# ATTACHMENT A

# Comments

# on the

# Draft Environmental Impact Report (DEIR)

# for the

# Valero Benicia Crude by Rail Project

Benicia, California

September 15, 2014

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I have reviewed the Draft Environmental Impact Report (DEIR)[1] for the Valero Benicia Crude by Rail Project (CBR Project) prepared for the City of Benicia (City) by ESA, as well as records referenced in the DEIR and files obtained from the Bay Area Air Quality Management District (BAAQMD).

The CBR Project will install facilities to allow the Valero Benicia Refinery (Refinery) to receive up to 70,000 barrels per day (bbl/day) of North American crude oils by rail. The facilities that would be installed include about 8,880 feet of new track; a new tank car unloading rack capable of unloading two parallel rows of tank cars simultaneously; and 4,000 feet of 16-inch diameter crude oil pipeline and associated fugitive components (valves, flanges, pumps) connecting the offloading rack and an existing crude supply pipeline. DEIR, pp. ES-1 to ES-4.

Based on my review, I conclude this DEIR is fundamentally defective in that it omits crucial information to understanding the Project's significant impacts. Specifically, the DEIR does not disclose the Project's crude slate, relies on flawed analyses in addressing whether the Project would enable refining of substantial quantities of tar sands and Bakken crudes, relies on unsupported assumptions as to the Project's light crude composition, and underestimates the Project's operational emissions of reactive organic gases ("ROG") and toxic air contaminants ("TAC"). When these underestimates are corrected, the CBR Project results in significant air quality and public health impacts. The City must correct these defects and recirculate the DEIR, so that the public and decision-makers can be fully informed of the Project's air quality and public health and safety impacts.

My resume is included in Exhibit 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; air quality management; water quality and water supply investigations; hazardous waste investigations; hazard investigations; risk of upset modeling; environmental permitting; nuisance investigations (odor, noise); environmental impact reports, 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 with minors in Hydrology and Mathematics. I am a licensed professional engineer (chemical, environmental) in five states, including California; a Board Certified Environmental Engineer, certified in Air Pollution Control by the American Academy of Environmental Engineers; and a Qualified Environmental Professional, certified by the Institute of Professional Environmental Practice.

[1] ESA, Valero Benicia Crude by Rail Project, Draft Environmental Impact Report, SCH # 2013052074, Use Permit Application 12PLN-00063, June 2014.

I have prepared comments, responses to comments and sections of EIRs for both proponents and opponents of projects on air quality, water supply, water quality, hazardous waste, public health, risk assessment, worker health and safety, odor, risk of upset, noise, land use and other areas for well over 100 CEQA documents. This work includes Environmental Impact Reports (EIRs), Negative Declarations (NDs), and Mitigated Negative Declarations (MNDs) for all California refineries; crude oil and rail terminals in California, Louisiana, Oregon, New York, Texas, and Washington; and various other permitting actions for tar sands and light shale crude refinery upgrades in Indiana, Louisiana, Michigan, Ohio, South Dakota, Utah, and Texas and liquefied natural gas (LNG) facilities in Texas, Louisiana, and New York.

My work has been cited in two published CEQA opinions: (1) *Berkeley Keep Jets Over the Bay Committee, City of San Leandro, and City of Alameda et al. v. Board of Port Commissioners* (2001) 111 Cal.Rptr.2d 598 and *Communities for a Better Environment v. South Coast Air Quality Management Dist.* (2010) 48 Cal.4th 310.

I commented on the Initial Study/Mitigated Negative Declaration (IS/MND) (attached to the DEIR as Appx. A[2]) that the CBR Project would allow a change in crude oil slate quality, to heavier higher sulfur crudes and/or to lighter sweeter crudes, which would result in emission increases that were not considered in the CEQA review. Fox IS/MND Comments[3], pp. 2-35. The DEIR does not correct the defects that I identified in my IS/MND comments. Rather, it advances an argument that the rail-imported crudes will be blended with other crudes to meet the same sulfur and weight specifications as in the baseline Refinery. Thus, the DEIR asserts that crude slate quality and emissions from refining it would not change. This is incorrect. This does not address my comments on the IS/MND. Therefore, I reassert my IS/MND comments and incorporate them here by reference. The following sections present my evaluation of the DEIR's response to my previous crude slate switch comments, point by point. The DEIR's response to my comments is included in Appendices C.1 and C.2, based on a report contained in Appendix K. The following comments on Appendices C.1 and C.2 apply equally to the underlying analyses in Appendix K.

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[2] ESA, Valero Crude by Rail Project, Initial Study/Mitigated Negative Declaration, Use Permit Application 12PLN-00063, Prepared for City of Benicia, May 2013.

[3] Phyllis Fox, Comments on Initial Study/Mitigated Negative Declaration for the Valero Crude by Rail Project, Benicia, California, Use Permit Application 12PLN-00063, July 1, 2013; http://www.ci.benicia.ca.us/vertical/sites/%7B3436CBED-6A58-4FEF-BFDF-5F9331215932%7D/uploads/Report_by_Dr._Phyllis_Fox.pdf.

## I. THE DEIR FAILS TO ANALYZE THE AIR QUALITY IMPACTS FROM REFINING DIFFERENT TYPES OF CRUDE

### A. Heavy Sour Crudes

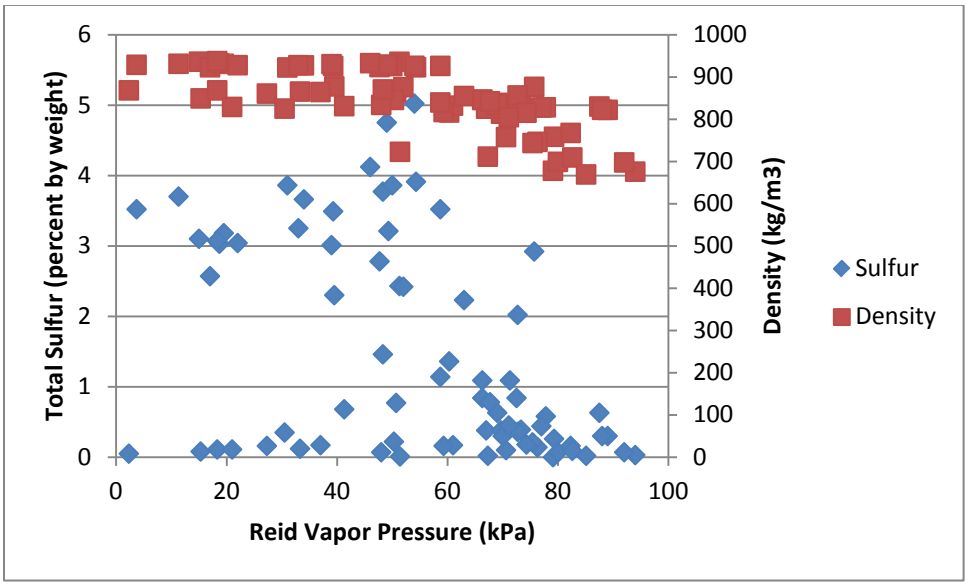
The CBR Project DEIR responds to the heavy sour crude slate issues that I raised in Appendix C.1. The thrust of the CBR Project DEIR's response is based on the "weight" (API gravity)[4] and sulfur content of the crude, which it argues would not change due to the Project, but rather would remain within a narrow range. Therefore, the CBR Project DEIR argues, emissions would not increase. The CBR Project DEIR argues: "Thus, to the extent that the Project would cause an increase in emissions based on an increase in the weight and sulfur content of crude feedstocks – any such emissions increase would be within the baseline environmental conditions." DEIR, Appx. C.1, p. C.1-3.

*First*, this misses the point, as explained in my previous comments at Section II.D, pp. 19-31. There are important differences between crudes that are not related to the weight and sulfur content of the crude that result in adverse impacts. Even if the weight and sulfur content of a particular crude blend fall within the range specified in the DEIR, or don't change at all, other components in the crude, such as TACs like benzene, or highly malodorous compounds such as mercaptans, may be present at much higher concentrations than in the crudes they replace with identical sulfur and API gravity.

Further, other characteristics of the crude, such as its vapor pressure or flammability, may differ in significant ways from the crudes they would replace. These other constituents and properties are not a function of the API gravity or the sulfur content and are present independent of them. The DEIR's consultant, Dr. McGovern, demonstrated there is no relationship between vapor pressure (expressed as RVP) and crude gravity (expressed as API). DEIR, Appx. K, p. K-18. This is further substantiated by analysis of data published by Enbridge, summarized here in Figure 1. The Enbridge data covering 76 different types of crude oil show that crude oil attributes of sulfur content and density are completely independent of vapor pressure.

[4] Note that throughout the DEIR, the term "weight" is used to indicate API gravity or density, where "density" is technically what is meant. We will use the same terminology in this report; "weight" indicates density.

**Figure 1: Reid Vapor Pressure Compared to Total Sulfur and Density for 76 different types of Crude Oil**




Source: Enbridge Pipelines Inc., 2013 Crude Characteristics, http://www.enbridge.com/~/media/www/Site%20Documents/Delivering%20Energy/2013%20Crude%20Characteristics.pdf

The vapor pressure of crude determines to a large extent the amount of ROG and TAC emissions that are emitted when it is transported, stored, and refined. Thus, a crude slate may have identical sulfur content and weight, but would result in dramatically different ROG and TAC emissions. Similarly, the nature of the chemical bonds in crude determines the amount of energy and hydrogen that must be supplied to refine it. Thus, a crude slate may have identical sulfur and weight, but a different mix of chemicals that would affect the amount of energy and hydrogen required to convert it into refined products.

These differences—in both chemical and physical characteristics other than API gravity and sulfur content— fluctuate independent of sulfur content and API gravity and will result in significant impacts that have not been considered in the DEIR. These impacts include, for example, significant increases in ROG emissions, contributing to existing violations of ozone ambient air quality standards; significant increases in TAC emissions, resulting in significant health impacts; significant increases in malodorous sulfur compounds, resulting in significant odor impacts; significant increases in combustion emissions, contributing to existing violations of ambient air quality standards; and significant increases in flammability and thus the potential for more dangerous accidents involving train derailments or spills on-site. The DEIR fails to consider these significant impacts by raising irrelevant issues.

*Second*, the rationale that sulfur levels and density of the crude slate would stay within a narrow range ignores the possibility of gradual creep within that range that would still be

significant. This recently occurred at the nearby Chevron Richmond Refinery. This refinery gradually changed crude slates, while staying within its established crude unit design basis for total weight percent sulfur of the blended feed to the crude unit.[5] This change increased corrosion rates in the 4-sidecut line, which led to a catastrophic pipe failure in the #4 Crude Unit on August 6, 2012. This accident sent 15,000 people from the surrounding area for medical treatment due to the release and resulting fire that created huge black clouds of pollution over the surrounding community. Fox IS/MND Comments, pp. 25–26.

These types of accidents can be reasonably expected to result from incorporating tar sands crudes into the Benicia crude slate, even if the range of sulfur and gravity of the crudes remain the same, unless significant upgrades in metallurgy occur, as these crudes have a significant concentration of sulfur in the heavy components of the crude coupled with high total acid number (TAN) and high solids, which aggravate corrosion. The gas oil and vacuum resid piping, for example, may not be able to withstand naphthenic acid or sulfidation corrosion from tar sands crudes, leading to catastrophic releases.[6] Fox IS/MND Comments, pp. 35-36.

Catastrophic releases of air pollution from these types of accidents were not considered in the DEIR. Rather, the DEIR relies on the Refinery's existing Process Safety Management program, including the Management of Change (MOC) and Mechanical Integrity (MI) programs, to prevent corrosion. DEIR, p. 3-16. However, these programs were also in place at Chevron at the time of the August 2012 accident discussed above, and they did not prevent a catastrophic accident caused by sulfur creep. The recent Chevron FEIR incorporated many additional mitigation measures to improve these programs,[7] which should be required for the Valero Rail Project.

