SPARE THE AIR
COOL THE CLIMATE

A BLUEPRINT FOR CLEAN AIR AND
CLIMATE PROTECTION IN THE BAY AREA

BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

DRAFT 2017 CLEAN AIR PLAN

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SS1: Fluid Catalytic Cracking in Refineries

Brief Summary:
This control measure will reduce emissions of condensable particulate matter (PM) from fluid catalytic cracking units (FCCUs) at the four Bay Area refineries where these devices are operated, as well as precursors to the formation of secondary PM. These reductions will be achieved through Air District Regulation 6, Rule 5 (Rule 6-5), adopted in December 2015, ("Particulate Emissions from Refinery Fluidized Catalytic Cracking Units") and possible further amendments to this rule.

Purpose:
Reduce health impacts of fine PM from refinery FCCUs. FCCUs are large sources of fine PM (classified as $PM_{2.5}$ in Air District inventories) which is emitted both as filterable matter, and also as condensable gases which are not captured or detected with filters, but which condense into solid or liquid $PM_{2.5}$ after they are emitted from the FCCU and cool to ambient temperature. Secondary PM is formed in the atmosphere, not as a result of condensation, but as a result of a reaction between ammonia and both nitrogen oxides (NO_x) and sulfur oxides (SO_x). Rule 6-5 was adopted, and may be further amended, to address condensable PM and secondary PM from refinery FCCUs.

Source Category:
Stationary Source - petroleum refineries

Regulatory Context and Background:
An FCCU is a complex processing unit that cracks heavy oils from crude distillation units into lighter oils using a chemical reaction that is promoted by a powdered catalyst. The emissions from an FCCU come from the "regenerator" portion of the FCCU where used catalyst, that has become coated with coke during the cracking reaction, is heated to burn off the coke so that the catalyst may be reused. The FCCU emissions consist of the combustion emissions from this coke burn-off process. In the Bay Area, four of the five petroleum refineries operate an FCCU (Chevron, Shell, Tesoro, Valero). All four FCCUs are equipped with add-on particulate controls: three refineries use electrostatic precipitators (ESPs), while Valero operates a tertiary cyclone. ESPs and tertiary cyclones are expected to remove about 99 percent of filterable PM from the FCCU regenerator exhaust, although they are ineffective in removing the vapors that constitute condensable PM. Valero also operates a wet scrubber on its FCCU exhaust which probably provides significant condensable PM control. Ammonia occurs in the FCCU exhaust because it is added to promote the operation of ESPs, although it appears that excessive ammonia is being used.

District Regulation 6, Rule 1 (Rule 6-1) addresses filterable PM emissions from many sources, including FCCUs. However, the test methods used to monitor compliance with this rule only quantify filterable PM emissions, and are incapable of measuring condensable PM. Similarly, federal rules, NSPS Subpart J and NESHAP Subpart UUU, have PM emission limits for FCCUs that do not address condensable PM emissions because of monitoring limitations. In addition, because of the high exhaust temperature of an FCCU, it is unlikely that the opacity limits in Rule

6-1 and Subpart J constitute a limit on condensable PM emissions from FCCUs. Therefore, no federal or Air District regulation, or Air District permit condition, currently addresses condensable PM or secondary PM from refinery FCCUs.

In 2003, the South Coast AQMD adopted Rule 1105.1 to limit emissions of both filterable PM and ammonia from FCCUs. The ammonia limits were proposed because of ammonia's role in the formation of both condensable PM and secondary PM. Prior to the adoption of the Air District's Rule 6-5, Rule 1105.1 appeared to be the only air pollution rule in California to address either condensable PM or secondary PM from refinery FCCUs.

In December 2015, the Air District adopted Rule 6-5 to impose the same 10 ppmv ammonia emission limit as South Coast Rule 1105.1. Rule 6-5 allows a refinery, in lieu of compliance with the 10 ppmv limit, to perform an ammonia optimization study and to propose a higher ammonia limit that results in lower overall condensable PM emissions; this may be possible because ammonia, in addition to contributing to condensable and secondary PM formation, also promotes the capture of PM at ESPs.

Implementation Actions:
The Air District will:

- During development of Rule 6-5, the Air District began a program of testing Bay Area FCCUs for condensable PM emissions using a relatively new EPA test method (Method 202). This testing is expected to continue through 2016.
- During 2016 and 2017, the Air District will evaluate refinery progress in performing ammonia optimizations, as well as the results of Method 202 testing, to determine appropriate further actions. These may include limits on condensable PM emissions as well as limit on SO_2 emissions, or other measures.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	1,222	1,222
TACs	241	241

**criteria pollutants and TACs are reported in lbs/day*

The ammonia emission limit adopted in Regulation 6-5 was estimated to result in an ammonia emission reduction of 44 tons/year by January 2018, with a corresponding reduction of 223 tons/year of condensable PM2.5. Further reductions of PM2.5 and other pollutants will be determined by the specific future implementation actions in a future amendment of Regulation 6-5.

Exposure Reductions:
Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution,

which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy. Specifically, Rule 6-5, as adopted in 2015, will achieve emission reductions of ammonia and a corresponding reduction of condensable PM2.5. Ammonia is a toxic air contaminant (TAC). Also, exposure to PM2.5 is by far the leading public health risk from air pollution in the Bay Area, accounting for more than 90 percent of premature mortality related to air pollution. Further emission reductions through a future amendment of Rule 6-5 will be estimated based on Method 202 emission testing that will be completed in 2016.

Emission Reduction Trade-Offs:
The ammonia emission limit in Rule 6-5 allowed an ammonia optimization option to prevent increases in overall PM emissions as a result of ammonia use reductions. Future amendments of Rule 6-5 must consider all of the pollutants emitted from FCCUs and ensure that emission limits that target $PM_{2.5}$ do not result in unintended emission increases of other pollutants.

Costs:
The cost of further reductions of $PM_{2.5}$ will depend on the specific future implementation actions proposed for Rule 6-5. However, there are expected to be cost-effective control options given that the costliest option in terms of capital cost – installation of a wet scrubber on the FCCU exhaust – has been demonstrated at several US refineries.

Co-Benefits:
Further reductions in condensable PM emissions are expected to result in reductions in secondary $PM_{2.5}$ formation.

Issue/Impediments:
None.

Sources:

1. South Coast AQMD: Final Staff Report, Rule 1105.1 ("Reduction of PM10 and Ammonia Emissions from Fluid Catalytic Cracking Units"), September 16, 2003.
2. Bay Area Air Quality Management District: Bay Area 2010 Clean Air Plan, Executive Summary, September 2010.
3. Bay Area Air Quality Management District: Final Staff Report, Petroleum Refinery Emissions Reduction Strategy, Appendix A (FCCUs), December 2015.

SS2: Equipment Leaks

Brief Summary:
This control measure would further reduce emissions of total organic gases (TOG) – including reactive organic compounds (ROG) and methane – from equipment leaks at petroleum refineries.

Purpose:
The purpose of this control measure is to achieve further reductions in fugitive emissions of total organic gases (including ROG, toxic organics, and methane) at refineries.

Source Category:
Stationary sources – petroleum refineries, chemical plants, bulk plants and bulk terminals.

Regulatory Context and Background:
Component leaks commonly occur at the joints or connections between sections of piping, at valves, at pumps or from barrier fluid contained between seals, and at leaking pressure relief devices (PRDs).

The Air District originally adopted Regulation 8, Rule 18 in 1980 and has amended it twice, first in 1992 and again in 2004. In addition, some minor changes were made to the rule in 1998 and 2002. The original intent of the rule was to control fugitive organic gas leaks from valves and connectors at refineries, chemical plants, bulk plants, and bulk terminals. Rule amendments adopted in 1992 significantly lowered the allowable leak concentration limits to the lowest levels in the country and required more effective inspection and repair programs in order to reduce emissions and promote self-compliance. The 1992 amendments reduced ROG emissions by an estimated 1,200 pounds/day.

The allowable leak standard is 500 parts per million volume (ppmv) for pumps, compressors, and PRDs.[1] For valves and other equipment, the allowable leak standard is 100 ppmv. Leaks are detected using a portable combustible gas indicator.

The U.S. Environmental Protection Agency (EPA) has promulgated leak detection and repair (LDAR) standards for facilities in the synthetic organic chemical manufacturing industry but not for petroleum refineries. The EPA's standards in 40 CFR parts 60 and 63 include LDAR provisions for monitoring and repairing equipment in heavy liquid service and do not rely on instrumental monitoring, but instead rely on "visual, audible, olfactory, or any other detection method."

Implementation Actions:
In December 2015, the Air District amended Rule 8-18. The Air District will develop an implementation plan for the Rule. The amendments strengthened the Rule through the

[1] PRDs are also subject to the requirements of Air District Regulation 8, Rule 28, *Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants*.

following changes:

- Requiring future monitoring of equipment in heavy liquid service;
- Reducing the amount of equipment that can be added to the “non-repairable” equipment list;
- Addition of a maximum mass emission rate for fugitive equipment subject to the rule;
- Requiring facilities to identify the causes of background readings greater than 50 ppmv;
- Adding a maximum leak concentration and maximum mass emission rate for fugitive equipment placed on the “non-repairable” equipment list;
- Clarification of definitions; and
- Provisions for heavy liquid components will take effect on Jan 1, 2018.

Emission Reductions:

Pollutants*	2020	2030
ROG	4,546	4,546
CO_{2e}	340	340

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Once in full effect, Regulation 8, Rule 18 is anticipated to reduce ROG emissions from the five Bay Area refineries by approximately 4,546 pounds per day. About 2,000 pounds per day of these reductions would come from methane, resulting in estimated GHG emission reductions equivalent to 860 MT C02e per year, on a 20-year timeframe, and 340 MT CO_2e per year, on a 100-year timeframe.

Exposure Reductions:

Emissions from the Bay Area’s five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy. Specifically, a reduction in organic compounds will result in a reduction in air toxics exposures.

Emission Reduction Trade-Offs:

None

Costs:

Expansion of leak detection and repair program is anticipated to cost approximately $6.8 million per year (capital costs: $250,000).

Co-Benefits:
None identified.

Issue/Impediments:
There are thousands of additional equipment components in heavy liquid service that would be required to be identified and monitored under an expanded LDAR program. This would be a major undertaking for refineries. In addition, equipment in heavy liquid service is handled at an elevated temperature and may require special equipment to handle safely.

Sources:

1. Bay Area Air Quality Management District, Proposed Regulation 8, Rule 18: Equipment Leaks, December 16, 2015
2. EPA Method 21 – Determination of Volatile Organic Compound Leaks
3. Bay Area Air Quality Management District, staff report for Refinery Emissions Reduction Strategy, October 2015.

SS3: Cooling Towers

Brief Summary:
Petroleum refineries use cooling towers to return waste heat to the environment through the evaporation of water. Leaks in heat exchange systems can result in emissions of total hydrocarbons (THC) and, sometimes, toxic air contaminants (TACs). This control measure is intended to reduce THC and TAC emissions from cooling towers in petroleum refineries. The amendments to Air District Regulation 11, Rule 10, *Hexavalent Chromium Emissions from Cooling Towers* which has been renamed *Hexavalent Chromium from All Cooling Towers and Total Hydrocarbon Emissions from Petroleum Refinery Cooling Towers* were adopted by the Air District's Board of Directors on December 16, 2015.

Purpose:
To reduce THC and TAC emissions from cooling towers at Bay Area refineries by requiring more rapid detection and repair of leaking heat exchangers.

Source Category:
Stationary sources – petroleum refineries

Regulatory Context and Background:
The Bay Area has five large-scale petroleum refineries which operate a total of 34 cooling towers. These cooling towers are large, industrial heat exchangers that dissipate significant heat loads to the atmosphere through the evaporation of water. Process liquids, which often contain THC and sometimes TACs, may leak into cooling tower water and then be evaporated into the environment. The longer leaks go undetected and unrepaired, the greater the quantity of emissions.

The Air District developed Regulation 11, Rule 10 (Rule 11-10) in 1989 to eliminate the use of hexavalent chromium additives in cooling towers.

In 2009, US EPA promulgated, and, in 2013, amended, 40 CFR, part 63, subpart CC, National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries (MACT CC). MACT CC requires periodic monitoring (monthly or quarterly) of heat exchangers in organic TAC service and requires repair of leaks as soon as is practicable (but no later than 45 days after detection).

Implementation Actions:
On December 16, 2015, the Air District Board of Directors adopted the following amendments to Rule 11-10, which went into effect July 1, 2016:

- Owners and operators of cooling towers at petroleum refineries will be required to install continuous THC monitors or test for THC in cooling water daily unless the APCO approves an alternative monitoring regime.
- The amended regulation establishes a THC concentration standard of 6 ppmv (by volume) for existing cooling towers and a 3 ppmv standard for new cooling towers when measured

in stripped air by a continuous analyzer. The THC concentration standard is 84 ppbw (by weight) when measured in cooling water.

- Refineries are required to minimize the leak within 5 calendar days and shall repair the leak within 21 days.

Because the scope of the regulation has increased, the title has been amended from "Hexalvalent Chromium Emissions from Cooling Towers" to "Hexavalent Chromium Emissions from All Cooling Towers and Total Hydrocarbon Emissions from Petroleum Refinery Cooling Towers." Staff is preparing an implementation plan for the amended regulation.

Emission Reductions:

Pollutants*	2020	2030
ROG	5,200	5,200

**criteria pollutants are reported in lbs/day*

Exposure Reductions:
Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy. Specifically, a reduction in THC will result in reduced exposure to air toxics.

Emission Reduction Trade-Offs:
None

Costs:
Air District staff expect the cost to implement the amended regulation to be in the range of $1-3 million per year divided among the five major Bay Area refineries, depending on the monitoring methods selected and the number of leaks that need to be repaired.

Co-Benefits:
A co-benefit of Rule 11-10 will be reduction of TAC emissions that are present in some process liquids.

Issue/Impediments:
None identified

Sources:

1. Bay Area Air Quality Management District, 2011 Base Year Emissions Inventory,
2. Bay Area Air Quality Management District, Petroleum Refinery Emissions Reduction Strategy: Staff Report, October 2015

SS4: Refinery Flares

Brief Summary:
The Air District's refinery flare monitoring Regulation 12, Rule 11 (Rule 12-11) has been in place since 2003, and the flare reduction Rule 12-11 has been in place since 2005. Air District staff will review the results of these rules at each of the five refineries in the Bay Area to identify amendments that may make the rules more effective at reducing emissions.

Purpose:
Reduce frequency and magnitude of flaring events, thereby reducing particulate matter (PM), black carbon, and unburned hydrocarbons that may occur during a significant flare event.

Source Category:
Permitted Point Sources – refinery flares

Regulatory Context and Background:
July 20, 2005, the Air District adopted Regulation 12, Rule 12 (Rule 12-12) to reduce flaring at the Bay Area's five oil refineries. The rule, the first of its kind in the nation, affected flares that were in operation at the time of the rules adoption. The rule was intended to reduce air pollution by minimizing flaring during normal operations. Flaring – the burning off of excess gases at refineries to prevent them from being vented directly into the atmosphere – would still be allowed when necessary to safely operate a refinery.

In June 2003, the Board adopted a flare monitoring rule which required refineries to monitor and report flare emission data to the Air District. By installing compressors to recover refinery gases and by instituting better operating practices, flare emissions have been reduced by 75 percent - from 1,600 pounds per day of total organic compounds, on average, to 4,000 pounds per day at the present time. The 2005 rule built on the 2003 rule by making the reductions permanent.

The 2005 rule requires that each refinery prepare a Flare Minimization Plan (FMP) that determines how best to further minimize flaring. Air District staff carefully reviews the plans for effectiveness and takes public comment on them. The FMPs must include:

- Detailed information about equipment and operating practices related to flares,
- Steps the refinery has taken and will take to minimize the frequency and duration of flaring, a schedule for implementation of all feasible flare prevention measures.

Plans must be approved by the Air District. The FMPs are updated annually to incorporate the latest technologies and practices.

Rule 12-12 also requires a causal analysis of flaring events involving the emission of more than 500,000 cubic feet of gases. Less significant events will also be included in a required annual report and feasible prevention measures will be incorporated into the FMPs. These evaluation processes will result in continuous improvement and management of major flaring events.

The entire structure of this rule relies on critical review of the causes of flaring so that effective corrective actions can be determined, and implemented. Without commitment to this process, flaring events and resulting emissions are not prevented to the degree they could be with such commitment.

Implementation Actions:
The Air District will:

- Propose amending Rule 12-12 to mirror the “breakdown” requirements in Regulation 1. This will allow both the Air District and the refineries to evaluate areas of opportunity to further reduce emissions from flares and to redefine flaring that should be allowed in the FMP.

Emission Reductions:

Pollutants*	2020	2030
ROG	60	60
SO_2	100	100

**criteria pollutants are reported in lbs/day*

Exposure Reductions:
Emissions from the Bay Area’s five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy. Specifically, this measure will reduce exposure to toxic air contaminants, which hare included in smoke from flares.

Emission Reduction Trade-Offs:
None

Costs:
The work associated with conducting root cause failure analysis is typically done by existing refinery staff. Implementing preventive/corrective actions can be significant, and costly if refinery process units, infrastructure, or flare systems must be redesigned. However, these costs are offset by the benefits of reducing costs associated with a refinery incident, fire damage, equipment repair and associated lost production.

Co-Benefits:
Improved production, less equipment damage, and potential for reduced methane emissions. Methane is typically a component of flared gas, but usually burns effectively at the flare tip.

Very little quantitative information is available regarding unburned methane during flare events.

Issue/Impediments:
None, however, adequate follow up will be required to prevent recurrence.

Source:

1. http://www.baaqmd.gov/Divisions/Compliance-and-Enforcement/Refinery-Flare-Monitoring/Emissions.aspx

SS5: Sulfur Recovery Units

Brief Summary:
Each of the five Bay Area refineries operates one or more sulfur recovery units (SRUs) that produce marketable, elemental sulfur from gaseous sulfur compounds removed from petroleum feedstocks. SRUs in the Bay Area are subject to a 30 year-old limit (both federal and Air District imposed via Rule 9-1) on sulfur dioxide (SO_2). This control measure is projected to reduce actual SO_2 emissions from sulfur recover units by about 68 percent based on current, achievable practices.

Purpose:
Reduce SO_2 emissions from SRUs at petroleum refineries.

Source Category:
Permitted Sources – petroleum refineries

Regulatory Context and Background:
Crude petroleum naturally contains some sulfur compounds. California crude oils typically contain between one and two percent sulfur by weight. Because gasoline, diesel fuel, and other refined petroleum products are required to contain sulfur in concentrations on the order of parts per million, this sulfur must be removed, most of it recovered in the SRU. Unrecovered sulfur is emitted, mostly as SO_2.

In 1983, the Air District established a 250 ppm limit on emissions of SO_2 from SRUs through Rule 9-1. The United States Environmental Protection Agency (U.S. EPA) subsequently established identical limits in its *Standards of Performance for Petroleum Refineries* and *Standards of Performance for Petroleum Refineries for which Construction, Reconstruction, or Modification Commenced after May 14, 2007*. The Air District's limit, however, applies to all SRUs regardless of the date of construction, reconstruction or modification.

In November, 2010, the South Coast Air Quality Management District (SCAQMD) published a staff report on the SO_2 limits of equipment subject to its Regional Clean Air Incentives Market (RECLAIM) program. SCAQMD found SO_2 limits of 10 ppm to be feasible through SRU and tail gas treating system process improvement, and SO_2 limits of 5 ppm to be achievable by installing wet caustic scrubbers[1]. However, cost effectiveness of wet caustic scrubbers sometimes exceeded $50,000 per ton of SO_2 removed. SCAQMD elected to establish a limit of 5 ppm for SRUs as part the RECLAIM cap-and-trade program.

A review of the Bay Area refineries' SRUs' emissions show that all of them easily attain the 250 ppm limit. Two of them already achieve the 10 ppm SO_2 limit. A third SRU has achieved a 10 ppm limit during a source test using existing equipment, though it normally emits SO_2 at about twice this rate. The two remaining refineries have SRUs that would require 75-85 percent emission reductions to attain the 10 ppm SO_2 limit.

[1] A wet caustic scrubber is a control method that removes a pollutant by bringing the polluted gas stream into contact with a caustic (or alkaline) scrubbing liquid.

Implementation Actions:

The Air District will:

- Consider amendments to Rule 9-1, *Sulfur Dioxide* to achieve the lowest SO_2 emission feasible through increased efficiency of sulfur recovery units and improved tail gas treatment (i.e., an SO_2 limit of 10 ppm).
- Consider amendments to Rule 9-1 to achieve the lowest SO_2 emission feasible through installation of wet caustic scrubbers (i.e., an SO_2 limit of 5 ppm).
- Review cost effectiveness and incremental cost effectiveness of controls required to achieve the SO_2 limits of 5 ppm and 10 ppm.

Emission Reductions:

Pollutants*	2020	2030
SO_2	900	900

**criteria pollutants are reported in lbs/day*

Exposure Reductions:

Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Costs:

There is considerable uncertainty in the cost of control as emission reductions can result from efficiency improvements within the unit itself, from a variety of proprietary tail gas treatment technologies, or the addition of add-on control equipment (e.g., wet caustic scrubbers).

Co-Benefits:

There will be less secondary $PM_{2.5}$ formation from reduced sulfates.

Issue/Impediments:

None

Sources:

1. Code of Regulations, Title 40, part 60, subpart J, *Standards of Performance for Petroleum Refineries* [54 FR 34031, August 17, 1989, as amended at 55 FR 40178, Oct. 2, 1990]

2. Code of Regulations, Title 40, part 60, subpart Ja, *Standards of Performance for Petroleum Refineries for which Construction, Reconstruction, or Modification Commenced after May 14, 2007* [77 FR 56480, September 12, 2012]
3. *California Crude Oil Production and Imports*, Margaret Sheridan, Fossil Fuels Office, Fuels and Transportation Division, California Energy Commission, April, 2006
4. SCAQMD Rule 2002: RECLAIM
5. SCAQMD, Final Staff Report: SOx RECLAIM, Part 1, BARCT Assessment & RTC Analysis, November 2, 2010

SS6: Refinery Fuel Gas

Brief Summary:
The lightest components of crude oil separated by a refinery's atmospheric fractionator are methane and ethane, which are also the primary components of natural gas. These products, along with gases produced at other refinery process units, commonly called refinery fuel gas (RFG), are used as fuel in steam generators, process heaters, and other combustion units. Because RFG contains naturally occurring sulfur compounds, it produces sulfur dioxide (SO_2) as a combustion byproduct.

Purpose:
Reduce SO_2 emissions from RFG combustion at petroleum refineries.

Source Category:
Permitted Sources - petroleum refineries

Regulatory Context and Background:
RFG can contain between a few hundred and a few thousand parts per million-volume (ppmv) sulfur in the form of hydrogen sulfide (H_2S) and organic sulfur compounds, such as mercaptans. During combustion, the sulfur in all of these compounds will oxidize to form SO_2, which is a criteria air pollutant and a precursor to particulate matter. Scrubbing with an amine solution can be effective at removing H_2S and some acidic sulfur containing compounds, but is generally ineffective at removing nonacidic sulfur compounds. Hydrotreating, a catalytic chemical process, converts these sulfur compounds to hydrogen sulfide which can then be removed by scrubbing.

In 1990, the Air District modified Regulation 9, Rule 1: *Sulfur Dioxide*, requiring all refineries that process more than 20,000 barrels per day of crude oil to operate a sulfur removal and recovery system that removes and recovers, on a refinery wide basis, 95 percent of the H_2S from RFG.

In 2008, the United States Environmental Protection Agency (EPA) promulgated 40 CFR part 60, subpart Ja, *Standards of Performance for Petroleum Refineries for which Construction, Reconstruction, or Modification Commenced after May 14, 2007*. The regulation limits H_2S concentration in combustion units to 162 ppmv, determined hourly on a three-hour rolling average, and to 60 ppmv, determined daily on a 365-day rolling average. Alternatively, refiners can choose to comply with post-control SO_2 emission limits of 20 parts per million- volume, dry (ppmvd), determined hourly on a three-hour rolling average, and 8 ppmvd, determined daily on a 365-day rolling average, with all SO_2 concentrations corrected to 0 percent oxygen.

The South Coast Air Quality Management District's (SCAQMD) Rule 431.1 limits the sulfur content of RFG, calculated as H_2S, to 40 ppmv, four-hour average. The initial compliance date was May 4, 1994 for large refineries and May 4, 1996 for small refineries. SCAQMD allows facilities to demonstrate equivalent SO_2 emission reductions within the facility, provided alternative plans have been approved by the Executive Officer in writing.

All of the major refineries in the Bay Area are complying with federal limits for H_2S, but two of them combust RFG with elevated levels of organic sulfur compounds in some or all of their combustion units.

Implementation Actions:
The Air District will:

- Consider amendments to Rule 9-1, *Sulfur Dioxide*, that would reduce fuel sulfur limits for RFG and determine the appropriate averaging periods.

Emission Reductions:

Pollutants*	2020	2030
SO_2	6,000	6,000

**criteria pollutants and TACS are reported in lbs/day*

Exposure Reductions:
Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Emission Reduction Trade-Offs:
None

Costs:
Because sulfur processing and removal is linked with nearly all refinery processes, costs are difficult to estimate. If improved sulfur removal is combined with other refinery upgrades (e.g. propane and butane recovery or processing sweeter crudes), there could be revenue enhancements and a net cost reduction. Without increased revenue, the two refineries with elevated levels of organic sulfur compounds in their RFG could see net costs in the range of $1-3 million per year. The other refineries could see more modest costs to improve refinery processes depending on the form of the final rule.

Co-Benefits:
There will be less secondary $PM_{2.5}$ formation from reduced sulfates.

Issue/Impediments:
None

Sources:

1. Regulation 9, Rule 1, Sulfur Dioxide, last modified March 15, 1995
2. 40 CFR part 60, subpart J, *Standards of Performance for Petroleum Refineries* [54 FR 34031, August 17, 1989, as amended at 55 FR 40178, Oct. 2, 1990]
3. 40 CFR part 60, subpart Ja, *Standards of Performance for Petroleum Refineries for which Construction, Reconstruction, or Modification Commenced after May 14, 2007* [77 FR 56480, September 12, 2012]
4. SCAQMD Rule 431.1: Sulfur Content of Gaseous Fuels, amended June 12, 1998

SS7: Sulfuric Acid Plants

Brief Summary:
Sulfuric acid is used as a catalyst in alkylation units at petroleum refineries. Over time, sulfuric acid is contaminated with petroleum products and needs to be regenerated.

The first step in the process is thermal decomposition of spent sulfuric acid in a furnace, producing sulfur dioxide (SO_2). The catalytic reaction oxidizing SO_2 to SO_3 (which then reacts with water to form fresh sulfuric acid) is an equilibrium reaction which is never 100 percent efficient. As a result, there is always some unreacted SO_2 that is vented to the atmosphere.

There are three acid plants associated with Bay Area refineries. The Tesoro Refinery near Martinez operates an acid plant; Eco Services in Martinez operates an acid plant as a support facility for the Shell and Valero refineries on a regular basis and serves as a backup facility for the Tesoro Refinery when Tesoro's acid plant is shut down; and Chemtrade West in Richmond operates an acid plant as a support facility for Chevron Products.

Purpose:
Reduce SO_2 emissions from sulfuric acid regeneration associated with petroleum refining.

Source Category:
Permitted Sources – sulfuric acid plants

Regulatory Context and Background:
In 1977, the United States Environmental Protection Agency (EPA) promulgated 40 CFR part 60, subpart H, *Standards of Performance for Sulfuric Acid Plants*. The regulation limits SO_2 emissions to 4 pounds per ton of acid produced and limits sulfuric acid mist emissions to 0.15 pounds per ton of acid produced. Air District Regulation 9, Rule 1 (Rule 9-1) establishes emission limits for sulfur dioxide from all sources including ships, and limits ground level concentrations of sulfur dioxide. In 1992, the Air District amended Rule 9-1, establishing an SO_2 emission limit of 300 parts per million-volume (ppmv) for sulfuric acid plants, calculated at 12 percent oxygen.

In 2007, Rhodia, Inc. entered into a consent decree with EPA and the United States Department of Justice limiting SO_2 emissions from the acid plant (now operated by Eco Services) to 2.2 pounds per ton of 100 percent sulfuric acid produced, 365-day average, and 3.0 pounds per ton of 100 percent sulfuric acid produced, three-hour average.[1]

In their November 2010, RECLAIM Report, South Coast Air Quality Management District (SCAQMD) staff recommended a limit of 0.14 lbs per ton of acid produced (10 ppmv), which was adopted by SCAQMD.

[1] This was part of a nation-wide consent decree and was not limited to the Martinez acid plant.

A review of EPA's RACT/BACT/LAER Clearinghouse[2] (RBLC) revealed a 2006 synthetic minor permit from New Jersey with an SO_2 limit of 0.2 lbs per ton of acid produced and a 2012 PSD permit from Indiana with an SO_2 BACT limit of 0.25 lbs per ton of acid produced, 24-hour average.

The New Jersey Department of Environmental Protection provided the Air District with two recent source test reports for the facility in Union County, New Jersey with the 0.2 pound per ton limit. The State of New Jersey confirmed that the facility was in compliance with its emission limits.

Implementation Actions:
Consider amendments to Rule 9-1, *Sulfur Dioxide*, that would limit SO_2 emissions from acid plants associated with petroleum refining. Consider establishing BARCT limits of 0.2 lbs. of acid mist per ton of acid produced.

Emission Reductions:

Pollutants*	2020	2030
SO_2	2,800	2,800

**criteria pollutants are reported in lbs/day*

Exposure Reductions:
Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Emission Reduction Trade-Offs:
None

Costs:
BARCT limits of 0.2 lbs per ton of acid produced will require wet scrubbers at each of the three acid plants. One acid plant already has a wet scrubber, but it may need to be upgraded or replaced to meet the new standards. Capital costs are estimated at $7,000,000 for each facility, amortized to $700,000 annually. Operating costs are estimated at $200,000 per year at two facilities, and $300,000 per year for the third (higher caustic costs for higher SO_2 reductions). Total costs are $2,800,000 per year.

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[2] The RBLC is a national database of case-by-case emission limitations made by permitting authorities when authorizing new sources of air pollution.

Co-Benefits:
There will be less secondary $PM_{2.5}$ formation from reduced sulfates.

Issue/Impediments:
None

Sources:

1. 40 CFR part 60, subpart H, *Standards of Performance for Sulfuric Acid Plants* [42 FR 37936, July 25, 1977]
2. South Coast Air Quality Management District, Final Staff Report: Sox RECLAIM, Part 1, BARCT Assessment & RTC Analysis, November 2, 2010
3. US Environmental Protection Agency, RACT/BACT/LAER Clearinghouse (RBLC) Clean Air Technology Center
4. Bay Area Air Quality Management District, Regulation 9: Rule 1, *Inorganic Gaseous Pollutants: Sulfur Dioxide*, last amended March 1995

SS8: Sulfur Dioxide from Petroleum Coke Calcining

Brief Summary:
This control measure will limit emissions of sulfur dioxide (SO_2) from petroleum coke calcining by requiring that emission controls at coke calcining kilns remove an equivalent of 59 percent of the SO_2 created by the calcining process. These reductions will be achieved through Air District Regulation 9, Rule 14 (Rule 9-14), adopted in April 2016.

Purpose:
Reduce SO_2 and particulate matter emissions.

Source Category:
Stationary source – petroleum coke calcining operations

Regulatory Context and Background:
The Air District is a nonattainment area for the California PM_{10} and $PM_{2.5}$ clean air standards and for the national $PM_{2.5}$ standards. Particulate matter (PM) comes from natural sources (dust, sea salt), motor vehicles (mostly diesel soot), and industrial sources (catalyst emissions from refineries, black carbon from power plants). Particulates can also form in the air from reaction of ammonia with NO_X and sulfur oxides (SO_X). Exposure to PM pollution has the greatest health impact because the smallest particles can penetrate deep into the lungs, causing damage to lung tissue. The finest of these particles can penetrate through lung tissue into the bloodstream causing a large variety of health issues such as aggravating existing heart disease.

SO_2 is a pungent-smelling gas commonly formed from the burning of fossil fuel materials that contain sulfur, such as coal or oil, and from certain industrial processes, such as petroleum refining, chemical production, and metal smelting. It is also released from natural sources such as volcanoes, geothermal hot springs and wildfires.

Once emitted into the atmosphere, SO_2 reacts with chemicals in the air, such as ozone, or in the presence of water to form sulfuric acid and eventually reacts with ammonia in the air to form ammonium sulfate, a component of $PM_{2.5}$.

Two coke calcining kilns at the Bay Area's only petroleum coke calcining facility emit a total of 4.0 tons per day of sulfur dioxide when the Carbon Plant is fully operational. Air District staff has investigated more stringent SO_2 limits at coke calcining facilities. The Carbon Plant currently operates a dry sorbent injection abatement device to control SO_2 emissions to maintain compliance with the current SO_2 limit in Regulation 9, Rule 1 (Rule 9-1) of 400 ppm by volume or 113 kg (250 pounds) per hour, whichever is more restrictive. The Carbon Plant as well as Air District staff have source tested the calcining operation and have determined that the Carbon Plant currently reduces SO_2 emissions, on average, by approximately 42 percent overall, which is higher than previously known. The South Coast AQMD and San Luis Obispo County APCD both require a minimum of 80 percent SO_2 control, which is more restrictive than the Air District's current requirements.

An analysis of the impact of an 80 percent SO_2 control showed a significant impact on the Bay Area's Carbon Plant. Therefore, the Air District adopted Rule 9-14: Coke Calcining Operations which would allow for a mass emission limit of 1,050 tons per year (tpy) which is equivalent to 59 percent control in a typical year. This emission limit is a combined limit for both kilns. Staff anticipates this mass emission standard will realize an SO_2 emission reduction of 430 tpy. The rule also proposes an hourly limit of 320 pounds per hour for the combined SO_2 emissions from both kilns.

Implementation Actions:

The Air District will:

- Ensure that both of the Carbon Plant's kilns comply with the SO_2 pounds per hour emission limit by January 1, 2019.
- Ensure that both kilns comply with the tons per year emission limit by January 1, 2020.

Emission Reductions:

Pollutants*	2020	2030
SO_2	2,356	2,356

**criteria pollutants are reported in lbs/day*

Exposure Reduction:

Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Emission Reductions Trade-offs:

None identified.

Costs:

Air District staff has estimated that it will cost between $4 and $5 million to upgrade the existing SO_2 controls system to meet the requirements of Rule 9-14. Under the Air District's standard method for distributing one-time capital costs over the life of the equipment, that translates to an annual cost of $680,000/year. Another significant cost is the purchase of dry sorbent material to react with the SO_2 in the process stream and to convert it to an inert solid that is captured in the existing particulate matter control system. Based on cost quotes from a sorbent supplier, Air District staff estimates these costs to be $500 per ton of additional sorbent.

In summary, the estimated annual cost for the Carbon Plant to improve their current Dry Sorbent Injection (DSI) system to comply with the 1,050 tpy emission requirement in Rule 9-1 is approximately $1.87 million.

Issues/Impediments:
None identified.

Sources:

1. South Coast AQMD Rule 1119: Petroleum Coke Calcining Operations – Oxides of Sulfur.
2. San Luis Obispo County Air Pollution Control District Rule 440: Petroleum Coke Calcining and Storage Operations.
3. South Coast AQMD November 2010 SO_X Reclaim BARCT Assessment Staff Report.
4. Applied Development Economics October 2015 Socioeconomic Analysis of Carbon Plant and draft Regulation 9 Rule 14.
5. Bay Area Air Quality Management District, Draft Staff Report: Proposed Regulation 9, Rule 14: Petroleum Coke Calcining Operations, January 2016.

SS9: Enhanced NSR Enforcement for Changes in Crude Slate

Brief Summary:
This measure would enhance the Air District's New Source Review (NSR) permit program to ensure that refineries are complying with all applicable NSR permit requirements when they change the type of crude oil they process, i.e. changes to the crude slate. This requirement would compel refineries to submit a permit application providing details of any significant change in crude slate, which would allow the Air District to review the change and determine whether it is subject to NSR requirements. Requiring a review of all such significant crude slate changes will allow the Air District to evaluate such changes in detail and ensure that they will comply with applicable NSR permitting requirements.

Purpose:
To ensure compliance with NSR program requirements.

Source Category:
Stationary Source – petroleum refineries

Regulatory Context and Background:
The Air District's NSR program is a comprehensive air permitting program that applies to a wide range of stationary source facilities within the Air District's regulatory jurisdiction. The program requires a facility to obtain a permit and implement state-of-the-art air pollution control technology whenever a facility installs a new source of air emissions or makes a modification to an existing source.

The Air District's NSR program is set out in Regulation 2, Rule 2 (Rule 2-2) and is the Air District's fundamental permitting requirement for regulating criteria pollutant emissions. It requires facilities to obtain an NSR permit for any new or "modified" source of air emissions, and to satisfy a number of air pollution control requirements in order to be eligible for the permit. [1] These requirements vary somewhat depending on the pollutant involved, being somewhat more stringent for pollutants for which the region is not in attainment of the applicable ambient air quality standards (non-attainment pollutants) and somewhat less stringent for pollutants for which the region is in attainment of the applicable ambient air quality standards (attainment pollutants).

This control measure is designed to ensure that refineries comply with applicable NSR permitting requirements when they change the types of crude oil – known as the refinery's

[1] "Modified source" is defined in Regulation 2-1-234 as (i) any physical change, change in the method of operation, increase in throughput or production, or other similar change to a source that will result in an increase in the source's permitted emissions (or for "grandfathered" sources that are not subject to any permit limits, in increase in the source's physical capacity to emit air pollutants); or (ii) for sources at "major" facilities, which includes all Bay Area refineries, any change that will result in a "significant" increase in the source's actual emissions as defined in EPA's federal NSR regulations.

"crude slate" - that they process.[2] Concerns have been raised that refineries may be making changes associated with moving to new crude oil slates that are subject to NSR permitting requirements, but without obtaining NSR permits or complying with the substantive requirements of the NSR program. A situation could arise where a refinery makes a physical change or change in its method of operations associated with a change in crude slate that meets the definition of a "modification" and would thus require the refinery to obtain an NSR permit under Rule 2-2 and implement the NSR program requirements before making the change. If a refinery makes such a "modification" associated with crude slate changes without applying for or obtaining an NSR permit, it may be difficult or impossible for the Air District (and the public) to discover that the modification was made. Refineries are large, complex operations, and any modifications associated with crude slate changes may be relatively subtle and not immediately obvious.

In 2000, the Air District added the term "alteration" in Regulation 2, Rule 1 (Rule 2-1) Section 233, defined as a change at a source that does *not* increase emissions and is therefore not a "modification" (i.e., a change that does increase emissions). Rule 2-1 Section 301 requires facilities to obtain a permit before making either an "alteration" or a "modification," and so a permit is required for all such changes, whether they increase emissions (a modification) or do not increase emissions (an alteration). In this manner, *all* changes at a facility that may impact emissions require a permit review, which allows the Air District to determine whether or not they are subject to NSR requirements.

Air District staff is investigating potential amendments to Rule 2-1 to expand the definition of "alteration" to include any significant crude slate change at a petroleum refinery. A crude slate change that increases emissions would be a "modification," and a crude slate change that does not increase emissions would be an "alteration." In both cases the refinery would need to obtain a permit before making the change. If the refinery believes that the crude slate change will involve an emissions increase (i.e., will be a "modification"), it can apply for an NSR permit and implement the NSR requirements as it would for any other modification. If the refinery believes that the crude slate change will not involve an emissions increase (i.e., will be an "alteration"), it can apply to have the change permitted as an alteration, which is not subject to NSR. The Air District will then review the application to determine whether there will in fact be any emissions increase or not. If the Air District confirms that there will not be any increase, it will issue a permit and authorize the change as an alteration. If the Air District finds that there will be an increase, however, it will require the change to be treated as a modification and will require the refinery to implement the NSR requirements as a condition to making the crude slate change.

[2] The term "crude slate" refers to the mix of crude oil types that a refinery processes, and it reflects various characteristics of the crude oil such as sulfur content and density. The crude slates being refined by Bay Area refineries have been changing recently, and they are expected to continue to change in the future as California's crude oil resources in the Central Valley start to become depleted and refineries look to other sources of crude oil.

Implementation Actions:
The Air District would revise the definition of "alteration" in Rule Section 2-1-233 to clarify that any significant crude slate change is an alteration, such that refineries will need to obtain Air District approval before making such a change. The approval process will allow the Air District to review the change and determine whether it is subject to NSR permitting requirements, and if so, to ensure compliance with any applicable NSR requirements.

Emission Reductions:
This proposed revision is primarily aimed at improving compliance with and enforcement of the Air District's NSR program; it is difficult to quantify the extent of any additional emission reductions associated with such revisions. In situations where a refinery making a crude slate change would have complied with all NSR permitting requirements anyway, the proposed amendment would have essentially no impact. If refineries are making crude slate changes subject to NSR without complying with the regulations, then better enforcement to require the refineries to implement these requirements - as called for in this measure - will have substantial emission reduction benefits.

Exposure Reductions:
Emissions from the Bay Area's five major oil refineries have been steadily decreasing over the past several decades, however, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Emission Reduction Trade-Offs:
None identified at this time.

Costs:
This measure would entail compliance costs, however, they would not be new costs imposed by additional regulations; they are simply existing compliance costs. These costs may be viewed as "additional" by refineries if they have not been complying with existing regulations, and therefore incurring compliance costs of the existing regulation. The extent of any such compliance costs is unknown, given that the scope of any such non-compliance is unknown.

Co-Benefits:
None.

Issue/Impediments:
None.

SS10: Petroleum Refining Emissions Tracking

Brief Summary:
On April 20, 2016, the Air District Board adopted Regulation 12, Rule 15 (Rule 12-15). The regulation includes provisions to: 1) improve petroleum refinery emissions inventories of criteria pollutants, toxic air contaminants (TACs) and greenhouses gases (GHGs), 2) collect volume and composition data on crude oil and other feedstocks processed by refineries, and 3) expand refinery fenceline air monitoring. The improved emission inventory requirement also applies to five refinery support facilities.

Purpose:
The purpose of this control measure is to implement Rule 12-15; to improve the quality of refinery air emissions data, so that the public may be better informed, and to better inform future rulemaking efforts. Rule 12-15 itself does not include emission limits or trigger levels for emission mitigation actions, although the information provided through implementation of Rule 12-15 could lead to emission limits or emission mitigation triggers in separate, future rulemaking.

Source Category:
Stationary sources – petroleum refineries

Regulatory Context and Background:
A petroleum refinery is an industrial facility that converts crude oil into gasoline, diesel fuel, heating oil, lubricating oil, and other products. The Bay Area has five large-scale petroleum refineries that rank among the ten largest sources of air pollution in the air basin and are classified as major sources of criteria pollutants, toxic air contaminants, and greenhouse gases. As a result, the refineries are subject to Air District major source permitting requirements to operate, as well as when constructing or modifying operations.

Numerous federal, state, and local regulations apply emission limits and associated monitoring, record keeping, and reporting requirements to owners and operators of equipment commonly found at petroleum refineries including:

- Federal standards under 40 CFR parts 60 and 63 that apply to storage tanks, combustion equipment, equipment leaks, wastewater treatment plants, sulfuric acid plants, sulfur recovery units, flares, and common refinery process units;
- State Air Toxics Control Measures that apply to combustion units; and
- Air District Rules that apply to storage tanks, combustion equipment, equipment leaks, wastewater treatment plants, sulfur dioxide emissions, hydrogen sulfide emissions, flares, and other common refinery process units.

In addition, petroleum refineries are required under 40 CFR part 98 to report greenhouse gas emissions annually to the federal government and by California's Mandatory Reporting Rule to report greenhouse gas emissions annually to the State of California.

Implementation Actions:
Air District staff will prepare an implementation plan to identify required actions and deadlines for both refineries and responsible District staff. New Rule 12-15 requires refineries to:

- Prepare reports of emissions of criteria pollutants, toxic air contaminants, and greenhouse gases from the refinery (refineries and certain refinery support facilities),
- Generate a crude slate report describing the characteristics of crude oil and imported feedstocks processed by the refinery, and
- Develop air monitoring plans and install and operate fenceline air monitoring systems.

Emission Reductions:
None. Rule 12-15 is intended to provide information rather than reduce emissions.

Exposure Reductions:
Rule 12-15 is intended to provide information rather than reduce emissions.

Emission Reduction Trade-Offs:
None.

Costs:
According to the socioeconomic study prepared for Rule 12-15, the costs associated with this rule include:

- $315,000 per refinery, per year for 10 years as the annualized cost of preparing Air Monitoring Plans and installing fence-line air monitors, and
- $140,000 per refinery, each year, for new emissions inventories and crude/feedstock reports, and operation and maintenance of air monitoring systems.

Co-Benefits:
Increased transparency and tracking of refining emissions.

Issue/Impediments:
None.

Sources:

1. Regulation 12, Rule 15: Petroleum Refining Emissions Tracking, April 20, 2016.
2. Socioeconomic Analysis of Proposed Regulation 12, Rule 15, prepared for Bay Area Air Quality Management District, Applied Development Economics, Inc., March, 2016.

SS11: Petroleum Refining Facility-Wide Emissions Limits

Brief Summary:
This control measure would limit facility-wide emissions of greenhouse gases (GHG) and three criteria air pollutants - particulate matter (PM), oxides of nitrogen (NO_X), and sulfur dioxide (SO_2) - from Bay Area petroleum refineries through Air District Regulation 12, Rule 16.

Purpose:
The purpose of this control measure is to prevent increases of GHG and certain criteria air pollutant emissions that could result from operational changes at Bay Area refineries in order to protect the climate, and the region's air quality.

Source Category:
Stationary sources – petroleum refineries

Regulatory Context and Background:
A petroleum refinery is an industrial facility that converts crude oil into gasoline, diesel fuel, jet fuel, lubricating oil, and other products. The Bay Area has five large-scale petroleum refineries that rank among the ten largest sources of air pollution in the air basin. Refineries and their associated facilities contribute significantly to carbon dioxide (CO_2) emissions (the primary driver of climate change), criteria pollutant emissions (including NO_X, SO_2, and PM), and toxic air contaminant emissions which can exacerbate community health risks. While refinery criteria pollutant emissions have declined over time, refinery GHG emissions have been relatively stable in the last few years[1], so there is a possibility that changes in facility operations, crude or product slates, or increases in production could increase GHGs and other emissions from refineries.

Given community concern about the potential for emission increases from oil refineries, the Board of Directors directed Air District staff to evaluate draft Regulation 12, Rule 16 (Rule 12-16) as an option to address potential emission increases from operational changes at the Bay Area refineries. Draft Rule 12-16 reflects a policy recommendation from Communities for a Better Environment (CBE) and their associated organizations. The rule, as proposed by CBE, would limit the emissions of climate pollutants and three criteria pollutants: PM, NOx, and SO_2 from Bay Area petroleum refineries and three associated facilities. The draft rule would establish facility-wide emissions limits for the covered pollutants at each of the affected facilities to ensure that each facility does not increase emissions. Each facility emissions limit would be set at the historical maximum-annual emissions reported for that facility, with an additional allowance over the maximum annual emission rate for each pollutant to allow for normal variation. Rule 12-16 will be evaluated alongside Regulation 11, Rule 18, which focuses on existing sources of toxic air contaminants (TACs) such as refineries (see SS20: Air Toxics Risk Cap and Reduction from Existing Facilities).

[1] According to ARB's GHG mandatory reporting data from 2008 through 2015.

Implementation Actions:
The Air District will develop draft language for new regulation, Rule 12-16, based on CBE's proposal, in order to evaluate its cost-effectiveness and socioeconomic impacts as part of the rule development process. Staff will also evaluate Rule 12-16, alongside Rule 11-18, in a combined Environmental Impact Report to ensure that all of the potential environmental impacts for both rules are considered and addressed.

Emission Reductions:
Emission reductions are not expected from Rule 12-16 because the rule is designed to prevent future facility-wide emissions increases over a baseline based on the latest years of operations.

Exposure Reductions:
Refineries are major sources of criteria air pollutants, TACs, and GHGs and are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Costs:
The costs and economic impacts of Rule 12-16 to refineries and other affected parties will be analyzed as part of the rule development process.

Source:

1. California Air Resources Board (2016) 2030 Target Scoping Update Plan Concept Paper. June 17. Available at: http://www.arb.ca.gov/cc/scopingplan/document/2030_sp_concept_paper2016.pdf

SS12: Petroleum Refining Climate Impacts Limit

Brief Summary:
This control measure would limit facility-wide carbon intensity at each Bay Area petroleum refinery through a new Air District regulation. Carbon intensity for each refinery would be tracked with a Refining Climate Index (RCI). Emission increases that result in RCI increases over an established baseline would be required to be offset using the existing Low Carbon Fuel Standard (LCFS) framework.

Purpose:
The purpose of this control measure is to prevent increases in carbon dioxide (CO_2) from Bay Area refineries, at current levels of production.

Source Category:
Stationary sources – petroleum refineries

Regulatory Context and Background:
The Bay Area has five large-scale petroleum refineries that, along with their associated facilities, contribute significantly to greenhouse gas (GHG) emissions, among other pollutants. Though refinery GHG emissions have stabilized over time, there is concern that changes in crude or product slate could increase these emissions, even at current levels of production. As conventional oil resources dwindle and technology advances, unconventional hydrocarbon deposits such as shale oil, tar sands, and heavy oils in once-unreachable areas have become viable resources. The emission profiles, and resulting climate and health impacts, of these new sources of crude oil are not well understood.

There are numerous existing federal, state, and local regulations that apply emission limits and associated monitoring, record keeping, and reporting requirements to refineries, though not all refinery sources are covered. In April 2016, the Air District adopted a new rule (Regulation 12, Rule 15) to improve the quality of refinery air emissions data so that the public may be better informed, and to better inform future rulemaking to further reduce emissions. Rule 12-15 requires that all refineries: 1) submit consistent, enhanced periodic emissions inventory information; 2) submit periodic crude slate information; and 3) install and operate new air monitoring facilities at refinery fence lines (see SS10: Petroleum Refining Emission Tracking).

Meanwhile, the Air District continues to seek to minimize the health and environmental impacts of emissions from refinery sources. One way to address any GHG emission increases resulting from refineries changing crude slates is to establish a limit on their carbon intensity, generally characterized as the average GHG emissions released per barrel of crude oil processed.[1] The Air District will explore the use of the Oil-Climate Index, developed by the

[1] There is no standard way to calculate carbon intensity; it is generally defined as the average rate of carbon emissions relative to the intensity of a specific activity (in this case, refining). Air District staff has currently chosen to calculate carbon intensity based on crude oil processed but this definition may change in the future.

University of Calgary, to systematically estimate the total GHG emissions embodied in crude oil from different origins. The Oil-Climate Index (OCI) is a streamlined tool that integrates three open-source models to estimate GHG emissions from all stages of the life cycle of a barrel of crude oil: upstream (oil production and transport to the refinery), midstream (oil refining and distribution to the consumer), and downstream (consumption of oil products as transportation fuels) (Gordon et al., 2016). Refineries are already held accountable for the upstream and downstream portion of their emissions at the state level through the Low Carbon Fuel Standard (LCFS) regulation. In fact, the LCFS uses the same model that the OCI employs to estimate oil production and transport emissions, the Oil Production Greenhouse Gas Estimator (OPGEE). However, the LCFS assumes an average refining carbon intensity for all California refineries hence it does not track changes in the carbon intensity of crude processing at the individual refineries.

Air District staff proposes the use of the OCI model that estimates refining energy use and GHG emissions, the Petroleum Refinery Life Cycle Inventory Model (PRELIM)[2], to establish a benchmark Refining Climate Index (RCI) for each Bay Area refinery. This baseline RCI would be based on the GHG emissions produced by the specific crude slates processed at each refinery during the baseline period for crude slate reporting in Rule 12-15, namely 2013 – 2016. On every consequent year, an RCI value would be calculated for each individual Bay Area refinery and compared with its baseline RCI. Staff proposes the use of the existing LCFS market as a framework to prevent emission increases over the baseline, since the emissions accounting in the RCI would be consistent that in the LCFS. Any increase in a refinery yearly RCI from their baseline RCI would generate LCFS debits. Each refinery would be required to obtain LCFS credits as needed to balance the account by the end of following year.

Implementation Actions:
The Air District will evaluate the cost-effectiveness and socioeconomic impacts of establishing a Refining Climate Index limit for each of the Bay Area refineries as part of the rule development process.

Emission Reductions:
Emission reductions are not expected from this measure since a facility-wide carbon intensity limit for refineries would be based on the current carbon intensity of each refinery. This approach is designed to prevent increases in facility GHG emissions, within each facility's current level of production. However, facility GHG emissions may still increase with production increases since capping carbon intensity only limits GHG emissions per unit produced.

Exposure Reductions:
Criteria air pollutant emissions from the Bay Area's five major oil refineries have generally been decreasing over the past several decades, while GHG emissions have been relatively stable in

[2] The PRELIM is an Excel-based model that estimates energy use and GHG emissions associated with petroleum refining. Results are presented by product type, based on crude oil assay's properties, for two types of refinery configurations: coking and hydro.

the last few years.[3] However, refineries are major sources of criteria air pollutants, TACs, and GHGs. Refineries are also located in impacted communities, including in Richmond. In October 2014, the Air District Board of Directors adopted a Refinery Emissions Reduction Resolution, which established a goal of reducing refinery criteria air pollutant emissions by 20 percent or as much as feasible by 2020. In response to that directive, the Air District has developed a Bay Area Refinery Emissions Reduction Strategy. The Refinery Strategy ensures that refineries are taking the strongest feasible steps to reduce emissions and minimize their health impacts on neighboring residents and the region as a whole. This measure is one of twelve control measures in the 2017 Plan that make up the Refinery Strategy.

Costs:
The costs and economic impacts of a refinery carbon intensity limit will be analyzed as part of the rule development process.

Source:

1. Deborah Gordon, Adam Brandt, Joule Bergerson, and Jonathan Koomey, Oil-Climate Index, http://oci.carnegieendowment.org/, created 2015 and updated 2016

[3] According to ARB's GHG mandatory reporting data from 2008 through 2015.

SS13: Natural Gas and Crude Oil Production, Processing and Storage

Brief Summary:
Upstream natural gas and crude oil production, processing and storage operations are responsible for significant emissions of organic compounds including methane, a potent greenhouse gas (GHG), toxic air contaminants (TACs), and volatile organic compounds (VOCs). This control measure seeks to control fugitive and vented emissions from these operations by working with the California Air Resources Board (ARB) on their upcoming oil and gas rule, and by potentially amending an existing Air District rule (Rule 8-37) to address any local concerns specific to the Bay Area.

Purpose:
To reduce emissions of methane, a potent GHG, and other organic compounds from natural gas and crude oil production, processing and storage facilities throughout the Bay Area.

Source Category:
Stationary sources – oil and gas production facilities

Regulatory Context and Background:
In 2011, the California Air Resources Board (ARB) completed a comprehensive survey of the oil and gas industry for the calendar year 2007 with the intention of developing a rule to address emissions of GHGs from these industrial sectors. This survey found 68 active crude oil and natural gas facilities[1,2] in the Air District, which ARB estimated to emit a total of 198,987 MT CO_2e, using a 20-year time horizon, during that year (ARB, 2013)[3]. However, this source-level estimate may be considered as conservatively low given that recent studies have shown a large gap between atmospheric (or “top down”) estimates and source-level (or “bottom up”) estimates of methane emissions from this sector nationally and state-wide (Brandt *et al.*, 2014; Jeong *et al.*, 2013).

<u>Laws Affecting Organic Emissions from the Oil & Gas Sector:</u>

Federal
In 2015, the U.S. Environmental Protection Agency (EPA) proposed a suite of actions to reduce methane and further reduce VOC emissions from the oil and natural gas industry. Some of these actions are focused on regulation, such as updating the 2012 New Source Performance Standards to address methane and clarifying the agency’s air permitting rules for oil and gas production. However, EPA’s recent proposed regulatory actions for methane emission

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[1] In ARB’s survey, any facility that extracts crude oil, natural gas or both was considered as an individual facility, regardless of the size of the operation. In this context, crude oil or natural gas wells may be counted as facilities.
[2] While more recent data from California’s Division of Oil, Gas & Geothermal Resources (DOGGR) and the Air District indicate a higher number of wells, ARB’s 2007 data are presented as a conservative estimate.
[3] Calculated using ARB’s estimates of carbon dioxide and methane emissions for the Air District, and a global warming potential (GWP) for methane of 86 over 20 years, per Chapter 8 of the IPCC Fifth Assessment Report.

reductions apply to new and modified sources only, and not to existing facilities which are responsible for the majority of this sector's emissions (EPA, 2015). In March 10, 2016, EPA announced its intention to explore regulating methane emissions from existing oil and gas operations. EPA started outreach efforts with stakeholders in March 2016 and launched a formal information collection process in April of 2016 (EPA, 2016).

State

In April 2015, ARB released the first draft of its proposed regulation to address GHGs from this industry, titled "Greenhouse Gas Emissions Standards for Crude Oil and Natural Gas Facilities." If adopted, this rule would apply to existing and new, onshore and offshore oil and gas production, processing and storage facilities, including natural gas underground storage and transmission compressor stations. It would regulate fugitive and vented methane emissions from equipment at these facilities, such as at uncontrolled oil and produced water tanks (also known as degassing units), compressor seals, and pneumatic control systems. ARB staff has also proposed controlling vapors from well stimulation (fracking and acid stimulation) and incorporating methane-leaking components into air districts' leak detection and repair (LDAR) programs. ARB staff formed a local air district workgroup in which Bay Area Air District staff members are actively participating. The final draft of this rule was released for public comment on May 31, 2016. This draft of the rule was presented by ARB staff to its Board on July 21, 2016 for initial recommendations. ARB's Board directed staff to continue to work with local districts and other state agencies on implementation and coordination, address significant comments, and then bring the final environmental analysis and proposed regulation for approval at a subsequently scheduled public hearing. ARB staff currently intends that most aspects of the regulation, such as reporting, record-keeping and flash testing requirements, as well as LDAR and compressor strategies, will come into effect on January 1, 2017. Provisions requiring retrofits of existing sources will be effective January 1, 2018, to provide time for covered entities to come into compliance with new requirements.

Regional

Air District Regulation 8, Rule 37, (Rule 8-37) adopted in March 20, 1985 and amended in October 17, 1990, limits emissions of organic compounds from natural gas and crude oil production facilities. However, methane is exempted from this rule because it was aimed at reducing ozone formation at the time of the rule's adoption and subsequent amendment.[4] Rule 8-37 also lacks regulatory requirements for important sources of organic emissions from this sector such as liquid storage tanks, dehydration units and separators. Staff also expects to find other opportunities for emission reductions as this rule is updated.

South Coast Rule 1148.1, adopted in March 5, 2004 and amended in September 2015, limits emissions of VOCs, TACs and total organic compounds (TOCs), which includes methane, from crude oil and natural gas wells and associated equipment that produce more than a barrel of oil

[4] EPA has officially excluded methane from the definition of VOCs –organic compounds that participate in atmospheric photochemical reactions, such as the formation of ozone– since methane has negligible photochemical reactivity. In other words, methane is not considered an ozone precursor.

or 200 standard cubic feet of gas per day. It requires closed ventilation for any tank systems with 95 percent abatement of all tank and process vapors. Rule 1148.1 has an equipment leak standard of 500 ppm for TOCs (SCAQMD, 2015).

Implementation Actions:

Air District staff will continue working with ARB staff on the development of its Oil and Natural Gas Production, Processing and Storage rule. Once adopted, the Air District plans to collaborate with ARB on the implementation and enforcement of the Oil & Gas rule, including its provisions for natural gas underground storage facilities. The Air District will also consider amending Rule 8-37 to ensure it properly addresses local needs and concerns that may not be the focus of ARB's rule, including:

- Applicability of Thresholds
    - The Air District wants to ensure that any emissions applicability threshold applies to facilities and associated equipment in the Bay Area. ARB's rule provides flexibility for a local air district to implement lower leak thresholds or require more frequent inspections, which the Air District may do if deemed necessary and cost-effective.
- Testing Methodology
    - The Air District wants to ensure that all testing and sampling methodology required by ARB and Air District rules is scientifically sound, cost effective, and appropriate. To this purpose, Air District staff will continue to provide comments on testing and sampling procedure, particularly in their areas of expertise such as leak detection and flash emissions[5] testing methodology as collection of a representative sample is very complex.
- Storage Tanks and Loading
    - There may be significant flash, working and weathering losses to the atmosphere associated with storage tanks at some well sites within the Air District. Air District staff will evaluate whether closed (vapor collection system) tankage would be a cost effective control strategy. Tank vapors can be controlled onsite by routing these vapors back to process equipment, to onsite combustion equipment or to other abatement equipment. Additionally, significant emissions may result from the transfer of liquid materials into mobile tankage and vacuum trucks. Air District staff will evaluate potential control strategies for these loading operations, including the utilization of a balance system where displaced vapors are routed back to onsite tankage.

The Air District will monitor the progress of EPA's rulemaking for existing oil and gas facilities to make sure any proposed rule amendments are in harmony with federal efforts. In addition, the Air District will leverage its current efforts to develop a fixed site GHG monitoring network over the region and deploy a mobile GHG measurement platform to collect source-specific data on active oil and gas wells and associated facilities with the long-term goal to better characterize

[5] Flash emissions occur when volatile compounds in a liquid are exposed to temperature increases or pressure decreases, as is the case when produced liquid separated from extracted natural gas or crude oil is transferred from the production separators to atmospheric storage tanks.

GHG and toxic emissions from this sector (see SL3: GHG Monitoring and Emissions Measurement Network).

Emissions Reductions:

Pollutants*	2020	2030
CO_{2e}	35,530	35,530

** CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emissions Reductions Methodology:
Applying the control strategies required in ARB's rule to Bay Area oil and gas facilities, including installing vapor collection on open separators and tank systems, upgrading to low-bleed pneumatic devices and pumps (or installing gas capture), maintaining and repairing compressors, and implementing an LDAR program, would be expected to reduce methane emissions on the order of 89,870 MT CO_2e per year (20-year GWP), or 35,530 Mt CO_2e per year (100 yr GWP). Though some of these strategies have control efficiencies over 95 percent for emissions, this estimate assumes a 50 percent reduction of methane emissions in order to be conservative. More precise emission reduction estimates will be calculated as more detailed equipment inventory for these facilities is developed.

Costs:
The cost to oil and gas facilities to implement an LDAR program will be approximately $100,000 – 200,000 per year, based on the overall LDAR cost estimated by ARB and the number of LDAR components in the Bay Area (ARB, 2016). ARB estimated that fitting separators and tank systems with vapor recovery units (VRUs) would cost $35,000 – 100,000 per two tank system. Some additional costs may also be incurred from the replacement of polyethylene tanks with tanks of steel or a similar material compatible with pressure applications such as VRUs.

Co-Benefits:
Reduction of methane emissions from oil and gas facilities will likely reduce toxic air emissions frequently co-emitted with methane. Toxic air emissions detected in testing of the headspace vapors of storage tanks in the Oil and Gas industry include benzene, toluene, ethylbenzene, xylenes (collectively known as BTEX) and n-Hexane.

Issue/Impediments:
None at this time.

Sources:

1. EPA (2015) EPA's Air Rules for the Oil & Gas Industry. Available at: http://www3.epa.gov/airquality/oilandgas/pdfs/og_fs_081815.pdf
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3. Brandt, A.R. *et al.* (2014) Methane Leaks from North American Natural Gas Systems. *Science* 343: 733-735,doi: 10.1126/science.1247045.
4. Jeong, S. *et al.* (2013) A Multitower Measurement Network Estimate of California's Methane Emissions. *J. Geophys. Res. Atmos.*, 118, 11,339-11,351, doi:10.1002/jgrd.50854.
5. ARB (2013) 2007 Oil and Gas Industry Survey Results Final Report (Revised). Available at: http://www.arb.ca.gov/cc/oil-gas/FinalReportRevised.pdf
6. Air District (2016) Regulation 8, Rule 37: Natural Gas and Crude Oil Production Facilities. Available at: http://www.baaqmd.gov/~/media/files/planning-and-research/rules-and-regs/reg-08/rg0837.pdf?la=en
7. South Coast Air Quality Management District (SCAQMD) (2015) Rule 1148.1 – Oil and Gas Production Wells. Available at: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1148-1.pdf?sfvrsn=
8. ARB (2016) Staff Presentation on February 4, 2016 Workshop. Available at: http://www.arb.ca.gov/cc/oil-gas/meetings/Reg_Workshop_Feb2016.pdf

SS14: Methane and Other Fugitive Emissions from Capped Oil and Gas Wells

Brief Summary:
Recent studies have shown that capped oil and gas wells have the potential of emitting methane, volatile organic compounds (VOCs) and toxic air contaminants (TACs). There are over 1,200 capped oil and gas wells in the Bay Area but no emissions data are available for these facilities. This control measure seeks to better characterize emissions from these capped oil and gas wells, and to explore rulemaking to address these emissions.

Purpose:
To reduce fugitive emissions of methane, VOCs and toxic pollutants from capped oil and gas wells in the Bay Area in order to provide climate protection, prevent ozone formation and reduce health impacts in the region.

Source Category:
Stationary source – oil and gas production facilities

Regulatory Context and Background:
Currently, there are a total of 1,442 oil and gas wells in the nine districts within the jurisdiction of the Bay Area Air Quality Management District (Air District) (DOGGR, 2016). Of these wells, only 113 are actively producing oil and/or gas while 1,250 are plugged/capped and 72 are idle. A recent study by Kang *et al.*, published in the Proceedings of the National Academy of Sciences, has been the first to measure methane leak rates from abandoned oil and gas wells. The study focused on 19 abandoned wells in Pennsylvania, five of which were plugged. The median methane leak rate at these wells (1.3×10^{-3} kg/day per location) was significantly higher than at forested, wetland, grassland and river locations near the wells, chosen with identical aerial footprint to the nearest well to serve as controls in the study (1.6×10^{-7} kg/day per location). Methane measurements obtained from the wells ranged from 1.5×10^{-5} to 2.1 kg/day per well, with three out of the 19 wells found to be high emitters, having methane flow rates three orders of magnitude larger than the median leak rate. In addition, the study found higher ratios of ethane, propane and n-butane to methane emissions at well locations than at their surroundings, indicating that abandoned wells may also emit certain VOCs. These results are not surprising since natural gas is known to contain up to five percent ethane, propane, n-butane and other VOCs.

At the present time, there are no emissions data available for capped or abandoned oil and gas wells in the Bay Area. As an initial estimate, methane emissions from Bay Area capped wells were calculated to be approximately 51 MT CO_2e/yr[1], using the median leak rate from the Kang *et al.* (2014) study. However, methane emissions could be up to three orders of magnitude higher if the Bay Area wells have leak rates comparable to the high emitter wells in the study. Moreover, these capped wells may also be emitting toxic pollutants that have been associated with active wells in the past. McKenzie *et al.* (2012) estimated elevated cancer and non-cancer

[1] Using the 20-yr time horizon global warming potential of methane, 86, per the IPCC Fifth Assessment Report.

risks for residents within ½ mile of an active natural gas well due to benzene, trimethylbenzene, xylene and aliphatic hydrocarbon emissions.

Laws Affecting Fugitive Emissions from Capped Wells:
In the Air District, fugitive emissions of organic compounds from oil and gas production facilities, such as oil and gas wells, are regulated under Regulation 8, Rule 37 – Natural Gas and Crude Oil Production Facilities (Rule 8-37). However, methane is explicitly exempt from this regulation (8-7-112) because it was aimed at reducing ozone formation at the time of the rule's adoption and subsequent amendment.[2] Rule 8-37 may be updated to remove the methane exemption and improve the VOC control requirements (See SS13: Oil and Gas Production, Processing and Storage). Furthermore, the definitions of natural gas production facility (8-37-213) and crude oil production facility (8-37-214) appear to exclude any facility not engaged in the active production of natural gas or crude oil, an d thus would exclude capped wells. Methane emissions from capped oil and gas wells are not addressed by ARB's Cap and Trade Program.

Implementation Actions:
To support the development of an Air District program to regulate fugitive emissions from capped oil and gas wells, the Air District will:

- Gather background data: Engage the Division of Oil, Gas & Geothermal Resources (DOGGR) to obtain more information on inactive oil and gas wells in the Bay Area, including any applicable requirements and regulations, and to identify any other relevant stakeholders. Review existing regulation and programs from other local air districts, and conduct extensive literature search on fugitive emissions of inactive or capped oil and gas wells.
- Characterize emissions from these facilities: Coordinate with and leverage the Air District's current efforts to develop a fixed site GHG monitoring network over the region and deploy a mobile GHG measurement platform to collect source-specific data (see SL3: Greenhouse Gas Monitoring and Emissions Measurement Network).
- Consider rulemaking for these facilities: Draft a new rule or amend Rule 8-37 to establish limits for methane emissions, in support of the objectives in the Air District's 10-Point Climate Action Work Program and of ARB's AB 32 Scoping Plan, and for VOC and toxic pollutant emissions, consistent with existing regulations.

Emission Reductions:

Pollutants*	2020	2030
CO_{2e}	19	19

CO_{2e} is reported in metric tons/year (100 yr GWP)

Due to accessibility issues (e.g., plugged wells under built structures), it likely will not be possible to repair all leaking wells. Assuming Bay Area capped wells were emitting methane at the median leak rate from the Pennsylvania well study (Kang *et al.,* 2014), repairing 90 percent

[2] EPA has officially excluded methane from the definition of VOCs –organic compounds that participate in atmospheric photochemical reactions, such as the formation of ozone– since methane has negligible photochemical reactivity. In other words, methane is not considered an ozone precursor.

of leaking wells would result in emissions reductions on the order of 47 MT CO_2e per year (20 year GWP) or 19 MT CO_2e per year (100 year GWP). However, if a fourth of the Bay Area wells were in the “high emitter” category (a fraction similar to that found in the same study), emissions reductions could be on the order of 18,000 metric tons of CO_2e per year. In addition, leaking plugged wells are likely emitting toxic pollutants such as BTEX[3] in addition to methane (Warneke *et al*., 2014). Based on typical mixing ratios of methane to toxic VOCs emitted from active oil and gas wells, these repairs could also result in emissions reductions on the order of 200 pounds per year of benzene, 340 pounds per year of toluene, and 225 pounds per year of C8 aromatics such as ethylbenzene and xylenes.

Emission Reduction Trade-Offs:
None.

Costs:
TBD. The operator cost of re-plugging abandoned wells that are leaking natural gas depends on the number and depth of these wells, as well as the price of cement in the Bay Area Region. In California, DOGGR plugged 1,307 orphan wells from 1977 to 2010 at a total cost of $23.7 million, an average cost of about $18,000 per well (DOGGR, 2016).

Co-Benefits:
Reduction in fugitive emissions from capped oil and gas wells would reduce methane emissions, a potent greenhouse gas, resulting in climate protection. It would also have potential health benefits on populations near capped wells by reducing toxic emissions such as benzene and toluene, which can increase the risk of cancer and other serious health effects.

Issues/Impediments:
The Air District will coordinate with state agencies, including ARB and the DOGGR, to ensure non-duplicative regulations. The Air District will also coordinate with the Yolo-Solano Air Quality Management District to strive for consistent treatment of sources within Solano County. In addition, some wells may be buried, or otherwise not accessible for testing and compliance verification.

Sources:
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2. Kang, M., Kanno, C.M., Reid, M.C., Zhang, X., Mauzerall, D.L., Celia, M.A., Chen, Y., and Onstott, T.C. (2014) Direct measurements of methane emissions from abandoned oil and gas wells in Pennsylvania. PNAS, 111 (51), 18,173-18,177, doi: 10.1073/pnas.1408315111.

[3] BTEX stands for benzene, toluene, ethylbenzene, and xylenes.

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SS15: Natural Gas Processing, Storage and Distribution

Brief Summary:
This control measure would seek to ensure reductions of methane emissions from natural gas pipelines, storage and processing operations by working with the California Public Utilities Commission (CPUC) to develop rules and procedures to reduce methane emissions as required by Senate Bill 1371.

Purpose:
Significantly reduce the emissions of methane, a potent greenhouse gas, from the natural gas processing, storage and distribution network throughout the Bay Area and improve climate protection.

Source Category:
Stationary sources – natural gas processing, storage and distribution

Regulatory Context and Background:
Overview: In 2014, approximately 93 million metric tons (MMT) of natural gas were consumed in the nine Bay Area counties (CEC, 2015). Based on a 0.2 percent line loss rate, 0.02 MMT of natural gas were lost due to fugitive emissions (leaks) from natural gas pipelines (Markey, 2013; EIA, 2012). This loss translates to 1.4 MMT of CO_2e, when using a 20-year time horizon.[1,2] It is worth noting that this estimate does not account for large, undetected natural gas leaks such as the Aliso Canyon storage facility leak. Preliminary calculations by the Air Resources Board (ARB) estimate that 2.4 MMT of CO_2e were released from the time this leak was discovered, in October 2015, until it was controlled in February 2016 (ARB, April 2016). It is difficult to incorporate large and unanticipated natural gas leaks, such as the Aliso Canyon leak, into emissions estimates since their frequency is unknown and their magnitude is difficult to quantify accurately even if detected. However, top-down methane emissions estimates for the U.S., California and for its San Francisco and South Coast air basins suggest that there are large, unaccounted emissions from the oil and gas system in bottom-up inventories, and that a large fraction of these originate from a small number of “super-emitters” (Brandt et al., 2014; Jeong et al., 2013; Fairley and Fischer, 2015; Cui et al., 2015).

There are approximately 1,450 miles of natural gas transmission lines within boundaries of the nine Bay Area counties, about 1,300 miles of which are owned by one entity (PHMSA, 2013). A natural gas Leak Detection Repair, Rehabilitation and Replacement (LDAR) program could have a major beneficial impact on greenhouse gas emissions. Pipes constructed out of cast iron or bare steel are the pipes most likely to leak, releasing 27.25 and 12.58 cubic feet of methane per hour, per mile, respectively, according to the U.S. Environmental Protection Agency (EPA) (40 CFR Part 98). PHMSA also lists these materials as high-risk pipeline infrastructure that is prone

[1] Calculated using a 20-yr global warming potential (GWP) of 86 for methane, per the IPCC Fifth Assessment Report.
[2] Calculated assuming that natural gas consists of 90 percent methane, and varying amounts of ethane, propane, butane and inert compounds.

to failure (PHMSA, 2011). Cast iron and bare steel leak 18 times more gas than plastic pipes and 57 times more gas than protected steel (40 CFR Part 98).

<u>Laws Affecting GHG Emissions from Natural Gas Pipelines</u>: Senate Bill 1371: Natural Gas Leakage Abatement, Leno, was signed into law by Governor Brown on September 21, 2014 (California Public Utilities Code, Sections 975-978). SB 1371 seeks to reduce natural gas leaks and associated greenhouse gas emissions (methane) from California utility gas systems. Methane emissions from natural gas lines are not addressed by ARB's Cap and Trade Program (ARB, 2015). SB 1371 requires the CPUC, in consultation with the ARB, to reduce emissions of natural gas from intrastate transmission and distribution natural gas lines to the maximum extent feasible in order to advance the state's goals in reducing emissions of greenhouse gases pursuant to the California Global Warming Solutions Act of 2006 (CA PUC 975(B)(2)).

The CPUC adopted rule(s) must:

- Provide for the technologically-feasible and cost-effective repair of leaks and leaking components within a reasonable time after discovery, consistent with the California Global Warming Solutions Act of 2006 and established safety requirements and the goals of reducing air pollution and the climate change impacts of methane emissions.
- Evaluate the operations, maintenance, and repair practices to determine whether existing practices are effective at reducing methane leaks and promoting public safety and whether alternative practices may be more effective at reducing natural gas emissions.
- Establish and require the use of best practices for leak surveys, patrols, leak survey technology, leak prevention, and leak reduction.
- Establish protocols and procedures for the development and use of metrics to quantify the volume of emissions from leaking gas pipelines, and for evaluating and tracking leaks geographically and over time, that may be used for required plans or other state emissions tracking systems, including the regulations for the reporting of greenhouse gases to ARB.
- Require the calculation and reporting to the CPUC and the ARB of a baseline system-wide leak rate and periodically update that system-wide leak rate calculation, and annually report on measures that will be taken in the following year to reduce the system-wide leak rate.

Under this statute, the CPUC started the rulemaking process in January 2015 under proceeding number R.15-01-008. Air District staff has actively participated in the rulemaking process, including presenting at the policy and technology panels on the initial workshop of the proceeding as well as attending all subsequent meetings to date. In May 2015, in accordance with the requirements of SB 1371, affected utilities reported the following to the CPUC:

- A summary of their leak management practices.
- A list of new methane leaks in 2013 by grade.
- A list of open leaks that are being monitored or are scheduled to be repaired.
- A best estimate of gas loss due to leaks.

In addition, current CPUC rulemaking process includes stakeholders from underground natural gas storage facilities and calls for the emissions from this sector to be estimated. However, it is uncertain whether methane emissions from underground storage will be addressed by CPUC's

Gas Leak Abatement rule.[3] Phase 1 of the CPUC rulemaking process, on the subject of "Policies and Guidelines", is currently underway and scheduled to conclude by December 2016. Phase 2, on the subject of "Ratemaking and Performance Based Financial Incentives", is scheduled for January 2017 through the summer of 2017.

