
Cost-Effectiveness of Proposed New Mexico Environment Department Oil and Gas Emissions Reduction Rules

Impacts and Co-Benefits of Reduced Volatile
Organic Compound Emissions from the Oil and
Gas Industry

Prepared for Environmental Defense Fund

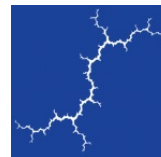
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1. INTRODUCTION

The New Mexico Environment Department recently announced proposed oil and gas emissions reduction rules (hereafter called “proposed rules”) that would require a set of actions to reduce pollutant emissions of volatile organic compounds (VOC) from the oil and gas industry in New Mexico. These rules also reduce methane emissions as a co-benefit; however, reducing methane flaring is not included in these proposed rules.¹ Methane emissions can occur in the production, processing, or delivery phases of the oil and gas supply chain. The total cumulative methane emissions reduction expected to be realized by the proposed rules over a 10-year period (2020–2030) is 8.6 million tonnes. Similarly, the total cumulative VOC emissions reduction required by these controls is approximately 3 million tonnes. Though these proposed rules set specific requirements or performance standards intended to achieve emissions reductions, they do not always specify a mitigation technology. Rather, by setting standards the proposed rules allow for flexibility and encourage innovation in pollution control technologies.²

Though reducing pollutant emissions has many benefits for the people of New Mexico, there are also costs to implementing the recommended standards. On behalf of Environmental Defense Fund (EDF), Synapse Energy Economics, Inc. (Synapse) performed a benefit-cost assessment of the proposed rules for New Mexico. In developing the analysis presented in this report, Synapse relied upon calculations conducted by EDF and Spherical Analytics for emission reductions that would result from implementation of the recommended standards (see APPENDIX C. Emissions Reduction Data by County). The sections below present Synapse’s approach and results.

The Environment Department’s proposed emissions rules currently exempt two classes of sites from the regulation: (1) sites with stripper wells, which over the course of a year produce less than 10 barrels of oil per day, less than 60,000 standard cubic feet of gas per day, or less than 10 barrels of oil equivalent of both oil and gas per day, and (2) sites with wells having a potential to emit less than 15 tons of VOCs per year. According to EDF’s analysis, 95 percent of producing wells in New Mexico fall into one of these two categories.³ Therefore, this analysis evaluates the cost-effectiveness of the proposed rules without

¹ The accompanying proposed emissions rules drafted by the Oil Conservation Division include reduced methane flaring. This report does not analyze the additional impact of those proposed rules.

² New Mexico Environment Department (NMED). Draft Ozone Precursor Rule for Oil and Natural Gas Sector. July 20, 2020. See <https://www.env.nm.gov/new-mexico-methane-strategy/wp-content/uploads/sites/15/2020/07/Draft-Ozone-Precursor-Rule-for-Oil-and-Natural-Gas-Sector-Version-Date-7.20.20.pdf>.

³ Oil and gas facilities are required to have Minor permits if they have any regulated air contaminant emissions above 25 tons per year. EDF downloaded all oil and gas production facilities permits from this NMED website: <https://air.net.env.nm.gov/rsmt/>. NMED is correct in claiming that almost all their permits are above the 15 tons per year threshold; however, less than 1% of oil and gas facilities in the state have a permit. Since the threshold for permits (25 tons per year) is higher than the 15 tons per year potential to emit exemption threshold, EDF also analyzed Notice of Intent (NOI). Oil and gas facilities are required to submit a NOIs if they have any regulated air contaminant emissions above 10 tons per

any exemptions, to determine whether removing the exemptions would result in rules that would have a negative impact on New Mexico.

2. COST-EFFECTIVENESS EVALUATION

In order to determine the cost-effectiveness of the proposed rules without exemptions, Synapse calculated the benefits of reducing methane and VOC emissions and the costs of reducing those emissions. Together, the benefits and costs come together to yield a benefit-cost ratio (BCR). In this section, we discuss the benefit types evaluated in this study, followed by the costs associated with the regulation. In the following section we present a description of the three BCRs used to evaluate the proposed rules for New Mexico.

2.1. Benefits Estimation

Synapse quantified four categories of benefits from the proposed set of regulations: (1) the human health benefits of reduced air pollution; (2) the reduced cost of compliance with federal ozone regulations; (3) the value of captured gas that would otherwise be vented or flared; and (4) the global social benefit from the reduction in greenhouse gas emissions. We discuss the methodology for each category below.

Human Health Benefits

Exposure to air pollution from fossil-fuel production and combustion can exacerbate human respiratory disease, cause heart attacks, and lead to premature death. Illnesses from air pollution can also result in other costs to society, such as medical costs and lost wages to treat and recover from the illness. Oil and gas operations are associated with forms of air pollution during the fuel extraction process, including methane gas flared into the atmosphere (i.e., burned and converted into carbon dioxide and other compounds). Furthermore, VOCs released during oil and gas production can react with existing nitrogen oxides (NO_x) in the atmosphere to form ground-level ozone, which can lead to respiratory diseases.⁴

Synapse utilized U.S. Environmental Protection Agency's (EPA) CO-Benefits Risk Assessment (COBRA) tool to quantify a portion of the human health benefits of reduced emissions associated with the proposed rules.⁵ COBRA estimates both health and health-related economic impacts of changes in

year. The NMED methane map (<https://gis.web.env.nm.gov/oem/?map=methane>) includes NOIs along with permits. EDF's analysis indicates about 95% of production facilities in the state will be exempt under the NMED's initial proposed draft rule.

⁴ U.S. EPA, Health Effects of Ozone Pollution. Available at: <https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution>. Accessed 2019.

⁵ U.S. EPA, CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool. Available at: <https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool>.

pollutant emissions for a given geography. COBRA quantifies human health impacts from reductions of the following air pollutants: PM_{2.5}, sulfur dioxide (SO₂), NO_x, ammonia (NH₃), and VOCs. COBRA does not quantify the impact of direct methane emissions into the atmosphere, but it can quantify the impacts of its combustion (flaring) products (SO₂ and NO_x).

Because the proposed rules do not require a reduction in emissions from methane flaring, we focused solely on health benefits associated with reduced particulates from reduced VOC emissions. The value of direct health impacts of reduced ground-level ozone (smog) was excluded due to the complexity of the process by which ozone is created in the atmosphere. Nonetheless, as the following section on ozone air quality regulations indicates, the proposed rules would have a substantial positive effect on human health from the reduction in ground-level ozone exposure. Because PM_{2.5} and ozone were excluded from the health impacts analysis, we consider our calculation of the benefits associated with the proposed rules to be conservative. Actual benefits are likely to be greater than estimated in this report.

Avoided NAAQS Nonattainment Costs

Atmospheric concentrations of ozone in the state of New Mexico have risen rapidly in recent years, increasing the risk of violating the U.S. EPA's National Ambient Air Quality Standards (NAAQS) for ground-level ozone. Many of the increases in ozone are concentrated in areas of increasing oil and gas production and, therefore, increasing air pollution. VOCs react with NO_x to generate ozone, so regulatory actions to limit VOC emissions from the oil and gas industry should reduce ozone concentrations, all else being equal. Failure of a county to meet the EPA's ozone threshold of 70 parts per billion (ppb) results in both direct and indirect economic costs to residents and businesses in the area (in addition to the human health costs discussed above). For example, once an area is in nonattainment (i.e., has exceeded the ozone threshold), new potential sources of emissions must be reviewed through a permitting process and various programs related to transportation emissions become required. If emissions are not brought down quickly, further measures may be imposed. These measures can impede economic development by requiring greater investment in pollution controls for expanded or new facilities. This process creates localized costs of doing business that could encourage development to happen elsewhere—in a different county of New Mexico or in another state entirely.