*Third*, the unloading rack, storage tanks and associated fugitive components are major sources of the ROG and TAC emissions. These unload, transport, and store crude oil as delivered, before it is blended. Therefore, the argument that the rail-imported crude is blended before it is refined is irrelevant.

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[5] US Chemical Safety and Hazard Investigation Board, Chevron Richmond Refinery Pipe Rupture and Fire, August 6, 2012, p.34 ("While Chevron stayed under its established crude unit design basis for total wt. % sulfur of the blended feed to the crude unit, the sulfur composition significantly increased over time. This increase in sulfur composition likely increased corrosion rates in the 4-sidecut line.").

[6] See, for example, K. Turini, J. Turner, A. Chu, and S. Vaidyanathan, Processing Heavy Crudes in Existing Refineries. In: Proceedings of the AIChe Spring Meeting, Chicago, IL, American Institute of Chemical Engineers, New York, NY, Available at: http://www.aiche-fpd.org/listing/112.pdf.

[7] See, for example, Chevron Refinery Modernization Project, Revisions to Draft EIR Volumes 1& 2, p. 4-40, Mitigation Measure 4.13-7h, Available at: http://chevronmodernization.com/project-documents/.

1. The CBR Project DEIR Must Evaluate the Potential Impacts of the Full Range of Crude Oil Types That Could Be Imported

The CBR Project DEIR asserts: "There is no reason to believe that…Valero would be more likely to purchase heavy Canadian crudes than any number of other North American crudes that are lighter and/or sweeter…" DEIR, Appx. C.1, p. C.1-1. The CBR Project DEIR presents a table that lists 38 "available North American crudes" that could potentially be imported by the proposed rail facilities. DEIR, Table 3-1. Of these 38 crudes, 87% or 33 of them, are Canadian tar sands crudes and of the tar sands, 15 are "heavy sour" and 5 are "medium sour." Canadian tar sands crudes are chemically distinct from the current crude slate and thus will result in significant impacts that were not analyzed in the CBR Project DEIR. Fox IS/MND Comments, pp. 25-28. DEIR Table 3-1 is prima facie evidence that tar sands crudes are likely to be in the mix of crudes that will be imported by the CBR Project.

Regardless of which of these 38 crudes is selected, the DEIR must analyze the full range of resulting impacts, from all of the 38, as the DEIR suggests all or any of them may be refined. Impacts would vary greatly between tar sands crudes on the heavy high sulfur end and by Bakken crudes on the light sweet end, each end of this range with unique and significant impacts. The DEIR does not include impacts from either of these, but rather only an unidentified default crude that is not representative of any of the 38. See Comment III.

2. Blended Weight and Sulfur Content Do Not Determine ROG and TAC Emissions

The CBR Project DEIR argues that "even if Valero were to purchase large amounts of heavy sour Canadian crudes as a result of the Project, this would not cause an increase in refinery emissions because Valero must blend crude feedstocks to a narrow range of weight and sulfur content before processing them." DEIR, pp. 3-14, 3-24, 4.1-17, C.1-1/2. This is insufficient information to analyze impacts, as noted above, because the weight (API gravity) and sulfur content are not the only characteristics of crude oil that determine environmental impacts. Other important factors include volatility, flammability, metal content, ROG speciation profile, the specific suit of heavy organic compounds in the crude, and the TAC and sulfur speciation profile (i.e., the concentration of individual TAC and sulfur compounds present in the crude).

Elevated levels of benzene or hydrogen sulfide, for example, cannot be blended out because they are emitted from tanks and fugitive components before the crudes reach the mixing tanks. The majority of the toxic TACs and malodorous chemicals are emitted before blending occurs, during unloading and from fugitive components along the pipeline and at the storage tanks. Blending by itself does not eliminate them.

Similarly, elevated metals that end up in coke fugitive particulate emissions cannot be blended out. No matter how much blending is done with relatively less contaminated crudes, a significant amount of heavy metals from lower quality rail-imported crude would still remain, mostly partitioning to the coke. Blending also does not remove but only dilutes elevated concentrations of high molecular weight organic compounds such asphaltenes and resins that require high energy input to break down into marketable products. Fox IS/MND Comments, pp. 4-10. These characteristics may vary in significant ways among crudes with the same range of API gravity and sulfur, resulting in significant environmental impacts. Fox IS/MND Comments, pp. 29-30.

3. Crude Slate Impacts Are Not Part of the Baseline

The CBR Project DEIR indicates that Valero made significant modifications to the Refinery between 2004 and 2010. These modifications are collectively known as the "Valero Improvement Project" or VIP. The City certified the VIP project EIR and approved the VIP project in April 2003. It later certified the VIP EIR addendum in July 2008. DEIR, p. 3-12.

The CBR Project DEIR argues that crude slate impacts are part of the VIP baseline, "[e]ven if refinery emissions were to increase based on Valero's purchase of heavy sour Canadian crudes, any such emissions increases would properly be considered part of the baseline because the baseline includes the full scope of operation allowed under existing permits that were issued based upon prior CEQA review." DEIR, p. C.1-1. The DEIR cites several CEQA cases regarding subsequent environmental review for modifications to existing projects.

Setting aside legal considerations, this argument has no technical merits for three reasons. First, the scope of operations previously approved did not include any impacts from a crude slate change and did not contemplate the crudes listed in DEIR Table 3-1. Second, the CBR Project Project is not a modification of the previously permitted VIP, which underwent CEQA review. Third, even assuming the VIP EIR evaluated a crude slate change and the CBR Project is just a modification of the VIP, both of which are false, the regulatory framework has changed, requiring additional CEQA review.

*a. The Scope of the VIP Project Did Not Include Impacts from Crude Slate Change*

Even if the CBR Project were simply a modification of the VIP Project, the VIP EIR did not evaluate impacts from a crude slate change. The existence of permits, absent CEQA review of the proposed change, is not determinative.

The VIP CEQA documents do not discuss cost-advantaged North American crudes, such as those in CBR Project DEIR Table 3-1. None of these crudes is evaluated, or even identified,

in the VIP EIR. Thus, the impacts of refining these crudes were in no way considered or incorporated. Therefore, the CBR Project DEIR cannot rely on the VIP CEQA review to address the impacts of refining any of them. Rather, the VIP EIR proposed to import heavy sour crudes by ship. The crudes available by ship in 2002 are chemically and physically different from the crudes available by rail in 2014, over a decade later. The oil markets have changed dramatically due to the advent of fracking and the development of tar sands, all of which occurred long after the VIP EIR analyses were performed.

There are many cost-advantaged, heavy high sulfur crudes that likely were the target of the VIP analyses prepared in 2002, such as heavy sour crudes from Ecuador, Venezuela, Colombia and Iraq, which were refined at the post-VIP Refinery. Fox IS/MND Comments, Figure 1. These heavy sour crudes are distinguishable from the crudes that are currently the target of the CBR Project, which are tar sands crudes and light sweet crudes with distinct physical and chemical characteristics. DEIR, p. C.2-1. The crudes that are currently the target of the CBR Project (DEIR, Table 3-1) were not available in the marketplace in 2002 when the VIP CEQA analysis was performed and thus were not considered in prior CEQA analyses. The differences between the crudes considered in the VIP EIR and those that would be imported by the CBR Project are discussed in my July 2013 comments on the IS/MND.

There is no evidence that the VIP was designed to refine, and that the VIP CEQA review addressed, the unique impacts of refining any of the cost-advantaged North American crudes listed in DEIR Table 3-1. Further, the lynchpin of the VIP EIR, a new, bigger hydrogen plant to allow refining of more heavy sour crude, may not be built as Valero has enough hydrogen to meet its current needs. DEIR, p. 3-12. This could be due to the availability of hydrogen from another source or a change in crude slate to lighter crudes that do not require more hydrogen to refine.

Bakken and Bakken blends with tar sands crudes, for example, would fall into this class. Further, the rail emissions assume a line haul one-way distance of 1,500 miles (DEIR, p. 4.1-22 and Appx. E.5, pdf 1197), which is consistent with Bakken crudes. There is no evidence in the record that impacts from refining this lighter, sweeter crude were considered in the VIP EIR. These impacts are discussed below in Comment I.B.

*b. The CBR Project Is a New Project*

The City did not treat the CBR Project as a modification of a previously permitted project in the IS/MND, but rather as a new project. Furthermore, even the DEIR refers to the VIP as a "previous" project. DEIR at 1-4. The characterization of the CBR Project as a modification of the VIP Project in the DEIR for baseline purposes improperly characterizes the projects and causes the CBR Project DEIR to underestimate or ignore real environmental impacts.

*c. The Regulatory Framework Has Changed, Requiring Additional CEQA Review*

Even if one hypothetically assumed that the VIP EIR evaluated the crude slate switch facilitated by the CBR Project, the regulatory and informational framework within which the CBR Project would be developed has changed dramatically, rendering the 2002 analysis obsolete. The City certified the VIP project EIR and approved the VIP project in April 2003. It later certified a VIP EIR addendum in July 2008. DEIR, p. 3-12. The Addendum incorporated a flue gas change related to the Main Stack Scrubber and added an analysis of greenhouse gas emissions. These changes do not affect any of the issues discussed here.[8]

When the VIP CEQA analysis was performed, none of the cost-advantaged crudes listed in Table 3-1 were in the marketplace. In response to ESA questions, for example, Valero responded that the CBR Project "was implemented to take advantage of land-locked North American crudes that have **recently** become available." Valero 2013,[9] p. 1 (emphasis added). As discussed earlier, these crudes are notably different from the current crude slate, in ways that are much broader than just sulfur content and weight. Thus, none of the impacts of refining these physically and chemically distinct crudes could have been anticipated and evaluated in 2002 when the VIP CEQA analysis was performed. Further, as explained in my comments on the IS/MND, the regulatory framework has significantly changed, requiring additional CEQA review even if the Project were a modification of a project that had previously undergone CEQA review. Fox IS/MND Comments, pp. 33-34.

Since the VIP FEIR was certified in 2003, new scientific evidence about the potential adverse impacts of air pollutants has become available, and in response, new guidance has been published and several federal and state ambient air quality standards have been revised. These include:

- The 8-hour state ozone standard was approved by the California Air Resources Board (CARB) on April 28, 2005 and became effective on May 17, 2006;
- The U.S. Environmental Protection Agency (EPA) lowered the 24-hour PM2.5 (particulate matter equal to or smaller than 2.5 micrometers) standard from 65 $\mu g/m^3$ to 35 $\mu g/m^3$ in 2006. EPA designated the Bay Area as nonattainment of this PM2.5 standard on October 8, 2009;
- On June 2, 2010, the EPA established a new 1-hour $SO_2$ (sulfur dioxide) standard, effective August 23, 2010;

[8] Valero Improvement Project, Addendum to VIP EIR, June 2008, Available at: http://www.ci.benicia.ca.us/vertical/sites/%7B3436CBED-6A58-4FEF-BFDF-5F9331215932%7D/uploads/%7B5A35F17D-5E23-404C-8032-6597BE84B5F9%7D.PDF.

[9] Valero Responses to: Valero Crude by Rail Project Data Request Number 2, April 2, 2013.

- The EPA promulgated a new 1-hour $NO_2$ (nitrogen dioxide) standard of 0.1 ppm, effective January 22, 2010;
- The EPA issued the greenhouse gas tailoring rule in May 2010, which requires controls of GHG emissions not contemplated in the VIP FEIR or the 2008 Addendum;
- The CARB has identified lead and vinyl chloride as "toxic air contaminants" with no threshold level of exposure below which there are no adverse health effects determined;
- The EPA issued a final rule for a national lead standard, rolling 3-month average, on October 15, 2008. The Project would increase lead emissions. Fox IS/MND Comments, p. 1, 20;
- Various BAAQMD regulations, including Regulation 2-2 (adopted December 19, 2012); and
- BAAQMD is currently developing a regional refinery regulation that could require additional emission controls.