Implementation Actions:
Before embarking on the development of an Air District program to regulate methane emissions from natural gas pipelines, the Air District will:

- Continue to engage with CPUC and ARB staff responsible for developing and implementing the required elements of SB 1371;
- Continue to participate in the CPUC regulatory process;
- Assess the CPUC-developed regulations for areas where Air District efforts may result in additional methane emission reductions and to ensure harmony with the Air District's Climate Protection Strategy; and
- Review the utility-reported data, when available, to glean additional information on GHG emissions and practices used to prevent and minimize methane emissions.

Listed below are the elements a potential Air District program may contain to address this major source of GHG emissions. The program may require entities responsible for natural gas pipelines to audit and reduce methane emissions in four phases.

<u>Phase 1</u>: Develop:

- Consistent methods for estimating and reporting natural gas/methane losses from natural gas lines, and
- Inventory of the estimated natural gas/methane losses from Bay Area natural gas pipelines sources.

<u>Phase 2</u>: Audit the pipeline system: Identify and map all the natural gas lines in the Air District by:

- Type of piping: transmission lines, distribution mains, or service lines and capacities;
- Material from which it is constructed: cast iron, bare steel, plastic, or protected steel;
- Components: valves, connectors, pumps, compressors, PRDs.
- Prioritize pipe according to leaks, capacity, age, and construction materials.

<u>Phase 3</u>**:** Develop an LDAR Program plan that would include an audit of the natural gas lines. Also, identify and prioritize piping that should be rehabilitated or replaced and establish a plan for doing so. Plan would be subject to approval by Air District with periodic updates.

[3] The current draft of ARB's Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities rule (Oil & Gas rule), dated May 31st, 2016, includes provisions for natural gas underground storage facilities [95668(i)] which require continuous monitoring and timely leak repairs. [4] This can be easily accomplished by segregating a line segment and flooding it with water and capturing the natural gas at an exit point.

Phase 4: Implement the Air District approved LDAR Program plan according to the approved schedule. Ensure that natural gas is captured when evacuating lines for inspection and repair.[4]

Emission Reductions:

Pollutants*	2020	2030
CO_{2e}	283,062	283,062

**CO_{2e} is reported in metric tons/year (100 yr GWP)*

If a natural gas LDAR program could reduce line losses by 50 percent, this program would result in an estimated emissions reduction of 715,980 MT of CO_2e per year (20 year GWP) or 283,062 MT of CO_2e per year (100 year GWP).

Exposure Reductions:
N/A

Emission Reduction Trade-Offs:
None

Costs:
Cost estimates will be developed during rule making. However, the approximate cost of LDAR programs at Bay Area refineries is $4,100 per 1,000 components. Cost for such a program for natural pipelines could be much higher due to the higher inaccessibility (pipes are buried and may need to be excavated) and much greater geographical expanse of the natural gas distribution network.

Co-Benefits:
A reduction in the amount of natural gas line losses not only reduces GHG emissions, it also reduces VOC emissions. Natural gas contains up to five percent ethane, propane and other VOCs. Thus, this control measure may also result in reductions of VOC emissions associated with natural gas. In addition, methane contributes to background tropospheric ozone levels, and studies consistently show that reducing global methane emissions can lower tropospheric ozone (ARB, 2014). Furthermore, a reduction of methane leaks would result in improved safety of the natural gas line network in the Bay Area and reduce the risk of gas explosions and fires.

Issues/Impediments:
The Air District would have to coordinate with several state and local agencies, including the ARB, the California Energy Commission (CEC), the CPUC, the local Certified Unified Program Agencies (CUPA), the Pipeline and Hazardous Materials Safety Administration (PHMSA) to ensure non-duplicative regulations.

[4] This can be easily accomplished by segregating a line segment and flooding it with water and capturing the natural gas at an exit point.

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SS16: Basin-Wide Methane Strategy

Brief Summary:
This control measure seeks to better quantify and reduce emissions of methane, and its co-pollutants, from all sources throughout the Air District by implementing a coordinated strategy that combines research, rulemaking, collaborations with state agencies, and other programs.

Purpose:
This control measure seeks to reduce emissions of methane and its co-pollutants, such as nitrous oxide (N_2O) and volatile organic compounds (VOCs), throughout the Air District.

Source Category:
Stationary and area sources.

Regulatory Context and Background:
The latest science has underscored the need to immediately reduce emissions of super-GHGs in order to stabilize global warming below 2°C, a critical threshold to avoid the worse impacts of climate change (IPCC, 2014). Methane (CH_4) is a powerful super-GHG. It is 86 times more potent than carbon dioxide (CO_2) when compared on a 20-year time horizon (or 34 times on a 100-year basis) and it has a much shorter atmospheric lifespan of 12 years (vs. 20 – 200 years) (IPCC, 2014). Due to these factors, actions to reduce methane emissions can provide significant and immediate climate benefits while CO_2 emissions are steadily reduced to achieve long-term climate stability. Curbing methane emissions would also reduce emissions of its co-pollutants, which can include key climate, criteria and toxic pollutants, resulting in public health and (further) climate benefits. For example, finding and reducing methane leaks from oil and gas production facilities would decrease emissions of frequently co-emitted toxic volatile organic compounds (VOCs), such as benzene, toluene, ethylbenzene, and xylenes. Focusing on methane sources in the waste sector would also address emissions of co-pollutants such as nitrous oxide, a potent greenhouse gas (GHG) that warms the atmosphere 298 times faster than CO_2 on a per-molecule basis.

The importance of super-GHGs, and particularly of methane, has been recognized at the international, national, and state levels. There have been many global efforts focused on reducing methane emissions such as the Global Methane Initiative (a partnership of 43 countries comprising over 70 percent of global methane emissions that focuses on methane abatement and recovery), and several methane-specific climate pledges made ahead of the Paris COP21[1]. In March 2014, the White House published a Strategy to Reduce Methane Emissions as part of the President's Climate Action Plan. As part of that strategy, the U.S. Environmental Protection Agency (EPA) and other federal agencies have undertaken several actions to reduce methane from the waste, agriculture, coal mining, and oil and natural gas

[1] COP21 stands for the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change, which convened in December 2015. The climate pledges, or Intended Nationally Determined Contributions (INDCs), are non-legally binding emission reduction that countries committed to ahead of the COP21.

sectors. For instance, EPA recently adopted a regulation for new oil and gas production facilities (June 2016) and is currently exploring a regulation for existing oil and gas operations. In the State of California, the Air Resources Board (ARB) released a proposed super-GHG, or short-lived climate pollutant (SLCP) reduction strategy in April 2016 and is expected to present the final SLCP strategy to their Board for approval in late 2016. The proposed strategy addresses emissions of methane (and other super-GHGs) not covered in ARB's Cap-and-Trade program. In the document, ARB emphasizes the critical role that air districts can play in the success of the State's strategy by implementing super-GHG emission reduction strategies in their own jurisdictions.

Methane is the second leading greenhouse gas (GHG) in the Bay Area Air District. In 2015, sources in the district emitted an estimated 10 million metric tons of CO_2 equivalent (MMT CO_2e), about 10 percent of the GHG inventory when calculated on a 20-year basis[2]. According to a recent study commissioned by the Air District to evaluate its methane inventory (Fischer and Jeong, 2016), three source categories represent approximately 84 percent of these emissions. These categories are mainly related to human activities; landfills are the largest source by far, accounting for 53 percent of these emissions, followed by livestock (16 percent) and natural gas production and distribution (15 percent). These emissions estimates carry a large uncertainty (50 percent or more), consistent with a recent study that suggests that methane emissions in the Air District's "bottom-up" inventory[3] are 1.5 – 2 times lower than expected from top-down measurements (Fairley and Fischer, 2015). This "methane gap" has been repeatedly observed for the U.S. and California regions, where top-down observations that account for ambient methane concentrations suggest that there are large, unaccounted methane emissions in bottom-up inventories (Brandt et al., 2014; Hsu et al., 2010; Jeong et al., 2013; Cui et al., 2015).

Given the importance and potential co-benefits of controlling methane, the Air District will implement a comprehensive basin-wide methane strategy to reduce the region's methane emissions, in support of ARB's methane reduction goals (40 – 45 percent below current levels by 2030). Elements of this strategy will include: 1) intensifying efforts to improve the Air District's methane emissions inventory, 2) considering amendments to existing Air District Regulation 8, Rule 2 (Rule 8-2) to prohibit significant methane leaks throughout the district, 3) collaborating with state agencies on their methane rules under development, 4) identifying cost effective and technically feasible methane emissions reduction opportunities throughout the Bay Area, and 5) considering the removal of methane exemptions from existing Air District rules when appropriate. These elements are described in more detail below.

- ***Improve Methane Emissions Inventory***: The Air District will improve its methane emissions estimates by tracking regional methane emission patterns using a fixed-site GHG monitoring

[2] Based on the 20-yr global warming potential (GWP) reported for methane in the IPCC Fifth Assessment Report.
[3] The Air District traditionally develops its emissions inventory through a bottom-up methodology. In this approach, established emission factors (e.g., methane emitted per unit of natural gas burned) are combined with activity data (e.g., throughput of natural gas) to generate source-specific emissions estimates.

network, and by conducting source-specific measurements of methane throughout the Bay Area. See **SL3: Greenhouse Gas Monitoring and Measurement Network** for more details.

- ***Prohibit Significant Methane Leaks***: Currently, there is no Air District rule designed to address large leaks of methane. Air District Rule 8-2 prohibits leaks of organic compounds that exceed 15 pounds per day (and a concentration of 300 ppm) but methane and natural gas are exempted from that prohibition. Thus, the Air District would be limited in its ability to take action should a large natural gas leak similar to the Aliso Canyon storage facility leak occur in the Bay Area. To prevent this potential scenario, the Air District will consider rule amendments to Rule 8-2 that establish a limit above which methane leaks would be prohibited in the region. This leak limit would apply to all stationary sources, including methane leaks from natural gas pipelines, storage tanks, underground storage facilities, refineries, and oil and gas production operations. This rule would serve as a near-term action while additional efforts to address particular sectors are finalized. Such efforts include collaborating with state agencies on their methane rules under development, and seeking cost effective methane reduction opportunities (see items below).

- ***Collaboration with State and Other Agencies***: The Air District will continue to collaborate with ARB on their development of an oil and gas production regulation, and with ARB and the California Public Utility Commission (CPUC) on their joint development of a natural gas processing and distribution network regulation, both of which are aimed at reducing methane emissions from these sources. In addition, Air District staff will seek cooperation with other agencies or groups that have similar methane reduction goals, such as the ongoing collaboration with the City of San Francisco's Department of the Environment on potential emission reduction opportunities for local governments.

- ***Methane Reduction Opportunities***: The Air District plans to continually identify cost effective and technically feasible methane emissions reduction opportunities throughout the Bay Area. These opportunities will include, but are not limited to, the following initiatives, identified based on the existing methane emissions inventory:
  - Stationary Sources
    - *Natural Gas & Oil Production:* In addition to collaborating with ARB staff on their oil and gas rule, the Air District will consider amending its existing rule for oil and gas facilities (Rule 8-37) to address methane and VOC emissions from facilities which would otherwise be exempted from ARB's rule. These include smaller facilities, which are more prevalent in the Bay Area, and capped oil and gas wells, if these facilities prove to be a significant source of emissions. See **SS13: Natural Gas and Crude Oil Production, Processing and Storage** and **SS14: Methane and Other Fugitive Emissions from Capped Oil and Gas Wells** for more details.
    - *Natural Gas Distribution Network:* The Air District will continue participating in CPUC and ARB's joint development of the Natural Gas Leak Abatement rule, described in detail in **SS15: Natural Gas Processing, Storage and Distribution**.
  - Waste

    - *Landfills:* The Air District will propose amendments to the existing Air District landfill rule (Regulation 8, Rule 34) with stricter control and fugitive leak standards, and will evaluate if methane emissions from facilities currently exempt from this rule warrant regulation. See **WA1: Landfills** for more details.
    - *Composting and Anaerobic Facilities:* The Air District will consider a rule requiring best practices to reduce methane (and co-pollutant) emissions from composting operations and anaerobic digesters, similar to those adopted in other districts, and will explore further measures to address anaerobic digestion emissions. See **WA2: Composting Operations** for further details.
  - Water
    - *Publically Owned Treatment Works (POTWs):* The Air District will seek to better understand and quantify methane and nitrous oxide emissions at POTWs in order to inform potential rulemaking to address these potent greenhouse gases. See **WR1: Limit GHGs from POTWs** for more details.
  - Agriculture
    - *Livestock:* The Air District will seek to reduce methane emissions associated with raising livestock by promoting methane capture for on-site energy production, and by engaging with the agriculture community to develop best practices to address enteric fermentation emissions. See **AG2: Dairy Digesters** and **AG3: Enteric Fermentation** for further details.
    - *Confined Animal Facilities:* See **AG4: Livestock Waste/Confined Animal Facilities** for additional information.

- ***Remove Methane Exemption from Relevant Rules***: Air District Regulation 8 rules limit the emissions of organic pollutants. In many cases, the specific Reg. 8 rule addresses an industry or source that does not emit methane, such as dry cleaning or architectural coatings. In others, the focus of control may be emissions of smog forming (precursor) compounds, though the industry may also emit methane. Due to that original intent, organic compounds were generally defined in these rules as “any compound of carbon, excluding methane, carbon monoxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate.” Out of the 53 rules that are currently part of Regulation 8, only four rules do not exclude methane as a regulated pollutant. The majority of the rules that exclude methane regulate products like solvents, coatings, and adhesives; in those cases, removal of the methane exemption would not result in reductions of methane emissions. However, there are a few Regulation 8 rules that may benefit from the removal of the methane exclusion. Air District staff will examine emissions and other relevant data to determine if removing the exemption from these rules would result in methane emissions reduction.

Implementation Actions:
The Air District will:
- improve quantification of methane and nitrous oxide in the Air District emissions inventory
- consider amending Regulation 8-2 to prohibit significant leaks of methane throughout the Air District

- address emissions of methane and its co-pollutants from the following sources, prioritizing rule development efforts based on the magnitude of emissions:
  - Natural gas & oil production, natural gas distribution network, natural gas underground storage, and refineries
  - Landfills, composting sites and anaerobic digestion facilities
  - POTWs
  - Livestock and confined animal facilities
- consider removing the methane exemption from existing Air District Regulation 8 rules, when appropriate

Emissions Reductions:
This section presents near-term GHG emission reductions for one element of the strategy, amending Rule 8-2, designed to serve as a stopgap for large methane leaks, while sector-specific regulations are developed. These emissions reductions, estimated to be 0.64 MMT CO_2e per year on a 20-year horizon (or 0.25 MMT CO_2e/yr on a 100-yr basis), are expected to increase once sector specific rules targeting the same GHG emissions in a more comprehensive way are adopted and implemented. Please see GHG reductions from these sector specific rules in their respective control measures (outlined above).

Emissions Methodology:
Oil & Gas Sector: Recent scientific evidence suggests that large leaks ("super emitters") can account for a large portion of the fugitive emissions from the natural gas distribution network, oil and gas wells, and natural gas storage facilities (Lyon et al., 2016). Given these findings, gross estimations of the potential methane reductions from amending Rule 8-2 for this sector were calculated assuming that 80 percent of emissions are due to 20 percent of the leaks – leaks most likely to be defined as a prohibited leak – and a 50 percent discovery and fixing rate for these leaks.

- Natural Gas Distribution Network: Air District staff estimated that the Bay Area natural gas distribution network emits approximate 1.4 MMT of CO_2e per year (based on a 0.2 percent leak rate and using the 20-year time horizon for methane). Using the methodology outlined above, the potential GHG emission reduction would be 0.57 MMT CO_2e per year.
- Natural Gas & Oil Production: ARB estimated that 68 active crude oil and natural gas facilities in the Air District emit a total of approximate 0.2 MMT CO_2e, using a 20-year time horizon, during 2007. Applying the assumptions given above, GHG emissions would be reduced approximately 72,000 MT CO_2e per year.
- Natural Gas Storage Facilities: Considering the environmental incident at the Aliso Canyon natural gas storage facilities, the Air District would monitor facilities such as this quite closely. Potential emission reductions from these sources will be estimated during rule development.
- Petroleum Refineries: Currently, methane emissions from refineries are estimated to constitute less than 2 percent of the anthropogenic methane emitted in the Bay Area. However, preliminary study findings indicate that fugitive methane emissions from refineries may be significantly higher than bottom-up inventory estimates. Due to the

uncertainty in the fugitive emissions from this sector, emission reductions cannot be estimated at this time.

Waste, Water and Agriculture Sectors: Due to the uncertainty and poor understanding of the emissions from sources in these sectors, such as composting, wastewater treatment, and livestock, emissions reductions from amending Rule 8-2 cannot be estimated at this time.

Emission Reduction Trade-Offs:
None

Costs:
Costs are expected to vary widely depending on the source type and proposed regulation and thus will be developed during rulemaking.

Co-Benefits:
The methane strategy has the potential to reduce other pollutants, such as VOCs and toxic compounds associated with oil and gas production, ammonia (a precursor to secondary PM), and N_2O, a potent GHG frequently co-emitted with methane from sources in the waste sector.

Issues / Impediments:
None

Sources:

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SS17: GHG BACT Threshold

Brief Summary:
This measure would lower the threshold at which facilities subject to the Air District's New Source Review permit program must implement the "Best Available Control Technology" to control their greenhouse gas (GHG) emissions below the current 75,000 tons per year (tpy) CO_2e. In addition, this threshold would apply to all regulated facilities, not just "major" facilities.

Purpose:
The purpose of this control measure is to lower GHG emissions in the Bay Area.

Source Category:
Stationary Source – all regulated facilities

Regulatory Context and Background:
The Air District's New Source Review (NSR) program is a comprehensive air permitting program that applies to a wide-range of stationary source facilities within the Air District's regulatory jurisdiction. The program requires a facility to obtain a permit and implement state-of-the-art air pollution control technology whenever a facility installs a new source of air emissions or makes a modification to an existing source.

The federal NSR program requirements were established in the 1977 federal Clean Air Act (CAA) Amendments. The CAA requires local programs to implement requirements through the CAA's system of "cooperative federalism," under which each state or local agency develops and adopts an NSR program that meets (or exceeds) the minimum requirements of the federal NSR program. These programs are submitted to the United States Environmental Protection Agency (EPA) for review and approval. In 1988, the California legislature enacted the California Clean Air Act, which imposes additional state-law NSR permitting requirements that go beyond the federal NSR program in certain aspects. Each air district in California is required to adopt an NSR program that meets both the additional state-law requirements and the federal NSR program requirements; these programs are subject to review and approval by the California Air Resources Board. The Air District's NSR program operates within the overlay of these state and federal requirements.

The Air District's NSR program is set out in Regulation 2, Rule 2 (Rule 2-2) and is the Air District's fundamental permitting requirement for regulating criteria pollutant emissions. It requires facilities to obtain an NSR permit for any new or "modified" source of air emissions, and to satisfy a number of air pollution control requirements in order to be eligible for the permit. [1]

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[1] "Modified source" is defined in Regulation 2-1-234 as (i) any physical change, change in the method of operation, increase in throughput or production, or other similar change to a source that will result in an increase in the source's permitted emissions (or for "grandfathered" sources that are not subject to any permit limits, in increase in the source's physical capacity to emit air pollutants); or (ii) for sources at "major" facilities (maximum emissions of any pollutant over 100 tpy or 250 tpy, depending on the facility type), any change that will result in a significant increase in the source's actual emissions as defined in EPA's federal NSR regulations.

These requirements vary somewhat depending on the pollutant involved. For pollutants for which the region is not in attainment of the applicable air quality standards ("non-attainment" pollutants), the NSR requirements are generally more stringent. For pollutants for which the region is in attainment of the applicable air quality standards ("attainment" pollutants), the requirements are generally less stringent. The requirements for attainment pollutants are referred to as "Prevention of Significant Deterioration" (PSD) requirements and include: (i) using the "Best Available Control Technology" (BACT) to limit emissions; and (ii) conducting an air quality impact analysis to ensure that the source being permitted will not jeopardize continued attainment of the applicable air quality standards or cause other adverse air quality impacts.

PSD is the element of the NSR program under which GHGs are regulated. The PSD provisions require new and modified sources at "major" facilities that will increase GHG emissions by 75,000 tpy or more of CO_2e to go through the PSD permitting process and implement BACT to reduce their GHG emissions.[2] More specifically, if a facility is a "major" facility under the federal CAA, it must comply with the PSD BACT requirement (i) for any new source that will emit 75,000 tpy or more CO_2e, and (ii) for any modification to an existing source that will result in a net increase in emissions of 75,000 tpy or more CO_2e. The District's NSR program incorporates this 75,000 tpy CO_2e threshold from EPA's federal NSR regulations, which regulate GHGs at that level.

Since this 75,000 tpy CO_2e threshold was adopted 2012, it has become apparent that a lower threshold may be appropriate for GHG permitting for the Bay Area. Specifically, an evaluation of all permit applications that the Air District has received over the past ten years indicates that reducing the threshold below the current 75,000 tpy CO_2e will subject a substantial additional amount of GHG emissions to the BACT requirement. Staff continues to investigate an appropriate revised threshold.

In addition, Air District staff is proposing to make the revised threshold apply at all facilities, not just facilities that have emissions of regulated air pollutants over the 100/250 tpy federal "major" facility threshold. Staff believes facilities under this latter threshold should be subject to regulation if their GHG emissions are of sufficient magnitude. While the EPA is limited to regulating GHG emissions only from major facilities, the Air District is not precluded from adopting the more stringent approach under its rulemaking authority under the California Health and Safety Code.[3]

It should be noted that the while a new lower threshold would require more sources to implement BACT to limit their GHG emission, as with the existing BACT requirement, the regulations will not prescribe exactly what technology must be applied in any particular case. Specifically, as with the current regulations, that determination will be made on a case-by-case basis by evaluating the most stringent level of GHG emissions control that can feasibly be

[2] A "major" facility is one that emits 100 tpy or more of a regulated air pollutant other than GHGs (or 250 tpy or more for certain source categories).

[3] The 2014 Supreme Court's decision in *Utility Air Regulatory Group v. EPA* (134 S.Ct. 2427) held that the EPA cannot regulate GHGs under the CAA from facilities that do not exceed this major facility threshold.

implemented for each individual source being permitted, taking into account considerations such as energy impacts, any ancillary environmental impacts, and economic impacts. Therefore, the BACT requirement for GHGs under a revised CO_2e threshold will work just as it does under the current threshold.

Implementation Actions:
The Air District would create a new subsection in Section 2-2-304, the provision in Rule 2-2 that sets forth the PSD BACT requirement. Section 2-2-304, as enacted in the December 2012 amendments, incorporates the federal PSD BACT requirement by reference, including the 75,000 tpy CO_2e thresholds discussed above. The proposed revisions would create two subsections in Section 2-2-304: (i) Subsection 2-2-304.1, which would continue to incorporate the federal PSD BACT requirement by reference; and (ii) Subsection 2-2-304.2, which would be the new requirement to apply BACT at a lower threshold.

Emission Reductions:
Emission reductions will result from additional sources being required to implement GHG BACT under the lower threshold. However, it is difficult to predict with certainty what the impacts will be for these sources, as the BACT requirement does not prescribe any specific emissions performance level. Generally speaking, however, Air District staff expect that overall GHG emission reductions from a new lower threshold will be modest at first, but will become significant over time as new and more effective GHG emissions control technologies become available.

Exposure Reductions:
None.

Emission Reduction Trade-Offs:
None.

Costs:
This proposed change would be expected to result in cost impacts as additional sources would be required to implement BACT under the lower threshold. However, it is difficult to predict with certainty what the impacts will be for these sources, as the BACT requirement does not prescribe any specific course of action these sources must take to comply and what cost impacts would result.

Overall, additional costs for regulated facilities will most likely be fairly limited in the near term for the same reasons that GHG emission reduction impacts will most likely be limited in this time frame. In the longer term, however, lowering the BACT threshold for GHGs may well involve increased compliance costs as new technologies become more widely used. It is worth noting, however, that the BACT requirement has a built-in cost-effectiveness test, as specified in CAA Section 169's mandate to take into consideration "economic impacts and other costs."

Co-Benefits:
For many facilities, reduction of GHG emissions will likely reduce criteria air pollutants frequently co-emitted in processes that typically generate GHGs (e.g., combustion), particularly if energy efficiency is selected as BACT.

Issue/Impediments:
None

SS18: Basin-Wide Combustion Strategy

Brief Summary:
This control measure seeks to stabilize and then reduce emissions of greenhouse gas (GHG), criteria air pollutant and toxic emissions from stationary[1] combustion sources throughout the Air District by first establishing carbon intensity caps on major GHG sources, and then adopting new rules to reduce fuel use on a source-type by source-type basis.

Purpose:
Reduce emissions of greenhouse gas, criteria air pollutant and toxic emissions from stationary combustion sources throughout the Air District.

Source Category:
Stationary combustion sources.

Regulatory Context and Background:
Fuel combustion contributes significantly to carbon dioxide (CO_2) emissions, the primary driver of anthropogenic climate change. It is also a significant source of criteria pollutants (including nitrogen dioxide (NOx), sulfur dioxide (SO_2), and particulate matter (PM) emissions) and toxic air contaminants, which can exacerbate health risks. One way to address these emissions is to find opportunities to increase the efficiency of combustion processes in order to reduce fuel consumption. Fuel use reduction would directly result in emission reductions of these pollutants, and since this approach also leads to fuel cost savings, most if not all of the investment can be recovered over time. Reducing combustion emissions would help the Air District attain and maintain compliance with state and federal air quality standards, reduce local contributions to anthropogenic climate change, and reduce emissions of some toxic pollutants.

Though many stationary sources of combustion emissions are already well-controlled as a result of existing Air District regulation targeting criteria and toxic pollutants, combustion from stationary sources still accounts for over half of all GHG emissions in the Bay Area. Combustion emissions from all stationary sources in the Air District are about 40 million metric tons of carbon dioxide equivalent (MMT CO_2e), including combustion for electricity generation, residential and commercial uses, and combustion at industrial facilities such as oil refineries and cement plants. Residential and commercial fuel usage account for approximately 10 MMT CO_2e of that total, while industrial combustion (including electricity production) generates approximately 30 MMT CO_2e. Typical combustion sources in the industrial and electricity-generation sectors include natural-gas fired turbines, furnaces, boilers, and process heaters, though the top GHG emitting sources will vary by specific facility. For instance, in the refinery sector, the equipment units that comprise the fluid catalytic cracking (FCC) plant, the co-

[1] For the purpose of this control measure, stationary combustion sources include all non-mobile sources, including residential/commercial buildings and electricity generation. In the 2017 Plan, building- and energy-related emission sources are discussed in the Building and Energy sectors.

generation plant, and the hydrogen plant – which include boilers, steam generators, and heaters – are usually the largest sources of these emissions. Building and water heating, which typically involve natural gas combustion, is responsible for the majority of the GHG emitted from the residential and commercial sector.

The Air District will implement a Basin-wide Combustion Strategy to address emissions from stationary combustion, the largest contributor of GHG emissions within the Air District's direct regulatory jurisdiction.[2] The first phase of the strategy would evaluate carbon intensity caps as an immediate action to prevent GHG emissions increases at current levels of production. The second phase would involve developing source-specific regulations to reduce combustion emissions through increased efficiency. Both phases of the combustion strategy are described below:

- ***Phase 1: Carbon Intensity Caps – Stabilize Combustion Efficiency***

The Air District will explore establishing a regulatory cap on the carbon intensity of all major industrial combustion sources in the region, at a level consistent with their current performance. Carbon intensity is the amount of CO_2 emitted for each unit of product or output generated (e.g., pounds of CO_2 emitted per kW of electricity generated for a power plant). In general, the carbon intensity of a facility can be an indication of its efficiency when compared to similar facilities in the same sector.

One advantage of this approach is that since carbon intensity is a rate-based-standard (e.g., CO_2/unit produced) and not an absolute standard (e.g., CO_2 emissions), it does not limit production at particular facilities. Therefore, it would reduce the economic incentive for industry to move outside of the Bay Area due to increased production. Moving outside the Bay Area may result in greater overall emissions due to pollution associated with transporting the product and/or less stringent air pollution regulation.

Nearly 75 percent of CO_2 emissions from industrial combustion in the Bay Area come from the refining of transportation fuels, the generation of electricity and the production of cement. Each of these key industries would be subject to a carbon intensity standard that makes the most sense for that industry. For instance, petroleum refineries use large quantities of energy to convert crude oil into transportation fuels, mainly supplied from the combustion of crude oil and natural gas, and from grid electricity. The methodology to calculate the carbon intensity for the refining sector would need to account for the CO_2 emissions from all of these sources. Since refineries produce several different products (e.g., gasoline, diesel and jet fuel), the standard could be expressed in pounds of CO_2 per gallon of product. A metric such as such as gasoline-equivalent-gallon could be used to aggregate all the products into "gallons of product".

After defining a carbon intensity calculation standard for each sector, caps would be set on a facility-by-facility basis at a level consistent with current operations, with reasonable allowance for year-to-year variation.

[2] The California Air Resources Board has primary regulatory jurisdiction over mobile sources.

- ***Phase 2: Source-by-Source Rulemaking – Increase Combustion Efficiency***

Given the wide variety of combustion emissions sources, regulatory approaches to reduce combustion emissions through increased efficiency will have to be tailored to the specific sector and equipment type. Combustion sources will be evaluated in order to identify cost-effective and technically feasible efficiency improvements that would result in GHG and criteria emission reductions. These evaluations will be prioritized based on two factors: 1) the magnitude of facility GHG and criteria emissions from combustion processes, and 2) the energy efficiency opportunities available for each source-type. Combustion GHG and criteria emissions from Bay Area facilities are comprehensively quantified in the Air District Emissions Inventory and in the California Air Resources Board (ARB) Greenhouse Gas Mandatory Reporting Data. The Air District may rely on the energy efficiency and co-benefits assessment of large industrial sources conducted by ARB, among other resources, to assess the energy efficiency opportunities available for each source-type within each sector. These assessments were completed for the refinery, cement, hydrogen, and electricity generation during the years 2013 through 2015.

Implementation Actions:

Air District Staff will:

- evaluate carbon intensity caps for the refinery, power generation and cement sectors
- promote energy efficiency improvements through new rules on a source-type by source-type basis
- evaluate combustion sources for emissions and efficiency in order to identify cost-effective and technically feasible improvements that would lead to reductions in fuel use
- prioritize the evaluation of combustion sources based on the magnitude of the emissions and the energy efficiency opportunities for each source-type

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	604	604
CO_{2e}	1,600,000	1,600,000

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reductions Methodology:

Implementing a basin-wide combustion strategy is estimated to result in emission reductions, as presented in the table above, assuming a 5 percent emissions reduction across all industrial combustion sources. This value is based on the average GHG emission reductions across all sectors from uncompleted projects, as reported in ARB's energy efficiency and co-benefits assessment of large industrial sources for the refinery, cement, hydrogen, and electricity generation (ARB, 2013-2015). GHG emission reductions from the residential and commercial fuel usage subsectors are difficult to estimate at this time given the complexity of the regulatory landscape affecting energy efficiency in these categories. Reducing fuel combustion through efficiency will also reduce criteria air pollutants and toxic air contaminant emissions, but anticipated emissions reductions will vary by regulation and source and therefore cannot be quantified at this point. $PM_{2.5}$ emission reductions can be estimated using the same assumption as for greenhouse gases (5 percent emissions reduction across all industrial combustion sources). NO_x emission reductions are also anticipated, but have not been quantified at this time.

Emission Reduction Trade-Offs:
This control measure is designed to reduce energy or fuel use, so there would be no direct emission trade-offs. There might be an increase of indirect emissions associated with the production and delivery of some energy efficiency technologies.

Costs:
Upfront costs to implement energy efficiency and fuel reduction projects are expected to be borne by the individual facilities. These costs will vary widely depending on the type of project and source-type, but will be partly or entirely offset by savings in electricity or fuel costs.

Issues / Impediments:
Considering the wide variety of sources impacted, specific issues and/or impediments will be identified during rule making.

Source:

1. ARB (2013-2015) Energy Efficiency and Co-Benefits Assessment of Large Industrial Sources Public Reports. Available at: http://www.arb.ca.gov/cc/energyaudits/publicreports.htm.

SS19: Portland Cement

Brief Summary:
Air District Regulation 9, Rule 13 (Rule 9-13) limits the emissions of nitrogen oxides, particulate matter, and toxic air contaminants from the manufacture of Portland cement. This measure proposes to amend sections of the rule pertaining to ammonia and sulfur dioxide (SO_2) emissions, and may reduce GHG emissions.

Purpose:
Air District Rule 9-13 regulates emissions from cement manufacturing. At present, the Lehigh Hanson Cement Plant (Lehigh) in Cupertino is the only operating cement manufacturing plant in the Bay Area. Since the adoption of the rule in September 2012, there have been changes in production processes at Lehigh, changes to the California Office of Environmental Health Hazard Assessment (OEHHA) Health Risk Assessment guidelines, and possible future regulatory changes. This Portland Cement control measure would amend sections of the rule to reflect these changes in processes, guidelines, and the regulatory environment to further reduce emissions from cement manufacturing.

Source Category:
Stationary source – cement manufacturing

Regulatory Context and Background:
As written, Rule 9-13 assumes consistent levels of ammonia in feedstock. However, since the adoption of the rule, Lehigh has provided ammonia emissions monitoring data documenting the variability in baseline ammonia levels of their feedstock. An amendment of the rule is needed to reflect this variability.

Since adoption of Rule 9-13, OEHHA has updated state guidelines regarding toxicity and cancer potencies. These changes may require changes to Lehigh's existing notification requirements regarding toxic compounds. While this change does not require an amendment to the rule, any rule development effort will need to explain the notification requirements to members of the public.

Air District staff proposes amending Rule 9-13 to include an SO_2 emissions limit for consistency with other Air District rules controlling SO_2 emissions, while accommodating operational changes at the Lehigh facility. Impending Air District rules would impose SO_2 limits on coke calcining and cat cracking units at refineries, and Lehigh, which burns petroleum coke, is the largest uncontrolled source of SO_2 in the Air District. Emissions from Lehigh are considered uncontrolled because the facility does not currently have control devices installed to reduce emissions. While emissions are not "controlled", Lehigh's permit conditions limit SO_2 emissions to 481 pounds per hour (lb/hr) averaged over a 24-hour period. Due to variability in their feedstock, Lehigh has proposed a modified permit limit of 481 lbs/hr averaged over 30 rolling operating days for SO_2 emissions. Federal law determines that this proposed modification to operating conditions would be an increase in emissions and therefore requires new source review. The averaging periods necessary to allow operational flexibility would be reflected in the rule, so long as emission reductions remain consistent and enforceable.

In addition, Lehigh has a long history of public complaints regarding visible plumes, and the potential for increased emissions of ammonia and SO_2 addressed above may lead to greater potential for detached plume events. A detached plume is a plume that forms above the stack release point.

Production of Portland cement is an energy intensive process that relies on burning petroleum coke. Replacing some of the petroleum coke with biomass such as woodchips (e.g., yard waste, clean construction wood) could reduce emissions, including GHG emissions. Lafarge's cement plant in Bath, Ontario, is aggressively pursuing carbon emission reduction strategies through the planting of multiple energy crops that may eventually replace some of the coal and petroleum coke the plant requires as fuel each year. Recently, Lafarge began a multiyear life-cycle assessment study with Kingston, Ontario-based Queen's University's Energy and Environmental Policy Institute, and has been working closely with researchers on planting trials of perennial crops, utilizing about 2,500 acres of land surrounding the cement plant. Further research is needed to determine if biomass can be viable, cost-effective, and would result in emission reductions. Alternatively, the use of supplementary cementitious materials in place of clinker, such as rice hull ash and fly ash could reduce emissions. Further research is needed to determine how much clinker could be replaced, whether the use of rice hull ash or fly ash could pose a toxic risk, and how the change in cement blends would affect emissions.

Implementation Actions:

The Air District will:

- Consider amending sections of existing Air District Rule 9-13 pertaining to ammonia emissions to allow for replacement of the rolling 24-hour average with a different averaging period for ammonia emissions, and
- Amend Rule 9-13 to impose a standard for SO_2 consistent with other Air District rules; amend the rule as necessary to incorporate language regarding detached plumes, and consider amendments to the rule to reduce GHG emissions.

Emission Reductions:

Pollutants*	2020	2030
SO_2	4,493	4,493
CO_{2e}	85,055	85,055

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

The amendments to Air District Rule 9-13 discussed above are estimated to reduce 4,493 pounds per day of SO_2 emissions based on operating permit conditions potential to emit. As an initial estimate, replacing 10% of the petroleum coke burned with biomass would result in an emission reduction of 85,055 MT CO_{2e}/yr, assuming that such biomass would be carbon neutral.

Exposure Reductions:
TBD

Emission Reduction Trade-Offs:
Stricter emissions standards may require modifications to control equipment increasing the potential for a detached plume.

Costs:
Further study is needed to determine cost information and cost effectiveness.

Co-Benefits:
SO_2 is a PM precursor contributing to the formation of sulfate aerosols which directly and indirectly affect warming and cooling in the earth's atmosphere. Long term exposure to SO_2 can cause breathing difficulties, respiratory illness and aggravate exiting heart disease. Reductions in SO_2 emissions will protect public health.

Issue/Impediments:
The cost effectiveness of rule amendments that require further reductions in emissions from Lehigh in Cupertino would need to be investigated.

Sources:

1. Bay Area Air Quality Management District, Regulation 9, Rule 13: Nitrogen Oxides, Particulate Matter, and Toxic Air Contaminants from Portland Cement Manufacturing Scoping Paper, July 2012

SS20: Air Toxics Risk Cap and Reduction from Existing Facilities

Brief Summary:
This control measure seeks to further reduce public exposure to toxic air contaminants (TACs) from existing facilities. New Regulation 11, Rule 18 (Rule 11-18) is expected to substantially reduce health risks from existing facilities that emit TACs, by requiring the implementation of all technically and economically feasible risk reduction measures at significant sources of TACs in these facilities. The rule also incorporates the Office of Environmental Health Hazard Assessment (OEHHA's) recently adopted (2015) Health Risk Assessment Guidelines into its required health risk estimation methodology.

Purpose:
The purpose of this measure is to ensure that existing facilities that emit TACs do not pose an unacceptable health risk to nearby residents, workers, and/or students.

Source Category:
Stationary Sources

Regulatory Context and Background:
Various facilities in the Bay Area region emit toxic air contaminants that can adversely impact public health, including data centers, petroleum refineries, a cement kiln, gasoline dispensing facilities, etc. The Air District's long-standing Air Toxics Program for reducing TAC emissions from stationary sources and statewide programs for reducing emissions from mobile sources have been largely responsible for decreasing these pollutants by at least 87 percent since 1990. However, there is still progress to be made. Many Bay Area residents have expressed concern about the impact of these toxic pollutants on public health.

To directly address concerns about community health risks, Air District staff will propose that the Air District adopt a new Regulation 11, Rule 18 (Rule 11-18): Cap and Reduction of Risk from Air Toxic Emissions at Existing Facilities. Rule 11-18 would enhance the component of the Air District's Air Toxics Program that assesses and reduces health risks from existing facilities. Rule 11-18 would apply to all facilities whose emissions of toxic air contaminants may result in a significant risk to nearby residents and workers, including petroleum refineries.

In order to determine if health risks are significant for each Bay Area facility that emits toxic compounds, Air District staff will first conduct site-specific Health Risk Screening Analysis (HRSA) based on the annual toxic emissions inventories reported to the Air District. The HRSA assesses the potential for adverse health effects from public exposure to routine and predictable emissions of TACs using guidelines adopted by the California Air Resources Board (ARB) and by the California Air Pollution Control Officers Association (CAPCOA). The Air District would determine a priority score (PS) for each facility based on the HRSA results. These scores are influenced by the amount of TACs emitted, the toxicity of these materials, and the proximity of the facility to potential receptors. Site-specific Health Risk Assessments (HRAs) would be conducted and prioritized based on a facility's PS. The results of the HRA would determine whether a facility would be affected by Rule 11-18. HRAs conducted as part of this process will incorporate the latest science, by using the OEHHA's 2015 HRA Guideline Revisions, a major update to these guidelines that focuses on children's health protection.[1]

Rule 11-18 would affect facilities with health risk impact that exceed any of the following risk action level thresholds (risk caps):

- ten per million (10/M) cancer risk
- 1.0 hazard index for chronic risk
- 1.0 hazard index for acute risk

The Air District would notify facilities of their health risk scores. Facilities that pose a health risk in excess of any of these risk caps would be required to reduce that risk below the cap through one of two ways: (1) the implementation of a Risk Reduction Plan approved by the Air District within three years of approval of the plan, or (2) the demonstration that all significant sources of toxic emissions are controlled by Best Available Retrofit Control Technology for Toxics (TBARCT). Risk reduction plans would detail how the facility would reduce its health risk below the risk caps in the specified timeframe and would be expected to include a characterization of each source of toxic emissions, an evaluation of risk reduction measures to be implemented, a schedule for implementing these as quickly as possible, and an estimate of the remaining risk following such implementation. In general, TBARCT is considered to be the most effective or stringent retrofit emission control that is technologically feasible and achieved in practice.

It is anticipated that hundreds of existing facilities may be impacted by Draft Rule 11-18.

Implementation Actions:
Air District staff will:

- Develop Rule 11-18 to include the screening and comprehensive evaluation (if warranted) of health risks from all facilities that emit toxic air contaminants in the Air District, and to require the implementation of all technically and economically feasible risk reduction measures to significant sources of TACs in these facilities.

Emission Reductions:
Specific emission reduction estimates will be estimated during rule development.

Exposure Reductions:
Specific exposure reduction estimates will be estimated during rule development.

Emission Reduction Trade-Offs:
None expected.
Costs:

[1] In March 2015, OEHHA revised the HRA guidelines to include consideration of children's health protection. Advances in science have shown that early-life exposures to air toxics contribute to an increased lifetime risk of developing cancer, and/or other adverse health effects, compared to exposures that occur in adulthood. The revised risk assessment methodology reflects both this greater sensitivity and more refined data in childhood and adult exposure to air toxics.

Specific costs will be developed during rule development.

Co-Benefits:
Reducing TAC emissions will likely result in reduced emissions of TOG, ROG, and particulate matter.

Issue/Impediments:
The regulated community not already subject to the requirements of the Air District Air Toxics "Hot Spots" Program may oppose thresholds that are more stringent. Those already subject to the current Air Toxic ATHS program may oppose increased restrictions as a result of lowering these thresholds.

Sources:

1. Proposed Amendments to Regulation 2, Permits, Rule 5: New Source Review of Toxic Air Contaminants, BAAQMD, Dated December 2009. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Public%20Hearings/2009/0205_RFC_102109/0205_stfrcomplete_121109.ashx?la=en
2. OEHHA Public Notice for Release of Air Toxics Hot Spots Draft Guidance Manual for Public Comment, March 6, 2015. Available at: http://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk-0

SS21: New Source Review of Toxic Air Contaminants

Brief Summary:
Air District Regulation 2, Rule 5 (Rule 2-5) requires a health impact review for new and modified sources that emit toxic air contaminants (TACs) in excess of emissions trigger levels. It also establishes risk thresholds for mitigation and permit approval. The Air District conducts the health impact review in accordance with the California Office of Environmental Health Hazard Assessment (OEHHA) Health Risk Assessment Guidelines and the CARB/CAPCOA Risk Management Guidelines. These guidelines were revised in 2015. This measure would update the toxic New Source Review (NSR) program by incorporating the 2015 Health Risk Assessment (HRA) guideline revisions into the Air District's health impact review procedures. The use of the 2015 guidelines will increase the stringency of the toxics NSR program because the new health risk calculation procedures will result in higher cancer risk estimates for the same level of emissions.

Purpose:
This control measure will ensure that the Air District is using the most up to date scientific information and procedures to assess health impacts for new projects. This will also ensure consistency with the related Air Toxics Hot Spots Program that assesses health impacts due to TAC emissions from all sources at a facility.

Source Category:
This rule applies to all new or modified stationary sources that emit toxic air contaminants.

Regulatory Context and Background:
The Air District's Toxics Control Program includes the following three components: Toxics New Source Review, Air Toxics Hot Spots Program and CEQA. The Toxics NSR Program prevents significant increases in health risks resulting from new and modified sources of TACs through the preconstruction permit review process. As part of the engineering evaluation of a permit application, an assessment of health impacts is required. Site-specific health impacts are determined through preparation of an HRA that is performed in accordance with the OEHHA's guidelines. These guidelines are periodically updated to reflect advances in science.

As mandated under the Children's Environmental Health Protection Act of 1999 or SB25, OEHHA revised the HRA guidelines to include consideration of children's health protection. Advances in science have shown that early-life exposures to air toxics contribute to an increased lifetime risk of developing cancer, and/or other adverse health effects, compared to exposures that occur in adulthood. The revised risk assessment methodology reflects both this greater sensitivity and more refined data in childhood and adult exposure to air toxics.

Implementation Actions:
Air District staff will propose revisions to Air District Rule 2-5 to:

- Revise the Air District's Health Risk Assessment Guidelines based on OEHHA's 2015 risk assessment guidelines and CARB/CAPCOA's 2015 risk management guidelines.

- Revise the Air District's health risk assessment trigger levels for each toxic air contaminant using the 2015 guidelines and most recent health effects values.

Emission Reductions:
This measure will not directly require emission reductions, but the Air District expects it to result in higher level of health protection via evaluations of permit applications. The proposed revisions to the risk calculation procedures will result in higher cancer risk estimates for residential receptors compared to current procedures. As a result, applicants for new or modified sources of TACs will be required to implement risk mitigation measures or limit project risks at lower emission rates compared to current procedures.

Exposure Reductions:
As with emissions, this measure will not directly result in exposure reductions, but new or modified sources of TACs may reduce exposure as one method of meeting the project health risk limits.

Emission Reduction Trade-Offs:
Risk mitigation measures may include lower operating rates, alternative material, and lower emissions for new projects. These mitigation measures may also include abatement devices (afterburners, oxidizers, diesel particulate filters, etc.) and exhaust modifications (stack relocations, taller stacks, flow rate changes, etc.). Small increases in fuel or electricity usage are possible which could increase GHG emissions. However, reductions of black carbon particulate emissions may offset any climate change impacts due to abatement devices or increased electricity use.

Costs:
Specific costs will be developed during rule making.

Co-Benefits:
Risk mitigation measures for new and modified sources will result in reductions of precursor organic compounds and particulate matter emissions and TACs such as benzene and diesel PM. Reductions in diesel PM emissions will also reduce black carbon particulates.

Issue/Impediments:
No major issues have been identified.

Sources:

1. OEHHA 2015 Risk Assessment Guidelines: Guidance Manual for Preparation of Health Risk Assessments
2. CARB/CAPCOA 2015 Risk Management Guidance for Stationary Sources of Air Toxics
3. BAAQMD Regulation 2, Rule 5: New Source Review of Toxic Air Contaminants

SS22: Stationary Gas Turbines

Brief Summary:
In 2006, the Air District amended Regulation 9, Rule 9 (Rule 9-9), *Nitrogen Oxides from Stationary Gas Turbines*, applying the most stringent emission limits for oxides of nitrogen (NO_x) to larger stationary gas turbines. Less stringent limits were applied to small and medium sized units. The Air District is considering whether more stringent limits are warranted for medium-sized gas turbines.

Purpose:
Further reduce NO_X emissions from stationary gas turbines in the Bay Area.

Source Category:
Permitted sources - stationary gas turbines

Regulatory Context and Background:
A gas turbine is an engine that combusts gaseous fuel to generate rotational motion. It consists of three basic parts: a compressor, where air is compressed up to 30 times atmospheric pressure; a combustor, where air and fuel are mixed and burned; and a power turbine, where expanding combustion gases spin rotating blades. The power turbine provides mechanical energy to operate the compressor and to either generate electricity or mechanical energy (e.g. a jet engine or natural gas compressor). To increase efficiency, hot exhaust gases can be used to generate steam to operate a secondary steam turbine and to heat the combustion air so less fuel is needed.

The primary pollutants from gas turbines are the combustion byproducts carbon monoxide and NO_x. Most of the NO_x is emitted as nitrogen monoxide (NO), which oxidizes in air to form nitrogen dioxide (NO_2), a precursor to ozone and fine particulate matter ($PM_{2.5}$). NO_x emissions can be controlled by enhanced water or steam injection, Ultra Dry Low NO_X (DLN) combustion controls, or Selective Catalytic Reforming (SCR) of NO_X to nitrogen through a reaction with ammonia. SCR is the most effective technology but results in some ammonia emissions (ammonia slip).

In 2006, the Air District amended Rule 9-9, *Nitrogen Oxides from Stationary Gas Turbines*, limiting NO_x emissions depending on turbine size and fuel source (natural gas or other). Gas turbines larger than 250 million British thermal units per hour (MMBtu/hr) are required to install SCR and meet the most stringent limit of 9 ppm. Gas turbines between 50-250 MMBTU/hr in size are required control NO_x by other means, such as water injection or DLN, and meet less stringent limits depending on the size of the turbine, the fuel used, and the type of controls available.

Implementation Actions:

The Air District will:

- Consider amendments to Rule 9-9 that will strengthen the NO_X limits for medium sized gas turbines.

Emission Reductions:

Pollutants*	2020	2030
NO_x	250	250

**criteria pollutants are reported in lbs/day*

Exposure Reductions:

Reducing NO_x emissions will reduce $PM_{2.5}$ and ozone concentrations. While ammonia slip could contribute to additional $PM_{2.5}$ formation, overall $PM_{2.5}$ concentrations are expected to be lower with this control measure.

Emission Reduction Trade-Offs:

Ammonia slip from SCR systems can increase secondary $PM_{2.5}$ formation. SCR may result in additional GHG emissions from both the reduction in efficiency of the gas turbine, and the increased energy required to operate the SCR equipment.

Costs:

The estimated annualized costs for the use of SCR technology for medium sized gas turbines (including a 30 percent increase to accommodate retrofit to existing facilities) range from $0.42 – 1.36 million.

Co-Benefits:

Unknown

Issue/Impediments:

None

Sources:

1. Staff Report, Regulation 9, Rule 9, *Nitrogen Oxides from Stationary Gas Turbines,* November, 2006
2. Regulation 9, Rule 9, *Nitrogen Oxides from Stationary Gas Turbines*, amended: December 6, 2006
3. AP 42, Fifth Edition, Volume I, Chapter 3, Stationary Internal Combustion Sources, Section 3.1, Stationary Gas Turbines, amended: April, 2000.

SS23: Biogas Flares

Brief Summary:
Require that all biogas and non-refinery flares meet lowest available emissions reduction (LAER) level of 0.025 pounds of NO_X per million Btu.

Purpose:
Reduce secondary emissions of NO_X from flares used to abate organic emissions from solid waste landfills and anaerobic digesters.

Source Category:
Stationary Source – landfills and anaerobic digesters

Regulatory Context and Background:
Flares employed at solid waste landfills, publicly owned treatment works, and other anaerobic digesters function as pollution abatement devices and as such are not subject to new source review. Per Air District's permit Regulation 2, Rule 2 (Rule 2-2), section 112, secondary pollutants resulting from abatement devices are exempt from the best available control technology (BACT) requirements of the rule (2-2-301); however, these secondary emissions are still subject to the less stringent reasonable available control technology (RACT) requirements.

BACT is defined (2-2-206) as the most stringent of any control device or technique successfully utilized for that source category, or that is determined to be technically feasible, and it must be at least as stringent as any applicable federal, state or District laws, rules or requirements. Conversely, RACT is defined (2-2-243) as the lowest emission limit that can be achieved taking into account technological feasibility, cost-effectiveness, the specificities of the source in question, or the lowest emission limit achieved by application of control equipment to similar but not necessarily identical categories of sources.

The federal Clean Air Act (section 171(3)) defines the lowest achievable emission rate (LAER) as the most stringent emission limitation achieved in practice for a source category or which is contained in the state implementation plan (SIP) of any state for the same source category. LAER can be equivalent to RACT, but is often equivalent to BACT when stricter standards are required due to nonattainment of national ambient air quality standards for a given jurisdiction. The Air District's definition of BACT is similar to the federal LAER definition; however, BACT is evaluated on a case-by-case basis whereas LAER is uniform for a source category.

Air District staff has determined RACT for enclosed landfill gas flares to be 0.06 pounds of NO_X per million Btu of heat input (lbs/MMBTU), with CO emissions limited to 0.2 lbs/MMBTU. Current LAER for enclosed landfill gas flares achieved in practice is 0.025 lbs/MMBTU for NO_X, and 0.06 lbs/MMBTU for CO.

Implementation Actions:
Given the current exemption in Rule 2-2, imposing LAER level control would require a new rule in Regulation 9 specifically for secondary emissions from non-refinery flares. Air District staff will investigate the potential for more stringent limits on emissions from non-refinery flares.

Emission Reductions:

Pollutants*	2020	2030
NO_x	920	920
CO	2,940	2,940

**criteria pollutants are reported in lbs/day*

Emission Reductions Methodology:
The majority of emissions from biogas and non-refinery flares come from flares subject to RACT level controls. If these flares were subjected to LAER controls, NOx would be reduced by 58 percent and CO would be reduced by 70 percent. According to the 2011 inventory, landfill flares account for 980 pounds per day of NO_X, and 3,220 pounds per day of CO. Therefore, implementation of this measure would yield potential emission reductions of 920 pounds per day of NO_X, and 2,940 pounds per day of CO.

Exposure Reductions:
None expected.

Emission Reduction Trade-Offs:
None expected.

Costs:
In a 2013 technical support document for a permit for a landfill in Washington state, South West Clean Air Agency staff determined that a 30 MMBTU per hour flare meeting LAER control would result in reduced NO_X emissions at a cost of approximately $7,000 per ton of NO_X reduced. However, this determination is really a comparison of the installation and maintenance costs of a new LAER compliant flare ($260,000 capital cost) to a new RACT compliant flare ($250,000 capital cost). To retrofit existing flares to meet LAER requirements would be somewhere between this delta and the costs of a completely new flare, assuming that not all components would need to be replaced. More research is required to determine the retrofit costs for a LAER compliant flare, and thereby the emission reduction cost in dollars per ton of NO_X reduced.

Co-Benefits:
Reduction in CO emissions as specified in Emission Reductions section above.

Issue/Impediments:
The regulated community would likely oppose the additional costs imposed by retrofitting their existing equipment.

Sources:

1. Bay Area Air Quality Management District, Regulation 2, Permits, Rule 2: New Source Review, June 15, 2005
2. Bay Area Air Quality Management District, Engineering Evaluation Report, Potrero Hills Landfill, Application #210118, October 13, 2013
3. Technical Support Document, Cowlitz County Headquarters Landfill, Air Discharge Permit Application CO-916, Southwest Clean Air Agency, August 8, 2013
4. California Air Pollution Control Officers Association BACT Clearinghouse Resource Manual, CAPCOA, June 21, 2000. http://www.arb.ca.gov/bact/docs/manual.htm
5. Specifying a Cost Effective Landfill Flare System, John Zink Company LLC, Brandy Johnson, P.E. March 8, 2005 http://www.johnzink.com/wp-content/uploads/tp_cost_effective_landfill_rev.pdf

SS24: Sulfur Content Limits of Liquid Fuels

Brief Summary:
This control measure would propose amendments for Air District Regulation 9, Rule 1 to incorporate several fuel-specific sulfur content limits for diesel and other liquid fuels.

Purpose:
Reduce SO_2 emissions, and as a co-benefit, reduce particulate matter (PM) formation as a secondary pollutant.

Source Category:
Stationary sources.

Regulatory Context and Background:
The California Air Resources Board (ARB) currently limits sulfur content in all diesel fuels. SCAQMD Rule 431.2 reflects the same sulfur content limits of 15 ppm for low sulfur fuel used in stationary sources. The SCAQMD 15 ppm sulfur limit is equivalent to the federal ultra-low sulfur diesel fuel limit.

Sulfur emissions lead to the formation of sulfur dioxide (SO_2) which is a criteria pollutant. Although the Air District is in attainment with federal ambient air quality standards for SO_2 concentrations, it is not in attainment for the federal and state $PM_{2.5}$ standards. SO_2 is a precursor of $PM_{2.5}$. The adoption of low sulfur fuel limits will help make continued progress toward achieving state PM standards and help ensure federal standards are not exceeded.

Currently, Rule 9-1 limits the sulfur content of liquid fuels to 0.5 percent by weight. This standard applies to diesel fuel. The ARB and SCAQMD standards for diesel fuel are more stringent and thus should be evaluated for potential inclusion in Rule 9-1.

Implementation Actions:
The Air District would propose amendments to Rule 9-1 to incorporate a new sulfur content limit for liquid fuels. The terms “liquid fuel” is not currently defined by the rule. In proposing amendments to Rule 9-1, the Air District will be acting pursuant to its authority provided in Health and Safety Code 40447.6 to protect public health by lowering the sulfur content in diesel fuel.

Emission Reductions:
Emission reductions will be estimated during rule amendment process.

Exposure Reductions:
NA

Emission Reduction Trade-Offs:
None.

Costs:
Specific costs will be estimated at time of rule amendment.

Co-Benefits:
Reduction of SO_2 emissions will reduce formation of secondary $PM_{2.5}$ in the form of ammonium sulfate.

Issue/Impediments:
None.

Sources:

1. Bay Area Air Quality Management District, Regulation 9, Rule 1 Inorganic Gaseous Pollutants, Sulfur Dioxide
2. South Coast Air Quality Management District, Rule 431.2 Sulfur Content of Liquid Fuels
3. California Air Resources Board, California Diesel Fuel Regulations

SS25: Coatings, Solvents, Lubricants, Sealants, and Adhesives

Brief Summary:
This control measure would seek to reduce the VOC emissions from miscellaneous coatings, adhesive, solvent and lubricant categories by lowering certain product VOC limits. Examples of the miscellaneous categories to be considered include coatings used in aerospace; adhesives used in a variety of sealing applications; solvents for cleaning and preservation or graffiti abatement activities; fountain solutions for printing operations; and lubricants used as metalworking fluids to reduce heat and friction to prolong life of tools, improve product quality and carry away debris.

Purpose:
Reduce emissions of VOCs from coatings, solvents, lubricants and adhesives.

Source Category:
Area - coatings and solvents

Regulatory Context and Background:
The following Air District rules contain VOC limits addressing coatings, solvents, lubricants, sealants, or adhesives: Rules 8-4, 8-11, 8-12, 8-13, 8-14, 8-16, 8-19, 8-20, 8-23, 8-26, 8-29, 8-31, 8-32, 8-35, 8-36, 8-38, 8-43, 8-49, and 8-51. Rules 8-3 and 8-45 also have VOC limits for coatings and solvents; but these rules are modeled on suggested control measures (SCM) developed by the ARB in consultation with the state air districts and the California Air Pollution Control Officers Association (CAPCOA). The SCMs are developed to help ensure consistency in the regulation of architectural and automotive coatings and solvents throughout the state. The Air District's current VOC limits for coatings range from 20 grams per liter (g/l) to 1,800 g/l (Reg. 8-13), 120 to 850 g/l for adhesives, 50 g/l to 880 g/l (Reg. 8-20) for solvents, and, currently, there are not standards for lubricants and vanishing oils. The control measure will examine the potential to reduce the allowable VOC content of coatings, adhesives, and solvents regulated by the above listed Regulation 8 rules. The following table presents a simplified comparison of the potentially affected Air District coatings, adhesives, and solvent rules with comparable rules adopted by the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Air Pollution Control District (SJVAPCD).

TABLE 1
Comparisons of Air District Coatings, Adhesives, and Solvent VOC Limits to Comparable, SCAQMD, and SJVAPCD Rules

Bay Area Rules VOC Limit Range	South Coast Rules VOC Limit Range	San Joaquin Valley VOC Limit Range
8-4: General Solvent and Surface Coating Operations 4,533 kg/yr emission rate or 85 to 90% control or 420 g/l VOC content and 50 g/l solvent limit	Rule 1122: Solvent Degreasers & Rule 1171: Solvent Cleaning Operations 25-50 g/l or 90% and other controls	Rule 4661: Organic Solvents 2,489 kg/yr or 85% control

Bay Area Rules VOC Limit Range	**South Coast Rules VOC Limit Range**	**San Joaquin Valley VOC Limit Range**
8-11: Metal Container, Closure and Coil Coating 20 to 600 g/l	Rule 1125: Metal Container, Closure, and Coil Coating Operations 0 to 800 g/l	Rule 4604: Can and Coil Coating Operations 20 to 750 g/l
8-12: Paper, Fabric and Film Coating 265 g/l or effective 120 g/l control	Rule 1128: Paper, Fabric, and Film Coating Operations 265 g/l or effective 120 g/l control (20 g/l for plastisol)	Rule 4607: Graphic Arts and Paper, Film, Foil and Fabric Coatings 20 to 600 g/l
8-13: Light and Medium Duty Motor Vehicle Assembly Plants 450 to 1,800 g/l or 90% control	Rule 1115: Motor Vehicle Assembly Line Coating Operations 145 to 1,800 g/l	Rule 4602: Motor Vehicle Assembly Coatings 250 to 1,440 g/l or 90% control
8-14: Surface Coating of Large Appliances and Metal Furniture 275 to 420 g/l	Rule 1107: Coating of Metal Parts and Products 275 to 420 g/l	Rule 4603: Surface Coating of Metal Parts and Products, Plastic Parts and Products, and Pleasure Crafts 275 to 420 g/l
8-16: Solvent Cleaning Operations 50 g/l or 90% and other controls	Rule 1122: Solvent Degreasers & Rule 1171: Solvent Cleaning Operations 25-50 g/l or 90% and other controls	Rule 4662 Organic Solvent Degreasing Operations & Rule 4663: Organic Solvent Cleaning, Storage, and Disposal 25 to 800 g/l or 85% control
8-19: Surface Coating of Miscellaneous Metal Parts and Products 275 to 420 g/l or 85% control 50 g/l for surface prep solvent	N/A	N/A
8-20: Graphic Arts Printing and Coating Operations 25 to 400 g/l	Rule 1130: Graphic Arts 16 to 300 g/l	Rule 4607: Graphic Arts and Paper, Film, Foil and Fabric Coatings 20 to 600 g/l
8-23: Coating of Flat Wood Paneling and Wood Flat Stock 250 g/l or 90% control	Rule 1104: Wood Flat Stock Coating Operations 250 g/l or 90% capture /95% control (85% overall) control & 50 ppm emission limit	Rule 4606 Wood Products and Flat Wood Paneling Products Coating Operations 120 to 750 g/l or 15 lbs/day pre controls
8-26: Magnet Wire Coating Operations 200 g/l or 90% control	Rule 1126: Magnet Wire Coating Operations 200 g/l or 90% control	N/A
8-29: Aerospace Assembly and Component Coating Operations 250 to 850 g/l or 85% control	Rule 1124: Aerospace Assembly and Component Manufacturing Operations 120 to 1000 g/l or 90% capture /95% control (85% overall control)	Rule 4605: Aerospace Assembly and Component Coating Operations 120 to 1000 g/l or 90% capture /95% control (85% overall control)
8-31: Surface Coating of Plastic Parts and Products 420 to 800 g/l coatings and 50 g/l solvent or 85% control	Rule 1145: Plastic, Rubber, and Glass Coatings 50 to 800 g/l or 90% capture /95% control (85% overall control) & 50 ppm emission limit	Rule 4603: Surface Coating of Metal Parts and Products, Plastic Parts and Products, and Pleasure Crafts 275 to 880 g/l

Bay Area Rules VOC Limit Range	South Coast Rules VOC Limit Range	San Joaquin Valley VOC Limit Range
8-32: Wood Products Coatings 150 to 550 g/l & 50 g/l solvent limit	Rule 1136: Wood Products Coatings 120 to 750 g/l	Rule 4606 Wood Products and Flat Wood Paneling Products Coating Operations 120 to 750 g/l or 15 lbs/day pre controls
8-35: Coating, Ink and Adhesive Manufacturing 200 g/l solvent limit	Rule 1141.1. Coatings and Ink Manufacturing No VOC limits	Rule 4652: Coatings and Ink Manufacturing No VOC limits
8-36: Resin Manufacturing 95% control or 4.5 kg/day VOC emissions limit	Rule 1141: Control of Volatile Organic Compound Emissions From Resin Manufacturing 95-98% control or 0.12 to 0.5 lb VOC emitted per 1000 lbs resin produced.	Rule 4684: Polyester Resin Operations 10 to 48 wt% VOC content & 25 g/l cleaning solvent
8-38: Flexible and Rigid Disc Manufacturing 85% control	N/A	N/A
8-43: Surface Coating of Marine Vessels 275 to 610 g/l	Rule 1106: Marine Coating Operations 275 to 780 g/l	Rule 4603: Surface Coating of Metal Parts and Products, Plastic Parts and Products, and Pleasure Crafts 275 to 880 g/l
8-49: Aerosol Paint Products 60 to 95 g/l	ARB Aerosol Coating Products Regulation 60 to 95 g/l	ARB Aerosol Coating Products Regulation 60 to 95 g/l
8-51: Adhesive and Sealant Products 30 to 850 g/l	Rule 1168: Adhesive and Sealant Applications 30 to 850 g/l	Rule 4653: Adhesive and Sealants 25 to 850 g/l

Implementation Actions:

The Air District will:

- Review applicable Air District rules for coatings, solvents, and adhesives and compare the VOC limits with limits in other Bay Area Air District rules and comparable VOC limits in other California air districts rules, such as the SCAQMD and SJVAPCD, and propose revised limits as appropriate. The table above is a cursory comparison of coating, adhesive, and solvent rules from the Air District to similar rules from the SCAQMD and SJVAPCD.
- A more comprehensive comparison of VOC limits for specific coating, adhesive, and solvent categories would be undertaken to determine which areas are most likely to present opportunities for additional emission reductions.

Emission Reductions:

Emission reductions will be calculated at time of rule-making.

Exposure Reductions:

N/A

Emission Reduction Trade-Offs:
N/A
Costs:
Specific costs will be estimated at time of rule-making.

Co-Benefits:
N/A

Issue/Impediments:
None.

Source:

1. South Coast Air Quality Management District, 2012 Air Quality Management Plan

SS26: Surface Preparation, Cleanup, and Equipment Cleaning Solvents

Brief Summary:
Lower the VOC limits for solvents used for surface preparation, cleanup, and equipment cleaning in Air District Rules 8-24, 8-29, 8-30, 8-35 and 8-38.

Purpose:
Reduce emissions of VOC from various surface preparation, cleanup, and equipment cleaning activities.

Source Category:
Stationary Source and Area Source: Evaporative emissions

Regulatory Context and Background:
Most Air District rules addressing surface preparation and cleanup and equipment cleaning solvents include a VOC limit for these materials. Air District Rules 8-4: General Solvent and Surface Coating Operations, 8-19: Surface Coating of Miscellaneous Metal Parts and Products, 8-31: Surface Coating of Plastic Parts and Products all have a VOC limit of 50 grams per liter (g/l) for surface preparation and cleanup, which is the most stringent in the Air District. However, there are several other Air District rules addressing solvent use that either do not contain solvent limits for surface preparation, cleanup, and equipment cleaning or have solvent limits in excess of 50 g/l. These Air District rules are Rules 8-24, 8-29, 8-30, and 8-35, and 8-38.

Air District Rule 8-24: Pharmaceutical and Cosmetic Manufacturing Operations only includes evaporation minimization measures. In comparison, South Coast AQMD Rule 1171, Sacramento Metropolitan AQMD Rule 466: Solvent Cleaning, and San Joaquin Valley APCD Rule 4663 include a VOC limit of 800 g/l for addressing surface preparation and cleanup for pharmaceutical production. Both Sacramento Metropolitan AQMD Rule 466 and San Joaquin Valley Rule 4663 include a 600 g/l limit for equipment cleaning for pharmaceutical production. Because Feather River APCD Rule 3-14: Surface Preparation and Clean-up does not have an explicit limit or exemption for cosmetic manufacturing, the default of 50 g/l limit would apply.

Air District Rule 8-29: Aerospace Assembly and Component Coating Operations contains no VOC limit for surface preparation and cleanup. South Coast AQMD Rule 1124: Aerospace Assembly and Component Manufacturing Operations and San Joaquin Valley APCD Rule 4605 Aerospace Assembly and Component Coating Operations both have VOC limits of 200 g/l for cleaning solvents and 300 g/l for stripping solvents.

Air District Rule 8-30: Semiconductor Wafer Fabrication Operations includes a VOC limit of 10 percent by weight for wipe cleaning in semiconductor manufacturing. This limit was established in 1998 and is higher than the Air District's most stringent solvent limit of 50 g/l VOC. South Coast AQMD Rule 1164: Semiconductor Manufacturing contains a 200 g/l limit for equipment cleaning. Sacramento Metropolitan AQMD, Rule 466 contains a 100 g/l limit for electronic components manufacturing, which could be interpreted to include semiconductor wafer fabrication.

Air District Rule 8-35: Coating, Ink and Adhesive Manufacturing includes a VOC limit of 200 g/l for equipment cleaning solvent. This limit was established in 1994 and is higher than the most stringent solvent limit of 50 g/l VOC found in many district regulations in other regions. San Joaquin Valley APCD Rule 4663 Organic Solvent Cleaning, Storage, and Disposal and South Coast AQMD Rule 1171 have a VOC limit of 25 g/l for general product cleaning and surface preparation and cleaning of coating or adhesive application equipment.

Most District rules addressing cleanup solvent include a VOC limit for these materials. Air District Rule 8-38: Flexible and Rigid Disc Manufacturing, Section 8-38-116 provides a blanket exemption for VOC emissions from "cleaning of disc coating or polishing equipment." Further, Air District Rule 8-4 also exempts surface preparation operations for flexible and rigid disc manufacturing operations subject to Rule 8-38. A review of Air District permit records indicates that there is only one operation that may be subject to this rule.

Implementation Actions:
The Air District will:

- Draft amendments to Rules 8-29, 8-30, and 8-35 that would reduce the VOC limit for general product cleaning, surface preparation, and equipment cleaning solvents to no more than 50 g/l or, if compliant products are suitably available, no more than 25 g/l.
- Consider possible removal of VOC emission exemptions from Rule 8-38.

Emission Reductions:
The four source categories addressed by these rules emit approximately 2.4 tons of VOCs per day (2.2 tons attributable to wipe cleaning); however, it is unknown what fraction of these emissions would be available to be reduced through the implementation of this control measure.

Exposure Reductions:
N/A.

Emission Reduction Trade-Offs:
None.

Costs:
Specific costs will be estimated during rule amendments.

Co-Benefits:
N/A.

Issue/Impediments:
Training of workers in the use of alternative solvents. Undetermined health or odor issues associated with potential alternatives.

Sources:

1. Bay Area Air Quality Management District, Rule 8-4: General Solvent and Surface Coating Operations.
2. Bay Area Air Quality Management District, Rule 8-16: Solvent Cleaning Operations.
3. Bay Area Air Quality Management District, Rule 8-19: Surface Coating of Miscellaneous Metal Parts and Products.
4. Bay Area Air Quality Management District, Rule 8-24: Pharmaceutical and Cosmetic Manufacturing Operations.
5. Bay Area Air Quality Management District, Rule 8-31: Surface Coating of Plastic Parts and Products.
6. Bay Area Air Quality Management District, Rule 8-35: Coating, Ink and Adhesive Manufacturing.
7. Bay Area Air Quality Management District, Rule 8-38: Flexible and Rigid Disc Manufacturing.
8. Feather River Air Quality Management District, Rule 3-14: Surface Preparation and Clean-Up.
9. San Joaquin Valley Air Pollution Control District, Rule 4663: Organic Solvent Cleaning, Storage, and Disposal.
10. South Coast Air Quality Management District, Rule 1171: Solvent Cleaning Operations.

SS27: Digital Printing Operations

Brief Summary:
This control measure would reduce VOC emissions from digital printing operations, most likely by one of two approaches:

- Adopting VOC limits on inks and solvents used, or
- Adopting control technology requirements.

Purpose:
Reduce emissions of VOC from digital printing operations.

Source Category:
Area Source-digital printing operations

Regulatory Context and Background:
District Regulation 8, Rule 20 (Rule 8-20): Graphics Arts Printing and Coating Operations limits organic emissions from traditional graphic arts operations during printing, coating, adhesive, and cleaning activities. Traditional printing technologies include lithographic, letterpress, gravure, flexographic, and screen printing. VOC emissions from such operations are reduced by the rule via VOC limits on various inks, coatings and solvents.

Maryland's Code of Regulations (Section 26.11.19.18F), for example, addresses VOC emissions from screen printing and digital printing. The regulation applies to persons, owners, or operators that perform screen printing, manufactures plastic cards, coats plywood used for signs, or digital imaging and causes VOC emissions of 20 pounds or more per day. The regulation sets requirements on the maximum VOC content of inks used for screen printing. As a general requirement, persons, owners, or operators of digital imaging subject to the regulation may not cause VOC emissions exceeding 100 pounds per day from all digital printing at the premises. Those subject to the regulation must maintain records for not less than 3 years on the use of inks, and VOC content of each type of ink.

Digital printing (DP) is a fairly new, non-traditional printing process that is emerging in virtually every segment of the graphic arts industry as well as other industries. In traditional printing and graphic arts, images are transferred from a press to a paper or paper-like product. In a small percentage of operations, images are applied to limited types of textiles. In the DP process a digital image that is stored on a computer is converted into an image that can be printed on a wide variety of substrates besides paper, such as many types of textiles, and three dimensional objects. This differs from traditional graphic arts printing, which uses fixed-image masters or "plates." One primary reason DP is gaining greater acceptance is that DP has a faster turnaround time because it requires considerably less setup time for each job compared to other printing processes. Furthermore, last minute revisions are easily carried out without having to make significant changes, and may have environmental advantages, such as reduced waste. The nine basic types of digital printing technology include liquid inkjet printing; thermal transfer printing; laser printing, liquid electrophotographic printing; electrostatic printing; solid ink printing; magnetographic printing; ionographic printing; and dye sublimation printing. Some digital printing operations utilize hydrocarbon mediums and some do not. Of all the digital printing operations, inkjet printing and electrophotographic printing appear to have the largest market share in the graphic arts industry on a world-wide basis. Although DP accounted for only about three percent of the total U.S. printing industry output in 1991, it is forecast to have at least a 20 percent market share by 2018.

A newer type of non-traditional printing process, known as 3D printing, is also emerging. 3D printing (or additive manufacturing) is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the entire object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. There are many variations of 3D printing technologies. It is yet to be determined whether 3D printing should be classified as a digital printing category. The prevalence of 3D printing in the Bay Area is not yet known. The extent of organic vapor emissions from this industry is not known. However, some of the resin materials used to create 3D images is known to contain monomers which release organic vapors when polymerized.

Emissions from the DP industry are not regulated by the Air District's rule to control emissions from printing presses, Rule 8-20. However, the 2008 amendments to Rule 8-20 require certain large commercial digital printing operations to keep records of the usage of ink and other VOC-containing materials. Staff has identified two DP technologies that are believed to have significant emissions, Air District-wide: liquid electrophotographic printing and solvent-based inkjet printing. Solvent-based inkjet printers can produce images on the widest formats in the printing industry and use inks with high VOC contents. Inkjet printing and electrophotographic printing appear to be the most likely DP processes to emit significant ROG emissions.

Implementation Actions:
The Air District will:
- Determine VOC emission rates from various DP technologies in order to establish a DP emissions inventory. Determine the feasibility to control such emissions and whether the controls should be incorporated into the current graphic arts rule or a new DP rule.
- Consider establishing a limit for VOC emissions from DP facilities, such as Maryland's 100 pounds per day limit for example. Consider add-on controls or equipment requirements to control emissions.
- Consider establishing emission limits for each DP technology, allowing a combination of low-VOC materials and add-on controls, as necessary.

Emission Reductions:
It is estimated that 40 to 50 large, liquid electrophotographic presses may exist in the Bay Area. The number of large, commercial inkjet printers as well as other commercial DP operations is not known.

Exposure Reductions:
N/A

Emission Reduction Trade-Offs:
N/A

Costs:
Costs are unknown at this time. Some DP operations may reduce emissions through internal controls of ink usage, making ink and/or solvents available for re-use.

Co-Benefits:
- Reduction in ROG emissions may reduce emissions of toxic organic compounds.

Issue/Impediments:
Unlike traditional printing, technical barriers to the development of low-VOC inks may exist due to the nature of how the DP creates images. Inkjet printing relies on ink with a very low viscosity to be sprayed through tiny nozzles. Electrophotographic printing relies on the polarity of ink molecules to be attracted to charged plates.

Sources:

1. EPA Office of Compliance Sector Notebook Project: Profile of the Printing & Publishing Industry, 1995 http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/printpt1.pdf
1. EPA Design for the Environment Printing Industry Profile, http://www.p2pays.org/ref/01/00936/execsum.htm
2. Digital Printing: The Reference Handbook, 2004, Uri Levy & Gilles Biscos
3. Today's Digital Imaging: Version 5.0, 2005, Smart Papers
4. Conference call with Sandra Lowe-Leseth, Rule Developer, San Joaquin Valley Air Pollution Control District, 5/2/07
5. Code of Maryland Regulations: 26.11.19.18. 18 Control of Volatile Organic Compound Emissions from Screen Printing and Digital Imaging
6. Digital Printing Market Forecast to 2018: Smithers Pira https://www.smitherspira.com/market-reports/news/printing/digital-printing-trends-market-analysis-2018.aspx

SS28: LPG, Propane, Butane

Brief Summary:
Investigate potential ROG reductions by regulating filling of, and leakage from LPG, propane and butane tanks.

