Additional Information

Mack Energy
McDonald SWD-2531
Received 2-27-2024

ALL CONSULTING
GOVERNMENT RELATIONS · ENERGY · PLANNING · TECHNOLOGY
ENGINEERING · ENVIRONMENTAL

February 22, 2024

PN 1904.SEIS.00

Mr. Phillip Goetze, P.G.
NM EMNRD – Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

Subject: **Mack Energy Corporation**
McDonald SWD #1 - Seismic Potential Letter

Dear Mr. Goetze,

At the request of Mack Energy Corporation (Mack Energy), ALL Consulting, LLC (ALL) has assessed the potential injection-induced seismicity risks in the vicinity of Mack Energy's McDonald SWD #1 (Subject SWD), a proposed saltwater disposal (SWD) facility in Lea County, New Mexico, and summarized the findings in this letter. This assessment used publicly available data to identify the proximity and characteristics of seismic events and known faults to evaluate the potential for the operation of the McDonald SWD #1 to contribute to seismic activity in the area.

Geologic Evaluation

The Subject SWD is requesting a permit to inject into the Permian San Andres Formation at a depth of 5,120-5,640 feet below ground surface (bgs). The San Andres primarily consists of Permian-age limestones, dolomites, and sandstones and is overlain by approximately 70 feet of low porosity carbonate rocks within the upper San Andres Formation, which would prevent the upward migration of injection fluid and serve as the upper confining layer (see **Attachment 1**). Additionally, approximately 120 feet of low porosity and low permeability other carbonate rocks lie within the lower San Andres Formation and upper Glorieta Formation and act as a lower confining zone by preventing downward migration of injected fluids into the underlying Glorieta Formation (see **Attachment 1**). A stratigraphic chart depicting the geologic setting is included as **Figure 1**.[1]

Seismic Events and Fault Data

A review of United States Geological Survey (USGS) and New Mexico Tech Seismological Observatory (NMTSO) earthquake catalogues determined that four (4) seismic events have been recorded within a 100 square mile area [9.08-kilometer (km) radius] around the Subject SWD.

[1] Yang, K.-M., & Dorobek, S. L. (1995). The Permian Basin of west Texas and New Mexico: Tectonic history of a "composite" Foreland Basin and its effects on stratigraphic development. *Stratigraphic Evolution of Foreland Basins*, 149–174. https://doi.org/10.2110/pec.95.52.0149

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The closest recorded seismic event was a M1.44 that occurred on May 16, 2021, and was located approximately 3.06 miles west of the Subject SWD (see **Attachment 2**).

Fault data from United States Geological Survey (USGS) and the Texas Bureau of Economic Geology (BEG)[2] indicates that the closest known fault is located approximately 1.98 miles south of the Subject Well (see **Attachment 2**). This identified fault is within the Precambrian basement, which is approximately 9,000 feet below the proposed injection interval.[3] A map of the seismic events and faults within 9.08 km of the Subject SWD is included as **Attachment 2.**

Figure 1 – Delaware Basin Stratigraphic Chart (Adapted from Yang and Dorobek 1995)

SYSTEM	SERIES/ STAGE	CENTRAL BASIN PLATFORM	DELAWARE BASIN
PERMIAN	OCHOAN	DEWEY LAKE RUSTLER SALADO	DEWEY LAKE RUSTLER SALADO CASTILE
	GUADALUPIAN	TANSILL YATES SEVEN RIVERS QUEEN GRAYBURG SAN ANDRES GLORIETA	DELAWARE MT GROUP BELL CANYON CHERRY CANYON BRUSHY CANYON
	LEONARDIAN	CLEAR FORK WICHITA	BONE SPRING
	WOLFCAMPIAN	WOLFCAMP	WOLFCAMP
PENNSYLVANIAN	VIRGILIAN	CISCO	CISCO
	MISSOURIAN	CANYON	CANYON
	DESMOINESIAN	STRAWN	STRAWN
	ATOKAN	ATOKA — BEND	ATOKA — BEND
	MORROWAN	(ABSENT)	MORROW
MISSISSIPPIAN	CHESTERIAN MERAMECIAN OSAGEAN KINDERHOOKIAN	CHESTER MERAMEC OSAGE "BARNETT"	CHESTER MERAMEC OSAGE "BARNETT"
		KINDERHOOK	KINDERHOOK
DEVONIAN		WOODFORD DEVONIAN	WOODFORD DEVONIAN
SILURIAN		SILURIAN SHALE FUSSELMAN	MIDDLE SILURIAN FUSSELMAN
ORDOVICIAN	UPPER	MONTOYA	SYLVAN MONTOYA
	MIDDLE	SIMPSON	SIMPSON
	LOWER	ELLENBURGER	ELLENBURGER
CAMBRIAN	UPPER	CAMBRIAN	CAMBRIAN
PRECAMBRIAN			

