A 2023 ASSESSMENT OF THE CO_2 ENHANCED OIL RECOVERY POTENTIAL IN THE VICINITY OF THE WASTE ISOLATION PILOT PLANT, EDDY COUNTY, NEW MEXICO

Melzer CO_2nsulting

P.O. Box 2083
Midland, Texas 79702

Final Draft Report

November 13, 2023

TABLE OF CONTENTS

Section	Page #
I. OVERVIEW AND THE CURRENT STATUS OF THE REGIONAL AND LOCAL OIL INDUSTRY	2
II. PAST AND CURRENT CO_2 FLOODING STATUS	6
III. NEW TRENDS AND GROWTH POTENTIAL OF CO_2 EOR	9
IV. SUMMARY OF WIPP AREA CO_2 INJECTION PROJECTS	15
VII. REFERENCES	17

APPENDIX 1: TABLE OF ACTIVE PERMIAN BASIN CO_2 EOR PROJECTS

REPORT FIGURES

Figure	Title	Page #
1	Oil Price History in the Permian Basin and Key Milestones	3
2	Annual US Oil Production 1995 through Jun '23	4
3	Permian Basin Total and Horizontal Oil Production: Jan '10-Jun '23	4
4	The Growth of Production in the Eddy and Lea Counties of New Mexico	5
5	Tracking the Total and Horizontal Well Counts in Eddy & Lea Counties NM: Jan '10 thru May '23	5
6	Existing Horizontal Drilling Wells and Currently Permitted Wells in the 9-Township Region around the WIPP Site	6
7	The Phases of CO_2 Enhanced Oil Recovery (as Benchmarked by the Permian Basin)	7
8	Historical Look at Active Permian Basin CO_2 Projects and Production – 1994 thru 2022	7
9	McElmo Dome CO_2 production trend (Jan '15 – Jun '23)	8
10	WIPP Area Stratigraphic Section Showing the Relative Positions of the WIPP, Conventional Vertically Exploited and Flooded Formations, and the Horizontal Well Bone Spring and Wolfcamp (Shale) Formation Targets	9
11	Permian Basin Map Showing Location of CO_2 Floods (by Lithology Type)	11
12	Water and CO_2 Flooding Reservoir Sweep Challenges	12
13	Map of the Position of the Delaware and Midland Basin Shorelines in Permian Period and Corresponding to Trends of Reservoir Quality Rocks for Possible Future CO_2 Flooding (note: points denote positions of vertical wells)	15

AN UPDATED ASSESSMENT OF THE CO_2 ENHANCED OIL RECOVERY POTENTIAL IN THE VICINITY OF THE WASTE ISOLATION PILOT PLANT, EDDY COUNTY, NEW MEXICO
Melzer Consulting, September 2023

I. OVERVIEW AND THE CURRENT STATUS OF THE REGIONAL AND LOCAL OIL INDUSTRY

The Permian Basin region of the southwestern United States has undergone a significant uplift in drilling activity in the last five years. The Basin has always been considered one of premier oil and gas provinces in the world, but many are recognizing it today as being one of the top five oil "superbasins"[1] throughout the World. That new recognition and basin status change is owed to the thick basin deposits (so-called shale (oil) source rocks) and the accelerating development of horizontal drilling which came of age in the last 12 years. Prior to that time, production in the Basin was continuing to decline from its peak in the early 1970's from a level of about 2 million barrels of oil per day (bbls/day) to a level of less than one million bbls/day after the turn of the century. The declining production was evident for nearly four decades; the general consensus for the Region was that the industry's expansion days were over and the Basin was in its final stage of both oil and gas production.

The declining Permian Basin production levels in the last quarter of the 20th century were lessened to a degree by several industry players who converted producing wells to injecting wells thereby 1) initiating new water floods, 2) expanding the already successful ones, and 3) transitioning many of them to commercial CO_2 flooding (also known as CO_2 enhanced oil recovery or CO_2 EOR). After the peak regional oil production that was witnessed in the early 1970's, CO_2 EOR was joining with water flooding to become a proven technology by the mid-1980's. CO_2 EOR continued to demonstrate project growth history from an early handful of projects to reaching almost 80 projects by the time of the last Waste Isolation Pilot Plant (WIPP) assessment report in 2018[2](Ref 9). The traditional oil industry[3] realized that those expanding flooding technologies were key to some slowing of the decline curve and extending the productive life of the Basin and its oilfields. But most argued that enhanced recovery flooding processes were only delaying the Basin's waning energy influence and most did not expect to be able to maintain levels of oil or gas production. As a corollary, it is fair to say that there was also a general consensus that a reinvigoration of the Permian Basin's oil industry seemed unlikely.

This time of declining Permian Basin production above was underway in the late 1990's at the time the Waste Isolation Pilot Plant (WIPP) site was first certified in 1998[4](Ref 1). Subsequent to the initial

[1] Superbasin as defined has more than 5 billion bbls oil equivalent in both cumulative and remaining production, an assemblage of conventional & unconventional reservoirs, stacked pays, along with established infrastructure, access to markets, and service sectors and supply chains (source: www.aapg.org)

[2] Melzer, L.S. 2018, An Updated Assessment of the Potential for Carbon Dioxide Flooding in the Vicinity of the Waste Isolation Pilot Plant, Eddy and Lea Counties, New Mexico, July 15, 2018.

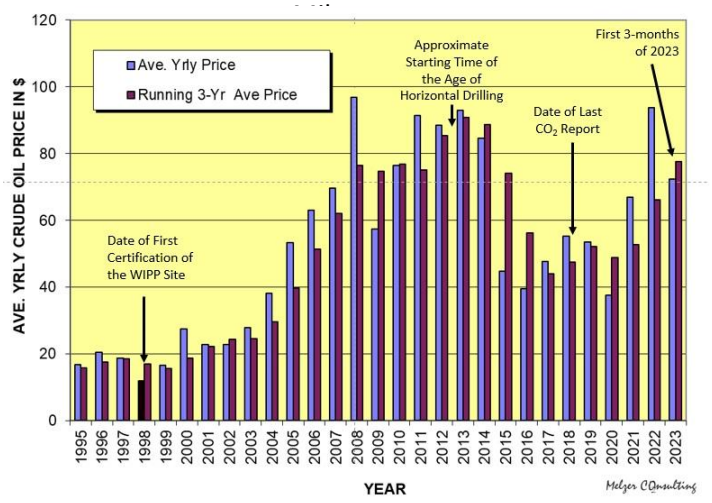
[3] Traditional defined herein as that part of the oil and gas industry concentrated on drilling (i.e., primary recovery)

[4] U.S. Environmental Protection Agency (EPA). 1998. 40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations; Certification Decision: Final Rule." Federal Register, Vol 63 (May 18, 1998): 27353-406.

certification, the Compliance Recertification Applications of 2004, 2009, 2014, 2019[Refs 2-5] and assessments of CO_2 EOR [Refs. 6-9] were performed in 2003, 2008, 2013, and 2018 as they pertained to the local area around the WIPP site. An assessment of water flooding for EOR near the WIPP site was also included in the Compliance Recertification Applications of 2009, 2014 and 2019.

It is worthy of mention here that the declining oil production in the Permian Basin was not necessarily the case around the rest of the world. Worldwide oil production was growing at rates just sufficient to meet the consumptive oil demands for the world marketplace. But then in the 1990's and holding throughout part of the next decade, the worldwide supplies began to provide an excess of oil and oil prices fell into the $15-30/barrel (bbl) range. Those low prices became a disincentive for new exploration and reservoir discoveries.
The lack of new discoveries eventually led to price recoveries into the $60-80/bbl range in the last half of the 2000's and into 2014. Fig. 1 tracks the oil prices since 1995 as measured by the West Texas Intermediate (WTI) oil price index. It is noted here that the WTI oil price index had become a worldwide index price in the last half of the 20th century and, as recent advances in well drilling and completions occur, it still remains a relatively good worldwide index of global oil prices. Since oil is an easily transported and traded commodity, differences between WTI and other indices including Brent Crude and Arab light, all follow similar curves but smaller differences exist principally by costs of transportation to localized markets and secondarily by the cost of refining the oil into usable products.

Figure 1: Oil Price History in the Permian Basin and Key



The recognition of more limited oil supplies began showing its effect starting in about 2005. Much of this was attributed, in large measure, to significant worldwide growth in the transportation fuels sector led by crude oil demand in China and India. The effect of this demand growth struck a tighter balance between oil supply and consumption and gave rise to increases in oil prices to levels nearing $100/bbl and well over the prices seen at the time of the initial certification of the WIPP site. But the year 2014 provided another profound change as the world witnessed a collapse in oil prices to about half its past value in just one year. Many experts now attribute this collapse in oil prices (see Figure 1) to the recognition of large oil reserve additions due to the so-called 'shales' and the horizontal drilling revolution. This development has been dominated in large measure by the Permian Basin but also the Eagle Ford formation in Texas, the Bakken formation in North Dakota and other areas have played an important but less significant role in oil reserve growths even at oil prices in the $40/bbl range.

[5] U.S. Department of Energy (DOE). 2019. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). DOE/WIPP 2019-3591. Carlsbad, NM: Carlsbad Field Office (latest Recert).

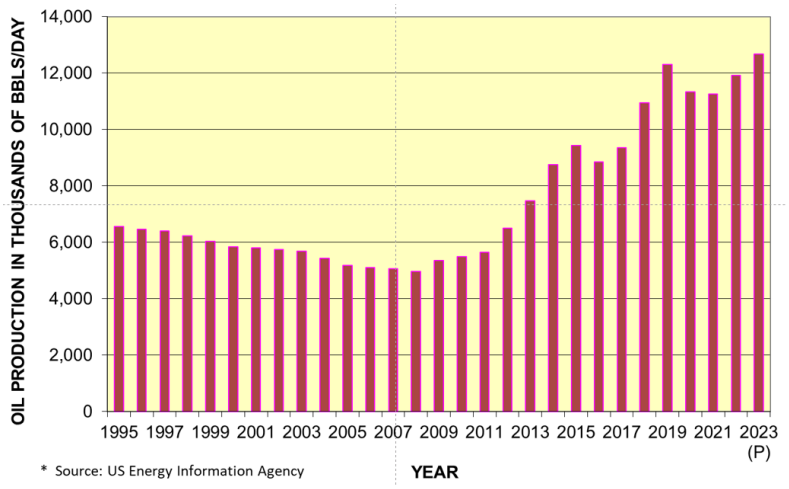
The COVID year of 2020 had a substantial impact on transportation fuel demand and drove prices below $40/bbl but, as demand recovered, the oil supplies more closely matched the increasing demand with prices beginning to rise back into the $70 range. Oil demand remains strong at the time of this report with supplies more closely affected by recent Organization of the Petroleum Exporting Countries production announcements and supply curtailments.