Purpose:
Reduce ROG emissions that occur when venting LPG, propane, and butane storage vessels during the filling process.

Source Category:
Area Source

Regulatory Context and Background:
The Air District already enforces tight gas requirements at stationary sources for a variety of operations, including refineries and bulk terminals. This control measure would set leakage allowance standards for Liquid Petroleum Gases (LPG), propane and butane tanks and connections, as well as prohibit or control venting during filling of such tanks.

Typically, LPG should occupy no more than 80 to 85 percent of the volume of a tank to allow for liquid expansion if a tank gets heated (such as by sunlight). These tanks have a bleed valve that indicates to the person filling the container when the level of liquid in the tank is at the "full" level (80 to 85 percent by volume). The current standard practice is to bleed LPG vapor from the tank while filling, and then stop filling when liquid LPG "spits" from the bleed valve. However, these tanks can be safely refilled without venting by filling to a final weight or by filling to a final liquid volume using a tank gage. A research project at CARB in 2009 indicated that technological solutions were available and cost effective.

California LPG demand is 652 million gallons per year. Bay Area demand is approximately 20 percent, based on population. Approximately 40 percent of the LPG is used for residential heating and cooking, 40 percent industrial, 13 percent commercial, and 7 percent transportation uses. ROG fugitive emissions from LPG in the Bay Area are estimated to be 7,200 pounds per day.

South Coast Air Quality Management District (SCAQMD) adopted a rule (Rule 1177) in June 2012 that requires:

- A vapor tight vapor recovery system for LPG bulk loading facilities,
- Use of new filling technology, or a low emission Fixed Liquid Level Gauge (FLLG) at LPG transfer and dispensing facilities.
- New cargo tanks manufactured after 7/1/2013 must be fitted with a low emission FLLG.
- A cylinder or portable storage tank must be fitted with a low emission FLLG by 7/1/2017.
- The owner/operator must develop and implement and Leak Detection and Repair (LDAR) program.
- Appropriate record keeping.

Provisions do not apply to any container less than 4 gallons, or LPG cylinders used with recreational vehicles.

Implementation Actions:
The Air District will:
- Investigate the potential for a new rule to regulate VOC emissions from LPG storage facilities, equivalent to SCAQMD Rule 1177.

Emission Reductions:

Pollutants*	2020	2030
ROG	5,000	5,000

**criteria pollutants are reported in lbs/day*

Emissions Reduction Methodology:
ROG emission reductions are estimated to be 5,000 pounds per day, based on expected reduction of about 70 percent fugitive LPG emissions with the proposals in Rule 1177.

Exposure Reductions:
None

Emission Reduction Trade-Offs:
None

Costs:
Costs for vapor tight vapor recovery system for LPG bulk loading facilities, low emissions connectors, and low emissions Fixed Liquid Level Gauge (FLLG) will total about $9.1M capital, amortized to $1.4M annually, and $0.4M annually for operating costs.

Co-Benefits:
None

Issue/Impediments:
None.

Sources:

1. South Coast Air Quality Management District Rule 1177, and Staff Report, June 1, 2012
2. Maximus™ SFI – Measurement and Reduction of Gas Outage Gauge Emissions, the ADEPT Group, Inc. California Air Resources Board, Chair's Air Pollution Seminar, March 19, 2009

SS29: Asphaltic Concrete

Brief Summary:
Cutback and emulsified asphalts are used to seal and repair roads, parking lots, walkways and airport runways. Other locations in the US have more restrictive petroleum distillate (solvent) limits for these liquid asphalt products than is currently required in the Bay Area. Some locations have limits for emulsified or cutback asphalt set at no more than 0.1 wt. percent ROG. This measure is intended to reduce ROG emissions from asphalt.

Purpose:
Reduce reactive organic emissions that are precursors to ozone formation

Source Category:
Area source – emulsified asphalt

Regulatory Context and Background:
The 2008 Massachusetts State Implementation Plan (SIP) identified Asphalt Paving as an area of opportunity to reduce ROG, however it does not appear that Massachusetts took any action on that initiative. The current Massachusetts limit for ROG in cutback asphalt is 5 weight percent. Maine established a requirement in 2010 limiting ROG content during summer months for both cutback and emulsified asphalt to no more than 0.1 wt. percent ROG. South Coast and San Joaquin Valley air districts limit ROG content of cutback asphalt to 0.5 volume percent, and limit ROG content of cutback asphalt to 3 volume percent. Similarly, Air District Regulation 8, Rule 15 currently allows 0.5 volume percent distillates (described as petroleum solvents) in Slow-Cure Liquid Asphalt, and 3.0 volume percent distillates in emulsified asphalt.

In a related issue, a recent study by the Institute for Research and Technical Assistance (IRTA) determined that asphalt contractors were using diesel fuel to clean their equipment.[1] IRTA found that recycled vegetable oil worked just as well with reduced concerns about toxicity.

Implementation Actions:
Air District staff will:

- Evaluate the cost effectiveness, and feasibility of limiting solvent content of emulsified asphalt.
- Evaluate the availability of substitutes to diesel to clean asphalt related equipment.

Emission Reductions:

Pollutants*	2020	2030
ROG	400	400

**criteria pollutants are reported in lbs/day*

[1] "Alternative Low-VOC Release Agents and Mold Cleaners for Industrial Molding, Concrete Stamping and Asphalt Applications", IRTA, October 2013.

Emissions Reduction Methodology:
Current emissions estimated for emulsified asphalt is 600 pounds of ROG per day. Emissions can be reduced by 400 pounds per day by limiting ROG content of these emulsified asphalts.

Exposure Reductions:
None

Emission Reduction Trade-Offs:
None

Costs:
Solvents / distillates are generally the most expensive component of emulsified asphalt, except for the emulsifying agent. Reducing ROG content may reduce the costs to manufacture. These costs may be offset by higher product testing and quality assurance costs during the transition to the lower ROG content materials.

Co-Benefits:
None

Issue/Impediments:
None

Sources:

1. EPA AP-42: Emission factors for Asphalt Paving Operations, Chapter 4.5
2. CARB Attachment C: Asphalt Paving and Roofing, from STI's Area Source Emissions Updates, March 2003.
3. Rita Leahy, Consultant for California Asphalt Pavement Association
4. Massachusetts Department of Environmental Protection, 310 CMR 7.18
5. Maine Department of Environmental Protection, Chapter 131, Cutback Asphalt and Emulsified Asphalt
6. South Coast Air Quality Management District, Rule 1108, 1108.1
7. San Joaquin Valley Air Pollution Control District, Rule 4641

SS30: Residential Fan-Type Furnaces

Brief Summary:
This control measure would reduce oxides of nitrogen (NO_X) emissions from fan type central furnaces by reducing allowable NO_X emission limits on new furnace installations in Regulation 9, Rule 4 (Rule 9-4). Also, Rule 9-4 would be amended to apply to non-residential furnaces in the same size range.

Purpose:
Reduce emissions of NO_X from fan-type central furnaces.

Source Category:
Combustion

Regulatory Context and Background:
The Air District's Rule 9-4 is a "point-of-sale" type regulation, requiring that any new residential furnace rated up to 175,000 BTU/hr be certified to meet 40 nanograms (ng) of NO_X per joule of delivered heat, which is equivalent to an emission concentration of about 55 ppmv at 3 percent oxygen. Rule 9-4 was adopted and last amended in 1983. In 2009, the South Coast Air Quality Management District (SCAQMD), which previously imposed the same 40 ng/joule NO_X limit as Rule 9-4 in their Rule 1111, adopted a future NO_X limit of 14 ng/joule for most categories of central furnace rated up to 175,000 BTU/hr (conventional units, high-efficiency condensing units, mobile-home units), with the first category subject to the reduced limit in October 2014. As of the beginning of 2014, SCAQMD staff reported to their governing board that manufacturers had developed and tested prototype furnaces in each device category that comply with the 14 ng/joule NO_X limit, but that commercial versions of these devices were not yet available, and that Rule 1111 might be amended in 2014 to address this timing issue. In September 2014, Rule 1111 was indeed amended to delay the compliance date for condensing (high efficiency) units until April 1, 2015, and to allow up to three years' delay for residential furnace manufacturers to meet the 14 ng/joule emission limit with payment of a mitigation fee.

The intent of this control measure is to reduce NOx and CO emissions. In a broader context, the Air District is working with local governments and others to phase out the use of fossil fuel-based technologies in buildings, as part of the Air District's large-scale effort to reduce greenhouse gas emissions (see BL2: Decarbonize Buildings). When it is not feasible to install a non-fossil fuel-based furnace, this control measure ensures that the furnace installed uses best available retrofit control technology (BARCT). This control measure establishes maximum allowable NOx and CO emission levels for a specified type and size range of furnace. Any future greenhouse gas reduction rules the Air District may develop as part of its climate protection strategy may restrict commerce in or use of certain types of fossil fuel combustion devices, including devices addressed in NOx and CO BARCT rules.

Implementation Actions:

The Air District will:

- Develop amendments to Rule 9-4 to include the 14 ng/joule NO_X limit that appears in SCAQMD Rule 1111 and extend the rule to non-residential applications.
- Explore opportunities regarding the use of fossil fuel-based technologies in residential and non-residential space heating (see BL2: Decarbonize Buildings).

Emission Reductions:

Pollutants*	2020	2030
NO_x	13,200	13,200

**criteria pollutants are reported in lbs/day*

Emission Reductions Methodology:

Because the amended rule will apply only to new devices and because central furnaces have an average life of about 20 years, the emission reductions from this measure will be phased in as existing furnaces are replaced. Emissions reductions will be 12,000 to 14,400 pounds per day after the measure is fully implemented (emission reductions in the table above represent an average of these two estimates). This estimate is based on a 65 percent reduction (14 ng/joule versus 40 ng/joule) of the 2011 NO_X inventory for domestic space heating using natural gas fuel (17,220 pounds/day), plus some portion of commercial natural gas use (4,820 pounds/day). The inventory also includes industrial natural gas use (5,880 pounds/day), but this is assumed to not be used for space heating.

Exposure Reductions:

Not applicable to NO_X emissions.

Emission Reduction Trade-Offs:

Depending on the technology selected, NO_X reductions may increase GHG emissions, specifically CO_2, by reducing efficiency of the combustion process. This trade-off is unlikely for this control measure, however, because efficient low-NO_X burners have been developed for similar types of appliances. New forced air heaters will probably be more efficient than the ones they replace, reducing GHG emissions.

Costs:

In the staff report for Rule 1111, South Coast AQMD estimated that compliance with a 14 ng/joule NO_X limit would cost from $9,400 to $20,750 per ton of NO_X reduced and would result in an additional consumer cost of $118 to $223 per furnace, all in 2014 dollars.

Co-Benefits:

Because NO_X compounds in the atmosphere contribute to the formation of secondary particulate matter (PM), any NO_X emission reduction will also result in a reduction of $PM_{2.5}$. Secondary PM is formed from the conversion of NO_X to ammonium nitrate (NH_4NO_3). District staff has estimated the ratio between NH_4NO_3 formation to NO_X emissions to range between 1:6 and 1:10. Assuming a NO_X emission reduction of 12,000 to 14,400 pounds/day, and a particulate formation factor of 1:8, secondary particulate matter will be reduced by 1,600 to 1,800 pounds/day by the control measure.

Issue/Impediments:
No specific issues or impediments have been identified.

Sources:
1. South Coast Air Quality Management District, Rule 1111
2. Bay Area Air Quality Management District (BAAQMD), Regulation 9, Rule 4

SS31: General Particulate Matter Emission Limitation

Brief Summary:
Reduce the Air District's emissions limits for particulate matter.

Purpose:
Reduce particulates, especially PM2.5.

Source Category:
Permitted stationary sources

Regulatory Context and Background:
There are currently seven Air District rules directly addressing particulate matter (PM) emissions:

- Regulation 5: Open Burning
- Regulation 6, Particulate Matter, Rule 1: General Requirements
- Regulation 6, Particulate Matter, Rule 2: Commercial Cooking Equipment
- Regulation 6, Particulate Matter, Rule 3: Wood Burning Devices
- Regulation 6, Particulate Matter, Rule 4: Metal Recycling and Shredding Operations
- Regulation 9, Inorganic Gaseous Pollutants, Rule 13: Nitrogen Oxides, Particulate Matter, and Toxic Air Contaminants from Portland Cement Manufacturing
- Regulation 12, Miscellaneous Standards of Performance, Rule 4: Sand Blasting
- Regulation 12, Miscellaneous Standards of Performance, Rule 13: Foundry and Forging Operations

Regulation 6: Particulate Matter was originally adopted by the Air District on October 18, 1973, and then amended on December 17, 1975 to allow enforcement of limits on smoking motor vehicles. Regulation 6 was amended on January 5, 1983, and again on July 11, 1990 to be consistent with the California Health and Safety Code regarding emissions from pile driving equipment. On December 19, 1990, Regulation 5: Open Burning was amended, and minor adjustments were made to Reg. 6 for consistency. On December 5, 2007, Regulation 6: Particulate Matter was renumbered and retitled to Regulation 6, Particulate Matter, Rule 1: General Requirements. This was done to accommodate a new rule for commercial charbroilers, titled Regulation 6: Particulate Matter, Rule 2: Commercial Cooking Equipment. Regulation 6, Particulate Matter, Rule 3: Wood Burning Devices was adopted on July 9, 2008 to address $PM_{2.5}$ from wood stoves and fireplaces during the winter. On September 19, 2012 the District adopted Regulation 9, Rule 13, which controls nitrogen oxides, particulate matter, and toxic air contaminants from Portland cement manufacturing. On May 1, 2013, the District adopted two rules: Regulation 6, Rule 4: Metal Recycling and Shredding Operations, and Regulation 12, Rule 13: Foundry and Forging Operations. Both of these rules require plans to control fugitive emissions of particulate matter. Regulation 5 Open Burning was amended on June 19, 2013.

The general requirement limits for particulate matter emissions in Rule 6-1 are:

- Particulate emissions (TSP) must be less than 343 milligrams per dry standard cubic meter (mg/dscm), or 0.15 grains per dry standard cubic foot (gr/dscf); and
- No more than 20 percent opacity for stack emissions (or no more than Ringelmann 1.0 for uncontained plumes) for no more than 3 minutes in any hour.

Many existing stationary sources with PM emissions have been modified over the years. Permit conditions have been established to require Best Available Control Technology (BACT) when these sources were installed, modified, or replaced, requiring more stringent levels of control than required by Rule 6-1. These permit conditions often also define testing, monitoring, reporting and recordkeeping requirements.

<u>Comparison of Air District PM Regulations to other air districts</u>

Air District rules controlling particulate matter are less stringent in certain respects than similar rules in other urban air districts in the state. Rule 6-1 limits PM to 0.15 gr/dscf, where the limit is 0.10 gr/dscf in several other air districts. Rule 6-1 limits based on "process weight" are less restrictive than in South Coast, San Joaquin Valley and Sacramento air districts. In addition, South Coast also establishes a PM concentration limit, in both milligrams per dry cubic meter (mg/dscm), and grains per dry standard cubic foot (gr/dscf) based on volumetric flow rate, culminating in a limit of 0.01 gr/dscf for volume flows exceeding 70,000 cubic meters per minute (~ 2.5 million standard cubic feet per minute).

Requirements for visible emissions are very similar throughout California's air districts. Most visible emissions are limited based on the Ringelmann scale or within a specific opacity limit using an opacity sensing device. Visible limits are often based on a "not to exceed" limit of three or four minutes within any 60-minute period. Visible emissions are also sometimes limited to remaining within the source's property boundaries.

One difference among local air district rules for PM is that the Bay Area Air District has just a few all-inclusive PM rules, where other air districts have recognized several specific industries or categories of PM sources, and have developed specific PM rules for each industry or category. As the Air District moves forward in further controlling PM emissions, staff will consider the largest source categories of PM emissions and determine the best approach to control each category.

The 2017 Plan control strategy will also have control measures that limit PM emissions through its source specific proposed rules and control measures, e.g. enforce ARB regulations to reduce PM emissions from diesel engines in the Bay Area communities most impacted by PM emissions (SS39: Enhanced Air Quality Monitoring); continue and enhance its program to reduce residential wood-burning (SS34: Wood Smoke); and provide grants and incentives to reduce emissions of particulate matter and BC from heavy-duty vehicles (TR19); PM from trackout (SS36); and PM from asphalt operations (SS37).

State and Federal PM Requirements

California air pollution control laws address particulate matter from stationary sources in several specific ways. They set standards for diesel pile-driving hammers, and for sandblasting so that they are consistent throughout the state. State law also addresses requirements on portable equipment for consistency. State law provides guidelines for the local air districts to regulate agricultural burning. Almost all other state PM related regulations are directed at mobile sources – primarily diesel engines.

Federal regulations from the United States Environmental Protection Agency limiting particulate matter encompass a wide variety of stationary sources. The Air District enforces these federal requirements. Air District requirements can be more stringent, as needed, to achieve National and California Ambient Air Quality Standards.

Implementation Actions:

The Air District will

- Investigate the potential for a new or amended rule that considers application of available control technology to reduce or revise allowable weight rate limitations on existing PM emissions sources.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	340	340
PM_{10}	640	640

**criteria pollutants are reported in lbs/day)*

Emission Reductions Methodology:

Reductions are expected to be relatively modest, because most permitted sources have been modified over the years, triggering BACT and permit conditions that are far more stringent than 6-1.

Exposure Reductions:

Particulate matter from stationary sources can also contain toxics, depending on the specific source.

Emission Reduction Trade-Offs:

Minor – some additional energy required to operate cyclones/baghouses, or roto-clones/ESP's due to increase in pressure drop across these devices.

Costs:

Both initial capital cost and annual cost (based on EPA Cost Models, in 2012 dollars) can vary depending on control technology and size. A wet scrubber can cost between $85,000 to $488,000, with annualized costs ranging from $25,000 to $146,000. Cyclones range from $64,000 to over $600,000, and have varying annual costs. Baghouses range from $278,000 to just over $900,000; while ESPs are the most expensive and cost anywhere from 1.8 million to nearly $4.4 million.

Cost effectiveness is dependent on the loading of particulates at the inlet.

Co-Benefits:
None identified.

Issue/Impediments:
None Identified.

Source:

1. Bay Area Air Quality Management District, 2014 amendments to Rule 6-1, workshop report.

SS32: Emergency Back-up Generators

Brief Summary:

Emergency back-up generators (BUGs) provide power when primary sources are unavailable (e.g. during blackouts or brownouts). Most BUGs are powered by diesel fired engines that emit diesel particulate matter (DPM), a toxic air contaminant (TAC), and black carbon which contributes to climate change. Beginning with the year 2000, the federal government and the State of California have enacted progressively stricter emissions standards for diesel engines that power BUGs, but thousands of BUGs that do not meet current standards remain in operation. Draft Regulation 11, Rule 18 (Rule 11-18) will address health risks resulting from all significant sources of TAC emissions, including emergency BUGs.

Purpose:

This measure will reduce emissions of DPM and black carbon from BUGs through Draft Rule 11-18, resulting in reduced health risks to impacted individuals, and in climate protection benefits. Black carbon's short atmospheric lifetime, combined with its strong warming potential, means that targeted strategies to reduce black carbon emissions can provide climate benefits within the next several decades.

Source Category:

Stationary sources – emergency back-up generators

Regulatory Context and Background:

Stationary diesel engines are regulated at the federal, state and local level. DPM is not classified as a hazardous air pollutant by US EPA, but many components of diesel emissions are identified as such. Federal requirements for diesel engines are contained in the National Emission Standard for Hazardous Pollutants (NESHAP) from Stationary Reciprocating Internal Combustion Engines and the New Source Performance Standards (NSPS) for stationary diesel engines. The NESHAP issued in 2004 targets toxic emissions (formaldehyde, acrolein, methanol, acetaldehyde, among others) from stationary compression and spark ignited engines located at major facilities and area sources of hazardous air pollutants. In 2006, US EPA promulgated the NSPS establishing emission standards for criteria pollutants from new engines, modeled after US EPA standards for non-road and marine diesel engines. These included progressively more stringent emissions standards phased in over several years (tiers one through three), with the most stringent tier (tier four) for prime (non-emergency) engines requiring add-on controls such as selective catalytic reduction (SCR) for NO_x and diesel particulate filters (DPF) for PM.

State requirements for diesel engines stem from identification of DPM as a TAC by the California Air Resources Board (CARB) in 1998. In 2000, CARB approved a risk reduction plan to reduce PM emissions from diesel fueled engines and vehicles with a recommendation for an 85 percent reduction in cancer risk from these sources by 2020. In 2004, the stationary compression ignition engine Air Toxics Control Measure (ATCM) was adopted to limit public exposure to diesel PM, establishing emission limits for new and in-use stationary diesel engines. Emissions standards are linked to state off-road compression ignition engine standards and implementation schedules based on model year and size of the engine. Emissions certification standards are phased in as tiers one through four becoming more stringent and coming into effect in 4 to 5 year increments, similar to federal standards. In 2007, the ATCM was amended to establish standards for in-use stationary diesel engines used in agricultural applications. The ATCM was further amended in 2011 to eliminate the need for new emergency standby engines to meet the tier four standards which require add-on controls and align direct drive fire pump engines with NSPS standards.

In response to CARB's identification of DPM as a TAC in conjunction with problems with the California energy grid, the Air District amended Regulation 2, Rule 1 in 2001 to eliminate a permit exemption for engines used for stand-by power. In addition, as part of that rulemaking, Regulation 9, Rule 8 (Rule 9-8) was amended to clarify the conditions under which standby engines may be operated during emergencies. In 2007, Rule 9-8 was further amended to regulate emissions of NO_X from diesel engines along with other amendments for internal combustion engines fired by gaseous fuels and liquid fuels other than diesel.

No air district has implemented add-on controls or emission standards (aside from limiting hours for maintenance and testing) to reduce emissions from existing BUGs, and most air districts implement the ATCM adopted in 2004 by CARB for controls on new engines. South Coast Air Quality Management District places slightly more stringent requirements on new engines located near sensitive receptors.

Over 6,700 diesel fired engines are permitted in the Air District for emergency standby power (electrical power generation and pumps). This represents over one quarter of all permitted sources in the Air District. Of the 6,700 permitted BUGs in the Bay Area, 40 percent predate US EPA emissions standards as well as emissions certification by CARB, and so they are known as tier zero engines. Less than 15 percent of the permitted BUGs meet the current level of control required for new engines (tier 4), and approximately 400 engines have installed add on emission controls.

Annual DPM emissions from all permitted BUGs are relatively small in total mass. According to the 2011 inventory, BUGs operating in the Air District account for 18 tons per year of total particulate. Annual black carbon emissions from BUGs account for less than 14 tons per year district-wide. Some older, higher-emitting BUGs may present health risks if they are used in proximity to residential or other sensitive receptors.

Implementation Actions:
Air District staff will implement Rule 11-18, once adopted. See SS20: Air Toxics Risk Cap and Reduction from Existing Facilities for more detail on this rule and its implementation.

Emission Reductions:

Pollutants*	2020	2030
CO_{2e}	0	1.8

**CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Trade-Offs:
None

Costs:
The cost to replace a back-up generator is roughly $121 dollars per horsepower ($121/hp), or $30,250 to replace a 250 hp engine (Source #1 adjusted from 2003 to 2015 dollars). Costs for a diesel particulate filter (DPF) vary, averaging about $67/hp, so for the same 250 hp engine this would be $16,750 (Source #5 adjusted from 2012 to 2015 dollars). Because CARB has yet to certify any control device for use with tier zero engines, application of these devices would require some sort of additional verification. In most cases, replacement of the engine would be a more likely outcome considering years of service and the additional costs of source testing for compliance verification. Air District staff will refine cost estimates as this measure is developed further.

Co-Benefits:
In addition to having lower emission rates of DPM, newer engines emit less carbon monoxide (CO), reactive organic gases (ROG), and oxides of nitrogen (NOx). Back-up generators do not represent a large percentage of the Air District inventory for these pollutants, however. Some operators may choose to replace older BUGs with cleaner technologies, such as fuel cells or propane-fired engines instead of purchasing new diesel-fired units.

Issues/Impediments:
There is a large inventory of permitted tier zero BUGs, and there may be additional unpermitted BUGs. In developing and implementing Rule 11-18, the Air District will conduct extensive outreach to communicate all regulatory changes to the large number of affected stakeholders, which span many different industries.

Sources:

1. CARB; Staff Report; Initial Statement of Reasons for Adoption of the Proposed Airborne Toxic Control Measure for Stationary Compression-Ignition Engines, Emissions Assessment Branch, Stationary Source Division, CARB; September 2003
2. California Air Resources Board; Staff Report; Final Statement of Reasons for Rulemaking: Proposed Amendments to the Airborne Toxic Control Measure for Stationary Compression-Ignition Engines; October 2010
3. Regulatory Impact Analysis for Existing Stationary Reciprocating Internal Combustion Engines (RICE) NESHAP, Final Report; US EPA Office of Air Quality Planning and Standards, Air Benefit and Cost Group; February 2009
4. Regulatory Impact Analysis for Reconsideration of Existing Stationary Reciprocating Internal Combustion Engines (RICE) NESHAP; US EPA Office of Air Quality Planning and Standards, Health and Environmental Impact Division, Air Economics Group and Risk and Benefits Group; January 2013
5. South Coast Air Quality Management District; Revised Staff Report; Proposed Amended Rule 1110.2 –Emissions from Gaseous- and Liquid- Fueled Engines; August 2012
6. Bay Area Air Quality Management District; HRSA Streamlining Policy Report for Stationary Emergency Standby and Fire Pump Diesel Engines; May 2015
7. Bay Area Air Quality Management District; Backup Generator Emission Factor Study; January 2015

SS33: Commercial Cooking Equipment

Brief Summary:
Air District Regulation 6, Rule 2 (Rule 6-2) requires installation of certified control devices for chain driven and underfired charbroilers (grills). At this time, no control devices have been certified for underfired charbroilers. This measure would amend Rule 6-2 so that the Air District can approve control devices for underfire charbroilers.

Purpose:
To further reduce particulate matter (PM) emissions from commercial cooking operations.

Source Category:
Stationary Sources

Regulatory Context and Background:
In 2007, the Air District passed Rule 6-2, which limits PM emissions when cooking beef at chain driven charbroilers and underfired charbroilers. Chain driven charbroilers are semi-enclosed, mechanically driven cookers commonly used at fast food establishments. Underfire charbroilers are generally recognized as grills. Food preparation contributes a significant proportion to the PM inventory in the Bay Area.

Because chain driven charbroilers can be delivered with ready-made control devices, many units in the Bay Area are controlled. To date, however, there are no approved control devices for underfired charbroilers. The current version of Rule 6-2 establishes an emission limit of 1.0 lbs PM/1000 pounds of meat cooked. Recent evidence from the University of California, Riverside shows that this limit is not attainable because the original emission factors were not realistic (too low). In order to certify control equipment for underfire charbroilers, another certifying criterion, such as percent control efficiency, will be required.

Implementation Actions:
The Air District will determine adequate criteria for approving add-on equipment to control PM emissions from underfire charbroilers, amend Rule 6-2, and develop an implementation plan for the amended rule.

Emission Reductions:

Pollutants*	2020	2030
ROG	n/a	340

**criteria pollutants are reported in lbs/day*

Exposure Reductions:
Restaurants often operate in or near residential and commercial areas. Reductions in PM and associated air toxics will occur near peoples' homes and in or near shopping and recreation areas.

Emission Reduction Trade-Offs:
Modest additional electricity required to operate the control devices.

Costs:
Specific costs will be estimated during rule amendment.

Co-Benefits:
Related reductions in organic compounds and air toxics.

Issue/Impediments:
None identified.

Sources:

1. Bay Area Air Quality Management District, Regulation 6, Rule 2, *Commercial Cooking Equipment*, December 5, 2007
2. Bay Area Air Quality Management District, Draft Staff Report, Regulation 6, Rule 2, *Commercial Cooking Equipment*, November, 2007
3. University of California, Riverside, College of Engineering-Center for Environmental Research and Technology, "Comparison of Particulate Matter Emissions Measurement for a Commercial Charbroiling Process with and without Controls," Final Draft Report, prepared for Bay Area Air Quality Management District

SS34: Wood Smoke

Brief Summary:
The Air District amended Regulation 6 Particulate Matter and Visible Emissions,
Rule 3: Wood-Burning Devices in late 2015 to impose additional significant restrictions on wood burning. However, wood smoke continues to be a significant contributor to $PM_{2.5}$ exceedances during the winter, when low winds can result in the formation of an inversion layer over the Bay Area. Exemptions currently in place in Rule 6-3 allow homes without any other form of permanent heat to burn wood in an EPA certified wood burning device. This control measure considers banning wood burning completely during Spare the Air episodes.

Purpose:
Reduce wood smoke during Winter Spare the Air alerts

Source Category:
Area Source – wood burning devices

Regulatory Context and Background:
The Air District adopted Rule 6-3 in 2008, and later amended it on October 21, 2015. This rule has been very effective at reducing wood smoke emissions. During the winter season from November through February, $PM_{2.5}$ emissions from wood smoke are estimated to average 34,000 pounds per day. When the Air District calls a Winter Spare the Air Alert, $PM_{2.5}$ emissions from wood smoke are estimated to be reduced to approximately 720 pounds per day. The Bay Area still periodically exceeds air quality standards for fine particulates. Therefore, staff is identifying further opportunities to reduce $PM_{2.5}$ emissions, including considering a complete ban of wood burning during Winter Spare the Air Alerts.

Implementation Actions:
Air District staff will:

- Investigate further limits on wood burning, including additional limits to exemptions from existing Rule 6-3, Wood Burning Devices.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	60	60

**criteria pollutants are reported in lbs/day*

Emission Reductions Methodology:
$PM_{2.5}$ emissions from wood smoke are estimated to average 34,000 pounds per day during the winter season. During Winter Spare the Air Alerts, when Rule 6-3 restrictions are in effect, $PM_{2.5}$ emissions from wood smoke are approximately 720 pounds per day. Complete ban of wood burning during Winter Spare the Air Alerts will reduce $PM_{2.5}$ emissions by 60 pounds per day for each Winter Spare the Air Alerts are in effect (typically 15 – 25 nights each winter), or approximately 72,000 pounds per year.

Exposure Reductions:
Rule 6-3 reduces $PM_{2.5}$ exposure, especially in certain locations where wood smoke may accumulate. A large and growing body of scientific evidence indicates that both short-term and long-term exposure to fine particles can cause a wide range of health effects, including: aggravated asthma and bronchitis; hospital visits for respiratory and cardiovascular symptoms; and contributes to strokes and heart attacks, some of which result in premature deaths. The evidence also shows that reducing PM emissions can reduce mortality and increase average life span. Therefore, measures that reduce PM emissions may have a significant impact on public health.

Emission Reduction Trade Offs:
None, although some perceive wood as a renewable source of energy. The Environmental Impact Report (EIR) completed in 2008 during the development of the original Rule 6-3 indicated that most firewood comes from old-growth trees and land clearing, not from managed tree farms.

Costs:
Individuals with homes without an alternative permanent source of heat may need to install one. Many of these homes are in rural areas, so natural gas is not available. The simplest approach is to add electric space heaters. Electric heat is quite expensive, but would be required only during Winter Spare the Air Alerts. Other forms of permanent alternative heat, such as a heat pump and associated air ducts are much more expensive, estimated at $10,000 capital. Heating costs are dependent on the type of alternate heat. Heat pumps are very efficient, so electric heat pump on-going costs are comparable with natural gas costs. Propane heat is efficient, but propane is expensive. Further cost impacts would be evaluated during rule development.

Co-Benefits:
Wood smoke contains some black carbon, which is a short-lived climate pollutant; further reduction of wood burning would decrease black carbon emissions.

Issue/Impediments:
Some members of the public are strongly in support of a complete ban on wood burning, while other members of the public may not support further limits on wood burning.

Sources:

1. Bay Area Air Quality Management District, staff report for amendments to Rule 6-3, 2015
2. US Environmental Protection Agency, Report to Congress on Black Carbon, 2012. Available at: http://www3.epa.gov/blackcarbon/2012report/fullreport.pdf

SS35: Particulate Matter from Bulk Material Storage, Handling and Transport, Including Coke and Coal

Brief Summary:
The Air District has been receiving complaints about black dust from petroleum coke and coal storage and transfer operations. This dust is leaving black residue on residential property and business equipment. South Coast AQMD Rule 1158 addresses coke, coal (and elemental sulfur) storage and handling. The intent of this measure is to develop a new regulation to control fugitive dust from bulk material operations throughout the Bay Area, including petroleum coke and coal storage and handling operations.

Purpose:
Reduce public nuisance complaints and $PM_{2.5}$ emissions from storage, handling and transport of all bulk materials with potential to create fugitive dust, particularly petroleum coke and coal storage and handling operations.

Source Category:
Point Sources – bulk material handling including petroleum coke and coal storage and transfer operations

Regulatory Context and Background:
Regulation 6, Particulate Matter, Rule 1: General Requirements (Rule 6-1) currently has a provision that does not allow particulates from a source to cross the property line and impact neighbors. Enforcement of this provision of Rule 6-1 is difficult when trying to identify the specific source of excessive dust. Bulk materials including petroleum coke and coal dust are easier to trace, but more explicit requirements and performance standards are needed to reduce impacts from bulk material storage and handling operations.

Implementation Actions:
Air District staff will develop a new rule, Regulation 6, Particulate Matter, Rule 8: Bulk Material Storage, Handling and Transport to prevent and control wind-blown fugitive dust from these types of storage and handling operations. Establish enforceable visible emission limits to support preventive measures such as water sprays, enclosures to surround the bulk materials, and wind barriers. Consider enhanced controls where sources are located near sensitive populations or areas currently impacted by cumulative sources of air pollution.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	4	4
PM_{10}	32	32

**criteria pollutants are reported in lbs/day*

Emission Reduction Methodology
PM emissions of fugitive dust from coke and coal storage and handling operations are currently estimated to be 0.21 tpd TSP, 0.064 tpd PM10, and 0.007 tpd PM2.5. Controls for fugitive dust include enclosures or wind brakes to reduce wind-blown dust, and water sprays or wetting agents to improve moisture content and bind silt to the bulk coke or coal. Enclosures with secondary controls (baghouses) of dust emissions are 95 percent effective. Wind screens and water sprays may be more practical for existing facilities, and are expected to be 50 – 75 percent effective. Based on conservative assumption that control requirements are applied to 50 percent of sources, emission reductions are estimated to be 32 pounds/day PM10, and 4 pounds per day PM2.5.

Exposure Reductions:
The main threat to urban populations near bulk material storage facilities is the very small particles from dust that may develop from wind erosion or through handling of these solid materials. Particles from coal and petroleum coke piles are highly visible and the source of many complaints from the surrounding community. Small particles (less than 2.5 microns) have been found to cause a wide range of health impacts. In addition, coke oven workers have been found to have higher incidents of lung cancer, bronchitis, and chronic obstructive pulmonary disease (COPD).

Petroleum coke is known to contain polycyclic aromatic hydrocarbons (PAH's), and high levels of nickel and vanadium. The nickel and vanadium were found in water runoff, but further study is needed to identify risks to aquatic life. Plants using water with high metals are found to also contain high metals. Toxicity studies relevant to human health found PAH's do not leach into the water streams. Petroleum coke exposure does not lead to higher incidents of types of cancer, and showed low reproductive and developmental toxicity. Coal is lower in silt content, as well as lower in PAH's, but metals levels in coal can be higher.

Emission Reduction Trade-Offs:
Enclosures and wind screens are one-time projects, so the only emissions impacts occur during construction. If secondary controls (baghouses) are required for the enclosures, they require energy but typically not more than 100 HP. Water consumption is a concern during drought periods, however many facilities can recycle water used for wetting the storage piles and transfer systems. Occasionally reclaimed water may be available.

Costs:
Enclosures can cost as much as $500,000 in capital expenses, depending on difficulty of retrofit with the existing facilities. Secondary controls on the enclosures, like baghouses can cost an additional $250,000 in capital. Wind screens are much lower cost – typically no more than $50,000 for a large facility. Transfer systems (conveyors) need wind screens and spillage control added, usually less than $20,000 per conveyor. Water spray systems can be quite inexpensive – less than $10,000 each. If water spray mist is needed, an air compressor to generate the mist can cost an additional $10,000. Water control and recycle systems can be significant, as much as $250,000.

Co-Benefits:
Fugitive dust control will help reduce regional haze, and can also help reduce black carbon particulate matter that contributes to climate change.

Issue/Impediments:
None identified.

Sources:

1. BAAQMD proposed amendments to 6-1, and new 6-8 associated workshop reports.
2. "Petroleum Coke in the Urban Environment: A Review of Potential Health Effects", International Journal of Environmental Research and Public Health, 29May2015

SS36: Particulate Matter from Trackout

Brief Summary:
The intent of this measure is to develop a new regulation, Regulation 6, Particulate Matter; Rule 6: Trackout (Rule 6-6), to address mud and dirt that can be "tracked out" from construction sites, bulk material storage, and disturbed surfaces onto public paved roads where vehicle traffic will pulverize the mud and dirt into fine particles and entrain them into the air.

Purpose:
Reduce $PM_{2.5}$ emissions from trackout of mud and dirt onto paved public roadways.

Source Category:
Area Sources – construction sites, bulk material storage

Regulatory Context and Background:
Particulate matter emissions due to trackout at construction sites is not currently subject to Air District regulations. However, PM from trackout is subject to state requirements for large construction sites. These requirements mandate the preparation of a Storm Water Pollution Prevention Plan; the plan includes provisions for reducing trackout.

Trackout dust can contain much higher levels of fine particulate matter – because mud and dirt that are tracked out onto paved roads can be subsequently pulverized by passing vehicles into silt, then entrained into the air as fine particulate by the wind currents from the passing vehicles.

Implementation Actions:
The Air District will:
- Develop a new rule to prevent trackout onto paved roads, establish visible emission limits to prevent trackout, require cleanup if the trackout is significant, and limit visible emissions of dust during cleanup of any material that is tracked out.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	93	93

**criteria pollutants are reported in lbs/day*

Emission Reductions Methodology:
Particulate matter (PM) emissions of fugitive dust from construction sites, bulk material storage sites, and from disturbed surfaces are estimated to be 11,800 pounds per day TSP, 5,600 pounds per day PM_{10}, and 680 pounds per day $PM_{2.5}$. Controls for trackout are already required to meet Storm Water Pollution Prevention Plans, so the proposed new rule will improve enforcement of existing requirements. Staff estimates fine particle emission reductions of 140 pounds per day for the 8 months of the dry season (34,000 pounds per year).

Exposure Reductions:
A large and growing body of scientific evidence indicates that both short-term and long-term exposure to fine particles can cause a wide range of health effects, including: aggravated asthma and bronchitis; hospital visits for respiratory and cardiovascular symptoms; and contributes to strokes and heart attacks, some of which result in premature deaths. The evidence also shows that reducing PM emissions can reduce mortality and increase average life span. Therefore, measures that reduce PM emissions may have a significant impact on public health.

Emission Reduction Trade-Offs:
Possible exhaust emissions and dust from street sweepers during the cleanup of trackout materials. Cleanup by hand, or using a PM_{10} efficient regenerative street sweeper, can minimize this dust during cleanup.

Costs:
Trackout prevention typically consists of using grizzly bars or rumble grates, or a truck wheel wash system. Most facilities are currently equipped with grizzly bars, but the bars often fill with mud and stop working effectively. Truck wheel wash systems can cost $150,000 in capital, and $1,000 per month in operating costs. Cleanup can typically be completed with two workers and hand tools.

Co-Benefits:
Fugitive dust control will help reduce regional haze.

Issue/Impediments:
None identified.

Source:

1. Bay Area Air Quality Management District, proposed amendments to 6-1, and new Regulation 6-6 workshop reports

SS37: Particulate Matter from Asphalt Operations

Brief Summary:
This measure would develop a new regulation, Regulation 6, Particulate Matter, Rule 7: Asphalt Operations (Rule 6-7), to prevent condensable particulate matter when paving asphalt is loaded into storage bins on a delivery truck. Similarly, this measure would prevent condensable particulate matter when chip seal asphalt is sprayed onto a roadway. These particulate matter (PM) emissions are condensed asphalt aerosols known as "blue smoke". This regulation will require blue smoke abatement, and establish visible emissions limits for these operations. In addition, this measure would establish a requirement to use low fuming asphalt for all roofing asphalt operations.

Purpose:
Reduce $PM_{2.5}$ emissions from paving asphalt, chip seal asphalt, and roofing asphalt.

Source Category:
Point Sources – Particulate Matter for Asphalt Plants
Area Sources – Particulate Matter for Chip Seal Paving and Roofing Asphalt operations

Regulatory Context and Background:
Visits to asphalt plants identified vapors coming from paving asphalt as it is loaded into delivery trucks as significant sources of visible smoke. This smoke consists of small condensed aerosols from asphalt vapors, commonly referred to as "blue smoke". Chip seal operations are also large sources of "blue smoke". In addition, roofing asphalt is heated to application temperatures in a heating device known as an asphalt kettle. Hot roofing asphalt and asphalt kettles also produce smoke, and since application is usually in populated areas, odors are also a concern.

Implementation Actions:
The Air District will:
- Develop a new rule to prevent blue smoke emissions from paving asphalt and chip seal operations and to require "low fuming" roofing asphalt for roofing asphalt operations.
- Investigate whether more use of Warm Mix Asphalt rather than Hot Mix Asphalt is a viable method to reduce PM emissions.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	175	175

**criteria pollutants are reported in lbs/day*

PM emissions of blue smoke from paving asphalt operations are estimated to be 240 pounds per day $PM_{2.5}$ (50 pounds per day from each of three large paving asphalt plants) for approximately eight months of the year (during the paving season). Similarly, PM emissions of blue smoke from chip seal operations are estimated to be 120 pounds per day of $PM_{2.5}$ for six months of the year. Controls for blue smoke emissions from these sources are expected to be

75 percent effective, resulting in emission reductions of 270 pounds per day of $PM_{2.5}$ or 30 tons per year (tpy). PM emissions of smoke and fumes from roofing asphalt is estimated to be 250 pounds per day, and control from the polymer in low fuming asphalt is conservatively expected to be 70 percent, resulting in emission reductions of 175 pounds per day of $PM_{2.5}$ for approximately 8 months each year (21 tpy).

Exposure Reductions:
A large and growing body of scientific evidence indicates that both short-term and long-term exposure to fine particles can cause a wide range of health effects, including: aggravated asthma and bronchitis; hospital visits for respiratory and cardiovascular symptoms; and contributes to strokes and heart attacks, some of which result in premature deaths. The evidence also shows that reducing PM emissions can reduce mortality and increase average life span. Therefore, measures that reduce PM emissions may have a significant impact on public health.

Emission Reduction Trade-Offs:
Operations of blue smoke abatement will require some energy use, estimated to be less than 50 horsepower for each abatement device. No trade-offs for the polymer used in low fuming roofing asphalt.

Costs:
Blue smoke abatement facilities are estimated to cost $200,000 capital, amortized to $30,000 per year plus $10,000 per year operating costs. Low fuming asphalt raises the cost of roofing asphalt approximately $1.00 above the base of $40 - $45 per 100 lb. plug.

Co-Benefits:
Low fuming roofing asphalt for asphalt operations is approximately 75 percent less odorous than regular roofing asphalt.

Issue/Impediments:
None.

Source:

1. Bay Area Air Quality Management District, proposed amendments to Regulation 6-1, and proposed Regulation 6-7, workshop reports

SS38: Fugitive Dust

Brief Summary:
Air District staff are currently developing amendments for Regulation 6, Particulate Matter, and Rule 1: General Requirements (Rule 6-1). In addition, Air District staff are developing specific targeted fugitive dust and particulate matter controls for proposed Rule 6-6: Trackout; proposed Rule 6-7: Asphalt Operations, and proposed Rule 6-8: Bulk Material Storage, Handling and Transport, Including Coke and Coal. This control measure proposes that Air District staff review and recommend controls for a broader range of more general sources of fugitive dust, such as large construction sites, and disturbed surfaces larger than 1 acre.

Purpose:
Reduce particulate matter (PM_{10} & $PM_{2.5}$) fugitive dust emissions from traffic and other operations on construction sites, large disturbed surfaces, and other sources of fugitive PM emissions.

Source Category:
Area Sources

Regulatory Context and Background:
Air District staff are developing amendments to Rule 6-1, and developing new rules for three sources of fugitive dust: trackout of mud and dirt onto paved public roads; smoke and fumes from paving and roofing asphalt operations; and dust from petroleum coke and coal storage and handling.

Fugitive dust from construction sites and bulk material handling operations are sources of PM_{10}, and to a lesser extent sources of $PM_{2.5}$. In addition, control of fugitive dust from these sources will reduce regional haze. This measure will evaluate potential control strategies in preparation of future rulemaking opportunities.

Implementation Actions:
Air District staff will:

- Evaluate the availability of cost-effective control strategies for these sources of particulate matter and consider future rulemaking.
- Consider applying the proposed fugitive dust visible emissions limits to a wider array of sources.
- Consider enhanced controls where sources are located near sensitive populations or areas currently impacted by cumulative sources of air pollution.

Emission Reductions:

Pollutants*	2020	2030
$PM_{2.5}$	400	400
PM10	2,800	2,800

**criteria pollutants are reported in lbs/day*

Total current PM emissions of fugitive dust from construction sites, bulk material storage sites, and from disturbed surfaces are estimated to be 11,800 pounds per day TSP, 5,600 pounds per day PM_{10}, and 680 pounds per day $PM_{2.5}$. Controls for fugitive dust from large sources are estimated to result in a 50 percent reduction in PM emissions, resulting in 5,800 pounds per day TSP, 2,800 pounds per day PM_{10}, and 400 pounds per day $PM_{2.5}$.

Exposure Reductions:
None

Emission Reduction Trade-Offs:
None, although concern about additional water usage to control fugitive dust may raise questions about the priority of air quality versus water conservation. These concerns are valid if water sources used for fugitive dust control are mostly potable water rather than reclaimed water.

Costs:
Fugitive dust control costs are typically minor. In many cases, these resources / costs are already in place to comply with existing Storm Water Pollution Prevention Plan requirements. Incremental costs to comply with proposed fugitive dust requirements are very low. Costs for application of fugitive dust requirements to sources that are not currently controlled are dependent of the size and nature of the source, but can be as high as $100,000 capital and total $30,000 per year amortized and operating costs to reduce 3 tons per year of PM.

Co-Benefits:
Fugitive dust control will help reduce regional haze.

Issue/Impediments:
Concern that additional source will require additional water resources during severe drought seasons.

Source:

1. Bay Area Air Quality Management District, proposed amendments to Regulation 6-1, and proposed Regulations 6-6, 6-7, and 6-8 associated workshop reports.

SS39: Enhanced Air Quality Monitoring

Brief Summary:
The Air District will evaluate and enhance its capabilities, as resources permit, to monitor air quality on a region-wide basis, as well as on a localized basis in the impacted communities identified under the Air District's Community Air Risk Evaluation (CARE) program.

Purpose:
The purpose of this measure is to provide the Air District with sufficient ambient air quality monitoring data needed to inform: 1) its efforts to improve air quality in impacted communities and 2) its air quality planning and modeling programs.

Source Category:
Not applicable.

Regulatory Context and Background:
In 2015, the Air District had 32 air monitoring stations operating in the Bay Area. An additional air monitoring station (Point Reyes) is operated by the California Air Resources Board. The air monitoring network is designed to: 1) provide the data required to determine the Bay Area's attainment status for both National and State ambient air quality standards; 2) provide air quality data to the public in a timely manner; and 3) support air pollution research and modeling studies. Additionally, a network of air toxic monitors collects data to ensure permit conditions are met at stationary sources and for State and National regulatory programs. The Air District's 2014 Air Monitoring Network Plan describes recent and planned changes and improvements to the Air District's air monitoring network.

In recent years, the Air District has undertaken initiatives, such as the Community Air Risk Evaluation (CARE) program and the Clean Air Communities Initiative, to analyze pollution exposure at a more localized level and identify communities that are disproportionately impacted by air pollution. In many cases, these communities correspond to areas identified as priority development areas (PDAs) under Plan Bay Area - the region's Sustainable Communities Strategy. Plan Bay Area encourages infill development in PDAs to promote smart growth and reduce sprawl, thus reducing automobile use and emissions. The data and information generated from these initiatives allows the Air District to implement more targeted policies and programs to reduce emissions and exposures in these communities.

The Air District has developed limited enhanced monitoring capabilities of key pollutants to gather more complete data to better assess local air quality conditions based upon the resources available. As an example, the Air District has conducted special air monitoring studies in areas impacted by wood smoke, deployed air toxics monitoring at a proposed school site in Newark, and in past years has implemented similar monitoring sites in Berkeley, Cupertino, and Benicia to address local air quality concerns. Such efforts generally require a minimum of one year of data collection to effectively characterize an area's air quality, but can require longer periods to properly assess local air quality trends. These efforts are resource intensive, requiring expensive instrumentation, specialized operators, coordination among many Air District staff, and long site-development and set-up times.

Additionally, as part of the implementation of Regulation 12-15 (See SS10: Petroleum Refining Emissions Tracking), the Air District will require enhanced fenceline air monitoring at refineries. Rule 12-15 requires refinery owner/operators to prepare and submit to the Air District an air monitoring plan for establishing an air monitoring system and, upon Air District approval of the plan, to install and operate fenceline monitors.

The Air District will also site and operate additional community air monitors via a Community Monitoring Program. The goal of the community monitoring program is to establish air monitoring stations in areas where major stationary sources may contribute to impacts in local communities. Data from these newly established monitoring locations would be used to compare air quality in potentially impacted communities with air quality measurements at other Air District sites. While it is important to recognize that sampling results from ambient air monitoring stations cannot usually be attributed to air pollutants from specific sources, monitoring in areas with large stationary sources will allow residents to determine if air quality in their neighborhoods is significantly different than other Bay Area locations. The first communities to have monitoring stations established will be those with refineries and other significant sources in their vicinity.

Implementation Actions:
Air District will:

- Ensure representative air quality data is being collected in the impacted communities identified under the CARE program. This effort would require review of the existing monitoring network with respect to the impacted communities to ensure that appropriate long term air quality data is being collected.
- Enhance monitoring of local air quality by collecting more information about pollutant concentrations and exposure at localized levels. This effort would be focused around microenvironments that may have significant local emission sources that could be assessed through the use of temporary monitors.
- Partner with County Health Departments to identify areas of poor air quality and collaborate with the community on ways to potentially measure and reduce exposure and emissions from local and regional sources.
- Require petroleum refineries to prepare and submit to the Air District an air monitoring plan for establishing an air monitoring system. Upon plan approval, require installation and operation of fenceline monitors.
- Implement the Community Monitoring Program.

Emission Reductions:
Control measure does not directly reduce emission; however, it does support emissions reduction programs.

Emission Reduction Methodology:
Not applicable.

Exposure Reduction:
Control measure does not directly reduce exposure but supports exposure reduction efforts.

Emission Reduction Trade-offs:
None identified.

Cost:
Costs would vary depending on the extent of enhanced monitoring implemented. Available resources would be determined through the Air District's budget process.

Co-benefits:
Not applicable.

Issues/Impediments:
Enhanced air quality modeling will require additional resources, including purchase of new instrumentation, equipment maintenance, and additional staff with technical expertise in atmospheric chemistry, and background and familiarity with monitoring equipment.

Sources:

1. Bay Area Air Quality Management District, *2014 Air Monitoring Network Plan*, July 2015, http://www.baaqmd.gov/~/media/files/technical-services/2014_network_plan.pdf?la=en
2. Bay Area Air Quality Management District, Staff Report, Proposed Air District Regulation 12, RULE 15: Petroleum Refining Emissions Tracking, April 2016
   Bay Area Air Quality Management District, Staff Report, Proposed Amendments to District Regulation 3: Fees, April 2016

SS40: Odors

Brief Summary:
This control measure would revise Air District Regulation 7 to reduce emissions of odorous substances and place emission limits on odor compounds. Revisions to Regulation 7 would also incorporate industry requirements to develop and identify odor management practices and control measures, and integrate odor detection technologies and evaluation methods. The rule amendment process would include reviewing the effectiveness of the current standards and consider best available technologies to reduce odors.

Purpose:
Reduce emissions from odorous compounds and improve enforceability of Regulation 7.

Source Category:
Stationary source and area source: industrial and commercial operations

Regulatory Context and Background:
In 1970, the Air District was directed by the State Legislature to establish standards for the emission of identifiable odorous substances. On August 2, 1972, the Air District adopted Regulation 2, Division 15 - Odorous Substances, which set emissions limits for five odorous compounds. The rule was originally intended to reduce odorous emissions from operations such as refineries, sewage treatment plants, and rendering plants. In 1976, the regulation was amended to alter the applicability to sources that generated citizen odor complaints, to establish general limitations on odorous substances to be evaluated by an odor panel, and to set limitations on total reduced sulfur (TRS) from kraft pulp mills.

Later the rule was renamed Regulation 7 – Odorous Substances. Between 1976 and 1982, the Air District restructured the regulations which resulted in two substantive amendments to Regulation 7 including, removing the sampling and analysis procedures for odorous substances and including those in a Manual of Procedures, and removing kraft pulp mill requirements and creating a new regulation entitled TRS from Kraft Pulp Mills. Through the Air District's Compliance and Enforcement Program odorous facilities are identified and those facilities are placed on a list of plants subject to Regulation 7.

Since adoption of Regulation 7 in 1972, changes in the Bay Area's population density and the closer proximity of industrial and manufacturing processes to residential areas and public spaces has resulted in significant odor impacts in certain communities. In 2015, the Air District received and responded to 4,946 odor complaints. Seventy-three percent of those odor complaints came from a single community in the Bay Area, alleging odors from solid waste and other organic waste related facilities in the area.

In 2011, in response to the California Legislature's goal of reducing solid waste going to landfills by 75 percent, CalRecycle recommended a statewide strategy to divert organic wastes from landfills. As a result, cities and counties across the Bay Area began utilizing old and new technologies to divert organic wastes and to convert organic wastes to energy and reusable materials. The decomposition of organic waste, once almost exclusively occurring at landfills and sewage treatment plants, is now creating odors at diverse operations of all sizes. These process changes to existing operations and addition of new types of operations have the potential to cause significant increases and changes in odors throughout nearby communities.

Strengthening the requirements and odor standards of the rule will help further reduce odor nuisances and allow the Air District to enforce limits on odorous compounds that negatively impact air quality in the Bay Area.

Implementation Actions:
The Air District will:

- Propose amendments to Regulation 7 to strengthen odor standards and enhance enforceability. An evaluation of newer air monitoring technologies will be aimed at increasing enforceability of the rule with respect to a wider range of odorous compounds and sources.

  Amending Regulation 7 will include the following emission reduction strategies and objectives:
  - Evaluate the complaint threshold that triggers applicability of the regulation.
  - Evaluate and identify source types that can attribute to odor complaints.
  - Identify odorous compounds that are associated to industrial and commercial operations.
  - Review the effectiveness of existing odor thresholds and emissions limits.
  - Evaluate methods of detection and monitoring practices of odorous compounds.
  - Amend regulatory requirements to ensure best management practices for the control of odorous emissions, such as the requirement of odor mitigation plans.

Emission Reductions:
N/A

Emission Reduction Methodology:
N/A

Costs:
N/A

Co-Benefits:
There are a wide range of chemical compounds that are odorous, some of which are toxic air contaminants (TAC), and others which are non-methane organic compounds (NMOC) that contribute to the creation of ground level ozone. Beyond reducing odor nuisances and impacts to surrounding communities, reducing odorous compounds reduces the emission of TACs and NMOCs.

Issue/Impediments:
There may be opposition from industries that have odorous sources of operations that have received a substantial number of odor complaints and are subject to the rule.

Source:
1. California Department of Resources Recycling and Recovery (CalRecycle). August 2015. *AB341 Report to the Legislature.* Publication # DRRR-2015-1538.

TR1: Clean Air Teleworking

Brief Summary:
The primary objective of the Clean Air Teleworking measure is to increase the number of employees who telework in the Bay Area, especially on Spare the Air days, by providing outreach and assistance to employees and employers.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, toxic air contaminants and greenhouse gases by reducing vehicle use associated with commuting throughout the Bay Area, especially on poor air quality days.

Travel Market Affected:
This measure would affect intraregional and inter-regional commute travel for people who work in the Bay Area.

Regulatory Context and Background:
Since July 1, 1995, each state agency has been required to implement a telecommuting plan as part of its telecommuting program in work areas where telecommuting is identified as being both practical and beneficial to the organization. In 2008, state policy went further when then Governor Schwarzenegger signed Executive Order S-04-08 encouraging telecommuting to ease congestion in the Sacramento area during the temporary closure of Interstate 5.

The state's policies on telecommuting are based on the theory that "appropriately planned and managed, telework is a viable work option that can benefit managers, employees, and customers of the State of California." According to the state's Executive Order, a good telework program increases the state's ability to respond to emergencies, amplifies effective use of new technologies within state service, and improves employee morale, which results in increased job effectiveness.

At the regional level, in 1995 the Association of Bay Area Governments (ABAG) operated a regional telecommuting assistance program. The program was funded through a grant of $185,000 from the Air District. The objective of the program was to eliminate automobile trips by increasing the number of people telecommuting to work. The Bay Area Telecommuting Assistance Project was a partnership of ABAG and the Alameda County Transportation Commission (then called the Alameda Congestion Management Agency), who provided matching funds.

ABAG's Telecommuting Assistance Project targeted employers with 100 or more employees to reduce the number of automobile trips to their work site. The project provided regional information and referral service to all employers and public agencies interested in telecommuting. The project also included one-on-one implementation assistance to selected employers. ABAG staff also developed and provided training for employee transportation coordinators on how to implement a telecommuting program. After a couple years of funding, ABAG's telecommuting program ended due to limited staff funding.

Bay Area Commuter Benefits Program; Alternative Benefit Option
The Bay Area Commuter Benefits Program includes a provision for employers to propose an alternative commuter benefit (Option 4). The alternative option may be especially relevant for employers whose work sites are not well served by transit. In March of 2015, the Air District and MTC developed an Option 4 Guide, which is intended to assist employers in developing and implementing an alternative commuter benefit, pursuant to Option 4.

Option 4 includes teleworking as a primary measure for employers in the region. For the purpose of administering a telework program, the Air District and MTC recommends that employers implement a companywide telework policy, and suggest that employees who participate in teleworking do so at least once per week on a regular basis.

Implementation Actions:
MTC will:
- Continue to provide support to employers for regional telecommuting programs in partnership with 511 Rideshare and the Bay Area Commuter Benefits Program.
- Continue to fund MTC's Regional Climate Initiatives Program: Innovative Grants.
- Initiate a Telecommute Pilot Project as part of the 2040 Plan Bay Area.

The Air District will:
- Include Spare the Air notifications to all Employer Program members that include the promotion of teleworking/telecommuting on Spare the Air Days.

Emission Reductions:

Pollutants*	2020	2030
ROG	1,474	620
NO_x	886	389
$PM_{2.5}$	157	118
PM_{10}	374	282
DPM	475	390
TACs	0.20	0.15
CO_{2e}	430,675	319,517

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
MTC's regional travel demand model (Version 0.3 of Travel Model One) was used to estimate the VMT impacts of this measure. The California Air Resources Board emission model (EMFAC 2014) calculated pollutant impacts. CO_2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants and mobile source air toxics (MSATs). MTC's regional travel demand model provides the framework for simulating the impacts of

telecommuting, including assumptions regarding employment status and whether or not individuals choose to work at home or not on a given day.

Exposure Reduction:
This measure will reduce air pollution emitted by vehicles and therefore will reduce the concentration of air pollution that people are exposed to on a daily basis. Impacted communities near freeways and roads with significant auto and truck traffic will benefit.

Emission Reduction Trade-offs:
None identified.

Cost:
Cost estimates are not available for this measure.

Co-benefits:
Telecommuting benefits both the employer and the employee. Employers gain an increase in productivity, a reduction in office space costs, improved employee retention, and a reduction in recruiting and training costs. Telecommuters benefit from having less stress associated with commuting, and spending more time with family and friends, rather than commuting.

Issues/Impediments:
The most common challenges to implementing a telecommuting program are convincing management to support the necessary scheduling and technological changes required for telecommuting and navigating through a number of legal issues relating to federal and state wage and hour laws. With the worker off-site, it becomes difficult to track time worked, overtime liability, and compliance with meal and rest periods.

Sources:

1. Noonan, Mary C., Glass, Jennifer L., *The Hard Truth about Telecommuting,* Monthly Labor Review, July 2012, http://www.bls.gov/opub/mlr/2012/06/art3full.pdf
2. California Government Code, Chapter 1389 Statutes of 1990, Section 14200 -14203 (as authorized by AB 2963 – Klehs)
3. Lewis, Patricia, A Feasibility Study of Implementing a Telecommuting Program at Booz-Allen and Hamilton, 1994 http://pfigliola.tripod.com/project.html
4. The Association of Bay Area Governments, the Bay Area Telecommuting Assistance Project, http://www.abag.ca.gov/abag/overview/pub/newsletter/svm295.html
5. Global Workplace Analytics, http://www.globalworkplaceanalytics.com/telecommuting-statistics
6. Maryland Department of the Environment, *Plan to Improve Air Quality in the Baltimore an, MD Region: State Implementation Plan (SIP) "Serious Area SIP",* July 2013

TR2: Trip Reduction Programs

Brief Summary:
The Trip Reduction measure includes a mandatory and voluntary trip reduction program. The regional Commuter Benefits Program, resulting from SB1339, and similar local programs in jurisdictions with ordinances that require employers to offer pre-tax transit benefits to their employees are mandatory programs. Voluntary programs include outreach to employers to encourage them to implement strategies that encourage their employees to use alternatives to driving alone.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, greenhouse gases, particulate matter and toxic air contaminants by reducing commute trips, vehicle miles traveled, and vehicle emissions.

Travel Market Affected:
This measure would affect commute trips for people who work in the Bay Area.

Regulatory Context and Background:
While commute trips make up less than a third of personal trips they tend to be longer distance trips and they make up most peak hour trips when traffic congestion is the worst. For these reasons, reducing commute vehicle trips can have a significant impact on reducing congestion and improving air quality.

Employees may choose to drive alone to work for a variety of reasons:

- Workplaces are not near transit or home locations.
- Barriers to ridesharing, e.g. information, personal preferences, lack of other riders, etc.
- Lack of pedestrian or bicycle connectivity to transit.
- Lack of "first mile" or "last mile" connectivity at origin or destination.
- Lack of bicycling amenities such as bicycle racks/lockers or showers at transit stations or workplaces.
- Availability of free (or underpriced) vehicle parking.

Mandatory Programs
Senate Bill 1339 authorized the Air District and the Metropolitan Transportation Commission to adopt and implement a Bay Area Commuter Benefits Program on a pilot basis through the end of 2016. The bill was modeled on local commuter benefit ordinances that have already been adopted by several Bay Area cities in recent years, including the cities of Berkeley, Richmond, and San Francisco (as well as San Francisco International Airport). In response to Senate Bill 1339, the Air District adopted Regulation 14, Rule 1: Mobile Source Emissions Reduction Measures, Bay Area Commuter Benefits Program. Shortly thereafter, MTC ratified the rule. Senate Bill 1128, approved September 2016, extended the Commuter Benefits Program indefinitely.

SB 1339 requires employers with greater than 50 employees to provide one of four alternative commute friendly strategies: 1) establish the option for employees to set aside pre-tax salary to pay for their transit or vanpool costs, 2) provide at least a $75/month transit subsidy to all employees, 3) provide a shuttle service from a transit hub to the work location, or 4) provide another approved alternative.

While it is assumed that all employers subject to SB1339 will implement a Commuter Benefits Program, MTC and the Air District support compliance through web-based self-help tools and other employer outreach efforts. Through 511.org, employers may access detailed employer assistance materials to select a commuter benefit option and an on-line registration process. Employer services representatives are also available in each county to offer employers with additional assistance through the 511 Regional Rideshare Program or local county programs.

Compliance with the Commuter Benefits Program is also monitored by Air District staff through verification of on-line registrations against lists of all Bay Area employers with greater than 50 employees. Air District staff conducts outreach to companies and government agencies subject to this Rule and participates in regular meetings with partners MTC and 511.org regarding implementation and management of the registration database. Staff also reviews alternative compliance plans from employers and complaints from employees for compliance with the Commuter Benefits Rule.

Voluntary Programs
The 511 Program has evolved to keep pace with the changing needs of consumers, advances in technology, and the availability of travel data. MTC has delivered traveler information since the mid-1990s, when it launched a multi-modal telephone service and a separate regional transit information website. 511 is now a consolidated, comprehensive, multi-media, multi-modal traveler information service. While Bay Area 511 information is available via phone and web, there are slight differences in how the information is presented due to limitations of the media. Because of web capabilities, the 511.org website is able to offer broader information and more detailed and interactive information to users than what could reasonably be provided via the 511 phone service.

511 Rideshare is one component of the 511 Program. Historically, 511 Rideshare has reached out to employers to encourage them to implement strategies to reduce vehicle trips to their worksites. However, 511 Rideshare's mission is carpool and vanpool formation. Therefore, beginning in approximately mid-2016, 511 Rideshare will move from employer-focused outreach to commuter-focused outreach. The program will leverage partnerships with private sector carpool matching applications for ridematching, instead of maintaining its own ridematch system. 511 Rideshare will also include a permanent Vanpool Support Program to offset ongoing vanpool capital and/or operating costs, incentivizing vanpool service providers to form more vanpools.

The purpose of changing 511 Rideshare is to improve carpool and vanpool formation, embrace private sector innovation/tools, and get the biggest 'bang for the buck' out of limited program funds.

In 1991, the California State Legislature authorized the Air District to impose a $4 surcharge on motor vehicles registered within the San Francisco Bay Area to fund projects that reduce on-road motor vehicle emissions. The Air District has allocated these funds to its Transportation Fund for Clean Air (TFCA) program to fund eligible projects. The statutory authority for the TFCA and requirements of the program are set forth in California Health and Safety Code Sections 44241 and 44242.

Sixty percent of TFCA funds are awarded directly by the Air District to eligible projects and programs implemented directly by the Air District (e.g., Spare the Air, Plug-in Electric Vehicle Program) and to a program referred to as the TFCA Regional Fund. The remaining forty percent of TFCA funds are forwarded to the designated agency within each Bay Area county and distributed by these through the County Program Manager program. Approximately $4 million is allocated through the Regional Fund each year to support trip reductions projects, including shuttle and rideshare service, which reduce single-occupancy vehicle commute-hour trips by providing the short-distance connection between a mass transit hub and employment centers and rideshare projects that reduce single-occupancy commute-hour vehicle trips by encouraging mode-shift to other forms of shared transportation.

Trip Cap Programs
Multiple trip cap programs have been developed in Stanford, Menlo Park, Mountain View, Sunnyvale, and Cupertino. A "trip cap" restricts the number of commute trips into an employment site or into an employment area. For example, in Menlo Park, the trip cap at the Facebook East Campus restricts the number of vehicle trips allowed to the campus during peak commute periods, "Between 7AM and 9AM, Facebook East Campus may have no more than 2,600 vehicle trips. Hourly trip measurement must be provided to the City of Menlo Park, using sensors at driveway entrances. For each trip above the cap, Facebook shall pay a penalty of $50 per day per trip. After noncompliance over 6 months, the fee increases to $100 per day per trip."

Implementation Actions:
MTC will:
- Refocus 511 Rideshare on carpool and vanpool formation.
- Create a Vanpool Support Program.
- As part of the Climate Initiatives Innovative Grants program, continue to fund travel demand management projects.
- Study new opportunities for Trip Cap program development in Plan Bay Area 2040.

The Air District will:
- Work with employers to support implementation and compliance with the Commuter Benefits Program.

- Continue to provide grants through the Transportation Funds for Clean Air (Regional Fund and County Program Manager Fund) to support trip reduction efforts.
- Encourage local governments to require mitigation of vehicle travel as part of new development approval, adopt transit benefits ordinances in order to reduce transit costs to employees, and to develop innovative ways to encourage rideshare, transit, cycling, and walking for work trips.
- Encourage transit agencies and shuttle providers to continue to implement and expand shuttle and feeder bus services to complement fixed route transit service and reduce the demand for parking at transit stations.

Emission Reductions:
Emission reductions for Commuter Benefits Program portion of this control measure are estimated as follows:

Pollutants*	2020	2030
ROG	61	41
NO_x	54	24
$PM_{2.5}$	10	10
PM_{10}	24	24
CO_{2e}	28,739	20,066

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reductions Methodology:
Emission reduction estimates are based on a 2015 analysis of the results of the Commuter Benefits Program over the first twelve months of the pilot project, *Commuter Benefits Program: Evaluation of Trip, VMT and Emission Impacts* Report, including participation rates in the program. That report is available here: http://www.baaqmd.gov/~/media/files/planning-and-research/commuter-benefits-program/reports/true-north-employee-survey-report_commuter-benefits-program_6_19_15-pdf.pdf?la=en) Reductions in vehicle miles traveled were estimated based on the results of a survey of employees who work for employers that are subject to the regulation, in combination with employer registration information. Years 2020 and 2030 emission factors were applied to estimated year 2015 vehicle trip reduction estimates, assuming continuation of the program into 2030.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
Air District Commuter Benefits Program costs are estimated at $1.4 million per year. For TFCA funded projects, approximately $4 million is allocated per year to provide funding for existing shuttle/feeder bus and regional ridesharing services.

For MTC programs, Plan Bay Area funds trip reduction programs, including the 511 Rideshare program, Vanpool Support, and travel demand projects via the Innovative Grants program. Funds are programed through 2020, and equal approximately $2.6 million. Beyond 2020, $52.7 million is allocated toward these trip reduction programs.

Co-benefits:
- Reduced travel costs for employees.
- Reduced costs in provision of parking for employers.

Issues/Impediments:
Employers can experience the following barriers to Employer-Based Trip Reduction program implementation: insufficient employee interest, minimal perceived benefits to organization, lack of upper management support, and worksite's distance to public transit.

Sources:

1. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013
2. Bay Area Air Quality Management District, Regulation 14, Rule 1: Bay Area Commuter Benefits Program, March 19, 2014
3. True North Research, Inc., Bay Area Commuter Benefits Program: Evaluation of Trip, VMT and Emission Impacts, June 19 2015
4. Transportation Fund for Clean Air, California Health and Safety Code, Sections 44241 and 44242 2

TR3: Local and Regional Bus Service

Brief Summary:
The Local and Regional Bus Service Improvements control measure will improve existing transit service on the region's core transit systems, and include new bus rapid transit lines in San Francisco, Oakland and Santa Clara County.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by improving bus service throughout the Bay Area.

Travel Market Affected:
This measure would affect intraregional travel, including commute travel, shopping, personal business, school trips, as well as social and recreational travel.

Regulatory Context and Background:
Over the next 28 years, operating and capital replacement costs for Bay Area transit providers are projected to total $161 billion. This includes $114 billion in operating costs plus $47 billion for capital replacement to achieve an optimal state of repair. Committed revenues over the same period are expected to total only $131 billion ($110 billion for operations and $21 billion for capital). The result is $30 billion in initial unfunded needs, approximately $26 billion of which is needed to bring the capital assets up to an optimal state of repair.

To address transit operating and capital needs, Plan Bay Area invests $13 billion in discretionary revenues. This includes more than $2 billion in discretionary revenue plus almost $2 billion in revenues that are expected to come from the new extension of the transportation sales tax in Alameda County to eliminate the $4 billion forecasted operating shortfall over the plan period. Another $9 billion in discretionary revenue will be invested in transit capital, leaving unfunded capital needs of $17 billion to achieve a state of optimal repair.

Plan Bay Area assumes that the region can attract approximately $2.5 billion in additional federal New Starts and Small Starts funding through 2040. Building on the successful delivery of Resolution 3434, and the results of the Performance Assessment and transit-specific project evaluation, Plan Bay Area's priorities for the next generation of federal New Starts and Small Starts funding include major rail and bus rapid transit (BRT) investments.

Along with identifying these significant future transit investments, Plan Bay Area also retains $660 million in financial capacity for projects that are in the planning stages. The $660 million New and Small Starts reserve, or a regional investment equivalent, is proposed to support transit projects that are located in or enhance transit service in the East and North Bay counties.

The Core Capacity Challenge Grant program commits $7.5 billion — including $875 million from Cap and Trade funds, $402 million in bridge toll revenues, and over $3 billion in federal transportation funds — over 15 years for capital improvements to the region's largest transit systems: San Francisco Muni, BART and AC Transit. Over 80 percent of the region's transit riders, and 75 percent of low-income and minority riders, are accommodated by these three systems. The program would fund transit vehicle replacement, fleet expansion and key facility upgrades. To receive the money, operators would need to meet certain performance and efficiency objectives, and match 30 percent of the grant money with their own funds.

The Transit Performance Initiative (TPI) has two components – the Incentive program and the Investment program. The TPI Incentive program has an annual funding distribution of $15 million, based on a formula related to annual passenger increase, annual passengers per hour increase, and annual passengers, with large operators receiving 85 percent of total funding and small operators receiving 15 percent. The TPI Investment program is a competitive grant program with $82 million total split over three rounds. To date, two rounds have been awarded to fund projects to improve bus and light rail service, with a third round expected in 2015 or 2016.

Implementation Actions:
MTC will assist in the funding of:

- Operations of existing bus services where feasible with available funding ($2 billion)
- Regional Measure 2 Express Bus North Improvements ($20 million)
- Transit Performance Initiative – ongoing annual Incentive program, third round of Investment program ($500 million)
- Bus Rapid Transit Service on the Telegraph Avenue/International Boulevard/E. 14th Street Corridor ($217.8 million)
- Sustain all bus service and operations, including Express Buses, at existing level of service where feasible with available funding ($2.3 billion)
- Replace and/or rehabilitate buses, vans and electric trolley buses ($1.95 billion)
- Bus Rapid Transit Service on the Grand-MacArthur Corridor ($41 million)
- Bus Rapid Transit project on Van Ness Avenue to include dedicated transit lanes, signal priority and pedestrian and urban design upgrades ($125.6 million)
- In Santa Clara County, implement:
    - BRT improvements in the Santa Clara/Alum Rock route ($146.6 million)
    - King Road Rapid Transit Project ($61.9 million)
    - BRT improvements on El Camino Real/The Alameda Corridor ($233.7 million)
    - Bus Rapid Transit improvements along in the Stevens Creek Corridor ($165.8 million)

Supporting Actions by Partner Entities:

- Transit agencies and CMAs to work with MTC, as appropriate, to implement service improvement

Emission Reductions:

Pollutants*	2020	2030
ROG	7.65	2.98
NO_x	5.92	1.87
$PM_{2.5}$	0.86	0.57
PM_{10}	2.03	1.36
DPM	2.61	1.88
TACs	<0.01	<0.01
CO_{2e}	2,365	1,536

**criteria pollutants and TACS are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:

The emission reduction estimate for this measure is based on various transit projects. Project include: AC Transit's BRT route from Uptown Station to 20th Street and the Grand-MacArthur corridor; BRT on Van Ness corridor; Regional Measure 2 Express Bus North Improvements, and various BRT projects in Santa Clara County, including the Santa Clara/Alum Rock route, King Road, El Camino Real/The Alameda Corridor, and Steven Creek Corridor. AC Transit's East Bay BRT Final Environmental Impact Statement/Environmental Impact Report (Jan. 2012) methodology was used to estimate emission reduction benefits for both AC Transit's and Muni's BRT routes. This approach included the use of CARB's EMFAC model series to calculate CO2 emissions for motor vehicles by average operating speed for use in estimating total corridor on-road transportation CO2 emissions associated with the BRT projects. Emission reduction data was updated to reflect the current version of the EMFAC model, EMFAC2014.

Exposure Reduction:

This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:

None identified.

Cost:

See above implementation actions.

Co-benefits:

- Improved connectivity between transit services and destinations
- Travel time savings from new express/enhanced bus projects that provide faster and/or more direct service between trip origins and destinations
- New transit options may allow some households to own fewer or no automobiles
- Community enhancements through the creation of higher quality transit options and services

Issues/Impediments:
Implementation requires funding to be available for programs. Bay Area transit providers continue to face challenges in maintaining and sustaining their existing systems and, in light of financial constraints, are cutting transit budgets and service and increasing fares, and/or are delaying capital maintenance and service enhancements. Therefore, simply maintaining the existing fleet, sustaining service, and restoring service will require new funding sources. New revenues may come from higher gas taxes, bridge tolls and/or county-wide voter-approved sales tax revenues.

Source:

1. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013

TR4: Local and Regional Rail Service Improvements

Brief Summary:
Improve rail service by sustaining and expanding existing services and by providing funds to maintain rail-cars, stations, and other rail capital assets. Specific projects for implementation include BART extensions, Caltrain electrification, Transbay Transit Center building and rail foundation, Capital Corridor intercity rail service, and Sonoma Marin Area Rail Transit (SMART) District commuter rail project.

Purpose:
The purpose of this measure is to reduce emissions of the key ozone precursors, ROG and NOx, as well as particulate matter, air toxics and greenhouse gases by sustaining and improving rail service throughout the Bay Area.