Seismic Potential Evaluation

Experience in evaluating induced seismic events indicates that most injection-induced seismicity throughout the U.S. (e.g., Oklahoma, Ohio, Texas, New Mexico, and Colorado) occurs as a result of injection into Precambrian basement rock, into overlying formations that are in hydraulic communication with the Precambrian basement rock, or as a result of injection near critically stressed and optimally oriented faults. Seismicity at basement depths occurs because critically stressed faults generally originate in crystalline basement rock and may also extend into overlying sedimentary formations. [4]

Injection into either the Precambrian basement rock or its overlying formations that are hydraulically connected to the basement rock through faulting or fracture networks can increase the pore pressure and may lead to the fault slipping, resulting in a seismic event.[4] As such, the vertical distance between the injection formation and Precambrian basement rock and the presence or lack of faulting within the injection interval are major considerations when determining the risk of injection-induced seismicity.

Geophysical logs from nearby well records show at least 9,000 feet of vertical separation between the injection interval and the Precambrian basement.[3] In addition, publicly available

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[2] Horne E. A. Hennings P. H., and Zahm C. K. 2021. Basement structure of the Delaware Basin, in The Geologic Basement of Texas: A Volume in Honor of Peter Flawn, Callahan O. A., and Eichubl P., The University of Texas at Austin, Bureau of Economic Geology.

[3] G. Randy Keller, J. M. Hills &; Rabah Djeddi, A regional geological and geophysical study of the Delaware Basin, New Mexico and West Texas, Trans Pecos Region (West Texas) (1980).

[4] Ground Water Protection Council and Interstate Oil and Gas Compact Commission. *Potential Injection-Induced Seismicity Associated with Oil & Gas Development: A Primer on Technical and Regulatory Considerations Informing Risk Management and Mitigation.* 2015. 141 pages.

fault data does not indicate any transmissive faulting is present above the Precambrian basement around the Subject SWD. Finally, injection-induced seismicity is not typically associated with shallow disposal wells in the Central Basin Platform area, such as the McDonald SWD #1.

For injection into the San Andres Formation to contribute to seismic activity, one of two hypothetical geologic scenarios must exist:[5]

1. Scenario #1: Earthquake hypocenters would need to be significantly shallower (several kilometers) than initially identified by the USGS and NMTSO seismic monitoring networks, and thus placing seismic activity high in the sedimentary column, rather than in the Precambrian basement.
2. Scenario #2: This scenario would require that both of the following conditions are met:
    a. Fault Transmissivity: High permeability and transmissive conduits from fault-damaged zones would need to be present below the San Andres Formation, allowing fluid to migrate through the underlying Glorieta Formation and through significantly deeper confining intervals, and eventually into the Precambrian basement.
    b. Pore Pressure: The injection fluids and bottom hole pressures in the San Andres Formation would need to exceed existing hydrostatic pressures within the deeper geologic formation in order for injection fluids to migrate downward.

There are no publications or geologic data that suggest either of these scenarios to be true for the area around the Subject SWD.

Conclusion

As an expert on the issue of induced seismicity, seismic monitoring, and mitigation, it is my opinion that the potential for the Subject SWD to cause injection-induced seismicity is expected to be minimal, at best. This conclusion is based on (1) the presence of numerous confining layers above and below the injection interval and (2) the significant vertical distance between the injection zone and Precambrian basement rock in which the nearest fault has been identified.

Sincerely,
ALL Consulting

Reed Davis
Geophysicist

[5] Skoumal, Robert J., et al. "Induced Seismicity in the Delaware Basin, Texas." *Journal of Geophysical Research: Solid Earth*, vol. 125, no. 1, 2020, doi:10.1029/2019jb018558.