**B. Light Sweet Crudes**

Light sweet crudes such as Bakken could be imported by rail and could result in an increase in ROG and TAC emissions from storage tanks, pumps, compressors, valves, and connectors that were not considered in the IS/MND. Fox IS/MND Comments, pp. 11, 25-28. The CBR Project DEIR concedes that "[o]nce the Project is constructed and operational, Valero may well purchase large amounts of light sweet North American crudes. In fact, this is Valero's stated plan." DEIR, p. C.2-1. Elsewhere, the DEIR notes that "[o]nce the Project is complete, Valero plans to obtain North American crudes that are, on average, lighter and sweeter than Valero's current feedstocks. According to Valero, the North American crudes will be 'Alaskan North Slope (ANS) look-alikes or sweeter' (Valero, 2013)." DEIR, p. 3-24. The closest and most cost advantaged of light sweet North American crudes listed in Table 3-1 that could be blended to be an ANS look-alike is Bakken crude.

An ANS look-alike crude, for example, could be created by blending 55% Bakken and 45% Western Canadian Select at a cost potentially far less than the ANS market price. The resulting mix has the same API gravity and slightly higher sulfur than ANS, and virtually identical distillation yields.[10] Both of these crudes are listed as available North American crudes in the DEIR. DEIR, Table 3-1. See also DEIR, pp. K-16/17. Alternatively, some of the lighter crudes, such as Bakken, could be fed directly to refining units, such as the fluid catalytic cracking unit (FCCU), eliminating the need for blending. Thus, the DEIR must evaluate the

[10] John R. Auers and John Mayes, North American Production Boom Pushes Crude Blending, Oil & Gas Journal, May 6, 2013, Available at: http://www.ogj.com/articles/print/volume-111/issue-5/processing/north-american-production-boom-pushes.html.

impacts of importing by rail and processing both Bakken and tar sands crudes, which span the range of likely impacts.

1. Bakken Crudes Have Properties That Will Result in Significant Impacts Not Evaluated in the DEIR

The DEIR makes the same arguments as to weight and sulfur content as previously made with respect to heavy sour crudes. The DEIR asserts that refining 70,000 bbl/day of light sweet crude would not cause an increase in ROG emissions because: "(a) Valero must blend crude feedstocks to a narrow range of weight and sulfur content before processing them, and (b) therefore, the average weight and sulfur content of crudes delivered to the Refinery will remain the same. In other words, any deliveries of light North American crudes by rail would simply replace the delivery of other light crudes by ship." DEIR, p. C.2-1. This is wrong for two principal reasons.

*First*, this is wrong because most of the ROG and TACs are emitted before the crudes are blended, from the rail cars, unloading, pipeline fugitive components (valves, pumps, connectors), and crude storage tanks. According to the Project description, two unit trains, each potentially carrying Bakken crude oil, would be unloading within a 24-hour period. DEIR, p. 3-22. This would result in an increase in daily ROG and TAC emissions, regardless of blending downstream to meet ANS-lookalike quality.

*Second*, this is wrong because all light sweet crudes are not created equal. The average weight (API gravity) and amount of sulfur in light sweet crudes do not determine the amount of ROG and TACs that will be emitted from Refinery tanks, pumps, compressors, valves, and connectors. The DEIR is correct when it asserts that "there is no relationship between the weight of a particular crude oil and the amount of fugitive emissions released from equipment containing that crude oil." DEIR, p. C.2-1. See also Figure 1.

The amount of ROG and TAC emissions is determined by the "volatility" of the crude and the concentration of TACs within the crude, not by its weight or sulfur content. The volatility can vary widely for "light sweet crudes," independent of weight and sulfur content. Processing in the oil fields, in particular, significantly affects volatility of shipped crudes, as discussed below. Bakken crudes, which are likely to be imported by the CBR Project, have uniquely elevated volatility, which has led to many spectacular accidents, such as those that occurred at Lac-Mégantic[11]; Casselton, North Dakota[12]; Alabama[13]; and more recently, Lynchburg, Virginia.[14]

[11] NTSB, Safety Recommendation In reply refer to: R-14-4 through -6; January 21, 2014. Available at: http://www.ntsb.gov/doclib/recletters/2014/R-14-004-006.pdf.

Volatility is measured in pounds per square inch (psi) and is typically reported as Reid Vapor Pressure (RVP).[15] Vapor pressure is an indirect measure of the evaporation rate of volatile compounds in the crude oil, with higher vapor pressures indicating greater losses from evaporation. The DEIR neglected to disclose the well-known relationship between the vapor pressure of a crude and the amount of emissions released from equipment containing the crude,[16] which is incorporated into the EPA TANK 4.0.9d model, universally used to estimate ROG and TAC emissions from tanks, including in the DEIR for this Project.

The CBR Project would facilitate the import of Bakken crudes, which have uniquely elevated vapor pressures compared to the light sweet crudes they would replace. As discussed elsewhere in these comments, most of the imported crude that would be replaced is Alaska North Slope (ANS) crude (API gravity = 31.6$^{o}$, S = 0.96%) and similar or heavier foreign imports. The ANS crude has a Reid Vapor Pressure (RVP) of 6.3 psi.[17] Most foreign imports have an even lower RVP. In comparison, Bakken crudes (API gravity = 38-40$^{o}$, S = 0.2%), the most likely replacement, have a RVP of up to 15.5 psi.[18] Thus, replacing ANS and foreign imports with Bakken would increase ROG and TAC emissions from tanks and fugitive sources by up to a factor of 2.5. The TAC emissions would increase even more as the concentration of TACs in the Table 3-1 crudes are much higher than in the current crude slate.

The volatility and TAC speciation information required to evaluate this crude switch, from ANS, to an ANS-look alike based on a Bakken blend, is completely absent from the DEIR. Vapor pressure and crude TAC speciation information are not confidential and are routinely

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[12] NTSB, Preliminary Report; DCA14MR004, 2014. Available at: https://www.ntsb.gov/doclib/reports/2014/Casselton_ND_Preliminary.pdf.

[13] Karlamangla, Soumya, "Train in Alabama oil spill was carrying 2.7 million gallons of crude." Los Angeles Times, http://articles.latimes.com/2013/nov/09/nation/la-na-nn-train-crash-alabama-oil-20131109, November 9, 2013.

[14] Los Angeles Times, May 1 2014, http://www.latimes.com/nation/nationnow/la-na-nn-ntsb-investigation-fiery-crude-oil-train-derailment-virginia-20140501-story.html.

[15] Measured by American Society for Testing and Materials Method ASTM D323-08, Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method) is used to determine the vapor pressure at 100 F with initial boiling point above 32 F.

[16] See AP-42, Section 7.1: Organic Liquid Storage Tanks.

[17] ExxonMobil Refining and Supply Company, ANS11U, Available at: http://www.exxonmobil.com/crudeoil/about_crudes_ans.aspx and http://www.exxonmobil.com/crudeoil/download/ans11u.pdf.

[18] Classification and Hazard Communication Provisions for Crude Oil – Bakken Crude Oil Data, June 13, 2014, Available at: http://www.unece.org/fileadmin/DAM/trans/doc/2014/dgac10c3/UN-SCETDG-45-INF26e.pdf; Dangerous Goods Transport Consulting, Inc., A Survey of Bakken Crude Oil Characteristics Assembled for the U.S. Department of Transportation, Submitted by American Fuel & Petrochemical Manufacturers, May 14, 2014, pp. 5, 19, Available for download from: https://www.afpm.org;

North Dakota Petroleum Council, Bakken Crude Quality Assurance Study, Available at: http://www.ndoil.org/image/cache/Summary_2.pdf;

included in public documents to support tank and fugitive emission calculations. Further, crude assay data is widely reported.[19] See, for example, the Tesoro Vancouver Application.[20]

The DEIR offers irrelevant information to support its theory, arguing that "the amount of fugitive emissions from a piece of equipment is a function of the mechanical integrity of the equipment and the pressure applied to its contents. The weight of the crude oil is not a factor." DEIR, p. C.2-2. While this is partially correct, in that the design of the equipment and the pressure exerted by the contained crude oil on this design are important factors that determine the amount of emissions during routine operations, it fails to acknowledge other key factors such as RVP and TAC concentrations in the crude discussed above. The DEIR must evaluate the foreseeable scenarios of both light sweet crude, including Bakken, and heavy sour crude, including tar sands.

The foreseeable switch from ANS and other current components of Valero's crude slate to a Bakken crude or a Bakken-tar sands mix, included in DEIR Table 3-1, is a feedstock change that should have been explicitly identified and evaluated in the DEIR. These new crudes are chemically and physically different from the current crude slate and the crude slate evaluated in the VIP EIR in ways that are not captured by exclusive consideration of crude slate sulfur content and API gravity. These differences will result in significant impacts not evaluated or disclosed in the CBR Project DEIR.

Bakken crudes have unique chemical and physical characteristics that distinguish them from currently refined crudes and which would result in significant environmental impacts not identified in the DEIR, including significant risk of upset, air quality, odor, and public health impacts. These unique characteristics include high volatility, flammability,[21] and elevated concentrations of TACs and ROG.

The amount of TACs and ROG released from storage tanks and fugitive components depends upon the vapor pressure of the crude oil. Bakken crude oils are the most volatile of the

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[19] Jeff Thompson, Public Crude Assay Websites, February 24, 2011. http://www.coqa-inc.org/docs/default-source/meeting-presentations/20110224_Thompson_Jeff.pdf.

[20] Tesoro Savage, Application for Site Certification Agreement (Vancouver Application), vol. 1, August 29, 2013, Available at: http://www.efsec.wa.gov/Tesoro%20Savage/Application/EFSEC%202013-01%20Volume%20I/EFSEC%202013-01%20-%20Compiled%20PDF%20Volume%20I.pdf and vol. 2, Available at: http://www.efsec.wa.gov/Tesoro%20Savage/Application/EFSEC%202013-01%20Volume%20II%20-%20Appendices/EFSEC%202013-01%20Compiled%20Volume%20II.pdf.

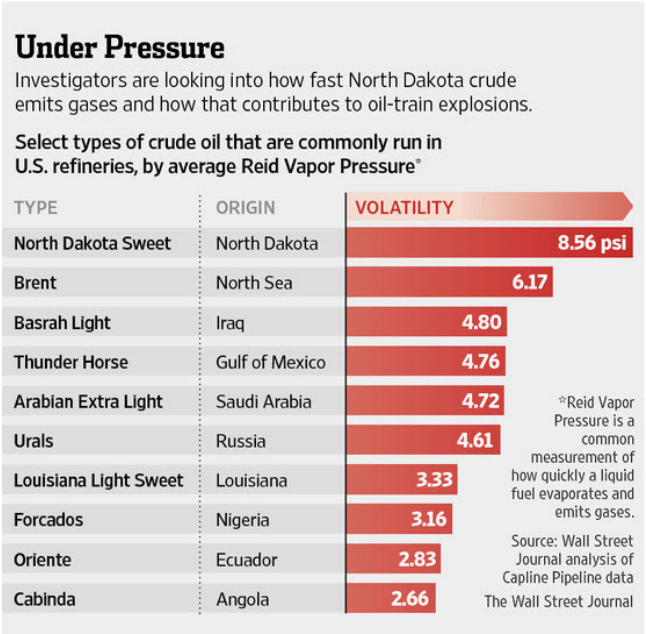
[21] Flammable crude oils will ignite when they are mixed with air in certain concentration ranges. The lowest temperature at which they produce sufficient vapor to support combustion is called the "flash point".

crudes listed in DEIR Table 3-1. Crude oil data collected by Capline Pipeline, which tested crudes from 86 locations world-wide for vapor pressure, found the following:[22]

> "[l]ight, sweet oil from the Bakken Shale had a far higher vapor pressure – making it much more likely to throw off combustible gases – than crude from dozens of other locations… According to the data, oil from North Dakota and the Eagle Ford Shale in Texas had vapor-pressure readings of over 8 pounds per square inch, although Bakken readings reached as high as 9.7 PSI. U.S. refiner Tesoro Corp., a major transporter of Bakken crude to the West Coast, said it regularly has received oil from North Dakota with even more volatile pressure readings – up to 12 PSI. By comparison, Louisiana Light Sweet from the Gulf of Mexico, had vapor pressure of 3.33 PSI, according to the Capline data."