Travel Market Affected:
This measure would affect intra and inter-regional commute and non-commute travel.

Regulatory Context and Background:
Plan Bay Area relied on a transportation Project Performance Assessment, which, together with public involvement, helped identify priorities for the next generation of transit investments. These include improvements to the region's core transit systems, new bus rapid transit lines in San Francisco and Oakland, rail extensions that support and rely on high levels of future housing and employment growth, and an early investment strategy for high-speed rail in the Peninsula corridor.

MTC's Resolution 3434, a 2001 framework that identified regional priorities for transit expansion projects, has guided transit investments in the Bay Area. Resolution 3434 established the region's priority projects for federal New Starts and Small Starts funds, creating a unified regional strategy to secure commitments from this highly competitive national funding source. In 2012, the Bay Area secured commitments for nearly $2 billion in federal funding for its two most recent New Start projects — San Francisco's Central Subway and the extension of BART to Berryessa in Santa Clara County. These successes pave the way for a new generation of projects that can leverage current and future development patterns to create financially stable transit service in these corridors.

The Bay Area's rail system includes light-rail (such as Muni Metro and VTA Metro), rapid rail (such as BART), and commuter rail (such as Caltrain, Capitol Corridor and ACE) services. During weekday peak hours in 2010, heavy and commuter rail transit (combined) provided 58.6 million seat miles on a typical weekday in the Bay Area.

Originally adopted as part of the 2001 Regional Transportation Plan, MTC's Resolution 3434 Regional Transit Expansion Program is a long-term, and multifaceted funding strategy for directing local, regional, state and federal dollars to nearly two dozen high-priority bus, rail and ferry expansion projects.

MTC's Resolution 3434 – or Regional Transit Expansion Program – identifies the top priorities for new Bay Area transit projects. And it helps the region compete with other metro areas for state and federal funding.

Several Regional Transit Expansion Program projects are now under construction:
- AC Transit Oakland-San Leandro Bus Rapid Transit
- BART to Warm Springs/Milpitas/San Jose
- e-BART extension in East Contra Costa County
- Transbay Transit Center (Phases 1 and 2)
- Muni Central Subway
- Sonoma-Marin Area Rail Transit (open for service in late 2016)
- Transbay Transit Center

Among the many Regional Transit Expansion Program projects already in service are:
- BART-Oakland Airport Connector
- Caltrain Baby Bullet
- Capitol Corridor and ACE Service Expansions
- San Francisco Bay Ferry Service Expansion
- Regional Express Bus

A handful of Resolution 3434 projects are still several years away from completion:
- Caltrain electrification
- Caltrain extension to Transbay Transit Center
- Dumbarton Rail
- Muni Bus Rapid Transit

Implementation Actions:
MTC to fund:
- Extension of BART/East Contra Costa Rail (eBART) eastward from the Pittsburg/Bay Point BART station into eastern Contra Costa County ($493 million)
- Transbay Terminal Phase 1: construct the new Transbay Transit Center Building and rail foundation ($1.6 billion)
- Caltrain electrification, including replacement of railcars and an advanced signal system ($451 million)
- Transit operations needs through 2040 at existing service levels ($2 billion for operating costs)
- Rail expansion and enhancement projects ($2.2 billion)
- Transit access improvements to BART in the Tri-Valley ($168 million)
- Sonoma-Marin Rail lnitial Operating Segment ($360 million)
- Extension of BART from Fremont (Warm Springs) to San Jose/Santa Clara ($6.3 billion)
- Extension of Caltrain Express service (Phase 2) ($427 million)
- Transbay Terminal Phase 2: extend Caltrain to the new Transbay Terminal ($2.6 billion)
- Capitol Corridor: Phase 2 enhancements ($254 million)
- MUNI Third Street Light Rail Transit Project – Central Subway ($1.6 billion)

- Implement Bus Rapid Transit in Santa Clara County and provide light rail extensions ($1.1 billion total):
    - To the Eastridge Transit Center in East San Jose
    - From the Winchester Station to Route 85 - Vasona Junction
- Revenues forecasted to be available for High-Speed Rail within the region ($1.5 billion)

The Air District will:

- Assist with funding for the electrification of the Caltrain corridor ($20 million)

Emission Reductions:

Pollutants*	2020	2030
ROG	318	134
NO_x	155	68
$PM_{2.5}$	34	26
PM_{10}	81	61
DPM	103	84
TACs	0.04	0.03
CO_{2e}	93,099	69,070

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Methodology:
Travel Model One produced all of the key outputs used in assessing the significance of local and regional rail service transportation impacts, including outputs such as vehicle miles traveled, vehicle hours of delay, and accessibility, as well as other outputs such as volume to capacity ratios and level of service.

This analysis uses existing ridership projections for rail developed by transit operators for each project. Growth factors, based on increases in each transit operator's ridership modeled as a part of the Travel Model One travel forecasts for Plan Bay Area, are applied to bring the ridership estimates to analysis year 2020. Using local data, estimated new ridership is reduced to factor in new riders that are transit dependent and those who drive to access rail, resulting in the number of vehicle trips reduced.

This analysis excludes estimates of emissions reduced from maintaining existing rail services and transit access improvements to BART, Caltrain, Sonoma-Marin Area Rail Transit (SMART), Capitol Corridor, ACE commuter rail systems and supporting infrastructure for high-speed rail. In addition, CO2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants and mobile source air toxics (MSATs).

Exposure Reduction:
This measure will reduce air pollution emitted by vehicles and therefore will reduce the concentration of air pollution that people are exposed to on a daily basis. Impacted communities near freeways and roads with significant auto and truck traffic will benefit.

Emission Reduction Trade-offs:
None identified.

Cost:
See above Implementation Actions.

Co-benefits:
- Improved connectivity between transit services and destinations
- Travel time savings from providing new rail services that provide faster and more direct service between trip origins and destinations
- Transportation cost savings by providing new rail transit options that may allow some households to own fewer or no cars
- Community enhancements through the creation of more and higher quality transit options

Issues/Impediments:
Implementation requires available funding. Bay Area transit providers continue to face challenges in maintaining and sustaining their existing systems and, in light of financial constraints, are cutting transit budgets and service and increasing fares, and/or are delaying capital maintenance and service enhancements. Therefore, simply maintaining the existing fleet, sustaining service, and restoring service will require new funding sources. New revenues may come from higher gas taxes, bridge tolls and/or county-wide voter-approved sale tax revenues. Environmental clearance, right-of-way availability and the level of public support are major impediments to sustain, improve, upgrade, and expand regional rail service.

Source:
1. Metropolitan Transportation Commission, Association of Bay Area Governments, *Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy*, July 2013

TR5: Transit Efficiency and Use

Brief Summary:
This measure will improve transit efficiency and make transit more convenient for riders through continued operation of 511 Transit, full implementation of Clipper® fare payment system and the Transit Hub Signage Program.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by improving transit efficiency and use through financial incentives, improved real-time transit service information, coordinated fare payment and collection, and improved transit connectivity.

Travel Market Affected:
This measure would affect intra and inter-regional commute and non-commute travel.

Regulatory Context and Background:
Launched by MTC in 2002, 511 is a 24-hour, toll-free phone and Web service (511.org) that consolidates Bay Area transportation information into a one-stop resource. 511 provides up-to-the-minute information on traffic conditions, incidents and driving times; schedule, route and fare information for dozens of public transportation services; instant carpool and vanpool referrals; and bicycle routes and more.

MTC, in close coordination with the region's over two dozen Bay Area transit operators, continues to operate, maintain, and further develop the 511 Transit information system, which includes the 511 Transit website and its features: the 511 Transit Trip Planner, 511 Departure Times, 511 Popular Destinations, as well as schedule, fare, route and agency-specific information for the region's numerous transit operators.

511 Transit also provides special service announcements for changes to services or transit disruptions and promotion of special services for events. Transit information and tools are also provided via the 511 SF Bay Transit applications for smart phones as well as the 511 Mobile site at m.511.org. Users can also receive transit departure times via text message, e-mail alert, or on a personalized Transit Tracker display. A new feature, the Enhanced Trip Planner, compares transit-only trips with drive-to-transit trips and drive-only trips. The 511 Transit Trip Planner generates approximately 800 thousand to 1 million itineraries per month.

Clipper offers transit riders a convenient and secure way to pay fares on multiple transit agencies. The reloadable Clipper card stores value in the form of electronic cash. Clipper is currently available on Muni, BART, AC Transit, Caltrain, SamTrans, Golden Gate Transit & Ferry, VTA and SF Bay Ferry. Clipper can also be used on transit agencies in Napa and Solano counties and on Livermore-Amador Valley Transit Authority (WHEELS) in Alameda County, County Connection, WestCAT and Tri-Delta Transit in Contra Costa County. The Clipper network expanded again in the spring of 2016 to include Santa Rosa City Bus, Sonoma County Transit, and Petaluma Transit in Sonoma County. Clipper also will be the fare payment method used by Sonoma-Marin Area Rail Transit (SMART) when it begins operation.

In 2010, Clipper began operating a pre-tax transit benefit program called Clipper Direct. Clipper Direct works with employers in the Bay Area to put cash value and transit passes directly onto Clipper cards using employees' pre-tax dollars. Clipper also has agreements with other pre-tax transit benefit providers so that customers of those programs can also use their transit benefits to put value onto their Clipper cards.

Currently, MTC and the participating transit agencies are beginning the planning process for the next version of Clipper. The current contract ends in 2019, and so the design phase for the new contract requirements has begun.

MTC, in partnership with transit operators, implemented the Hub Signage Program to address wayfinding signage, transit information and real-time transit information recommendations at 21 transit hubs and 3 airports. The design work for the Hub Signage Program at all 24 regional transit hubs was completed in 2012 and the entire program has been installed at all 24 Hubs.

Implementation Actions:
MTC will:
- Implement ridesharing measures (includes ride matching, vanpool services, and commute trip planning/consulting) ($14 million)
- Deploy, operate and maintain Clipper® on Bay Area transit agencies. Clipper® capital replacement costs for all operators are included and a portion of Clipper's operating costs ($584 million)
- Implement, operate and maintain wayfinding signage, transit information displays and real-time departure displays via the Hub Signage Program (HSP) ($10 million)
- Complete the Core Capacity study and fund grant projects via the Core Capacity Grant Challenge Program.

Supporting Actions by Partner Entities:
- Local governments and transit agencies to work with MTC on the Transit Hub Signage Program.
- Local governments, CMAs, transit agencies and other agencies to work with MTC to deploy, operate and maintain Clipper® and 511 Transit.
- Local governments are encouraged to implement programs that offer residents, students and employees free or discounted transit passes, such as Santa Clara's Ecopass program, and other innovations to encourage transit use.

Emission Reductions:

Pollutants*	2020	2030
ROG	15	6.23
NO_x	13	5.58
$PM_{2.5}$	0.23	0.17
PM_{10}	0.41	0.31
DPM	4.32	3.55
TACs	<0.01	<0.01
CO_{2e}	3,917	2,906

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
MTC developed a methodology to evaluate the expected emission reductions due to the expansion of the Clipper® program. The methodology calculates emissions reduction benefits based on time savings from using Clipper®. Time savings are realized from more efficient boarding resulting in shorter vehicle dwell times. While not explicitly captured by the analysis, there would be additional emission reductions resulting from Clipper® such as more reliable transit service through less vehicle bunching and shorter idling time at bus stops. The reduction in transit travel time increases transit ridership, thereby reducing emissions by offsetting automobile trips.

Route level transit operational characteristics from MTC's travel demand model provided average transit passenger miles per boarding, average transit travel time per boarding and average transit boarding per hour statistics which were input into the elasticity equations. In addition, current transit ridership (by operator) and current and projected Clipper® boardings were also put into emissions benefit calculations.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
$608 million, see above implementation actions for details

Co-benefits:
- Improved transit customer experience
- Travel time savings

Issues/Impediments:
Implementation of this measure requires that funding is available for these programs. In addition, technological issues, institutional support, and market penetration are factors that may impede full implementation of 511 and Clipper®.

Source:

1. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013

TR6: Freeway and Arterial Operations

Brief Summary:
This measure improves the performance and efficiency of freeway and arterial systems through operational improvements, such as implementing the Freeway Performance Initiative (FPI), the Bay Area Freeway Service Patrol (FSP), and the Arterial Management Program.

Purpose:
Implementation of this measure will reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by improving the efficiency of existing freeways and roadways throughout the Bay Area.

Travel Market Affected:
This measure would affect intra and inter-regional commute and non-commute travel.

Regulatory Context and Background:
Plan Bay Area supports MTC's Freeway Performance Initiative (FPI), which is designed to maximize the efficiency and improve the operations and safety of the existing freeway, highway and arterial network. FPI addresses both recurrent daily traffic that comes from the surge of commuters using the freeways during rush hours and nonrecurring congestion that results from unanticipated incidents and blockages of highway lanes. Half of all traffic congestion experienced in the Bay Area is caused by vehicle breakdowns, vehicular accidents, material spills and other incidents.

FPI investments made through Plan Bay Area have expanded the number of metered ramps throughout the Bay Area, directly resulting in reduced travel times and improved safety on major freeway corridors while managing the impact on local arterial operations. FPI investments also support the Program for Arterial System Synchronization (PASS), which was previously called the Regional Signal Timing Program, through which an average of 500 traffic signals is re-timed each year.

The role of MTC in the PASS is to provide program administration, project management, and facilitation of inter-agency communication and coordination. The primary responsibility for the operation and retiming of traffic signals resides with the agency that owns them. Under this regional program, technical assistance will be focused on traffic signal systems that: 1) interact with freeways and state highways, 2) involve traffic signals from multiple jurisdictions, 3) operate on corridors with established regional significance, 4) provide priority for transit vehicles, and 5) developed in conjunction with other regional programs.

FPI funding for the FSP and call boxes has enhanced the region's ability to quickly identify and respond to planned and unplanned freeway incidents. Currently, FSP includes 78 tow trucks that cover 552 miles of Bay Area freeways and respond to an average of 130,000 incidents per year. The 2,200 call boxes in place along the region's freeways and bridges receive an average of 22,000 calls per year.

The Bay Area Freeway Service Patrol is a fleet of tow trucks deployed during peak travel times (typically, 6-10am and 3-7pm) as part of an incident management program to detect and clear accidents, assist motorists and remove dangerous debris from freeways which cause more than 50 percent of traffic congestion. The Freeway Service Patrol is free at the time of service, funded through the state highway fund and supplemented by the SAFE motorist aid driver registration fee.

The MTC Arterial Operations Program provides assistance to Bay Area jurisdictions in their efforts to improve traffic operations on arterial streets by sponsoring various projects that address signal coordination and other arterial operations issues; developing and implementing initiatives to promote improved arterial operations; and supporting the Arterial Operations Committee (AOC) as a forum for discussion of shared issues and lessons learned for both public and private agencies. The program provides direct benefits through projects that reduce travel time and emissions and enhance traffic safety on arterial streets; as well as indirect benefits through projects that help local traffic engineers do their job more efficiently and effectively.

Implementation Actions:

MTC will:

- Through FPI, install additional ramp meters at entrance ramps, and monitor and adjust meter timing as appropriate.
- Through the PASS program, coordinate additional traffic signals and continue to update timing plans.
- Expand Freeway Service Patrol on I-280 from SR 92 to SR 85 in San Mateo and Santa Clara counties.

Emission Reductions:

Pollutants*	2020	2030
ROG	46	19
NO_x	63	18
$PM_{2.5}$	11	8
DPM	41	33
TAC	<.01	<.01
CO_{2e}	36,883	27,364

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
Emission reductions for the Program for Arterial System Synchronization (PASS) program and the expanded Freeway Service Patrol (FSP) service (on I-280 from SR 92 to SR 85 in San Mateo and Santa Clara counties) were calculated by two separate approaches.

For the PASS program emissions calculation, the synchronization of signals along an extended route was analyzed by using EMFAC 2011 emission factors. Emission factors dependent on the before-project (lower speeds, higher emission factors) and after-project (higher speeds, lower emission factors) average traffic speeds were applied to the corresponding before and after project vehicle miles traveled (VMT) to calculate the emission reductions for this component of measure. EMFAC 2011 emission factors were updated to reflect the current version of the EMFAC model, EMFAC2014 and CO2 conversion/equivalency factors were used to estimate the emission reduction benefits for the mobile source air toxics (MSATs).

For the expanded FSP service, CO2 emissions were calculated by applying an updated fuel consumption rate (from the Caltrans Mobility Performance Report 2011) and the other pollutant emission rates were estimated using ARB's emission model EMFAC 2007 were updated to reflect the current version of the EMFAC model, EMFAC2014. FY 13/14 FSP expanded service emission reductions were adjusted and forecasted to the 2020 and 2030 analysis years. As with the PASS program component of the transportation measure, CO2 conversion/equivalency factors were used to estimate the emission reduction benefits for the mobile source air toxics (MSATs).

Emission reductions generated from the FPI program were not generated in this analysis.

Exposure Reduction:
This measure will reduce air pollution emitted by vehicles and therefore will reduce the concentration of air pollution that people are exposed to on a daily basis. Impacted communities near freeways and roads with significant auto and truck traffic will benefit.

Emission Reduction Trade-offs:
None identified.

Cost:
Approximately $2.7 billion.

Co-benefits:
- Health (congestion can lead to stress, and increases drivers and nearby resident's exposure to harmful air pollutants) and economic savings for both businesses and travelers from reduced congestion
- Shorter travel times, reduced fuel consumption and fewer collisions secondary accidents.

Issues/Impediments:
By making more efficient use of existing capacity, the FPI should help to improve air quality by reducing peak period congestion, as well as incident-related delay, on the Bay Area's freeways. But, past research has shown (Levinson and Zhang, 2006) that ramp-metering may provide a greater travel time savings for vehicles making longer trips. Reducing travel time for long distance commuters could, at least in theory, encourage longer commutes from residential locations in the periphery of the region. If this were to occur, it could erode the air quality benefits of this measure over time.

Local jurisdictions may be concerned that ramp meters will spill over onto local streets and disrupt their arterial operations (although these impacts are most often mitigated prior to the operation of the ramp meters through protocols for the ramp metering timing or local street improvements to accommodate the ramp queues).

Where arterial signal coordination requires cooperation of multiple jurisdictions, the negotiations can take time to resolve both technical and policy issues.

Sources:
1. Metropolitan Transportation Commission, Program for Arterial System Synchronization (PASS), http://www.mtc.ca.gov/services/arterial_operations/pass.htm
2. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013
3. Metropolitan Transportation Commission, Arterial Operations Program, http://www.mtc.ca.gov/services/arterial_operations/
4. Metropolitan Transportation Commission, Freeway Service Patrol, http://www.mtc.ca.gov/services/fsp/

TR7: Safe Routes to Schools and Transit

Brief Summary:
This measure will facilitate safe routes to schools and transit by providing funds and working with transportation agencies, local governments, schools, and communities to implement safe access for pedestrians and cyclists. Likely projects will include implementation of youth outreach and educational programs to encourage walking and cycling, the construction of bicycle facilities and improvements to pedestrian facilities.

Purpose:
The purpose of this measure is to reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by improving bicycle and pedestrian access to schools and transit throughout the Bay Area.

Travel Market Affected:
This measure would affect intraregional travel for students traveling to and from school and for transit riders throughout the Bay Area.

Regulatory Context and Background:
Safe Routes to School is a state, regional and local program that encourages children to walk or bicycle to school by removing barriers. Barriers include lack of infrastructure, unsafe facilities that result in uninviting walking and bicycling conditions, and lack of education and enforcement programs aimed at children, parents and the community at large. Another important component is outreach and education in schools to encourage students to bike and walk to school, leading to mode shifts away from automobile trips and therefore VMT reductions. In 2010, grade school trips in the Bay Area accounted for nearly 2.2 million trips/day, or 9.5 percent of total personal trips. Safe Routes to School reduces vehicle trips to school and parents' vehicle trips to work, to the extent that parents may be able to switch to another mode if they do not need to drop their children off at school.

Safe Routes to Transit (SR2T) is a program that funds bicycle and pedestrian planning and capital projects that facilitate walking and bicycling to regional transit, thereby reducing vehicle trips to transit. The SR2T Program originally received Bay Area voter approval in March 2004 through Regional Measure 2, the $1 bridge toll increase for transit. By improving the safety and convenience of biking and walking to regional transit, SR2T encourages commuters to leave their cars at home and reduce emissions.

In May 2012, MTC approved a new funding approach that directs specific federal funds to support more focused growth in the Bay Area. The OneBayArea Grant (OBAG) program commits $320 million of federal surface transportation funding through 2017. The OBAG program allows communities flexibility to invest in transportation infrastructure that supports infill development by providing funding for bicycle and pedestrian improvements, local street repair, and planning activities, while also providing specific funding opportunities for Safe Routes to Schools projects.

Through the Air District's Bikeways, Roads, Lanes and Paths program, up to $3.84 million is available (fund made available in FYE 2016) for bicycle parking and bikeway projects. Funding is offered on a first-come, first-served basis, until all funds have been spent. In order to be eligible for funding projects must be included in an adopted countywide bicycle plan, Congestion Management Plan (CMP), or MTC's Regional Bicycle Plan. Funding is available for new Class-1 bicycle paths; new Class-2 bicycle lanes; new Class-3 bicycle routes; and new Class-4 cycle tracks or separated bikeways. Bike projects may support or be paired with a Safe Routes to School or Safe Routes to Transit projects.

Implementation Actions:
MTC will:
- Continue to award the Regional MTC County Safe Routes to School Program at Cycle 1 and Cycle 2 annual funding levels of $5 million a year through 2017 ($20 million)
- Explore new funding and program opportunities for Safe Routes to School and Safe Routes to Transit in Plan Bay Area 2040.

The Air District will:
- Distribute funding and manage grants distributed through the Bikeways, Roads, Lanes and Paths program. ($3.8 million)

Emission Reductions:

Pollutants*	2020	2030
ROG	0.94	0.39
NO_x	0.56	0.25
$PM_{2.5}$	0.10	0.08
PM_{10}	0.24	0.18
DPM	0.30	0.25
TACs	<0.01	<0.01
CO_{2e}	274	203

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
Shifting school trips away from family vehicles reduces start-up emissions and per-mile trip emissions. In addition, an increase in active transportation in the region resulted in a reduction in vehicle miles traveled in all counties analyzed. This translates to a reduction in GHG emissions, based on trip length as well as number of trips (i.e. student enrollment and mode split).

MTC's Climate Initiatives Program evaluation estimated that the Regional Safe Routes to School Program projects resulted in an annual GHG emission reduction of over 420,000 pounds (210 tons), an average 10.7 percent reduction in GHG emissions for trips one mile or less from school.

The emission reduction estimates for the Regional Safe Routes to School Program projects are the per student daily changes multiplied by 175 (the typical number of school days) and then by the follow up period enrollment to reflect changes over an entire school year for all counties included. Note that this analysis includes trips within one mile of school only. GHG-CO_2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants and air toxics (all emission reductions, except CO_2, are nominal).

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
MTC: $20 million; Air District $3.8 million

Co-benefits:
- Improved safety/reduced pedestrian-motor vehicle and bicycle-motor vehicle accidents.
- Improved public health/reduced obesity.
- Reduced travel costs.

Issues/Impediments:
Implementation of this measure requires that funding is available for these programs. The Safe Routes to School and Safe Routes to Transit programs receive a high volume of grant applications and have only limited amount of funds to award to projects. While funding for these programs has been identified in the short-term, many of these sources will sunset in the future. Future federal transportation legislation could include additional funding for Safe Routes to School and Transit. New funds may also be available from higher gas taxes, bridge tolls, and voter approved sales tax measures in individual counties.

Source:

1. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013

TR8: Ridesharing and Last-Mile Connections

Brief Summary:
The Ridesharing and Last-Mile Connections measure will promote ridesharing services and incentives through the implementation of the 511 Regional Rideshare Program, as well as local rideshare programs implemented by Congestion Management Agencies. These activities will include marketing rideshare services, operating a rideshare information call center and website, and provide vanpool support services. In addition, this measure includes provisions for encouraging car sharing programs.

Purpose:
This measure will reduce motor vehicle emissions of key ozone precursors, ROG and NOx, particulate matter, air toxics, and greenhouse gases by reducing single occupancy vehicle trips through the promotion of rideshare services and incentives.

Travel Market Affected:
This measure would affect intra and inter-regional commute and non-commute travel.

Regulatory Context and Background:
The Bay Area has had an organized vanpool program since 1981. The current program is managed by local, county, and regional partners including MTC's 511 program. The region's vanpool program helps people with long commutes that are not well-served by transit. Plan Bay Area enhances the appeal of vanpooling by dedicating $6 million to reduce the cost of van pool vehicle rentals and encouraging more people to participate in the vanpool program.

The 511 Regional Rideshare Program is operated by MTC and is funded by grants from the Federal Highway Administration, U.S. Department of Transportation, the MTC, the Air District, and county Congestion Management Agencies.

Barriers to ridesharing include:

- Difficulty for individuals in identifying others who both live and work proximate to them.
- Difficulty in setting up the logistics of a vanpool (such as establishing driver(s), shared payment for gas and other costs, identifying parking places).
- Additional travel time needed to pick up other carpoolers.
- Difficulty to change travel schedule due to emergencies.

The 511 Regional Rideshare Program provides a suite of services to facilitate carpooling and vanpooling online (511.org) and by telephone (511). These programs help remove some barriers to ridesharing identified above, and provide additional incentives for ridesharing. 511 is managed by a partnership of public agencies led by MTC, the California Highway Patrol, and the California Department of Transportation. 511 was developed with the mission to provide comprehensive, accurate, reliable and useful multimodal travel information to meet the needs of Bay Area travelers.

Additional 511 partners include:

- 511 Contra Costa
- Bishop Ranch Transportation Center
- City of Menlo Park, Transportation Department
- City of Pleasanton
- Contra Costa Centre Association
- Emeryville Transportation Management Association
- Hacienda Owners Association
- Moffett Park Business and Transportation Association
- Peninsula Traffic Congestion Relief Alliance
- San Francisco Department of Environment
- San Francisco Municipal Transportation Agency (SFMTA)
- San Jose State University
- Solano Napa Commuter Info
- Transportation Management Association of San Francisco

The Innovative Grants Program funds demonstration projects to test innovative strategies to promote changes in driving and travel behaviors. For Ridesharing Services and Incentives projects, the Innovative Grants Program includes the Dynamic Rideshare Programs, a pilot project which will coordinate the efforts of Contra Costa, Marin and Sonoma counties to offer a new form of carpooling, called "dynamic ridesharing."

Carpooling has declined precipitously since 1980 due to workers' increasingly variable work schedules, which are incompatible with the fixed plans required for traditional carpooling. Dynamic ridesharing – also called real-time ridesharing – addresses this problem using technology to match drivers and riders in real time right before their trips.

Dynamic, or real-time, ridesharing involves the use of information technology—namely a mobile app—to match drivers and riders in real time. This form of ridesharing does not require commuters to commit to a particular carpool with fixed routes and schedules; instead, it facilitates the matching of riders and drivers on an ad-hoc basis through a smartphone user platform offered by the vendor, Carma, which has developed a ridesharing app for use in a number of U.S. markets.

While the pilot project in Contra Costa, Marin and Sonoma counties share a software platform (custom-designed for the project by the vendor), the ridesharing effort has been managed somewhat differently in each county. The programs have used different outreach approaches; targeted different "affinity groups" (for example, employers/businesses or colleges and universities); contracted with different parties to provide support for program deployment and delivery; and, at times, offered different incentives to participants (to recruit participants, the programs have offered incentives to both drivers and riders and also have relied on payments from riders to drivers).

An evaluation of the Dynamic Rideshare Programs revealed that this measure, while still limited in its application, has a place in the transportation demand management (TDM) toolbox; unlike most TDM programs which rely on self-reported data, this type of program generates robust data that tracked use in detail.

In March 2016, MTC, through its 511 Rideshare program, began a partnership with Lyft to launch a new carpooling option for commuters. The partnership brings together Lyft's peer-to-peer ridesharing platform and MTC's established efforts to promote carpooling to make it easier for commuters to share rides.

Lyft's new carpooling service will allow commuters to offset the costs of driving on their regular commute routes. The partnership with Lyft represents MTC's first official partnership with a Transportation Network Company. MTC also has partnerships with the carpool-matching apps Carma (gocarma.com (link is external)) and Scoop (takescoop.com).

Car Sharing

Car sharing allows individuals to rent vehicles by the hour, thus giving them access to an automobile without the costs and responsibilities of individual ownership. Car sharing is growing rapidly in the Bay Area in traditional for profit/non-profit services (City CarShare, Zipcar, U Car Share, WeCar), new peer-to-peer car sharing (Getaround, RelayRides), and 1-way car share services (BMW DriveNow).

Traditional car sharing businesses operate on a membership basis. Users pay an annual or monthly fee in addition to hourly and/or per mile rates. Gas, maintenance, parking, insurance, and 24-hour access is all included in the membership and usage rates for car sharing. The pricing scheme encourages the use of the vehicles for short duration trips, such as running errands. For trips longer than one day, it is usually less expensive to rent a vehicle through a traditional car rental agency. Traditional car sharing works best for households in neighborhoods that are highly served by transit where vehicles are only infrequently needed, where parking is limited, and for households that share a primary car and have an occasional need for a second car. After joining a car sharing program, households in transit-dense neighborhoods can often shed all vehicles and just participate in car sharing. In less dense neighborhoods, car sharing may allow a two or three car family to shed one car and then use car sharing for the rare times that multiple vehicles are needed. Businesses are also signing up for business memberships to avoid maintaining a company fleet of vehicles.

Acknowledging the importance of car sharing on both the community and the environment, Plan Bay Area invests $13 million in car sharing over the course of the plan to achieve a 2.6 percent per capita reduction in greenhouse gas emissions. To support the car sharing goals identified in Plan Bay Area, in April 2014, MTC approved the Car Sharing Program - a $2 million grant program that helps expand car sharing services throughout the region. In July 2014, MTC released a call for projects for the Car Sharing Program to expand car sharing in the following areas:

- Suburban or urban communities that do not currently have robust car sharing service
- Underserved minority or low-income communities
- Business parks and transit connections
- Innovative/new technologies, i.e. point-to-point car sharing, electric vehicle (EV) fleets, etc.

In April 2015, MTC programmed the following car sharing projects into the 2015 Transportation Improvement Program (TIP) which allowed sponsors to obtain federal authorization (obligation) for their projects:

- Santa Rosa Car Share (Sonoma County Transportation Authority)
- CarShare4All (Contra Costa Transportation Authority)
- Car Sharing – A Catalyst for Change (City of San Mateo)
- Oakland Car Share and Outreach Program (City of Oakland)
- City of Hayward RFP for Car Sharing Services (City of Hayward)
- Car Share CANAL (Transportation Authority of Marin)

The Air District is also currently exploring options for expanding use of its TFCA funding to provide incentives for pilot projects that implement car sharing and other innovative last-mile solution trip reduction strategies. Beginning in FYE 2016, the Air District will increase the annual funding allocation for trip reduction programs by approximately $500,000 (to $4.5 million from $4 million).

Implementation Actions:
MTC will:

- Reduce cost of vanpooling through dedicated funding used to reduce cost of van rentals and to encourage more people to participate in vanpools ($6 million)
- Fund the Climate Initiatives Innovative Grants Ridesharing Services and Incentives project to support Dynamic Rideshare Programs, Contra Costa Transportation Authority, Sonoma County Transportation Authority, Transportation Authority of Marin ($2.4 million)
- Continue to provide 511 RideMatch services
- Continue to provide rideshare support services, including call center services, program marketing and materials
- Implement incentive programs sponsored by the congestion management agencies, county transportation authorities, cities and counties, and transit agencies.

The Air District will:

- Encourage employers to promote ridesharing to their employees through the Commuter Benefits Program.
- Provide incentive funding to pilot projects to determine feasibility of implementing cost-effective car sharing and other innovative last-mile solution trip reduction strategies.
- Encourage local governments to require ridesharing as a potential CEQA mitigation and/or explore the possibility of requiring new projects to include dedicated ridesharing parking spaces and car sharing services in-lieu of required parking spaces.

Supporting Actions by Partner Entities:

- Local government and Congestion Management Agencies to encourage ridesharing and create incentives to promote ridesharing and car sharing

Emission Reductions:

Pollutants*	2020	2030
ROG	0.81	0.34
NO_x	0.49	0.22
$PM_{2.5}$	0.09	0.07
PM_{10}	0.21	0.16
DPM	0.26	0.22
TACs	<0.01	<0.01
CO_{2e}	237	176

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
The Ridesharing and Last-Mile Connections measure emission reduction calculation was separated into three strategies:

- Dynamic Rideshare Demonstration Project
- Local Government EV Fleet Project
- eFleet: Car Sharing Electrified

Dynamic Rideshare Demonstration Project - Vehicle trips reduced were used to estimate starting-exhaust emissions (from cold starts) while VMT reduced was used to estimate running-exhaust emissions. Vehicle trips and VMT are translated into emissions using emission factors from EMFAC2011, the 2011 update of the computer model for estimating emissions from on-road vehicles in California. The factors used for the calculations are averages of the factors for light-duty autos operating in Contra Costa, Marin and Sonoma Counties, and weighted by each county's share of the number of shared rides (we assume that light-duty autos is the category that best represents the vehicles used).

Local Government EV Fleet Project - GHG emissions were quantified for the 90 vehicles purchased through the MTC grant program and were compared to the baseline control group vehicles to estimate emission reductions resulting from this project. The emissions were assessed on a lifecycle basis, which includes emissions related to processes upstream of the point of use in the vehicle, in addition to the direct emissions resulting from fuel combustion in the vehicle. Therefore, for electric vehicles, emissions from the generation and transmission of electricity were included in the analysis. For conventional gasoline and hybrid vehicles, this accounting included the production and delivery of the fuel and the combustion of the gasoline in the vehicle.

<u>eFleet: Car Sharing Electrified</u> - To compare project BEV and PHEV criteria pollutant emissions to baseline vehicle types, six months of activity data was analyzed from City CarShare (CCS) to determine the number of miles driven on all-electric mode and gasoline mode - for each vehicle model. For the miles driven in all-electric mode, there are no tailpipe emissions. For PHEVs, the CCS activity data does not distinguish between electric and gasoline powered VMT. Therefore, the vehicle models' estimated fuel economy was applied in all electric mode (kWh/mi) to the ChargePoint data for electricity consumption to determine the number of miles driven in all electric mode. The remaining mileage balance (total VMT minus electric VMT) then represents the gasoline-only VMT estimate.

Once the VMT was broken out by fuel type, criteria pollutant emissions factors were applied to the gasoline powered VMT to quantify the total amount of ROG, NOx, and PM emitted during the six-month data period. This quantity was then divided by the total VMT (both electric and gasoline) to determine the average amount of criteria pollutant emitted for each vehicle mile driven.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
See above implementation actions

Co-benefits:
- Reduced travel costs for employees through ridesharing and for Bay Area residents, businesses and visitors through car-sharing.
- Reduced costs in provision of employee parking, due to reduced single-occupancy driving.

Issues/Impediments:
Ridesharing
Many commuters need flexibility in their daily trips to conduct errands, or pick-up and drop-off children, and this can reduce the market for carpooling and vanpooling as traditional participation requires fixed schedules among participants. In addition, legal challenges such as Americans with Disabilities Act compliance, local regulations, insurance policies can also limit the growth of ridesharing as a travel option.

Car-Sharing
Car-sharing works best in dense urban areas; it may not be viable in all parts of the Bay Area.

Sources:

1. Metropolitan Transportation Commission, Program for Arterial System Synchronization (PASS), http://www.mtc.ca.gov/services/arterial_operations/pass.htm
2. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013
3. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy - Summary of Predicted Traveler Responses, July 2013, http://planbayarea.org/pdf/final_supplemental_reports/FINAL_PBA_Predicted_Traveler_Responses.pdf
4. Metropolitan Transportation Commission, Arterial Operations Program, http://www.mtc.ca.gov/services/arterial_operations/
5. Metropolitan Transportation Commission, Freeway Service Patrol, http://www.mtc.ca.gov/services/fsp/
6. Metropolitan Transportation Commission, Programming and Allocations Committee (December 2014 Meeting), http://apps.mtc.ca.gov/meeting_packet_documents/agenda_2327/3a_Car_Sharing_Program_Reso-4035.pdf
7. Metropolitan Transportation Commission (April 2015 Meeting), http://apps.mtc.ca.gov/meeting_packet_documents/agenda_2401/6_Reso-4175_TIP_Amendment-2015-09.pdf

TR9: Bicycle and Pedestrian Access and Facilities

Brief Summary:
The bicycle component of this measure will expand bicycle facilities serving employment sites, educational and cultural facilities, residential areas, shopping districts, and other activity centers. Typical improvements include bike lanes, routes, paths, and bicycle parking facilities. The bicycle component also includes a bike share pilot project that was developed to assess the feasibility of bicycle sharing as a first- and last-mile transit option.

The pedestrian component of this measure will improve pedestrian facilities and encourage walking by funding projects that improve pedestrian access to transit, employment sites, and major activity centers. Improvements may include sidewalks/paths, benches, reduced street width and intersection turning radii, crosswalks with activated signals, curb extensions/bulbs, buffers between sidewalks and traffic lanes, and street trees.

Purpose:
This measure will reduce motor vehicle emissions, including key ozone precursors ROG and NOx, particulate matter, air toxics, and greenhouse gases by sustaining and improving bicycle and pedestrian access and facilities, and encouraging walking and bicycling throughout the Bay Area.

Travel Market Affected:
This measure would affect all intraregional travel.

Regulatory Context and Background:
Bicycles are an inexpensive and widely available type of zero emissions vehicle. They promote health and in urban contexts, bicycles compete well with cars and transit in terms of door-to-door travel time. Bikes can be combined with public transit for longer trips and trans-Bay trips. Walking is the least expensive way of travelling and also provides benefits of improved health.

The average trip length for all personal trips in the Bay Area is just under 3 miles, a distance short enough for travelling by bicycle. Of the total personal weekday trips in 2010, 1 percent used bicycles and had an average travel distance of 2.4 miles. In 2010, 10 percent of total weekday personal trips were in exclusively the walk mode and 3.8 percent of total weekday personal trips were walk trips to transit.

Many barriers exist that prevent people from taking more bicycling and walking trips. In particular, parts of the Bay Area lack bicycle routes that include features such as lower speed limits, bicycle lanes, loop detectors that detect bicyclists waiting at red lights, and other complete street features. Low levels of pedestrian travel can be attributed to low population density, single-use land use patterns and development of streets, roads and land uses that lack adequate attention to the pedestrian environment.

Improved bicycle facilities can increase perceived and actual safety of travel by bicycle as well as its overall attractiveness, encourage mode shift for shorter trips, and encourage park-and-ride users to shift modes to bike-and-ride. Similarly, improved pedestrian facilities can increase perceived and actual safety of walking trips as well as the overall attractiveness of walking, encourage more mode shift for shorter trips, especially those less than a mile, and encourage park-and-ride users to shift modes to walk-and-ride.

Funding Sources

Transportation Fund for Clean Air (TFCA). From 2005 through 2015, TFCA has provided more than $31 million in funding to support the expansion of bicycle facilities. This investment has resulted in the installation of 176 miles of new bike paths and lanes, the creation of more than 14,000 new bicycle rack parking spaces and electronic locker parking spaces, and the Bay Area Bike Share Pilot Program. Funding for the TFCA program is provided by a $4 surcharge on motor vehicles registered within the Bay Area as authorized by the California State Legislature. To obtain TFCA funding, local jurisdictions must have the project identified in an adopted countywide bicycle plan, Congestion Management Plan (CMP), or within MTC's Regional Bicycle Plan. In addition, bicycle facilities must serve a major activity center (e.g. transit station, office building, or school) and be publicly accessible and available for use by all members of the public.

Since 2013, the Air District has administered an annual allocation of approximately $900,000 in TFCA Regional Fund monies for projects that expand access to bicycle parking and bikesharing. In 2013, the Air District launched the Bicycle Rack Voucher Program (BRVP) and the Electronic Locker Program to reduce motor vehicle emissions by cost-effectively expanding availability of new bicycle parking facilities in the nine-county Bay Area. The BRVP is a streamlined voucher-based program that provides local public agencies with access to discounted and no-cost bicycle rack equipment.

In 2013, the Bay Area Bike Share pilot project was launched as the nation's first regional bike sharing initiative. The pilot (funded in part by the Air District and MTC's Innovative Grants Program described below) was developed to assess how bicycle sharing could result in mode shifts that eliminate vehicle miles traveled (VMT) by single occupancy vehicles. One of the program's key goals is to offer a first- and last-mile transit option for public transit riders, with docking stations at train and ferry terminals and at locations 1-2 miles from public transit, enabling riders to bike to their destination without having to take a bicycle on the entire trip.

The Air District served as the lead administrator for the pilot project, which was conducted in partnership with MTC, the City and County of San Francisco, the San Mateo County Transit District, the City of Redwood City, the County of San Mateo, and the Santa Clara Valley Transportation Authority. In the summer of 2015, MTC took on the role of system administrator for Bay Area Bike Share. In upcoming years, the system is planned to expand the fleet to 7,000 bicycles.

Looking ahead, the Air District's TFCA Regional Fund will continue to be an eligible source of funding for bicycle facility improvement projects. Based on prior year funding awards for bicycle parking projects, it is anticipated that between 2015-2020 more that $7 million in TFCA Regional Funds will be available to help support the expansion of bicycle parking and bikeways.

OneBayArea Grant Program. The OneBayArea Grant Program is a new funding approach that better integrates the region's federal transportation program with the Sustainable Communities Strategy, or Plan Bay Area. OneBayArea grants provide funds for a wide range of bicycle and pedestrian improvements including bicycle facilities, bicycle education, outreach, sharing and parking, sidewalks, ramps, pathways and pedestrian bridges, user safety and supporting facilities, and traffic signal actuation.

OneBayArea also provides funds for Transportation for Livable Communities (TLC) projects to support community based transportation projects that bring new vibrancy to downtown areas, commercial cores, high density neighborhoods, and transit corridors, enhancing their amenities and ambiance and making them places where people want to live, work and visit. The TLC program supports Plan Bay Area by investing in improvements and facilities that promote alternative transportation modes rather than the single-occupant automobile.

Innovative Grants Program. MTC's Innovative Grants Program funds demonstration projects to test innovative strategies to promote changes in driving and travel behaviors. For Bicycle and Pedestrian Access and Facilities Improvements projects, the Innovative Grants Program includes the following strategies.

- Bay Area Bike Share Pilot Program - the nation's first regional bike sharing initiative included 700 bicycles and 70 kiosk stations in five cities: San Francisco, Redwood City, Palo Alto, Mountain View, and San Jose.
- Innovative Bicycle Detection Systems - The City of San Jose aims to reduce bicycle accidents by testing and adopting bicycle signal detection technologies and installing them on key corridors in the city's Primary Bikeway Network. It will test four types of technologies: video detection, radar, inductive loop and wireless magnetometer.
- Alameda County Bikemobile - The Bikemobile makes visits to schools and other sites, offering three specific services: Bike Safety Education, Bike Repair Education and Bike Riding Encouragement.

Transportation Development Act. The California Transportation Development Act (TDA) provides two major sources of funding for public transportation: the Local Transportation Fund and the State Transit Assistance fund. These funds are for the development and support of public transportation needs in California and are allocated to areas of each county based on population, taxable sales and transit performance. A share of the TDA goes to fund pedestrian and bicycle projects. To obtain TDA funding from MTC, local jurisdictions must have a Bicycle Advisory Committee to plan and prioritize funding for bike projects. TDA funds are assumed to grow at rates that take into account demographic and economic factors such as median income, regional employment and population growth.

Implementation Actions:
MTC will:

- Fund the Climate Initiatives Innovative Grants program for Bicycle and Pedestrian Access and Facilities Improvement projects ($500,000)
- Fund regional bike share program ($8.7 million)
- Fund bicycle and pedestrian improvement projects through State Transportation Development Act (TDA) and local sales tax funds ($4.6 billion)
- Fund complete streets projects, including stand-alone bicycle and pedestrian paths, bicycle lanes, pedestrian bulb-outs, lighting, new sidewalks, and Safe Routes to Transit and Safe Routes to Schools projects (see TR7) to improve bicycle and pedestrian safety and travel via the OneBayArea Grant program. ($14.6 billion One Bay Area Grant program total)

The Air District will:

- Continue to fund bike lanes, routes, paths, and bicycle parking facilities with TFCA funds through Bicycle Facilities Program ($7.2 million)
- Continue to encourage planning for bicycle and pedestrian facilities in local plans, e.g. general and specific plans

Emission Reductions:

Pollutants*	2020	2030
ROG	41	17
NO_x	32	14
$PM_{2.5}$	4	3
PM_{10}	10	8
DPM	14	11
TACs	0.01	<0.01
CO_{2e}	12,303	9,128

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
Emission reductions were estimated using data collected for bicycle and pedestrian projects in the Merced County Association of Governments (MCAG) planning area. In addition, emission benefits calculations are based on the applicable pollutants for the region, including the components of ozone (NOx and ROG) and particulate matter (PM). The emission reductions result from the decrease in emissions associated with auto trips replaced by bicycle trips for commute or other non-recreational purposes. Pedestrian facilities reduce emissions when auto trips are replaced by walking. ARB's emission model EMFAC 2014 was used to calculate emission reductions.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
Through 2020, $7.7 million; beyond 2020, over $4.6 billion

Co-benefits:
- Improved safety/reduced bicycle-motor vehicle accidents.
- Improved safety/reduced pedestrian-motor vehicle accidents
- Improved public health/reduced obesity.
- Reduced vehicle trips.
- Reduced travel costs.

Issues/Impediments:
Pedestrian travel and bicycle use is limited by factors such as physical ability, terrain, weather, and the need to carry cargo. Personal safety concerns may also prevent some people from switching modes to bicycle and pedestrian travel. Improving bicycle and pedestrian facilities and public education for pedestrians, bicyclists and drivers can increase perceived and actual safety.

Sources:
1. Metropolitan Transportation Commission, Association of Bay Area Governments, *Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy*, July 2013
2. Bay Area Air Quality Management District, Proposed TFCA Regional Fund Policies and Evaluation Criteria for FYE 2017

TR10: Land Use Strategies

Brief Summary:
Local land use decisions can directly and indirectly impact air quality and greenhouse gas emissions, as well as people's exposure to toxic air contaminants (TACs). This measure supports land use patterns that reduce vehicle miles traveled (VMT) and associated emissions and exposure to toxic air contaminants, especially within infill locations and impacted communities.

Purpose:
The purpose of this control measure is to reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by promoting land use patterns, policies, and infrastructure investments that support higher density mixed-use, residential and employment development near transit. This measures also includes actions to reduce exposure to toxic air contaminants.

Travel Market Affected:
This measure affects all intraregional travel.

Regulatory Context and Background:
Promote Land Use that Reduces Vehicle Miles Traveled
Land use and zoning are powerful tools local governments can use to reduce vehicle use and emissions. Transportation, and particularly passenger vehicle use, is responsible for the majority of air pollution in the Bay Area. Motor vehicles contribute significantly to ozone precursor emissions (23 percent of ROG and 43 percent of NOx), peak PM2.5 concentrations (20 percent) and nearly 40 percent of GHGs. Vehicle use also contributes to 31 percent of toxic air contaminant emissions.

A significant body of research has demonstrated the relationship between land use and travel behavior. People who live in areas with higher densities, a mix of residential, retail and office uses, with well-designed pedestrian, bicycle and transit infrastructure take more trips by transit, bicycle, and walking which results in reduced driving. The National Research Council concludes that "the most reliable studies estimate that doubling residential density across a metropolitan area might lower household VMT by 5 to 12 percent, and perhaps by as much as 25 percent, if coupled with higher employment concentrations, significant public transit improvements, mixed uses, and other supportive demand management measures."

Additionally, key findings from MTC's Station Area Residents Survey (STARS) Report include the following:

- People who live within ½ mile of a rail/ferry station are four times as likely to use transit as people living farther than ½ mile from a rail/ferry station.
- Individuals living and working within ½ mile of a rail/ferry station use transit for 42 percent of their commute trips, whereas those who neither live nor work within ½ mile of a station use transit for only 4 percent of their commute trips.
- Households within ½ mile of rail/ferry stations generate about half of the vehicle miles

traveled compared to their suburban and rural counterparts.

- People who live within ½ mile of rail/ferry station walk about 50 percent of the time for all short trips (less than one mile), whereas residents who live greater than ½ mile away walk for only about 25 percent of short trips.

The significant contribution automobile use makes to air pollution and GHGs and the compelling land use and travel behavior connection prompted the state to require that regional planning agencies consider how land use and transportation investments may be better coordinated to reduce vehicle emissions, specifically GHGs. Senate Bill 375, signed into law in September 2008, required the Air Resources Board (ARB) to adopt regional GHG reduction targets for emissions associated with automobiles and light trucks. Metropolitan planning organizations were then required to develop a Sustainable Communities Strategy (SCS) in their long-range transportation plans to reach the GHG reduction targets. The SCS must demonstrate how the land use development pattern and the transportation network can work together to reduce GHG emissions. In addition, SB 375 requires that regions house all of their projected population, by income level, thereby integrating the Regional Housing Needs Allocation (RHNA) into the long-term regional plan for transportation investments.

The Regional Housing Needs Allocation is a state-mandated program to identify the total number of housing units (by affordability level) that each jurisdiction must plan for to meet state housing goals. And since the adoption of SB 375, RHNA also plays a key role in meeting regional GHG targets. The California Department of Housing and Community Development (HCD) identifies the total housing need for the San Francisco Bay Area for an eight-year period (current cycle is 2014 to 2022). ABAG and MTC must then develop a methodology to distribute this need to local governments. The methodology takes into account projected job and population growth, access to transit and existing development. The method also needs to ensure that allocation is consistent with the long-term development pattern in the SCS. Once a local government has received its final housing allocation, it must develop an updated plan to accommodate its portion of the region's housing need (via the Housing Element of the General Plan). Both the SCS and RHNA are, therefore, powerful regional planning tools to ensure that land use and transportation work together to reduce GHG emissions from vehicle trips.

The Bay Area's first Sustainable Communities Strategy – known as Plan Bay Area - was developed and adopted by ABAG and MTC in 2013. The plan accomplishes its GHG reduction goals established by ARB (7 percent per capita reduction by 2020 and 15 percent per capita reduction by 2035) through a strategy to meet 80 percent of the region's future housing needs in Priority Development Areas (PDAs). PDAs are neighborhoods within walking distance of frequent transit service, that offer a wide variety of housing options, and amenities such as grocery stores, community centers, and restaurants. For the transportation component of the plan, Plan Bay Area specifies how $292 billion in anticipated federal, state and local funds will be spent through 2040.

Local governments play a fundamental role in implementing the land use component of Plan Bay Area, as they are responsible for land use, zoning and planning for affordable housing within their communities. Plan Bay Area assists jurisdictions in implementing the SCS through funding of land use planning and transportation investments in infill locations near transit, i.e. in PDAs. The One Bay Area Grant (OBAG) program is the funding mechanism for Plan Bay Area. OBAG programs include approximately $800 million for projects over a four-year period (through FY2016). Funds are distributed to local governments that plan for and build affordable housing, as allocated through the RHNA process. Funds also support local transportation projects within Priority Development Areas.

The Bay Area Transit-Oriented Affordable Housing (TOAH) fund provides additional financing for the development of affordable housing and other community services near transit throughout the Bay Area. Through the fund, developers can access flexible, affordable capital to purchase or improve available property near transit stations for the development of affordable housing, retail space and other residential services, such as child care centers, fresh food outlets and health clinics. The TOAH fund was made possible through a $10 million investment from MTC.

The Air District also offers incentive programs to support investments in infill locations and PDAs. Incentive programs are largely funded through the Air District's Transportation Fund for Clean Air (TFCA). In 1991, the California State Legislature authorized the Air District to impose a $4 surcharge on motor vehicles registered within the San Francisco Bay Area to fund projects that reduce on-road motor vehicle emissions. Sixty percent of TFCA funds are awarded directly by the Air District to eligible projects and programs implemented directly by the Air District; through a grant program known as the Regional Fund Program. The remaining forty percent is forwarded to each Bay Area county through the County Program Manager program (see www.baaqmd.gov/tfca4pm for details).

Both the Regional Fund and the County Program Manager program support infill development. The Regional Fund includes up to $13.6 million annually in incentives for a variety of trip reduction programs; a portion of these funds have been reserved for trip reduction pilot projects within PDAs. Projects must reduce single-occupancy commute-hour vehicle trips by encouraging mode-shift to other forms of shared transportation. The County Program Manager fund is nearly $10 million annually; it includes funding for a variety of pedestrian, transit, and other trip reduction programs, including programs that support "smart growth" or infill development.

Additionally, the Air District helps inform local land use plans by incorporating smart growth model policies and guidance within its California Environmental Quality Act (CEQA) Guidelines. CEQA was adopted in 1970 and is intended to inform policy-makers and the public about potential environmental effects of a project; identify ways to reduce adverse impacts; offer alternatives to a project; and enhance public participation in the planning process. The Air District's CEQA Guidelines were developed to assist lead agencies in analyzing and minimizing air quality impacts associated with proposed land use decisions and development projects. The most recent guidelines include numerous sample mitigation measures and model local plan policies to implement infill or smart growth principles to reduce vehicle trips.

Promote Infill Development to Preserve Open Space and Agricultural Lands
Promoting development within PDAs may take development pressure off of the region's open space and agricultural lands. Open space and agricultural lands play a vital role not only as landscapes that can sequester carbon, but also generate far fewer GHG emissions than urban or suburban uses. Urban and suburban uses encourage greater vehicle miles traveled and contribute to greater air quality impacts relative to open space and agricultural lands.

Plan Bay Area identifies Priority Conservation Areas (PCAs), which are open spaces that provide agricultural, natural resource, scenic, recreational, and/or ecological values and ecosystem functions. These areas are identified through consensus by local jurisdictions and park/open space districts as lands in need of protection due to pressure from urban development or other factors. Plan Bay Area includes a target to direct all non-agricultural development within the existing urban footprint, which represents existing urban development and urban growth boundaries.

Local Agency Formation Commissions (LAFCOs), regional planning agencies responsible for approving boundary changes of cities and special districts, can also play a role in agricultural preservation by guiding development toward PDAs and away from open space and agricultural lands (See AG1: Agricultural Guidance and Leadership and NW1: Carbon Sequestration in Rangelands for more information).

Reduce Population Exposure to Toxic Air Contaminants
Communities are exposed to TACs as a result of emissions from numerous stationary and mobile sources of air pollution. Communities near large industrial sources, distribution centers, major freeways and seaports experience relatively higher pollution levels and corresponding health effects, compared to other parts of the region. To reduce exposure to local air pollution, the Air District regulates a variety of stationary sources through the New Source Review for Toxics permitting process for new and modified sources of toxic air contaminants. Stationary sources are also regulated by the Air District via source-specific regulations. The Air District also limits TACs through the administration of the Air Toxics "Hot Spots" Program. (See SS20: Air Toxics Risk Reduction from Existing Facilities and SS21: New Source Review for Toxics)

The Air District's CARE program, *Planning Healthy Places*, CEQA Guidelines and CEQA review process also address local exposure to toxic air contaminants, from both vehicle and non-vehicle sources. The Air District initiated the Community Air Risk Evaluation (CARE) program in 2004 to evaluate and reduce health risks associated with local exposures to air toxics in the Bay Area. The program examines air toxics emissions from stationary sources, area sources and on-road and off-road mobile sources with an emphasis on reducing population exposure to diesel exhaust. CARE combines technical analysis, outreach to impacted communities, and policy mechanisms to reduce emissions and health risks in those communities.

The Air District provides technical assistance and guidance to local governments specifically to address local air pollution exposure when planning for infill development through a guidance document, *Planning Healthy Places*. Infill locations are often near freeways, distribution centers, or large industrial sources. *Planning Healthy Places* promotes "healthy infill development", by encouraging local governments and developers to address and minimize potential local air pollution issues early in the land-use planning and development process. As part of this effort, the Air District provides information, recommendations, and technical tools to assist cities in incorporating air quality considerations into their planning processes.

Tools and assistance in *Planning Healthy Places* include:

- Web-based, interactive mapping tools to locate areas in the region that are estimated to have elevated levels of fine particulates and/or toxic air contaminants.
- Best practices that may be implemented by local governments and developers to reduce health risks from air pollution in areas that experience elevated levels of air pollutants.

As stated above, the Air District's CEQA Guidelines were developed to assist lead agencies in analyzing and minimizing air quality impacts associated with land use development projects. In regards to local air pollution exposure, the Guidelines identify strategies on how local governments or project sponsors may avoid and mitigate population exposure to toxic air contaminants and criteria pollutants.

Implementation Actions:
The Air District will:

- Assist local governments with the implementation of Plan Bay Area:
  - Maintain land use plan guidance and best practices resources for local governments.
  - Continue to provide, and increase as appropriate, emission reduction incentive funding opportunities and vehicle trip reduction program funds (TFCA funds) for local government's with impacted communities and/or Priority Development Areas.
  - Assist local governments in securing incentive/grant funding for affordable housing projects or land use planning grants in transit rich areas, i.e. Priority Development Areas.
  - Work with local governments, regional agencies, and LAFCOs to discourage conversion of agricultural and natural lands, identified as PCAs in Plan Bay Area.
- Participate in the development of the land use scenario in the Sustainable Communities Strategy for 2040 Plan Bay Area to emphasize reduction of vehicle miles traveled and achievement of GHG emission reduction targets.
- Assist local governments with health protective infill development by:
  - Assisting local governments in accessing and utilizing on line maps via *Planning Healthy Places*.
  - Improving datasets for local-scale air pollution assessments, especially for permitted sources.
  - Assisting with the development of local plans to reduce exposure to air pollution.
  - Developing improved datasets on community health in impacted communities.
- Continue to assess health impacts to sensitive receptors living near highways and other emission sources.
- Continue to focus enforcement action on emission sources in impacted communities and look for opportunities to partner with local jurisdictions.
- Continue to provide land use planning guidance and best practices to local governments.

- Update the CEQA Guidelines to reflect new data and current policy approaches.
- Conduct outreach to local jurisdictions, consultants, developers, and community members on revised CEQA Guidelines and provide technical assistance to lead agencies.
- Continue CEQA commenting by the Air District:
  - Review CEQA documents prepared for projects that could impact the Bay Area and recommend mitigation measures as appropriate.
  - Continue to provide on the Air District's CEQA website a listing of all CEQA comment letters.

MTC will:
- Fund the One Bay Area Grant Program Regional PDA Planning Program including: $10 million to the Transit Oriented Affordable Housing (TOAH) fund; $8 million to Regional PDA Planning and Technical Assistance; and $2 million to ABAG for its research and planning activities. ($20 million)
- Monitor and manage all awarded project contracts associated with the Regional PDA Planning, PDA Technical Assistance, and PDA Staffing Assistance grants.
- Continue to fund the TOAH revolving loan fund for affordable housing projects near transit in PDAs throughout the region. ($50 million)

Emission Reductions:

Pollutants*	2020	2030
ROG	103	43
NO_x	62	27
$PM_{2.5}$	11	8
PM_{10}	26	20
DPM	33	27
CO_{2e}	30,024	22,275

**criteria pollutants and diesel PM are reported in lbs/day; all toxics, except diesel PM are in grams/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
The methodology for estimating emission reductions for this measure utilizes the concept of transportation efficiency by concentrating dense, mixed-use, and pedestrian-friendly urban "nodes" around public transportation. The overall approach for estimating infill vehicle-trip generation is based on adjusting baseline Institute of Transportation Engineers (ITE) vehicle-trip data[1].

The methodology has three steps:
1. Baseline ITE trip generation data are used to estimate the vehicular trip generation of the proposed infill development.

[1] See: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_758.pdf
NCHRP Report 758; Trip Generation Rates for Transportation Impact Analyses of Infill Developments

   a. Baseline/Suburban development assumed single family (9.57 trips per dwelling unit) residential trip rates and retail/shopping center (42.94 trips per dwelling unit) commercial trip rates
2. Infill vehicle trips ITE trip generation data are used in the evaluation of site traffic impacts.
   a. Infill development assumed multifamily (6.65 trips per dwelling unit) residential trip rates and general office building (11.01 trips per dwelling unit) commercial trip rates
3. Emission reductions result from the decrease in emissions associated with auto trips reduced by infill development compared to baseline/suburban development.

CO2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants and mobile source air toxics.

Exposure Reduction:
As stated above, the Air District's CARE program, Planning Healthy Places, CEQA Guidelines and CEQA review process address local exposure to toxic air contaminants, from both vehicle and non-vehicle sources. The CARE program, specifically, evaluates health risks associated with local exposures to air toxics in the Bay Area. The program examines air toxics emissions from stationary sources, area sources and on-road and off-road mobile sources with an emphasis on reducing population exposure to diesel exhaust.

Emission Reduction Trade-offs:
None identified.

Cost:
Costs for MTC programs are listed above.

For Air District programs, specific costs are unknown. The Air District will provide technical support to cities and counties to reduce demands on local resources.

Co-benefits:
- Reduced travel costs.
- Community enhancements through revitalized downtowns, transit centers, and other major activity nodes.
- Closer integration of transportation and land use.
- Increased access to jobs, services, and stores.
- Improved public health by reduced driving and increased walking and biking.
- Enhanced collaboration with local governments, resulting in more wide spread and effective implementation of Air District programs.

Issues/Impediments:

Land use changes and new development occur slowly and are directly regulated by local jurisdictions, not regional agencies. In addition, higher density development can raise neighborhood concern over impacts on traffic, parking, localized air pollution, and other issues.

Sources:

1. State of California, Office of Planning and Research, *CEQA Guidelines and Greenhouse Gases*, http://opr.ca.gov/index.php?a=ceqa/index.html
2. California Air Pollution Control Officers (CAPCOA) CEQA and Climate Change White Paper, http://www.capcoa.org/CEQA/CAPCOA%20White%20Paper.pdf
3. Metropolitan Transportation Commission, Association of Bay Area Governments, Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy, July 2013
4. California Air Pollution Control, *CAPCOA Model Policies for Greenhouse Gases in General Plans,* May 2009, http://www.capcoa.org/modelpolicies/CAPCOA%20Model%20Policies%20for%20Greenhouse%20Gases%20in%20General%20Plans%20-%20June%202009.pdf
5. California Air Resources Board, Air Quality and Land Use Handbook: A Community Health Perspective, April 2005, http://www.arb.ca.gov/ch/handbook.pdf
6. Metropolitan Transportation Commission, Characteristics of Rail and Ferry Station Area Residents in the San Francisco Bay Area: Evidence from the 2000 Bay Area Travel Survey, September 2006, http://www.mtc.ca.gov/planning/smart_growth/stars/
7. Cervero, Robert; Kickelman, Kara; National Research Council, *Travel Demand and the 3Ds: Density, Diversity, and Design*, September 1997

TR11: Value Pricing Strategies

Brief Summary:
This measure will pursue implementation of value pricing strategies such as tolling on trans-bay bridges and cordon pricing on roads, as well as auto pricing options, such as a VMT fee and pay-at-the-pump auto insurance.

Purpose:
The purpose of this measure is to reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by managing travel demand during congested conditions on Bay Area bridges, in San Francisco, and on other heavily congested freeways and roadways around the Bay Area.

Travel Market Affected:
The Value Pricing Strategies measure would affect intraregional travel, including commute travel, shopping, personal business, school trips, as well as social and recreational travel.

Regulatory Context and Background:
Congestion pricing involves charging drivers a fee to drive in congested areas. Revenue generated from fees are then used to fund transportation improvements — such as better transit service, signal coordination, and bicycle and pedestrian projects — that improve travel options and traffic flow. Congestion pricing is being advanced in San Francisco through a demonstration project as a part of the Treasure Island development project, and through ongoing planning for congestion pricing in downtown San Francisco.

In June 2011, the City of San Francisco approved development plans for Treasure Island, including 8,000 residential units, along with retail and commercial uses. The Treasure Island Transportation Implementation Plan, adopted as part of the development project's approval, calls for an integrated approach to managing traffic and improving mobility management, including a congestion fee to be assessed for residents traveling by private automobile on or off the island during peak hours. The congestion fee, in combination with parking charges and a pre-paid transit voucher for each household, will help fund a comprehensive suite of transportation services including new ferry service to San Francisco and enhanced East Bay bus services.

During rush hours, congestion in the greater downtown San Francisco area results in average bus transit and automobile speeds below 10 miles per hour. A study prepared by San Francisco County Transportation Authority found congestion pricing in downtown San Francisco to be a feasible and potentially effective way to manage and grow the transportation system while supporting new businesses and residents. San Francisco's mobility and pricing program could result in:

- 12 percent fewer peak-period vehicle trips and a 21 percent reduction in vehicle hours of delay
- 5 percent reduction in greenhouse gases citywide

- $60–80 million in annual net revenue for mobility improvements
- 20–25 percent transit speed improvement and 12 percent reduction in pedestrian incidents

In addition to congestion pricing in San Francisco, other pricing strategies could be considered region-wide to reduce VMT and congestion. Pricing strategies increase the marginal cost per mile driven, providing a greater incentive to reduce travel; resulting in fewer trips, shorter trips, greater use of alternative modes, and travel shifts to periods of lower congestion. The specific impacts depend on the alternatives available to travelers (i.e., mode, destination) and price sensitivity, which varies by income, personal and household characteristics, and specific aspects of the trip.

Pricing can take a number of forms, including:

- VMT fees (charging drivers per mile of travel)
- Increases in the existing gasoline tax or new fuel or carbon taxes that price travel according to fuel consumed or carbon emitted (providing an incentive to purchase more efficient vehicles as well as to reduce travel)
- Facility-specific tolls
- Congestion pricing (pricing roadway facilities when they are congested to reduce traffic on those facilities to an improved level of service)
- Cordon/area pricing (applying a fee for vehicles to enter or operate within a selected area, such as a central business district)
- Pay-As-You-Drive (PAYD) insurance (converting a significant portion of the essentially fixed cost of insurance to a marginal cost based on mileage).

VMT fees target reductions in vehicle miles of travel. Unlike road pricing measures where costs can be reduced by switching travel times, use of routes, or type of vehicle used, the only way for an individual to reduce costs under VMT fees is to drive less, thus reducing traffic and emissions. VMT fees do not, however, discourage peak-period driving (since every mile costs the same regardless of when it is driven) or encourage a shift to cleaner burning engines. They are not facility- or time-specific fees so they do not affect the entire vehicle fleet.

Past pricing studies have suggested that with higher travel costs region-wide, people and households tend to move to locations where accessibility to job opportunities is plentiful, so as to offset the impacts from an increase in travel costs. Correspondingly, employers will relocate to key locations to better align themselves with the newly emerging concentration of workers and households.

To assist in the implementation of the Sustainable Communities and Climate Protection Act of 2008 (SB 375), MTC is considering acquiring a federal Value Pricing Pilot Program grant from the Federal Highway Administration to examine road and auto pricing options, such as a VMT fee and pay-at-the-pump auto insurance.

Additionally, as mentioned in TR14: Cars and Light Trucks, MTC is considering proposing to use a feebate program to incentivize consumers to scrap older vehicles and purchase higher performing, cleaner vehicles. A feebate program uses a combination of fees and rebates to change consumer behavior. Consumers purchasing a vehicle that emits more CO_2 on a gram per mile basis than a defined standard are assessed a fee at the point of purchase. These fees are used to provide rebates to consumers that purchase vehicles that emit less CO_2 on a gram per mile basis than the defined standard.

Implementation Actions:

MTC will:

- Implement congestion pricing projects in San Francisco, as identified in Plan Bay Area ($150 million)
- Study ways to use pricing more effectively in funding of transportation by seeking a federal Value Pricing Pilot Program grant from the Federal Highway Administration to examine road and auto pricing options, such as a VMT fee.
- Explore options for developing a feebate program, as a funding mechanism for electric vehicle purchase incentives.

The Air District will:

- Support MTC in its grant application for a federal Value Pricing Pilot Program grant.
- Advocate for value pricing strategies that demonstrate their cost effectiveness in reducing vehicle emissions.

Emission Reductions:

Pollutants*	2020	2030
ROG	1,268	534
NO_x	762	335
$PM_{2.5}$	135	102
PM_{10}	322	243
DPM	409	336
TACs	0.17	0.13
CO_{2e}	370,601	274,947

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:

MTC's regional travel demand model (Version 0.3 of Travel Model One) was used to estimate the VMT impacts of this measure. The travel model assumes travel choices are determined by the perceived cost of operating an automobile, relative to the perceived cost of taking transit, paying a bridge toll, paying for parking, etc. As a simplification, the model assumes a uniform (across all travelers, across all travel conditions) perceived automobile operating cost. VMT fee could be implemented in a variety of ways and the method of implementation could impact the behavioral response, i.e. response to cost of automobile travel. For example, the VMT fee could be charged "at the pump", with the car communicating with the gasoline pump to determine the fee. Or, the fee could be collected annually/monthly/weekly as part of a vehicle registration process. The travel model assumes, implicitly, that paying the fee is similar to paying for gasoline and routine vehicle maintenance.

The California Air Resources Board emission model (EMFAC 2014) was used to calculate pollutant impacts. CO_2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants.

Exposure Reduction:
Reducing high speed driving should help to reduce emissions of ROG, NOx, PM, and CO_2 and therefore exposure to air pollution throughout the Bay Area. Impacted communities near freeways and roads with significant auto and truck traffic will benefit.

Emission Reduction Trade-offs:
None identified.

Cost:
$150 million for implementation of congestion pricing projects in San Francisco, as identified in Plan Bay Area

Co-benefits:
- Generation of new funds for multi-modal transportation improvements
- Travel time savings
- Reduce congestion
- Community enhancements through the creation of more and higher quality transit options
- Shift demand from the peak travel period, thereby making non-peak public transit more sustainable and financially viable
- Give residents an incentive to live at higher densities in more central locations

Issues/Impediments:
Congestion pricing raises several equity issues, including income equity, geographic equity and modal equity. With income equity, low-income groups could be negatively affected by pricing strategies, as fees or other pricing strategies could place the burden of travel-behavior change disproportionally on low-income individuals. In geographic equity, some parts of the region could be made worse off than others, as traffic diversion from tolled routes could negatively impact neighborhoods or reduce performance on alternative toll-free route. Finally, with modal equity, public perceptions with regard to encouragement of multi-modal transportation can be an issue, as some individuals believe that it is not fair to offer the same travel-time savings to those who pay a toll as to those who “do the right thing” by carpooling or taking transit.

Sources:
1. Metropolitan Transportation Commission, Association of Bay Area Governments, *Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy*, July 2013

2. San Francisco Transportation Authority, San Francisco Mobility, Access & Pricing Study, 2010
3. Rodier, Caroline J., University of California, Davis, A Review of the International Modeling Literature: Transit, Land Use, and Auto Pricing Strategies to Reduce Vehicle Miles Traveled and Greenhouse Gas Emissions, October 2009, http://eprints.cdlib.org/uc/item/2jh2m3ps
4. De Corla-Souza, Office of Innovative Program Delivery, Federal Highway Administration, U.S. Department of Transportation, Income-Based Equity Impacts of Congestion Pricing, December 2008, http://ops.fhwa.dot.gov/publications/fhwahop08040/fhwahop08040.pdf

TR12: Smart Driving

Brief Summary:
Smart Driving is a set of strategies and techniques that maximize fuel efficiency and reduce emissions by improving driving habits and vehicle maintenance. This measure would implement a smart driving pilot program that includes installing temporary in-vehicle devices that display vehicles gas mileage in real time, a social marketing campaign, vehicle maintenance tips, trip planning tools through 511.org and other public information/education initiatives.

Purpose:
The purpose of this measure is to reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gas emissions by educating drivers and improving vehicle maintenance.

Travel Market Affected:
This measure would affect intraregional travel, including commute travel, shopping, personal business, school trips, as well as social and recreational travel. This measure would primarily address freeway travel.

Regulatory Context and Background:
MTC has conducted an analysis on emissions created by vehicles traveling over 65 mph on freeways. The analysis demonstrated that by limiting passenger car travel to 65 mph, there is a potential to reduce VOC by 2,000 to 5,600 pounds per day and NOx by 1,800 to 3,800 pounds per day, if applied throughout the Bay Area. Approximately 60 percent of Bay Area driving (VMT) takes place on the freeway system and, based on Caltrans speed monitoring data, 34 percent of freeway driving occurs at speeds over 65 mph. Therefore, by addressing over-the-limit freeway driving, this measure could achieve significant emission reductions. A vehicle driven at 75 mph consumes approximately 40 percent more fuel and emits 35 percent more emissions than one driven at 60 mph.

There are a variety of techniques known as “smart driving”, “green driving”, or “eco-driving” that increase the fuel efficiency of auto travel, thereby reducing emissions and saving money; these include:

- Avoiding quick starts and aggressive driving
- Reducing highway speeds (55 mph is the most efficient speed for fuel consumption)
- Using overdrive and cruise control
- Avoiding driving in rush hour
- Using air conditioning sparingly
- Reducing idling
- Reducing drag by removing roof racks, tow-hook carriers, and other items that cause wind resistance
- Removing heavy unneeded items from cars
- Properly maintaining vehicles including optimal tire pressure

Smart driving also entails driver decisions such as vehicle selection and maintenance, route selection, vehicle load, and driver behavior, including vehicle speed.

The Metropolitan Washington Council of Governments (MWCOG) in Washington, D.C. completed an analysis of what it would take to meet their GHG goals. They found that the most cost effective and productive strategy that could be implemented at the regional or local level to reduce vehicle emissions was through smart driving strategies. For this reason, MWCOG joined in partnership with the Delaware, Maryland, New York, North Carolina, New Jersey, and Massachusetts Departments of Transportation, along with several other MPOs and Port Authorities to launch the I-95 eco-driving campaign, a public information campaign on the benefits of smart driving.

The largest smart driving study undertaken to date was by Fiat in 2010. The study analyzed the effects of their eco:Drive software with 5,700 drivers, over 428,000 journeys, 150 days and five countries. Over the course of the study, the average improvement in fuel economy was six percent. The top ten percent of participants improved their fuel efficiency by 16 percent. Based on the positive results of this study, Fiat has continued to expand their eco:Drive software to include in-vehicle displays and real time mobile apps. These improvements are mirrored in the technology that MTC is testing in their smart driving pilots (see below for more information). It is expected that with real-time feedback on driving habits, improvements in fuel efficiency could exceed the six percent seen in the initial study.

While there have been recent studies in the United States on smart driving, they have all been conducted with small sample sizes of twenty participants or less. In order to learn more about the potential of smart driving in the Bay Area, MTC is implementing the following smart driving pilots:

- In-vehicle devices, displaying real time miles per gallon (MPG) and/or feedback on efficient acceleration, deceleration, and maintaining a steady speed. These devices are mounted on the dashboard of the participants' vehicles; and
- MPG mobile apps, similar to the in-vehicle device pilot, but in a telephone application format. This pilot will be conducted in conjunction with ITS-UC Davis.

The in-vehicle display is connected to the vehicle's on-board diagnostic (OBD) port. The port receives information from the vehicles computer system in real-time to inform the display. The smart phone application calculates the driver's behavior based on the phone's GPS system. In both pilots, baseline driving habits over the course of at least one month will be collected. The devices will be in the participants' vehicles for a minimum of three months to see how quickly the smart driving habits are learned and if the behaviors persist over time.

Implementation Actions:
MTC will:
- Implement a smart driving social marketing campaign that will aim to teach drivers the basics of smart driving in-vehicle and maintenance behaviors in addition to trip linking and route planning. ($56 million)
- Offer several trip planning tools through 511.org. 511 provides real time and predicted future traffic information page which allows drivers to plan their trips to avoid congested routes.
- Implement a smart driving rebate program, linked to fuel efficiency meters. Under this program MTC will offer a $100 rebate to consumers who purchase an OBD-connected after-market device. This device would be very similar to the in-vehicle devices being tested through MTC's two pilots. The real time information on efficient driver behavior will quickly train drivers to alter their behavior in order to save money and gas, and reduce emissions. ($105 million)

The Air District will:
- Promote/implement a voluntary certification program with fleet operators that could be used as a marketing tool, utilizing Sustainable Earth Initiative's Green Fleets Toolkit
- Consider expanding Spare the Air Day messaging to include how complying with speed limits and other smart driving techniques can reduce smog forming pollution on Spare the Air Days, and reduce GHG's every day.

Emission Reductions:

Pollutants*	2020	2030
ROG	1,962	825
NO_x	1,178	518
$PM_{2.5}$	209	158
PM_{10}	497	376
DPM	633	519
TACs	0.20	0.02
CO_{2e}	573,189	425,247

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
Different equations were used to calculate the various component of this control measure. Equations were developed specifically for the social marking elements. These equations incorporated driving behavior, such as acceleration and deceleration, maintenance, route planning and trip linking. The equations were used to calculate how driving behaviors impact VMT and therefore emission reductions. Emission reduction estimates were estimated via EMFAC 2014 trip end and exhaust emission rates. CO2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants and mobile source air toxics (MSATs). Emission reductions estimated for criteria pollutants and toxics are nominal.

Exposure Reduction:
Reducing high speed driving should help to reduce emissions of ROG, NOx, PM, and CO_2 and therefore exposure to air pollution throughout the Bay Area.

Emission Reduction Trade-offs:
None identified.

