THE ECONOMIC IMPACT OF OIL FIELD REMEDIATION IN NEW MEXICO

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I. Executive Summary

Abundant fossil fuel resources have been one of New Mexico's most important economic assets. Prior to the COVID-19 pandemic, oil and gas production employed over 23,000 New Mexicans.[1] Then as now, the industry accounts for roughly one-third of the state's general operating revenue.

Fossil fuels are finite resources that cannot underpin New Mexico's economy forever, and reduced global demand for oil and gas will restructure New Mexico's economy, whether the state is ready for it or not. Factors such as international price wars, environmental liabilities, and the accelerating transition to renewable energy are already eroding the industry's economic dominance.

Oil and gas extraction has helped the state economically, but the tens of thousands of wells already drilled and the over 9,000 miles of pipelines currently installed on state trust and private lands in New Mexico pose environmental hazards and constitute major liabilities for the state. Although state and federal laws require oil and gas producers to plug wells and restore sites to their original form and function after production ceases, most well sites and associated infrastructure in New Mexico remain un-remediated. Moreover, low bonding requirements—a recent report estimated that financial assurance is sufficient to remediate just over 2 percent of the oil and gas infrastructure currently on state trust and private lands in New Mexico[2] – as well as the industry practice of selling off marginal wells to smaller, less financially resilient operators encourage exploration and production (E&P) companies to delay remediation and make it harder to assign liability when sites remain un-remediated.

Ensuring proper and timely industry clean-up of the over 28,000 oil, gas, and disposal wells and associated infrastructure on state trust and private lands in New Mexico can help to stabilize both jobs and revenue during the transition and mitigate clean-up liabilities. Remediation would forestall or reverse job losses arising from factors such as the COVID-19 pandemic and the global transition away from fossil fuels, as well as those resulting from routine price volatility in oil and gas markets.

This study estimates the jobs that could be created if oil and gas producers were to promptly remediate the unplugged oil and gas wells and associated infrastructure currently on state trust and private lands in New Mexico. Such an effort would inject over $8.2 billion into the New Mexico economy and support 65,337 job years (three years of employment for 21,779 New Mexicans) paying $4.1 billion in wages, salaries, and benefits to employees and sole proprietors. The economic benefits of remediation would accrue statewide but would be concentrated in Lea, Eddy, and San Juan counties where most of the work would occur. Similarly, a wide variety of industries throughout the state would benefit from intensified remediation, but oil and gas field services and non-residential construction would receive the biggest boost. Gross receipts and state personal income taxes levied on the value of reclamation services would generate $541 million in additional revenue for the State of New Mexico and the local jurisdictions, primarily counties, where the remediation work occurs.

The legal responsibility for clean-up resides with oil and gas companies, and the significant positive economic benefits of remediation will only accrue if the work is funded with out-of-state resources (e.g., oil and gas company shareholders or, in the case of bankruptcy, by holders of the financial assurance). Conversely, remediation funded by state or local governments would have minimal net impact on the New Mexico economy because these entities are required to balance their budgets and therefore any revenue devoted to remediation would have to be diverted from other public programs and beneficial uses. It is also worth noting that when companies walk away from their clean-up obligations entirely or have insufficient financial assurances to cover the full cost of remediation, the State of New Mexico ends up footing the clean-up bill.

Federal funding for reclamation would also constitute a net injection of capital to the state and thus produce a positive regional economic impact. However, current proposals for federally funded clean-up of orphan wells would produce just a fraction of the economic benefits that would result from oil and gas companies fulfilling their legal clean-up obligations; because orphan wells constitute only about 1 percent of all wells in New Mexico.

While remediation cannot fully replace the jobs and economic benefits generated by oil and gas extraction, nor the revenue generated by taxes and royalties on the value of oil and gas extracted in New Mexico, it can put surplus labor and idle capital back to productive use in the oil field, while also helping to address the environmental and public health risks posed by the tens of thousands of unplugged wells and additional oil and gas infrastructure scattered throughout New Mexico.

While the economic impact of remediation may seem small in comparison to the statewide economic impact of New Mexico's oil and gas extraction industry; they are hardly insignificant. Reclamation cannot fill the gap that a declining oil and gas sector will create in New Mexico's economy, but it can help to soften the impact of this virtually inevitable outcome while simultaneously addressing a significant source of environmental toxins and greenhouse gases, setting the stage for economic diversification by making New Mexico a cleaner, healthier, more desirable place to live, work, and invest.

II. Introduction

State law requires producers of oil and gas from state and private lands in New Mexico to remediate production sites and associated infrastructure when production permanently ceases.[3] [4] Remediation is a three-stage process that entails: (1) cleaning and plugging wells to prevent the contamination of ground water and the release of toxins, such as methane, into the atmosphere; (2) removal of all equipment and waste materials from the site, and (3) restoration of all surface areas to their pre-development form and function. Producers are required to post modest bonds with the state to help ensure that sites are remediated, though a recent study shows that financial assurances cover only about 2 percent of clean-up costs for oil and gas sites on state and private land in New Mexico. Once state regulators confirm that a site has been fully remediated the bonds and the site are released.

The drilling technologies that have fueled growth in the Permian have also increased financial risks to the state. Horizonal wells produce a large volume of oil over a relatively short period of time and are largely depleted in under three years. These wells are also deeper and often much more costly to remediate than traditional vertical wells.

Average actual plugging costs for wells on the Texas side of the Permian are published annually by the Texas Railroad Commission (RRC). In 2020, the RRC reported average plugging costs of $17.88/foot. Applying this value to the average depth of wells drilled on the New Mexico side of the Permian since 2016 yields average plugging costs of roughly $280,000 per well. Plugging and abandonment (P&A) is the first stage in a three-stage remediation process and can constitute less than half the cost of full remediation.

As of October 2020 there were 28,257 un-released oil and gas-related wells on state trust and private lands in New Mexico.[5] Fifty-seven percent of these wells produced primarily oil, 30 percent produced natural gas and the remaining 13 percent were used for injection, disposal or for the production of CO_2. Many of these wells are no longer economically viable and eventually all of them will reach the end of their productive lives. This study explores the potential economic impact of fully remediating all unreleased (orphaned, idle, and active) wells, pipelines and other midstream support infrastructure (e.g., pipelines, compressor stations, frac ponds, etc.) currently on state and private lands in New Mexico.

Remediation can help to stabilize oil patch employment by forestalling or reversing job losses arising from factors such as the COVID-19 pandemic and the global transition away from fossil fuels, as well as those resulting from routine price volatility in oil and gas markets. Increasing the pace at which inactive and marginal oil and gas sites are remediated can help address the environmental and public health risks posed by the tens of thousands of unplugged wells scattered throughout New Mexico while simultaneously expanding employment opportunities in oil-patch communities, putting idle oil field equipment to productive use, and utilizing skills possessed by many members of the oil and gas workforce.

This study builds upon remediation cost estimates developed by Vertex Resource Group Ltd (Vertex) in 2021[6] as well as an analysis of the gap between the financial assurances available for oil and gas well and associated midstream infrastructure clean-up in New Mexico and the true reclamation costs conducted by the Center for Applied Research, Inc. (CAR).[7] The present study is a high-level valuation of the jobs and other economic benefits to New Mexico of industry-funded oil and gas remediation. It is not a comprehensive benefit-cost analysis in that it does not attempt to quantify opportunity costs of

remediation nor does it account for the potentially significant economic benefits of restored ecosystems, reduced greenhouse gas emissions, and improvements in air and water quality.

III. Context

Oil and Gas in the New Mexico Economy

New Mexico has about 8 percent of the nation's proven crude oil reserves and 5 percent of proven natural gas reserves. In 2020, New Mexico was the nation's third-largest oil producing state, accounting for more than 9 percent of U.S. crude oil production and 5 percent of U.S. natural gas production.[8] Most of New Mexico's oil is produced in the state's southeast corner which overlies the Permian Basin. The Permian also contains significant deposits of natural gas. The San Juan Basin which is located in the Four Corners region of northwest New Mexico is another major gas producing region.

