STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO. **COMM. CASE NO. 24123**

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS, LEA COUNTY, NEW MEXICO. **DIV. CASE NOS. 23614-23617**

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO. **DIV. CASE NO. 23775**

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO. **DIV. CASE NOS. 24018-24020, 24025**

EMPIRE PETROLEUM CORPORATION EST. 1983

Rebuttal Testimonies
(Exhibits J, K, L, M & N)
February 10, 2025

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STATE OF NEW MEXICO
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES
OIL CONSERVATION COMMISSION

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SELF-AFFIRMED STATEMENT OF ROBERT F. LINDSAY – REBUTTAL

I, Robert F. Lindsay make the following self-affirmed statement:

1. I am over the age of 18, and have the capacity to execute this affirmation, which is based on my personal knowledge.

2. I submit this statement on behalf of Empire New Mexico LLC in connection with the above-referenced matters, in accordance with paragraph 7 of the Pre-Hearing Order issued in these matters on December 5, 2024.

3. I have not previously testified before the New Mexico Oil Conservation Division as an expert witness. My curriculum vitae is attached to my self-affirmed statement filed as Exhibit B on August 26, 2024, in these matters.

EXHIBIT J

4. I have reviewed the testimony of Mr. Preston McGuire filed on August 26, 2024 on behalf of Goodnight Midstream Permian, LLC ("Goodnight"). I make this statement in rebuttal to some of the conclusions drawn by his testimony, particularly the items described below.

5. On page 3 of Preston McGuire's testimony he indicates "Substantial data on the sustained and geographically extensive pressure differentials between the Grayburg and San Andres aquifer confirm (1) the presence of an effective geologic barrier between the two formations, and (2) that the Grayburg reservoir and San Andres aquifer are distinct geologic zones that are functionally severed and do not act, and cannot be considered, as a single reservoir." These are not true statements for the following reasons:

- From a well log perspective it would appear that there is a barrier between the overlying Grayburg Formation and underlying San Andres Formation. However, cores from both EMSU-679 and RR Bell #4 show that there are fractures through both Grayburg and San Andres formations.
- Both EMSU Grayburg reservoir and San Andres residual oil zone (ROZ) were dolomitized during the Permian. Dolomitization of carbonate rock forms a more brittle rock that can be easily fractured.
- When the EMSU asymmetric anticline formed during the Laramide orogeny in the Cretaceous into the Early Tertiary, Grayburg and San Andres dolostones were fractured. Fracture sets form what are termed fracture halos. Undersaturated fluids later solution-widened many of the fractures. No one individual solution-widened fracture will look like it is connected to other fractures. However, the only way to solution-widen a fracture is to have undersaturated water traverse through connected fractures.

- Grayburg and San Andres formations are in fluid communication. Historically, this has been proven by ascending plumes of water, where San Andres water ascended vertically upsection into the Grayburg. San Andres water is <10,000 ppm and contains sulfate (SO_4). This water is easy to identify via water analysis. Grayburg reservoir connate water is 120,000 ppm and contains Barium (Ba). Grayburg edge water, sourced from the Goat Seep aquifer, is <10,000 ppm and contains no sulfate (SO_4). Plumes of water were mapped in AGU prior to unitization. EMSUB-887 is another example of where a plume of water ascended vertically around the wellbore through fractures. EMSUB-887 core was found to be highly fractured and a fracture study was performed on that well.

6. On page 15 of Mr. McGuire's testimony, he states "There has never been any evidence that San Andres disposal operations have interfered with the Grayburg producing zone in the 60 plus years since San Andres disposal began at the EMSU." This is not true for the following reasons:

- As stated in my PhD dissertation and on page 45 of Mr. McGuire's testimony, "There have been places found in EMSU, EMSUB, and AGU where faults/fractures have allowed Upper San Andres Formation fluids to move up section into Grayburg Formation strata, which form vertically-oriented plumes of Upper San Andres Formation water within the Grayburg Formation." Injected water that is not managed by proper water injection monitoring can cause nonuniform sweep in the reservoir and bypass reserves.

- Chevron in their September 1989 Technical Committee Report on the Proposed Arrowhead Grayburg Unit (Exhibit J-1) specifically states, "Although siliciclastics between each zone generally prevent vertical communication, in some localized areas of the field they do not act as permeability barriers. When the barriers break down in the lower Grayburg members, the prolific San Andres aquifer can influx into the oil production horizons resulting in large volumes of water production." This additional water production increases handling costs and prevents uniform sweep in the reservoir.
- There have been vertically oriented water plumes that have risen up section from the San Andres ROZ into the Grayburg Reservoir through natural fractures, thus impacting Grayburg oil production.
- Disposal operations since 1986 could have impacted production much worse than it has if not for the large volumes of water produced from the San Andres water supply wells. Now that water withdrawals have slowed and water disposal increased, the impact upon Grayburg oil production will be much worse.

7. On page 21 of Mr. McGuire's testimony he states, "The upper San Andres is capped by tight dolomite and anhydrite, which serves as the upper geologic seal to prevent migration to the formations above, most importantly the producing Grayburg formation. This is not correct for the following reasons:

- Goodnight's selection of the top of the San Andres is inaccurate and in most cases is 150' to 200' too low. This would put their top of the San Andres reservoir at approximately the Lovington sandstone, which is not a complete barrier to fluid flow.
- There is also no bedded anhydrite within EMSU in the San Andres based on core studies. Nonporous dolomite is fractured.

- Non-porous dolomite is not laterally continuous as a layer, with much of the upper San Andres composed of sinkholes that are not laterally extensive but tend to form rounded to elongate solution-widened vertically oriented features filled with collapse breccia.

8. On page 35 of Mr. McGuire's testimony he states, "It appears Empire is seeking to create a conflict with Goodnight's disposal operations by calling a potential Grayburg ROZ (the zone below the Grayburg oil-water contact at -325 feet subsea) the San Andres. It is not the San Andres." This is not true for the following reasons:

- Goodnight's pick of the top of San Andres is low and therefore excludes a large portion of the San Andres ROZ from their estimates of oil-in-place. The structure is highest northeast of the Goodnight SWD wells, with R.R. Bell No. 4 (30-025-27504) reaching a subsea elevation of -319' subsea, well above the Grayburg oil-water contact. This results in a large San Andres ROZ in this area of the field. Even if we use Goodnight witness William Knight's testimony that there is a ROZ from -350' to -500' subsea, this would indicate that there is 181' of ROZ at the R.R. Bell No. 4 location inside EMSU.
- The Grayburg oil-water contact is not at -325' subsea as stated by Goodnight. The producible oil-water contact is at -540' subsea. Historically, water free oil was produced from -100' to -350' subsea. From -350' to -540' subsea a mixture of oil and water was produced. Beneath -540' subsea only water is produced from vertical wells.
- Oil saturations continue down section past -540' subsea in core (EMSU-329) to the base of the cored interval. A Grayburg ROZ in EMSU extends below -540' based on this core information.

9. On page 34 of Mr. McGuire's testimony he indicates "It appeared that the previous operators of the EMSU were not focused on picking an accurate or precise San Andres top in the EMSU. This is likely due to the fact that the San Andres aquifer is well below the oil-water contact at the EMSU, was never prospective for hydrocarbons, and not included in the EMSU waterflood operations." These statements are not correct for the following reasons:

- You never, I repeat never, correlate and try to pick the top of the San Andres formation using engineering data.
- The San Andres formation top has been regionally correlated throughout the Permian Basin by geologists that understand Permian Basin stratigraphy.
- The San Andres formation has been extensively studied in the Guadalupe Mountains and the top of San Andres has been correlated into the subsurface via well logs and cores.
- The San Andres top is a regional unconformity. Core tied back to well logs is the surest way to identify the top of the San Andres.
- Using core and well logs is how Empire has identified the top of the San Andres.
- Since the San Andres and Grayburg are each composed of carbonate strata deposited during lowstand, transgressive, and highstand cycles of deposition, the San Andres top is not always easy to reconcile on the logs. It often takes core data to confirm the actual top. When sea level rose, muddy deposits were laid down and when seal level fell, porous carbonate material was deposited. It was important for Chevron and XTO to know where the top of San Andres is so that they could drill their open hole completions only through the Grayburg interval and avoid exposing the San Andres ROZ interval.

- Goodnight fails to honor the unitization type log top for the field on the Meyer B-4 Well No. 23 (now EMSU SWD #1) which has the top of San Andres at 3942' (-347' subsea) which puts it right at the top of their Grayburg ROZ from -350' to -500' subsea. They have the San Andres picked at 4150' (-555' subsea) which is 208' too low.
- The R.R. Bell #4 where core data is available shows the top of San Andres at 3882' (-331' subsea). This well has a large ROZ in the San Andres as shown by core data.
- EMSU-679 core data shows the top of the San Andres at 4144' (-548' subsea). Even with this well being in a downdip position, it cored oil down to -762' subsea and therefore has at least a 214' ROZ.