Cost:
$161 million

Co-benefits:
- Reduced/less frequent servicing, maintenance and repair costs that result from reduced wear and tear of various vehicle components (i.e. tires, clutch, and engine).
- Economic savings from reduced costs associated with automobile crashes.
- Economic benefits from fuel savings to individual drivers and to the Bay Area economy as whole. For vehicles employing smart driving techniques, a range from 4.5 to 16.5 percent reductions in fuel consumption could be achieved.

Issues/Impediments:
Implementation of this control measure is dependent on available funding, collaboration between multiple agencies and the public's recognition of the consequences of high-speed driving and the positive effects of smart driving habits, e.g. maximizing fuel efficiency, fewer accidents.

Sources:
1. Metropolitan Transportation Commission, Association of Bay Area Governments, *Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy*, July 2013
2. Fiat, 2009. Eco-Driving Uncovered: The benefits and challenges of eco-driving based on the first study using real journey data.
3. Kurani, K., Stillwater, T., and Jones, M., 2013. Ecodrive I-80: A Large Sample Fuel Economy Feedback Field Test: Final Report. Institute of Transportation Studies Report: ITS-RR-13-15. Available at http://www.fueleconomy.gov/feg/pdfs/EcoDrive%20I-80.pdf

TR13: Parking Policies

Brief Summary:
Parking policies and practices have a profound impact on vehicle travel and mode choice, as well as land use patterns and the quality of the built environment. Parking policies are also an important tool in implementing focused growth strategies. This control measure outlines how MTC and the Air District, in cooperation with regional agency partners, will 1) take actions at the regional level to implement parking policies that will benefit air quality, and 2) encourage and support local agency parking policies to reduce motor vehicle travel and promote focused growth.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gases by implementing parking policies that support in-fill and transit-oriented development and reduce vehicles miles traveled.

Travel Market Affected:
This measure would affect intraregional travel, including commute travel, shopping, personal business, school trips, as well as social and recreational travel.

Regulatory Context and Background:
Local governments have traditionally implemented parking policies that provide plentiful parking. Although "free" parking is often provided, there are both direct and indirect costs associated with all parking. Parking policies and zoning codes that promote an oversupply of parking contribute to reliance on the automobile and undermine infill and transit-oriented development.

Promoting parking policy reform will require political leadership in combination with technical assistance, resources, and incentives and disincentives. Parking policy reform and strategies could come in various forms, including:

- Eliminate or reduce minimum parking requirements;
- Limit the supply of off-street parking in transit-oriented areas;
- Encourage developers and property owners to unbundle the price of parking spaces from rents and purchase prices;
- Promote shared parking by different users;
- Implement market-rate pricing for off-street parking in high-use areas;
- Implement parking assessment districts that use revenue from street parking to fund pedestrian and streetscape improvements;
- Adopt design guidelines and policies to minimize surface area for parking;
- Implement car sharing and bike sharing programs in appropriate locations in exchange for reduced parking requirements, and provide as a benefit to renters;
- Encourage a coordinated parking policy approach among jurisdictions to minimize spillover to other jurisdictions and fears of unfair competition.

Cities and counties have direct authority over parking policies. However, regional agencies can assist local governments by providing technical resources, recommending best practices, and leading by example in adopting internal and external policies. MTC has provided such assistance through the following:

- "Parking Advanced Implementation Labs" offers professional assistance to local governments in adopting and implementing a specific parking strategy.
- Training: MTC provided training for local governments on the MTC publication *Reforming Parking Policies to Support Smart Growth*.
- Technical Assistance: MTC surveyed local jurisdictions' parking policies, interests and challenges, provided technical assistance for five specific locations, prepared an economic assessment of parking structures at transit stations, and conducted parking fundamentals workshops for local jurisdictions and other interested parties.
- Parking Workshops: In 2012-2013 MTC focused on technical analyses and communications methods, culminating in a series of parking workshops aimed at planning and transportation professionals. This effort included quick engaging videos summarizing key parking policy issues, best practices workshops, and additional technical reports.
- Transit Oriented Development - Technical Assistance Program (TOD-TAP): funds for planning efforts that include parking policy analysis in numerous communities. MTC developed guidance for the parking policy analysis section of the station area plans, and staff comments on the parking elements in the draft plans.
- Value Pricing Pilot Program for the Parking Pricing Regional Analysis Project: MTC was awarded a competitive grant from the Federal Highway Administration (FHWA) to establish a regional parking database, analyze a number of regional parking pricing policy options, and create and demonstrate local parking analysis tools. This specific effort was completed in 2015; however, this project has created a foundation for additional future development of the parking database, regional policy analyses and local strategies.
- *Parking Technology Roundtable.* In December 2014 MTC sponsored a round table discussion to share information, experiences and questions on how to best evaluate and implement parking technologies in support of local smart growth policies.
- MTC's Innovative Grants Program funds demonstration projects to test innovative strategies to promote changes in driving and travel behaviors.

Implementation Actions:
MTC will:

- Continue to provide technical assistance to local jurisdictions through the Transit Oriented Development Technical Assistance Program (TOD TAP) and offering best practices workshops.
- Consider parking projects as part of future Climate Program grant opportunities, such as the Transportation Demand Management program.
- Incorporate parking issues into the broader public outreach program for climate action.
- Continue support for State and Federal bills to reduce subsidies for parking.

- Conduct the VPP Parking Pricing Regional Analysis Project, which will create a foundation for additional future development of the parking database, regional policy analyses and local strategies.
- Fund the Climate Initiatives Innovative Grants Parking Policy project, including: goBerkeley, City of BerkeleyGrant ($2 million)

The Air District will:
- Highlight parking best practices, mitigation strategies, and/or guidance documents on the Air District's web site.
- Consider funding parking technology projects, including: real-time parking information, pay-by-phone parking, and parking hotlines.
- Encourage parking cash-out programs to employers and local governments.
- Encourage local agencies to adopt innovative parking strategies, including:
    - Eliminate or reduce minimum parking requirements;
    - Limit the supply of off-street parking in transit-oriented areas;
    - Encourage developers and property owners to unbundle the price of parking spaces from rents and purchase prices;
    - Promote shared parking by different users;
    - Implement market-rate pricing for off-street parking in high-use areas;
    - Implement parking assessment districts that use revenue from street parking to fund pedestrian and streetscape improvements;
    - Adopt design guidelines and policies to minimize surface area for parking;
    - Implement car sharing and bike sharing programs in appropriate locations in exchange for reduced parking requirements, and provide as a benefit to renters;
    - Encourage a coordinated parking policy approach among jurisdictions to minimize spillover to other jurisdictions and fears of unfair competition.
- Continue to provide comments, in regard to parking policies, on CEQA analysis of local plans and other projects to lead agencies.

Emission Reductions:

Pollutants*	2020	2030
ROG	1.41	0.59
NO_x	0.85	0.37
$PM_{2.5}$	0.15	0.11
PM_{10}	0.36	0.27
DPM	0.45	0.37
TACs	<0.01	<0.01
CO_{2e}	412	306

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
According to the City of Berkeley, average daily traffic on the streets in the three pilot areas is 105,500. Commonly used figures are that 30% of traffic consists of drivers looking for a parking space and that the average cruising distance to find a curb space is 0.5 miles (this is based in part on research by UCLA Professor Donald Shoup). This translates to 15,825 daily VMT from "search driving" in the pilot areas. Also according to the City, the number of blocks in high parking demand areas that have on-street parking occupancy greater than 85 percent has decreased by 12 percent. This increase in parking availability is assumed to yield a corresponding 12 percent decrease in search driving. This results in a reduction of 1,899 VMT daily, or 693,135 VMT annually.

It is assumed that under demand-responsive parking management, it is easier to find parking but that the same number of trips continues to be made—in other words, there is no reduction in vehicle trips.

The above figures for reduced vehicle trips and VMT are translated into reduced GHG emissions using starting- and running-exhaust emission factors from EMFAC2011, the 2011 version of the computer model for estimating emissions from on-road vehicles in California. EMFAC 2011 emission factors were updated to reflect the current version of the EMFAC model, EMFAC2014 and the emission factors applied were for light-duty autos operating in Alameda County. Starting-exhaust emission factors are applied to the reduced trips while running-exhaust factors are applied to the reduced VMT. Emissions are given in metric tons of carbon dioxide-equivalent (CO2e), a measure of the aggregate global-warming potential of various air pollutants. CO2 conversion/equivalency factors were used to estimate the emission reduction benefits for the criteria pollutants and mobile source air toxics (MSATs).

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
Approximately $2.6 million for grants.

Co-benefits:
- Improved housing affordability.
- Conservation of energy.
- Improved water quality / reduced storm water run-off.
- Promotion of more efficient use of land.
- Increased transit ridership, walking, and cycling.
- Enhanced community design and quality of life.
- Cost savings to those providing parking cash-out program.

- Reduced vehicle cruising and associated congestion and emissions.
- Reduced health risks from vehicle emissions and enhanced walkability.
- Potential to use any revenue generated by parking fees to fund improvements to transit and other alternative modes of travel.

Issues/Impediments:
Local government parking reform can be impeded by limited resources and technical expertise, especially in small municipalities. Parking policies are a highly political issue on the local level. Local governments may be reluctant to adopt parking reforms due to lack of political support, business concern that their city will be at a disadvantage with competitors in neighboring cities without similar parking reforms. Since parking costs are often hidden in rents and purchases, residents may not understand the basis or need for parking reform.

Local governments develop local parking policies based upon local needs and priorities. Willingness to implement policies consistent with regional parking policies will vary among these entities.

Sources:

1. Donald Shoup. *The High Cost of Free Parking.* Washington D.C.: APA Planners Press, 2005.
2. Metropolitan Transportation Commission, Association of Bay Area Governments, *Plan Bay Area, Regional Transportation Plan and Sustainable Communities Strategy,* July 2013
3. Metropolitan Transportation Commission, Reforming Parking Policies to Support Smart Growth; Toolbox/Handbook: Parking Best Practices & Strategies for Supporting Transit Oriented Development in the San Francisco Bay Area, June 2007 http://mtc.ca.gov/sites/default/files/Toolbox-Handbook.pdf

TR14: Cars & Light Trucks

Brief Summary:
This control measures summarizes actions by the Air District, MTC, local businesses, city and county governments, and state and federal agencies to expand the use of Zero Emission Vehicles (ZEVs) and Plug-in Electric Vehicles (PEV), comprising both battery electric and plug-in hybrid passenger vehicles and light-duty trucks within the Bay Area.

Purpose:
This measure will reduce key ozone precursors of ROG and NOx, particulate matter, air toxics, and greenhouse gases by providing incentives for the purchase of electric and plug-in hybrid vehicles and light-duty trucks.

Travel Market Affected:
This measure would affect inter- and intraregional travel, including commute travel, shopping, personal business, school trips, as well as social and recreational travel.

Regulatory Context and Background:
In September 1990, ARB adopted the Low-Emission Vehicle Regulation to reduce pollution from passenger cars and light-duty trucks. This regulation required large auto manufacturers to bring to market vehicles with zero emissions beginning with 1998 model-year vehicles. The regulation is implemented through the Zero Emission Vehicle (ZEV) program, which originally required, starting with 1998 model year vehicles, that 10 percent of new vehicle sales by large auto manufacturers have zero emissions. ARB modified the program in 1998 and 2001 to allow up to 60 percent of the zero emission requirements to be met with vehicles having extremely low emissions and other specific attributes. Vehicles meeting these standards are referred to as "partial zero emission vehicles" (PZEV) and "advanced technology partial zero emission vehicles" (AT-PZEV).

Since its adoption, the ZEV Program, as part of the Low Emission Vehicle Regulation, has reduced the amount of air pollution from passenger cars and light-duty vehicles through the gradual introduction of partial and zero emission vehicles into the California fleet. The Low Emission Vehicle Regulation, which affects passenger cars and light-duty trucks, has been amended on several occasions since its inception (most recently in January 2012 and October 2013) to reflect the pace of ZEV development, the emergence of new ZEV and near-ZEV technologies, and the need to clarify the language of the regulation.

In January 2012, in order to address the need to further reduce vehicle emissions and achieve California's goals of meeting ambient air quality standards and reducing greenhouse gas emissions (GHG), ARB approved the Advanced Clean Cars (ACC) program. The ACC program incorporated three elements that combine the control of smog-causing (criteria pollutant) emissions and GHG into a single coordinated package of requirements for model years 2015 through 2025. These three elements included: the Low-Emission Vehicle III (LEV III) regulations, the Zero-Emission Vehicle (ZEV) regulations, and the Clean Fuels Outlet regulations.

Additionally, hydrogen fueling infrastructure was provided with a dedicated funding source by the California Legislature through passage of Assembly Bill 8 (AB 8 - 2013),

ARB's *Mobile Source Strategy*
As part of the development of the 2016 State Implementation Plans for the South Coast and San Joaquin Valley Air Basins, ARB developed a comprehensive strategy to reduce criteria, toxic and greenhouse gas emissions from mobile sources. For passenger vehicles, the strategy calls for increasing the penetration of plug-in hybrid electric vehicles (PHEV) and zero-emission vehicles (ZEV) such as battery-electric (BEV) and hydrogen fuel cell electric vehicles (FCEV) by over 50 percent compared to current programs. Additional, renewable energy will comprise at least 50 percent of the electricity and hydrogen supply supporting these electric vehicles. A large portion of the liquid fuels for combustion engine vehicles will also need to be sourced from renewable feedstock.

To implement the Mobile Source Strategy, ARB staff will propose modifications to the Advanced Clean Cars to increase the number of new ZEVs and PHEVs sold in California. The regulation may include lowering fleet emissions further beyond the super-ultra-low-emission vehicle (SULEV) standard for the entire light-duty fleet through at least the 2030 model year, and look at ways to improve the Smog Check and On-Board Diagnostics programs to ensure continued reductions in emissions. Additionally, new standards would be considered to further increase the sales of ZEVs and PHEVs in 2026 (and later years) beyond the levels required to ensure future emission reduction, climate, and petroleum targets are met.

MTC's Climate Initiatives Program and Plan Bay Area
In response to the passage of climate change legislation AB32 and SB375, in December 2009, MTC adopted a Climate Initiatives Program. The overall objective of the program is to make short-term investments that reduce transportation-related emissions by reducing vehicle miles traveled, and encouraging new technologies.

The Climate Initiatives Program is a key component of MTC's GHG emissions reduction strategy, which anticipates a 16 percent per capita reduction in GHG emissions from light duty vehicles by 2035.

Bay Area Plug-In Electric Vehicle (PEV) Readiness Plan
To further accelerate the purchase and lease of zero-emission and plug-in hybrid vehicles in the Bay Area, in 2013 the Air District, in partnership with MTC and ABAG, developed the *Bay Area Plug-In Electric Vehicle (PEV) Readiness Plan*. This plan is guiding the actions of the Air District, MTC and ABAG, as well as other regional public and private partners, in developing financial incentives for the purchase and lease of PEVs, locating charging locations at worksites and public areas, and developing local planning and building code best practices to ensure PEVs are well integrated into the region. The plan also includes a siting analysis, which seeks to guide and coordinate future PEV charging infrastructure-siting efforts based on anticipated or projected demand for PEVs.

PEV Incentives

Plug-in electric vehicles are being purchased at significant levels today in the Bay Area. As of May 2016, PEVs comprise nearly 2 percent of the Bay Area's light duty fleet, and monthly sales are estimated to be approximately 5 percent of total new light-duty vehicle sales. Nearly 70 percent of PEVs registered to Bay Area drivers are battery electric vehicles.

One of the main drivers for PEV sales has been the High Occupancy Vehicle (HOV) lane access. HOV facilities are intended to increase the total number of people moved through a congested corridor by offering two kinds of travel incentives: 1) a substantial savings in travel time, and 2) a predictable travel time. The use of HOV lanes can increase the average number of persons per vehicles, preserve the person-movement capacity of the roadway, reduce congestion, and enhance bus operations.

The DMV issues Clean Air Vehicle decals to vehicles that meet specified emissions standards, which allow a vehicle to be operated in an HOV lane by a single occupant. White Clean Air Vehicle decals are currently available to an unlimited number of qualifying Federal Inherently Low Emission Vehicles (ILEVs). Cars that meet these requirements are typically certified pure zero emission vehicles (100 percent battery electric or hydrogen fuel cell) and compressed natural gas (CNG) vehicles. Per AB 266, the expiration date for the white stickers has been extended to January 1, 2019. Green Clean Air Vehicle decals were originally available to the first 40,000 applicants that purchased or leased cars meeting California's transitional zero emission vehicles (TZEV) requirement, also known as the enhanced advanced technology partial zero emission vehicle (AT PZEV) requirement. Per SB 286, the expiration date for the green decals has also been extended to January 1, 2019. Additional legislation raised the green decal limits to 85,000 vehicles, which was reached in December 2015.

Additionally, because the higher purchase price of PEVs makes it difficult for middle and low income consumers to purchase a PEV and associated fueling stations, significant funding for incentives to help reduce the cost of PEV ownership/operation are being made available by the Air District's Transportation Fund for Clean Air and MTC's Climate Initiatives Program. Incentive funding to purchase a PEV will be provided, when combined with the buyback of an older, less efficient vehicle (See Vehicle Buy Back Program below). This is intended to extend the market for PEVs into a broader range of income classes. The combination of vehicle buyback and incentive program is intended to induce demand in middle and lower income brackets that might otherwise delay car purchasing, purchase a new conventional vehicle, or purchase a used vehicle.

Vehicle Buy Back Program

The Air District's Vehicle Buy Back Program (VBB) is a voluntary program that takes older, high polluting vehicles off the road. The VBB program pays $1,000 for an operating and registered 1994 and older vehicle. Vehicle dismantlers contracted by the Air District scrap the vehicles. The program is funded through the Air District's Carl Moyer, Mobile Source Incentive Fund and Transportation Fund for Clean Air (TFCA) programs.

The state administers a Voluntary Accelerated Vehicle Retirement (VAVR) program which targets vehicles that fail the biennial Smog Check. This program provides money to vehicle owners to retire older, more polluting vehicles. The purpose of this program is to reduce emissions by accelerating the turnover of the existing fleet to newer, cleaner vehicles. This program is a component of California's State Implementation Plan, which outlines the State's strategy for meeting health-based ambient air quality standards. The State's program provides $1,000 per vehicle ($1,500 for low-income vehicle owners) for old vehicles that fail the most recent biennial Smog Check Test.

To accelerate the removal of old, highly polluting cars from the San Joaquin Valley and South Coast Air Basins, ARB in 2015 ran a successful small enhancement to the VAVR program. The "Plus-Up" enhancement provide additional cash to low-income residents participating in the VAVR program if they purchased of a newer, cleaner car. The"Plus-Up" program is expanding in 2017; $40 million has been allocated to programs in the San Joaquin and South Coast Air Basins, with an additional $20 million to other parts of California.

Clean Vehicles Fee-bate Program
A fee-bate program uses a combination of fees and rebates to change consumer behavior. Consumers purchasing a vehicle that emits more CO_2 on a gram per mile basis than a defined standard are assessed a fee at the point of purchase. These fees are used to provide rebates to consumers that purchase vehicles that emit less CO_2 on a gram per mile basis than the defined standard.

Fee-bates have been used with some success in other countries, including Denmark, France, the Netherlands, and Norway. In the early 1990s, ARB studied a fee-bate program for California, and again in 2007, in response to a legislative initiative (AB 493, 2007). The Air District will, in cooperation with MTC and ARB, obtain legislative authority to implement a fee-bate program in the Bay Area.

Implementation Actions:
The Air District and/or MTC will:

- Consistent with the goals of the *Bay Area PEV Readiness Plan*, both the Air District and MTC will commit regional clean air funds toward qualifying vehicle purchases and infrastructure development subsidies.
- Partner with private, local, state and federal programs to promote the purchase and lease of battery-electric and plug-in hybrid electric vehicles.
- Partner with private, local, state and federal programs to install and expand public charging infrastructure and to promote existing charging infrastructure. Advocate for increased government incentives and research programs with local businesses, non-profits and governments.
- Develop model ordinances and/or direct local governments to existing ordinances (such as in Sonoma, Santa Clara, and Contra Costa County) concerning installation of vehicle charging in new homes.

- Support the use of renewable electricity in both ZEVs and PHEVs, with additional support for low carbon, renewable fuels in the onboard internal combustion engines in PHEVs.
- Support research programs advancing technology for plug-in hybrid, battery electric and hydrogen-fueled vehicles.
- Promote the DMV's Clean Air Vehicle decal program to encourage purchase of ZEVs and PHEVs
- Obtain legislative authority for a regional fee-bate initiative. Work with ARB and MTC to implement the program.
- In 2017, apply for funding to run a "Plus-Up" program in the Bay Area as part of the State's VAVR program. This funding will be used to assist low-income residents to retire older vehicles that fail Smog Check and purchase a newer, cleaner vehicle.
- In 2020, implement a regional "Plus-Up" program as part of the Vehicle Buy Back; this regional effort will assist vehicle owners in replacing older vehicles that still pass Smog Check with new a new zero emission or plug-in hybrid electric vehicle.
- Work with MTC to ensure ZEVs and PHEVs have access to the region's HOV lanes and the Express Lane Networks.

Emission Reductions:

Pollutants*	2020	2030
ROG	84	64
NO_x	84	64
$PM_{2.5}$	16	14
PM_{10}	17	15
DPM	-	-
TACs	-	-
CO_{2e}	4,566	3,963

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:

Emission reductions for this measure have been calculated for the years 2016 through 2030, and are based only on the Air District's and MTC's ongoing incentives for new fleet vehicles and the Vehicle Buy-back Program. For new vehicle purchases, the annual VMT is assumed to be 15,000 miles.

Emission reductions were calculated by assuming that each ZEV and PHEV will be purchased in lieu of an average brand new gasoline powered vehicle. For zero emission vehicles, the emission reductions are calculated as the difference between new vehicle emissions and zero emissions in the years 2016 through 2030. For these estimates, we assume that during the 15 year period, older vehicles are retired and replaced like-for-like with new vehicles, and the new vehicles remain in operation during the entire period; that is a vehicle purchased in 2017 would still be in operation in 2030. Because new standards haven't yet been adopted for MY 2026-2030, we assume that new gasoline and PHEV vehicles meet the existing SULEV20 standard.

For plug-in hybrid vehicles, it is assumed that the vehicles will be certified by ARB as Super Ultra Low Emission Vehicles and will operate in electric mode for 50 percent of the annual VMT, or 7,500 miles. For PHEV's, we have assumed that 75 percent of the electricity used by the vehicles will come from grid-electricity, while the remaining 25 percent of the electricity comes from burning gasoline in the vehicle engine.

Exposure Reduction:
Reduction in the use of gasoline will also reduce public exposure to air toxics, particularly in communities near heavily traveled roads and freeways.

Emission Reduction Trade-offs:
This measure will not increase emissions of any pollutant from motor vehicles; however, to the extent that it helps to increase the number of ZEVs and PHEVs in use within the Bay Area, it may increase emissions of criteria pollutants and greenhouse gases from power plants that generate the required electricity.

Cost:
Cost for the measure consists of $14 million allocated by the Air District Board of Directors for the FY 2015/16 incentives, plus the assumption that the Air District and MTC will subsequently provide up to $5 million per year from 2017 through 2021 and that the Air District will provide up to 2.5 million from 2022 through 2030 for subsidies towards the purchase of qualifying vehicles and infrastructure. Additional benefits from incentives will occur if the region receives funding from state and federal incentive programs, tax refunds and rebates, and private sources.

Co-benefits:
The expanded use of newer, cleaner electric powered cars will reduce water pollution and decrease reliance on crude oil for transportation fuel. Benefits of "green" job creation are dependent on commitments to manufacture compliant vehicles within the Bay Area.

Issues/Impediments:
- Funding for vehicle subsidies
- Limited availability of ZEV and Plug-in Hybrid vehicles
- Vehicle price and ongoing maintenance costs
- Advances in battery technology

Sources:
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4. Bunch, David S. and David L. Greene (2010) Potential Design, Implementation, and Benefits of a Feebate Program for New Passenger Vehicles in California: Interim Statement of Research Findings. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-10-13
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6. CARB, *Staff Report: Initial Statement Of Reasons For Proposed Rulemaking, Public Hearing To Consider The "Lev Iii" Amendments To The California Greenhouse Gas And Criteria Pollutant Exhaust And Evaporative Emission Standards And Test Procedures And To The On-Board Diagnostic System Requirements For Passenger Cars, Light-Duty Trucks, And Medium-Duty Vehicles, And To The Evaporative Emission Requirements For Heavy-Duty Vehicles,* December 7, 2011.
7. MTC, *Draft 2017 Transportation Improvement Program (TIP) For the Nine-County San Francisco Bay Area,* June 24, 2016
8. United States Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, "Hybrid and Plug-in Electric Vehicle Emissions Data Sources and Assumptions," retrieved on 7/1/2015 -- http://www.afdc.energy.gov/vehicles/electric_emissions_sources.html

TR15: Public Outreach

Brief Summary:
The Public Outreach control measure includes activities to encourage Bay Area residents to make choices that benefit air quality. This measure includes various public outreach campaigns to educate the public about the health effects of air pollution and the air quality benefits of reducing motor-vehicle trips and choosing transportation modes that reduce motor vehicle emissions. The measure includes outreach and education regarding electric vehicles, smart driving, carpooling, vanpooling, taking public transit, biking, walking, and telecommuting.

Purpose:
The purpose of this measure is to reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, air toxics and greenhouse gas (GHG) emissions.

Travel Market Affected:
This measure would affect intraregional travel, including commute travel; shopping, personal business, school trips, social and recreational travel. In addition, this measure may help to reduce emissions from the use of lawn and garden equipment and recreational watercraft.

Regulatory Context and Background:
Electric Vehicle Strategy
The Air District and MTC view PEVs as a promising technology for reducing tailpipe emissions, thus helping the region achieve local, state, and federal criteria pollutant and GHG emission reduction targets. In December 2013, the Air District, in partnership with MTC and ABAG, completed a *Bay Area Plug-in Electric Vehicle Readiness Plan* (www.baaqmd.gov/EVready). The plan outlines a series of strategies and best practices that can be taken by regional agencies and other PEV stakeholders to remove potential barriers and accelerate deployment of PEVs.

An EV Promotional Campaign is one of the strategies outlined in the Readiness Plan and a well-coordinated regional PEV marketing campaign that specifically targets Bay Area consumers is needed in order to successfully capture the attention and acceptance of the broader general public. This campaign was implemented in 2013-2016 by MTC and the Air District.

Campaign development began in October 2012 and included research into which activities would be the most successful to increase EV adoption. Research indicated that allowing interested individuals to test drive EVs in an environment free of sales pressure would be the best strategy. An initial one-year ride-and-drive campaign was then launched in Spring 2014, marketed as Experience Electric. Through the Experience Electric campaign, MTC offered twenty-one free, interactive Ride-and-Drive events at venues around the Bay Area. The ride-and-drives allowed drivers to test-drive EVs and share their experience via social media.

To evaluate the campaign, MTC implemented a pre-drive, post-drive and follow-up surveys (several months after the ride and drive) to event participants. Overall, the events yielded positive effects on perceptions of EVs, perceived barriers to EV purchase, and intent to purchase an EV immediately following the events in the post-drive survey. Because of these results, the Air District provided additional funds for six ride-and-drive events in winter 2015 and spring 2016.

In addition to the campaign, the Air District provides funding for outreach and activities including implementing the training described in the PEV Plan for local government agencies and the public, conducting workshops and participating in workgroups and other opportunities to support PEV deployment and sharing best practices.

Spare the Air

The STA Every Day Program is the backbone of the Air District's efforts to encourage the public to take direct action to reduce emissions and improve air quality. Since motor vehicles are the leading source of ozone forming emissions in the Bay Area, efforts to reduce vehicle travel, particularly on days with Spare the Air Alerts, can help avoid exceedance of federal and state standards. STA Every Day includes the following components:

- Outreach Program
  - STA Alert notifications via media channels, alert notification sign up lists, and the employer program.
  - Advertising campaign through print, billboards, TV ads and website ads.
  - Media outreach through news programs and community based outreach channels, such newsletters.
  - Outreach at community events, such as county fairs.
  - Coordination with MTC/511.
- Employer Program
  - Employer coordinators inform their workforce of impending Spare the Air days, educate employees about the ways individuals can improve air quality, and motivate them to take action.
- Community Resource Teams
  - Local civic groups, agencies, businesses and environmental organizations meet regularly and work collaboratively to implement projects that promote cleaner air. Team members, with Air District support, are responsible for developing and carrying out local projects.
- Winter Spare the Air
  - The Winter Spare the Air program notifies residents when particulate matter levels are anticipated to be unhealthy. On these high pollution days, the Air District issues a Winter Spare the Air Alert which prohibits wood burning throughout the Bay Area.
- Youth Programs
  - Protect Your Climate Curriculum: 16 lessons for 4th and 5th grade students that focus on air pollution, energy, waste reduction and transportation.
  - Clean Air Challenge Curriculum: a science-based curriculum which includes experiments that help students understand air pollution and climate change.
  - Cool the Earth: a greenhouse gas reduction program for K-8th grade students and their parents.

- As the World Warms: a classroom supplement including news stories and puzzles on climate change for elementary aged students.
- eCO2 Commute Challenge Project Manual: a tool to help high school students become a part of the solution to climate change by taking action in their schools to reduce greenhouse gas emissions from student commutes by promoting walking, biking, riding the bus and carpooling.

In addition, Spare the Air Youth is a regional program, implemented by MTC and the Air District, that aims to educate, inspire and empower youth and families in the San Francisco Bay Area to walk, bicycle, carpool and take transit. Spare the Air Youth seeks to find effective ways to reduce GHG and other emissions related to transportation, while also providing a regional resource for students, parents, teachers and program providers.

Non-Commute Trip Reductions Campaign
Non-commuting travel generally includes vehicle trips associated with schools, hospitals, medical centers, banks, stores, post offices, entertainment, recreation, etc. Reducing non-commute trips may contribute to the overall goal of reducing vehicle miles traveled (VMT) and therefore air pollution in the Bay Area.

Non-commute trip reduction strategies have been successfully implemented in the Bay Area and other regions of the nation. For example, the City of Walnut Creek and Emeryville offer free shuttles to and from shopping districts. In the Denver area, retail shopping centers are also operating shuttles that are realizing high ridership. Shuttles may be funded privately or through public-private partnerships. In the instance of shopping centers, retail benefits from shared underwriting of the shuttle costs; these costs return benefits for both shoppers and employees, especially in high shopping seasons where parking is limited.

Non-commute trips may also be the focus of residentially-based education and marketing campaigns. A particularly strategic time to approach people about travel behavior changes is when they change either their place of work or residence. The Sacramento Area Council of Governments (SACOG) is working with outreach partners throughout the region to expand on commute campaigns with information on non-commute trip reduction strategies. Outreach partners will be supported with collateral materials to share with real estate agents, rental and lease agents, and new home welcome services.

Outreach could also include presentations to interest groups, including but not limited to, realtor associations, business organizations, chambers of commerce and service clubs. Information could also be developed for new home buyers, seniors in assisted living facilities, recreation and park districts, school districts, senior centers, neighborhood associations, and advocacy groups for alternative modes, including bicycling and walking.

The Spare the Air Everyday Campaign has a non-commute emphasis as well. In addition to reducing commute trips, the campaign speaks to reduce driving and other activities that generate air pollution, not only during weekdays, but on all days of the week. Spare the Air

Everyday asks residents to reduce pollution by making clean air choices every day. This can include walking and biking more often, taking transit, telecommuting or carpooling, driving less, reducing energy consumption at home, and making many other daily choices that improve air quality.

Implementation Actions:
The Air District will:

- Implement the Spare the Air Every Day Campaign including Spare the Air alerts, employer program, and community resource teams
- Implement outreach and education efforts in partnership with MTC, including the Spare the Air Youth Program

MTC will:

- Implement the Spare the Air Youth Program with the Air District
- Encourage alternative modes of travel for non-commute trips, including walking, bicycling, transit and carpooling via the development of outreach programs to targeted travel sector groups
- Explore ways to expand public awareness of availability and benefits of transit, bicycling, walking, or carpooling/vanpooling for non-commute trips

Emission Reductions:
N/A

Emission Reduction Methodology:
N/A

Exposure Reduction:
N/A

Emission Reduction Trade-offs:
None identified.

Cost:
Spare the Air Program: $6 million/year
EV Outreach: approximately $500,000/year
Non-Commute Trips Campaign: N/A

Co-benefits:
This measure raises public awareness about the causes of and solutions to air pollution. People who choose to change their travel or other behaviors in response to a voluntary request for a STA Alert may reduce vehicle use or change other polluting activity on a regular basis, as advocated in the STA Every Day and the Spare the Air Youth programs. Additionally, increased travel by bike and walk modes may increase individuals' physical health and quality of life.

Issues/Impediments:

Implementation of this measure requires that funding is available for these programs. In addition, because the Spare the Air program is voluntary in nature, its effectiveness depends on the cooperation of the general public.

Sources:

1. Purvis, Charles L., *Incorporating Work Trip Accessibility in Non-Work Trip Generation Models in the San Francisco Bay Area*, January 1996 http://www.mtc.ca.gov/maps_and_data/datamart/research/paper96.htm

TR16: Indirect Source Review

Brief Summary:
An indirect source review (ISR) rule would reduce construction and operating emissions associated with new or modified land uses in the Bay Area. The Indirect Source Review measure is intended to address potential increases in air pollutant emissions related to economic and population growth in the region. Indirect sources are development projects that generate or attract motor vehicle trips, thus “indirectly” cause air pollution from vehicles and area sources. Area source emissions include fireplaces, home heating furnaces, hot water heaters, and landscape maintenance equipment.

Purpose:
This measure will reduce emissions of key ozone precursors, ROG and NOx, particulate matter, toxic air contaminants and greenhouse gases by reducing construction and operational emissions associated with new or modified land uses.

Travel Market Affected/Source Category:
On-road and off-road mobile emission sources are the main source categories targeted by this measure. However, space heating, landscape maintenance and wood burning emission source categories could also be included.

Regulatory Context and Background:
The California Clean Air Act (CCAA) explicitly grants air districts authority to adopt and implement regulations to reduce or mitigate emissions from indirect and area wide sources of air pollution. This may be done by air districts through the use of measures which reduce the number and length of vehicle trips (Health and Safety Code §40716(a)(1)). Based on CCAA enabling legislation, it is the intent of the legislature “that districts shall endeavor to achieve and maintain state ambient air quality standards…by the earliest practicable date. In developing attainment plans and regulations to achieve this objective, districts shall consider the full spectrum of emissions sources and focus particular attention on reducing the emissions from transportation and area wide emission sources (H&SC §40910).” The CCAA also states that this ISR authority does not limit or supersede local land use authority of cities and counties.[1]

Varying degrees and forms of ISR rules have been implemented in air districts throughout California, including Colusa County, Great Basin Unified, Imperial County, Mendocino County, San Joaquin, and Shasta County. Some of these rules are strictly cost recovery mechanisms for air districts to recoup the costs associated with CEQA review while others encourage new development to implement on-site emission reduction strategies or require applicants to pay an off-site mitigation fee.

[1] Other relevant ISR sections in the CCAA include: 40717(g), 40918(a)(4), and 42311(g).

In 2005, the San Joaquin Valley Air Pollution Control District (San Joaquin Valley APCD) adopted Rule 9510 as an ISR rule. The rule applies to residential, commercial, industrial, office and recreational development projects above a certain size (e.g., 50 residential units or 2,000 square feet of commercial space). Development projects must reduce their construction and operational emissions to be below two tons per year of NOx and PM10 through onsite mitigation or pay an off-site mitigation fee. The fee formula is structured to encourage on-site mitigation measures. San Joaquin Valley APCD uses the fees to fund off-site mitigation projects that reduce NOx and PM10 emissions. To date, San Joaquin Valley APCD has mostly funded off-site projects that include retrofitting or replacing engines in on-road and off-road vehicles and agriculture equipment.

Imperial County APCD adopted Rule 310, Operational Development Fee, in 2007. It assesses a per square foot fee on all new commercial development and a per unit fee on residential development above four units. Project proponents have the option to either provide on and off site mitigation, pay the mitigation fee, or do a combination of both. Fees collected are used to fund mitigation projects that reduce ozone precursors and PM10.

On November 2, 2010, Proposition 26 passed by over 52 percent of California voters. Proposition 26 amended the California Constitution by redefining “tax” to include any “levy, charge, or exaction of any kind” and requiring any new fees (or taxes) that meet this definition be approved by a 2/3 vote from each house of the State Legislature for statewide fees or by 2/3 voter approval for local fees. It should also be noted that there are seven exemptions to Proposition 26 requirements. Therefore, any ISR developed by the Air District that would include fees would have to be consistent with Proposition 26 requirements.

Implementation Actions:
The Air District will:
- Consider developing a rule that sets air quality performance standards for new and modified development.
- Reconvene a broad-based stakeholder workgroup to discuss Indirect Source Rule concepts.

Emission Reductions:

Pollutants*	2020	2030
ROG	0.30	Na
NO_x	0.24	Na
$PM_{2.5}$	0.11	Na
PM_{10}	0.47	Na
CO_{2e}	333	Na

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
The emissions reduction methodology for this measure is based on a methodology developed and reported by the San Joaquin Valley APCD Indirect Source Review (ISR) program. The San

Joaquin Valley APCD rule requires the payment of mitigation fees for projects that will result in 2 tons of NOx or 2 tons of PM emissions per year or more. Air District staff looked at the number of development projects and plans listed in the Air District CEQA database (estimated for the year 2020) that may be subject to the ISR program. The emission reductions above estimate the results if 15 percent of emissions from new construction are mitigated through off-site mitigations.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions. This measure will also reduce localized population exposure to air pollution.

Emission Reduction Trade-offs:
None identified.

Cost:
Specific costs will be determined during rule-making.

Co-benefits:

- Improved project design and planning.
- Public health benefits from reduced emissions, improved pedestrian access, and use of green building elements.

Issues/Impediments:
Regional rules or regulations that impact local land use decisions and/or development can be politically challenging to develop or implement.

Sources:

1. Memo to Mobile Source Committee, September 11, 2007: *2005 Ozone Strategy Further Study Measure 18: Indirect Source Mitigation Program*
2. SCAQMD ISR: http://www.aqmd.gov/home/regulations/rules/proposed-rules/pr2301
3. SJVAPCD ISR Web site http://www.valleyair.org/ISR/ISRHome.htm
4. Imperial Valley Rule 310 Operational Development Fee
5. 2008 Annual Report on the District's Indirect Source Review Program, SJVUAPCD http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2008/June/Item%2013/GVB%20Agenda%20Item%2013.pdf
6. Socioeconomic analysis SJVAPCD http://www.valleyair.org/ISR/Documents/RULE_9510_AppendixF.pdf

TR17: Planes - Cleaner Aircraft Engines and Renewable Jet Fuel

Brief Summary:
This measure consists of the efforts of the Federal Aviation Administration's (FAA) Continuous Lower Energy, Emissions and Noise (CLEEN) Program. The goals of the CLEEN Program include the development of new commercial aircraft engines by 2023-25 that would emit 60 to 75 percent fewer NOx emissions than current aircraft engines, as well as demonstrate the feasibility of jet fuel derived from crops and other renewable resources.

Purpose:
This measure will reduce emissions of a key ozone precursor, NOx, through the development and use of cleaner aircraft engines, and reduce GHGs through improvements in engine efficiencies and increased use of jet fuel derived from renewable sources.

Travel Market Affected:
This measure will affect airline travel into and out of the Bay Area.

Regulatory Context and Background:
Commercial aircraft engines operating from the three major airports in the Bay Area – San Francisco International, Oakland International and San Jose International – contribute 3.2 percent to the region's NOx inventory, while small aircraft, military planes, and ground support equipment contribute an additional 1.2 percent. All aircraft operations contribute 1.6 percent of the region's ROG emissions, and less than 1 percent of the region's PM2.5 emissions.

Aircraft emission standards have been in place for about 30 years and essentially apply to all commercial aircraft. Over the years, emission standards have been set for different aspects of aircraft engines:

- in 1974 for engine smoke (revised several times since) and fuel venting
- in 1984 for hydrocarbon emissions
- in 1997 for NOx and carbon monoxide emissions
- in 2005 for NOx emissions

The U.S. Environmental Protection Agency (US EPA) works with the FAA and the United Nations International Civil Aviation Organization (ICAO) in the development of international aircraft emission standards. The FAA is responsible for enforcing the aircraft emission standards set by US EPA. ICAO was established by the United Nations to ensure safety, equality, and consistency among international air transport services. One of ICAO's objectives is to lead international bodies in the development of standards and procedures for aircraft engines. The US EPA's current rules on aircraft emissions are equivalent to the ICAO standards.

To further reduce emissions from commercial jet engines, the FAA established the Continuous Lower Energy, Emissions and Noise (CLEEN) program in partnership with commercial airlines, jet engine manufacturers and airplane manufacturers. The CLEEN program (and some companion, subsidiary programs, such as the "Farm to Fly" program and the Airline

Sustainability Center [ASCENT]), is an effort to accelerate development and commercial deployment of environmentally promising aircraft technologies and sustainable alternative fuels. The aircraft technologies focus on reduction in aircraft noise, emissions, and fuel burn, while the renewable fuel programs focus on development of direct replacement of petroleum derived jet fuel.

In February 2016, the International Civil Aviation Organization finalized performance standards for new aircraft that will require improved fuel efficiency and reductions in Co2 emissions. The new standards will apply to all new commercial and business aircraft delivered after January 1, 2028. The standards require an average of 4% reduction in fuel consumption, with actual reductions ranging from 0 to 11%, depending on the size of the aircraft. The EPA is currently developing a federal regulation that will apply these standards to all domestic aircraft.

Implementation Actions:
The Air District will:

- Support efforts, via letters of support on legislative action or other activities, to increase the use of cleaner burning jet fuel and low-NOx engines in commercial jets arriving and departing the Bay Area.

Emission Reductions:
Emission reduction estimates for this measure are not available. The Air District will be encouraging airlines and the FAA to deploy cleaner planes, but there is too much uncertainty to reasonable estimate benefits over the next four to five years.

Exposure Reduction:
This measure may reduce region-wide population exposure to air pollutants.

Emission Reduction Trade-offs:
None identified.

Cost:
Unknown

Co-benefits:
More efficient engines and use of cleaner fuels will reduce GHG emissions.

Issues/Impediments:
Commercial aircraft emissions are regulated by US EPA and international treaties, which can take years to develop and implement any lower emission standards. Local air districts are preempted from adopting regulations controlling emissions from these sources.

Sources:

1. Federal Aviation Administration, Continuous Lower Emissions, Energy, and Noise (CLEEN) Program website; accessed February 9, 2015;

https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/

2. Federal Aviation Administration, website for Annual Meeting of the CLEEN Consortium, November 2014, accessed February 9, 2015. https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/2014_consortium/
3. Environmental Protection Agency, Office of Transportation and Air Quality, Regulatory Announcement, November 2005, http://www.epa.gov/oms/regs/nonroad/aviation/420f05015.pdf
4. Environmental Protection Agency, "Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare," Federal Register Volume 81, Number 157, August 15, 2016
5. International Civil Aviation Organization, *On Board a Sustainable Future: Environmental Report*, 2016

TR18: Goods Movement

Brief Summary:
The measure includes regional programs to reduce emissions associated with goods movement, including funding for goods movement related infrastructure, planning work to update the Regional Goods Movement Plan and participation in the regional Goods Movement Collaborative. Goods movement is a critical component of the Bay Area's economic and transportation system, and a significant source of air pollutant emissions. Exposure to diesel particulate matter from goods movement disproportionately impacts the health of residents near ports, rail yards, distribution centers, and roads with high truck volumes. Investing in the Bay Area's trade corridors will address existing air quality and public health issues as well as help the region to prepare for continued growth in this economic sector. This measure focuses primarily on regional planning and infrastructure, while Control Measures TR19, 20, 21, & 22 focus on reducing emissions from trucks and other equipment used to move goods.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, particulate matter, toxic air contaminants and greenhouse gases associated with goods movement.

Travel Market Affected:
This measure would affect goods movement activity within the region.

Regulatory Context and Background:
Goods movement is a critical component of the Bay Area's economic and transportation system. Whether it is delivering construction materials or consumer goods to the growing population, or exporting electronics and food throughout the world, a robust goods movement system is essential for both business and residents to function and thrive in the Bay Area.

Exposure to diesel particulate matter from goods movement operations greatly impacts the health of community residents near ports, rail yards, distribution centers, and roads with high truck volumes. Analysis by the Air District has found that emissions of diesel particulate matter (PM) account for 80 percent of the risk from toxic air contaminants (TACs) in the Bay Area. Twenty-two percent of the total California population living in close proximity to goods movement corridors is located in the Bay Area.

Nearly a third of the region's employment is in goods movement related industries, such as manufacturing, freight transportation, and the warehouse and distribution businesses. Goods movement is a critical source of job diversity in the region, providing job opportunities for people with lower levels of education and providing opportunities for training and career advancement.

The region is home to five maritime ports, including the Port of Oakland, which is the fifth busiest container port in the nation, as well as the gateway to two small river ports in Sacramento and Stockton. The Port of Oakland plays a particularly important role in supporting the state's agricultural sector, providing the primary means of exporting produce from the Central Valley to the Pacific Rim. The other four marine ports (Port of Redwood City, Port of Benicia, Port of Richmond and Port of San Francisco) are primarily niche ports serving bulk products, including petroleum products, construction material and scrap metal. In addition, both Oakland International Airport and San Francisco International Airport play key roles in air cargo trade.

In November 2006, California voters approved Proposition 1B, a $19.9 billion transportation infrastructure bond. Proposition 1B included a $2 billion Trade Corridors Improvement Fund (TCIF) to improve goods movement infrastructure statewide. In 2008 the state augmented the TCIF fund to nearly $2.5 billion and programmed just over $3 billion for high-priority goods movement projects. Nearly $585 million of this total will fund seven key Bay Area goods movement projects, including I-580 Truck Climbing Lane, I-880 Reconstruction at 29th and 23rd Avenues, the Outer Harbor Intermodal Terminal, and the Richmond Rail Connector.

Proposition 1B also included $1 billion for a Goods Movement Emissions Reduction program. The Air District is responsible for developing various programs for the bond, including a diesel truck replacement program. (See TR19: Medium and Heavy Duty Trucks)

In addition, ARB's 2007 Goods Movement Action Plan seeks to meet five specific goals for addressing the air pollution associated with goods movement, including reducing "total statewide international and domestic goods movement emissions to the greatest extent possible and at least back to 2001 levels by year 2010."

On July 16, 2015, Governor Brown issued an Executive Order directing state agencies to coordinate on the development of "… an integrated action plan that establishes clear targets to improve freight efficiency, transition to zero-emission technologies, and increase the competitiveness of California's freight system." The final plan was released on July 29, 2016. The plan and additional information on the State's sustainable freight efforts is available at More information is available at http://www.casustainablefreight.org/.

ARB's *2016 Mobile Source Strategy* includes a number of new regulatory proposals to further reduce emissions from the goods movement sector. These new proposals include lower NOx standards for new truck engines, a "last-mile" regulation requiring the use of near-zero and zero emission delivery trucks, and expansion of the current shore power regulation to cover bulk carriers and oil tankers.

Regional Goods Movement Planning

The Alameda County Transportation Commission (ACTC) is leading a Bay Area *Goods Movement Collaborative* which brings together partners, community members and stakeholders from across the region and the country. The intent is to create an organized structure to understand goods movement needs in the Bay Area and to identify, prioritize and advocate for short- and long-term strategies to address these needs within a Countywide Goods Movement Plan.

The ACTC has also partnered with MTC to jointly develop not only a Countywide Goods Movement Plan, but the Regional Goods Movement Plan – which will outline a long-range strategy for how to move goods efficiently, reliably, and sustainably within, to, from and through the county and the entire region. The joint long-range plan development will ensure consistency between both plans and enable outreach to a wider range of stakeholders to provide a comprehensive understanding of the goods movement system in Alameda County and the Bay Area.

In addition, MTC is developing as part of Plan Bay Area 2040a Freight Emissions Reduction Action Plan (Action Plan). The Action Plan will develop and evaluate strategies to reduce emissions from goods movement throughout the region. The Action Plan will recommend specific programs, projects and policies for the goods movement system, including all modes of transportation. The strategies will focus on potential application of near-zero and zero-emission technologies and also include an assessment of operational and technology-based strategies. MTC will work closely with the Air District as well as local and state stakeholders in the implementation of the Action Plan.

Implementation Actions:

MTC will:

- Fund the I-880 Improvements at 23^{rd} and 29^{th} Avenues via Proposition 1B Trade Corridors Improvement Fund
- Fund the Outer Harbor Intermodal Terminals project via Proposition 1B Trade Corridors Improvement Fund
- Continue work to update the Regional Goods Movement Plan.
- Continue participation in the Goods Movement Collaborative, led by the Alameda County Transportation Commission.
- Adopt the Freight Emissions Reduction Action Plan.

The Air District will:

- Continue participation in the implementation of the Regional Goods Movement Plan. The regional work is being closely integrated with the Alameda County Transportation Commission's countywide goods movement planning effort, as well as the ongoing state and federal freight planning and policy activity to ensure consistency among all plans.
- Continue participation in the Goods Movement Collaborative, led by the Alameda County Transportation Commission.
- Work with MTC on the implementation of a Freight Emissions Reduction Action Plan.
- Work with ARB and Caltrans on the implementation of the Sustainable Freight Action Plan, as well as participate in the development of the proposed freight-related regulations included in the *2016 Mobile Source Strategy*. The initial regulatory effort will focus on converting the fleet of Class 3-6 urban delivery and vocational trucks to near-zero and zero emission operations through introduction of low-NOx engines, hybrid drive systems and battery electric and/or fuel cell propulsion.

Emission Reductions:
This measure will reduce some of the emissions emitted by goods movement sources, as cleaner engines are deployed and improved infrastructure reduces delays. The emission reduction benefits from Air District actions are included in Control Measures TR19, 20, 21 & 22.

Exposure Reduction:
This measure will reduce local population exposure to diesel particulate matter in various parts of the region. Impacted communities near freeways and roads with significant auto and truck traffic will benefit.

Emission Reduction Trade-offs:
Infrastructure improvements that provide congestion relief or new capacity for trucks and trains may increase local exposure to diesel particulate matter.

Costs:
Cost to industries have not been estimated; planning activities are difficult to quantify in terms of financial impacts to trucking industry.

Co-benefits:
- Economic benefits from faster, more efficient goods movement

Issues/Impediments:
- In designing and implementing goods movement efficiency measures, care should be taken to avoid creating induced demand for goods movement that could increase emissions.
- High costs to reduce emissions from aging goods movement equipment and infrastructure may be burdensome for the private sector. For example, large diesel trucks, some of which stay on the road for many years and are replaced at a slow rate, often operate on very small profit margins.
- Funding availability may constrain the implementation of goods movement emission reduction programs.
- Technological issues may be a limiting factor in retrofitting and replacing on- and off-road mobile sources due to technical capabilities, availability and rate of deployment.
- Under existing guidelines, incentive funding can only be made available for projects that reduce emissions that are surplus and not required by existing regulation. As CARB regulations that require owners of diesel engines to replace or retrofit these engines are phased in over the next several years, the number of engines that are eligible for incentive funding will decrease. Therefore, it may be difficult to achieve the same amount of emission reductions through the existing incentive programs.
- The uncertain state of the economy may limit the number of diesel equipment owners willing to enter into contracts to receive incentive funding because it commits them to monitoring and use requirements that have financial implications.

TR19: Medium- and Heavy-Duty Trucks

Brief Summary:
The Air District will directly provide, and encourage other organizations to provide, incentives for the purchase of 1) new trucks with engines that exceed ARB's 2010 NOx emission standards for heavy-duty engines, 2) new hybrid trucks, and 3) new zero-emission trucks. The Air District will work with truck owners, industry, ARB, the California Energy Commission, and others to demonstrate additional battery-electric and hydrogen fuel cell zero emission trucks.

Purpose:
This measure will reduce key ozone precursors ROG and NOx by replacing older, higher emission trucks and engines. In addition, the measure will also reduce diesel particulate matter, toxic air contaminants and greenhouse gases.

Source Category/Travel Market Affected:
Medium- and Heavy Duty On-Road Trucks, including all trucks weighing more than 10,000 pounds in Gross Vehicle Weight (Classes 3-8).

Regulatory Context and Background:
Emissions from medium- and heavy-duty trucks account for nearly 24 percent of NOx emissions in the Bay Area; they are also a significant source of diesel particulate matter, a known carcinogen. Beginning with the model year (MY) 2010 standards adopted by both ARB and the US EPA, truck emissions for both particulate matter and NOx will be substantially lower than earlier model year trucks.

However, because medium- and heavy-duty trucks are kept in service for many years and fleet turnover is slow, it can take a long time to see the air quality benefits of the new emission standards. To accelerate the replacement or retrofit of old trucks, ARB adopted a regulation that requires truck fleets to meet progressively more stringent emission limits as calculated on a fleet-average or model year schedule.

In 2012, Governor Brown signed into law three bills – AB 1532 (Pérez), SB 535 (De León), and SB 1018 (Budget and Fiscal Review Committee) – that established the Low Carbon Transportation Greenhouse Gas Emission Reduction Fund (GGRF). This fund receives Cap-and-Trade auction proceeds and provides the framework for how the auction proceeds will be administered in furtherance of the purposes of AB 32, including supporting long-term, transformative efforts to improve public health and develop a clean energy economy. On June 23, 2015 ARB announced the availability of $47.3 million in Advanced Technology freight demonstration projects as part of their funding plan to distribute GGRF funds. These funds are open to public agencies and nonprofits. The demonstration of advanced freight technologies is an important step in reaching the state's and the Air District's air quality and GHG reduction goals, and reducing exposure to air toxics and PM in impacted communities.

Zero-Emission Drayage Truck Demonstration Project
A portion of the GGRF funds (up to $25 million statewide) will be directed at projects that reduce greenhouse gases, criteria pollutants, and toxic air contaminant emissions in disadvantaged communities. Projects funded under this solicitation are to demonstrate full zero-emission drayage trucks, and drayage trucks that offer zero-emission miles (near zero-emission) by employing on-board range extending internal combustion engines or other technologies. In May 2016, the South Coast Air Quality Management District, in collaboration with the Bay Area air district and other partners, were awarded $23.6 million to demonstrate various zero and near-zero emission technologies on trucks primarily serving the ports of Oakland, Los Angeles, and Long Beach.

In May 2016, ARB released its *Mobile Source Strategy* for meeting federal ambient air quality standards, as well as California's climate change and petroleum reduction goals. For trucks, ARB staff are proposing tighter NOx emission standards, support for EPA's greenhouse gas/fuel economy regulation, a new "Last Mile" regulation that would require use of near-zero and zero emission trucks for local deliveries, and a new fuel requirement that will require 50 percent of diesel fuel sold in California be derived from renewable sources.

In the Bay Area, the Air District will work with local/regional trucking companies to deploy near-zero and zero emission trucks in local service, with particular emphasis on trucks operating within West Oakland and other CARE areas. An example of the steps that can be taken to introduce cleaner trucks in the medium- and heavy-duty weight classes, the Air will provide up to $5 million in funding in 2016 to reimburse a percentage of the difference in cost between a zero emissions truck and a conventionally fueled truck.

Implementation Actions:
The Air District will:

- Directly provide, and/or work with other entities to provide, incentives to accelerate the replacement of heavy-duty on-road diesel engines in advance of requirements of the ARB in-use heavy-duty truck regulation.
- Either directly provide, and/or work with partner agencies and companies to provide, funding to demonstrate the technology of hybrid drive trains for medium-and heavy-duty trucks, to demonstrate the technology of battery electric trucks, and to support further development of hydrogen fuel cell trucks.
- As technologies become commercially available, the Air District will work directly with partner agencies and companies to offer financial incentives to accelerate deployment of near-zero and zero emission trucks.

Emission Reductions:

Pollutants*	2020	2030
ROG	53	44
NO_x	2,278	362
$PM_{2.5}$	4	10
PM_{10}	4	11
DPM	4	10
CO_{2e}	58,234	138,306

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
Because of the complexity of the incentive programs for heavy-duty trucks, the emissions reductions are based on the replacement of 2,500 medium- and heavy-duty (> 10,000 lbs) trucks with new zero emission trucks, at an average rate of approximately 180 trucks per year. The trucks are assumed to average 40,000 miles per year. Baseline emission factors for criteria pollutants are taken from ARB's Appendix D, Carl Moyer Program, 6/29/15. Emission factors for CO_2 are from EMFAC 2014. We assume that between 2017 and 2022, the replaced trucks were built before 2010, while between 2023 and 2030, the replaced trucks are MY 2010 or newer. Potential emissions reduction benefit from short-term truck demonstrations have not been included in the emissions estimates due to the uncertain nature of the cost and implementation timelines.

Exposure Reduction:
This measure will accelerate the realization of the health benefits of an adopted ARB regulation by reducing exposure to diesel PM and by reducing NOx emissions that contribute to regional ozone formation. Impacted communities near freeways and roads with significant truck traffic will benefit.

Emission Reduction Trade-offs:
None identified.

Cost:
The cost to implement this measure will be determined primarily by the level of financial incentive that will be offered to fleet owners to encourage early compliance with the ARB truck regulations, or for the purchased of advanced technologies such as hybrid drive systems and zero emission battery or fuel cell trucks. Incentive funding from the Air District and partner agencies fluctuates from year-to-year and depends upon annual budget allocations, so per truck incentive amounts will be determined during the development of the program. Existing incentive programs managed by the Air District currently provide up to $50,000 per truck.

Co-benefits:

To the extent this measure is successful in replacing diesel trucks with either hybrid drive systems and/or zero emission electric technologies, there will be a reduction in petroleum usage in the Bay Area.

Issues/Impediments:
This control measures sets forth enhancements for an existing program and should not give rise to any new obstacles, as long as funding for the incentives is secured.

Sources:

1. BAAQMD, Carl Moyer Incentive Program, http://www.baaqmd.gov/Divisions/Strategic-Incentives/Funding-Sources/Carl-Moyer-Program.aspx
2. California Air Resources Board, *2011 Carl Moyer Guidelines (as amended)*, December 31, 2001. http://www.arb.ca.gov/msprog/moyer/moyer.htm
3. California Air Resources Board, *Appendix D: Tables for Emission Reduction and Cost-Effectiveness Calculations*, June 29, 2015. http://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/2011cmp_appd_06_29_15.pdf
4. California Air Resources Board, *Mobile Source Strategy*, May 16, 2016.
5. Environmental Protection Agency and Department of Transportation – National Highway Traffic Safety Administration, "Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles – Phase 2: Final Rule," Prepublication Version, August 16, 2016. https://www3.epa.gov/otaq/climate/documents/2016-08-ghg-hd-final-rule-phase2-preamble.pdf

TR20: Ships - Ocean-Going Marine Vessels

Brief Summary:
This measure attempts to replicate the Green Ship Program (Program) that has been implemented at the Ports of Los Angeles and Long Beach. Financial incentives for cleaner Tier 2 and Tier 3 ocean-going vessels to call at the ports serve as the basis of the Program. The Program was initiated as part of the San Pedro Bay Ports Clean Air Action Plan. This measure also recognizes the need to monitor progress under such programs and augment them as necessary to ensure sufficient results.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, through the development and use of cleaner engines in ocean-going marine vessels. In addition, emissions of particulate matter, toxic air contaminants, carbon monoxide and greenhouse gases would be reduced.

Travel Market Affected:
This measure would affect cargo shipping into and out of Bay Area ports.

Regulatory Context and Background:
Large ships such as container ships, tankers, bulk carriers, and cruise ships are significant contributors of ozone precursors (VOC and NOx), carbon monoxide (CO), and particulate matter (PM), within commercial ports and along coastal areas. There are two types of diesel engines used on large ships: main propulsion and auxiliary engines. The main propulsion engines on many large ships are "Category 3" (or C3) marine diesel engines, which can stand over three stories tall and run the length of two school buses. Auxiliary engines on large ships typically range in size from small portable generators to locomotive-size engines. Marine diesel engines were first regulated by the U.S Environmental Protection Agency in 2004.

In a rule published on April 30, 2010, EPA adopted standards that apply to Category 3 engines installed on U.S. vessels and to marine diesel fuels produced and distributed in the United States. That rule added two new tiers of engine standards for C3 engines: Tier 2 standards that took effect in 2011, and applies to all newly constructed marine engines and Tier 3 standards, which will take effect in 2016, and will also apply to newly constructed marine engines. Older Category 3 vessels are not required to adopt new engine standards. It also includes a regulatory program to implement Annex VI to the International Convention for the Prevention of Pollution from Ships (a treaty called "MARPOL") in the United States, including engine and fuel sulfur limits, and extends the Emission Control Area (ECA) for engine and fuel requirements to U.S. internal waters.

The ports of Los Angeles and Long Beach have created the Green Ship Incentive Program, a voluntary clean-air initiative targeting the reduction of smog-causing nitrogen oxides (NOx). It financially rewards qualifying vessel operators for deploying “green” ships (vessels with new marine engines that meet Tier 2 and Tier 3 standards) to the Port of Long Beach. The program also aims to accelerate the use of Tier 2 and Tier 3 engines.

Vessels with main engines meeting 2011 Tier 2 standards established by EPA and the International Maritime Organization (IMO) will be eligible for an incentive of $2,500 per ship call. For still cleaner vessels meeting 2016 Tier 3 standards, the incentive will increase to $6,000 per ship call.

Tier 2 engines reduce NOx emissions by 15 percent, and Tier 3 engines reduce NOx emissions by 80 percent.

Shore Power

Shore power is the provision of electrical power to a ship at berth while its main and auxiliary engines are shut down. Shore power was first commercially implemented in 2001 by Princess Cruises in Alaska. China Shipping, in 2004, was the first container carrier in California to use shore power at the Port of Los Angeles. Between 2004 and 2012, the ports of Los Angeles, Long Beach, Oakland, and San Diego have installed a total of 5 shore power berths for cruise ships and 11 shore power berths for container vessels. More shore power berths are expected to be installed in the coming years.

Shore power saves consumption of fuel that would otherwise be used to power vessels while in port, and eliminates the air pollution associated with consumption of that fuel. Commercial ships can use shore-supplied power for services such as cargo handling, pumping, ventilation and lighting while in port. A port city may have anti-idling laws that require ships to use shore power. Use of shore power may facilitate maintenance of the ship's engines and generators, and reduces noise.

In December 2007, ARB approved the "Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port" Regulation, commonly referred to as the At-Berth Regulation. The At-Berth Regulation is intended to reduce emissions from diesel auxiliary engines, which emit diesel particulate matter and oxides of nitrogen (NOx) on container ships, passenger ships, and refrigerated-cargo ships while berthing at a California Port. The At-Berth Regulation effects the Ports of Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme.

The At-Berth Regulation requires vessel fleet operators visiting to either: 1) turn off auxiliary engines and connect the vessel to some other source of power, most likely grid-based shore power; or 2) use alternative control technique(s) that achieve equivalent emission reductions. Vessels are defined, for the most part, to include cruise ships (which berth in SF) and container ships, which most often berth at the Port of Oakland.

The Air District provides financial support, on a case-by-case basis, for the development of shore-power projects that reduce emissions from ships while at berth. Funds are provided through the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer

Program) which provides grant funding for cleaner-than-required engines and equipment. The Air District administer these grants and selects which projects to fund. Eligible projects include cleaner on-road, off-road, marine, locomotive, lawn & garden, light duty passenger vehicles being scrapped and agricultural equipment. For shore power projects, only applicants that can demonstrate that the project is not required by the ARB Shore Power Regulation are eligible.

Implementation Actions:
The Air District will:

- Work with the Ports of Oakland, San Francisco, Richmond, & Redwood City to develop a Green Ports incentive program in the Bay Area.
- Continue to provide financial support on a case-by-case basis for the development of shore-power projects that reduce emissions from ships while at berth.

Emission Reductions:

Pollutants*	2020	2030
NO_x	75	38

**criteria pollutants and TACs are reported in lbs/day*

Emission Reduction Methodology:
For the purposes of estimating emission reductions from a Green Ports program, Air District staff assumed that by 2020, the incentives would be sufficient to attract 100 Tier 2 compliant and 50 Tier 3 compliant vessels to Bay Area ports. Vessels are assumed to be container ships that remain in the Bay for 24 hours, proceed directly to and from the assigned berth for a total transit time of 2 hours, operate on fuel compliant with ARB's low-sulfur fuel rule, and are connected to shore power while at berth. Each vessel is assumed to have a main engine rated at 43,000 kilowatts.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
Based on the assumptions used to estimate emission reductions for this measure, costs in 2020 will be $5.5 million for incentives, while costs in 2030 will be $2 million

Co-benefits:
More fuel efficient engines with lower NOx may also reduce GHG emissions attributable to local shipping activity.

Issues/Impediments:

The most significant challenge to implementing this measure will be the willingness of both the local ports and ship operators to fund and participate in a Bay Area Green Ports program.

Sources:

1. US EPA, Ocean Vessels and Large Ships: EPA Actions website, accessed September 22, 2014; http://www.epa.gov/otaq/oceanvessels.htm https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/
2. Wyenn, Morgan: *LA and Long Beach Ports adopt Clean Ship Programs in Hopes to Reduce Air Pollution*, May 9, 2012; http://switchboard.nrdc.org/blogs/mwyenn/la_and_long_beach_ports_adopt.html
3. The Port of Long Beach, *The Port of Long Beach Green Ship Incentive Program* brochure; http://www.polb.com/civica/filebank/blobdload.asp?BlobID=9768
4. San Pedro Bay Ports Clean Air Action Plan; The Port of Los Angeles and the Port of Long Beach; October 2010, http://www.cleanairactionplan.org/reports/documents.asp
5. California Air Resources Board, *Mobile Source Strategy*, May 16, 2016.

TR21: Boats: Cleaner Commercial Harbor Craft

Brief Summary:
This measure supports control technologies that could be deployed on commercial harbor craft to reduce emissions beyond what is required by the statewide Harbor Craft Regulation. Possible technologies include wind assist, hybrid systems, use of alternative fuels, retrofit of existing older marine engines with selective catalytic converters, and diesel particulate filters.

Purpose:
This measure will reduce emissions of the key ozone precursors, ROG and NOx, through the development and use of cleaner commercial harbor craft engines. In addition, the measure will reduce emissions of particulate matter, toxic air contaminants and greenhouse gases.

Travel Market Affected:
This measure would affect emissions from travel done via commercial harbor craft, including ferries, excursion vessels, tugboats, towboats, and commercial and charter fishing boats in the Bay Area.

Regulatory Context and Background:
There are several types of harbor craft used in California and in the Bay Area, including crew and supply boats, charter fishing vessels, commercial fishing vessels, ferry/excursion vessels, pilot vessels, towboats or push boats, tug boats, and work boats. Approximately eighty percent of commercial harbor craft engines operating in California are unregulated diesel engines, accounting for approximately 6,600 pounds per day of diesel particulate matter and 146,000 pounds per day of NOx.

On April 12, 2010, ARB submitted to U.S. EPA a request pursuant to section 209(e) of the Clean Air Act, regarding ARB's regulations to enforce emission standards for new and in-use commercial harbor craft operated within California waters and twenty-four nautical miles of the California coastline. ARB approved the final commercial harbor craft regulations on September 2, 2008. ARB's commercial harbor craft regulations became operative under California state law on November 19, 2008. The regulations are codified in title 13, California Code of Regulations (CCR), section 2229.5 and title 17, CCR section 93118.5.

For new harbor craft, each propulsion and auxiliary diesel engine on the vessel is required to be certified to the most stringent federal new marine engine emission standards for that engine's power rating and displacement in effect at the time of sale, lease, rent, or acquisition. The commercial harbor craft regulation imposes additional requirements for larger new ferries (with the capacity to transport seventy-five or more passengers), either by using best available control technology ("BACT"), or by using a federal Tier 4 certified propulsion engine.

For in-use harbor craft, new or in-use diesel engines may not be sold, offered for sale, leased, rented, or acquired unless the diesel propulsion or auxiliary engines are certified to at least the federal Tier 2 or Tier 3 marine emission standards for new engines of the same power rating and displacement. In-use emission requirements are imposed on Tier 0 and Tier 1 marine engines in ferries, excursion vessels, tugboats, towboats, push boats, and multipurpose harbor craft. Those harbor craft are required to meet emission limits equal to or cleaner than the Tier 2 or Tier 3 standards in effect at the time the engine is brought into compliance.

California's commercial harbor craft regulations also impose requirements related to monitoring, reporting and recordkeeping of compliance on owners and operators of new and in-use harbor craft. Subject to ARB approval, harbor craft owners and operators may opt to meet requirements by implementing alternative emission control strategies.

The Air District offers funding to reduce emissions from commercial marine vessels subject to ARB's commercial harbor craft regulation. Funds are available for engine replacement, engine remanufacture, engine retrofit, and shore-power projects that reduce emissions from a ship at berth (as long as the shore-power project is not required by the ARB shore power regulation).

Implementation Actions:
The Air District will:
- Focus on assisting fleets to achieve early compliance with the ARB harbor craft air toxic control measure and supporting research efforts to develop and deploy more efficient engines and cleaner, renewable fuels for harbor craft.
- Coordinate with ARB, the CEC, local port authorities and vessel owners to support field demonstrations of advanced technology for marine and off-road engines and hybrid drive trains. Targeted technology should be those that reduce both criteria pollutants and greenhouse gases at the same time by focusing on fuel economy and renewable fuels.

Emission Reductions:

Pollutants*	2020	2030
ROG	2	< 0.1
NO_x	59	29
$PM_{2.5}$	2	2
PM_{10}	2	2
DPM	2	2
CO_{2e}	1,543	1,313

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
To estimate emission reductions for this measure, Air District staff assumed that between 2016 and 2020 the typical project will consist of the replacement of pre-1988 off-road engines rated at 350 brake horse power-hour with new Tier 3 compliant engines, and that between 2021 and 2030 the typical project will replace Tier 1 compliant engines with Tier 3 compliant engines. Each engine is assumed to operate 1,000 hours with an average load factor of 43 percent. Emission reductions are based on the replacement of ten engines per year between 2016 and 2030 at an average grant of $100,000. Due to advances in engine design, new Tier 3 engines

are approximately 15 percent more fuel efficient than pre-1988 engines, resulting in reductions of CO_2.

Exposure Reduction:
This measure will reduce region-wide population exposure to air pollutants based on the estimated reduction in emissions.

Emission Reduction Trade-offs:
None identified.

Cost:
The cost to implement this measure will be determined primarily by the level of financial incentives that will be offered for early compliance with the harbor craft regulation and for the new advanced technology demonstration projects.

Co-benefits:
New engines for marine vessels are incorporating better control of lubricating oils and unburned fuel droplets from crankcases, resulting in less oil leaking into vessels, thereby reducing harmful water pollution, as well as expensive disposal procedures by vessel owners. The development of more energy efficient engines and drive-trains, as well as local development of renewable diesel should both result in energy savings and the creation of "green" jobs.

Issues/Impediments:
- Funding for demonstrations of advanced engine designs and hybrid drive trains.
- Interest from fleets in early compliance with ARB's harbor craft air toxic control measure.

Sources:
1. Federal Register Volume 76, Number 125 (Wednesday, June 29, 2011), Notices, Pages 38153-38155, from the Federal Register Online via the Government Printing Office [www.gpo.gov], FR Doc No: 2011-16398, http://www.gpo.gov/fdsys/pkg/FR-2011-06-29/html/2011-16398.htm
2. California Air Resources Board, Commercial Harbor Craft: What Owners/Operators Need to Know; revised January 15, 2014; http://www.arb.ca.gov/ports/marinevess/harborcraft/documents/chcpamphlet01162014.pdf
3. Federal Register, *California State Nonroad Engine Pollution Control Standards; Commercial Harbor Craft Regulations; Notice of Decision*, December 13, 2011; https://www.federalregister.gov/articles/2011/12/13/2011-31916/california-state-nonroad-engine-pollution-control-standards-commercial-harbor-craft-regulations#footnote-7
4. State of California, Air Resources Board, Carl Moyer Program: http://www.arb.ca.gov/msprog/moyer/moyer.htm

TR22: Construction, Freight and Farming Equipment

Brief Summary:
The Air District will work to reduce emissions from off-road equipment used in the construction, freight handling and farming industries by pursuing the following strategies: 1) offering financial incentives between 2015 and 2025 to retrofit engines with diesel particulate filters or upgrade to equipment with electric or Tier IV off-road engines; 2) work with ARB, the California Energy Commission and others to develop more fuel-efficient off-road engines and drive-trains; and 3) work with local communities, contractors, freight handlers, farmers and developers to encourage the use of renewable electricity and renewable fuels, such as biodiesel from local crops and waste fats and oils, in applicable equipment.

Purpose:
This measure will reduce key ozone precursors, ROG and NOx, through the installation of abatement devices on existing diesel equipment and offering financial incentives to replace older diesel equipment. This measure will also reduce toxic air contaminants, such as diesel particulate matter (PM), and greenhouse gases.

Source Category/Travel Market Affected:
Construction, Freight Handling, and Farm Equipment

Regulatory Context and Background:
Construction, freight and farming equipment contribute approximately 15 percent of the regional inventory of NOx emissions, and 5 percent of PM2.5 emissions. Construction equipment is also a contributor to local exposure of diesel PM. Criteria pollutant emissions from the engines in construction, freight and farming equipment, which are primarily diesel, are subject to control under regulations adopted by both ARB and U.S. EPA.

ARB's control of criteria pollutant emissions from off-road engines used in construction, freight and farming equipment was authorized by the California Clean Air Act as codified in the Health and Safety Code sections 43013 and 43018. In 1992, ARB approved initial regulations to control exhaust emissions from heavy-duty off-road compression ignition (CI) engines 175 horsepower (130 kilowatts) and above. These initial standards are referred to as Tier I standards. In 1994, ARB approved the State Implementation Plan (SIP) for ozone, which included measures calling for new state and national emission standards for off-road CI engines beginning in 2005.

U.S. EPA promulgated new emission standards for off-road engines in 1998, with ARB adopting parallel standards in 2000. The standards are phased in through two additional stages which are referred to as Tiers 2 and 3. In 2004, Tier 4 emission standards were adopted and were phased in for new engines between 2011 and 2014. The coordinated efforts of ARB, U.S. EPA, and engine manufacturers to introduce lower-emission off-road CI engines nationwide will result in substantial air quality benefits in California and the rest of the country.

However, recognizing that construction, freight and farming equipment are long-lived, with existing engines remaining in service for many years, in 2007 ARB adopted an off-road equipment regulation to accelerate reductions of NOx and diesel PM from existing off-road engines. Beginning in 2012 and through 2023, the off-road regulation requires operators of older equipment to either install abatement devices, upgrade to Tier 3 and eventually Tier 4 engines, or to retire older equipment. However, equipment used in agricultural operations at least 50 percent of the time are exempt from the performance requirements of the ARB off-road regulations.

ARB's initial AB 32 Scoping Plan, adopted in 2008, identified strategies for reducing CO2 from a variety of sources in California, including construction, freight and farming equipment. ARB's strategies include reducing the carbon content of diesel fuel; promoting alternative fuels and renewable diesel fuels; and investigating ways of increasing fuel economy.

In 2012, Governor Brown signed into law three bills – AB 1532 (Pérez), SB 535 (De León), and SB 1018 (Budget and Fiscal Review Committee) – that established the Low Carbon Transportation Greenhouse Gas Emission Reduction Fund (GGRF). This fund receives Cap-and-Trade auction proceeds and provides the framework for how the auction proceeds will be administered in furtherance of the purposes of AB 32, including supporting long-term, transformative efforts to improve public health and develop a clean energy economy. On June 23, 2015 ARB announced the availability of $47.3 million in Advanced Technology freight demonstration projects as part of their funding plan to distribute GGRF funds. These funds are open to public agencies and nonprofits. The demonstration of advanced freight technologies is an important step in reaching the state's and the Air District's air quality and GHG reduction goals, and reducing exposure to air toxics and PM in impacted communities.

In May 2016, ARB released its 2016 *Mobile Source Strategy*. For construction and other off-road equipment, ARB staff are proposing increased use of fuel derived from renewable sources, measures to improve worksite efficiencies, deployment of zero emission technologies into targeted categories, programs to encourage application of on-road engine advances to off-road equipment, and increased incentives for early deployment of clean technologies.

Implementation Actions:
This measure will primarily focus on assisting fleets to achieve early compliance with the ARB in-use off-road regulation and supporting research efforts to develop and deploy more efficient engines and cleaner, renewable fuels for construction and farming equipment.

The Air District will:

- Between 2016 and 2030 provide incentives for the early deployment of electric, Tier 3 and 4 off-road engines used in construction, freight and farming equipment. Based on the recent four years of incentives, the Air District will likely provide incentives for the replacement of 82 off-road equipment engines annually through 2020. The actual number of replacements will depend on the amount of funding available and the number of engine owners taking advantage of the incentives.

- Between 2017 and 2025, coordinate with ARB and the CEC, as well as construction firms, farmers and others, to support field demonstrations of advanced technology for off-road engines and hybrid drive trains. Targeted technology should be those that reduce both criteria pollutants and greenhouse gases at the same time by focusing on fuel economy and renewable fuels.
- Beyond 2025, provide support for the purchase of commercially available off-road equipment that runs on both renewable electricity and diesel, with an emphasis placed on fuels that can be developed and produced locally.

