CALIFORNIA
AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510, 5th Floor
Sacramento, California 95814
(916) 445-0753

February 2, 2018
9:00 a.m.

ADVANCE AGENDA

I. Approval of Minutes of Previous Meeting:

August 25, 2017

II. Discussion of Responses to Requests for Proposals (RFP):

1. "Measuring Emissions from the On-Road Vehicle Fleet in West Los Angeles," University of Denver, $40,000, RFP No. 17RD015

CARB's Low-Emission Vehicle II (LEV II) regulation sets more stringent vehicle exhaust emission standards with longer durability requirements than the original LEV I regulation. In order to evaluate the effectiveness of LEV II regulation in reducing real-world vehicular emissions, and to identify any egregious emission issues in the real world, CARB needs a substantial set of long-term, real-world vehicle emission measurement data. Continued measurements of on-road light-duty vehicle (LDV) exhaust emissions in real-world conditions is a key to monitoring the emission trends over time and to verifying the effectiveness of the California emission regulations. In California, on-road LDV exhaust emissions have been measured successfully using roadside remote sensing devices (RSDs) at a West Los Angeles location every few years since 1999. This proposed project will conduct another such measurement campaign at the same location in spring 2018. The project includes the option for a second campaign in spring 2021. If CARB decides to sponsor the second campaign and if the Contractor agrees to conduct it, CARB will augment the contract to provide additional funds not to exceed $40,000, for a total contract amount not to exceed $80,000. Compared

with an upfront two-campaign contract, this “option to renew” approach provides CARB the opportunity to assess the need for a 2021 campaign based on a review of the 2018 campaign data.

The Contractor will measure gaseous concentrations of carbon monoxide (CO), hydrocarbons (HC), nitric oxide (NO), nitrogen dioxide (NO_2), and ammonia (NH_3), to extend historical emission trends, and to identify any anomalies in real-world vehicle emissions. The results will be useful to verify the effectiveness of California’s LEV II program in reducing vehicle emissions, identify the occurrence of high emitters, and possibly shed light on vehicle makes and models that emit significantly above emission certification standards in real-world driving. CARB staff has also previously used the historical record to quantify deterioration of emissions control based on vehicle model year and would fold results from this new dataset into that analysis.

2. “Identify Outlier Makes and Models of Light Duty Vehicles Using Remote Sensing Device Data,” Eastern Research Group, $74,975, RFP No. 17RD014

The recent discovery of high-emitting vehicles during real-world driving exposed the use of defeat devices which allowed certain vehicle makes and models to pass certification tests but subsequently become gross polluters during real-world driving. The discovery of these cheating and illegal defeat devises used to pass emission certification tests questions whether there are other vehicle makes and models exhibiting similar high-emitting behavior in the real-world, and whether this behavior is a widespread problem in the light-duty vehicle fleet. The objectives of this project are to characterize light-duty vehicle (LDV) fleet emission rates and to identify high-emitting vehicles by make, model, engine size, fuel type, and model year. The investigators will analyze recent remote-sensing data from the largest known database of remote sensing data, from the State of Colorado, and compare CO, HC, and oxides of nitrogen (NO_X) emissions from a wide array of light-duty vehicles grouped by vehicle make, model, engine size, fuel type, and model year. The investigators will focus on relatively new vehicles whose emissions are not expected to be insignificant deterioration and identify whether there are high-emitting vehicles for specific vehicle makes and models.

3. “Brake and Tire Wear Emissions,” Eastern Research Group, Inc. $349,990, Eastern Research Group, RFP No. 17RD016

   Currently California’s Emissions Factor Model (EMFAC) provides an estimate of brake-wear PM that is based on outdated information and does not account for newer technology such as regenerative braking. At the same time tailpipe emissions have decreased significantly such that brake and tire-wear PM emissions are now almost half of all vehicular PM emissions. In order to support future air quality programs, CARB needs to properly characterize the PM emissions from non-tailpipe sources and update the emission inventory model. The objective of this proposed research is to measure brake-wear emissions in a controlled laboratory setting and test various brake configurations, materials, vehicle loads, and driving behaviors in order to generate speed dependent brake-wear emission factors. This project will also characterize the braking behavior and emissions of vehicles using regenerative braking. Eastern Research Group, Inc. proposes to measure PM emissions from brake-wear under controlled laboratory conditions and to develop speed-dependent PM emissions rates using carefully planned test procedures and data analysis strategies. The proposers will determine a test cycle to be programmed into a brake dynamometer, determine the fraction of brake configurations and materials and vehicle configurations and loads that adequately represent the on-road fleet, and collect data on regenerative braking. The proposers will then create a test plan which varies as many of these parameters as possible, including replicates, while remaining representative of braking activity and materials used in California. The investigators will use the results of the implemented test plan to derive speed dependent emission factors of brake-wear PM for EMFAC.

