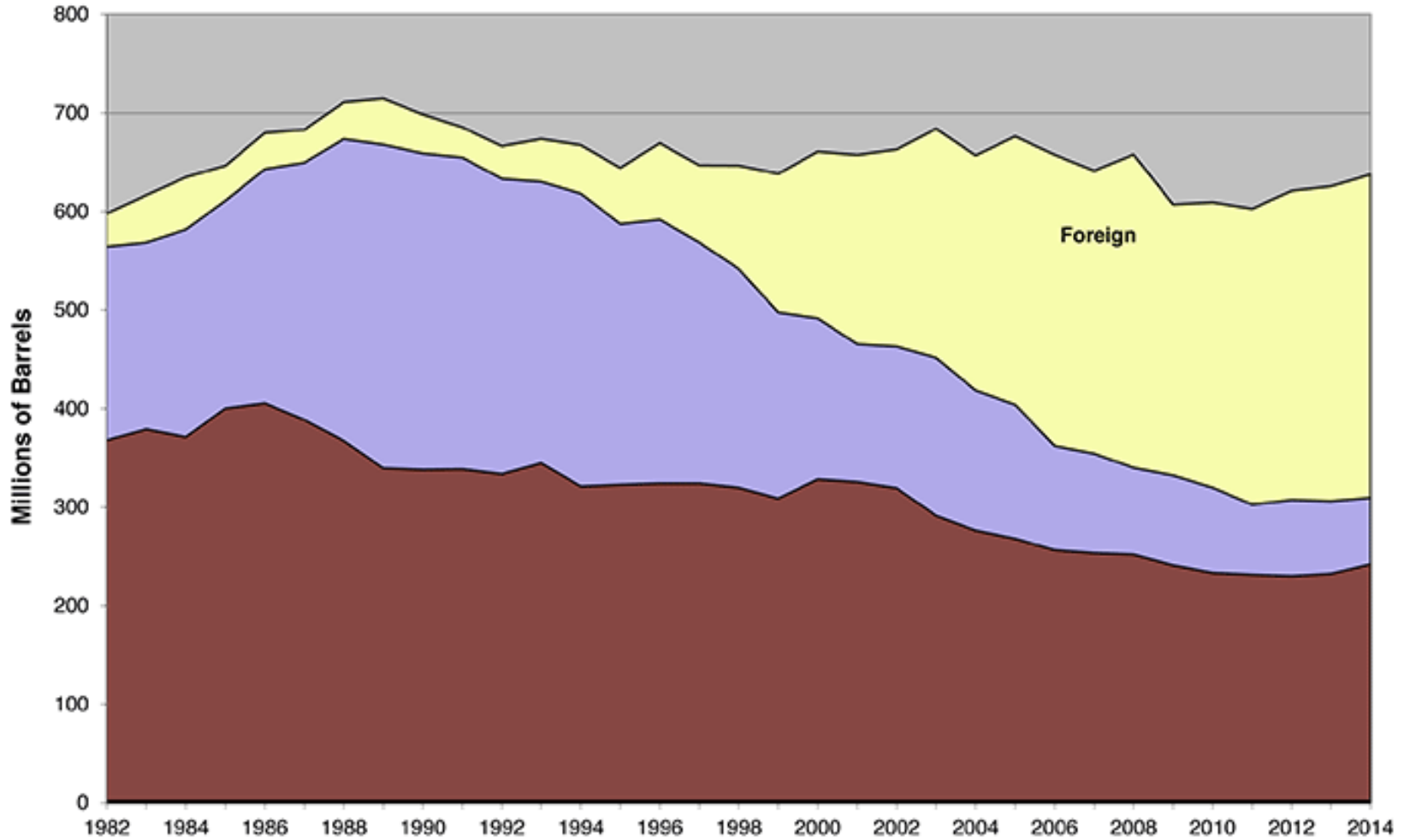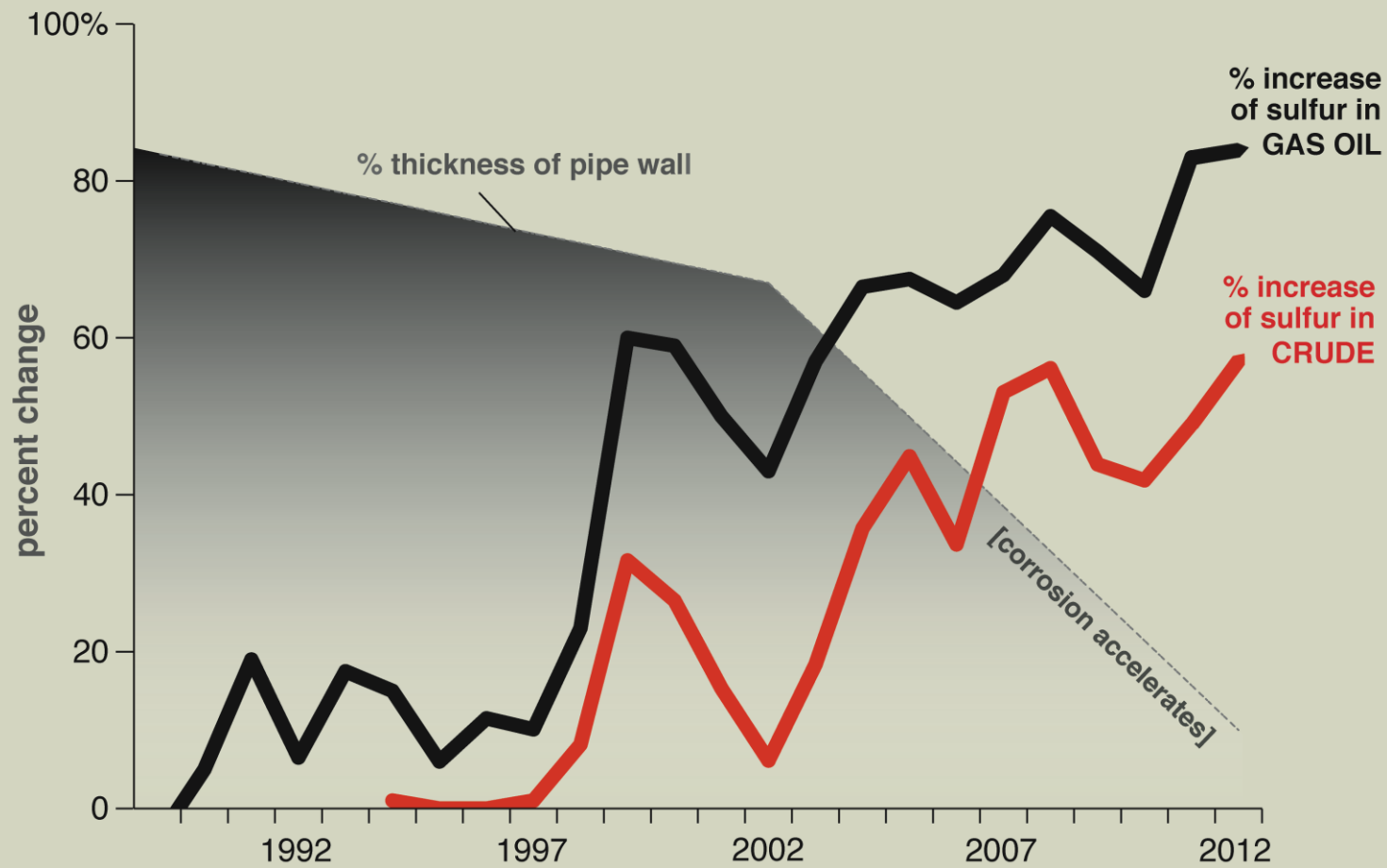Communities for a Better Environment (CBE)

