

GARDENDALE SEISMIC RESPONSE AREA

Range Hill Extension – Operator Response Plan

(Revised – August 18th, 2023)

OBJECTIVE

The Operator Lead Response Group has a simple and clear objective: To prevent the occurrence of >M3.5 seismicity within the Range Hill extension and the full Gardendale Seismic Response Area.

DEFINITIONS

1. Gardendale SRA – Defined by the Railroad Commission of Texas (RRC), Figure 1
2. Range Hill Extension – The Gardendale SRA was expanded to include a 9.08km radius around the 12/16/2022 seismic event
3. Shallow SWD Well – Permitted and completed above the base of the Wolfcamp Formation
4. Deep SWD Well – Permitted and completed below the base of the Wolfcamp Formation

SUMMARY

On December 16th, 2022, a magnitude 5.2 earthquake occurred at the northern edge of the Gardendale Seismic Response Area (SRA) in southwestern Martin County, approximately 13 miles north of Midland. The event was recorded by TexNet (USGS) as well as commercial and proprietary monitoring arrays. Local operators responded immediately, taking mitigation measures by shutting-in nearby water disposal wells. Local operators, out of an abundance of caution, also temporarily suspended hydraulic fracturing operations in the area.

On December 19th, the Railroad Commission of Texas (RRC) acted by enlarging the existing Gardendale SRA to include a radial area of 9 kilometers (100 square miles) around the location of this earthquake, which has since been named the “Range Hill” Extension (Figure 1, Figure 2A, Figure 2B). As a result, 16 saltwater disposal well permits (15 shallow and one deep) have been added to the Gardendale SRA. The RRC requested that within the expanded Gardendale SRA:

- Operators of shallow SWDs that are currently not in use should not begin, or return, those wells to injection.
- Active shallow disposal wells should not exceed a daily injection rate of 10,000 bbls/day.
- The three deep disposal wells within 9 km of the Range Hill event should be shut in.

On January 4th all the operators within the expanded Gardendale SRA met to discuss the Range Hill event. After some discussion it was agreed to establish a focused Operator Lead Response Group (OLRG) consisting of 14 companies (Figure 3); those with operations within 9km of the Range Hill seismic event, as well as additional members of the “Cowden 6” group which investigated and presented to the RRC on previous seismicity events along the Gardendale Fault (aka The Cowden fault, or North Midland fault).

The OLRG formed five Focus Groups to address key issues:

1. Fault Mapping
2. Earthquake Analysis
3. Water Disposal
4. Pressure Data
5. Hydraulic Fracturing Operations

March 23rd 2023, approximately 90 days after the initial seismic event, the OLRG had its initial meeting with the RRC. Subsequent meetings will be planned for each quarter.

After consolidating the analysis from the five Focus Groups, and receiving feedback from the RRC, the OLRG has initiated the following action plans.

MITIGATION ACTION PLANS

In line with the RRC requests the OLRG has developed a targeted, data-based plan to reduce seismicity by curtailing deep injection volumes, monitoring for seismicity, and measuring disposal zones pressure changes.

Response Action: Deep Disposal

The OLRG have examined the available data and determined that deep water disposal is the most likely causal factor to trigger deep seismicity within the SRA. Operators within the SRA have agreed to;

1. Shut-in all deep SWD disposal.

In addition to previously shut-in deep disposal wells in the original Gardendale SRA, water disposal into the three deep disposal wells within 9km of the Range Hill event has been stopped. This action removes 120,000 bbls/day of deep disposal permitted volumes within the Range Hill extension, Mabee 3 SWD (Well 72), Mabee SWD 1 (Well 73) and Mabee 239 1SW (Well 88) (Figure 1, Figure 2B)

2. Support the RRC initiative to collect pressure data in disposal wells.

The OLRG will work toward establishing a Pressure Monitoring Plan that does not impact normal operations. The plan will consist of a combination of

- Periodic Step-Rate Tests (SRT) and down-hole pressure gauges (DHPG) where possible to monitor reservoir pressure, and
- Pulse tests between wells to quantify any pressure communication between shallow and deep reservoirs and to ascertain reservoir diffusivity and permeability anisotropy within the deep reservoirs. At present, operators are still assessing which wellbores may be available for gauges or tests. The Pressure Focus Group will work towards establishing the plan before the next quarterly engagement with the RRC (June 2023)

Response Action: Shallow Disposal

On August 4th the RRC lifted the volume curtailment of shallow SWD wells within the Gardendale SRA. Daily injection rates for shallow SWDs may return to the levels specified in their permits.