This data, summarized in Figure 1, shows that "light" crude oils vary substantially in vapor pressure and thus would have a wide range of environmental impacts when stored and transported. The more volatile the crude, the higher the ROG, TACs, and methane (a potent greenhouse gas) emissions, the higher the flammability, and the greater the potential consequences in the event of an accident. Thus, the DEIR's assertions that there will be no increase in ROG and TACs as lights will replace lights is simply inaccurate.

**Figure 2: Volatility (psi) of Some Commonly Refined Crude Oils**

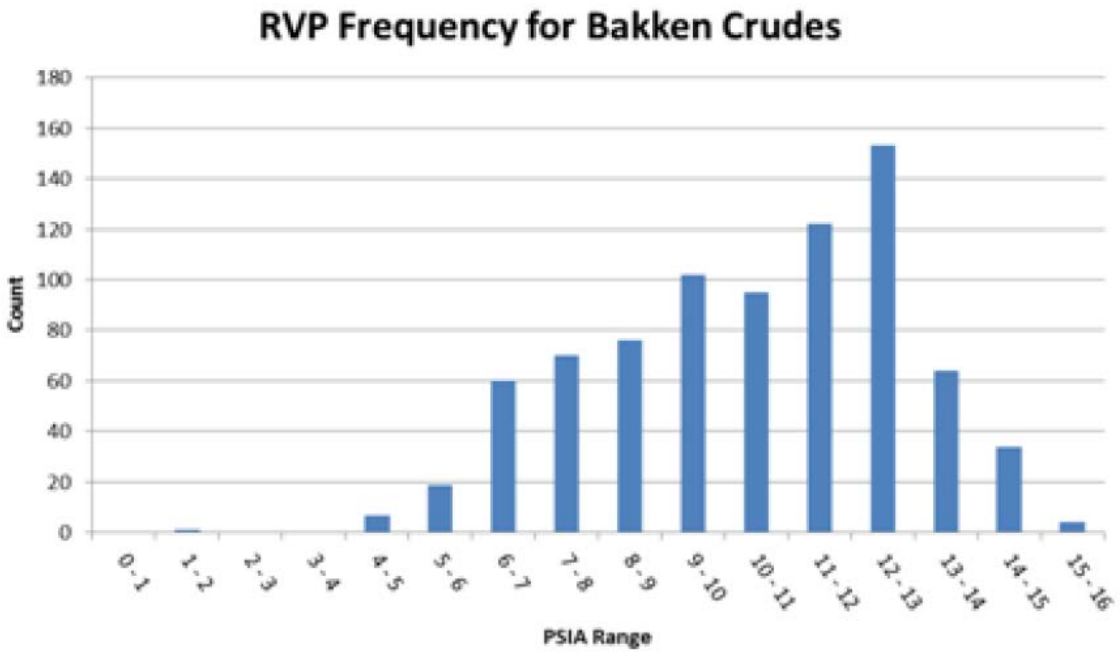



Source: Wall Street Journal, February 23, 2014

[22] Russell Gold, Analysis of Crude From North Dakota Raises Further Questions About Rail Transportation, Wall Street Journal, February 23, 2014.

Other data, summarized by American Fuel & Petrochemical Manufacturers[23] indicate that the RVP of Bakken crude oil can be substantially higher than the value reported based on Capline Pipeline data. A study of Bakken crudes involved in the Lac-Mégantic accident by the Transportation Safety Board of Canada (TSBC) [24] concluded that the volatility and flammability of Bakken crudes were more similar to gasoline than to crude oil, distinguishing Bakken crudes from conventional crude oils.

**Figure 3**




Source: Dangerous Goods Transport Consulting, Inc., 2014

Bakken and other light crude oils taken straight from the well typically contain large amounts of natural gas liquids (NGLs), known as light ends or condensate. [25] These include C2 to C5 hydrocarbons: methane, propane, butane, ethane, and pentane. These are the components most likely to volatilize, burn, or explode in an accident. These light ends have the effect of increasing a crude's vapor pressure, lowering its flash point and lowering its initial boiling point, all of which result in increased environmental risks. These are called "live" crude oils. The high concentration of light ends makes them highly flammable, more likely to form fire balls and

[23] Dangerous Goods Transport Consulting, Inc., 2014, North Dakota Petroleum Council.

[24] Transportation Safety Board of Canada, TSB Laboratory Report LP148/2013 (TSBC 2013), Available at: http://www.bst-tsb.gc.ca/eng/lab/rail/2013/lp1482013/LP1482013.asp.

[25] Dangerous Goods Transport Consulting, Inc., 2014, https://www.afpm.org/WorkArea/DownloadAsset.aspx?id=4229.

boiling liquid expanding vapor explosions (BLEVES) in accidents. The failure to recognize this resulted in a significant underestimate of ROG and TAC emissions and hazards in the CBR Project DEIR.

In most petroleum-producing regions, light ends are removed before they are shipped using a stabilizer—a tall, cylindrical tower that uses heat to separate the light ends, which are then condensed and sent to a fractionator for processing. Crude stabilizers and NGL pipelines to send the recovered NGLs to market are ubiquitous in oil fields that produce light crude oils as crude pipeline specifications set pressure limits that force stripping of the NGLs. However, in the Bakken fields, this infrastructure is rare and most Bakken crude that is shipped by rail is shipped live. This distinguishes it from other light crudes, which are shipped dry, e.g., Eagle Ford crudes in Texas, where oil field infrastructure exists to process it and most of it is shipped by pipeline, which requires that NGLs be stripped.[26]

Other crudes that Bakken would replace, such as ANS, are hard to ignite because they do not have as much combustible light ends. Most light crudes, including the imported foreign crudes currently processed, are stabilized. These stabilized crudes will not actively boil at ambient temperature and can be more safely shipped, stored, and refined. Thus, while "light" crude may replace other types of "light" crude, there are major differences in composition that affect environmental impacts. The CBR Project DEIR does not impose any condition(s) that require that NGLs be removed from received crudes to mitigate these impacts. Thus, analyses must assume that they will be present.

In addition, Bakken crudes, when blended with heavy crudes to meet crude slate requirements, have resulted in many refinery operating issues, which increase emissions. These include fouling of the cold preheat train; desalter upsets; and fouling of hot preheater exchangers and furnaces; as well as corrosion.[27] These operating problems increase emissions. These operating problems and attendant emission increases were not disclosed in the CBR Project DEIR.

2. <u>Crude Slate Impacts Are Not Part of the Baseline</u>

The DEIR next asserts that "[e]ven if VOC emissions were to increase based on Valero's purchase of light North American crudes, any such emissions increases would properly be considered part of the baseline because the baseline includes the full scope of operations allowed under existing permits that were issued based upon prior CEQA review." DEIR, p. C.2-1.

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[26] 'Degassing' North Dakota Crude Oil Before Shipping Among Safety Ideas, Insurance Journal, May 14, 2014, Available at: http://www.insurancejournal.com/news/national/2014/05/14/329095.htm.

[27] Innovative Solutions for Processing Shale Oils, Hydrocarbon Processing, 7/10/2013, http://www.hydrocarbonprocessing.com/Article/3223989/Innovative-solutions-for-processing-shale-oils.html.

Elsewhere, the DEIR asserts, "Finally, even if one assumed that Valero will purchase 70,000 barrels per day of light sweet North American crude, and the crudes delivered and processed became substantially lighter, any resulting increase in emissions would be within the baseline for operational air quality impact." This is supported by citing the same suite of CEQA cases relied on for the parallel argument with respect to heavy sour crudes discussed above. DEIR, p. C.2-2. The response to this argument around heavy sour crudes applies equally here and is incorporated by reference.

The baseline argument for light sweet crudes goes a step further than for heavy sour crudes, arguing that "Valero holds permits for all of the Refinery's process equipment… The City and the BAAQMD issued these permits based on the environmental impact report (EIR) for the Valero Improvement Project (VIP) prepared and certified by the City in 2003. The baseline includes the full scope of operations allowed under these permits. In particular, the baseline includes the permitted operation of the Refinery's eight crude oil storage tanks (storage tanks S-57 through S-62, S-1047, and S-1048). In connection with the VIP, the BAAQMD issued permits based on the City's EIR." DEIR, p. C.2-3.

This mischaracterizes the VIP EIR and the permits for the subject tanks. The VIP EIR evaluated only the two new storage tanks (VIP DEIR, p. 3-51) and the increase in ROG emissions from several other unidentified tanks up to a 5 ton/year increase in ROG relative to a 3-year baseline, based on a vapor pressure of 5 psi.[28] VIP DEIR, Table 4.2-9. The CBR Project would facilitate an additional increase in ROG and TAC emissions from these tanks over the same 3-year baseline, due to an increase in the vapor pressure of the stored crude oils and higher amounts of TACs in the rail-imported crudes. Thus, the VIP EIR did not evaluate the full scope of the ROG and TAC emissions that would occur as a result of the CBR Project.

In addition, the VIP EIR analyzed the TAC emissions from these tanks. These emissions were based on a speciation profile that assumes far less toxic air contaminants than would be present in the crudes listed in the CBR Project. DEIR Table 3-1. For example, the VIP EIR calculations assumed that benzene would be present in the crudes stored in new Tanks 1707 and 1708 at 0.009 weight percent (wt.%).[29] The benzene content of the suite of tar sands crudes listed in DEIR Table 3-1 are substantially higher than 0.009 wt.%, ranging from 0.02 wt.% to

[28] The BAAQMD Permit Handbook in Chapter 3.1 refers to U.S. EPA's AP-42 guidelines, Chapter 5.2, in which a default RVP for crude oil is listed as 5 psi, though it is noted that RVP of crude oils can range from less than 1 up to 10 psi. See: http://hank.baaqmd.gov/pmt/handbook/rev02/PH_00_05_03_01.pdf and http://www.epa.gov/ttnchie1/ap42/.

[29] The benzene concentration assumed in the storage tanks is calculated from post-VIP ROG emissions of 193 ton/yr (VIP DEIR, Table 4.2-9) and the post-VIP benzene emissions of 33.93 lb/yr (VIP DEIR, Table 4.7-6) as: 100x[33.93 lb/yr/(193 ton/yr)(2000 lb/ton)] = 0.009 wt%.

0.81 wt.%,[30] or over 2 to 90 times higher. Similarly, Material Safety Data Sheets (MSDSs) submitted by others seeking to import similar cost-advantaged North American crudes, including Bakken, indicate benzene concentrations up to 7 wt.%,[31] with Bakken crudes generally having the highest concentrations of benzene among all those evaluated. Benzene is a known human carcinogen. Human exposure to benzene has been associated with a range of acute and long-term adverse health effects and diseases, including cancer and adverse hematological, reproductive and development effects.[32]

The CBR Project DEIR incorrectly asserts that "even if the Project were to cause an increase in ROG emissions from storage tanks, any such increase would be considered part of the baseline conditions." DEIR, p. C.2-3. The CEQA baseline is not determined by permit conditions, but rather by actual conditions. The full scope of tank operations, i.e., storing crude oils that have much higher vapor pressures and concentrations of TACs than existed in the market place at the time of the 2002 VIP CEQA review, were never subject to CEQA review and must be evaluated in the instant case.

## II. THE DEIR UNDERESTIMATED ROG EMISSIONS

The DEIR estimated that the Project would result in a net decrease in ROG emissions of 1.61 ton/yr, as summarized in Table 1. DEIR, Table 4.1-5.