Oil production in New Mexico increased more than five-fold between 2010 and 2020 due to advanced drilling and oil recovery technologies that increased production from the Permian Basin's shale formations.[9] Advances in directional drilling and oil recovery over the past decade have vastly increased the size of New Mexico's proven oil reserves. This, in combination with relatively low production costs, has triggered an unprecedented surge in oil production from the Permian.[10]

New Mexico's oil and gas industry has long been an important economic driver and a key source of state and local government revenue. Prior to the COVID-19 pandemic, the industry directly employed 23,551 New Mexicans, mostly in rural and semi-rural areas of the state.[11] In addition, taxes and royalties on oil and gas production and earnings generated by the investment of those funds contribute about one-third of the state's general operating revenue.

For a variety of reasons, the significant economic benefits of New Mexico's oil and gas industry cannot be sustained indefinitely. The COVID-19 pandemic underscored this stark reality by dramatically decreasing global fossil fuel demand and thus the price of oil, compounding the impact of the 2020 price war between Russia and OPEC. In February 2021, New Mexico's fossil fuel extraction and construction industries had 10,900 fewer jobs than they had in February 2020,[12] despite the fact that oil prices had rebounded to about $50/bbl and production levels had largely recovered from the significant declines of the previous spring.[13] In April 2021, employment in New Mexico's mining sector (which includes oil and gas extraction) remained 30 percent below pre-pandemic levels, a loss of about 7,400 jobs.[14] At that time, some industry analysts posited that 70 percent of jobs lost in the oil patch during the pandemic would *not* be restored by the end of 2021.[15]

COVID-19 hit the oil and gas industry hard; but it hastened a process that was already well underway. The pandemic-induced downturn accelerated long-term industry trends, including the transition away from fossil fuels and toward renewables (the "energy transition") as well as increased automation and remote field operations.[16]

Like other fossil fuel-dependent jurisdictions throughout the U.S., New Mexico is actively seeking ways to diversify its economy, both to shield itself from the economic volatility of the extractive industries and to moderate the effects of the oil and gas industry's almost inevitable decline. Fossil fuels are not a permanent solution to New Mexico's economic woes, first and foremost, because they are depletable

resources that will be exhausted at some point. In addition, technological advances are making renewable power ever-more affordable while mounting evidence of climate change's destructive impacts is speeding the energy transition away from fossil fuels. Finally, heavy reliance on the extractive industries to fuel the economy and fund government subjects all New Mexicans to the uncertainty and volatility inherent to the global markets for oil and gas.

Active versus idle versus orphan wells

Although most of the unplugged wells on state and private land in New Mexico are deemed "active" by state regulators, only a fraction are currently producing significant amounts of oil and/or gas.[17] New Mexico law requires that wells be plugged and reclaimed at the end of their useful life.[18] However, remediation is expensive and producers often defer closure and clean-up of marginal wells on the grounds that future price increases may return them to profitability at some later date.[19] These wells are generally deemed "idle."

Although much recent attention has been paid to the threat that orphan wells - inactive wells with insolvent or unknown owners – pose both to the environment and to the governments that must shoulder the financial burden of their reclamation;[20] idle and inactive wells actually constitute equivalent, if not greater, risks to the environment, human health, and the economy, first and foremost because orphan wells constitute just 1 percent of all inactive wells in New Mexico.[21] Furthermore, all unplugged wells, regardless of ownership status, pose environmental hazards, as they may continue to emit methane and other toxins long after they have ceased to produce meaningful amounts of oil and gas.[22] [23] The EPA estimates that each inactive oil and gas well in the U.S. emits an average of 0.13 metric tons (287 lbs) of methane annually,[24] and credits these fugitive emissions with over 70 percent of methane emitted by fuel produced on federal lands.[25] For this reason and because all producing wells will eventually require plugging and site reclamation, this analysis does not distinguish between orphan, idle, inactive, and active wells and instead explores the impact of reclaiming all wells on state trust and private lands in New Mexico.

What is Remediation?

Oil and gas exploration and production are disruptive to the environment. Drilling a well requires that the pad site be cleared of vegetation and stripped of topsoil. In addition to the drilling rig, on-site equipment can include generators, fuel tanks, and tank batteries. Operators often must install access roads and reserve pits to store water, mud, and other by-products of drilling and production,[26] as well as pipelines and other off-site midstream support infrastructure.

Remediation is the process of restoring sites altered by the extraction of natural resources to their original or pre-disruption states. What constitutes successful reclamation will depend on the site, though typical indicators of successful remediation include establishment of a self-sustaining native plant community and re-shaping of all disturbed surface areas to their pre-disruption form and function.[27] Definitions of remediation and reclamation standards based on regulating entity across the country.

Remediating an oil and/or gas well is a three-stage process that starts with plugging and abandonment (P&A) in which the tubing and other completion equipment are removed, cement is pumped across producing zones; cement plugs are placed at various depths to protect freshwater zones, a cement plug is set at the surface to cap the well, and the well is plugged with concrete. During the second stage,

decommissioning, the drilling rig, tank batteries, other equipment, and contaminated fluids are removed from the site. The third stage, surface reclamation, involves removing roads, reshaping, and revegetating the lands around the wells to their condition prior to the disturbance.

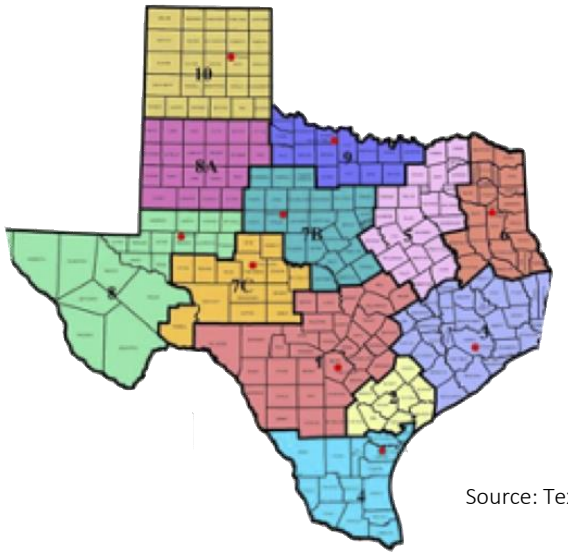
A sometimes lengthy monitoring period to ensure that reclamation is successful then follows. If reclamation fails to prevent further contamination or adequately restore the site, it must be re-done. While proper P&A greatly reduces the immediate risk of methane leaks and groundwater contamination, all three stages are critical to restoring the ecological stability and economic productivity of the site.

Final abandonment of pipelines and flowlines involves flushing and disposing of any fluids in the lines and removing surface lines and lines buried close enough to the surface to become exposed to erosion by subsequent uses. Deeply buried lines are typically left in place. Midstream infrastructure including all surface facilities, foundations, and equipment must also be removed and transported for recycling or disposal. Surface areas disturbed by pipeline routes and other off-site infrastructure must then be restored to their original condition. Surface reclamation of pipelines and other midstream infrastructure includes environmental testing and assessment; removal of fencing and markers; removal of contaminated soils; remediation of compacted soils; site regrading and contouring for erosion control; and seeding and revegetation.