III. Discussion of New Research Proposals:

1. “Design and Development of an Instrument for Toxic-metal Aerosol Real Time Analysis (TARTA),” University of California, Davis, $399,999, Proposal No. 2814-288

   Although technologies to screen for toxic compounds, such as benzene, toluene and many criteria pollutants are available, the same level of efficacy for community monitoring is not available for toxic metals. Examples of the need for such a device are found in the investigation of chromium in the Paramount area of Los Angeles

and the airborne lead emissions from the now closed Exide battery recycling facility in Vernon California. Deploying portable devices that can monitor for toxic metals in real-time will help CARB and communities to determine the source of these metals and develop strategies to reduce their emissions. Real-time measurements of metals from low-cost community monitoring efforts, and the ability to rapidly deploy portable devices will allow air districts to quickly identify and respond to emission events, and thereby minimize the impacts of heath hazardous incidents. These efforts are particularly important, and should be prioritized in disadvantaged communities, and those located close to industrial sources.

This project is designed to develop just such a portable, real time screening instrument to detect and quantify ambient concentrations of toxic metals that may drive health risk concerns, and will advance the state-of-the-science in real-time detection of ambient metal concentrations using fast, robust, smaller scale, and lower-cost technology solutions. Instruments based on x-ray fluorescence (XRF) are already available in this market segment which can measure metals on a continuous four hour time base but are very costly, power hungry and have consumables which need constant replacement can be costly. This project will develop a new instrument based on breakdown spectroscopy to detect toxic metals in particle phase in the atmosphere called Toxic-metal Aerosol Real Time Analysis (TARTA), and will be designed to measure a variety of elements including aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc.

The instrument developed under this contract will be useful to conduct community scale monitoring of critical air toxic metals in longer-term stationary operations and faster response mobile surveys, and to quantify their ambient concentrations to support the California Air Toxics Program. The ability to rapidly deploy portable instrument to measure airborne toxic metals will be useful for real-time response to emission events and identification of sources to support air quality management agencies, researchers, and other end users. The application of these technologies will be particularly important in disadvantaged communities, since many of the air toxics sources are disproportionately located in and around these communities.

2. “Benchmarking of Post-AMMP (Alternative Manure Management Practices Dairy Emissions and Prediction of Related Long-term Airshed Effects,” University of California, Davis, $384,974, Proposal No. 2815-288

   Dairy operations are an important source of methane (CH_4), volatile organic compounds (VOCs), and nitrogenous compounds such as nitrous oxide (N_2O) and NH_3. CH_4 and N_2O are potent greenhouse gases (GHG) that affect the global climate, and pollutants such as VOCs and NH_3 are major precursors for particulate matter (PM) and ozone (O_3) that contribute to the poor air quality (AQ) in regions across California that typically fall short of meeting the National Ambient Air Quality Standards. This project aims to utilize ambient measurements and chemical transport modeling to evaluate the GHG emissions and the AQ impacts of California dairies after the implementation of alternative manure management practices (AMMPs). Specifically, this project will study the emissions of CH_4, VOCs, N_2O, NH_3, oxides of nitrogen (NO_X), and PM from selected dairies in the San Joaquin Valley (SJV), and use a scenario-based regional AQ forecasting model to assess the GHG emission reduction and AQ impacts of various AMMPs over the next several decades. The results from this project will help determine whether the implementation of AMMPs in California’s agricultural sector is an effective air pollution mitigation strategy for existing dairies, and will help construct regulatory policies for the development of State Implementation Plans (SIP) and Short-Lived Climate Pollutant (SLCP) reduction strategies.