10. On page 45 of Preston McGuire's testimony he states that "Dr. Lindsay's statements alleging the presence of localized pathways are not supported by any data and no sources are cited to corroborate this statement. There is no discussion as to which Grayburg well or wells he contends produced San Andres aquifer water or how he was able to diagnose the purported plumes as water from the San Andres." I have the following comments on this:

- A fracture study on EMSU-679 (Exhibit J-2) core was performed by me while working for Chevron in 1991. This study has been provided to Goodnight.
- That fracture study focused on lower Grayburg Formation strata in zones 4, 5, and 6, as EMSU was under waterflood (secondary recovery) since unitization in the 1980's.
- This study pointed out that there were 313 vertical fractures and 4 intervals of collapse breccia within the 120' of oriented core, with northwesterly and poorly developed northeasterly trend of fractures.

- The lowermost part of the EMSU-679 oriented core extended 36' down section into the upper San Andres (Exhibit J-3) residual oil zone strata. Top of upper San Andres was intersected at 4144' (-548' subsea), with oriented core extending down section to 4180' (-584' subsea).
- The remainder of the EMSU-679 cored interval, cores 3-5 from 4180' to 4258' (178' total) were not oriented and were not included in the fracture study.
- As shown by Exhibit J-4, the upper San Andres had 129 total vertical fractures. These fractures have a major trend northeast to southwest, with a lesser trend northwest to southeast, and a minor trend north northeast to south southwest.
- As shown by Exhibit J-5, a total of 18 large vertical fractures were identified in the San Andres, with lengths between 1-3 feet. These large vertical fractures have a major trend to the east northeast to west southwest, with a lesser trend northwest to southeast.
- As shown by Exhibit J-6, a total of 109 small vertical fractures were identified that have lengths of a few inches. A major trend is northeast to southwest, with two intermediate trends west to east and northwest to southeast trend. Even with these fractures being small, they can contribute to communication between layers of strata and into higher permeability intervals.
- As shown by Exhibit J-7, a total of 82 fractures in collapse breccia were measured. Fractures associated with collapse breccia trend northeast to southwest and west northwest to south southwest.

- As shown by Exhibit J-8, only a small number of pyritized fractures (4 in total) were identified. Pyritized fractures trend northeast to southwest and east northeast to west southwest.
- Fractures in the upper San Andres were found to be en echelon with many solution-widened. En echelon fractures are indicative of a small fault zone surrounded by a fracture halo containing swarms of fractures.
- On the scale of a 4-inch core width it is hard to envision the swarm of fractures that surround the cored interval. However, these vertical en echelon fractures are connected with each other, which allowed the late stage undersaturated fluid during the late Eocene to Early Miocene, to dissolve and solution-widen individual fractures in dolostone strata.
- Origin of fractures was when the Eunice Monument double-humped asymmetric anticline formed during the Laramide orogeny. Folding of San Andres strata, composed of brittle dolostone, created a series of intersecting fractures. Not only did fractures form, but they formed as en echelon swarms of fractures with many solution-widened by ascending late stage undersaturated fluids. Late stage undersaturated fluids were provided in the Late Eocene to Early Miocene as meteoric water recharged into the subsurface of the Permian Basin (Lindsay, 1998; 2024).
- Though a small fracture study in the EMSU 679 oriented core of only the uppermost 36’ of upper San Andres, this study has identified that the San Andres is extensively fractured. The reason for so many fractures being present in such a short interval of strata is due to the San Andres strata having been dolomitized. Dolomitization

creates a rock that is much more brittle when compared to the limestone, and much easier to fracture.

- In addition to the EMSU-679 oriented fracture study, I had previously performed fracture studies on the EMSUB #887, AGU-225, and AGU-600 oriented cores in the Grayburg interval. This study is included with this rebuttal (Appendix 1).
- EMSUB #887 experienced abnormal water production which field personnel classified as a "plume" of San Andres water. After performing the oriented core study, it was determined that large vertical fractures were the reason why water ascended up-section out of the San Andres into Grayburg strata.
- AGU (Arrowhead Grayburg Unit) also experienced high water production in a number of wells and was mapped to show plumes of San Andres water entering up-section into the Grayburg. Oriented core studies on AGU-225 and AGU-600 showed two major fracture trends, north northeast to south southwest in the southwest part of AGU and north northwest to south southeast in the northwest part of AGU. Siliciclastics separating Grayburg zones 1, 2, 3, 4, 5, and 6 act as partial barriers to fluid flow but when fractured, the barriers break down and communication of fluids can occur. As Chevron pointed out on Exhibit J-1, "when the barriers break down in the lower Grayburg members, the prolific San Andres aquifer can influx into the oil productive horizons resulting in large volumes of water production." This indicates that fracturing in the Grayburg can impact fluid flow from the San Andres and that there is no continuous barrier between the two horizons.

I affirm under penalty of perjury under the laws of the State of New Mexico that this statement is true and correct.

2/10/2025

Robert F. Lindsay DATE

Exhibit J-1

Technical Committee Report
Proposed Arrowhead Grayburg Unit
Lea County, New Mexico

Chevron

September 1989

A portion of the water production is probably attributable to communication of Zones 4 and 5 with the Lower Grayburg and San Andres aquifers. Although siliciclastics between each zone generally prevent vertical communication, in some localized areas of the field they do not act as permeability barriers. When the barriers break down in the lower Grayburg members, the prolific San Andres aquifer can influx into the oil productive horizons resulting in large volumes of water production.

Other water production may be attributable to completions in the Penrose (Lower Queen) which has been found to be influenced by a water drive in the EMSU. Additional portions of the water production can be attributed to casing leaks, which have been identified in 36 wells.

Localized areas of high water production consist of less than five proration units. In most cases, wells adjacent to high water production areas have produced significantly less water. The change in water production appears to be independent of completion depth, both subsea and stratigraphically, and no clear water production trend is identifiable.

Based on the lack of uniform water production and the relationship of pressure depletion to recovery, solution gas drive is thought to be the predominant primary recovery mechanism with water influx having only a minor effect on recovery. The Arrowhead Grayburg Pool is therefore a good candidate for waterflooding with respect to primary recovery mechanism.

Chevron indicates one source of water production is from the San Andres as barriers break down in the Lower Grayburg.

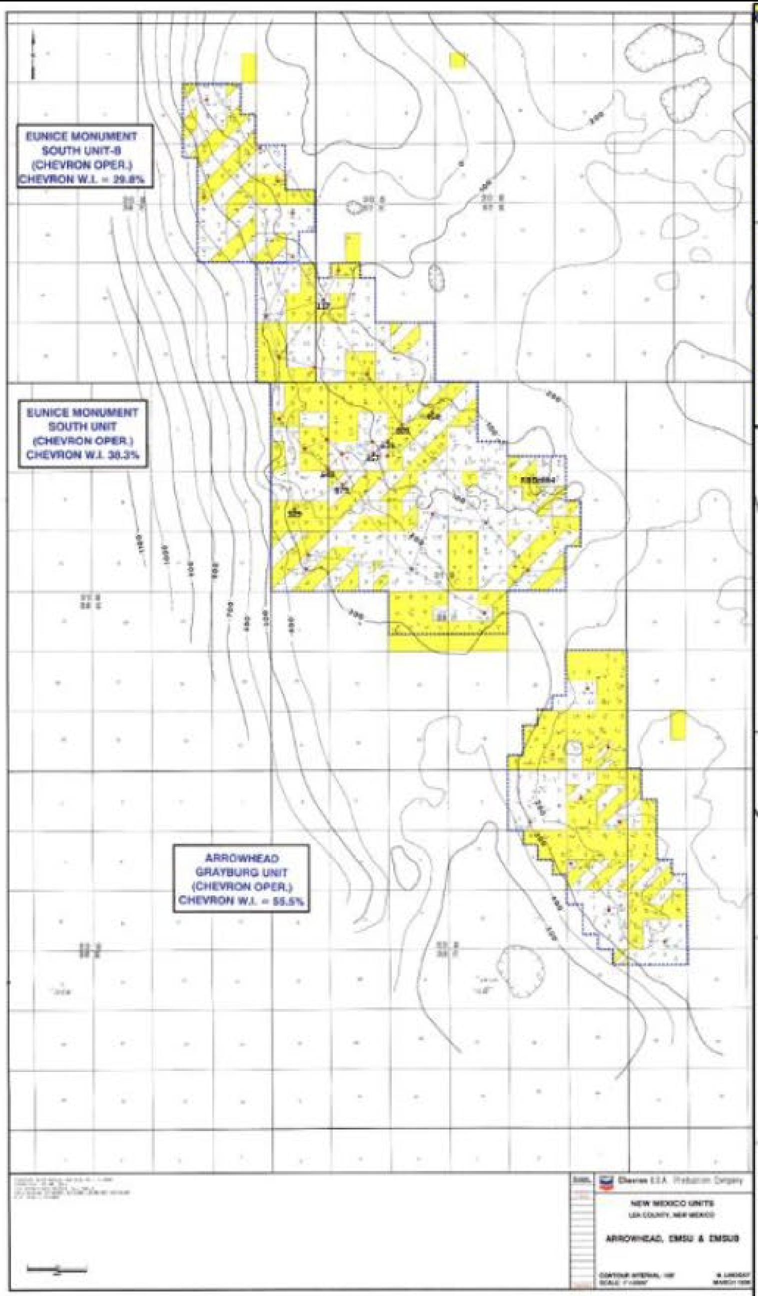
When they break down, the prolific San Andres aquifer can influx into the oil productive horizons resulting in large volumes of water production.