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Attachment 1
Upper and Lower Confining Zones

Mack Energy Corporation
McDonald SWD #1 Seismic Information
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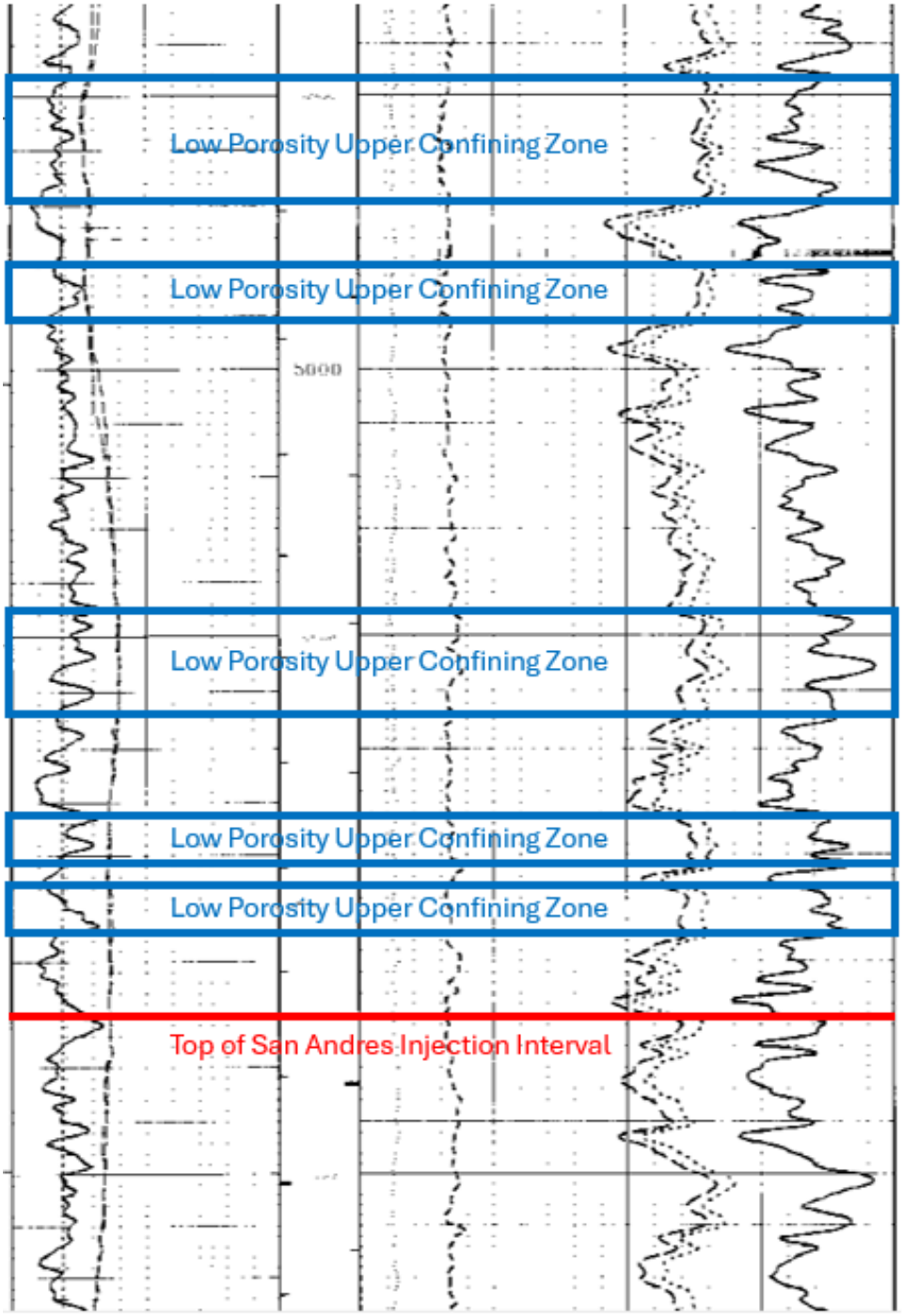
Upper Confining Zone from API No. 025-33678 (Subject SWD)



