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EARTHJUSTICE

December 7, 2017

VIA ELECTRONIC MAIL

Kerby E. Zozula
Engineering Division Manager
Ventura County Air Pollution Control District
669 County Square Drive
Ventura, CA 93003

RE: Mission Rock Energy Center
Application No. 83038-100
(CEC docket number 15-AFC-02)

Dear Mr. Zozula:

On behalf of the Wishtoyo Chumash Foundation, we submit these comments on the Preliminary Determination of Compliance (PDOC) issued by the Ventura County Air Pollution Control District (VCAPCD) for the proposed Mission Rock Energy Center (MREC). Our review of the PDOC was aided by two experts, Dr. Phyllis Fox, PE, and Lindsey Meyers. Their reports are attached hereto and incorporated into our comments in full.[1]

Our review has identified several shortcomings in the PDOC that renders it inconclusive about whether the facility complies with all applicable rules and federal laws. Further, some of the identified shortcomings render the proposed permit unable to ensure compliance with all applicable rules and laws. For the reasons summarized below, and described in more detail by Dr. Fox and Ms. Meyers, modeling for the PDOC must be redone, several proposed permit conditions must be re-written, and MREC must purchase emissions offset credits for its emissions of Reactive Organic Compounds (ROC) in compliance with VCAPCD's rules.

I. The modeling must be redone.

The purpose of modeling undertaken by the VCAPCD is to ensure compliance with rules and laws established to protect health and the environment. There are modeling guidance and best practices that help support the model's predictive value. The VCAPCD has made two modeling choices that may be masking significant environmental harms and violations of applicable rules and laws. First, VCAPCD chose sub-optimal meteorological data to rely upon

[1] Phyllis Fox, Comments on the Preliminary Determination of Compliance for the Mission Rock Energy Center (December 7, 2017) ("Fox") Exhibit 1; Lindsey Meyers, Air Quality Review and Comments: Mission Rock Energy Center Project (December 7, 2017) ("Meyers") Exhibit 2.

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throughout the PDOC. Second, VCAPCD uses tier 3 NO_2 modeling with the Ozone Limiting Method (OLM) for predicting 1 hour NO_2 exceedances. These two choices should be revisited to ensure this project's true impacts are more fully understood and disclosed.

One of the foundations of air pollution modeling is ensuring the meteorology data inputs properly represent conditions at the project. Here VCAPCD did not use the preferred meteorological data from the system located at Rio Mesa High School, rather the PDOC relies on Camarillo Airport data with model adjustments. Ms. Meyers finds that not only is Rio Mesa closer to the proposed MREC site, but "with two mountain ranges existing between Camarillo Airport and Mission Rock, the data from Rio Mesa is also likely more representative of conditions at the proposed facility."[2] As a separate, but related issue, VCAPCDs modeling used ozone and NO_2 levels from Rio Mesa, but more properly should have used levels from Piru because the winds at MREC's proposed site are from the southwest. Combined, these two data choices have the potential of underestimating the impacts of NO_2 emissions. Nitrogen oxides are ozone precursors. The project area already has elevated ozone levels and is classified as nonattainment for both federal and state ambient air quality standards on ozone.

In addition to the underlying meteorological data choices that shaped everything modeled for this PDOC, VCAPCD's use of tier 3 NOx modeling with OLM fails to disclose possible 1-hour ozone violations. VCAPCD picked a modeling method that indicates MREC's operations during commissioning; start up, shut down, and malfunction; and regular operations would not exceed 1 hour NO_2 standards. However, a different recognized method for NO_2 modeling, EPA's Plume Volume Ratio Method (PVMRM), shows MREC would result in exceedances.[3] Rerunning the VCAPCD's data using PVMRM, Ms. Meyers found her "results indicate that using the PVMRM method, the proposed Mission Rock Energy Center would be in violation of the 1-hour NO_2 NAAQS with 206.4 $\mu g/m^3$, which is well above the 1-hour NO_2 NAAQS of 188 $\mu g/m^3$."[4]

As a separate, but related issue, VCAPCD inexplicably uses the 8th highest hourly ozone level as background instead of using more traditional levels of the 1st – 3rd highest ozone levels. Again, this unexplained choice could result in failure to identify and address NO_2 exceedances that could be caused by MREC's operations.

Identifying the possibility that MREC's emissions would cause or contribute to violations of the NO_2 NAAQS is important because VCAPCD's rules and federal regulations require a permit to be denied for such violations. It is also of considerable concern given the known health and environmental harms caused by NO_2 and ozone. Because the known consequences of high NO_2 and ozone levels, VCAPCD should take the most conservative approach to modeling the impact of MREC's emissions, not the least. All of the modeling for the PDOC must be redone using this

[2] Meyers at 4.
[3] Meyers at 10.
[4] Meyers at 10.

more accurate data to ensure a more complete understanding of the impacts of this proposed facility.

II. Several permit conditions are practically unenforceable as written and do not ensure compliance with applicable rules and laws.

VCAPCD includes proposed DOC conditions in Appendix K of the PDOC. Federal law requires that permit conditions be "practicably enforceable."[5] This means that each condition must (1) clearly explain how the limitation or requirement applies to the facility; and (2) ensure it is possible to determine whether the facility is complying with the condition. Several of the conditions fail one or both of these requirements and therefore must be rewritten.

There are two pervasive problems with the PDOC's conditions: they do not incorporate a clear explanation of ROC manufacturer's emission data and they do not include sufficient monitoring to ensure compliance with ROC limits. PDOC condition numbers 27-31 set emission rates for MREC's turbines during startup, shutdown, normal operation, commissioning, and annually. Conditions 27 and 28 say that "compliance with ROC and PM10 emission limits shall be verified by CTG manufacture's emission data."[6] To be enforceable, the manufacture's emission data must be incorporated into the permit as emission limitations.[7] Further, none of the conditions requires continuous monitoring of ROC emissions, while such systems are required for other pollutants. Dr. Fox notes that that Continuous Emission Monitoring Systems (CEMS) are available to record emissions of ROC.[8] The current PDOC condition for annual ROC stack testing is inadequate because of the non-uniform operations of the turbines. This is especially important for MREC's permit because only a tiny variation in emissions from those used in VCAPCD's modeling would clearly result in MREC's emissions exceeding the offset threshold.[9]

The permit conditions in Appendix K of the PDOC should be rewritten to ensure they are clear and practically enforceable as required by federal law.

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[5] *See,* Clean Air Act § 504; 40 CFR § 70.6(a)(3) [requiring "monitoring sufficient to yield reliable data from the relevant time period that are representative of the source's compliance.]; 40 CFR § 70.6(c)(1) [requiring all Part 70 permits to contain "testing, monitoring, reporting, and recordkeeping requirements sufficient to assure compliance with the terms and conditions of the permit."]

[6] Condition 30, which covers emission rates during commissioning, is unclear but seems to establish "manufacturer's emission data" for monitoring ROC compliance while setting two monitoring methodologies for NOx and CO emissions: manufacturing's emission data and CEMS.

[7] If VCAPCD seeks to rely on a manufacture's guarantee as a basis for the emissions rates used in the modeling and permitting of MREC, that guarantee must also be included in the permit.

[8] Fox at 6.

[9] *Ibid*.

III. The proposed power plant must identify and surrender ROC emission reduction credits prior to issuance of the final Determination of Compliance.

VCAPCD requires an application for an Authority to Construct be denied if the applicant does not secure offsets for increases equal to or more than 5.0 tons per year of ROC.[10] Here, VCAPCD has estimated ROC emissions of 4.95 tons per year based, in large part, upon an unsubstantiated assertion by the applicant that ROC emissions during normal operation will be 1.0 ppmvd.[11] Then, using this assertion, VCAPCD calculates the tons per year of ROC emissions as 4.95 ton per year. However, manufacturer's data in Appendix A indicate that measurements relied on to calculate 4.95 tons per year are not accurate enough to support a ton per year value with three significant figures. The VCAPCD's emission calculations do not comply with basic mathematical principals of significant figures and rounding.[12] The mathematical principal of significant figures holds that a calculation cannot be more precise than its least precise component when based on measurements. So, if one does a calculation that multiplies a number with only two significant figures (here, for example, 1.0 ppmvd applicant supplied Emission Factor Basis for ROC) with any other number, regardless of how many significant digits it has, the final reported outcome can have no more than two significant figures. Here, that means that once the VCAPCD calculated the annual tons per year for ROC emissions to 4.95, it is compelled by principals of significant figures and rounding to complete the calculation by rounding up to 5.0—two significant figures. This is standard practice in math and engineering. This is the exact methodology the EPA teaches in its permit training courses and that is used in the adjacent San Joaquin Valley Air Pollution Control District. It should have been used here. VCAPCD's refusal to follow standard mathematical principles allows the facility to escape the requirement to offset its ROC emissions. This outcome harms the people and environment of the area and is unlawful.

In conclusion, for the reasons outlined in this letter and the attached expert reports, the PDOC proposed by VCAPCD must be revised after remodeling MREC's emissions, rewriting several of the proposed conditions, and adding a condition that MREC identify and surrender Emission Reduction Credits for its significant ROC emissions which exceed VCAPCD's offset thresholds.

Respectfully submitted,

Angela Johnson Meszaros
On behalf of Wishtoyo Chumash Foundation

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[10] VCAPCD Rule 26.2.B.
[11] Table VII-5. We note that VCAPCD describes the ROC emissions as being "equal to *approximately* 1 ppmvd."
[12] Fox at 7.

EXHIBIT 1

Comments

on the

Preliminary Determination of Compliance

for the

Mission Rock Energy Center

Santa Paula, California

December 7, 2017

Phyllis Fox, PhD, PE
745 White Pine Ave.
Rockledge, FL 32955

The Mission Rock Energy Center (Project) will include five GE LM6000-PG-Sprint simple-cycle natural gas fired combustion turbine generators (CTGs) with a total combined nominal ISO rating of 275 MW plus a new emergency diesel engine powering a fire water pump. The facility will be located to the southwest of Santa Paula, CA. The Ventura County Air Pollution Control District (VCAPCD) has issued a Preliminary Determination of Compliance (PDOC)[1] for this Project under VCAPCD Rule 26.9, New Source Review – Power Plants.

I have reviewed the PDOC. In summary, emission offsets are required for reactive organic compound (ROC). Further, many of the proposed permit conditions are not practically enforceable.

My resume is included in Attachment A to these Comments. I have over 40 years of experience in the field of environmental engineering, including air emissions and air pollution control; greenhouse gas (GHG) emission inventory and control; water quality and water supply investigations; hazardous waste investigations; hazard investigations; risk of upset modeling; environmental permitting; nuisance investigations (odor, noise); environmental impact reports (EIRs), including CEQA/NEPA documentation; risk assessments; and litigation support. I have M.S. and Ph.D. degrees in environmental engineering from the University of California at Berkeley. I am a licensed professional engineer in California.

I. OFFSETS ARE REQUIRED FOR REACTIVE ORANIC COMPOUNDS

The PDOC estimated annual ROC emissions from each CTG based on the following:

- Normal operation: 0.84 ton/yr[2]
- Startups: 0.075 ton/yr[3]
- Shutdowns: 0.075 ton/yr[4]

Summing the above, the total annual ROC emissions per CTG are 0.99 ton/yr. As the Project consists of five CTGs, the PDOC multiplied 0.99 ton/yr by five and reported

[1] Ventura County APCD, Preliminary Determination of Compliance, CEC Docket Number 15-AFC-02, October 13, 2017 (PDOC).

[2] PDOC, Table VII-5.

[3] PDOC, Table VII-6 (150 startups/yr).

[4] PDOC, Table VII-6 (150 shutdowns/yr).

total ROC emissions of 4.95 ton/yr.[5] The PDOC does not require any offsets for ROC because it asserts 4.95 ton/yr is less than 5.0 ton/yr. This calculation contains a fundamental flaw, which underestimates ROC emissions. As explained below, when total annual ROC emissions are correctly calculated, ROC offsets are required.

Ventura County Air Pollution Control District (VCAPCD) Rule 26.2.B requires:[6]

> The APCO shall deny an applicant an Authority to Construct for any new, replacement, modified or relocated emissions unit with an emission increase of any of the pollutants specified in Table B-1, and where the potential to emit of the stationary source would be greater than or equal to the limits specified in Table B-1, unless offsets are provided for any emission increases of such pollutants from the new, replaced, modified, or relocated emissions unit.
>
> Table B-1.
>
> | | |
> |---|---|
> | ROC | 5.0 ton/yr |

Offsets are required if ROC emissions "would be greater than or equal to "5.0 ton/yr.[7] As discussed below, the ROC emissions, when properly calculated, equal 5.0 ton/yr. Thus, the VCAPCD should deny the Application unless the Applicant offsets these emissions using valid emission reduction credits at a tradeoff ratio of 1.3.[8]

The ROC emissions of 4.95 ton/yr were calculated from various inputs, some of which were reported to only two significant figures, e.g., tons/yr for startups and shutdowns (0.075);[9] number of startup hours (75 hrs)[10]; and the ROC emission factor basis (1.0 ppmvd@15% O2).[11] The results of the emission calculations are reported to three significant figures, *viz*., 4.95 ton/yr. If the correct number of significant figures had been used in the ROC emission calculations, the ROC emission increase would equal 5.0 ton/yr, triggering offsets under VCAPCD Rule 26.2.B.1. The District did not

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[5] PDOC, Table VIII-8: Total annual ROC emissions for five turbines = (0.99 ton/yr-turbine) x 5 turbines = 4.95 ton/yr.

[6] VCAPCD Rule 26.2.B.1.

[7] VCAPCD Rule 26.2.B.1.

[8] VCAPCD Rule 26.2.B.2.

[9] PDOC, Table VII-6 and VII-7 (leading zeros, e.g., the second zero in 0.075 ton/yr) are not significant. See, *e.g.*, http://ccnmtl.columbia.edu/projects/mmt/frontiers/web/chapter_5/6665.html.

[10] PDOC, Table VII-7.

[11] PDOC, Appendix A.

follow standard procedures for reporting results of calculations, taught in math and science courses as well as in U.S. EPA air pollution courses.

Further, manufacturer data in Appendix B reports maximum total ROC emissions of 1991.4 lbs/yr and 4.98 ton/yr.[12] These values are even higher than the PDOC calculations and closer to the offset threshold. The supporting calculations confirm a maximum number of significant figures of two, requiring rounding of 4.98 to 5.0 ton/yr.

The number of significant figures is simply the number of figures that provide meaning in the context of the measurement. It is well established among professional engineers and scientists that meaning cannot be ascribed beyond the *smallest* number of significant figures of any of the factors included in the calculation, *viz.*, "The product often has a different precision than the factors, but the significant figures must not increase."[13] This is standard practice throughout the engineering and scientific professions.[14]

This rule is taught in EPA air pollution training courses.[15] The EPA Manual instructs: "When approximate numbers are multiplied or divided, the result is expressed as a number having the same number of significant digits as the expression in the problem having the least number of significant digits. In other words, if you multiply a number having four significant digits by a number having two significant digits, the correct answer will be expressed to two significant digits."[16] An adjacent air district, which performed the air quality modeling for this Project, has guidance for significant figures. This guidance, APR 1105: *Guidelines for the Use of Significant Figures*

[12] PDOC, Appendix B.

[13] E.A. Avallone and T. Baumeister III (Eds.), Marks' Standard Handbook for Mechanical Engineers, 10th Ed., McGraw-Hill, New York, 1996, p. 2-4.

[14] See, *e.g.*, Philip R. Bevington, Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill, Inc., 1969, pp. 4, 9; Lothar Sachs, Applied Statistics. A Handbook of Techniques, 2nd Ed., Springer-Verlag, New York, 1984, p. 21; Sal Kahn, Khanacademy, Rule of Significant Figures; Available at: https://www.khanacademy.org/math/arithmetic-home/arith-review-decimals/arithmetic-significant-figures-tutorial/v/more-on-significant-figures; Yale, A Short Guide to Significant Figures; Available at: www.astro.yale.edu/astro120/SigFig.pdf.

[15] U.S. EPA, APTI Virtual Classroom, Course SI 100: Mathematics Review for Air Pollution Control (EPA Manual), Lesson 2 Significant Figures and Rounding Off, Attachment B.

[16] EPA Manual, p. 2-5/2-6.

In Engineering Calculations,[17] is in accord. The Guidance instructs that "Rounding off is accomplished by dropping the digits that are not significant. The digits 0, 1, 2, 3, and 4 are dropped without altering the preceding digit. The preceding digit is increased by one when a 5, 6, 7, 8, or 9 is dropped."

Thus, the results of the multiplications and additions used in the VCAPCD's ROC emission calculations should have been rounded off to the same number of significant figures as the factor with the least number of significant figures, which is no more than two (the basis of the CTG normal operation ROC emission factor, 1.0 ppm). Therefore, the results of the annual ROC calculations should have been reported to no more than two significant figures, corresponding to the number of significant figures in the underlying factors used in the calculations, not to **three** significant figures, or 4.95 ton/yr. Rounding 4.95 to two significant figures yields 5.0 ton/yr. This equals the VCAPCD offset threshold for ROC, requiring ROC offsets at a ratio of 1.3 to 1 or 6.5 ton/yr.