Response Action: Monitoring and Reporting

The OLRG has made plans to monitor ongoing seismicity, take action if required, and to report back to the RRC every three months.

1. Monitor seismicity within the Range Hill extension for 18 months.

In line with the expectations of the RRC the OLRG will monitor for seismicity above M3.5 and quickly take mitigation actions should it occur (Figure 5).

- If a >M3.5 earthquake occurs within six months of the Dec 16th Range Hill cluster, then the OLRG will meet within 48 hours. If the event is within the vicinity and considered to be an aftershock related to the Dec 16th event, then no additional action is needed.
 - If a >M3.5 earthquake occurs after 6 months (June 16, 2023) then the OLRG will meet within 48 hours to determine the type and extent of any additional mitigation steps. All mitigation actions will be based on TexNet “final” magnitude and location.
 - If no seismicity >M3.5 occurs within the SRA for 18 months, the OLRG will meet to discuss next steps.
2. Going forward, the OLRG will meet with the RRC every 3 months.
At these meetings the group will
 - Provide an update on the level of seismicity and its trend.
 - Provide an update on pressure monitoring.
 - Seek feedback from RRC on the effectiveness of the group’s response plans.

Other Actions

1. Operators of SWD wells within the SRA will continue to report daily pressure and volume data on a monthly basis to the RRC via the TexNet reporting tool
(<https://injection.texnet.beg.utexas.edu/>)
2. All earthquake magnitudes and locations are based on the TexNet Earthquake Catalog.
(<https://www.beg.utexas.edu/texnet-cisr/texnet/earthquake-catalog>)
3. Data Constraints: Three of the Focus Groups identified small errors in the databases they used to generate their analysis.
 - Earthquakes – Some uncertainty in depth estimates of events between monitoring arrays.
 - Pressure Monitoring – Very limited data is currently available in the area.
 - Water Disposal – A very small number of the wells reporting to the TexNet database had shallow volumes incorrectly assigned to deep disposal. This misreporting should be rectified before the next meeting with the RRC.

Figure 1: RRC Gardendale Seismic Response Area (SRA) Map

Gardendale Seismic Response Area (SRA)