3. “Strategies to Reduce Methane Emissions from Enteric and Lagoon Sources,” University of California, Davis, $114,995, Proposal No. 2816-288

   Enteric fermentation and manure management contributed over 50 percent of statewide methane (CH_4) emissions in California, 97 percent of which came from cattle operations. Strategies reducing methane emissions from enteric and manure sources are thus crucial for achieving SB 1383 goals that require reduction of statewide methane emissions by 40 percent below 2013 levels by 2030. Recently, the use of additives (chemical or other ingredients) in animal feed or manure storage lagoons as inhibitors to reduce methane emissions has been proposed as one of the mitigation strategies in livestock industry. This project will conduct literature review, database analysis, and life cycle assessment (LCA) to evaluate the potential and feasibility of using additives in feed and lagoons as a mitigation

strategy to reduce methane emissions, and develop a research roadmap identifying data gaps and prioritizing future research efforts. The LCA will take into account of overall GHG emissions, and other environmental and economic impacts associated with the additive use beyond methane emissions and classify the identified additives into different categories with regard to their potential applicability and benefits in California conditions. The project will inform the SLCP strategies with a target on the largest source of methane emissions in the State and help California in meeting its broader climate goals.

IV. Discussion of Proposed Contract Augmentations:

1. "Zero-Carbon Buildings in California: A Feasibility Study," University of California, Berkeley, $250,000, Contract No. 16RD004

   Commercial and residential buildings contribute to 30 percent of California's GHG emissions due to energy demand, water use, and wastewater treatment.[1,2] Additional GHG emissions occur during the operation of buildings from waste generation and vehicle trips taken for commuting, shopping, travel, and leisure. California's 2030 Climate Change Scoping Plan recognizes that zero carbon buildings will contribute significantly to achieving long-term climate goals. A research study is underway to explore the technical feasibility of zero or near-zero carbon strategies for both residential and commercial buildings. However, a contract augmentation is needed to address a critical research gap to determine which strategies are better implemented at the neighborhood scale rather than the building level to achieve zero net carbon community performance. The results of this study will be essential to identify cost-effective GHG mitigation strategies to achieve California's 2030 and 2050 climate targets.

V. Discussion of Draft Final Reports:

1. "Benefits of High Efficiency Filtration to Children with Asthma," University of California, Davis, $3,350,000, Contract No. 11-324

   PM and other air pollutants have long been known to cause adverse health effects, which can be particularly severe for children who have asthma. This study

[1] California Air Resources Board, California Greenhouse Gas Emission Inventory: 2000-2015, June 6, 2017
[2] California Air Resources Board, California's 2017 Climate Change Scoping Plan, November 2017.

investigated the effects of introducing high efficiency filtration into the homes of asthmatic children to determine the impacts of filtration on improvement of indoor air quality and the children's respiratory health and asthma symptoms. The study was conducted in Fresno and Riverside, California, two cities known to have high outdoor levels of air pollution. One hundred forty-nine participants, from 136 households, completed the study. Each participant received true air filtration for a year and sham or low efficiency filtration for a year, either through central system filtration or portable air cleaners. High efficiency filtration significantly improved indoor air quality over sham/low efficiency filtration, with a 48 percent reduction in the geometric mean indoor PM0.2 and PM2.5 concentrations, and a 31 percent reduction in indoor PM10 concentrations. While there was not a significant improvement in reported asthma symptoms, there was a significant decrease in clinic visits and a lesser decrease in Emergency Room visits and hospitalizations, especially for participants categorized as severe asthmatics. Participants who had air cleaners in their bedrooms also reported less awakening due to asthma when their bedroom door was kept closed. The results from this research provide guidance for improving indoor air quality in homes located in areas of high outdoor air pollution and protecting children's health, and support ARB's recommendation for requiring MERV 13 filters in new homes in the proposed 2019 Title 24 Energy Code update.

2. "Reducing Formaldehyde Emissions from Home Central Heating and Air Conditioning Filters," Lawrence Berkeley National Laboratory, $350,000, Contract No. 14-303

Formaldehyde is a toxic air contaminant that poses a risk of cancer and other adverse health impacts. Studies have shown that some fiberglass filters used in commercial heating, ventilation and air conditioning (HVAC) systems can be sources of formaldehyde. This study assessed formaldehyde emissions from residential fiberglass filters relative to synthetic filters, and estimated their contributions to indoor concentrations in California homes. The results showed that fiberglass filters emitted more formaldehyde than synthetic filters. At high relative humidity (RH), fiberglass filters became strong sources of formaldehyde, with emission rates in the range 500-3500 µg h-1 m-2, but emissions from synthetic filters were only 100-120 µg h-1 m-2. Formaldehyde emissions from

fiberglass filters increased significantly with RH and face velocity. The core filtration media and the glued frame each contributed about half of the formaldehyde emissions. Under most conditions, contributions of fiberglass filters to indoor formaldehyde levels were estimated to be small. However, under certain conditions (e.g., a very small apartment with low air exchange), fiberglass filters were estimated to increase indoor formaldehyde by 2.5-9.3 ppb, sometimes exceeding the California 8-hr reference exposure level and Proposition 65 no significant risk levels. This study found that the use of synthetic particle filters instead of fiberglass filters could be a part of the solution to reduce indoor formaldehyde exposures.