II. ROC EMISSION LIMITS ARE NOT ENFORCEABLE

The underestimate in ROC discussed in Comment I would not be detected because many of the proposed permit conditions limiting ROC emissions are not practically enforceable. Many proposed permit conditions do not require any or adequate monitoring, the *sine quo non* of an enforceable permit.[18] The permit conditions must assure that the total ROC emissions, wrongly estimated at 4.95 ton/yr, are properly monitored over the life of the Project. However, the proposed conditions fail to require sufficient monitoring for ROC to assure compliance with the permit's requirements.

The PDOC estimated total annual ROC emissions by summing emissions from each turbine during normal operation (0.84 ton/yr),[19] startups (0.075 ton/yr), and shutdowns (0.075 ton/yr)[20], totaling 0.99 ton/yr. This total was then multiplied by five, the number of CTGs, to yield 4.95 ton/yr.[21] The proposed permit conditions do not require adequate monitoring to assure that these emissions are achieved in practice.

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[17] San Joaquin Valley Air Pollution Control District, APR 1105: Guidelines for the Use of Significant Figures In Engineering Calculations, Attachment C.

[18] Yuhaung Chemical Inc., EPA Order on Petition No. Vl-2015-03, p.14 (2016) (Yuhuang Order).

[19] PDOC, Table VII-5.

[20] PDOC, Table VII-6.

[21] Total ROC emissions = 5(0.84+0.075+0.075) = 4.95 ton/yr.

First, the proposed permit conditions do not require any monitoring to assure compliance with assumed ROC emissions during startups and shutdowns. Instead, for example, Conditions 27, #28, and #30 only require that ROC (and PM10) emission limits used to calculate emissions "be verified by CTG manufacturer's emission data."[22] All of the permit's conditions must be modified to require periodic testing during representative, unstaged startups and shutdowns over the lifetime of the facility and during commissioning to verify the CTG manufacturer's emission data. This is critically important as ROC emissions are very close to the offset threshold. Further, turbine performance degrades over time, manufacturer data is typically only guaranteed for one year, and the underlying vendor guarantees are not in the record. Vendor guarantees, for example, typically limit the conditions under which the guarantee applies. In addition, unexpected events can occur during commissioning, which could result in ROC emissions equaling or exceeding 5.0 ton/yr.

Second, compliance with ROC emissions during normal operation of each CTG is verified with an initial and annual source test and compliance with annual operating limits.[23] Most (85%) of the ROC emissions occur during normal operation. An annual stack test is not adequate to assure that ROC emissions are accurately monitored continuously and remain below the offset threshold.

A stack test typically lasts three hours and is conducted under ideal operating conditions, generally after the source is tuned up, which minimizes emissions compared to routine operation. Further, the CTGs do not operate at a uniform rate, but rather vary depending on electricity demand. A three-hour optimal snapshot every year is not adequate to assure that total annual ROC emissions remain below the ROC offset threshold of 5.0 ton/yr.

Continuous Emission Monitoring Systems (CEMS) are available for volatile organic compounds (VOCs). The nonreactive fraction of the VOCs can be separately monitored continuously using an on-line gas chromatograph or mass spectrometer. ROC must be continuously monitored because the estimated ROC emissions are essentially equal to the ROC offset threshold when properly rounded.

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[22] PDOC, pdf 125-127, Conditions 27, 28 and 30.

[23] PDOC, pdf 126, Condition 29 and pdf 128, Condition 31.

Third, ROC emissions during "unplanned load changes"[24] are specifically omitted from monitoring requirements during normal operation[25] and are not included elsewhere in the proposed permit conditions. As ROC emissions are so close to the ROC offset threshold, these emissions alone could result in total ROC emissions of 5.0 ton/yr.

Fourth, compliance with commissioning emission limits, which could cause an exceedance of the ROC offset threshold, is determined only using manufacturer's data, while NOx and CO commissioning emissions are verified by CEMS or stack test. As CEMS are available for ROC, CEMS must also be used to verify ROC commissioning emissions.

The failure to require adequate real world monitoring for ROC is an egregious omission as ROC is converted into ozone in the atmosphere. Ventura County currently violates federal and state ozone standards.[26] The PDOC should be revised to require ROC offsets and adequate monitoring to ensure compliance with all permit emissions limits. See Comment I.

III. DPM EMISSIONS ARE NOT ENFORCEABLE

The proposed diesel emergency engine will emit diesel particulate matter (DPM), which is a potent carcinogen.[27] The risk management review indicates that DPM emissions from this engine result in a cancer risk of 6.76×10^{-6} compared to a significance threshold of 10×10^{-6}. This is sufficiently close to the threshold to warrant periodic testing. The proposed permit conditions do not require any testing to verify DPM emissions from this engine. The only proposed compliance demonstration is to maintain documentation.[28]

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[24] PDOC, pdf 123-125, Condition 22.

[25] PDOC, pdf 126, Condition 29.

[26] PDOC, Table 5-1.

[27] PDOC, pdf 82, Table 6-1.

[28] PDOC, pdf 137, Condition 6.

ATTACHMENT A

Phyllis Fox, Ph.D, PE
Environmental Management
745 White Pine Ave.
Rockledge, FL 32955
321-626-6885
PhyllisFox@gmail.com

Dr. Fox has over 40 years of experience in the field of environmental engineering, including air pollution control (BACT, BART, MACT, LAER, RACT), greenhouse gas emissions and control, cost effectiveness analyses, water quality and water supply investigations, hydrology, hazardous waste investigations, environmental permitting, nuisance investigations (odor, noise), environmental impact reports, CEQA/NEPA documentation, risk assessments, and litigation support.

EDUCATION

Ph.D. Environmental/Civil Engineering, University of California, Berkeley, 1980.
M.S. Environmental/Civil Engineering, University of California, Berkeley, 1975.
B.S. Physics (with high honors), University of Florida, Gainesville, 1971.

REGISTRATION

Registered Professional Engineer: Arizona (2001-2014: #36701; retired), California (2002-present; CH 6058), Florida (2001-2016; #57886; retired), Georgia (2002-2014; #PE027643; retired), Washington (2002-2014; #38692; retired), Wisconsin (2005-2014; #37595-006; retired)
Board Certified Environmental Engineer, American Academy of Environmental Engineers, Certified in Air Pollution Control (DEE #01-20014), 2002-2014; retired)
Qualified Environmental Professional (QEP), Institute of Professional Environmental Practice (QEP #02-010007, 2001-2015: retired).

PROFESSIONAL HISTORY

Environmental Management, Principal, 1981-present
Lawrence Berkeley National Laboratory, Principal Investigator, 1977-1981
University of California, Berkeley, Program Manager, 1976-1977
Bechtel, Inc., Engineer, 1971-1976, 1964-1966

PROFESSIONAL AFFILIATIONS

American Chemical Society (1981-2010)
Phi Beta Kappa (1970-present)
Sigma Pi Sigma (1970-present)
Who's Who Environmental Registry, PH Publishing, Fort Collins, CO, 1992.
Who's Who in the World, Marquis Who's Who, Inc., Chicago, IL, 11th Ed., p. 371, 1993-present.

Who's Who of American Women, Marquis Who's Who, Inc., Chicago, IL, 13th Ed., p. 264, 1984-present.
Who's Who in Science and Engineering, Marquis Who's Who, Inc., New Providence, NJ, 5th Ed., p. 414, 1999-present.
Who's Who in America, Marquis Who's Who, Inc., 59th Ed., 2005.
Guide to Specialists on Toxic Substances, World Environment Center, New York, NY, p. 80, 1980.
National Research Council Committee on Irrigation-Induced Water Quality Problems (Selenium), Subcommittee on Quality Control/Quality Assurance (1985-1990).
National Research Council Committee on Surface Mining and Reclamation, Subcommittee on Oil Shale (1978-80)

REPRESENTATIVE EXPERIENCE

Performed environmental and engineering investigations, as outlined below, for a wide range of industrial and commercial facilities including: petroleum refineries and upgrades thereto; reformulated fuels projects; refinery upgrades to process heavy sour crudes, including tar sands and light sweet crudes from the Eagle Ford and Bakken Formations; petroleum, gasoline and ethanol distribution terminals; coal, coke, and ore/mineral export terminals; LNG export, import, and storage terminals; crude-by-rail projects; shale oil plants; crude oil/condensate marine and rail terminals; coal gasification and liquefaction plants; oil and gas production, including conventional, thermally enhanced, hydraulic fracking, and acid stimulation techniques; underground storage tanks; pipelines; compressor stations; gasoline stations; landfills; railyards; hazardous waste treatment facilities; nuclear, hydroelectric, geothermal, wood, biomass, waste, tire-derived fuel, gas, oil, coke and coal-fired power plants; transmission lines; airports; hydrogen plants; petroleum coke calcining plants; coke plants; activated carbon manufacturing facilities; asphalt plants; cement plants; incinerators; flares; manufacturing facilities (e.g., semiconductors, electronic assembly, aerospace components, printed circuit boards, amusement park rides); lanthanide processing plants; ammonia plants; nitric acid plants; urea plants; food processing plants; wineries; almond hulling facilities; composting facilities; grain processing facilities; grain elevators; ethanol production facilities; soy bean oil extraction plants; biodiesel plants; paint formulation plants; wastewater treatment plants; marine terminals and ports; gas processing plants; steel mills; iron nugget production facilities; pig iron plant, based on blast furnace technology; direct reduced iron plant; acid regeneration facilities; railcar refinishing facility; battery manufacturing plants; pesticide manufacturing and repackaging facilities; pulp and paper mills; olefin plants; methanol plants; ethylene crackers; alumina plants, desalination plants; selective catalytic reduction (SCR) systems; selective noncatalytic reduction (SNCR) systems; halogen acid furnaces; contaminated property redevelopment projects (e.g., Mission Bay, Southern Pacific Railyards, Moscone Center expansion, San Diego Padres Ballpark); residential developments; commercial office parks, campuses, and shopping centers; server

farms; transportation plans; and a wide range of mines including sand and gravel, hard rock, limestone, nacholite, coal, molybdenum, gold, zinc, and oil shale.

EXPERT WITNESS/LITIGATION SUPPORT

- For the California Attorney General, assist in determining compliance with probation terms in the matter of People v. Chevron USA.
- For plaintiffs, assist in developing Petitioners' proof brief for National Parks Conservation Association et al v. U.S. EPA, Petition for Review of Final Administrative Action of the U.S. EPA, In the U.S. Court of Appeals for the Third Circuit, Docket No. 14-3147.
- For plaintiffs, expert witness in civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1997-2000) at the Cemex cement plant in Lyons, Colorado. Reviewed produced documents, prepared expert and rebuttal reports on PSD applicability based on NOx emission calculations for a collection of changes considered both individually and collectively. Deposed August 2011. *United States v. Cemex, Inc.*, In U.S. District Court for the District of Colorado (Civil Action No. 09-cv-00019-MSK-MEH). Case settled June 13, 2013.
- For plaintiffs, in civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1988 – 2000) at James De Young Units 3, 4, and 5. Reviewed produced documents, analyzed CEMS and EIA data, and prepared netting and BACT analyses for NOx, SO2, and PM10 (PSD case). Expert report February 24, 2010 and affidavit February 20, 2010. *Sierra Club v. City of Holland, et al.*, U.S. District Court, Western District of Michigan (Civil Action 1:08-cv-1183). Case settled. Consent Decree 1/19/14.
- For plaintiffs, in civil action alleging failure to obtain MACT permit, expert on potential to emit hydrogen chloride (HCl) from a new coal-fired boiler. Reviewed record, estimated HCl emissions, wrote expert report June 2010 and March 2013 (Cost to Install a Scrubber at the Lamar Repowering Project Pursuant to Case-by-Case MACT), deposed August 2010 and March 2013. *Wildearth Guardian et al. v. Lamar Utilities Board,* Civil Action No. 09-cv-02974, U.S. District Court, District of Colorado. Case settled August 2013.
- For plaintiffs, expert witness on permitting, emission calculations, and wastewater treatment for coal-to-gasoline plant. Reviewed produced documents. Assisted in preparation of comments on draft minor source permit. Wrote two affidavits on key issues in case. Presented direct and rebuttal testimony 10/27 - 10/28/10 on permit enforceability and failure to properly calculate potential to emit, including underestimate of flaring emissions and omission of VOC and CO emissions from wastewater treatment, cooling tower, tank roof landings, and malfunctions. *Sierra Club, Ohio Valley Environmental Coalition, Coal River Mountain Watch, West Virginia Highlands Conservancy v. John Benedict, Director, Division*

of Air Quality, West Virginia Department of Environmental Protection and TransGas Development System, LLC, Appeal No. 10-01-AQB. Virginia Air Quality Board remanded the permit on March 28, 2011 ordering reconsideration of potential to emit calculations, including: (1) support for assumed flare efficiency; (2) inclusion of startup, shutdown and malfunction emissions; and (3) inclusion of wastewater treatment emissions in potential to emit calculations.

- For plaintiffs, expert on BACT emission limits for gas-fired combined cycle power plant. Prepared declaration in support of CBE's Opposition to the United States' Motion for Entry of Proposed Amended Consent Decree. Assisted in settlement discussions. *U.S. EPA, Plaintiff, Communities for a Better Environment, Intervenor Plaintiff, v. Pacific Gas & Electric Company, et al.*, U.S. District Court, Northern District of California, San Francisco Division, Case No. C-09-4503 SI.
- Technical expert in confidential settlement discussions with large coal-fired utility on BACT control technology and emission limits for NOx, SO2, PM, PM2.5, and CO for new natural gas fired combined cycle and simple cycle turbines with oil backup. (July 2010). Case settled.
- For plaintiffs, expert witness in remedy phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1998-99) at Gallagher Units 1 and 3. Reviewed produced documents, prepared expert and rebuttal reports on historic and current-day BACT for SO2, control costs, and excess emissions of SO2. Deposed 11/18/09. *United States et al. v. Cinergy, et al.*, In U.S. District Court for the Southern District of Indiana, Indianapolis Division, Civil Action No. IP99-1693 C-M/S. Settled 12/22/09.
- For plaintiffs, expert witness on MACT, BACT for NOx, and enforceability in an administrative appeal of draft state air permit issued for four 300-MW pet-coke-fired CFBs. Reviewed produced documents and prepared prefiled testimony. Deposed 10/8/09 and 11/9/09. Testified 11/10/09. *Application of Las Brisas Energy Center, LLC for State Air Quality Permit*; before the State Office of Administrative Hearings, Texas. Permit remanded 3/29/10 as LBEC failed to meet burden of proof on a number of issues including MACT. Texas Court of Appeals dismissed an appeal to reinstate the permit. The Texas Commission on Environmental Quality and Las Brisas Energy Center, LLC sought to overturn the Court of Appeals decision but moved to have their appeal dismissed in August 2013.
- For defense, expert witness in unlawful detainer case involving a gasoline station, minimart, and residential property with contamination from leaking underground storage tanks. Reviewed agency files and inspected site. Presented expert testimony on July 6, 2009, on causes of, nature and extent of subsurface contamination. *A. Singh v. S. Assaedi,* in Contra Costa County Superior Court, CA. Settled August 2009.

- For plaintiffs, expert witness on netting and enforceability for refinery being upgraded to process tar sands crude. Reviewed produced documents. Prepared expert and rebuttal reports addressing use of emission factors for baseline, omitted sources including coker, flares, tank landings and cleaning, and enforceability. Deposed. *In the Matter of Objection to the Issuance of Significant Source Modification Permit No. 089-25484-00453 to BP Products North America Inc., Whiting Business Unit, Save the Dunes Council, Inc., Sierra Club., Inc., Hoosier Environmental Council et al., Petitioners, B. P. Products North American, Respondents/Permittee,* before the Indiana Office of Environmental Adjudication. Case settled.
- For plaintiffs, expert witness on BACT, MACT, and enforceability in appeal of Title V permit issued to 600 MW coal-fired power plant burning Powder River Basin coal. Prepared technical comments on draft air permit. Reviewed record on appeal, drafted BACT, MACT, and enforceability pre-filed testimony. Drafted MACT and enforceability pre-filed rebuttal testimony. Deposed March 24, 2009. Testified June 10, 2009. *In Re: Southwestern Electric Power Company*, Arkansas Pollution Control and Ecology Commission, Consolidated Docket No. 08-006-P. Recommended Decision issued December 9, 2009 upholding issued permit. Commission adopted Recommended Decision January 22, 2010.
- For plaintiffs, expert witness in remedy phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1989-1992) at Wabash Units 2, 3 and 5. Reviewed produced documents, prepared expert and rebuttal report on historic and current-day BACT for NOx and SO2, control costs, and excess emissions of NOx, SO2, and mercury. Deposed 10/21/08. *United States et al. v. Cinergy, et al.*, In U.S. District Court for the Southern District of Indiana, Indianapolis Division, Civil Action No. IP99-1693 C-M/S. Testified 2/3/09. Memorandum Opinion & Order 5-29-09 requiring shutdown of Wabash River Units 2, 3, 5 by September 30, 2009, run at baseline until shutdown, and permanently surrender SO2 emission allowances.
- For plaintiffs, expert witness in liability phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for three historic modifications (1997-2001) at two portland cement plants involving three cement kilns. Reviewed produced documents, analyzed CEMS data covering subject period, prepared netting analysis for NOx, SO_2 and CO, and prepared expert and rebuttal reports. *United States v. Cemex California Cement,* In U.S. District Court for the Central District of California, Eastern Division, Case No. ED CV 07-00223-GW (JCRx). Settled 1/15/09.
- For intervenors Clean Wisconsin and Citizens Utility Board, prepared data requests, reviewed discovery and expert report. Prepared prefiled direct, rebuttal and surrebuttal testimony on cost to extend life of existing Oak Creek Units 5-8 and cost to address future regulatory requirements to determine whether to control or shutdown one or more of the units. Oral testimony 2/5/08. Application for a Certificate of Authority to Install Wet Flue Gas Desulfurization and Selective Catalytic Reduction Facilities and Associated Equipment

for Control of Sulfur Dioxide and Nitrogen Oxide Emissions at Oak Creek Power Plant Units 5, 6, 7 and 8, WPSC Docket No. 6630-CE-299.