**Table 1: Annual and Daily Net Operational ROG Emissions**

| **Source** | **ROG*** (ton/yr) | **ROG**** (lb/day) |
|---|---|---|
| Unloading Rack & Pipeline Fugitive Components | 1.88 | 10.30 |
| Locomotives | 1.70 | 9.32 |
| Marine Vessels (Displaced Baseline) | -5.18 | -28.38 |
| **Total Net Emissions** | **-1.61** | **-8.77** |

* Source: DEIR Table 4.1-5

** Calculated as (ton/year)(2000 lbs/ton)/(365 days/year)

[30] www.crudemonitor.ca. Concentrations reported in volume % (v/v) in this source were converted to weight % by dividing by the ratio of compound density in kg/m$^3$ at 25 C (benzene =876.5 kg/m$^3$) to crude oil density in kg/m$^3$, based on the most recent sample, as of June 27, 2014.

[31] TSBC 2013; Tesoro Savage, Application for Site Certification Agreement, vol. 2, Appendix G: Material Safety Data Sheets for Enbridge Bakken (n-hexane = 11%); sour heavy crude oil (benzene = 7%; toluene = 7%; ethylbenzene = 7%; xylene = 7%); sweet heavy crude oil (toluene = 7%); light sweet crude oil (benzene = 7%; toluene = 7%; ethylbenzene = 7%; xylene = 7%), August 29, 2013, Available at: http://www.efsec.wa.gov/Tesoro%20Savage/Application/EFSEC%202013-01%20Volume%20II%20-%20Appendices/EFSEC%202013-01%20Compiled%20Volume%20II.pdf.

[32] CARB, Report to the Scientific Review Panel on Benzene, Prepared by the Staffs of The Air Resources Board and The Department of Health Services, November 27, 1984, Available at: http://www.arb.ca.gov/toxics/id/summary/benzene.pdf; Chronic Toxicity Summary: Benzene, Available at: http://www.oehha.org/air/chronic_rels/pdf/71432.pdf; World Health Organization, Exposure to Benzene: A Major Public Health Concern, Available at: http://www.who.int/ipcs/features/benzene.pdf.

The DEIR underestimated ROG emissions as it excluded many sources of ROG emissions from the Project, discussed below. The *increase* in ROG emissions is significant when these omissions are cured.

### A. Decrease In Ship Emissions Are Not Real Or Enforceable

The ROG emissions in Table 1 assume marine vessel emissions would be reduced by 5.18 ton/yr, by eliminating 73 vessel trips (70,000 bbl/day x 365 day/350,000 bbl/vessel). DEIR, p. 4.1-16. The DEIR asserts that "[c]rude oil delivered to the Refinery by tank car would not displace crude oil delivered to the Refinery by pipeline." DEIR, p. ES-3, 1-1.

However, it is well known that San Joaquin Valley crude oil production is declining.[33] The nearby Shell Oil Refinery in Martinez, for example, recently increased crude storage capacity to substitute imported crude oil by marine vessel "for diminishing San Joaquin Valley crude by pipeline." DEIR, Table 5-1. ESA expressed concern that ship deliveries could increase in the future to replace diminishing supplies of crude oil available by pipeline. Valero 2013, Data Request No. 2, Item 1.[34] Further, the BAAQMD Statement of Basis for the VIP Project states: "Valero anticipates the possibility that crude may no longer be brought in by pipeline. This could result from a problem with the pipeline, or a change in the cost of crude that makes pipeline supply no longer economical."[35] Thus, it is entirely possible, especially in the absence of any enforceable conditions of approval, that the Project would not decrease marine deliveries to the extent claimed in the DEIR.

The DEIR must be modified to include clearly stated and enforceable provisions to assure that any increase in ROG and TAC emissions from importing crude by rail rather than by marine vessel or pipeline are fully offset by reductions in ship emissions and that the reductions are achieved in practice. These conditions should include requirements to test, record, and report to the City the RVP of all crude oil delivered by ship, rail, and pipeline and source testing of representative ship and locomotive emissions to assure the reductions are achieved.

### B. Storage Tanks ROG and TAC Emissions Were Omitted

The DEIR did not adequately quantify emissions from the tanks that would store the crude oil delivered by rail. The emissions from floating-roof tanks include: tank breathing losses

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[33] California Energy Commission, Margaret Sheridan, California Crude Oil Production and Imports, April 2006, Available at: http://www.energy.ca.gov/2006publications/CEC-600-2006-006/CEC-600-2006-006.PDF.

[34] Valero Responses to: Valero Crude by Rail Project Data Request Number 2, April 2, 2013.

[35] http://www.baaqmd.gov/~/media/Files/Engineering/Title%20V%20Permits/B2626/B2626_2010-05_renewal_03.ashx?la=en.

(the sum of rim seal losses, withdrawal losses, deck fitting losses, and deck seam losses estimated by the EPA model TANKS 4.0.9d) and roof landing losses.

1. Significant Tank Breathing Losses Were Omitted

Tank breathing losses are estimated using the EPA model: TANKS 4.0.9d. The CBR Project DEIR did not include any emissions from the tanks that would store the rail-imported crude.

The CBR Project DEIR describes the Project as replacing 70,000 bbl/day of crude oil delivered by ship with 70,000 bbl/day of crude oil delivered by train. The CBR Project DEIR fails to consider what happens to the crude oil after it is transferred from the rail cars through a new pipeline. DEIR, Sec. 3.2. It simply states that the contents of each tank car will be pumped "into storage tankage located in the Refinery's crude oil storage tank field." DEIR, p. 3-20. This crude oil will be stored in existing storage tanks. As the imported crude oil will have a higher vapor pressure than current crude oils stored in these tanks, ROG and TAC emissions from the tanks will increase. The VIP EIR did not evaluate these emission increases. The CBR Project DEIR also does not include these ROG and TAC emissions.

The Project described in the IS/MND included transferring crude oil from rail cars into existing external floating roof tank 1776. This required changing the service of this tank from jet fuel and other refinery products to crude oil. The ROG emissions were estimated with the EPA TANKS 4.0.9d model for a throughput of 70,000 bbl/day and a crude oil RVP of 9.4 psi. The resulting ROG emissions were 39.3 lb/day and 7.18 ton/yr. The net ROG emission increase, relative to December 2009 through November 2012 baseline, was 23.7 lb/day and 4.33 ton/yr. DEIR, Appx. E.3 (2/13 Application, Table 3-2). The supporting calculations for these emission increases (in Appendix B to the February 2013 Application, provided in DEIR, Appx. E.3, Attachments B-1 and B-2) were withheld from the DEIR as confidential business information (CBI).

The Project was modified in November 2013 to replace Tank 1776 with Tanks 1701 through 1708 (S-57 through S-62). These are existing external floating roof tanks that are currently permitted to store crude oil and have historically stored crude oil delivered by both ship and pipeline. DEIR, Appx. E.4 (11/13 Application, p. 6). Thus, the baseline emissions from these tanks include both San Joaquin Valley crudes and ANS and other ship-imported crudes. These tanks are not in the Title V permit for the Valero Refinery, but rather in the Title V Permit for NuStar Logistics, L.P., Facility B5574. The November 2013 Application incorrectly asserts that these tanks are neither altered nor modified sources and thus are not subject to Authority to Construct and New Source Review requirements for the CBR Project. DEIR, Appx. E.4 (11/13 Application, p. 7). The November 2013 Application at p. 7 (DEIR, Appx. E.4) asserts:

> "Changes in material stored. The tanks are currently permitted to store crude oil received by marine vessels and pipeline. With the implementation of this project, the tanks will continue to store crude oil. The crude oil will be received from rail cars, as well as from marine vessels and pipeline. Tanks 1701 through 1706 have historically stored crude oil delivered by ships and pipeline. Tanks 1707 and 1708 were recently constructed and were permitted under NSR to store crude oil. These tanks currently comply with all the requirements in Regulation 8, Rule 5, and associated permit conditions."

Similarly, the DEIR argues (DEIR, p. 4.1-17):

> "Nor would the Project cause any emissions increases from storage tanks. Currently, the Refinery stores crude oil delivered by ship and pipeline in eight existing storage tanks numbered 1701 through 1708. Crude oil delivered by rail would be stored in the same tanks. The tanks would not be modified, and would continue to be subject to the same throughput limit and other permit conditions."

Thus, the DEIR does not include any ROG or TAC emissions from these tanks. However, this assertion is invalid, as explained above. The basis of this argument is that "Valero must blend crude feedstocks to a narrow range of weight and sulfur content before they can be processed into marketable products. Because the crude oil blends cannot become significantly heavier or lighter, nor contain significantly more sulfur, there would be no increase in processing emissions." DEIR, p. 4.1.17. This is immaterial as to ROG and TAC emissions because they do not depend on weight and sulfur content of the crude, but rather on vapor pressure and TAC speciation of the crude. These are not related to the gravity or sulfur content of the crude oil.

The ROG and TAC emissions from the receiving storage tanks would increase if 70,000 bbl/day of ship-imported or pipeline-imported crude were replaced with 70,000 bbl/day of rail-imported crude. The DEIR is deficient for failing to include any estimate of these emission increases and for withholding all information required to estimate these emissions, information that is never classified as CBI in public documents—vapor pressures, tank characteristics, baseline emissions, etc.

An approximate estimate of the increase in daily ROG emissions can be made from the previously reported daily ROG emissions for Tank 1776. The IS/MND estimated daily ROG emissions of 39.3 lb/day for a 70,000 bbl/day throughput of crude with an RVP of 9.4 psi. The RVP of the baseline crude in the seven storage tanks that would be used is unknown. However, the DEIR indicates that it is either San Joaquin Valley crude (pipeline) or Alaska North Slope lookalikes.

*First*, assuming the baseline crude has an RVP equal to that for Alaska North Slope crude, or 6.3 psi,[36] the baseline ROG emissions for 70,000 bbl/day would be **26.3 lb/day**.[37] The increase in ROG emissions, from storing 70,000 bbl/day of Bakken crude in the same tank(s), assuming the reported upper-bound vapor pressure for Bakken crude (15.5 psi)[38] would be **64.8 lb/day**.[39] Thus, the net increase in ROG emissions from replacing 70,000 bbl/day of ship-imported ANS with 70,000 bbl/day of rail-imported Bakken is **38.5 lb/day** (64.8 - 26.3 = 38.5). The corresponding net increase in annual emissions would be **7.0 ton/year**[40] if all of the rail-imported crude were Bakken. This is a reasonably foreseeable scenario as crudes required to blend 100% Bakken to an ANS-lookalike crude could be imported by marine vessel

*Second*, assuming the baseline crude has an RVP equal to that of San Joaquin Valley crude or other similar heavy sour crudes, 0.04 psi,[41] the baseline ROG emissions for 70,000 bbl/day would be **0.2 lb/day**.[42] As detailed above, the increase in ROG emissions, from storing 70,000 bbl/day of Bakken crude in the same tank(s), assuming the reported upper-bound vapor pressure for Bakken crude (15.5 psi)[43] would be **64.8 lb/day**.[44] Thus, the net increase in ROG emissions from replacing 70,000 bbl/day of pipeline-imported San Joaquin Valley or other similar heavy sour crudes with 70,000 bbl/day of rail-imported Bakken is **64.6 lb/day** (64.8 - 0.2 = 64.6). The corresponding net increase in annual emissions would be **11.8 ton/year** if all of the rail-imported crude were Bakken. This is a reasonably foreseeable scenario as crudes required to blend 100% Bakken to an ANS-lookalike could be imported by marine vessel.

The resulting daily net increase in ROG emissions for a San Joaquin Valley or other similar heavy crude baseline, but otherwise assuming all of the CBR Project DEIR's emissions, is 56 lb/day, as shown in Table 2. This increase in ROG emissions is significant, as it exceeds

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[36] ExxonMobil Refining and Supply Company, ANS11U, Available at: http://www.exxonmobil.com/crudeoil/about_crudes_ans.aspx and http://www.exxonmobil.com/crudeoil/download/ans11u.pdf.

[37] Baseline ROG emissions from storage of 70,000 bbl/day of ANS in one or more of existing tanks 1701 - 1708 = (39.3 lb/day) (6.3 psi/9.4 psi) = **26.3 lb/day**.