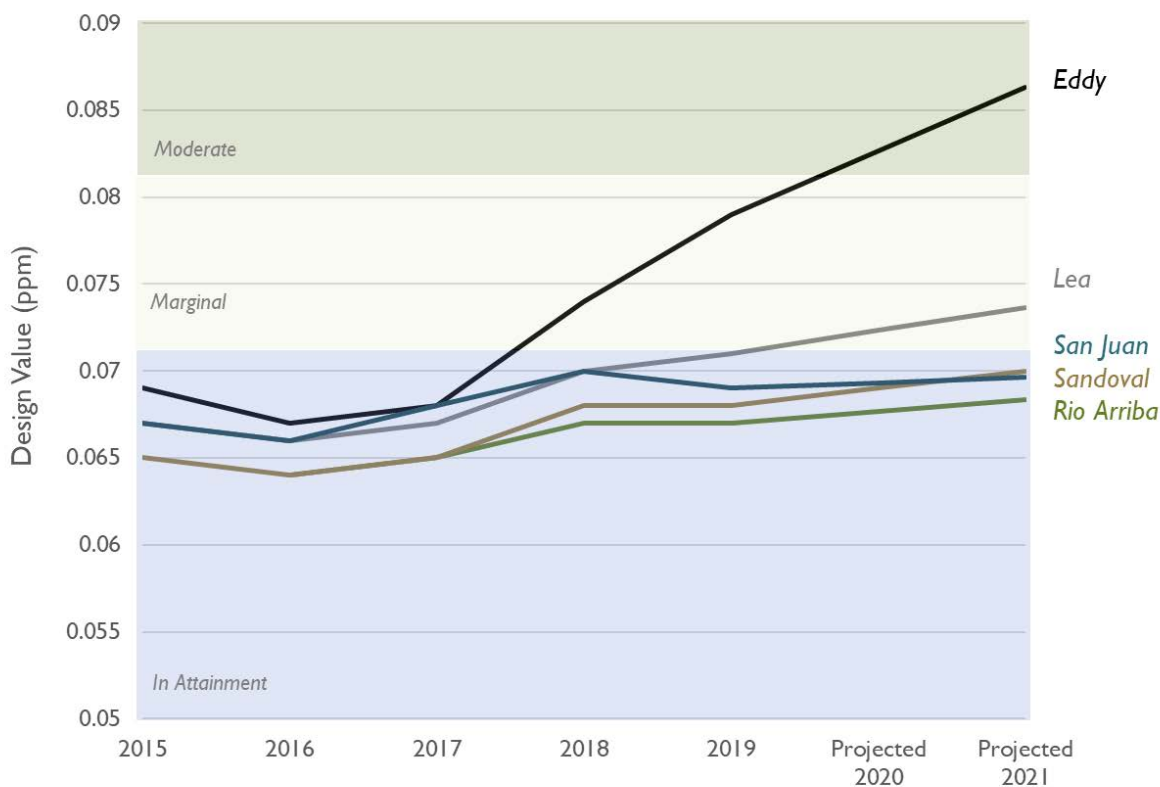
Nonattainment is classified in multiple levels of severity depending on ozone concentration. Each level has its own requirements that become more severe and require more time for remediation at higher ozone concentration levels. In our analysis, we examined data from the five counties in New Mexico with EPA air monitoring stations that overlapped with our emissions data.⁶ Nonattainment classification is based on the “design value,” which is the three-year average of the monitor's fourth highest eight-hour average ozone reading in each year. Among the five oil and gas producing counties, only Eddy and Lea Counties had locations with design values above the nonattainment threshold as of the end of 2019. It is impossible to determine exactly how severe future ozone design values will be, but an estimate can be obtained through historical growth rates in annual ozone values. Figure 1 shows this increase in

⁶ Other counties may have poor or worsening air quality but are not monitored.



ozone design values (three-year average) between 2015–2021, with 2020 and 2021 representing projected values. Design values for 2020 and 2021 are calculated by continuing the average growth trajectory of the three previous years. Assuming this conservative level of growth, by 2021 Eddy County will enter moderate nonattainment and Lea County remains in marginal nonattainment. Design values for Rio Arriba, Sandoval, and San Juan Counties under these assumptions would be under 70 ppb and thus technically in attainment by 2021; but increases in their annual ozone values would push those counties into nonattainment as well.

Figure 1. Projected ozone design values to 2021



Source: Synapse calculations based on EPA historical design values.

Our projection supports the idea that nonattainment is an imminent threat and the resulting regulatory costs are highly probable in the near term unless actions are taken. The proposed rules could help the state avoid the costs associated with nonattainment, as well as avoid the human health impacts of higher ground-level ozone levels. Once a county falls into a nonattainment status of moderate or above, the state must file a state implementation plan (SIP) that outlines its path to compliance. At the moderate nonattainment level, the SIP must include developing a major emissions statement and conducting a transportation conformity demonstration, including a motor vehicle emissions budget. Furthermore, all major emissions sources greater than 100 metric tonnes per year must go through new source review and permitting. These major emissions sources are also required to purchase offset

credits to ensure there is no increase in emissions. At the moderate level, there is also the requirement to impose reasonably available control technology on all major emitting sources, reduce VOC emissions by 15 percent of the county's baseline, and impose a vehicle inspection and maintenance program.

For our analysis, we modeled avoided costs based on a moderate nonattainment level using information from two reports from Texas, one developed by the Capital Area Council of Governments (CAPCOG) and the other conducted for the Alamo Area Council of Governments focusing on the San Antonio metropolitan area.^{7,8} These studies occurred after NAAQS standards were made more stringent—decreasing from 75 ppb to 70 ppb in 2015—after which a number of counties fell into nonattainment, including those outlined in these reports. It is difficult to quantify the specific costs of compliance actions because, while there are general benchmarks that must be met, how a state decides to meet them can be very different. Our analysis attempted to quantify the hard costs associated with nonattainment, including permitting, offsets, and vehicle inspection and maintenance. Because our analysis is forward-looking, we could not reasonably estimate some of the softer costs associated with nonattainment, such as the loss of business expansion due to permitting costs.

Overall, the most significant costs identified in our nonattainment analysis stem from increased permitting costs and the cost of offset purchases. These costs are incurred because any new major emitting source above 100 tonnes per year of NO_x or VOCs that is built in the state under nonattainment must go through a special permitting process. In addition, any new emissions source must purchase offset credits equal to 1.15 times the tonnes per year amount in the permit. Using data from the New Mexico Environment Department Air Quality Bureau, we were able to approximate the size and quantity of permits by county. We took offset prices from 2017 California Air Resources Board (CARB) data and used them to determine total offset costs.⁹ The costs of vehicle inspection and maintenance programs were calculated using inspection and repair costs outlined in the Texas reports multiplied by the number of vehicles in New Mexico. We calculated vehicle quantities using populations by county and motor vehicle registrations in the state to determine vehicles per county. Finally, the cost of a 15 percent reduction in VOCs was calculated using EPA data of VOC emissions in the state of New Mexico and CAPCOG's estimate of the cost per tonne of VOC reduction.¹⁰

⁷ Capital Area Council of Governments (CAPCOG). 2015. *The Potential Costs of Ozone Nonattainment Designation to Central Texas*. Available at: http://www.capcog.org/documents/airquality/reports/2015/Potential_Costs_of_a_Nonattainment_Designation_09-17-15.pdf.

⁸ Navin, S. et al. 2017. *Potential Cost of Nonattainment in the San Antonio Metropolitan Area*. Available at: <https://www.tceq.texas.gov/assets/public/agency/nc/air/Appendix-B-for-EPA-HQ-OAR-2018-0635.pdf>.