The 2023 $70 US/bbl price seems to be the median even today and many believe that this price level will continue to strike an approximate balance with long-term supplies and demand for oil. Many believe that this price level supports continued horizontal well development in the shales.

Figure 2 charts the U.S. oil production levels from 1995-2023, the same time interval shown in Figure 1. One can see that the levels of oil production prior to the horizontal well revolution have now been more than doubled.

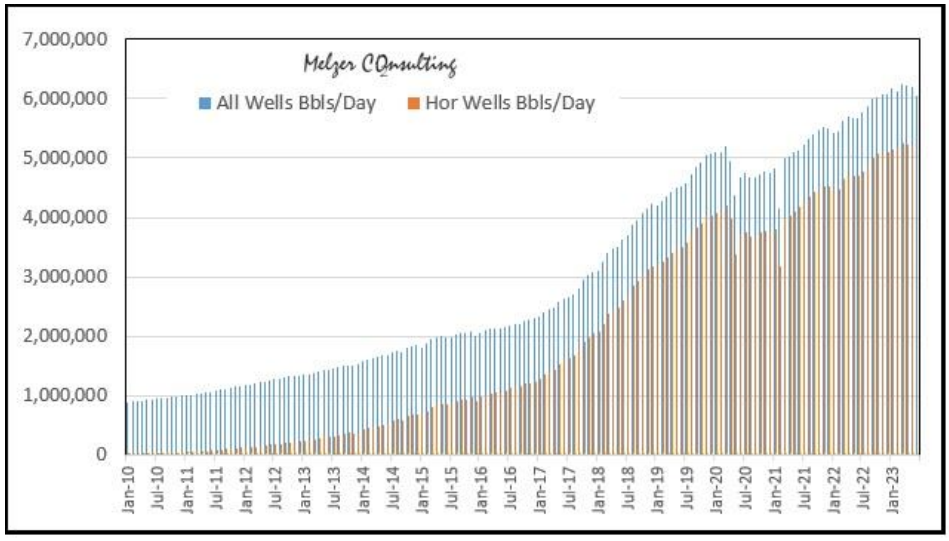
Figure 3 breaks out the Permian Basin starting in 2010 and graphically illustrates the percentages of production from horizontal wells. Using the Permian Basin as a benchmark region, it is not too difficult to surmise that today's oil price marketplace is driven more by the huge additions of oil supply from the horizontal well revolution than from other sources of oil. The chart also shows that historical vertical well production has declined.

Figure 2: Annual US Oil Production: 1995 - Jun '23



This modern trend of horizontal well drilling should lead to a continuation of drilling in both the Delaware Basin around the WIPP site and also in the sister sub-basin of the Midland Basin to the east (included the numbers in Figure 3).

Figure 3: Permian Basin Total and Horizontal Oil Production: Jan '10-Jun '23



Figures 4 and 5 focus in on the oil production and numbers of wells that are located closer to the WIPP site. The

charts specifically look at the active New Mexico counties of Eddy and Lea. The trend of increasing oil production in the Permian Basin (from Fig 3) clearly holds true for the two NM counties as well (Fig 4). The modern well counts in Figure 5 are clearly dominated by horizontal wells and representing approximately 30% of all wells today.

Taken in context, what Figures 3-5 are showing is a story that the oil and gas industry has moved into a new phase where the best returns on investments are coming from the drilling and stimulating of horizontal wells.

When one looks at where the wells are being drilled, it clearly is within the shale basins. Most of the historical production came from the reservoirs on the rimming formations that surround the geological basins.

These broader observations of the new age of horizontal wells have a direct relationship to oil activity related to the WIPP site area. The new age brought on by horizontal drilling in the last 10 to 12 years is reflected in the region around the WIPP site. The Permian Basin, and also specifically the Delaware Basin surrounding the WIPP site, is ideally suited for this technological revolution.

Figure 4: The Growth of Production in the Eddy and Lea Counties of New Mexico

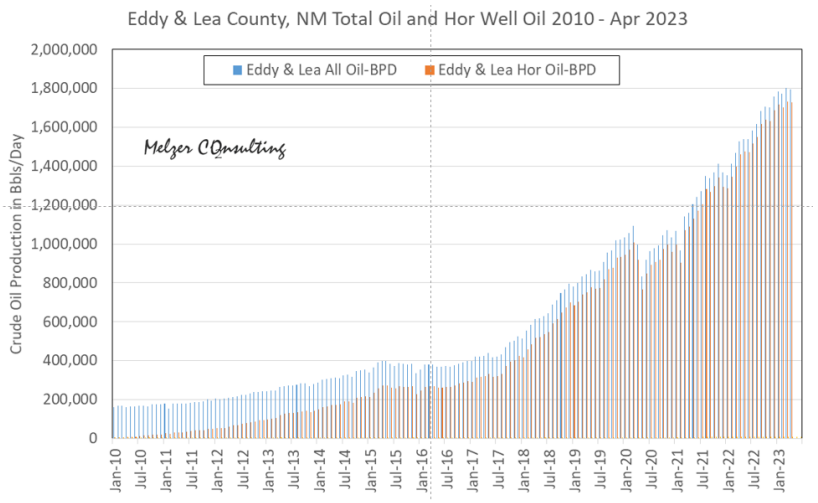


Figure 5: Tracking the Total Horizontal Well Counts in Eddy & Lea Counties, NM: Jan '10 thru May '23

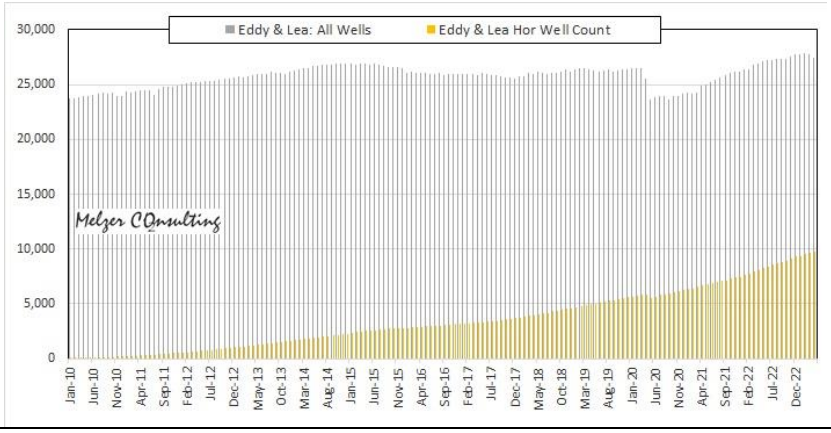
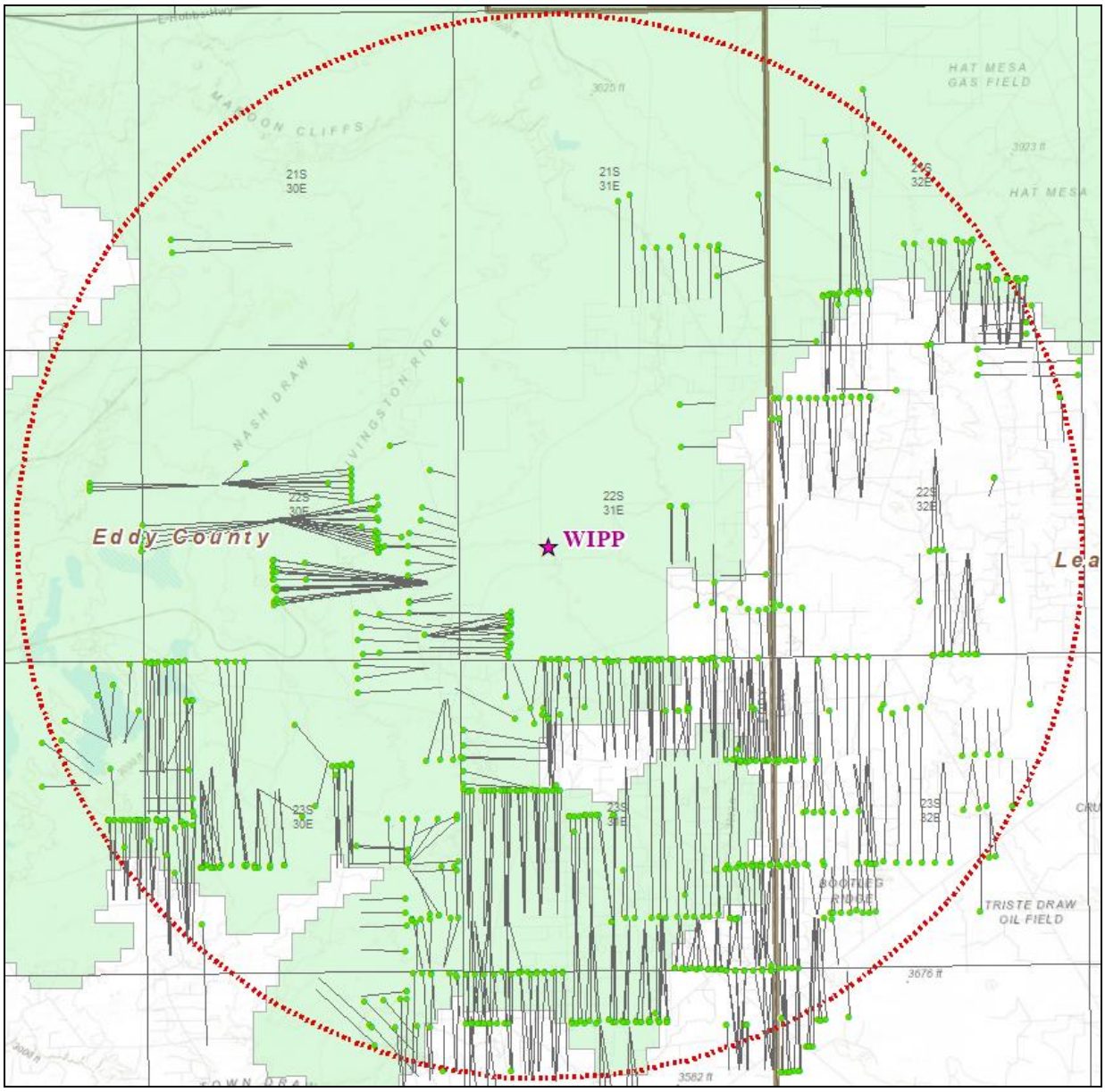


Figure 6 shows the existing and newly permitted wells in the 9-section township area around the WIPP site. The formations being drilled are of the right composition of oil and gas to be very high on the list of criteria for continued exploitation. The oil is sweet (i.e., low in sulfur content), intermediate in composition, and with lots of entrained gas that provides the solution gas drive for pushing the oil to the wellbores. The WIPP site sits in one of the most active drilling regions of Permian Basin, the Delaware Basin.

