DOCKET: EPA-HQ-OAR-2019-0534

TECHNICAL SUPPORT DOCUMENT FOR SECTION 194.33

REVIEW OF BOREHOLE DRILLING RATE AND PLUGGING PATTERN FREQUENCY CALCULATIONS IN THE CRA-2019 PERFORMANCE ASSESSMENT

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Center for Waste Management and Regulations
1200 Pennsylvania Ave, NW
Washington, DC 20460

April 2022

EXECUTIVE SUMMARY

The most significant pathways for postclosure releases of radionuclides from the Waste Isolation Pilot Plant (WIPP) are those created by the inadvertent intrusion of the repository by exploratory boreholes in the future. Those releases may occur at the time a borehole first penetrates repository waste as well as after a borehole has been plugged and abandoned. The rate at which boreholes are drilled and the locations of plugs that are installed in abandoned boreholes have significant effects on projections of future repository performance in isolating the waste from the environment. This Technical Support Document (TSD) provides a summary of the U.S. Environmental Protection Agency's (EPA's) review of the approach used by the U.S. Department of Energy (DOE) in calculating borehole drilling rates and assessing plugging practices in the 2019 Compliance Recertification Application (CRA-2019).

The WIPP site is located in the northern part of the Delaware Basin of southeast New Mexico and western Texas. The EPA regulations in 40 CFR §194.33 treat the drilling practices and technology currently used in the Delaware Basin as analogues for projecting future drilling practices and technology in WIPP Performance Assessment (PA). Future drilling rates at the WIPP site are assumed to be the same as the average rates for drilling in the Delaware Basin over the past 100 years and, based on local regulatory considerations, future borehole plugging practices are assumed to be the same as plugging practices in the New Mexico portion of the Delaware Basin since 1988. DOE compiles information on borehole drilling and plugging practices obtained from state and federal agencies and maintains a database that is updated annually.

Drilling Rates. Drilling rates are separately calculated by DOE for shallow and deep boreholes. For purposes of WIPP PA, shallow boreholes are those that do not extend below the 2,150-foot depth of the repository and deep boreholes are those that equal or exceed that depth. Deep boreholes consist almost entirely of wells drilled for exploration and recovery of oil and gas resources. The distinction between shallow and deep is important because only deep boreholes are currently considered in PA to have an effect on future repository performance.

EPA performed a detailed review of the DOE's approach to calculating deep and shallow drilling rates as part of its analysis of the CRA-2019 PA. DOE's approach categorizes boreholes as either deep, shallow, or of unknown depth. Those of unknown depth are by default counted with the shallow total. The boreholes in this last category have unknown depths because of incomplete documentation available at the time of reporting. The database used for the CRA-2019 PA consists of 33,382 wells in the Texas and New Mexico parts of the Delaware Basin, of which 22,886 were known to be deep, 7,416 were known to be shallow, and 3,080 were of unknown depth. DOE's practice has been to initially assume that all boreholes of unknown depth were shallow and if they were actually deep, they would be reclassified as deep when complete documentation became available, usually within 1 to 2 years. At any given time, the categorization of unknown wells as shallow wells creates a data lag that underestimates drilling rates for deep wells. This adds to the known lag in PA calculations for each recertification due to earlier, specified data cutoff dates. EPA explored the impacts of this shortcoming with an alternative methodology that assumes that, at any given time, boreholes lacking depth information will fall under similar proportions of shallow to deep as the total number of fully

documented wells. A similar approach was previously applied by DOE in the 1996 Compliance Certification Application (CCA) Appendix DEL to water supply wells whose depth information was unavailable due to lack of documentation. EPA requests that DOE reconsider its drilling rate methodology for CRA-2024 because the drilling rate has increased over recent years, creating a larger discrepancy between the actual drilling rate and the drilling rate as it is captured in PA. This could be part of DOE's larger review of the Delaware Basin Drilling Surveillance Program and if deemed appropriate, DOE may propose an alternative method for Agency review before the CRA-2024.

Plugging Frequencies. Prior to abandonment, boreholes are sealed by placing concrete plugs at various depth intervals for the purpose of isolating subsurface mineral- or water-bearing zones. The depth of placement and lengths of plugs create plugging patterns that control the ability of fluids to flow vertically within boreholes after abandonment. With regard to the WIPP, certain patterns promote waste isolation while other patterns do not. The frequencies of occurrence of the various plugging patterns that are currently used in the Delaware Basin are used in WIPP PA as analogues for patterns that would be placed in future boreholes that penetrate WIPP waste. At the time of the 1996 CCA, DOE considered various approaches for calculating plugging pattern frequencies and proposed basing the calculation on all plugged boreholes in the New Mexico portion of the Delaware Basin as an appropriate regulatory and geologic analogue. Although the WIPP is on federal land where the plugging requirements of the U.S. Bureau of Land Management (BLM) apply, DOE chose to include all boreholes in its sample because of the close similarity between BLM requirements and those of the New Mexico Oil Conservation Division (OCD) that apply to state and private lands. This approach was approved by EPA and used by DOE in the 1996 CCA and in all subsequent CRAs until the CRA-2019.

In the CRA-2019 DOE changed its approach for calculating plugging pattern frequencies to one based on the portion of the Delaware Basin within the Known Potash Leasing Area (KPLA). This area is within the New Mexico part of the Delaware Basin and has the requirement of a continuous plug through the salt section in abandoned boreholes that are located within known potash reserves. The DOE justified this change because the WIPP site is within the KPLA and the KPLA could therefore be considered to represent an appropriate regulatory and geologic analogue for future plugging practices at the WIPP. This change increased the frequency of continuous plugs by a factor of four and had the effect of significantly reducing calculated releases in WIPP PA. Because DOE deviated from the historical approach and the changes are impactful, the Agency closely evaluated the basis for DOE's decision and its impact on PA.

The plugging and abandonment of wells within the KPLA is controlled by OCD Order R-111-P. This order gives the OCD District Supervisor discretionary authority to waive the continuous plug requirement at barren locations where economic grade potash ore is absent. This authority appears to be frequently exercised because field data collected by DOE shows that, as of 2018, 60% of plugged and abandoned boreholes within the KPLA were not installed with continuous cement plugs and instead used other plugging configurations more typical of outside the KPLA.

DOE has previously shown that the WIPP is in such a barren area because economic grade potash ore is not present. Current practice within the KPLA therefore indicates that continuous plugs would likely not be required for future abandoned boreholes at the WIPP. In such a

situation the same BLM/State plugging requirements would, by default, apply to the WIPP site as are applied to the New Mexico portion of the Delaware Basin. This conclusion supports the appropriateness of looking at a broader area such as was done in the original DOE proposal to base plugging frequency calculations on all abandoned boreholes within the New Mexico portion of the Delaware Basin.

An additional concern is that the part of the KPLA considered in the DOE's new approach is a small subset of the larger New Mexico part of the Delaware Basin and provides less representative samples of plugging practices. This concern applies to both the reduced geographical area and the reduced sample size of the KPLA. The WIPP site is at the far eastern edge of the KPLA and restricting the sample to the KPLA does not capture plugged and abandoned wells that are within the Delaware Basin and immediately adjacent to the WIPP LWA but outside the KPLA. Such wells are clearly relevant geologic analogues for evaluating future plugging practices at the WIPP site and were included in the historic approach that considered all wells in the New Mexico part of the basin. The KPLA-based sample size used by the DOE to calculate plugging frequencies for the CRA-2019 PA was 154 boreholes while the sample size that would have been used if the calculation had been based on the entire New Mexico part of the Delaware Basin was 822 boreholes. EPA recognizes that in general larger sample sizes better reflect the characteristics of a population and larger samples would be preferred provided they are relevant and representative.

The effects of DOE's KPLA-only-based plugging calculations on the CRA-2019 PA are shown in Figure EXEC.1. This figure compares average total repository releases calculated using the historic plugging pattern frequency calculations with releases calculated by the DOE in the CRA-2019 PA. The effect of DOE's new approach is clearly evident in reducing calculated repository releases, even on a logarithmic scale. EPA recognizes that not all performance calculations that show reduced releases are non-conservative. The Agency allows changes in performance calculations that show reduced releases when those changes are based on sound reasoning and supported by data and new technology. However, the new approach used by DOE to calculate plugging pattern frequencies in the CRA-2019 PA is not adequately supported by current regulatory considerations or practice.

In view of the foregoing concerns with the DOE's KPLA-based plugging proposal, EPA expects DOE to revert to the previously-approved plugging frequency methodology in the CRA-2024 PA, or otherwise propose and use alternative methods that may be approved by EPA prior to that time.

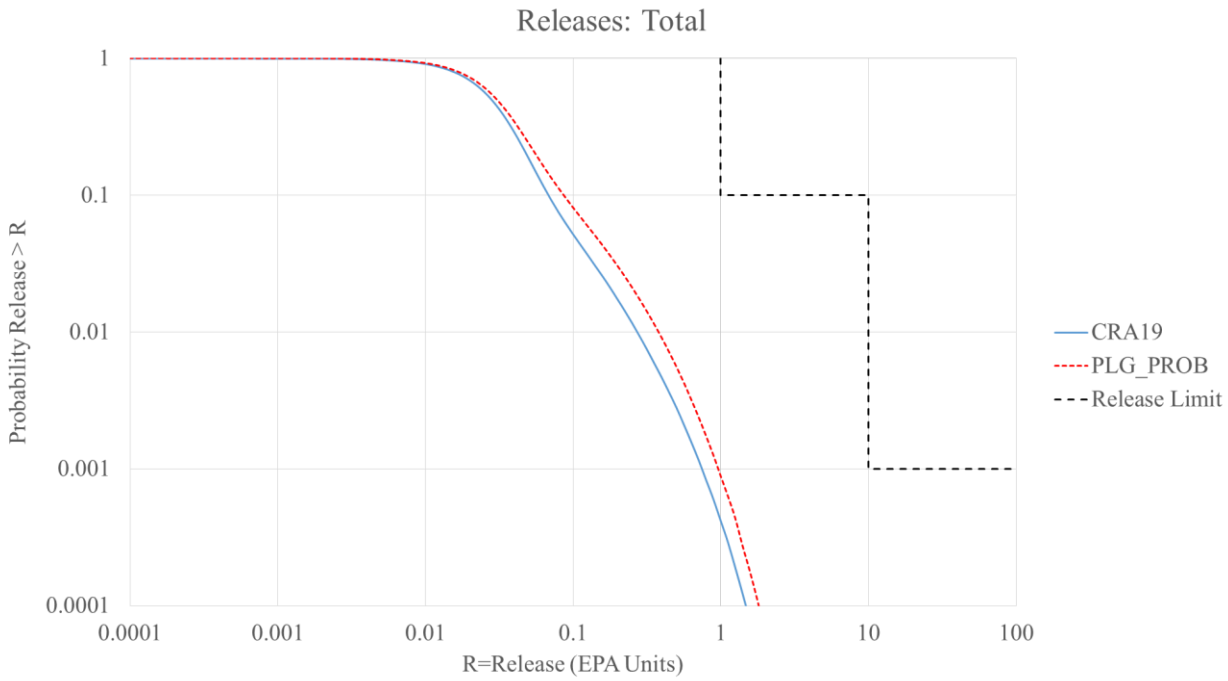

Figure EXEC.1. EPA sensitivity study results showing average total repository releases using DOE's historic plugging pattern frequency calculation (PLG_PROB curve) compared with total releases using DOE's new plugging pattern frequency calculation (CRA19 curve).

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii
1.0 INTRODUCTION 1
2.0 DEEP BOREHOLE DRILLING RATE CALCULATION 2
2.1 Background 2
2.2 DOE Calculation Methodology 2
2.3 EPA Evaluation of DOE Methodology 3
2.4 EPA Conclusions 7
3.0 DEEP BOREHOLE PLUGGING PATTERN FREQUENCY CALCULATION 8
3.1 Background 8
3.2 DOE Calculation Methodologies 11
3.2.1 DOE's Original Methodology 11
3.2.2 DOE's Revised Methodology 15
3.3 EPA Evaluation of DOE Methodology 19
3.3.1 Consideration of EPA Regulatory Requirements 21
3.3.2 Consideration of OCD Order R-111-P Regulations 22
3.3.3 Consideration of Borehole Plugging Practices within the KPLA 24
3.3.4 Consideration of Representative Samples 26
3.3.5 Consideration of Impacts on WIPP PA 30
3.4 EPA Conclusions 32
4.0 COMBINED DRILLING RATE AND PLUGGING ANALYSIS AND SUMMARY 33
REFERENCES 35
APPENDIX A A-1
APPENDIX B B-1
APPENDIX C C-1
Attachment QA QA-1

LIST OF APPENDICES AND ATTACHMENTS

APPENDIX A. EPA Completeness Questions, DOE Responses, and EPA Evaluations of Responses Related to Borehole Drilling Rate and Plugging Pattern Frequency in WIPP Performance Assessment

APPENDIX B. EPA Completeness Questions, DOE Responses, and EPA Evaluations of Responses Related to the Delaware Basin Drilling Surveillance Program and Delaware Basin Monitoring Annual Report

APPENDIX C. Data Table from Baker Hughes Rig Count, North America Rig Count, 2021

ATTACHMENT QA: QA Documentation for EPA's PLG_PROB Sensitivity Analysis

LIST OF TABLES

Table 3.1. Plugging Pattern Types and Frequencies as of August 31, 2018

Table 3.2. Plugging Pattern Frequencies by Compliance Application

Table 3.3. Comparison of Mean Total Releases at EPA Compliance Points for PLG_PROB Sensitivity Study

Table 4.1. Parameter Value Changes in EPA's combined borehole sensitivity analysis

LIST OF FIGURES

Figure EXEC.1. EPA sensitivity study results showing average total repository releases using DOE's historic plugging pattern frequency calculation (PLG_PROB curve) compared with total releases using DOE's new plugging pattern frequency calculation (CRA19 curve).

Figure 2.1. Total boreholes and drilling rates compiled from Delaware Basin Monitoring Annual Reports (DBMARs) since 1998 and Appendix DEL for 1996. Additional curves derived from these same data sources and plotted by EPA using modified approaches as described in the text.

Figure 2.2. EPA's alternative calculation of total releases based on a deep drilling rate of 109.1 boreholes per km^2 over 10,000 years (DRILL_RATE curve) in comparison with DOE's 2019 Deferred PA deep drilling rate of 99.0 boreholes per km^2 over 10,000 years (CRA19 curve).

Figure 3.1. Typical borehole plug configurations in the Delaware Basin.

Figure 3.2. Map of the Delaware Basin and vicinity showing the location of the WIPP site.

Figure 3.3. Map of the KPLA at the northern edge of the Delaware Basin.

Figure 3.4. Potential extent of mining within the WIPP LWA based on 1993 BLM map of lease grade ore.

Figure 3.5. Potential extent of mining based on areas within the LWA that had been offered by the BLM for leasing.

Figure 3.6. Extent of economically viable lease grade potash ore based on a 1995 assessment by the New Mexico Bureau of Mines and Mineral Resources.

Figure 3.7. Map showing the Delaware Basin portion of the KPLA as defined by OCD Order R-111-P.

Figure 3.8. Map showing wells that would have been used in the CRA-2019 PA to determine plugging frequency based on the historic methodology of considering all abandoned wells in the New Mexico part of the Delaware Basin.

Figure 3.9. Map showing KPLA wells used by DOE to determine plugging frequency for the CRA-2019 PA.

Figure 3.10. Plugging pattern frequencies in DOE compliance applications from the original certification and subsequent recertifications in Table 3.2. Lines diverge at 2014 projecting the historic methodology (dashed lines) and DOE's new methodology (solid lines) to 2019.

Figure 3.11. EPA sensitivity study results showing average total repository releases using historic plugging pattern frequency calculation (PLG_PROB curve) compared with total releases using DOE's new plugging pattern frequency calculation (CRA19 curve).

Figure 4.1. EPA's combined borehole sensitivity analysis results comparing average total repository releases calculated using EPA's alternative higher drilling rate and historic plugging pattern frequency calculations (DR_PLG curve) with releases calculated by the DOE in the CRA-2019 PA (CRA19 curve).

LIST OF ACRONYMS AND ABBREVIATIONS

BLM	U.S. Bureau of Land Management
CC	Completeness Comment
CCA	Compliance Certification Application
CFR	*Code of Federal Regulations*
CRA	Compliance Recertification Application
DBDSP	Delaware Basin Drilling Surveillance Plan
DBMAR	Delaware Basin Monitoring Annual Report
DOE	U.S. Department of Energy
DPA	Deferred Performance Assessment
EPA or the Agency	U.S. Environmental Protection Agency
KPLA	Known Potash Leasing Area
LMR	Life of Mine Reserve
LWA	WIPP Land Withdrawal Area
NMBMMR	New Mexico Bureau of Mines and Mineral Resources
NOI	Notice of Intent
NWP	Nuclear Waste Partners
OCC	New Mexico Oil Conservation Commission
OCD	New Mexico Oil Conservation Division
PA	Performance Assessment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
SNL	Sandia National Laboratories
TRU	Transuranic
TSD	Technical Support Document
WIPP	Waste Isolation Pilot Plant

Support for this report was provided by SC&A, Arlington, Virginia, under Contract 68HERD20A0005, Task Order 68HERH20F0404, Task 1132-0003-001-001-02b. Although issues of both technical practice and regulatory intent are addressed in this report, the final interpretation of the EPA rule and ultimate acceptance or rejection of the EPA expectations expressed in this report are only within the purview of the Agency.

1.0 INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) repository was developed by the Department of Energy (DOE or the Department) for the permanent disposal of transuranic (TRU) waste. The repository is located in deeply buried deposits of bedded salt in the Salado Formation within the Delaware Basin in southeastern New Mexico. The Environmental Protection Agency (EPA or the Agency) regulates post-closure containment of TRU waste at the WIPP in accordance with the radioactive waste disposal standards at Code of Federal Regulations (CFR) Title 40, Parts 191 and 194. The WIPP was first certified by EPA as complying with these standards and approved for TRU waste disposal in 1998. The WIPP Land Withdrawal Act (LWA) is a federal statute requiring the DOE to submit recertification applications at five-year intervals following the first waste shipment in March 1999, with the most recent recertification application submitted in March 2019. The EPA's decision whether to recertify the WIPP is based in part on the results of an assessment of the projected ability of the repository to meet the Agency's numerical waste isolation standards over the 10,000-year post-closure regulatory time frame. The ability to meet the Agency's numerical standards is determined by the results of computer modeling conducted for the DOE by Sandia National Laboratories (SNL). That modeling simulates the repository's future performance in a process called Performance Assessment (PA). The most recent assessment was included in DOE's 2019 Compliance Recertification Application (CRA) and is called the CRA-2019 PA (DOE 2019). The CRA-2019 PA was submitted to the Agency in December 2019 (Sosson 2019). This PA, also called the CRA19 PA or the Deferred PA (DPA), was, by Agency agreement, not submitted at the same time as the recertification application. The Agency approved this delay to allow the Department to conserve resources needed to address planned major modifications of the WIPP repository design and performance simulation that would be submitted for independent peer review and subsequent Agency review as part of the DOE's CRA-2024. Because the CRA-2019 PA was not yet complete at the time the DOE's 2019 recertification application was submitted, that application referred to the Agency-approved CRA-2014 PA on an interim basis as the current baseline PA. Upon completion, the deferred CRA-2019 PA superseded the CRA-2014 PA and was regarded by the Agency as the DOE's formal, updated demonstration of continuing compliance with EPA's performance requirements.

Title 40, Section 194.33 of the Code of Federal Regulations instructs the DOE on the treatment of borehole drilling activities in PA. These activities are an important aspect of assessing repository performance because all significant potential radionuclide release pathways involve the hypothetical, inadvertent penetration of repository waste by deep exploratory boreholes for oil and gas resources beneath the WIPP repository. This Technical Support Document (TSD) addresses two aspects of drilling activities, the rate at which deep drilling may occur in the future, and the methods used to plug and abandon those boreholes at the ends of their useful lives. Both the projected future drilling rate and the projected future plugging patterns significantly affect calculated repository releases.

As part of its compliance programs and as important inputs to the PAs included in every 5-year recertification, the DOE and its contractors monitor activities in the Delaware Basin, including the drilling and plugging of boreholes for hydrocarbon and potash resources. This information is collected as part of the DOE's Delaware Basin Drilling Surveillance Program (DBDSP) and is compiled in its database, the Delaware Basin Well Tracking Application. The information comes

from commercial databases or state and federal regulatory agencies such as the Texas Railroad Commission, New Mexico Oil Conservation Division (OCD), and the federal Bureau of Land Management (BLM). This information is supplemented by surveys sent to and interviews with drillers operating in the area. Boreholes are then organized by depth and category, such as oil and gas wells, saltwater disposal wells, and potash exploration holes. Two parameters, the deep borehole drilling rate and the deep borehole plugging pattern frequency, are especially impactful on radionuclide releases in PA simulations because they govern the probability of boreholes directly intersecting the repository waste and subsequent fluid flow into and out of the repository.

EPA's review of the borehole drilling rate and plugging pattern frequency calculations in the DOE's CRA-2019 PA is documented in this TSD. Section 2 describes the Agency's review of borehole drilling rate calculations and Section 3 describes the Agency's review of plugging pattern frequency calculations. Each of these sections provides a description of the DOE's calculation methodology and supporting rationale, followed by the Agency's evaluation of that methodology. Section 4 provides a summary of the Agency's evaluations and expectations for improvement. Appendix A lists EPA's completeness questions regarding borehole drilling and plugging calculations, DOE's responses, and EPA's evaluation of those responses. Similarly, Appendix B lists EPA's completeness questions regarding the conduct and documentation of DOE's drilling surveillance program.

2.0 DEEP BOREHOLE DRILLING RATE CALCULATION

2.1 Background

Drilling information for the Delaware Basin was first reported by DOE in Appendix DEL (Delaware Basin) and the methodology described for its collection was reported in Appendix DMP (Delaware Basin Drilling Monitoring Plan) in the 1996 WIPP Compliance Certification Application (CCA) (DOE 1996). The DBDSP has been periodically updated and Revision 8 (NWP 2019) is the most recent. DOE contractors regularly compile drilling information from the region and incorporate it each September into the Delaware Basin Monitoring Annual Report (DBMAR), which covers the preceding year from September 1 to August 31.

2.2 DOE Calculation Methodology

Typically, at the time of reporting some proportion of borehole records are incomplete and lacking required information such as depth. Those boreholes where depth information is unknown at the time are categorized by DOE as "Drilling or Waiting on Paperwork" and speculatively counted as "shallow" wells until depth information is available and the wells can be properly sorted between shallow (<2150 feet) and deep (≥2150 feet) boreholes. A smaller number of boreholes have depth information but are lacking other information. These also are categorized as "Drilling or Waiting on Paperwork" and fall under their respective shallow and deep categories. Before about 2010, the number of boreholes of unknown depth was no more than a few hundred, but increased drilling activity over the past decade has resulted in the number jumping from 431 in 2011 to more than 3000 in 2017 and 2018. For comparison, the total number of boreholes in the database as of 2019 for the entire Delaware Basin was just under 35,000. EPA requested DOE to provide an explanation of the practice of calculating drilling rates

in Completeness Comment CC5-33-8 as part of the Agency's CRA-2019 completeness review. The complete text of EPA's comment, DOE's response, and the Agency's evaluation of that response are provided in Appendix A.

2.3 EPA Evaluation of DOE Methodology

Drilling rates in WIPP PA are expressed as boreholes per unit area over the 10,000-year regulatory period. The "drilling rate" as used in WIPP PA is the areal density of boreholes that would occur in the Delaware Basin after 10,000 years if the average annual of rate borehole drilling in the basin over the past 100 years continued unchanged for the next 10,000 years.

The formula for calculating the drilling rate was originally proposed by DOE for the 1996 CCA (DOE 1996, Appendix DEL). The formula was consistent with the requirements of 40 CFR §194.33 and was accepted by EPA but the DOE retained responsibility for developing and updating the specific parameter values. EPA's concern is that the impact on WIPP PA of DOE's practice of automatically excluding boreholes of unknown depth from the deep category has substantially increased since the CCA. This practice, which originally excluded a few hundred wells, now excludes a few thousand wells from PA calculations, even though historical trends show that most boreholes drilled are actually deep, and that the percentage of deep boreholes has increased in recent years. This practice creates an effective data lag by undercounting the number of deep boreholes and inflating the number of shallow boreholes in the basin at any given moment in time while waiting for the well records to be completed. This undercounting is impactful to WIPP PA because only deep boreholes currently contribute to repository releases. While it may be asserted that regulatory activities such as the DBDSP are ongoing and the data collected are representative of "a snapshot in time" (see DOE 8th Set of Responses in Appendix A), the apparent lag and undercount since ~2015 is an order of magnitude higher than it has been historically and will likely persist so long as oil and gas drilling activities remain high and the governmental and commercial entities that DOE utilizes in regularly updating its database struggle to keep up. Deep boreholes are an important PA parameter and a significant driver of releases in PA. This categorization approach has also resulted in non-physical artifacts in the reported data such as the total number of shallow boreholes decreasing from year to year over several editions of the DBMAR. These observations led EPA take a closer look at DOE's current methodology and underlying data.

Figure 2.1 plots the total number of shallow and deep boreholes as reported in the DBMARs over time and shows the marked increase in drilling in the Delaware Basin at the beginning of the last decade. It also shows an "artifact" of DOE's current approach: decreases in the total number of shallow boreholes after 2008 and 2017 explained by lumping all boreholes of unknown depth as *shallow* and then later changing some of them to *deep* as information becomes available and the database is updated. The ratio of total deep to shallow boreholes was nearly 2:1 at the time of the WIPP CCA in 1996 and has gradually widened to approximately 3:1 in 2019. Also plotted are the deep drilling rates reported by DOE and the number of boreholes categorized as shallow "drilling or waiting on paperwork." The shallow drilling rate has not been regularly reported in DBMAR since 2012 and was calculated by EPA from the total number of shallow boreholes.

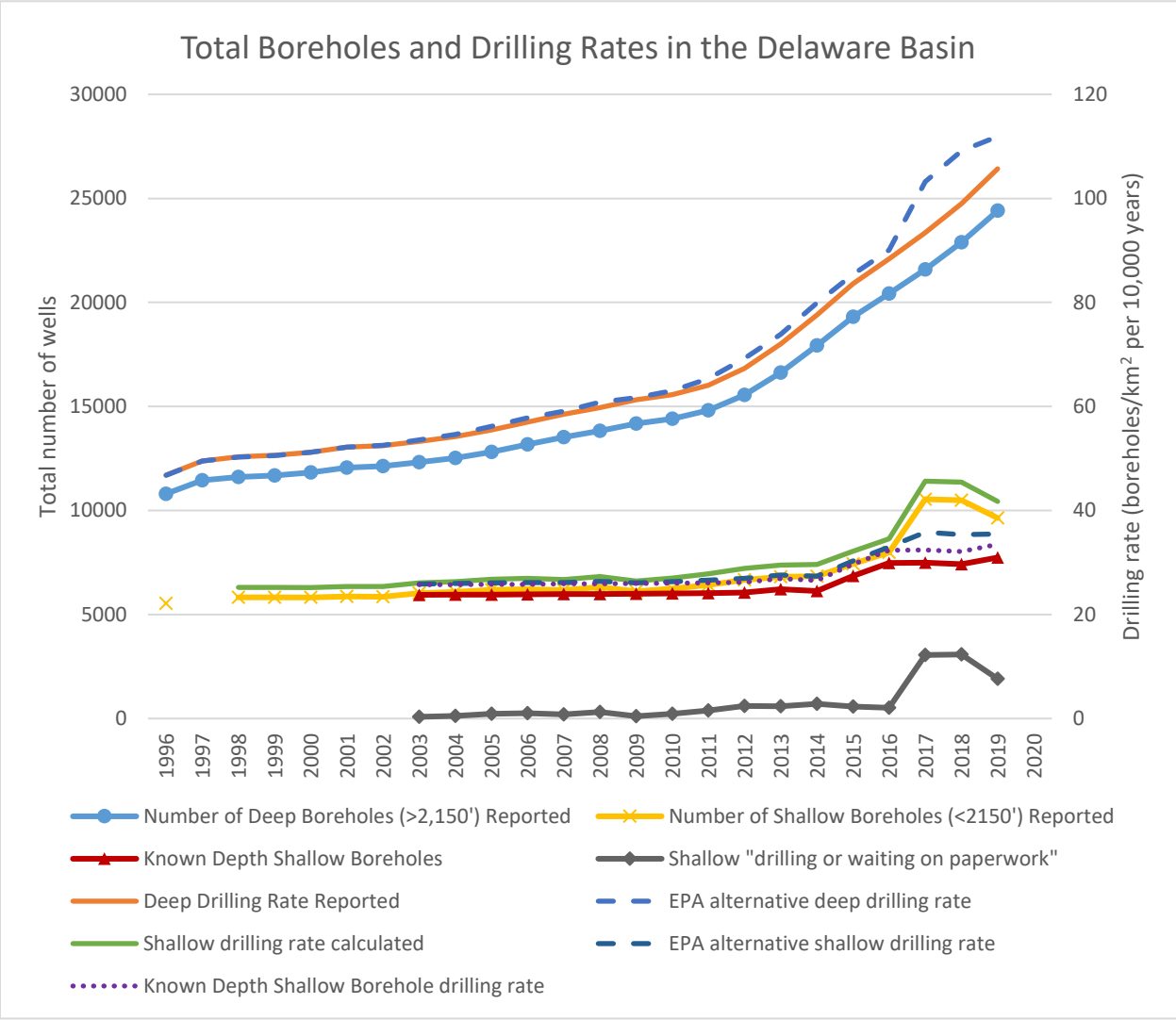

Figure 2.1. Total boreholes and drilling rates compiled from Delaware Basin Monitoring Annual Reports (DBMARs) since 1998 and Appendix DEL for 1996. The additional curves were derived from these same data sources and plotted by EPA using alternative approaches as described in the text (Sources: DOE 1999-2019; DOE 1996, Appendix DEL).

In order to explore the impact of DOE's speculatively assigning all boreholes of unknown depth as shallow by default, EPA used an alternative approach to calculating drilling rates. This alternate approach splits the categorization of wells lacking depth information at the time of reporting at a ratio proportional to the total known deep and shallow boreholes in the Delaware Basin. As calculated below, this increases the deep borehole drilling rate of 99.0 boreholes/km^2 over 10,000 years used in the CRA-2019 PA to 109.1 boreholes/km^2. This approach more closely matches the actual number of both deep and shallow boreholes in the basin at the time of reporting, thus reducing the impact of the lag in reporting by the data sources feeding the DBDSP. There is precedent to such an approach in DOE's early compliance documentation. At the time of the CCA, DOE applied similar logic to a method for allocating water wells lacking

depth documentation as either shallow or deep when calculating the corresponding drilling rates (see DOE 1996, Appendix DEL 7.4).