They indicate that solution gas drive is primary recovery mechanism with water influx having only a minor effect on recovery.

Exhibit J-2

Eunice Monument Unitized Fields

EMSUB-EMSU-AGU



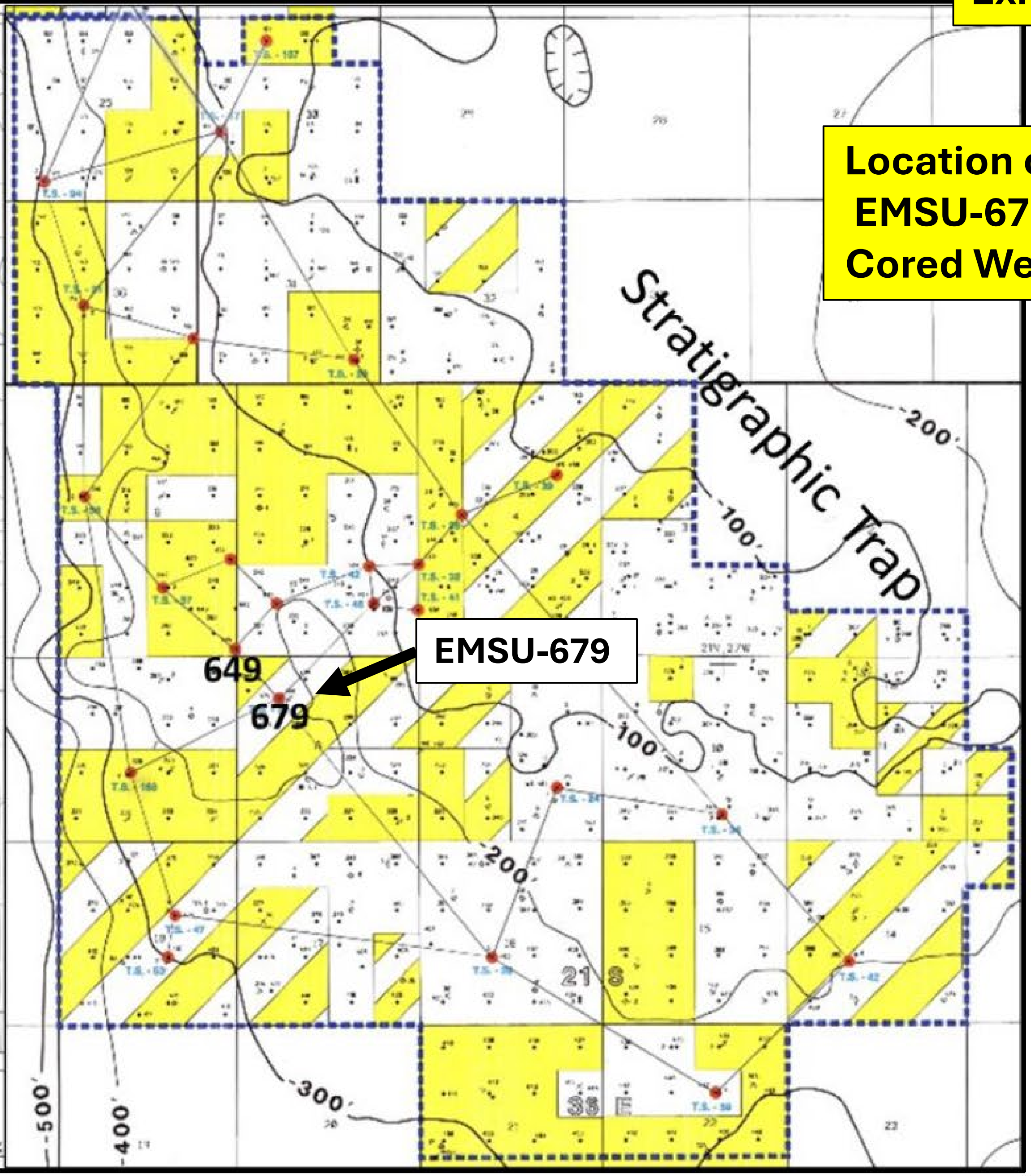
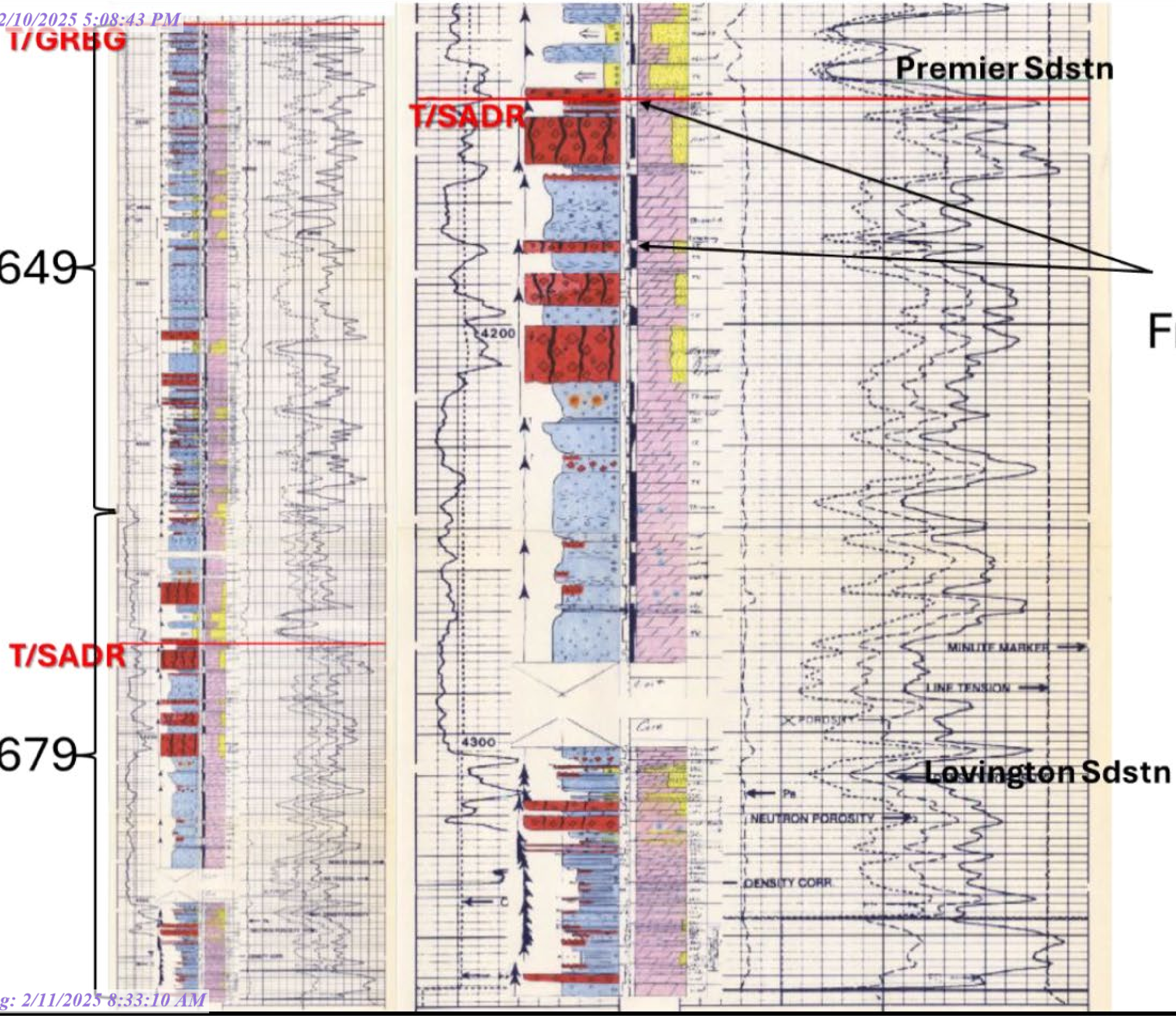