3. "Ozone in the Lower Atmosphere and its Contribution to High Ozone Concentrations at Ground-Level in the Southern San Joaquin Valley," University of California, Davis, $300,021, Contract No. 14-308

   Despite making significant progress in reducing emissions of ozone precursors, the San Joaquin Valley (SJV) remains classified as an extreme nonattainment area with respect to the 8-hour ozone National Ambient Air Quality Standard (NAAQS). To further improve the air quality in the SJV, it becomes imperative that the dynamical processes that occur in the long, narrow isolated valley are accurately understood. These processes include vertical mixing at the top of the atmospheric boundary layer (ABL), time scale of stagnation and recirculation of the air layer above the ABL, and photochemical production rates of ozone on high concentration days. This research addressed these key processes by extensively sampling the lower 1,500 meters of the atmosphere using an instrumented research aircraft. By using two teams, consisting of a pilot and flight scientist, the flights collected 165 flight hours of quality-assured data in the summer of 2016, which includes horizontal wind velocities, humidity levels, temperatures, concentrations of ozone, NO_2, and methane, and other meteorological parameters. This unique dataset provide important observational constraints for modeling atmospheric processes that generate high ozone concentrations in the southern SJV. In particular, by measuring the explicit terms, transport and photochemistry, of the ozone budget equation, this project provides components needed in modeling to quantify the contribution of O_3 aloft to the following day's afternoon maximum at the surface. The report also includes information on the

night-time atmospheric mixing of ozone concentrations above the very shallow night-time boundary layer, mid-day mixing of ozone concentration within and above boundary layer, regional average emissions of methane and NO_2, and mid-day ozone photochemical production rates in the SJV. Results from this work will help evaluate the physical mechanisms that are used in ozone modeling, and will help future development of effective State Implementation Plans (SIPs) to improve California's air quality.

4. "Characterization of PM2.5 Episodes in the San Joaquin Valley Based on Data Collected During the NASA DISCOVER-AQ Study in the Winter of 2013," University of California, Davis, $200,000, Contract No. 14-307

Air quality in the SJV continues to be the worst in the state with wintertime PM2.5 air pollution often exceeding the U.S. EPA 24-hour standard. In addition, models used in air quality planning for this region are inconsistent in their ability to predict high PM2.5 concentrations. The current project investigated this gap in understanding the processes for PM2.5 formation in the SJV through advanced analyses of a unique data set: aircraft and surface measurements collected during NASA's campaign Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ). This program created an extensive set of vertically resolved aircraft measurements of PM2.5 and critical gaseous species for the SJV for January/February 2013. These were complemented by measurements at a network of ground sites, which included a "supersite" at CARB's Fresno-Garland monitoring station that provided detailed high time resolution, measurements of PM2.5 composition and optical properties. Results from these analyses provided a case study of how vertical coupling between chemistry and meteorology can lead to build up episodes of high particulate matter. In particular, the relative contributions of daytime photochemical and nocturnal heterogeneous hydrolysis production of nitrate to total PM mass were resolved. Analysis of detailed chemical composition measurements from the supersite provided estimates of contributions from primary sources and secondary formation, both organic and inorganic, to PM in the SJV. This work showed that both organic aerosol (directly emitted and secondarily produced) and ammonium nitrate, which are out of phase with respect to day and night, are essential in keeping PM2.5

concentrations elevated during pollution events during the winter in the SJV. The results indicate that further controls in emissions of primary PM (vehicle, cooking and wood burning), gas phase secondary organic precursors, and NO_X are needed for long-term PM mitigation; and that NO_X reductions are likely to have a direct, and significant, impact on nocturnal ammonium nitrate production aloft. This deeper understanding of the process that can lead to high PM2.5 episodes in the SJV will be of immediate value for improving air quality models for this region and in developing effective air quality attainment strategies.