In the first 1½ decades of WIPP operations, DOE's automatic inclusion of boreholes of unknown depth at the time of reporting as shallow created a relatively small lag or difference between the reported drilling rate and the final classification when complete borehole data, including depth information, became available later. This is evidenced by the narrow gap in reported and EPA's alternative drilling rates in Figure 2.1. However, with the increase over the past decade of drilling activity in the Delaware Basin, this gap has widened to thousands of wells and effectively a 1 to 2 year time lag in reporting. This wide gap cannot be accounted for solely by assuming that the wells in questions are in the process of being drilled or completed because at any given time there have never been more than a few hundred active drilling rigs in the entire Permian Basin region, of which the Delaware Basin is a part (see Appendix C for data from the industry-standard Baker Hughes Rig Count). On top of this, DOE's data cutoff for inclusion in recertification PA calculations already creates a known time lag of more than a year. For example, the CRA-2014 PA used data from DBMAR 2012 which collected data through August 31, 2012. Combined, these can make the drilling rates used for PA calculations lag several years behind by the time a compliance application is submitted.

Other approaches to calculating drilling rates were also considered by EPA. One would automatically assign boreholes of unknown depth by default to the deep category instead of shallow. This approach would increase the deep drilling rate from 99.0 boreholes/km^2 to 112.4 boreholes/km^2 but it would potentially underestimate or create a lag in the shallow borehole drilling rate and overestimate the deep drilling rate. The second approach would eliminate boreholes of unknown depth at the time of reporting from speculative depth categorization by placing them in a separate category outside of those calculations. Since all such boreholes were categorized as shallow in CRA-2019, the total number of deep boreholes and the deep drilling rate would not change, but the total number of shallow boreholes would decrease by the number of boreholes of unknown depth (3080 boreholes in CRA-2019). EPA calculated that the shallow drilling rate would decrease from 45.4 to 32.1 boreholes/km^2 using this approach (see *Known Depth Shallow Borehole drilling rate* in Fig. 2.1). However, this approach would not account for the known total number of boreholes drilled, and it would not address lag time.

The *EPA alternative deep drilling rate* utilized in Figure 2.1 was calculated by adding boreholes of unknown depth previously categorized as shallow to the deep borehole total but proportionally at the ratio of the total number of shallow boreholes to deep boreholes of known depth in the Delaware Basin. EPA concluded that the use of historical rates to categorize borehole depth is a cautious, but reasonable approach that is more defensible than either of the two alternatives described above.

Using the same 2018 data sources as above:

EPA Alternative Deep Drilling Rate =

$$\frac{\left(\text{Known Deep Boreholes} + \text{Unknown Depth Boreholes} \times \frac{Known\ Deep\ Boreholes}{Total\ Known\ Depth\ Boreholes}\right) \times \text{Reg time period}}{\text{Basin area}} \times \frac{1}{100\ years}$$

with

Total Boreholes = 22,886 + 10,496 = 33,382

Known Deep Boreholes = 22,886 boreholes

Total Unknown Depth Boreholes = 3,080 boreholes

Known Shallow Boreholes = 10,496 – 3,080 = 7,416 boreholes

Total Known Depth Boreholes = 22,886 + 7,416 = 30,302 boreholes

Regulatory time period = 10,000 years

Basin area = 23,102.1 km^2

This equation results in a deep drilling rate of 109.1 boreholes per km^2 over 10,000 years.

Using the same approach as above, an alternative shallow drilling rate could similarly be calculated by substituting the number of known shallow boreholes for the number of known deep boreholes:

$$\frac{\left(\text{Known Shallow Boreholes} + \text{Unknown Depth Boreholes} \times \frac{Known\ Shallow\ Boreholes}{Total\ Known\ Depth\ Boreholes}\right) \times \text{Reg time period}}{\text{Basin area}} \times \frac{1}{100\ years}$$

This equation gives a shallow drilling rate of 35.4 boreholes per km^2 over 10,000 years for DBMAR 2018 data. This number for previous years is plotted as "*EPA alternative shallow drilling rate*" in Figure 2.1.

The impact of using the alternative approach to calculating the deep drilling rate on total releases in WIPP PA is shown in comparison to DOE's PA calculations from CRA-2019 in an EPA-prepared, separate, non-regulatory sensitivity analysis shown in Figure 2.2. The impact of a higher drilling rate is shown as expected by a small but noticeable rightward shift closer to the compliance limits. Rightward shifts (i.e., increased releases) were also seen in every release pathway involving intrusion boreholes, including cuttings and cavings, spallings, releases to the Culebra, and direct brine releases.

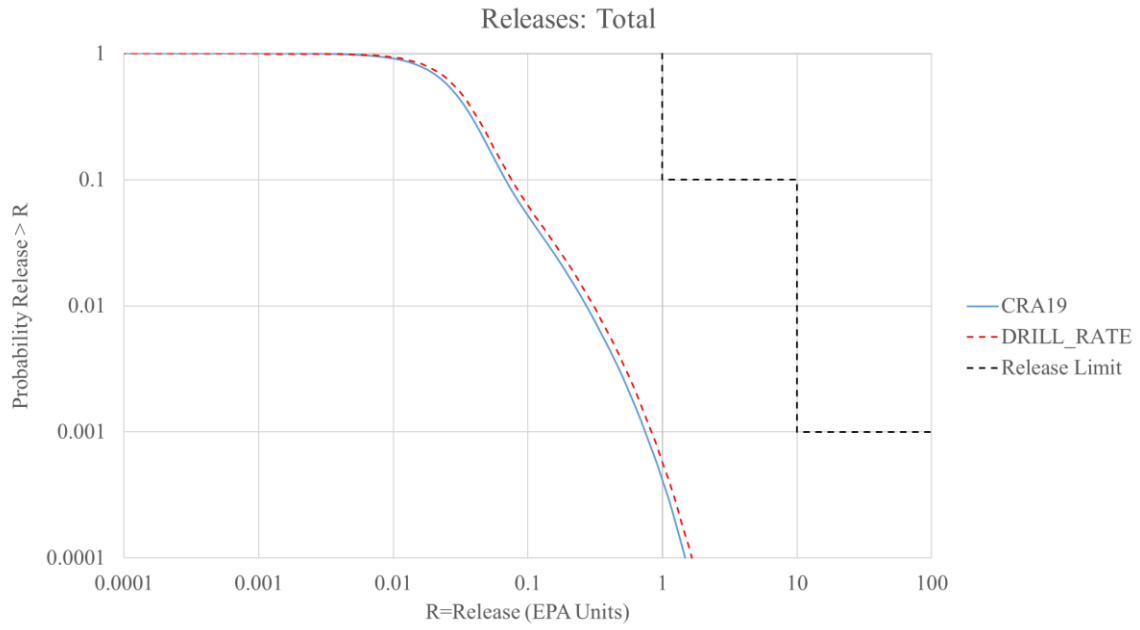

Figure 2.2. EPA's calculation of mean total releases based on an alternative deep drilling rate of 109.1 boreholes per km^2 over 10,000 years (DRILL_RATE curve) in comparison with DOE's 2019 Deferred PA deep drilling rate of 99.0 boreholes per km^2 over 10,000 years (CRA19 curve).

2.4 EPA Conclusions

Boreholes of unknown depth may be in the process of being drilled, recently drilled and waiting to be completed, or recently completed. The DBDSP's automatic categorization of boreholes of unknown depth as shallow effectively undercounts the number of deep boreholes and overcounts shallow boreholes at any given time. This results in an effective lag of 1-2 years or more in the deep drilling rate reported during periods of high drilling activity in the basin. This is in addition to the lag of more than one year resulting from data cutoff dates by DOE and its contractors for inclusion in PA calculations. The deep borehole drilling rate is an important PA parameter and a primary driver of radionuclide releases in all pathways. Given the high rate of drilling activity in the region in the last decade, this approach has led to a potential undercount of thousands of deep wells at the time of reporting, approaching 10% of the total number of wells drilled in the basin in 2017 and 2018. Within a few years of adding them to the database, the necessary information and complete documentation should be available from the governmental and commercial sources DOE uses to properly categorize these boreholes, but DOE's current method may be seen as speculatively assigning categories (shallow vs. deep) to boreholes of uncertain depth that, at any given time, leads to underestimating repository releases.

EPA's alternative method for dealing with uncertain boreholes is to categorize wells of unknown depth at the empirically-determined ratio of known deep to shallow boreholes for calculating the deep and shallow drilling rates. EPA considers this to be one way to get a better approximation of actual borehole drilling practices at the time of reporting than DOE's current method. Based on the 2018 DBMAR data used in the CRA-2019, EPA calculates this rate as 109.1 boreholes/km^2 over 10,000 years. EPA requests that DOE reconsider its drilling rate methodology for CRA-2024 because the drilling rate has increased over recent years, creating a

larger discrepancy between the actual drilling rate and the drilling rate as it is captured in PA. This reconsideration of methodology may be part of DOE's review of the DBDSP (see DOE response to EPA question CC5-MON-4 in Appendix A). EPA further requests that DOE engage early with the Agency if it decides to implement changes or propose a new method for calculating these parameters before the next CRA. This would allow EPA to review and approve it separately.

3.0 DEEP BOREHOLE PLUGGING PATTERN FREQUENCY CALCULATION

3.1 Background

Plugging and abandonment of boreholes is an important step in the process to permanently close a well. It should be noted that the term "abandon" in this context does not imply that an operator simply leaves behind a well and responsibility for its cleanup and site closure. Wells in that situation are typically referred to as "orphaned" wells. In New Mexico, state and federal regulations require abandoned boreholes to be plugged with concrete at various depth intervals to prevent potential contamination of geologic horizons by the vertical transfer of fluids through the boreholes and to protect potash mining activities in some cases. Borehole plugging patterns describe the lengths and locations of the plugs. Plug lengths and locations are important to the performance of the WIPP because they help determine when long-term flow of brine can occur through an abandoned borehole into the repository from deeper horizons and out of the repository waste area to shallower horizons. Deep exploratory boreholes in search of oil and gas resources can create pathways for WIPP repository releases if they inadvertently intersect the repository waste area. As previously noted, a "deep borehole" is defined as one that extends below the 2,150 ft depth of the WIPP repository. In WIPP PA, such boreholes are assumed to be plugged and abandoned immediately upon completion of drilling.

The DOE has identified six basic configurations of borehole plugs in use within the Delaware Basin, as shown in Figure 3.1. All deep boreholes are assumed to have a shallow plug at the ground surface and another deep plug at the bottom of the salt section. In local terminology, the "salt section" refers to the Salado and Castile Formations. The deeper plug is treated in WIPP PA as stopping all upward flow into the repository from geologic horizons below the Castile. Between the shallow and deep plugs, additional plugs may be installed at various depths as shown in Figure 3.1 or a single, long plug may be installed throughout all or most of the salt section. The ability of boreholes to create release pathways depends in part on the locations of the borehole plugs that were installed. An evaluation of the long-term functionality of concrete plugs is presented in DOE (1996, Appendix MASS, Section MASS.16-3).

The depth and length of borehole plugs either allow or preclude long-term upward flow of pressurized brine into the WIPP repository through an abandoned borehole from the underlying Castile Formation. The presence of Castile brine in the repository is particularly favorable to the occurrence of low probability but high consequence radionuclide releases to the ground surface. This is called the direct brine release (DBR) pathway. The occurrence of DBRs requires elevated repository brine pressure and the presence of a mobile brine phase in the repository. Both requirements are commonly satisfied when brine from the underlying Castile Formation is

released into the repository and both are rarely satisfied when such a release does not occur. Releases of Castile brine into the repository do not occur in boreholes with continuous plugs.

As described in the introduction to this TSD, the DOE maintains an inventory of plugging patterns in abandoned boreholes that is updated regularly and documented annually in Delaware Basin Monitoring Annual Reports. As an example, the plugging pattern data used in the CRA-2019 PA was presented in DOE (2018). These data are first categorized into the six basic configurations shown in Figure 3.1. Then, for purposes of WIPP PA, they are further categorized into three combinations of the six basic plugging configurations that are significant to releases. These are called the one-plug, two-plug, and three-plug patterns (CRA-2019, Appendix PA-2019, Section PA-1.1.11). One of these plug patterns is randomly selected based on its frequency of occurrence and applied to each intruding borehole in WIPP PA.

- The one-plug pattern consists only of plugging configuration Type VI shown in Figure 3.1. This is a single, continuous plug that extends through a significant portion of the salt section. This type of plug maintains functionality as a very low-permeability barrier to fluid movement from the time of intrusion through the remainder of the 10,000-year regulatory time frame and is treated in PA as having no effect on long-term repository performance (DOE 1996, Appendix MASS, Section MASS.16.3). The thickness of the salt section in the vicinity of the WIPP site is on the order of 3,200 feet (see SNL 1992, Figure 2.2-1).
- The two-plug pattern consists of plugging configuration Types I, III, and V shown in Figure 3.1. These plugging types are grouped together because none have plugs emplaced between the WIPP repository and the Castile Formation. The lack of a plug at this location allows pressurized Castile brine to flow vertically upward into the repository after the borehole is plugged. The two-plug pattern is the only plugging pattern that allows significant upward flow of Castile brine into the repository.
- The three-plug pattern consists of plugging configuration Types II and IV shown in Figure 3.1. This pattern has a plug emplaced between the Castile and the repository horizon. The presence of this plug eliminates significant upward fluid flow from the Castile into the repository.

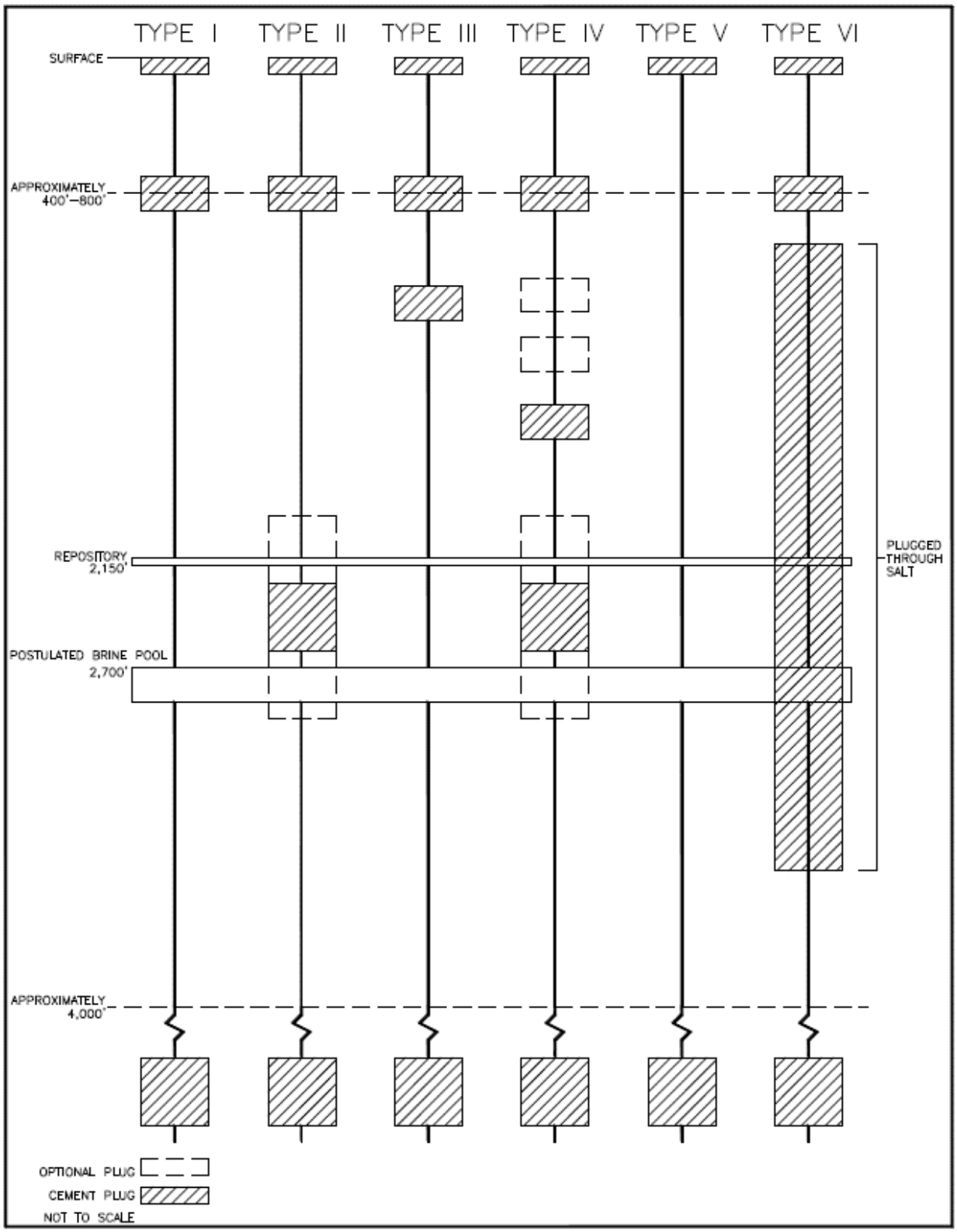

Figure 3.1. Typical borehole plug configurations in the Delaware Basin (Source: DOE 2018, Figure 4).

Concrete plugs in the two-plug and three-plug patterns that are located below the repository but above the bottom of the Castile are assumed to remain functionally intact for 200 years after the time of intrusion. During this period these plugs are assigned a low permeability that is sampled between 10^{-19} and 10^{-17} m^2 and the open parts of the borehole are assigned a high permeability of 10^{-9} m^2. If the two-plug pattern is randomly selected, fluids can flow freely during this period from the Castile into the repository through an essentially open borehole. If the two-plug pattern is not selected, flow from the Castile into the repository is essentially blocked by an intact, very low permeability concrete plug. After 200 years and for the next 1,000 years, concrete plugs below the repository but above the bottom of the Castile are assumed to fail and the borehole is assigned a permeability typical of silty sand (sampled between $10^{-16.3}$ and 10^{-11} m^2). The silty sand inhibits but does not eliminate brine and gas flow (CRA-2019, Appendix PA-2019, Table PA-26). At 1,200 years after the time of intrusion and until the end of the regulatory period, the permeability of boreholes below the repository is reduced by one order of magnitude due to creep closure, further curtailing flow of Castile brine into the repository (CRA-2019, Appendix PA-2019, Table PA-26). However, if the one-plug pattern is selected, the plug is assumed to be long enough to remain functionally intact for the entire 10,000-year regulatory period and the plugged borehole is considered in PA to have no effect on long-term repository performance by effectively preventing fluid flow into and out of the repository.

Concrete plugs in the two-plug and three-plug patterns located at a shallower depth than the repository are also assumed to remain functionally intact for 200 years after the time of intrusion. During the first 200 years, the plugs are assigned the same low permeability as below the repository (sampled between 10^{-19} and 10^{-17} m^2) and the open parts of the borehole are assigned the same high permeability (10^{-9} m^2). After 200 years and until the end of the 10,000-year regulatory period, the concrete plugs in the two-plug and three-plug patterns are assumed to fail and the borehole above the repository is assigned the same permeability typical of silty sand (sampled between $10^{-16.3}$ and 10^{-11} m^2) as below the repository. However, further permeability reductions are not considered above the repository because of lower in situ stresses. If the one-plug pattern is selected, the plug is assumed to be long enough to remain functionally intact above as well as below the repository for the entire 10,000-year regulatory period and the plugged borehole is considered in PA to have no effect on long-term repository performance (DOE 1996, Appendix MASS, Section MASS.16.3).

3.2 DOE Calculation Methodologies

3.2.1 DOE's Original Methodology

Beginning with the 1996 CCA and continuing in all recertifications until the CRA-2019, the DOE calculated plugging pattern frequencies based on all deep boreholes abandoned in the New Mexico portion of the Delaware Basin since 1988, without consideration of the presence or absence of potash or of the different regulatory or other institutional requirements within that area. A map of the Delaware Basin showing the New Mexico and Texas portions is presented in Figure 3.2. The year 1988 was selected because it was the date when the most recent plugging regulation, New Mexico Oil Conservation Division (OCD) Order R-111-P, came into force (DOE 1996, Appendix MASS, Attachment MASS.16-3, p. 3; OCD 1988). Boreholes in the Texas portion of the Delaware Basin were not included by DOE in the inventory because they

were plugged according to Texas plugging regulations that were not considered by DOE to be applicable to WIPP. These criteria resulted in a sample of 188 boreholes in 1996 and these boreholes were used to determine plugging frequencies for the CCA (DOE 1996, Appendix MASS, Attachment MASS.16-1, p. 2).

When developing the original inventory of plugged and abandoned boreholes, the DOE considered plugging frequency alternatives based on consideration of more local regulatory requirements than the entire New Mexico portion of the Delaware Basin. The WIPP is located on federal land subject to BLM regulations and is on the eastern edge of the Known Potash Leasing Area (KPLA; also called the potash enclave, (Interior) Secretary's Potash Area, or Designated Potash Area) defined by OCD Order R-111-P. The KPLA overlaps the northern edge of the Delaware Basin as shown in Figure 3.3. The WIPP LWA area was designated out of and added to the KPLA which surrounds it on roughly three sides. This order was adopted by the state to protect potash mining activities from water flooding. The DOE first considered limiting the data set to plugged and abandoned boreholes on federal land in a barren area within the KPLA, which would therefore be subject to plugging under the 1988 OCD Order R-111-P. This regulation requires all deep boreholes that are within the KPLA to be continuously plugged within the salt section (OCD 1988). The "barren area" criterion was included by DOE because "…the WIPP is within the potash enclave, but is in a barren area, where potash grades and quantities are not of economic value." (DOE 1996, Appendix MASS, Attachment MASS.16-1, p. 1).

The DOE's conclusion that the WIPP repository is located in a barren area was supported by information on potash leasing areas and the extent of economic grade ore within the WIPP LWA. This information was developed by the BLM and by the New Mexico Bureau of Mines and Mineral Resources (NMBMMR) and is shown in Figures 3.4 through 3.6. The DOE considered these figures to represent three possible interpretations for the extent of future potash mining within the LWA controlled area (DOE 1996, Appendix MASS, Attachment MASS 15-5, p. 7). Figure 3.4 shows the potential extent of potash reserves based on a 1993 BLM map of potash lease grade ore. This map shows those areas that had historically been considered worth retaining by mining companies for future development. The DOE considered this to be the most conservative interpretation of the extent of mining because the map includes significant locations that more detailed studies have shown to not have economic grade ore. Figure 3.5 shows sections within the LWA that had been offered by the BLM to mining companies for leasing but were withdrawn when the LWA was established. The DOE notes that Section 32 south of the repository location within the LWA had also been offered for leasing but was not included in this map because the section was later determined to be essentially barren of lease grade ore. Figure 3.6 more precisely depicts the extent of economically viable lease grade ore based on a 1995 NMBMMR assessment. This map was considered by the DOE as providing the best basis for use in analyzing the impacts of future mining on repository performance. Although none of the three maps show economically viable lease grade ore at the WIPP repository location, economic grade potash is shown to be present within the LWA and the potential effect of future mining of that ore on hydraulic transmissivity in the Culebra dolomite is considered in WIPP PA.

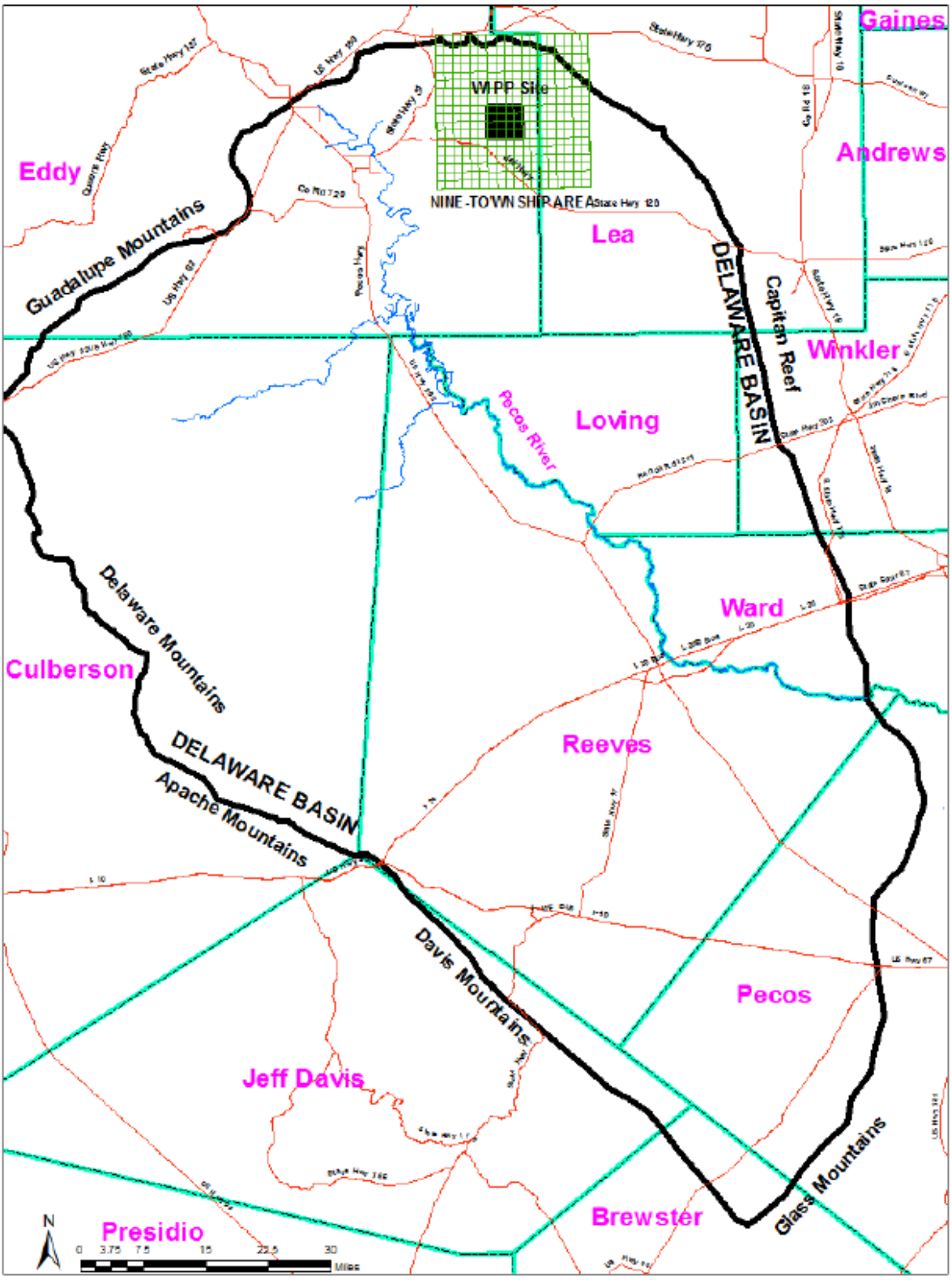

Figure 3.2. Map of the Delaware Basin and vicinity showing the location of the WIPP site (Source: DOE 2018, Figure 1).

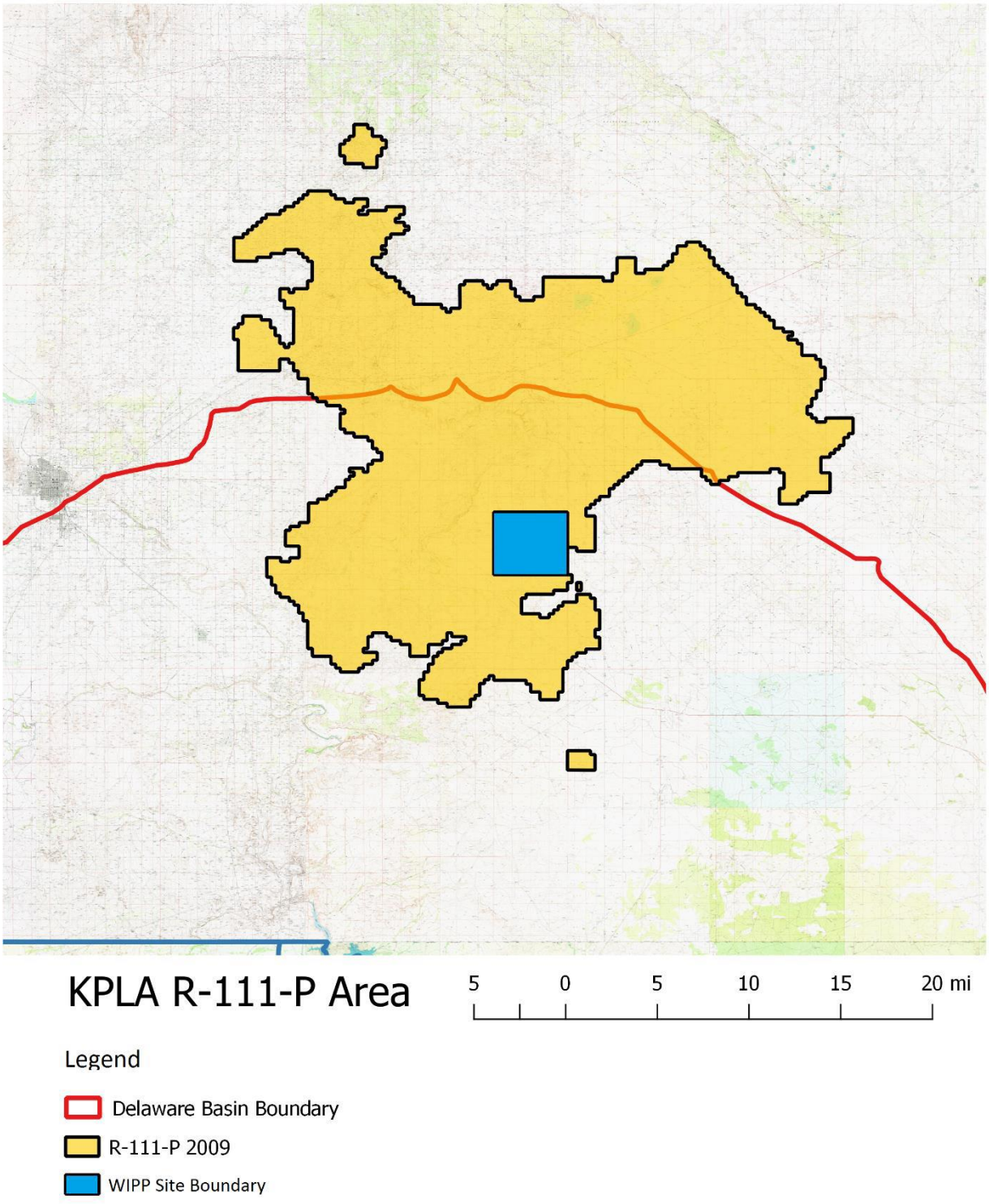

Figure 3.3. Map of the KPLA at the northern edge of the Delaware Basin (Source: DOE 2018, Figure 9).