Emission Reductions:

Pollutants*	2020	2030
ROG	12	0.9
NO_x	111	59
$PM_{2.5}$	4	1
PM_{10}	4	1
DPM	4	1
CO_{2e}	2,575	1,931

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
To estimate emission reductions for this measure, Air District staff assumed that the typical projects between 2016 and 2020 will consist of the replacement of uncontrolled "Tier 0" off-road engines rated at 175 brake horse power-hour with new Tier 4 compliant engines; and between 2021 and 2030 the typical project will consist of the replacement of Tier 2 compliant engines with Tier 4 compliant engines. Each engine is assumed to operate 500 hours annually with an average load factor of 35 percent. Due to advances in engine design, load sensing, and idle-limit controls, new engines are approximately 25 percent more fuel efficient than Tier 1 engines, resulting in reductions of CO_2Emission reductions are based on the replacement of 82 engines per year at an average grant of $12,195.

Exposure Reduction:
Efforts to reduce diesel PM will reduce exposure of residents and workers in the vicinity of construction sites and farms. Additionally, reduction of NOx emissions will help reduce regional ozone levels/exposure, while reductions in both NOx and diesel PM emissions will contribute to reductions in the directly emitted PM and formation of secondary PM, reducing overall population exposure to fine particulate matter.

Emission Reduction Trade-offs:
The use of diesel PM filters and other abatement devices on Tier 4 compliant engines generally reduces fuel economy by approximately 3 percent however advances in engine design and load sensing generally improve the fuel efficiency of new engines. Additionally, installation of abatement devices on equipment utilizing hybrid drive systems will not result in any fuel penalties.

Cost:
Available funding from the Air District varies from year to year as approved by the Board of Directors. Between 2010 and 2014, funding ranged from $2.8 and $11.3 million. The average incentive offered to a fleet operator to purchase a Tier 4 engine or to participate in a demonstration of near-zero or zero emission equipment varies, as the number of grant applicants vary each year.

Co-benefits:
New engines for construction, freight and farming equipment are incorporating better control of lubricating oils and unburned fuel droplets from crankcases, resulting in less oil leaking on the ground, thereby reducing harmful water pollution. The development of more energy efficient engines and drive-trains, as well as local development of renewable diesel should both result in energy savings and the creation of "green" jobs. In addition, this measure will reduce black carbon, which is short lived greenhouse gas.

Issues/Impediments:
- Limited funding for demonstrations of advanced engine designs and hybrid drive trains.
- Interest from fleets in early compliance with ARB's off-road in-use engine air toxic control measure.

Sources:
1. BAAQMD, Base Year 2008 Emissions Inventory: Summary Report, May 2011
2. BAAQMD, Base Year 2008 Emissions Inventory: Source Categories, May 2011
3. BAAQMD, Source Inventory of Bay Area Greenhouse Emissions, December 2008
4. State of California, Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking: Proposed Regulation for In-Use Off-Road Diesel Vehicles*, April 2007.
5. State of California, Code of Regulations, Title 13, Section 2449 et seq., 2009
6. State of California, Air Resources Board, Carl Moyer Program: http://www.arb.ca.gov/msprog/moyer/moyer.htm

TR23: Lawn Care Equipment

Brief Summary:
Use of gasoline lawn mowers and leaf blowers contribute to air pollution, primarily through the release of volatile organic compounds (VOC) and particulate matter (PM). While progressively more stringent emission standards have reduced pollution from lawnmowers and leaf blowers, sufficient numbers of older two-stroke and four-stroke engines remain in use in the Bay Area. The Air District has pursued removal of these older engines through voluntary exchange programs that target commercial all lawn and garden equipment, including mowers and backpack-style leaf blowers. The Air District will continue this program, as well as seek funding to develop an internet-based exchange program for residential lawn care equipment.

Purpose:
Reduce VOC and PM emissions through the continuation of the Air District's Commercial Lawn and Garden Equipment Replacement program and through the development of an ongoing residential lawn mower exchange program.

Source Category:
Lawn, Garden and Utility Equipment: Gasoline Lawn Mowers and Leaf Blowers

Regulatory Context and Background:
Lawn, garden and utility equipment includes of a wide variety of small engines used in lawn mowers, leaf blowers, chainsaws, trimmers, shredders, stump grinders, commercial turf equipment and other types of equipment that collectively account for less than 6 percent of the total VOC inventory in the Bay Area. This equipment primarily uses gasoline engines, although there is some diesel and propane powered equipment. Electric powered equipment has begun to gain market share, particularly with lawnmowers, chainsaws, leaf blowers and other small equipment used by homeowners.

The small gasoline engines on lawn and garden equipment were first regulated in 1995 by ARB, with the newest, most stringent regulations becoming effective with the MY 2008 equipment. There are over 1.71 million lawnmowers and leaf blowers in the Bay Area, of which approximately 310,000 are two stroke engines. Two stroke engines generate significantly more air pollution, especially particulate matter, compared to four stroke engines. The Air District conducted lawn mower exchange programs between 1999 and 2006 by offering cash incentives to consumers to purchase electric or mechanical equipment. Residents exchanged slightly more than 7,800 two- and four-stroke lawnmowers for new electrical and mechanical mowers. Estimated emission reductions from the program were 10,600 pounds per year of ROG, NOx and PM, at an annualized cost-effectiveness of approximately $3.90 per pound.

In the *2016 Mobile Source Strategy*, ARB staff have proposed three actions to further reduce emissions from small engines: enhanced enforcement, tighter emissions standards, and incentives to increase the use of electric equipment. Because there have been high failure rates have been observed in evaporative emissions testing of small engines, ARB staff is proposing to increase enforcement of current standards with manufacturers beginning in FY 2016/17. ARB staff would develop and propose a regulation in 2018 to tighten exhaust and evaporative emission standards for small off-road engines; this proposed regulation may include incentives for manufacturers to produce zero-emission equipment and would be phased in between 2022 and 2030. ARB staff also plans to propose a combination of manufacturing and purchasing incentives to replace at least 25 percent of the existing small engines with zero emission equipment, while the remaining engines will would meet exhaust and evaporative emission standards that by 2030 would be approximately 90 percent tighter than today's standards. These proposed actions are not included in the emissions estimates below.

The Air District will focus its efforts through its grant programs by encouraging the purchase of zero emission electrical and mechanical equipment. In November 2014, $470,000 became available for a *Commercial Lawn and Garden Equipment Replacement* effort in Alameda and Contra Costa Counties. These funds were used to replace commercial lawn mowers, leaf blowers, sweepers, chainsaws, line trimmers, and hedge trimmers with zero-emission equipment.

The Air District hopes to secure funds to expand the Commercial Lawn and Garden Equipment Replacement program into all Bay Area counties, as well developing a residential program in the near future.

Implementation Actions:
The Air District will:

- Seek additional funding to expand the Commercial Lawn and Garden Equipment Replacement Program into all nine Bay Area counties.
- Establish a Residential Lawn and Garden Equipment Replacement Program.
- Explore options to expand the program to cover shredders, stump grinders, and commercial turf equipment. Expansion of the program will depend on the availability of cleaner replacement equipment, costs, and a reliable source of incentive funding.

Emission Reductions:

Pollutants*	2020	2030
ROG	1,134	2,835
NO_x	32	315
$PM_{2.5}$	63	630
CO_{2e}	8,742	21,854

**criteria pollutants and TACs are reported in lbs/day; CO_{2e} is reported in metric tons/year*

Emission Reduction Methodology:
For the purposes of estimating cumulative reductions achieved by 2020 and 2030, it is assumed that the incentive program will expend $500,000 per year to encourage the purchase of 2,000 new, zero emission electric or mechanical instead of new gasoline powered pieces of

equipment. The emission reduction estimates in the table above represent the amount of avoided emissions because 8,000 zero emission pieces will be in use in the year 2020 and 20,000 in the year 2030 due to the provision of the Air District's incentive funding. (It is assumed for these calculations that the equipment purchased between 2017 and 2020 will be retired by 2030.) Emission reductions are based on the average new gasoline equipment have small engines rated at 7 hp, consume an average of 0.3 gallons of gasoline per day and operate 1.4 hours on a typical day, and met ARB emission standards for engines manufactured beginning in 2008.

Exposure Reduction:
Gasoline engines emit high levels of hydrocarbons, many species of which are listed as air toxics. Purchasing electric or mechanical zero- emission equipment will result in reductions in toxic emissions.

Emission Reduction Trade-offs:
This measure will reduce emissions of NOx, ROG, CO, PM and CO2, but because it potentially replaces gasoline powered equipment with electric powered equivalent, it will contribute to an incremental increase in electricity production, which may cause slight increases in emissions from power plants.

Cost:
The average incentive amount provided as part of the Commercial Lawn and Garden Equipment program in Alameda and Contra Costa Counties was $940. Because the proposed program will include equipment used for both commercial and residential application, the expected average incentive amount would be $250.

Co-benefits:
Use of push lawn mowers, electric or battery lawn mowers and leaf blowers will result in reductions in water pollution and fossil fuel use. There will also be consumer savings. New leaf-blowers also operate at lower decibel levels, reducing noise impacts.

Issues/Impediments:
The main obstacle is the need to secure funding to implement this measure. While funding is potentially available through the CARB-administered Carl Moyer Program, limitations on the amount available statewide and types of qualifying equipment will mean other sources of funding will be crucial for the success of this control measure.

Sources:

1. Bay Area Air Quality Management District, *Bay Area Emissions Inventory Summary Report: Criteria Air Pollutants*, Base Year 2011, May 2014
2. Bay Area Air Quality Management District, *Staff Report: Acceptance of Funds from the National Fish and Wildlife Foundation for a Commercial Lawn and Garden Equipment Replacement Program*, November 26, 2014

3. Data on total lawn mowers and leaf blowers obtained from California Air Resources Board, Offroad2007 model
4. California Air Resources Board, *California Exhaust Emission Standards and Test Procedures for 2005 and Later Small Off-Road Engines*, July 26, 2004 (www.arb.ca.gov/regact/sore03/sore03.htm; accessed on November 18, 2016.)
5. California Air Resources Board, *Mobile Source Strategy*, May 2016

EN1: Decarbonize Electricity Generation

Brief Summary:
This measure would focus on lowering carbon emissions by switching the fuel sources used in electricity generation. The measure would promote and expedite a transition away from fossil fuels used in electricity generation (i.e., natural gas) to a greater reliance on renewable energy sources (e.g., wind, solar). In addition, this measure would promote an increase in cogeneration, which results in useful heat in addition to electricity generation from a single fuel source.

Purpose:
The purpose of this control measure is to reduce emissions of criteria pollutants, toxic air contaminants and greenhouse gases (GHGs) in the generation of electricity.

Source Category:
This measure affects electricity-generating power plants in the Bay Area.

Regulatory Context & Background:
Power plants generate electricity via a variety of fuel sources – fossil fuels (most commonly coal or natural gas), renewables (e.g., solar and wind) or other sources (e.g., nuclear). In addition, cogeneration, also referred to as combined heat and power (CHP), is the simultaneous generation of useful heat and electricity from a single fuel source. As such, CHP systems result in more “use” from a fuel source than non-CHP systems and thus increase the total efficiency of the fuel source.

As shown in Table 1, as of April 2016, nearly 85 percent of the electricity generation capacity in the Bay Area is from fossil-fueled power plants, all from natural-gas plants (CEC 2016).[1] Renewable fuel sources account for the remaining capacity (over 15 percent), with the majority of this capacity coming from wind power (nearly 13 percent). While renewable plants contribute a modest portion of the energy-generation capacity in the Bay Area, plants fueled by renewable sources account for the majority of physical electricity-generating facilities in the Bay Area (nearly 72 percent). Lastly, while nearly 64 percent of natural-gas plants in the Bay Area are CHP facilities (28 of 44), the electricity-generation capacity of these CHP plants represents less than 16 percent of the total capacity of these plants (1,011 MW of 6,351 MW).

[1] There are also ten peaker plants in the Bay Area, only used for power generation when there is high demand. These plants, all fueled by natural gas, have a total capacity of just over 775 MW.

Table 1. Electricity Generation Capacity in the Bay Area by Fuel Source

Fuel Source	**Capacity (1)** *MW (%)*	**Plants**	
		# (%)	**CHP facilities** (MW/#)
Fossil Fuels			
Natural gas	*6,351 (84.8%)*	*44 (28.4%)*	*1,011/28*
Fossil Fuels Sub-total	**6,351 (84.8%)**	**44 (28.4%)**	**1,011/28**
Renewables			
Wind	*954 (12.7%)*	*25 (16.1%)*	*-/-*
Solar	*109 (1.5%)*	*68 (43.9%)*	*-/-*
Digester or Landfill Gas	*65 (0.9%)*	*13 (8.4%)*	*13/3*
Hydroelectric	*15 (0.2%)*	*5 (3.2%)*	*-/-*
Renewables Sub-total	**1,143 (15.2%)**	**111 (71.6%)**	**13/3**
TOTALS			
	7,494	**155**	**1,024 /31**

<u>Note:</u>
1. Capacity total is 100.1 percent due to rounding.

As the regional agency responsible for protecting air quality in the Bay Area, the Air District has the authority to adopt regulations and rules to limit air emissions from stationary sources. As such, power plants must request and be granted an authority to construct and a permit to operate from the Air District that outlines the operating conditions of and emission limits at each facility. Among the permit requirements required by the Air District is the condition that combustion equipment – such as gas turbines and heat recovery boilers – use the Best Available Control Technology (BACT) to minimize emissions. In addition, projects may be subject to emission offset requirements, Prevention of Significant Deterioration (PSD) analysis requirements, and health risk screening analysis (HRSA) requirements.

Electricity is delivered to residential and commercial customers in the Bay Area via a mix of investor-owned utilities (IOU), publically-owned utilities (POU) and community choice aggregators (CCA). The dominant electricity provider in the Bay Area is the IOU Pacific Gas and Electric (PG&E). Two examples of POUs are the municipal electric utilities Alameda Municipal Power, which provides electricity to residents and businesses in the city of Alameda, and Silicon Valley Power, which provides electricity to residents and large corporations such as Yahoo in the city of Santa Clara. CCAs are growing in popularity. A CCA is a system that allows cities and counties to aggregate the buying power of individual customers within a defined jurisdiction in order to secure alternative energy supply contracts on a community-wide basis. As of mid-2016, the three operational CCAs in the Bay Area are Marin Clean Energy (MCE), serving Marin County, unincorporated Napa County and the cities of Benicia, El Cerrito, Richmond and San Pablo, Sonoma Clean Power (SCP), serving a number of cities in and unincorporated areas of Sonoma County, and CleanPowerSF, serving San Francisco City and County.

California, with its abundant natural resources, has a long history of supporting the development and utilization of renewable energy. For example, following deregulation of the electric utilities in California in 1998, the California Energy Commission (CEC) was placed in charge of a new Renewable Energy Program to help increase total renewable electricity production statewide. Among the various elements of the program, market-based incentives were provided for new and existing utility-scale facilities powered by renewable energy. In 2002, California established its Renewables Portfolio Standard (RPS) Program. This program, jointly implemented by the California Public Utilities Commission (CPUC) and the CEC, is one of the most ambitious renewable energy standards in the country. The RPS program required that all electricity retailers in California (including IOUs, POUs, and CCAs) increase procurement from eligible renewable energy resources to 20 percent by the end of 2013, then to further increase renewable procurement to 25 percent by the end of 2016, and 33 percent of total procurement by 2020. Passage of Senate Bill (SB) 350 in September 2015 increased and extended the required procurement from renewable sources to 50 percent by 2030.

Electricity providers in the Bay Area are on track to meet, and in some cases have already exceeded, these RPS goals. For example, PG&E served 29.5 percent of its retail electricity sales with renewable power in 2015, placing it ahead of the 2016 requirement, and has stated that it is well ahead of schedule in meeting the 2020 goal (PG&E 2016a). In addition, PG&E's Solar Choice Program allows customers to purchase 50 to 100 percent of their electricity needs from solar projects created for this program in PG&E's service territory (PG&E 2016b). The CCAs in the Bay Area have exceeded these goals, providing customers electricity generated with 33 percent (SCP), 35 percent (CleanPowerSF) and 50 percent (MCE), or offering for a premium 100 percent renewable energy (all three Bay Area CCAs). Similarly, Silicon Valley Power and Alameda Municipal Power offer customers the option to buy electricity generated by 100 percent renewable sources.

In addition, there are numerous efforts at the State level to promote the development of CHP. For example, ARB's Initial Scoping Plan (2008) outlines a target of 4,000 MW of additional CHP capacity, and an associated reduction of 6.7 MMT CO_2e, by 2020. Similarly, AB 1613, the *Waste Heat and Carbon Emissions Reduction Act*, created a feed-in tariff to incentivize the development of small CHP (no larger than 20 MW). In addition, in 2010, Governor Brown called for an additional 6,500 MW of new CHP capacity by 2030 in his Clean Energy Jobs Plan.

Implementation Actions:
The Air District will:

- Engage with PG&E, municipal electric utilities and CCAs to maximize the amount of renewable energy contributing to the production of electricity within the Bay Area as well as of electricity imported into the region.
- Work with CCA networks (such as LEAN Energy) to explore options for supporting the formation of new CCAs, such as providing start-up funding or credit guarantees.
- Support the development of bioenergy to displace electricity generated from fossil fuels. Track and participate in the state's Bioenergy Interagency Working Group. Engage with stakeholders including dairy farms, forest managers, water treatment facilities, food

processors, public works agencies and waste management to increase use of biomass in electricity production. The Air District's role may be to facilitate pilot testing of new technologies and applications, expedite Air District permitting of biofuel facilities, provide technical analysis, etc.

- Expedite Air District permitting for new, large-scale renewable energy generation facilities, biofuel facilities, and high-efficiency CHP facilities.
- Explore developing grant and/or incentive programs to facilitate, promote and pilot test new renewable energy-based electricity technologies and applications, such as energy storage technology.

Emission Reductions:
Emission reduction estimates are not available.

Emission Reduction Methodology:
N/A

Exposure Reduction:
The decarbonizing of fuel sources used to generate electricity in the Bay Area would result in fewer GHG and criteria pollutant emissions. In addition, as generation of electricity shifts away from fossil-fueled power plants to plants fueled by renewable sources (either because plants are converted or production at these plants is lowered), communities located near fossil-fueled power plants would be exposed to lower levels of criteria pollutants and toxic air contaminants. Moreover, increased efficiencies with CHP would reduce fuel consumption which in turn lowers GHG and criteria pollutant emissions.

Emission Reduction Trade-Offs:
None anticipated.

Cost:
To shift electricity generation at power plants in the Bay Area away from fossil fuels to renewable sources, existing plants would need to be modified and/or new (renewable) plants would need to be constructed. This effort would require considerable upfront capital investment. At the same time, renewable power plants (particularly solar and wind) have considerably lower operational costs than traditional fossil-fuel plants – in part because the "fuel" used is essentially free – such that this initial investment would be returned on a shorter term.

Co-Benefits:
In addition to the emission reduction benefits of decarbonizing electricity generation, a greater reliance on renewable fuel sources has these additional benefits:

- There is an essentially endless supply of many of these resources (e.g., wind and solar), some are generated as byproducts of other industries (i.e., biomass) and others are replenished over time (i.e., hydro).

- Once fully developed, these facilities are much more cost-effective as the fuel source is far cheaper than coal and/or natural gas.
- Power generation from these sources (esp. wind and solar) are isolated from fluctuations in economic markets and are not affected by international political instability.
- There are economic benefits associated with manufacturing and maintaining renewable power plants, keeping businesses and jobs in California.

Additional benefits from CHP include:
- Reduced electricity losses from transmission and distribution along power lines due to electricity and heat being generated on-site.
- Increased reliability for critical facilities, such as hospitals, data centers, prisons, and wastewater treatment plants.

Issues/Impediments:
Fossil-fuel power plants typically generate greater quantities of electricity than renewable plants (e.g., solar and wind farms need substantial amounts of land), so there is the challenge of generating enough electricity to meet demand via renewable sources. In addition, renewable energy sources have issues with the reliability, predictability and consistency of the supply since renewable energy often relies on the weather for its source of power. For example, hydro generators need rain to fill dams to supply flowing water, wind turbines need wind to turn the blades, and solar collectors need clear skies and sunshine to collect heat and make electricity. When these resources are unavailable, so is the capacity to make energy from them. Similarly, the intermittent nature of many renewables renders them non-dispatchable and thus ineffective at responding to changing demand, especially meeting peak demand. As such, developing systems to cost-effectively store this energy for later use is key to improving the viability of renewable energy. Lastly, there are issues with grid reliability and integration associated with the intermittent nature of power generated by way of renewable resources (especially wind and solar).

Sources:
1. California Air Resource Board, *Climate Change Scoping Plan – a framework for change*, December 2008.
2. California Energy Commission, *California Electricity Data, Facts, & Statistics*, California Power Plant Database (Excel File), created on April 12, 2016, website accessed at http://energyalmanac.ca.gov/electricity/ on July 13, 2016.
3. CEC, *California Electricity Producers*, http://energyalmanac.ca.gov/electricity/overview.html.
4. CEC, *California Renewable Energy Overview and Programs*, http://www.energy.ca.gov/renewables/.
5. CEC, *Combined Heat and Power*, http://www.energy.ca.gov/chp/.
6. California Public Utilities Commission, California Renewables Portfolio Standard (RPS), http://www.cpuc.ca.gov/PUC/energy/Renewables/.

7. PG&E, 2016a, *PG&E Achieves Major Renewable Energy Milestone*, http://www.pgecurrents.com/2016/02/25/pge-achieves-major-renewable-energy-milestone/, posted February 25, 2016.
8. PG&E, 2016b, *PG&E's Solar Choice Program*, http://www.pge.com/en/myhome/saveenergymoney/solar/choice/index.page.

EN2: Decrease Energy Use

Brief Summary:
This measure focuses on decreasing energy use in the Bay Area by (1) increasing consumer awareness about energy efficiency through education and outreach and (2) tracking electricity use.

Purpose:
The purpose of this control measure is to decrease the amount of energy consumed in the Bay Area through increased efficiency and conservation. With decreased energy use, less electricity generation is required, and thus there would be a reduction in the emissions of greenhouse gases (GHGs), criteria pollutants and toxic air contaminants (TACs).

Source Category:
This measure affects electricity-generating power plants.

Regulatory Context & Background:
Table 1 indicates the electricity usage in the nine-county Bay Area for the last ten years broken down by non-residential and residential users (CEC 2016). After a sharp increase in electricity usage from non-residential users in 2007 and 2008, non-residential usage fell in 2009 and has gradually climbed since to just under 40 million megawatt hours (MWh) annually in 2014. Residential electricity usage has followed a slightly different pattern, with a one-year peak in 2006 followed by lower usage that gradually increased through 2009, and then slowly declined in the last five years, capped by a sharper drop to under 16 million MWh annually in 2014. Overall, since climbing until a peak in 2008, total electricity usage in the nine-county Bay Area has averaged just over 55 million MWh annually. In addition, over this ten-year period, the split between annual non-residential and residential usage has remained quite constant, with non-residential users accounting for approximately 71 percent of electricity consumption annually and residential users some 29 percent.

Table 1. Electricity Consumption in the nine-county Bay Area (in million MWh)

	2005	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***
Non-Residential	37.4	37.9	40.1	40.4	38.8	38.7	39.3	38.9	39.3	39.7
Residential	15.9	16.5	16.0	16.2	16.3	16.2	16.3	16.2	16.1	15.7
Total	**53.3**	**54.4**	**56.1**	**56.6**	**55.1**	**54.9**	**55.6**	**55.1**	**55.4**	**55.4**

Projections of electricity consumption over the next decade indicate that demand for electricity will increase over this time period as a result of economic and demographic growth (Kavalec 2015).[1] Specifically, in the Bay Area, electricity consumption is expected to increase 0.98 percent annually under a low-energy demand scenario to as much as 1.66 percent annually

[1] This study also considered the effect of other factors – such as electricity rates and the effects of efficiency programs and on-site electricity production - on electricity demand.

under a high-energy demand scenario each year between 2013 and 2025.[2] Statewide, the majority of this annual increased demand would be attributed mostly to growing demand in the residential sector (1.44 to 2.29 percent), more moderate demand growth in the commercial sector (0.97 to 1.79 percent) and limited demand growth (or even decrease) in the industrial sector (-0.42 to 0.44 percent). It is reasonable to expect that demand will continue to increase beyond 2025 along with expected increases in both the population and job numbers in the Bay Area, as shown in Table 2 (ABAG 2013).

Table 2. Total Population and Jobs in the Bay Area: 2005 through 2040.

	2005	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Population	7,096,500	7,150,739	7,461,400	7,786,800	8,134,000	8,496,800	8,889,000	9,299,100
Jobs	3,449,740	3,385,300	3,669,990	3,987,150	4,089,320	4,196,580	4,346,820	4,505,230

Sources: Numbers from ABAG 2013.

It is important to note that demand for electricity would also grow as a result of increased electrification across sectors (i.e., switching from fossil fuels to electricity as a fuel source), a key component of the Air District's regional GHG-reduction efforts. For example, control measure BL2: Decarbonize Buildings calls for replacing furnaces, water heaters and other appliances in buildings currently powered by fossil fuels with low- and zero-carbon alternatives, including electric-powered options. Similarly, control measure TR14: Cars & Light Trucks promotes the replacement of fossil-fueled vehicles with electric vehicles. While these efforts to increase electrification would result in an overall decrease in GHG emissions, they would also put upward pressure on electricity demand.

At the same time that electricity consumption is expected to increase in the future, emissions of GHGs from electricity generation are actually expected to decrease over this time period.[3] This decline in emissions is largely the result of implemented policies that serve to lower GHG emissions from this sector by increasing reliance on renewable sources to generate electricity, such as the Renewable Portfolio Standard.

This control measure serves to strengthen another important factor in lowering GHG emissions from this sector - reducing energy use. Much of this effort to date has taken the form of energy-efficiency programs, which originated during the energy crisis of the 1970s with the emergence of the concept of "energy conservation" as a means for customers to cope with soaring energy prices (ACEEE 2015). Since that time, despite a decline in energy efficiency programs with utility deregulation in the 1990s, these programs have expanded and are widely regarded as an integral and highly valuable element of utility investments and operations that provide significant energy and economic benefits to both the utility and ratepayers, while also

[2] This forecast is for the Pacific Gas and Electric Company (PG&E) planning area, which extends beyond the Bay Area into more northern, southern and eastern portions of the state. PG&E is the principal electricity provider in the Bay Area.

[3] GHG emissions from the energy sector include emissions from electricity generated and used within the Bay Area, and electricity generated outside the Bay Area that is imported into and used within the region (BAAQMD 2015).

generating jobs and reducing emissions of air pollutants. California's investment in energy efficiency programs has resulted in per capita energy use in California remaining essentially flat since the 1970s, while per capita consumption in the rest of the United States has increased by about 33 percent (CPUC 2015).

Energy efficiency programs in California either focus on achieving in-the-moment demand reductions, or on longer-horizon energy consumption reductions. For example, Flex Alerts, issued by the California Independent Systems Operator (ISO), are urgent, voluntary calls to conserve electricity and shift demand by using major appliances after 6 pm. This program decreases not only energy consumption but also the reliance on peaker plants, which generate electricity only when there is high demand and generally emit more criteria pollutants and GHGs than facilities that run consistently. Longer-horizon programs include Energy Upgrade California, a state initiative to help Californians make investments to save energy and conserve natural resources, help reduce demand on the electricity grid, and make informed energy management choices at home and at work. Regionally, the Bay Area Regional Energy Network (BayREN), a collaboration of the nine Bay Area counties led by the Association of Bay Area Governments, implements a series of initiatives that deliver energy savings such as providing technical assistance to consumers and contractors to retrofit housing units, offering energy-saving rebates for the housing sector, and offering multiple financing options to assist diverse consumers in undertaking energy projects. Locally, cities and counties across the Bay Area have adopted a wide range of policies, including measures in their climate action plans, aimed at increasing energy efficiency such as facilitating energy audits of buildings and promoting energy-efficiency retrofits of existing homes and commercial buildings.

As noted in ARB's 2008 Climate Change Scoping Plan, one of the challenges to fully implementing energy efficiency programs and actions is lack of access by the public, residents and business to information about these programs, their benefits, and how to participate in them. Therefore, while California has a long history of success in implementing regulations and programs to encourage energy efficiency, additional efforts are needed to overcome the information barriers to provide the benefits of increased efficiency to more Californians and, in doing so, help meet California's GHG emission goals. This control measure serves to overcome these challenges.

Implementation Actions:
The Air District will:

- Provide education and outreach about energy-efficiency programs and financing available to local governments, residents, and businesses in the Bay Area.
- Increase consumer awareness about energy efficiency benefits by incorporating this message into existing outreach programs such as Spare the Air, outreach to Bay Area schools, community engagement campaigns, etc.
- Work with partners such as PG&E, municipal utilities and community choice aggregators to develop messaging to decrease electricity demand during peak times.
- Distribute information on state and local energy-efficiency programs to permitted sources.

- Work with local governments to adopt additional energy-efficiency policies and programs, including within climate action plans and other local plans, and to identify resources for tracking building stock information (e.g., square footage, age of buildings) to inform future policy-making.

Emission Reductions:
Due to the uncertain nature of the implementation actions, emission reductions cannot be quantified.

Emission Reduction Methodology:
NA

Exposure Reduction:
Reducing energy use would reduce the need to generate electricity in or import electricity into the Bay Area. As electricity generation drops, communities located near fossil-fueled power plants would be exposed to lower levels of criteria pollutants and TACs.

Emission Reduction Trade-Offs:
This control measure is designed purely to reduce energy consumption, so there would be no direct emission trade-offs. There may be indirect emissions associated with the production and delivery of some energy-efficient technologies.

Cost:
NA

Co-Benefits:
In addition to a reduction in emissions of GHGs, criteria pollutants and TACs, there are a number of co-benefits associated with reducing demand for electricity:

- Improved air quality near power plants (due to reduced production);
- Increased reliability of power supply and cost; and
- Financial savings through reduced energy usage.

Issues/Impediments:
No significant issues or impediments are anticipated due to the voluntary nature of this control measure.

Sources:

1. American Council for an Energy-Efficient Economy, *Energy Efficiency Programs*, http://aceee.org/portal/programs, accessed on September 28, 2015.
2. Association of Bay Area Governments, *ABAG Projections 2009: Regional Projections*, http://www.abag.ca.gov/planning/currentfcst/regional.html.
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6. California Air Resources Board, 2008, *Climate Change Scoping Plan – a framework for change*.
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8. California Public Utilities Commission, *Energy Efficiency*, http://www.cpuc.ca.gov/PUC/energy/energy+efficiency/, accessed on September 28, 2015.
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BL1: Green Buildings

Brief Summary:
This control measure would increase energy efficiency and the use of onsite renewable energy—as well as decarbonize existing end uses—for all types of existing and future buildings. The measure includes policy assistance, incentives, diffusion of public information, and targeted engagement and facilitation of partnerships in order to increase energy efficiency and onsite renewable energy in the buildings sector.

Purpose:
This measure will reduce greenhouse gas (GHG) emissions, criteria pollutants and toxic air contaminants (TACs) associated with the operation of buildings.

Source Category:
Building energy use, including electricity and natural gas use.

Regulatory Context and Background:
The majority of the residential building stock was constructed prior to 1978, when the first statewide building energy efficiency standards, Title 24, Part 6 of the California Building Code, were implemented. The California Energy Commission periodically updates these standards, however, the standards and their updates focus on new construction and alterations, leaving a large part of the building stock unaffected by these statewide requirements. There are approximately 2.8 million housing units in the Bay Area (ABAG/MTC 2013) and 70 percent of them were built prior to 1980 (ACS 2012). In order to meet this challenge, Governor Brown is making energy efficiency in existing buildings a pillar of the State's plan to reduce GHG emissions. Senate Bill 350, passed by the Legislature in September 2015, calls for a doubling of energy efficiency in existing buildings throughout the state.

According to state law, only the California Building Standards Commission can establish building standards, with energy efficiency standards developed by the California Energy Commission. Air Districts do not have the legal authority to adopt or enforce building standards. However, cities and counties may adopt local ordinances that exceed state energy efficiency standards under certain conditions. Many local jurisdictions in the Bay Area have adopted ordinances that require higher energy efficiency standards than those under Title 24. These municipal ordinances largely focus on reducing energy use in new construction rather than mandating changes to existing buildings when a change in ownership or the structure itself would provide an opportunity to upgrade the properties. Some local jurisdictions have enacted voluntary efforts to improve energy efficiency and increase the rates of adoption for onsite renewable energy (e.g., solar photovoltaic systems). These programs have also helped offset participating buildings' demand for energy from nonrenewable sources to some degree. Some buildings have even been able to generate an energy surplus that utility companies have purchased based on rates set by state law. Local ordinances and programs that address energy efficiency in new construction are important, but existing buildings also need to be addressed in order to meet California's energy efficiency goal and the Air District's regional GHG reduction target.

Various financing options, including rebates and tax incentives, have led to wider adoption of energy saving improvements and renewable energy technology. On-bill financing of energy improvements has helped some California utility customers make improvements that immediately reduce their energy bill, which allows them to realize significant long-term energy savings and enjoy cost savings once they finish paying for their improvements in the near- to mid-term. Programs that provide public funding for private energy improvements, such as the Low-Income Weatherization Program (LIWP) or Bay Area Regional Energy Network (BayREN), help realize energy savings for many households and property owners who would otherwise be unable to afford it. BayREN is a collaboration of the nine counties, ABAG, and the PUC designed to implement scalable regional initiatives that deliver effective energy savings. BayREN programs include such initiatives as providing technical assistance to consumers and contractors to retrofit housing units, offering energy-saving rebates for the housing sector, and working with local agencies to enhance energy code compliance. To date, over 2,200 single-family homeowners in the Bay Area have participated in BayREN's Home Upgrade Initiative and completed their projects. More than 1,400 more have participated in its Assessment Incentive Initiative. To date, 15,896 multi-family units have completed the BayREN Multi-family program that offers free technical assistance and rebates for energy efficiency upgrades.

Another energy financing option is Property Assessed Clean Energy (PACE) programs. PACE programs are financing approaches that help residential and commercial property owners fund energy efficiency upgrades, and on-site renewable energy systems. Thousands of homeowners have used PACE to secure 100 percent upfront financing for building performance upgrades that are repaid over time through a voluntary special assessment on their property tax bill. All Bay Area counties are now participating in at least one of the PACE financing programs for single-family housing, which means that all homeowners can apply for financing for energy improvements. Almost all Bay Area jurisdictions also have a multi-family and commercial PACE program available.

State laws and regulations, utility company policies and the choices of utility consumers have helped to improve energy efficiency and the percentage of renewable energy in the region's energy mix. For example, in addition to increasing energy efficiency of existing buildings, Senate Bill 350 calls for a 50 percent renewable content in the statewide electricity mix by 2050. Rebate programs by utility companies combined with state and federal tax breaks have incentivized many utility customers to make energy efficiency upgrades or replacements. This means that less electricity will be used to operate residential, commercial, institutional and industrial buildings. Decarbonizing buildings by moving away from natural gas appliances in favor of electric-powered end uses and stimulating the use of onsite renewable energy will help the region contribute to meeting the state's goal while reducing emissions of GHGs, TACs and criteria pollutants.

Implementation Actions:
The Air District will implement the following approaches in an effort to reduce building-related emissions.

Policy Assistance to Local Jurisdictions

- Develop or identify and promote best practices and model ordinances such as:
  - requiring energy assessments, building benchmarking and/or upgrades at time of sale
  - requiring or incentivizing best practices such as: cool roofs and pavement; solar roofs; geothermal or electric heat pumps and solar water heating; streamlining, coordination and reduction of permit fees for energy efficiency/low carbon strategies; or use of green concrete and other low-energy building materials
  - implementing innovative development strategies, such as transferable development credits that limit the overall amount of conditioned space in an area.
- Engage local jurisdictions and the California Energy Commission to identify barriers to effective local implementation of the CALGreen (Title 24) statewide building energy code, and develop solutions to improved implementation/enforcement.
- Provide information and/or guidance on developing funding mechanisms (such as carbon fees) that generate revenue to reinvest in local climate protection programs.

Incentives

- Develop tools and incentives to facilitate PACE financing.
- Work with ABAG's BayREN program to make additional funding and other financial incentives available for energy-related projects in the buildings sector.
- Develop or identify and promote financing options for property owners and utility customers to implement energy-related projects (e.g., public agencies purchasing solar systems in bulk to secure discounts; working with state officials and county tax assessors to develop tax incentives).

Targeted Engagement and Partnerships

- Partner with KyotoUSA to identify energy-related improvements and opportunities for onsite renewable energy systems in school districts, and investigate funding strategies to implement upgrades.
- Explore opportunities to advocate at the state level to allow air districts to promulgate rules that establish green building standards that apply at a regional level.
- Engage with partners (e.g., BayREN) to target reducing emissions from specific types of buildings or certain geographic areas (e.g., neighborhoods with older homes are most in need of upgrading).

Emission Reductions:

Pollutants*	2020	2030
ROG	7	30
NO_x	78	367
$PM_{2.5}$	12	53
SO_2	2	9
CO_{2e}	37,149	141,767

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Methodology:
Only actions that support energy efficiency were quantified in this control measure. Actions that support implementation of renewable energy programs and projects are considered supportive measures of control measure BL2: Decarbonize Buildings and are quantified under that control measure. Average participation rates for existing buildings are derived from local climate action plans, and then multiplied by the number of existing residential buildings. The same was done for new housing stock derived from ABAG's 2013 Projections for the years 2016 to 2030. Energy use data in the residential sector, including average energy consumption by end use, were determined from a number of sources including CEC, USDOE, RECS and AHS/ACS (U.S. Census) reports. These figures were then multiplied by the most recent CO_2e emission factors from PG&E, assuming that California would meet its 2030 renewable portfolio standard of 50 percent.

Commercial participation rates were determined in a similar approach as the residential sector and were multiplied by the amount of commercial space available in the Bay Area. New regional commercial building stock was determined based on the anticipated number of new jobs multiplied by the current amount of square feet used by employees today. Commercial sector energy use data, including average energy consumption by end use in existing buildings and energy savings, were determined based on a number of sources including CEC, USDOE, and CBECS (U.S. Census) reports.

Saving energy will also reduce various criteria pollutants including NOx, ROG, $PM_{2.5}$ (all PM from domestic natural gas production is considered to be < 1 micron), CO and SO_2. Emission reductions were estimated for grid-sourced electricity from Bay Area power plants that was replaced by renewable energy (e.g., solar photovoltaics) using 2014 emission factors from PG&E.[1] Emission reductions associated with natural gas were also estimated using PG&E emission factors for 2014.

Given that the majority of the implementation actions in this control measure are voluntary, emission reduction estimates for both 2020 and 2030 were revised down by 50 percent in order to conservatively estimate the impact of this control measure.

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[1] Electricity imported from outside the region was not included in total electricity used to calculate criteria pollutant emission reductions because these emissions have no impact on regional air quality in the Bay Area.

Exposure Reduction:
This measure could help to reduce exposure in impacted communities that are located near power plants, particularly "peaker plants," due to the reduction in electricity use. In addition, decarbonizing area sources like furnaces, water heaters and woodstoves that rely on combustion will reduce the prevalence of particulate matter and TACs both in residential units and nearby.

Emission Reduction Trade-offs:
This control measure is designed to reduce energy consumption, so there would be no direct emission trade-offs. There might be an increase of indirect emissions associated with the production and delivery of some energy efficient technologies.

Cost:
The cost of implementing the action items will be borne by public agencies, companies and individual households. Public agencies could also incur direct costs from directly financing programs aimed at improving energy efficiency or encouraging renewable energy projects. For example, Renewable Funding, one of the largest financing companies for PACE programs, estimates that every $10,000 provided by the Air District or other public entity to cover transaction costs would leverage approximately $250,000 in PACE financing for building owners. Local jurisdictions could forgo revenue by lowering certain fees or taxes intended to stimulate projects. Households would also incur upfront costs by investing in projects that boost energy efficiency or implement renewable energy for their homes, while accruing net savings over the long-term.

Co-benefits:
Increasing energy efficiency and onsite renewable energy generation will result in a number of co-benefits, including:

- Improved air quality near power plants (due to reduced production)
- Increased reliability of power supply and cost
- Reduced capital costs for utilities by avoiding upgrades and expansions
- Energy savings, including savings by reducing distribution losses between power plants and the end user
- Financial savings for utility customers through reduced energy usage
- Green job creation (local manufacturers/suppliers/contractors for installing technologies)
- Increased property values
- More transparency and certainty in real estate market by allowing a prospective property owner to know the energy performance of a structure

Issues/Impediments:
Significant impediments to the voluntary approaches described in this measure are not anticipated. At the local level, jurisdictions may face resistance for some of the ordinances due to concerns about the cost of implementation. Significant impediments to implementation of the incentive-based components to this control measure are not anticipated, however,

provision of financial incentives would depend upon the availability of adequate financial resources.

Sources:

1. Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC). 2013. *Plan Bay Area: Strategy for a Sustainable Region*. http://planbayarea.org/plan-bay-area/final-plan-bay-area.html.
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BL2: Decarbonize Buildings

Brief Summary:
This control measure would reduce greenhouse gas (GHG) emissions, criteria pollutants and toxic air contaminants (TACs) by limiting the installation of space- and water-heating systems and appliances powered by fossil fuels. This measure will be implemented by developing model policies for local governments that support low- and zero-carbon technologies as well as potentially developing a rule limiting the sale of natural gas furnaces and water heaters.

Purpose:
This measure will reduce GHGs, criteria pollutants and TACs associated with the burning of fossil fuels by limiting the sale and installation of natural gas furnaces, water heaters and appliances, and by encouraging the use of low- and zero-carbon technology alternatives throughout buildings in collaboration with local governments.

Source Category:
Area sources – fossil-fuel powered furnaces, water heaters and appliances.

Regulatory Context and Background:
Residential and commercial building occupants often rely on natural gas to power furnaces, water heaters, stoves, and clothes dryers, making building-related combustion a significant contributor to GHG emissions and other air pollutants in the Bay Area. In 2010, there were almost 2.8 million housing units in the Bay Area and by 2040 the number of housing units is expected to exceed 3.4 million. Currently, the majority of residents in single-family homes and multi-unit residences use natural gas for space and water heating, and many households use natural gas for other end uses such as cooking and clothes drying. As a result, residential end uses are responsible for about two-thirds of regional GHG emissions directly emitted from buildings. The burning of fossil fuels in both residential and commercial buildings was responsible for approximately 12 percent of regional GHG emissions in 2015. In 2011, residential combustion was responsible for roughly 25 percent of total Bay Area fine particulate matter ($PM_{2.5}$) emissions. Residential combustion also generates a significant amount of nitrogen oxides (NOx) and carbon monoxide (CO) emissions. Fossil fuel combustion in buildings also produces TACs including polycyclic aromatic hydrocarbons (PAHs) and formaldehyde, both of which have been identified as carcinogens.

Direct emissions from buildings can be eliminated by switching to renewable energy technologies, or greatly reduced by switching to electricity, in order to heat space and water as well as to cook food and dry clothes. For example, ground-source heat pumps (GSHP) or air-source heat pumps (ASHPs) can replace natural gas-powered central furnaces and wood-burning heating systems. The GSHP technology uses a heat-exchanging fluid flowing through a series of underground lines to heat and cool buildings. Since GSHP systems cool or heat a building using only the electricity needed to circulate the heat exchanging fluid, they are highly energy efficient. ASHP technology works in a similar fashion using the ambient air, but tends to be less efficient than geothermal systems.

Reducing emissions from water heating is also possible through the use of solar and electric water heaters. Solar water heater systems use the energy of the sun to directly heat water before the water is sent to a storage tank. This storage tank can be a traditional water heater or the system can be combined with electric tankless water heaters to ensure an adequate supply of hot water. A residential or commercial building that uses a GSHP or ASHP for space heating can use the excess heat captured with a de-superheater to heat the building's water.

Certain natural gas appliances can also be supplanted by electric-powered alternatives. Induction stoves use electricity to generate a magnetic field that creates heat in the bottom of the cookware made with ferromagnetic material. This process results in less energy loss and faster cooking times. Induction also offers users greater control over cooking temperatures and therefore does not sacrifice the performance offered by gas stoves. In the case of drying clothes, gas dryers have long been touted as being more energy efficient than conventional electric dryers. However, gas dryers still use more energy than high-efficiency electric dryers. In addition, electric heat-pump dryers are the most efficient type of clothes dryer on the market. Using electricity for these end uses still results in some GHG emissions, as natural gas constitutes part of the energy fuel mix supplying the electricity used in the Bay Area. However, as the electricity mix continues to be less carbon-intensive, the GHG benefit of switching from natural gas to electricity end uses will increase.

Implementation Actions:
The Air District will:

- Explore potential Air District rule-making options regarding fossil fuel-based space and water heating systems for both residential and commercial use.
- Develop or identify and promote model policies and best practices for local governments to restrict the use of fossil fuel-based furnaces, water heaters and natural-gas appliances in buildings.
- Explore incentives for property owners to replace their furnace, water heater or natural-gas powered appliances with zero-carbon alternatives.
- Provide resources that inform building owners and tenants of the technical considerations, economic advantages and environmental benefits on low- and zero-carbon technologies such as renewable energy systems (e.g., ground source heat pumps, solar water heaters) and electrical appliances (e.g., induction stoves, ENERGY STAR clothes dryers).
- Update the Air District's CEQA Guidelines to recommend that all commercial and multifamily developments install low-GHG technology, such as ground source heat pumps, solar thermal and solar hot water heaters, as a mitigation measure when project emissions are anticipated to have a significant impact on air quality or GHGs.
- Work with local jurisdictions to include low- and zero-carbon technologies in green building ordinances for all developments where it is technically feasible.
- Advocate for state regulation updates to encourage the development and installation of low/zero-carbon technologies.
- Support the development of financial incentives, such as low interest loan programs or tax incentives that facilitate the installation of zero-carbon technologies.

Emission Reductions:

Pollutants*	2020	2030
ROG	14	54
NO_x	157	635
$PM_{2.5}$	25	98
SO_2	9	34
CO_{2e}	90,858	313,586

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Methodology:
Emission reductions are assumed to come from switching from natural gas or utility-provided electricity to renewable energy. There are four primary fuel-switching technologies that were quantified as part of this measure: solar photovoltaics, solar water heating, ground-source heat pumps, and air-source heat pumps. Participation rates for existing buildings are drawn from local climate action plans, and various reports on these technologies, and were then multiplied by the number of existing residential buildings for their respective target years. Segmentation for new housing stock was derived from ABAG's 2013 Projections for the years 2016 to 2030. Assumptions on energy savings came from a number of sources including CEC, USDOE, RECS and AHS/ACS (U.S. Census) reports.

Commercial participation rates were determined in a similar approach as the residential sector. Commercial sector energy use data, were determined based on a number of sources including CEC, USDOE, and CBECS (U.S. Census) reports. New regional commercial building stock was determined based on the anticipated number of new jobs multiplied by the current amount of square feet used by employees today. These figures were then multiplied by GHG emission factors from PG&E, assuming that California would meet its 2030 renewable portfolio standard of 50 percent.

With the replacement of natural gas furnaces and water heating systems, various criteria pollutants will be reduced, including NOx, ROG, $PM_{2.5}$ (all PM from domestic natural gas production is considered to be < 1 micron), CO and SO_2. Emission reductions were estimated for grid-sourced electricity from Bay Area power plants that was replaced by renewable energy (e.g., solar photovoltaics) using 2014 emission factors from PG&E.[1] Emission reductions associated with natural gas were also estimated using PG&E emission factors for 2014.

Given that the majority of the implementation actions are voluntary, emission reduction estimates for both 2020 and 2030 were revised down by 50 percent in order to conservatively estimate the impact of this control measure.

[1] Electricity imported from outside the region was not included in the total electricity used to calculate criteria pollutant emission reductions because these emissions have no impact on regional air quality in the Bay Area. Criteria pollutant emission factors were from the year 2014.

Exposure Reduction:
This measure will reduce region-wide population exposure to criteria pollutants as building users switch from natural gas to low- and zero-carbon systems and appliances. It will also potentially improve indoor air quality by reducing exposure to TACs within buildings.

Emission Reduction Trade-offs:
This control measure is designed to reduce energy generated from fossil fuels. There might be an increase of indirect emissions associated with the production and delivery of some energy efficient technologies. While the demand for electricity could rise with a switch from natural gas to some technologies (e.g., heat pumps), the carbon content of electricity will continue to diminish (due to the statewide Renewables Portfolio Standard and EN1: Decarbonize electricity Generation), resulting in lower net emissions.

Cost:
Cost estimates for the various actions identified for this measure will be estimated during program implementation.

Co-benefits:
Ground- and air-source heat pumps are the most efficient types of heating systems currently available. These systems can also cool residential units and negate the need for dedicated air conditioning systems. This reduces the demand for peak power used to cool residential units in warm seasons, which could offset the need for "peaker" power plants and prevent rolling blackouts. Likewise, solar water heaters reduce the need to use electricity and natural gas to heat water.

Over the life of low- and zero-carbon systems and appliances, utility customers will realize significant cost savings. These savings exceed the marginal capital cost of these systems – thereby providing a long-term net economic benefit.

Eliminating sources of combustion from residential units can also reduce the incidents of carbon monoxide poisoning and fire-related injuries and deaths due to equipment failures, accidents and natural disasters.

Issues/Impediments:
Low- and zero-carbon technologies can require a greater upfront capital investment. However, they result in reduced operating costs over the lifetime of the investment. GSHPs are expected to have a long lifespan of 50 years or more, which lowers replacement costs. Some site-specific constraints could exist for certain types of low-carbon systems. GSHPs may not be feasible due to site-specific geological conditions. ASHPs generate more noise than other heating systems and have an exterior unit (similar to certain air conditioning units) that could dissuade some potential users due to aesthetics. In the case of solar water heating, a building's surroundings (e.g., tree cover) could affect solar exposure and the performance of a system. The cultural attachment to gas stoves and the cost of purchasing new cookware could affect the adoption of induction stoves.

Sources:

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BL3: Market Solutions

Brief Summary:
This control measure will facilitate market-based solutions to reduce greenhouse gas emissions (GHGs), criteria pollutants and toxic air contaminants (TACs) from existing residential, commercial, institutional and industrial buildings. The Air District aims to create a supportive environment for inventors, entrepreneurs, and private companies as they develop innovative solutions for building-related energy and the scaling of those interventions.

Purpose:
This measure will reduce GHGs, criteria pollutants and TACs associated with the operation of buildings.

Source Category:
Building energy use, including electricity and natural gas use.

Regulatory Context and Background:
Existing buildings pose a significant challenge and opportunity to reducing emissions in the buildings sector. More than half of California's residential buildings and more than 40 percent of commercial buildings were built prior to California adopting its first energy standards in 1978 as part of the state's Title 24 building code. The Bay Area is the oldest urban area of California so it is not surprising that almost 70 percent of the Bay Area housing stock was built prior to 1980. Many of these buildings would require significant upgrades to bring their energy performance up to today's standards. Senate Bill 350, passed by the Legislature in September 2015, calls for a doubling of energy efficiency in existing buildings, yet state building energy efficiency requirements only apply to existing structures if they undergo a major renovation or addition. Innovative market-based solutions that encourage owners and tenants to voluntarily improve the energy performance of the existing building stock could play an important role in the effort to achieve GHG reductions in the buildings sector.

Individual inventors, entrepreneurs and private companies have proven their ability to bring key energy-related innovations to market. Innovative solutions have developed in response to government regulations, or in response to market forces such as high energy prices. Regardless of the motivation, the role of the market is important in the development of new energy-saving solutions, the adaptation of existing technologies to the building sector, and the marketing or scaling up of a proven energy-related solution.

The state and the federal government have played key roles in supporting market-based solutions for the building sector. Research grants, competitions and project funding have been provided for the development and commercialization of building-related technology that produces or saves energy. Each year, the Department of Energy's Energy Efficiency and Renewable Energy Office allocates hundreds of millions of dollars to building-related initiatives, programs and projects, including funding for private sector innovation. It also helps facilitate partnerships and business between private sector actors. The California Energy Commission has provided millions more annually to enable the market to provide new or expanded solutions to energy-related challenges. Some public agencies also offer “calls for innovation” that seek the private sector’s help in solving challenging energy-related problems that may currently be overlooked by the market or require incentives to develop potential solutions. For example, the U.S. Department of Energy has offered grant funding for the development of new infiltration diagnostic technologies that can be used for large buildings because existing technologies are unable to adequately quantify air leaks in the envelopes of these structures.

Implementation Action:
The Air District will consider issuing a call for innovation to support market-based approaches that bring new, viable solutions to significantly reducing GHG emissions associated with existing buildings.

Emission Reductions:
Emission reductions may be estimated during specific program implementation.

Emission Reduction Methodology:
NA

Exposure Reduction:
This control measure could reduce exposure of building occupants to certain TACs and criteria pollutants by encouraging the adoption of green technologies that emit fewer pollutants and release fewer GHGs.

Emission Reduction Trade-offs:
Certain technologies may have emission reduction trade-offs. For example, a product that helps seal a house could reduce GHGs from heating and cooling the structure, but also contribute to increased indoor air pollutants. Potential trade-offs will need to be evaluated on a project- or program-basis.

Cost:
The primary cost of implementing this measure is the award associated with the call for innovation. The size of this award, or awards, will be determined.

Co-benefits:
This control measure has the potential to increase energy efficiency and onsite renewable energy generation, which will result in a number of co-benefits including:

- Improved air quality near power plants (due to reduced electricity demand/production)
- Reduced capital costs for utilities by avoiding upgrades and expansions
- Financial savings for utility customers through reduced energy usage
- Green job creation (local manufacturers, suppliers, contractors for installing technologies, other support services, etc.)
- Increased property values

Issues/Impediments:
No significant issues or impediments are identified at this time.

Sources:

1. U.S. Bureau of the Census (BOC). 2012. 2008 – 2012 American Community Survey 5-Year Estimates, Table B25034; generated by Douglas Kolozsvari; using American FactFinder; http://factfinder2.census.gov.
2. Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy. http://energy.gov/eere/buildings/emerging-technologies.

BL4: Urban Heat Island Mitigation

Brief Summary:
This control measure aims to reduce the "urban heat island" (UHI) phenomenon by increasing the application of "cool roofing" and "cool paving" technologies, as well as increasing the prevalence of urban forests and vegetation, through voluntary approaches and educational outreach.

Purpose:
The purpose of this control measure is to reduce greenhouse gas (GHG) emissions and the formation of ground level ozone by mitigating the urban heat island phenomenon. Reducing UHI effects can reduce localized ozone levels, as well as emissions of particulate matter (PM), air toxics and greenhouse gases related to energy consumption associated with air conditioning. In addition, it can help to offset impacts of temperature increases related to global warming.

Source Category Affected:
Electricity generation for buildings and evaporative emissions from automobiles.

Regulatory Context and Background:
As urban areas develop, natural, permeable surfaces and vegetation are replaced by impermeable structures and paved surfaces. This development transforms the area into a drier micro-environment, which absorbs, rather than reflects, the heat of the sun. Thus, urban heat islands are created, which can be up to 10°F hotter than natural background temperatures. Factors that contribute to UHI formation include the following:

- many man-made surfaces composed of dark materials that absorb and store the sun's heat;
- buildings, industrial processes, and motor vehicles that produce heat;
- loss of trees and vegetation due to urbanization causing a reduction in cooling from evapo-transpiration;
- urban structures that form canyons that reduce ventilation and trap heat.

Elevated temperatures caused by UHIs can accelerate the formation of ground level ozone, or smog, and can contribute to adverse health impacts, such as respiratory and heat-related ailments. Higher temperatures can also result in increased electricity use to cool buildings. Mitigation methods include judiciously increasing the reflectivity of built surfaces, such as roads, parking lots and rooftops, increasing tree-cover and other vegetation (for shading and the cooling effect of increased evapo-transpiration), and increasing ventilation.

Cool Paving
On average, about 12 percent of an urban city's land area is devoted to parking lots. This number can be even higher in suburban communities. The hottest pavements tend to be impermeable and dark in color, with solar reflectance values (albedo) under 25 percent. These pavements can heat to 150°F or more on hot days. Utilizing cool paving techniques, such as using coatings or paving mixes that increase the road surface's reflectiveness, can reduce this

temperature by 30°F or more. Many parking lots are resurfaced every 5-10 years. The amount of parking lot construction and re-surfacing that occurs in the Bay Area provides a significant opportunity to increase albedo (reflectivity) while providing ancillary benefits such as an extended life of the paved surface and storm water benefits associated with use of permeable pavement.

Cool Roofs
Most existing flat roofs have an albedo of only 10 to 20 percent. These roofs absorb much of the remaining solar radiation and heat up the buildings they cover. Cool roofing technologies, such as lighter or more reflective paint, coatings, membranes, shingles or tiles, can increase a roof's albedo, on average, to about 50-60 percent. A 2000 study by Lawrence Berkeley National Laboratory revealed a 13-18 percent reduction in air conditioning-related electricity use in residential and commercial buildings in San Jose due to the application of cool roof strategies. While cool roofing reduces the need for air conditioning during periods of heat, it can have an opposite impact during periods of cold by reflecting solar radiation away from the buildings, potentially requiring an increase in heating during winter months. In most locations, the balance of these two effects results in a net reduction in energy use. However, in some locations, there may not be an energy reduction benefit from the application of cool roof technologies. Implementation of cool roof technologies should take into account local climate conditions across the Bay Area and potentially include mitigation strategies (e.g., attic insulation) to reduce the amount of energy needed to heat these structures on cooler days.

Urban Forests
Planting trees through a comprehensive urban forestry program can mitigate urban heat islands by reducing the amount of the sun's energy absorbed and stored by pavements and roofs, and through transpiration – the process by which plants convert moisture to water vapor and cool the air. Choosing the right trees is critical in fostering urban forests that can benefit both air quality and the global climate. Deciduous trees that provide shade in the hotter summer months but lose their leaves in the cooler winter period can have a greater positive impact on energy use than evergreen trees. In addition, some trees emit a very high level of volatile organic compounds (VOCs) whereas other trees emit very few. Some tree species also require more water than others to establish, which could increase energy use for irrigation. While this control measure focuses on tree planting on parking lots, urban tree planting is addressed more broadly in control measure NW2: Urban Tree Planting.

The California Energy Commission oversees the regular updating of the State's Building Energy Efficiency Standards for Residential and Nonresidential Buildings. These Standards apply to new construction and alterations/remodels of existing buildings, and were most recently updated in 2013. The 2013 update included, in its prescriptive approach, standards for cool roofs. Standards for cool paving were not included. Under state law, local governments (cities and counties) have the ability to adopt local energy efficiency requirements that are more stringent than the State Standards, however, air districts do not have this authority. Without direct authority to adopt building codes, the Air District's approach under this control measure is to work with local governments to adopt their own local ordinances and policies that complement the requirements set by the State.

Implementation Actions:
The Air District will:
- Develop and promote adoption of a model ordinance for "cool parking" that promotes the use of cool surface treatments for new parking facilities as well existing parking lots undergoing re-surfacing. This could include a combination of cool pavement and use of shade trees.
- Develop and promote adoption of model building code requirements for new construction or re-roofing/roofing upgrading for commercial and residential multi-family housing to accelerate implementation of and expand the number of roofs impacted by the State's Building Energy Efficiency Standards.
- Include cool roof, cool paving and parking lot tree shading as recommended mitigation measures in CEQA comments and guidance.
- Collaborate with expert partners such as LBNL to investigate the spatial and temporal variation in current and projected Bay Area temperatures and ozone levels, as well as the air quality and other health benefits that could accrue from various urban cooling measures. Include Bay Area-specific heat vulnerability assessments in the analysis.
- Collaborate with expert partners such as LBNL to perform outreach to cities and counties to make them aware of cool roofing and cool paving techniques, having white roofs on their fleets, and of new tools available.
- Develop a geographically targeted public awareness campaign for urban cooling measures.
- Support adoption of more rigorous State energy standards for cool roofs by helping the California Energy Commission incorporate quantified air quality benefits in cost-benefit analyses.
- See NW2 for proposed actions related to urban tree planting.

Emission Reductions:

Pollutants*	2020	2030
ROG	2	3
NO_x	16	31
$PM_{2.5}$	3	6
SO_2	1	3
CO_{2e}	12,831	14,512

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Methodology:
Emission reductions for this measure primarily focus on electricity demand for cooling buildings. The Air District's GHG inventory estimates indirect emissions for electricity use for both commercial and residential buildings to be 4.3MMT CO2e and 3.9 MMT CO2e per year in 2015, respectively. Title 24 energy efficiency standards require some large commercial and residential buildings to install cool roofs. It was assumed that roughly 50 percent of new and

existing commercial buildings and 30 percent of residential buildings would have a cool roof by 2030. Air conditioning accounts for roughly 15 percent of commercial electricity use and about 7 percent of residential use. It was assumed that cool roofs in the Bay Area would reduce air conditioning related electricity use by an average of 20 percent.

Due to the reduction of electricity used for cooling buildings, criteria pollutants are also expected to decrease. Emission reductions were estimated for grid-sourced electricity from Bay Area power plants only using current emission factors from PG&E[1]. All PM from domestic natural gas production-based electricity is considered to be < 1 micron and hence classified as $PM_{2.5}$. The energy reduction was assumed to be just from the implementation of cool roofs and not cool paving (which is harder to quantify), which makes the estimates more conservative.

Given that the majority of the implementation actions are voluntary, GHG emission reduction estimates for both 2020 and 2030, and criteria pollutant estimates for year 2020 were revised down by 50 percent.

Exposure Reduction:
This measure would help reduce smog formation by reducing the ambient air temperature, particularly in areas that experience excessive heat. It would be especially effective in reducing population exposure in those areas of the Bay Area that experience higher daily ambient temperatures and contain more impermeable surfaces exposed to sunlight, such as San Jose, Concord, the Tri-Valley and San Leandro/East Oakland.

Emission Reduction Trade-offs:
Caution would have to be taken in compiling the technology specifications to ensure that cool roofing and paving products that could produce toxic emissions during their use are not recommended. Trees can also contribute to emission increases. For example, some trees emit biogenic volatile organic compounds (BVOCs) that can contribute to ozone formation. The Air District will promote trees that emit fewer BVOCs.

Cost:
Cool roofs deflect some desired heat gain during the winter. In general, though, cool roofs result in net energy savings, especially in areas where electricity prices are high. Although costs will vary greatly depending on location and local circumstances, there is often no cost premium for cool roofs versus conventional roofing materials. However, in some cases, cost premiums can range from 1 to 20 percent (5 to 20 cents per square foot).

Co-Benefits:
Heat island mitigation measures bring a number of co-benefits to a community, including:

- Improved air quality
- Improved public health (lower risk of respiratory and heat-related ailments)

[1] Electricity imported from outside the region was not included in total electricity used to calculate criteria pollutant emission reductions because these emissions have no impact on regional air quality in the Bay Area.

- Greater comfort
- Energy savings
- Financial savings through reduced energy usage
- Green job creation (local suppliers/contractors for installing technologies)

Trees in particular provide for numerous additional benefits that include:
- Sequestering carbon
- Improving water quality by reducing stormwater runoff, a major source of pollution entering wetlands, streams and the San Francisco Bay
- Reducing flood risk and recharged groundwater supplies from captured stormwater
- Making the streetscape more attractive for pedestrians and cyclists
- Providing wildlife habitat in the built environment
- Prolonging the useful life of sidewalks and pavement by reducing the daily heating and cooling and thus expansion and contraction of asphalt
- Increasing property values - research suggests that people are willing to pay 3 to 7 percent more for properties with ample trees versus few or no trees
- Offering social and psychological benefits by beautifying the landscape, promoting social interactions, providing stress relief and noise reduction, contributing to public safety and providing pleasure to humans

Issues / Impediments:
Advocating for local building code requirements that include cool roof standards for re-roofing/roofing upgrades may raise concerns about a potential increase in up-front costs among some stakeholders, such as the construction and development industries or local governments. Similar requirements for cool paving may also raise concerns due to a lack of information on the availability and sourcing of these technologies and products. By promoting and encouraging adoption of these types of policies, the Air District will facilitate demonstration of the actual cost benefits of such policies and work toward overcoming these barriers. It is possible that some local jurisdictions will not have the funding available to increase the number of trees in their urban forest.

Sources:
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11. *Report on advisory Council Activities January-May 2015: Impacts of the Urban Heat Island Effect on Energy Use, Climate, Air Pollution, Greenhouse Gas Emissions, and Health*. Bay Area Air Quality Management District; June, 2015.

AG1: Agriculture Guidance and Leadership

Brief Summary:
This measure includes broad actions to reduce GHGs from the agriculture sector, including working to obtain funding for on-farm GHG reduction activities; promoting carbon farm plans; providing guidance to local governments on including carbon-based conservation farming measures and carbon sequestration in local climate actions plans and reducing conversion of agricultural lands to urban/suburban uses; and conducting outreach to agriculture businesses on best practices, including biogas recovery, to reduce GHG emissions.

Purpose:
The purpose of this measure is to reduce emissions of GHGs related to agricultural practices and preserve and enhance agricultural lands. This measure is also intended to emphasize and promote the opportunities for GHG capture, including carbon sequestration and biogas recovery, and the associated economic and environmental co-benefits.

Source Category:
Agricultural operations, including animal waste and soil tillage.

Regulatory Context and Background:
Reduce Emissions of GHGs Related to Agricultural Practices
The Bay Area has more than 8,500 agricultural operations on over 350,000 acres of productive agricultural land that provide a diversity of goods including fruits, vegetables, meat, dairy and wines. The $1.8 billion agriculture industry in the region provides jobs, contributes to the local economy, and offers other public benefits including scenic beauty, environmental value as undeveloped watersheds and wildlife habitat, and historic significance. Most agricultural operations in the Bay Area are small farms selling niche products locally, with relatively few large agricultural operations growing thousands of acres of product.

Sources of air pollution from agricultural operations can include on- and off-road trucks and farming equipment, agricultural aircraft, pesticide use, crop residue burning, animal waste, travel on unpaved roads and soil tillage. These sources can result in air pollution emissions such as ozone precursor emissions of nitrogen oxides and reactive organic gases, particulate matter (PM_{10} & $PM_{2.5}$), greenhouse gases (carbon dioxide, methane, and nitrous oxide), ammonia, hydrogen sulfides and nitrogen. While Bay Area agricultural operations contribute to air pollution levels in the region, their overall contribution is relatively small in comparison to other Bay Area sources. This measure will seek to reduce overall GHG emissions related to agricultural operations, and also promote opportunities to sequester CO_2 through carbon capture in the soil, and biogas recovery (from animal waste).

The majority (62 percent) of GHG emissions in the agriculture sector is associated with animal waste (methane from enteric fermentation and manure management). There are statewide programs addressing animal waste, but these programs are primarily focused on large scale operations and thus have little impact on Bay Area farms.

The Air District's regulatory authority in the agricultural sector varies. The Air District does not have regulatory authority over soil management, but does have authority related to biomass burning (Regulation 5) as well as the potential to impose permit limits on emissions associated with animal waste (per Regulation 2-10). The Air District is pursuing limits on emissions associated with animal waste (see AG-4).

A general strategy to reduce overall GHG emissions from the agriculture sector is for Bay Area residents to transition to a lower-GHG intensive diet. Practices like switching to vegetarian or vegan meals one or more days a week, eating locally grown/produced foods, and choosing less processed foods all contribute to lowering the GHG intensity of our diets.

Prevent Conversion of Agricultural Lands
Over the past 50 years, a large amount of agricultural land has been converted to urban/suburban uses in the Bay Area, with losses of over one-third of farmland. Agricultural lands are currently under threat from development in the Bay Area. In addition to the loss of habitat, carbon sequestration, and other ecological benefits of agriculture, conversion of farmland to urban/suburban uses also results in higher emissions of GHGs, as urban/suburban land use is associated with greater emissions of GHGs and other air pollutants.

The state's Sustainable Agricultural Land Conservation Program (SALCP) aims to reduce GHG emissions through projects that support agricultural land conservation. The SALCP compliments investments made in urban areas through the purchase of agricultural conservation easements, development of agricultural land strategy plans, and other mechanisms to result in GHG emissions reductions.

In order to address open space and agricultural preservation, Plan Bay Area identifies Priority Conservation Areas (PCAs), which are open spaces that provide agricultural, natural resource, scenic, recreational, and/or ecological values and ecosystem functions. These areas are identified through consensus by local jurisdictions and park/open space districts as lands in need of protection due to pressure from urban development or other factors. Plan Bay Area includes a target to direct all non-agricultural development within the year 2010 urban footprint, which represents existing urban development and urban growth boundaries. The Air District can play a role in agricultural preservation through collaborating with the state's SALCP and through implementation of Plan Bay Area (See TR10: Land Use Strategies).

Implementation Actions:
The Air District will:

- Work with the agricultural community through existing organizations to obtain funding for on-farm GHG reductions activities. Research and track state, federal, regional, or private grant opportunities, including the availability of Cap and Trade funds for agriculture GHG

reduction activities. Facilitate applications for Cap and Trade funds on behalf of farms in the Bay Area. Funding could target activities such as:
  - Demonstration projects (methane digesters, soil sequestration, land management best practices, other new technologies);
  - Preservation and/or acquisition of agricultural land;
  - Implementation of GHG reduction technologies/strategies specific to agriculture; and
  - Fostering emerging ideas/technologies.
- Track and participate in state level working groups formed to reduce GHG emissions from the agriculture sector, including the Dairy Digester Workgroup, the Bioenergy Interagency Workgroup, and the Interagency Workgroup on Local and Regional Land Use.
- Disseminate information on carbon-based farming techniques in the Bay Area. Develop guidance materials on carbon sequestration and carbon-based conservation farming techniques (complementary to and in support of NW1: Carbon Sequestration in Rangelands). This could include:
  - Updating the Air District's GHG Plan Level Guidance to include carbon-based conservation farming measures as components of a local climate action plan;
  - Providing information to local government staff on carbon sequestration and incorporating the potential for carbon capture into local climate actions plans. This includes how carbon sequestration may impact baseline emissions, what the emission reduction potential of carbon sequestration is, and how to incorporate into a local GHG inventory;
  - Providing county-specific GHG reduction strategies and best practices specific to agriculture;
  - Identifying agriculture-related practices appropriate for climate action plans and local general plans (specific to each county); and
  - Providing county-specific goals for reducing agriculture-related GHG emissions which will align with any goals set at the state and Bay Area levels.
- Launch a public education/outreach campaign promoting the alternatives to and benefits of low-GHG diets.
- Explore the feasibility of matching Air District grant monies with Cap and Trade Funds to support the protection/acquisition of agricultural and natural lands as a GHG reduction action.
- Collaborate with the state's Sustainable Agricultural Land Conservation Program and counties that are implementing farmland protection projects to prevent premature land conversion resulting in higher GHG emissions, including through strategic grant making.
- Work with local governments to discourage conversion of agricultural and natural lands in PCAs identified in Plan Bay Area.

Emission Reductions:

Due to the voluntary nature of this measure, estimating potential emission reductions would rely on many assumptions and speculations, and is therefore not possible at this point in time.

Emission Reduction Trade-offs:
None identified.

Cost:
Costs would vary. Available resources would be determined through the Air District's budget process.

Co-Benefits:
Aside from reducing emissions of GHGs, full implementation of this measure has many environmental and economic co-benefits.

The measure promotes "carbon farm plans," which connect on-farm practices directly with ecosystem processes, including climate change mitigation and increases in on-farm climate resilience, soil health and farm productivity. Carbon farm plans seek to reduce GHGs from common agricultural practices, such as driving a tractor, and tilling the soil, while also promoting soil carbon sequestration to remove CO_2 from the atmosphere at a faster rate. In addition to reducing GHGs from the atmosphere, carbon farming provides economic benefits to farmers by increasing forage production, improving the soil quality, decreasing the risk of water and wind erosion and increasing nutrient and water availability for vegetation. Additionally, demonstration farms in Marin have shown reduced water demand after an addition of compost was applied to grazed grasslands.

This measure will also promote anaerobic digesters on livestock farms and the biogas they produce. Benefits of biogas recovery, aside from reduced emissions of methane into the atmosphere, include cleaner air and water (pathogens are reduced through anaerobic digestion); enhanced nutrient management; reduced odors; stabilized organics; and importantly, a potential source of revenue or cost-recovery mechanism for farms. The revenue stream/cost recovery is from the recovered biogas, which can be used as a source for distributed energy generation in rural areas; to generate electricity or be used as fuel for boilers or furnaces; or to be sold as renewable fuel through a biogas pipeline or compressed natural gas. In addition, farmers could create revenue through the sale of energy or carbon credits from the implementation of biogas recovery systems. Biogas recovery systems also generate additional bi-products for use on farms, including animal bedding and high quality fertilizer.

This measure will promote the conservation and preservation of agricultural land, which will help to protect the Bay Area's regional food supply, as well as provide additional public benefits such as wildlife habitat and open space protection.

Issues/Impediments:
Due to the relatively small size of Bay Area agricultural operations, the implementation of GHG reduction activities requiring sizeable infrastructure investments such as biogas recovery systems may be economically limiting or infeasible.

Sources:

1. EPA's AgStar Program: http://www2.epa.gov/agstar/benefits-biogas-recovery
2. NY Times, "A Price Tag on Carbon as a Climate Rescue Plan": http://www.nytimes.com/2014/05/30/science/a-price-tag-on-carbon-as-a-climate-rescue-plan.html?_r=0
3. White paper by American Farmland Trust, Greenbelt Alliance, & Sustainable Agriculture Education, "Sustaining our Agricultural Bounty, an Assessment of the Current State of Farming and Ranching in the San Francisco Bay Area": http://www.sagecenter.org/wp-content/uploads/2009/05/sustaining-our-agricultural-bounty-an-assessment-of-agriculture-in-the-sf-bay-area_march-20111.pdf
4. Marin Carbon Project: http://www.marincarbonproject.org

AG2: Dairy Digesters

Brief Summary:
This measure will promote implementation of dairy digester facilities (also known as biogas recovery) at farms to capture methane as an energy source and to reduce methane emissions.

Purpose:
The purpose of this measure is to reduce emissions of methane, a potent greenhouse gas (GHG), and to promote associated economic and environmental co-benefits, by supporting expansion of dairy digesters.

Source Category:
Stationary sources – Dairies and electricity use

Regulatory Context and Background:
Biogas recovery provides farmers an opportunity not only to reduce methane emissions, but also to generate renewable energy and use it on-site, or sell it to generate revenue or recover costs. At this time, biogas systems across the country are capturing methane from farming operations and using it to generate renewable energy that provides enough power for the equivalent of almost 70,000 average American homes. For example, in Sacramento, the New Hope and Van Warmerdam dairies installed digester systems as part of a utility-sponsored project. These systems generate enough electricity to power roughly 500 single-family homes in Sacramento, while also capturing and destroying methane that would have otherwise been released into the atmosphere. In addition, dairy digesters can stabilize manure, reduce odor and flies, and produce byproducts that could be sold such as compost or bedding material.

The Bay Area has more than 8,500 agricultural operations on over 350,000 acres of productive agricultural land that provide a diversity of goods including fruits, vegetables, meat, dairy and wines. Most agricultural operations in the Bay Area are small farms selling niche products locally, with relatively few large agricultural operations growing thousands of acres of product. However, studies indicate that dairy digesters can be viable on small farms as well as large farms. An analysis conducted by the University of Wisconsin compared the per-cow electricity demands of different scale farms, and found that small dairies use more than twice as much electricity per-cow as their larger counterparts. There is therefore an incentive for small farm operations to utilize anaerobic digesters for on-site renewable energy. Example: A small, 200-cow dairy farm in Chaseburg, WI installed a “small-farm” digester created by the Universal Sanitary Equipment Manufacturing Company – this small scale dairy digester system, capable of serving a farming operation with as few as 100 cows, allowed the farm to recoup its investment within seven years.

The Air District’s Regulation 5 controls emissions related to biomass burning at agricultural facilities. The Air District currently does not have any regulations targeted at controlling methane emissions at agricultural facilities. At this time, the Air District is not proposing to pursue regulatory requirements to limit methane emissions at dairy facilities due to their small size, and the relatively small contribution to the overall GHG emissions inventory in the region (total agriculture emissions represent ~1.5 percent of total GHG emissions). However, the Air District is pursuing supportive actions to promote the implementation of dairy digesters, including working with the animal farming community to explore the feasibility of dairy digesters, to promote the many benefits, and to identify barriers to the widespread use of dairy digesting facilities.

Implementation Actions:
The Air District will:

- Work with the animal farming community to:
  - Explore the feasibility of biogas recovery/anaerobic digester systems at farms;
  - Promote the many benefits of anaerobic digester systems; and
  - Identify barriers to widespread use of anaerobic digesters throughout the Bay Area.
- Explore the feasibility of:
  - Creating a biogas pipeline to transport raw dairy biogas to either a centralized clean-up facility or directly to a utility;
  - Marketing digested solids for residential and commercial uses;
  - Negotiating and securing carbon credits; and
  - Organizing the co-digestion of dairy wastes with other waste streams.
- Research the number, size and location of dairy facilities throughout the Bay Area. Identify examples and case studies (if possible) where dairy digesters have been implemented at dairy farms similar in size to those in the Bay Area. Share information with farmers throughout the region.
- Participate in and track progress of the state's BioEnergy Interagency Workgroup and the State Dairy Digester Workgroup. Develop implementation measures for any strategies identified through these working groups that would be cost effective in reducing GHG emissions in the Bay Area.