- For plaintiffs, expert witness on alternatives analysis and BACT for NOx, SO2, total PM10, and sulfuric acid mist in appeal of PSD permit issued to 1200 MW coal fired power plant burning Powder River Basin and/or Central Appalachian coal (Longleaf). Assisted in drafting technical comments on NOx on draft permit. Prepared expert disclosure. Presented 8+ days of direct and rebuttal expert testimony. Attended all 21 days of evidentiary hearing from 9/5/07 – 10/30/07 assisting in all aspects of hearing. *Friends of the Chatahooche and Sierra Club v. Dr. Carol Couch, Director, Environmental Protection Division of Natural Resources Department, Respondent, and Longleaf Energy Associates, Intervener*. ALJ Final Decision 1/11/08 denying petition. ALJ Order vacated & remanded for further proceedings, Fulton County Superior Court, 6/30/08. Court of Appeals of GA remanded the case with directions that the ALJ's final decision be vacated to consider the evidence under the correct standard of review, July 9, 2009. The ALJ issued an opinion April 2, 2010 in favor of the applicant. Final permit issued April 2010.
- For plaintiffs, expert witness on diesel exhaust in inverse condemnation case in which Port expanded maritime operations into residential neighborhoods, subjecting plaintiffs to noise, light, and diesel fumes. Measured real-time diesel particulate concentrations from marine vessels and tug boats on plaintiffs' property. Reviewed documents, depositions, DVDs, and photographs provided by counsel. Deposed. Testified October 24, 2006. *Ann Chargin, Richard Hackett, Carolyn Hackett, et al. v. Stockton Port District*, Superior Court of California, County of San Joaquin, Stockton Branch, No. CV021015. Judge ruled for plaintiffs.
- For plaintiffs, expert witness on NOx emissions and BACT in case alleging failure to obtain necessary permits and install controls on gas-fired combined-cycle turbines. Prepared and reviewed (applicant analyses) of NOx emissions, BACT analyses (water injection, SCR, ultra low NOx burners), and cost-effectiveness analyses based on site visit, plant operating records, stack tests, CEMS data, and turbine and catalyst vendor design information. Participated in negotiations to scope out consent order. *United States v. Nevada Power.* Case settled June 2007, resulting in installation of dry low NOx burners (5 ppm NOx averaged over 1 hr) on four units and a separate solar array at a local business.
- For plaintiffs, expert witness in appeal of PSD permit issued to 850 MW coal fired boiler burning Powder River Basin coal (Iatan Unit 2) on BACT for particulate matter, sulfuric acid mist and opacity and emission calculations for alleged historic violations of PSD. Assisted in drafting technical comments, petition for review, discovery requests, and responses to discovery requests. Reviewed produced documents. Prepared expert report on BACT for particulate matter. Assisted with expert depositions. Deposed February 7, 8, 27, and 28, 2007. *In Re PSD Construction Permit Issued to Great Plains Energy, Kansas City Power & Light – Iatan Generating Station, Sierra Club v. Missouri Department of Natural Resources,*

Great Plains Energy, and Kansas City Power & Light. Case settled March 27, 2007, providing offsets for over 6 million ton/yr of CO2 and lower NOx and SO_2 emission limits.

- For plaintiffs, expert witness in remedy phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications of coal-fired boilers and associated equipment. Reviewed produced documents, prepared expert report on cost to retrofit 24 coal-fired power plants with scrubbers designed to remove 99% of the sulfur dioxide from flue gases. Prepared supplemental and expert report on cost estimates and BACT for SO2 for these 24 complaint units. Deposed 1/30/07 and 3/14/07. *United States and State of New York et al. v. American Electric Power*, In U.S. District Court for the Southern District of Ohio, Eastern Division, Consolidated Civil Action Nos. C2-99-1182 and C2-99-1250. Settlement announced 10/9/07.
- For plaintiffs, expert witness on BACT, enforceability, and alternatives analysis in appeal of PSD permit issued for a 270-MW pulverized coal fired boiler burning Powder River Basin coal (City Utilities Springfield Unit 2). Reviewed permitting file and assisted counsel draft petition and prepare and respond to interrogatories and document requests. Reviewed interrogatory responses and produced documents. Assisted with expert depositions. Deposed August 2005. Evidentiary hearings October 2005. *In the Matter of Linda Chipperfield and Sierra Club v. Missouri Department of Natural Resources.* Missouri Supreme Court denied review of adverse lower court rulings August 2007.
- For plaintiffs, expert witness in civil action relating to plume touchdowns at AEP's Gavin coal-fired power plant. Assisted counsel draft interrogatories and document requests. Reviewed responses to interrogatories and produced documents. Prepared expert report "Releases of Sulfuric Acid Mist from the Gavin Power Station." The report evaluates sulfuric acid mist releases to determine if AEP complied with the requirements of CERCLA Section 103(a) and EPCRA Section 304. This report also discusses the formation, chemistry, release characteristics, and abatement of sulfuric acid mist in support of the claim that these releases present an imminent and substantial endangerment to public health under Section 7002(a)(1)(B) of the Resource Conservation and Recovery Act ("RCRA"). *Citizens Against Pollution v. Ohio Power Company*, In the U.S. District Court for the Southern District of Ohio, Eastern Division, Civil Action No. 2-04-cv-371. Case settled 12-8-06.

- For petitioners, expert witness in contested case hearing on BACT, enforceability, and emission estimates for an air permit issued to a 500-MW supercritical Power River Basin coal-fired boiler (Weston Unit 4). Assisted counsel prepare comments on draft air permit and respond to and draft discovery. Reviewed produced file, deposed (7/05), and prepared expert report on BACT and enforceability. Evidentiary hearings September 2005. *In the Matter of an Air Pollution Control Construction Permit Issued to Wisconsin Public Service Corporation for the Construction and Operation of a 500 MW Pulverized Coal-fired Power Plant Known as Weston Unit 4 in Marathon County, Wisconsin*, Case No. IH-04-21. The

Final Order, issued 2/10/06, lowered the NOx BACT limit from 0.07 lb/MMBtu to 0.06 lb/MMBtu based on a 30-day average, added a BACT SO2 control efficiency, and required a 0.0005% high efficiency drift eliminator as BACT for the cooling tower. The modified permit, including these provisions, was issued 3/28/07. Additional appeals in progress.

- For plaintiffs, adviser on technical issues related to Citizen Suit against U.S. EPA regarding failure to update New Source Performance Standards for petroleum refineries, 40 CFR 60, Subparts J, VV, and GGG. *Our Children's Earth Foundation and Sierra Club v. U.S. EPA et al.* Case settled July 2005. CD No. C 05-00094 CW, U.S. District Court, Northern District of California – Oakland Division. Proposed revisions to standards of performance for petroleum refineries published 72 FR 27178 (5/14/07).
- For interveners, reviewed proposed Consent Decree settling Clean Air Act violations due to historic modifications of boilers and associated equipment at two coal-fired power plants. In response to stay order, reviewed the record, selected one representative activity at each of seven generating units, and analyzed to identify CAA violations. Identified NSPS and NSR violations for NOx, SO_2, PM/PM10, and sulfuric acid mist. Summarized results in an expert report. *United States of America, and Michael A. Cox, Attorney General of the State of Michigan, ex rel. Michigan Department of Environmental Quality, Plaintiffs, and Clean Wisconsin, Sierra Club, and Citizens' Utility Board, Intervenors, v. Wisconsin Electric Power Company, Defendant*, U.S. District Court for the Eastern District of Wisconsin, Civil Action No. 2:03-CV-00371-CNC. Order issued 10-1-07 denying petition.
- For a coalition of Nevada labor organizations (ACE), reviewed preliminary determination to issue a Class I Air Quality Operating Permit to Construct and supporting files for a 250-MW pulverized coal-fired boiler (Newmont). Prepared about 100 pages of technical analyses and comments on BACT, MACT, emission calculations, and enforceability. Assisted counsel draft petition and reply brief appealing PSD permit to U.S. EPA Environmental Appeals Board (EAB). Order denying review issued 12/21/05. *In re Newmont Nevada Energy Investment, LLC, TS Power Plant*, PSD Appeal No. 05-04 (EAB 2005).
- For petitioners and plaintiffs, reviewed and prepared comments on air quality and hazardous waste based on negative declaration for refinery ultra low sulfur diesel project located in SCAQMD. Reviewed responses to comments and prepared responses. Prepared declaration and presented oral testimony before SCAQMD Hearing Board on exempt sources (cooling towers) and calculation of potential to emit under NSR. Petition for writ of mandate filed March 2005. Case remanded by Court of Appeals to trial court to direct SCAQMD to re-evaluate the potential environmental significance of NOx emissions resulting from the project in accordance with court's opinion. California Court of Appeals, Second Appellate Division, on December 18, 2007, affirmed in part (as to baseline) and denied in part. *Communities for a Better Environment v. South Coast Air Quality Management District and ConocoPhillips and Carlos Valdez et al v. South Coast Air Quality Management District and*

ConocoPhillips. Certified for partial publication 1/16/08. Appellate Court opinion upheld by CA Supreme Court 3/15/10. *(2010) 48 Cal.4th 310*.

- For amici seeking to amend a proposed Consent Decree to settle alleged NSR violations at Chevron refineries, reviewed proposed settlement, related files, subject modifications, and emission calculations. Prepared declaration on emission reductions, identification of NSR and NSPS violations, and BACT/LAER for FCCUs, heaters and boilers, flares, and sulfur recovery plants. *U.S. et al. v. Chevron U.S.A.*, Northern District of California, Case No. C 03-04650. Memorandum and Order Entering Consent Decree issued June 2005. Case No. C 03-4650 CRB.
- For petitioners, prepared declaration on enforceability of periodic monitoring requirements, in response to EPA's revised interpretation of 40 CFR 70.6(c)(1). This revision limited additional monitoring required in Title V permits. 69 FR 3203 (Jan. 22, 2004). *Environmental Integrity Project et al. v. EPA* (U.S. Court of Appeals for the District of Columbia). Court ruled the Act requires all Title V permits to contain monitoring requirements to assure compliance. *Sierra Club v. EPA*, 536 F.3d 673 (D.C. Cir. 2008).
- For interveners in application for authority to construct a 500 MW supercritical coal-fired generating unit before the Wisconsin Public Service Commission, prepared pre-filed written direct and rebuttal testimony with oral cross examination and rebuttal on BACT and MACT (Weston 4). Prepared written comments on BACT, MACT, and enforceability on draft air permit for same facility.
- For property owners in Nevada, evaluated the environmental impacts of a 1,450-MW coal-fired power plant proposed in a rural area adjacent to the Black Rock Desert and Granite Range, including emission calculations, air quality modeling, comments on proposed use permit to collect preconstruction monitoring data, and coordination with agencies and other interested parties. Project cancelled.
- For environmental organizations, reviewed draft PSD permit for a 600-MW coal-fired power plant in West Virginia (Longview). Prepared comments on permit enforceability; coal washing; BACT for SO_2 and PM10; Hg MACT; and MACT for HCl, HF, non-Hg metallic HAPs, and enforceability. Assist plaintiffs draft petition appealing air permit. Retained as expert to develop testimony on MACT, BACT, offsets, enforceability. Participate in settlement discussions. Case settled July 2004.
- For petitioners, reviewed record produced in discovery and prepared affidavit on emissions of carbon monoxide and volatile organic compounds during startup of GE 7FA combustion turbines to successfully establish plaintiff standing. *Sierra Club et al. v. Georgia Power Company* (Northern District of Georgia).
- For building trades, reviewed air quality permitting action for 1500-MW coal-fired power plant before the Kentucky Department for Environmental Protection (Thoroughbred).

- For petitioners, expert witness in administrative appeal of the PSD/Title V permit issued to a 1500-MW coal-fired power plant. Reviewed over 60,000 pages of produced documents, prepared discovery index, identified and assembled plaintiff exhibits. Deposed. Assisted counsel in drafting discovery requests, with over 30 depositions, witness cross examination, and brief drafting. Presented over 20 days of direct testimony, rebuttal and sur-rebuttal, with cross examination on BACT for NOx, SO_2, and PM/PM10; MACT for Hg and non-Hg metallic HAPs; emission estimates for purposes of Class I and II air modeling; risk assessment; and enforceability of permit limits. Evidentiary hearings from November 2003 to June 2004. *Sierra Club et al. v. Natural Resources & Environmental Protection Cabinet, Division of Air Quality and Thoroughbred Generating Company et al.* Hearing Officer Decision issued August 9, 2005 finding in favor of plaintiffs on counts as to risk, BACT (IGCC/CFB, NOx, SO_2, Hg, Be), single source, enforceability, and errors and omissions. Assist counsel draft exceptions. Cabinet Secretary issued Order April 11, 2006 denying Hearing Offer's report, except as to NOx BACT, Hg, 99% SO2 control and certain errors and omissions.
- For citizens group in Massachusetts, reviewed, commented on, and participated in permitting of pollution control retrofits of coal-fired power plant (Salem Harbor).
- Assisted citizens group and labor union challenge issuance of conditional use permit for a 317,000 ft^2 discount store in Honolulu without any environmental review. In support of a motion for preliminary injunction, prepared 7-page declaration addressing public health impacts of diesel exhaust from vehicles serving the Project. In preparation for trial, prepared 20-page preliminary expert report summarizing results of diesel exhaust and noise measurements at two big box retail stores in Honolulu, estimated diesel PM10 concentrations for Project using ISCST, prepared a cancer health risk assessment based on these analyses, and evaluated noise impacts.
- Assisted environmental organizations to challenge the DOE Finding of No Significant Impact (FONSI) for the Baja California Power and Sempra Energy Resources Cross-Border Transmissions Lines in the U.S. and four associated power plants located in Mexico (DOE EA-1391). Prepared 20-page declaration in support of motion for summary judgment addressing emissions, including CO_2 and NH_3, offsets, BACT, cumulative air quality impacts, alternative cooling systems, and water use and water quality impacts. Plaintiff's motion for summary judgment granted in part. U.S. District Court, Southern District decision concluded that the Environmental Assessment and FONSI violated NEPA and the APA due to their inadequate analysis of the potential controversy surrounding the project, water impacts, impacts from NH_3 and CO_2, alternatives, and cumulative impacts. *Border Power Plant Working Group v. Department of Energy and Bureau of Land Management*, Case No. 02-CV-513-IEG (POR) (May 2, 2003).
- For Sacramento school, reviewed draft air permit issued for diesel generator located across from playfield. Prepared comments on emission estimates, enforceability, BACT, and health impacts of diesel exhaust. Case settled. BUG trap installed on the diesel generator.