Although the initial selection criteria described above appeared to DOE to provide the most accurate analogues for plugging practices in future boreholes that might be drilled at the WIPP site, these criteria resulted in only one plugged borehole and that borehole was found by the DOE to have been exempted from OCD Order R-111-P because it was in a barren area. The DOE noted that waivers from the requirements of R-111-P can be "…granted due to the fact that in barren areas, there is no potash ore to protect." The DOE concluded that "Clearly, a sample size of one is not adequate to determine plugging practice in the area of interest." (DOE 1996, Appendix MASS, Attachment MASS.16-1, p. 2). However, the Agency has found that current 2021 federal and state practices regarding exemptions from the requirements of R-111-P are more stringent than those described by the DOE in 1996 and are discussed below in Section 3.3.2.

To increase the original 1996 sample size, the DOE considered expanding its selection criteria to include all boreholes in the New Mexico portion of the Delaware Basin that were plugged since 1988 under BLM regulations because the WIPP LWA is on federal land. This change yielded a sample size of 115. Wells plugged on state land were subsequently added to obtain an even larger sample because state requirements were very similar to BLM requirements (DOE 1996, Appendix MASS, Attachment MASS.16-1, p. 2). The addition of state land increased the final sample size to 188.

The final 1996 methodology described above included all deep boreholes on state and federal land in the New Mexico portion of the Delaware Basin that had been plugged since 1988 without regard to the presence or absence of potash. This methodology was proposed by the DOE and accepted by the EPA. For purposes of this TSD, it will be called the historic methodology. It was applied to the CCA in 1996 and to the next three recertifications. DOE's study also found that no wells in the basin had been left unplugged since the implementation of the most current regulations. Therefore, the DOE concluded that all abandoned boreholes are plugged and none are left unplugged.

3.2.2 DOE's Revised Methodology

A revised methodology for calculating plugging pattern frequencies was proposed by the DOE and used in the CRA-2019 PA. This methodology was again based on consideration of the KPLA. It was similar to the approach first considered by the DOE in 1996 but included all plugged and abandoned boreholes within the New Mexico portion of the KPLA instead of only those within the KPLA that were also in barren areas and on federal land. The WIPP site is located on the eastern edge of the KPLA as shown in greater detail in Figure 3.7. The rationale for this change was described in DOE's 2018 Delaware Basin Monitoring Annual Report as follows (DOE 2018, Section 2.7).

> "Guidance in 40 CFR Part 194.32 (a) states; "Performance assessments should assume that the permeability of sealed boreholes will be affected by natural processes, and should assume that the fraction of boreholes that will be sealed by man equals the fraction of boreholes which are currently sealed in the Delaware Basin." The criteria also state that "...drilling practices will remain as those of today."

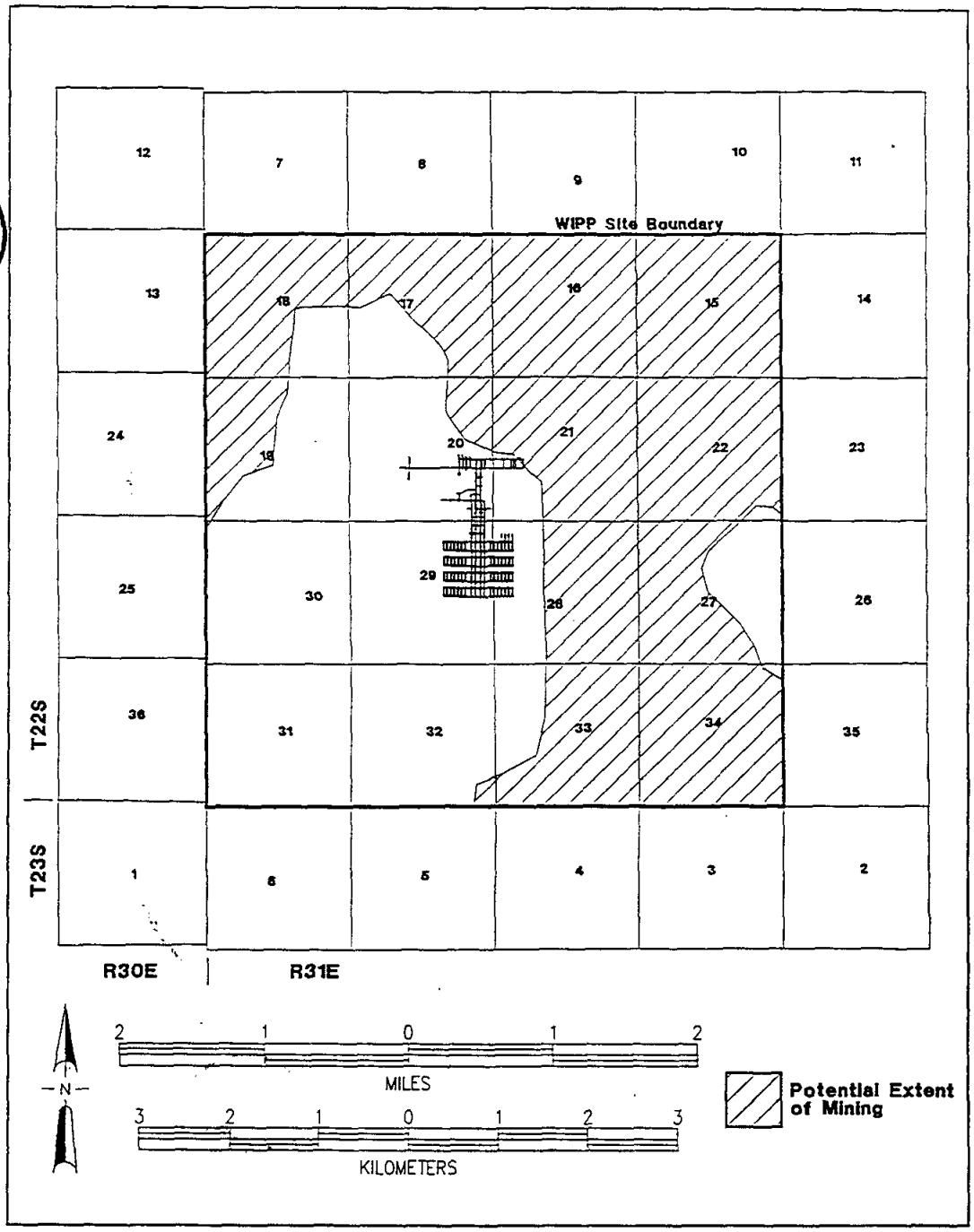

Figure 3.4. Potential extent of mining within the WIPP LWA based on 1993 BLM map of lease grade ore (Source: DOE 1996, Appendix MASS, Attachment MASS 15-5, Figure 6).

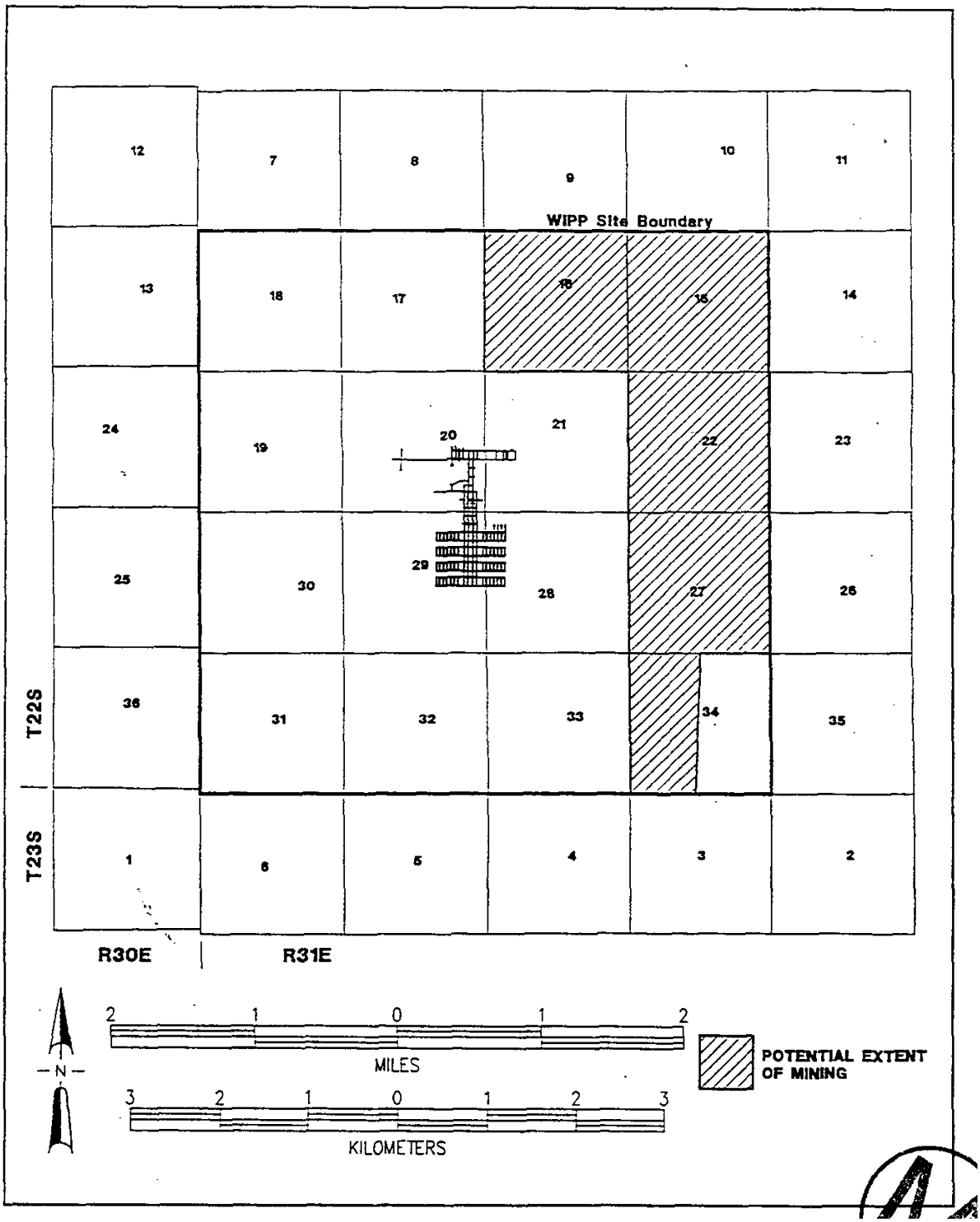

Figure 3.5. Potential extent of mining based on areas within the LWA that had been offered by the BLM for leasing (Source: DOE 1996, Appendix MASS, Attachment MASS 15-5, Figure 7).

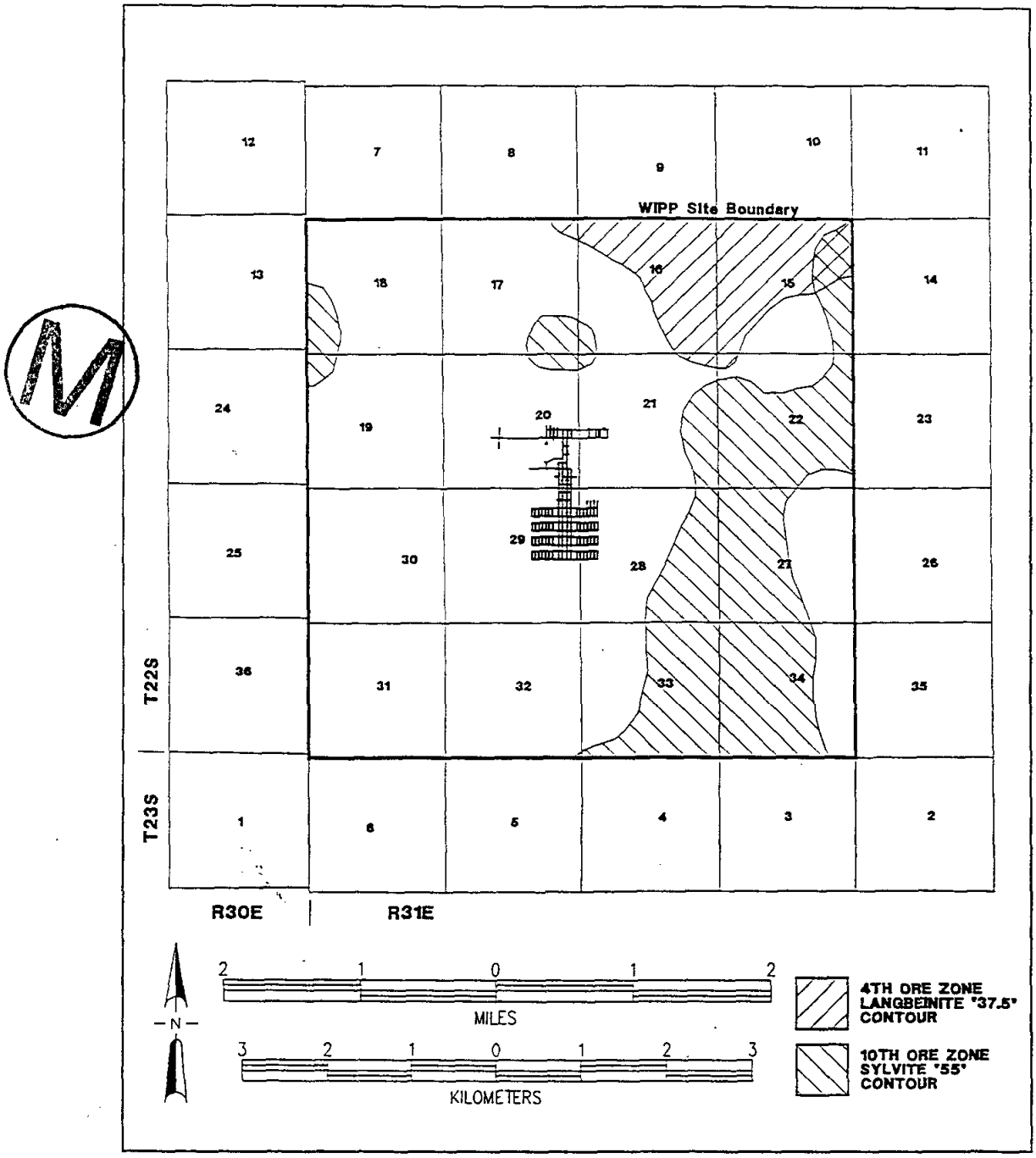

Figure 3.6. Extent of economically viable lease grade potash ore based on a 1995 assessment by the New Mexico Bureau of Mines and Mineral Resources (Source: DOE 1996, Appendix MASS, Attachment MASS 15-5, Figure 8).

> "Previous reports have included wells outside the KPLA into the plugging summary. This has been determined to be inappropriate since wells outside the KPLA lie in a different resource area and are not direct regulatory and geologic analogs for wells near or at the WIPP. Such wells are plugged under a different regulatory structure and do not represent current practice in the KPLA. It has been determined that the dataset used in this report more accurately represents plugging techniques and activities used in the vicinity of the WIPP and is consistent with the provisions of 40 CFR §194.33(c)(1) and the future states assumptions of 40 CFR §194.25."
>
> "Plugging techniques near the WIPP are driven by State regulations that are in place to protect other resources present, namely potash. For wells within the Known Potash Leasing Area (KPLA), NMOCD R-111-P regulations apply and require the operator to install a solid cement plug through the entire salt section and any water-bearing horizon, in addition to installing a bridge plug above the perforations. … The WIPP lies within the KPLA and plugging in the vicinity generally follows this plugging technique although there are cases in which exemptions to this technique have been granted to the operator by the regulator. Additionally, older plugged wells that pre-date the NMOCD R-111-P regulation may not be plugged in this manner."

Thus, the DOE has decided to base plugging pattern frequencies only on the Delaware Basin portion of the KPLA. In summary, the DOE's justification for changing to this approach is that the WIPP site is within the KPLA and the approach satisfies both the regulatory focus on the Delaware Basin and the future states assumptions of 40 CFR §194.25. These criteria yielded a sample of 154 plugged and abandoned boreholes to determine plugging pattern frequencies for the CRA-2019 PA (DOE 2018, Table 9).

3.3 EPA Evaluation of DOE Methodology

The DOE's proposed revision of the method for calculating borehole plugging frequencies required thorough evaluation by the EPA because it was expected to significantly decrease calculated repository releases. The DOE's proposed revision increased the frequency of continuous borehole plugs (the most effective at limiting brine flow, plugging Pattern 1 [Type VI]) tenfold from 4% in the CRA-2014 PA (DOE 2014, Appendix PA-2014, Section PA-3.7) to 40% in the CRA-2019 PA (DOE 2019, Appendix PA-2019, Section PA-1.1.11). As previously mentioned, a change that significantly changes calculated repository performance must be adequately supported on both a technical and regulatory basis. The following sections describe EPA regulatory requirements for WIPP PA, state and federal requirements for borehole plugging in the KPLA, actual borehole plugging practices in the KPLA as indicated by reported data, and how well DOE's new methodology matches actual practices and regulations in the WIPP area.

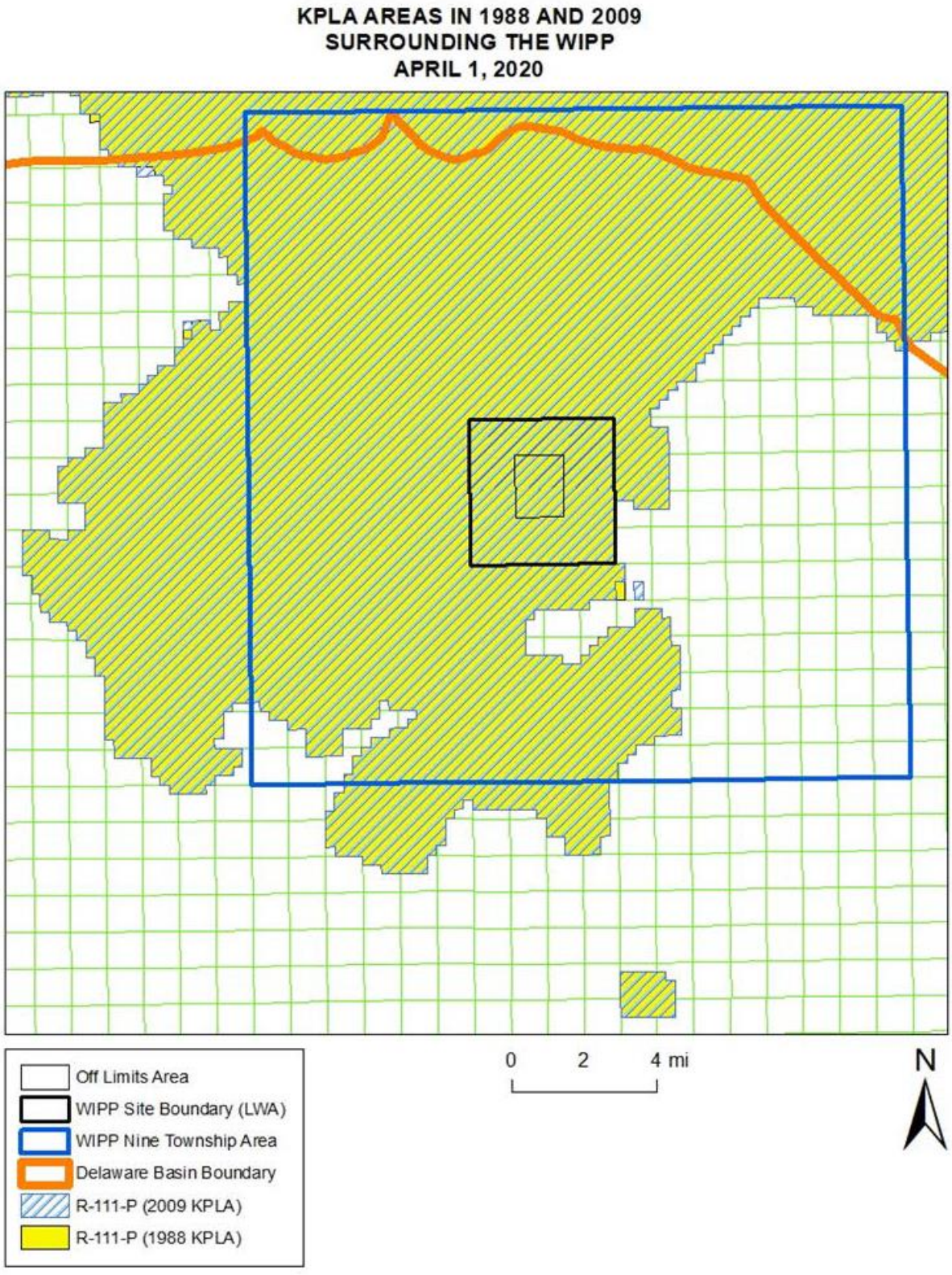

Figure 3.7. Map showing the Delaware Basin portion of the KPLA at the time of the most recent boundary revisions in 2009 as defined by OCD Order R-111-P (Source: DOE 2020).

3.3.1 Consideration of EPA Regulatory Requirements

In justifying its change in calculating plugging pattern frequencies, the DOE cited the provisions of 40 CFR §194.33(c)(1) and the future states assumptions of 40 CFR §194.25. Section 40 CFR §194.33(c)(1) requires the DOE to assume that:

> "Future drilling practices and technology will remain consistent with the practices in the Delaware Basin at the time a compliance application is prepared. Such future drilling practices shall include … the fraction of such boreholes that are sealed by humans ..."

In a related statement, Section 40 CFR §194.25(a) requires the DOE to assume that:

> "Unless otherwise specified in this part or in the disposal regulations, performance assessments and compliance assessments … shall assume that characteristics of the future remain what they are at the time the compliance application is prepared, provided that such characteristics are not related to hydrogeologic, geologic or climatic conditions."

These regulations use the drilling practices in the Delaware Basin at the time a compliance application is prepared as analogues for addressing future practices in WIPP PA. Three aspects of these regulations need to be satisfied. These are (1) "… characteristics of the future"; (2) "… at the time the compliance application is prepared"; and (3) "… in the Delaware Basin". At the time the regulations were prepared, the frequency of borehole penetrations into the repository had a significantly greater impact on repository performance than the plugging pattern frequencies primarily because continuous plugs were not commonly used in the Delaware Basin. The greater consideration that the calculation of drilling rates was given in the rule can therefore be used to help explain the Agency's intent regarding these three aspects of the rule.

Section 40 CFR §194.33(b)(3) provides instructions regarding the calculation of deep drilling rates. Future drilling rates are to be calculated based on the deep drilling that has occurred over the past 100 years throughout the Delaware Basin. Similar requirements are imposed for calculating shallow drilling rates in Section 40 CFR §194.33(b)(4). To minimize uncertainty in this calculation, the Agency provided a specific definition of what was meant by the "Delaware Basin" in Section 40 CFR §194.2.

As applied to drilling rates, the "… characteristics of the future" and "… future drilling practices and technology" were to be the actual practice in the entire Texas and New Mexico portions of the Delaware Basin without regard to local regulations and resources; "… at the time the compliance application is prepared" was with reference to the past 100 years; and "… in the Delaware Basin" was the area specifically defined in Section 40 CFR §194.2. As stated in Section 2 of this TSD, this approach led to a deep drilling rate calculation based on over 22,000 deep boreholes in the CRA-2019 PA.

No similarly specific instructions were provided by the EPA for calculating the borehole plugging pattern frequency. Instead, the same general criteria for such a calculation were stipulated as for the drilling rate calculation and EPA allowed the DOE to propose a detailed approach for Agency approval. The DOE subsequently proposed the approach described above in Section 3.2.1. This approach addressed the Agency's requirements for deep and shallow

drilling rates except that the sampled area was reduced to the New Mexico portion of the Delaware Basin in consideration of the different regulatory plugging requirements in Texas and New Mexico and the time period was reduced to only consider plugging activities since the effective date (1988) of the most recent regulation (DOE 1996, Appendix MASS, Attachment MASS.16-1, p. 2). This approach to calculating plugging pattern frequencies was accepted by the EPA. It was based on comprehensive plugging practices within a part of the Delaware Basin that completely encompassed the WIPP LWA and provided a sample size that grew from the aforementioned 188 plugged wells in 1996 to over 800 plugged wells in 2018 (see DOE response to EPA Completeness Comment CC1-33-3d in Appendix A to this TSD).

3.3.2 Consideration of OCD Order R-111-P Regulations

OCD Order R-111-P, dated April 21, 1988, defines New Mexico Oil Conservation Division regulations for drilling, plugging, and abandoning oil and gas wells within the KPLA. The order states that Amendment P to Order R-111 was promulgated because operation of the KPLA had become virtually unworkable due to a lack of tolerance between competing oil/gas and potash industries for access to resources in areas where leasehold interests are overlapping, and because of confusion in recording the boundaries of the KPLA as established by the (Federal) BLM compared with the boundaries of the "Potash Area" established by (State) OCD Order R-111-A and subsequent amendments R-111-B through O (see OCD 1988, Findings 1 through 8). To help rectify this situation, in consultation with representatives of each industry, the New Mexico Oil Conservation Commission (OCC) published the following Findings related to well drilling locations and abandonment that provided the basis for plugging requirements in OCD Order R-111-P (OCD 1988, Findings 9, 12, and 22):

> "(9) The agreement represents a compromise by both industries, the potash operators relinquishing lower grade marginal or uneconomic ore deposits in order to more fully
>
> protect their higher grade ore deposits; and the oil/gas operators receiving such lands containing sub-economic ore deposits as prospective drill-sites."
>
> "(12) The report of the work committee presents a reasonable process for determining where wells for oil and gas would cause waste of potash and the pertinent portions of said report should be contained in the order as a reasonable process for prohibiting oil and gas drilling in such areas in the absence of substantial evidence that waste of potash as described by the statute would not result."
>
> "(22) Expansion of the R-111 area to coincide with the KPLA will bring under the purview of this order areas where potash is either absent or non-commercial and such areas should be granted less stringent casing, cementing and plugging requirements, at the discretion of the OCD district supervisor."

Based on these Findings, the New Mexico OCC established Order R-111-P, which contained the following sections relevant to borehole plugging: the boundaries of the Potash Area (Section B); drilling locations in the Potash Area (Section C); drilling and casing requirements in the Potash Area (Section D); plugging and abandonment of wells (Section F); and designation of drillable locations for wells (Section G).

Section G. Before commencing drilling operations for oil or gas within the Potash Area, Section G requires the well operator to submit a *Notice of Intention to Drill* to the OCD for drilling locations on state and private lands and to the BLM for locations on federal lands, with copies to potentially affected potash operators. Applications to drill within an approved Life-of-Mine Reserve (LMR) must be approved by the lessees. An LMR is an area that includes lands reserved for future potash mining as well as active mine workings and mined-out areas. Areas outside an LMR are the barren areas described by the DOE and referenced in Section 3.2.1 above. Section G further states:

> "Applications to drill outside the LMR will be approved as indicated below; provided there is no protest from potash lessee within 20 days of his receipt of a copy of the notice:
>
> (a) a shallow well shall be drilled no closer to the LMR than one-fourth (1/4) mile or 110% of the depth of the ore, whichever is greater.
>
> (b) A deep well shall be drilled no closer than one-half (1/2) mile from the LMR."

For the purpose of drilling for oil and gas, Order R-111-P defines a shallow well as penetrating formations above the base of the Delaware Mountain Group or with a total depth of less than 5,000 feet, whichever is the lesser (OCD 1988, Section D). In the context of Order R-111-P, "shallow" oil and gas wells would be classified as "deep" wells in WIPP PA because there is no oil or gas above the repository and such wells would therefore extend below the 2,150-foot depth of the repository horizon.

Section F. Plugging and abandonment requirements are provided in Section F. This section states:

> "All wells … drilled within the Potash Area shall be plugged in accordance with the general rules or field rules established by the Division that will provide a solid cement plug through the salt section and any water-bearing horizon and prevent liquids or gases from entering the hole above or below the sa1t section."

EPA's review of the historical regulations relevant to the KPLA also noted that the solid continuous cement plug requirement through the salt section also existed in the first version of the state Order, R-111-A, established in 1955 and subsequent revisions (R-111-B through P). Although the area and boundaries under Order R-111 have been subject to small changes over time, in 1988 it was expanded to completely overlap with the (federal) KPLA, and a provision included that any future changes to the boundaries will coincide.

Section C. Paragraph 4 of Section C states:

> "(4) The Division's District Supervisor may waive the requirements of Sections D and F which are more rigorous than the general rules upon satisfactory showing that a location is outside the Life of Mine Reserves (LMR) and surrounding buffer zone as defined hereinbelow and that no commercial potash resources will be unduly diminished."

Order R-111-P does not provide a formal procedure for granting the aforementioned waiver. In practice, a Notice of Intent to Abandon (NOI) a well is prepared by oil/gas operators using OCD Form C-103, *Sundry Notices and Reports on Wells,* and is submitted to the OCD. If the well is on federal land, the operator also submits an NOI using Federal Form 3160-5. The NOI includes the operator's proposed plugging pattern. Abandonment plans for wells on federal lands are reviewed by the BLM and the OCD either approves per the BLM approval or makes appropriate changes as needed. The EPA understands that the current BLM policy is to approve plugging plans based on the most stringent of the state and federal plugging requirements. If changes are made in the operator's plugging proposal, they will be toward the most stringent condition to satisfy both BLM and OCD requirements. Subsequent changes by the OCD are therefore infrequent. Well operators are therefore required to have like approval by the OCD and BLM for any wells on federal lands in New Mexico. If a well is found to not meet the plugging standards of the approved NOI to Abandon, the BLM can require the operator to clean the well and take appropriate steps to rectify the plugging.

In review, plugging pattern approvals within the KPLA are based on the following considerations, as documented in OCD Order R-111-P.

- Section G states that applications to drill *will be approved* by the regulators provided the well is outside an LMR and its buffer zone and is not protested by lessees.
- Section F states that all wells drilled within the Potash Area *will be provided* with solid cement plugs through the salt section;
- However, Section C allows a less rigorous plug design *at the discretion of the OCD District Supervisor* for wells outside an LMR and its buffer zone;
- The New Mexico OCC Finding 22 states that well operators *should be granted* less stringent plugging requirements, at the discretion of the OCD District Supervisor, in areas where potash is either absent or non-commercial; and
- OCD and BLM plugging design approvals are based on the most stringent of the state and federal requirements, and if changes are made in the operator's plugging proposal, they will be toward the most stringent condition to satisfy both OCD and BLM requirements.

3.3.3 Consideration of Borehole Plugging Practices within the KPLA

The DOE is basing its new methodology for calculating plugging pattern frequencies on plugging practices within the KPLA part of the Delaware Basin since 1988 when OCD Order R-111-P was put into effect. As described in Section 3.3.1, 40 CFR §194.33(c)(1) requires the DOE to assume that future drilling practices and technology will remain consistent with the practices in the Delaware Basin at the time a compliance application is prepared. It is therefore important to consider the plugging practices that have been used in the KPLA part of the Delaware Basin since 1988 and to what extent those practices are applicable to the WIPP site.