Remediation Costs are Increasing

Remediation costs for oil and gas wells and infrastructure across the country vary widely due to a number of factors, including market conditions,[28] state reclamation requirements, site accessibility, site contamination, and perhaps most importantly, the depth and directionality of the well.[29] [30] Information about the cost of full remediation of modern unconventional wells is extremely limited.[31] [32] Publicly-available estimates of remediation costs tend to be either anecdotal or based on expenses incurred by the public sector in reclaiming orphan wells. These wells, which often pre-date modern bonding requirements, are typically shorter than modern unconventional wells and therefore far less expensive to plug.[33] [34] For example, the New Mexico Oil Conservation Division reported plugging costs of about $38,100/well for orphan wells plugged by the state in fiscal year 2020,[35] while analysts at Carbon Tracker estimated average P&A costs of $141,000 per unplugged well in New Mexico. Regulators in Texas publish average actual per-foot plugging costs for wells plugged by the state in the preceding state fiscal year. Separate values are calculated for each of the Texas Railroad Commission's (RRC) 13 Oil and Gas Division Districts. RRC District 8 overlies the Delaware Basin and abuts New Mexico (Figure 1).

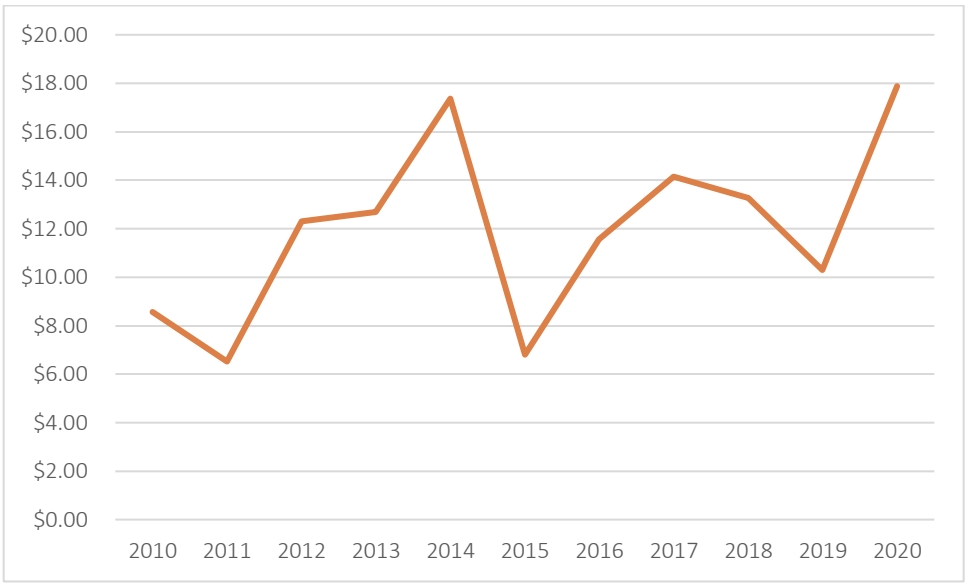
Figure 1 Texas Railroad Commission Oil and Gas Districts



Source: Texas Railroad Commission

Applying the RRC 2020 per-foot plugging costs for District 8 (Figure 2) to the average 2016-2020 well depths for Eddy and Lea counties in Table 1 yields estimated per-well plugging costs of over $277,000 and $298,000 respectively. It is important to note that these estimates exclude surface reclamation, which can constitute upwards of 50 percent of total closure costs.[36]

Figure 2 Texas Railroad Commission District 8 Per-Foot Well Plugging Costs



Source: Texas Railroad Commission. Plugging Costs. Retrieved from: https://rrc.texas.gov/oil-and-gas/compliance-enforcement/hb-2259-hb-3134-inactive-well-requirements/cost-calculation/

A 2021 study also found depth to be a primary reclamation cost driver, with each additional 1,000 feet of well depth increasing costs by 20 percent.[37] Table 1 shows the average depth of wells drilled in New Mexico between 2005 and 2020 by county. During that period, average vertical depth increased by 140 percent, from 6,495 ft to 15,696 ft.

Table 1 Average of Measured Vertical Well Depth (ft) by Spud Year			
	2005-2009	2010-2015	2016-2020
Chaves	6,978	7,247	7,051
Eddy	8,055	8,559	15,506
Harding	2,349	2,433	2,253
Lea	7,734	10,656	16,671
McKinley	1,770	21,356	n/a
Quay	2,770	7,337	7,800
Rio Arriba	6,818	9,430	12,117
Roosevelt	11,123	7,243	9,851
San Juan	4,649	6,250	9,836
Sandoval	6,000	9,824	11,733
Union	2,563	2,504	n/a
Weighted Average	**6,495**	**8,891**	**15,696**

Source: New Mexico EMNRD Oil Conservation Division, October 2020

As well depths and thus plugging costs increase, the potential cost to the public sector of reclaiming orphaned wells also climbs. The practice of selling off marginal wells to smaller, less financially stable producers has become widespread among the major oil companies.[38] When these smaller companies declare bankruptcy, an increasingly common occurrence in the volatile oil and gas industry, the wells are often orphaned and taxpayers assume responsibility for their reclamation. Over the past six years, 262 U.S. oil and gas producers have declared bankruptcy[39] and this trend is expected to accelerate as capital remains tight, environmental liabilities mount and the energy transition accelerates.[40]

Remediation as an Engine of Economic Recovery

Remediation of oil and gas wells and infrastructure on New Mexico state and private lands has the potential to re-employ large numbers of workers displaced by the COVID-19 pandemic, the energy transition, and routine swings in fossil fuel prices and production. Remediation differs from exploration and production but utilizes many of the same skills. Drawing on interviews with industry representatives and state regulators, researchers at Columbia noted "a clear match between the skills of unemployed oil and gas workers and the requirements needed to plug orphan and other abandoned wells properly."[41] Representatives of the oil and gas industry offered a similar perspective in a March 2021 opinion piece in the *Albuquerque Journal*. The Energy Workforce and Technology Council,[42] an oil field services industry group, wrote that hundreds of oil field services companies stood ready to rehire oil patch workers laid off during the pandemic, if additional reclamation funds were made available.[43] The article also noted that oil field services workers with the "experience and expertise to plug orphan wells" earn an average of $80,860 annually.[44]

A 2020 assessment of the potential employment and environmental impacts of a federal program to plug orphaned and abandoned oil and gas wells nationwide concluded that plugging 500,000 wells could create as many as 120,000 job-years while simultaneously reducing air pollution and greenhouse gas emissions at a competitive cost per ton of CO_2-equivalent.[45] Assessments of individual reclamation programs, although not entirely analogous, have reached similar conclusions. An economic impact analysis of a natural resource restoration program in Humboldt County, California found that a $14.5 million investment produced 210 full-time equivalent direct jobs.[46] Similarly, an economic impact analysis of forest and watershed reclamation in Oregon found that restoration work, especially when part of a sustained program, conferred significant economic benefits to the state economy, much of which accrued to economically distressed rural areas.[47]

The regional economic impact of spending on remediation is determined to a large extent by who foots the bill. The legal responsibility for clean-up resides with oil and gas companies, and the significant positive economic benefits only accrue if remediation is funded from out-of-state resources (e.g., oil and gas company shareholders or, in the case of bankruptcy, by holders of the financial assurance). Conversely, remediation funded by state or local governments would have minimal net impact on the New Mexico economy because these entities are required to balance their budgets and therefore any revenue devoted to remediation would have to be diverted from other public programs and beneficial uses. Remediation costs would be left to the state in the case of a company walking away from its clean-up obligations entirely or having insufficient financial assurances to cover full remediation.

Federal funding for reclamation would also constitute a net injection of capital to the state and thus produce a positive regional economic impact. However, current proposals for federally funded clean-up of orphan wells would produce just a fraction of the economic benefits that would result from oil and gas companies fulfilling their legal clean-up obligations; because, as noted earlier, orphan wells constitute less than one percent of all wells in New Mexico.