⁹ California Air Resources Board, New Source Review - Emission Reduction Credit Offsets. Available at: <https://ww3.arb.ca.gov/nsr/erco/erc17.pdf>. Accessed 2019.

¹⁰ CAPCOG. 2015. *The Potential Costs of Ozone Nonattainment Designation to Central Texas*. Pg. 77.

Value of Captured Gas

Methane that is produced (either as the primary product or associated with oil production) can have one of three fates: (1) it is captured into the pipeline infrastructure and carried downstream to eventual customers; (2) it is lost or purposely emitted into the atmosphere; or (3) it is burned in a flare. One effect of the proposed regulations would be shifting methane that would have been emitted or flared into the captured category. Captured gas has economic value, so the increased capture results in an economic benefit attributable to the regulation.

Synapse calculated the value of the captured gas to gas producers in New Mexico using a method based on revealed market prices, combined with expert assessment of the impact of increased gas pipeline capacity. Gas prices paid to producers in New Mexico are lower than the Henry Hub price (the most common national benchmark for natural gas prices) because of the cost to transport gas to the national market. This difference between Henry Hub and New Mexico gas prices is called the “basis.”

In New Mexico, oil and gas is primarily produced in two locations: the Permian Basin (southeastern New Mexico) and the San Juan Basin (northwestern New Mexico). We used market forward prices from CME Group for basis futures in the Permian and San Juan areas to calibrate current expected basis estimates.^{11,12} At each location, we calculated the average expected future basis for the next 18 months (through the end of 2021). In the Permian Basin, this average is \$0.39 per mcf, while in the San Juan Basin the average is \$0.30 per mcf. These 18-month averages are also very close to the midpoint between the highest and lowest monthly expected bases in each basin.

We used the market projections of the Henry Hub natural gas price as revealed in the price of market forward purchases on the NYMEX exchange.¹³ These values tend to be lower than the U.S. Energy Information Administration’s projections from the Annual Energy Outlook, so the gas value reflected using these prices is a conservative estimate. In 2019 dollars, the market projection of Henry Hub prices is nearly flat, ranging between \$2.23 per mcf and \$2.29 per mcf in all years except for 2021 and 2022, when the futures market expects somewhat higher prices (\$2.59 and \$2.39 per mcf, respectively).

Pipeline capacity out of both the Permian and San Juan production areas is currently constrained. This is demonstrated by the fact that the value of gas in New Mexico is substantially lower than the national Henry Hub price. Pipeline companies have begun substantial new investments in pipeline capacity to relieve these constraints. For example, the U.S. Energy Information Administration is tracking the progress of six announced pipelines or expansions to transport gas from the Permian Basin, totaling over

¹¹ CME Group, “Permian Natural Gas (Platts IFERC) Basis Futures Quotes.” Accessed July 31, 2020 at <https://www.cmegroup.com/trading/energy/natural-gas/el-paso-permian-basin-natural-gas-basis-swap-futures-platts-iferc.html>.

¹² CME Group, “San Juan Natural Gas (Platts IFERC) Basis Futures Quotes.” Accessed July 31, 2020 at <https://www.cmegroup.com/trading/energy/natural-gas/san-juan-basin-natural-gas-basis-swap-futures-platts-iferc.html>.

¹³ CME Group, “Henry Hub Natural Gas Futures Quotes.” Accessed July 31, 2020 at <https://www.cmegroup.com/trading/energy/natural-gas/natural-gas.html>.

8.4 billion cubic feet (Bcf) per day. Three new pipelines or expansions totaling 2.43 Bcf per day of capacity came online in 2019.¹⁴ As these pipelines enter service, the basis should decline. McKinsey & Company estimates that the basis should shrink to \$0.10 per mcf once the constraints are relieved.¹⁵ This remaining cost reflects the continued cost of transporting the gas away from New Mexico to the national market. We assumed that this new equilibrium would be established by 2025, with the basis declining linearly to \$0.10 per mcf between 2021 and 2025. Subtracting the basis projection from the Henry Hub projection results in a projected net value of gas to New Mexico producers, by region (Figure 2).

The State of New Mexico will see some direct fiscal benefit from the increased capture and sale of gas resulting from these regulations, including federal royalties that are returned to the state, state trust royalties, emergency school tax, severance tax, conservation tax, and ad valorem production tax.¹⁶ The county-specific fractions of the gas value that would flow as royalties were provided directly by Spherical Analytics. Though the fiscal benefit from increased royalties does not impact the BCRs, we present the percentage of royalty benefit and absolute fiscal benefit by county in New Mexico.

¹⁴ U.S. Energy Information Administration, "Pipeline projects." Accessed August 10, 2020 at <https://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects.xlsx>.

¹⁵ Brick, J. 2018. "Permian, we have a gas problem(s)." McKinsey & Company, July 1, 2018. <https://www.mckinsey.com/industries/oil-and-gas/our-insights/petroleum-blog/permian-we-have-a-gas-problems>.

¹⁶ The tax calculations assume that 49 percent of federal royalties (a rate of 12.5 percent) are returned to the state of New Mexico; the state trust royalty tax rate is 19 percent; emergency school tax is 4 percent, severance tax is 3.75 percent; conservation tax is 0.19 percent; and the ad valorem tax varies by land type (ranging from 0.82 percent on tribal land to 1.39 percent on private land).

Figure 2. Projected value of captured gas in the San Juan and Permian regions, 2020–2030



Source: Synapse calculations based on market futures prices for Henry Hub natural gas prices and near-term bases.

Avoided Greenhouse Gas Costs

Synapse quantified the impact that reducing methane emissions has on mitigating climate change, including reducing damages associated with the spread of disease, coastal destruction, and decreased food security. We applied the societal cost of methane calculated by the U.S. Government Interagency Working Group (IWG) in 2016, as calculated using a 3 percent real discount rate.¹⁷ The 3 percent discount rate was selected for this analysis because the IWG considers it a central estimate based on average climate outcomes. This cost is equivalent to \$1,462 per tonne of methane in 2020 and escalates to \$1,949 per tonne in 2030 (2019 dollars).

¹⁷ Interagency Working Group on Social Cost of Greenhouse Gases. 2016. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. Available at: https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf.

2.2. Cost Estimation

Oil and gas producers in New Mexico will incur costs in order to comply with the proposed rules. Synapse researched and compiled compliance costs by source of methane on a dollar-per-mcf and dollar-per-metric-tonne basis. We then calculated total costs by county using annual methane and VOC emissions reduction potential provided by Spherical Analytics.

The 15 emissions sources outlined in our study can be broadly classified in two categories: vented and fugitive emissions. Vented emissions are the intentional release of gases (e.g., flaring and venting), while fugitive emissions are the result of unintentional gas leaks from various valves, pumps, and other equipment throughout the production, gathering, and boosting processes. Reductions in vented emissions are primarily accomplished through increasing gas capture with vapor recovery units (VRU) and zero-emissions equipment. Reductions in fugitive emissions come from quarterly leak detection and repair (LDAR).

The proposed state emissions rules address only fugitive methane emissions, as they do not address gas venting and flaring. Within the category of fugitive emissions, the largest methane reduction potential comes from equipment malfunctions (i.e., “abnormal emissions”), which represent 79 percent of the total methane emission reduction potential and 65 percent of VOC reduction. Abnormal emissions are measured by comparing the difference between top-down site-level measurements and bottom-up aggregation of source-level emissions.¹⁸ Total site emissions can be calculated by using optical gas-imaging cameras downwind of production facilities.¹⁹

¹⁸ Zavala-Araiza, D. et al. 2017. *Super-emitters in natural gas infrastructure are caused by abnormal process conditions*. Available at: <https://www.nature.com/articles/ncomms14012>.