USGS & BEG TexNet Earthquakes M>=3.0

Date Range: January 1, 2017, to December 21, 2022

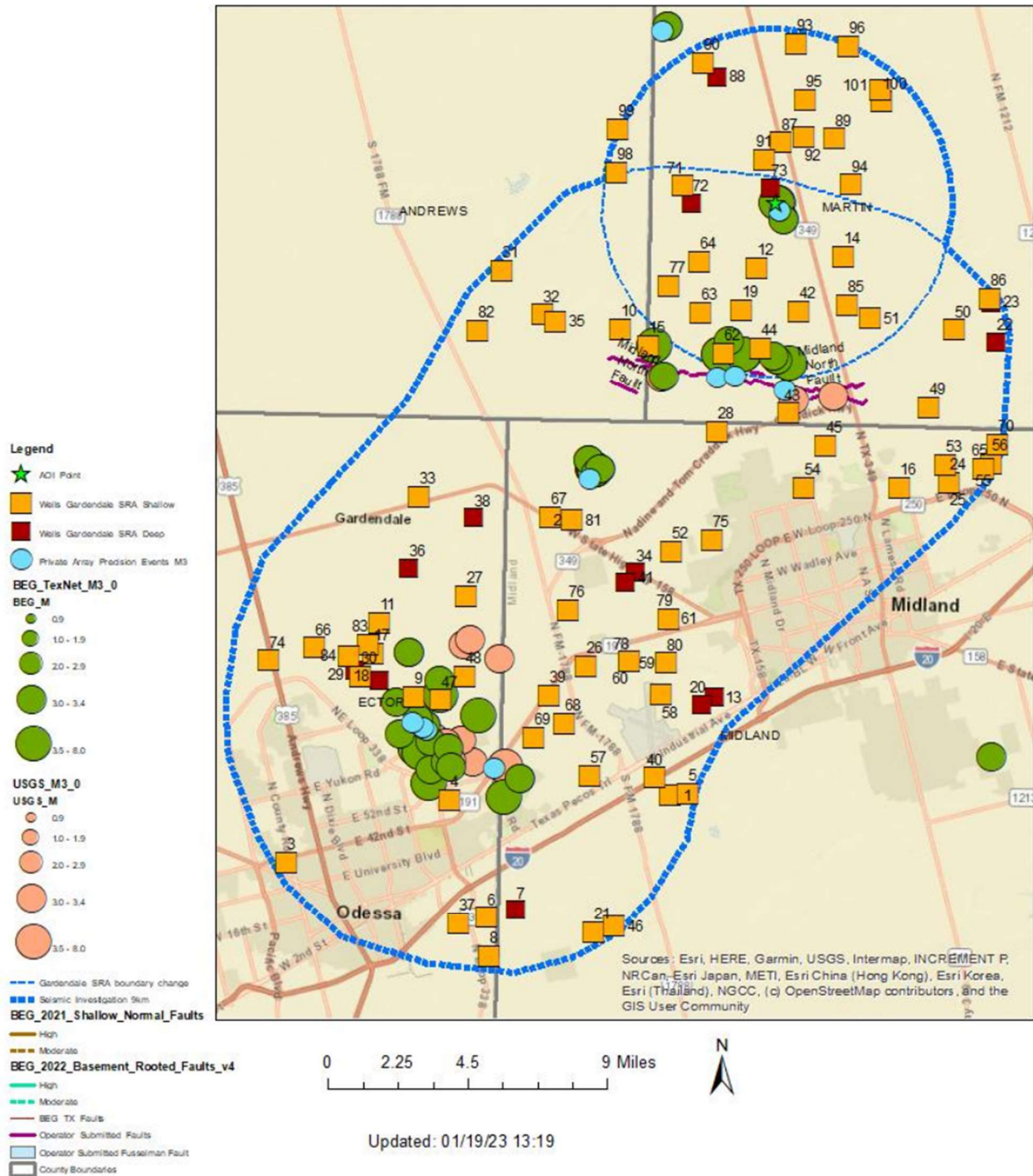


Figure 2A: Permitted Shallow SWD Wells within Gardendale SRA

INDEX NO	ADDED TO SRA	STATUS UPDATED	OPERATOR	OP. NUMBER	LEASE NAME	WELL NO	UIC NUMBER	DAILY AVG 2022 (BBL)	PERMIT MAX (BBL)
1			SELECT AGUA LIBRE MIDSTREAM, LLC	765601	WEST MIDLAND SWD	1	000102302	2,679	20,000
3			CAMBRIAN MANAGEMENT, LTD.	126758	BAGLEY, VINA	14	000102849	-	10,000
4			CHEVRON U. S. A. INC.	148113	HEADLEE DEVONIAN UNIT	63	000039662	-	5,000
5			CHEVRON U. S. A. INC.	148113	SOA SCHARBAUER SE	2109M	000117380	3,515	15,000
6			COG OPERATING LLC	166150	PARKS, ROY -B- TG	19D	000012239	150	15,000
8			COG OPERATING LLC	166150	PARKS, ROY -B- TG	24W	000012242	339	15,000
9			COG OPERATING LLC	166150	RATLIFF A	3201	000101348	232	15,000
10			COG OPERATING LLC	166150	CROSS BAR RANCH	2000SW	000101479	6,022	10,000
11			COG OPERATING LLC	166150	RATLIFF A	1903	000104207	2,389	15,000
12			COG OPERATING LLC	166150	JOHNSON RANCH	1000SW	000104336	5,000	12,000
14			COG OPERATING LLC	166150	GLASS, G.W. "B"	19	000110036	1,115	10,000
15			COG OPERATING LLC	166150	CROSS BAR RANCH	1901SW	000110055	4,117	15,000
16			COG OPERATING LLC	166150	SYNATSCHK	100SW	000110504	1,107	20,000
17		CONVERTED DEEP TO SHALLOW	COG OPERATING LLC	166150	RATLIFF A	3004SW	000111129	-	24,000
19		CONVERTED DEEP TO SHALLOW	COG OPERATING LLC	166150	JOHNSON RANCH	16SW	000116559	-	24,000
21			CORONADO OPERATING, LLC	179385	ST. GEORGE SWD	1	000123046	-	25,000
24			DE3 OPERATING LLC	518310	MAYS 20 SWD	1	000118122	-	25,000
26			DIAMONDBACK E&P LLC	217012	KINGSNAKE	1D	000124768	-	20,000
27			EARTHSTONE OPERATING, LLC	238732	WHITTENBURG	2200SW	000101188	286	10,000
28		CONVERTED DEEP TO SHALLOW	ENVIRONMENTAL DSPL SYSTEMS, LLC	253105	NORTHWEST MIDLAND SWD	1WD	000113218	-	20,000
30		CONVERTED DEEP TO SHALLOW	EUREKA PROSPECTING COMPANY	255347	RATLIFF RANCH 'A'	5A	000116242	245	10,000
31		CONVERTED DEEP TO SHALLOW	FASKEN OIL AND RANCH, LTD.	263696	DAVID FASKEN "O"	1	000099289	3,627	30,000
32		CONVERTED DEEP TO SHALLOW	FASKEN OIL AND RANCH, LTD.	263696	FEE "BM"	1	000103009	1,901	30,000
33		CONVERTED DEEP TO SHALLOW	FASKEN OIL AND RANCH, LTD.	263696	FEE "BL" SWD	1	000104206	3,005	30,000
35			FASKEN OIL AND RANCH, LTD.	263696	FEE "BM"	25W	000111251	1,643	20,000