Table 3.1 shows the frequencies of the six plugging pattern types developed by the DOE for wells in the KPLA part of the Delaware Basin that were plugged and abandoned over the past 30 years (i.e., between 1988 and the cutoff date of August 31, 2018). Those frequencies were used as inputs to the CRA-2019 PA. The table provides detailed counts of DOE's six plugging pattern

types and shows that out of the 154 wells that were plugged and abandoned during this period, about 40% were abandoned with continuous plugs (plugging pattern type VI) and the remaining 60% were abandoned with non-continuous plugs. This indicates that the majority of the boreholes plugged in the KPLA are in practice not being plugged according to the strict, potash-protective regulations, either due to granted exemptions or to imperfect oversight and enforcement.

However, Order R-111-P does make a difference in plugging type frequencies within the KPLA in comparison with frequencies for the entire New Mexico part of the Delaware Basin. These latter data are also shown in Table 3.1. Both sets of data were developed by the DOE and both sets cover the same period of time. The results show that the 40% frequency of continuous, Type VI plugs within the KPLA is four times greater than the 9.5% frequency of the same plugs in the larger New Mexico part of the Delaware Basin, and that most, but not all of the type VI plugs in the region are installed in the KPLA.

Table 3.1. Plugging Pattern Types and Frequencies as of August 31, 2018

Pattern Type	All Boreholes in the Delaware Basin in New Mexico[1]		Boreholes in the KPLA Part of the Delaware Basin in New Mexico[2]	
	Count	Frequency (%)	Count	Frequency (%)
I	180	21.9	22	14.29
II	199	24.2	26	16.88
III	189	23.0	10	6.49
IV	148	18.0	15	9.74
V	28	3.4	19	12.34
VI[3]	78	9.5	62	40.26
Totals	822	100.0	154	100.00

Sources:

1. Taken from DOE response to EPA Completeness Comment CC1-33-3d in Appendix A to this TSD.
2. Taken from Table 9, DOE/WIPP-18-2308, Rev. 1. Also see DOE response to EPA Completeness Comment CC1-33-3a in Appendix A to this TSD.
3. Plugging pattern type VI is a continuous plug through the salt section.

Based on the requirements of Order R-111-P, the remaining 60% of wells in the Delaware Basin part of the KPLA that were abandoned with non-continuous plugs were likely at locations outside an LMR and its buffer zone and were not protested by potash lessees. As previously noted in Section 3.2.1, such locations have been described by the DOE as barren areas where there is no economic grade potash ore to protect. Detailed information on plugging records provided by DOE in response to EPA Completeness Comment CC5-33-5b, included in Appendix A to this TSD, show that many wells within the KPLA have been abandoned with non-continuous plugs both before and after Order R-111-P was promulgated and that such practices have continued through the 2018 data cutoff for the CRA-2019 PA.

Order R-111-P states that approval of non-continuous plugging patterns in barren areas is discretionary on the part of the OCD District Supervisor. This discretion makes such approval uncertain, even when considering the New Mexico OCC's admonition in Finding 22 that well operators *should be granted* less stringent plugging requirements in barren areas. In addressing this uncertainty, the Agency believes that the use of non-continuous plugs is *more likely* in

barren areas such as the WIPP than in the KPLA as a whole and the use of continuous plugs is therefore *less likely*. EPA believes that using overall plugging pattern frequencies for the KPLA as an analogue for the WIPP ignores the additional information that the WIPP is located in a barren area and tends to inflate the frequency of continuous plugs in barren areas. Combined with the potential for imperfect regulatory oversight of these activities, DOE's new approach for calculating plugging pattern frequencies therefore would lead to underestimating repository releases.

EPA considers the frequent use of non-continuous plugs at abandoned boreholes in barren areas within the KPLA to be a current practice within the Delaware Basin and that, in keeping with the requirements of OCD Order R-111-P, such plugs appear to be preferentially approved in barren areas, such as the WIPP waste area, that are devoid of economic grade potash ore. Based on these observations, potential future boreholes that intersect the WIPP waste area could, at the discretion of the OCD District Supervisor, be abandoned with non-continuous plugs. Because the WIPP site is on federal land, less restrictive BLM plugging requirements for locations outside the KPLA would then apply inside the KPLA. The EPA therefore continues to believe that the actual practices at the time CRA-2019 was prepared were better incorporated in plugging pattern frequency calculations by basing those calculations considering all plugged and abandoned boreholes over a broader area, such as was done with the historic methodology, i.e., the New Mexico portion of the Delaware Basin, rather than on only the subset of samples within the KPLA.

3.3.4 Consideration of Representative Samples

The attributes of a representative sample of plugged and abandoned boreholes include the locations and numbers of those samples.

Locations of Samples. The WIPP site is located in the Delaware Basin and in preparing the requirements of 40 CFR Part 194, the EPA considered only conditions within that basin to be acceptable geologic analogues for conditions near or at the WIPP. Figure 3.8 presents a map of abandoned wells in the New Mexico part of the Delaware Basin that would have been used to calculate plugging pattern frequencies for the CRA-2019 PA if the historic, EPA-approved calculation method had been used. The sample size would have consisted of 822 wells and the sample locations would have completely encompassed the WIPP site. As shown in the figure, the wells are scattered over the entire northern Delaware Basin and include wells within the Delaware Basin part of the KPLA as well as many wells east of the WIPP site that are in the immediate vicinity of the WIPP but are not within the KPLA. In comparison to other parameters derived from and practices monitored by DBDSP and similar DOE activities, the new area over which DOE calculated borehole plugging patterns is more limited in both a geographical and regulatory sense. For example, the DBDSP counts the total number of boreholes for the entire Delaware Basin in both New Mexico and Texas, and many other DBMAR monitoring activities generally focus on the 9 township area surrounding WIPP.

Figure 3.9 presents a map of abandoned wells within the KPLA portion of the Delaware Basin that were used in the CRA-2019 PA to calculate plugging pattern frequencies. That calculation does not include wells in the immediate vicinity of the WIPP shown in Figure 3.8 that may be relevant geologic analogues to the WIPP but are east of the site and outside the KPLA. For

example, several small clusters of plugged boreholes exist within a few miles of the southeast corner of the WIPP boundary but outside the KPLA. The EPA considers the exclusion of abandoned wells immediately adjacent to the WIPP site but outside the KPLA to be an undesirable aspect of the DOE's new approach. It may be also noted that not all areas within the KPLA have potash resources, or active or prior leases, nor are all active potash leases and resources in the Delaware Basin located entirely inside the KPLA (see DOE response to Completeness Question CC4-MON-2 & 3 in Appendix A).

Number of Samples. A general rule of statistics is that the closer the sample size is to the size of the population, the more accurate the sample will be in reflecting the characteristics of the population. In its original consideration of alternative ways of calculating borehole plugging pattern frequencies, the DOE had the options of: 1) including all abandoned boreholes in the Delaware Basin consistent with the EPA requirement for considering all boreholes when calculating drilling rates; 2) limiting the calculation to all abandoned boreholes in the New Mexico part of the Delaware Basin subject to New Mexico regulatory requirements; or 3) to further limit the calculation to abandoned boreholes in barren areas on federal land in the Delaware Basin subject to KPLA plugging requirements. As discussed in Section 3.2.1, the DOE first considered and then rejected Option 3 because of the small sample size of only one well and proposed Option 2 as an intermediate choice. At the time it was proposed in 1996, Option 2 provided a sample size of 188 abandoned wells with broadly similar geology and regulatory considerations and was accepted by the EPA. As shown in Table 3.1, by the time of the CRA-2019 the Option 2 sample size had grown to 822 wells and the DOE implemented a variation of Option 3 that reduced the sample size to 154, which may be adequate numerically, but not necessarily representative. The larger sample size of 822 may still be considered relevant because WIPP is partially located at the outside boundary of the KPLA and preferable to a more restricted, in a geographical and regulatory sense, subset of 154 samples, particularly when the calculation is to be used as an analogue for projecting plugging pattern frequencies over 10,000 years.

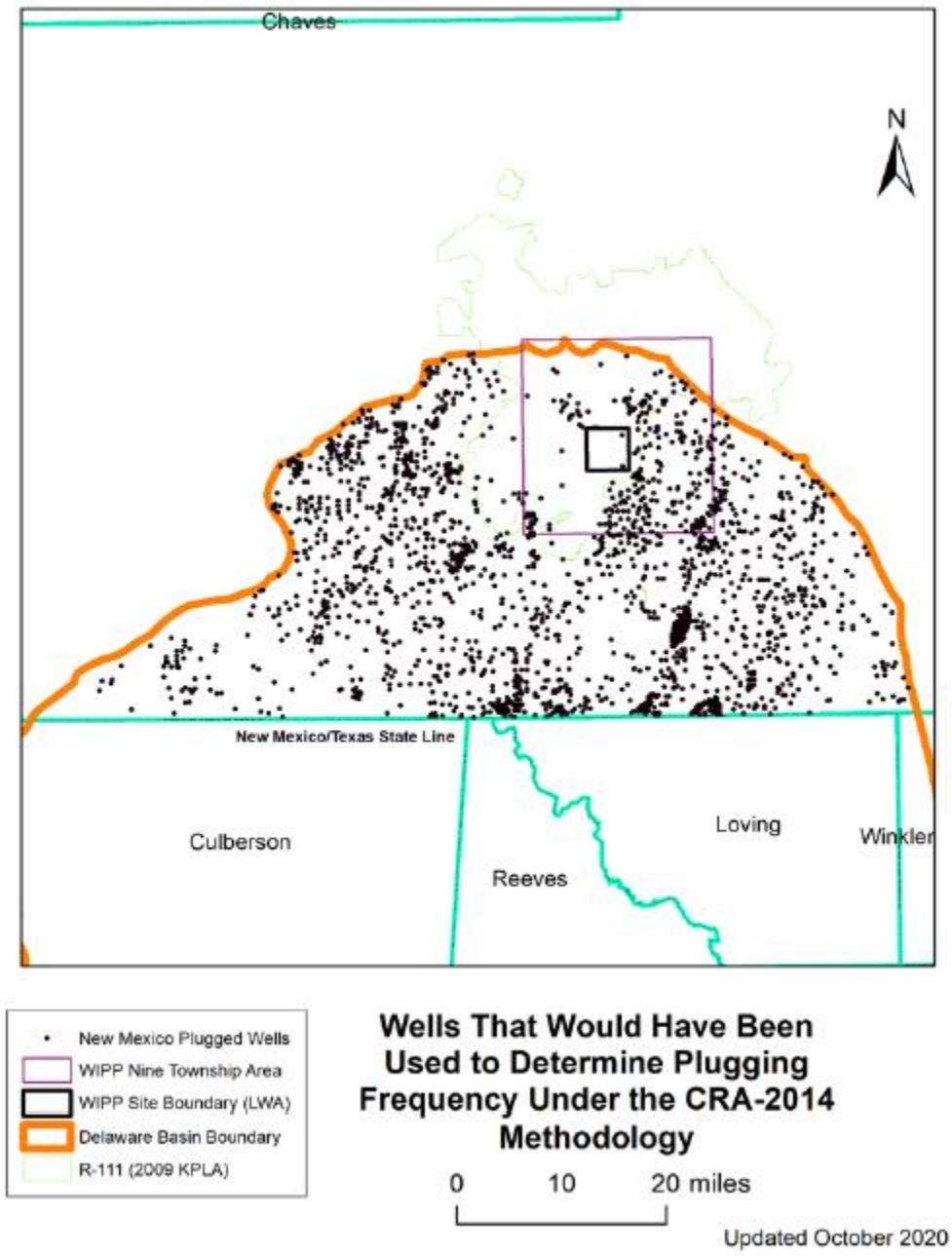

Figure 3.8. Map showing wells that would have been used in the CRA-2019 PA to determine plugging frequency based on the historic methodology of considering all abandoned wells in the New Mexico part of the Delaware Basin (Source: DOE 2020, Enclosure 1, Response to EPA Completeness Question CC5-33-5c).

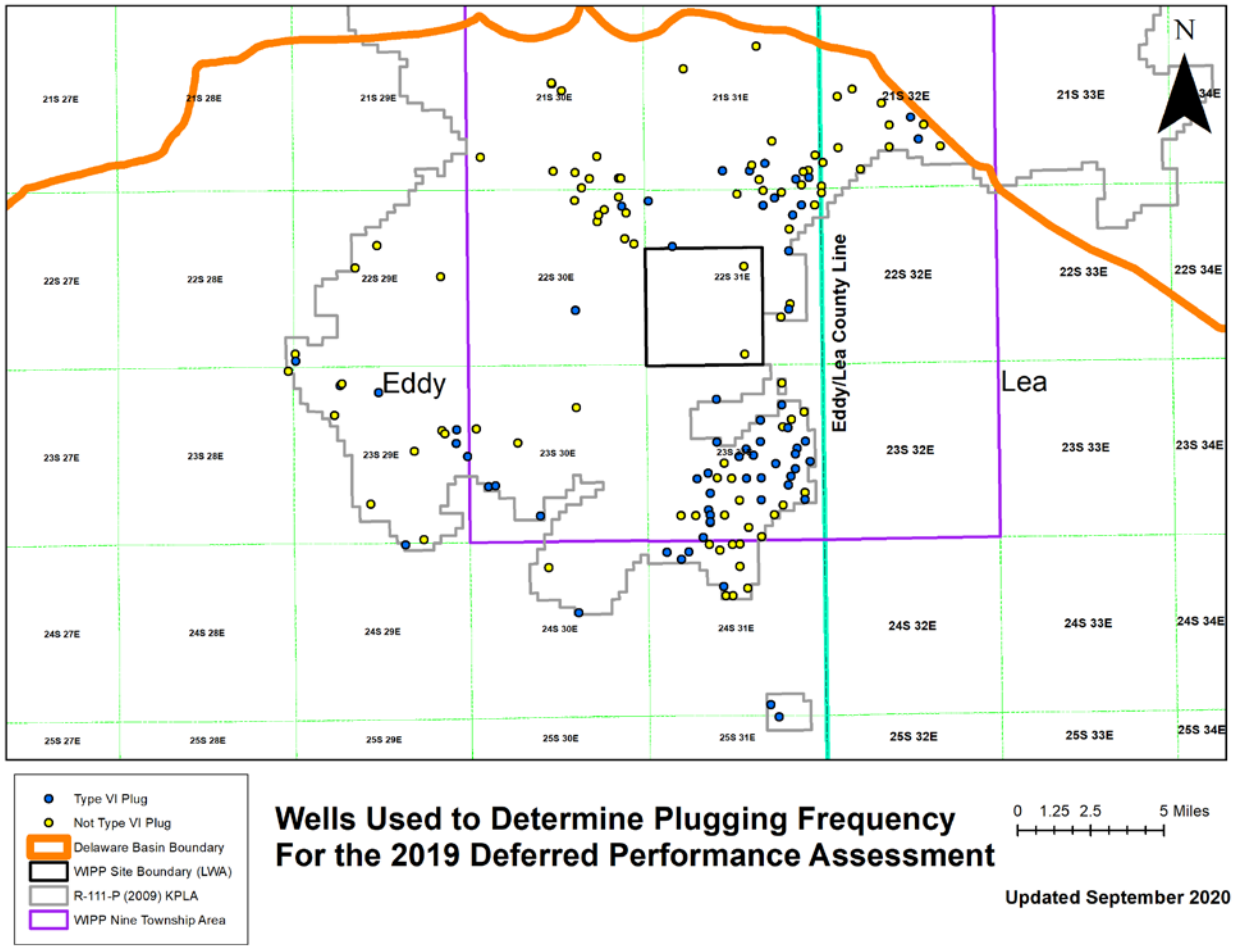

Figure 3.9. Map showing KPLA wells used by DOE to determine plugging frequency for the CRA-2019 PA (Source: DOE 2020, Enclosure 1, Response to EPA Completeness Question CC5-33-5a).

3.3.5 Consideration of Impacts on WIPP PA

Borehole plugging patterns were expected to have a strong impact on WIPP PA. This is because the only significant release pathways are through deep exploratory boreholes that may penetrate the waste after the repository is closed and active institutional control ceases. The assumptions of plug degradation used in calculating long-term repository performance are described in Section 3.1. As previously discussed, movement of contaminated, pressurized brine up a borehole to the ground surface is the source of low probability but high impact DBRs to the accessible environment. Such releases most commonly occur when the underground waste area is inundated by pressurized brine that has flowed up an abandoned borehole from the deeper Castile Formation. Such flow can only occur unimpeded if no borehole plugs are present between the repository and the Castile Formation. As described in Section 3.1, three plugging patterns are considered in WIPP PA and only one of these, the two-plug pattern, does not have such a plug. DBRs do not occur if the salt section is sealed with a continuous plug.

The frequency of occurrence of the two plug pattern in the New Mexico part of the Delaware Basin has decreased over time as the occurrences of the one plug and three plug patterns has increased. The changes in plug pattern frequencies that have occurred since the 1996 CCA are shown in Table 3.2. Two sets of frequencies relevant to EPA's review of DOE's new calculation approach are provided in the table. The first set, used in the CRA-2019 EPA Sensitivity Study PLG_PROB, shows the frequencies that would have been used in the CRA-2019 PA if plugging pattern frequencies had been calculated using the historic method based on all plugged and abandoned boreholes in the New Mexico part of the Delaware Basin. The second set shows the frequencies based on data from the Delaware Basin part of the KPLA that were actually used by the DOE in the CRA-2019 PA. These two data sets are also plotted in Figure 3.10 and illustrate the dramatic effect of DOE's decision to limit the calculation to only those abandoned boreholes within the Delaware Basin part of the KPLA.

Table 3.2. Plugging Pattern Frequencies by Compliance Application

Compliance Application	Calculation Basis	One Plug (Type VI) (%)	Two Plug (Types I, III, V) (%)	Three Plug (Types II, IV) (%)
CCA-1996 DOE PA[1]	NM part of Delaware Basin	2.0	68.0	30.0
CRA-2004 DOE PA[2]	NM part of Delaware Basin	1.5	69.6	28.9
CRA-2009 DOE PA[2]	NM part of Delaware Basin	1.9	66.5	31.6
CRA-2014 DOE PA[2]	NM part of Delaware Basin	4.0	59.4	36.6
CRA-2019 Data using previous methodology (EPA Sensitivity Study PLG-PROB)	NM part of Delaware Basin	9.5	48.3	42.2
CRA-2019 DOE PA[3]	Delaware Basin part of KPLA	40.3	33.1	26.6

Sources:

1. DOE 1996, Section 6.4.12.7
2. Calculated from DOE response to EPA Completeness Comment CC1-33-3d in Appendix A to this TSD. These data are also provided in Table 3.1.
3. CRA-2019, Appendix PA-2019, Table PA-14

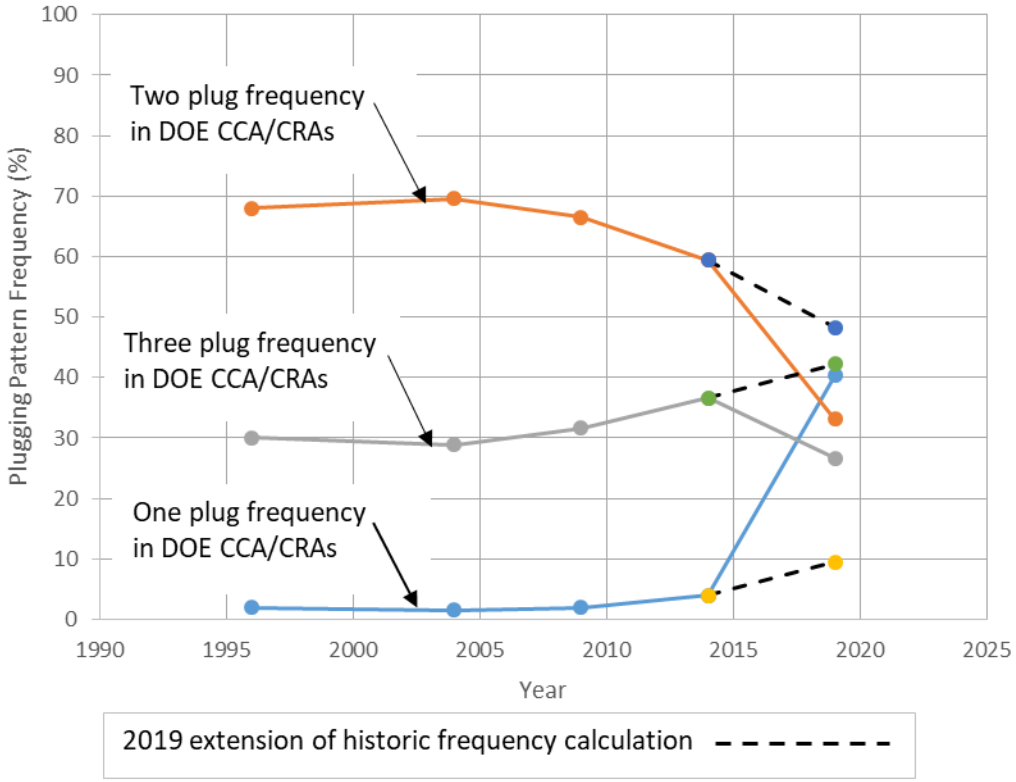

Figure 3.10. Plugging pattern frequencies in DOE compliance applications from the original certification and subsequent recertifications in Table 3.2. Lines diverge at 2014 projecting the historic methodology (dashed lines) and DOE's new methodology (solid lines) to 2019.

The DOE's changes in plugging pattern frequencies had a visible effect on reducing calculated WIPP releases. Figure 3.11 compares the CRA-2019 PA releases calculated based only on Delaware Basin wells inside the KPLA with CRA-2019 PA releases that would have been calculated if plugging pattern frequencies had been based on all Delaware Basin wells in New Mexico. The only difference between these two curves is the method of calculating plugging pattern frequencies. The effect on results is clearly evident even on a logarithmic scale. Table 3.3 summarizes these results for the 0.1 and 0.001 probability compliance points. The PLG_PROB Sensitivity Study in Figure 3.11 and Table 3.3 was fully qualified under the Agency's QAPP, to be used in supporting regulatory decisions. A description of this sensitivity study and documentation of compliance with the requirements of EPA's QAPP are provided in Attachment QA in this TSD. A copy of the EPA's QAPP is archived in Docket ID No. EPA-HQ-OAR-2019-0534.

The results of EPA's sensitivity study show that the average total repository releases are lower when calculated using DOE's new methodology than when using the historic methodology. The foregoing considerations of non-representative sampling and the reduced number and geographic locations of sampled boreholes in DOE's new approach indicate that the resulting changes in plugging pattern frequencies may not adequately capture the uncertainty in future plugging

practices. In addition, the Agency's review shows that plugging regulations applicable outside the KPLA can also be applicable for many wells within the KPLA.

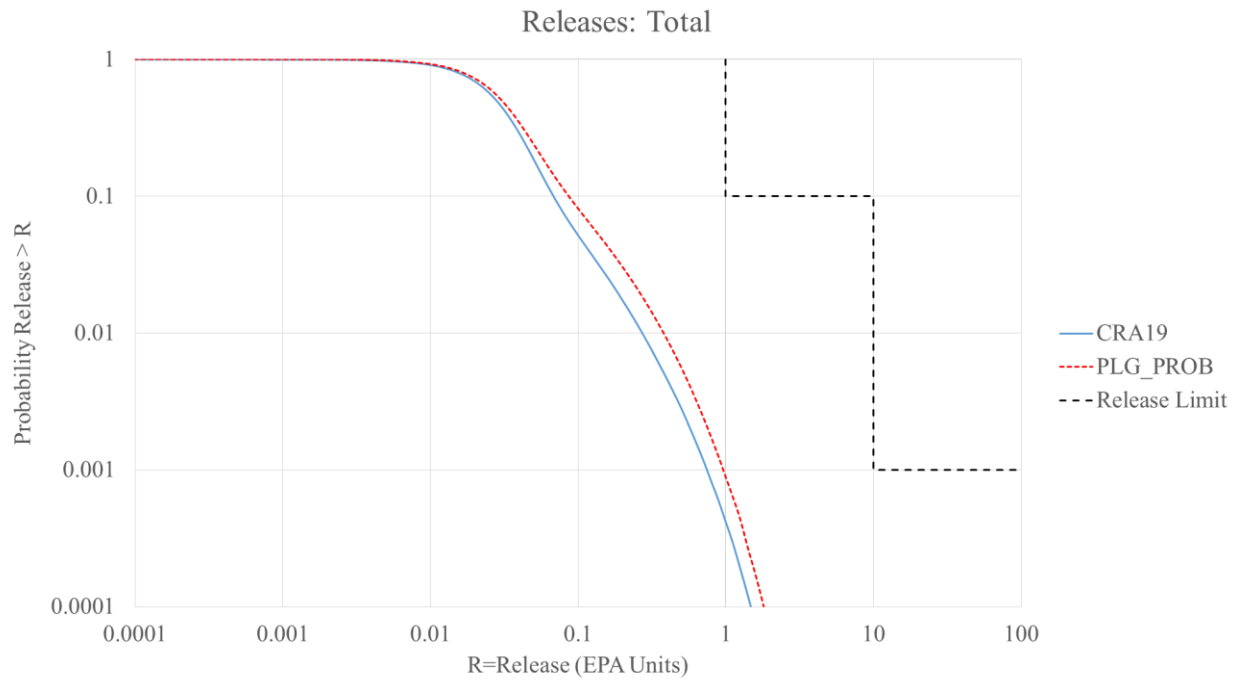

Figure 3.11. EPA sensitivity study results showing average total repository releases using historic plugging pattern frequency calculation (PLG_PROB curve) compared with total releases using DOE's new plugging pattern frequency calculation (CRA19 curve).

Table 3.3. Comparison of Mean Total Releases at EPA Compliance Points for PLG_PROB Sensitivity Study

Probability	Mean Total Release (EPA Units)		Increase in Calculated Mean Total Release	EPA Release Limit (EPA Units)
	Value in CRA-2019 PA	Value in EPA Combined Borehole Sensitivity Study		
0.1	0.06853	0.09035	32%	1.0
0.001	0.7505	0.9976	33%	10.0

3.4 EPA Conclusions

The EPA expected the DOE's change in calculating plugging pattern frequencies to have a significant effect on calculated total repository releases and it was therefore closely evaluated. EPA's evaluation was in five parts: first, the regulatory requirements in 40 CFR §194 and their historic implementation; second, the requirements of OCD Order R-111-P; third, the effects of the implementation of OCD Order R-111-P on plugging pattern frequencies within the KPLA; fourth, consideration to the representativeness of data that were limited to wells within the KPLA; and fifth, the Agency performed a sensitivity study to determine the effect of DOE's new plugging pattern frequency calculations on WIPP releases.

The Agency review showed that there are many wells (60%) within the KPLA that do not have continuous plugs through the salt section and that these wells are likely to have been in barren areas without significant potash reserves. Given the location of the WIPP in a barren area and the ability of the OCD to waive continuous plugging requirements at such locations, and/or the potential for imperfect regulatory oversight of plugging activities, it is not certain that plugging requirements at the WIPP will be significantly different from those outside the KPLA. Because the WIPP repository is located in an area where there is no economic grade potash ore to protect, non-continuous plugs could be approved consistent with standard BLM plugging requirements applicable to wells on federal lands outside the KPLA. The EPA concludes that for these reasons the WIPP repository would not necessarily be subject to the specific plugging requirements of the KPLA and that the DOE's approach of not accounting for the WIPP location in a barren area can lead to *overestimating* the use of continuous plugs in PA. In addition, DOE's new methodology significantly narrows the sampling area in a way that excludes wells directly adjacent to WIPP solely because they are located just outside of the KPLA boundary, even though they may be more relevant and geologically similar than more distant wells still within the KPLA. The sample size is also reduced by nearly an order of magnitude.

EPA's consideration of the effects of DOE's new plugging pattern calculations on WIPP PA as described above and documented by a sensitivity study show that the DOE's new calculations result in projecting significantly lower total releases, on average, than if the previously approved method had been used. However, this sensitivity study and the release results show WIPP is still well within regulatory limits. The Agency concludes that the basis for DOE's change to the plugging pattern probabilities is not adequately justified in consideration of both the regulatory requirements and actual practices in the area surrounding WIPP, as reflected in the data provided. Therefore, EPA expects DOE to utilize the prior approved methodology for the next recertification or propose a new methodology that could be approved by EPA beforehand.

4.0 COMBINED DRILLING RATE AND PLUGGING ANALYSIS AND SUMMARY

Figure 4.1 shows the combined effects of DOE's lagging borehole drilling rate and plugging pattern frequency calculations on reducing the average total calculated releases in the CRA-2019 PA. EPA prepared this separate, non-regulatory sensitivity analysis by making the changes to DOE's CRA-2019 PA shown in Table 4.1. The sources of these values are described in Sections 2 and 3 of this TSD. These changes resulted in a larger projection of repository releases than were projected by the CRA-2019 PA (Figure 4.1). The increase in calculated releases at the two EPA compliance points are shown in Table 4.2. The combined effects of EPA's alternate approach to the borehole drilling rate and plugging pattern frequency calculations increase the calculated mean total releases at each compliance point by about one-third. Even so, releases in PA would still be below regulatory limits, therefore they do not impact the Agency's recertification decision.