¹⁹ EDF Methodology. Available at: <https://www.edf.org/nm-oil-gas/methodology/>. Accessed 2019.

Table 1. Emissions sources and corresponding abatement technology and unit cost

Emission Source	Technology	Unit Cost (\$/mcf of reduced methane)	Unit Cost (\$/tonne of reduced methane)	Source
Abnormal Emissions	<i>Quarterly LDAR*</i>	\$0.00	\$0.00	ICF, 2015
Associated gas flaring	VRU	\$4.18	\$217.36	CARB, 2017
Associated gas venting	VRU	\$4.18	\$217.36	CARB, 2017
Centrifugal compressors	Wet Seal Degassing Recovery System for Centrifugal Compressors	\$0.82	\$42.64	CARB, 2017
Dehydrators	VRU	\$4.18	\$217.36	CARB, 2017
Gathering station blowdowns	Transmission Station Venting -Redesign Blowdown Systems /ESD Practices	\$3.84	\$199.68	ICF, 2016
Gathering stations	LDAR (weighted average)	\$7.35	\$382.20	ICF, 2015
High-bleed pneumatic controller	High-bleed to zero-bleed pneumatic controller	\$7.89	\$410.14	Carbon Limits, 2016
Leaks	LDAR (weighted average)	\$7.35	\$382.20	ICF, 2015
Liquids unloading	Liquid Unloading - Install Plunger Lift Systems in Gas Wells	\$5.03	\$261.56	ICF, 2016
Low-bleed pneumatic controller	Low-bleed to zero-bleed pneumatic controller	\$49.30	\$2,563.40	Carbon Limits, 2016
Malfunctioning pneumatic controllers	<i>Quarterly LDAR*</i>	\$0.00	\$0.00	ICF, 2015
Oil and condensate tanks	VRU	\$4.18	\$217.36	CARB, 2017
Pneumatic pump	Solar electric pneumatic pump replacement	\$4.86	\$217.36	ICF, 2016
Reciprocating compressors	Replacement of Reciprocating Compressor Rod Packing Systems	\$1.83	\$95.16	CARB, 2017

Note: Abnormal emissions and malfunctioning pneumatic controllers are addressed by quarterly LDAR for leaks and gathering stations, therefore their costs are not repeated.

All types of fugitive emissions can be mitigated through LDAR. LDAR is one of the most common emission mediation methods and is relatively inexpensive to implement on a cost-per-volume basis. The cost of LDAR is primarily associated with the labor cost of sending a technician to the site. We assume that all abnormal emissions (including those from malfunctioning pneumatics) will be identified and addressed as part of the quarterly LDAR process. Therefore, we conclude that there is no additional cost associated with those two source categories.

Retrofitting high- and low-bleed pneumatic controllers with zero-bleed alternatives represents the second-largest emissions reduction category (7 percent). Pneumatic controllers are also the most significant cost driver, as there is a higher capital cost relative to the volume of gas savings. It should be noted that all costs per unit of emissions reduction are variable, and this is particularly true for zero-

bleed systems. In the face of this variability we have taken a conservative approach which likely over-represents these costs.

Sources of Cost Data

Synapse compiled abatement technology cost data from several sources. Given that LDAR makes up a substantial portion of the emissions reductions in this analysis, we utilized a source specific to LDAR that calculated costs using facility models and Monte Carlo simulations.²⁰ Zero-bleed pneumatic controller costs were calculated using a Carbon Limits tool developed for the Clean Air Task Force.²¹ For the remaining technologies, we use a 2017 CARB report for the costs it contains (including VRU, wet seal degassing, and reciprocating compressors) because it was the most recent source of methane abatement technology costs.²² The remainder of costs that were not covered by other more recent sources were sourced from two reports by ICF International, one prepared for EDF in 2014 and the other prepared for One Future, Inc. in 2016.²³ In all cost categories for which we relied on an ICF International report, the two reports agreed and we have cited the 2016 report. Table 1 summarizes each emissions source analyzed by Spherical, the technology used, and the cost of emissions reduction on a dollar-per-mcf and dollar-per-tonne basis.

3. BENEFIT-COST RESULTS

3.1. Benefit-Cost Ratio Definitions

Comparing the benefits and costs described above yields a BCR with the discounted benefits in the numerator and the discounted costs in the denominator. A BCR above 1 indicates that the program is cost-effective because the total lifetime benefits outweigh the total lifetime costs of the regulation. In contrast, a BCR below 1 indicates that the program is not cost-effective because the costs are higher than the benefits. All costs and benefits in this analysis were discounted at a rate of 3 percent and in constant 2019 dollars. Synapse calculated three distinct BCRs, each different in which benefits are included in the numerator of the ratio:

²⁰ ICF International. 2015. *Leak Detection and Repair Cost-Effectiveness Analysis* (Revised 2016). Available at: https://www.edf.org/sites/default/files/content/edf_ldar_analysis_120415_v7.pdf.

²¹ Carbon Limits. 2016. *Zero emission technologies for pneumatic controllers in the USA*. Available at: <https://www.ourenergypolicy.org/wp-content/uploads/2014/04/epa-devices.pdf>.

²² California Air Resources Board. 2017. Regulation for greenhouse gas emission standards for crude oil and natural gas facilities, Attachment 2. Available at: <https://ww3.arb.ca.gov/regact/2016/oilandgas2016/oilgasatt2.pdf>

²³ ICF International. 2014. *Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries*. Available at: https://www.edf.org/sites/default/files/methane_cost_curve_report.pdf; ICF. 2016. *Economic Analysis of Methane Emission Reduction Potential from Natural Gas Systems*. Available at: <http://onefuture.us/wp-content/uploads/2018/05/ONE-Future-MAC-Final-6-1.pdf>

1. **New Mexico BCR:** This ratio includes the benefits of captured gas, avoided health impacts for New Mexico, and the value of avoided NAAQS nonattainment. These benefit streams are the most tangible benefits to New Mexicans. Though the NAAQS nonattainment benefits have a high degree of uncertainty, we consider this ratio to be conservative because the local health benefits associated with reduced ground-level ozone are not included.
2. **National BCR:** In addition to the benefits of the New Mexico BCR, this ratio also includes the avoided health impacts for the rest of the contiguous United States. This ratio quantifies the benefits of the proposed rules to the entire country.
3. **Global BCR:** In addition to the benefits of the National BCR, this ratio also includes the greenhouse gas benefit of avoided methane emissions. This benefit is only included in the Global BCR because the value will accrue to the benefit of people around the world, rather than just to Americans.