- Assisted unions in appeal of Title V permit issued by BAAQMD to carbon plant that manufactured coke. Reviewed District files, identified historic modifications that should have triggered PSD review, and prepared technical comments on Title V permit. Reviewed responses to comments and assisted counsel draft appeal to BAAQMD hearing board, opening brief, motion to strike, and rebuttal brief. Case settled.
- Assisted California Central Coast city obtain controls on a proposed new city that would straddle the Ventura-Los Angeles County boundary. Reviewed several environmental impact reports, prepared an air quality analysis, a diesel exhaust health risk assessment, and detailed review comments. Governor intervened and State dedicated the land for conservation purposes April 2004.
- Assisted Central California city to obtain controls on large alluvial sand quarry and asphalt plant proposing a modernization. Prepared comments on Negative Declaration on air quality, public health, noise, and traffic. Evaluated process flow diagrams and engineering reports to determine whether proposed changes increased plant capacity or substantially modified plant operations. Prepared comments on application for categorical exemption from CEQA. Presented testimony to County Board of Supervisors. Developed controls to mitigate impacts. Assisted counsel draft Petition for Writ. Case settled June 2002. Substantial improvements in plant operations were obtained including cap on throughput, dust control measures, asphalt plant loadout enclosure, and restrictions on truck routes.
- Assisted oil companies on the California Central Coast in defending class action citizen's lawsuit alleging health effects due to emissions from gas processing plant and leaking underground storage tanks. Reviewed regulatory and other files and advised counsel on merits of case. Case settled November 2001.
- Assisted oil company on the California Central Coast in defending property damage claims arising out of a historic oil spill. Reviewed site investigation reports, pump tests, leachability studies, and health risk assessments, participated in design of additional site characterization studies to assess health impacts, and advised counsel on merits of case. Prepare health risk assessment.
- Assisted unions in appeal of Initial Study/Negative Declaration ("IS/ND") for an MTBE phaseout project at a Bay Area refinery. Reviewed IS/ND and supporting agency permitting files and prepared technical comments on air quality, groundwater, and public health impacts. Reviewed responses to comments and final IS/ND and ATC permits and assisted counsel to draft petitions and briefs appealing decision to Air District Hearing Board. Presented sworn direct and rebuttal testimony with cross examination on groundwater impacts of ethanol spills on hydrocarbon contamination at refinery. Hearing Board ruled 5 to 0 in favor of appellants, remanding ATC to district to prepare an EIR.
- Assisted Florida cities in challenging the use of diesel and proposed BACT determinations in prevention of significant deterioration (PSD) permits issued to two 510-MW simple cycle

peaking electric generating facilities and one 1,080-MW simple cycle/combined cycle facility. Reviewed permit applications, draft permits, and FDEP engineering evaluations, assisted counsel in drafting petitions and responding to discovery. Participated in settlement discussions. Cases settled or applications withdrawn.

- Assisted large California city in federal lawsuit alleging peaker power plant was violating its federal permit. Reviewed permit file and applicant's engineering and cost feasibility study to reduce emissions through retrofit controls. Advised counsel on feasible and cost-effective NOx, SOx, and PM10 controls for several 1960s diesel-fired Pratt and Whitney peaker turbines. Case settled.
- Assisted coalition of Georgia environmental groups in evaluating BACT determinations and permit conditions in PSD permits issued to several large natural gas-fired simple cycle and combined-cycle power plants. Prepared technical comments on draft PSD permits on BACT, enforceability of limits, and toxic emissions. Reviewed responses to comments, advised counsel on merits of cases, participated in settlement discussions, presented oral and written testimony in adjudicatory hearings, and provided technical assistance as required. Cases settled or won at trial.
- Assisted construction unions in review of air quality permitting actions before the Indiana Department of Environmental Management ("IDEM") for several natural gas-fired simple cycle peaker and combined cycle power plants.
- Assisted coalition of towns and environmental groups in challenging air permits issued to 523 MW dual fuel (natural gas and distillate) combined-cycle power plant in Connecticut. Prepared technical comments on draft permits and 60 pages of written testimony addressing emission estimates, startup/shutdown issues, BACT/LAER analyses, and toxic air emissions. Presented testimony in adjudicatory administrative hearings before the Connecticut Department of Environmental Protection in June 2001 and December 2001.
- Assisted various coalitions of unions, citizens groups, cities, public agencies, and developers in licensing and permitting of over 110 coal, gas, oil, biomass, and pet coke-fired power plants generating over 75,000 MW of electricity. These included base-load, combined cycle, simple cycle, and peaker power plants in Alaska, Arizona, Arkansas, California, Colorado, Georgia, Florida, Illinois, Indiana, Kentucky, Michigan, Missouri, Ohio, Oklahoma, Oregon, Texas, West Virginia, Wisconsin, and elsewhere. Prepared analyses of and comments on applications for certification, preliminary and final staff assessments, and various air, water, wastewater, and solid waste permits issued by local agencies. Presented written and oral testimony before various administrative bodies on hazards of ammonia use and transportation, health effects of air emissions, contaminated property issues, BACT/LAER issues related to SCR and SCONOx, criteria and toxic pollutant emission estimates, MACT analyses, air quality modeling, water supply and water quality issues, and methods to reduce water use, including dry cooling, parallel dry-wet cooling, hybrid cooling, and zero liquid discharge systems.

- Assisted unions, cities, and neighborhood associations in challenging an EIR issued for the proposed expansion of the Oakland Airport. Reviewed two draft EIRs and prepared a health risk assessment and extensive technical comments on air quality and public health impacts. The California Court of Appeals, First Appellate District, ruled in favor of appellants and plaintiffs, concluding that the EIR "2) erred in using outdated information in assessing the emission of toxic air contaminants (TACs) from jet aircraft; 3) failed to support its decision not to evaluate the health risks associated with the emission of TACs with meaningful analysis," thus accepting my technical arguments and requiring the Port to prepare a new EIR. See *Berkeley Keep Jets Over the Bay Committee, City of San Leandro, and City of Alameda et al. v. Board of Port Commissioners* (August 30, 2001) 111 Cal.Rptr.2d 598.
- Assisted lessor of former gas station with leaking underground storage tanks and TCE contamination from adjacent property. Lessor held option to purchase, which was forfeited based on misrepresentation by remediation contractor as to nature and extent of contamination. Remediation contractor purchased property. Reviewed regulatory agency files and advised counsel on merits of case. Case not filed.
- Advised counsel on merits of several pending actions, including a Proposition 65 case involving groundwater contamination at an explosives manufacturing firm and two former gas stations with leaking underground storage tanks.
- Assisted defendant foundry in Oakland in a lawsuit brought by neighbors alleging property contamination, nuisance, trespass, smoke, and health effects from foundry operation. Inspected and sampled plaintiff's property. Advised counsel on merits of case. Case settled.
- Assisted business owner facing eminent domain eviction. Prepared technical comments on a negative declaration for soil contamination and public health risks from air emissions from a proposed redevelopment project in San Francisco in support of a CEQA lawsuit. Case settled.
- Assisted neighborhood association representing residents living downwind of a Berkeley asphalt plant in separate nuisance and CEQA lawsuits. Prepared technical comments on air quality, odor, and noise impacts, presented testimony at commission and council meetings, participated in community workshops, and participated in settlement discussions. Cases settled. Asphalt plant was upgraded to include air emission and noise controls, including vapor collection system at truck loading station, enclosures for noisy equipment, and improved housekeeping.
- Assisted a Fortune 500 residential home builder in claims alleging health effects from faulty installation of gas appliances. Conducted indoor air quality study, advised counsel on merits of case, and participated in discussions with plaintiffs. Case settled.
- Assisted property owners in Silicon Valley in lawsuit to recover remediation costs from insurer for large TCE plume originating from a manufacturing facility. Conducted investigations to demonstrate sudden and accidental release of TCE, including groundwater

modeling, development of method to date spill, preparation of chemical inventory, investigation of historical waste disposal practices and standards, and on-site sewer and storm drainage inspections and sampling. Prepared declaration in opposition to motion for summary judgment. Case settled.

- Assisted residents in east Oakland downwind of a former battery plant in class action lawsuit alleging property contamination from lead emissions. Conducted historical research and dry deposition modeling that substantiated claim. Participated in mediation at JAMS. Case settled.
- Assisted property owners in West Oakland who purchased a former gas station that had leaking underground storage tanks and groundwater contamination. Reviewed agency files and advised counsel on merits of case. Prepared declaration in opposition to summary judgment. Prepared cost estimate to remediate site. Participated in settlement discussions. Case settled.
- Consultant to counsel representing plaintiffs in two Clean Water Act lawsuits involving selenium discharges into San Francisco Bay from refineries. Reviewed files and advised counsel on merits of case. Prepared interrogatory and discovery questions, assisted in deposing opposing experts, and reviewed and interpreted treatability and other technical studies. Judge ruled in favor of plaintiffs.
- Assisted oil company in a complaint filed by a resident of a small California beach community alleging that discharges of tank farm rinse water into the sanitary sewer system caused hydrogen sulfide gas to infiltrate residence, sending occupants to hospital. Inspected accident site, interviewed parties to the event, and reviewed extensive agency files related to incident. Used chemical analysis, field simulations, mass balance calculations, sewer hydraulic simulations with SWMM44, atmospheric dispersion modeling with SCREEN3, odor analyses, and risk assessment calculations to demonstrate that the incident was caused by a faulty drain trap and inadequate slope of sewer lateral on resident's property. Prepared a detailed technical report summarizing these studies. Case settled.
- Assisted large West Coast city in suit alleging that leaking underground storage tanks on city property had damaged the waterproofing on downgradient building, causing leaks in an underground parking structure. Reviewed subsurface hydrogeologic investigations and evaluated studies conducted by others documenting leakage from underground diesel and gasoline tanks. Inspected, tested, and evaluated waterproofing on subsurface parking structure. Waterproofing was substandard. Case settled.
- Assisted residents downwind of gravel mine and asphalt plant in Siskiyou County, California, in suit to obtain CEQA review of air permitting action. Prepared two declarations analyzing air quality and public health impacts. Judge ruled in favor of plaintiffs, closing mine and asphalt plant.

- Assisted defendant oil company on the California Central Coast in class action lawsuit alleging property damage and health effects from subsurface petroleum contamination. Reviewed documents, prepared risk calculations, and advised counsel on merits of case. Participated in settlement discussions. Case settled.
- Assisted defendant oil company in class action lawsuit alleging health impacts from remediation of petroleum contaminated site on California Central Coast. Reviewed documents, designed and conducted monitoring program, and participated in settlement discussions. Case settled.
- Consultant to attorneys representing irrigation districts and municipal water districts to evaluate a potential challenge of USFWS actions under CVPIA section 3406(b)(2). Reviewed agency files and collected and analyzed hydrology, water quality, and fishery data. Advised counsel on merits of case. Case not filed.
- Assisted residents downwind of a Carson refinery in class action lawsuit involving soil and groundwater contamination, nuisance, property damage, and health effects from air emissions. Reviewed files and provided advise on contaminated soil and groundwater, toxic emissions, and health risks. Prepared declaration on refinery fugitive emissions. Prepared deposition questions and reviewed deposition transcripts on air quality, soil contamination, odors, and health impacts. Case settled.
- Assisted residents downwind of a Contra Costa refinery who were affected by an accidental release of naphtha. Characterized spilled naphtha, estimated emissions, and modeled ambient concentrations of hydrocarbons and sulfur compounds. Deposed. Presented testimony in binding arbitration at JAMS. Judge found in favor of plaintiffs.
- Assisted residents downwind of Contra Costa County refinery in class action lawsuit alleging property damage, nuisance, and health effects from several large accidents as well as routine operations. Reviewed files and prepared analyses of environmental impacts. Prepared declarations, deposed, and presented testimony before jury in one trial and judge in second. Case settled.
- Assisted business owner claiming damages from dust, noise, and vibration during a sewer construction project in San Francisco. Reviewed agency files and PM10 monitoring data and advised counsel on merits of case. Case settled.
- Assisted residents downwind of Contra Costa County refinery in class action lawsuit alleging property damage, nuisance, and health effects. Prepared declaration in opposition to summary judgment, deposed, and presented expert testimony on accidental releases, odor, and nuisance before jury. Case thrown out by judge, but reversed on appeal and not retried.
- Presented testimony in small claims court on behalf of residents claiming health effects from hydrogen sulfide from flaring emissions triggered by a power outage at a Contra Costa County refinery. Analyzed meteorological and air quality data and evaluated potential health

risks of exposure to low concentrations of hydrogen sulfide. Judge awarded damages to plaintiffs.

- Assisted construction unions in challenging PSD permit for an Indiana steel mill. Prepared technical comments on draft PSD permit, drafted 70-page appeal of agency permit action to the Environmental Appeals Board challenging permit based on faulty BACT analysis for electric arc furnace and reheat furnace and faulty permit conditions, among others, and drafted briefs responding to four parties. EPA Region V and the EPA General Counsel intervened as amici, supporting petitioners. EAB ruled in favor of petitioners, remanding permit to IDEM on three key issues, including BACT for the reheat furnace and lead emissions from the EAF. Drafted motion to reconsider three issues. Prepared 69 pages of technical comments on revised draft PSD permit. Drafted second EAB appeal addressing lead emissions from the EAF and BACT for reheat furnace based on European experience with SCR/SNCR. Case settled. Permit was substantially improved. See *In re: Steel Dynamics, Inc.*, PSD Appeal Nos. 99-4 & 99-5 (EAB June 22, 2000).
- Assisted defendant urea manufacturer in Alaska in negotiations with USEPA to seek relief from penalties for alleged violations of the Clean Air Act. Reviewed and evaluated regulatory files and monitoring data, prepared technical analysis demonstrating that permit limits were not violated, and participated in negotiations with EPA to dismiss action. Fines were substantially reduced and case closed.
- Assisted construction unions in challenging PSD permitting action for an Indiana grain mill. Prepared technical comments on draft PSD permit and assisted counsel draft appeal of agency permit action to the Environmental Appeals Board challenging permit based on faulty BACT analyses for heaters and boilers and faulty permit conditions, among others. Case settled.
- As part of a consent decree settling a CEQA lawsuit, assisted neighbors of a large west coast port in negotiations with port authority to secure mitigation for air quality impacts. Prepared technical comments on mobile source air quality impacts and mitigation and negotiated a $9 million CEQA mitigation package. Represented neighbors on technical advisory committee established by port to implement the air quality mitigation program. Program successfully implemented.
- Assisted construction unions in challenging permitting action for a California hazardous waste incinerator. Prepared technical comments on draft permit, assisted counsel prepare appeal of EPA permit to the Environmental Appeals Board. Participated in settlement discussions on technical issues with applicant and EPA Region 9. Case settled.
- Assisted environmental group in challenging DTSC Negative Declaration on a hazardous waste treatment facility. Prepared technical comments on risk of upset, water, and health risks. Writ of mandamus issued.

- Assisted several neighborhood associations and cities impacted by quarries, asphalt plants, and cement plants in Alameda, Shasta, Sonoma, and Mendocino counties in obtaining mitigations for dust, air quality, public health, traffic, and noise impacts from facility operations and proposed expansions.
- For over 100 industrial facilities, commercial/campus, and redevelopment projects, developed the record in preparation for CEQA and NEPA lawsuits. Prepared technical comments on hazardous materials, solid wastes, public utilities, noise, worker safety, air quality, public health, water resources, water quality, traffic, and risk of upset sections of EIRs, EISs, FONSIs, initial studies, and negative declarations. Assisted counsel in drafting petitions and briefs and prepared declarations.
- For several large commercial development projects and airports, assisted applicant and counsel prepare defensible CEQA documents, respond to comments, and identify and evaluate "all feasible" mitigation to avoid CEQA challenges. This work included developing mitigation programs to reduce traffic-related air quality impacts based on energy conservation programs, solar, low-emission vehicles, alternative fuels, exhaust treatments, and transportation management associations.

SITE INVESTIGATION/REMEDIATION/CLOSURE

- Technical manager and principal engineer for characterization, remediation, and closure of waste management units at former Colorado oil shale plant. Constituents of concern included BTEX, As, 1,1,1-TCA, and TPH. Completed groundwater monitoring programs, site assessments, work plans, and closure plans for seven process water holding ponds, a refinery sewer system, and processed shale disposal area. Managed design and construction of groundwater treatment system and removal actions and obtained clean closure.
- Principal engineer for characterization, remediation, and closure of process water ponds at a former lanthanide processing plant in Colorado. Designed and implemented groundwater monitoring program and site assessments and prepared closure plan.
- Advised the city of Sacramento on redevelopment of two former railyards. Reviewed work plans, site investigations, risk assessment, RAPS, RI/FSs, and CEQA documents. Participated in the development of mitigation strategies to protect construction and utility workers and the public during remediation, redevelopment, and use of the site, including buffer zones, subslab venting, rail berm containment structure, and an environmental oversight plan.
- Provided technical support for the investigation of a former sanitary landfill that was redeveloped as single family homes. Reviewed and/or prepared portions of numerous documents, including health risk assessments, preliminary endangerment assessments, site investigation reports, work plans, and RI/FSs. Historical research to identify historic waste

disposal practices to prepare a preliminary endangerment assessment. Acquired, reviewed, and analyzed the files of 18 federal, state, and local agencies, three sets of construction field notes, analyzed 21 aerial photographs and interviewed 14 individuals associated with operation of former landfill. Assisted counsel in defending lawsuit brought by residents alleging health impacts and diminution of property value due to residual contamination. Prepared summary reports.

- Technical oversight of characterization and remediation of a nitrate plume at an explosives manufacturing facility in Lincoln, CA. Provided interface between owners and consultants. Reviewed site assessments, work plans, closure plans, and RI/FSs.
- Consultant to owner of large western molybdenum mine proposed for NPL listing. Participated in negotiations to scope out consent order and develop scope of work. Participated in studies to determine premining groundwater background to evaluate applicability of water quality standards. Served on technical committees to develop alternatives to mitigate impacts and close the facility, including resloping and grading, various thickness and types of covers, and reclamation. This work included developing and evaluating methods to control surface runoff and erosion, mitigate impacts of acid rock drainage on surface and ground waters, and stabilize nine waste rock piles containing 328 million tons of pyrite-rich, mixed volcanic waste rock (andesites, rhyolite, tuff). Evaluated stability of waste rock piles. Represented client in hearings and meetings with state and federal oversight agencies.