Table 4.1. Parameter Value Changes in EPA's combined borehole sensitivity analysis

Parameter	Description	Value in CRA-2019 PA	Value in EPA Sensitivity Study
GLOBAL: LAMBDAD	Deep Borehole Drilling Rate (boreholes/km^2 over 10,000 years)	99.0	109.1
GLOBAL: ONEPLG	Probability of having Plug Pattern 1 (full plug Type VI)	0.403	0.095
GLOBAL: TWOPLG	Probability of having Plug Pattern 2 (plug Types I, III, V)	0.331	0.483
GLOBAL: THREEPLG	Probability of having Plug Pattern 3 (plug Types II, IV)	0.266	0.422
Plug Pattern Totals		1.000	1.000

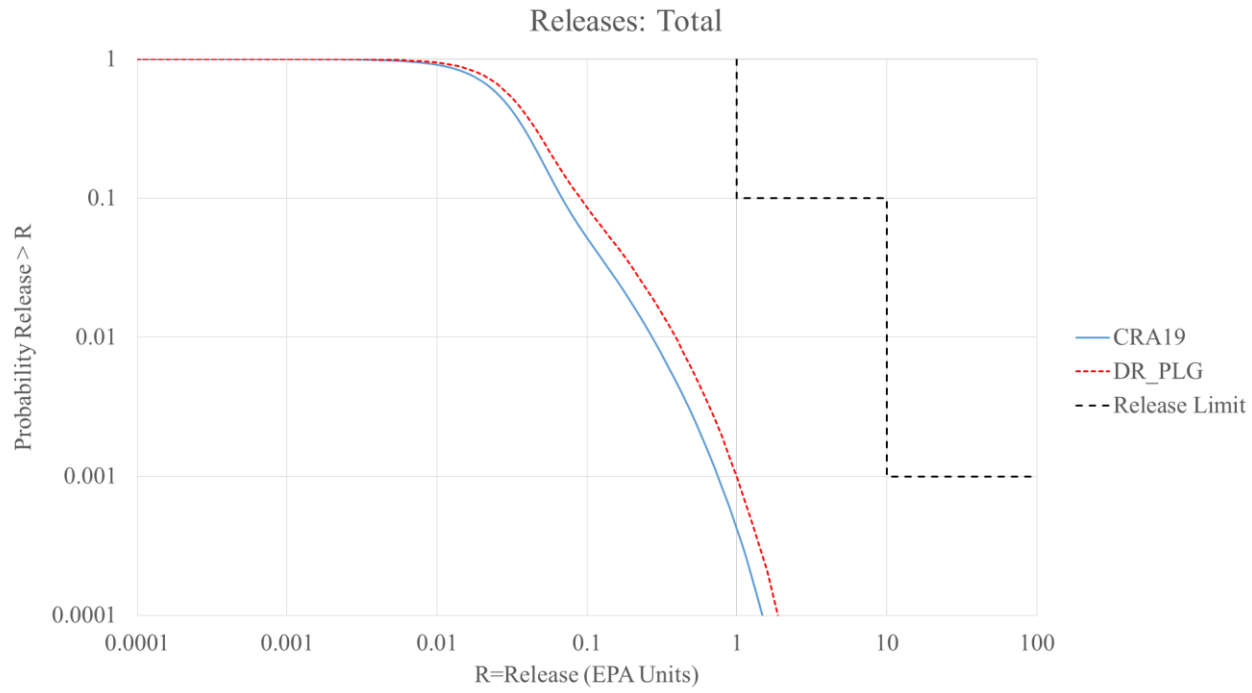

Figure 4.1. EPA's Combined Borehole Sensitivity Analysis results comparing average total repository releases calculated using EPA's alternative higher drilling rate and historic plugging pattern frequency calculations (DR_PLG curve) with releases calculated by the DOE in the CRA-2019 PA (CRA19 curve).

These results clearly show the significant impact of both the drilling of boreholes and their plugging and abandonment in the WIPP area for the disturbed case in PA. They demonstrate that the accuracy and quality of the data collected are crucial, uncertainty must be quantified, and any changes to methodology must be carefully evaluated and justified with consideration to both regulatory requirements and practice. EPA encourages DOE to work more closely with EPA going forward when considering methodology changes to impactful parameters.

REFERENCES

DOE 1999-2019. *Delaware Basin Monitoring Annual Reports* (DBMAR), DOE-WIPP-xx-2308, 1999 through 2019.

DOE 1996. *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant.* 21 Vols. DOE/CAO 1996-2184. Carlsbad Area Office, Carlsbad, New Mexico. October.

DOE 2014. *Title 40 CFR Part 191 Subparts B and C. Compliance Recertification Application 2014 for the Waste Isolation Pilot Plant.* DOE/WIPP- DOE/WIPP-14-3503. Carlsbad Field Office, Carlsbad, New Mexico.

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OCD 1988. *Order R-111-P, Potash Areas of Eddy and Lea Counties, NM.* Case 9316, Revision to Order R-111-P. April 21, 1988. Santa Fe, New Mexico.

SNL 1992. Preliminary Performance Assessment for the Waste Isolation Pilot Plant, December 1992, Volume 3: Model Parameters. SAND92-0700/3. Sandia National Laboratories, Albuquerque, New Mexico.

Sosson, Gregory 2019. Deferred Performance Assessment for the Compliance Recertification Application 2019. Letter 19-0279 from Gregory Sosson (DOE) to Lee Veal (EPA). Carlsbad, New Mexico. December.

APPENDIX A

EPA Completeness Questions, DOE Responses, and EPA Evaluations of Responses Related to Borehole Drilling Rate and Plugging Pattern Frequency in WIPP Performance Assessment

Table A-1. Summary of EPA Completeness Questions and DOE Responses Related to Boreholes

Question	Topic	DOE Response Set	EPA Evaluation/Resolution	Documentation/ Discussion in TSD
CC1-33-1 a,b	Borehole plugging	#1 (6/10/20)	Satisfactory, text updated and corrected	Appendix A
CC1-33-2 a-d	Borehole plugging maps and additional info	#1 (6/10/20)	Satisfactory, information provided	Sec 3.2.2 (a), Sec 3.3.2-3 (b-c), Sec 3.1 (d), Appendix A
CC1-33-3 a-d	Borehole plugging database	#2 (7/8/20)	Satisfactory, data provided	Sec 3.3.3 (a), Sec 3.3, 3.3.5 (d), Appendix A
CC5-33-5 a-c	Borehole location laps and plugging exemptions	#8 (1/13/21)	Satisfactory (a), partially adequate (b,c); descriptions and maps don't agree	Sec 3.3.3 (b), Sec 3.3.4 (a, c), Appendix A
CC5-33-6	Apparent conflict in descriptions of areas used for determining plugging patterns	#8 (1/13/21)	Partially adequate; does not match map provided	Appendix A
CC5-33-7	Clarification of data discrepancies between DBMAR 2018 (“Rev. 0”) and DBMAR 2018 Rev. 1	#8 (1/13/21)	Satisfactory; data availability problem cited, added to erratum	Appendix A
CC5-33-8	Categorization of boreholes of unknown depth and/or incomplete information	#8 (1/13/21)	Satisfactory; DOE should reevaluate methodology for future	Sec 2.2, 2.3, Appendix A

Contents

APPENDIX A A-1

Table A-1. Summary of EPA Completeness Questions and DOE Responses Related to Boreholes A-2

CC1-33-1: Borehole Plugging Frequency Error A-4

CC1-33-2: Borehole Plugging Requirements Completeness Request A-5

CC1-33-3: Borehole Plugging Database A-11

CC1-33-4: Not Used A-15

CC5-33-5: Borehole Location Maps and Plugging Exemptions A-15

CC5-33-6: Apparent Conflict in Descriptions of Areas Used for Determining Plugging Patterns A-25

CC5-33-7: Clarification of Data Discrepancies between DBMAR 2018 (“Rev. 0”) and DBMAR 2018 Rev. 1 ..... A-26

CC5-33-8: Categorization of Boreholes of Unknown Depth and/or Incomplete Information . A-27

CC1-33-1: Borehole Plugging Frequency Error

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 1)

There appear to be inconsistencies and numerical errors in Section PA-1.1.11:

Question 33-1a. Inconsistency in Correlating the Six Borehole Plug Configuration Types

Inconsistency in correlating the six borehole plug configuration types with the three plugging patterns used in PA. The current text reads "…type VI is the same as a full plug, types II and IV are the same as a two-plug, and types I, III, and V are the same as a three-plug configuration." However, it appears that types I, III, and V are the same as a two-plug configuration and types II and IV are the same as a three-plug configuration. The CRA19 frequency values in Table PA-14 are consistent with this latter correlation. Please confirm.

DOE Response (from DOE Response Package 1 (DOE RP1 2020a))

The text in PA-1.1.11 describing the correlations between the six well plug types and the three plugging patterns assumed in PA is incorrect. For the CRA-2019 PA, there was no change to the correlations used in the CRA-2014 PA. The plugging pattern probability numbers in Table PA-14 for CRA19 were calculated correctly and consistently with what was done for CRA14. The correct parameter values were used in CRA19 calculations. An updated Table PA-14 is included below, which includes an added column (Well Plug Type[1]) to clarify the correlations between plug types and plugging patterns used in PA.

Table PA-14 – Drilling Rate and Plugging Pattern Parameters (CRA14 and CRA19)

Material	Property	Description	Units	Well Plug Type[1]	CRA14 Value	CRA19 Value
GLOBAL	LAMBDAD	Drilling rate per unit area	km^{-2} yr^{-1}	(-)	6.73E-3	9.90E-3
GLOBAL	ONEPLG	Probability of having Plug Pattern 1 (full plug)	(-)	VI	4E-2	4.03E-1
GLOBAL	TWOPLG	Probability of having Plug Pattern 2	(-)	I, III, V	5.94E-1	3.31E-1
GLOBAL	THREEPLG	Probability of having Plug Pattern 3	(-)	II, IV	3.66E-1	2.66E-1

[1]Well plug types are used in determining parameter values and are defined in *DOE, 2018. Delaware Basin Monitoring Annual Report. DOE/WIPP-18-2308, Rev. 1.*

The reference included in the footnote was added to Section 33.4 References.

The sentence beginning as follows in the third paragraph or PA-1.1.11, will be changed to the following text.

> "This same translation scheme (i.e., type VI is the same as a full plug, types I, III, and V are the same as a two-plug, and types II and IV are the same as a three-plug configuration) was used for the parameterization of the GLOBAL:ONEPLG, GLOBAL:TWOPLG, and GLOBAL:THREEPLG parameters for the CRA-2019 PA (see WIPP Performance Assessment [2010] for a description of the use of the plugging pattern parameters in WIPP PA)."

These changes are included in Enclosure 2, CRA-2019 Errata Tracking.

EPA Evaluation of Response

The DOE response was satisfactory. The inconsistency in correlating plug types to plug configurations was acknowledged and corrected by DOE in the CRA-2019 Errata Tracking, and the correct parameter values were used in the CRA-2019 PA.

Question 33-1b. Typographical Error in Table PA-14.

Typographical error in Table PA-14. The CRA-14 value for GLOBAL_ONEPLUG is reported as $E-2. We believe the correct value is 4E-2 (see Zeitler 2019, ERMS 571150, Table 2-13). Please confirm.

DOE Response (from DOE Response Package 1 (DOE RP1 2020a))

There is a typographical error in Table PA-14. The "$E-2" value for ONEPLG (CRA14) should be "4E-2". No calculations were impacted by this error. The updated Table PA-14 included in the response to comment 33-1a shows the corrected value. This change is included in Enclosure 2, CRA-2019 Errata Tracking.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged and corrected by DOE in the CRA-2019 Errata Tracking, and the correct parameter values were used in the CRA-2019 PA.

CC1-33-2: Borehole Plugging Requirements Completeness Request

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 1)

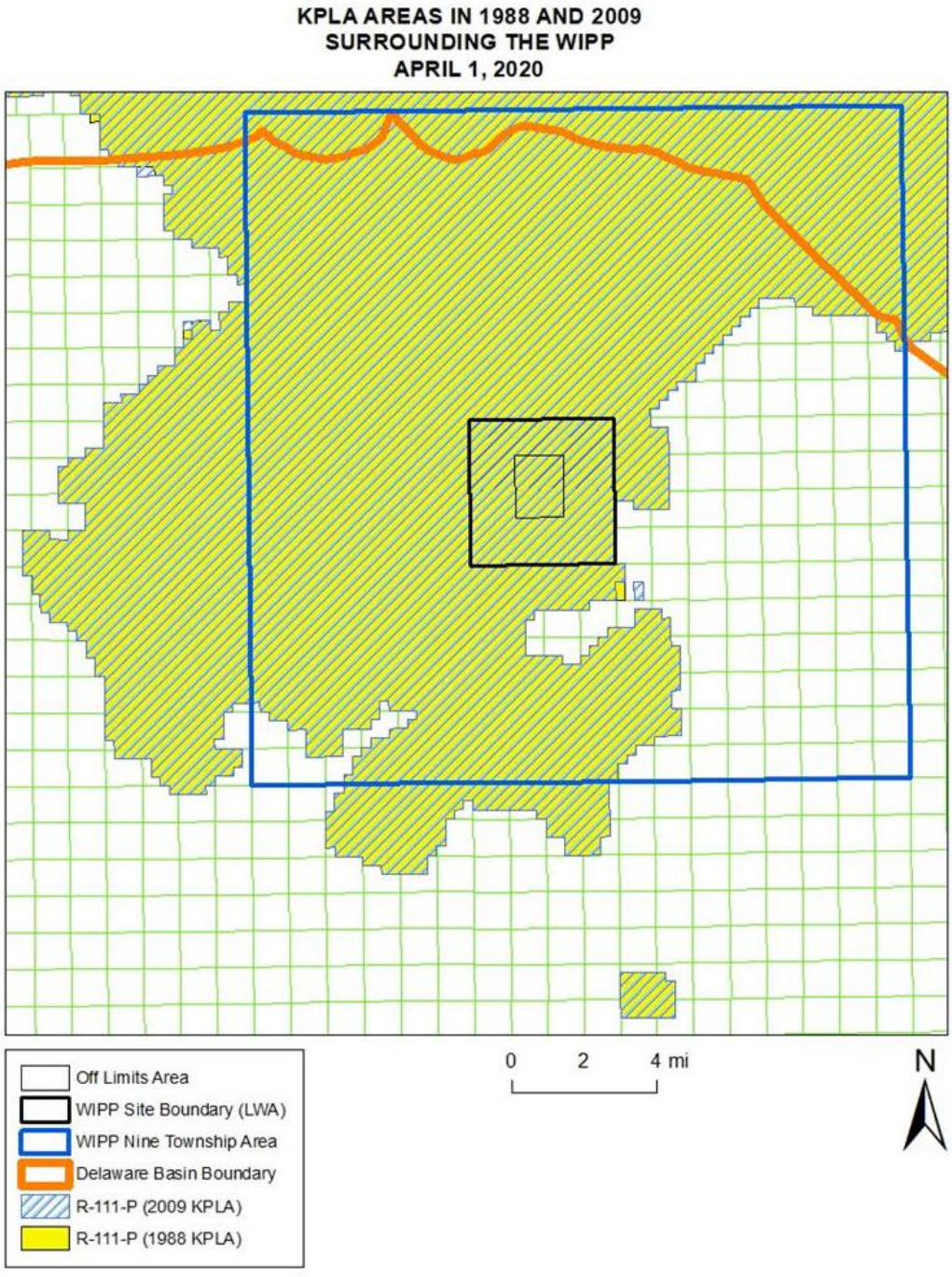
Please provide the following information:

Question 33-2a. Maps of the Known Potash Leasing Area (KPLA)

Maps of the Known Potash Leasing Area (KPLA), especially comparing the original (1988) and 2009 (R-111-P) areas referred to in the Delaware Basin Monitoring Reports.

DOE Response (from DOE Response Package 1 (DOE RP1 2020))

Below is a map of the Known Potash Lease Area (KPLA) showing the extent of this area for both 1988 and 2009. The Delaware Basin boundary is also shown on this map. There is a very slight difference that resulted in an agreement between the oil and potash industries to convert two "drill islands" in what was previously KPLA. One lies to the southeast of the Waste Isolation Pilot Plant (WIPP), the other west-northwest.



EPA Evaluation of Response

The DOE response was satisfactory. The map was provided as requested.

Question 33-2b. Summary of Current Plugging Requirement for Abandoned Boreholes

A summary of the current plugging requirements for abandoned boreholes within the New Mexico portion of the Delaware Basin outside the KPLA.

DOE Response (from DOE Response Package 1 (DOE RP1 2020a))

Plugging requirements for wells on both federal and state lands use essentially the same plugging requirements (note: Department of Energy (DOE) response to comment 33-2c below cites the federal and state regulatory requirements). In general terms, the operator must plug the well in a manner that permanently confines all oil, gas, and water in their original, native strata. To accomplish this, the following guidelines are used by both the Bureau of Land Management and the State of New Mexico:

All plugs must be a minimum of 100’ in length plus an additional 10% slurry for each 1,000’ depth (e.g., a plug set at 5,000’ depth would be 150’ in length).

A cement plug is required to be set at least 50’ below and 50’ above all casing shoes.

A cement plug shall be placed opposite all open perforations and extend a minimum of 50’ below to 50’ above the perforated interval.

There will not be more than 3,000’ between plugs in a cased hole and 2,000’ in open hole.

Operators must detail the plugging configuration planned for each well in their notice of intent to plug to the appropriate regulatory body. This plugging plan will be reviewed and modified as necessary by the regulator, prior to granting approval to plug. Once approved, each operator must give prior notice to plugging activities to allow the regulator ample opportunity to witness plugging activities.

EPA Evaluation of Response

The DOE response was satisfactory. The summary of current plugging requirements was provided as requested.

Question 33-2c. Copies of New Mexico Plugging and Abandonment Regulations

Copies of the borehole abandonment and plugging regulations for boreholes within the New Mexico portion of the Delaware Basin outside the KPLA.

DOE Response (from DOE Response Package 1 (DOE RP1 2020a))

Plugging and abandonment regulations for boreholes on federal land in New Mexico that lie outside the KPLA are subject to 43 CFR 3160, the Bureau of Land Management's "Onshore Oil and Gas Operations; Federal and Indian Oil and Gas Leases; Onshore Oil and Gas Order No. 2, Drilling Operations." Section III G. of this rule provides the specific plugging and abandonment requirements. It can be found online here: Onshore Oil and Gas Order No. 2.

Plugging and abandonment regulations for boreholes on state land in New Mexico that lie outside the KPLA are found in New Mexico Administrative Code Title 19, "Natural Resources and Wildlife," Chapter 15, "Oil and Gas," Part 25 "Plugging and Abandonment of Wells" (NMAC 19.15.25). These rules can be found online here: NMAC 19.15.25.

Attachment A to this comment's response provides New Mexico Oil Conservation Division's guidelines for plugging activities used in District II. These guidelines are applicable to wells plugged in Eddy County on State of New Mexico Lands, but within the Delaware Basin and outside the KPLA. These guidelines are essentially the same as those prescribed on federal lands (see Onshore Oil and Gas Order No. 2 above), but outside the KPLA.

Attachment A - DOE Response to EPA CC-33-2C

CONDITIONS FOR PLUGGING AND ABANDONMENT
NMOCD District II / Artesia N.M.

The following is a guide or checklist in preparation of a plugging program, this is not all inclusive and care must be exercised in establishing special plugging programs in unique and unusual cases, **Notify NMOCO District Office II at (575)-748-1283 at least 24 hours before beginning work.**

1. A notice of intent to plug and abandon a wellbore is required to be approved before plugging operations are conducted. A cement evaluation tool is required in order to ensure isolation of producing formations, protection of water and correlative rights. A cement bond Jog or other accepted cement evaluation tool is to be provided to the division for evaluation if one has not been previously run or if the well did not have cement circulated to surface during the original casing cementing job or subsequent cementing jobs.
2. Closed loop system is to be used for entire plugging operation. Upon completion, contents of steel pits are to be hauled to a permitted disposal location.
3. Trucking companies being used to haul oilfield waste fluids to a disposal - commercial or private - shall have an approved NMDCD C-133 permit. A copy of this permit shall be available in each truck used to haul waste products. It is the responsibility of the operator as well as the contractor, to verify that this permit is in place prior to performing work. Drivers shall be able to produce a copy upon request of an NMOCD Field inspector.
4. Filing a subsequent C-103 will serve as notification that the well has been plugged.
5. A final C-103 shall be filed (and a site inspection by NMOCD Inspector to determine if the location is satisfactorily cleaned, all equipment, electric poles and trash has been removed to Meet NMOCD standards) before bonding can be released.
6. Squeeze pressures are not to exceed 500 psi, unless approval is given by NMOCD.
7. Produced water will not be used during any part of the plugging operation.
8. Mud laden fluids must be placed between all cement plugs mixed at 25 sacks per 100 bbls of water.

9. All cement plugs will be a minimum of 100' in length or a minimum of 25 sacks of cement, whichever is greater. 50' of calculated cement excess required for inside casing plugs and 100% calculated cement excess required on outside casing plugs.

10. Class 'C' cement will be used above 7500 feet.

11. Class 'H' cement will be used below 7500 feet.

12. A cement plug is required to be set 50' above and 50' below, casing stubs, D\(tools, attempted casing cut offs, cement tops outside casing, salt sections and anywhere the casing is perforated, these plugs require a 4 hour woe and then will be tagged.

13. All Casing Shoes Will Be Perforated 50' below shoe depth an Attempted to be Squeezed, cement needs to be SO' above and SO' Below Casing Shoe inside the Production Casing.

14. When setting the top out cement plug in production, intermediate and surface casing, wellbores should remain full at least 30 minutes after plugs are set.

15. A ClBP Is to be set within 100' of production perforations, capped with 100' of cement, WOC 4 hours and tag.

16. A CIBP with 35’ of cement may be used in lieu of the 100’ plug if set with a bailer. This plug will be placed within 100’ of the top perforation, **(WOC 4hrs and tag).**

17. No more than **3000’ is allowed between cement plugs in cased hole and 2000’ in open hole.**

18. Some of the Formations to be isolated with cement plugs are: These plugs to be set to isolate formation tops

a. Fusselman
b. Devonian
c. Morrow
d. Wolfcamp
e. Bone Springs
f. Delaware
g. Any salt sections
h. Abo
i. Glorieta
j. Yates
k. **Potash:** --- (In the R-111-P Area (Potash Mine Area)), a solid cement plug must be set across the salt section. Fluid used to mix the cement shall be saturated with the salts that are common to the section penetrated and in suitable proportions, not more than 3% calcium chloride (by weight of cement) will be considered the desired mixture whenever possible, **WOC 4 hours and tag, this plug will be 50’ below the bottom and 50” above the top of the Formation.**

19. If cement does not exist behind casing strings at recommended formation depths, the casing can be cut and pulled with plugs set at recommended depths. If casing is not pulled, perforations will be shot and cement squeezed behind casing, WOC and tagged. These plugs will be set 50’ above formation top inside the casing.

DRY HOLE MARKER REQUIREMENTS

The operator shall mark the exact location of the plugged and abandoned well with a steel marker not less than four inches in diameter, 3’ below ground level with a plate of at least ¼” welded to the top of the casing and the dry hole marker welded on the plate with the following information welded on the dry hole marker:

1. Operator name 2. Lease and Well Number 3. API Number 4. Unit Letter 5. Quarter Section (feet from the North, South, East or West) 6. Section, Township and Range 7. Plugging Date

8. County

(SPECIAL CASES)

AGRICULTURE OR PRARIE CHCKEN BREEDING AREAS

In these areas, a below ground marker is required with all pertinent information mentioned above on a plate, set 3' below ground level, a picture of the plate will be supplied to NMOCD for record, the exact location of the marker (longitude and latitude by GPS) will be provided to NMOCD (We typically require a current survey to verify the GPS).

GENERAL GUIDELINES FOR PLUGGING PROCEDURES

1. All cement plugs from the surface casing shoe to 5000 ft. will be a minimum of 100 ft. in length or a minimum of 25 sx whichever is greater.

2. All plugs spotted from 5,000 to 10,000 ft. must be a minimum of 150 ft. in length or a minimum of 25 sx whichever is greater.

3. All plugs spotted from 10,000 to 15,000 ft. must be a minimum of 200 ft. in length or a minimum of 25 sx whichever is greater.

4. A cement plug is required to be set at least 50 ft below and 50 ft. above all casing shoes and casing stub plugs and must be tagged. A CIBP with 35 ft. of cement on top may be set in lieu of the required cement plugs.

5. A cement plug shall be placed opposite all open perforations and extend a minimum of 50 ft. below to 50 ft. above the perforated interval. In lieu of the cement plug, a bridge plug is acceptable and set 50 ft. above the uppe1most perforation with 35 ft. of cement on top.

6. The salt section shall be isolated by placing a cement plug at the base of the salt and at the top of the salt section. These plugs shall be 100 ft. in length or 25 sx whichever is greater. If in the R-111-P potash area the requirement is a solid cement plug be set across the salt section (50 ft. below to 50 ft. above the salt section). Fluid used to mix this cement plug shall be saturated with the salts common to the salt section penetrated and with suitable proportions but not more than three percent of calcium chloride by weight of cement being considered the desired mixture whenever possible. This plug to be tagged.

7. If cement does not exist behind casing at recommended geological formations to be isolated, the casing must be cut and pulled and cement plugs placed at recommended formations to be isolated or casing must be perforated and cement squeezed behind casing at recommended formations to be isolated.

8. Formations to be isolated with 100 ft. cement plug or CIBP with 35 ft. on top are as follows, top of Fusselman, top of Devonian, top of Morrow, top of Wolfcamp. In Delaware Basin: top of Bone Springs, top of Delaware, top and base of salt section. In platform shelf: top of Abo, top of Glorieta, top of Yates will be base of salt plug.

9. There will not be more than 2000 ft. more or less between cement plugs.

10. Mud laden fluids mixed at 25 sx of gel per 100 barrels of water shall be placed between all plugs.

11. Cement plugs shall consist of either Class C, for up to 7,500 feet of depth, mixed at 14.8 lbs/gal with 6.3 gallons of fresh water per sack or Class H, for deeper than 7,500 feet plugs, mixed at 16.4 lbs/gal with 4.3 gallons of fresh water per sack.

12. DV tools are required to have a 100' cement plug (25 sx minimum) set at 50' below and extend 50' above the DV tool.

EPA Evaluation of Response

The DOE response was satisfactory. The complete NMOCD and BLM plugging regulations were provided by reference and current guidelines for well plugging and abandonment issued by NMOCD District II (Artesia Office) were also provided. The guidelines were not requested by EPA but provided additional insight into general plugging practices and were appreciated.

Question 33-2d. Summary of Current Plugging Patterns

A summary of the current plugging patterns employed to meet those regulations. If the patterns are the same as those documented for the CRA-2014 PA, you may simply so indicate.

DOE Response (from DOE Response Package 1 (DOE RP1 2020a))

Current plugging patterns used in the Delaware Basin are the same as those documented for the CRA-2014 PA, as well as previous certification applications.

EPA Evaluation of Response

The DOE response was satisfactory. The response confirmed that the plugging patterns used to meet state and federal regulations are the same as those documented for the CRA-2014 PA.

CC1-33-3: Borehole Plugging Database

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 1)

EPA understands that the plugging pattern frequencies used in the CRA-2019 PA were based on plugging data collected only within the KPLA. Please provide the following information on the borehole plugging database:

Question 33-3a. KLPA Plugged Boreholes within Delaware Basin

The number of plugged boreholes within the KPLA that were also within the Delaware Basin.

DOE Response (from DOE Response Package 2 (DOE RP2 2020b))

Based on the Delaware Basin Monitoring Annual Report (DBMAR) for 2018 (U.S. DOE 2018), there were 154 plugged wells within the Known Potash Lease Area (KPLA) that are also within

the Delaware Basin. This value is derived by utilizing the data gathered from commercial databases by the Delaware Basin Drilling Surveillance Program and applying Global Information System (GIS) tools to select only the data in a specific delineated area (in this case, the KPLA area that falls within the Delaware Basin boundary).

Table 1: KPLA Plugging Summary by Type as of August 31, 2018 [1, 2]

Type	Count	Frequency
I	22	14.29%
II	26	16.88%
III	10	6.49%
IV	15	9.74%
V	19	12.34%
VI	62	40.26%
Totals	154	100.00%

[1] Taken from Table 9, *DOE/WIPP-18-2308, Rev. 1*

[2] This is the date of the most current Delaware Basin Monitoring Annual Report issued before the Deferred Performance Assessment (DPA)-2019 January 2019 cut-off date.

The DBMAR reports six types of plugging patterns (summarized above in Table 1, and in Table 9 of the DBMAR), which have historically been translated into three unique plugging patterns for Performance Assessment (PA) purposes. This same translation scheme (i.e., type VI is the same as a full plug, types I, III, and V are the same as a two-plug, and types II and IV are the same as a three-plug configuration) was used for the parameterization of the GLOBAL:ONEPLG, GLOBAL:TWOPLG, and GLOBAL:THREEPLG parameters for the Compliance Recertification Application (CRA)-2019. Table 2 below lists the resulting plugging probabilities used in the CRA-2019 DPA. They are presented here for convenience:

Table 2: Plugging Pattern Parameters used in CRA-2014 and CRA-2019[1]

Material	Property	Description	CRA-2019 Value
GLOBAL	ONEPLG	Probability of having Plug Pattern 1 (Type VI)	40.26%
GLOBAL	TWOPLG	Probability of having Plug Pattern 2 (Types I, III, V)	33.12%
GLOBAL	THREEPLG	Probability of having Plug Pattern 3 (Types II, IV)	26.62%

[1]The text in Appendix PA-2019, Section PA-1.1.11 describing the correlations between the six well plug types and the three plugging patterns assumed in PA is incorrect and was questioned in U.S. Environmental Protection Agency (EPA) completion comment CC1-33-G1, but the values in the corresponding Table PA-14 were correct. The table above also provides correct values and is consistent with the U.S. Department of Energy (DOE) Response to EPA Comment CC1-33-1a.

EPA Evaluation of Response

The DOE response was satisfactory. In addition to providing the requested number of boreholes, the DOE also provided a summary of plugging frequency by borehole type and a table of plugging pattern parameters used in the CRA-2019 PA. The extra information was appreciated.

Question 33-3b. KPLA Plugged Boreholes Outside Delaware Basin

The number of plugged boreholes within the KPLA that were outside the Delaware Basin.

DOE Response (from DOE Response Package 2 (DOE RP2 2020b))

Because 40 CFR 194.33(c)(1) directs the DOE to apply the Delaware Basin as the region of interest for drilling activities that may relate to the Waste Isolation Pilot Plant's (WIPP's) performance, we typically only collect data within the Delaware Basin. However, to satisfy EPA's request we have been able to determine that there are 720 plugged wells within Eddy and Lea counties that meet the requested criteria. This well count was derived by using the "EnverusTM" energy and minerals database and then overlaying United States Geological Survey (USGS) shape files to carefully select the KPLA area outside the Delaware Basin Boundary. Wells were then sorted by well status to identify plugged and abandoned wells within this area.

EPA Evaluation of Response

The DOE response was satisfactory. The number of boreholes was provided as requested.

Question 33-3c. Plugged Boreholes near Delaware Basin Boundary

The number of plugged boreholes near the Delaware Basin boundary where it is not clear whether they are inside or outside that boundary.

DOE Response (from DOE Response Package 2 (DOE RP2 2020b))

There are essentially zero wells where the location is not clear whether they are inside or outside the Delaware basin. In cases where the well location is close to the boundary, Delaware Basin Monitoring Program staff visit the well site and using global positioning system coordinates at the wellhead, determine the exact location and then translate this precise location to the GIS database, which can delineate the precise location of the Delaware Basin boundary.

EPA Evaluation of Response

The DOE response was satisfactory. The number of boreholes was provided as requested.

Question 33-3d. Plugging Pattern Type and Frequencies

Please provide the numbers of wells of each plugging pattern type and the plugging pattern frequencies that would have been determined if the data collection and analysis methods used in the CRA-2014 PA had also been used in the CRA-2019 PA.

DOE Response (from DOE Response Package 2 (DOE RP2 2020b))

The following table shows the probabilities that result if the same data set conditions were applied to the CRA-2019 plugging data.