37			FIREBIRD ENERGY LLC	268933	PRO-SELECT SWD ECTOR	1	000107144	5,240	30,000
39			INFLOW OPERATING	424260	HOLIFIELD	1	000102300	3,131	15,000
40			NGL WATER SOLUTIONS PERMIAN, LLC	609265	MIDLAND SW	1	000107109	-	27,500
42			OCCIDENTAL PERMIAN LTD.	617544	SOUTH CURTIS RANCH	1416D	000103766	3,495	10,000
43			OCCIDENTAL PERMIAN LTD.	617544	SOUTH CURTIS RANCH	404	000108021	3,674	10,000
44			OCCIDENTAL PERMIAN LTD.	617544	SOUTH CURTIS RANCH	2130WD	000109530	6,085	10,000
45			OCCIDENTAL PERMIAN LTD.	617544	SOUTH CURTIS RANCH	1026WD	000109649	-	10,000
46			GRAVITY WATER MIDSTREAM OP LLC	326423	1788 SWD	2	000115006	9,939	20,000
47			OWL SWD OPERATING, LLC	629870	PARKS BELL SWD	4101	000106396	4,987	20,000
48			OWL SWD OPERATING, LLC	629870	SWD PARKS BELL	3301	000106400	6,534	20,000
49			PIONEER NATURAL RES. USA, INC.	665748	STIMSON BURLEY -D-	1D	000045155	593	6,000
50			PIONEER NATURAL RES. USA, INC.	665748	GLASS -E-	1D	000050386	320	6,000
51			PIONEER NATURAL RES. USA, INC.	665748	GLASS -J-	2D	000064225	268	5,000
52			PIONEER NATURAL RES. USA, INC.	665748	PECAN ACRES 23	1D	000105168	-	8,000
53			PIONEER NATURAL RES. USA, INC.	665748	ALEX 17	1D	000116241	10,705	25,000
54		CONVERTED DEEP TO SHALLOW	PIONEER NATURAL RES. USA, INC.	665748	DIAMOND RIO 9	1D	000117514	14,252	30,000
56		CANCELLED	PIONEER NATURAL RES. USA, INC.	665748	MABEE FOUNDATION 'G'	1DD	000118206	-	25,000
57			RATTLER MIDSTREAM OPERATING LLC	694704	HOOPER SWD	1	000108124	3,724	20,000
58		CONVERTED DEEP TO SHALLOW	RATTLER MIDSTREAM OPERATING LLC	694704	HMW	1	000112479	5,437	20,000
62		CONVERTED DEEP TO SHALLOW	RATTLER MIDSTREAM OPERATING LLC	694704	KIRBY	1D	000119159	7,798	24,999
63		CONVERTED DEEP TO SHALLOW	RATTLER MIDSTREAM OPERATING LLC	694704	DIRT DEVIL	1D	000119160	6,371	20,000
64			RATTLER MIDSTREAM OPERATING LLC	694704	ROOMBA	1D	000124875	-	20,000
65			SHENANDOAH PETROLEUM CORPORATION	775563	SHENANDOAH BAR M SWD	400D	000124265	-	25,000
66			SLANT OPERATING, LLC	786697	BARROW, AUGUSTA	2	000015177	320	6,000
67		CONVERTED DEEP TO SHALLOW	SOLARIS WATER MIDSTREAM, LLC	801148	M.F. KING SWD	2	000109838	-	30,000
68		CONVERTED DEEP TO SHALLOW	RATTLER MIDSTREAM OPERATING LLC	694704	DJK 48 SWD	1	000114255	-	24,000
69		CONVERTED DEEP TO SHALLOW	SOLARIS WATER MIDSTREAM, LLC	801148	KATYLIZ SWD	1	000118005	-	24,000