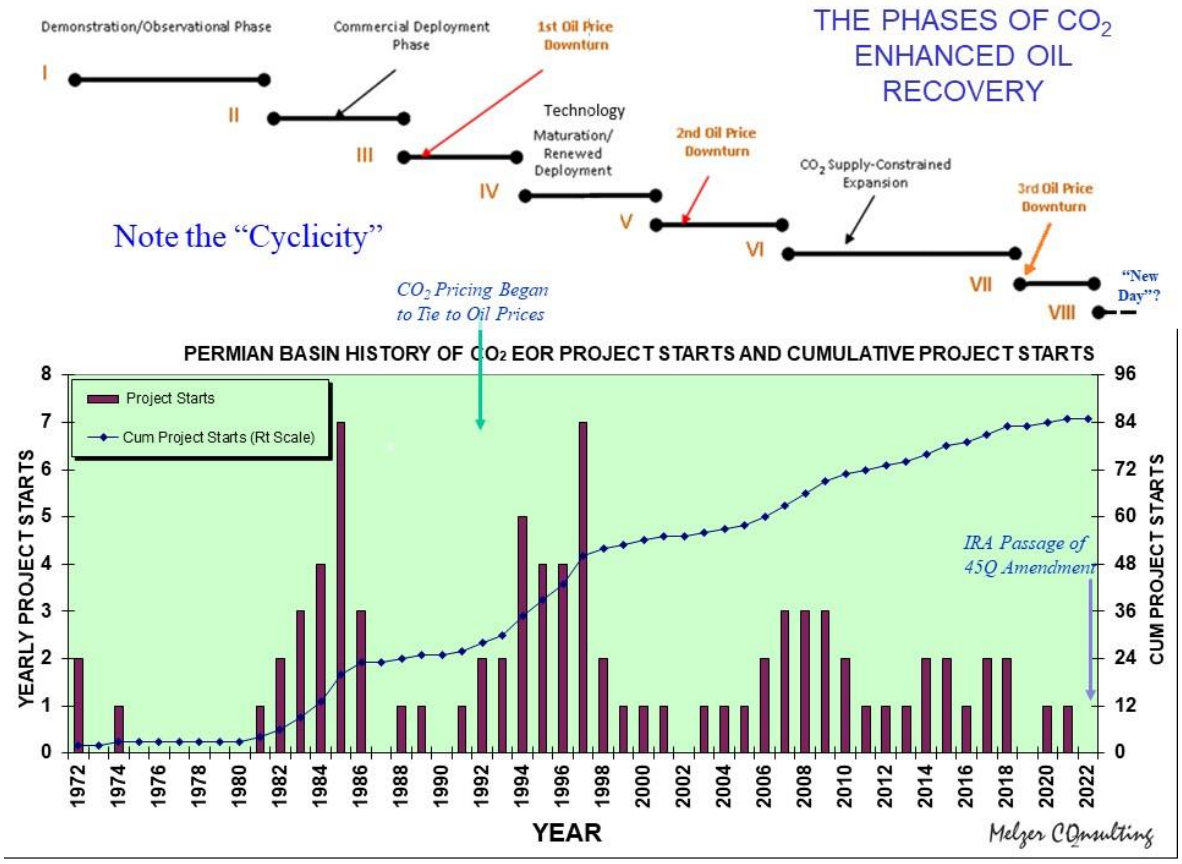
Figure 6: Existing Horizontal Drilling Wells and Currently Permitted Wells in the 9-Township Region around the WIPP Site



II. PAST AND CURRENT CO_2 FLOODING STATUS

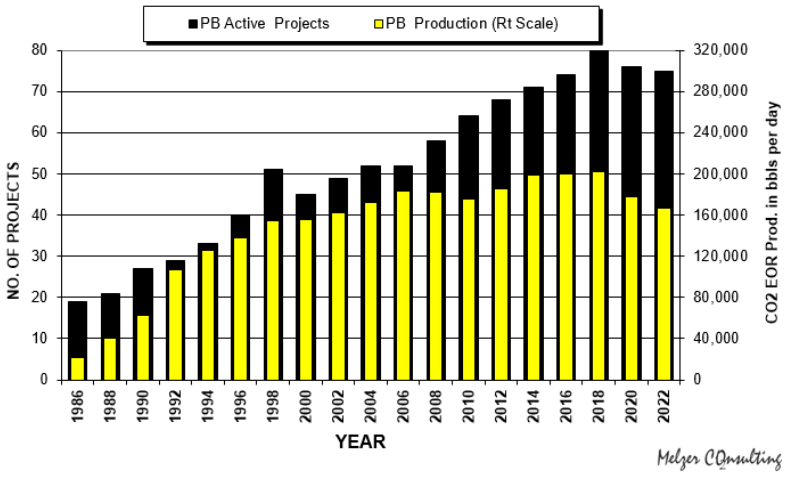
Figure 7 illustrates the Permian Basin regional history of CO_2 EOR project startups by year and by the accumulating numbers of floods since 1986. Note that the trends in new EOR project starts is cyclical. The first oil price crash on the chart occurs in 1998, the second in the early years of the new millennium and the latest in 2018. All three price downturns demonstrate project startup sensitivity to oil price swings. Designing new projects is a slow process with substantial delays from project investment commitments, to startup, and then further to first production. But the projects are long-term producing projects with some having produced oil for over 30 years. That fact tends to smooth the production history which leads to a relatively consistent trend of growing EOR production (Figure 8).

Figure 7: The Phases of CO_2 Enhanced Oil Recovery (as Benchmarked by the Permian Basin)



One striking observation in Figure 8 is the decline in wells and EOR production starting in 2020. It is the author's opinion that this declining production starting in 2020 has two key factors at work. The first factor is, of course, the lack of new projects being implemented. The second factor is the more optimal economics of horizontal wells discussed in the previous section. There is a likely third factor in the decline. This factor may owe its cause to the recently enacted passage of the Inflation Reduction Act of 2021[6]. This Federal legislation has placed a substantial tax

Figure 8: Historical look at Active Permian Basin CO_2 Projects and Production – 1986 thru 2022 (Ref 11)

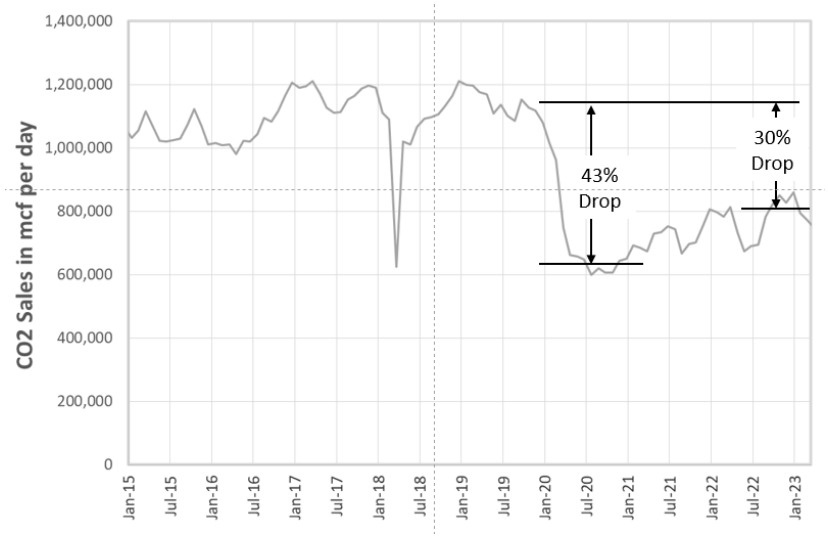


[6] https://www.iea.org/policies/16255-inflation-reduction-act-2022-sec-13104-extension-and-modification-of-credit-for-carbon-oxide-sequestration

credit incentive on installing industrial CO_2 capture and is giving the advantage to anthropogenic CO_2 over the natural underground sourced CO_2 which has been the staple of CO_2 supply throughout EOR's history to date. Since the industrial CO_2 capture projects take time to implement, new floods may be waiting for the new industrially captured CO_2 supplies to enter the scene.

It is also instructive to examine the source field's CO_2 sales to EOR. The prolific McElmo Dome, located in SW Colorado[7](Ref 12), is the leading CO_2 supplier for nearly 60% of the Permian Basin CO_2 EOR sales. Figure 9 summarizes the CO_2 production (sales) from McElmo Dome. One can conclude that, whatever the reasons, today's oil producers are buying 30% less CO_2 from the ground to supply their injection needs. This depressed state of purchases is recovering somewhat but at a very slow rate even considering the rebounding oil prices in 2023. Both the lack of new flood implementation and the decline of existing projects appear to be the controlling factors for not only the oil production but also the CO_2 purchases. The second factor mentioned above, competing investment opportunities from shale reservoir horizontals and their faster revenue returns seems to be carrying the day. At least for the short term, the data from the various information sources suggest primary oil recovery from horizontal well drilling is relegating new flood implementations in a 'wait-and-see' mode.