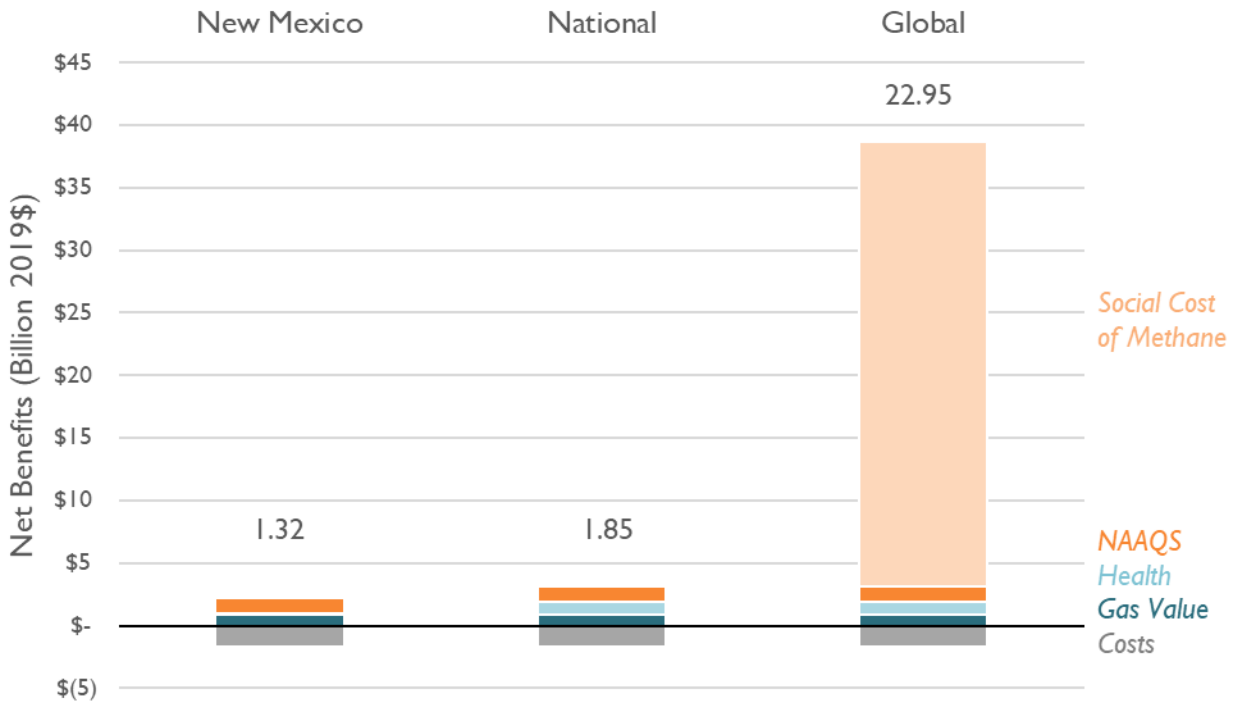
3.2. Overview of Results

The proposed oil and gas emission reduction rules were found to be cost-effective across all three BCRs. The New Mexico BCR, which is considered the most conservative ratio, is 1.32 over the 11-year study period. If negative health impacts from ground-level ozone were quantified, this ratio would be higher. Based on this perspective, for every \$1 million of costs associated with the proposed rules, New Mexicans are expected to benefit by at least \$1.32 million from captured gas revenue, reduced health-related costs, and reduced NAAQS compliance costs. This translates to a net benefit of \$0.49 per mcf of recovered methane.

The National BCR, which also includes the human health benefits to the rest of the contiguous United States from particulates associated with reduced VOC emissions, is 1.85 over the 11-year study period. In this case, for every \$1 million of costs associated with the comprehensive controls, the United States is expected to benefit by at least \$1.85 million from captured gas revenue, reduced health-related costs, and reduced ozone regulation compliance costs. This translates to a net benefit of \$1.30 per mcf of recovered methane.

Finally, the Global BCR—which includes all benefits from the National BCR, plus the avoided social cost of methane—is 22.95 over the 11-year study period. For every \$1 million of costs associated with the proposed rules, we calculate a global benefit of at least \$22.95 million from captured gas revenue, reduced health-related costs, reduced ozone regulation compliance costs, and mitigation of climate change. This translates to a net benefit of \$33.36 per mcf of recovered methane.

Figure 3. Net benefits and benefit-cost ratios for the proposed rules in New Mexico



Source: Synapse calculations.

3.3. Cost Summary

In total, the comprehensive controls are expected to achieve a 450 million mcf reduction in methane emissions and nearly 3 million tonnes reduction of VOCs from 2020–2030. The total compliance cost of \$1.7 billion translates to \$3.75 per mcf of methane reduced or \$195.50 per tonne of methane gas emissions reduced, in 2019 dollars. Furthermore, this translates to \$573.40 per tonne of VOC reduced. About 77 percent of the cost is associated with zero-bleed controllers.

Table 2. Total cost of methane and VOC reduction by emissions source

Emission Source	Methane Reduction (million mcf)	VOC Reduction (thousand tonnes)	Discounted NPV Cost (2019\$ millions)
Abnormal Emissions	354	1,920	\$0
Gathering Stations	19	105	\$127
High-Bleed Pneumatic Controller	2	8	\$12
Leaks	26	116	\$177
Liquids Unloading	13	47	\$57
Low-bleed Pneumatic Controller	29	118	\$1,271
Oil and Condensate Tanks	5	618	\$19
Pneumatic Pump	2	10	\$11
Total	1,199	6,959	\$1,684

Source: Spherical Analytics (emissions reductions) and Synapse calculations (costs). Values may not sum to total due to rounding.

3.4. Benefits Summary

Human Health

Reduced VOC emissions lead to lower human mortality, illnesses, and associated detriment to the economy. Though the VOC emission reductions originate in only nine of New Mexico counties, the benefits are reaped across the state as well as the country. Across New Mexico, the total discounted value of this subset of human health benefits amounts to just over \$126 million over the 2020–2030 study period. Within New Mexico, 87 percent of the health benefits from reduced VOC emissions are reaped in the nine counties where the emissions originate. Across the entire United States, the total discounted value of these health benefits amounts to about \$1 billion over the study period.

Note that these benefits do not include those associated with reduced ground-level ozone (resulting from reduced VOC emissions). As such, we consider this category of benefits to be conservative. Actual benefits are likely to be higher than what is estimated in this report.

NAAQS Avoided Nonattainment Costs

In total we found moderate nonattainment would cost the five New Mexico counties a total of \$1.2 billion (over a six-year nonattainment time period at a 3 percent discount rate), but we expect the actual impact could be much higher. This analysis excludes costs associated with project delays, decreases in gross regional product (GRP) due to loss of business expansion, and costs of point source emissions reductions through reasonably available control technology.²⁴ While more localized to individual businesses, the softer costs of nonattainment may have large effects on the local economy. These localized impacts were outside the scope of this analysis. Therefore, we note that our estimate of

²⁴ Both Texas studies were able to approximate these costs, finding tens of billions of dollars in losses in GRP.

avoided nonattainment benefits is very conservative, and the BCRs are likely higher than calculated in this report.

Table 3. Present value of cost of moderate nonattainment

Measure	Discounted NPV (Millions 2019\$)
NSR Permitting	\$23
Offset	\$647
Transportation Conformity	\$0.04
Vehicle I-M	\$10
15% VOC RFP	\$541
Total	\$1,220

Source: Synapse calculations.

Examining each county individually, we found that the total costs at risk range from \$62 million in Sandoval County to \$416 million in San Juan County (Table 4).

Table 4. Discounted value of avoided NAAQS nonattainment costs for 2020–2030, by county

County	Discounted NPV (Millions 2019\$)
Chaves	-
Colfax	-
Eddy	\$236
Lea	\$369
McKinley	-
Rio Arriba	\$138
Roosevelt	-
San Juan	\$416
Sandoval	\$62
All	\$1,220

Source: Synapse calculations. Note: Chaves, Colfax, McKinley, and Roosevelt Counties do not have air quality monitoring stations; therefore, we could not conduct the analysis for those four counties.

Value of Captured Gas

The value of captured gas from the comprehensive controls over the period of 2020 to 2030 varies greatly by county, from about \$416,000 (McKinley) to just over \$320 million (Eddy). This variation is due in large part to the volume of captured gas in each county and in small part to the difference in gas value between the Permian and San Juan Basins. The total discounted value of captured gas from the comprehensive controls over the 11-year study period is nearly \$730 million (Table 5). Of this value,

approximately 14 percent (\$99 million) is expected to be realized by the State of New Mexico in gas royalties.