70			ENVIRONMENTAL DSPL SYSTEMS, LLC	253105	SHENANDOAH BAR M SWD	2	000119433	6,372	25,000
71		CONVERTED DEEP TO SHALLOW	HIGH LONESOME MIDSTREAM, LLC	100176	MABEE SOUTH SWD	2	000108807	-	30,000
74			GRAVITY WATER MIDSTREAM OP LLC	326423	CUDA DISPOSAL	1	000105208	227	15,000
75			XTO ENERGY INC.	945936	ROBBIE	24	000105122	-	20,000
76			XTO ENERGY INC.	945936	NOBLES	30	000105543	-	20,000
77	11/30/2021		RATTLER MIDSTREAM OPERATING LLC	694704	HOOVER	1D	000124979	7,139	20,000
78	2/10/2022		RATTLER MIDSTREAM OPERATING LLC	694704	RATTLER	2D	000125102	2,595	20,000
79	2/10/2022		RATTLER MIDSTREAM OPERATING LLC	694704	DYSON	2D	000125103	7,961	20,000
80	3/10/2022		RATTLER MIDSTREAM OPERATING LLC	694704	HMW	4D	000125153	-	20,000
81	4/8/2022		CALLON PETROLEUM OPERATING CO	124828	CASSELMAN8	2D	000125186	-	20,000
82	4/13/2022		FASKEN OIL AND RANCH, LTD.	263696	FEE 'BP'	501	000125193	-	20,000
83	5/10/2022		COG OPERATING LLC	166150	RATLIFF A	1901	000101272	-	1,500
84	5/10/2022		EUREKA PROSPECTING COMPANY	255347	RATLIFF, S. W., -A-	13J	000102703	299	3,000
85	5/10/2022		VENCER ENERGY, LLC	884498	GEORGE W. GLASS -24-	1D	000089207	102	1,500
86	6/9/2022		CROWNQUEST OPERATING, LLC	191554	SOCKET	1D	000125294	-	10,000
87	12/18/2022		BLACKBUCK-N DEEP, LLC	72509	HORNED FROG	1	000104257	-	20,000
89	12/18/2022		GRAVITY WATER MIDSTREAM OP LLC	326423	ROADRUNNER 349	1	000110975	2,751	25,000
90	12/18/2022		HIGH LONESOME MIDSTREAM, LLC	100176	MABEE 4 SWD	1	000125659	-	10,000
91	12/18/2022		NGL WATER SOLUTIONS PERMIAN, LLC	609265	MARTIN SWD	2	000111717	156	25,000
92	12/18/2022		PIONEER NATURAL RES. USA, INC.	665748	SCHARBAUER -H-	1D	000067865	-	15,000
93	12/18/2022		PIONEER NATURAL RES. USA, INC.	665748	SCHARBAUER RANCH	3D	000107461	10,446	18,000
94	12/18/2022		PIONEER NATURAL RES. USA, INC.	665748	LOTTIE	2D	000108804	2,658	25,000
95	12/18/2022		PIONEER NATURAL RES. USA, INC.	665748	DOVE "Z"	1D	000109714	7,990	20,000
96	12/18/2022		PIONEER NATURAL RES. USA, INC.	665748	SCHARBAUER RANCH	4D	000117648	8,690	25,000
98	12/18/2022		SCOUT ENERGY MANAGEMENT LLC	760218	MABEE UNIT	279W	000102939	-	20,000
99	12/18/2022		SCOUT ENERGY MANAGEMENT LLC	760218	MABEE UNIT	41	000113489	-	12,000
100	12/18/2022		VENCER ENERGY, LLC	884498	SCHARBAUER SWD	1	000117120	-	10,500
101	12/18/2022		VENCER ENERGY, LLC	884498	SCHARBAUER "B"	17R	000119940	7,872	25,000