Exhibit J-3

EMSU-649

EMSU-679



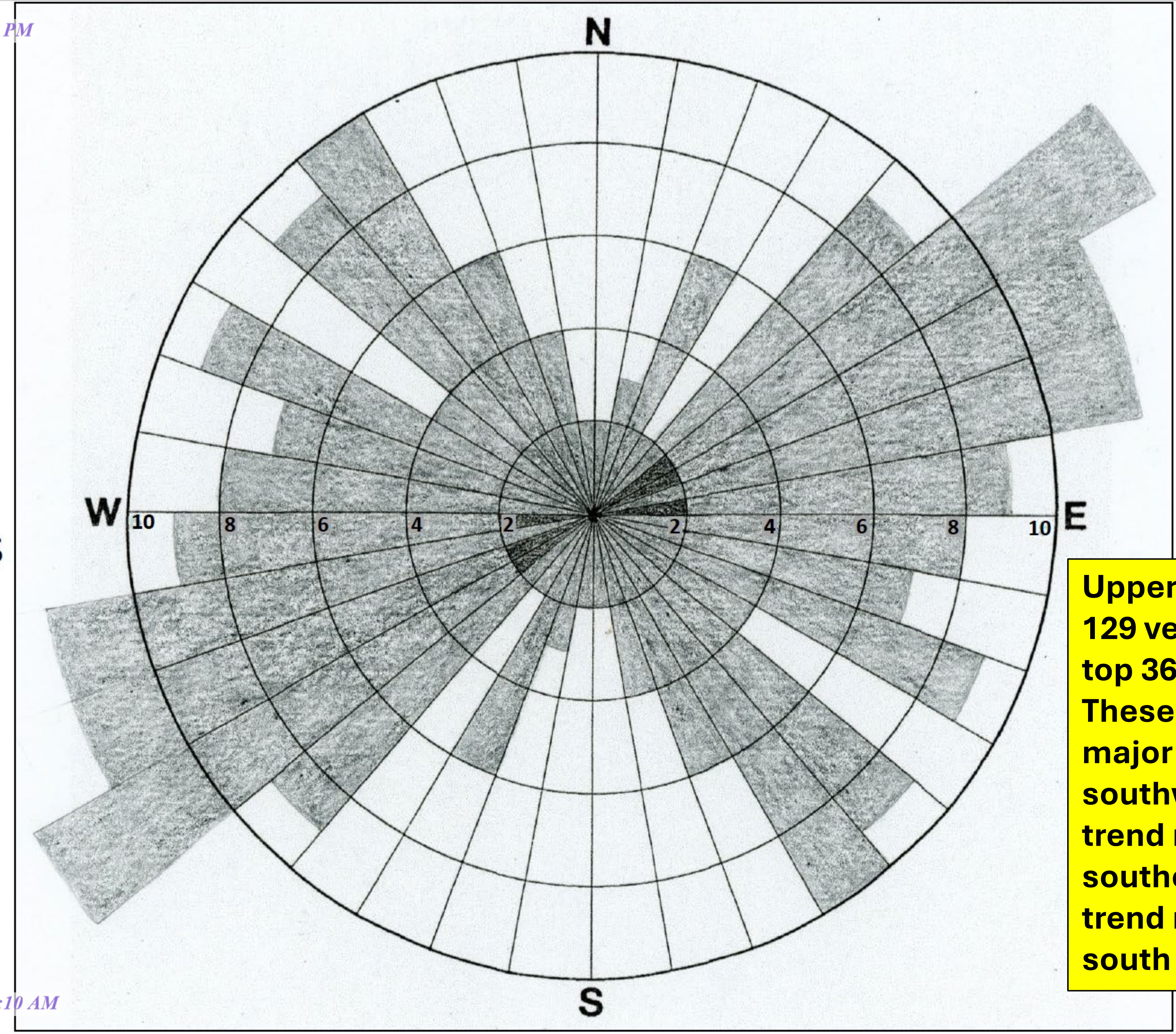
EMSU-679
San Andres
Fracture Study

Logs of EMSU-649 and EMSU-679 showing Grayburg and San Andres cored intervals (left)

Log of EMSU-679 showing cored interval in the San Andres (right)

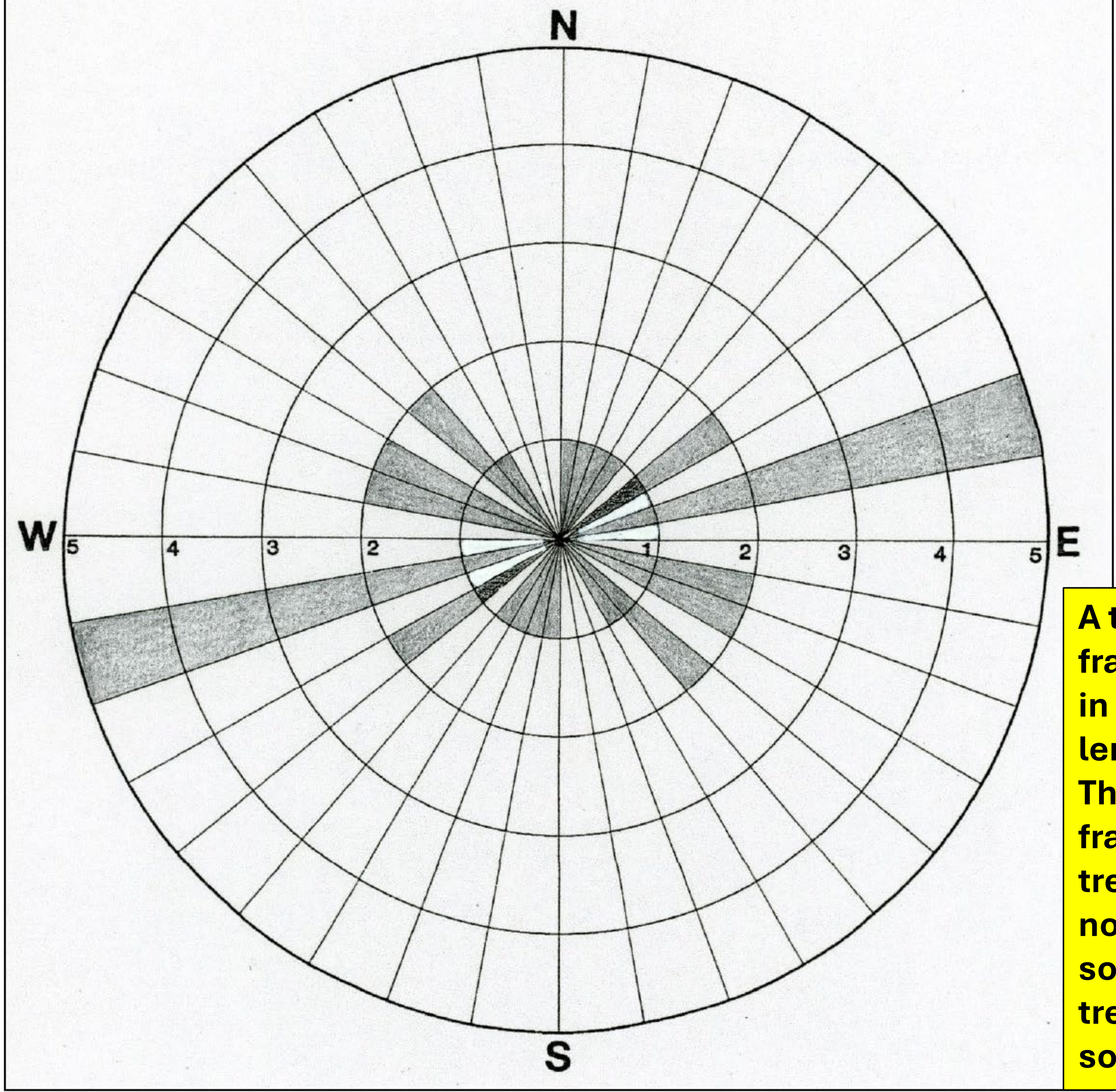
Exhibit J-4

EMSU-679
San Andres
Total Fractures
(129)



Upper San Andres had 129 vertical fractures in top 36' of oriented core. These fractures have a major trend northeast to southwest, with a lesser trend northwest to southeast, and a minor trend north northeast to south southwest