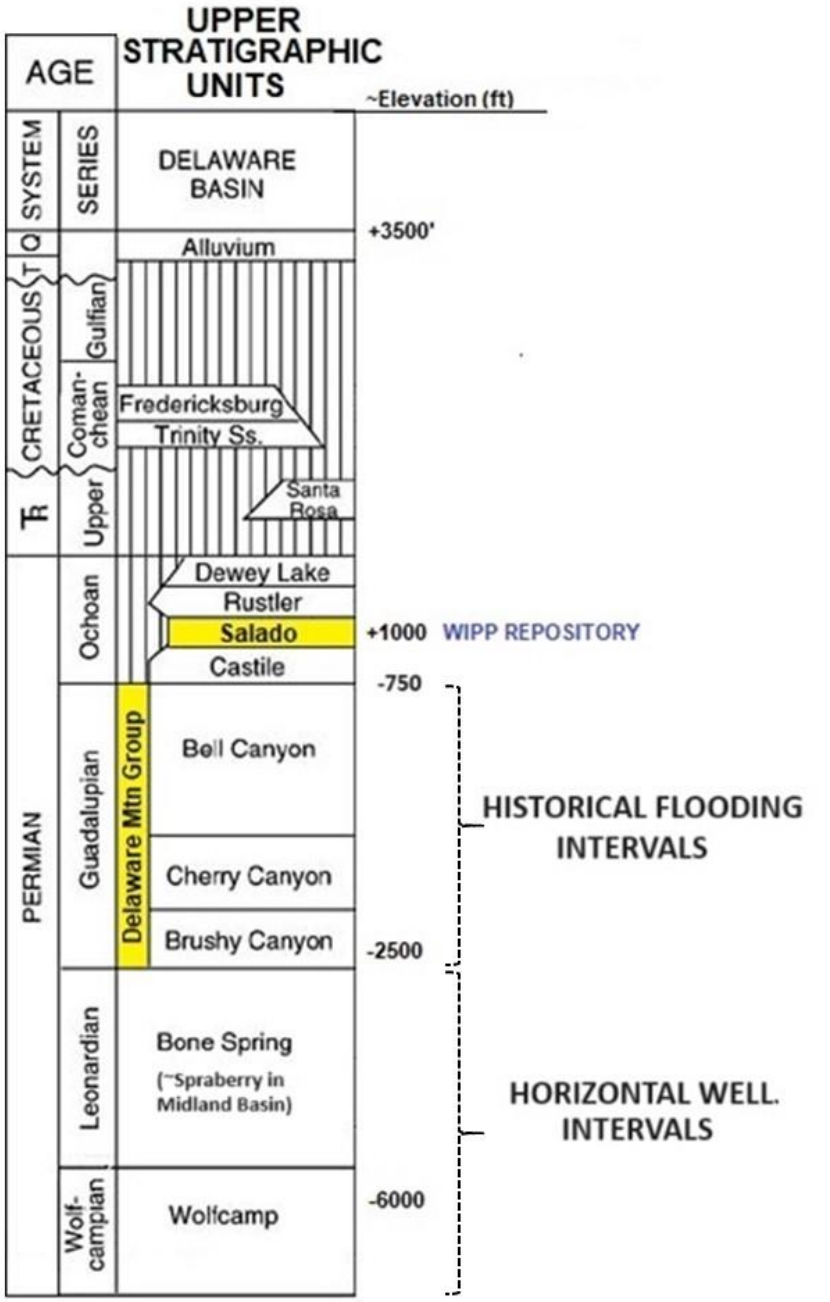
Figure 9: McElmo Dome CO_2 production trend (Jan '15 – Jun '23)



The more challenging economics of CO_2 flooding, as discussed above, is significant. The time from investment to first oil production is quite long when compared to the investment in a new horizontal well to its first production. Two- and three-mile horizontal laterals can be drilled, completed and be producing in a matter of six to eight months. Even though CO_2 floods produce for long times, the time value of money and slow returns on investment is what makes them undesirable. Before the huge oil resources represented by the shale formations were shown to be economically produced and when oil was considered a more limited commodity, long-term oil investment projects were deemed important. Now that the world has moved to drilling of the massive shale oil resources being exploited horizontally, the common view is that conventional flooding projects, with their slower economic returns, cannot compete against them.

[7] McElmo Dome Leadville Carbon Dioxide Field, Colorado

Figure 10: WIPP Area Stratigraphic Section Showing the Relative Positions of the WIPP, conventional vertically exploited and flooded formations, and the horizontal well Bone Spring and Wolfcamp (Shale) formation targets



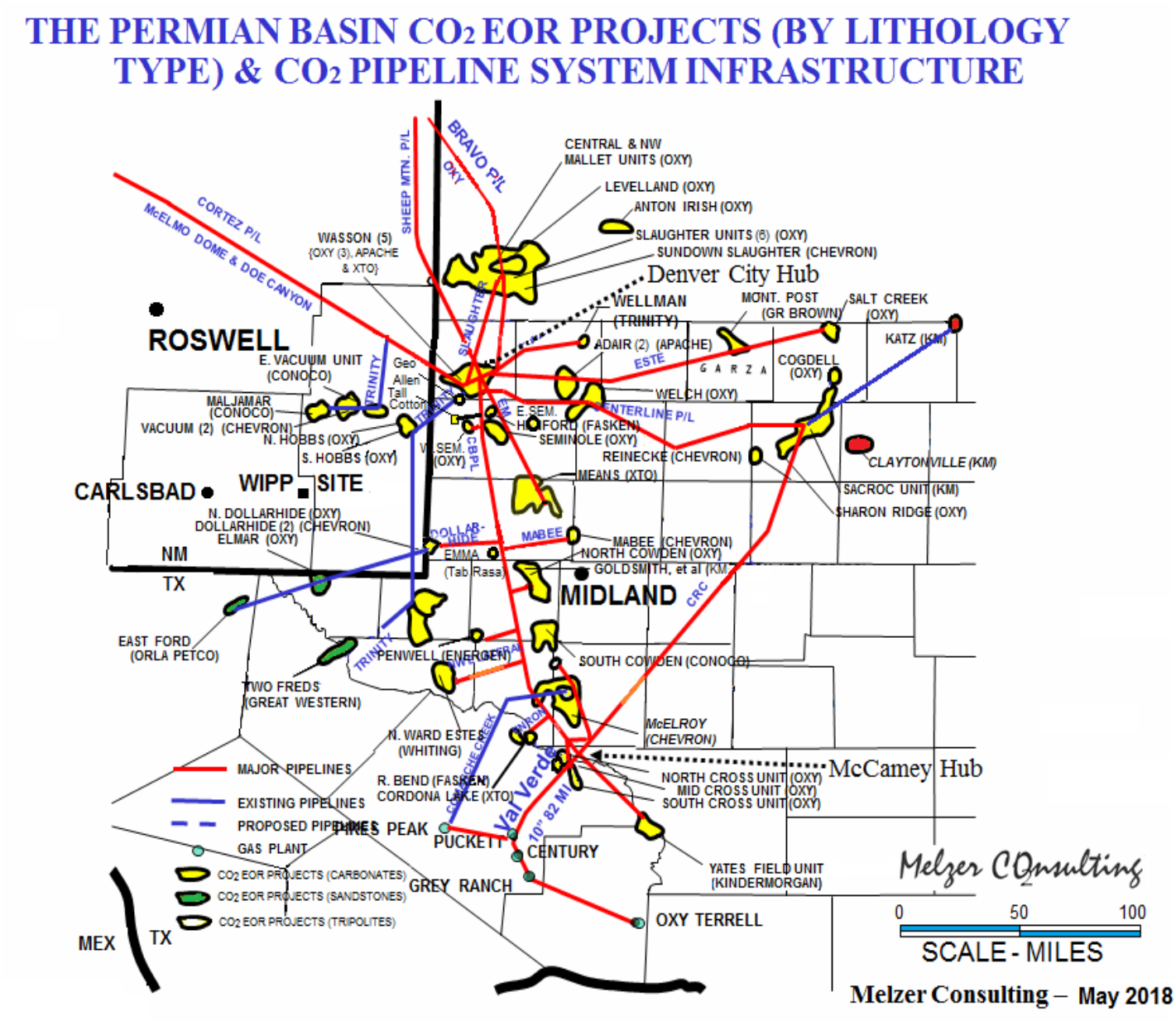
III. NEW TRENDS AND GROWTH POTENTIAL OF CO_2 EOR

Now that the case has been made in the first two sections here, one can assume the 'conventional'

oil industry (composed of the **vertical** drilling, primary, secondary, and tertiary production sectors) is currently in a state of decline. And one can also directly state that the Permian Basin is a case history to illustrate that the quicker revenue returns from horizontal drilling in the so-called unconventional reservoirs like the Wolfcamp, Spraberry and Bone Springs formations (see Fig. 10), are replacing the 'conventional' projects. Companies focused on attempting to find ways to get more oil from an existing conventional reservoir using water flooding and EOR (historically flooded intervals) are becoming fewer. The past success of those conventional sub-industries led to a thousand or more water floods starting in the 1960's and growing to 80 active CO_2 EOR projects in the Permian Basin starting from the early 1970's. Those fields not yet taken beyond water flooding to EOR should create many targets for new CO_2 flood implementation. Like all producing reservoirs, the conventional water flooded fields decline making a need to move into more advanced recovery which can include CO_2 EOR. Otherwise, the field must be plugged and abandoned. The Permian Basin has been the classic example where a conventional sub-industry was very successful in moving into CO_2 EOR and producing more oil from a declining oilfield. Appendix 1 to this report provides a detailed listing of those CO_2 projects and their attributes.