Emission Reductions:
More information on the exact number and size of dairy or cattle operations within the Bay Area is needed to assess the potential emission reduction as a result of full implementation of this measure. However, case studies from dairy and/or cattle operations within California and other parts of the U.S. demonstrate significant reductions of methane emissions from implementation of digester systems.

Emission Reduction Methodology:
To be developed.

Exposure Reduction:
N/A

Emission Reduction Trade-offs:
None

Cost:
Establishing digester facilities, even small scale, will involve up-front costs to farmers. The Wisconsin example above indicates that current technologies could have relatively short payback periods. Costs can be reduced when offset by selling emissions credits through ARB's protocol for Livestock Projects within the Cap and Trade program, or by generating electricity to be used onsite.

Co-Benefits:
Benefits of biogas recovery via dairy digesters, aside from reduced emissions of methane into the atmosphere, include cleaner air and water (pathogens are reduced through anaerobic digestion); enhanced nutrient management; reduced odors; stabilized organics; and importantly, a potential source of revenue or cost-recovery mechanism for farms. The revenue stream/cost recovery is from the recovered biogas, which can be used as a source for distributed energy generation in rural areas, to generate electricity or be used as fuel for boilers or furnaces, or to be sold as renewable fuel through a biogas pipeline or compressed natural gas. In addition, farmers could create revenue through the sale of energy or carbon credits from the implementation of biogas recovery systems. Biogas recovery systems also generate additional by-products for use on farms, including animal bedding and high quality fertilizer.

Issues/Impediments:
It is not yet clear if the relatively small size of most Bay Area dairy operations will be a disincentive for implementation of dairy digesters. The feasibility of putting biogas into a regional pipeline network is unresolved and not fully understood.

Sources:

1. US EPA's, Biogas Roadmap: http://www3.epa.gov/climatechange/Downloads/Biogas-Roadmap.pdf
2. US Department of Energy: http://energy.gov/eere/articles/energy-department-works-sacramento-municipal-utility-district-renewable-electricity
3. Guy Roberts, Intervale Innovation Center, "Small-Scale Manure Digesters: Potential for On-Farm Heat and Energy": http://www.uvm.edu/~cmorriso/AltEnergy/smallmanure.pdf
4. Doing More for Dairy: http://www.dairydoingmore.org/environment/bioenergy/petersdigester
5. White paper by American Farmland Trust, Greenbelt Alliance, and Sustainable Agriculture Education, "Sustaining Our Agricultural Bounty: An Assessment of the Current State of Farming and Ranching in the San Francisco Bay Area": http://www.sagecenter.org/wp-content/uploads/2009/05/sustaining-our-agricultural-bounty-an-assessment-of-agriculture-in-the-sf-bay-area_march-20111.pdf

AG3: Enteric Fermentation

Brief Summary:
This measure includes actions to engage the animal farming community in developing and implementing best practices to reduce methane emissions from enteric fermentation.

Purpose:
The purpose of this measure is to reduce emissions of methane, a potent greenhouse gas (GHG). The methane emissions from enteric fermentation comprise approximately 30 percent of total Bay Area agriculture GHG emissions, and approximately 0.5 percent of the total Bay Area GHG emissions.

Source Category:
Livestock

Regulatory Context and Background:
Livestock emit methane as part of their regular digestive processes; this is referred to as enteric fermentation. According to the US EPA, (nationwide) cattle emit more than 90 percent of the methane from livestock (other livestock animals include sheep, goats, and pigs). The amount of methane produced is influenced significantly by animal and feed characteristics, including the quantity of feed consumed, and the efficiency by which an animal converts feed to product (i.e., meat or milk).

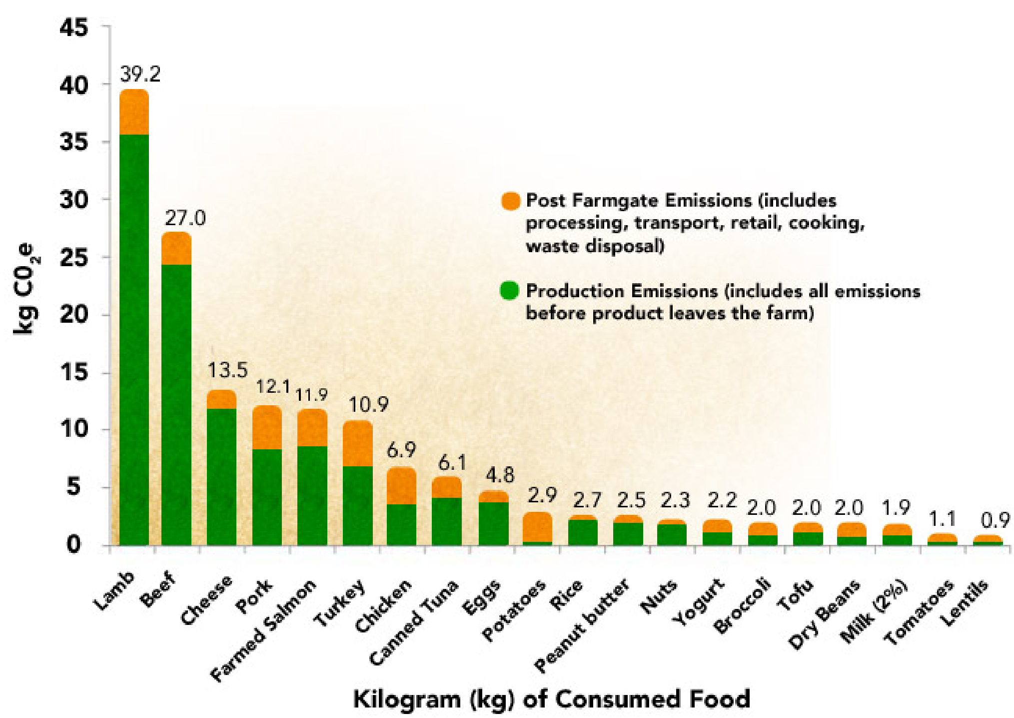
Improving animal productivity decreases methane emissions per unit of product. For example, if a cow produces more meat or milk, then meeting consumer demand is possible with fewer animals. In the US, the dairy industry has demonstrated the ability to improve productivity and therefore lower methane emissions. From 1960 – 1990, annual milk production increased by ten million tons with 7.4 million fewer cows, thereby reducing methane emissions (US EPA, Enteric Fermentation). Dairy and beef producers can increase production efficiency by implementing management techniques to improve animal nutrition and reproductive health. Feed that is tailored to the metabolic requirements of the animal and that can be digested efficiently results in a greater proportion of the energy consumed going towards production (e.g. milk) and less to waste and methane emissions.

Another strategy to reduce methane emissions is grazing management. According to the US EPA, implementing proper grazing management practices to improve the quality of pastures increases animal productivity and has a significant impact on reducing methane emissions. For example, “intensive grazing” involves rotating animals regularly among grazing paddocks, to maximize forage quality and quantity (unlike continuous grazing). This leads to more vigorous plant growth, healthier soils, and a more constant source of nutritious food for cattle.

Another method shown to reduce methane emissions from enteric fermentation is diet manipulation. Diet manipulation can reduce methane by decreasing the fermentation of organic matter in the rumen, allowing for greater digestion in the intestines – where less enteric fermentation takes place (Center for Climate & Energy Solutions, Enteric Fermentation Mitigation). Research has shown that increasing animal intake of dietary oils helps to curb enteric fermentation *and* increase yields of product by limiting energy loss due to fermentation. Studies have found that added dietary oils (such as cottonseed, sunflower, or coconut) can decrease methane emissions from enteric fermentation by 6-22 percent.

The Air District recently conducted a consumption-based GHG emissions inventory for the Bay Area. The inventory indicates that food choices can significantly influence household GHG emissions. Reducing consumption of beef and/or dairy products would involve changes in consumer behavior, and could lead to reductions in methane emissions from enteric fermentation. Choosing other meat products such as turkey or chicken, or non-meat protein such as lentils, has been found to be much less GHG-intensive than beef (see Figure 1). Additionally, there are other environmental co-benefits from reducing consumption of beef and dairy products. Research has shown that beef production requires 28 times more land, 11 times more irrigation water, and produces 5 times more GHGs, and 6 times more nitrogen on average than other livestock categories such as poultry.

Figure 1: Full Lifecycle Greenhouse Gas Emissions from Common Proteins and Vegetables (Source: Environmental Working Group, Meat Eater's Guide to Climate Change + Health



Implementation Actions:
The Air District will:

- Collaborate with appropriate state agencies and working groups and engage the animal farming community in developing and implementing best practices to reduce methane emissions from enteric fermentation. Specific tasks may include:
  - Collaborate on a literature review and/or additional research to further determine the effectiveness of dietary strategies, grazing management, and other techniques in reducing methane emissions from enteric fermentation; and
  - Identify and circulate best practices to the agriculture community.
- Engage the public to provide information on the GHG emissions associated with beef and/or dairy, and on the environmental benefits of choosing other sources of protein (such as chicken, turkey, or non-meat foods).

Emission Reductions:
This measure focuses on engaging the public and the animal farming community in a discussion about reducing GHG emissions associated with enteric fermentation. Estimating emission reductions would rely on many assumptions and ensuring an acceptable level of accuracy would be difficult.

Emission Reduction Methodology:
See above.

Exposure Reduction:
N/A

Emission Reduction Trade-offs:
No emissions reduction trade-offs are identified at this time.

Cost:
This measure focuses on outreach and education regarding livestock diet and consumer habits. It is unlikely that changes to feed or feeding practices would involve any significant costs.

Co-Benefits:
Improving efficiency of feedstock and production to reduce methane emissions from enteric fermentation could provide economic benefits to farmers. According to the Climate and Land Use Alliance, improving forage and feed processing, as well as providing supplements (such as lipids, nitrates, ionophores, and growth hormones) are win-win opportunities (due to increased productivity) for farmers in most livestock systems, and have significant greenhouse gas emission reduction potential. Reducing consumption of beef or dairy, while politically difficult, has a number of co-benefits. Aside from reduced methane from both enteric fermentation and animal waste, there are a number of other environmental co-benefits including reduced deforestation, reduced impacts from overgrazing, improved water quality (and reduced water demand), and reduction in impacts from nitrogen fertilizer.

Issues/Impediments:

It is not anticipated that there would be significant impediments due to the voluntary nature of this control measure.

Sources:

1. Boadi, Benchaar, Chiquette, and Masse, "Mitigation Strategies to Reduce Enteric Methane Emissions from Dairy Cows: Update review": ftp://s173-183-201-52.ab.hsia.telus.net/Inetpub/wwwroot/DairyWeb/Resources/Research/CJAS84/CJAS8403_319.pdf
2. US EPA, Enteric Fermentation: http://www.epa.gov/outreach/reports/06-enteric.pdf
3. Eshel, Makov, Milo, and Shepon, "Land, Irrigation Water, Greenhouse Gas, and Reactive Nitrogen Burdens of Meat, Eggs, and Dairy Production in the United States": http://www.pnas.org/content/111/33/11996
4. Climate and Land Use Alliance, "Mitigation Opportunities in the Agricultural Sector (2014)": http://www.climateandlandusealliance.org/uploads/PDFs/Technical_Annex_Mitigation_Opportunities_In_The_Agricultural_Sector.pdf
5. Environmental Working Group, "Meat Eater's Guide to Climate Change and Health, Lifecycle Assessment Methodology and Results (2011)": http://static.ewg.org/reports/2011/meateaters/pdf/methodology_ewg_meat_eaters_guide_to_health_and_climate_2011.pdf?_ga=1.88364056.287731961.1444342974
6. Center for Climate and Energy Solutions, "Enteric Fermentation Mitigation": http://www.c2es.org/technology/factsheet/EntericFermentation

AG4: Livestock Waste/Confined Animal Facilities

Brief Summary:
This control measure includes actions to reduce particulate matter (PM), ammonia, and organic emissions from livestock waste by requiring best management practices already being implemented in the San Joaquin Valley Air Pollution Control District (SJVAPCD), and South Coast Air Quality Management District (SCAQMD) to be applied at Bay Area dairies and other confined animal facilities (CAFs).

Purpose:
Reduce PM, volatile organic compounds (VOC), methane, and ammonia emissions from livestock facilities (feedlots, dairies, and poultry facilities) operating in the Bay Area.

Source Category:
Area Source – confined animal facilities

Regulatory Context and Background:
California law and Air District regulations have historically exempted many agricultural sources of air pollution from obtaining air quality permits, or complying with most air quality regulation. This exemption was revoked in 2003 with the passing of Senate Bill 700 (SB 700), which requires air districts to adopt regulations for large CAFs and amends air pollution control requirements of the California Health and Safety Code related to agricultural sources of air pollution, effective January 1, 2004. As a result, SCAQMD Rule 1127 was adopted in August of 2004 to implement best management practices to reduce emissions of ammonia, VOC and PM_{10} from livestock waste from dairies. In April of 2005, SCAQMD also amended Rule 403 to require applicable conservation management practices for the remaining CAFs. In 2006, the Air District adopted Regulation 2, Rule 10 (Rule 2-10) on Large Confined Animal Facilities, in accordance with SB 700 requirements. However, Rule 2-10 did not result in emission reductions since no Bay Area CAFs met the size applicability requirements.

SCAQMD Rule 1127 requires best management practices to reduce emissions of ammonia, VOCs and PM_{10} from livestock waste regardless of the animal facility size. SCAQMD Rule 223 establishes mitigation requirements as part of the permitting process for large confined animal facilities. Reducing pH level in manure through the application of acidifiers is one of the potential mitigations for ammonia included in the rule. Specifically, sodium bi-sulfate (SBS) is considered for use in animal housing areas where high concentrations of fresh manure are located. SBS can also be applied to manure stock piles and at fence lines and upon scraping manure to reduce ammonia spiking from the leftover remnants of manure and urine. SBS application may be required seasonally or episodically during times when high ambient $PM_{2.5}$ levels are of concern.

SJVAPCD adopted Rule 4570 in June of 2006, addressing the same facilities previously addressed by SB 700. At the time, Rule 4570 represented the most stringent emissions regulation for CAFs in the nation and identified handling of solid and liquid animal waste as the largest source of VOC emissions at CAFs, based on the prevalent research findings of the time. Current research indicates a greater portion of VOC emissions are attributable to handling of feed and silage (fodder preserved through fermentation in a silo). Additionally, a greater variety of dairy practices are found in the large CAFs in SJVAPCD than are found in the smaller Bay Area CAFs. In October of 2010, Rule 4570 was amended to provide better clarity in its definitions, to lower the exemption limits based on facility size (milking cows and poultry reduced from SB 700 values down to: 500 milking cows; 4000 chicken or ducks; and all other limits unchanged), and to provide greater flexibility for dairy and feedlot facilities to meet emission reductions. For poultry operations, mitigation measures were changed from a menu of options to mandatory measures in order to address EPA concerns regarding enforceability and efficacy.

Air District Rule 2-10 defines a large CAF by size limits consistent with SB 700 (1,000 milking cows; 3,500 beef cattle; 7,500 calves, heifers or other cattle; 100,000 turkeys, 650,000 chickens, laying hens, or ducks; 3,000 swine, 15,000 sheep, lambs or goats; 2,500 horses; 30,000 rabbits or other animals). This regulation requires that CAFs at or above these size limits obtain a permit to operate and implement control measures to reduce emissions of VOC, NOx, and PM_{10} from the facility. The rule allows the Air District's Air Pollution Control Officer (APCO) to establish a reasonable compliance schedule for facilities to implement these measures within one year of the date on which the permit is issued. Currently, the Air District does not provide a list of control measures that are applicable under this regulation. Based on the Air District's review of USDA census data, no facility in the Bay Area currently meets the applicability requirements of Rule 2-10, due to the smaller size of CAFs in the Bay Area.

In general, the facilities in the Bay Area are far smaller than the exemption limits found in SJVAPCD Rule 4570. According to the California Agricultural Statistics Review for 2012, there are approximately 100 dairies in the San Francisco Bay Area with an average herd size of 350 milking cows. In addition to milking cows, the Bay Area also supports a small stock of chicken, turkey, goat, and swine farms. Ongoing research by Air District staff will determine the number of facilities in operation and the average amount of livestock being supported at these facilities. Most of these dairies and other facilities are located in Sonoma and Marin Counties with a smaller number in Alameda, Contra Costa, Napa, San Mateo, Santa Clara, and Solano counties.

Implementation Actions:
The Air District will

- Further investigate the number and size of CAFs in operation in the Bay Area, and quantify the ammonia and methane emission reduction potential for this industry.
- Evaluate research conducted in support of 1) SJVAPCD rule development efforts with regard to feed and silage handling, and 2) SCAQMD rule development efforts with regard to livestock waste emission reductions.

Emission Reductions:

Pollutants	2020	2030
ROG	400	400

**criteria pollutants are reported in lbs/day*

Emission Reduction Methodology

Bay Area emissions from all livestock sources (cattle, poultry, pigs, etc.) were estimated to account for 4,960 pounds/day of PM_{10}, 110,400 pounds/day of total organic gases (TOG), 4,620 pounds/day of reactive organic gases (ROG), and 7.21 tons/day of ammonia in 2011. In addition, livestock within the Air District's jurisdiction were estimated to emit 19,568 metric tons of methane per year by a recent study (LBNL, 2015). In fact, livestock is the second-highest emitting source category for methane, and a major source category for ammonia in the Bay Area. Adoption of VOC mitigation measures mandated by SJVUAPCD Rule 4570 for medium-size dairies is estimated to reduce ROG by approximately 400 pounds/day in the Bay Area. Since the number of dairy cows in the Bay Area is relatively small, additional emission reductions could be obtained when applying best practices to other livestock sources with a greater population such as non-dairy cattle. In addition, the emission reduction potential for methane and $PM_{2.5}$ may be significant and needs to be further investigated.

Emission Reduction Trade-Offs:

None

Costs:

The annual cost to adopt mitigation measures similar to those required by SJVAPCD Rule 4570 is estimated at approximately $20 per cow for medium-size dairies. For an average dairy in the Bay Area that houses 350 dairy cows, the implementation cost is estimated at $7,000 per year.

Co-Benefits:

None

Issues/Impediments:

The best management practices developed under the SJVAPCD rule were developed through a collaborative effort with affected parties in the SJVAPCD, and were supported by most industry representatives. Facilities in the Bay Area are much smaller, and thus costs of operation would probably be higher. Collaboration with local industry representatives will be necessary to tailor control efforts to best meet local conditions and to thereby reduce opposition from affected facilities.

Sources:

1. BAAQMD Proposed Regulation 2, Rule 10: Large Confined Animal Facilities, Staff Report, dated 7/5/2006
2. Sacramento Metropolitan Air Quality Management District, Rule 496 Large Confined Animal Facilities, Staff Report, dated 6/19/2006.

3. SJVAPCD Rule 4570 (Confined Animal Facilities), Final Draft Staff Report, dated 6/15/2006
4. SJVAPCD Revised Proposed Amendments to Rule 4570 (Confined Animal Facilities), Final Draft Staff Report, dated 10/21/2010
5. SCAQMD Rule 403: Fugitive Dust. Amendment proposal Memo under Agenda Item 40, June 3, 2005
6. SCAQMD Rule 1127: Emission Reductions from Livestock Waste, Final Staff Report, dated 8/6/2004
7. California Agriculture Statistics Review 2012-2013, California Department of Food and Agriculture
8. Methane Emissions Inventory for BAAQMD, Lawrence Berkeley National Laboratory (LBNL), dated July 15, 2015
9. Development of an Ammonia Emissions Inventory for the San Francisco Bay Area, Sonoma Technology Inc. (STI), dated March 2008

NW1: Carbon Sequestration in Rangelands

Brief Summary:
This control measure would increase carbon sequestration in rangelands across the Bay Area by providing technical and research assistance to local governments, regional agencies and private owners of rangelands.

Purpose:
Encouraging good soil management and enhancement practices will increase the uptake and sequestration of carbon dioxide (CO_2) by the soils and vegetation of these habitats.

Source Category:
Area sources - rangelands

Regulatory Context & Background:
Nearly 2.8 million acres in the Bay Area, approximately two-thirds of the region's land mass, are undeveloped lands. Forested and woodland areas make up nearly 50 percent, grasslands over one-third and shrub lands composed of chaparral and coastal shrub make up the remaining nearly 15 percent. Approximately two-thirds of these undeveloped areas (some 1.9 million acres) function as rangelands, lands that produce vegetation suitable for livestock grazing.

Some 70 percent of the rangelands in the Bay Area (about 1.35 million acres) are privately owned. In addition, approximately 26 percent of the rangelands (nearly 500,000 acres) are permanently protected from development through conservation easements, or through outright purchase of a property for conservation purposes.

To understand the role rangelands play in carbon sequestration, it is critical to understand the carbon cycle, the role of soils in this cycle, and what carbon sequestration is. Carbon is found in all living organisms on Earth and exists predominately as plant biomass, soil organic matter, and CO_2 in the atmosphere and dissolved in seawater. Carbon sequestration is the storage of carbon in oceans, soils, vegetation, and geologic formations. Although oceans store most of the Earth's carbon, soils contain approximately 75 percent of the carbon pool on land, three times more than the amount stored in living plants and animals. Through photosynthesis, plants absorb and store atmospheric carbon as they grow. Some portion of this carbon migrates from plant roots into the surrounding soil in other organic forms; this carbon can remain in the soil, i.e., become sequestered in the soil, to varying degrees depending on how the soil and vegetation is managed. As such, rangelands, and other ecosystems such as forestlands, play a critical role in sequestering carbon at a global scale.

In agricultural systems, the amount and length of time carbon is stored is determined predominately by how the soils are managed. One practice that has been found to increase carbon storage is the addition of organic matter, and compost in particular, to agriculture and/or rangeland soils. The addition of compost results in the slow release of fertilizer to the soils as the compost decomposes, and improved soil moisture conditions; both result in increased plant production. In turn, more plant growth leads to more CO_2 being removed from the atmosphere through photosynthesis and thus more CO_2 being transferred (i.e., sequestered) through the plant to the soil as roots and detritus.

The Marin Carbon Project (MCP) has conducted extensive studies of the effects of organic matter soil amendment. MCP is a consortium of the leading agricultural institutions and producers in Marin County, university researchers, county and federal agencies, and nonprofit organizations seeking to understand and demonstrate the potential of enhanced carbon sequestration in Marin's agricultural and rangelands soils. Beginning in 2006, MCP launched an intensive research effort to determine if the application of compost on grazed rangelands could increase the land's carbon-sequestering ability.

Results from MCP's work indicate that a single application of a half-inch layer of compost on grazed rangelands significantly increases plant growth (by 40 to 70 percent), and increases soil water holding capacity. Modeling results further indicate that soil carbon sequestration could increase by at least 0.4 metric tons (MT) per acre annually for 30 years without re-application. Scaling up from MCP's results indicates that applying compost at this rate on 50 percent of the rangeland area in California could offset 42 million metric tons (MMT) of CO_2e annually, an amount equivalent to the annual GHG emissions from energy used by the commercial and residential sectors in California.

Other studies have confirmed that amending rangelands and other managed lands with compost and other organic materials increases carbon sequestration of these lands. For example, studies in California coastal and valley grasslands found that adding compost resulted in annual sequestration rates after three years ranging from 0.2 to 1.7 MT CO_2e per acre. Scaling up to 5 percent of California's rangeland, these sequestration rates would mitigate between 0.7 and 4.7 MMT CO_2e annually. A recently released study (Ryals et. al, 2015) based on field data and modeling indicates that sequestration rates ranged from 0.51 to 0.67 MT CO_2e per acre annually when assessed over a 10-year time period and 0.25 to 0.38 MT CO_2e per acre annually over a 30-year time period. Some of the variability noted was ascribed to the carbon-to-nitrogen ratio of the amendments (amendments with lower carbon-to-nitrogen ratios resulted in higher sequestration rates over time) and the application rates (i.e., single or multiple applications). Nevertheless, in all cases all compost amendment scenarios analyzed led to net GHG sinks that persisted for several decades.

Implementation Actions:
The Air District will:

- Include off-site mitigation of GHG emissions through carbon sequestration projects using the MCP GHG reduction protocol in Air District CEQA guidance and comments, and the CAPCOA GHG Reduction Exchange or other third-party protocols approved for use by the Air District.
- Work with the MCP, resource conservation districts, and local farms to apply compost amendments on grazed grasslands and rangelands across the Bay Area.

- Develop climate action plan guidance and/or best practices on soil management for local agencies and farmers and their associations to maximize GHG sequestration on rangelands.

Emission Reductions:

Pollutant*	2020	2030
CO_{2e}	16,667	57,500

** CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Methodology:
Table 1 displays the total amount of carbon that would be expected to be sequestered (as a range in MMT CO_2e) on rangelands if various percentages of rangelands in the nine-county Bay Area (total of approximately 1.9 million acres) received soil amendments. These estimates are based on extrapolations of the results from the studies described above.

Table 1. Expected range of total carbon sequestration (MMT CO_2e) with soil amendment over specific time period

	Percent of total rangeland in Bay Area amended			
	10%	25%	50%	100%
Over 3 years	0.1 – 0.9	0.3 – 2.4	0.7 – 4.7	1.4 – 9.5
Over 10 years	1.0 – 1.3	2.4 – 3.2	4.9 – 6.4	9.8 – 12.8
Over 30 years	1.4 – 2.2	3.5 -5.4	7.0 – 10.8	14.1 – 21.7

Emissions reductions were determined by using the midpoint value of the 10 percent of total rangeland amended indicated in the Table above and assumed that 1 percent of all rangelands were amended by 2020 and 5 percent by 2030. For 2020, the midpoint value of total expected carbon sequestered over three years (0.5 MMT CO_2e) was divided by 10 (equal to 1 percent of all rangelands), while for 2030, the midpoint value of total expected carbon sequestered over 10 years (1.15 MMT CO_2e) was divided by 2 (equal to 5 percent of all rangelands). Both values were then converted into a per-year estimate of CO_2e reductions by 2020 and 2030.

Exposure Reduction:
This measure will reduce CO_2 in the atmosphere by sequestering CO_2 into rangelands and other managed agricultural lands.

Emission Reduction Trade-Offs:
Adding compost to rangelands can result in the release of other GHGs, nitrous oxide (N_2O) in particular, from these same amendments. Ryals et al. (2015) found that amendments with lower carbon-to-nitrogen ratios, which resulted in higher sequestration rates, also experienced greater N_2O fluxes. In addition, multiple smaller compost additions resulted in lower cumulative N_2O emissions, but also a time lag in sequestration. These results demonstrate that there is a trade-off between maximizing carbon sequestration and minimizing N_2O emissions following addition of soil amendments. Therefore, potential increases in the emission of these other GHGs should be considered when managing agricultural lands for carbon sequestration.

Cost:
Cost estimates will be further developed during program implementation.

Co-Benefits:
Removing CO_2 from the atmosphere is only one significant benefit of enhanced carbon storage in soils. Improved soil and water quality, decreased nutrient loss, reduced soil erosion, increased water conservation, and greater crop production may result from increasing the amount of carbon stored in agricultural soils. In addition, diverting manure, yard and food wastes to composting systems can lead to significant GHG offsets.

Issues/Impediments:
Successful implementation of this measure would require adequate availability of appropriate sources of composting material.

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NW2: Urban Tree Planting

Brief Summary:
The control measure promotes the planting of trees in urbanized settings to take advantage of the myriad benefits provided by these trees, including: shading to reduce both the “urban heat island” phenomenon and the need for space cooling, and the absorption of ambient criteria air pollutants as well as carbon dioxide (CO_2).

Purpose:
The purpose of this control measure is to reduce criteria pollutants and GHGs by promoting the planting of trees in urban settings. These efforts will also serve to mitigate the urban heat island phenomenon and lower cooling and heating energy costs.

Source Category:
Area sources – urban trees

Regulatory Context & Background:
In urban areas, where buildings and paved surfaces have replaced the natural landscapes, solar energy is absorbed into roads and rooftops, causing the surface temperature of urban structures to increase and radiate heat. These higher temperatures in turn lead to higher overall ambient air temperatures, a phenomenon known as the "urban heat island." The average ambient temperature of an urban center can be 2-5 degrees Fahrenheit higher than surrounding areas. This difference can be more pronounced at night as urban infrastructure continues to slowly release heat well into the evening, with a potential temperature increase over surrounding areas of as much as 22 degrees Fahrenheit (USEPA 2015).

The resulting higher temperature caused by the urban heat island has numerous effects with air quality implications, including:

- With increased temperatures, there is increased demand for cooling-related energy use in commercial and residential buildings. The increased electricity generation required to meet the increased demand for energy leads to increased emissions of numerous pollutants at power plants, including SO_2, CO, NO_x, and PM, as well as CO_2.
- The increased temperatures in these settings can accelerate the formation of smog, as ozone precursors (i.e., NO_x and VOCs) react with increased temperatures to produce ground level ozone.

Numerous studies have shown that increasing the tree canopy in an urban setting can provide various environmental and economic benefits, including ameliorating the urban heat island effect. Details on these benefits are provided below.

Carbon sequestration

Trees absorb CO_2 from the atmosphere during photosynthesis and store this carbon as biomass.[1] The rate at which carbon is absorbed, and then released through decay and decomposition, varies based on numerous factors, including tree species and local environmental conditions. It is estimated that U.S. urban trees and forests store 2,358.4 million metric tons (MMT) CO_2 and sequester a net total of 69.3 MMT CO_2 per year (Nowak et al. 2013a). This same analysis estimated that California urban trees store 115.1 MMT CO_2 and sequester nearly 4.3 MMT CO_2 annually. An analysis of street trees in California (a subset of all urban trees) indicates that California's 9.1 million street trees store 7.78 MMT CO_2 and sequester 567,758 MT CO_2 annually (McPherson et al. 2014). At a more local scale, net sequestration by the 6.6 million urban trees in the San Francisco Bay Area was calculated at 696,686 MT CO_2 annually (McPherson et al. 2010). Even finer scale studies found that Berkeley's 36,485 municipal trees sequestered 3,025 MT CO_2 annually and that the approximate 669,000 trees in the San Francisco urban forest sequester some 19,067 MT CO_2 annually (Nowak et al. 2007, McPherson et al. 2010).

Reduction in Pollution Concentrations

Trees reduce ambient concentrations of criteria pollutants as well. Trees absorb pollutants such as ozone, NO_2 and SO_2 primarily through leaf stomata as well as on plant surfaces and bark pores. In fact, the U.S. EPA has recognized tree planting as a measure for reducing ozone in state implementation plans. Trees affect ambient concentrations of PM by intercepting small airborne particles, which deposit on trees' leaves, twigs and bark.

Table 1 summarizes the findings from various analyses and modeling studies of the rate of annual ambient pollution removal of various criteria pollutants by urban trees. As indicated in the table's note, these studies use the percent of the urban landscape covered by trees (i.e., percent tree cover) in their calculations of the emission reductions achieved by these trees.

Table 1. Metric tons of air pollution removal by urban trees annually

	O_3	PM_{10}	$PM_{2.5}$	NO_2	SO_2	*CO*	*Source*
Conterminous United States	523,000		27,000	68,000	33,000		Nowak et al. 2014
	305,100	214,900		97,800	70,900	22,600	Nowak et al. 2006
San Jose	305	243		188	28	34	
San Francisco	80	107		63	12	15	
	83	84		45	13	11	Nowak et al. 2007
			5.5				Nowak et al. 2014, Nowak 2014

The percent of tree cover in each study varied as follows: from 11.9 percent (Nowak et al. 2007) to 27 percent (Nowak et al. 2006) to 34.2 percent (Nowak et al. 2014) to 36.1 percent (Nowak 2014 and Nowak et al. 2014).

[1] This discussion distinguishes between the amount of carbon trees absorb from the atmosphere each year ("to sequester") and the amount of carbon that is contained in the trees' biomass ("to store").

Lastly, urban trees can lead to lower evaporative emissions. Specifically, by shading asphalt surfaces and parked cars, trees serve to reduce hydrocarbon emissions (i.e., ozone precursors) from gasoline that evaporates from leaky tanks and hoses.

Reduction in Ambient Temperatures

One of the functions performed by trees in urban settings that is most easily recognizable is the shade these trees provide to outdoor areas, buildings and urban structures such as sidewalks and parking lots. This shade has the direct effect of lowering ambient temperatures; these lower temperatures result in less ozone formation. Moreover, trees directly cool the air through transpiration – the evaporation of water from plants.

Energy Savings

If appropriately placed around buildings, trees can lower the energy demands for heating and cooling from these buildings, leading to energy savings. Specifically, the lower temperatures resulting from shade trees can reduce the energy demands to cool structures on hotter days. These energy savings are particularly critical when they occur at the hottest time of the day and thus reduce peak energy consumption. In addition, trees can provide for energy savings in the winter. Specifically, by reducing wind speed, trees can mitigate the infiltration of outside air into interior spaces. In this manner, trees can lower the heat loss from cool winter winds, resulting in heating savings.

The energy savings provided by trees throughout the year can be substantial. A study of all of California's 177 million trees found that these trees reduce annual electricity used for cooling by 6,407 gigawatt hour (GWh), enough energy to power 730,000 homes (McPherson and Simpson 2001). Similarly, California's 9.1 million street trees are estimated to save 684 GWh of electricity annually, equal to the amount of energy required to air condition 530,000 households in California each year (McPherson et al. 2015). Similarly, the 6.6 million existing urban trees in the San Francisco Bay Area are estimated to provide annual energy savings valued at $327 million (reported in McPherson et al. 2010). Likewise, an analysis of the 36,485 municipal trees in Berkeley found a citywide annual energy savings of $553,066 ($15.16/tree), 17 percent from winter heating and 83 percent from summer air conditioning (McPherson et al. 2010). Specifically, annual electricity use for air conditioning was reduced by 3,469 megawatt hour (MWh) ($12.58/tree) and annual savings of natural gas for heating was 7,209 million British thermal units (MBtu) ($2.58/tree).

Implementation Actions:

The Air District will:

- Develop or identify an existing model municipal tree planting ordinance and encourage local governments to adopt such an ordinance.
- Provide assistance to local governments to increase tree canopy by assisting in identifying and securing incentive funds that are available for the planting of trees.
- Include tree planting recommendations in Air District's guidelines for local plans and CEQA review.

- Provide information via technical guidance, best practices, outreach materials, presentations and workshops to local government planning and public works staff on how to maximize air quality, GHG and public health benefits from municipal tree planting programs.

Emission Reductions:
Due to the level of uncertainty in terms of the impact this program may have on number of trees planted, emission reductions have not been estimated.

Emission Reduction Methodology:
N/A

Exposure Reduction:
Tree planting in urban settings would serve to reduce ambient concentrations of numerous criteria pollutants as well as sequester CO2. Additionally, studies have demonstrated that access to trees within an urban setting is a direct reflection of income.[2] Increasing urban trees in low income communities, therefore, may not only reduce cooling expenses of residents and improve air quality, but may also reduce disparity.

Emission Reduction Trade-Offs:
It is important to take into account that trees can also contribute to emission increases. For example, some trees emit biogenic volatile organic compounds (BVOCs) that can contribute to ozone formation. The contribution of BVOC emissions from city trees to ozone formation depends on complex geographic and atmospheric interactions, and differs considerably across tree species, and has not been studied in most cities (McPherson et al. 2010). Additional research would need to be conducted to identify the tree species that are most beneficial to air quality overall. It is also important to consider that trees also emit particles such as pollen and particles captured on plant surfaces can be re-suspended into the air. In addition, equipment used for tree planting and maintenance (e.g., vehicles, chain saws, chippers) release CO_2.

Cost:
An analysis of small, medium and large broadleaf trees and a coniferous tree in the Northern California Coast Region (which covers large portions of the nine-county Bay Area) found that the benefits conveyed by trees outweigh the costs of maintaining these trees. Table 2 presents the average annual benefits, costs and net benefits per tree for a 40-year period (McPherson et al. 2010).

Table 2. Average annual benefits, costs and net benefits per tree for a 40-year period

	Average Annual:		
Tree type	**Benefits**	**Costs**	**Net Benefits**

[2] "Ecosystem services and urban heat riskscape moderation: water, green spaces, and social inequality in Phoenix, USA." By G. Darrel Jenerette, Sharon L. Harlan, William L. Stefanov, and Chris A. Martin. Ecological Applications, Vol. 21 No. 7, October 2011.)

			(Benefits – Costs)
Small broadleaf	$41 to $51	$10 to $17	$31 to $34
Medium broadleaf	$57 to $71	$11 to $24	$46 to $47
Large broadleaf	$115 to $135	$13 to $28	$102 to $107
Conifer	$161 to $176	$15 to $33	$142 to $143

The largest portion of the benefits results from increased property value and energy savings; additional benefits are derived from reduced storm water runoff, lower levels of air pollutants and reduced ambient CO_2. The majority of costs are associated with tree planting, pruning and removal.

Co-Benefits:
Trees in urban settings provide for numerous additional benefits – ranging from environmental to economic to psychological and social. For example, trees:

- Improve water quality by reducing storm water runoff, a major source of pollution entering wetlands, streams and the San Francisco Bay.
- Reduce flood risk and recharging groundwater supplies by capturing storm water.
- Provide wildlife habitat in the built environment.
- Prolong the life of sidewalks and pavement by reducing the daily heating and cooling and thus expansion and contraction of asphalt.
- Have been found to increase property values - research suggests that people are willing to pay 3 to 7 percent more for properties with ample trees versus few or no trees.
- Provide social and psychological benefits by beautifying the landscape, promoting social interactions, providing stress relief and noise reduction, contributing to public safety and providing pleasure to humans.

It is also important to consider the additional benefits associated with planting native and/or drought-tolerant or drought-resistant trees. Specifically, since native plants have evolved in and with the local environment, they tend to be better adapted to local conditions (e.g., soil type, rain regime) and less susceptible to pest and diseases than non-native trees. As such, they require little long-term maintenance if they are properly planted and established. In addition, native trees provide food and habitat for native wildlife, birds, bees and butterflies; these animals in turn play key roles in the local ecosystem. Drought-tolerant and -resistant trees (whether native or not) require far less water than exotic trees, especially once established. Encouraging water-wise landscaping will become increasingly important as a result of the altered weather patterns expected with climate change.

Issues/Impediments:
Due to the voluntary nature of this measure, significant impediments to implementation are not anticipated.

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NW3: Carbon Sequestration in Wetlands

Brief Summary:
This control measure would increase carbon sequestration in wetlands in the San Francisco Bay by providing technical and research assistance, policy support, and incentive funding to local governments and regional agencies to ensure the preservation and restoration of wetlands.

Purpose:
Ensuring the preservation and restoration of wetlands in the Bay Area will (1) reduce the emissions of CO_2 that results when wetlands are destroyed and/or degraded, and (2) increase the uptake and sequestration of atmospheric CO_2 within these habitats when they are re-established and protected.

Source Category:
Area sources - wetlands

Regulatory Context & Background:
The development and urbanization of the nine-county Bay Area, in particular since the mid-1850s following the Gold Rush, has affected and changed nearly all the region's natural habitats. Among the most severely affected were the wetlands that once ringed the San Francisco Bay. By the 1960s, filling of shallow areas of the San Francisco Bay had reduced the Bay's size by one-third and destroyed 90 percent of the Bay's tidal marsh.

The Save San Francisco Bay Association (now Save the Bay) was established in 1961 to stop unregulated filling of San Francisco Bay and to open up the Bay shoreline to public access. This movement helped support the establishment in 1969 of the San Francisco Bay Conservation and Development Commission (BCDC) as a permanent state agency to regulate shoreline development and increase public access. BCDC has jurisdiction over the open water, marshes and mudflats of greater San Francisco Bay, the first 100 feet inland from the shoreline around the Bay as well as managed wetlands that have been diked off from the Bay.

Efforts by governmental agencies and non-profit groups have been on-going across the Bay to preserve and restore wetlands. Of particular note, in the 1990s, in response to the growing recognition of the importance of wetlands, nine state and federal agencies and dozens of concerned scientists came together to produce a guide for restoring and improving the wetlands and adjacent habitats of San Francisco Bay in order to establish a long-term vision for a healthy and sustainable baylands ecosystem. This effort was called the San Francisco Bay Area Wetlands Ecosystem Goals Project (Goals Project 1999).[1] Among the key recommendations of the Goals Project was to increase the total area of tidal marsh across the

[1] An update to the 1999 Goals Project report was released in 2015 (Goals Project 2015). This updated report synthesizes the latest science, including advances in the understanding of climate change, and provides new recommendations for achieving healthy baylands ecosystems. The habitat acreage goals set in 1999 remain the same.

Bay from 40,000 acres to about 95,000 to 105,000 acres, requiring the restoration of large areas of diked habitats such as salt ponds, managed marshes and agricultural flatlands. Re-establishing extensive areas of tidal marsh would have major environmental benefits, including improving the Bay's natural filtering system and enhancing water quality, increasing primary productivity of the aquatic ecosystem, and reducing the need for flood control and channel dredging. In addition, Goals Project 2015 specifically addresses the carbon sequestration benefits that would result from restoration of these wetlands.

The scientific foundation for the protection and re-establishment of wetlands across the Bay provided by the Goals Project in 1999 has served to guide wetlands restoration and enhancement around the Bay for well over a decade. For example, the San Francisco Bay Joint Venture, a partnership organization that works to protect, restore and enhance wetlands in the Bay Area, has completed over 150 wetland habitat projects resulting in the conservation of over 70,000 acres of habitat. Additional wetlands restoration projects have taken place, in particular in the South and North Bay regions, or are planned on lands purchased by government agencies such as the U.S. Fish and Wildlife Service, the California Department of Fish and Game and the California Coastal Conservancy, and by private organizations and land trusts. Overall, since the Goals Project report was published in 1999, over 12,000 acres of tidal marsh and wetlands have been restored, and nearly 30,000 more are now under way (Goals Project 2015).

Fundamental to the successful re-establishment of wetlands is attracting significant funding for land acquisition and restoration as well as maintenance and protection of re-established wetlands. Efforts to secure funding for restoration included the passage of AB 2954 in 2008 which established the San Francisco Bay Restoration Authority (Restoration Authority) as a regional body with the power to raise and allocate local resources for the "restoration, enhancement, protection, and enjoyment of wetlands and wildlife habitat in the San Francisco Bay and along its shoreline." In June 2016, a $12 per year parcel tax placed on the ballot by the Restoration Authority (the "San Francisco Bay Clean Water, Pollution Prevention, and Habitat Restoration Program," also known as the Clean and Healthy Bay Ballot Measure) was approved by the required two-thirds majority of voters in all nine counties of the Bay Area. The measure is expected to generate approximately $25 million per year and $500 million over its 20-year life to protect and restore the San Francisco Bay.

There is existing federal and state funding for wetlands restoration projects in the Bay Area. Specifically, the United States Environmental Protection Agency's (EPA) San Francisco Bay Water Quality Improvement Fund (SFBWQIF) has been available since 2008. This Fund has invested almost $16 million in 26 projects to restore over 4,000 acres of wetlands around the Bay; these projects have leveraged additional funds from partner agencies and organizations, resulting in $100 million being invested in San Francisco Bay and its watersheds since 2008. In addition, the new Wetlands Restoration for Greenhouse Gas Reduction Grant Program, administered by the California Department of Fish and Wildlife, granted its first awards to 12 projects throughout California (one in the Bay Area) in April 2015. This Program allocates Greenhouse Gas Reduction Funds (GGRF) from California's Cap-and-Trade proceeds to restore wetlands that sequester GHGs and provide other ecological benefits in mountain meadow ecosystems, the Sacramento-San Joaquin Delta and coastal wetlands.

In addition, in late 2015, a new protocol for wetland carbon finance was approved by the Verified Carbon Standard. Specifically, the Wetlands Restoration and Conservation project category provides a framework for accounting for emission reductions in mangroves, tidal and coastal wetlands, marshes, seagrasses, floodplains, deltas, and peatlands among others tidal wetlands and seagrass restoration. These groundbreaking requirements are the first for crediting restoration and conservation activities across wetland ecosystems.

Implementation Actions:
The Air District will:

- Collaborate with other local, regional, state and federal agencies to protect, restore and enhance existing wetlands that provide carbon sequestration value in the Bay Area.
- Develop or identify guidance based on acceptable quantification methods for local climate action plans on estimating GHG sequestration associated with wetlands restoration and protection.
- Partner with other local and regional agencies to apply the Wetlands Restoration and Conservation methodology or other applicable third-party protocols to potential carbon offset projects.
- Include offsite mitigation strategies for GHG emissions through carbon sequestration from wetland restoration and preservation in CEQA guidance and comments.
- Identify federal, state and regional agencies, and collaborative working groups that the Air District can assist with technical expertise, research or incentive funds to enhance carbon sequestration in wetlands around the Bay Area.
- Provide technical assistance as needed for SFBWQIF and GGRF projects.
- Assist agencies and organizations that are working to secure the protection and restoration of wetlands in the San Francisco Bay to reach the Goals Project recommendation of 100,000 acres.

Emission Reductions:

Pollutants*	2020	2030
CO_{2e}	90,000	90,000

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Emission Reduction Methodology:
Emissions reductions achieved based on sequestration potential of wetlands and the recommended area of wetlands to be restored. It is estimated that every acre of healthy salt marsh captures and converts at least 0.87 metric tons (MT) of CO_2 into plant material annually (Save the Bay 2007). Therefore, if full restoration of the 100,000 acres recommended by the Goals Project is achieved, it would be expected that nearly 90,000 MT of CO_2 would be sequestered annually.

Exposure Reduction:
This measure will reduce CO_2 in the atmosphere by sequestering CO_2 into wetlands.

Emission Reduction Trade-Offs:
The creation, restoration and maintenance of wetlands can result in criteria and GHG emissions associated with on-road vehicles and off-road heavy equipment that may be used to restore and or maintain the wetlands.

Cost:
The main costs for this control measure will be funding for the acquisition, planning and maintenance of restoration projects. Save The Bay's 2007 report, "Greening the Bay," estimated that it would cost $1.43 billion over 50 years to fully restore the over 36,000 acres of shoreline property that had already been acquired and awaiting restoration to tidal wetlands at that time. The report did not estimate the costs of acquiring and restoring the remaining 20,000 acres or so to reach the 100,000-acre goal. Overall, most of the expenses are a one-time investment, with more than 80 percent needed for planning, construction and monitoring of the restoration projects. Once restored, tidal marshes require little maintenance with expenses focused on ongoing operations and maintenance, security, public access facilities and protecting other infrastructure at restored marshes.

Co-Benefits:
Restoring and preserving wetlands not only ensures increased capture and storage of carbon by these areas, but also provides a multitude of environmental co-benefits from these areas:

- Protection and buffer from floods, erosion and sea-level rise as these area act as sponges, slowing down and soaking up large quantities of runoff and water from rain storms and high tides;
- Habitat for over 500 species of fish and wildlife;
- Improved water quality by trapping and filtering out pollutants and toxins;
- Open Space and Recreation for visitors to and residents of a highly urbanized Bay Area; and
- Economic Benefits from tourism, fishing, and recreation opportunities in and around wetlands.

In addition, it is critical to note that wetlands provide economic benefits that are not reflected in the costs outlined in the section above. Specifically, Save the Bay's report noted that wetlands produce $4,650 per acre in flood control and dredging cost savings compared to engineered dams, reservoirs and channels and, since they purify water so well, they are often used for tertiary treatment by municipal sewage plants.

Issues/Impediments:
The major issue/impediment to restoring and preserving wetlands for all the associated environmental benefits, including carbon sequestration, is adequate funding. Wetland restoration requires long-term, consistent funding for acquisition, planning, on-the-ground construction, and operations and maintenance.

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WA1: Landfills

Brief Summary:
This control measure would reduce emissions of methane and non-methane organic compounds from landfills by increasing standards for landfill gas collection control devices and fugitive leaks. Revisions to Regulation 8, Rule 34 (Rule 8-34) would also improve consistency with State and Federal rules governing solid waste disposal sites.

Purpose:
Reduce emissions of methane and non-methane organic compounds (NMOC) and improve enforceability of Rule 8-34.

Source Category:
Stationary source and area source – solid waste disposal sites.

Regulatory Context and Background:
On May 2, 1984, the Air District adopted Rule 8-34 to control emissions of methane and other organic compounds from landfill gas. The rule has been amended several times since then to tighten standards and improve application of the rule requirements, with the most recent amendment occurring in October 1999. In March 1996, the U.S. Environmental Protection Agency (US EPA) adopted Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills into the Code of Federal Regulations. The 1999 amendments to Rule 8-34 were intended to meet the Air District's obligation to implement the federal emission guidelines, and to streamline compliance with new source performance standards, emission guidelines, and Air District requirements by providing a single rule containing all applicable requirements. As a result of these amendments to achieve consistency with the federal rule, the emissions standards for gas collection systems were changed from organic compounds and methane control requirements to NMOC control requirements. This effectively removed control requirements for methane from the collection systems, but the rule retained a "measured as methane" requirement for fugitive emissions from the landfill surface as well as collection system component leaks.

On June 17, 2010, California adopted the Landfill Methane Control Measure (LMCM) to reduce methane emissions from municipal solid waste landfills. This measure was identified in 2007 as a discrete early action greenhouse gas (GHG) emission reduction measure pursuant to the California Global Warming Solutions Act of 2006 (AB 32). The measure requires smaller and other uncontrolled landfills to install gas collection and control systems and also includes requirements to ensure that existing gas collection and control systems operate optimally to control methane emissions.

The requirements set forth in the LMCM differ from those in Rule 8-34 and the federal rule, well beyond the methane versus NMOC issue and lower threshold for gas collection noted above. The LMCM includes a 99 percent methane capture and control requirement for gas collection systems and an instantaneous 500 parts per million by volume (ppmv) standard for fugitive emissions from surface leaks and component leaks under positive pressure (after the blower). There is also a 25 ppmv integrated surface monitoring standard in the LMCM. Rule 8-34 includes 98 percent NMOC destruction efficiency for gas collection systems, a 1,000 parts per million (ppm) “measured as methane” standard for component leaks, and an instantaneous 500 (ppmv) expressed as “methane above background” standard for surface leaks. Both rules have somewhat relaxed emission limits for energy recovery control systems used as control in place of flares. Each rule contains requirements for plan submittals for construction, collection and control system design and alternative compliance, with different criteria for each rule leading to overlap and inconsistency.

In addition to amendments to Rule 8-34 that would improve consistency with the state rule, Air District staff has identified several potential avenues for further emissions reductions. Control equipment at facilities in the Bay Area routinely meets the current control levels of both rules, so increasing the stringency to 99 percent control for NMOC and 99.5 percent for methane is technically feasible with little added costs for facilities utilizing flares. More research is needed to determine if lean burn engines can meet more stringent standards. The time allowed for installation of gas collection in expanded areas of active landfills can be shortened and thereby reduce fugitive emissions. Enacting consistent component leak standards (500 ppmv versus 1000 ppmv, and the entire system rather than just the positive side of the blower) would reduce fugitive emissions of both methane and NMOC.

Air District staff will evaluate methane emissions from facilities currently exempt from Rule 8-34 and LMCM requirements including smaller facilities and closed landfills. Higher tipping fees at larger landfills may cause diversion of organic waste to smaller active landfills with no gas collection system in place. Recent research suggests that some closed landfills with no gas collection systems may emit significant amounts of methane. Air District staff will measure fugitive methane emissions at these facilities to determine emission levels and evaluate appropriate amendments to Rule 8-34 or management practices if necessary.

Implementation Actions:
The Air District will:
- Propose amendments to Rule 8-34 to increase stringency of control and fugitive leak standards, and improve consistency with the LMCM and federal rules.
- Evaluate methane emissions at smaller or closed landfills where green waste has been accepted and consider amendments to Rule 8-34 to address fugitive methane emissions if deemed significant.

Emission Reductions:

Pollutants*	2020	2030
ROG	400	400
CO_{2e}	233,308	233,308

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Potential emissions reductions from increased standards on control equipment would be somewhat small, but there is potentially greater emission reduction potential for fugitive emissions. The 2011 Air District inventory lists fugitive emissions from landfills at 186.33 tons per day of methane and 3,340 pounds per day ROG, and controlled emissions from landfill gas collection systems at 4.79 tons per day of methane, and 200 pounds per day ROG. Increasing the stringency of control standards would yield emission reductions of 0.01 tons per day of methane, and less than 20 pounds per day ROG. Reducing the time for installation of collection wells in expanded portions of active landfills and tightening the component leak standard while expanding it to more of the gas collection system would result in 2 to 5 percent reduction in fugitive emissions, yielding a reduction of 3.77 to 9.32 tons per day of methane and 60 to 160 pounds per day ROG.

Emission Reductions Methodology

In calculating fugitive emissions from landfills, Air District staff currently assumes that gas collection systems collect 75 percent of both methane and NMOC, and that 25 percent of the landfill gas escapes as fugitive emissions. In the California Air Resources Board's (ARB) Statement of Reasons for the LMCM, ARB has indicated that compliance with the measure will result in 85 percent capture. Amending Rule 8-34 to be consistent with or more stringent than requirements for both methane and NMOC would lead to greater rates of gas collection and would result in emission reductions on the order of 18.8 tons per day of methane and 400 pounds per day ROG. The reduction in methane emissions result in GHG emission reductions equivalent to 590,132 MT C02e per year, on a 20-year timeframe, and 233,308 MT CO_2e per year, on a 100-year timeframe.

Emission Reduction Trade-Offs:

There may be minimal increases in combustion emissions as a result of increased capture of landfill gases.

Costs:

Given that most flares have the potential to meet more stringent control standards, only increased labor costs might be incurred as capital costs would be minimal or nonexistent. Similarly, for the elements associated with stricter fugitive emission standards, there would only be increased labor costs. These costs would be offset by elimination of redundant monitoring requirements due to improved consistency between State and Air District requirements.

Co-Benefits:
Increased capture of landfill gases would likely result in less potential for odor complaints.

Monitoring Mechanisms:
Air District staff will monitor compliance of the improved standards through facility inspections.

Issue/Impediments:
There may be some opposition from industry to lower fugitive standards (due to increased labor costs), but improved consistency is likely to be welcomed.

Sources:

1. Proposed Amendments to Regulation 8, Rule 34: Solid Waste Disposal Sites; Regulation 3: Fees, Schedule K; and Regulation 9, Rule 2: Hydrogen Sulfide Staff Report; BAAQMD, September 28, 1999
2. Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills; California EPA, Air Resources Board, Stationary Source Division, Emissions Assessment Branch, May 2009

WA2: Composting & Anaerobic Digesters

Brief Summary:
This control measure would reduce emissions of greenhouse gases (GHGs) and volatile organic compounds (VOCs) from anaerobic digesters and composting operations by requiring best management practices derived from measures adopted by the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Air Pollution Control District (SJVAPCD).

Purpose:
Reduce GHG and VOC emissions, and reduce secondary particulate matter (PM) emissions via ammonia emission reductions from composting operations and related activities.

Source Category:
Area Source – anaerobic digesters and composting operations

Regulatory Context and Background:
As a result of recent changes to directives, policies, and state law surrounding waste management in California, more organic waste is being diverted from landfills to either composting, anaerobic digestion, or a combination of the two. Anaerobic digestion is a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen. One of the end products is biogas, which is combusted to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels.

In 2011, under Strategic Directive 6.1, CalRecycle announced its goal of reducing the amount of organic waste disposed in landfills by 50 percent. In addition to helping conserve landfill capacity, this policy sought to capture the energy value of organic wastes more efficiently thereby reducing emissions of GHGs which contribute to climate change. Subsequent to this effort, CalRecycle adopted the Anaerobic Digestion Initiative to encourage the development of anaerobic digestion facilities (ADFs) as an alternative to landfill disposal of organic solid waste. This initiative provides grants, loans and contracts to develop ADFs, as well as guidance publications to assist operators and local enforcement agencies, and revised regulations regarding design, operation and permitting of ADFs. In October 2014, Governor Brown signed into law AB 1826, requiring businesses to recycle their organic waste on or after April 1, 2016, and requiring local jurisdictions across the state to implement organic waste recycling programs on or after January 1, 2016 to divert organic waste generated by businesses, including multifamily residential properties of five or more units.

The Air District issued an Authority to Construct (A/C) in 2012 for an ADF in Milpitas to process up to 135,000 tons per year of food/green waste, and the facility began operations in December 2013. Operation of this facility is integrated into operations of a nearby landfill, recycling and compost operation, and water treatment facility. Another smaller ADF in South San Francisco was issued an A/C in 2013 to process up to 11,200 tons per year of food/green waste, and operations began in April of 2015. Operations at this ADF are not integrated with a nearby landfill, and a composting operation permitted for this location is in-vessel as opposed to open windrows.

In 2003, the SCAQMD adopted a suite of rules to address emissions from composting and related operations. These were: Rule 1133 – Composting and Related Operations, General Administrative Requirements; Rule 1133.1 – Chipping and Grinding Activities; and Rule 1133.2 – Emission Reductions from Co-Composting Operations. The purpose of these rules was to establish a registration and annual reporting program for composting-related facilities to better characterize the emissions and keep track of activity levels (1133), develop holding and processing time requirements for chipping and grinding activities to prevent inadvertent decomposition of greenwaste and foodwaste (1133.1), and reduce VOC and ammonia emissions from co-composting operations (1133.2). In 2010, SCAQMD amended 1133.1 for consistency with state regulations regarding greenwaste processing requirements and adopted Rule 1133.3 to establish best management practices for greenwaste composting operations.

In March 2007, SJVAPCD adopted Rule 4565, Biosolids, Animal Manure, and Poultry Litter Operations (similar to South Coast's Co-composting Rule 1133.2, but Rule 4565 includes provisions for land application of organic material and sets forth mitigation measures as a means of control for smaller operators). In 2008, SJVAPCD began development of Rule 4566 - Composting Green Waste, but efforts were slowed by perceived overestimation of emissions (62 tons per day in 2007 was revised to 19 tons per day in 2010) combined with a lack of studies demonstrating efficacy of proposed mitigation measures. Collaborating with stakeholders and other regulatory agencies in 2009, SJVAPCD directed a field study designed to measure the effectiveness of four potential best management practices. Based on the field study results, SJVAPCD adopted a new version of rule 4566 (August 2011). Rule 4566 defines organic material to include green material, food material, or a mixture thereof, and may include wood material and up to 100 wet tons per year of biosolids, animal manure, or poultry litter. SJVAPCD adopted rule 4566 – Organic Material Composting Operations on August 18, 2011.

In the Bay Area 2010 Clean Air Plan, composting operations were identified as a potential source for emission reductions in further study measure FSM-15. This further study measure sought to use the results of the San Joaquin field study along with the lessons learned from the rule development efforts of SCAQMD and SJVAPCD. Now that those efforts have been completed there is more information to support potential Air District rulemaking. The potential increase of anaerobic digestion operations in the Bay Area increases the need for regulation of these two integrated operations.

Implementation Actions:
The Air District will:

- Propose a rule to limit emissions from composting operations and anaerobic digesters, similar to San Joaquin Valley Air Pollution Control District Rule 4566 and South Coast Air Quality Management District Rule 1133.
- Review guidance publications from CalRecycle, which may provide additional measures for ADFs.

Emission Reductions:

Pollutants*	2020	2030
ROG	1,440	1,440
Ammonia	1,400	1,400
CO_{2e}	1,241	1,241

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

According to the Air District's 2011 emission inventory estimates, emissions from composting operations account for 0.19 tons per day of methane and 2,880 pounds per day of reactive organic gases (ROG). Ammonia emissions from composting are estimated to be approximately 1.40 tons per day. Mitigation measures drawn from the SJVAPCD or SCAQMD rules are estimated to reduce organic emissions by 15 percent to 30 percent, and are more likely to be adopted at small scale composting operations. More capital intensive controls such as construction of aerated static piles and/or biofilters appropriate for larger operations have demonstrated 80 percent control. Assuming a conservative estimate of 50 percent reduction in emissions would yield a reduction of 0.1 tons per day of methane, 1,440 pounds per day ROG, and 1,400 pounds per day of ammonia. The reduction in methane emissions result in GHG emission reductions equivalent to 3,139 MT C02e per year, on a 20-year timeframe, and 1,241 MT CO_2e per year, on a 100-year timeframe.

Emission Reduction Trade-Offs:
As noted in the background section, materials and byproducts of the anaerobic digestion process must be properly integrated into other waste management processes. Leachate and wet (or heavily inoculated) end products can cause pockets of methane to form in landfills or may overwhelm wastewater treatment control systems. A holistic approach to composting and anaerobic digestion regulations will ensure that emissions are not diverted to other operations rather than ultimately controlled. Should the adoption of best management practices prove to be too costly, more organic material may end up being trucked outside of the Air District. This would result in increases in emissions of methane from the landfills and combustion emissions associated with truck traffic.

Costs:
The control costs for the adoption of emission mitigation measures range from $390 per ton of VOC reduced for watering systems to $2,500 per ton of VOC reduced for facilities utilizing watering systems and finished compost cover. Costs for demonstrated 80 percent reductions are likely to exceed a range from $5,000 to $10,000 per ton of ROG reduced, and $9,000 to $13,000 per ton of ammonia reduced. These estimates are based on facilities in SJVAPCD. Costs for the operations in the Bay Area will be estimated during rule development.

Co-Benefits:
The adoption of best management practices may also reduce the potential for odor and subsequent complaints from individuals downwind of these facilities.

Issue/Impediments:
There may be some opposition from this industry to being regulated. CalRecycle as well as local municipalities may claim that regulation of composting operations works against waste diversion goals. The best management practices, however, are supported by most industry representatives and were developed through a collaborative effort with affected parties in the San Joaquin, South Coast, and Mojave Desert air districts.

Sources:
1. San Joaquin Valley Air Pollution Control District, Preliminary Draft Staff Report for Rule 4566, Composting Green Waste, dated 1/10/2008
2. SJVAPCD, Final Draft Staff Report for Rule 4566, Organic Waste Operations, dated 12/18/2008
3. SJVAPCD, Final Draft Staff Report: Revised Proposed New Rule 4566, dated 8/18/2011
4. The Policy Committee for the Central California Ozone Study, and SJVAPCD, Request for Proposal for the Organic Waste Composting Study, dated 12,16,2008
5. South Coast Air Quality Management District, Technology Assessment for Proposed Rule 1133, Emission Reductions from Composting and Related Operations, Dated 3/22/2002
6. SCAQMD, Final 2007 Air Quality Management Plan, Control Measure CM # 2007MCS-04, dated 6/1/2007
7. SCAQMD, Final Staff Report: Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations, Dated 7/8/2011
8. Anaerobic Digestion Initiative and Statewide Anaerobic Digestion Facility for Treatment of Municipal Organic Solid Waste-Final PEIR-SCH#2011024100, CalRecycle, 6/22/2011
9. Final Statement of Reasons, Compostable Materials and Transfer/Processing Regulations, CalRecycle, 9/2015

WA3: Green Waste Diversion

Brief Summary:
This control measure would reduce the total amount of green waste being disposed in landfills by supporting the diversion of green waste to other uses.

Purpose:
Reduce air pollutants and greenhouse gas (GHG) emissions from the disposal of green waste in landfills. Diverting green waste, which includes both food and yard waste, away from landfills or keeping it out of the waste stream entirely would reduce the amount of methane, nitrous oxide and other volatile organic compounds (VOC)s.

Source Category:
Solid waste: landfills

Regulatory Context and Background:
California has been a leader in reducing emissions from the landfilling of solid waste. In 1989, California adopted landmark legislation that established the State's Integrated Waste Management Board (now called CalRecycle) and required cities and counties to achieve a 50 percent diversion rate of waste going to landfill by 2000. By 2012, California had surpassed this mandate and achieved a 66 percent waste diversion rate. More recent legislation has set a goal to reduce, recycle or compost 75 percent of solid waste by 2020. In response, many local agencies have set zero-waste goals for their communities. Finding ways to divert green waste from landfills is an essential component of achieving these local goals. Doing so will preserve space in local landfills, reducing criteria pollutants and GHGs in the process.

Methane is a significant component of landfill gas, generated largely through anaerobic decomposition[1] of yard and food waste. Reducing methane is a priority due to its high global warming potential.[2] The Air District has long sought to reduce methane and other air pollutants emitted from landfills. In 1984, the Air District adopted Rule 8-34 that targeted methane emissions at large landfills by requiring landfill gas collection systems. The Air District has subsequently amended the rule to further reduce emissions. Despite the effectiveness of this rule, landfills are still responsible for more than half of all methane emissions in the Bay Area.

At the state level, agencies such as CalRecycle have recognized that reducing the amount of green waste going to landfills is key to both the goals of solid waste reduction and reducing GHG emissions. Assembly Bill 1826, for example, requires commercial generators of food or

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[1] Anaerobic digestion (AD) is the process whereby bacteria break down organic material in the absence of air. A by-product is biogas, which can be used to produce energy.

[2] "Global warming potential" (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. For methane, the Air District uses a GWP of 34, according to the Intergovernmental Panel on Climate Protection's 5th Assessment Report.

other green waste to subscribe to composting or anaerobic digestion service for their organics starting in 2016. Another bill, AB 1594, removes the "diversion credit" given to waste management entities when they use green materials such as yard trimmings as alternative daily cover in landfills. Diverting more green waste to composting facilities as well as anaerobic digestion facilities will be an essential step that will help avoid methane emissions from landfills. Feedstock for anaerobic digestion could include food waste and other green materials currently going to landfill instead of being considered for composting.

Local programs have also helped reduce green waste. Many jurisdictions now offer curb-side pickup of both yard and food waste. This is more common for single-family homes, but local waste management agencies are increasingly offering these services to multi-family and commercial customers. Some cities also encourage residents to compost food and yard waste at home by providing training and, in some cases, composting equipment. Composting at home reduces transport emissions and when done on a small scale, the decomposition could emit fewer GHG emissions than landfills depending on how the compost pile is maintained (e.g., if it is turned to allow air to enter the system). In addition, homeowners can use the resulting compost instead of buying new soil or artificial fertilizers, thereby reducing transport-related emissions and energy used to produce chemical fertilizers.

Implementation Actions:
The Air District will investigate the following approaches in an effort to reduce emissions from green waste.

- Identify or develop model policies to facilitate local adoption of ordinances and programs to reduce the amount of green waste going to landfill; partner with stakeholders such as CalRecycle on these efforts. Activities addressed by such model policies may include:
    - developing a zero waste goal for the community and implement programs to achieve the goal while ensuring that these goals do not lead to increased use of incineration to avoid landfilling;
    - requiring large commercial and institutional facilities to use compost in their landscaping operations rather than employ artificial fertilizers.
- Advocate for state and federal legislation that supports efforts to divert green waste from landfills, such as tax incentives for commercial food donation, creation of additional disposal facilities or the establishment of new collection strategies for green waste.
- Collaborate with public agencies and local businesses in seeking support from state, federal or other funding programs to implement green waste diversion programs such as on-site composting.
- Promote use of compost in urban areas and on rangelands for carbon sequestration and to reduce landfill-related GHGs (see NW1: Carbon Sequestration in Rangelands).
- Promote replacement of high-maintenance landscapes (e.g., lawns) with climate-appropriate landscapes that include native and drought-tolerant plants to decrease green waste production.

Emission Reductions:

Pollutants*	2020	2030
ROG	452	542
CO_{2e}	n/a	162,997

**criteria pollutants are reported in lbs/day; CO_{2e} is reported in metric tons/year (100 yr GWP)*

Implementing the actions in this control measure could result in annual emission reductions in 2030 of 408,591 MTC02e per year, on a 20-year timeframe, and 162,997 MTCO2e per year, on a 100-year timeframe. It could also result in a reduction of 452 pounds per day of ROG in 2020 and 542 pounds per day of ROG in 2030.

Emission Reduction Methodology:
This measure would support efforts to achieve a 90 percent diversion rate of suitable organics from the existing waste stream by 2030, which is critical to helping overall diversion rates. Given that recycling rates (including composting) have stagnated, additional efforts need to be made to divert more waste away from landfills both for short-term and long-term goals.

Assuming that the waste from jurisdictions in the Bay Area is proportional to population, the region was responsible for landfilling roughly 1.87 million tons of organic waste suitable for composting or anaerobic digestion in 2010. Achieving a 90 percent reduction would mean diverting 1.68 million tons to composting or anaerobic digestion facilities. Assuming that the organics are evenly distributed between composting or anaerobic digestion facilities, and applying ARB emission factors for each facility type, the amount of GHGs reduced would be approximately 1.02 MMTCO2e per year. Implementation actions were assumed to achieve 10 percent of the total emission reductions.

Emissions of criteria pollutants were calculated assuming that 70 percent of organics are green waste and the remaining 30 percent is a higher-emission producing green waste/food scrap mix. ROG emission factors come from a CalRecycle study, “Emission Testing of VOC from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley.” The mid-point value for each of the emission factors was used.

Exposure Reduction:
N/A

Emission Reduction Trade-offs:
Certain strategies may have emission reduction trade-offs. For example, waste that is diverted from a landfill with a high gas capture rate and sent to a compost facility could result in an increase in VOCs, contributing to ozone formation, depending on the type and operation of the facility. In addition, composting facilities that do not implement best available technology or effective operating procedures could generate odors that impact people nearby. Control

Measure WA2: Composting and Anaerobic Digesters proposes new rulemaking to minimize emissions and odors from composting facilities.

Cost:
Cost estimates will be determined during specific program implementation.

Co-benefits:
Diverting green waste away from landfills has the potential to generate multiple co-benefits. Local composting of green waste could reduce the number of truck hauling miles while yielding valuable compost that can be used in place of artificial fertilizers and pesticides. The application of compost on urban open space (e.g., parks, planting strips) and rangelands can decrease atmospheric GHG emissions by increasing the carbon sequestration capacity of soils, and indirectly through enhanced plant growth that further increases carbon sequestration. In addition, compost applications can reduce the amount of water needed in agricultural operations and landscaping, reducing the amount of energy required to pump water for irrigation. Composting can save space in existing landfills, and can produce biogas which can be refined and used to produce electricity or burned in an internal combustion engine.

This measure also has the potential to stimulate local job growth through the development of more Bay Area-based facilities capable of processing green waste.

Monitoring Mechanisms:
The Air District will track the number of local jurisdictions that adopt a green waste-related ordinance.

Issues/Impediments:
Siting of composting facilities has generated controversy in the past over the potential for odors coming from static piles, but modern composting facilities that implement best-available technology and effective operating procedures can reduce the potential of odors reaching homes and businesses. Some new composting facilities use closed systems that can be located within urban areas without disturbing people nearby. Funding for additional compost facilities to handle more green waste could be needed to support implementation of these action items.

Sources:

1. Arminger, Florian, Stefan Peyr, and Carsten Cuhls. 2008. Greenhouse gas emissions from composting and biological treatment. *Waste Management and Research* 26(1): 47-60.
2. Bay Area Biosolids to Energy. *A Regional Approach to Sustainable Biosolids Management*. http://www.bayareabiosolids.com/yahoo_site_admin/assets/docs/BAB2Efactsheet_Timeline_Nov2013.321120804.pdf.
3. California Air Resources Board (ARB). 2011. *Method for Estimating Greenhouse Gas Emission Reductions from Compost from Commercial Organic Waste*.

4. California Department of Resources Recycling and Recovery (CalRecycle). 2002. *Landfill Facility Compliance Study: Checklist of Pertinent Environmental Regulatory Requirements*. Publication number 520-02-002.
5. California Department of Resources Recycling and Recovery (CalRecycle). 2011. *Final Program Environmental Impact Report (EIR) for Statewide Anaerobic Digester Facilities for the Treatment of Municipal Organic Solid Waste*. Prepared by ESA. State Clearinghouse No. 2010042100.
6. California Integrated Waste Management Board (CIWMB). 2007. *Emission Testing of VOC from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley*. Publication number 442-2007-0009.
7. U.S. Environmental Protection Agency (USEPA). Website titled *Organics: Anaerobic Digestion*. http://www.epa.gov/region9/organics/ad/.
8. U.S. Environmental Protection Agency (USEPA). *The Benefits of Anaerobic Digestion of Food Waste At Wastewater Treatment Facilities.* http://www.epa.gov/region9/organics/ad/Why-Anaerobic-Digestion.pdf.
9. U.S. Environmental Protection Agency (USEPA). 2014. *Framework for Assessing Biogenic CO2 Emissions from Stationary Sources*.

WA4: Recycling and Waste Reduction

Brief Summary:
This control measure aims to reduce the amount of solid waste that the Bay Area sends to landfills by strengthening recycling programs and developing additional waste reduction strategies.

Purpose:
Reduce greenhouse gas (GHG) emissions by diverting recyclables and other materials from landfills.

Source Category
Landfills

Regulatory Context and Background:
Landfill gas (LFG), which results from decomposition of organic materials, is approximately 50 percent methane, a potent GHG. Diverting materials from landfills by recycling or other waste reduction programs reduces the amount of landfill gas resulting from waste disposal. In addition, recycling reduces the need to use virgin materials in goods production. This reduces the demand for energy for resource extraction and processing, as well transportation – resulting in further reductions of GHGs.

California has long been at the forefront of the recycling movement. The California Beverage Container Recycling and Litter Reduction Act (AB 2020) was passed in 1986 and has led the state to have one of the most effective beverage container recycling programs in the country. In 1989, California adopted landmark legislation (AB 939) that established the state's Integrated Waste Management Board and required cities and counties to achieve a 50 percent waste diversion rate by 2000. AB 939 has been the single most important state-level policy in managing the state's waste stream and its resulting GHG emissions. By 2012, California had surpassed this mandate and achieved a 66 percent overall reduction in waste going to landfill.

In order to reduce the remaining 30 million tons of solid waste being sent to landfills each year and to support the goals set forth by California's Global Warming Solutions Act (AB 32), the legislature adopted AB 341 in 2011. This legislation sets a goal to reduce, recycle or compost 75 percent of solid waste by 2020. AB 341 also specifically targets commercial waste – one of the largest sources of solid waste in California. Achieving this waste reduction goal will result in a yearly GHG reduction between 20 and 30 million metric tons (MMT) of CO_2e statewide. The AB 32 Scoping Plan Update released in 2014 also discusses the possibility of setting even more ambitious goals, including a net zero GHG emissions target for the waste sector. Many local jurisdictions have already adopted policies that support achieving a zero waste goal.

Implementation Actions:

The Air District will:

- Develop or identify and promote model ordinances requiring or facilitating:
    - community-wide zero waste goals;
    - recycling of construction and demolition materials in all commercial and public construction projects.
- Track and disseminate best practices in waste reduction among Bay Area local governments.
- Actively communicate state and federal funding opportunities for waste reduction programs to local governments, and support funding applications.
- Participate in regional efforts to promote low-waste purchasing, such as the Bay Area Green Purchasing Roundtable
- Encourage the reuse of existing asphalt, concrete and cement materials in construction and repaving projects; the reuse of construction, demolition and other building materials, such as fixtures, trim, mulch from lumber, etc. instead of using virgin materials on building projects; and deconstruction (i.e., the selective dismantlement of building components) where demolition is required by including this actions among recommended mitigation measures in the Air District's CEQA Guidelines and comments.
- Collaborate with and track progress of the state and regional working groups working on waste management issues.

Emission Reductions:

Pollutants*	2020	2030
CO_{2e}	n/a	45,185

** CO_{2e} is reported in metric tons/year (100 yr GWP)*

The implementation of this control measure is anticipated by 2030 to reduce 72,838 MTCO2e annually, on a 20-yr timeframe, and 45,185 MTCO2e annually, on a 100-yr timeframe, from the increased recycling of materials currently being landfilled.

Emission Reduction Methodology:

Emission reduction estimates were developed based on assuming an increase in the amount of glass and lumber recycled and the associated emission factors for these materials found in the U.S. EPA's WARM model. It was assumed that a 30 percent increase in waste diversion would be achieved due in part to implementation actions included in this control measure.
The existing recycling rates for glass and lumber were taken from the City of Palo Alto's Waste Characterization Study. More information is needed about the waste characterization and recycling rates specifically for the Bay Area as a whole.

Criteria pollutants are not estimated for this measure; the majority of those emissions are anticipated to occur outside the Air District's boundaries.

Exposure Reduction:
This control measure could reduce TACs from landfills and transfer stations that process solid waste by diverting certain materials (e.g., electronics, compact florescent lighting) to recycling facilities that can properly handle them.

Emission Reduction Trade-offs:
Certain strategies may have emission reduction trade-offs depending on where the solid waste stream is processed. For example, waste that is exported out of the region for recycling could result in increased transportation emissions.

Cost:
Cost estimates will be determined during specific program implementation.

Co-benefits:
Beyond protecting air quality, reusing and recycling products can protect the environment by preserving natural lands that would have been used for resource extraction or landfills. Reducing the amount of natural resources (metals, wood, etc.) needed to produce new products also reduces the use of energy associated with extraction, processing and transport of these materials.

Issues/Impediments:
No significant issues or impediments are anticipated due to the voluntary nature of this control measure.

Sources:

1. CalRecycle EPP program: http://www.calrecycle.ca.gov/EPP/Resources/default.htm.
2. California Air Resources Board (ARB). 2014. *First Update to the Climate Change Scoping Plan: Building on the Framework*.
3. California Department of Resources Recycling and Recovery (CalRecycle). 2002. *Landfill Facility Compliance Study: Checklist of Pertinent Environmental Regulatory Requirements*. Publication number 520-02-002.
4. City of Palo Alto. 2013. *Waste Characterization Report.*

WR1: Limit GHGs from POTWs

Brief Summary:
This measure will explore regulatory action to reduce GHG emissions from publicly owned treatment works (POTWs), as well as work with POTWs to obtain funding for green infrastructure or demonstration projects. Finally, this measure will explore the potential to streamline the Air District's permitting process relating to POTW permits.