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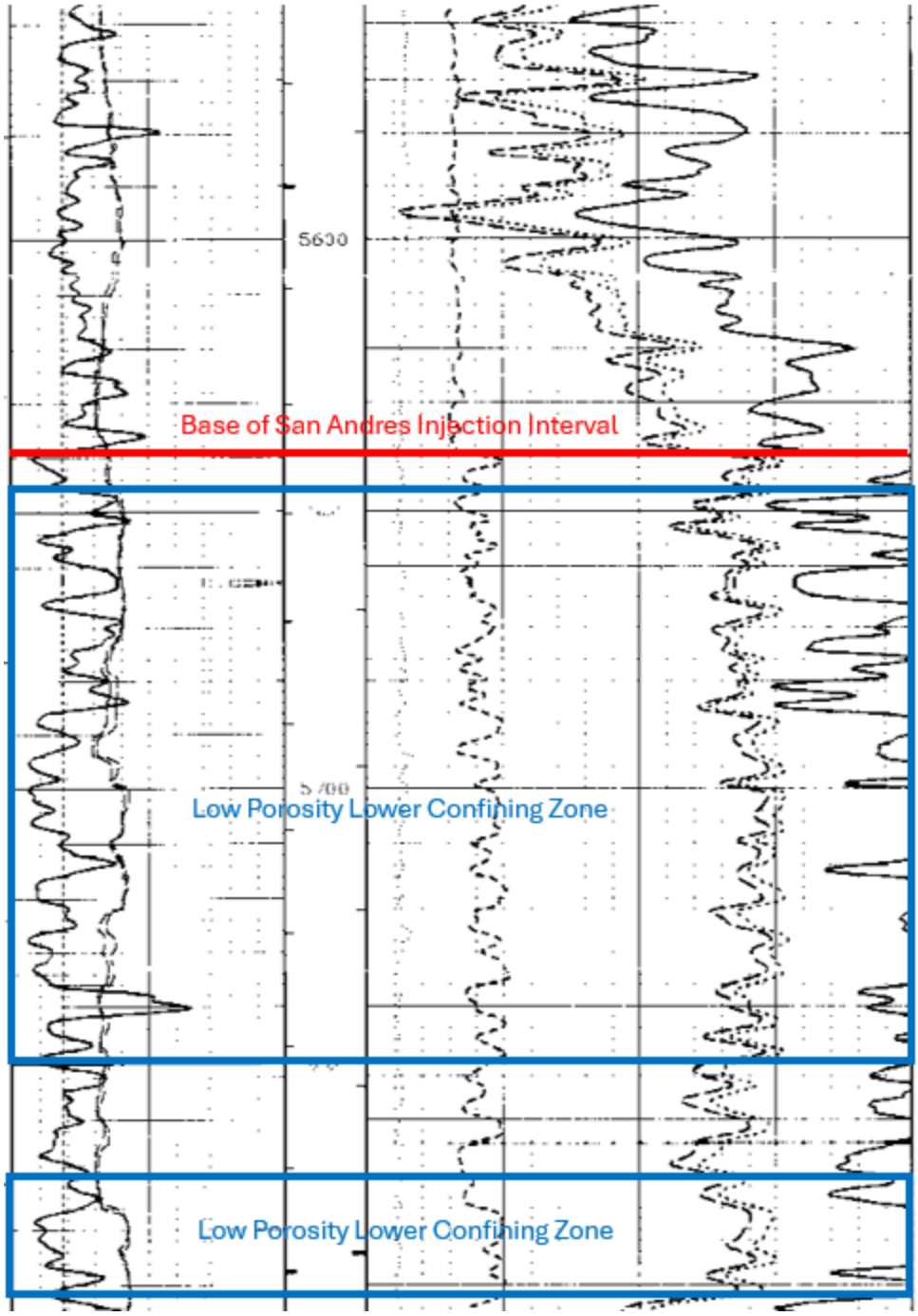
Lower Confining Zones from API No. 025-33678 (Subject SWD)