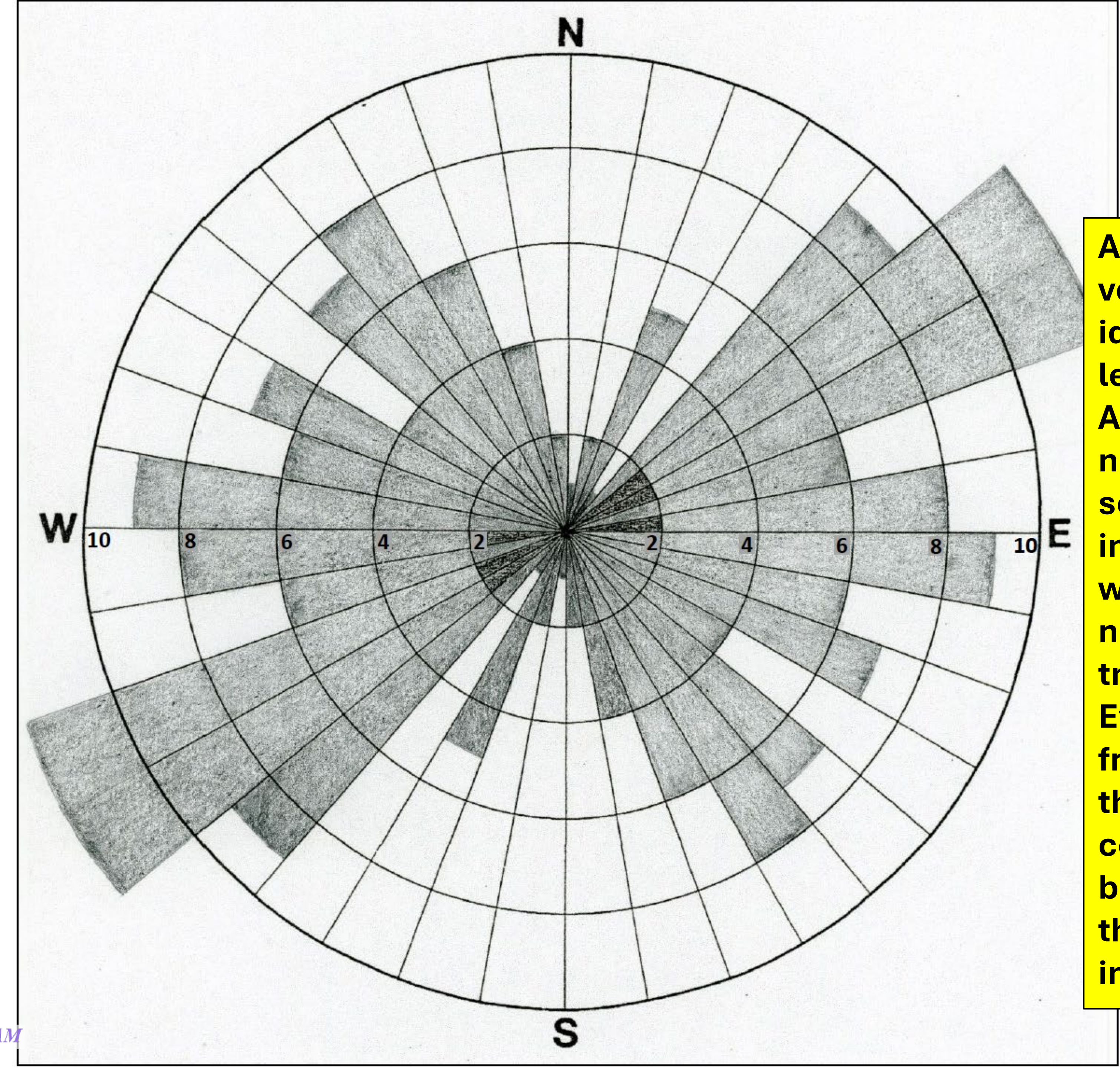
EMSU-679
San Andres
Large Fractures
(18)



A total of 18 large vertical fractures were identified in the San Andres, with lengths between 1-3 feet. These large vertical fractures have a major trend to the east northeast to west southwest, with a lesser trend northwest to southeast.

Exhibit J-6

EMSU-679 San Andres Small Fractures (109)



A total of 109 small vertical fractures were identified that have lengths of a few inches. A major trend is northeast to southwest, with two intermediate trends west to east and northwest to southeast trend.

Even with these fractures being small, they can contribute to communication between layers and into the higher permeability intervals.

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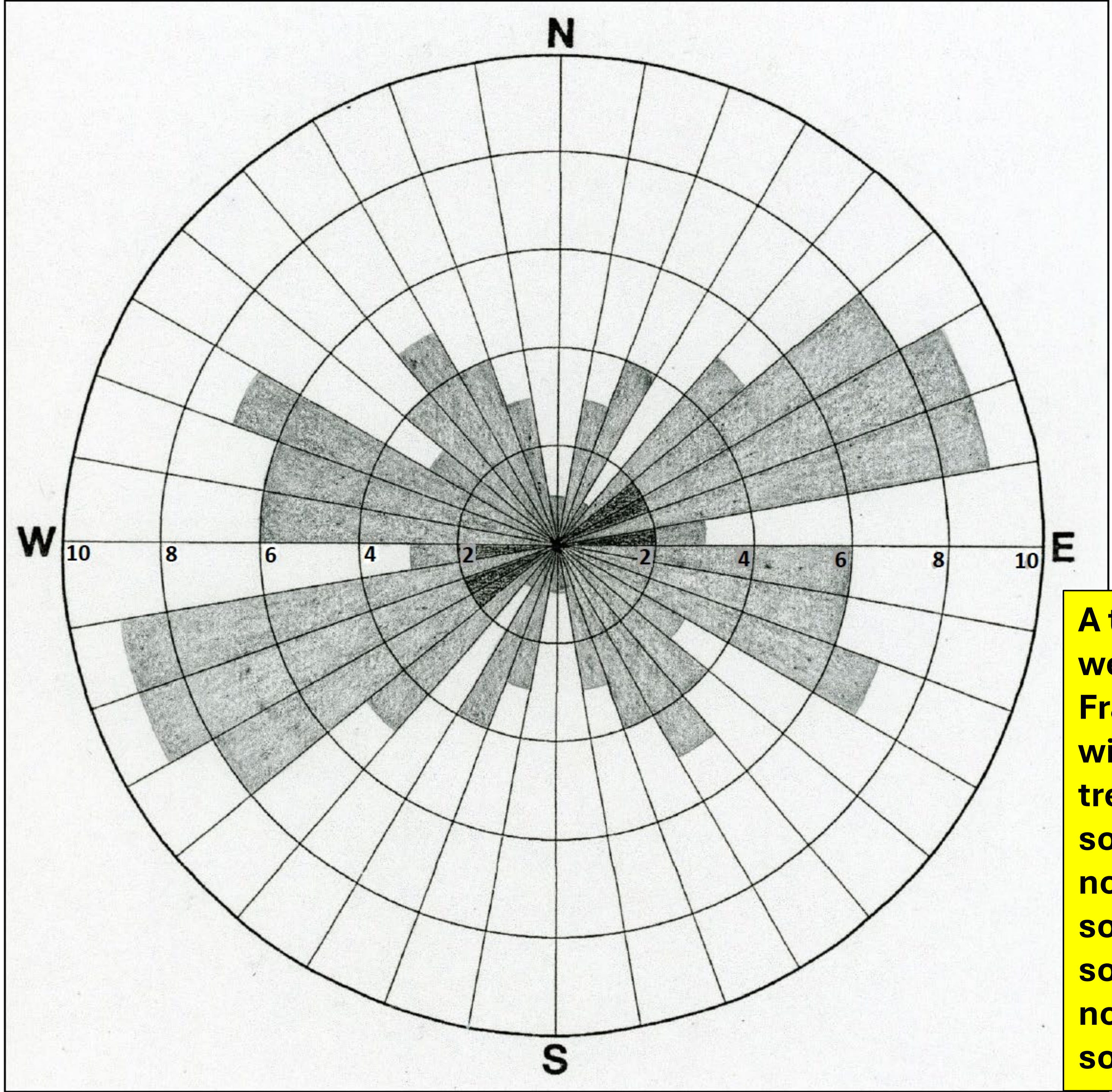
Exhibit J-7

EMSU-679
San Andres
Collapse Breccia
Fractures
(82)



A total of 82 fractures were measured. Fractures associated with collapse breccia trend northeast to southwest, west northwest to south southwest, northwest to southeast, and north northeast to south southwest.