REGULATORY (PARTIAL LIST)

- In September and November 2017, prepared comments on revised Negative Declaration for Delicato Winery in San Joaquin County, California.
- In October and November 2017, prepared comments on North City Project Pure Water San Diego Program DEIR/DEIS to reclaim wastewater for municipal use.
- In August 2017, reviewed DEIR on a new residential community in eastern San Diego County and researched and wrote 60 pages of comments on air quality, greenhouse gas emissions, and health impacts.
- In August 2017, reviewed responses to comments on Part 70 operating permit and researched and wrote comments on metallic HAP issues.
- In July 2017, reviewed the FEIS for an expansion of the Port of Gulfport and researched and wrote 10 pages of comments on air quality and public health.
- In June 2017, reviewed and prepared technical report on an Application for a synthetic minor source construction permit for a new Refinery in North Dakota.

- In June 2017, reviewed responses to NPCA and other comments on the BP Cherry Point Refinery modifications and assisted counsel in evaluating issues to appeal, including GHG BACT, coker heater SCR cost effectiveness analysis, and SO_2 BACT.
- In June 2017, reviewed Part 70 Operating Permit Renewal/Modification for the Noranda Alumina LC/Gramercy Holdings I, LLC alumina processing plant, St. James, Louisiana, and prepared comments on HAP emissions from bauxite feedstock.
- In May and June 2017, reviewed FEIR on Tesoro Integration Project and prepared responses to comments on the DEIR.
- In May 2017, prepared comments on tank VOC and HAP emissions from Tesoro Integration Project, based on real time monitoring at the Tesoro and other refineries in the SCAQMD.
- In April 2017, prepared comments on Negative Declaration for Delicato Winery in San Joaquin County, California.
- In March 2017, reviewed Negative Declaration for Ellmore geothermal facility in Imperial County, California and prepared summary of issues.
- In March 2017, prepared response to Phillips 66 Company's Appeal of the San Luis Obispo County Planning Commission's Decision Denying the Rail Spur Extension Project Proposed for the Santa Maria Refinery.
- In February 2017, prepared comments on Kalama draft Title V permit for 10,000 MT/day methanol production and marine export facility in Kalama, Washington.
- In January 2017, researched and wrote 51 pages of comments on proposed Title V and PSD permits for the St. James Methanol Plant, St. James Louisiana, on BACT and enforceability of permit conditions.
- In December 2016, prepared comments on draft Title V Permit for Yuhuang Chemical Inc. Methanol Plant, St. James, Louisiana, responding to EPA Order addressing enforceability issues.
- In November 2016, prepared comments on Initial Study/Mitigated Negative Declaration for the AES Battery Energy Storage Facility, Long Beach, CA.
- In November 2016, prepared comments on Campo Verde Battery Energy Storage System Draft Environmental Impact Report.
- In October 2016, prepared comments on Title V Permit for NuStar Terminal Operations Partnership L.P, Stockton, CA.
- In October 2016, prepared expert report, Technical Assessment of Achieving the 40 CFR Part 423 Zero Discharge Standard for Bottom Ash Transport Water at the Belle River Power Plant, East China, Michigan. Reported resulted in a 2 year reduction in compliance date for elimination of bottom ash transport water. 1/30/17 DEQ Letter.

- In September 2016, prepared comments on Proposed Title V Permit and Environmental Assessment Statement, Yuhuang Chemical Inc. Methanol Plant, St. James, Louisiana.
- In September 2016, prepared response to "Further Rebuttal in Support of Appeal of Planning Commission Resolution No. 16-1, Denying Use Permit Application 12PLN-00063 and Declining to Certify Final Environmental Impact Report for the Valero Benicia Crude-by-Rail Project.
- In August 2016, reviewed and prepared comments on manuscript: Hutton et al., Freshwater Flows to the San Francisco Bay-Delta Estuary over Nine Decades: Trends Evaluation.
- In August/September 2016, prepared comments on Mitigated Negative Declaration for the Chevron Long Wharf Maintenance and Efficiency Project.
- In July 2016, prepared comments on the Ventura County APCD Preliminary Determination of Compliance and the California Energy Commission Revised Preliminary Staff Assessment for the Puente Power Project.
- In June 2016, prepared comments on an Ordinance (1) Amending the Oakland Municipal Code to Prohibit the Storage and Handling of Coal and Coke at Bulk Material Facilities or Terminals Throughout the City of Oakland and (2) Adopting CEQA Exemption Findings and supporting technical reports. Council approved Ordinance on an 8 to 0 vote on June 27, 2016.
- In May 2016, prepared comments on Draft Title V Permit and Draft Environmental Impact Report for the Tesoro Los Angeles Refinery Integration and Compliance Project.
- In March 2016, prepared comments on Valero's Appeal of Planning Commission's Denial of Valero Crude-by-Rail Project
- In February 2016, prepared comments on Final Environmental Impact Report, Santa Maria Rail Spur Project.
- In February 2016, prepared comments on Final Environmental Impact Report, Valero Benicia Crude by Rail Project.
- In January 2016, prepared comments on Draft Programmatic Environmental Impact Report for the Southern California Association of Government's (SCAG) 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy.
- In November 2015, prepared comments on Final Environmental Impact Report for Revisions to the Kern County Zoning Ordinance – 2015(C) (Focused on Oil and Gas Local Permitting), November 2015.
- In October 2015, prepared comments on Revised Draft Environmental Report, Valero Benicia Crude by Rail Project.

- In September 2015, prepared report, "Environmental, Health and Safety Impacts of the Proposed Oakland Bulk and Oversized Terminal, and presented oral testimony on September 21, 2015 before Oakland City Council on behalf of the Sierra Club.
- In September 2015, prepared comments on revisions to two chapters of EPA's Air Pollution Control Cost Manual: Docket ID No. EPA-HQ-OAR-2015-0341.
- In June 2015, prepared comments on DEIR for the CalAm Monterey Peninsula Water Supply Project.
- In April 2015, prepared comments on proposed Title V Operating Permit Revision and Prevention of Significant Deterioration Permit for Arizona Public Service's Ocotillo Power Plant Modernization Project (5 GE LMS100 105-MW simple cycle turbines operated as peakers), in Tempe, Arizona; Final permit appealed to EAB.
- In March 2015, prepared "Comments on Proposed Title V Air Permit, Yuhuang Chemical Inc. Methanol Plant, St. James, Louisiana". Client filed petition objecting to the permit. EPA granted majority of issues. In the Matter of Yuhuang Chemical Inc. Methanol Plant, St. James Parish, Louisiana, Permit No. 2560-00295-V0, Issued by the Louisiana Department of Environmental Quality, Petition No. VI-2015-03, Order Responding to the Petitioners' Request for Objection to the Issuance of a Title V Operating Permit, September 1, 2016.
- In February 2015, prepared compilation of BACT cost effectiveness values in support of comments on draft PSD Permit for Bonanza Power Project.
- In January 2015, prepared cost effectiveness analysis for SCR for a 500-MW coal fire power plant, to address unpermitted upgrades in 2000.
- In January 2015, prepared comments on Revised Final Environmental Impact Report for the Phillips 66 Propane Recovery Project. *Communities for a Better Environment et al. v. Contra Costa County et al. Contra Costa County (Superior Court, Contra Costa County, Case No. MSN15-0301, December 1, 2016).*
- In December 2014, prepared "Report on Bakersfield Crude Terminal Permits to Operate." In response, the U.S. EPA cited the Terminal for 10 violations of the Clean Air Act. The Fifth Appellate District Court upheld the finding in this report in CBE et al v. San Joaquin Valley Unified Air Pollution Control District and Bakersfield Crude Terminal LLC et al, Super. Ct. No. 284013, June 23, 2017.
- In December 2014, prepared comments on Revised Draft Environmental Impact Report for the Phillips 66 Propane Recovery Project.
- In November 2014, prepared comments on Revised Draft Environmental Impact Report for Phillips 66 Rail Spur Extension Project and Crude Unloading Project, Santa Maria, CA to allow the import of tar sands crudes.

- In November 2014, prepared comments on Draft Environmental Impact Report for Phillips 66 Ultra Low Sulfur Diesel Project, responding to the California Supreme Court Decision, *Communities for a Better Environment v. South Coast Air Quality Management Dist. (2010) 48 Cal.4th 310.*
- In November 2014, prepared comments on Draft Environmental Impact Report for the Tesoro Avon Marine Oil Terminal Lease Consideration.
- In October 2014, prepared: "Report on Hydrogen Cyanide Emissions from Fluid Catalytic Cracking Units", pursuant to the Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards, 79 FR 36880.
- In October 2014, prepared technical comments on Final Environmental Impact Reports for Alon Bakersfield Crude Flexibility Project to build a rail terminal to allow the import/export of tar sands and Bakken crude oils and to upgrade an existing refinery to allow it to process a wide range of crudes.
- In October 2014, prepared technical comments on the Title V Permit Renewal and three De Minimus Significant Revisions for the Tesoro Logistics Marine Terminal in the SCAQMD.
- In September 2014, prepared technical comments on the Draft Environmental Impact Report for the Valero Crude by Rail Project.
- In August 2014, for EPA Region 6, prepared technical report on costing methods for upgrades to existing scrubbers at coal-fired power plants.
- In July 2014, prepared technical comments on Draft Final Environmental Impact Reports for Alon Bakersfield Crude Flexibility Project to build a rail terminal to allow the import/export of tar sands and Bakken crude oils and to upgrade an existing refinery to allow it to process a wide range of crudes.
- In June 2014, prepared technical report on Initial Study and Draft Negative Declaration for the Tesoro Logistics Storage Tank Replacement and Modification Project.
- In May 2014, prepared technical comments on Intent to Approve a new refinery and petroleum transloading operation in Utah.
- In March and April 2014, prepared declarations on air permits issued for two crude-by-rail terminals in California, modified to switch from importing ethanol to importing Bakken crude oils by rail and transferring to tanker cars. Permits were issued without undergoing CEQA review. One permit was upheld by the San Francisco Superior Court as statute of limitations had run. The Sacramento Air Quality Management District withdrew the second one due to failure to require BACT and conduct CEQA review.
- In March 2014, prepared technical report on Negative Declaration for a proposed modification of the air permit for a bulk petroleum and storage terminal to the allow the

import of tar sands and Bakken crude oil by rail and its export by barge, under the New York State Environmental Quality Review Act (SEQRA).

- In February 2014, prepared technical report on proposed modification of air permit for midwest refinery upgrade/expansion to process tar sands crudes.
- In January 2014, prepared cost estimates to capture, transport, and use CO2 in enhanced oil recovery, from the Freeport LNG project based on both Selexol and Amine systems.
- In January 2014, prepared technical report on Draft Environmental Impact Report for Phillips 66 Rail Spur Extension Project, Santa Maria, CA. Comments addressed project description (piecemealing, crude slate), risk of upset analyses, mitigation measures, alternative analyses and cumulative impacts.
- In November 2013, prepared technical report on the Phillips 66 Propane Recovery Project, Rodeo, CA. Comments addressed project description (piecemealing, crude slate) and air quality impacts.
- In September 2013, prepared technical report on the Draft Authority to Construct Permit for the Casa Diablo IV Geothermal Development Project Environmental Impact Report and Declaration in Support of Appeal and Petition for Stay, U.S. Department of the Interior, Board of Land Appeals, Appeal of Decision Record for the Casa Diablo IV Geothermal Development Project.
- In September 2013, prepared technical report on Effluent Limitation Guidelines for Best Available Technology Economically Available (BAT) for Bottom Ash Transport Waters from Coal-Fired Power Plants in the Steam Electric Power Generating Point Source Category.
- In July 2013, prepared technical report on Initial Study/Mitigated Negative Declaration for the Valero Crude by Rail Project, Benicia, California, Use Permit Application 12PLN-00063.
- In July 2013, prepared technical report on fugitive particulate matter emissions from coal train staging at the proposed Coyote Island Terminal, Oregon, for draft Permit No. 25-0015-ST-01.
- In July 2013, prepared technical comments on air quality impacts of the Finger Lakes LPG Storage Facility as reported in various Environmental Impact Statements.
- In July 2013, prepared technical comments on proposed Greenhouse Gas PSD Permit for the Celanese Clear Lake Plant, including cost analysis of CO2 capture, transport, and sequestration.
- In June/July 2013, prepared technical comments on proposed Draft PSD Preconstruction Permit for Greenhouse Gas Emission for the ExxonMobil Chemical Company Baytown Olefins Plant, including cost analysis of CO2 capture, transport, and sequestration.

- In June 2013, prepared technical report on a Mitigated Negative Declaration for a new rail terminal at the Valero Benicia Refinery to import increased amounts of "North American" crudes. Comments addressed air quality impacts of refining increased amounts of tar sands crudes.
- In June 2013, prepared technical report on Draft Environmental Impact Report for the California Ethanol and Power Imperial Valley 1 Project.
- In May 2013, prepared comments on draft PSD permit for major expansion of midwest refinery to process 100% tar sands crudes, including a complex netting analysis involving debottlenecking, piecemealing, and BACT analyses.
- In April 2013, prepared technical report on the Draft Supplemental Environmental Impact Statement (DSEIS) for the Keystone XL Pipeline on air quality impacts from refining increased amount of tar sands crudes at Refineries in PADD 3.
- In October 2012, prepared technical report on the Environmental Review for the Coyote Island Terminal Dock at the Port of Morrow on fugitive particulate matter emissions.
- In October 2012-October 2014, review and evaluate Flint Hills West Application for an expansion/modification for increased (Texas, Eagle Ford Shale) crude processing and related modification, including netting and BACT analysis. Assist in settlement discussions.
- In February 2012, prepared comments on BART analysis in PA Regional Haze SIP, 77 FR 3984 (Jan. 26, 2012). On Sept. 29, 2015, a federal appeals court overturned the U.S. EPA's approval of this plan, based in part on my comments, concluding "..we will vacate the 2014 Final Rule to the extent it approved Pennsylvania's source-specific BART analysis and remand to the EPA for further proceedings consistent with this Opinion." Nat'l Parks Conservation Assoc. v. EPA, 3d Cir., No. 14-3147, 9/19/15.
- Prepared cost analyses and comments on New York's proposed BART determinations for NOx, SO2, and PM and EPA's proposed approval of BART determinations for Danskammer Generating Station under New York Regional Haze State Implementation Plan and Federal Implementation Plan, 77 FR 51915 (August 28, 2012).
- Prepared cost analyses and comments on NOx BART determinations for Regional Haze State Implementation Plan for State of Nevada, 77 FR 23191 (April 18, 2012) and 77 FR 25660 (May 1, 2012).
- Prepared analyses of and comments on New Source Performance Standards for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 FR 22392 (April 13, 2012).
- Prepared comments on CASPR-BART emission equivalency and NOx and PM BART determinations in EPA proposed approval of State Implementation Plan for Pennsylvania Regional Haze Implementation Plan, 77 FR 3984 (January 26, 2012).

- Prepared comments and statistical analyses on hazardous air pollutants (HAPs) emission controls, monitoring, compliance methods, and the use of surrogates for acid gases, organic HAPs, and metallic HAPs for proposed National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units, 76 FR 24976 (May 3, 2011).
- Prepared cost analyses and comments on NOx BART determinations and emission reductions for proposed Federal Implementation Plan for Four Corners Power Plant, 75 FR 64221 (October 19, 2010).
- Prepared cost analyses and comments on NOx BART determinations for Colstrip Units 1- 4 for Montana State Implementation Plan and Regional Haze Federal Implementation Plan, 77 FR 23988 (April 20, 2010).
- For EPA Region 8, prepared report: Revised BART Cost Effectiveness Analysis for Tail-End Selective Catalytic Reduction at the Basin Electric Power Cooperative Leland Olds Station Unit 2 Final Report, March 2011, in support of 76 FR 58570 (Sept. 21, 2011).
- For EPA Region 6, prepared report: Revised BART Cost-Effectiveness Analysis for Selective Catalytic Reduction at the Public Service Company of New Mexico San Juan Generating Station, November 2010, in support of 76 FR 52388 (Aug. 22, 2011).
- For EPA Region 6, prepared report: Revised BART Cost-Effectiveness Analysis for Flue Gas Desulfurization at Coal-Fired Electric Generating Units in Oklahoma: Sooner Units 1 & 2, Muskogee Units 4 & 5, Northeastern Units 3 &4, October 2010, in support of 76 FR 16168 (March 26, 2011). My work was upheld in: *State of Oklahoma v. EPA*, App. Case 12-9526 (10th Cri. July 19, 2013).
- Identified errors in N_2O emission factors in the Mandatory Greenhouse Gas Reporting Rule, 40 CFR 98, and prepared technical analysis to support Petition for Rulemaking to Correct Emissions Factors in the Mandatory Greenhouse Gas Reporting Rule, filed with EPA on 10/28/10.
- Assisted interested parties develop input for and prepare comments on the Information Collection Request for Petroleum Refinery Sector NSPS and NESHAP Residual Risk and Technology Review, 75 FR 60107 (9/29/10).
- Technical reviewer of EPA's "Emission Estimation Protocol for Petroleum Refineries," posted for public comments on CHIEF on 12/23/09, prepared in response to the City of Houston's petition under the Data Quality Act (March 2010).
- Prepared comments on SCR cost effectiveness for EPA's Advanced Notice of Proposed Rulemaking, Assessment of Anticipated Visibility Improvements at Surrounding Class I Areas and Cost Effectiveness of Best Available Retrofit Technology for Four Corners Power Plant and Navajo Generating Station, 74 FR 44313 (August 28, 2009).