[38] Classification and Hazard Communication Provisions for Crude Oil – Bakken Crude Oil Data, June 13, 2014.

[39] Increase in POC emissions from storing 70,000 bbl/day of Bakken crude in one or more of existing tanks 1701-1708 = (39.3 lb/day)(15.5 psi/9.4 psi) = **64.8 lb/day.**

[40] Increase in annual emissions = (38.5 lb/day)(365 days/year)/(2000 lb/ton) = **7.02 ton/yr.**

[41] Emission Calculation Protocol for Oil Production Tanks, September 1, 2000.

[42] Baseline ROG emissions from storage of 70,000 bbl/day of ANS in one or more of existing tanks 1701 - 1708 = (39.3 lb/day) (0.04 psi/9.4 psi) = **0.17 lb/day**.

[43] Classification and Hazard Communication Provisions for Crude Oil – Bakken Crude Oil Data, June 13, 2014.

[44] Increase in ROG emissions from storing 70,000 bbl/day of Bakken crude in one or more of existing tanks 1701 - 1708 = (39.3 lb/day)(15.5 psi/9.4 psi) = **64.8 lb/day.**

the BAAQMD CEQA significance threshold[45] of 54 lb/day and triggers New Source Review thresholds that require Best Available Control Technology. This is a significant impact that was not disclosed in the DEIR. The total Project increase would be even greater than the emissions in Table 2, which do not include ROG increases from other omitted sources, discussed below.

**Table 2: Revised Annual and Daily Net Operational ROG Emissions**
**San Joaquin Valley Crude Baseline**

| **Source** | **ROG** (ton/year) | **ROG** (lb/day) |
|---|---|---|
| Unloading Rack & Pipeline Fugitive Components | 1.88 | 10.30 |
| Locomotives | 1.70 | 9.32 |
| ***Storage Tank (SJV Crude Baseline)*** | ***11.79*** | ***64.60*** |
| Marine Vessels (Displaced Baseline) | -5.18 | -28.38 |
| **Total Net Emissions** | **10.19** | **55.83** |
| BAAQMD CEQA Significance Threshold | 10 | 54 |
| Significant? | **YES** | **YES** |

The increase in ROG emissions in Table 2 would be accompanied by an increase in TAC emissions, which are estimated by multiplying the ROG emission increase by the weight percent of each TAC in the ROG emissions (i.e., the TAC speciation profile). The contribution of TAC emissions from these tanks were not included in the DEIR's health risk assessment, which only evaluated diesel particulate matter and PM2.5.

Because the Project would result in significant ROG emissions, the lead agency is required to examine the impact of the increase in localized ROG emissions on ambient air quality and the local community and identify mitigation that is capable of reducing or eliminating these impacts to below a level of significance. To mitigate the Project's significant ROG emissions, the City should consider feasible mitigation measures such as the use of zero-leak fugitive components; use of geodesic domes on external floating roof tanks, which are commonly used on tanks that store RVP 11 crude oils; cable-suspended, full-contact floating roofs; and the use geodesic domes on the existing fixed roof tanks.[46]

[45] BAAQMD Proposed Air Quality CEQA Thresholds of Significance, May 3, 2010, Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Summary_Table_Proposed_BAAQMD_CEQA_Thresholds_May_3_2010.ashx?la=en.

[46] See, e.g., Phillips 66 Los Angeles Refinery Carson Plant – Crude Oil Storage Capacity Project, September 6, 2013, Draft Negative Declaration (Carson Neg. Dec.), Available at: https://www.aqmd.gov/CEQA/documents/2013/nonaqmd/Draft_ND_Phillips_66_Crude_Storage.pdf and City of Richmond, Chevron Refinery Modernization Project DEIR (Chevron DEIR), Chapter 4.3, pp. 4.3-92, Available at: http://chevronmodernization.com/wp-content/uploads/2014/03/4.3_Air-Quality.pdf.

2. Roof Landing, Degassing, and Cleaning Emissions Were Omitted

The increase in ROG emissions estimated above is based on an adjustment of a calculation in the IS/MND based on EPA's TANKS 4.0.9d model (TANKS). However, this model only estimates rim seal losses, withdrawal losses, deck fitting losses, and deck seam losses. It does not estimate roof landing losses, inspection losses, or flashing losses. Thus, it underestimated tank emissions. Therefore, the above estimate of the increase in ROG emissions in Table 2 is an underestimate. These additional emissions should be estimated, added to other tank emissions, and mitigated when the DEIR is revised.

The Project involves seven existing external floating roof tanks configured to comply with BAAQMD Regulation 8-5. DEIR, p. 3-5. These tanks are pontoon-type tanks. DEIR, Appx. E.4 (2/13 Application, p. 1-8). Pontoon tank roofs are supported on legs. In floating roof tanks with leg-supported roofs, the roof floats on the surface of the liquid inside the tank and reduces evaporative losses during normal operations. However, when the tank is emptied, the roof sits on the legs and is essentially uncontrolled.

The EPA has explained that the TANKS model does not include roof landings, and recommended that they be estimated with the equations in AP-42. In other words, the EPA TANKS model estimates evaporative emissions for normal operations only, *i.e.*, it assumes that the floating tank roof is always floating.[47] However, when a tank is emptied to the point that the roof no longer floats on the liquid but lands on deck legs, evaporative losses occur.

> After the floating roof is landed and the liquid level in the tank continues to drop, a vacuum is created which could cause the floating roof to collapse. To prevent damage and to equalize the pressure, a breather vent is actuated. Then, a vapor space is formed between the floating roof and the liquid. The breather vent remains open until the roof is again floated, so whenever the roof is landed, vapor can be lost through this vent.[48]

These losses are called "roof landing losses."

In addition, "degassing and cleaning losses" occur when tanks are drained and degassed for inspection and/or cleaning. These include both roof landing emissions, complete tank

[47] EPA, TANKS Software Frequent Questions, Updated February 2010, Available at: http://www.epa.gov/ttnchie1/faq/tanksfaq.html. ("How can I estimate emissions from roof landing losses in the tanks program? … In November 2006, Section 7.1 of AP42 was updated with subsection 7.1.3.2.2 Roof Landings. The TANKS program has not been updated with these new algorithms for internal floating roof tanks. It is based on the 1997 version of section 7.1.").

[48] EPA, AP-42, Chapter 7.1 Organic Liquid Storage Tanks, November 2006, Available at: http://www.epa.gov/ttn/chief/ap42/ch07/final/c07s01.pdf.

degassing, and emissions from cleaning out accumulated sludge. These emissions are essentially uncontrolled tank emissions.[49]

The tank cleaning emissions could be substantially higher for Bakken crudes than for other types of crude. Bakken crudes leave waxy deposits in pipelines and tanks, which require more frequent cleaning,[50] and thus higher emissions, than the crudes they would replace. Environmental impacts from chemical dispersants used to control these waxy deposits in tanks and pipelines also should be evaluated.

The EPA recommends methods to estimate emissions from degassing and cleaning and roof landing losses.[51] The method for estimating emissions depends on the construction of the tank, *e.g.*, the flatness of the tank bottom and the position of the withdrawal line (the so-called liquid "heel"). Degassing, cleaning, and roof landing losses continue until the tank is refilled to a sufficient level to again float the tank roof. Total ROG emissions from floating roof tanks during a roof landing is the sum of standing idle losses and filling losses. They can be estimated using formulas contained in EPA's *Compilation of Air Pollutant Emission Factors* ("AP-42"), Chapter 7.1, Organic Liquid Storage Tanks, Section 7.1.3.2.2. These emissions are routinely included in emission inventories. They are required to be reported, for example, in Texas.[52] They are also included in the emission inventory for Tesoro's Vancouver Terminal, which imports similar crudes by rail, and stores them in tanks.[53]

To reduce emissions from tank breathing losses (Comment II.B.1), degassing, cleaning and roof landing losses, the City should require the Applicant to install geodesic domes on the tanks that would store rail-imported crudes, thus avoiding emissions from these and other tank sources.

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[49] See EPA guidance on estimating these emissions at: http://www.epa.gov/ttnchie1/faq/tanksfaq.html#13 .

[50] Innovative Solutions for Processing Shale Oils, Hydrocarbon Processing, 7/10/2013, Available at: http://www.hydrocarbonprocessing.com/Article/3223989/Innovative-solutions-for-processing-shale-oils.html.

[51] "How Can I Estimate Emissions from Degassing and Cleaning Operation During a Tank Turnaround? And How Can I Estimate Emissions from Roof Landing Losses in the TANKS Program:?", Available at: http://www.epa.gov/ttnchie1/faq/tanksfaq.html#13 .

[52] Memorandum from Dan Eden, Deputy Director, Office of Permitting, Remediation, and Registration; David C. Schanbacher, Chief Engineer; and John Steib, Deputy Director, Office of Compliance and Enforcement, Re: Air Emissions During Tank Floating Roof Landings, December 5, 2006, Available at: http://www.tceq.state.tx.us/assets/public/permitting/air/memos/tank_landing_final.pdf .

[53] Tesoro Savage, Application for Site Certification Agreement, Section 5.1.2.1.4, Available at: http://www.efsec.wa.gov/Tesoro%20Savage/Application/EFSEC%202013-01%20Volume%20I/EFSEC%202013-01%20-%20Compiled%20PDF%20Volume%20I.pdf .

Over 10,000 aluminum domes have been installed on petrochemical storage tanks in the United States.[54] The ExxonMobil Torrance Refinery: "completed the process of covering all floating roof tanks with geodesic domes to reduce volatile organic compound (VOCs) emissions from facility storage tanks in 2008. By installing domes on our storage tanks, we've reduced our VOC emissions from these tanks by 80 percent. These domes, installed on tanks that are used to store gasoline and other similar petroleum-derived materials, help reduce VOC emissions by blocking much of the wind that constantly flows across the tank roofs, thus decreasing evaporation from these tanks."[55]

A crude storage project, recently proposed at the Phillips 66 Los Angeles Carson Refinery, required external floating roof tanks with geodesic domes to store crude oil with an RVP of 11.[56] Carson Neg. Dec. Table 1-1. The ConocoPhillips Wilmington Refinery added a geodesic dome to an existing oil storage tank to satisfy BACT.[57] Similarly, Chevron proposes[58] to use domes on several existing tanks to mitigate VOC emission increases at its Richmond Refinery.[59] The U.S. Department of Justice CITGO Consent Decree required a geodesic dome on a gasoline storage tank at the Lamont, Texas refinery.[60] Further, numerous vendors have provided geodesic domes for refinery tanks.[61] The crudes that would be stored in the Project tanks have vapor pressures that are comparable to gasoline (TSBC 2013, Sec. 3.2.7), justifying the use of geodesic domes to control tank emissions.

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[54] M. Doxey and M. Trinidad, Aluminum Geodesic Dome Roof for Both New and Tank Retrofit Projects, Materials Forum, v. 30, 2006, Available at: http://www.materialsaustralia.com.au/lib/pdf/Mats.%20Forum%20page%20164_169.pdf.

[55] Torrance Refinery: An Overview of our Environmental and Social Programs, 2010, Available at: http://www.exxonmobil.com/NA-English/Files/About_Where_Ref_TorranceReport.pdf.

[56] See, e.g., Phillips 66 Los Angeles Refinery Carson Plant – Crude Oil Storage Capacity Project, September 6, 2013, Table 1-1, Draft Negative Declaration, Available at: https://www.aqmd.gov/CEQA/documents/2013/nonaqmd/Draft_ND_Phillips_66_Crude_Storage.pdf.

[57] SCAQMD Letter to G. Rios, December 4, 2009, Available at: http://yosemite.epa.gov/r9/air/epss.nsf/e0c49a10c792e06f8825657e007654a3/e97e6a905737c9bd882576cd0064b56a/$FILE/ATTTOA6X.pdf/ID%20800363%20ConocoPhillips%20Wilmington%20-%20EPA%20Cover%20Letter%20%20-AN%20501727%20501735%20457557.pdf.