Table 3: Plugging Type Frequency Using CRA-2014 Analysis Method

Type	CRA-2014 Well Count	CRA-2014 Frequency	CRA-2019 Well Count[1]	CRA-2019 Frequency[1]
I	147	26.9%	180	21.9%
II	110	20.1%	199	24.2%
III	163	29.9%	189	23.0%
IV	90	16.5%	148	18.0%
V	14	2.6%	28	3.4%
VI	22	4.0%	78	9.5%
TOTALS	546	100.0%	822	100.0%

[1] These values were derived using CRA-2014 analysis methods.

As described in the DBMAR, the methodology for determining the plugging type frequency was changed for the CRA-2019 to be consistent with the future states assumption for drilling as provided in Title 40 CFR Part 194.33(c)(1) where it states: "Future drilling practices and technology will remain consistent with practices in the Delaware Basin at the time a compliance application is prepared. Such future drilling practices shall include, but shall not be limited to: The types and amounts of drilling fluids; borehole depths, diameters, and seals; and the fraction of such boreholes that are sealed by humans…"

Plugging techniques near the WIPP are driven by state regulations that are in place to protect other resources present, namely potash. For wells within the KPLA, New Mexico Oil Conservation Division (NMOCD) R-111-P regulations apply and require the operator to install a solid cement plug through the entire salt section and any water-bearing horizon, in addition to installing a bridge plug above the perforations. This plugging technique provides protection to mineralized potash areas and workings by requiring a continuous plug so there is virtually no chance of flooding nearby mines throughout their development and operation. The WIPP site lies entirely within the KPLA and plugging in the vicinity generally follows this plugging technique, although there are cases in which exemptions to this technique have been granted to the operator by the regulator. Additionally, older plugged wells that pre-date the NMOCD R-111-P regulation may not be plugged in this manner.

Reference

U.S. Department of Energy (DOE). 2018. Delaware Basin Monitoring Annual Report, Rev. 1. DOE/WIPP-18-2308.

EPA Evaluation of Response

The DOE response was satisfactory. The plugging pattern frequency information was provided as requested.

CC1-33-4: Not Used

CC5-33-5: Borehole Location Maps and Plugging Exemptions

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 5)

Question 33-5a. Map of Borehole Locations Used to Calculate Plugging Frequencies

Please provide a map showing the locations of boreholes used to calculate the plugging frequencies used in the CRA-2019 PA. On this same map please also show, at a minimum, the WIPP LWA boundary, the Delaware Basin boundary, the known Potash Leasing Area (KPLA) boundary, and the locations of boreholes within the Delaware Basin part of the KPLA that were granted exemptions from the New Mexico Oil Conservation Division (NMOCD) KPLA R-111-P plugging requirements.

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

Figure 1 below illustrates wells that were used to determine plugging frequency for the 2019 Deferred Performance Assessment (PA). The wells labeled “not type VI,” are those wells that do not have a continuous plug through the salt bearing zones.

EPA Evaluation of Response

The DOE response was satisfactory. The borehole location map was provided as requested.

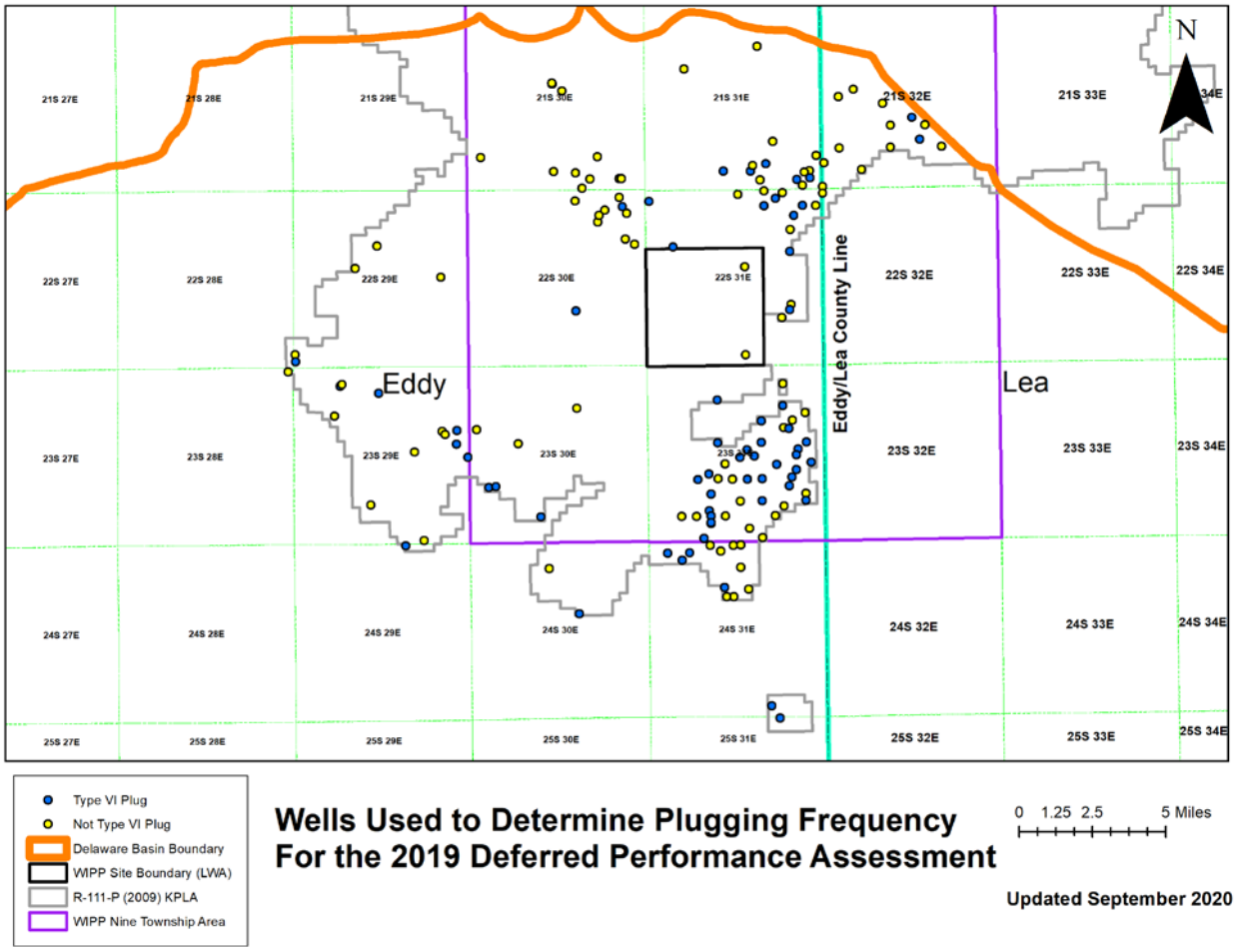


Figure 1: Wells Used to Determine Plugging Frequency in the 2019 Deferred PA

Question 33-5b. KPLA Boreholes with Exemptions from NMOCD KPLA R-111-P Plugging Requirements.

Please provide a list of boreholes within the KPLA that were given exemptions from the NMOCD KPLA R-111-P plugging requirements, the borehole locations, the type of plugging pattern used, and the reason for the exemption.

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

A list of wells that are not plugged within the Known Potash Lease Area (KPLA) per R-111-P can be found below (Table 1).

Table 1: Wells in the KPLA Area Not Plugged with a Type VI Plugging Pattern

API	Lat.	Long.	Well Name	Well Number	Plug Date	Plug Type	Comments
3001538393	32.25183818	-103.789787	SUNDANCE 4 FEDERAL	32	4/19/11	NA	Incomplete NMOCD Records
3001526908	32.40785892	-103.7411296	MARTHA AIK FEDERAL	5	5/31/18	I	
3001532527	32.43598473	-103.7325078	LOST TANK AIS STATE	7	12/8/16	I	
3001531792	32.43234957	-103.7582206	LUCY ALC STATE	2	12/8/16	I	
3001531606	32.42690698	-103.7560735	GRAHAM AKB STATE	9	8/29/16	I	
3001521431	32.27085904	-103.7464812	TODD 26 O FEDERAL	7	12/8/15	I	
3001531604	32.42599992	-103.7454079	GRAHAM AKB STATE	3	3/18/09	I	
3001521050	32.41659474	-103.836483	LIVINGSTON RIDGE WELL	9	5/16/08	I	
3001529785	32.31704497	-103.7336158	BARCLAY FEDERAL	7	4/21/05	I	
3002533647	32.44780704	-103.7118808	BILBREY 30 FEDERAL	5	4/20/05	I	
3002531403	32.42561812	-103.7218457	FEDERAL 6	1	1/28/95	I	
3001527966	32.40389428	-103.8375432	JAMES E	16	7/3/94	I	

API	Lat.	Long.	Well Name	Well Number	Plug Date	Plug Type	Comments
3002531394	32.42872426	-103.7218432	BW 31 FEDERAL	1	5/26/94	I	
3002531518	32.47321687	-103.7119043	FEDERAL N L	2	11/17/93	I	
3002531193	32.44799333	-103.6519011	LINCOLN FEDERAL UNIT	1	12/13/91	I	
3001535306	32.29206131	-103.7806645	PURE GOLD A FEDERAL	13	6/20/18	II	
3001532777	32.30981202	-103.7461917	TODD 14 B FEDERAL	3	9/25/17	II	
3001537324	32.33981289	-104.035242	LONGVIEW 1 FEDERAL	14	8/24/17	II	
3001528012	32.40116559	-103.8320196	JAMES RANCH UNIT	70	6/19/17	II	
3001532558	32.22641311	-103.7764808	LOTOS C FEDERAL	905	3/22/17	II	
3001529590	32.33156744	-103.7465096	BARCLAY STATE	2	9/23/15	II	
3001521501	32.43385811	-103.8394724	LIVINGSTON RIDGE UNIT	1Y	7/11/13	II	
3001540786	32.43954429	-103.7625342	LAVA TUBE 27 STATE	1H	6/7/13	II	
3001527666	32.34835524	-104.0309263	QUAHADA RIDGE 31	1	5/15/07	II	
3001526934	32.43701714	-103.8662651	JULIA AJL FEDERAL	4	3/19/96	II	
3001527225	32.44414891	-103.7254874	MR 25 FEDERAL	1	10/4/93	II	
3001526631	32.4293867	-103.8623919	CABIN LAKE 34 FEDERAL	1	3/25/93	II	
3001526519	32.30323728	-103.9013363	EXXON FEDERAL	1	7/2/91	II	
3001526446	32.33338286	-104.003825	CARTHEL FEDERAL	1	8/30/90	II	

API	Lat.	Long.	Well Name	Well Number	Plug Date	Plug Type	Comments
3001522971	32.31042885	-103.9254679	NASH UNIT	7	8/5/88	II	
3001526586	32.4296283	-103.7335837	LOST TANK AIS STATE	3	11/20/17	III	
3001535356	32.22640983	-103.7806403	LOTOS C FEDERAL	912	9/2/14	III	
3002530886	32.43695805	-103.6989772	BILBREY 32 STATE COM	1	11/9/09	III	
3001526638	32.36424029	-103.7465254	FEDERAL 26	2	8/20/07	III	
3002530757	32.45878313	-103.6818586	BILBREY 21 FEDERAL	1	8/25/04	III	
3002530873	32.45884581	-103.6616109	BILBREY 22 FEDERAL COM	1	10/24/90	III	
3001526829	32.41962978	-103.7261498	FEDERAL 1	3	7/17/18	IV	
3001523175	32.28486657	-103.7848786	PURE GOLD A FEDERAL	1	10/20/17	IV	
3001526437	32.42443334	-103.8407706	LIVINGSTON RIDGE FEDERAL	3	10/10/16	IV	
3001526314	32.41571714	-103.8527477	JAMES A	10	2/29/16	IV	
3001521777	32.30968584	-103.9457706	NASH UNIT	4	3/19/15	IV	
3001526395	32.23004637	-103.7677747	LOTOS B FEDERAL	1	1/22/14	IV	
3002530664	32.44789263	-103.6818672	BILBREY 28 A FEDERAL	1	3/13/13	IV	
3001525699	32.41843592	-103.8493755	JAMES A	2	12/30/09	IV	
3001523587	32.26635081	-103.7977257	POKER LAKE 32 STATE	1	11/19/07	IV	
3001531096	32.25581411	-103.9568151	GOODNIGHT 35 FEDERAL	1	6/7/06	IV	
3001526802	32.42304904	-103.8667094	DONELL 3 FEDERAL	1	3/30/93	IV	

API	Lat.	Long.	Well Name	Well Number	Plug Date	Plug Type	Comments
3001526625	32.43666667	-103.7293	MARY AIV STATE	1	12/26/06	V	
3002531442	32.44052638	-103.7207655	LUKE FEDERAL	2	4/26/98	V	
3001527038	32.43759603	-103.8790879	KALEIDOSCOPE AKO	1	3/13/96	V	
3001542194	32.30821323	-103.9438207	NASH UNIT	54H	4/10/14	NA	
3002502616	32.47686749	-103.703305	LEMON	1	8/16/38	NA	Pre-R-111-P Records limited/not available
3001503688	32.40171242	-103.9827772	DANFORD PERMIT	1	7/27/37	NA	Pre-R-111-P Records limited/not available
3001503690	32.29962755	-103.961872	FOGARTY	1	5/4/37	NA	Pre-R-111-P Records limited/not available
3001506143	32.32040744	-103.8669749	MONTGOMERY	1	1/29/35	NA	Pre-R-111-P Records limited/not available
3001504733	32.44496345	-103.9216764	DUNCAN	1	12/28/34	NA	Pre-R111-P Records limited/not available
3001505847	32.25999788	-103.7666878	GARDNER TL	1	5/13/28	NA	Pre-R-111-P Records limited/not available

API	Lat.	Long.	Well Name	Well Number	Plug Date	Plug Type	Comments
3001503689	32.38605113	-103.9456428	AR WORKMAN	1	10/30/27	NA	Pre-R-111-P Records limited/not available
3001520879	32.43390898	-103.857668	JAMES C	1	1/31/86	I	Pre-R-111-P
3001524608	32.26632944	-103.7517514	CALMON	1	10/16/83	I	Pre-R-111-P
3001523045	32.45141205	-103.7506913	FEDERAL	1	9/26/82	I	Pre-R-111-P
3001524085	32.39083985	-103.9955518	BIG EDDY UNIT	96	4/22/82	I	Pre-R-111-P
3001522708	32.47749137	-103.8736999	BIG EDDY UNIT	67	6/29/79	I	Pre-R-111-P
3001520872	32.38968263	-103.767817	BADGER UNIT FEDERAL	1	4/8/74	I	Pre-R-111-P
3001510830	32.25183483	-103.7720489	JENNINGS FEDERAL	1	12/15/66	I	Pre-R-111-P
3001510036	32.31342303	-103.7411308	BAUERDORF FEDERAL	1	2/23/63	I	Pre-R-111-P
3001525757	32.41243413	-103.853496	JAMES E	2	10/22/87	II	Pre-R-111-P
3001525595	32.25546087	-103.7592549	FEDERALL 44	1	5/9/86	II	Pre-R-111-P
3001524577	32.27350172	-103.9876339	BLAKEMORE ESTATE FEDERAL	1	12/31/83	II	Pre-R-111-P
3001522702	32.31785533	-104.0084233	TELEDYNE 8 GAS COM	1	8/26/80	II	Pre-R-111-P
3001522678	32.24093356	-103.7720684	JONES RANCH 3	1	1/25/79	II	Pre-R-111-P
3001521723	32.48114435	-103.8793706	BIG EDDY UNIT	45Y	4/19/76	II	Pre-R-111-P
3002524663	32.46966264	-103.6861521	SALT LAKE SOUTH UNIT	1	2/16/75	II	Pre-R-111-P
3001510884	32.25183566	-103.7763391	STEWART MM FEDERAL	1	12/3/66	II	Pre-R-111-P

API	Lat.	Long.	Well Name	Well Number	Plug Date	Plug Type	Comments
3001505846	32.26634373	-103.7806396	WRIGHT FEDERAL	3	1/6/62	II	Pre-R-111-P
3001505837	32.48770632	-103.8020829	CARPER BOSWORTH	1	10/14/49	II	Pre-R-111-P
3001505838	32.49859833	-103.7592787	WILLIAMSON	1	6/14/45	II	Pre-R-111-P
3001524258	32.24134055	-103.8839895	POKER LAKE UNIT	54	12/19/82	III	Pre-R-111-P
3001520948	32.34608766	-103.7678391	GRACE COTTON BABY FEDERAL	1	12/22/75	III	Pre-R-111-P
3001505845	32.26271878	-103.789139	WRIGHT FEDERAL	2	9/5/61	III	Pre-R-111-P
3001520269	32.24909089	-103.7837727	BETTY FEDERAL	1	12/15/69	IV	Pre-R-111-P
3001505842	32.28447254	-103.7763656	MUSE FEDERAL	1	6/4/62	IV	Pre-R-111-P
3001505839	32.370592	-103.7411536	WRIGHT FEDERAL 23	1	4/25/62	IV	Pre-R-111-P
3001505843	32.27359737	-103.7720641	WRIGHT FEDERAL	1	6/26/61	IV	Pre-R-111-P
3001520934	32.44478974	-103.8533646	JAMES D	1	3/12/75	V	Pre-R-111-P
3001505844	32.26635426	-103.8062163	CONTINENTAL STATE	1	2/22/61	V	Pre-R-111-P

EPA Evaluation of Response

The DOE response was useful but not fully explained. The provided list included borehole locations and type of plugging pattern used but did not include all boreholes used to calculate CRA-2019 plugging frequencies, it did not include the reasons for the exemptions, and it did not include an explanation of why the requested information was not included.

With regard to the first of these concerns, the DOE response to CC1-33-3a states that the CRA-2019 plugging frequencies were based on 154 wells, of which 62 were of Type VI. This leaves 92 wells with other types of plugs that were presumably exempted from the KPLA requirement for a continuous plug. However, instead of the expected 92 wells, the DOE response included only 51 post-R-111-P wells, of which two had incomplete records and the plugging type could

not be determined. These two could not have been used to support the CRA-2019 PA, leaving 49 wells that would have been used and 43 wells presumably used in the plugging frequency calculation that are unaccounted-for. An explanation of why the DOE's tabulation did not include all 92 wells was not provided.

With regard to the second of these concerns, the DOE response provided no reasons why the 92 wells were exempted from the KPLA continuous plug requirement, not did the response provide an explanation of why the exemptions were given. This information was the principal objective of EPA's completeness comment because of its corroboration of the 1996 DOE observation that Order R-111-P allows for waivers of the continuous plug requirement for barren areas within the KPLA where no economic grade potash ore is present (see Section 3.2.1 of this TSD).

With regard to the third of these concerns, an explanation of why the table did not include all boreholes used to determine plugging pattern frequencies for the CRA-2019 and why the requested exemption information was not included would have been helpful.

Nevertheless, the EPA found the information that was provided on Table 1 to be useful in understanding the extent of plugging pattern exemptions within the KPLA and appreciates the effort expended to prepare the table.

Reference

DOE (U.S. Department of Energy) 2018. Delaware Basin Monitoring Annual Report, Rev. 1. DOE/WIPP-18-2308. Carlsbad, New Mexico.

Question 33-5c. Map of Borehole Locations Using CRA-2014 PA Data Collection and Analysis Methods.

Please provide a map showing the locations of boreholes that would have been used to determine plugging pattern frequencies if the data collection and analysis methods used in the CRA-2014 PA had also been used in the CRA-2019 PA. On this same map please also show, at a minimum, the WIPP LWA boundary, the Delaware Basin boundary, the KPLA boundary, and the New Mexico – Texas state line.

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

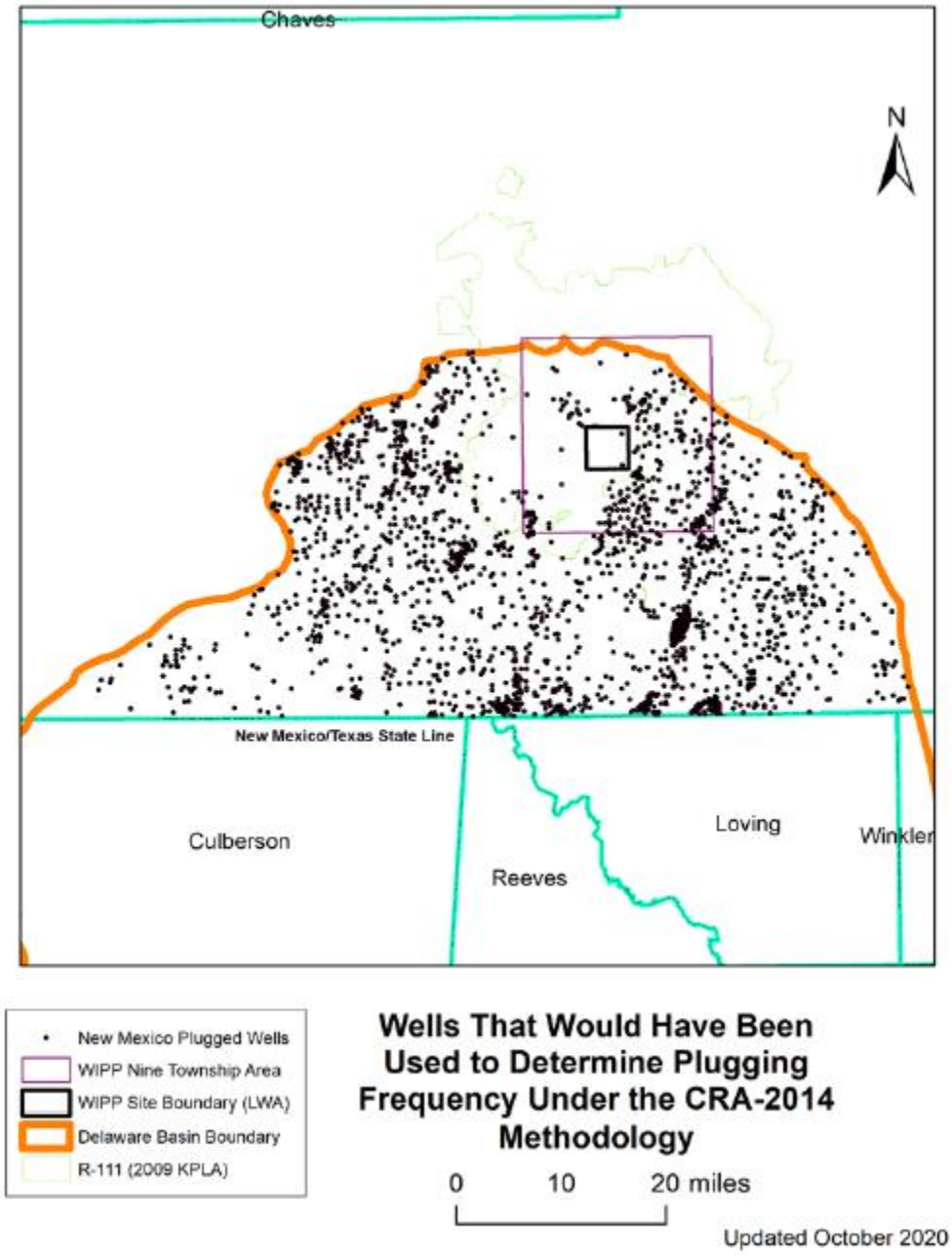


Figure 2: Plugging Frequency, 2014 Methodology

EPA Evaluation of Response

The DOE response was satisfactory. The map was provided as requested.

CC5-33-6: Apparent Conflict in Descriptions of Areas Used for Determining Plugging Patterns

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 5)

Is the area over which DOE is calculating plugging pattern probabilities limited to the 9-township area surrounding WIPP and within the KPLA and Delaware Basin, or is it the entire KPLA area within the Delaware Basin? What is currently being used, and why is there inconsistency in DOE's documentation [i.e., different versions of the Delaware Basin Monitoring Annual Report (DBMAR)]? This question may be answered in conjunction with CC5-33-5.

> *In describing the area used for calculating plugging pattern probabilities, and in several locations in the text, DBMAR 2018 "Rev. 0" (included with the March CRA submission) indicates that only the KPLA area within the 9 township area surrounding WIPP was used. Likewise, DBMAR 2019 also specifies that only the KPLA area within the 9 township area was used. However, DBMAR 2018 Rev. 1 describes using the KPLA area within the New Mexico portion of the Delaware Basin with no mention of the 9 township area, as does the second set of responses from DOE to EPA's completeness question CC1-33-3 which were received on 7/9/20. EPA notes that DBMAR 2018 Rev. 1 includes one plugged well (API 30-015-27248) located outside the 9 townships area. DBMAR 2019, although not directly a part of the current review, does include wells identified by EPA as falling outside the 9 township area, in contradiction with the area described in the text (see first full paragraph on page 16 of DBMAR 2019 and the last paragraph of Section 2.7). For example, Table 8: #4, 7, 9, 15, 23.*

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

The area described in Delaware Basin Monitoring Annual Report (DBMAR) 2018 Rev. 1, is the area that was used for the Performance Assessment (PA) analysis for the Deferred PA. There was a miscommunication sometime after the submittal of the Deferred PA that led to the Delaware Basin Drilling Surveillance Program thinking it was only the nine-township portion of the Known Potash Leasing Area (KPLA) (also referred to as the R-111-P area), but that misconception has been cleared up. The area used for calculating plugging pattern probabilities is the entire KPLA (also referred to as the R-111-P KPLA) within the Delaware Basin boundary, inside the nine-township area in the vicinity of the Waste Isolation Pilot Plant (WIPP) site. The reason for the change is discussed in the DBMAR 2018 Rev. 1, section 2.7 (DOE 2018). In short, it was changed in an effort to more closely align with the regulation in 40 CFR § 194.33.c(1) concerning drilling practices in the vicinity of the WIPP site. The U.S. Department of Energy (DOE) felt that considering plugging practices for wells that were both not within the KPLA area in which the WIPP site is located (and thus not subject to the R-111-P rule) and also up to 30 miles away, was inconsistent with the regulation.

Mention in any documents of the plugging frequency analysis area including only wells in the nine-township portion of the KPLA will be corrected in a memo to file or an erratum depending

on the document. The definition of the area for plugging probabilities will be clarified in future DBMARs.

The instance of the DBMAR 2018 Rev. 1 reporting a plugged well that fell outside of the nine-township area will be corrected in an erratum.

The DBMAR 2019 was issued after the cutoff dates for both the Compliance Recertification Application (CRA)-2019 and the Deferred PA. It is therefore outside the scope of the CRA-2019 completeness review, and will not be addressed in this response.

EPA Evaluation of Response

The DOE response was satisfactory. The DOE acknowledged and clarified the differences in descriptions of the area used for calculating plugging pattern probabilities for the CRA-2019 PA and committed to correcting them in an erratum.

CC5-33-7: Clarification of Data Discrepancies between DBMAR 2018 ("Rev. 0") and DBMAR 2018 Rev. 1

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 5)

Please explain the discrepancy between the number of plugged wells included in the first DBMAR 2018 report and DBMAR 2018 Rev. 1, i.e. why does Table 8 in the former include only 9 wells and Table 8 in the latter include 15 wells if they both list the same reporting period?

> *The explanation as to the need for revisions to the report in December 2018 is found in Section 2.0 "to support the 2019 Deferred Performance Assessment calculations." No other details were given for the changes to Table 8, whether this is related to issues of data availability, or data quality, or some other reason. EPA notes that plugged well API # 30015327770000 was not included in the second revision so the number of additional wells in Rev. 1 was 7.*
>
> *Also, note that the date of the report listed in Rev. 1 is still listed as September 2018 on the title page and footers, but the text itself (Section 2.0) notes that this report was actually revised in December 2018. The dates should have been changed accordingly and noted in an errata sheet.*

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

The answer to this question is multi-faceted, but ultimately data availability is the issue. The Delaware Basin Drilling Surveillance Program (DBDSP) pulls its data from a New Mexico Oil Conservation Division (NMOCD) database. Drilling reports, required by New Mexico State regulation, are filed with NMOCD by drilling operators. Personnel at NMOCD then manually enter those reports into their database. Reporting delays from busy operators, the ongoing oil

boom in the Delaware Basin, and labor constraints at NMOCD affect the timing of data entry. Therefore, the DBDSP may see a three to 18-month lag from the time oilfield activities occur to when they are reported in the NMOCD database.

The data cutoff for the DBMAR is September 1st of each year. This is a snapshot in time that is used to produce the Delaware Basin Annual Report. The DBDSP does not, however, cease to gather and update data. This activity continues on a daily basis.

At the time of Rev. 0 there were nine plugged wells in the KPLA for the reporting period in the database. When it was decided in December 2018 to revise the report with the most current KPLA plugging numbers to support the Deferred PA, a current version of the database was downloaded and the KPLA plugged wells were reanalyzed. In the months between revisions, data had been added to the database on the additional wells and were included in the analysis. It is not clear why the well API # 30015327770000 was omitted from the revision. It should have been included, raising the total KPLA plugged well count for the reporting period to 16. The omission of this well in table 8 does not change the overall plugging frequency. DOE has confirmed that the well was included in the total plugged well count for the KPLA area. This oversight will be corrected in an erratum, along with the publication dates associated with Rev 1.

EPA Evaluation of Response

The DOE response was satisfactory. The DOE provided explanations of the differences in the well data and of the need to update the DBMAR 2018, and committed to prepare an erratum correcting the omission of well API # 30015327770000 and the publication dates.

CC5-33-8: Categorization of Boreholes of Unknown Depth and/or Incomplete Information

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 5)

The total number of shallow boreholes drilled shows several examples of decreases from year to year as reported in the DBMAR. It appears that boreholes of unknown depth at the time of compilation of the annual monitoring report are being automatically counted as shallow boreholes (excluding them from PA), then are later sorted out into the correct categories as complete information is made available. This has the effect of decreasing the deep borehole-drilling rate, or creating a lag in the input of what is a major driver of releases in PA. Please confirm whether this is correct and explain whether it is consistent with the principle of conservatism for unknown parameters. Also, please include an estimate of the length of time it typically takes for those boreholes of unknown depth to be updated with complete documentation and incorporated into their proper categories in the Delaware Basin Drilling Surveillance Program (DBDSP) database.
Reviewing borehole data from the Delaware Basin Monitoring Annual Report shows that the total number of shallow boreholes in the Delaware Basin have actually decreased between years, for example 2006-2007 from 6,222 to 6,179 wells, respectively; 2008-2009 from 6,311 to

6,111; 2017-2018 from 10,544 to 10,496, and from 10,496 to 9,644 in 2019. Basin-wide, the total number of documented and reported deep boreholes (>2150') in a given year is approximately double or triple that of shallow (<2150') boreholes. Categorizing all wells of unknown depth as shallow significantly underestimates the actual number of deep wells. The only explanation EPA could find for this approach to categorizing wells of unknown depth is in a caption, below Table 4 in the 2019 Monitoring Annual Report, and similar statements in prior reports:

> *"The 1,905 wells under the "Drilling or Waiting on Paperwork" category do not have an associated depth until one has been reported on paperwork. These are listed as shallow wells but may eventually be placed in the deep classification when a depth has been listed in the paperwork."*

In the last decade especially given the high drilling activity, this approach has led to a potential undercount of thousands of deep wells at the time of reporting (approaching 10% of the total number of wells drilled in the basin). EPA calculates, based on DBMAR numbers, the ratio of total deep wells to shallow wells is nearly to 2.5 to 1.