Figure 2B: Permitted Deep SWD Wells within Gardendale SRA

INDEX NO	ADDED TO SRA	STATUS UPDATED	OPERATOR	OP. NUMBER	LEASE NAME	WELL NO	UIC NUMBER	DAILY AVG 2022 (BBL)	PERMIT MAX (BBL)
2		SUSPENDED	CALLON PETROLEUM OPERATING CO	124828	CASSELMAN8	1D	000112402	-	30,000
7		SUSPENDED	COG OPERATING LLC	166150	PARKS, ROY -B- TG	20W	000012240	-	25,000
13		SUSPENDED	COG OPERATING LLC	166150	SPANISH TRAIL	200SW	000109201	5,047	30,000
18		SUSPENDED	COG OPERATING LLC	166150	S. W. RATLIFF -L-	1	000115273	-	25,000
20		SUSPENDED	COG OPERATING LLC	166150	SPANISH TRAIL	300SW	000117962	-	40,000
22		SHUT-IN	CROWNQUEST OPERATING, LLC	191554	NAIL RANCH "36"	1D	000113312	10,484	30,000
23		SHUT-IN	CROWNQUEST OPERATING, LLC	191554	WATERBURGER	1D	000117180	14,106	25,000
25		SUSPENDED	DE3 OPERATING LLC	518310	MAYS 20 SWD	1	000118123	-	35,000
29		SUSPENDED	EUREKA PROSPECTING COMPANY	255347	RATLIFF 'F'	1	000113121	-	3,000
34		MONITOR WELL	FASKEN OIL AND RANCH, LTD.	263696	FEE "AA"	1	000107930	59	30,000
36		SUSPENDED	FDL OPERATING, LLC	263924	GARDENDALE 8 SWD	1	000103282	-	7,000
38		SUSPENDED	INDEPENDENCE RESOURCES MGMT, LLC	423716	MCRAE FARM	1SW	000119285	-	20,000
41		PLUGGED	NGL WATER SOLUTIONS PERMIAN, LLC	609265	MIDLAND 817 SWD	1	000110306	-	25,000
55		SUSPENDED	PIONEER NATURAL RES. USA, INC.	665748	MABEE FOUNDATION G	1DD	000118205	-	25,000
59		PLUGGED	RATTLER MIDSTREAM OPERATING LLC	694704	HMW	2	000114496	6,940	30,000
60		PLUGGED	RATTLER MIDSTREAM OPERATING LLC	694704	RATTLER	1D	000115807	2,685	30,000
61		PLUGGED	RATTLER MIDSTREAM OPERATING LLC	694704	DYSON	1D	000117758	7,608	30,000
72		SHUT-IN	WASSER OPERATING, LLC	900210	MABEE 3 SWD	3	000114611	11,359	30,000
73		SHUT-IN	WASSER OPERATING, LLC	900210	MABEE SWD	1	000117564	6,711	60,000
88	12/18/2022	SHUT-IN	COG OPERATING LLC	166150	MABEE 239	1SW	000111185	5,777	30,000

Wells within Range Hill extn.



Figure 3: OLRG Membership

1	ConocoPhillips - Lead
2	Blackbuck-N Deep
3	Double Eagle
4	Endeavor
5	Fasken
6	Gravity Water Midstream
7	High Lonesome/Wasser
8	NGL
9	Ovintiv
10	Oxy
11	Pioneer
12	Diamondback (Rattler)
13	Scout Energy
14	Vencer Energy

Figure 4: Decision Matrix

Feb-March-April	1 May 2023 Start of Monitoring Plan		Forward Actions	
<p>OLPG will monitor seismicity rate and magnitude within 9km of each SWD</p>	<p>No seismicity above M3.5 observed within prior 3 months</p>	<p>Ease restriction to 15,000 bpd</p>	<p>No seismicity above M3.5 observed</p>	<p>Return to permitted volumes</p>
		<p>Allow new permit applications</p>		
		<p>Reinstate suspended permits</p>		
	<p>Seismicity above M3.5 observed within prior 3 months</p>	<p>Maintain 10,000bpd limitation on wells within 9km of seismicity</p>	<p>Seismicity above M3.5 observed</p>	<p>Maintain 10,000bpd limit, or 15,000 if previously eased</p>
		<p>Maintain suspension of new permits</p>		<p>Maintain suspension of new permits</p>
		<p>Reconvene as a group to propose additional actions</p>		<p>Reconvene as a group to propose additional actions</p>

Figure 5: Monitoring and Contingency Plan