Mack Energy Corporation
McDonald SWD #1 Seismic Information
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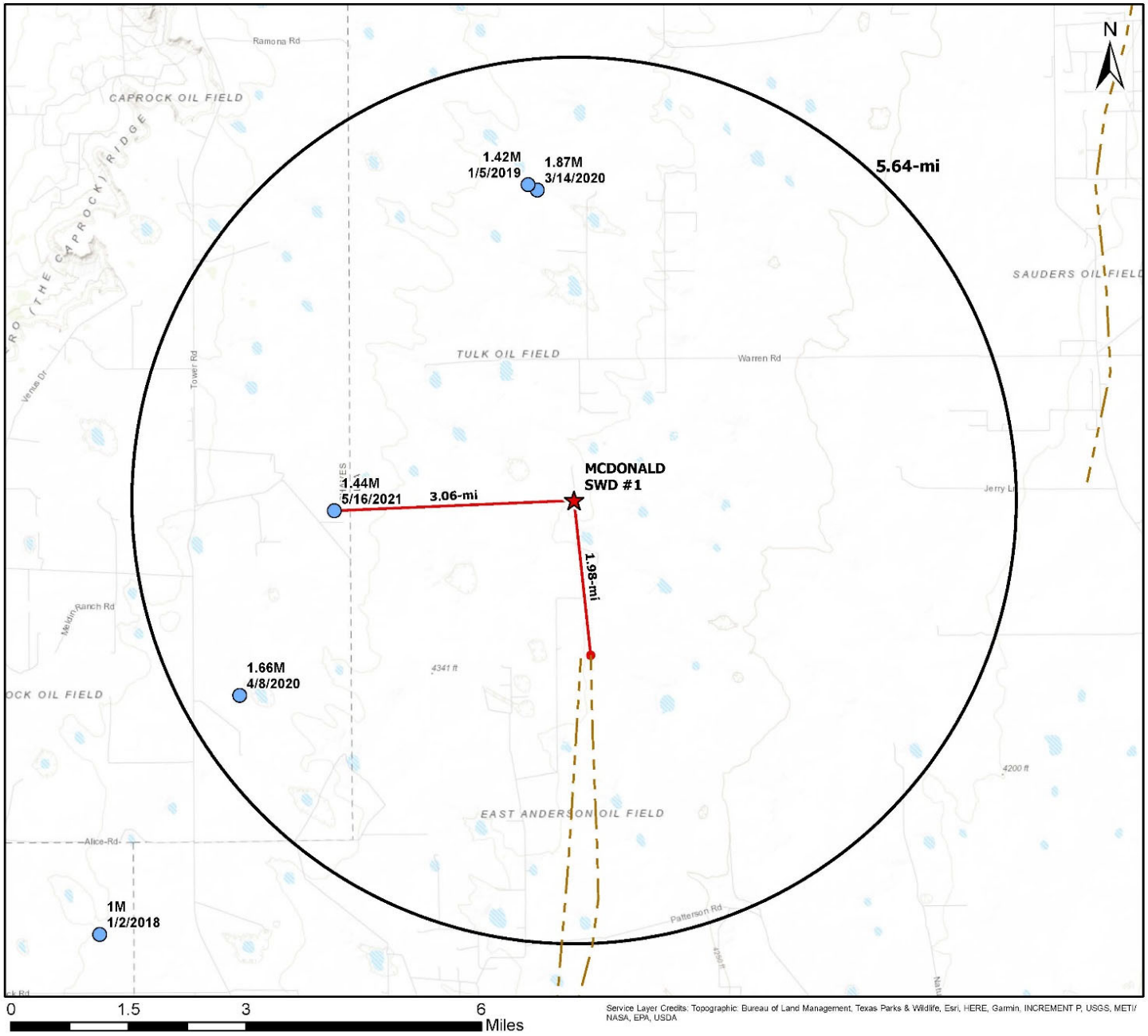
Attachment 2
Seismic Event Map

Mack Energy Corporation
McDonald SWD #1 Seismic Information
February 22, 2024

McDonald SWD #1 Nearby Seismic Events and Faults



Service Layer Credits: Topographic: Bureau of Land Management, Texas Parks & Wildlife, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA

Legend

- Proposed SWD (1)
- NMTSO Seismic Events - 2/16/24 (5)
- Deep Faults (3)

Seismic Analysis Map		
MCDONALD SWD #1 LEA COUNTY, NEW MEXICO		
Proj Mgr: Oliver Seekins	February 16, 2024	Mapped by: Ben Bockelmann
Prepared for: MACK Energy Corporation		Prepared by: ALL CONSULTING

From: Harris, Anthony, EMNRD
To: Jerry Sherrell; Goetze, Phillip, EMNRD; Gebremichael, Million, EMNRD
Cc: Deana Weaver
Subject: RE: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required
Date: Tuesday, February 27, 2024 4:43:00 PM
Attachments: image001.png

Thanks Jerry

Report has been received and added to the applicable OCD folder for the McDonald well.