IV. Data

Information about the type and location of oil and gas wells on state trust and private lands was obtained from the Oil Conservation Division of the New Mexico Energy, Minerals, and Natural Resources Department (EMNRD) and the New Mexico State Land Office. Cost estimates for plugging and abandonment (P&A), site decommissioning, and surface reclamation developed by Vertex Resources Group Ltd[48] were used to estimate total remediation expenditures and allocate those expenditures to the appropriate industrial sectors within a model of the New Mexico economy (this process is discussed in more detail under 'Methods'). Table 2 shows the number of wells on state trust and private lands as of October, 2020 by county and fluid type.

Table 2 Unreleased Oil, Gas, and Salt Water Disposal (SWD) Wells on State Trust and Private Lands, 2020							
	State Trust			Private			Grand Total
County	Gas	Oil	SWD	Gas	Oil	SWD	
Catron	1	0	0	0	0	0	1
Chaves	348	499	16	206	459	8	1,536
Colfax	0	0	0	847	4	7	858
Eddy	1,108	4,183	141	912	1,076	107	7,527
Guadalupe	0	1	0	1	0	0	2
Harding	145	0	0	232	0	3	380
Lea	928	6,768	165	562	4,845	127	13,395
Luna	0	1	0	0	0	0	1
McKinley	2	30	0	5	78	0	115
Quay	0	1	0	10	1	0	12
Rio Arriba	490	43	1	435	62	5	1,036
Roosevelt	5	147	2	20	118	7	299
San Juan	983	72	15	1,583	36	11	2,700
Sandoval	4	21	0	2	4	0	31
Union	54	0	0	304	0	2	360
Grand Total	**4,068**	**11,766**	**340**	**5,119**	**6,683**	**277**	**28,253**
Source: New Mexico Energy Minerals and Natural Resources Department Oil Conservation Division, 2020							

Estimated Well Costs by Reclamation Stage

Based on the Vertex cost estimates and OCD well counts from October 2020, total closure and clean-up costs for wells on state trust and private lands in New Mexico range from $152,000 to $218,000 per well and total $5.6 billion.

Plugging and Abandonment

For purposes of this analysis, plugging and abandonment costs for wells located on state trust and private lands in New Mexico are assumed to range from $77,000 to $120,400 (Table 3). This is a conservative assumption. As noted in Section III, the Vertex P&A estimates, which average $94,772/well, are extremely conservative when compared to those developed from 2020 actual per-foot plugging costs published by the Texas Railroad Commission (approximately $280,000/well).

The analysis performed by Vertex found considerable variation in P&A costs due to a variety of well-specific factors including location, age, depth, number of producing pools crossed, drilling profile direction, and fluid type (oil, gas, or salt water disposal). To account for these differences, Vertex identified 13 different well classifications and prepared classification-specific plugging and abandonment cost estimates for each. These estimates are presented in Table 3.

Table 3 Average P&A Costs by Well Characteristics					
Well Characteristics			Well Count		Average P&A Cost
Well Class	Measured Depth (ft)	Producing Pools	State Trust	Private	
1	<5k	1	1,680	2,798	$77,000
2	<5k	2	616	332	$86,500
3	5k – 10k	1	1,093	1,060	$83,600
4	5k – 10k	2	683	805	$93,100
5	>10k	1	1,536	709	$97,000
6	>10k	2	1,310	773	$106,400
7	<5k	1	3,669	2,089	$90,900
8	<5k	2	252	192	$100,400
9	5k – 10k	1	1,359	421	$97,600
10	5k – 10k	2	1,455	1,609	$108,600
11	>10k	1	928	458	$110,900
12	>10k	2	966	391	$120,400
13	Plugged	n/a	627	446	n/a
Total			**16,174**	**12,083**	**$94,772***
Source: Vertex Resources Ltd.					*weighted average

Well Pad Surface Facility Decommissioning

Average well pad surface facility decommissioning cost estimates range from $3,226 to $27,523 and include removal of all above-ground facilities and equipment, disconnection and removal of the wellhead; cutting and capping the well below grade; disconnection and isolation of flowlines; removal of foundations, and transportation of all removed equipment for disposal or storage. Drivers of site-to-site variation in decommissioning costs include: fluid type (oil, gas, or SWD), flow type (pumping or flowing), the presence of on-site storage, and, for gas wells, the presence of additional process equipment. A pumping oil well with on-site storage is the most costly of the 13 configurations to decommission while a disposal well is the least costly.

Wellsite Surface Reclamation

Vertex cost estimates for wellsite surface reclamation range from $27,196 to $225,285 and include environmental testing and assessment; removal of fencing; removal of contaminated soils; remediation of compacted soils; site regrading and contouring; and seeding and revegetation. Drivers of variation in site reclamation costs include: drilling date (pre- or post-2012), fluid type, and basin. Surface reclamation costs are highest for gas wells drilled after 2012 in the Permian ($225,285) and San Juan ($220,011) basins and lowest for salt water disposal wells drilled outside either basin.

Pipeline and Other Surface Infrastructure Reclamation

The oil and gas industry relies on an extensive system of infrastructure to store, process, and transport oil and gas and produced water. On state trust lands, this infrastructure includes approximately 3,254 miles of above-ground and 1,316 miles of buried oil and gas pipelines, as well as 616 commercial lease sites that include a wide variety of oil and gas midstream infrastructure such as storage sites and tanks, compressor stations, fresh water frac ponds, processing and dehydration facilities, produced water recycling containment ("Rule 34") facilities and a range of other sites, facilities, and equipment. There are an additional 4,370 miles of pipeline on private land. Data on commercial lease sites is not currently available for private land in New Mexico.

Vertex used the estimated cost per acre for well pad surface facility decommissioning and reclamation to estimate the cost of decommissioning and reclaiming pipeline infrastructure on state and private lands, concluding that reclaiming these sites "to industry standards" (e.g., leaving buried pipe in place) would cost approximately $1.9 billion - $981 million for pipelines and infrastructure on state trust lands and $876 million for pipeline miles on private land. Complete removal of all pipeline infrastructure (including the full excavation of buried lines) would cost significantly more ($11.7 billion) and could, in some cases, be more environmentally disruptive than leaving safely buried pipe in place. The economic impact estimate is therefore based on the more cost-effective "industry standard" pipeline removal scenario. However, an estimate of the economic impact of full removal is also provided in Section III for reference. Remediation of commercial lease sites on state trust lands was estimated to cost an additional $876.4 million. Due to lack of data, clean-up estimates for commercial lease sites on private land are not included in the analysis.

Data Limitations

Several features of the data make the remediation cost estimates used in this analysis extremely conservative. First, the lack of data for commercial lease sites on private land likely reduces remediation cost estimates by several hundred million dollars.[49] Second, the New Mexico-specific P&A cost estimates developed by Vertex Resources Ltd average $94,772 per well, two-thirds less than the costs published annually by the Texas Railroad Commission for wells on the Texas side of the Delaware play. Finally, the remediation cost estimates used in this report assume that all sites are successfully remediated the first time around. In reality, plugged wells sometimes leak[50] and surface reclamation doesn't always adequately restore sites on the first try. Reclamation failures increase remediation costs by an average of 50 percent.[51]

V. Methods

The IMPLAN Pro 3.1 modeling system[52] was used to estimate the impact that remediation of oil and gas wells and infrastructure on state trust and private lands would have on the economies of New Mexico and the state's major oil and gas producing counties. IMPLAN® is a widely used software package and database for estimating regional economic impacts[53] using input-output (I-O) analysis.

I-O analysis is an objective way to estimate the total impact that an initial change in economic activity will have on a regional economy. It is based on the premise that regional economies are composed of interconnected households, industries, and institutions. These sectors purchase output from each other

and supply inputs to each other in a complex web of interdependencies. An alteration to one sector will therefore impact the many other sectors to which that sector is connected.

In an I-O model, the initial economic change is called the "direct" effect. As the impact of the initial change travels outward through the regional economy it produces "indirect" and "induced" effects. Multipliers represent the mathematical relationship between the initial change in one sector of the economy and the changes in employment, income, and productivity it catalyzes in other sectors.