Table 5. Discounted value of captured gas and royalty revenues for 2020–2030, by county

County	Discounted NPV (Millions 2019\$)	Royalty Revenue (Millions 2019\$)	Percent of Revenue for Royalties
Chaves	\$32	\$4	13%
Colfax	\$9	\$0.8	9%
Eddy	\$267	\$37	14%
Lea	\$252	\$33	13%
McKinley	\$0.3	\$0.1	15%
Rio Arriba	\$67	\$9	14%
Roosevelt	\$3	\$0.3	10%
San Juan	\$95	\$13	14%
Sandoval	\$3	\$0.4	15%
All	\$728	\$99	14%

Source: Synapse calculations (discounted NPV) and Spherical Analytics calculations (royalty percentages). Values may not sum to totals due to rounding.

In a similar analysis, the Colorado Division of Public Health and Environment (CDPHE) conducted a cost-benefit analysis of Colorado’s emissions regulations. Its analysis aligned with our findings, concluding that the emissions regulations are cost-effective.²⁵ Furthermore, CDPHE found total annual costs of \$59.2 million compared to \$16.8 million in captured gas value, representing 28 percent of cost recovery. In our analysis, we calculated 10-year costs at \$6.4 billion and a value of captured gas of roughly \$2 billion, or 31 percent of total costs. In its analysis, CDPHE found that the costs to oil and gas companies only represented 0.4 percent of their annual revenues and that regulations would be unlikely to cause price impacts to consumers. In fact, major oil and gas companies in Colorado supported these regulations.

Avoided Greenhouse Gas Costs

Reducing methane emissions has a long-term global benefit: mitigating the costly effects of climate change (e.g., sea-level rise and property damage, increased transfer of illnesses, ecological damage). The total discounted value of this global benefit amounts to \$12.3 billion over the 2020–2030 study period (Table 6). McKinley County would generate the least of these benefits (\$6 million), while Eddy County would generate the greatest of these benefits (\$4.5 billion).

²⁵ Colorado Department of Public Health and Environment. 2014. *Cost Benefit Analysis*. Available at: <http://www.ematrix.org/files/control/BP%20Doc%20Colorado%201.pdf>.

Table 6. Discounted value of avoided social cost of methane for 2020-2030, by county

County	Discounted NPV (Millions 2019\$)
Chaves	\$540
Colfax	\$15
Eddy	\$4,500
Lea	\$4,260
McKinley	\$6
Rio Arriba	\$1,120
Roosevelt	\$44
San Juan	\$1,580
Sandoval	\$50
All	\$12,250

Source: Synapse calculations. Values may not sum to total due to rounding.

4. CONCLUSIONS

To calculate the cost-effectiveness of the proposed oil and gas emission rules in New Mexico, Synapse evaluated three BCRs of the regulation for 2020 through 2030, each with different combinations of benefit streams but the same cost assumptions. Where cost choices were available, higher technology cost assumptions were chosen to be as conservative as possible. These ratios range from conservative to comprehensive and are termed the New Mexico BCR, the National BCR, and the Global BCR. A BCR greater than 1 is considered cost-effective because the total benefits over the study period are greater than the total costs. Based on this analysis, we determined that the proposed rules are cost-effective without the existing exemptions, regardless of which BCR is used.

Synapse considers the New Mexico BCR the most conservative ratio, inclusive of benefit streams that are readily quantifiable and have a direct and tangible impact on New Mexicans. The benefits calculated as part of this ratio include only the avoided human health costs (due to reduced air pollution) for New Mexicans, the avoided NAAQS nonattainment costs, and the value of captured (i.e., non-leaked or non-vented) methane that supports the state's economy. Though nonattainment has both direct and indirect costs, Synapse limited the analysis to the direct costs, including permit and transportation programmatic costs. The resulting New Mexico BCR is 1.32.

The National BCR includes the benefits of the New Mexico BCR, plus the human health benefits reaped across the entire country. This ratio speaks to the cost-effectiveness of the proposed rules for the entire United States. The resulting National BCR demonstrates even greater cost-effectiveness, with a ratio of 1.85.

Finally, the Global BCR takes the most comprehensive view of benefits, including long-term climate benefits to the global population—not just to New Mexicans or Americans. The Global BCR includes all benefits from the National BCR, plus the avoided social cost of methane associated with methane's greenhouse gas effect on climate change. The resulting Global BCR is 22.95, demonstrating the substantial global benefits that would flow from reducing methane emissions.

This study illustrates that, regardless of the perspective of benefits, the proposed oil and gas emissions rules are cost-effective without the exemptions for sites with stripper wells or wells with a potential to emit less than 15 tons per year of VOCs.

APPENDIX A. COST CALCULATIONS

The Carbon Limits tool used in this analysis estimated methane abatement costs by calculating 10-year lifetime capital costs of the project and emissions reductions from a zero-bleed controller. Key inputs and assumptions that affected the final cost in dollars per tonne of methane emissions avoided include the number of controllers at a site, the emissions factor of a high- and low-bleed controller in cubic feet per hour, and the capital costs of the project. Included in the capital cost are the controllers, control panel, solar panel, battery backup, as well as replacement batteries and labor over the lifetime of the project. We made a conservative assumption that there is no electric connection at these sites to power the controllers and that all devices are paired with solar and battery storage. Upfront capital costs for the project totaled \$35,640 for an average site retrofit with six continuous bleed controllers (Table 7). Additional operating costs include \$1,200 every four years for battery replacement and \$480 annually for labor cost.

Table 7. Upfront capital cost of an average zero bleed controller retrofit

Type	Unit Cost	Units	Total Cost
Continuous Controller	4,000	6	\$24,000
Control Panel	4,000	1	\$4,000
Solar Panel	500	1	\$500
Battery	400	3	\$1,200
Installation Cost		20% of CAPEX	\$5,940
Total			\$35,640

The largest driver of the abatement cost for zero-bleed controllers was the emissions rate. Additionally, capital costs were the same between high- and low-bleed retrofits, therefore high-bleed devices had a much lower cost per mcf of methane emissions avoided comparative to low-bleed because their emissions reduction potential is greater. We used EPA's reported emissions rate of 13.75 standard cubic feet per hour (scfh) for high-bleed devices and 2.17 scfh for low-bleed.²⁶ Controllers per site was taken from a University of Texas at Austin study that sampled the number of controllers at 65 sites throughout the United States.²⁷ Overall, high-bleed controllers had an abatement cost of \$7.89 per mcf of methane compared to a low-bleed retrofit at \$49.3 per mcf.

²⁶ EPA. 2014. *Oil and Natural Gas Sector Pneumatic Devices*. High and low bleed available in table 2-4 at: <https://www.ourenergypolicy.org/wp-content/uploads/2014/04/epa-devices.pdf>.

²⁷ Allen, D. et al. 2014. *Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers*. Available at: <https://pubs.acs.org/doi/pdf/10.1021/es5040156?rand=pedkv1qx>.

APPENDIX B. NAAQS – NONATTAINMENT

Nonattainment costs are composed of offset trading, 15 percent baseline VOC reduction, vehicle inspection and maintenance, new source review and permitting, and transportation conformity costs. Costs were dominated by offsets and VOC reduction which together accounted for 97 percent of the total.