Regards
Tony Harris
Petroleum Specialist
Anthony.harris@emnrd.nm.gov
505 549 8131.

From: Jerry Sherrell <jerrys@mec.com>
Sent: Tuesday, February 27, 2024 7:58 AM
To: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>; Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Cc: Deana Weaver <dweaver@mec.com>
Subject: RE: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required

Please see the attached Seismic Letter.

From: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>
Sent: Tuesday, February 06, 2024 3:57 PM
To: Jerry Sherrell <jerrys@mec.com>; Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Cc: Deana Weaver <dweaver@mec.com>
Subject: RE: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required

EXTERNAL EMAIL - Verify the sender and use caution before opening attachments or clicking links

Good Afternoon, Jerry

Please provide an assessment for the induced-seismicity risk potential for the subject well.
Attached is an example of a “shallow-injection” risk assessment that you can use as a guideline.

Please feel free to call me if you have any questions

Regards
Tony Harris
Petroleum Specialist
Anthony.harris@emnrd.nm.gov
505 549 8131.

From: Jerry Sherrell <jerrys@mec.com>
Sent: Tuesday, February 6, 2024 8:07 AM
To: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>; Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Cc: Deana Weaver <dweaver@mec.com>
Subject: FW: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required

Good Morning Tony,

Just following up on this application. Did you get what you needed? Can I get an update?

Jerry W. Sherrell
Regulatory Supervisor
Mack Energy Corporation
Redwood Operating LLC
PO Box 960
Artesia, NM 88210

Office 575-748-1288
Cell 575-703-7382
jerrys@mec.com

From: Deana Weaver <dweaver@mec.com>
Sent: Tuesday, January 23, 2024 10:14 AM
To: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>; Jerry Sherrell <jerrys@mec.com>
Cc: Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Subject: RE: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required

It has been corrected.

Thank you

Deana Weaver
Regulatory Technician II
Mack Energy Corporation
575-748-1288

From: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>
Sent: Tuesday, January 23, 2024 10:04 AM
To: Deana Weaver <dweaver@mec.com>; Jerry Sherrell <jerrys@mec.com>
Cc: Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Subject: RE: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required

EXTERNAL EMAIL - Verify the sender and use caution before opening attachments or clicking links

Deana

Can you please confirm the location and API# for the Subject well? The additional information that was submitted contains a discrepancy.

Your original submission included the following location and API#
Unit I Sec 9 T15S R32E
API# 30-025-33678

The location and API# for the most recent submission is highlighted in yellow below.

Please confirm the correct parameters for the subject well.

Thanks
Tony

MACK ENERGY CORPORATION
McDonald SWD #1 (Re-Entry)
Sec 32-T16s-R27e
API #30-015-31436

Well Information

Original Well Information.

Operator: H.L. Brown Operating LLC
Well Name: North Feather State Unit #2
TD: 12,500'
P&A: 05/20/2009

Existing Casing:

Hole	MD (ft)	Casing	Weight	Grade	Coupling	Comments
17 ½"	0'- 535'	13 3/8"	48#			500 sacks. Circ to surface.
11"	0'- 4,050'	8 5/8"	32#			Pumped 1400 sacks. Circulated 50 sacks.
7 7/8"	12,500'	5 ½"	17-20#	N-80	LT&C	Pumped 1,150 sacks+800 sacks. Circ. 20 sacks

New Production Casing

Hole	MD (ft)	Casing	Weight	Grade	Coupling	Comments

Production Casing: OD - 5 ½" 20#- N-80 ID: 4.778" Drift: 4.653 Burst: 9,190 psi
Production Casing: OD - 5 ½" 17#- N-80 ID: 4.892" Drift: 4.767 Burst: 7,740 psi

Procedure

Objective: Drill out cement plugs and clean out casing to 6,701'. Test casing. Turn over to Completions.