- Prepared comments on Proposed Rule for Standards of Performance for Coal Preparation and Processing Plants, 74 FR 25304 (May 27, 2009).
- Prepared comments on draft PSD permit for major expansion of midwest refinery to process up to 100% tar sands crudes. Participated in development of monitoring and controls to mitigate impacts and in negotiating a Consent Decree to settle claims in 2008.
- Reviewed and assisted interested parties prepare comments on proposed Kentucky air toxic regulations at 401 KAR 64:005, 64:010, 64:020, and 64:030 (June 2007).
- Prepared comments on proposed Standards of Performance for Electric Utility Steam Generating Units and Small Industrial-Commercial-Industrial Steam Generating Units, 70 FR 9706 (February 28, 2005).
- Prepared comments on Louisville Air Pollution Control District proposed Strategic Toxic Air Reduction regulations.
- Prepared comments and analysis of BAAQMD Regulation, Rule 11, Flare Monitoring at Petroleum Refineries.
- Prepared comments on Proposed National Emission Standards for Hazardous Air Pollutants; and, in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electricity Utility Steam Generating Units (MACT standards for coal-fired power plants).
- Prepared Authority to Construct Permit for remediation of a large petroleum-contaminated site on the California Central Coast. Negotiated conditions with agencies and secured permits.
- Prepared Authority to Construct Permit for remediation of a former oil field on the California Central Coast. Participated in negotiations with agencies and secured permits.
- Prepared and/or reviewed hundreds of environmental permits, including NPDES, UIC, Stormwater, Authority to Construct, Prevention of Significant Deterioration, Nonattainment New Source Review, Title V, and RCRA, among others.
- Participated in the development of the CARB document, *Guidance for Power Plant Siting and Best Available Control Technology*, including attending public workshops and filing technical comments.
- Performed data analyses in support of adoption of emergency power restoration standards by the California Public Utilities Commission for "major" power outages, where major is an outage that simultaneously affects 10% of the customer base.
- Drafted portions of the Good Neighbor Ordinance to grant Contra Costa County greater authority over safety of local industry, particularly chemical plants and refineries.

- Participated in drafting BAAQMD Regulation 8, Rule 28, Pressure Relief Devices, including participation in public workshops, review of staff reports, draft rules and other technical materials, preparation of technical comments on staff proposals, research on availability and costs of methods to control PRV releases, and negotiations with staff.
- Participated in amending BAAQMD Regulation 8, Rule 18, Valves and Connectors, including participation in public workshops, review of staff reports, proposed rules and other supporting technical material, preparation of technical comments on staff proposals, research on availability and cost of low-leak technology, and negotiations with staff.
- Participated in amending BAAQMD Regulation 8, Rule 25, Pumps and Compressors, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of low-leak and seal-less technology, and negotiations with staff.
- Participated in amending BAAQMD Regulation 8, Rule 5, Storage of Organic Liquids, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of controlling tank emissions, and presentation of testimony before the Board.
- Participated in amending BAAQMD Regulation 8, Rule 18, Valves and Connectors at Petroleum Refinery Complexes, including participation in public workshops, review of staff reports, proposed rules and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of low-leak technology, and presentation of testimony before the Board.
- Participated in amending BAAQMD Regulation 8, Rule 22, Valves and Flanges at Chemical Plants, etc, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of low-leak technology, and presentation of testimony before the Board.
- Participated in amending BAAQMD Regulation 8, Rule 25, Pump and Compressor Seals, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability of low-leak technology, and presentation of testimony before the Board.
- Participated in the development of the BAAQMD Regulation 2, Rule 5, Toxics, including participation in public workshops, review of staff proposals, and preparation of technical comments.
- Participated in the development of SCAQMD Rule 1402, Control of Toxic Air Contaminants from Existing Sources, and proposed amendments to Rule 1401, New Source Review of

Toxic Air Contaminants, in 1993, including review of staff proposals and preparation of technical comments on same.

- Participated in the development of the Sunnyvale Ordinance to Regulate the Storage, Use and Handling of Toxic Gas, which was designed to provide engineering controls for gases that are not otherwise regulated by the Uniform Fire Code.
- Participated in the drafting of the Statewide Water Quality Control Plans for Inland Surface Waters and Enclosed Bays and Estuaries, including participation in workshops, review of draft plans, preparation of technical comments on draft plans, and presentation of testimony before the SWRCB.
- Participated in developing Se permit effluent limitations for the five Bay Area refineries, including review of staff proposals, statistical analyses of Se effluent data, review of literature on aquatic toxicity of Se, preparation of technical comments on several staff proposals, and presentation of testimony before the Bay Area RWQCB.
- Represented the California Department of Water Resources in the 1991 Bay-Delta Hearings before the State Water Resources Control Board, presenting sworn expert testimony with cross examination and rebuttal on a striped bass model developed by the California Department of Fish and Game.
- Represented the State Water Contractors in the 1987 Bay-Delta Hearings before the State Water Resources Control Board, presenting sworn expert testimony with cross examination and rebuttal on natural flows, historical salinity trends in San Francisco Bay, Delta outflow, and hydrodynamics of the South Bay.
- Represented interveners in the licensing of over 20 natural-gas-fired power plants and one coal gasification plant at the California Energy Commission and elsewhere. Reviewed and prepared technical comments on applications for certification, preliminary staff assessments, final staff assessments, preliminary determinations of compliance, final determinations of compliance, and prevention of significant deterioration permits in the areas of air quality, water supply, water quality, biology, public health, worker safety, transportation, site contamination, cooling systems, and hazardous materials. Presented written and oral testimony in evidentiary hearings with cross examination and rebuttal. Participated in technical workshops.
- Represented several parties in the proposed merger of San Diego Gas & Electric and Southern California Edison. Prepared independent technical analyses on health risks, air quality, and water quality. Presented written and oral testimony before the Public Utilities Commission administrative law judge with cross examination and rebuttal.
- Represented a PRP in negotiations with local health and other agencies to establish impact of subsurface contamination on overlying residential properties. Reviewed health studies

prepared by agency consultants and worked with agencies and their consultants to evaluate health risks.

WATER QUALITY/RESOURCES

- Directed and participated in research on environmental impacts of energy development in the Colorado River Basin, including contamination of surface and subsurface waters and modeling of flow and chemical transport through fractured aquifers.
- Played a major role in Northern California water resource planning studies since the early 1970s. Prepared portions of the Basin Plans for the Sacramento, San Joaquin, and Delta basins including sections on water supply, water quality, beneficial uses, waste load allocation, and agricultural drainage. Developed water quality models for the Sacramento and San Joaquin Rivers.
- Conducted hundreds of studies over the past 40 years on Delta water supplies and the impacts of exports from the Delta on water quality and biological resources of the Central Valley, Sacramento-San Joaquin Delta, and San Francisco Bay. Typical examples include:
    1. Evaluate historical trends in salinity, temperature, and flow in San Francisco Bay and upstream rivers to determine impacts of water exports on the estuary;
    2. Evaluate the role of exports and natural factors on the food web by exploring the relationship between salinity and primary productivity in San Francisco Bay, upstream rivers, and ocean;
    3. Evaluate the effects of exports, other in-Delta, and upstream factors on the abundance of salmon and striped bass;
    4. Review and critique agency fishery models that link water exports with the abundance of striped bass and salmon;
    5. Develop a model based on GLMs to estimate the relative impact of exports, water facility operating variables, tidal phase, salinity, temperature, and other variables on the survival of salmon smolts as they migrate through the Delta;
    6. Reconstruct the natural hydrology of the Central Valley using water balances, vegetation mapping, reservoir operation models to simulate flood basins, precipitation records, tree ring research, and historical research;
    7. Evaluate the relationship between biological indicators of estuary health and down-estuary position of a salinity surrogate (X2);
    8. Use real-time fisheries monitoring data to quantify impact of exports on fish migration;
    9. Refine/develop statistical theory of autocorrelation and use to assess strength of relationships between biological and flow variables;

10. Collect, compile, and analyze water quality and toxicity data for surface waters in the Central Valley to assess the role of water quality in fishery declines;
11. Assess mitigation measures, including habitat restoration and changes in water project operation, to minimize fishery impacts;
12. Evaluate the impact of unscreened agricultural water diversions on abundance of larval fish;
13. Prepare and present testimony on the impacts of water resources development on Bay hydrodynamics, salinity, and temperature in water rights hearings;
14. Evaluate the impact of boat wakes on shallow water habitat, including interpretation of historical aerial photographs;
15. Evaluate the hydrodynamic and water quality impacts of converting Delta islands into reservoirs;
16. Use a hydrodynamic model to simulate the distribution of larval fish in a tidally influenced estuary;
17. Identify and evaluate non-export factors that may have contributed to fishery declines, including predation, shifts in oceanic conditions, aquatic toxicity from pesticides and mining wastes, salinity intrusion from channel dredging, loss of riparian and marsh habitat, sedimentation from upstream land alternations, and changes in dissolved oxygen, flow, and temperature below dams.

- Developed, directed, and participated in a broad-based research program on environmental issues and control technology for energy industries including petroleum, oil shale, coal mining, and coal slurry transport. Research included evaluation of air and water pollution, development of novel, low-cost technology to treat and dispose of wastes, and development and application of geohydrologic models to evaluate subsurface contamination from in-situ retorting. The program consisted of government and industry contracts and employed 45 technical and administrative personnel.
- Coordinated an industry task force established to investigate the occurrence, causes, and solutions for corrosion/erosion and mechanical/engineering failures in the waterside systems (e.g., condensers, steam generation equipment) of power plants. Corrosion/erosion failures caused by water and steam contamination that were investigated included waterside corrosion caused by poor microbiological treatment of cooling water, steam-side corrosion caused by ammonia-oxygen attack of copper alloys, stress-corrosion cracking of copper alloys in the air cooling sections of condensers, tube sheet leaks, oxygen in-leakage through condensers, volatilization of silica in boilers and carry over and deposition on turbine blades, and iron corrosion on boiler tube walls. Mechanical/engineering failures investigated

included: steam impingement attack on the steam side of condenser tubes, tube-to-tube-sheet joint leakage, flow-induced vibration, structural design problems, and mechanical failures due to stresses induced by shutdown, startup and cycling duty, among others. Worked with electric utility plant owners/operators, condenser and boiler vendors, and architect/engineers to collect data to document the occurrence of and causes for these problems, prepared reports summarizing the investigations, and presented the results and participated on a committee of industry experts tasked with identifying solutions to prevent condenser failures.

- Evaluated the cost effectiveness and technical feasibility of using dry cooling and parallel dry-wet cooling to reduce water demands of several large natural-gas fired power plants in California and Arizona.
- Designed and prepared cost estimates for several dry cooling systems (e.g., fin fan heat exchangers) used in chemical plants and refineries.
- Designed, evaluated, and costed several zero liquid discharge systems for power plants.
- Evaluated the impact of agricultural and mining practices on surface water quality of Central Valley steams. Represented municipal water agencies on several federal and state advisory committees tasked with gathering and assessing relevant technical information, developing work plans, and providing oversight of technical work to investigate toxicity issues in the watershed.

AIR QUALITY/PUBLIC HEALTH

- Prepared or reviewed the air quality and public health sections of hundreds of EIRs and EISs on a wide range of industrial, commercial and residential projects.
- Prepared or reviewed hundreds of NSR and PSD permits for a wide range of industrial facilities.
- Designed, implemented, and directed a 2-year-long community air quality monitoring program to assure that residents downwind of a petroleum-contaminated site were not impacted during remediation of petroleum-contaminated soils. The program included real-time monitoring of particulates, diesel exhaust, and BTEX and time integrated monitoring for over 100 chemicals.
- Designed, implemented, and directed a 5-year long source, industrial hygiene, and ambient monitoring program to characterize air emissions, employee exposure, and downwind environmental impacts of a first-generation shale oil plant. The program included stack monitoring of heaters, boilers, incinerators, sulfur recovery units, rock crushers, API separator vents, and wastewater pond fugitives for arsenic, cadmium, chlorine, chromium, mercury, 15 organic indicators (e.g., quinoline, pyrrole, benzo(a)pyrene, thiophene, benzene), sulfur gases, hydrogen cyanide, and ammonia. In many cases, new methods had to be developed or existing methods modified to accommodate the complex matrices of shale plant gases.

- Conducted investigations on the impact of diesel exhaust from truck traffic from a wide range of facilities including mines, large retail centers, light industrial uses, and sports facilities. Conducted traffic surveys, continuously monitored diesel exhaust using an aethalometer, and prepared health risk assessments using resulting data.
- Conducted indoor air quality investigations to assess exposure to natural gas leaks, pesticides, molds and fungi, soil gas from subsurface contamination, and outgasing of carpets, drapes, furniture and construction materials. Prepared health risk assessments using collected data.
- Prepared health risk assessments, emission inventories, air quality analyses, and assisted in the permitting of over 70 1 to 2 MW emergency diesel generators.
- Prepare over 100 health risk assessments, endangerment assessments, and other health-based studies for a wide range of industrial facilities.
- Developed methods to monitor trace elements in gas streams, including a continuous real-time monitor based on the Zeeman atomic absorption spectrometer, to continuously measure mercury and other elements.
- Performed nuisance investigations (odor, noise, dust, smoke, indoor air quality, soil contamination) for businesses, industrial facilities, and residences located proximate to and downwind of pollution sources.

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(Partial)

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Assessment, Control and Remediation of LNAPL Contaminated Sites, API and USEPA, 9/94
Pesticides in the TIE Process, SETAC, 6/96
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Design of Gas Turbine Combined Cycle and Cogeneration Systems, Thermoflow, 12/00
Air-Cooled Steam Condensers and Dry- and Hybrid-Cooling Towers, Power-Gen, 12/01
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CEQA Update, UC Berkeley Extension, 3/02
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Noise Exposure Assessment: Sampling Strategy and Data Acquisition, AIHA PDC 205, 6/02
Noise Exposure Measurement Instruments and Techniques, AIHA PDC 302, 6/02
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ATTACHMENT B

Lesson 2

Significant Figures and Rounding Off

Just Working with Numbers

In most cases, rather than using paper and pencil, you will be performing math calculations using a handheld calculator, a personal computer, or a mainframe computer. However, whether you use an electronic tool or paper and pencil, you are often required to make decisions based on certain basic rules and principles of mathematics. In addition, when a calculator or computer is used, you have the additional responsibility for ensuring that the tool (hardware or software) is, in fact, providing accurate and reliable results.

In this initial lesson some of the most basic mathematical concepts are reviewed. These concepts, though basic and supposedly simple, often lead to periods of frustration and hair pulling when ignored or overlooked. The basics to be presented in this lesson deal with determining how many figures to keep (where to **truncate**) and how or when to round off.

The number of digits displayed as the answer on most calculators and computers is governed by the physical properties of the instrument (e.g., many handheld calculators display only 10 digits). Determining how many digits to keep (where to truncate, or which digits to throw away), and when and how to round are decisions that you must make. On the next page you will be asked to solve 12 problems requiring you to determine which digits to keep and when to round.

Using your calculator, provide your answers in two forms, the *complete* answer, and the *corrected* answer. In the first column (Complete) supply the complete answer obtained by performing the required function (probably an answer with 10 digits on many calculators). In the second column (Corrected), supply the answer retaining the *correct* number of digits, rounded where necessary.

Intro Problems

	Problem	Complete	Corrected
1.	$3.5 + 2.075 =$		
2.	$3.49 - 2.0075 =$		
3.	$2.0 \times 307 =$		
4.	$2.49 \times 3.07 =$		
5.	$2.074 \times 4.700 =$		
6.	$4.1 \times 3.29875 =$		
7.	$50 \div 3.0069 =$		
8.	$9.4 \div 3.34 =$		
9.	$9.4000 \div 0.02 =$		
10.	$0.052 \div 0.0026 =$		
11.	$0.00791 \div 0.52 =$		
12.	$0.0025 \times 0.00025 =$		

Now, compare your answers with those provided on page 2-9.