We approximated air permitting and offset costs using publicly available data sources through the New Mexico Environment Department Air Quality Bureau. For permitting cost, we used the annual number of new permits by county and cost per permit. First, we found the percentage of total Title V permits (major emissions sources greater than 100 tonnes per year) by county by taking total permits by county divided by the total permits in the state from the “Permitted Facilities Lat Long” dataset.²⁸ Then, annual permitting data between 2016 and 2018 was used to calculate the average number of new permits granted by year in New Mexico.²⁹ Between 2016 and 2018 there were 31 new Title V permits on average. To find new permits by county, we multiplied the county-level distribution percentage by the annual average number of Title V permits in the state of New Mexico. S. Navin, et al. estimated permitting costs between \$100,000 and \$250,000; therefore, we used the average for our cost and multiplied by annual permit count to get total cost (Table 8).³⁰

Table 8. Average Title-V permitting distribution and cost by county

County	Title-V (%)	Annual Permit Count	Average Permit Cost	Annual Permit Cost	Six-Year Permit Costs
Eddy	20.9	6	\$175,000	\$1,050,000	\$6,951,647
Lea	18	6	\$175,000	\$1,050,000	\$6,951,647
Rio Arriba	7.6	2	\$175,000	\$350,000	\$2,317,215
Sandoval	21.5	7	\$175,000	\$175,000	\$1,158,607
San Juan	2.9	1	\$175,000	\$1,225,000	\$8,110,255
ALL	70.9	22	\$175,000	\$3,850,000	\$25,489,373

Source: Synapse calculations.

²⁸ At the time of our analysis, we used the file “Permitted Facilities Lat Long as of 07/01/19.” Current version is as of 09/03/19. Available at: https://www.env.nm.gov/air-quality/aqb-p_current_permitting_activites/.

²⁹ New Mexico Environment Department. Monthly Report of Title V Permitting Activities Fiscal Year 2016-2018. Available at: <https://www.env.nm.gov/air-quality/monthly-report-of-permitting-statistics/>.

³⁰ Navin, S. et al. 2017. *Potential Cost of Nonattainment in the San Antonio Metropolitan Area*. Available at: <https://www.tceq.texas.gov/assets/public/agency/nc/air/Appendix-B-for-EPA-HQ-OAR-2018-0635.pdf>.

Under moderate nonattainment, any new major emissions source must also supply an offset equal to 1.15 times the amount specified in its permit. For offset cost we multiplied the annual number of permits filed by county and the average permit size in tonnes of both NO_x and VOC that we calculated from our initial “Permitted Facilities Lat Long” dataset. We used the maximum value between VOC and NO_x to calculate the total required offset amount. Offset costs were taken from CARB offset transactions from 2017 for both NO_x and VOCs. Average NO_x offset costs per tonne were \$13,883 and VOC were \$6,242 per tonne. We used the average of the two offset costs (Table 9).³¹

Table 9. Average Title-V emissions and offset costs by county

County	NO _x (tonnes/year)	VOC (tonnes/year)	Offset Amount (tonnes)	Offset Cost (\$/tonne)	Annual Offset Cost	Six-Year Offset Cost
Eddy	176.6	197.1	1360.1	10,062.5	\$13,686,078	\$90,610,270
Lea	587.6	134.4	4054.6	10,062.5	\$40,799,348	\$270,116,834
Rio Arriba	188.2	200.6	461.3	10,062.5	\$4,641,746	\$30,731,220
Sandoval	82.1	53.3	94.4	10,062.5	\$950,051	\$6,289,922
San Juan	589.5	164.3	4745.3	10,062.5	\$47,749,655	\$316,132,149
ALL	1,624.0	749.7	10,715.7	10,062.5	\$107,826,877	\$713,880,398

Source: Synapse calculations.

We calculated costs associated with 15 percent VOC reductions by using EPA National Emissions Inventory Data VOCs from 2014 and CAPCOG’s cost in dollars per tonne of VOC emission reductions (Table 10).³²

³¹ California Air Resources Board. 2017. New Source Review – Emissions Reduction Credit Offsets. Available at: <https://ww3.arb.ca.gov/nsr/erco/erc17.pdf>.

³² EPA National Emissions Inventory Data 2014. <https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data>.

Table 10. Estimation of 15 percent VOC reduction costs by county, 2020–2030

County	VOC Baseline (tonnes)	Reduction (tonnes)	VOC Reduction \$/ton	Total Cost
Eddy	122,785.6	18,417.8	7,965	\$161,871,974
Lea	97,680.2	14,652.0	7,965	\$128,774,782
Rio Arriba	89,329.0	13,399.3	7,965	\$117,765,088
Sandoval	43,329.6	6,499.4	7,965	\$57,122,698
San Juan	99,706.6	14,956.0	7,965	\$131,446,167
All	452,831.0	67,924.5	7,965	\$596,980,711

Source: Synapse calculations.

The remainder of costs were relatively small in comparison to offsets, and VOC reduction represented just 3 percent of total costs. A transportation conformity analysis estimated at \$0.10 per person by CAPCOG was multiplied by county-level census data to get total costs.³³ Similarly, vehicle inspection and maintenance was calculated using county-level population data in addition to vehicle registration data and CAPCOG cost estimations. CAPCOG estimated inspection and repair costs as well as the percentage of vehicles that would require repair of the total vehicles inspected. From those estimations, we calculated an average cost per vehicle at \$26.26 which includes initial inspection and a percentage of total vehicles that would require a secondary inspection and repair. Using total New Mexico vehicle registrations, we determined a statewide vehicles-per-person number based on state population. This ratio of .87 vehicles per person was multiplied by total population by county and finally by the cost of \$26.26 per vehicle for a total shown in Table 11.

Table 11. Vehicle inspection and maintenance and transportation conformity costs based on county population

County	Population	Vehicles	I-M Cost	Transportation Conformity Cost
Eddy	57,900	50,385	\$1,459,913.18	\$6,388.89
Lea	69,611	60,576	\$1,755,198.90	\$7,681.13
Rio Arriba	39,006	33,943	\$983,512.49	\$4,304.06
Sandoval	145,179	126,335	\$3,660,599.92	\$16,019.57
San Juan	125,043	108,813	\$3,152,882.96	\$13,797.70
All	436,739	380,051	\$11,012,107.45	\$48,191.36

For other cost calculations including LDAR, wet seal degassing for centrifugal compressors, and replacement of reciprocating compressor rod packing systems, we utilized values from a CARB proposed

³³ County-level population data taken from U.S. Census Bureau. <https://www.census.gov/>.

regulation.³⁴ CARB reported emissions reductions in metric tonnes of carbon dioxide equivalent (CO₂e) which we converted to tonnes of methane by dividing by IPCC's global warming potential for methane.³⁵ We then multiplied by 52 to convert tonnes to mcf.³⁶

³⁴ California Air Resources Board. 2017. *Regulation for greenhouse gas emission standards for crude oil and natural gas facilities, Attachment 2*. Available at: <https://ww3.arb.ca.gov/regact/2016/oilandgas2016/oilgasatt2.pdf>.

³⁵ Using 100-year global warming potential (25) for methane from IPCC Annual Report 4. Chapter 2 table 2.14. Changes in Atmospheric Constituents and in Radiative Forcing. Available at: <https://wg1.ipcc.ch/publications/wg1-ar4/ar4-wg1-chapter2.pdf>.

³⁶ Using a calculated tonnes to cubic feet conversion. Available at: https://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/Infographic-Climate-Risks-of-Natural-Gas-Fugitive-Emissions-Methodology-and-Assumptions.pdf.