> ***Direct effects*** represent the initial change to the industry in question.
>
> ***Indirect effects*** result when the industries that supply the industry in question respond to the change in demand.
>
> ***Induced effects*** reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors.

The IMPLAN Pro 3.1 modeling system includes 546 industrial sectors, representing all private industries in the U.S., one of which is "Support activities for oil and gas operations." This industry,[54] is comprised of establishments primarily engaged in performing support activities (except site preparation and related construction) on a contract or fee basis for oil and gas operations. Services provided by this industry include most plugging and abandonment activities, but do not include many of the activities that make up the other phases of reclamation. Full reclamation of an oil and/or gas site utilizes goods and services from a variety of other sectors including truck transportation, non-residential construction services, waste and remediation services, laboratory testing, and landscape materials. The Vertex analysis included a breakdown of reclamation costs by fluid type, well age, and well condition. These data were used to allocate re. clamation expenditures across the directly impacted industrial sectors within the economic impact model.

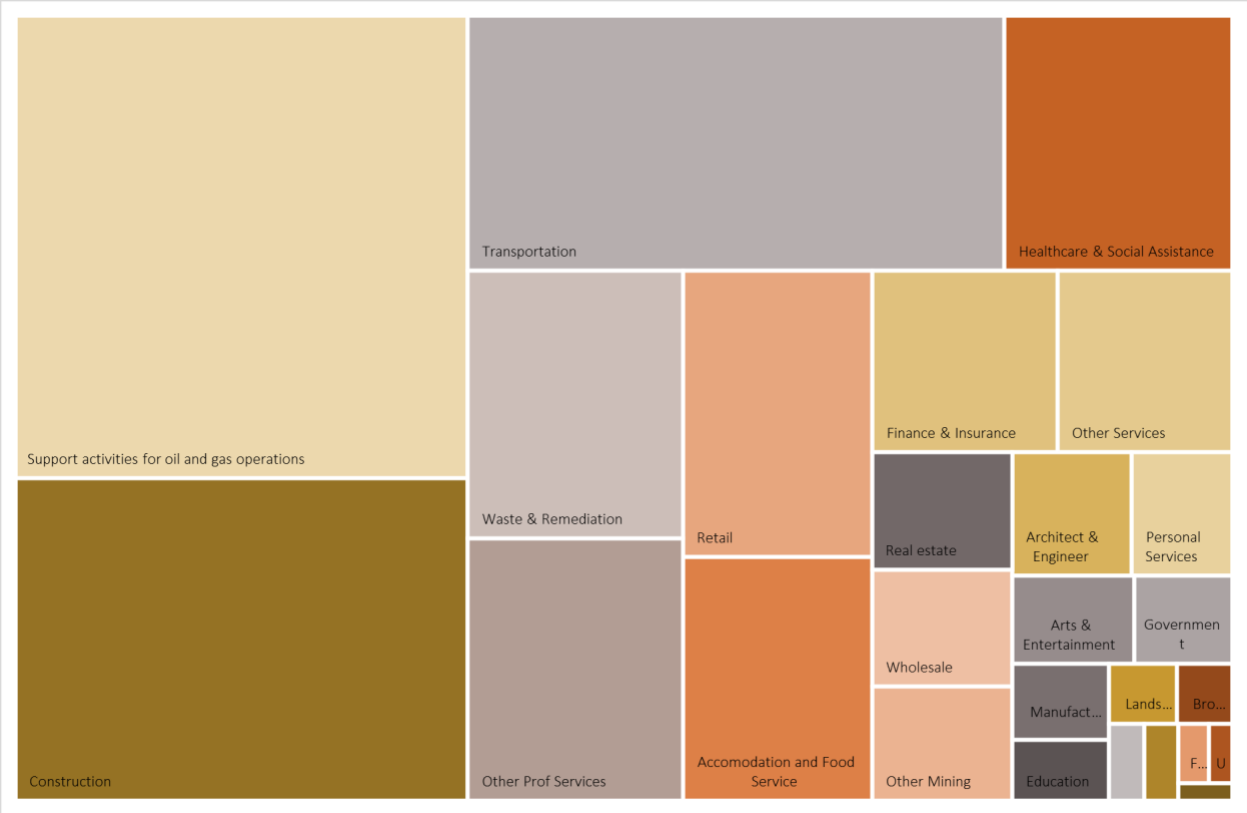
VI. Results

The combined statewide economic impact of reclaiming all wells, pipelines, and miscellaneous oil and gas infrastructure currently located on New Mexico state trust and private lands, for which Vertex could access data, is presented in Table 4. Such an effort, if funded by the major oil companies and/or other entities external to New Mexico, would inject roughly $8.2 billion into the state economy, which would support 39,211 direct remediation-related "job years."[55] The indirect and induced impacts created as the new funds were spent and re-spent within the New Mexico economy would total an additional $4.7 billion and support 26,126 additional job years, for a total economic impact of $12.8 billion in output and 65,337 "job-years" of employment (or 3 years of full-time employment for 21,779 workers). Direct jobs created by the effort would provide employee compensation averaging $73,610 annually, while indirect and induced jobs would pay an average of $46,829 annually.

Table 4 Economic Impact Summary: Full Reclamation of Wells, Pipelines, and Related Infrastructure on State Trust and Private Lands in New Mexico ($ millions)			
Effects	Employment (job years)	Labor Income	Output
Direct	39,211	$2,886.30	$8,176.32
Indirect	12,364	$641.67	$2,576.04
Induced	13,762	$581.80	$2,080.65
Total	**65,337**	**$4,109.77**	**$12,833.01**

While oil and gas field service businesses would derive the single greatest benefit from a major investment in remediation, firms in a wide variety of other industries, including trucking, non-residential construction, waste management, retail, healthcare, real estate, employment services, accommodation, and food service would also benefit either directly or indirectly. Figure 3 depicts the distribution of employment impacts by industrial sector.

Figure 3 Total Employment Impacts of Remediation of Oil and Gas Sites on State Trust and Private Lands by Industrial Sector



It is important to note that a remediation effort of the magnitude envisioned for purposes of this analysis would take years to complete and would entail additional years of monitoring to ensure plugging integrity and reclamation success. Thus, while the economic impacts are presented here as lump sums, they would likely be achieved over the course of three or more years.

Well Sites

Economic impacts for abandonment and reclamation of well sites were estimated for New Mexico's three largest oil and gas producing counties and for the state overall. Table 5 shows the statewide total economic impacts of well abandonment and reclamation and Table 6 summarizes those impacts at the sub-state level. Abandonment and reclamation of well sites would inject $5.4 billion into New Mexico's economy, generating 24,577 direct job-years and 15,066 indirect and induced job-years paying a total of $2.6 billion in employee compensation and proprietor income.