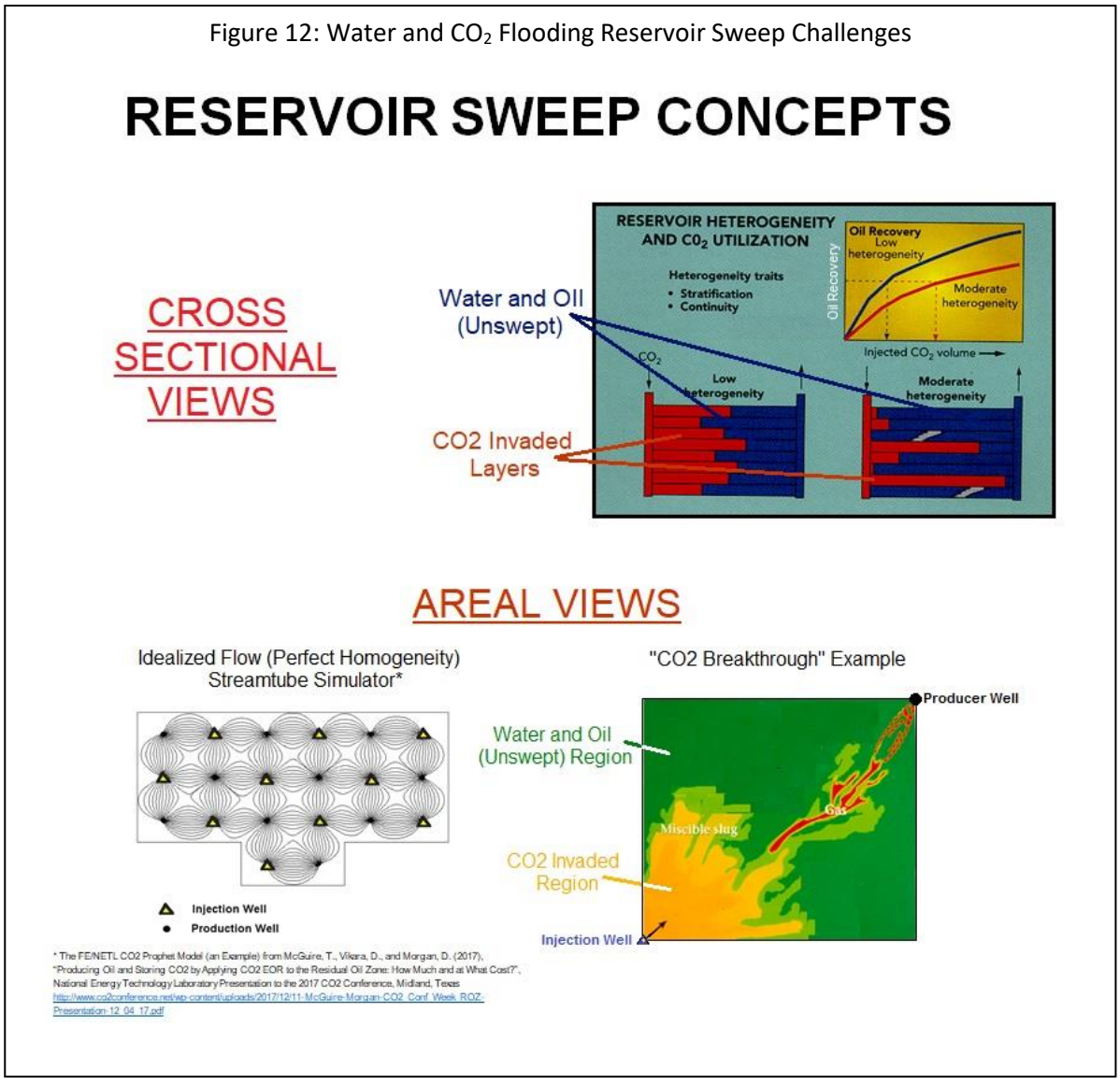
The active CO_2 EOR projects are primarily concentrated within the eastern portion of the Permian Basin (Fig. 11). One notes that there are only a very few anywhere near the WIPP site. There are two primary reasons for this. First, the WIPP site lies with the Delaware Basin proper and making it somewhat distant from the 'basin-rimming' carbonate shelf reservoirs that host almost all of the CO_2 projects. Secondly and in a complimentary sense, the sandstone reservoirs in closer proximity to the WIPP site have been largely poor economic producers, especially in a flooding configuration.

Figure 11: Permian Basin Map Showing Location of CO_2 Floods (by Lithology Type)



The lateral continuity of formations is a critical requirement of a flooding project. Figure 12 illustrates CO_2 flooding sweep challenges due to geological heterogeneities and their extents in both vertical direction (see cross-sections) and horizontal directions (see plan-views). Effective CO_2 flooding requires volumetric contact of the CO_2 with the oil to change the oil properties and allow flow to the wellbores. These reservoir challenges lead to an inefficiency of contact and lower oil recoveries, often referred to as poor reservoir "sweep."

Figure 12: Water and CO_2 Flooding Reservoir Sweep Challenges



One of the most interesting Permian Basin trends has to do with the availability for contracting new volumes of CO_2 for a project. The common contract formula for pricing CO_2 utilized in the past can be simply expressed as 2% of the oil price where oil price is in units are $/bbl and CO_2 price in units of $/1000 cubic feet (mcf). So, if oil were priced at an average of $70/bbl then CO_2 would be selling at ~$1.40/mcf. These are not project gate prices so actual numbers will vary according to location of the project, total pipeline tariffs to get the CO_2 to the project, and other minor factors such as delivery pressure. CO_2 was in robust demand and short supply during the $80-100/bbl days of 2010-2013 since new projects were coming on line. When the oil price crash of 2014 hit, all new projects in planning

were put on hold or cancelled. One would normally expect that CO_2 pricing for a new project would fall and follow the oil price decline, but many contracts had a CO_2 price "floor" so much lower prices did not occur. Also, most contracts are long term and CO_2 purchases were still under contract forcing the flood operators to drop back to minimum required ("take or pay") volumes. Suppliers could 'choke back' deliveries but were not able to negotiate new contracts to keep CO_2 production high since the full contract volume commitments were in place. The decline in produced (purchased) CO_2 as shown for McElmo Dome in Figure 9 has not caused the suppliers to lower prices for new projects. Time will tell if the higher prices will hold but, as the next section infers, new CO_2 supplies could be coming soon from anthropogenic sources incentivized by a new Federal tax credit.

As mentioned above, shown in Fig. 11 and tabled in Appendix 1, most of the operated CO_2 floods in the Permian Basin have been deployed in carbonate reservoirs. At current count, there are 53 of the active 76 floods in the San Andres dolomite formation and 19 others in other dolomite or limestone reservoirs. The clastic (sandstone) reservoirs are the few remaining ones. Their numbers are small since they are generally smaller oil targets and somewhat more challenging both in an economic and technical sense. The needed infrastructure for an EOR project includes CO_2 pipeline and recycle plants making economics difficult due to the smaller oil recoveries. Additionally, the clastic reservoirs generally have reservoir lateral continuity challenges and are often faced with lower reservoir sweep efficiencies[8]. The carbonate reservoirs owe their origin to shallow shelf environments rather than in the deeper basins with their finer-grained clastics and clays such as the shales. Previous assessments of the nearby CO_2 flooding potential to the WIPP site have stressed this latter challenge suggesting new CO_2 floods near the basin region WIPP site are quite unlikely given the state of CO_2 EOR technology today.

Several things are worth noting that are different now than in previous WIPP CO_2 assessments. The first is the concept of using geologic formations to permanently store CO_2 that is captured from surface emission streams. Climate change concerns have advanced to a degree that a variety of solutions are being proposed to reduce greenhouse gas emissions. Some governmental entities in such places as Norway have moved to assess a tax on CO_2 to induce an emitter to capture their emissions and inject it underground. The U.S. has approached the concerns over accelerating emissions in a different way. The U.S. Senate and House recently passed an enhanced tax credit incentive trying to achieve the same result for emission reductions. The provision, called 45Q, included in the Future Act passed in February of 2018, was amended in 2022 in the Inflation Reduction Act[9] and provides a federal tax credit of \$60/ton (~\$3.10/mcf) to the emitting CO_2 capturing plant. The tax credit is available if shown by monitoring to lead to permanent CO_2 sequestration like in an oil reservoir. If the injected CO_2 goes into a deep saline formation, the credit starts at \$85/ton and is adjusted for inflation over time. Both are eligible for a 12-year period of capture and storage. Time will tell if this newly amended tax credit will lead to significant capture and geologic storage but the first indications are that the planning for field capture and storage projects for the easiest[10] sources of emitted CO_2 are already underway.

[8] Sweep efficiency is a term used to quantify the ability for the CO_2 to spread out in the formation from an injection well to the nearby (injection pattern) producer wells and contact oil left behind by the previous stage waterflood. 'Channeling' from injector to producer wells can cause poor sweep efficiencies and render a project uneconomic.

[9] https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/

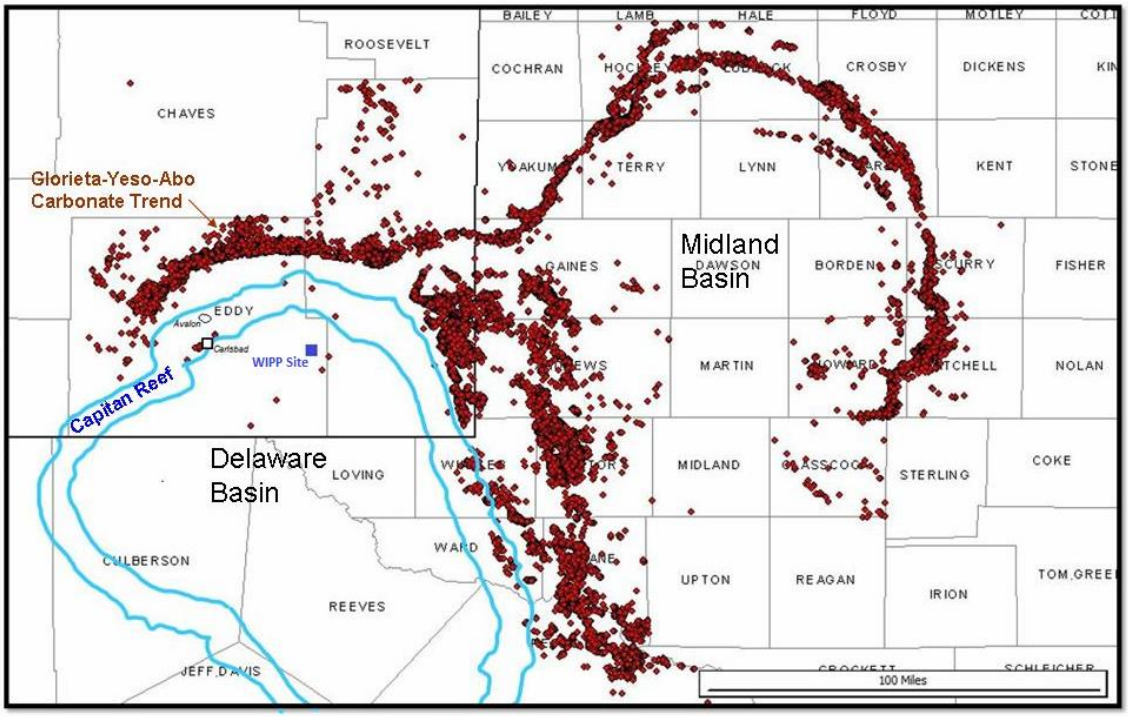
[10] Those emission streams of relatively pure CO_2 with volumes in excess of 0.1 million tons of CO_2 per year (5 million cubic feet per day).