Western Canadian Crude Markets

From *Oil & Gas Journal* (2007)

Crude Oil Supply Sources to California Refineries
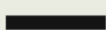
From California Energy Commission.

RICHMOND REFINERY FEEDSTOCK QUALITY / 4-SIDECUT PIPE CORROSION   1989–2012

thickness of 4-sidecut pipe wall	sulfur in gas oil increase determined using % of 1984 average	sulfur in crude feed increase determined using % of 1996 average

Analysis and chart: CBE   Pipe thinning and gas oil data from CSB interim report; see CBE 9 April 2013 memo to CSB for crude oil data.   www.cbecal.org   4/19/2013

Crude switching *already* causes local refinery impacts:

1994 (Rodeo)—10X more Se release/barrel refined

1999 (Martinez)—Tosco refinery fire kills five workers
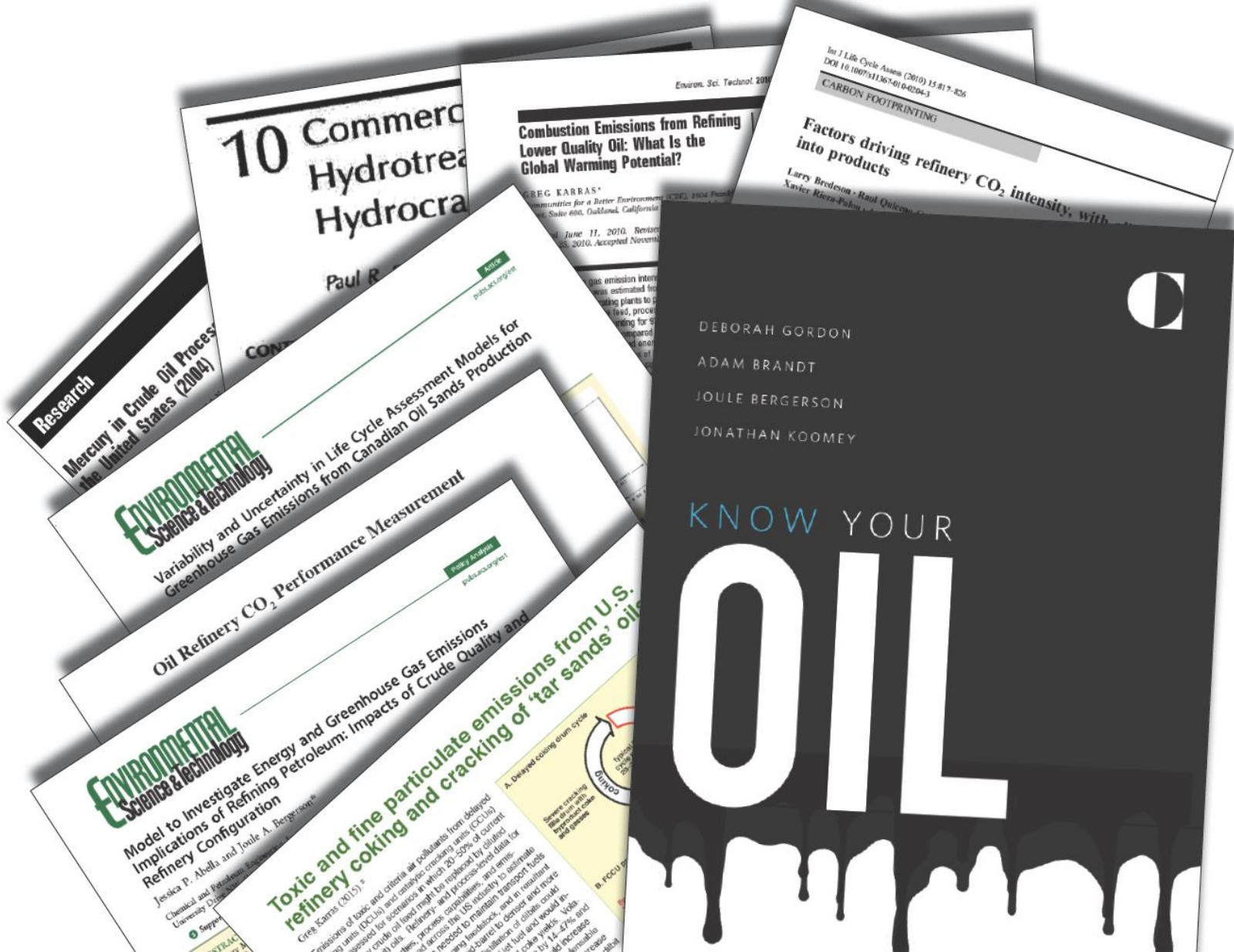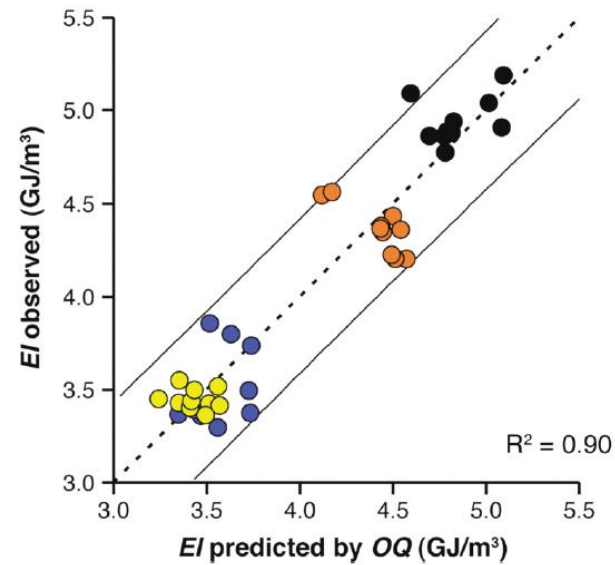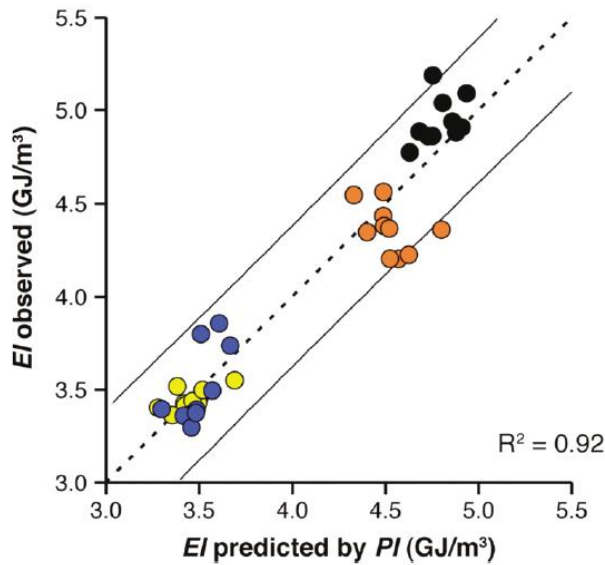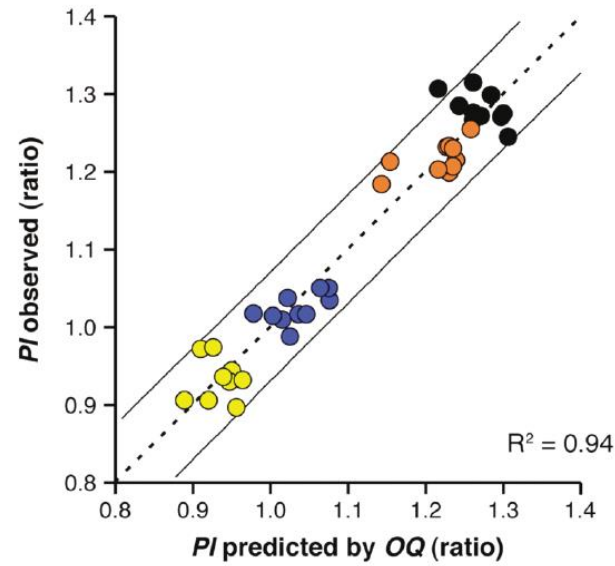
2007 (Richmond)—1st Chevron crude unit fire