5. "Evaluation of the Impacts of Emissions Averaging and Flexibility Programs for all Tier 4 Final Off-Road Diesel Engines," University of California, Riverside, $300,000, Contract No. 14-301

The U.S. EPA administers programs for off-road Tier 4 diesel engines called Averaging Banking and Trading (ABT) and Transition Program for Engine Manufacturers (TPEM) which aid engine and equipment manufacturers in complying with Tier 4 engine emission standards. Both programs allow manufacturers to produce a fraction of engines and equipment which emit above the current model year standard as long as these emissions are balanced by engines and equipment that emit below the standard. On a national level the emissions from all off-road engines meet the standard in aggregate under these programs. However, there is a concern that a large number of ABT and TPEM engines could be operating within California having serious implications for the emissions inventory and the air quality within non-attainment areas. The objective of this study is to determine whether California is receiving a disproportionate number of ABT and TPEM engines within state borders. The study was carried out by the University of California, Riverside (UCR), and their main method was to analyze the United States Environmental Protection Agency (U.S. EPA) ABT and TPEM reports and CARB's Diesel Off-Road Online Reporting System (DOORS) database. The comparison of DOORS database results and overall U.S. ABT and TPEM production values suggests there may be a disproportionate number of non-compliant engines in California, but this information comes with caveats due to various issues identified with the reporting system used for the ABT and TPEM programs. This research also suggests that a vastly improved reporting system is needed at the Federal level to determine whether these

programs negatively affect specific areas and the emissions inventory in California.

6. “Collection of Tractor-Trailer Activity Data,” University of California, Riverside, $488,560, Contract No. 14-302

   The heavy-duty freight sector is a major source of GHGs in California. In response to AB 32, aerodynamic improvements for box trailers at least 53 feet in length were implemented beginning in 2010 to improve the fuel economy of tractor trailers. Other trailer types are currently exempt from the aerodynamic requirements, including container chassis under 53 feet in length, tankers, flatbeds and curtainside trailers. The exemption was justified with the assumption that these trailers do not typically travel at highway speeds or for long distances, rendering aerodynamic improvements ineffective. However, detailed activity data on this class of trailers was previously not available and thus a proper assessment of the efficacy of aerodynamic improvements could not be made. A contract was awarded to the University of California, Riverside (UCR), to collect second-by-second activity data from exempt trailer fleets during typical in-use trailer operation to test this assumption. The activity data were analyzed to derive the percentage of time and distance spent at various speeds. From the activity data collected from eight fleets, they found that on average 78 ± 17 percent of the distance traveled was at speeds greater than 45 mph, at which aerodynamic improvements begin to induce significant emissions reductions. The investigators also conducted a national survey for exempted trailers and found that a significant portion of the exempted trailers travels long distances on an annual basis. The results of this project provide evidence that additional aerodynamic improvements for all or some fraction of these currently exempt trailers would substantially reduce GHG emissions. These results did not appear to depend on trailer type, but rather on location, load and other factors, thus, future GHG reduction efforts could require aerodynamic devices based on operation characteristics.

7. “The Dynamics of Plug-in Electric Vehicles in the Secondary Market and their Implications for Vehicle Demand, Durability, and Emissions,” University of California, Davis, $300,000, Contract No. 14-316

   This study examined the nascent secondary plug-in electric vehicle (PEV) market through two separate methods. The first goal of this study was to evaluate who

buys used PEVs, their motivation, and usage. This was accomplished by administering a survey to used PEV owners in 2015 and comparing the results with surveys of new PEV owners previously deployed by co-PI. Results show that this early set of used PEV buyers were interested in buying the specific vehicle model purchased, which were typically relatively new vehicles still under warranty, with low mileage and low purchase price, and were satisfied with their purchase. Compared to new PEV owners, these used PEV buyers tended to have higher driving needs, were motivated by carpool lane access, and plugged in their plug-in hybrid electric vehicle (PHEV) less. These results complement previous research that showed that incentives are more important in driving battery electric vehicles (BEV) adoption than PHEV adoption. The study's second goal was to examine the flow of PEVs into and out of California and to quantify the impact of incentives on PEV flow. This was done through an econometric analysis utilizing vehicle auction and registration data. Results indicate that the presence of new-PEV purchase incentives is associated with higher used-PHEV prices and lower used-battery electric vehicle (BEV) prices. These results can be used to evaluate and inform CARB policies, such as the Advanced Clean Cars ZEV program and ZEV incentive programs, intended to encourage the adoption of PEVs.