Table 5 Economic Impacts of Wellsite Abandonment, Decommissioning, and Surface Reclamation ($ millions)

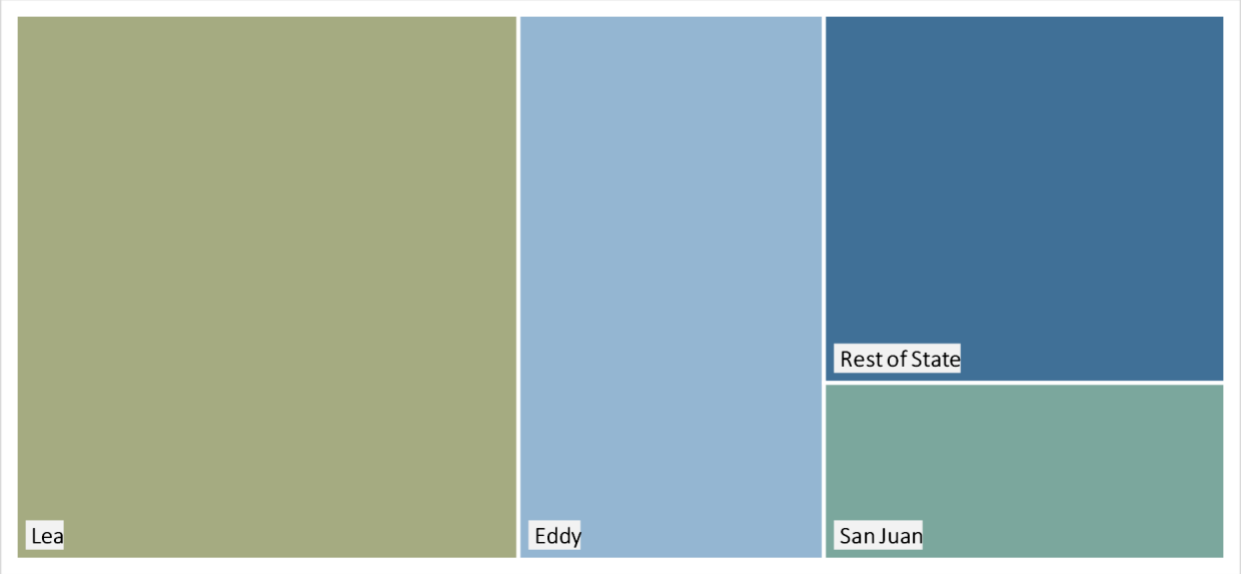
Impact Type	Employment (job years)	Labor Income	Output
Direct	24,577	$1,909.15	$5,384.73
Indirect	7,395	$397.35	$1,592.36
Induced	7,671	$327.08	$1,173.56
Total	**39,643**	**$2,633.59**	**$8,150.66**

Employment impacts of well remediation would be concentrated in Eddy and Lea counties; but San Juan county would gain over 4,000 job-years and another 8,890 job years would be distributed across the state's 30 other counties (Table 6). The intensity of oil and gas production activity on state trust and private lands is primary determinant of remediation expenditures and thus county-level economic impacts, but other factors, including fluid type, contamination levels, and distance to dump sites also contribute to county-by-county variation in economic impacts.

Table 6 Total Economic Impacts of Wellsite P&A, Decommissioning, and Surface Reclamation by County, 2021 ($ millions)

	Employment (job years)	Labor Income	Output
Eddy	10,006	$754.60	$2,210.79
Lea	16,485	$1,211.77	$3,558.57
San Juan	4,263	$255.49	$821.08
Rest of State	8,890	$411.72	$1,560.22
Total	**39,643**	**$2,633.59**	**$8,150.66**

Figure 2 Jobs Created by Remediation by County



Source: IMPLAN Pro 3.1 and author calculations

Pipelines and Miscellaneous Infrastructure

Decommissioning and reclaiming pipelines and other oil and gas infrastructure on state lands would support 14,634 direct job-years paying an average of $66,774 annually. Indirect and induced impacts would support an additional 11,060 job years, bringing total job creation to 25,694 job-years or three years of full-time employment for 8,565 New Mexicans.

Some oil and gas infrastructure, including pipelines, could not be assigned to a single well-site or county. Economic impacts for the reclamation of oil and gas pipelines and other infrastructure such as frac ponds, compressor station sites, and processing and dehydration facilities were therefore estimated at the state level only. While the economic impacts depicted in Table 7 are for the state overall, it is reasonable to assume that these impacts, like those from the abandonment and reclamation of well sites, would be concentrated in the Permian and San Juan basins.

Direct economic impacts exclude produced water, freshwater, and most gathering pipelines used by oil and gas operators. Estimates further assume that buried pipelines are abandoned in-place rather than fully removed.

Table 7 Economic Impacts of "Industry Standard" Pipeline and Infrastructure Remediation, ($ millions), 2021

Impact Type	Employment (job years)	Labor Income	Output
Direct	14,634	$977.14	$2,791.59
Indirect	4,969	$244.32	$983.67
Induced	6,091	$254.72	$907.09
Total	**25,694**	**$1,476.18**	**$4,682.35**

For reference, Table 8 presents the economic impacts of full excavation removal of all pipelines and infrastructure on state trust and private lands.

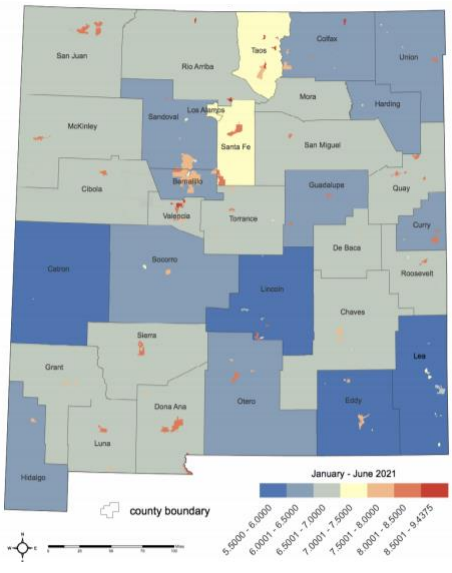
Table 8 Economic Impacts of Full Removal of all Pipeline and Midstream Infrastructure and Reclamation, ($ millions), 2021			
Impact Type	Employment (job years)	Labor Income	Output
Direct	61,663.0	$ 4,117.47	$11,763.15
Indirect	20,938.8	$ 1,029.51	$4,144.98
Induced	25,666.6	$ 1,073.33	$3,822.27
Total	**108,268.4**	**$ 6,220.32**	**$19,730.40**

Fiscal Impacts

Oil and gas production is a major source of state tax revenue. While reclamation cannot replace revenue derived from taxes and royalties on the value of oil and gas production, it will generate gross receipts and income taxes that can help to offset state and local revenue losses from declining production.

Full remediation of all oil and gas wells and related infrastructure on New Mexico state trust and private lands would generate an estimated $541 million in state and local tax revenue (Table 9).

Figure 3 2021 GRT Rates



Source: New Mexico Taxation and Revenue Department

Table 9 State and Local Fiscal Impact Summary	
State General Fund	$483.0 MM
Local Governments	$58.2MM
Total	**$541.0MM**

Reclamation services are generally subject to New Mexico's gross receipts tax (GRT). The GRT layers rates imposed by local governments atop a state "base" of 5.125 percent and thus varies by location from 5.5 percent in certain parts of Lincoln and Lea Counties to 9.4 percent in Taos Ski Valley. In municipalities, the GRT rate typically includes the state base, city-imposed rates, and some county-imposed rates. Figure 3 depicts GRT rates in New Mexico by location. The GRT tends to be lower outside of municipalities because it includes only state and county- imposed rates. Most, (but not all) oil and gas well sites and infrastructure are located in the unincorporated areas of counties. Table 10 shows the 2021 GRT rates for the unincorporated areas of Eddy, Lea, and San Juan Counties and the weighted average GRT rate in the unincorporated areas of the 15 other New Mexico counties with oil and/or gas wells on state trust or private land. Also presented in Table 10 are estimated taxable remediation expenditures and the state and county GRT revenue that would be generated by these expenditures. "Unallocated" includes wells outside of Lea, Eddy, and San Juan Counties as well as reclamation expenditures, such as those for pipelines, that were not attributable to a specific county. Much of this revenue would likely accrue to Eddy, Lea, and San Juan Counties as well.