2008 (Bay Area)—CO_2/bbl exceeds other US regions

2012 (Richmond)—2nd Chevron crude unit fire

Now (Bay Area)—more GHG, PM emit than in 1990s.

From attachments to CBE technical comments.

10 Commerc...
Hydrotrea...
Hydrocra...

Paul R...

Combustion Emissions from Refining
Lower Quality Oil: What Is the
Global Warming Potential?

GREG KARRAS*

Communities for a Better Environment, Suite 600, Oakland, California

Environ. Sci. Technol. 201...

Factors driving refinery CO₂ intensity, with...
into products

Larry Bredeson · Raul Quiceno...
Xavier Riera-Palou...

Research

Mercury in Crude Oil Process...
the United States (2004)

CONT...

ENVIRONMENTAL
Science & Technology

Variability and Uncertainty in Life Cycle Assessment Models for
Greenhouse Gas Emissions from Canadian Oil Sands Production

Oil Refinery CO₂ Performance Measurement

ENVIRONMENTAL
Science & Technology

Model to Investigate Energy and Greenhouse Gas Emissions
Implications of Refining Petroleum: Impacts of Crude Quality and
Refinery Configuration

Jessica P. Abella and Joule A. Bergerson

Toxic and fine particulate emissions from U.S.
refinery coking and cracking of 'tar sands' oils

Greg Karras (2015)

DEBORAH GORDON
ADAM BRANDT
JOULE BERGERSON
JONATHAN KOOMEY

KNOW YOUR
OIL

American Chemical Society (2010). *OQ:* crude feed quality. *PI:* refinery processing intensity. *EI:* refinery energy intensity. Colors correspond to US PADD numbers at upper left of figure.

FIGURE 3. Refinery CO_2 emission intensity observed versus predicted by oil quality. *OQ*: Oil quality. Black circles: District 1, 2, 3, or 5 annually, 1999−2008. Black diamonds: United States in 2002, 2005, 2006, 2007. Black square: San Francisco Bay Area in 2008. Diagonal lines bound the 95% confidence of prediction for observations. R^2 value shown is for the comparison among districts and years.
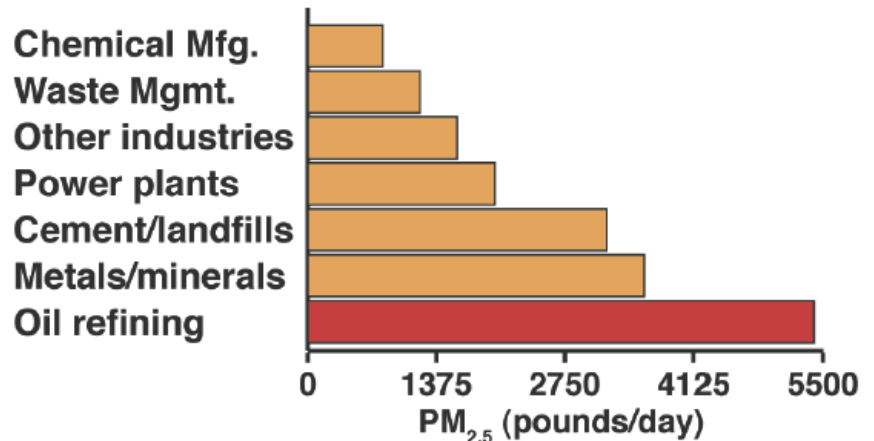
Total CO_2 emitted/m³ oil refined by Bay Area refineries (circled) was the highest observed (see vertical axis) and predicted by oil quality (horizontal axis) among U.S. refining regions, as of 2008.