The question to address with this new 45Q provision is whether nearby Permian Basin sources of emission streams of CO_2 will take advantage of the credit and begin CO_2 capture, pipeline, and injection planning of a project. There are Permian Basin companies operating within several tens of miles from the WIPP site that have the technologies and experience to begin the planning but they are focused on the quicker and robust returns from horizontal drilling. In addition, the aforementioned basin sediments in the near vicinity of the WIPP site are not ideal formations to conduct the injection. A preference to carbonate reservoirs will likely be the reservoir option if new floods are designed. The 2008 report documented that the nearest carbonate reservoirs are within the Yeso formation carbonates but they are 20 miles to the north of WIPP.

The second feature of CO_2 has to do with the evolution of CO_2 flooding in what have become to be known as the residual oil zones (ROZs). These intervals have been shown to be widespread in the Permian Basin [Refs. 13a, 13b, 13c]. They exist in the same formations below the pay intervals of the carbonate reservoirs and they also exist out in what have become known as "greenfields" where they do not have intervals with overlying mobile oil conventional oil reservoirs. The ROZs are now known to be the remnants of a paleo oil trap that has been laterally flooded by water at some time after the paleo oil entrapment. Work is ongoing around the U.S. and the world to identify these zones as they have been shown to be commercial via CO_2 flooding in the Permian Basin. To date, the ROZs are especially prevalent in the San Andres formation along the carbonate shelf regions like the aforementioned Yeso formation that rim the deeper basins such as the Delaware and Midland Basins. Note that in Fig. 13, the position of the Permian shelf carbonates is defined for Abo/Wichita, Yeso/Clearfork, and Glorieta formations representing the shoreline rim of the Delaware Basin. Fig. 10 provides the stratigraphic column illustrating the vertical reservoir sections of interest. All of these formations outcrop to the west of Carlsbad, Artesia and Roswell allowing influx of meteoric derived water to laterally flush these reservoirs of their paleo trapped oil and forming a residual oil zone. Because these formations are carbonates, it is likely they will emerge as the targets for CO_2 EOR rather than the clastic basin sediments closer to the WIPP site.

Figure 13: Map of the Position of the Delaware and Midland Basin Shorelines in Permian Epoch and Corresponding to Trends of Reservoir Quality Rocks for possible Future CO_2 Flooding *(note: points denote positions of vertical wells)*

Producing Wells from the Glorieta, Yeso, Clearfork and Abo Reefal Trends Depicting the Shorelines of the Delaware and Midland Basins in the Permian Age*



* The Capitan Reef shown around the Delaware Basin represents the last stage of reservoir quality rock deposition prior to the formation of a Salty (Dead) Sea

IV. SUMMARY OF WIPP AREA CO_2 INJECTION PROJECTS

The implementation of CO_2 EOR projects has seen a steady rise from the start of commercial deployment in the early 1980's through the present time. The pace slows during the low oil price years but resumes when oil prices rebound[11]. Today, there are 76 CO_2 injection projects in the Permian Basin, more than any other region in the world.

Water flood and EOR projects have historically been sought by the oil and gas industry because of the desire to improve oil recovery from existing oil fields that recover only a small part of the oil in place before going uneconomic. In addition to improving the recovery efficiency from a reservoir, some of that impetus came from a feeling that oil was a limited resource. Today, with the explosion of new technologies in horizontal drilling and well completion techniques in the unconventional reservoirs (aka 'shales'), the concept of scarce oil has all but disappeared. The motivation to improve oil recovery in existing fields is therefore waning especially as it provides an expensive and longer-term project when compared to the success being seen from advances in horizontal drilling and well stimulations.

[11] The exception to the correlation of growth during higher oil prices are the years 2010-2013 when shortages of CO_2 supply restricted new project starts

A new factor is emerging today that may play a role in balancing out the current negative dynamics for CO_2 flooding investments. CO_2 EOR has become widely recognized to provide the additional advantage of permanently storing CO_2 along with producing oil. With concerns over climate change and the role that atmospheric accumulations of CO_2 emissions may play in warming global temperatures, policies are being put in place to encourage anthropogenic CO_2 capture so as to limit those emissions. CO_2 EOR can play a large role in finding a place to safely sequester captured CO_2. A provision in the 2022 Inflation Reduction Act provided a significant enhancement to the U.S. tax code for a tax credit provision entitled 45Q that was recently passed by Congress and signed into law by the President. The newly amended law and US Treasury guidance provides details on a tax credit incentive for the capturing company. The tax credit goes to the surface plant capturing entity but may play a large indirect role in benefiting the transporting and the injecting companies as well. There are indications that the newly enhanced tax credit may lead to an increase in CO_2 supply for permanently storing CO_2 in injection projects.

Flood economics is still largely controlled by the efficiency of oil recovery from a reservoir. The history of the Permian Basin illustrates that carbonate lithologies are preferred for CO_2 flooding. These rocks are the carbonates located on the carbonate shoreline 'rims' of the geologic basins. WIPP lies within the Delaware Basin and is ten to twenty miles distant from the preferred rocks on the northern rim of the Delaware Basin that are more amenable to CO_2 flooding.

The above paragraphs outline the major and competing factors for affecting the future of CO_2 injection projects in the 9-township area around the WIPP site. As emphasized in this report, the first factor has to do with the onset of the horizontal drilling age with its fast returns on investments in the basin reservoir rocks (shales). One can extend this argument to say this factor is already curtailing CO_2 EOR deployment of new projects and even personnel availability for EOR projects in general.

The second factor relates to the availability to contract affordable CO_2 supplies needed for EOR. As discussed earlier, the prices of CO_2 supplies have remained tight even with oil prices at current levels. For lower efficiency clastic reservoirs like those in the vicinity of the WIPP site, more affordable supplies are needed. Perhaps additional supplies will come from anthropogenic CO_2 via the 45Q tax credit enhancement but will likely be directed to the carbonate reservoirs rimming the basin deposits. However, those anthropogenic CO_2 supplies are not prolific in the Permian Basin region. Perhaps a CO_2 pipeline from the Gulf Coast with its intense CO_2 emissions may come. Aggregating CO_2 emissions from ethanol plants to the north of the Permian Basin is yet another possibility. Capturing the smaller quantities of CO_2 from the emission streams of the gas plants gathering natural gas could also create supply for new CO_2 flooding projects.

Because of the larger reservoirs and more successfully CO_2 flooded carbonate formations, the likelihood of the additional supplies of CO_2, even considering CO_2 EOR's benefit of concurrent storage, will still not affect CO_2 injection anywhere near the WIPP project area for at least ten years. And even then, the huge potential for EOR in the many carbonate reservoirs and their residual oil zones will take precedence over the many challenges of flooding the shales and Delaware sandstone reservoirs located closer to the WIPP site.

V. REFERENCES

1 U.S. Environmental Protection Agency (EPA). 1998. 40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations; Certification Decision: Final Rule." Federal Register, Vol 63 (May 18, 1998): 27353-406.

2 U.S. Department of Energy (DOE). 2004. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). 10 vols. DOE/WIPP 2004-3231. Carlsbad, NM: Carlsbad Field Office.

3 U.S. Department of Energy (DOE). 2009. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). DOE/WIPP 2009-3424. Carlsbad, NM: Carlsbad Field Office.

4 U.S. Department of Energy (DOE). 2014. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). DOE/WIPP 2014-3532. Carlsbad, NM: Carlsbad Field Office.

5 U.S. Department of Energy (DOE). 2019. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). DOE/WIPP 2019-3591. Carlsbad, NM: Carlsbad Field Office.

6 Melzer, L.S. 2003, An Updated Look at the Potential for Carbon Dioxide Flooding Near the Waste Isolation Pilot Plant, Eddy and Lea Counties, New Mexico. June 15, 2003. Westinghouse TRU Solutions, Carlsbad, NM.

7 Melzer, L.S. 2008, An Assessment of the CO_2 Enhanced Oil Recovery Potential in the Vicinity of the Waste Isolation Pilot Plant (June '08), Midland, TX, Melzer Consulting.

8 Melzer, L.S. 2013, An Updated Look at the Potential for Carbon Dioxide Flooding Near the Waste Isolation Pilot Plant, Eddy and Lea Counties, New Mexico, June 30, 2013.

9 Melzer, L.S. 2018, An Updated Assessment of the Potential for Carbon Dioxide Flooding in the Vicinity of the Waste Isolation Pilot Plant, Eddy and Lea Counties, New Mexico, July 15, 2018.

10 Hall, R.K., D. R. Creamer, S.G. Hall, and L.S. Melzer, 2008. Water Injection in WIPP Vicinity: Current Practices, Failure Rates and Future Operations. August 2008. Midland, TX. Russell K. Hall and Associates, Inc. ERMS # 549596.

11 Data Source: Oil & Gas Journal Annual Production Report, Apr 2, 2016, and UTPB Petroleum Industry Alliance (4/2016)

12 C. R. Gerling, D.R. (1983), "McElmo Dome Leadville Carbon Dioxide Field, Colorado," in Oil and Gas Fields of the Four Corners Area, Volume III, 1983, ppg 735-739.