If this were approached in keeping with the principle of conservatism for unknown parameters (i.e., whether or not the well is shallow or deep) in that wells of unknown depth were counted as deep wells, or split among shallow and deep boreholes at a ratio closer matching the totals in the basin, the deep drilling rate would be considerably higher than it is accounted for currently. Within a few years of adding them to the database, the necessary information and documentation should be available to properly categorize these boreholes, but DOE's current approach has the effect of artificially decreasing the actual deep borehole-drilling rate or creating a time lag. Using the most conservative methodology of counting all wells of unknown depth as deep by default, EPA has recalculated the deep drilling rate and finds that the drilling rate for CRA-2019 would have been 112.4 instead of 99 boreholes/km2 over 10,000 years.

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

At the time a well is entered into the Delaware Basin Database and categorized as "unknown," the following information is known about the well:

1. The well's location
2. The well has been permitted
3. The name of the Operator
4. The well has been "spudded" (The operator has begun initial drilling operations)

A well categorized as "unknown" is physically in the process of being drilled. Therefore, until drilling has reached the 2,150-foot mark, the well is a shallow borehole. These wells are classified as "unknown" because until a well has been reported as "completed," the DBDSP cannot determine the well type or its completion depth. Classifying these wells as shallow is more accurate considering that a borehole drilling process begins at a depth of zero. If all "unknown" wells were to be automatically considered as "deep" wells, then the program would

be overestimating the number of deep wells existing in the Delaware Basin at any given moment. This would be a conservative approach, but the DOE believes that such a high level of conservatism would be inappropriate for a monitoring program where the unknown parameter will become known in a relatively short time frame.

As noted in a separate response (CC5-33-7), due to a number of factors outside the control of the DBDSP, the time between when oilfield activities actually occur and the time when these activities are reflected in the reports and sundry notices varies widely, but can generally be stated to be between three and 18 months. Because recertification activities are viewed as "a snapshot in time," this seems acceptable, because any unrecorded information within the current recertification cycle will be included in the next cycle, and so forth.

EPA Evaluation of Response

The DOE response was complete in explaining the approach taken by DOE and its contractor and the rationale behind it. The DOE acknowledged that the EPA's understanding of the reason for occasional decreases in the number of shallow wells is correct but defended their methodology by noting that the data represent a "snapshot in time" and are corrected within one or two years. The Agency is concerned that the deep drilling rate is an important parameter for calculating potential repository releases in WIPP PA and that the current method always leads to underestimating the deep drilling rate and overestimating the shallow drilling rate at the time of recertification. A comprehensive review of DOE's drilling rate methodology is presented in Section 2 of this TSD.

Source Citations for DOE Completeness Question Response Packages

DOE RP12020a. *Response 1 to U.S. Environmental Protection Agency's 2019 Compliance Recertification Application Completeness Comments Letter dated March 23, 2020 from Tom Peake to Mike Brown.* Letter from Gregory Sosson (DOE) to Lee Veal (EPA). CBFO:OEP:MRB:MC:20:0237:UFC 5486.00. Carlsbad, New Mexico. June 10, 2020. (First Response Package).

DOE RP2 2020b. *Response 2 to U.S. Environmental Protection Agency's 2019 Compliance Recertification Application Completeness Comments Letter dated March 23, 2020 from Tom Peake to Mike Brown.* Letter from Gregory Sosson (DOE) to Lee Veal (EPA). CBFO:OEP:MRB:MC:20-0248:UFC 5486.00. Carlsbad, New Mexico. July 9, 2020. (Second Response Package).

DOE RP8 2021. Department of Energy Response 8 to EPA Completeness Comments. Letter from Reinhard Knerr (DOE) to Lee Veal (EPA). CBFO:OEP:MRB:MC:20-1513:UFC 5486.00. Carlsbad, New Mexico. January 13, 2021. (Eighth Response Package).

APPENDIX B

EPA Completeness Questions, DOE Responses, and EPA Evaluations of Responses Related to Appendix-MON: the Delaware Basin Drilling Surveillance Program and Delaware Basin Monitoring Annual Report

Table B-2. Summary of EPA Completeness Questions and DOE Responses Related to the Delaware Basin Drilling Surveillance Program

Question	Topic	DOE Response Set	EPA Evaluation/Resolution	Documentation/ Discussion in TSD
CC4-MON-2	Updated map of potash mining	#6 (10/26/20)	Partially adequate; updated map of potash leases provided, but not mined areas	Sec 3.3.4; Appendix B
CC4-MON-3	Status of proposed new potash mine east of WIPP	#6 (10/26/20)	Satisfactory	Sec 3.3.4; Appendix B
CC5-MON-4 a-m	Data errors and anomalies in Delaware Basin Drilling Surveillance Program	#9 (3/4/21)	Satisfactory; DOE has committed to audit program, take corrective action	Exec. Summary; Sec 2.4; Appendix B
CC5-MON-5	Response rate of Delaware Basin Drilling Surveillance Program surveys of area operators	#9 (3/4/21)	Satisfactory	Appendix B
CC5-MON-6	Uncounted shallow sulfur exploration holes previously identified from New Mexico	#9 (3/4/21)	Satisfactory	Appendix B

Contents

APPENDIX B B-1

Table B-1. Summary of EPA Completeness Questions and DOE Responses Related to the Delaware Basin Drilling Surveillance Program B-2

CC4-MON-2: Updated Map of Potash Mining B-4

CC4-MON-3: Status of Proposed New Potash Mine East of WIPP B-5

CC5-MON-4: Delaware Basin Drilling Surveillance Program Errors and Inconsistencies B-5

CC5-MON-5: Delaware Basin Drilling Surveillance Program Surveys B-13

CC5-MON-6: Uncounted Shallow Sulfur Exploration Holes B-15

CC4-MON-2: Updated Map of Potash Mining

WIPP Compliance Recertification Application 2019 Appendix MON (Monitoring)

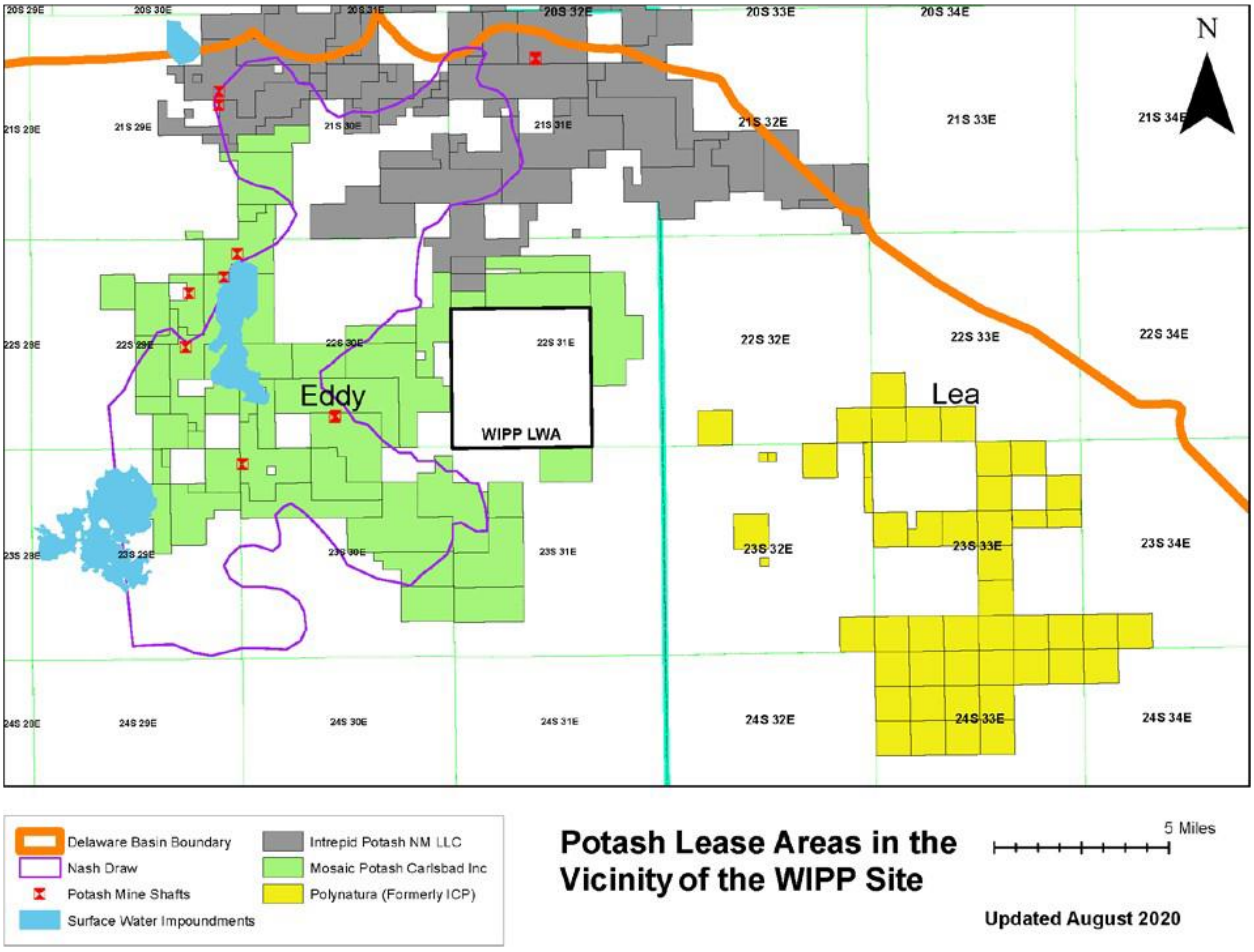
EPA Question (from EPA Completeness Comment Package 4)

Please provide a more recent, updated map of potash operations with potash areas outlined but not obscuring the mine labels and include the boundary of the Delaware Basin where it crosses the map area.

> *The Delaware Basin Monitoring Annual Report (DBMAR) includes diagrams and maps of various extractive industries and infrastructure, including drilling for oil and gas, and potash mining. A map of current potash mining has been provided in Figure 7 for the last several years of the DBMAR. This figure is useful; however, it has not been updated since 2007 (according to the legend) and does not include all of the features that are referred to in the text. For example, the* orange layer of potash mining completely obscures the names and locations of mine facilities referenced in the text.

DOE Response (from DOE Response Package 6 (DOE RP6 2020))

See Figure below for the most recent map of potash lease areas in the vicinity of the WIPP site.



EPA Evaluation of Response

The DOE response was partially adequate. An updated map of potash leases was provided, plus mine shafts, but it did not delineate the active and mined out areas.

CC4-MON-3: Status of Proposed New Potash Mine East of WIPP

WIPP Compliance Recertification Application 2019 Appendix MON (Monitoring)

EPA Question (from EPA Completeness Comment Package 4)

Please provide the status lease locations and location data of any new or proposed mines not described in CRA-2019. This information may be included with the updated potash mining map requested by the previous comment

> *DBMAR 2011 through 2015 mentioned new potash leases acquired by Intercontinental Potash Corp east of WIPP and an Environmental Impact Statement (EIS) that was approved by the BLM in 2016 for a new underground mine. This proposed new mine is not mentioned in subsequent reports or any other CRA documentation that EPA has reviewed.*

DOE Response (from DOE Response Package 6 (DOE RP6 2020))

For the most recent information on Potash lease locations near the WIPP site, please see the updated map provided in MON-2. Polynatura (formerly Intercontinental Potash Corp [ICP]) expansion plans have been suspended for an unspecified amount of time with no additional public status or information.

EPA Evaluation of Response

The DOE response was satisfactory combined with the previous response.

CC5-MON-4: Delaware Basin Drilling Surveillance Program Errors and Inconsistencies

WIPP Compliance Recertification Application 2019 Appendix MON (Monitoring)

EPA Question (from EPA Completeness Comment Package 5)

There appear to be several numerical inconsistencies and/or anomalies over time in the Delaware Basin Monitoring Annual Reports (DBMAR) that need explanation or correction.

Question MON-4 Overview. Data errors and anomalies in Delaware Basin Drilling Surveillance Program

Close examination and compilation of data provided in the Delaware Basin Monitoring Annual Reports (DBMAR) identifies several numerical inconsistencies and/or anomalies that need explanation or correction.

> *EPA recognizes that there may be some limitations and errors in the source data (i.e., NMOCD, Texas RRC, and commercial databases) due to delays in reporting, differing reporting requirements, and categorization, but these should be at least mentioned when identified, and more significant ones documented and explained in the DBMAR itself. Or there may be problems in the DBDSP database itself.*
> *EPA has questions about DOE's oversight of this crucial monitoring program. Please summarize the quality assurance practices for this program, and how DOE ensures that they are being followed.*
> *Examples of possible data quality issues, typographical, or numerical errors:*

DOE Response Overview (from DOE Response Package 9 (DOE RP9 2021))

Under sub-contract to the Department of Energy (DOE) Carlsbad Field Office (CBFO) through the Nuclear Waste Partnership (NWP), Regulatory Environmental Services (RES) performs the quality assurance review on each Delaware Basin Monitoring Annual Report (DBMAR). The RES review process consists of the following stages of review:

> 1. Technical review: An in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification or validation for applicability, correctness, adequacy, completeness, and assurance.
> 2. Editorial Review: A review for style, grammar, punctuation, format, and completeness.
> 3. Management review: A review by the RES manager as a last check for completeness and accuracy before submittal to CBFO.

The quality issues identified in this EPA comment have been entered into the formal WIPP corrective action system and corrective actions have been identified. A plan will be drafted to make all the errata corrections to the DBMARS's and make adjustments to the Delaware Basin Drilling Surveillance Program data collecting and reporting procedures as appropriate. After these items have been addressed, an independent review of the Delaware Basin Drilling Surveillance Program will be conducted. The target to complete this work is the close of FY2021. All the corrections identified in this response have been added to the CRA-2019 Errata Tracking List.

The following sections address each inconsistency that EPA identified in this comment:

Question MON-4a. Data errors and anomalies in Delaware Basin Drilling Surveillance Program: number of wells spudded

DBMAR 2018 (both "Rev. 0" and Rev. 1) Summary Section (4.0) lists 157 wells spudded outside the nine-township area in New Mexico, but Section 2.5.2 in the same report lists 178. Similarly, the summary section of DBMAR 2017 lists 523 wells spudded in the Texas portion of the Delaware Basin, but Section 2.5.2 lists 546. And 2016 DBMAR Section 4 Summary lists 98 spudded wells outside the 9 township area in New Mexico, but Section 2.5.2 only lists 96. Please clarify.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

a. DBMAR 2018: The inconsistency between section 2.5.2 and the summary section is the result of a wrong number mistakenly being entered. The summary section should read 178 wells, not 157.
b. DOE assumes the EPA meant the DBMAR 2018 for this portion of the comment, not the DBMAR 2017. The inconsistency between section 2.5.2 and the summary section is the result of a wrong number being mistakenly entered. The summary section should read 546 wells, not 523.
c. DBMAR 2016: The inconsistency between section 2.5.2 and the summary section is the result of a typo. The summary section should read 96 wells, not 98.

EPA Evaluation of Response

The DOE response was satisfactory. Corrective actions are being taken and more scrutiny will be applied going forward.

Question MON-4b. Number of rotary rigs in New Mexico portion of DWB

DBMAR 2018 Section 2.1.1 lists 182 wells spudded in the New Mexico portion of the DWB in the first paragraph, but the next paragraph states that the 178 wells were drilled using rotary rigs. Are these referring to the same group of wells as the previous paragraph, or were not all drilled with rotary rigs, or is it a subset of wells that were spudded and drilled, not just spudded? Please explain.

Inconsistent or imprecise use of terminology might offer an explanation. Please define the terms: spudded, drilled, and completed according to how they are being used in DBMAR. Typical oilfield usage for spudding involves the initial steps of the drilling process; drilling refers to the process of drilling the borehole itself to depth; completions are the final activities of bringing a well into production, including installation of production casing and surface equipment.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

In the DBMAR 2018, there were 178 wells spudded in the New Mexico portion of the Delaware Basin outside of the Nine-township area. There were four wells spudded within the Nine-township area. That makes a total of 182 wells spudded in the New Mexico portion of the

Delaware Basin. The 182 number cited in the opening paragraph of 2.1.1 is the correct number. The number cited in the subsequent paragraph should also have been 182.

Oilfield terminology usage within the Delaware Basin Drilling Surveillance Program (DBDSP) is consistent with how the EPA has described it in their question.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA. Corrective actions are being taken and more scrutiny will be applied going forward.

Question MON-4c. Number of injection wells in 9 township area

DBMAR 2018 Section 2.9.1 describes injection wells in the 9 township area, but seemingly contradicts itself on numbers. It first mentions seven total injection wells, two injection wells owned by ConocoPhillips, and five OXY injection wells. But the next sentence states "the six wells are injecting into the Brushy Canyon Formation of the Delaware Basin." Should this actually be seven, or is a single well injecting water into a different interval not mentioned? The same statement is also made in DBMARs 2014 through 2017. Please clarify.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

The word "six" should be "seven." This will be corrected for future reports.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA. Corrective actions are being taken and more scrutiny will be applied going forward.

Question MON-4d. Castile Brine Encounter note on unit of measurement

Apparent typo in DBMAR 2018, Table 7: Castile Brine Encounters. The well information for James Ranch Unit #63 (the fourth listed Castile Brine Encounter Since July 1995) reads that "35 ppm was reported but quickly dissipated to 3 ppm." Given the context, the correct unit is likely gpm (gallons per minute) not ppm (parts per million). The same apparent typographical error is also found in prior years of the DBMAR. Please confirm.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

To answer this question, DBDSP personnel went back to the original report filed by the operator. In the DBMAR, there are words missing from how it was reported by the operator. It should read as follows (bolded words are what was missing):

> *"Sulfur water encountered at 2,900 ft.* ***H2S of*** *35 ppm was reported* ***in the sulfur water*** *but quickly dissipated to 3 ppm in a matter of minutes. Continued drilling."*

DOE will make the correction in the next DBMAR.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA. Corrective actions are being taken and more scrutiny will be applied going forward.

Question MON-4e. Number of plugged brine wells mismatch in tables

DBMAR 2018, Table 11 lists 10 active, 1 unknown, and 8 plugged brine wells for a total of 19, but adding the numbers in Tables 4 & 5 gives a number of 12 active and 7 plugged brine wells. Please explain.

Repurposing of wells (e.g., dry holes or non-producing hydrocarbon wells being converted to salt water disposal) is a common practice in the Delaware Basin. Might the repurposing of wells account for these numbers, or what else might be happening? Have some of these wells been repurposed?

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

The numbers reported in tables 4 and 5 of the DBMAR 2018 are correct. The status of two wells (4238900408 and 4247582265) did not get changed to "active" as they should have in Table 11.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA. Corrective actions are being taken and more scrutiny will be applied going forward.

Question MON-4f. Number of shallow wells drilling or waiting on paperwork in TX and NM in 2017 and 2018

Shallow wells: zero wells reported under drilling or waiting on paperwork for Texas in 2017, but 3057 in New Mexico, and these numbers reverse for 2018 (3057 in TX and 0 in NM), and the numbers don't add up to the reported total of 3080 in 2018. Please explain.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

These numbers were reported incorrectly in both the 2017 and 2018 DBMARs. The correct numbers for "Drilling or Waiting on Paperwork" for the 2017 and 2018 DBMAR's (which would all be entered on the shallow wells table, under the Texas column) should be as follows:

2017: 978
2018: 1823

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA. Corrective actions are being taken and more scrutiny will be applied going forward.

Question MON-4g. Jump in number of dry holes from year to year

Shallow wells: the number of dry holes reported jumps from 2 to 10 and back to 1 from 2014, 2015, and 2016. A possible explanation could be some wells being repurposed as injection wells, brine wells, or junked and abandoned, but no corresponding increases under those categories can numerically account for the decreases. Please explain.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

DOE assumes the EPA meant shallow gas wells with this comment. This number anomaly is the result of a typo. Instead of ten shallow gas wells the 2015 DBMAR should have reported one shallow gas well.

EPA Evaluation of Response

The DOE response was satisfactory, and DOE correctly pointed out that EPA's comment was actually about the shallow gas well category, not the dry hole. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA.

Question MON-4h. Number of shallow gas wells in TX, NM jumping from year to year

Shallow wells: the number of gas wells reported in Texas decreases from 8 to 2, up to 10 in 2015, then back to 1 in 2016. For New Mexico 9 gas wells were listed for 2011-13, but zero in the following years. Again, a possible explanation could be some wells being repurposed as injection wells, brine wells, plugged, or junked and abandoned, but no corresponding increases under these categories can fully account for the jumps in numbers. Please explain.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

Technology and practices in the oil field are constantly evolving. Operators are often changing how a well is utilized. The DBDSP continually updates existing well records when data become available and wells are changed. The change in these reported numbers can be attributed to any number of things associated with wells. Likely scenarios, given the state of drilling in the basin, are wells that were previously classified as gas wells, could have been reevaluated, reworked and re-completed when it was realized they had potential to be oil producing wells, they were plugged and abandoned, or they were repurposed in some other way (i.e. Salt Water Disposal Well). It should be noted the DBDSP is a monitoring program and has no regulatory authority or control over activities by private companies in the oil fields outside of the WIPP site.

EPA Evaluation of Response

The DOE response was satisfactory, and the explanation generally confirms what EPA had surmised on the matter. A similar, general explanation accounting for these types of apparent anomalies would be helpful in subsequent DBMARs.

Question MON-4i. Decreases and increases in deep oil and gas wells in consecutive years

Deep wells: the number of reported wells in the "oil and gas well" category for both TX and NM decrease between 2016 and 2017 (total of 309 to 290), then jump to higher numbers in 2018, but the decrease cannot be fully accounted for in the "plugged oil and gas well" category. Perhaps some wells were being repurposed as injection wells, brine wells, plugged, or junked and abandoned? Please explain.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

See the answer to Mon-4h above. Wells are often being reworked and repurposed or plugged and abandoned.

EPA Evaluation of Response

The DOE response was satisfactory, and the explanation generally confirms what EPA had surmised on the matter. A similar, general explanation accounting for these types of apparent anomalies would be helpful in subsequent DBMARs.

Question MON-4j. Large jump in number of potash core holes reported

Deep wells: a large jump in the number of wells in the "Potash Core Hole" category from 23 to 111 between 2015 and 2016 seems anomalous compared to long term trends. This might be explained by activities related to the proposed new mine by Intercontinental Potash Corp mentioned in the DBMAR in 2015 and earlier years. Please confirm.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

The number in the 2015 DBMAR was an error. The correct value was 111.

EPA Evaluation of Response

The DOE response corrects the number in question, but fails to provide an explanation for the error, nor does it explain the cause of the jump. A complete response is not critical; however, EPA is disappointed that a more complete answer was not provided. The numerical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and it is anticipated that revisions to the reports will be provided to EPA.

Question MON-4k. Decrease in "other" deep wells category

Deep wells: the number of wells in the "other" category drops from 6 in previous years to zero in 2016 without a corresponding increase in other plausible categories. Please explain.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

The Delaware Basin data used to be housed in Microsoft Access databases. The original Microsoft Access databases were migrated into a single SQL Server based database and was reported as such starting with DBMAR 2011. The SQL server well tracking application was designed to track hydrocarbon wells, although newer mineshafts were added as well. The Gnome wells were legacy mine shafts and monitoring wells that were tracked in a separate Microsoft Access database. The mineshafts and wells within this database were not included in the well tracking application. The Gnome wells and mineshafts will be added to the Delaware Basin Well Tracking Application. In addition, the WIPP shafts were incorrectly grouped into the shallow well count when they should have been reported as deep, as they transcend a depth of 2150 feet. After going back and reviewing the old Microsoft Access database, it has been concluded that the numbers reported in the "other" category should still be 44 in the shallow table and 6 in the deep table. Migration of the gnome wells into the database is currently underway.

EPA Evaluation of Response

The DOE response was satisfactory. The anomaly was acknowledged and investigated, and related issues were identified. DOE has committed to correct and improve the database accordingly, and it is anticipated that these will be incorporated into subsequent related reports.

Question MON-4l. Data table typographic error in DBMAR 2018

Deep wells: data table typo in DBMAR 2018. Table 5 gives the total number of gas wells as 2,394; the number should be 2,934, from summing the numbers listed for TX and NM. Please correct.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

The correction will be made, as suggested.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA.

Question MON-4m. Number of brine wells in TX and NM not adding up

Deep wells: DBMAR 2017, Table 5 lists eight brine wells in Texas and zero in New Mexico yet gives the total number of brine wells as nine. Please explain.

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

The correct number of deep brine wells for the 2017 DBMAR was nine. The number in the Texas column should have been nine. This error will be corrected.

EPA Evaluation of Response

The DOE response was satisfactory. The typographical error was acknowledged, included by DOE in the CRA-2019 Errata Tracking, and revisions to the reports will be provided to EPA.

CC5-MON-5: Delaware Basin Drilling Surveillance Program Surveys

WIPP Compliance Recertification Application 2019 Appendix MON (Monitoring)

EPA Question (from EPA Completeness Comment Package 5)

Question MON-5. Response rate of Delaware Basin Drilling Surveillance Program surveys of area operators

What has been the yearly response rate (i.e., the total number of surveys sent out and the number of completed surveys received) of DBDSP annual surveys since 2010? These numbers were regularly reported in DBMAR up until 2010, but only twice in subsequent years. DBMAR 2013 gives these numbers as 13 and 3 for a response rate of 23%, but 2016 simply reports that survey responses were received without giving the number. The remaining years either make no mention of the survey being sent out, state that no survey was sent out, or mention that no surveys were returned. Please include all these numbers going forward.

> *EPA notes that response rates in prior years were typically less than 50%, but the especially poor response rates of the past decade makes EPA question the effectiveness of the program. Without this information, it is difficult to evaluate the validity of the conclusions based upon it, i.e., less confidence in conclusions regarding brine reservoirs based on the number of brine encounters reported.*

DOE Response (from DOE Response Package 9 (DOE RP9 2021))

Surveys are sent out each fiscal year to Oil Field Operators who have completed wells in the Nine-Township area surrounding the WIPP during that reporting period. Operators are not required by regulation to respond to the surveys. Beginning in 2016, operators who have offices in the local area (Carlsbad, Artesia, Loving, and Hobbs) were hand-delivered the surveys by DBDSP personnel in an effort to increase the response rate. Forms to companies not in the local area continued to be mailed to their headquarters. Despite these efforts, response rates from Operators have remained low. One way to interpret this low response rate is that the surveys are being ignored. A different way to look at it, is that the operators have not been responding because they have nothing to report. They simply have not been having Castile brine encounters. Instead of determining that the low volume of data means there is a flaw in the program and the results cannot be trusted, one could determine that the program is working as intended and the non-responses mean that there have been no encounters to report. The table below is a summary of surveys sent vs. responses received since 2010.

Year	Survey Forms Sent	Responses Received
2010	Sent in the 2011 survey	NA
2011	34	0
2012	0[1]	0
2013	13	3
2014	14	0
2015	15	0
2016	9	2
2017	6	0
2018	19	0

[1]No surveys were sent for the 2012 reporting period. The reason for this omission is not clear.

EPA Evaluation of Response

The DOE response was satisfactory. The response rates were provided as requested in a table form with explanation. However, EPA is wary of the assertion that the low to no response rate is strong evidence by itself of no Castile Brine encounters.

CC5-MON-6: Uncounted Shallow Sulfur Exploration Holes

40 CFR §194.33 Consideration of Drilling Events in Performance Assessments

EPA Question (from EPA Completeness Comment Package 5)

Question MON-6. Uncounted shallow sulfur exploration holes previously identified from New Mexico

DBMARs 2003-2010 mention finding BLM records for multiple shallow sulfur exploration holes in New Mexico, but these do not appear to have been added to the DBDSP database. What is the status of these wells and the database?

> *In DBMARs 2003-2009 it was mentioned that a number of sulfur exploration boreholes were found in BLM records from the far southwestern corner of the Delaware Basin in New Mexico but have not yet been added to the database. They were reported as being shallow and drilled from the late 1960s through early 1980s in Yeso Hills near Washington Ranch. In DBMAR 2009 and 2010, it was stated that none of the records were complete, and that they will be field verified before adding to the DBDSP tracking app. No mention of these wells was made in subsequent years of the DBMAR or any other DOE reports examined by EPA, and the corresponding data tables show no changes.*

DOE Response (from DOE Response Package 8 (DOE RP8 2021))

A search of DBDSP records found that 19 of the 61 wells were field verified in the early 2000's time frame. At the time, DBDSP personnel searched for the other wells, but physical evidence of their presence could not be located in the field. For reasons that are not clear at this time, the wells that were field verified were not added to the Delaware Basin database. These wells will be added to the database and will appear in the next Delaware Basin Drilling Surveillance Program Annual Report.

The quality issue identified in this EPA comment has been entered into the formal WIPP corrective action system and corrective actions have been identified. A plan will be drafted to make all the errata corrections to the DBMARS's and make adjustments to the Delaware Basin Drilling Surveillance Program data collecting and reporting procedures as appropriate. After these items have been addressed, an independent review of the Delaware Basin Drilling Surveillance Program will be conducted. The target to complete this work is the close of FY2021. The correction identified in this response has been added to the CRA-2019 Errata Tracking List.

A list of the wells to be added can be found in Table 1 below:

Table 1: Sulfur Coreholes to be Added to the Delaware Basin Database

Sulfur Corehole	Location	Latitude	Longitude
NMSEH-11	2080 FNL 1500 FEL	32.0586669	-104.448367
NMSEH-22	50 FNL 1200 FEL	32.0788229	-104.3612807
NMSEH-23	1500 FSL 120 FWL	32.0686626	-104.4086988
NMSEH-24	1470 FNL 1230 FEL	32.0752662	-104.3959872
NMSEH-25	1615 FNL 1800 FEL	32.0746922	-104.4150414
NMSEH-26	720 FNL 1800 FWL	32.0772135	-104.4203023
NMSEH-27	1650 FNL 1850 FWL	32.0746922	-104.4204035
NMSEH-28	700 FNL 2440 FEL	32.0772243	-104.4170989
NMSEH-29	2300 FNL680 FWL	32.073217	-104.424018
NMSEH-30	2450 FNL 1850 FWL	32.0724928	-104.4204918
NMSEH-31	1200 FNL 1150 FWL	32.0758992	-104.422176
NMSEH-32	2000 FNL 1500 FWL	32.073732	-104.4213908
NMSEH-33	2550 FNL 2490 FEL	32.0721173	-104.4173645
NMSEH-34	1560 FNL 2500 FWL	32.0749283	-104.4179406
NMSEH-35	100 FNL 2094 FWL	32.0788497	-104.4195677
NMSEH-36	2090 FSL 720 FWL	32.0702827	-104.4241573
NMSEH-39	1820 FSL 1280 FEL	32.0694351	-104.4303234
NMSEH-41	2639 FSL 250 FWL	32.0573115	-104.4255297
NMSEH-42	560 FSL 210 FEL	32.0513785	-104.4101807

EPA Evaluation of Response

The DOE response was satisfactory. The omission was acknowledged, will be included in a corrective action, and data will be added to the Delaware Basin database and related reports going forward. EPA also requests to be notified of the results of the independent review when they are published.