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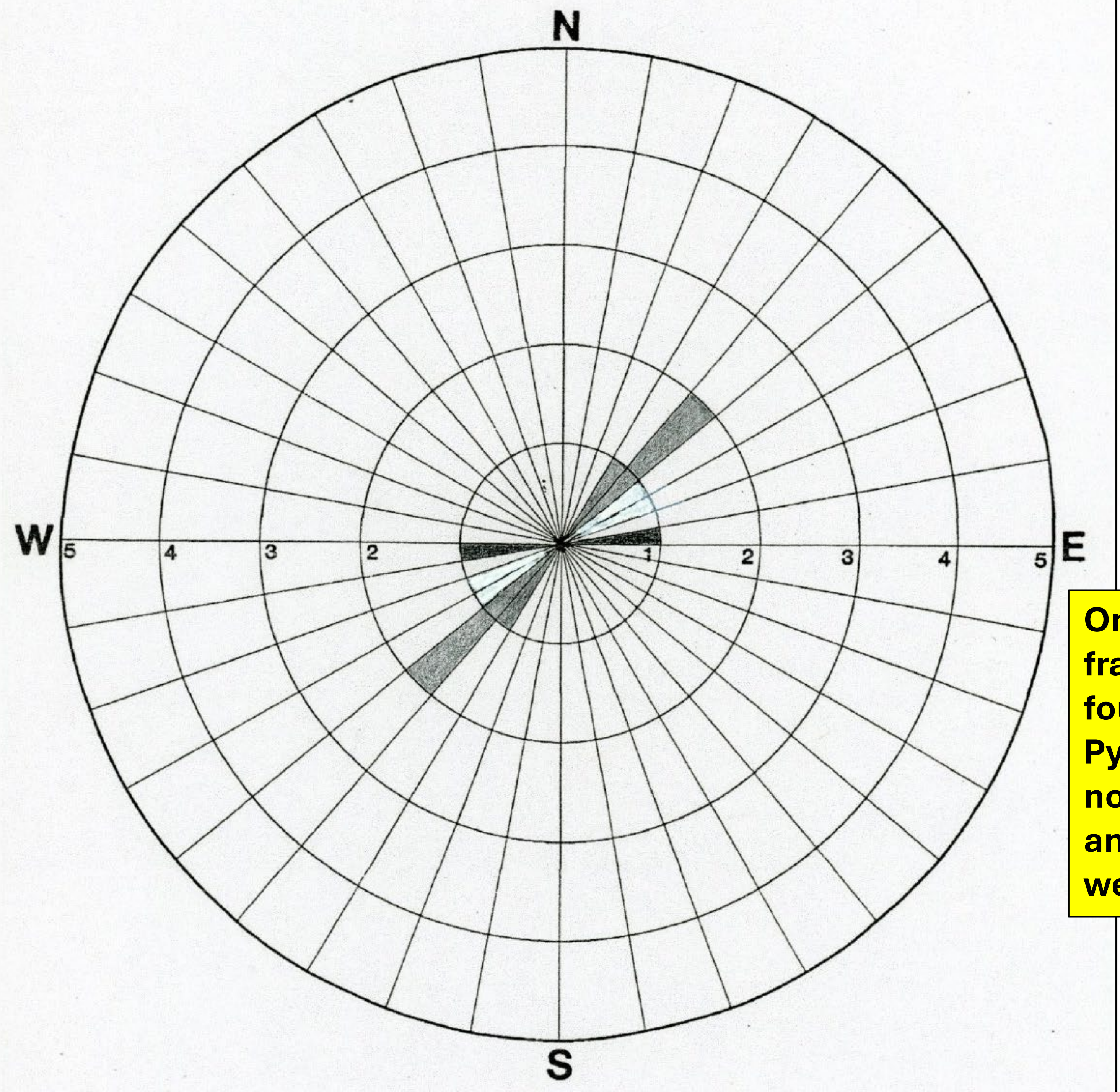
Exhibit J-8

EMSU-679 San Andres Pyrite in Fractures (4)



Only a small number of fractures (4 in total) were found to be pyritized. Pyritized fractures trend northeast to southwest and east northeast to west southwest.

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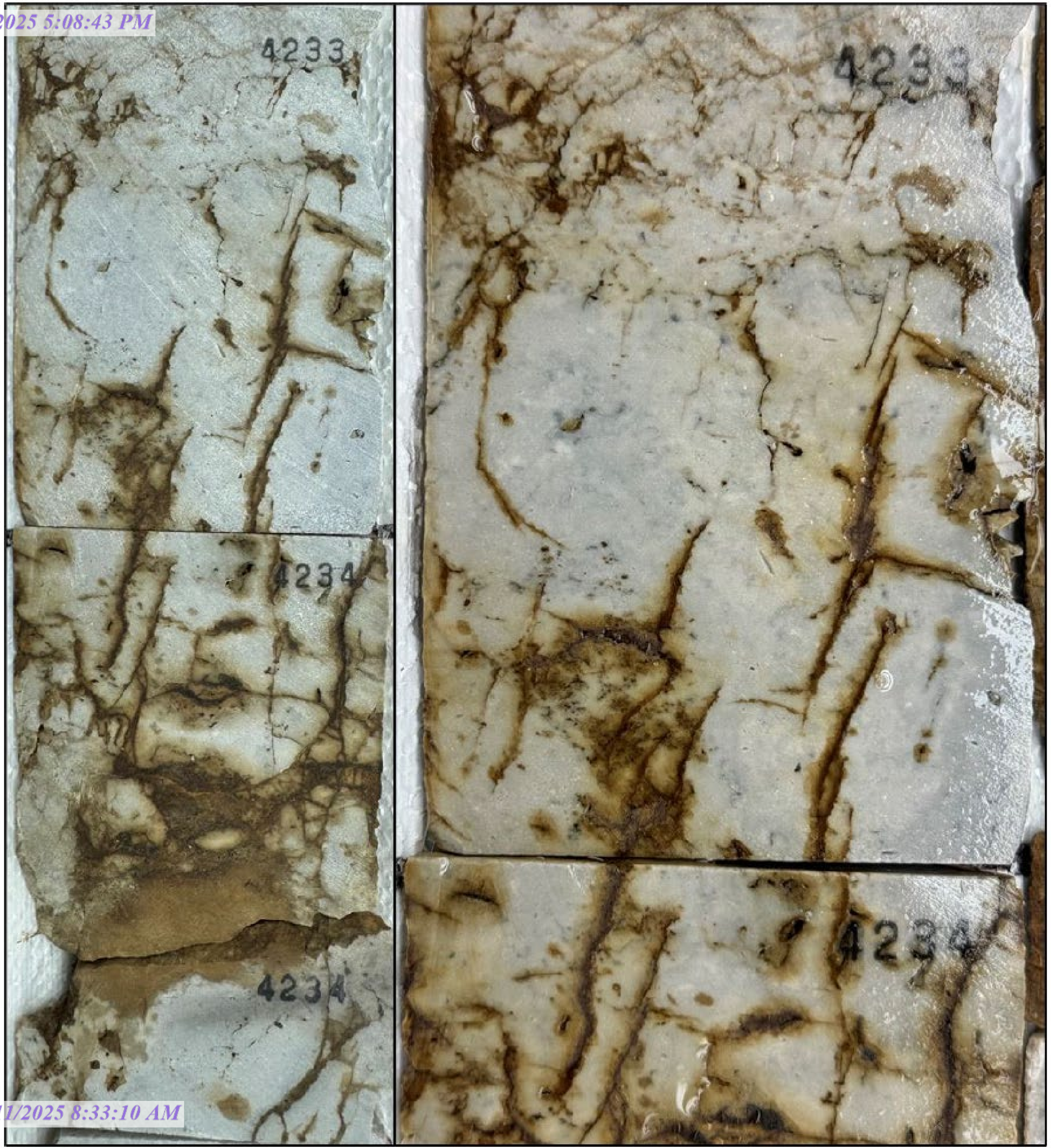
Exhibit J-9



San Andres en echelon solution-widened fractures from 4233-34' (-637 to -638' subsea) in EMSU-679 core.

Left photo = dry

Right photo = wet

Small fractures are in fluid communication. Otherwise, they would not have been solution-widened and saturated with mobile oil. This is typical of a fracture halo, where individual fractures appear to be isolated, when in reality they are connected to each other.