Purpose:
The purpose of this measure is to reduce direct emissions of nitrous oxide and methane, related to water and wastewater treatment. This measure is also intended to promote additional emission reduction opportunities within the water sector, including the potential for methane capture and re-use at POTWs through biogas recovery systems.

Source Category:
Stationary sources – water and wastewater treatment.

Regulatory Context and Background:
California's water system includes a complex infrastructure that has been developed to support the capture, use, conveyance, storage, conservation, recycling and treatment of water and wastewater. Statewide, the majority of developed water resources (80 percent) are used for agriculture. However, a significant amount of water is also used to support residential, commercial, and industrial activities. In the Bay Area, over 400 billion gallons of water is used each year. This water use results in air pollutant emissions, including greenhouse gases (GHG), criteria air pollutants, and toxic air contaminants (TACs).

Greenhouse gas emissions from the water sector are primarily associated with the energy required to pump, convey, recycle, and treat water and wastewater throughout the Bay Area; these are referred to as *indirect* GHG emissions. Greenhouse gases are also *directly* emitted from POTWs which treat water and wastewater. Greenhouse gases are emitted from wastewater collection, treatment, and storage systems through the volatilization of organic compounds (VOCs) at the liquid surface. Methane is emitted from wastewater when it is treated in anaerobic conditions. Nitrous oxide (N_2O) emissions are also emitted during the wastewater treatment process. In addition, combustion sources at POTWs emit GHGs, as well as criteria air pollutants and TACs.

The water sector also provides opportunities. Greenhouse gas emissions, primarily methane, can be captured and reused in POTWs through biogas recovery systems. Anaerobic digestion captures the methane that might otherwise be released into the atmosphere. This biogas can be used on-site for heat, electricity, or mechanical energy, or can be purified for off-site vehicle use or use as a natural gas substitute. For example, the Las Gallinas Valley Sanitary District's wastewater treatment plant in San Rafael operates a biogas-fueled internal combustion engine which generates renewable heat and power for on-site use.

The Air District regulates criteria pollutants and TACs at POTWs, and could expand these activities to include rules to reduce GHGs at POTWs as well. The Air District intends to work closely with POTWs to explore regulatory action to reduce GHGs. The first step in this process is to better understand total GHG emissions at each POTW. The Air District will also increase its efforts by exploring potential monetary incentives and/or assisting POTWs in securing funding to implement biogas recovery systems and to foster other emerging ideas and technologies.

Implementation Actions:
Air District will:

- Initiate a process to better understand and quantify GHG emissions at POTWs.
- Explore rulemaking to reduce GHGs emitted directly within POTWs.
- Work with the POTW operators and existing organizations such as the Bay Area Clean Water Agencies (BACWA) to obtain funding for the development of green infrastructure in POTWs.
- Collaborate with POTWs on potential streamlining of the Air District's permitting processes to promote biogas recovery, as well as address potential cross-media regulatory issues such as State Water Resources Control Board regulations on nutrient removal (which may increase GHG emissions).

Emission Reductions:
Emission reductions will be identified and quantified during the formal rule development phase of this control measure, if rulemaking is pursued.

Emission Reduction Methodology:
Emission reductions will be identified and quantified during the formal rule development phase of this control measure, if rulemaking is pursued.

Emission Reduction Trade-offs:
Emission reduction trade-offs will be identified and quantified during the formal rule development phase of this control measure, if rulemaking is pursued.

Cost:
Implementation of this control measure may include costs to POTWs for new equipment and technologies. These costs could be offset by securing grant funding or financing. Costs could also be offset if projects included production and use of on-site energy. Precise cost estimates (pertaining to POTWs and the Air District) will be identified and quantified during the formal rule development phase of this control measure, if rulemaking is pursued.

Co-Benefits:
Aside from reducing GHGs, this measure has the potential to provide economic benefits to POTWs. This measure will promote biogas recovery systems in wastewater treatment facilities. Benefits of biogas recovery, aside from reduced emissions of GHGs, include production of on-site renewable power (potentially at a cost below retail electricity), and enhanced power reliability.

Issues/Impediments:
The BACWA Air Issues and Regulations Committee has expressed concern regarding potential Air District regulatory action targeting POTWs. According to BACWA, Air District regulations inadvertently discourage biogas recovery and use as a fuel substitute. For example, Air District Best Performance Standards for limiting air emissions from engines and boilers are difficult for bio-gas fired engines and boilers to meet cost-effectively. The Air District is therefore investigating these potential conflicts through implementation of this control measure.

Sources:

1. US EPA, "Opportunities for and Benefits of Combined Heat and Power at Wastewater Treatment Facilities" April 2007: http://water.epa.gov/infrastructure/sustain/upload/2009_5_13_wwtf_opportunities.pdf
2. California Air Resource's Board Scoping Plan: http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf
3. "Bay Area Integrated Regional Water Management Plan", September 2013: http://bairwmp.org/docs/2013-bairwm-plan-update/2013-final-plan/San%20Francisco%20Bay%20Area%20IRWMP%20Final_September%202013.pdf/view
4. Letter dated June 6, 2014, from Bay Area Clean Water Agencies to Air District.
5. CAPCOA, Organic Waste Digestion Project Protocol Version 2.0: https://www.valleyair.org/notices/Docs/2013/12-17-13_CAR/provisionally-approved-organic-waste-digestion-protocol.pdf
6. California Air Resource's Board Scoping Plan: http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf
7. SPUR, "The Future of Water", March 2013: http://www.spur.org/publications/article/2013-03-07/future-water

WR2: Support Water Conservation

Brief Summary:
This measure will promote water conservation, including reduced water consumption and increased on-site water recycling, in residential, commercial and industrial buildings for the purpose of reducing greenhouse gas (GHG) emissions.

Purpose:
The purpose of this measure is to reduce indirect emissions of GHGs associated with the electricity use required to capture, use, convey, store, conserve, recycle and treat water and wastewater in the Bay Area.

Source Category:
Water conveyance and wastewater treatment.

Regulatory Context and Background:
California's water system includes a complex infrastructure that has been developed to support the capture, use, conveyance, storage, conservation, recycling and treatment of water and wastewater. Statewide, the majority of developed water resources (80 percent) are used for agriculture. However, a significant amount of water is also used to support residential, commercial, and industrial activities. The State Water Resources Control Board (State Water Board) ensures high water quality by setting statewide policy for waste and storm water discharge. Regional water quality control boards make water quality decisions for their regions, issuing permits and setting standards for water discharge.

In 2009, Governor Schwarzenegger signed into law the Water Conservation Act, which requires that urban water demand be reduced by 20 percent by the year 2020. The Act also requires urban water suppliers to calculate their baseline water use and set water use targets for 2015 and 2020 based on guidance from the Department of Water Resources (DWR). A report to the Legislature on progress meeting these targets is scheduled for 2016. On April 1, 2015, Governor Brown issued an Executive Order directing the State Water Board to implement mandatory water reductions in urban areas to reduce urban water use by 25 percent statewide. In response, the State Water Board adopted an emergency conservation regulation setting this target, taking effect on May 18, 2015. The Governor's Executive Order also directed DWR to update the State's Model Water Efficient Landscape Ordinance, which promotes the benefits of landscaping practices that go beyond traditional water conservation practices. Local agencies had until early 2016 to adopt the Ordinance or a local ordinance that is at least as effective in conserving water.

In the Bay Area, over 400 billion gallons of water is used each year. Energy associated with this water consumption results in air pollutant emissions, including GHGs, criteria air pollutants, and toxic air contaminants. Greenhouse gas emissions from the water sector are primarily associated with the energy required to pump, convey, recycle, and treat water and wastewater throughout the Bay Area. These are referred to as *indirect* GHG emissions, as they are generated at electric power plants, rather than at the point of water use. Greenhouse gases are also *directly* emitted from publicly owned treatment works (POTW) that treat water and wastewater (see WR1: Limit GHGs from POTWs).

The Air District does not have regulatory authority over water consumption and the resulting indirect GHG emissions. Therefore, the Air District is taking a supportive and collaborative role to encourage reductions in water use throughout the Bay Area.

Implementation Actions:
Air District will:

- Support efforts of local governments in achieving and exceeding state water use reduction goals by:
  - Disseminating best practices that reduce water consumption and increase on-site water recycling in new and existing buildings;
  - Encouraging the adoption of water conservation ordinances; and
  - Incorporating public outreach and education on water conservation into the Air District's outreach programs.
- Incorporate best practices for water use into local plan guidance, CEQA guidance, and other resources for cities and counties.

Emission Reductions:
Due to the voluntary nature of this measure, estimating potential emission reductions would rely on many assumptions and speculations, and is therefore not possible at this point in time.

Emission Reduction Trade-offs:
None identified.

Cost:
Costs would vary. Available resources would be determined through the Air District's budget process.

Co-Benefits:
Aside from reducing indirect GHGs, this measure has the potential to reduce water consumption throughout the Bay Area which is increasingly important during periods of drought. Water conservation and recycling will continue to be crucial as population and demand increase. In addition, a Stanford University study has argued that the on-going drought in California is linked to climate change, which could mean that future periods of drought could be more frequent or prolonged. Thus, water conservation helps reduce GHGs *and* is a critical adaptation strategy.

Issues/Impediments:
It is not anticipated that there would be significant impediments due to the voluntary nature of this control measure.

Sources:

1. California Air Resource's Board Scoping Plan: http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf
2. SPUR, "The Future of Water", March 2013: http://www.spur.org/publications/article/2013-03-07/future-water
3. Bay Area Integrated Water Management Plan, September 2013: http://bairwmp.org/docs/2013-bairwm-plan-update/2013-final-plan/San%20Francisco%20Bay%20Area%20IRWMP%20Final_September%202013.pdf/view
4. Bulletin of the American Meteorological Society, "The Extraordinary California Drought of 2013/2014: Character, Context, and the Role of Climate Change" Tsiang, M., Haugen, M., Singh, D., Charland, A., Rajaratnam, B., Diffenbaugh, N. S. 2014; 95 (9): S3-S7

SL1: Short-Lived Climate Pollutants

Brief Summary:
This measure describes actions that the Air District will implement to reduce emissions of short-lived climate pollutants (SLCPs), also known as super-GHGs.

Purpose:
The purpose of this measure is to protect the climate by reducing emissions of super-GHGs. Reducing super-GHG emissions can help to restrain global warming in the near term, thereby complementing efforts to reduce CO_2 emissions over the long term.

Source Category:
The term "short-lived climate pollutant", or super-GHGs, refers to a diverse group of climate forcers[1] that have a relatively short lifetime in the atmosphere, but high global warming potential (GWP). GWP is a measure of how much heat a greenhouse gas traps in the atmosphere relative to CO_2 and can be expressed in either a 100-year or 20-year timeframe. A 100-year GWP works well for most of the proposed control measures in the 2017 Plan. However, for short-lived climate pollutant measures, it is more relevant and appropriate to use a shorter 20-year time horizon. Emission reductions expressed using a 20-year time frame highlight the much greater near-term benefit of actions to address short-lived climate pollutants that have a high GWP.

Super-GHGs addressed in this measure, with their GWP values[2], include:

- Methane (100-year GWP = 34; 20-year GWP = 86)
- Black carbon (BC) (100-year GWP = 900; 20-year GWP = 3,200)
- Fluorinated gases (F-gases) [3] (100-year GWP ranges from 140 to 23,900; 20 year-GWPs generally increase by a factor of 2-3)

Methane is the second leading GHG in the Bay Area inventory, after CO_2. Three source categories currently account for approximately 84 percent of total methane emissions in the Bay Area:

- Landfills: 53 percent
- Livestock: 16 percent
- Natural gas production and distribution: 15 percent

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[1] A "climate forcer" is defined as any gas or particle that alters the Earth's energy balance by absorbing or reflecting solar radiation.
[2] GWP values are derived from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2013). See Chapter 8 of Working Group 1 report.
[3] In this document, we use the term "fluorinated gases" for this category of climate forcers to be consistent with terminology at the State level. The term "high GWP gases" is also sometimes used to describe this category of climate pollutant.

Recent studies indicate that current federal, state and regional methods for estimating methane emissions may be under-reporting methane by as much as 50 percent.[4] The Air District will pursue a Basin-wide Methane Strategy (see control measure SS16) to address methane emissions in the region. The strategy includes an effort to better quantify and characterize Bay Area methane emissions, as described in control measure SL3: Greenhouse Gas Monitoring and Measurement Network.

Black carbon, often referred to as soot, is a component of fine particulate matter. In addition to its effects in heating the climate, BC also has negative impacts on public health. Leading sources of BC emissions in the Bay Area include diesel engines and residential wood-burning. As climate change intensifies droughts in California, emissions of BC from wildfires are expected to increase. Some wildfires occur within Air District boundaries, but the Bay Area is also affected by wildfires in surrounding counties. Besides heating the climate, emissions of BC from wildfires impact public health in the Bay Area on an episodic basis.

Fluorinated gases are man-made compounds, many of which are potent climate forcers. Hydrofluorocarbons (HFCs) are the most prevalent F-gases in the Bay Area. HFCs are used in refrigeration and air conditioning systems in commercial, industrial, and residential applications, as well as air conditioning in motor vehicles.

Regulatory Context and Background:
Collectively, super-GHGs account for a significant portion of the total Bay Area GHG inventory, especially if global warming potential is measured over a twenty-year timeframe rather than 100 years. Because super-GHGs have a relatively short atmospheric lifetime, reducing SLCP emissions offers an effective means to reduce GHG emissions in the near term, while strategies to reduce emissions of longer-lived GHGs such as CO_2 are developed and implemented. In addition to directly reducing GHG emissions, near-term actions to decrease super-GHGs can slow climate feedback mechanisms in the Arctic and elsewhere (such as the release of CO_2 and methane caused by the thawing of permafrost) that would otherwise further accelerate global warming. According to the Air Resources Board (ARB), reducing emissions of super-GHGs on a global scale can:

- Cut global warming in half, by 0.6°C in 2050, and by 1.4°C in 2100.
- Reduce warming in the Arctic by two-thirds (0.7°C) by 2040.
- Reduce sea level rise by 25 percent.
- Increase chances of keeping average warming below 2°C to greater than 90 percent by 2050.

In his January 2015 inaugural address, Governor Brown identified reducing SLCP emissions as one of five key pillars of the state's climate protection strategy. The ARB released a draft SLCP

[4] For example, a recent study by a team of Stanford University researchers published in the February 14, 2014 edition of *Science* found that leakage from natural gas pipelines may be a significant source of methane emissions. See http://www.nytimes.com/2014/02/14/us/study-finds-methane-leaks-negate-climate-benefits-of-natural-gas.html?_r=0

Reduction Strategy in April, 2016. Once the final SLCP Reduction Strategy has been reviewed and approved by the ARB Board, the Air District will take appropriate actions to help implement and support the statewide SLCP strategy. In September 2016, Governor Brown signed SB 1383, known as the Super Pollutant Reduction Act, which targets the following reductions in SLCPs to meet the State's long-term GHG reduction goals: 50 percent black carbon, 40 percent methane and 40 percent HFC gases in California by 2030.

Because of their high global warming potential and relatively short atmospheric lifetime, the various SLCPs are often grouped together as a single, separate category of climate pollutants. However, the SLCPs differ in terms of their sources, their projected emission trends, and the specific mechanism by which they contribute to global warming. Therefore, the emission reduction measures for each type of SLCP must be tailored to reflect its specific attributes.

The Air District has been working to reduce emissions of super-GHGs, in conjunction with federal, state, and local efforts to regulate these pollutants. The US EPA and the California ARB have both been pursuing measures to reduce methane emissions. The Air District already limits emissions from key sources of methane via regulation and/or permits from landfills (e.g., Regulation 8-34), composting operations, and natural gas production and distribution (e.g., Regulation 8-37). Additional Air District measures to further reduce methane emissions are described in the "Implementation Actions" section below.

Over the past 10-15 years, there has been great progress in reducing black carbon in response to (1) ARB regulations to reduce emissions from diesel engines, (2) Air District grant programs to reduce emissions from heavy-duty diesel vehicles and equipment, and (3) reductions in wood smoke as a result of the Air District's efforts to reduce wood-burning during winter months. Bay Area BC emissions are projected to continue decreasing through 2020. However, in the absence of additional policies and programs (beyond those already adopted), BC emissions are projected to begin increasing once again from 2020 through 2030 as the Bay Area economy grows and the number of diesel engines increases. Therefore, additional measures may be needed to prevent an increase in BC emissions and to protect public health from exposure to harmful particulate matter.

Emissions of F-gases are regulated at the international, national, and state level. At the global scale, in October 2016, international negotiators reached an important binding agreement, an amendment to the Montreal Protocol, to phase out the production and use of HFCs. In addition, some 50 nations, including the US as well as 50+ partner organizations, have joined the *Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants*. The Air District works to enforce State of California F-gas regulations in the Bay Area. For example, to promote compliance with the state regulation to reduce HFC emissions from commercial and industrial refrigeration systems, the Air District entered into a memorandum of understanding with ARB to ensure that regulated sources register their facilities with ARB and comply with program requirements. Although the State's regulation requires detected leaks to be fixed within 14 days, smaller systems that are subject to the regulation only have to perform leak inspections once a year. For leaks that go undetected in these and larger systems, it is possible a system could lose its entire charge of high-GWP refrigerant and still be in compliance if the leak is then fixed. Also, many systems have higher leak rates than the estimated average of 20-25 percent annually, leaving opportunities for better control of these emissions.

Additionally, the regulation does not include comfort cooling systems (such as air conditioning units in office buildings), multi-family residences, hotels or other commercial, industrial or institutional spaces such as schools. F-gas emissions from these systems that occur during normal operation or maintenance are not reported and may be significant.

Implementation Actions:
Key Air District implementation actions to reduce emissions of super-GHGs are summarized below, with reference to control measures that address super-GHG emissions from several different economic sectors. For additional detail, see the control measures cited in parentheses.

Reduce methane emissions:

- Reduce methane emissions from landfills by amending Rule 8-34 to increase stringency of control and fugitive leak standards, and improve consistency with the State of California Landfill Methane Control Measure federal rules (see WA1).
- Reduce the amount of waste material entering landfills by expanding recycling and waste diversion (see WA4).
- Reduce the amount of waste material entering landfills by increasing the amount of organic material diverted to composting (see WA3).
- Develop model policies that can be employed by local agencies, such as adopting a zero waste ordinance, requiring large commercial and institutional facilities to use compost in their landscaping operations rather than employ artificial fertilizers, and requiring the recycling of construction and demolition materials in all commercial projects and public infrastructure projects (see WA3 and WA4).
- Promote the use of biogas recovery/anaerobic digester systems at Bay Area farms (see AG2).
- Work with the animal farming community to reduce methane emissions from enteric fermentation (see AG3).
- Collaborate with ARB and/or CPUC to develop a rule or rule amendments to reduce methane emissions from natural gas production, processing and storage operations (see SS13: Natural Gas and Crude Oil Production, Processing and Storage) and natural gas pipelines and processing operations (see SS15: Natural Gas Processing, Storage and Distribution).
- Reduce methane emissions from capped natural gas wells (see SS14).
- Continue to implement the amendments to Regulation 8-18, adopted in December 2015, to reduce emissions of methane and other organic gases from equipment leaks at oil refineries (see SS2: Equipment Leaks).

Reduce black carbon emissions:

- Continue and intensify Air District efforts to reduce residential wood-burning (see SS34: Wood Smoke).

- Implement programs to further reduce emissions from diesel-powered back-up generators (see SS32: Emergency Backup Generators).
- Provide grants and incentives to reduce emissions of particulate matter and BC from heavy-duty vehicles (see TR19: Medium- and Heavy-Duty Trucks).
- Continue to enforce ARB diesel regulations in the Bay Area communities most impacted by PM emissions.
- Monitor and support ARB efforts to promote more efficient drive trains in heavy-duty vehicles.
- Pursue strategies to reduce motor vehicle use, as described in various transportation measures, and to decarbonize the transportation sector by promoting alternative fuel vehicles, as described in TR14 (Cars and Light Trucks).

Reduce F-gas emissions:

- Continue to enforce ARB's regulation to reduce leaks from commercial and industrial refrigeration systems that use high-GWP refrigerants.
- Explore potential regulatory options to identify and reduce F-gas emissions in large refrigeration and/or air conditioning systems
- Incentivize leak detection and remediation in large refrigeration and air conditioning systems.
- Develop and promote best practices for leak avoidance, identification and remediation in refrigeration and air conditioning systems
- Incentivize early adoption of low-GWP refrigerants in commercial, industrial and residential refrigeration and air conditioning system retrofits and new installations, including a requirement that disposal of any replaced high-GWP refrigerant follow stringent practices.
- Support the adoption of more stringent regulations by ARB and/or US EPA, such as production phase-downs and sales restrictions of high-GWP refrigerants.
- Encourage better HFC disposal practices of high-global warming potential refrigerants.
- Develop or identify an existing model high-GWP refrigerant disposal ordinance and encourage local governments to adopt such an ordinance.
- Promote measures, such as the Air District's vehicle buy-back program described in control measure TR14 (Cars and Light Trucks), to accelerate turnover in the vehicle fleet of older model vehicles using high-GWPs in their air conditioning systems to vehicles that use low-GWP refrigerants.

Emission Reductions:
The potential emission reductions for many of the implementation actions described above are discussed in specific control measures which those implementation actions proposed for the agriculture, energy, stationary source, and waste sectors. The implementation actions related to F-gases are not duplicative of other control measures and their estimated emission reductions are discussed here. Total emission reductions of F-gases from this control measure are estimated to be 13,200 MT CO2e per year, on a 20-year timeframe, and 6,600 MT CO2e on a 100-year timeframe in 2020. In 2030, reductions are estimated to be 57,200 MT C02e per year, on a 20-year timeframe and 28,600 MT CO2e per year, on a 100-year time frame.

Pollutants*	2020	2030
CO_{2e}	6,600	28,600

**CO_{2e} is reported in metric tons/year (100 yr GWP) in this table*

Emission Reduction Methodology:
Reductions of F-gas emissions for this control measure focus on the impacts of providing incentives for early adoption of low-GWP refrigerants in commercial and industrial refrigeration systems. These reductions are considered additional to State and federal policies. Emission reductions for this measure were calculated based on ARB's proposed Short-Lived Climate Pollutant Reduction Strategy released in April 2016. ARB estimates 2 $MMTCO_2e$ reductions (20 year GWP) could be achieved statewide through a $20 million investment. This dollar per ton cost effectiveness was multiplied by 0.20 to account for the District's portion of the State's population. A typical leak rate of 15-20 percent for large commercial refrigeration systems was assumed.

Exposure Reduction:
Decreasing emissions of black carbon will reduce population exposure to soot and thus help to reduce the wide-ranging health effects related to fine PM and the cancer risk associated with exposure to diesel PM.

Emission Reduction Trade-offs:
Some technologies that reduce PM emissions from vehicles may slightly decrease fuel efficiency. In these cases, it is possible that emissions of CO_2 may slightly increase.

Cost:
The potential costs for many implementation actions described above are discussed in the specific control measures proposed for the agriculture, energy, stationary source, and waste sectors.

The cost/benefit data provided in the table below illustrates that prior regulatory actions at the State level associated with reducing emissions of F-gases associated with refrigerants appear to be cost effective (data is from ARB's Refrigerant Management Program). However, potential Air District regulatory and/or programmatic activities are unknown at this time and therefore a cost/benefit analysis will be performed when and if specific regulatory actions are identified for the Bay Area.

Annual costs	Facilities with small systems (50-200 lbs. high GWP refrigerant)	Facilities with medium systems (200 – 2,000 lbs.)	Facilities with large systems (>2,000 lbs.)
Total gross cost	$651	$2,770	$5,410
Refrigerant savings	$637	$2,740	$14,130
Total net annual cost	$14	$30	$8,720 (savings)

Co-benefits:
Decreasing emissions of black carbon will protect public health by reducing population exposure to fine PM. Mitigating leaks of F-gases in refrigeration and air conditioning increases the efficiency of the system and offsets the cost of mitigation.

Issues/Impediments:
None identified at this time.

Source:
1. Air Resources Board. *Proposed Short-Lived Climate Pollutant Reduction Strategy*. April 2016
2. Air Resources Board. *Initial Statement of Reasons for Proposed Regulation for the Management of High Global Warming Potential Refrigerants for Stationary Sources Appendix C: Economic Estimates*. October 23, 2009.

SL2: Guidance for Local Planners

Brief Summary:
The Air District will develop guidance to help local agencies address short-lived climate pollutants (SLCPs), or super-GHGs, in their climate action plans and programs.

Purpose:
The purpose of this measure is to encourage local agencies to include actions to reduce super-GHG emissions in their climate plans and programs.

Source Category:
The term "short-lived climate pollutants", or super-GHGs, refers to a diverse group of climate forcers[1] that have a relatively short lifetime in the atmosphere, but have high global warming potential (GWP).[2] Super-GHGs addressed by this control measure include:

- Methane
- Black carbon (BC)
- Fluorinated gases (F-gases)

Methane is the second leading GHG in the Bay Area inventory, after CO_2. Three source categories currently account for 90 percent of total methane emissions in the Bay Area:

- Landfills: 50 percent
- Animal waste: 27 percent
- Natural gas production and distribution: 13 percent

Leading sources of BC emissions in the Bay Area include diesel engines and residential wood-burning.

Hydrofluorocarbons (HFCs) are the most prevalent of the fluorinated gases in the Bay Area. HFCs are used in refrigeration and air conditioning systems in commercial, industrial, and residential applications, as well as air conditioning in motor vehicles.

Regulatory Context and Background:
As described in control measure SL1, super-GHGs account for a significant portion of the total Bay Area greenhouse gas (GHG) inventory. Current and proposed regulatory measures to reduce super-GHG emissions are also described in SL1. Because super-GHGs have a relatively short atmospheric lifetime, reducing super-GHG emissions offers an effective means to reduce GHG emissions in the near term, while strategies to reduce emissions of longer-lived GHGs such as carbon dioxide (CO_2) are developed and implemented. In addition to directly reducing GHG

[1] A "**climate forcer**" is defined as any gas or particle that alters the Earth's energy balance by absorbing or reflecting solar radiation.
[2] In this document, we use the term "short-lived climate pollutants" for this category of climate forcers in order to be consistent with terminology at the State level. However, the term "high GWP gases" might be more accurate to describe this category since most fluorinated gases have long lifespans in the atmosphere, as discussed below.

emissions, near-term actions to decrease super-GHG emissions can slow climate feedback mechanisms in the Arctic and elsewhere (for example, the release of CO_2 and methane caused by the thawing of permafrost) that would otherwise further accelerate global warming. According to the Air Resources Board (ARB), reducing emissions of super-GHGs on a global scale can:

- Cut global warming in half, by $0.6^{o}C$ in 2050, and by $1.4^{o}C$ in 2100.
- Reduce warming in the Arctic by two-thirds ($0.7^{o}C$) by 2040.
- Reduce sea level rise by 25 percent.
- Increase chances of keeping average warming below $2^{o}C$ to greater than 90 percent by 2050.

In his January 2015 inaugural address, Governor Brown identified reducing SLCP emissions as one of six key pillars of the state's climate protection strategy. The ARB released a draft statewide SLCP Reduction Strategy in April 2016. The draft statewide SLCP strategy identifies a number of potential opportunities for local actions to reduce super-GHG emissions. ARB staff is currently preparing a final version of the strategy for review and approval by the ARB board.

Many local agencies in the Bay Area play an important role in reducing emissions of GHGs by implementing policies that complement state and regional programs. Some local agencies already address super-GHGs in their climate action plans, primarily via measures that would help to reduce methane emissions from landfills, water treatment, or agriculture. In addition, several local climate action plans include measure to address F-gases. For example, the Marin County climate action plan includes a measure to implement best management practices to reduce F-gas emissions from the use and disposal of refrigerants. The City of Livermore climate action plan includes several potential measures to reduce emissions of F-gases, and the City of El Cerrito climate action plan calls for developing a local policy to reduce emissions of F-gas refrigerants to the lowest achievable and practical levels.

To date, however, most of the 60+ local climate action plans adopted by Bay Area cities and counties primarily focus on reducing emissions of CO_2. Local governments can potentially increase the scope and effectiveness of their climate action plans by adding super-GHGs to their local GHG inventories and including measure to reduce super-GHGs in their climate action strategies.

Implementation Actions:
The Air District will encourage local agencies to help reduce emissions of super-GHGs in the Bay Area by:

- Providing information to local agencies to describe the current and projected emissions of super-GHGs and their contribution to the overall regional GHG inventory.
- Explaining why reducing super-GHG emissions can be an important element of a comprehensive local
  climate action plan and providing technical assistance to develop or update climate action plans to address super-GHGs.
- Suggesting potential policies or measures that local agencies can implement to reduce super-GHG emissions (see examples of potential actions described below).

- Tracking progress in adoption of super-GHG reduction measures in local plans via its database that catalogs local GHG policies.

Examples of potential actions that local agencies can take to reduce super-GHG emissions are described below.

Methane reductions:

- Reduce methane emission from landfills by diverting food waste and organic materials from the waste stream (see WA2).
- Work with the farming community to promote practices and projects that reduce methane from agriculture, such as promoting dairy digesters (see measures AG1 and AG2).

Black carbon reductions:

- Promote the use of alternative fuel vehicles in local fleets and communities in order to reduce emissions of black carbon from diesel engines.
- Promote the use of the cleanest available construction equipment in local projects, promote the use of clean construction equipment as a CEQA mitigation measure, and monitor project implementation to ensure compliance with clean equipment requirements.
- Support the Air District's efforts to reduce residential wood-burning.
- Consider collaborating with land management and fire agencies to promote land use and forestry practices that reduce the chance of large-scale wildfires.

F-gas reductions:

- Take action to minimize F-gas emissions from use and/or disposal of air conditioning systems, motor vehicles, refrigeration units, and other sources.

Emission Reductions:
No emission reduction estimates have been quantified for this measure.

Exposure Reduction:
Decreasing emissions of black carbon will reduce population exposure to soot and thus help to reduce the wide-ranging health effects related to fine PM and the cancer risk associated with exposure to diesel PM.

Emission Reduction Trade-offs:
None identified.

Cost:
No significant costs associated with this measure are identified at this time.

Co-benefits:

Decreasing emissions of black carbon will protect public health by reducing population exposure to fine PM.

Issues/Impediments:
No significant issues or impediments are identified at this time.

Source:

1. Air Resources Board. *Draft Short-Lived Climate Pollutant Reduction Strategy*. April 2016

SL3: Greenhouse Gas Monitoring and Measurement Network

Brief Summary:
This measure facilitates the Air District's continued efforts to operate a fixed site greenhouse gas (GHG) monitoring network across the San Francisco Bay Area.

Purpose:
This control measure will increase the Air District's knowledge of methane and other GHG emission sources in the Bay Area by identifying emission 'hotspots', facilitate verifying and validating the Air District's regional methane emissions inventory, and to ultimately evaluate the efficacy of policy measures and regulatory actions adopted and implemented by the Air District.

Source Category:
This measure is related to information gathering and is not specific to any particular source category.

Regulatory Context & Background:
The Air District traditionally estimates emissions for the regional GHG inventory using a bottom-up methodology. In this approach, emission factors (e.g. the amount of methane emitted per unit of biomass burned), based on accepted studies and practices, are combined with activity data (e.g. population density, fuel consumed) to generate source-specific emissions estimates. This approach is consistent with how the Air Resources Board (ARB) and the U.S. Environmental Protection Agency (EPA) develop statewide and national GHG inventories, respectively. As methane measurement technologies have improved over the last decade, there is increased interest within the scientific community to verify and validate the estimates in the bottom-up inventories using a variety of top-down observational techniques that depend on direct measurement of methane concentrations in the atmosphere. Recent literature suggests that traditional bottom-up methods of generating emission inventories in California may be significantly under-estimating actual emissions of methane (Wunch et al., 2009; Hsu et al., 2010; Wennberg et al., 2012; Peischl et al., 2013; Jeong et al., 2014). In a recent study that utilizes methane data collected over the last two decades from several Air District monitoring stations (Fairley and Fischer, 2015), the authors conclude that the resulting methane emissions are 1.5 to 2 times greater than the Air District's bottom-up inventory estimates. With this control measure, the Air District intends to resolve this data gap through source-specific measurements of methane throughout the Bay Area.

The first phase of this program focused on setting up a long-term GHG monitoring network at four sites. One of the four sites is located north and generally upwind of the urban core at Bodega Bay along the Pacific Coast. This site receives clean marine inflow from the west-northwest and hence provides a regional background level of ambient methane. The other three sites are strategically located at exit points for Bay Area wind paths that contain concentration enhancements generated from Bay Area GHG sources added to the prevailing background concentrations. These stations are at San Martin, which is located south and generally downwind of the San Jose metropolitan area; at Patterson Pass, which is at the cross section of the eastern edge of the Bay Area with California's Central Valley; and at Bethel Island at the mouth of the Sacramento-San Joaquin Delta. At all sites, carbon dioxide and methane are being measured continuously, along with carbon monoxide (acting as a source tracer for combustion emissions) and other air pollutants.

The second phase of the program will include use of a van to serve as a mobile GHG measurement platform, equipped with state-of-the-art instruments capable of measuring not only methane, carbon dioxide and carbon monoxide, but also nitrous oxide (N_2O), isotopic methane and the hydrocarbon tracer ethane. There are a variety of local stationary GHG sources in the Bay Area including landfills, wastewater treatment plants, dairies, oil refineries, natural gas cogeneration plants, gas pipelines etc. Measurements of concentrations of GHGs conducted upwind and downwind of such sources will be combined with short-range measurement techniques and an atmospheric dispersion model to verify source emission rates. The isotopic information will aid in source attribution. These measurements from local sources will allow verification and validation of the Air District's regional GHG emissions inventory for the Bay Area.

Implementation Actions:

- Continue development of a GHG monitoring plan for the Bay Area that includes strategic selection of measurement locations, selection of relevant measurement technologies and procurement of appropriate GHG instrumentation, calibration gas standards and sampling logistics.
- Operate and maintain the fixed-site GHG monitoring network.
- Report monitoring data on the Air District's website for access by the public and scientific community alike.
- Utilize an ultraportable methane analyzer to detect emissions hotspots in the Bay Area.
- Analyze date from fixed-site network data to develop future source-specific investigation plans.
- Fabricate and equip the Air District's mobile measurement van with high resolution instrumentation, meteorological devices, and related equipment for localized GHG measurements.
- Collaborate with the scientific community to use different methods to estimate regional methane emissions for the Bay Area utilizing top-down observations, estimate methane mass emission rates from individual sources and facilities, and develop spatially resolved maps of methane emissions.

Emission Reductions:
This control measure will inform policy, program and rule development efforts targeted at methane emission reductions.

Emission Reduction Methodology:
This control measure will not directly reduce emissions.

Exposure Reduction:
This control measure will not directly impact emission exposure.

Emission Reduction Trade-Offs:
This control measure will not directly impact emissions.

Cost:
To date, approximately $600,000 has been invested in the GHG monitoring network. The majority of this amount (~ $570,000) has been spent on procuring eight sophisticated and top-of–the-line GHG instruments that will be the core of the GHG stationary and mobile network. Existing Air District staff operate and maintain the equipment and evaluate the data collected.

Co-Benefits:
In addition to improving the Air District's methane emissions estimates, the GHG monitoring and measurement network also includes CO_2 measurements at the fixed-site locations, and both CO_2 and N_2O aboard the mobile platform. There is significant uncertainty in ARB's bottom-up N_2O emissions inventory especially in the transportation sector (Guha et al., 2015) that needs to be investigated through top-down studies. The N_2O measurement capability is a powerful tool to better understand the Bay Area's N_2O emission sources. Additionally, the methane measurement infrastructure will attract potential collaborators in academic and research institutions, building knowledge which will be critical to the implementation of other control measures in the 2016 Plan.

Issues/Impediments:
Methane source identification and attribution becomes more robust when accompanied by simultaneous measurement of source markers e.g. volatile organic compounds like ethane (to detect methane from fugitive oil and gas sources) and methanol (to detect methane from dairy and livestock sources). Adding additional measurement capability to the GHG mobile platform would require additional financial resources.

Sources:

1. Fairley, David, and Marc L. Fischer. "Top-down methane emissions estimates for the San Francisco Bay Area from 1990 to 2012." Atmospheric Environment 107 (2015): 9-15.
2. Guha, A., Gentner, D. R., Weber, R. J., Provencal, R., & Goldstein, A. H. (2015). Source apportionment of methane and nitrous oxide in California's San Joaquin Valley at CalNex 2010 via positive matrix factorization. Atmospheric Chemistry and Physics Discussions, 15(5), 6077-6124.
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FSM_SS1: Internal Combustion Engines

Brief Summary:
This measure is based on San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule 4702 which appears to have lower NO_x emission limits for some categories of internal combustion (IC) engines, compared to BAAQMD Regulation 9-8. Rule 4702 also applies to smaller engines than Regulation 9-8.

Purpose:
Further emission reductions of NO_x from IC engines.

Source Category:
Stationary IC engines.

Further Study Measure Description:
San Joaquin Valley APCD Rule 4702 was significantly revised in 2011 to incorporate new emission limits for IC engines. [The latest, November 2013 amendment of SJVAPCD Rule 4702 was entirely editorial and administrative.] The analogous BAAQMD rule – Regulation 9-8 – was last amended in 2007.

The differences between SJVAPCD Rule 4702 and BAAQMD Regulation 9-8 may be summarized as follows:

1) SJVAPCD Rule 4702 has standards for agricultural and non-agricultural engines, while BAAQMD Regulation 9-8 exempts agricultural engines entirely.

2) SJVAPCD Rule 4702 applies to engines as small as 25 bhp, while Regulation 9-8 applies to engines larger than 50 bhp. It should be noted that the South Coast AQMD Rule 1110.2 (September 2012) applies only to engines larger than 50 bhp.

SJVAPCD Rule 4702 does not set emission limits for engines in the 25 to 50 bhp size range. Instead, it requires that engines sold in this size range comply with EPA's New Source Performance Standards (NSPS) for both spark-ignition and compression ignition engines (40 CFR 60, Subparts JJJJ and IIII, respectively), and only if the engines are not used in agricultural operations. This requirement is also not applicable to leased engines. Because Rule 4702 does not require existing engines in the 25 to 50 bhp size range to meet any particular standard, and does not require that existing engines be phased out, SJVAPCD claimed no emission reductions for engines in the 25 to 50 bhp size range and also concluded that "there is no cost associated with adding engines between 25 bhp and 50 bhp" [to rule 4702].

The 2011 BAAQMD emissions inventory includes an element for "reciprocating engines / liquid fuel (area)" which includes all engines rated 50 bhp and less which do not require permits. The total NO_x emissions for this inventory element is 0.27 ton/day. This emission figure is not based on direct data about engines rated less than 50 bhp that are operated in the Bay Area since neither BAAQMD, nor any other agency, requires permits or registration of such engines. Also, this total emission figure includes emissions from engines rated less than 25 bhp.

Typically, for engines and other combustion devices such as boilers, smaller devices are more numerous than larger devices. Therefore, if all engines rated less than 50 bhp have total emissions of 0.27 ton/day, engines rated 25 to 49 bhp might reasonably be expected to have about half of these emissions, or no more than 0.14 ton/day NO_x. The staff report for the 2007 amendments to Regulation 9-8 estimated NO_x emission reductions of 45 percent to 71 percent for each category of engine for which new emission limits were imposed. Assuming the highest reduction (71 percent) could be achieved on engines rated 25 to 49 bhp, the resulting NO_x emission reduction would be slightly less than 0.1 ton/day. So, even making these conservative assumptions, the potential NO_x emission reduction appears to be marginal, and realization of this reduction would require that older engines be replaced on an accelerated basis. If the requirement applied only to new engine sales, without applying to existing engines, then the quantifiable emission reductions would be negligible. In other words, Rule 4702's provisions with regard to small engines do not represent a significant improvement beyond the current provisions of BAAQMD Regulation 9-8.

3) SJVAPCD Rule 4702 imposes lower NO_x limits than BAAQMD Regulation 9-8 for engines larger than 50 bhp, and includes emission limits for agricultural engines that BAAQMD Regulation 9-8 exempts entirely. SJVAPCD regulates spark-ignition and compression-ignition engines in different ways. For spark-ignition engines, the differences in these rules may be summarized as follows:

Table 1: Spark-Ignition NO_x Limits in SJVAPCD Rule 4702 and BAAQMD 9-8 (at 15% oxygen)

Application	SJVAPCD 4702	BAAQMD 9-8
Agricultural (spark-ignition), installed after 6/16/05	•Rich-burn: 90 ppmv •Lean-burn: 150 ppmv	•Unregulated •Unregulated
Agricultural (spark-ignition), installed on or before 6/16/05	CARB certified to be <0.6 g/bhp-hr for NO_x and VOC (combined)	•Unregulated •Unregulated
Non-Agricultural (spark-ignition), phase 1: 1/1/12 thru 1/1/17	•Rich burn, waste gas: 50 ppmv •Rich burn, fossil fuel: 25 ppmv •Lean-burn, all fuel: 65 ppmv	•Rich burn, waste gas: 70 ppmv •Rich burn, fossil fuel: 25 ppmv •Lean burn, waste gas: 70 ppmv •Lean burn, fossil fuel: 65 ppmv
Non-Agricultural (spark-ignition), phase 2	•Rich burn, waste gas: 50 ppmv •Rich burn, ≤4,000 hr/yr: 25 ppmv	No change from phase 1

	•Rich burn, all others: 11 ppmv •Lean burn, waste gas: 65 ppmv •Lean burn, ≤4,000 hr/yr: 65 ppmv •Lean-burn, all others: 11 ppmv	

For compression-ignition engines, SJVAPCD Rule 4702 and BAAQMD Regulation 9-8 use completely different regulatory schemes. BAAQMD Reg 9-8 simply applies a NO_x limit of 180 ppmv (at 15 percent oxygen) to engines rated 51 to 175 bhp, and a limit of 110 ppmv to larger engines.

To understand SJVAPCD's regulatory scheme for compression-ignition engines, it is necessary to understand US EPA's emission limits for non-road compression-ignition engines, which are generally known as the "Tier" standards. US EPA imposed a set of emission limits (Tier 1 through Tier 4). These limits applied to new, compression ignition engines. Each tier was in effect for 3 or 4 years and during that time, was phased in for different engine size ranges. Because each tier was phased in over a period of years, on any date different tiers may have been in effect for different engine size ranges. In 2014 and 2015, the "final" Tier 4 limits are being implemented. Each tier applies only to engines manufactured while that tier is in effect, and each subsequent tier reduces the emission limits. The tier limits do not apply to existing engines and therefore the emission reductions associated with the tier limits are realized as pre-Tier 1 engines are retired, as well as Tier 1, Tier 2 and Tier 3 engines. Under this federal scheme, eventually only Tier 4 engines will remain in service. SJVAPCD Rule 4702 requires that existing engines (agricultural and non-agricultural) meet specific EPA tier requirements, and addresses pre-Tier 1 differently than later engines. For pre-Tier 1 engines, depending on the engine size, Rule 4702 requires compliance with either Tier 3 or Tier 4 emission limits or a NO_x limit of 80 ppmv. For Tier 1 and Tier 2 engines, Rule 4702 requires compliance with Tier 4 limits by no later than 2018. For Tier 3 and Tier 4 engines, Rule 4702 has no other requirements.

Considering Table 1 for spark-ignition engines and the discussion of both districts' treatment of compression-ignition engines, SJVAPCD has more stringent standards than BAAQMD because:

1) SJVAPCD imposes emission limits on spark-ignition, agricultural engines while BAAQMD does not,

2) While current emission limits for non-agricultural engines are similar at both districts, SJVAPCD has adopted a next phase of emission limits for these engines that are significantly lower, although these limits apply only to engines that operate more than 4,000 hr/yr, and

3) For compression-ignition engines (agricultural and non-agricultural) SJVAPCD requires existing engines to eventually comply with either US EPA Tier 3 or Tier 4 emission limits or an 80 ppmv NO_x limit, while BAAQMD has a NO_x limit of either 110 or 180 ppmv NO_x (depending on engine size, all at 15% oxygen). These NO_x limits are equivalent to 2.5 and 3.7 g NO_x/bhp-hr, respecitively, according to the 2007 staff report for Regulation 9-8 amendments.

A final factor to consider in comparing SJVAPCD and BAAQMD requirements is that, for compression-ignition engines, CARB has issued an ATCM that imposes emission limits on virtually all stationary, compression-ignition engines in California. The final compliance date for the ATCM is 12/31/2015, although this date is extended for recently-installed and relatively low-emitting engines. Although the main purpose of the ATCM was to reduce toxic diesel PM emissions, the ATCM imposes combined NO_x and non-methane volatile organic compound (MHC) limits for new, emergency and prime-use engines. For existing, emergency and prime-use engines, the ATCM simply requires that NO_x and NMHC emissions not increase over "baseline" levels.

The potential areas for improvement in BAAQMD Regulation 9-8 that are discussed above were anticipated in the 2007 staff report for the last amendments to Regulation 9-8. The staff report indicates that:

• For spark-ignition and compression-ignition engines, the 2007 emission limits represented "the most stringent demonstrated retrofit control technology available".

• For compression-ignition engines, the new limits "incorporate the most stringent future-effective EPA standards", which refers to the "Tier" standards.

• With regard to agricultural engines, the staff report indicates that CARB data was used to estimate total annual NO_x emissions of 0.076 ton/day, and that these emissions did not justify including agricultural engines in the rule.

Based on the discussion above, BAAQMD will:

1) No action to reduce NO_X emissions from agricultural engines, based on the previous emission estimates for these devices in the 2007 Regulation 9-8 staff report. However, because the BAAQMD emissions inventory does not have an element for stationary, agricultural IC engines, the inventory should be improved in this area.

2) As discussed above, SJVAPCD Rule 4702 imposes a low 11 ppmv NOx limit on high-use, non-agricultural, spark-ignition engines (>4,000 operating hr/yr). The 2007 Regulation 9-8 staff report considers spark-ignition engines used >100 hr/yr to be "prime" engines and imposed a NOx limit ranging from 25 to 70 ppmv. SJVAPCD further identified "high-use" engines where SCR would be cost-effective and imposed an 11 ppmv limit on these engines. Neither the 2007 Regulation 9-8 staff report, nor the BAAQMD base-year 2011 inventory identifies high-use engines in the Bay Area. However, even after implementation of the emission controls in Regulation 9-8, prime spark-ignition engines would still have a total NOx emission inventory of 2.6 ton/day (based on the emission and emission reduction data in Table 12 of the 2007 staff report). Therefore, depending on how many of these engines are "high-use", further NOx controls might be justified.

Sources:

1. San Joaquin Valley APCD: Final Draft Staff Report with Appendices for Revised Proposed Amendments to Rule 4702, August 2011.
2. BAAQMD: Staff Report for Proposed Amendments to Regulation 9-8, July 2007.
3. BAAQMD: Base Year 2011 Emissions Inventory.

FSM_SS2: Boilers, Steam Generator and Process Heaters

Brief Summary:
This measure is based on Measure D.1.2 from the 2012 San Joaquin Valley Air Pollution Control District (APCD) $PM_{2.5}$ Plan. Measure D.1.2 examined the possibility of further emission reductions from Boilers, Steam Generators and Process Heaters from 2MM to 5 MM BTU/hr in size through San Joaquin's Rule 4307.

Purpose:
Further reductions of oxides of nitrogen (NO_X) emissions from small boilers, steam generators and process heaters.

Source Category:
Combustion

Further Study Measure Description:
Air District Regulation 9, Rule 7 regulates all Bay Area boilers, steam generators and process heaters with a rated heat input above 2 MM BTU/hr, while San Joaquin has a rule specifically for the size category of 2MM to 5MM BTU/hr.

Rule 9-7 was last amended in 2011. For devices rated above 2 to 5 MM BTU/hr (both new and existing), Rule 9-7 imposes a 30 ppmv NO_X limit at 3% oxygen, and requires certification of models by manufacturers and registration of installed devices by owner or operators. The 30 ppmv limit was effective on January 1, 2013 with multi-unit facilities able to extend full compliance by as much as 2 years to January 1, 2015.

San Joaquin Rule 4307 also imposes a 30 ppmv NO_X limit for existing devices, but has more stringent limits of either 12 or 9 ppmv for new or replacement devices (atmospheric and non-atmospheric devices, respectively). Both limits for new devices have been in effect in San Joaquin since 2010. The question presented by this measure is whether to reduce the current 30 ppmv NO_X limit in Rule 9-7 for new devices.

As of July 2014, San Joaquin has certified only a single compliant device, so it is unclear if devices that comply with the 12 and 9 ppmv limits are generally available. South Coast AQMD's Rule 1146.2 applies to boilers, steam generators and process heaters in a smaller size category (above 400,000 to 2MM BTU/hr) and South Coast maintains an extensive list of certified devices on their website. These smaller devices are certified for an emission limit of 20 ppmv $NO_{X.}$

Further actions the Air District could take include verifying the actual commercial availability of boilers, steam generators and process heaters in the size range above 2MM BTU/hr with certified NO_X emission rates less than 30 ppmv. Depending on the availability of lower-NO_X devices, estimate potential emission reductions and cost-effectiveness of a reduced NO_X limit for new devices in this size range.

Source:

1. San Joaquin Valley Unified APCD 2012 PM2.5 Plan, Control Measure D.1.3: "Boilers, Steam Generators and Process Heaters-0.075 MM BTU/hr to less than 2.0 MM BTU/hr".

FSM_ SS3: GHG Reductions from Non Cap-and-Trade Sources

Brief Summary:
This measure will use quantitative analysis to evaluate greenhouse gas (GHG) reduction opportunities from stationary sources that are not covered under the California Air Resources Board's (ARB's) Cap-and-Trade Program.

Purpose:
The purpose of this measure is to complement the State's Cap-and-Trade program by achieving GHG emission reductions from stationary sources within the Bay Area that do not fall under the Cap-and-Trade program

Source Category:
Small-scale stationary sources not covered by the State Cap-and-Trade program.

Further Study Measure Description:
At the state level, the California Global Warming Solutions Act of 2006 (AB 32) requires a 20 percent reduction in the State's GHG emissions below 1990 levels by 2020. The first AB 32 Scoping Plan identified a cap-and-trade program as one of the strategies California would employ to meet the State's GHG reduction goals. ARB's Cap-and-Trade program established a cap on GHG emissions from certain categories of sources, set to decline approximately 3 percent each year beginning in 2013. Facilities subject to this cap are able to trade allowances to emit GHGs in order to minimize compliance costs.

The Cap-and-Trade program includes exemptions such as fugitive emissions from certain industrial processes, and facilities with emission levels below the reporting threshold of 25,000 MT CO_2e/yr. In the Bay Area, there are over 5,700 stationary sources that emit GHGs. Of these, approximately fifty exceed this reporting threshold. This figure indicates that there is an opportunity to explore options for reducing stationary source emissions outside of the Cap-and-Trade program. Preliminary analyses indicate that the bulk of these emissions occurred in the biofuel, natural gas distribution, sewage treatment, and landfills sectors. At the regional level, the Air District has adopted a GHG reduction target of 80 percent below 1990 levels by 2050. In an effort to complement ARB's climate work and meet its own goals, Air District staff will analyze GHG data for Bay Area stationary sources not covered under ARB's Cap-and-Trade program. These analyses can help the Air District prioritize its climate protection efforts by highlighting Bay Area stationary sources having the largest emissions not covered under Cap-and-Trade. Further analysis of the data may uncover new rulemaking opportunities.

Sources:
1. Assembly Bill No. 32: California Global Warming Solutions Act of 2006
2. California Air Resources Board's Cap-and-Trade Program: http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm
3. California Air Resources Board's Greenhouse Gas Inventory Data:

http://www.arb.ca.gov/cc/inventory/data/data.htm

FSM_SS4: Methane Exemptions from Wastewater Regulation

Brief Summary:
The Air District's regulation regarding waste water, Regulation 8, Rule 8, currently does not apply to methane emissions. As outlined in SS16, the Air District proposes to evaluate and eliminate methane exemptions in Regulation 8 where feasible and relevant.

Purpose:
This measure seeks emission reductions of methane, a powerful greenhouse gas (GHG). Removing the methane exemption from Rule 8-8 may also improve the rule enforceability.

Source Category:
Stationary Sources – waste water systems

Further Study Measure Description:
Regulation 8, Rule 8 currently applies to "wastewater collection and separation systems that handle liquid organic compounds from industrial processes." The regulation applies to oil/water separators and air flotation (AF) devices and associated equipment, but does not apply to "secondary treatment" processes downstream of the separator and AF device. Methane is excluded in the definitions of both "Organic Compound" and of "Critical Organic Compound." The term "Organic Compound" is used in the vapor leak standard for separators and the required efficiency of abatement devices. The concentration of "Critical Organic Compounds" is the basis for the exemption in 8-8-112 for refinery and non-refinery separators, and for associated records.

A draft scoping paper for the amendment of Rule 8-8 was prepared in early 2015. In the scoping paper, Air District staff assumed that add-on controls, such as thermal oxidizers, could be installed on various parts of the wastewater system to combust methane. However, rule development on Rule 8-8 was suspended because methane concentration data at Bay Area refinery wastewater systems suggested that concentrations were too low to justify such add-on controls. Instead, additional research and testing will be required to identify significant methane sources farther upstream in the process, where methane concentrations may be higher.

The Air District will conduct research and testing to identify significant methane sources in the refinery wastewater collection systems, and to determine how these sources may be minimized or controlled. In addition, the Air District will seek to better understand methane emissions from non-refinery wastewater systems, such as those used in publicly owned treatment works (POTWs), and quantify potential emission reductions for methane, as well as for volatile organic compounds (VOC), in order to determine if Reg. 8-8 should be expanded to additional non-refinery sources. See WR1: Limit GHGs from POTWs for more detail.

Sources:

1. BAAQMD Regulation 8, Rule 8

FSM_SS5: Controlling SSMM Emissions

Brief Summary:
Existing Air District regulations and permit conditions limit criteria pollutant emissions from equipment at chemical plants, bulk terminals, and petroleum refineries. However, most requirements apply to routine operations and have exemptions from emissions limits during startup, shutdown, maintenance, and malfunction (SSMM) events. This measure would consider further addressing emissions from SSMM events.

Purpose:
Reduce NO_X, $PM/PM_{10}/PM_{2.5}$, SO_2, VOC, and TAC emissions by considering implementing requirements to minimize SSMM emissions through abatement technology, equipment design considerations, revised activity scheduling, or planned redundancy.

Source Category:
Equipment at chemical manufacturing plants, bulk terminals, and petroleum refineries that undergo SSMM activities.

Further Study Measure Description:
Other than malfunctions, SSMM activities may be either planned or unplanned. Planned SSMM activities may result in unplanned SSMM events. Depending on the activity, emissions from SSMM activities can be significant (a single refinery turnaround in 2015 lasted 56 days and emitted 180 tons of VOC and 394 tons of SO_2).

Planned SSMM activities include:
- Process unit de-inventory
- Process unit depressurization
- Equipment cleaning, purging, repair, rebuild
- Equipment installation or removal
- Catalyst installation or removal
- Refractory installation, repair, or removal

Unplanned SSMM activities include:
- Plant upset
- Equipment failure

Emissions during SSMM activities may result from bypassing control devices, purging vessels, pressure relief valve venting, flaring, or usage of temporary combustion sources (e.g. diesel generators, steam boilers, thermal oxidizers, etc.).

During maintenance periods, a petroleum refinery flare or flare gas recovery system may have limited capacity or availability and flare gas loading can exceed the capacity of the flare gas recovery system. Such “high loading” events can cause upsets to entire facility operations.

Several Air District regulations limit emissions from some SSMM activities but there is no comprehensive SSMM rule that applies to all SSMM activities.

Regulation 8, Rule 10 limits organic compound emissions from process vessel depressurizing but does not apply when either the internal pressure or internal organic compound concentration (regardless of mass) is low.

Regulation 8, Rule 28 limits organic compound emissions from pressure relief devices at petroleum refineries and chemical plants. However, this rule does not apply to devices handling heavy liquids (e.g. diesel, jet fuel, gas oil, etc.).

Regulation 12, Rule 12 requires minimizing flaring events through facility-developed flare minimization plans. However, there is a large variation in the specificity and comprehensiveness of each refinery plan. In addition, refineries are required to notify, determine, and report the cause of only large flaring events.

Title 40 of the Code of Federal Regulations Part 63 (National Emission Standards for Hazardous Air Pollutants for Source Categories), Subpart A (General Provisions) includes requirements to develop a startup, shutdown, and malfunction plans. However, these plans only apply to those sources that are subject to a NESHAP rule.

Techniques to reduce or eliminate SSMM emissions include:

- Implementing a management of change/SSMM process
- Optimal scheduling (scheduling to minimize emissions)
- Implementing best practices
- Permanent or temporary emission control technology
- Usage of lower emitting equipment (e.g. scrubbers)
- Implementing redundancy for critical equipment
- Using vapor recovery rather than combustion technology

In order to investigate controlling these emissions, the Air District will:

- Complete study on SSMM emissions.
- Complete study of regulatory efforts on largest, most cost effective SSMM emission reductions and mitigation steps.
- Explore the number, types, and durations of SSMM activities and events at chemical manufacturing plants, bulk terminals, and petroleum refineries in the Air District.
- Explore potential design, equipment, scheduling, and process variability considerations that affect SSMM emissions.
- Estimate potential emission reduction and costs.

Sources:

1. Air District Regulation 8, Rule 10

2. Air District Regulation 8, Rule 28
3. Air District Regulation 9, Rule 10
4. Air District Regulation 12, Rule 12
5. Title 40 Code of Federal Regulations Part 63 Subpart A
6. Texas Administrative Code Title 30 Part 1 Chapter 115 Subchapter D Division 1 (Process Unit Turnaround and Vacuum-Producing Systems in Petroleum Refineries) Rule 115.312 (Control Requirements)
7. SCAQMD Rule 1123 (Refinery Process Turnarounds)
8. SJVUAPCD Rule 4454 (Refinery Process Unit Turnaround)

FSM_SS6: Carbon Pollution Fee

Brief Summary:
The measure would explore options for placing a fee on fossil fuels based on the carbon intensity of the fuel.

Purpose:
Placing a fee on the carbon pollution generated by fossil fuels creates an incentive to all those that consume these fuels – individuals, businesses, industry – to reduce use. This reduction in consumption would reduce emissions of criteria pollutants, toxic air contaminants and greenhouse gases (GHGs) not only because less fuel is combusted but also because less fuel is processed and manufactured in response to reduced demand.

Source Category:
Consumption of fossil fuel for all uses – e.g., heating, fueling vehicles, manufacturing.

Further Study Measure Description:
A carbon pollution fee, or carbon tax, is a form of carbon pricing that assesses a fee on fuel based on the carbon content of that fuel. Since the carbon content of every form of fossil fuel - and thus the CO_2 emissions from burning these fuels - is precisely known, a carbon tax is, in fact, a tax on the CO_2 emissions from burning fossil fuels. For example, since generating a unit of energy (Btu) from coal produces 30 percent more CO_2 than a Btu from oil, and 80 percent more CO_2 than a Btu from natural gas, a carbon fee could follow these proportions and tax coal more heavily than oil, and much more heavily than natural gas. Fuels that do not require combustion for power generation, and thus do not result in emissions of CO_2 (e.g., wind, solar), would not be taxed.

A fee on carbon pollution creates broad incentives to encourage decision-makers in all areas of society – individuals, businesses, and industry - to reduce fossil fuel consumption and thus CO_2 emissions. These reductions would take place as a result of a range of changes in behavior, from conservation to fuel substitution to technological innovation. In addition, a carbon fee creates incentives at every link in the chain of decision and action — from individuals' choices and uses of vehicles, appliances, and housing, to businesses' choices of new product design, capital investment and facility location.

It should be noted that there are currently two existing fee programs in place in the Bay Area associated with GHG emissions. Specifically, since 2008, the Air District has imposed a GHG fee - the first in the nation - on permitted facilities based on the facility's annual CO_2e emissions. The funds raised are used to recover the costs of climate protection activities from the Air District's core programs including environmental review, air pollution regulations and emissions inventory development. In addition, California's Cap and Trade Program, which began in 2012, sets a firm and declining cap through 2020 on GHG emissions from major sources. This cap is translated into tradable emission allowances that are auctioned or allocated to covered sources; this system establishes a price signal to drive long-term GHG reductions.

There are numerous factors that are critical in the design of a carbon fee that would require further study, including the appropriate level of the fee and how the revenues should be spent. It would be quite useful to study carbon fee efforts worldwide – some successful and on-going and some flawed and short-lived – to learn the lessons from these experiences. For example, British Columbia's carbon tax introduced in 2008 was North America's first economy-wide carbon pricing policy and is widely regarded as a success. Among the design elements that have contributed to its success are the facts that the tax: (1) is revenue neutral (i.e., taxes are returned to those taxed via individual and corporate income tax cuts and low-income tax credit) and (2) was phased in, giving individuals and businesses time to adapt. In contrast, Australia's national carbon tax was approved in 2012, but then repealed in 2014. The failure of this tax was in part tied to the program's lack of transparency as well as uncertainty surrounding how the tax revenues would be spent.

Implementation of a carbon pollution fee would require approval by the California Legislature by one of two avenues. One approach is for the Legislature to impose a carbon tax on the Bay Area by way of a $2/3^{rds}$ majority vote. The second way is for the Legislature, via a simple majority, to approve regional legislation enabling such a tax to be implemented in the Bay Area. This legislation would then require approval by $2/3^{rds}$ of the voters in the Bay Area. There is precedent for this second approach. Specifically, in 1997, MTC was granted authority by the Legislature for a regional gas tax of up to 10 cents/gallon, although MTC has not placed this measure on the ballot. Given the need for legislative and/or voter approval, further development of this measure may require a survey or other research to gauge the public's opinion of a carbon pollution tax.

This further study measure takes a broader view of pollution-based taxing than that described in transportation control measure TR11: Value Pricing. TR11 is limited in scope to a transportation fuel-based tax, and does not address fuel and energy use related to manufacturing and industry, or building energy use. The Air District will work with MTC on implementation of TR11, but will also explore options for economy-wide carbon-based pricing through this further study measure.

Sources:

1. Carbon Tax Center, http://www.carbontax.org/.
2. Center for Climate and Energy Solutions, 2015, *Market Mechanisms: Understanding the Options.*
3. Clean Energy Canada, 2015, *How to Adopt A Winning Carbon Price: Top Ten Takeaways from Interviews with the Architects of British Columbia's Carbon Tax*.
4. Eberhard, Kristin, 2014, *All the World's Carbon Pricing Systems in One Animated Map*, http://daily.sightline.org/2014/11/17/all-the-worlds-carbon-pricing-systems-in-one-animated-map/.

5. Sustainable Prosperity, 2012, *British Columbia's Carbon Tax Shift: The First Four Years – Research Report*, University of Ottawa.

FSM_SS7: Vanishing Oils and Rust Inhibitors

Brief Summary:
Research VOC reductions from vanishing oils and rust inhibitors.

Purpose:
Reduce VOC emissions.

Source Category:
Stationary Source

Further Study Measure Description:
Vanishing oils are lubricants used in metalworking (such as cutting oil) or other oil used in manufacturing. Rust inhibitors are fluids used to inhibit, protect or prevent corrosion on metal surfaces. Vanishing oils and rust inhibitors are used in various metal working operations at facilities and operations such as aerospace, machine shops (job shops), steel mills, auto rebuild, screw machine operations, steel tubes (pipes) manufacturing, steel springs manufacturing, maintenance operations, and captive machine shop operations (captive machine shops are machine shops located inside of another type of business that supports the business, but is not the primary aspect of that business). The South Coast AQMD adopted Rule 1144 in 2009 to reduce VOC emissions from vanishing oils and rust inhibitors. The South Coast Rule 1144, does not apply to oils and inhibitors that have a flash point of less than 200^{o}F. It sets an interim VOC limit for rust inhibitor at 300 grams VOC per liter of material, and a final limit for both inhibitor and oil at 50 grams VOC per liter of material. The staff report projects emissions reductions of 2.7 tons per day (tpd) from a 3.2 ton per day inventory. BAAQMD inventory for rust preventives is 1.7 tpd of VOC emissions. Businesses using these materials include machine shops (job shops), aerospace facilities, steel mills, auto part rebuilders, screw machine shops, steel tube (pipe) manufacturers, steel spring manufacturers and captive machine shops located inside of other types of businesses. Staff will investigate the emissions from this sector to determine the feasibility of establishing regulatory limits that would achieve emissions reductions in a cost-effective manner.

Source:

1. South Coast AQMD Rule 1144, Staff Report, SCAQMD, March 6, 2009

FSM_SS14: Dryers, Ovens and Kilns

Brief Summary:

This further study measure would investigate potential further emission reductions of nitrogen oxide (NO_X) from combustion devices that are currently exempt from the requirements of Regulation 9, Rule 7: *NO_X and CO from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters*, specifically, devices in the category of "kilns, ovens, and furnaces used for drying, baking, heat treating, cooking, calcining, or vitrifying" (9-7-110.6).

Purpose:

Further emission reductions of NO_X, an ozone and fine particulate matter ($PM_{2.5}$) precursor.

Source Category:

Area sources – dryers, ovens and kilns

Further Study Measure Description:

Regulation 9-7 is a non-industry-specific rule that applies NO_X and CO emission limits to a broad range of combustion devices, but generally exempts "kilns, ovens, and furnaces".

In December 2005, the San Joaquin Valley Air Pollution Control District (SJVAPCD) adopted Rule 4309 to limit emissions of NO_X from dryers, dehydrators and ovens with a rated heat input of 5 MM BTU/hr or more. Rule 4309 was fully implemented in December 2008.

In December 2008, the South Coast Air Quality Management District (SCAQMD) adopted Rule 1147 to limit NO_X emissions from combustion devices, including "ovens, dryers, dehydrators, heaters, kilns, calciners, [and] furnaces" among others. Rule 1147 was fully implemented in July 2014.

The Air District's 2011 emissions inventory includes emissions from natural gas-fired devices of this type under 3 sub-categories for Combustion – Other External Devices:

"Natural gas (point source)" referring to permitted devices:	3.50 ton/day NO_X
"Natural gas (area source), industrial" referring to non-permitted devices:	2.94 ton/day NO_X
"Natural gas (area source), commercial" referring to non-permitted devices:	2.41 ton/day NO_X

Air District staff estimates that over 90 percent of the NOx emissions from dryers, overs and kilns in the 2011 stationary source (permitted) inventory either have been addressed by Regulation 9-13 (adopted in 2012 to address Lehigh Cement) or were evaluated for further control (with no further control proposed as of this date) in Regulation 9-14. Therefore, further study should focus on area (non-permitted) sources. For area sources, Air District staff will refine the NO_X inventory to determine if NO_X emissions from the "kilns, ovens, and furnaces" sector justifies further action, and if so, to determine an appropriate methodology.

Sources:

1. SJVAPCD Rule 4309, December 15, 2005
2. SCAQMD Rule 1147, September 9, 2011

FSM_ SS9: Omnibus Rulemaking to Achieve Continuous Improvement

Brief Summary:
This measure seeks to accelerate the pace of greenhouse gas (GHG) emission reductions in the Bay Area by exploring the feasibility of broad-sweeping, or "omnibus," rulemaking. Omnibus rules could achieve larger GHG emission reductions by targeting multiple sources and/or sectors simultaneously. However, the complexity associated with omnibus rules might present significant challenges to the socioeconomic and environmental analyses required for good rulemaking.

Purpose:
The purpose of this measure is to reduce GHG emissions in order to protect the global climate.

Source Category:
Stationary and area GHG sources

Further Study Measure Description:

In response to the immediate threat from climate change to our region, the Air District has adopted the goals of reducing Bay Area greenhouse gas (GHG) emissions 40 percent below 1990 levels by 2030, and 80 percent below 1990 levels by 2050.[1] Meeting these aggressive mid- and long-term targets will likely require implementing new approaches and streamlining existing processes to accelerate the pace of GHG reductions. Traditionally, the Air District's rulemaking process focuses on developing a unique rule to address a specific pollutant from a particular source-type. While this approach has achieved significant criteria and air toxic emission reductions in the Bay Area over the past decades, there might be alternative approaches that are more effective in reducing GHG emissions at the rate needed. Thus, the Air District is planning to evaluate a more encompassing rulemaking process –omnibus rules that could address GHG emissions from multiple source-types or entire source sectors, simultaneously– as a future approach. These "omnibus" rules could address GHG emissions more broadly and systematically, therefore yielding faster and larger GHG emission reductions. For example, approximately half of Bay Area GHG emissions (~40 MMT CO_2e) result from stationary combustion across industrial, commercial and residential sectors. The Air District is currently developing a basin-wide combustion strategy to systematically address these emissions (see **SS18: Basin-Wide Combustion Strategy**). Phase 1 of the combustion strategy will explore establishing a regulatory cap on the carbon intensity, or CO_2 emitted per unit of product, of all major industrial combustion sources at current levels. Phase 2 calls for source-by-source rulemaking to increase combustion efficiency. An omnibus rule could offer an alternative or parallel approach to accelerate the efforts of Phase 2.

There are important challenges that the Air District would need to overcome in order to

[1] These goals are consistent with the State of California's GHG 2030 reduction target, per SB 32 (Pavley, 2016), and the State's 2050 GHG reduction target per Executive Order S-3-05.

develop, evaluate, adopt and enforce omnibus rules. In order for rules to be legally defensible and free from unintended negative consequences, the rulemaking process must comply with federal Clean Air Act requirements, the requirements of the California Health and Safety Code, include a robust and comprehensive public engagement process, and the development of technical, socioeconomic and environmental impacts analyses. The complexity that would be necessarily associated with an omnibus rule would present challenges to the Air District in completing these legal and administrative requirements in a timely and thorough manner, therefore increasing the possibility of legal challenges and the chance of unanticipated negative environmental and/or economic consequences.

Particularly, there are significant concerns in four areas of the rulemaking process:

- *transparency and public outreach*
  An omnibus rule, encompassing multiple sectors and source-types, would likely involve a much higher number of stakeholders from affected communities, industries, environmental groups, as well as other regulatory agencies, than the traditional rulemaking process. Reaching and engaging all relevant parties in the rule development, while maintaining process transparency, will probably become more difficult as the number and geographic variety of stakeholders increase.
- *technical development and evaluation of the rule*
  The complex nature of an omnibus rule would present substantial challenges during the technical analysis of the rule. For instance, the greater variety of sources, in terms of type of equipment and potential emission controls, means longer and more complex technical research and analyses. Among these analyses, the H&SC requires the Air District to detail all existing rules and control requirements for each source-type or equipment included in the proposed rule as well as any conflict, difference or duplication that may occur between these regulations.
- *socioeconomic and California Environmental Quality Act (CEQA) analyses*
  The significant increase in the number of stakeholders and technical complexity might also make it difficult to conduct accurate and comprehensive socioeconomic and environmental impacts (CEQA) analyses; there simply might be too many factors to consider in each analysis.
- *implementation and enforcement*
  Air District staff might need to develop individual implementation plans and enforcement strategies for each source-type affected by an omnibus rule, in order for these to be useful to our Compliance and Enforcement staff and to relevant industries.

The challenges described above would need to be further investigated to assure that developing an effective, legally-defensible, and enforceable omnibus rule would achieve greater emissions reductions and/or efficiencies than developing individual rules to accomplish the same objectives. Air District staff will consider all these issues as they evaluate whether omnibus rulemaking might be a feasible and effective strategy to accelerate the pace of GHG emission reductions. The Air District will also explore the omnibus rulemaking concept for criteria and toxic air contaminant emissions.

Source:

1. OEHHA (2013) Indicators of Climate Change in California. Available at: http://oehha.ca.gov/climate-change/document/indicators-climate-change-california

FSM_BL1: Large Residential and Commercial Space Heating

Brief Summary:
Regulation 9, Rule 4 regulates NO_X emissions from central furnaces in the size range typically found in single-family homes. This measure addresses larger furnaces rated above 175,000 BTU per hour that are found in multi-family residential buildings and large commercial spaces.

Purpose:
This measure seeks to reduce NO_X emissions from large residential building central furnaces, and from commercial space heating. While the intent of this measure is to reduce NO_X emissions, in a broader context, the Air District is working with local governments and others to phase out the use of fossil fuel-based technologies in buildings, as part of the Air District's large-scale effort to reduce greenhouse gas emissions (see measure BL2: Decarbonize Buildings). When it is not feasible to install a non-fossil fuel-based furnace, this measure explores ensuring that in the future, large furnaces use Best Available Control Technology (BACT). This measure explores options for establishing maximum allowable NO_X emission levels for large size furnaces.

Source Category:
Stationary Source – large space heating furnaces (above 175, 000 BTUs)

Further Study Measure Description:
While smaller central residential and commercial furnaces in this and other air quality jurisdictions have been regulated for many decades, larger space heating applications have not been regulated anywhere in the state. Specifically, regulation of central furnaces in the Bay Area has been restricted to residential and commercial furnaces with a heat capacity of less than 175,000 BTU per hour (Rule 9-4), requiring a 40 ng/joule NO_X limit since the 1980s. Rules with these same limits are also in place in the South Coast Air Quality Management District (AQMD) (Rule 1111) and the San Joaquin Valley Air Pollution Control District (APCD) (Rule 4905) jurisdictions.

While there are no adopted rules in any of these three air districts that limit NO_X emissions from larger devices, these devices are subject to permit requirements. For example, in the Bay Area, natural gas combustion devices must be permitted if they are larger than 10 million BTU per hour (MM BTU/hr). The South Coast AQMD requires permits for large commercial furnaces with a heat input rating or more than 2 MM BTU/hr; these units are subject to new source review and a BACT NO_X limit of 30 ppmv at 3 percent oxygen (about 21 ng/joule).

As described above, the Air District has no direct experience in limiting NO_X emissions from furnaces in the size range covered by this measure. As part of this measure, Air District staff will investigate appropriate future NO_X limit for space-heating gas furnaces larger than 175,000 BTU/hr, and will coordinate development and adoption of consistent NO_X limits and certification methods for these devices with the South Coast AQMD, San Joaquin Valley APCD and other air districts. Staff may also investigate a state-wide model rule that will be developed cooperatively, or under the auspices of the California Air Resources Board (ARB) or the California Air Pollution Control Officers Association (CAPCOA).

Sources:
1. Bay Area Air Quality Management District, Regulation 9, Rule 4
2. South Coast Air Quality Management District, Rule 1111
3. San Joaquin Valley Air Pollution Control District, Rule 4905.

FSM_AG1: Wineries

Brief Summary:
Study potential to reduce VOC's from fermentation at wineries.

Purpose:
Reduce VOC emissions from fermentation at wineries and breweries.

Source Category:
Stationary Source

Further Study Measure Description:
In 2005, San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) adopted rule 4694 to control emissions from wineries that emit over 10 tons/year of organic emissions (primarily ethanol) based on formulae in the rule. The rule requires a reduction of fermentation emissions of 35 percent, and also requires that storage tanks of 5,000 gallon size or greater be equipped with a pressure/vacuum valve and be kept at a temperature of no greater than 75° F. San Joaquin staff estimated that 18 wineries would be subject to the rule, 14 of which were major stationary sources subject to federal Title V permits. The rule achieves emission reductions of between 0.6 to 0.7 tons per day from a total inventory of 4.6 tons per day ROG from wineries.

In 2009, SJVUAPCD adopted rule 4695 to control emissions from wine and brandy aging operations. This rule increased the control requirements for storage tanks to raise emission reductions from 35 to 50 percent. In their 2007 ozone plan, SJVUAPCD investigated further control to remove alternative compliance provisions in Rule 4694 to require operators to achieve an 86 percent VOC capture and control efficiency on fermentation tanks. Due to significant technical uncertainty and high costs associated with installing additional controls (greater than $100,000 per ton of VOC reduced per year), these additional requirements were not part of the rule, and SJVUAPCD staff recommended future study on equipment advancements that may produce additional reductions.

The Air District is not aware of any existing rules addressing emissions from breweries beyond permit requirements resulting from Reg. 2, New Source Review. Further research is needed to determine the number and size of breweries in the Bay Area.

The Air District inventory for winery emissions is 0.79 tons per day of ROG, as compared with SJVUAPCD at 4.6 tons per day. SJVUAPCD counted 109 wineries in their district in 2007. Whereas, there are over 300 wineries in Napa County alone that collectively account for about 60 percent of the Bay Area winery emissions. Further research will have to be done to determine whether any of the Bay Area wineries meet the San Joaquin threshold of 10 tons ROG emissions per year, or whether cost-effective controls could be applied to Bay Area facilities.

District staff will investigate the number and size of winery facilities in operation in the Bay Area and their estimated emissions. In addition, staff will investigate the number and size of breweries to determine if capture and control methods may be applied to this industry.

Sources:

1. SJVAPCD, Rule 4694: Wine Fermentation and Storage Tanks, Dec 15, 2005
2. SJVAPCD 2007 Ozone Plan, measure S-IND-12, dated April 30, 2007
3. SJVAPCD, Rule 4695: Brandy Aging and Wine Aging Operations, dated September 17, 2009