Source Citations for DOE Completeness Question Response Packages

DOE RP6 2021. Department of Energy Response 6 to EPA Completeness Comments. Letter from Reinhard Knerr (DOE) to Lee Veal (EPA). CBFO:OEP:MRB:MC:20-0277:UFC 5486.00. Carlsbad, New Mexico. October 26, 2020. (Sixth Response Package).

DOE RP8 2021. Department of Energy Response 8 to EPA Completeness Comments. Letter from Reinhard Knerr (DOE) to Lee Veal (EPA). CBFO:OEP:MRB:MC:20-1513:UFC 5486.00. Carlsbad, New Mexico. January 13, 2021. (Eighth Response Package).

DOE RP9 2021. Department of Energy Response 9 to EPA Completeness Comments. Letter from Reinhard Knerr (DOE) to Lee Veal (EPA). CBFO:OEP:MRB:MC:21-0207:UFC 5486.00. Carlsbad, New Mexico. March 4, 2021. (Ninth Response Package).

APPENDIX C

Data Table from Baker Hughes Rig Count

North America Rig Count 2021

Data from Baker Hughes Rig Count 2021 North America Rig Count

https://rigcount.bakerhughes.com/na-rig-count

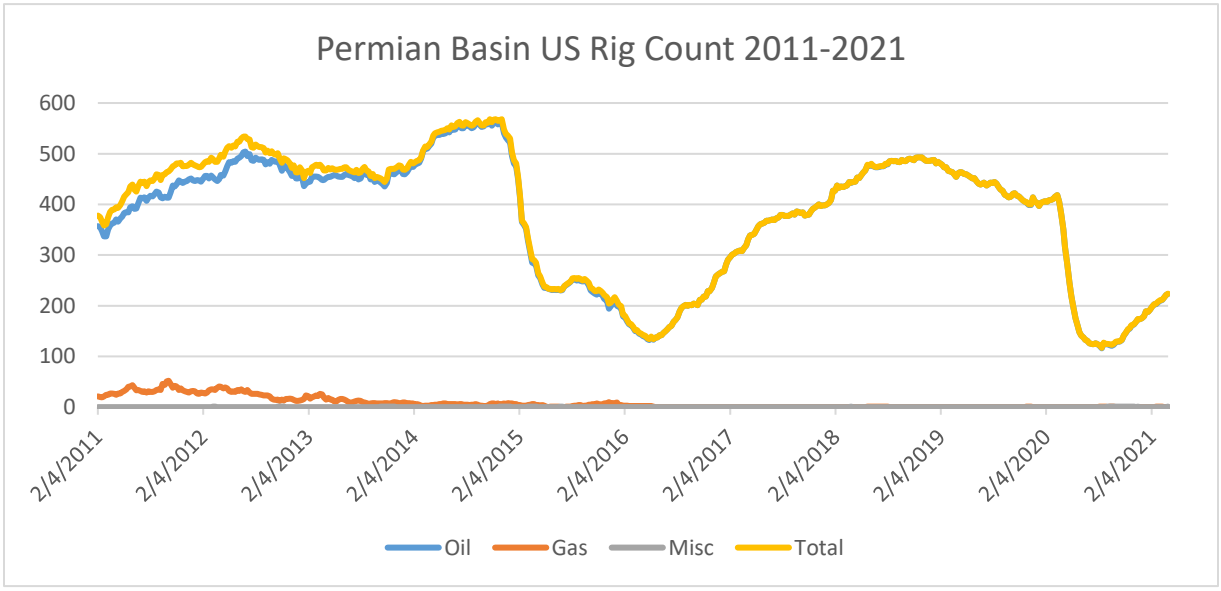
Accessed 4/6/2021

Baker Hughes US Rig Count by Basin

Data copied from Baker Hughes North America Rig Count January 2000-current

US Count by Basin. The Delaware Basin is part of the greater Permian Basin region

NOTE from Baker Hughes FAQs: To be counted as active a rig must be on location and be drilling or 'turning to the right' for the majority of the week (4 out of 7 days). A rig is considered active from the moment the well is "spudded" until it reaches target depth or "TD". Rigs that are in transit from one location to another, rigging up or being used in non-drilling activities such as workovers, completions or production testing, are NOT counted as active.



C- 1. Number of active drill rigs in the Permian Basin over time based on the data table below.

	Permian			
Date	**Oil**	**Gas**	**Misc**	**Total**
2/4/2011	357	21	0	378
2/11/2011	355	20	0	375
2/18/2011	347	19	0	366
2/25/2011	337	21	0	358
3/4/2011	337	24	0	361
3/11/2011	351	24	0	375
3/18/2011	358	27	0	385
3/25/2011	362	27	0	389
4/1/2011	364	26	0	390
4/8/2011	370	24	0	394
4/15/2011	366	27	0	393
4/22/2011	372	27	0	399
4/29/2011	376	30	0	406
5/6/2011	383	32	0	415
5/13/2011	385	35	0	420
5/20/2011	384	40	0	424
5/27/2011	394	41	0	435
6/3/2011	396	43	0	439
6/10/2011	391	38	0	429
6/17/2011	392	33	0	425
6/24/2011	402	34	0	436
7/1/2011	413	32	0	445

7/8/2011	412	30	0	442
7/15/2011	414	31	0	445
7/22/2011	407	29	0	436
7/29/2011	413	31	0	444
8/5/2011	417	30	0	447
8/12/2011	416	30	0	446
8/19/2011	420	31	0	451
8/26/2011	425	34	0	459
9/2/2011	423	35	0	458
9/9/2011	414	34	0	448
9/16/2011	412	46	0	458
9/23/2011	415	44	0	459
9/30/2011	413	51	0	464
10/7/2011	413	52	0	465
10/14/2011	423	46	0	469
10/21/2011	437	38	0	475
10/28/2011	435	42	0	477
11/4/2011	440	41	0	481
11/11/2011	447	34	0	481
11/18/2011	445	37	0	482
11/25/2011	442	33	0	475
12/2/2011	445	31	0	476
12/9/2011	446	30	0	476
12/16/2011	449	29	0	478
12/23/2011	451	31	0	482
12/30/2011	447	32	0	479

1/6/2012	446	31	0	477
1/13/2012	448	27	0	475
1/20/2012	447	26	0	473
1/27/2012	445	29	0	474
2/3/2012	450	28	0	478
2/10/2012	456	27	0	483
2/17/2012	456	29	0	485
2/24/2012	451	33	0	484
3/2/2012	457	35	0	492
3/9/2012	453	35	1	489
3/16/2012	449	34	1	484
3/23/2012	446	38	0	484
3/30/2012	450	41	0	491
4/5/2012	458	40	0	498
4/13/2012	457	37	0	494
4/20/2012	465	39	0	504
4/27/2012	475	37	0	512
5/4/2012	483	32	0	515
5/11/2012	482	30	0	512
5/18/2012	485	31	0	516
5/25/2012	484	30	0	514
6/1/2012	490	34	0	524
6/8/2012	492	32	0	524
6/15/2012	495	35	0	530
6/22/2012	503	31	0	534
6/29/2012	504	30	0	534

7/6/2012	495	34	0	529
7/13/2012	499	29	0	528
7/20/2012	487	26	0	513
7/27/2012	486	26	0	512
8/3/2012	492	26	0	518
8/10/2012	489	26	0	515
8/17/2012	488	25	0	513
8/24/2012	489	24	0	513
8/31/2012	488	23	0	511
9/7/2012	479	23	0	502
9/14/2012	483	23	0	506
9/21/2012	480	21	0	501
9/28/2012	488	17	0	505
10/5/2012	485	15	0	500
10/12/2012	484	14	0	498
10/19/2012	485	15	1	501
10/26/2012	478	12	1	491
11/2/2012	466	15	1	482
11/9/2012	477	13	1	491
11/16/2012	473	16	0	489
11/21/2012	471	16	0	487
11/30/2012	464	17	0	481
12/7/2012	456	16	0	472
12/14/2012	463	14	0	477
12/21/2012	451	12	0	463
12/28/2012	451	12	0	463

1/4/2013	460	13	0	473
1/11/2013	453	14	0	467
1/18/2013	436	16	0	452
1/25/2013	441	23	0	464
2/1/2013	444	22	0	466
2/8/2013	445	17	0	462
2/15/2013	454	19	0	473
2/22/2013	455	21	0	476
3/1/2013	455	23	0	478
3/8/2013	454	22	0	476
3/15/2013	452	26	0	478
3/22/2013	448	25	0	473
3/28/2013	448	19	0	467
4/5/2013	452	15	0	467
4/12/2013	454	18	0	472
4/19/2013	454	15	0	469
4/26/2013	456	15	0	471
5/3/2013	458	11	0	469
5/10/2013	457	11	0	468
5/17/2013	455	14	0	469
5/24/2013	454	16	0	470
5/31/2013	454	16	0	470
6/7/2013	458	15	0	473
6/14/2013	460	13	0	473
6/21/2013	458	10	0	468
6/28/2013	457	9	0	466

7/3/2013	456	9	0	465
7/12/2013	452	11	0	463
7/19/2013	456	12	0	468
7/26/2013	449	13	0	462
8/2/2013	451	12	0	463
8/9/2013	460	10	0	470
8/16/2013	465	9	0	474
8/23/2013	458	8	0	466
8/30/2013	459	6	0	465
9/6/2013	449	7	0	456
9/13/2013	452	8	0	460
9/20/2013	444	8	0	452
9/27/2013	447	7	0	454
10/4/2013	446	7	0	453
10/11/2013	443	7	1	451
10/18/2013	440	7	1	448
10/25/2013	435	8	1	444
11/1/2013	442	8	1	451
11/8/2013	461	7	1	469
11/15/2013	462	7	1	470
11/22/2013	460	9	1	470
11/27/2013	459	10	1	470
12/6/2013	464	9	0	473
12/13/2013	469	8	0	477
12/20/2013	468	8	0	476
12/27/2013	460	9	0	469

1/3/2014	459	9	0	468
1/10/2014	464	7	0	471
1/17/2014	470	8	0	478
1/24/2014	477	7	0	484
1/31/2014	474	7	0	481
2/7/2014	478	5	0	483
2/14/2014	480	6	0	486
2/21/2014	482	5	0	487
2/28/2014	490	3	0	493
3/7/2014	504	2	0	506
3/14/2014	511	3	0	514
3/21/2014	510	3	0	513
3/28/2014	515	3	0	518
4/4/2014	520	4	0	524
4/11/2014	532	4	0	536
4/17/2014	535	5	0	540
4/25/2014	537	5	0	542
5/2/2014	537	6	0	543
5/9/2014	539	6	0	545
5/16/2014	539	7	0	546
5/23/2014	540	7	0	547
5/30/2014	544	6	0	550
6/6/2014	542	6	0	548
6/13/2014	550	6	0	556
6/20/2014	547	6	0	553
6/27/2014	548	6	0	554

7/3/2014	555	5	0	560
7/11/2014	557	6	0	563
7/18/2014	550	6	0	556
7/25/2014	550	5	0	555
8/1/2014	557	5	0	562
8/8/2014	555	5	0	560
8/15/2014	554	4	0	558
8/22/2014	550	5	0	555
8/29/2014	552	5	0	557
9/5/2014	557	6	0	563
9/12/2014	561	5	0	566
9/19/2014	557	3	0	560
9/26/2014	553	3	0	556
10/3/2014	554	2	0	556
10/10/2014	560	2	0	562
10/17/2014	558	3	0	561
10/24/2014	562	6	0	568
10/31/2014	555	7	0	562
11/7/2014	560	7	0	567
11/14/2014	562	6	0	568
11/21/2014	558	7	0	565
11/26/2014	560	5	1	566
12/5/2014	561	6	1	568
12/12/2014	540	7	1	548
12/19/2014	532	6	1	539
12/26/2014	527	8	1	536

1/2/2015	522	7	1	530
1/9/2015	495	7	0	502
1/16/2015	481	6	0	487
1/23/2015	475	6	0	481
1/30/2015	450	4	0	454
2/6/2015	413	4	0	417
2/13/2015	365	3	0	368
2/20/2015	359	3	0	362
2/27/2015	352	3	0	355
3/6/2015	328	4	1	333
3/13/2015	305	5	1	311
3/20/2015	285	6	1	292
3/27/2015	283	6	1	290
4/2/2015	280	4	1	285
4/10/2015	260	4	0	264
4/17/2015	255	3	0	258
4/24/2015	242	4	0	246
5/1/2015	235	3	0	238
5/8/2015	236	1	0	237
5/15/2015	233	0	0	233
5/22/2015	232	1	0	233
5/29/2015	231	1	0	232
6/5/2015	232	1	0	233
6/12/2015	231	1	0	232
6/19/2015	232	1	0	233
6/26/2015	230	0	1	231

7/2/2015	231	0	1	232
7/10/2015	239	0	0	239
7/17/2015	241	1	0	242
7/24/2015	244	1	0	245
7/31/2015	247	1	0	248
8/7/2015	252	2	0	254
8/14/2015	252	3	0	255
8/21/2015	250	3	0	253
8/28/2015	251	4	0	255
9/4/2015	249	4	0	253
9/11/2015	248	2	0	250
9/18/2015	250	3	0	253
9/25/2015	247	3	0	250
10/2/2015	240	5	0	245
10/9/2015	230	5	0	235
10/16/2015	227	6	0	233
10/23/2015	224	5	0	229
10/30/2015	222	7	0	229
11/6/2015	226	6	0	232
11/13/2015	224	5	0	229
11/20/2015	219	6	0	225
11/25/2015	214	7	0	221
12/4/2015	209	8	0	217
12/11/2015	194	10	0	204
12/18/2015	199	7	0	206
12/23/2015	204	8	0	212

12/31/2015	209	8	0	217
1/8/2016	200	9	0	209
1/15/2016	198	4	0	202
1/22/2016	195	4	0	199
1/29/2016	179	3	0	182
2/5/2016	177	3	0	180
2/12/2016	169	3	0	172
2/19/2016	163	2	0	165
2/26/2016	162	2	0	164
3/4/2016	156	2	0	158
3/11/2016	150	2	0	152
3/18/2016	150	2	0	152
3/24/2016	145	2	0	147
4/1/2016	143	2	0	145
4/8/2016	140	2	0	142
4/15/2016	139	2	0	141
4/22/2016	134	2	0	136
4/29/2016	132	2	0	134
5/6/2016	137	2	0	139
5/13/2016	133	1	0	134
5/20/2016	137	0	0	137
5/27/2016	137	0	0	137
6/3/2016	142	0	0	142
6/10/2016	142	0	0	142
6/17/2016	146	0	0	146
6/24/2016	150	0	0	150

7/1/2016	154	0	0	154
7/8/2016	158	0	0	158
7/15/2016	160	0	0	160
7/22/2016	168	0	0	168
7/29/2016	172	0	0	172
8/5/2016	177	0	0	177
8/12/2016	189	0	0	189
8/19/2016	196	0	0	196
8/26/2016	199	0	0	199
9/2/2016	202	0	0	202
9/9/2016	200	0	0	200
9/16/2016	202	0	0	202
9/23/2016	201	0	0	201
9/30/2016	204	0	0	204
10/7/2016	203	0	0	203
10/14/2016	201	0	0	201
10/21/2016	212	0	0	212
10/28/2016	212	0	0	212
11/4/2016	218	0	0	218
11/11/2016	218	0	0	218
11/18/2016	229	0	0	229
11/23/2016	228	0	0	228
12/2/2016	235	0	0	235
12/9/2016	246	0	0	246
12/16/2016	258	0	0	258
12/23/2016	262	0	0	262

12/30/2016	264	0	0	264
1/6/2017	267	0	0	267
1/13/2017	268	0	0	268
1/20/2017	281	0	0	281
1/27/2017	291	0	0	291
2/3/2017	295	0	0	295
2/10/2017	301	0	0	301
2/17/2017	303	0	0	303
2/24/2017	306	0	0	306
3/3/2017	308	0	0	308
3/10/2017	309	0	0	309
3/17/2017	308	0	0	308
3/24/2017	315	0	0	315
3/31/2017	319	0	0	319
4/7/2017	331	0	0	331
4/13/2017	339	0	0	339
4/21/2017	340	0	0	340
4/28/2017	342	0	0	342
5/5/2017	349	0	0	349
5/12/2017	357	0	0	357
5/19/2017	361	0	0	361
5/26/2017	362	0	0	362
6/2/2017	364	0	0	364
6/9/2017	368	0	0	368
6/16/2017	368	0	0	368
6/23/2017	369	0	0	369

6/30/2017	370	0	0	370
7/7/2017	369	0	0	369
7/14/2017	373	0	0	373
7/21/2017	374	0	0	374
7/28/2017	379	0	0	379
8/4/2017	379	0	0	379
8/11/2017	377	0	0	377
8/18/2017	377	0	0	377
8/25/2017	377	0	0	377
9/1/2017	380	0	0	380
9/8/2017	382	0	0	382
9/15/2017	380	0	0	380
9/22/2017	386	0	0	386
9/29/2017	385	0	0	385
10/6/2017	383	0	0	383
10/13/2017	384	0	0	384
10/20/2017	378	0	0	378
10/27/2017	379	0	0	379
11/3/2017	380	0	0	380
11/10/2017	386	0	0	386
11/17/2017	391	0	0	391
11/22/2017	393	0	0	393
12/1/2017	397	0	0	397
12/8/2017	400	0	0	400
12/15/2017	397	0	0	397
12/22/2017	398	0	0	398

12/29/2017	398	0	0	398
1/5/2018	400	0	0	400
1/12/2018	403	0	0	403
1/19/2018	409	0	0	409
1/26/2018	427	0	0	427
2/2/2018	427	0	0	427
2/9/2018	437	0	0	437
2/16/2018	433	0	0	433
2/23/2018	435	0	0	435
3/2/2018	434	0	0	434
3/9/2018	436	0	0	436
3/16/2018	437	0	0	437
3/23/2018	444	0	0	444
3/29/2018	442	0	1	443
4/6/2018	444	0	0	444
4/13/2018	445	0	0	445
4/20/2018	453	0	0	453
4/27/2018	452	0	0	452
5/4/2018	458	0	0	458
5/11/2018	463	0	0	463
5/18/2018	467	0	0	467
5/25/2018	477	1	0	478
6/1/2018	476	1	0	477
6/8/2018	479	1	0	480
6/15/2018	475	1	0	476
6/22/2018	473	1	0	474

6/29/2018	473	1	0	474
7/6/2018	474	1	0	475
7/13/2018	475	1	0	476
7/20/2018	475	1	0	476
7/27/2018	479	1	0	480
8/3/2018	479	1	0	480
8/10/2018	485	0	0	485
8/17/2018	486	0	0	486
8/24/2018	485	0	0	485
8/31/2018	486	0	0	486
9/7/2018	484	0	0	484
9/14/2018	483	0	0	483
9/21/2018	488	0	0	488
9/28/2018	486	0	0	486
10/5/2018	485	0	0	485
10/12/2018	489	0	0	489
10/19/2018	490	0	0	490
10/26/2018	489	0	0	489
11/2/2018	487	0	0	487
11/9/2018	492	0	0	492
11/16/2018	493	0	0	493
11/21/2018	493	0	0	493
11/30/2018	493	0	0	493
12/7/2018	489	0	0	489
12/14/2018	486	0	0	486
12/21/2018	486	0	0	486

12/28/2018	486	0	0	486
1/4/2019	487	0	0	487
1/11/2019	488	0	0	488
1/18/2019	481	0	0	481
1/25/2019	484	0	0	484
2/1/2019	481	0	0	481
2/8/2019	478	0	0	478
2/15/2019	473	0	0	473
2/22/2019	473	0	0	473
3/1/2019	466	0	0	466
3/8/2019	465	0	0	465
3/15/2019	464	0	0	464
3/22/2019	459	0	0	459
3/29/2019	454	0	0	454
4/5/2019	462	0	0	462
4/12/2019	464	0	0	464
4/18/2019	463	0	0	463
4/26/2019	460	0	0	460
5/3/2019	459	0	0	459
5/10/2019	457	0	0	457
5/17/2019	454	0	0	454
5/24/2019	451	0	0	451
5/31/2019	452	0	0	452
6/7/2019	446	0	0	446
6/14/2019	441	0	0	441
6/21/2019	439	0	0	439

6/28/2019	441	0	0	441
7/3/2019	443	0	0	443
7/12/2019	437	0	0	437
7/19/2019	440	0	0	440
7/26/2019	443	0	0	443
8/2/2019	442	0	0	442
8/9/2019	444	0	0	444
8/16/2019	441	0	0	441
8/23/2019	434	0	0	434
8/30/2019	429	0	0	429
9/6/2019	427	0	0	427
9/13/2019	419	0	0	419
9/20/2019	417	0	0	417
9/27/2019	414	0	0	414
10/4/2019	415	0	0	415
10/11/2019	421	0	0	421
10/18/2019	422	0	0	422
10/25/2019	417	0	0	417
11/1/2019	416	0	0	416
11/8/2019	412	0	0	412
11/15/2019	408	0	0	408
11/22/2019	405	0	0	405
11/27/2019	404	1	0	405
12/6/2019	399	1	0	400
12/13/2019	399	1	0	400
12/20/2019	414	0	0	414

12/27/2019	405	0	0	405
1/3/2020	403	0	0	403
1/10/2020	397	0	0	397
1/17/2020	403	0	0	403
1/24/2020	405	0	0	405
1/31/2020	406	0	0	406
2/7/2020	405	0	0	405
2/14/2020	408	0	0	408
2/21/2020	409	0	0	409
2/28/2020	411	0	0	411
3/6/2020	415	0	0	415
3/13/2020	418	0	0	418
3/20/2020	405	0	0	405
3/27/2020	382	0	0	382
4/3/2020	351	0	0	351
4/9/2020	316	0	0	316
4/17/2020	283	0	0	283
4/24/2020	246	0	0	246
5/1/2020	219	0	0	219
5/8/2020	198	0	0	198
5/15/2020	175	0	0	175
5/22/2020	162	0	0	162
5/29/2020	148	0	0	148
6/5/2020	141	0	0	141
6/12/2020	137	0	0	137
6/19/2020	132	0	0	132

6/26/2020	131	0	0	131
7/2/2020	126	0	0	126
7/10/2020	125	0	0	125
7/17/2020	124	0	0	124
7/24/2020	126	0	0	126
7/31/2020	124	0	0	124
8/7/2020	121	1	0	122
8/14/2020	116	1	0	117
8/21/2020	126	1	0	127
8/28/2020	124	1	0	125
9/4/2020	124	0	1	125
9/11/2020	122	1	1	124
9/18/2020	121	1	1	123
9/25/2020	123	1	1	125
10/2/2020	128	0	1	129
10/9/2020	129	0	1	130
10/16/2020	129	0	1	130
10/23/2020	132	0	1	133
10/30/2020	141	0	1	142
11/6/2020	146	0	1	147
11/13/2020	153	0	1	154
11/20/2020	155	0	1	156
11/25/2020	160	0	1	161
12/4/2020	163	0	1	164
12/11/2020	168	0	0	168
12/18/2020	173	0	1	174

12/23/2020	173	0	0	173
12/31/2020	175	0	0	175
1/8/2021	179	0	0	179
1/15/2021	189	0	0	189
1/22/2021	188	0	0	188
1/29/2021	192	0	0	192
2/5/2021	198	0	0	198
2/12/2021	203	0	0	203
2/19/2021	203	1	0	204
2/26/2021	207	1	0	208
3/5/2021	210	1	0	211
3/12/2021	211	1	0	212
3/19/2021	216	0	0	216
3/26/2021	221	0	0	221
4/1/2021	223	0	1	224

Attachment QA

QA Documentation for EPA's Borehole TSD PLG_PROB Sensitivity Analysis

Excerpts of the QAPP relevant to this TSD and the PLG_PROB Sensitivity Study.

A.5.2 CRA19_COMP Analyses

For the CRA-2019 review, EPA will perform its own set of model calculations to determine the sensitivity of releases to issues EPA identified in its review. The combined results of the studies listed below will be used by EPA in supporting its regulatory determination for DOE's 2019 Compliance Recertification Application.

Task 3a. Check of Borehole Plugging Frequency Input Parameters

This study will compare repository releases calculated by DOE in the CRA-2019 PA, which used DOE's new approach to calculating borehole plugging frequency, with releases that would have been calculated if the historic approach previously approved by EPA had been used.

Task 3b: Establish Data Quality Objectives (DQOs).

The plugging frequency data that will be used as the basis for EPA's borehole plugging frequency modifications in the Agency's [PLG_PROB] analysis was not developed by the Agency. Rather, it was developed by the DOE in response to EPA Completeness Question CC1-33-3d, which requested the DOE to provide the plugging pattern frequencies for each of the six plugging pattern types that would have been determined if the data collection and analysis methods used in the CRA-2014 PA had also been used in the CRA-2019 PA. In their response, the DOE stated that these values were derived using CRA-2014 analysis methods, which were qualified consistent with the Quality Assurance requirements of 40 CFR §194.22 as applied by the DOE (DOE 2019, Appendix PA- 11 2019, p. PA-34). The EPA will accept these data as adequately qualified for the purposes of the [PLG_PROB] analysis and apply them unaltered when preparing the [PLG_PROB] model. In preparing that model, the Agency will make the following changes to DOE's CRA-2019 PA.

- *The DOE's data representing the frequencies of the six plugging pattern types will be combined by EPA into the three plugging pattern parameter data sets required as inputs for WIPP PA calculations using the methodology developed by DOE and described in the DOE response to EPA Completeness Question CC1-33-3a.*
- *The three plugging pattern parameter data sets used by DOE in the CRA-2019 PA will be replaced by the three plugging pattern parameter data sets prepared by EPA.*

The entire texts of CC1-33-3a and -3d, and DOE's responses, are presented in Appendix A to the EPA's Borehole TSD. Verification of calculations will be performed by the Technical Reviewer. The results of the QA evaluation of the calculations will be included in an appendix to the Overview TSD.

Task 3c.: Quality Assurance of Data Substitutions

The changes to the data input files will involve changing the parameters below to the values shown in bold in the last column of the table. Material Property Description CRA14 Value CRA19 Value PLG_PROB Value GLOBAL ONEPLG Probability of having Plug Pattern 1 (full plug) 4E-2 4.03E-1 9.5E-2 GLOBAL TWOPLG Probability of having Plug Pattern 2 5.94E-1

3.31E-1 4.83E-1 GLOBAL THREEPLG Probability of having Plug Pattern 3 3.66E-1 2.66E-1 4.22E-1 The data Input for the Borehole Plugging Frequency will be checked by creating screenshots of the "reltab" files in the output folders to allow the independent reviewer to ensure that the updated property parameter values are used in the calculation.

NOTE: [PLG_PROB] has been inserted in place of CRA19_COMB in the text which refers to the combined EPA sensitivity analysis that included PLG_PROB.

Summary

As part of the Quality Assurance Project Plan (QAPP), EPA checked that the parameter value changes were correctly assigned to the PLG_PROB sensitivity analysis as shown in the screenshot below:

Task 3(c) Screenshot of PLG_PROB Parameter Updates

```
mysql> select * from AnalysisToVersion where Property in ('ONEPLG', 'TWOPLG', 'THREEPLG') and Analysis='PLG_PROB';
+----------+----------+----------+----------+----------+-----------+---------------+------------------+---------------------+
| Analysis | Material | Property | Version  | auto_num | Code      | VersionNumber | AnalysisRevision | LastModified        |
+----------+----------+----------+----------+----------+-----------+---------------+------------------+---------------------+
| PLG_PROB | GLOBAL   | ONEPLG   | PLG_PROB |   324478 | PRECCDFGF |             5 |                0 | 2020-07-09 11:22:34 |
| PLG_PROB | GLOBAL   | THREEPLG | PLG_PROB |   324482 | PRECCDFGF |             5 |                0 | 2020-07-09 11:22:34 |
| PLG_PROB | GLOBAL   | TWOPLG   | PLG_PROB |   324485 | PRECCDFGF |             5 |                0 | 2020-07-09 11:22:34 |
+----------+----------+----------+----------+----------+-----------+---------------+------------------+---------------------+
3 rows in set (0.06 sec)

mysql> select * from ParamAttributes where Property in ('ONEPLG', 'TWOPLG', 'THREEPLG') and VersionNumber = 5;
+----------+----------+----------+--------------+-------+---------------------+---------------+---------------------+----------+
| Material | Property | Version  | Attribute    | value | EffectiveDate       | VersionNumber | LastModified        | vString  |
+----------+----------+----------+--------------+-------+---------------------+---------------+---------------------+----------+
| GLOBAL   | ONEPLG   | PLG_PROB | Distribution |     0 | 0000-00-00 00:00:00 |             5 | 2020-07-09 11:27:14 | Constant |
| GLOBAL   | ONEPLG   | PLG_PROB | Value        | 0.095 | 0000-00-00 00:00:00 |             5 | 2020-09-21 08:17:37 |          |
| GLOBAL   | THREEPLG | PLG_PROB | Distribution |     0 | 0000-00-00 00:00:00 |             5 | 2020-07-09 11:27:14 | Constant |
| GLOBAL   | THREEPLG | PLG_PROB | Value        | 0.422 | 0000-00-00 00:00:00 |             5 | 2020-09-21 08:18:10 |          |
| GLOBAL   | TWOPLG   | PLG_PROB | Distribution |     0 | 0000-00-00 00:00:00 |             5 | 2020-07-09 11:27:14 | Constant |
| GLOBAL   | TWOPLG   | PLG_PROB | Value        | 0.483 | 0000-00-00 00:00:00 |             5 | 2020-09-21 08:17:54 |          |
+----------+----------+----------+--------------+-------+---------------------+---------------+---------------------+----------+
6 rows in set (0.01 sec)

mysql>
```

Figure 1. Screenshot of input parameters used for the PLG_PROB sensitivity analysis.

This confirms that the PLG_PROB analysis was completed in accordance with the QAPP for EPA's review of CRA-2019.