8. "Identifying, Evaluating, and Selecting Indicators, Indices and Data for Future Monitoring System of the Implementation of Sustainable Communities Strategies," University of California, Los Angeles, $149,485,
Contract No. 15RD010

Tracking real-world Senate Bill (SB) 375-related GHG reductions is important for ensuring that adopted sustainable communities strategies (SCSs) are helping the state achieve its climate change goals. The objective of this research is to investigate ways to construct a tracking system and to evaluate potential indicators and metrics for ongoing monitoring of progress. Using literature reviews and consultations with stakeholders and experts, the researchers identified a set of baseline indicators and short-term measures to assess whether observed, real-world changes are consistent with SB 375 goals, using Los Angeles County (LA) as a test case. The selected indicators elucidate land use and access patterns in the baseline year (2010) and evaluate changes at one year and four years after the baseline.

The indicators included: 1) housing unit density; 2) access to jobs; 3) access to retail; and 4) access to transit. The researchers constructed a Los Angeles County Prototype Monitoring System ("LA Prototype"), which showed that new housing is being located in areas with greater transit access and that jobs have been increasingly added to areas with high transit access—both of which support SB 375 goals. The indicators also show, however, that a disproportionately higher share of new housing was added in comparatively lower density, less job accessible, and less retail accessible neighborhoods within LA County as a whole. This observation may be at least partially explained by the fact that, pursuant to State Housing Element law and consistent with other fair housing objectives of federal and State law, most jurisdictions within large metropolitan areas are required to zone sites and facilitate additional housing at a density of 30 dwelling units per acre or higher to accommodate affordable housing. These areas may be within comparatively lower density areas of LA County as a whole, yet be supportive of VMT reduction within individual jurisdictions.

Overall, the researchers conclude that CARB, policymakers, and other stakeholders should carefully consider conditions and variables that may influence calculated indicators; in some cases, results may show SB 375-supportive changes that are not necessarily spurred by SCS planning or policies, and vice-versa. The report acknowledges that the interactive consequences of land use patterns play out over the long term and are challenging to capture in short term metrics. Finally, a complementary effort explored data sharing dynamics between local jurisdictions and metropolitan planning organizations (MPOs) to identify opportunities for improving information flow. The researchers found that data collection and sharing practices among MPOs and their member jurisdictions vary widely across the state and recommend that a monitoring system for SB 375 progress will require a unified statewide data system.

9. "Measurement of Real-World Emissions from Heavy-duty Vehicles to Investigate the Durability of Diesel Engine Emissions Controls," University of Denver, $289,678, Contract No. 11-309

Heavy-duty diesel vehicles (HDDVs) are a substantial source of oxides of nitrogen (NO_X) and particulate matter (PM) in the state of California. For controlling NO_X and PM effectively, current technology HDDVs use selective catalytic reduction

systems (SCR) and diesel particulate filters (DPF), respectively. However, it is unknown how well these DPFs and SCRs have performed during real-world use, and how this performance may change over the life of the HDDV. Fuel-based emission factors for in-use HDDVs were measured at both the Cottonwood weigh station and the Port of Los Angeles in 2013, 2015 and 2017 with the University of Denver's On-road Heavy-duty Measurement System (OHMS). A total of 7,076 measurements were made. At the Port, average PM emissions were less than or equal to 100 mg/kg fuel for all three years, reflecting the earlier timing of the Drayage Truck Regulation. At Cottonwood, average PM emissions decreased from 600 to 100 mg/kg fuel, reflecting the impact of the Truck and Bus Rule. Average PM emissions at the Port increased from 2013 to 2015, suggesting deterioration of on-road DPFs; however, these values returned to 2013 levels during the 2017 campaign. In general, DPF deterioration does not seem to be a fleet-wide issue, but can be substantial for specific manufacturers and specific model years (typically the first few years of DPFs, i.e. chassis model years 2008-2010). Overall, these results indicate that most on-road HDDVs reduced PM emissions significantly since the implementation of DPF technologies, although the importance of a small number of high-emitting HDDVs is increasing over time. Continued effort towards identifying these high-emitting HDDVs is warranted to reduce overall emissions. NO_X emissions were similar at the two sites (~20 g/kg fuel), although they increased each campaign at the Port but not at Cottonwood. By 2017, NO_X emissions were 27 and 19 g/kg fuel at the Port and at Cottonwood, respectively. The higher average NO_X at the port is likely due to the lower SCR temperatures expected for drayage trucks at that location. NO_X emissions were generally higher than predicted based on certification standards, and reflect the reduced efficiency of SCR systems at sub-optimal temperatures.

VI. Other Business:

1. Update on the Planned Air Pollution Research for FY 2018-2021