APPENDIX C. EMISSIONS REDUCTION DATA BY COUNTY

Source	Emission Type	CHAVES	COLFAX	EDDY	LEA	MCKINLEY	RIO ARRIBA	ROOSEVELT	SAN JUAN	SANDOVAL	ALL COUNTIES
Abandoned Wells	CH4 Emissions	507	0	1,421	2,537	101	406	304	1,116	0	6,394
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	209	0	522	940	0	104	104	313	0	2,192
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Abnormal Emissions	CH4 Emissions	723,460	189,384	6,066,805	5,746,067	7,760	376,294	60,897	1,153,228	45,041	14,368,936
	CH4 Reduction	344,601	90,119	2,873,902	2,724,923	3,701	168,064	28,895	541,515	21,448	6,797,168
	VOC Emissions	239,380	4,612	1,871,394	1,721,050	169	40,159	18,336	148,488	4,556	4,048,144
	VOC Reduction	114,051	2,186	886,539	816,288	89	16,726	8,698	69,269	2,186	1,916,032
Associated gas flaring	CH4 Emissions	1,103	53	57,712	41,643	0	525	158	735	53	101,980
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	367	0	17,519	12,326	0	105	52	105	0	30,474
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Associated gas venting	CH4 Emissions	1,260	158	38,120	25,991	315	1,995	263	15,542	1,523	85,166
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	419	0	12,252	7,644	0	314	105	1,780	157	22,671
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Centrifugal Compressors	CH4 Emissions	293	0	2,926	1,873	0	176	59	293	0	5,619
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	114	0	912	570	0	57	0	57	0	1,710
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Combustion Exhaust	CH4 Emissions	3,950	1,756	32,293	32,418	63	29,471	251	61,262	3,073	164,536
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	503	251	4,149	4,149	0	3,835	0	7,921	377	21,185
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Dehydrators	CH4 Emissions	150	150	1,204	827	0	2,482	0	5,341	75	10,230

Source	Emission Type	CHAVES	COLFAX	EDDY	LEA	MCKINLEY	RIO ARRIBA	ROOSEVELT	SAN JUAN	SANDOVAL	ALL COUNTIES
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	74	0	369	221	0	369	0	812	0	1,845
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Flares	CH4 Emissions	1,131	0	16,650	17,593	0	314	63	440	63	36,254
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	378	0	5,356	5,230	0	63	0	63	0	11,089
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Gathering Pipelines	CH4 Emissions	10,195	5,622	82,084	86,582	75	77,736	600	98,576	2,474	363,944
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	3,523	1,949	28,485	30,059	0	18,215	225	23,088	600	106,143
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Gathering Station Blowdowns	CH4 Emissions	1,426	2,327	37,158	30,702	0	23,270	150	35,281	1,201	131,515
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	522	821	12,834	10,595	0	5,447	75	8,208	298	38,800
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Gathering Stations	CH4 Emissions	13,938	22,923	362,165	298,915	141	226,539	1,698	343,700	12,027	1,282,047
	CH4 Reduction	3,861	6,340	100,340	82,819	58	62,763	461	95,211	3,343	355,196
	VOC Emissions	4,811	7,924	125,727	103,794	0	53,064	566	80,516	2,830	379,232
	VOC Reduction	1,325	2,189	34,794	28,746	0	14,690	173	22,294	806	105,017
High-Bleed Pneumatic Controller	CH4 Emissions	3,737	113	11,135	14,495	0	7,776	75	9,173	453	46,958
	CH4 Reduction	2,353	78	7,008	9,129	0	4,888	52	5,767	284	29,560
	VOC Emissions	1,289	0	3,526	4,322	0	1,365	38	1,365	38	11,942
	VOC Reduction	810	0	2,222	2,719	0	863	26	863	26	7,528
Intermittent-bleed Pneumatic Controller	CH4 Emissions	4,827	815	67,197	42,688	125	108,693	376	161,159	2,445	388,325
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	1,568	0	20,761	12,733	0	21,326	125	27,598	251	84,363
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Leaks	CH4 Emissions	22,639	12,361	179,310	184,102	139	163,337	1,250	209,310	5,486	777,935
	CH4 Reduction	14,454	7,884	114,087	117,229	57	103,975	800	133,226	3,485	495,197

Source	Emission Type	CHAVES	COLFAX	EDDY	LEA	MCKINLEY	RIO ARRIBA	ROOSEVELT	SAN JUAN	SANDOVAL	ALL COUNTIES
	VOC Emissions	7,571	278	55,292	55,153	0	30,633	347	32,578	556	182,409
	VOC Reduction	4,808	172	35,262	35,147	0	19,520	229	20,779	343	116,261
Liquids Unloading	CH4 Emissions	675	825	3,074	2,175	150	229,530	75	148,471	1,650	386,625
	CH4 Reduction	378	566	1,888	1,322	0	144,432	0	93,456	1,133	243,175
	VOC Emissions	225	0	976	676	0	47,021	0	25,689	150	74,738
	VOC Reduction	187	0	560	374	0	29,332	0	15,880	187	46,520
Low-bleed Pneumatic Controller	CH4 Emissions	22,688	1,316	54,840	47,570	313	474,630	627	341,761	7,521	951,266
	CH4 Reduction	13,097	760	31,658	27,461	181	273,995	362	197,292	4,342	549,148
	VOC Emissions	7,577	0	17,346	14,152	0	101,570	188	63,309	751	204,893
	VOC Reduction	4,374	0	10,013	8,170	0	58,634	108	36,547	434	118,280
Malfunctioning Pneumatic Controller	CH4 Emissions	29,109	4,126	224,733	160,580	565	652,890	1,357	703,478	12,265	1,789,104
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	9,720	113	69,738	47,754	0	134,503	452	124,500	1,187	387,967
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Oil and Condensate Tanks	CH4 Emissions	3,782	204	40,273	36,900	51	39,660	716	52,641	869	175,095
	CH4 Reduction	2,050	95	22,074	20,214	48	21,692	381	28,843	477	95,875
	VOC Emissions	24,352	1,381	259,687	238,098	358	256,003	4,553	340,059	5,730	1,130,222
	VOC Reduction	13,297	763	142,031	130,258	191	140,029	2,478	186,022	3,146	618,215
Pneumatic Pump	CH4 Emissions	2,260	699	13,881	12,482	0	7,694	161	16,087	215	53,480
	CH4 Reduction	1,552	517	9,682	8,721	0	7,834	74	16,408	222	45,010
	VOC Emissions	752	0	4,513	3,761	0	1,236	54	2,310	0	12,626
	VOC Reduction	503	0	3,091	2,588	0	1,222	0	2,300	0	9,705
Produced Water	CH4 Emissions	1,349	9,970	76,386	112,068	75	3,298	600	19,565	1,274	224,587
	CH4 Reduction	24	174	1,334	1,957	1	58	10	342	22	3,922
	VOC Emissions	74	594	4,526	6,603	0	223	0	1,187	74	13,280
	VOC Reduction	1	10	79	115	0	4	0	21	1	232
Reciprocating Compressors	CH4 Emissions	184	184	1,720	1,167	0	2,274	0	4,854	123	10,507
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	62	0	558	372	0	434	0	806	0	2,233

Source	Emission Type	CHAVES	COLFAX	EDDY	LEA	MCKINLEY	RIO ARRIBA	ROOSEVELT	SAN JUAN	SANDOVAL	ALL COUNTIES
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Well Completions	CH4 Emissions	83	0	4,949	4,810	0	222	56	1,668	250	12,038
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	27	0	1,504	1,395	0	27	27	246	27	3,255
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Well Testing	CH4 Emissions	2	0	20	20	0	16	0	20	0	79
	CH4 Reduction	0	0	0	0	0	0	0	0	0	0
	VOC Emissions	0	0	6	6	0	2	0	2	0	16
	VOC Reduction	0	0	0	0	0	0	0	0	0	0
Well Workovers	CH4 Emissions	102	0	918	918	0	714	0	918	0	3,572
	CH4 Reduction	63	0	568	568	0	442	0	568	0	2,208
	VOC Emissions	0	0	268	268	0	89	0	89	0	714
	VOC Reduction	0	0	166	166	0	55	0	55	0	442