Approximate Numbers

Any number may be classified as exact or as approximate. An exact number is derived from the use of specific numbering systems and arithmetic rules. (For example, 12 is an exact number.) Approximate numbers are derived from measurements and calculations where rounding has been, or may be, applied. When it is stated that 12 eggs are consumed by five people, or that each person consumed 2.4 eggs, 2.4 eggs represents an approximate number. Even if the eggs were scrambled, we have no way of ensuring that each person consumed exactly 2.4 eggs.

With air pollution problems, we deal primarily with measurements. Therefore, we are dealing primarily with approximate numbers. Another way of considering approximate numbers is to acknowledge that an approximate number has some degree of error associated with it. Since the numbers being used are approximate and contain some degree of error at the outset, care must be taken to avoid introducing any more error into problems and their solutions.

The following general rules are useful in remembering the rules and calculating the values associated with approximate numbers.

Rule 1 (General)

In most cases, mathematical rules governing the results of an addition or subtraction operation are quite similar to one another, if not the same. Also, the rules governing the results of a multiplication or division operation are similar to one another, or the same. But the rules governing the results of addition and subtraction operations are generally quite different from the rules governing the results of multiplication and division operations.

Rule 2 (General)

When performing calculations with approximate numbers, carry as many digits as possible until the final result is calculated. Once the final result is calculated, apply the appropriate rules for truncating and rounding.

Since the rule for rounding approximate numbers applies to addition, subtraction, multiplication, and division, and is easy to remember, we will look at it first.

Rounding Approximate Numbers

For the moment, we will not concern ourselves with where and how to truncate numbers. We will simply assume that the appropriate number of digits to be retained are givens in the following examples. When truncating (removing final, unwanted digits), rounding is normally applied to the last digit to be kept.

Rule for Rounding Approximate Numbers

If the value of the first digit to be discarded is less than 5, retain the last kept digit with no change. If the value of the first digit to be discarded is 5 or greater, increase the last kept digit's value by one.

Example: 25.0847

Assume only the first two decimal places are to be kept (the 4 and 7 are to be dropped). Round to 25.08. Since the first digit to be discarded (4) is less than 5, the 8 is not rounded up.

Example: 25.0867

Assume only the first two decimal places are to be kept (the 5 and 7 are to be dropped). Round to 25.09. Since the first digit to be discarded (6) is 5 or more, the 8 is rounded up to 9.

Adding and Subtracting Approximate Numbers

When adding or subtracting approximate numbers, a rule based upon **precision** determines how many digits are kept. In general, precision relates to the decimal significance of a number. When a measurement is given as 1.005 cm, we can say that the number is precise to the *thousandth* of a centimeter. If the decimal is removed (1005 cm) we have a number that is precise to *thousands* of centimeters.

You may make a measurement in gallons or liters. Although a gallon or a liter may represent an exact quantity, the measuring instruments that are used are capable of producing approximations only. Using a standard graduated flask as an example, can you determine whether there is exactly one liter? Likely not. In fact you would be hard pressed to verify that there was a liter to within ±1/10 of a liter. Therefore, depending upon the instruments used, the precision of a given measurement may vary.

If a measurement is given to us as 16.0 L, the zero after the decimal indicates that the measurement is precise to within 1/10 L. Given a measurement of 16.00 L, we have precision to 1/100 L. In short, the digits following the decimal indicate how precise the measurement is. Precision is used to determine where to truncate when approximate numbers are added or subtracted.

Truncating Approximate Numbers Following Addition or Subtraction

When approximate numbers are added or subtracted, the results are expressed in terms of the least precise number in the problem.

Since this is a relatively simple rule to master, just one problem will be used to illustrate it. Calculate the following and express the result in precise terms:

6.04 L + 2.8 L - 4.173 L = 4.7 L

The complete result is 4.667 L. The answer follows the rule of precision. The expressions in the problem have two, one, and three decimal places respectively. The least precise number (least decimal places) in the problem is 2.8, a value carried only to the tenths position. Therefore, the answer must be calculated to the tenths position only. Thus the correct answer is 4.7 L. (The last 6 and the 7 are dropped from 4.667 L, and the first 6 is rounded up to provide 4.7 L.)

Intro Problems 1 and 2 represent addition and subtraction of approximate numbers.

Problem 1: 3.5 + 2.075 = 5.575 = 5.6
The least precise number (3.5) is provided to one decimal place. The answer must therefore contain only one decimal and the second 5 is rounded up to 6.

Problem 2: 3.49 - 2.0075 = 1.4825 = 1.48
Two decimal places are represented by the least precise number (3.49). The answer is given to two decimals and the 8 is not rounded up.

Multiplying and Dividing Approximate Numbers

In multiplication and division of approximate numbers, finding the number of significant digits is used to determine how many digits to keep (where to truncate). We must first understand **significant digits** in order to determine the correct number of digits to keep or remove in multiplication and division problems.

Significant Digits

Generally, the digits 1 through 9 are considered to be significant. Thus, the numbers 123, 53, 7492, and 5 contain three, two, four, and one significant digits respectively.

The digit 0 must be considered separately.

Zeros are significant when they occur between significant digits. In the following examples, all zeros are significant: 10001, 402, 1.1001, 50.09 (five, three, four, and four significant digits respectively).

Zeros are not significant when they are used as place holders. When used as a place holder, a zero simply identifies where a decimal is located. For example, each of the following numbers has only one significant digit: 1000, 500, 60, 0.09, 0.0002. In the numbers 1200, 540, and 0.0032, there are two significant digits, and the zeros are not significant.

When zeros follow a decimal and are preceded by a significant digit, the zeros are significant. In the following examples, all zeros are significant: 1.00, 15.0, 4.1000, 1.90, 10.002, 10.0400. In the example 10.002, the zeros are significant because they fall between

two significant digits. In the last example, 10.0400, the first two zeros are significant because they fall between two significant digits; the last two zeros are significant because they follow a decimal and are preceded by a significant digit.

Additional illustrations of significant digits are provided in the following chart. The significant digits are underlined.

Example		Number of Significant Digits
1.	123	3
2.	12300	3
3.	12003	5
4.	123.000	6
5.	12300.0	6
6.	1.0004	5
7.	0.0004	1
8.	0.005003	4
9.	0.005300	4
10.	1000.0001	8

Example 1 is pretty easy. There are three non-zero digits and no decimal places; therefore, three significant digits. Example 2 uses two zeros as "place holders" to locate the decimal. The two zeros are not significant; thus, only three digits are significant. In example 3 the two zeros are not place holders, but part of a five-digit number; hence, five significant digits. Example 4 contains three zeros after the decimal. The zeros follow a decimal and are preceded by three significant digits. (The zeros show **precision**, which is explained later.) Example 5 is similar to the previous example. By the presence of the zero after the decimal preceded by significant digits, the last zero becomes significant. Now the two zeros before the decimal become significant since they fall between significant digits.

The three zeros in example 6 follow the rule described in examples 4 and 5. The zeros in example 7 establish the position of the decimal only; therefore, they are not significant and the 4 is the lone significant digit. Example 8 uses four zeros. The first two zeros (place holders) are not significant; the other two are significant digits. In example 9, the two trailing zeros are significant because they follow a significant digit that follows a decimal. In the last example, all six zeros are significant since they all fall between significant digits.

Having determined how to count significant digits, we can now apply this information to determine where to truncate the results from multiplying or dividing approximate numbers.

Truncating Approximate Numbers Following Multiplication or Division

When approximate numbers are multiplied or divided, the result is expressed as a number having the same number of significant digits as the expression in the problem having the least number of significant digits.

In other words, if you multiply a number having four significant digits by a number having two significant digits, the correct answer will be expressed to two significant digits.

Let's consider a measurement of 200 ft. Not knowing how the measurement was made, we can only know for certain that the measurement represents a distance of 200 ft or greater but less than 300 ft. There is one significant digit, and no matter what computation this measurement enters, the result is good to only one significant digit. Thus, if the problem 200 ft x 13.6 is solved, the complete answer is 2720.0 ft. The two numbers, 200 and 13.6, represent one and three significant digits, respectively. One significant digit is less than three; therefore the correct answer will be rendered to one significant digit. Thus, after rounding, the correct answer is 3000 ft.

If the measurement were made to two significant digits, such as 290 ft, we know that the measurement represents a distance of 290 ft or greater, but less than 300 ft. Again using the measurement, 290 ft x 13.6, the complete result yields 3944.0, and the correct result is 3900 ft. In this case, two significant digits are used (39). Since the first discarded digit is 4, the 39 remains.

Now let's reconsider the answers to problems 3 through 12 (on page 2-9) for the problems you worked.

Problem 3: 2.0 x 307 = 614 = 610

The number 2.0 represents two significant digits since the zero following the decimal follows a significant digit. The number 307 has three significant digits. The *least* number of significant digits is two. Therefore, the 4 in the answer is not significant and it is less than 5, so the answer, properly rounded to two significant digits, is 610. The 4 is dropped.

Problem 4: 2.49 x 3.07 = 7.6443 = 7.64

There are three significant digits in each number of the problem. The answer, expressed to three significant digits, is 7.64, keeping the decimal and dropping the two non-significant digits (43).

Problem 5: 2.074 x 4.700 = 9.7478 = 9.748

Again, both numbers in the problem have the same number of significant digits (four). By keeping four significant digits (9.747), truncating the 800 and rounding, we have 9.748.

Problem 6: 4.1 x 3.29875 = 13.524875 = 14

The numbers in this problem represent two and six significant digits, respectively. Using the fewest significant digits (two) the 13 is kept. By dropping and rounding 0.524875, the correct result is 14.

Problem 7: 50 ÷ 3.0069 = 16.6284213 = 20

The first number, 50, has one significant digit. Therefore, the results will be expressed with the accuracy of one significant digit. The first digit to be truncated is the first 6. So, rounding the 1, the only significant digit becomes 2. The correct answer is then 20.

Problem 8: 9.4 ÷ 3.34 = 2.814371257 = 2.8

Two significant digits divided by three significant digits means the answer must be calculated to two significant digits. The first digit to be discarded is the 1. The 8 remains unchanged, and the answer is 2.8.

Problem 9: 9.4000 ÷ 0.02 = 470 = 500

The 0.02 in the problem contains the least number of significant digits, one. Remember that zeros used as place holders are not significant digits. Therefore, the 4 in the answer must be retained as the only significant digit. By dropping the 7 and rounding, the 4 becomes 5 and the answer is 500.

Problem 10: 0.052 ÷ = 0.0026 = 20 = 20

Here, both numbers in the problem are comprised of two significant digits. As it happens, the calculated number and the correct number are the same.

Problem 11: 0.00791 ÷ 0.52 = 0.015211538 = 0.015

Again, the least number of significant digits is two (0.52). Since the first digit to be discarded is a 2, the 5 remains unchanged and the answer is 0.015.

Problem 12: 0.0025 x 0.00025 = 0.000000625 = 0.00000063

Once again, the least number of significant digits is two. The answer yielded three significant digits, 625. The 5 is discarded, the 2 is rounded up to 3, and the answer is 0.00000063.

Reasonability

The rules for handling approximate numbers are used when there is no overriding rule or condition to be met. In all measurement work, deriving correct answers must be considered in context of the conditions that exist. For example, suppose you are provided numeric data to be processed. The results of your calculations are to be given to a technician who will adjust the airflow through a system. The calculation and raw results are as follows. What value should you give to the technician?

20.067 cfm x 12.9362 cfm ÷ 18.00782 cfm = 14.41544426 cfm

You probably arrived at the value 14.415 cfm, which is a correct value using the rules provided. However, if the gauge that the technician uses to adjust the airflow is calibrated in whole cubic feet per minute, what value should you provide? The numbers following the decimal are of no value so you should give the technician the value of 14 cfm. So now things are all set, or are they? With the piece of equipment being used, the manufacturer states that it is better to be on the high side rather than on the low side. So, since the mathematical results are actually more than 14 cfm, you had better give the technician a value of 15 cfm.

At this point you should see that even though 14.415 cfm is the correct mathematical result, the solution must be modified by reasonability to meet the environment and the operating conditions.

Rule to Meet the Conditions of Reasonability

This rule of common sense may be stated as follows: *Keep only those results that are reasonable (meaningful) in the context of the work being done and the equipment being used.*

Remember, generally you are not dealing with exact numbers, you are working with *approximate numbers*. With approximate numbers you must always be careful not to introduce undesirable errors into the final results. When multiple calculations are performed on approximate numbers, errors may become so large that the final results are of no value.

Practice Exercise

Answers are located in Appendix A.

1. Give the number of significant digits for each of the following:

   a. 3.7 = _____

   b. 2.06 = _____

   c. 17.41 = _____

   d. 0.114 = _____

   e. 0.00134 = _____

   f. 12000.0 = _____

   g. 12000 = _____

   h. 1200.001 = _____

2. Give the most accurate/precise number for the following calculations:

   a. 1.50 + 2.317 = _____

   b. 1.50 - 2.317 = _____

   c. 1500 x 3.94 = _____

   d. 1500 + 3.94 = _____

   e. 1.500 + 3.94 = _____

Intro Problem Answers (from page 2-2)

	Problem	Complete	Corrected
1.	3.5 + 2.075 =	5.575	5.6
2.	3.49 – 2.0075 =	1.4825	1.48
3.	2.0 × 307 =	614.0	610
4.	2.49 × 3.07 =	7.6443	7.64
5.	2.074 × 4.700 =	9.7478	9.748
6.	4.1 × 3.29875 =	13.524875	14
7.	50 ÷ 3.0069 =	16.6284213	20
8.	9.4 ÷ 3.34 =	2.814371257	2.8
9.	9.4000 ÷ 0.02 =	470	500
10.	0.052 ÷ 0.0026 =	20	20
11.	0.00791 ÷ 0.52 =	0.015211538	0.015
12.	0.0025 × 0.00025 =	0.000000625	0.00000063

The numbers given in the preceding chart represent the answers obtained when the correct rules for truncating and rounding are applied. If your answers agree with those provided, you may go to Lesson 3. Otherwise, continue with "Approximate Numbers" on page 2-2.

ATTACHMENT C

San Joaquin Valley
Unified Air Pollution Control District

GUIDELINES FOR THE USE OF SIGNIFICANT FIGURES IN ENGINEERING CALCULATIONS

Approved by: _____ Date:_____
Seyed Sadredin
District Manager of Permit Services

PURPOSE: The purpose of this procedure is to provide guidelines for the presentations of data in engineering calculations. The result of engineering calculations must contain an adequate number of significant digits to determine compliance with District rules. The level precision used in permit conditions must reflect good measurement practices. The use of an excessive number of digits beyond the decimal point in the results of calculations may misrepresent the precision of the data used in the calculations.

SCOPE: These guidelines apply to engineering calculations made in the Permit Services Division of the San Joaquin Valley Unified Air Pollution Control District.

GUIDELINES:

I. New Source Review and Emission Reduction Calculations.

The levels of precision required for emissions rate calculations and daily emissions limits, based on regulatory requirements, are given in the following table:

	Smallest Significant Units		
Pollutant	(lb/hr)	(lb/day)	(lb/qtr or season)
Oxides of Nitrogen	0.01	0.1	1
Reactive Organic Gases	0.01	0.1	1
PM10	0.01	0.1	1
Sulfur Oxides	0.01	0.1	1
Carbon Monoxide	0.01	0.1	1
Lead	0.01	0.1	1
Asbestos	0.001	0.01	1
Beryllium	0.00001	0.0001	0.01
Mercury	0.001	0.01	1
Vinyl Chloride	0.001	0.01	1
Fluorides	0.001	0.01	1
Sulfuric Acid Mist	0.001	0.01	1
Sulfur Compounds (other than oxides)	0.001	0.01	1

The calculated quantities are rounded off to the smallest significant units. The calculated quantity of 8.21 lb/day of Oxides of Nitrogen, for example, would be rounded off to 8.2 lb/day. The calculated quantity of 1,378.4 lb/qtr of PM10 would be rounded off to 1378 lb/qtr.

Rounding off is accomplished by dropping the digits that are not significant. The digits 0, 1, 2, 3, and 4 are dropped without altering the preceding digit. The preceding digit is increased by one when a 5, 6, 7, 8, or 9 is dropped. Increases in Permitted Emissions (IPE) of less than 0.5 lb/day, in accordance with policy issued previously, will be rounded off to 0 lb/day.

Daily emissions limits expressed as emissions factors should be used when hourly emissions rates are low. An emissions limit expressed in pounds per thousand gallons of fuel consumed, for example, may be used in conjunction with a limit for the hourly rate of fuel consumption

II. Emission Concentration Limits

The significant digits for specifying emissions concentrations should be consistent with the method of measurement. The levels consistent with some common methods, as determined from the method detection limit, are given in the following table:

	Smallest Significant Units	
Pollutant	(ppm)	(up/m3)
Oxides of Nitrogen	0.1	-
Reactive Organic Gases	0.1	-
Sulfur Oxides	0.1	-
Carbon Monoxide	1	-
Hydrogen chloride	0.1	-
Ammonia	0.1	-
Trace Metals	-	.01
PAH	-	0.001
PCB	-	0.001
Dioxins/Furans	-	0.00001
Volatile Aromatics	0.001	-
Phenols	0.001	-
Formaldehyde	0.001	-

The smallest significant unit for PM10 concentration limits is 0.0001 gr./dscf.