1. Remove Dry Hole Marker. Dig out old Cellar. Find 8 5/8" casing stub. Inspect casing for pits and holes. Install 8 5/8"x11"x 5K Wellhead and test.
2. MIRU PU.
3. Nipple up BOPE and test.
4. PU 4 1/2" bit, 3 1/2" (10) DC's w/2 3/8" L-80 work string.
5. Drill out cement plugs. Plug #1 surface plug #1 (30 sacks) from 0' to 585'? Test casing to 500 psi. Plug #2 (25 sacks) at 1,464' to 1,564' Test casing to 500 psi. Plug #3 (25 sacks) at 3,675' to 4,109'. Test casing to 500 psi. Clean out to 6,701'. Test casing to 1,000 psi for 30 minutes.
6. Circulate casing clean with Fresh Water.
7. TOH 2 3/8" tubing and lay down drill collars.
8. Rig up Wireline and run a Cement Bond Log from 6,701' to 4,050' (8 5/8" casing shoe).
9. Set a CIBP at 5,875' and cap with 35' of cement.
10. Turn well over to completions.

MACK ENERGY CORPORATION
McDonald SWD #1 (Re-Entry)
Sec 32-T16s-R27e
API #30-015-31436

From: Deana Weaver <dweaver@mec.com>
Sent: Tuesday, January 23, 2024 8:07 AM
To: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>; Jerry Sherrell <jerrys@mec.com>
Cc: Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Subject: [EXTERNAL] RE: Mack Energy - McDonald SWD-2531 Additional Information required

Tony

The information you requested is attached.

Thank you

Deana Weaver
Regulatory Technician II
Mack Energy Corporation
575-748-1288

From: Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>
Sent: Monday, January 22, 2024 2:59 PM
To: Deana Weaver <dweaver@mec.com>; Jerry Sherrell <jerrys@mec.com>
Cc: Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>
Subject: Mack Energy - McDonald SWD-2531 Additional Information required
Importance: High

Good Afternoon

Below are a list of items that need to be included in the subject well (API# 30-025-33678) SWD application.

1. Section VIII – A list of Aquifers must be included for all USDW overlying / underlying the proposed injection interval.
    a. Please provide the “Geologic name” and “Depth to bottom” of all USDW overlying and underlying the proposed injection interval as applicable
2. A Cement Bond Log (CBL) will be required across the 5.5” production casing prior to perforating the San Andres injection interval.
    a. CBL logging interval should be from ~ 6700 ft (ie. Top of plug at 6701 ft) to the 8-5/8” shoe at 4050 ft.
    b. Please include a Statement, with reference to Section X (Logs and Test Data), to include a CBL across the 5.5” production casing from approx. 6700 ft – 4050 ft.
3. To satisfy the SWD Best Practices with respect to rathole requirements, please note the following.
    a. A Cast Iron bridge plug must be run and capped with cement such that a 200 foot rathole exists below the proposed San Andres bottom perforation (ie. Top of Cement at 5840 feet)
    b. Please update the wellbore diagram to reflect the plugging and rathole requirements.
    c. Please update the procedure and/or include a statement to reflect the plug and cement details to provide a 200 ft rathole below the lowermost San Andres

perforation.

d. Cement cap above the plug should be a minimum of 35 feet in length.

Please include the above items in a document entitled " McDonald SWD-2531 Additional Information" and send it via e-mail at your earliest convenience.

Regards

Tony Harris
Petroleum Specialist
Anthony.harris@emnrd.nm.gov
505 549 8131.

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District III
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Phone:(505) 334-6178 Fax:(505) 334-6170
District IV
1220 S. St Francis Dr., Santa Fe, NM 87505
Phone:(505) 476-3470 Fax:(505) 476-3462

State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

CONDITIONS

Action 353318

CONDITIONS

Operator: MACK ENERGY CORP P.O. Box 960 Artesia, NM 882110960	OGRID: 13837
	Action Number: 353318
	Action Type: [IM-SD] Admin Order Support Doc (ENG) (IM-AAO)

CONDITIONS

Created By	Condition	Condition Date
anthony.harris	None	6/12/2024