Exhibit J-10

Core analysis report for EMSU-679 with fracture orientation information added

CORE LABORATORIES

CHEVRON U.S.A., INC.
E.M.S.U. NO. 679

Field : EUNICE MONUMENT SOUTH
Formation : GRAYBURG

File No.: 57181-16203
Date : 10-16-90

C O R E   A N A L Y S I S   R E S U L T S

SAMPLE NUMBER	DEPTH ft	PERMEABILITY KA MAX md	PERMEABILITY 90 DEG md	PERMEABILITY N/S md	PERMEABILITY E/W md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
78	4141.0- 42.0			25.0	27.0	6.60	11.5	13.4	47.7	2.85	Dol sli/anhy f vug styl
79	4142.0- 43.0			294.	308.	5.30	11.9	13.1	44.8	2.85	Dol sli/anhy vug
80	4143.0- 44.0			25.0	0.13	0.11	7.9	12.6	64.4	2.82	Dol vf vug
81	4144.0- 45.0			9.20	8944.	606.	3.9	5.9	59.5	2.86	Dol sli/anhy vf f vug styl
82	4145.0- 46.0			0.56	0.35	0.33	3.3	1.6	65.3	2.84	Dol vug styl
83	4146.0- 47.0			14.0	268.	7.40	6.2	2.2	43.9	2.86	Dol sli/anhy F vuf vug
84	4147.0- 48.0			0.57	4.60	1.40	4.8	6.0	60.2	2.82	Dol vf f vug
85	4148.0- 49.0			66.0	317.	13.0	10.0	23.1	33.0	2.85	Dol vf f sli/vug styl
86	4149.0- 50.0			97.0	114.	906.	12.8	20.3	33.8	2.84	Dol vf f p.p.
87	4150.0- 51.0			62.0	56.0	126.	6.5	0.0	55.8	2.89	Dol cht sli/pyr vf f vug
88	4151.0- 52.0			40.0	10940.	5056.	6.4	0.0	68.0	2.87	Dol sli/cht sli/pyr vf f vug
89	4152.0- 53.0			22.0	12.5	4.40	[illegible]	24.8	41.4	2.85	Dol sli/cht sli/pyr vf vug
90	4153.0- 54.0			[illegible]	[illegible]	[illegible]	11.8	15.8	40.7	2.86	Dol sli/anhy sli/cht vf vug
91	4154.0- 55.0			530.	543.	75.0	11.1	1.1	44.6	2.86	Dol cht sli/anhy vf vug
92	4155.0- 56.0			560.	[illegible]	[illegible]	11.4	14.5	35.4	2.80	Dol cht vf vug
93	4156.0- 57.0			785.	[illegible]	[illegible]	14.6	21.2	32.4	2.85	Dol cht sli/anhy vf vug
94	4157.0- 58.0			[illegible]	26.0	6.60	8.0	21.0	42.1	2.83	Dol cht vf vug
95	4158.0- 59.0			[illegible]	[illegible]	4.90	6.0	25.0	34.4	2.86	Dol sli/anhy sli/cht vf f sli/vug
96	4159.0- 60.0			1.70	0.15	0.07	4.3	1.9	94.5	2.86	Dol sli/anhy sli/shy vf f styl
97	4160.0- 61.0			<.01	0.04	0.07	4.1	1.3	91.6	2.86	Dol sli/anhy F styl
98	4161.0- 62.0			0.02	0.01		0.9	8.5	84.9	2.85	Dol sli/anhy sli/pyr F styl
99	4162.0- 63.0			20.0	47.0	39.0	10.6	29.8	29.8	2.83	Dol sli/sdy p.p.
100	4163.0- 64.0		84.0			138.	11.7	14.0	46.6	2.83	Dol sli/sdy vf p.p. styl
101	4164.0- 65.0			36.0	25.0	43.0	9.0	25.7	31.9	2.83	Dol vf p.p.
102	4165.0- 66.0			711.	281.	61.0	9.6	27.9	31.9	2.85	Dol sli/anhy vf p.p. foss
103	4166.0- 67.0			20.0	20.0	0.66	11.2	26.0	31.2	2.83	Dol vf p.p. styl
104	4167.0- 68.0			1.70	1.80	1.70	11.0	22.8	32.5	2.89	Dol anhy p.p.
105	4168.0- 69.0			4.50	5.00	3.50	10.7	20.8	36.3	2.87	Dol anhy sli/sdy vf p.p.
106	4169.0- 70.0			3.10	3.80	3.10	10.7	23.5	33.8	2.85	Dol sli/sdy sli/anhy p.p.

Exhibit J-11

CORE LABORATORIES

CHEVRON U.S.A., INC.
E.M.S.U. NO. 679

Field : EUNICE MONUMENT SOUTH
Formation : GRAYBURG

File No.: 57181-16203
Date : 10-16-90

C O R E A N A L Y S I S R E S U L T S

Core analysis report for EMSU-679 with fracture orientation information added

SAMPLE NUMBER	DEPTH		PERMEABILITY				PERMEABILITY (VERTICAL)	POROSITY (HELIUM)	SATURATION (PORE VOLUME)		GRAIN DENSITY	DESCRIPTION
	ft		KA MAX md	90 DEG md	N/S md	E/W md	Kair md	%	OIL %	WATER %	gm/cc	
107	4170.0- 71.0	(N33°W), N12°E			52.0	21.0	13.0	10.7	23.9	34.1	2.85	Dol sli/sdy sli/anhy F p.p.
108	4171.0- 72.0	N49°W, N38°E, N42°W			0.86	0.76	0.52	8.6	23.3	33.3	2.84	Dol F bnd p.p.
109	4172.0- 73.0				7.80	12.0	1.10	8.8	33.1	25.3	2.84	Dol sli/sdy p.p.
110	4173.0- 74.0	N53°E			0.25	0.46	0.18	7.2	37.0	26.4	2.82	Dol sli/sdy F vf p.p.
111	4174.0- 75.0	–			21.0	1.30	0.16	6.7	32.1	33.4	2.84	Dol sli/sdy F p.p.
112	4175.0- 76.0	N84°E, (N50°E)			5.20	4.90	16.0	12.5	24.2	36.3	2.82	Dol sli/sdy p.p.
113	4176.0- 77.0	N7°W			226.	159.	58.0	16.1	25.7	37.0	2.84	Dol sli/sdy p.p. styl
114	4177.0- 78.0	–			232.	197.	165.	15.9	22.7	46.5	2.82	Dol sli/sdy p.p.
115	4178.0- 79.0	N34°W, N27°E, N43°E, N69°W, N36°W, N104°W			0.95	1.10	0.89	6.6	33.4	52.4	2.84	Dol sli/cht F styl
116	4179.0- 80.0	N84°W, N28°W, N67°W, N77°W			4.00	3.30	1.90	7.2	7.2	72.2	2.84	Dol cht F styl

CORE NO. 3 4180-4240 CUT 60' REC 60'

SAMPLE NUMBER	DEPTH ft	KA MAX md	90 DEG md	N/S md	E/W md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	OIL %	WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
117	4180.0- 81.0	5.50	4.80			3.20	10.5	25.2	37.9	2.86	Dol sli/sdy sli/anhy vf f p.p.
118	4181.0- 82.0	61.0	61.0			72.0	14.7	29.7	39.6	2.83	Dol sdy vf
119	4182.0- 83.0	12.0	11.0			24.0	12.7	24.9	37.4	2.82	Dol sli/sdy vf p.p.
120	4183.0- 84.0	5.10	4.00			2.60	9.5	35.3	31.1	2.83	Dol sli/sdy vf p.p. ool
121	4184.0- 85.0	5.70	5.10			4.30	6.3	26.5	60.7	2.80	Dol sli/sdy vf
122	4185.0- 86.0	0.95	0.35			1.00	4.9	28.5	52.2	2.85	Dol sli/anhy vf f sli/vug ool
123	4186.0- 87.0	12.0	1.10			2.40	6.8	4.2	75.2	2.84	Dol vf f ool
124	4187.0- 88.0	0.12	0.03			0.10	3.7	6.6	85.6	2.82	Dol vf f styl
125	4188.0- 89.0	0.90	0.24			0.14	3.2	2.7	81.3	2.84	Dol vf f styl
126	4189.0- 90.0	3.40	0.43			0.90	2.4	0.8	94.7	2.83	Dol vf f foss
127	4190.0- 91.0	0.04	0.02			0.40	5.3	3.9	85.4	2.84	Dol sli/pyr vf f p.p. foss
128	4191.0- 92.0	0.21	0.13			0.16	3.8	4.4	92.3	2.84	Dol vf f styl
129	4192.0- 93.0	0.98	0.91			0.24	5.9	4.0	79.4	2.83	Dol vf f vug
130	4193.0- 94.0	0.37	0.03			0.10	8.9	2.3	81.5	2.82	Dol vf f sli/vug
131	4194.0- 95.0	11.0	1.90			1.60	2.1	11.5	80.6	2.82	Dol sli/sdy vf f
132	4195.0- 96.0	71.0	15.0			7.30	10.0	7.8	65.9	2.81	Dol vf p.p.