III. Material Usage and Process Rate Limits

The level of precision for material usage and process rate limitations must be consistent with good measurement practices.

IV. Design Calculations And Performance Standards for Pollution Control Equipment

Data used for design calculations may be obtained from source tests, engineering manuals, or manufacturer's guarantees. The use of significant figures for design calculations should be consistent with level of precision of the data used to make the calculations.

EXHIBIT 2

Air Quality Review and Comments:

Mission Rock Energy Center Project

Prepared by:

Lindsey Meyers

December 7, 2017

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Introduction

The Wishtoyo Chumash Foundation is a party to a California Energy Commission licensing proceeding for the Mission Rock Energy Center (Docket Number 15-AFC-02). I reviewed the Ventura County Air Pollution Control District Preliminary Determination of Compliance (PDOC) for the Mission Rock Energy Center Project at the request of Wishtoyo's counsel.

I hold an M.A. (2012) degree in Geography from California State University, Northridge, where I specialized in GIS and air dispersion modeling. My thesis, titled "Diesel Trucks: Health Risk and Environmental Equity," involved the use of USEPA's AERMOD model to determine concentrations of diesel particulate matter (DPM) around several Southern California freeways, focusing on pollution from port-related diesel truck traffic. I also performed a population analysis examining inequities related to race and income groups exposed to DPM.

I have broad experience as a consultant. I have performed numerous air quality modeling analyses using AERMOD and other air dispersion models, prepared meteorological data using AERMET, performed health risk assessments, and created many detailed maps and graphics. I have experience preparing analyses of various emission types from many sources and facilities including natural gas and coal-fired power plants, agricultural fields, and mobile sources.

I have discovered several concerning issues in the PDOC modeling methodology that may result in an underestimation of modeled concentrations of NO_2. I also suggest modeling cumulative impacts from other sources in close proximity to Mission Rock, which the PDOC fails to consider. In the following sections, I will describe in detail the issues I have observed with regard to the PDOC modeling.

I. The PDOC fails to justify the use of 8th highest ozone levels for NO_2 modeling.

Appendix G of the PDOC includes a description of a tiered approach to 1-hour NO_2 modeling. The 1-hour NO_2 modeling results for emissions during the commissioning period reflect a tier-3 approach. This approach to modeling provided by VCAPCD indicates the use of the ozone limiting method (OLM) and 8th highest hr-of-day background concentrations of ozone and NO_2 for its modeling runs.

VCAPCD should justify the use of 8th highest hr-of-day background concentrations of ozone when using OLM. EPA does not recommend using 8th highest hr-of-day background concentrations of ozone, which may underestimate impacts. Further, I have never seen anyone choose the 8th highest ozone value when conducting modeling to determine possible violation of 1-hour NO_2 standards.

II. The modeling presented in the PDOC does not include the use of appropriate meteorological data.

The modeling presented in Appendix G of the PDOC includes the use of surface meteorological data from Camarillo Airport with the Adjusted U* applied. Instead of using Adjusted U* in conjunction with airport surface meteorological data, USEPA states that turbulence measurements provide the best AERMOD model performance:

> "The best performing scenario is the use of full site-specific meteorology, with turbulence measurements, and without the ADJ_U* option applied (Figure 35 and Figure 36). This is consistent with EPA's position that modeling with a full meteorological dataset that includes turbulence measurements is preferred and results in the best performance."[1]

Site-specific meteorological data is readily available from the VCAPCD's meteorological data collection in support of their air monitoring system at Rio Mesa High School. Not only does Rio Mesa include turbulence measurements, but it is closer to the proposed Mission Rock facility than Camarillo Airport by about 3.5 kilometers. Also, with two mountain ranges existing between Camarillo Airport and Mission Rock, the data from Rio Mesa is also likely more representative of conditions at the proposed facility. Given these considerations, the most recent year of meteorological data from Rio Mesa should be used for all modeling scenarios presented in the PDOC.

III. The background concentrations used in the PDOC modeling analysis are not from appropriate monitoring stations.

The applicant's modeling analysis includes the use of background levels from Rio Mesa in Oxnard. As stated by USEPA:

> "AERMOD now includes directional-varying background options for both the primary pollutant (e.g., NO_2) and ozone in the Tier 3 methods. The general recommendation is that background data located downwind of the isolated source and near the receptor should be used for new sources and background data upwind of the isolated source should be used for non-nearby existing sources in order to minimize double-counting the impact of the existing source on the background data." [2]

According to data from the Rio Mesa monitoring station, winds in the area are most commonly from the southwest, which is also the geographic position of Rio Mesa in comparison to the

[1] USEPA, AERMOD Model Formulation and Evaluation, EPA-454/ R-17-001, May 2017, p. 166.
[2] USEPA, Memorandum: Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO_2 National Ambient Air Quality Standard, September 30, 2014.

proposed facility (see the wind rose in section IV – f). It would be more appropriate in this case to use background levels from Piru monitoring station, which is about 29 km northeast of the proposed Mission Rock Energy Center.

IV. The PDOC does not consider results of the PVMRM approach to NO_2 modeling.

The modeling results presented in Appendix G of the PDOC indicate 1-hour NO_2 levels during the commissioning period to be just 15 $\mu g/m^3$ under the NAAQS. These results were determined using tier 3 NO_2 modeling methods with OLM. As an exercise, I modeled the applicant's AERMOD input files using the PVMRM method that is also recommended as a tier 3 option. I used the same modeling methodology as the applicant with the exception of the PVMRM approach instead of OLM and 2014 Rio Mesa meteorological data that I had prepared for a previous project instead of the applicant's Camarillo Airport data with adjusted U*. The following sections outline my methods in preparing the meteorological data and the results of my modeling analysis.

a. Meteorological Data

I prepared 2014 site-specific meteorological data to be used in my air dispersion modeling analysis. This was the most recent year of data readily available.

I developed 2014 meteorological data that incorporates methods to reduce calm and missing hours (e.g. use one-minute data and USEPA's AERMINUTE program).[3] The meteorological data required by AERMOD is prepared by AERMET. Required data inputs to AERMET are: surface meteorological data, twice-daily soundings of upper air data, and the micrometeorological parameters surface roughness, albedo, and Bowen ratio. AERMET creates the model-ready surface and profile data files required by AERMOD.

This section discusses how I prepared meteorological data to be used in my modeling analysis. Using AERMET v. 16216, I created an AERMOD-ready meteorological data set to model the fields. This data set covers 2014, and is summarized as follows:

Meteorological data used for modeling the fields:

Site-specific surface data:	VCAPCD Rio Mesa High School
Supporting airport surface data:	Camarillo Airport ASOS (KCMA)
Regional upper air data:	Vandenberg Air Force Base (KVBG)

[3] USEPA, AERMINUTE User's Instructions, v. 15272, p. 1.

b. Site-specific Surface Data

I obtained and processed hourly meteorological data collected at Rio Mesa High School. These data, collected by the Ventura County Air Pollution Control District (VCAPCD), are the most representative data available for modeling the impacts of the proposed Mission Rock facility.

These data were provided to me by the VCAPCD, and include hourly wind speed, wind direction, air temperature, relative humidity, and the standard deviation of the horizontal wind direction fluctuations (sigma-theta). The wind data are collected at an anemometer height of 10 meters.

I processed these site-specific data using AERMET v. 16216, to provide the site-specific pathway data used for creating the AERMOD-ready surface and profile meteorological data sets.

c. Supporting Airport Surface Data

I used 2013 Integrated Surface Hourly (ISH) data obtained from the National Climatic Data Center (NCDC). From the ISH dataset, I extracted ASOS data from the Camarillo Airport. Based on distance and site characteristics, I determined that this airport is the most appropriate National Weather Service location for supplementing the site-specific Rio Mesa meteorological data set.

I also obtained 2013 one-minute ASOS wind data from the Camarillo Airport, which I processed with AERMINUTE v. 15272. I downloaded these one-minute data from the NCDC.[4] I input the ice-free wind instrument start date (January 25, 2007) and used default settings with AERMINUTE. As a quality assurance measure, I compared values developed from the one-minute data with the corresponding ISH data file.

The data from the KCMA ASOS site (ISHD) are used to supplement the site-specific data collected at Rio Mesa. The KCMA data are used to provide additional data necessary for AERMET to calculate certain AERMOD inputs, as well as for providing inputs in cases where wind measurements may be missing from the Rio Mesa data set.

I processed the ISH data through AERMET Stage 1, which performs data extraction and quality control checks. I merged the AERMINUTE output files with the processed AERMET Stage 1 ISH and site-specific data, and the upper air pathway data in AERMET stage 2.

[4] See: ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/

d. Upper Air Data

I used 2014 upper air data from twice-daily radiosonde measurements obtained from Vandenberg Air Force Base. These data are in Forecast Systems Laboratory (FSL) format which I downloaded in ASCII text format from NOAA's FSL website.[5] I downloaded and processed all reporting levels with AERMET.

Upper-air data are collected by a "weather balloon" that is released twice per day at selected locations. As the balloon is released, it rises through the atmosphere, and radios the data back to the surface. The measuring and transmitting device is known as either a radiosonde, or rawindsonde. Data collected and radioed back include: air pressure, height, temperature, dew point, wind speed, and wind direction. I processed the FSL upper air data through AERMET Stage 1, which performs data extraction and quality control checks.

e. AERSURFACE

AERSURFACE is USEPA's program for extracting surface roughness, albedo, and daytime Bowen ratio for an area surrounding a given location.[6] AERSURFACE uses land use and land cover (LULC) data in the U.S. Geological Survey's 1992 NLCD to extract the necessary micrometeorological data. I used these 1992 LULC data for processing meteorological data sets which then serve as input to AERMOD.

I used AERSURFACE v. 13016 to develop surface roughness, albedo, and daytime Bowen ratio values in a region surrounding the meteorological data collection site (Camarillo Airport). Using AERSURFACE, I extracted surface roughness in a one kilometer radius surrounding the data collection site. I also extracted Bowen ratio and albedo for a 10 kilometer by 10 kilometer area centered on the meteorological data collection site. I processed these micrometeorological data for seasonal periods using 30-degree sectors.

I developed variable Bowen ratios, based on precipitation for each season of 2014. I determined the seasonal moisture conditions (wet, average, dry) using 1981 through 2010 climatic mean monthly rainfall data for the Camarillo Airport.[7] For each season, I compared the seasonal total

[5] Available at: http://esrl.noaa.gov/raobs/

[6] Albedo is the fraction of total incident solar radiation reflected by the surface back to space (whiter surfaces have higher albedo). The Bowen ratio is an indicator of surface moisture. It is the ratio of sensible heat flux to latent heat flux and drier areas have a higher Bowen ratio. Surface roughness, shown in shorthand as ("z_0"), is an essential parameter in estimating turbulence and diffusion. Technically, it's the height above the ground that the log wind law extrapolates to zero. For our purposes, z_0 can be thought of as a measure of how much the surface characteristics interfere with the wind flow. Very smooth surfaces, like short grass or calm ponds, have very low values of z_0 -- on the order of 0.01 meter or less. Tall and irregular surfaces, which are a greater obstacle to wind flow, have higher values of z_0 – up to 1.0 meter or more for forests.

[7] See http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html

rainfall to climatic means for that season. Seasonal rainfall less than 75% of climatic means was assessed as dry. I assessed seasonal rainfall greater than 125% of climatic means as wet.[8]

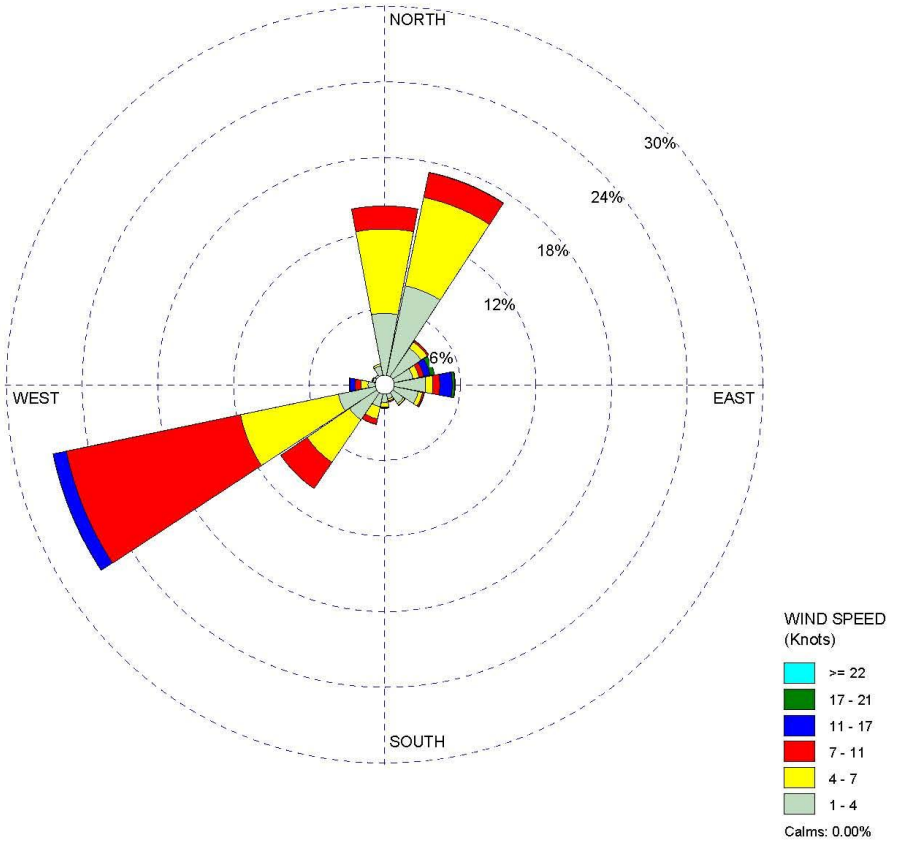
f. Data Review

I did not fill missing hours in the meteorological data sets as the data files easily exceed USEPA's 90% data completeness requirement.[9] The following figure is a wind rose of the AERMOD-ready meteorological data set I created for the 2014 Rio Mesa/Camarillo Airport/Vandenberg Air Force Base:

[8] USEPA, Non-Hg Case Study Chronic Inhalation Risk Assessment for the Utility MACT Appropriate and Necessary Analysis, March 16, 2011, p. 11.
[9] USEPA, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-05, February 2000, Section 5.3.2, pp. 5-4 – 5-5.

WIND ROSE PLOT:
Surface met: Camarillo Airport with Rio Mesa onsite data
Upper air: KVGB, Vandenburg Air Force Base

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Using 1-minute ASOS winds with AERMINUTE v. 15272	**Start Date: 1/1/2014 - 00:00** **End Date: 12/31/2014 - 23:00**	MODELER:	
	CALM WINDS: **0.00%**	TOTAL COUNT: **8760 hrs.**	
	AVG. WIND SPEED: **5.23 Knots**	DATE: **12/4/2017**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

g. PVMRM Modeling Results

My results indicate that using the PVMRM method, the proposed Mission Rock Energy Center would be in violation of the 1-hour NO_2 NAAQS with 206.4 $\mu g/m^3$, which is well above the 1-hour NO_2 NAAQS of 188 $\mu g/m^3$. These results are detailed in the following table:

Commissioning Period Tier 3 PVMRM NO_2 Concentrations

Averaging Time	NAAQS	Modeled Concentration ($\mu g/m^3$)	UTM X	UTM Y	Exceeds Standard?
1-hour 98th Percentile	188	206	307775	3798950	YES

Considering the other issues regarding the PDOC modeling methods, this is an indication that the proposed facility has the potential to be in violation of the 1-hour NO_2 NAAQS.

V. The PDOC modeling fails to address cumulative impacts from nearby sources.

The location of the proposed Mission Rock Energy Center is in a pocket of industrial facilities. Some such facilities, including Granite Construction Co. and Western Oil Spreading Services Inc, are within a half mile of Mission Rock. These facilities are likely contributing to ambient levels of criteria pollutants in the area. The closest background levels for the modeling analysis presented in the PDOC were measured at Rio Mesa, which is more than 4 miles away from Mission Rock and in a location that is not representative of where plumes from the existing facilities are likely to travel. Considering this, cumulative impacts of the multiple facilities within close proximity need to be modeled.

Conclusion

The modeling analysis presented in the PDOC has several concerning issues. These include the failure to justify the use of 8th highest ozone values and using OLM versus PVMRM when modeling 1-hour NO_2 with tier-3 methods, as well as the failure to address cumulative impacts from sources in very close proximity to the proposed facility. In addition, the use of Rio Mesa for monitored background levels and Camarillo Airport for surface meteorological data are not the best options available. Due to these errors, the modeling presented in the PDOC may underestimate NO_2 impacts and fail to identify NAAQS violations of the proposed Mission Rock Energy Center.