[58] City of Richmond, Chevron Refinery Modernization Project, Environmental Impact Report, Volume 1: Draft EIR, March 2014 (Chevron DEIR), Available at: http://chevronmodernization.com/project-documents/ .

[59] Chevron DEIR, Chapter 4.3.

[60] CITGO Petroleum Corp. Clean Air Act Settlement, Available at: http://www2.epa.gov/enforcement/citgo-petroleum-corporation-clean-air-act-settlement.

[61] See, e.g., Aluminum Geodesic Dome, Available at: http://tankaluminumcover.com/Aluminum-Geodesic-Dome; Larco Storage Tank Equipments, Available at: http://www.larco.fr/aluminum_domes.html; Vacono Dome, Available at: http://www.easyfairs.com/uploads/tx_ef/VACONODOME_2014.pdf; United Industries Group, Inc., Available at: http://www.thomasnet.com/productsearch/item/10039789-13068-1008-1008/united-industries-group-inc/geodesic-aluminum-dome-roofs/.

### 3. Tank Flashing Emissions Were Omitted

Most Bakken crudes are transported raw, without stabilization, due to the lack of facilities in the oil fields, as discussed elsewhere in these Comments. Unstabilized or "live" crude oils have high concentrations of volatile materials entrained in the bulk crude oil. Tank flashing emissions occur when these crude oils, such as Bakken, are exposed to temperature increases or pressure drops. When this occurs, some of the compounds that are liquids at the initial pressure/temperature transform into gases and are released or "flashed" from the liquid. These emissions are in addition to working and breathing emissions from tanks and are not estimated by the EPA TANKS 4.0.9d model. These emissions can be calculated using standard procedures.[62] The DEIR did not mention or calculate these emissions, nor does it include permit conditions that would allow only stabilized crude oils to be received.

### 4. Water Draw Tank Emissions Were Omitted

Crude oil typically contains small amounts of water, which is separated from the crude oil and accumulates in the bottom of storage tanks. This accumulated water, referred to as water draw, is typically transferred from the crude oil storage tanks into a smaller water draw surge tank for processing prior to disposal. Over time, a thick layer of crude oil forms in the water draw surge tank. The water draw surge tank and processing of wastewaters from it emit ROG and TACs. The DEIR does not mention water draw, or include emissions from storing or processing it, which would increase as the vapor pressure of the stored crude increases, i.e., as from a switch from San Joaquin Valley to Bakken crude.

## C. Rail Car Unloading Emissions Were Omitted

The Project includes a rail car unloading rack capable of unloading two parallel rows of 25 crude oil rail cars simultaneously. DEIR, p. ES-3. The DEIR does not disclose any emissions from the unloading process, while EIRs for other similar facilities such as the proposed Phillips 66 CBR Project in Santa Maria, report unloading emissions.[63]

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[62] See, e.g., calculation methods at: Paul Peacock, Marathon, Bakken Oil Storage Tank Emission Models, March 23, 2010; TCEQ, Air Permit Reference Guide APDG 5941, Available at: http://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/guidance_flashemission.pdf; Kansas Dept. of Health & Environment, Available at: http://www.kdheks.gov/bar/download/Calculation_Flashing_Losses_Handout.pdf; B. Gidney and S. Pena, Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation, July 16, 2009, Available at: http://www.bdlaw.com/assets/htmldocuments/TCEQ%20Final%20Report%20Oil%20Gas%20Storage%20Tank%20Project.pdf .

[63] Marine Research Specialists (MRS), Phillips 66 Company Rail Spur Extension Project Public Draft Environmental Impact Report and Vertical Coastal Access Assessment, November 2013; p. 2-14, Available at: http://www.slocounty.ca.gov/Assets/PL/Santa+Maria+Refinery+Rail+Project/Draft+EIR-Phillips+66+Rail+Spur+Extension+Project+(November+2013)/Full+EIR+-+Large+File/p66.pdf.

At Valero, each side of the rack would have 25 unloading stations, which would "bottom-unload" closed-dome tank cars using 4-inch-diameter hoses, with dry disconnect couplings that would connect to a common header between the two sides of the rack (a check valve, connected to the top of each tank car via 2-inch-diameter hose would open to allow ambient air to enter during unloading and immediately close when unloading is finished). DEIR, p. 3-2.

A check valve would be installed onto each vent valve on the top of each tank car. The vent valve on the top of each tank car would be opened and the accompanying check valve would only allow fresh air into each tank car, and would prevent release of hydrocarbon fugitive emissions to the atmosphere. At each end car and on approximately every 8 tank cars in the 25 tank car string, a hose would be connected from the tank car's vent connection to a separate "equalization header." The equalization header would ensure the vapor spaces above the stored liquid crude in the tank cars is equalized between the tank cars. Individual drain hoses would be manually connected to the bottom of each tank car by on-site workers. The contents of each tank car would be drained by gravity into a collection pipe (collection header) and then pumped directly into storage tanks. DEIR, p. 3-21.

A typical rail car unloading system is described differently in the Santa Maria Rail DEIR. Santa Maria DEIR, p. 2-14. In that DEIR, the rail car unloading system consists of an adapter unit that connects the rail car to couplings, hoses, valves and piping that connect to a positive displacement pump. Air and crude oil vapors are commonly mixed in with crude oil, from loading and evaporation during transit. These vapors can present an explosion risk for downstream equipment and are typically removed with air eliminators. As the vapors contain high concentrations of ROG and TACs, they are typically routed to carbon columns or an incinerator to control the emissions.

The Valero CBR Project DEIR does not mention these vapors, an air eliminator, or indicate how they will be controlled. The Valero CBR Project DEIR only notes that "the BAAQMD will consider locomotive emissions and tank car unloading emissions as may be caused by the Project." DEIR, p. 3-2. This is not adequate. If unloading emissions will occur, at an air eliminator or other release point, the DEIR should be modified to describe them and to quantify them. If they are not present, the DEIR should explain how the explosion hazard typically associated with unloading cargos such as Bakken crude will be addressed as it is not clear that the air equalization system would eliminate this hazard.

**D. Sump Emissions Were Omitted**

The unloading facility includes a liquid spill containment sump with the capacity to contain the contents of at least one tank car. DEIR, p. ES-2. Crude oil that spills into this sump

would release vapors including ROG and TAC emissions. The DEIR did not include these emissions.

### E. Rail Car Fugitive Emissions Were Omitted

ROG and TACs will be emitted from rail cars from their point of origin through unloading as rail cars are not vapor tight. The DEIR did not include these emissions.

The crude oil would be shipped in tank cars, such that the volume of loaded crude oil shipped is less than the capacity of the rail car to accommodate expansion during shipping. This volume reduction creates free space at the top of the tank car, which provides space for entrained gases to be released from the crude oil[64] and emitted to the atmosphere during transit and idling in rail yards.[65]

As rail cars are not vapor tight, these vapors in the head space above the oil are emitted to the atmosphere during rail transport and at the unloading terminal. Further, most Bakken crudes are shipped live as discussed earlier. These crudes will flash in the tank cars when exposed to temperature increases or pressure drops, causing valves to open, emitting ROG and TACs.

These losses are consistent with the well-known "crude shrinkage" issue associated with crude by rail. The crude delivered is significantly less than the crude loaded. The reported range in crude shrinkage is 0.5% to 3% of the loaded crude.[66] Some of this shrinkage is likely due to emissions from the rail car during transit. The emissions of ROG and TACs from rail cars has been confirmed by field measurements.[67] The DEIR did not include these ROG and TAC emissions in its emission calculations or the health risk assessment.

Tank cars have domes to allow space for the product to expand as temperatures rise. Each dome has a manhole through which the tank car can be loaded, unloaded, inspected, cleaned, and repaired. Dome covers may be hinged and bolted on or screwed on. Most domes

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[64] Anthony Andrews, Congressional Research Service, Crude Oil Properties Relevant to Rail Transport Safety: In Brief, February 18, 2014, pp. 8-9.

[65] A DOT 111 (or comparable) tank car generally has a capacity of 34,500 gallons or 263,000 lbs. gross weight on rail. Under some conditions, the maximum gross weight can be increased to 286,000 lbs. At an API gravity of 50$^{o}$, a tank car can hold its maximum volume of 31,800 gallons and not exceed the 286,000 lb gross weight on rail limit. As the API gravity drops, the amount of oil that can be carried must also drop. Thus, a tank car of Bakken crude, at its highest density of 39.7$^{o}$ API, can only hold 30,488 gallons, a volume reduction of about 1,300 gallons. Further, as crude oil density (and thus API gravity) is temperature dependent, volume will increase as temperature increases. Thus, the shipper may have to reduce the shipped volume even further. This volume reduction creates a space above the crude oil where vapors accumulate.

[66] Alan Mazaud, Exergy Resources, Pennsylvania Rail Freight Seminar, May 23, 2013, p. 17. Available at: http://www.parailseminar.com/site/Portals/3/docs/Alan%20Mazaud%20Presentation%20-%20AM.pptx

[67] http://www.youtube.com/watch?v=35uC1gLctnw.

have vents and safety valves to let out vapors.[68] Thus, they are sources of ROG emissions that were omitted from the emission calculations. Further, when dome covers are left open, any residual vapors escape to atmosphere. Residual material clings to the bottom and sides of empty rail cars and emits ROG and TAC while the rail cars idle at the site, waiting for the entire unit train to be unloaded. Open covers are common in railyards as they are opened for inspections and repairs. The ROG and TAC emissions from these sources were omitted from the DEIR's emission inventory.

Further, each tank car has a bottom outlet which is used for loading and unloading that includes pumps, manifolds, and valves, all of which leak ROG and TACs. Finally, liquid leaks occur when unloading arms are disconnected, even for the so-called no leak arms proposed for the Project. These disconnect leaks evaporate, contributing to ROG and TAC emissions.

An estimate of these emissions can be based conservatively on the lower end of the range of crude shrinkage (0.5%) discussed above and the maximum freight weight per car of 106 tons from the TRN Spec Sheet-1. DEIR, Appx. E.6 (6/11/14 Memo to Morgan from Velzy, pdf 1208). Assuming 50 cars/train and two unit trains per day, a total of 53 ton/day[69] of ROG can be emitted as the trains traverse the 1500 miles between the shipping point and the Valero rail terminal. Of these 1500 miles, 263 miles are within California.[70] DEIR, Appx. E.5 (Air Quality & GHG Supplement, pdf 1198). Thus, 9.3 ton/day of ROG (18,600 lb/day) can be emitted within California from rail car leakage.[71] Of the 263 miles within California, 22 miles are within the boundary of the BAAQMD. *Ibid.* Thus, 0.8 ton/day (1,555 lb/day) of ROG emissions can be emitted within the BAAQMD.[72] These daily emissions greatly exceed the BAAQMD daily CEQA significance threshold for ROG of 54 lb/day, requiring mitigation.

Additional ROG would be emitted at the Valero railyard, while railcars wait for the entire train to be unloaded, and from the emptied railcars, enroute to the cleaning facility, from residual product that clings to the bottom and sides of the railcars.

These ROG emissions contain the same chemicals found in the crude oil, including benzene, toluene, xylene, hexane, and ethylbenzene. As discussed below, some crudes can contain up to 7% benzene by weight. See Table 3 below. Thus, greater than 1,301 lb/day of benzene could be emitted in California and greater than 109 lb/day of benzene within the

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[68] Chapter 11. Tank Car Operations, Available at: http://www.globalsecurity.org/military/library/policy/army/fm/10-67-1/CHAP11.HTML.

[69] ROG emissions from train transit = (106 ton/car)(50 car/train)(2 train/day)(0.005) = **53 ton/day.**

[70] Distance within California = (136+390)/2 = 263 mi.