13a Research Partnership to Secure Energy for America Project (2012) entitled "Commercial Exploitation and the Origin of Residual Oil Zones: Developing a Case History in the Permian Basin of New Mexico and West Texas"

13b U.S. Department of Energy's Research Project (2016) entitled "Using 'Next-Generation' CO_2 EOR Technologies to Optimize the Residual Oil Zone CO_2 Flood at the Goldsmith Landreth Unit, Ector County, Texas"

13c Research Partnership to Secure Energy for America Project (2017) entitled "Identifying and Developing Technology for Enabling Small Producers to Pursue the Residual Oil Zone (ROZ) Fairways of the Permian Basin, San Andres

APPENDIX 1: TABLE OF ACTIVE PERMIAN BASIN CO_2 EOR PROJECTS

Producing CO_2 EOR Projects in the Permian Basin

	Flood Type / Operator	Field	State	County	Field Unit Orig Discovery date	Orig Oil in Place MMBbls	Project Start date	Project Area, acres	No. prod. Wells	No. inj. Wells	Formation Flooding	Formation	Ave Form'tn Porosity, %	Ave Form'tn Permeability, md	Resvr Depth, ft	Oil Gravity, °API	Oil Visc. cp	Res Temp °F	Oil Type	Prev. Stage of Prod.	Oil Satur. % start	Oil Satur. % end	Proj. matur.	Tot. Crude Oil Prod., bopd	Enh.Crude Oil Prod., bopd
	CO_2 miscible																								
1	Apache	Adair	Tex.	Gaines	4/47	168	1997	5,338	90	61	San Andres	Dolomite	14.1	4	4,789	34		104	Sour	WF			HF	2,300	1,600
2	Apache	Adair	Tex.	Gaines	9/50	102	2004	2,550	11	11	Wolfcamp	Dolomite	12.4	28	8,500	42		126	Sweet	WF			JS	282	200
3	Apache	Roberts	Tex.	Yoakum	7/59		2012	13,600	222	186	San Andres	Dolomite	8.5						Sour					2,085	1,685
4	Apache	Slaughter	Tex.	Hockley & Terry	1/40		5/85	569	43	21	San Andres	Dolomite	12.5	6.3	4,900	32	1.3	110	Sour	WF			HF	600	600
5	Apache	Slaughter	Tex.	Hockley & Cochran	1/40		6/89	8,559	259	164	San Andres	Dolomite	10	3	5,000	32	1.6	107	Sour	WF	45	8	JS	2,200	2,200
6	Chevron	Mabee	Tex.	Andrews-Martin	10/43	18	1/92	3,600	220	85	San Andres	Dolomite	9	4	4,700	32	2.3	104	Sour	WF	36	10	NC	1,810	1,800
7	Chevron	Vacuum	NM	Lea Co.			7/97	1,084	48	24	San Andres	Dolomite	12	22	4,550	38	1.0	101	Sour	WF	36	15	HF	4,000	3,200
8	Chevron	Dollarhide (Devonian) Unit	Tex.	Andrews	8/45	122	5/85	6,183	83	66	Devonian	Dolo./Tripolitic Chert	13.5	9	8,000	40	0.4	122	Sweet	Prim./WF	35	22	HF	1,755	1,755
9	Chevron	Dollarhide (Clearfork "AB") Unit	Tex.	Andrews	6/49	73	11/95	160	21	4	Clearfork	Dolomite	11.5	4	6,500	40	0.5	113	Sour	Prim./WF	30	10	JS	960	960
10	Reinecke Operating	Reinecke	Tex.	Borden	2/50	166	1/98	700	32	8	Cisco Canyon Reef	LS/Dolomite	10.4	170	6,700	44	0.4	139	Sour	WF	35	10	JS	530	530
11	ConocoPhillips	South Cowden	Tex.	Lea			2/81	4,900	43	22	San Andres	Dolomite	11.7	11	4,500	38	1.0	101	Sour	Prim.	70	50	JS	160	160
12	ConocoPhillips	Vacuum	NM	Lea			2/81	4,900	192	103	San Andres	Dolomite	11.7	11	4,500	38	1.0	101	Sour	Prim.	70	50	HF	6,000	5,500
13	Energen Resources	East Penwell (SA) Unit	Tex.	Ector	3/27	188	5/96	1,020	49	30	San Andres	Dolomite	10	4	4,000	34	2.0	86	Sour	WF	55	40	HF	1,220	700
14	ExxonMobil	Means (San Andres)	Tex.	Andrews	1/34	402	11/83	8,500	484	284	San Andres	Dolomite	9	20	4,300	29	6.0	97	Sour	WF			HF	5,818	5,000
15	Fasken	Abell (Devonian)	Tex.	Crane	9/53	46	4/09	809	18	14	Devonian	Tripolitic Chert	21.9	3	5,300	42	0.5	105	Sweet	WF	45		JS	240	200
16	Fasken	Hanford	Tex.	Gaines	1/38		7/86	1,120	23	26	San Andres	Dolomite	10.5	4	5,500	32	1.4	104	Sour	Prim.	60.7	18.7	NC	400	400
17	Fasken	Hanford East	Tex.	Gaines	3/40		3/97	340	7	4	San Andres	Dolomite	10	4	5,500	32	1.4	105	Sour	WF	45	19	C	45	45
18	Fasken	Hanford (San Andres)	Tex.	Gaines	3/40		7/09	150	7	4	San Andres ROZ	Dolomite	10	5	5,700	32	1.0	105	Sour	Prim.	50		JS	280	80
19	Fasken	River Bend (Devonian)	Tex.	Crane	10/54		4/09	400	9	7	Devonian	Tripolitic Chert	23.7	5	5,500	42	0.5	105	Sour	WF	55	46	JS	290	180
20	Great Western Drilling	Twofreds	Tex.	Loving,Ward,Reeves	1/57	55	1/74	4,392	32	9	Delaware, Ramsey	SS	19.5	32	4,900	36	1.5	105	Sweet	WF	50		NC	100	100
21	George R. Brown	Garza	Tex.	Garza	8/35		11/09	1,778			San Andres	Dolomite			3,000				Sour					1,500	1,000
22	Hunt Oil	Anne Tandy Burnett Ranch)	Tex	King	5/55	5	3/14	10,750	53	23	Twin Peaks, L. Strawn	LS	15	50	5,150	38			Sweet	WF			JS	3,000	3,000
23	Kinder Morgan	SACROC	TX	Scurry	9/48	2113	1/72	49,900	390	503	Canyon	LS	4	19	6,700	39	0.7	135	Sweet	Prim / WF	78	39	HF	30,800	28,300
24	Kinder Morgan	Katz	TX	Stonewall, King			1/11	5,000	156	101	Strawn	LS	17	75	4,950	38	2.2	117	Sweet	Prim, WF	70	40	JS	3,700	3,700
25	Kinder Morgan	Goldsmith-Landreth	TX	Ector	5/35	246	5/09	21,205	637	389	San Andres	Dolomite	12	32	4,100	35	1.3	95	Sour	Prim, WF	80	35	HF	2,100	2,067
26	Orla Petco	East Ford	Tex.	Reeves	9/63	10	7/95	1,953	8	4	Delaware, Ramsey	SS	23	30	2,680	40	0.8	82	Sweet	Prim.	49	36	HF	50	50
	Oxy (See Below)																								
76	Sabinal Energy Operating	Slaughter Sundown	Tex.	Hockley Co	4/37		1/94	5,500	155	144	San Andres	Dolomite	11	6	4,950	33	1.4	105	Sour	WF	41	25	HF	3,540	3,500
77	Tabula Rasa	East Seminole	Tex.	Gaines	5/59	19	10/13	160	12	4	San Andres	Dolomite	10	6	5,400	33	2.2	108	Sour	Prim./WF	80	43.9	JS	533	433
78	Tabula Rasa	Emma Pilot	Tex.	Andrews			2015	100	5	10	San Andres	Dolomite							Sour	Prim./WF				incl below	incl below
79	Tabula Rasa	Emma	Tex.	Andrews			12/17	200	8	16	San Andres	Dolomite							Sour	Prim./WF				470	450
80	Tabula Rasa	Lindoss	Tex.	Gaines	5/59	19	10/13	160	12	4	San Andres	Dolomite	10	6	5,400	33	2.2	108	Sour	Prim./WF	80	43.9	JS	300	267
81	Trinity	Wellman	Tex.	Terry	7/50	164	7/1/83	1,400	14	9	Wolfcamp	LS	9.2	100	9,800	43.5	0.5	151	Sweet	WF	35	10	HF	1,930	1,930
82	Whiting Petroleum	North Ward Estes	Tex.	Ward/Winkler	4/29	1,200	5/07	16,300	816	816	Yates	SS	16	37	2,600	36	1.6	83	Sour	Prim./WF	26.5	21	JS	10,194	7,700
83	XTO Energy Inc.	Goldsmith	Tex.	Ector	1/35	1,000	12/96	330	16	9	San Andres	Dolomite	11.6	32	4,200	35		105	Sour	WF			JS	1,620	1,620
84	XTO Energy Inc.	Cordona Lake	Tex.	Crane	10/49	68	12/85	2,084	44	23	Devonian	Tripolitic Chert	22	4	5,500	40	0.5	101	Sweet	WF			HF	910	500
85	XTO Energy Inc.	Wasson (Cornell Unit)	Tex.	Yoakum	1/37	141	7/85	1,923	96	64	San Andres	Dolomite	8.6	2	4,500	33	1.0	106	Sour	WF			HF	2,000	1,350
86	XTO Energy Inc.	Wasson (Mahoney)	Tex.	Yoakum	1/37	90	10/85	640	49	27	San Andres	Dolomite	13	6	5,100	33	1.0	110	Sour	WF	54.4	39.2	HF	1,500	1,300
	CO_2 immiscible																								
87	Kinder Morgan	Yates	Tex.	Pecos	10/26	4,000	3/04	26,000	606	123	San Andres	Dolomite	17	175	1,400	30	6.0	82	Sour	GI	75	54	HF	17,000	16,000

Producing CO_2 EOR Projects in the Permian Basin (Cont'd)