From CBE Attachment 13, American Chemical Society (2010) except for notes in red

Particulate matter (PM$_{2.5}$): direct industrial emissions in the San Francisco Bay Area. BAAQMD data (2010 SIP).

Chemical Mfg.
Waste Mgmt.
Other industries
Power plants
Cement/landfills
Metals/minerals
Oil refining

0   1375   2750   4125   5500
PM$_{2.5}$ (pounds/day)

Greenhouse gasses (CO$_2$e): direct industrial emissions in the San Francisco Bay Area. Calif. ARB data (2012 MRR).

Chemical Mfg.
Waste Mgmt.
Metals/minerals
Cement/landfills
Other industries
Power plants
Oil refining

0   4   8   12   16
CO$_2$e (million tonnes/yr)
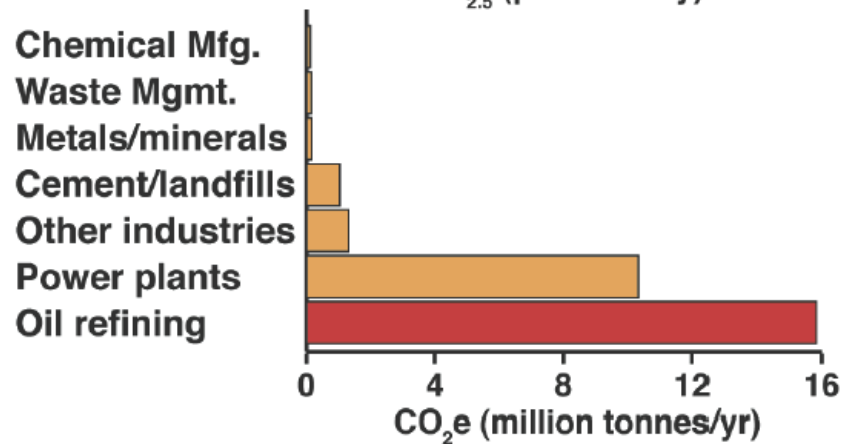
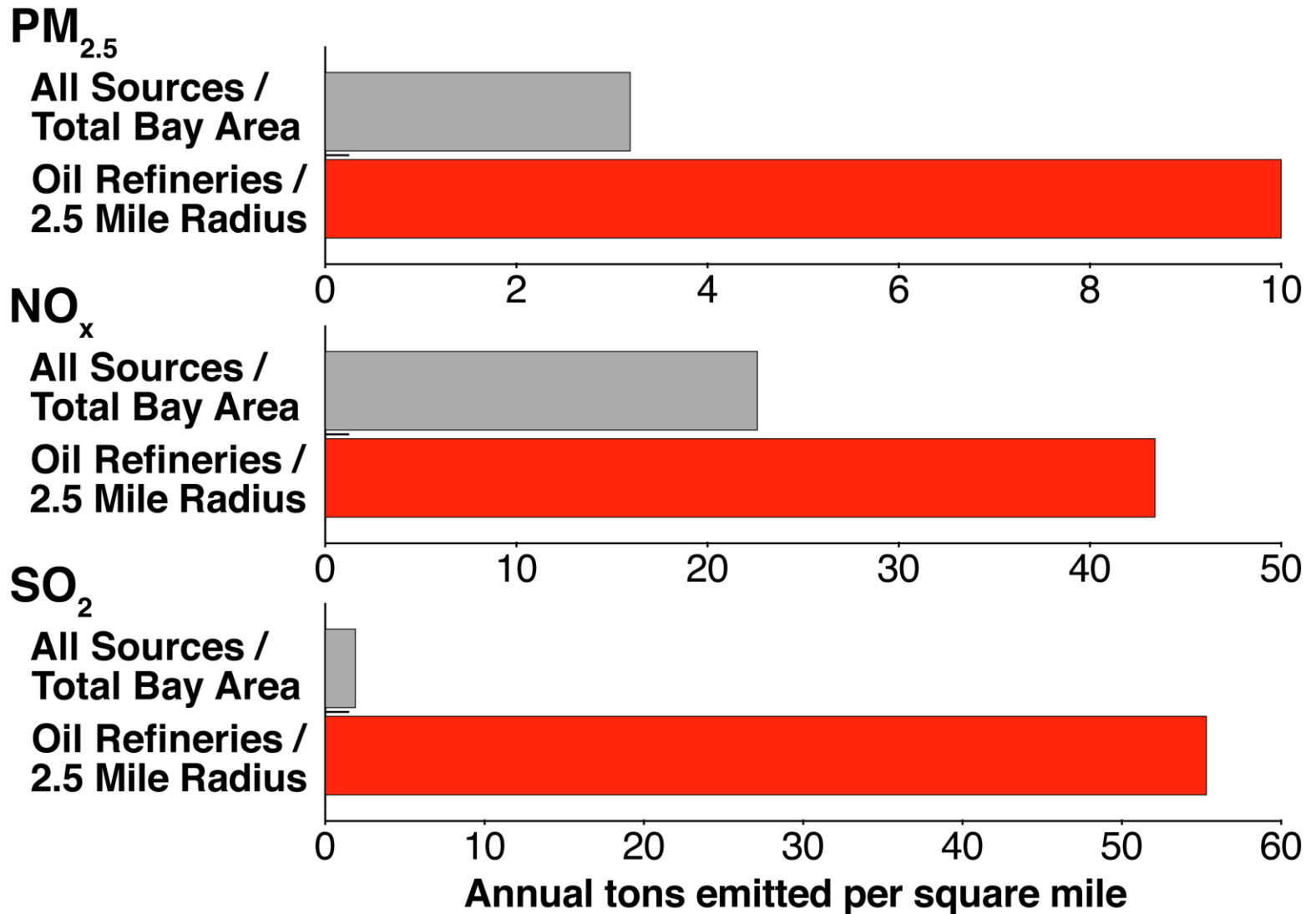"Petroleum refineries account for the largest portion (93%) of the state-wide disparity score, or difference between the emissions burdens for people of color and non-Hispanic whites."