[71] ROG emitted within California = (318 ton/day)(263/1500) = **9.3 ton/day.**

[72] ROG emitted within BAAQMD = (318 ton/day)(22/1500) = **0.8 ton/day.**

BAAQMD from rail car leakage. This rail car leakage is much greater than the amount of benzene (and other TACs) included in the HRA. For example, the HRA included only 0.06 lb/day of benzene[73] from fugitive components (DEIR, Appx. E.4, pdf 1160) or a tiny fraction of the 109 lb/day of benzene that could be emitted within the BAAQMD from the rail cars themselves.

These are huge emissions, greatly exceeding the ROG (and HRA) CEQA significance thresholds of the BAAQMD and other air district along the rail route. See DEIR, Tables 4.1-5 and 4.1-6. The City must require mitigation for these ROG and TAC emissions.

## III. THE DEIR FAILS TO DISCLOSE AND UNDERESTIMATES TAC EMISSIONS USED IN HEALTH RISK ASSESSMENT

Health Risk Assessments (HRAs) typically contain tables that summarize the amount of each TAC and the corresponding cancer, chronic, and acute health risk due to each. The supporting TAC emission calculations are presented in an appendix. The modelling files are separately attached. The HRA in this DEIR does not include most of this information. (Modelling files are available on a CD, which must be requested.) The supporting emission calculations are incomplete and scattered throughout many appendices with no road map explaining how it all fits together, with many analyses superseded.

There is no evident basis for concluding the Project would not result in a significant health impacts as the results are simply stated without the supporting emission calculations, leaving the reader the chore of digging through thousands of pages of appendices to make guesses at the TAC emissions included in the HRA analysis.

My analysis of this material indicates that the HRA only included diesel particulate matter and PM2.5 emissions from locomotives and TAC emissions from fugitive sources, a comparatively minor source of TAC emissions. The TAC emissions from all other sources (storage tanks, idling rail cars) discussed in Comment II were excluded. The TAC emissions from fugitive sources were underestimated, as explained below.

The unloaded crude oil will be transported from the unloading rack to existing crude supply piping in a 4,000–foot-long pipeline. DEIR, p. 1-2. The connecting system includes 3 pumps, 521 valves, 940 flanges, 295 connectors, and 6 pressure relief valves (plus a 15% contingency for valves, flanges and connectors). DEIR, Appx. E.4-1 (11/13 Application, pdf 1179). Crude oil vapors will be emitted from all of these components. The DEIR estimated TAC emissions from these components by first estimating ROG emissions using CARB

[73] Benzene in fugitive emissions from Ex. E.4, Table 3-5: (2.57E-3 lb/hr)(24 hr/day)/(2000 lb/ton) = **3.1E-5 ton/day.**

emissions factors. The ROG emissions were then multiplied by the weight percent of each TAC in the crude.

The TAC emissions from fugitive components were estimated using the "default speciation profile" for crude oil from the EPA program, TANKS4.09.[74] DEIR, Appx. E.4-1 (11/13 Application, pdf 1179, footnote). A "speciation profile" for a petroleum product identifies each chemical in the liquid and its concentration, reported as volume or weight percent. The default speciation profile used in the DEIR is not representative of the crude oil(s) that could be imported at the rail terminal and is entirely hypothetical. DEIR, Table 3-1. The conclusion that the hypothetical speciation profile is appropriate to evaluate Project health impacts is unsupported.

My review of the HRA speciation profile indicates that it is not based on the maximum amount of each TAC found in the crude oils that could be stored in the tanks. Material Safety Data Sheets (MSDSs) submitted in other applications to import cost-advantaged North American crudes[75] indicate that much higher concentrations of TACs could be present in the crude oils unloaded at the Valero Rail Terminal.

The upper bound values from these MSDSs are summarized in Table 3 and compared with the speciation profile used in the DEIR. This table shows that the HRA significantly underestimated all of the organic TACs included in the HRA. Similar information for diesel particulate matter, the only other TAC included in the HRA, is not available in the documents I reviewed.

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[74] Crude oil component speciation data was obtained by using the TANKS409d model available at http://www.epa.gov/ttnchie1/software/tanks/ using the database interface to export the speciation profile for the TANKS default crude oil, *viz.*, "Data --> Speciation Profiles --> Export" menu selection and choosing crude oil. This spreadsheet confirms that the default benzene level for crude oils is 0.6 wt.%.

[75] Tesoro Application to SCAQMD for Tank 80079 Throughput Increase, October 3, 2013, PRN 556835 (10/3/13 Application), MSDS for Light Sweet Crude, pdf 12; Tesoro Savage, Application for Site Certification Agreement, vol. 2, Appendix G: Material Safety Data Sheets, August 29, 2013, Available at: http://www.efsec.wa.gov/Tesoro%20Savage/Application/EFSEC%202013-01%20Volume%20II%20-%20Appendices/EFSEC%202013-01%20Compiled%20Volume%20II.pdf.

**Table 3: Comparison of DEIR Draft EIR, Appx. E.4, Table 3-5, HRA Speciation Profile for Fugitive Emissions with Maxima Reported in MSDS(s)**[76]

| TAC | Weight Percent | | |
|---|---|---|---|
| | HRA Speciation Profile[77] | Maxima MSDS | Factor Difference |
| Benzene | 0.6 | 7 | 11.7 |
| Ethyl Benzene | 0.4 | 7 | 17.5 |
| Hexane | 0.4 | 11 | 27.5 |
| Toluene | 1 | 7 | 7.0 |
| Xylenes | 1.4 | 7 | 5.0 |

Table 3 shows that the risk assessment underestimated the amount of benzene, ethyl benzene, hexane, toluene and xylenes in emissions by factors of 5 (xylenes) to 28 (hexane). Actual TAC emissions, after adjusting for the speciation profile, would be much higher as the DEIR excluded most of the sources of ROG emissions that would contribute TACs. The increase in benzene alone is large enough to increase the cancer risk at the maximum exposed individual worker (MEIW) over the BAAQMD Regulation 2-5 significance threshold of 1 in one million. DEIR, Appx. E.4-1 (11/13 Application, pdf 1189).

The DEIR argues that the benzene content of two Canadian crudes are on average lower than the benzene content of Alaska North Slope crude (0.33%), the design crude for the refinery. DEIR, Appx. K, p. K-17. However, the benzene content of other crudes listed in DEIR Table 3-1 are on average much higher than ANS. Light crudes, like Bakken, have been reported to contain benzene concentrations of up to 7 weight %, or twenty-one times more than the design ANS crude.

In sum, the DEIR fails to properly analyze the health impacts of importing, storing, and refining the crude oil that the CBR Project will likely bring to Valero.

[76] Tesoro Savage, Application for Site Certification Agreement, vol. 2, Appendix G: Material Safety Data Sheets for Enbridge Bakken (n-hexane = 11%); sour heavy crude oil (benzene = 7%; toluene = 7%; ethylbenzene = 7%; xylene = 7%); sweet heavy crude oil (toluene = 7%); light sweet crude oil (benzene = 7%; toluene = 7%; ethylbenzene = 7%; xylene = 7%), August 29, 2013, Available at: http://www.efsec.wa.gov/Tesoro%20Savage/Application/EFSEC%202013-01%20Volume%20II%20-%20Appendices/EFSEC%202013-01%20Compiled%20Volume%20II.pdf. See also 3/7/13 Revised Application, pdf 96-115.

[77] DEIR, Appx. E.4, Table 3-5, pdf 1160.

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Pesticides in the TIE Process, SETAC, 6/96
Sulfate Minerals: Geochemistry, Crystallography, and Environmental Significance, Mineralogical Society of America/Geochemical Society, 11/00.
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
Combustion Turbine Power Augmentation with Inlet Cooling and Wet Compression, Power-Gen, 12/01
CEQA Update, UC Berkeley Extension, 3/02
The Health Effects of Chemicals, Drugs, and Pollutants, UC Berkeley Extension, 4-5/02
Noise Exposure Assessment: Sampling Strategy and Data Acquisition, AIHA PDC 205, 6/02
Noise Exposure Measurement Instruments and Techniques, AIHA PDC 302, 6/02
Noise Control Engineering, AIHA PDC 432, 6/02
Optimizing Generation and Air Emissions, Power-Gen, 12/02
Utility Industry Issues, Power-Gen, 12/02
Multipollutant Emission Control, Coal-Gen, 8/03
Community Noise, AIHA PDC 104, 5/04
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University of California, Berkeley, Program Manager, 1976-1977
Bechtel, Inc., Engineer, 1971-1976, 1964-1966

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Air and Waste Management Association
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Phi Beta Kappa
Sigma Pi Sigma

*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 investigations, as outlined below, for a wide range of industrial and commercial facilities including refineries, reformulated fuels projects, petroleum distribution

terminals, conventional and thermally enhanced oil production, underground storage tanks, pipelines, gasoline stations, landfills, railyards, hazardous waste treatment facilities, power plants, transmission lines, airports, hydrogen plants, petroleum coke calcining plants, 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, urea plants, food processing plants, grain processing facilities, ethanol production facilities, paint formulation plants, wastewater treatment plants, marine terminals, ports, gas processing plants, steel mills, battery manufacturing plants, pesticide manufacturing and repackaging facilities, pulp and paper mills, redevelopment projects (e.g., Mission Bay, Southern Pacific Railyards, Moscone Center expansion, San Diego Padres Ballpark), residential developments, commercial office parks, campuses, shopping centers, server farms, 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 a coalition of Nevada labor organizations, 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. Prepared about 100 pages of technical analyses and comments on BACT, MACT, emission calculations, and enforceability.
- For petitioners and plaintiffs, review and prepare comments on air quality and hazardous waste based on negative declaration for refinery ultra low sulfur diesel project located in SCAQMD. Review responses to comments and prepare response. Prepare declaration and present oral testimony before SCAQMD Hearing Board on exempt sources (cooling towers) and calculation of potential to emit under NSR. (Los Angeles Superior Court).
- 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. U.S. et al. v. Chevron U.S.A. (Northern District of California).
- For petitioners, prepare 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).
- 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.

Prepared written comments on BACT, MACT, and enforceability on draft air permit for same facility.

- For property owners in Nevada, evaluate 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.
- For environmental organizations, reviewed draft PSD permit for a 600-MW coal-fired power plant in West Virginia. Prepared comments on permit enforceability; coal washing; BACT for $SO_2$ and PM10; Hg MACT; and MACT for HCl, HF, and non-Hg metallic HAPs. 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. Sierra Club et al. v. Georgia Power Company (Northern District of Georgia). Summary Judgment Order issued December 14, 2004 granting plaintiffs' motion as to opacity violations and startup not defense to violations.
- For building trades, reviewed air quality permitting action for 1500-MW coal-fired power plant before the Kentucky Department for Environmental Protection.
- Expert witness for plaintiffs in Sierra Club et al. v. Natural Resources & Environmental Protection Cabinet, Division of Air Quality and Thoroughbred Generating Company et al, an administrative challenge 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.
- For citizens group in Massachusetts, reviewed, commented on, and participated in permitting of pollution control retrofits of coal-fired power plant.
- 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. Case in progress.

- 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 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 analyses, 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. Prepare technical comments on draft PSD permits on BACT, enforceability of limits, and toxic emissions. Review responses to comments, advise counsel on merits of cases, participate in settlement discussions, present oral and written testimony in adjudicatory hearings, and provide 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 30 large combined cycle, simple cycle, and peaker power plants in California, Arizona, Georgia, Florida, Illinois, Missouri, Oklahoma, Oregon, and elsewhere. Prepare analyses of and comments on applications for certification, preliminary and final staff assessments, and permits issued by local agencies. Present written and oral testimony before California Energy Commission and Arizona Power Plant and Transmission Line Siting Committee 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 pending.
- 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 to be 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. Currently representing neighbors on technical advisory committee established by port to implement the air quality mitigation program.
- 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, 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 PERMITTING/NEGOTIATIONS*

- 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.
- Prepare 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 Central Coast. Negotiated conditions with agencies and secured permits.
- Prepared Authority to Construct Permit for remediation of a former oil field on the 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, New Source Review, 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 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 30 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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