Table 10 State and Local Gross Receipts Tax Revenue ($ millions)				
County	Remainder of County GRT Rate	Taxable Remediation	State GRT Revenue	County GRT Revenue
Eddy	5.96%	1,509	$77.3	$12.6
Lea	5.50%	2,449	$125.5	$9.2
San Juan	6.69%	517	$26.5	$8.1
Unallocated	5.89%	3,701	$189.7	$28.3
Total		**$8,176.3**	**$419.0**	**$58.2**

Full remediation of all oil and gas sites on state and private land in New Mexico would generate roughly $64 million in state personal income tax revenue. A significant portion of employee compensation and sole proprietor income produced directly and indirectly by remediation expenditures would be taxable under New Mexico's personal income tax.[56] Statutory 2021 personal income tax rates for New Mexico range from 1.7 percent to 5.9 percent of taxable income; but due to exemptions, deductions, credits, and a substantial zero bracket, the average effective state personal income tax rate is just under 1 percent of household income.[57] This rate was used to estimate indirect and induced state personal income tax impacts, while an average effective rate of 2.2 percent was used to estimate direct impacts. It is worth noting that this income will, in turn, generate additional state and local tax revenue when it is spent on goods and services taxable under New Mexico's GRT and/or state selective excise taxes, including those on liquor, cigarettes, tobacco products, and gasoline. New Mexico's average effective combined GRT and selective excise tax rate is roughly 6.8 percent.[58] However, these amounts are not included in the revenue estimates.

VII. Discussion

Reclamation of the 28,257 unreleased oil and gas wells, pipelines, and related infrastructure currently on New Mexico state trust lands would cost over $8.2 billion and support over 65,000 "job years" of employment, primarily in the Permian and San Juan basins. These jobs would produce over $4.1 billion in income for New Mexicans, helping to offset employment losses in the oil and gas industry and generating over $541 million in tax revenue for state and local governments.

At a cost of approximately $125,141 per job created or retained, reclamation appears comparable to other forms of economic stimulus, such as the targeted infrastructure investments in the 2009 American Recovery and Reinvestment Act.[59]

While these amounts may seem small in comparison to the statewide economic impact of New Mexico's oil and gas extraction industry; they are hardly insignificant. Reclamation cannot fill the gap that a declining oil and gas sector will create in New Mexico's economy, but it can help to soften the impact of this virtually inevitable outcome while simultaneously addressing a significant source of environmental toxins and greenhouse gases, setting the stage for economic diversification by making New Mexico a cleaner, healthier, more desirable place to live, work, and invest.

[1] Flaherty, M. (2019). The Oil and Gas Industry in New Mexico. New Mexico Department of Workforce Solutions. Retrieved from: https://www.dws.state.nm.us/Portals/0/DM/LMI/Oil_and_Gas_Industry_in_NM.pdf

[2] Center for Applied Research, Inc. (2021). An Analysis Of The Adequacy Of Financial Assurance Requirements For Oil And Gas Infrastructure Located On State Trust And Private Lands In New Mexico.

[3] 19.15.25 NMAC

[4] Federal law contains similar requirements for oil and gas sites on federal land. The present study deals only with sites on state and private land and utilizes data and estimates specific to wells and infrastructure on state and private lands developed by Vertex Resources Ltd and the Center for Applied Research.

[5] New Mexico Energy Minerals and Natural Resources Department Oil Conservation Division, 2020.

[6] Vertex Resource Group Ltd. (2021, January). New Mexico Oil and Gas Liability Assessment.

[7] Center for Applied Research, Inc. (2021). An Analysis Of The Adequacy Of Financial Assurance Requirements For Oil And Gas Infrastructure Located On State Trust And Private Lands In New Mexico.

[8] U.S Energy Information Administration. New Mexico State Energy Profile. Retrieved from: https://www.eia.gov/state/analysis.php?sid=NM

[9] Palmer, I. (2021, 27 January). What Makes The Permian Basin's New Mexico Portion Such A Success? Forbes. Retrieved from: https://www.forbes.com/sites/ianpalmer/2021/01/27/what-makes-the-permian-basins-new-mexico-portion-such-a-success/?sh=30cf67d01dd7

[10] While recent over-supply has caused production in many other parts of the U.S. to contract, production boomed in the Permian, where the "break-even" oil price ($36.50/bbl as of December 2020) is one of the nation's lowest. See: BloombergNEF. (2020, December). U.S. Oil Drillers' Break-Even Costs Plunge 20% in 2020 Retrieved from: https://about.bnef.com/blog/u-s-oil-drillers-break-even-costs-plunge-20-in-2020/

[11] According to the 2020 Energy Employment by State Report, New Mexico had 15,020 jobs in petroleum fuels and 8,531 jobs natural gas jobs, 87% of which were in mining. See: Foster, D. (2020). 2020 U.S. Energy & Employment Report (USEER). Energy Futures Initiative. https://www.usenergyjobs.org

[12] Hedden, Adrian (2021, 14 April). Data: Energy and oil and gas jobs remain lucrative in New Mexico, nationwide amid COVID-19 Carlsbad Current Argus. Retrieved from: https://www.currentargus.com/story/news/local/2021/04/14/data-energy-and-oil-and-gas-jobs-lucrative-new-mexico-nationwide/7149157002/

[13] New Mexico Legislative Finance Committee. (2021, April 22).. General Fund Revenue Tracking Report. Retrieved from: https://www.nmlegis.gov/Entity/LFC/Documents/Revenue_Reports/Monthly_Revenue_Tracking/2021/January%202021%20Revenue%20Report.pdf

[14] New Mexico Legislative Finance Committee. (2021, April 22).. General Fund Revenue Tracking Report. Retrieved from: https://www.nmlegis.gov/Entity/LFC/Documents/Revenue_Reports/Monthly_Revenue_Tracking/2021/January%202021%20Revenue%20Report.pdf

[15] Deloitte. 2021 oil and gas industry outlook. Retrieved from: https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/oil-and-gas-industry-outlook.html

[16] Deloitte. 2021 oil and gas industry outlook. https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/oil-and-gas-industry-outlook.html

[17] Carbon Tracker estimates that in New Mexico, roughly 19 percent of wells are producing while 47 percent of wells are stripper wells (minimally producing wells that "strip" the last remaining oil and gas before shut down, but can operate at low levels for years or even decades) and 3 percent are temporarily abandoned or longer-term idle wells.

[18] 19.15.25 NMAC

[19] Schuwerk, R. & Rogers, G. (2020, June) It's Closing Time: The Huge Bill to Abandon Oilfields Comes Early. Retrieved from: https://carbontracker.org/reports/its-closing-time/

[20] Daly, M. (2021, 1 April) Biden plan would spend $16B to clean up old mines, oil wells. Associated Press. Retrieved from: https://apnews.com/article/joe-biden-climate-change-coronavirus-pandemic-environment-pollution-9b97e1b2cb7e652ffe04ce35ddae8bb8

[21] "Bonding Requirements and Abandoned Wells," NM State Land Office presentation to the Water and Natural Resources Committee, Sept. 3, 2020

[22] Townsend-Small, A., Ferrara, T. W., Lyon, D. R., Fries, A. E., and Lamb, B. K. (2016), Emissions of coalbed and natural gas methane from abandoned oil and gas wells in the United States, Geophys. Res. Lett., 43, 2283– 2290, doi:10.1002/2015GL067623.

[23] http://www.worc.org/media/2021.3-WORC-Reclaiming-Wells-Addressing-Climate-Impacts-v2.pdf

[24] https://www.epa.gov/sites/production/files/2018-04/documents/ghgemissions_abandoned_wells.pdf

[25] Merrill, M.D., Sleeter, B.M., Freeman, P.A., Liu, J., Warwick, P.D., and Reed, B.C. (2018). Federal lands greenhouse gas emissions and sequestration in the United States—Estimates for 2005–14: U.S. Geological Survey Scientific Investigations Report 2018–5131, 31 p.