From Pastor et al. (2010)—CBE Attachment 39.

This finding is based on population-weighted particulate emissions from all the major GHG emitting industries under cap-and-trade within 2.5 miles of these emitters.

PM$_{2.5}$
All Sources / Total Bay Area
Oil Refineries / 2.5 Mile Radius

0   2   4   6   8   10

NO$_x$
All Sources / Total Bay Area
Oil Refineries / 2.5 Mile Radius

0   10   20   30   40   50

SO$_2$
All Sources / Total Bay Area
Oil Refineries / 2.5 Mile Radius

0   10   20   30   40   50   60

Annual tons emitted per square mile

Refinery source strength at 2.5 miles *v.* Bay Area Average.
Data from BAAQMD; 2.5–mile boundary after Pastor et al. (*See* CBE Att. 40.)
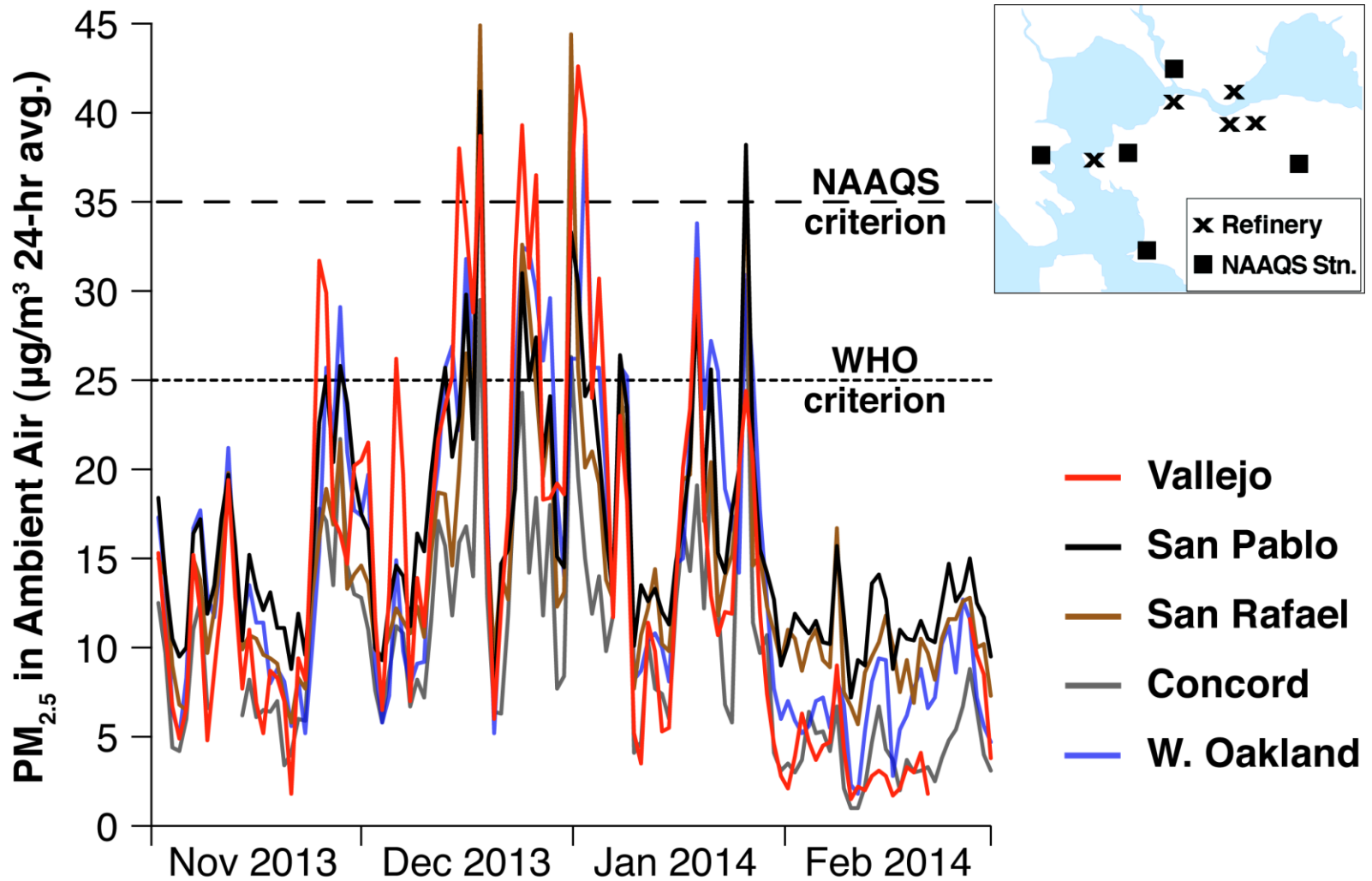
Daily PM$_{2.5}$ levels in ambient air at the five nearest NAAQS stations to Bay Area refineries, Winter 2013/14. (ARB data.)
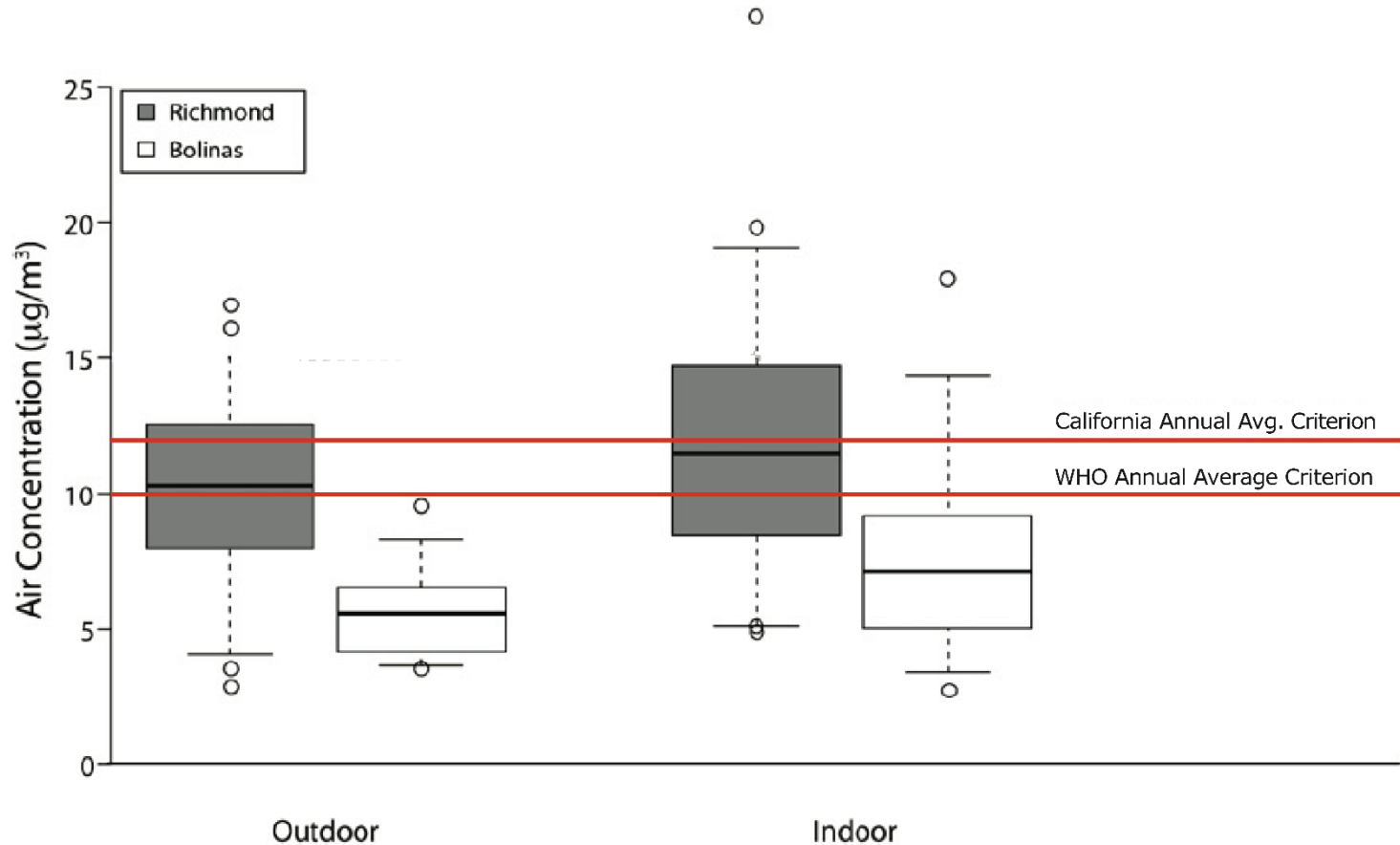
Outdoor *and* indoor PM$_{2.5}$ air concentrations: refinery-impacted (shaded) and control (plain) sites; Bay Area in Summer, 2006.