	Flood Type / Operator	Field	State	County	Field Unit Orig Discovery date	Orig Oil in Place MMBbls	Project Start date	Project Area, acres	No. prod. Wells	No. inj. Wells	Formation Flooding	Formation	Ave Form'tn Porosity, %	Ave Form'tn Permeability, md	Resvr Depth, ft	Oil Gravity, °API	Oil Visc. cp	Res Temp °F	Oil Type	Prev. Stage of Prod.	Oil Satur. % start	Oil Satur. % end	Proj. matur.	Tot. Crude Oil Prod., bopd	Enh.Crude Oil Prod., bopd
	CO_2 miscible (Cont'd)																								
27	Occidental Permian Ltd	Anton Irish	Tex.	Hale	12/44		4/97	4,437	199	93	Clearfork	Dolomite	7	4	5,800	30	3.0	109	Sour	Prim., WF	50	30	HF	3,631	3,500
28	Occidental Permian Ltd	Cedar Lake	Tex.	Yoakum	8/39		8/94	2,870	235	96	San Andres	Dolomite	14	5	4,800	32	2.3	102	Sour	WF	50	35	HF	3,049	3,049
29	Occidental Permian Ltd	Cogdell Canyon Reef Unit	Tex.	Scurry/Kent	12/49		10/01	2,684	119	90	Canyon Reef	LS	13	6	6,800	40	0.7	130	Sweet	WF	46	15	HF	6,333	5,800
30	OXY USA WTP, LP	El Mar	Tex.	Loving	1/59		4/94	7,100	8	8	Delaware	SS	16	20	4,500	41	1.1	97	Sweet	Prim./WF	40		NC	34	34
31	OXY USA WTP, LP	G-M-K South	Tex.	Gaines	5/57	47	1982	1,143	30	26	San Andres	Dolomite	10	3	5,400	30	3.0	101	Sour	Prim.	55	28	HF	364	300
32	Occidental Permian Ltd	Levelland (Levelland Unit)	Tex.	Hockley	2/45	170	9/04	1,179	137	110	San Andres	Dolomite	12	2	4,900	34	1.4	108	Sour	WF	45	26	JS	2,340	1,675
33	OXY Permian Ltd	Mid Cross Dev Unit	Tex.	Crane, Upton & Crockett			7/97	1,326	9	6	Devonian	Tripol.	18	2	5,400	42	0.4	104	Sweet	Prim., GI	60	20	HF	244	240
34	OXY Permian Ltd	North Cross /Dev./ Unit	Tex.	Crane & Upton	5/44	51	4/72	1,155	25	16	Devonian	Tripol.	22	5	5,300	44	0.4	104	Sweet	Prim., GI	49	21	NC	839	839
35	OXY USA WTP, LP	North Cowden	Tex.	Ector	9/30	107	2/95	465	30	15	Grayburg	Dolomite	10		4,200	34	1.5	91	Sour	WF	40	25	**Term.**		
36	OXY USA WTP, LP	North Dollarhide Devonian	Tex.	Andrews	8/45	94	11/97	1,280	23	16	Devonian	Tripol.	22	5	7,500	40	0.5	123	Sweet	WF	38	23	HF	563	350
37	OXY Permian Ltd	North Hobbs	NM	Lea			3/03	3,300	134	83	San Andres	Dolomite	15	15	4,200	35	0.9	102	Sour	WF	35	24	HF	7,860	6,445
38	OXY Permian Ltd	South Cross Unit	Tex.	Crockett			6/88	2,090	76	43	Devonian	Tripol.	21	4	5,200	43	0.6	104	Sour	Prim., GI	43	24	**NC**	4,194	4,194
39	OXY Permian Ltd	Salt Creek Field Unit	Tex.	Kent	5/50	500	10/93	12,000	170	145	Canyon	LS	20	12	6,300	39	1.0	125	Sweet	WF	89	15	HF	6,390	6,390
40	OXY USA WTP, LP	Sharon Ridge Canyon Unit	Tex.	Scurry	3/49	369	2/99	1,400	37	43	Canyon Reef	LS	10	70	6,600	43	0.4	125	Sweet	WF	39	26	HF	1,264	1,264
49	Oxy USA Inc.	Seminole Unit-Main Pay Zone	Tex.	Gaines	11/36	971	7/83	15,699	370	110	San Andres	Dolomite	12	1.3-123	5,300	35	1.1	104	Sour	WF	84		HF	8,500	8,150
50	Oxy USA Inc.	Seminole Unit-ROZ Phase 1	Tex.	Gaines	11/36	980	7/96	500	15	10	San Andres	Dolomite	12	1.3-123	5,500	35	1.1	104	Sour	none	30		HF	1,000	1,000
51	Oxy USA Inc.	Seminole Unit-ROZ Phase 2	Tex.	Gaines	11/36	980	4/04	480	16	9	San Andres	Dolomite	12	1.3-123	5,500	35	1.1	104	Sour	none	30		HF	1,500	1,500
52	Oxy USA Inc.	Seminole Unit-ROZ Stage 1	Tex.	Gaines	11/36	980	10/07	2,320	44	29	San Andres	Dolomite	12	1.3-123	5,500	35	1.1	104	Sour	none	30		HF	7,800	7,800
53	Oxy USA Inc.	Seminole Unit-ROZ Stage 2	Tex.	Gaines	11/36	980	5/11				San Andres	Dolomite	12	1.3-123	5,500	35	1.1	104	Sour	none	30		HF		
54	Oxy USA Inc.	Seminole Unit-ROZ Stage 3	Tex.	Gaines	11/36	980	7/13				San Andres	Dolomite	12	1.3-123	5,500	35	1.1	104	Sour	none	30		HF		
55	Oxy USA Inc.	Seminole Unit-ROZ Stage 4	Tex.	Gaines	11/36	980	1/15				San Andres	Dolomite	12	1.3-123	5,500	35	1.1	104	Sour	none	30		JS		
56	Occidental Permian Ltd	Slaughter (Alex Slaughter Estate)	Tex.	Hockley	1/37	13	8/00	246	18	18	San Andres	Dolomite/LS	10	5	4,950	31	1.8	105	Sour	WF	40	25	HF	123	123
57	Occidental Permian Ltd	Slaughter (Central Mallet Unit)	Tex.	Hockley	4/37	139	1984	6,412	157	116	San Andres	Dolomite	10	2	4,900	31	1.8	105	Sour	WF	48	25	HF	2,102	2,000
58	Occidental Permian Ltd	Slaughter (Frazier, W.G. Lease)	Tex.	Hockley	11/36		12/84	1,600	56	52	San Andres	Dolomite/LS	12	8	4,950	31	1.8	105	Sour	WF	38	23	NC	618	556
59	OXY USA WTP, LP	Slaughter (Boyd, H.T.)	Tex.	Cochran	4/37		8/01	1,240	37	22	San Andres	Dolomite	10	4	5,000	31	1.6	108	Sour	WF	47	36	HF	644	579
60	Occidental Permian Ltd	Slaughter (Igoe Smith Oper. Area)	Tex.	Cochran	4/37		9/05	1,235	45	34	San Andres	Dolomite	11	4	5,040	34	1.5	105	Sour	WF	47	36	HF	598	475
61	Occidental Permian Ltd	Slaughter (North West Mallet Unit)	Tex.	Cochran & Hockley	4/37		2008	1,048	94	30	San Andres	Dolomite	10	2	4,950	32	2.0	105	Sour	WF	47	31	JS	1,021	250
62	Occidental Permian Ltd	Slaughter (Slaughter Estate Unit)	Tex.	Hockley	4/37	300	12/84	5,700	171	140	San Andres	Dolomite/LS	12	5	4,950	31	1.8	105	Sour	WF	40	23	HF	2,325	2,093
63	Occidental Permian Ltd	Slaughter (Smith Igoe)	Tex.	Cochran	4/37		8/14	177	6	3	San Andres	Dolomite	10	4	5,000	31	1.6	108	Sour	WF	47	36	HF	151	110
64	Occidental Permian Ltd	Slaughter (West RKM Unit)	Tex.	Hockley	4/37	16	2006	1,561	145	48	San Andres	Dolomite	9	4	4,900	32	2.0	105	Sour	WF	42	29	JS	1,503	599
65	Occidental Permian Ltd	South Wasson Clearfork	Tex.	Yoakum	1/40	247	10/84	4,720	102	68	Clearfork	Dolomite	7	2	8,200	33	1.2	120	Sour	WF	70		Term.	1,757	0
66	OXY Permian Ltd	South Hobbs G/SA Unit	NM	Lea			7/15		57		Grayburg/San Andres	Dolomite	15	15	4,200	35	0.9	102	Sour	WF	35	24	JS	5,119	4,668
67	OXY USA WTP, LP	South Welch Unit	Tex.	Dawson	11/36	131	9/93	1,160	118	72	San Andres	Dolomite	11	4	4,900	34	2.3	98	Sour	WF	50	35	NC	610	500
68	Occidental Permian Ltd	Slaughter T-Star (Consolidated)	Tex.	Hockley			7/99	1,700	54	30	Abo	Dolomite	7	2	7,850	28	1.9	134	Sour	Prim./WF	75	45	HF	1,732	1,000
69	Occidental Permian Ltd	Wasson (Bennett Ranch Unit)	Tex.	Yoakum	1/36	301	6/95	2,154	173	150	San Andres	Dolomite	11	8	5,250	34	1.2	105	Sour	WF	55	37	HF	4,324	4,100
70	Occidental Permian Ltd	Wasson (Denver Unit)	Tex.	Yoakum & Gaines	4/36	2,108	4/83	27,848	73	70	San Andres	Dolomite	12	8	5,200	33	1.2	105	Sour	WF	51	31	HF	22,174	22,174
71	Occidental Permian Ltd	Wasson (ODC Unit)	Tex.	Yoakum	4/36		11/84	7,800	284	260	San Andres	Dolomite/LS	10	5	5,100	34	1.3	110	Sour	WF	49	34	HF	7,655	7,500
72	Occidental Permian Ltd	Wasson (Willard Unit)	Tex.	Yoakum	1/36	622	1/86	8,020	380	250	San Andres	Dolomite	9	2	5,100	32	1.2	105	Sour	WF	56	41	HF	6,488	6,350
73	OXY USA WTP, LP	West Welch	Tex.	Gaines	11/36	229	10/97	240	201	150	San Andres	Dolomite	10	3	4,900	34	2.3	98	Sour	WF	50	15	Term.	1,122	200
74	Occidental Permian Ltd	Levelland (South East Levelland)	Tex.	Hockley	1/45	144	4/14	1,184	186	40	San Andres	Dolomite	10	2	4,850	32	1.4	108	Sour	WF	30	15	JS	1,999	250
75	OXY USA WTP, LP	West Seminole San Andres Unit	Tex.	Gaines	6/48	154	7/1/13	1,620	81	50	San Andres	Dolomite	12	10	5,000	34	0.9	102	Sour	WF	65	30	JS	2,084	1,839
																								232,273	**207,955**