[26] United States Government Accountability Office (2019, Sept). GAO 19-615 Bureau of Land Management Should Address Risks from Insufficient Bonds to Reclaim Wells Retrieved from: www.gao.gov/assets/gao-19-615.pdf#page=22 -

[27] Intermountain Oil and Gas BMP Project, Reclamation Resources Guide for Oil and Gas Development. University of Colorado. Retrieved from: http://www.oilandgasbmps.org/resources/reclamation.php

[28] Prevailing prices for oil and gas determine the opportunity cost of utilizing oil field labor and equipment for reclamation

[29] Bordoff, J., Raimi, D., and Nerurkar, N.(2020). Green Stimulus For Oil And Gas Workers: Considering a Major Federal Effort To Plug Orphaned And Abandoned Wells. Retrieved from: https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/OrphanWells_CGEP-Report_071620.pdf

[30] Ho, J. S.; Shih, J-S.; Muehlenbachs, L. A.; Munnings, C.; Krupnick, A. J. (2018). Managing Environmental Liability: An Evaluation of Bonding Requirements for Oil and Gas Wells in the United States. Environ. Sci. Technol. 52 (7), 3908–3916.

[31] Raimi, D., Krupnick, A.J., Shih, J.; &Thompson, A. (2021): Decommissioning Orphaned and Abandoned Oil and Gas Wells: New Estimates and Cost Drivers. Retrieved from: https://chemrxiv.org/articles/preprint/Decommissioning_Orphaned_and_Abandoned_Oil_and_Gas_Wells_New_Estimates_and_Cost_Drivers/14378483

[32] Clancy, C. (Jul 18, 2019). Cost estimates to clean up oil and gas wells lack transparency, says advocacy group. Edmonton Journal. Retrieved from: https://edmontonjournal.com/news/politics/cost-estimates-to-clean-up-oil-and-gas-wells-lack-transparency-says-advocacy-group

[33] Schuwerk, R. & Rogers, G. (2020, June) It's Closing Time: The Huge Bill to Abandon Oilfields Comes Early. Retrieved from: https://carbontracker.org/reports/its-closing-time/

[34] Joyce, S. and J. Wirfs-Brock. 2015. "The Rising Cost of Cleaning Up After Oil and Gas." Inside Energy. October. Retrieved from: http://insideenergy.org/2015/10/01/the-rising-cost-of-cleaning-up-after-oil-and-gas/.

[35] Hedden, A.S. (2021, March 31). New Mexico spent millions plugging abandoned oil and gas wells in 2020. Carlsbad Current-Argus. Retrieved from: https://www.currentargus.com/story/news/local/2021/03/31/new-mexico-spent-millions-plugging-abandoned-oil-and-gas-wells-2020/6989263002/

[36] Schuwerk, R. & Rogers, G. (2020, Sept) Billion Dollar Orphans. Carbon Tracker. Retrieved from: https://carbontracker.org/reports/billion-dollar-orphans/

[37] Raimi, D., Krupnick, A.J., Shih, J.; &Thompson, A. (2021): Decommissioning Orphaned and Abandoned Oil and Gas Wells: New Estimates and Cost Drivers. https://doi.org/10.26434/chemrxiv.14378483.v1

[38] Sadasivam, N. (2021, 7 June). How bankruptcy lets oil and gas companies evade cleanup rules. Grist. Retrieved from: https://grist.org/accountability/oil-gas-bankruptcy-fieldwood-energy-petroshare/?utm_medium=email&utm_source=newsletter&utm_campaign=daily

[39] Haynes and Boone, LLP (2021, 31 March). OIL PATCH BANKRUPTCY MONITOR. Retrieved from: https://www.haynesboone.com/-/media/Files/Energy_Bankruptcy_Reports/Oil_Patch_Bankruptcy_Monitor

[40] Sadasivam, N. (2021). Abandoned in the Permian. The Texas Observer March/April. Retrieved from: https://www.texasobserver.org/texas-observer-enforcement-abandoned-oil-wells/

[41] Bordoff, J., Raimi, D., and Nerurkar, N.(2020). Green Stimulus For Oil And Gas Workers: Considering a Major Federal Effort To Plug Orphaned And Abandoned Wells. Retrieved from: https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/OrphanWells_CGEP-Report_071620.pdf-

[42] https://energyworkforce.org

[43] Tarpley, T. (2021, April 21). Time for a Bi-Partisan Solution to U.S. Orphaned Wells. Albuquerque Journal. Retrieved from: https://www.abqjournal.com/2382208/time-for-a-bipartisan-solution-to-orphaned-wells.html

[44] Tarpley, T. (2021, April 21). Time for a Bi-Partisan Solution to U.S. Orphaned Wells. Albuquerque Journal. Retrieved from: https://www.abqjournal.com/2382208/time-for-a-bipartisan-solution-to-orphaned-wells.html

[45] Bordoff, J., Raimi, D., and Nerurkar, N.(2020). Green Stimulus For Oil And Gas Workers: Considering a Major Federal Effort To Plug Orphaned And Abandoned Wells. Retrieved from: https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/OrphanWells_CGEP-Report_071620.pdf

[46] Baker, M. Socioeconomic characteristics of the natural resource restoration system in Humboldt County, California (Taylorsville, ca: Forest community research, 2004).

[47] Max Nielsen-Pincus and Cassandra Moseley. Economic and Employment Impacts of Forest and Watershed Restoration in Oregon https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/10776/WP24.pdf?sequence=1

[48] Vertex Resource Group Ltd. (2021, February). New Mexico Oil and Gas Liability Assessment, Draft 5.

[49] Assuming the relationship between the number of wells and the cost to remediate commercial lease sites on private lands is the same as it is on state trust land, the omission of commercial lease sites on private land from the analysis reduces estimated remediation costs by over $650 million.

[50] Lackey, G. Rajaram, H., Bolander, J., Sherwood, O., Ryan, J.N., Shih, C.Y., Bromhal, G.S., Dilmore, R.M. (2021). Public data from three US states provide new insights into well integrity. Proceedings of the National Academy of Sciences Apr 2021, 118 (14) e2013894118; DOI:10.1073/pnas.2013894118

[51] Chenoweth, D., Holland, D., Jacob, G., Kruckenberg, L., Rizza, J., Whitely, B., (2012). The Economic Benefits of Completing Initial Reclamation Successfully For Oil and Gas. Integrated Petroleum Environmental Consortium (IPEC) conference, Tulsa, OK. www.oilgasbmps.org/docs/GEN176-chenweth.pdf

[52] IMPLAN Group LLC. (2021). www.Implan.com

[53] IMPLAN Professional Version 4.1. Minnesota IMPLAN Group, Inc. http://www.implan.com.

[54] Corresponds to the North American Industry Classification System (NAICS) code 213112.

[55] One year of full time employment for one worker

[56] Labor income, which is composed of total employee compensation and proprietor income was reduced by 16 percent to account for payroll taxes and 24 percent for non-taxable employer sponsored benefits such as health insurance and some retirement contributions

[57] Institute for Taxation and Economic Policy (2018). Who Pays? 6th Edition. Retrieved from: https://itep.org/new-mexico/

[58] Institute for Taxation and Economic Policy (2018). Who Pays? 6th Edition. Retrieved from: https://itep.org/new-mexico/

[59] A 2012 estimate of the "jobs multiplier" of fiscal stimulus spending concluded that in its first year, ARRA spending produced about eight jobs per million dollars spent, a cost of $125,000 per job. See: Wilson, D.J. (2012). Fiscal Spending Jobs Multipliers: Evidence from the 2009 American Recovery and Reinvestment Act. American Economic Journal: Economic Policy, American Economic Association, vol. 4(3), pages 251-282, August. A study of ARRA-funded highway construction found evidence of lasting impacts - each dollar expended increased local construction payrolls by thirty cents during the five years following the Act's passage, with little evidence that the recovery spending crowded out other local construction. See: Garin, A. (2019). Putting America to work, where? Evidence on the effectiveness of infrastructure construction as a locally targeted employment policy, Journal of Urban Economics, Volume 111 Pages 108-131.