Boxes are interquartile ranges; black lines in boxes are medians; dashed vertical lines are 5th and 95th percentiles; circles are extreme data points. (CBE Att. 44.)

Crude feed quality drives refinery fuel energy intensity: averages observed in the Bay Area v. other U.S. regions, and combustion emissions potential for 'tar sands' oils.*

Region	Crude feed (kg/m^3)		Fuel energy intensity	
	density	sulfur	GJ/m^3 oil	% of SFBA
East Coast	864	7.08	3.35	63 %
Midwest	863	11.7	3.51	66 %
Gulf Coast	879	14.9	4.54	85 %
SF Bay Area	900	11.9	5.31	100 %
Heavy Oil	957	27.8	8.79	160 %
Bitumen	1,030	45.5	13.20	250 %

* Data and potential from CBE Attachment 13; observed data are region-wide 2008 averages except Heavy Oil and Bitumen are world averages.

Staff's Plan <u>allows</u> refinery emissions to increase:

<u>Facility</u> emissions potential exceeds piecemeal measures promise;

<u>New</u> facility 'maximum potential to emit' (PTE) 'limits' <u>after</u> tar sands projects could legalize and lock-in this emissions increase;

HRAs <u>do not control</u> local toxic impacts of refinery PM emissions;

The <u>proposed GHG exemption</u> allows a new climate threat from tar sands oil refining to be locked-in *and* increased local health impacts from increased refinery emissions of otherwise unregulated GHG co-pollutants—including $PM_{2.5}$ *and wholly unregulated ultra-fine PM*.

See CBE's and Stanford Law Clinic's comments on the Rule DEIR for details of this evidence.

Table 1. The enforceable numeric limits on refinery-wide emissions proposed[a]

Facility	GHG (metric tons/yr)	PM (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)
Chevron Refinery, Plt. A-0010	4,473,000	529	974	400
Shell Refinery, Plt. A-0011	4,272,000	569	1,040	1,340
Phillips 66 Refinery, Plt. A-0016	1,512,000	56.0	275	433
Tesoro Refinery, Plt. B-2758/2759	2,456,000	180	1,080	707
Valero Refinery, Plt. B-2626	2,950,000	134	1,410	138
Martinez Cogen LP,[b] Plt. A-1820	431,000	18.8	119	2.30
Air Liquide H_2 Plant,[b] Plt. B-7419	855,000	17.3	12.9	2.48
Air Products H_2 Plant,[b] Plt. B-0295	281,000	10.4	3.40	2.31

[a] Annual facility-wide emission limits. **GHG:** greenhouse gas emissions (CO_2e) as reported under Air Resources Board Mandatory Reporting; **PM:** filterable and condensable particulate matter; **NOx:** oxides of nitrogen; **SO2:** sulfur dioxide. PM, NOx and SO2 as reported in the Facility's annual emission inventory.
[b] The Martinez Cogen and Air Products facilities support Tesoro; Air Liquide supports Phillips 66.

From the community, environment, labor and academic groups' specific proposal (revised 21 Sep 2015; previously delivered 18 Sep 2015; proposed in concept 27 March 2015).

Our 'Caps' *prevent* harm Staff's plan could allow—they:

Prevent <u>facility</u> emission increases* that piecemeal measures allow;

Prevent <u>local impacts</u> from $PM_{2.5}$ emission increases HRAs allow;

Prevent a new climate threat <u>and</u> local health impacts of increasing ultra-fine PM by <u>following</u> ARB's advice on local GHG caps needed to address <u>otherwise unregulated</u> toxic GHG co-pollutants;

Prevent the maximum potential to emit from new tar sands projects <u>before they are locked-in and it may be too late</u> to reverse them;* &

Prevent <u>a potential explosion of local oil train traffic</u> to deliver tar sands oil by prohibiting the emissions increase from refining it here.

* Our 'Caps' are the only Bay Area refinery emission limits proposed now that are specific, apply facility-wide <u>and</u> are enforceable on adoption—as they <u>require no change in current performance</u>. This fact also supports them as reasonable. *See* CBE et al., 21 Sep 2015 Revision, for details.

The original need assessment for this Rule further supports the need to act on the evidence outlined above.

"The use of lower quality crude at refineries could potentially mean increased emissions of air contaminants such as sulfur containing pollutants ... Processing lower quality crudes also requires more intense processing and higher energy requirements, which can result in increased air emissions."