Exhibit J-12

Fracture orientation documentation

EMSU No. 679 Oriented Core
Fracture Azimuths

R F Lindsay
1/15/91
Midland, Tx

4120-21	—	Small Fx's
21-22	N85°E, N86°E, N47°W, N51°W	
22-23	N32°W pyrite, N39°W pyrite, N50°W, N86°W	
23-24	N83°W	
24-25	N39°E, N72°W	
25-26	—	
26-27	—	
27-28	—	
28-29	N24°E, N51°E, N67°W	Lg Fx's
29-30	N25°E, N32°E, N64°E, N11°W, N17°W, N77°W	
4130-31	N43°E, N82°E, N69°W	Small Fx's
31-32	N86°E	
32-33	N78°W (2), N83°W	
33-34	N78°E	
34-35	N15°W, N19°W, N52°W	
35-36	N47°E, N70°W	Large Fx's
36-37	N41°E, N52°W	
37-38	N28°E, N10°W, N75°W	
38-39	N31°E, N16°W, N29°W, N42°W, N48°W, N70°W	
39-40	N69°W	
4140-41	—	Collapse Breccia Small Fx's
41-42	N72°E, N65°W	
42-43	N9°W pyrite	
43-44	N7°W, N81°W, N83°W	
44-45	N40°E (2), N58°E	Fusulinid Facies Small Fx's
45-46	N50°E (2), N35°W, N39°W	
46-47	N34°W, N42°W, N43°W	
47-48	N49°E, N59°E, N73°E, N82°E, N88°E, N56°W, N64°W, N73°W, N80°W, N84°W, N86°W	
48-49	N56°E, N64°E, N65°E (2), N80°W (2), N84°W	Highly broken

EMSU No. 679 Oriented Core
Fracture Azimuths

R.F. Lindsay
1/15/91
Midland, Tx

4150-51	N14°W, N23°W, N49°W, N74°W	Collapse Breccia; Small Fx's; Lg; Small Fx's
51-52	N18°E, N49°E (2) pyrite, N88°E pyrite	
52-53	N5°E, N17°E, N25°E, N34°E pyrite, N32°W, N45°W, N64°W, N71°W	
53-54	N52°E, N55°E, N72°E, N76°E (4), N40°W, N64°W, N74°W	
54-55	N55°E, N71°E (2), N22°W, N36°W, N86°W	
55-56	N17°E, N46°E, N62°E, N66°E, N67°E, N71°E, N77°W, N87°W	
56-57	N50°E (2), N58°E, N68°E, N75°E, N13°W, N45°W, N50°W	
57-58	N52°E, N82°E, N27°W, N30°W, N52°W, N77°W	
58-59	N21°E, N23°E, N59°W, N61°W, N64°W, N66°W	
59-60	N60°E, N68°E, N84°E, N9°W	
4160-61	N66°E, N43°W	Small Fx's
61-62	N24°E, N36°E	Core broken-up during coring
62-63	N27°E, N62°E	
63-64	—	
64-65	N60°E, N18°W	
65-66	N28°W, N70°W	
66-67	N20°W, N62°W	
67-68	N34°W	
68-69	N52°E	
69-70	N43°E, N70°E	
4170-71	N2°E, N33°W	
71-72	N38°E, N42°W, N49°W	
72-73	—	
73-74	N53°E	
74-75	—	
75-76	N80°E, N89°E	
76-77	N7°W	
77-78	—	
78-79	N27°E, N43°E, N14°W, N34°W, N36°W, N69°W	Collapse Breccia

Eunice Monument South Unit Expansion Area B (EMSUB) Eunice Monument South Unit (EMSU) and Arrowhead Grayburg Unit (AGU) Fracture Study

Robert F. Lindsay PhD
Lindsay Consulting LLC
Affiliate Professor Brigham Young University
Adjunct Professor University of Texas Permian Basin

A multi-field fracture study was conducted on Eunice Monument South Unit Expansion Area B (EMSUB), Eunice Monument South Unit (EMSU), and Arrowhead Grayburg Unit (AGU) (Figure 1). Four oriented core fracture studies were performed on Grayburg core, with one oriented core in EMSUB and EMSU and two oriented cores in AGU. Oriented cored wells used in this fracture study are: 1) EMSUB-887; 2) EMSU-679; and 3) AGU-225 and AGU-600.

These three unitized oil fields are along the northwest corner of the Central Basin Platform (Figure 2). EMSUB and EMSU are adjacent to each other. EMSU and AGU are separated by a structural embayement (structural low).

The large structure at Eunice Monument is referred to as the Eunice High. The Eunice High is a large structural pop-up block. Initial structural movement was during uplift of the Central Basin Uplift (Platform) during the Marathon orogeny in the Late Mississippian through the Pennsylvanian. This was followed by later structural development of the Eunice Monument asymmetric anticline structural trap during the Laramide orogeny in the Cretaceous to the Early Tertiary (Figure 3). The Eunice High is not a single large structural block. Instead, it is composed of a series of smaller fault bounded, basement-cored blocks (Figure 4). These smaller fault blocks, with variable throw, folded strata to form the double-humped Eunice Monument asymmetric anticline.

During tectonism fault movement created a fracture halo, with fractures surrounding the fault (Figure 5). Late-stage fluid flow in the Late Eocene to Early Miocene solution-widened many but not all fractures. The shape and orientation of basement-cored structural blocks created variable fracture trends in EMSUB, EMSU, and AGU.

Fracture diagrams are shown on two scales: 1) a large scale showing the northeast end of the Delaware Basin and northwest part of the Central Basin Platform (CBP); and 2) a close-up map, showing the three unitized oil fields (EMSUB, EMSU, and AGU). The close-up map shows the top of Grayburg Formation structure map and unitized fields. These two illustrations help perceive large and small scale tectonic modifications along the northwest corner of the CBP. These also help relate the position of each unit (field) with respect to the position of the Goat Seep and Capitan aquifers further down-dip to the west. The Goat Seep aquifer is in fluid communication with EMSU. The Capitan aquifer is too far down-dip and is stratigraphically younger (Queen, Seven Rivers, and Yates age) and is not in fluid communication with EMSU.

Fault Trend

Only two vertical faults, approximately 6 ft in length, were identified in core (Figures 6 and 7). One fault is in EMSUB and trends north northeast to south southwest. The second fault is in AGU and also trends north northeast to south southwest. To be able to identify a fault in a 4 inch wide core is difficult. In these two cases some luck was involved.

Fault movement, however large or small, creates fracture halos around the fault. Fracture halos contain swarms of fractures, with some solution-widened (Figure 5).

Total Fractures

A plot of total vertical fractures show two major trends (Figures 8 and 9). In EMSU there is a major trend northwest to southeast and a lesser trend northeast to southwest. In AGU there is a stong trend north northeast to south southwest, with minor trends northwest to southeast and northeast to southwest. A structural embayment (structural low) separates EMSU and AGU. The structural embayment appears to have created the divergence in fracture orientations.

Large Fractures

Large vertical fractures, with lengths of 1 to 3 ft, are shown along the northwest corner of the CBP (Figures 10 and 11). In EMSUB large vertical fractures have major trends to the northeast to southwest, north northeast to south southeast, and north northwest to south southeast. In EMSU there is only one major trend northwest to southeast, with a minor trend from northeast to southwest. In the northwest part of AGU the major trend is north northwest to south southeast and a minor trends east northeast to west southwest and northwest to southeast. In the southwest part of AGU the is a major fracture trend north northeast to south southwest, with a minor trend east northeast to west southwest.

This striking difference between some of the fracture trends is due to a structural embayment (structural low) separating EMSU and AGU. The difference between EMSUB and AGU is due to the structural grain shifting from northwest to north as one traverses north from EMSU to EMSUB.

Intermediate Fractures

Intermediate vertical fractures, with lengths of 4 inches to 1 ft, are shown along the northwest corner of the CBP (Figures 12 and 13). In EMSUB there are three major trends northeast to southwest, east northeast to west southwest, and northwest to southeast. In the northwest part of AGU a major trend is to the north northeast to south southwest and northwest to southeast, with a lesser trend northeast to southwest. In the southwest part of AGU there is a strong fracture trend north northeast to south southwest and a lesser trend northeast to southwest.

In EMSU, where the first fracture study was carried out, no intermediate vertical fractures were originally broken out. Instead those fractures were labled as either large, greater than 1 ft, or small, less than 1 ft. In EMSU what constituted large, intermediate, and small vertical fractures was not completely understood. However, by the time EMSUB and AGU were studied the fracture lengths, large, intermediate, and small, had been identified and utilized.

Small Fractures
Small vertical fractures, less than 4 inches, are shown along the northwest corner of the CBP (Figures 14 and 15). In EMSUB there is one major trend north northeast to south southwest, with minor trends to the northeast to southwest and northwest to southeast. In EMSU fracture trends are northwest to southeast, north northwest to south southeast, west to east, and east northeast to west southwest. In the northwest part of AGU there is one major fracture trend that is north northwest to south southeast and northeast to southwest, with a minor trend east northeast to west southwest. In the southwest part of AGU there is a major fracture trend north to south and north northeast to south southwest, with lesser trends northeast to southwest and northwest to southeast.

Solution-widened Fractures
At first solution-widened vertical fracctures were not considerd a stand alone separate group of fractures until work commenced on EMSUB oriented core (Figures 16 and 17). Earlier studies on EMSU had recognized that many fractures were solution-widened, but a separate category was not decided on until working on EMSUB oriented core. In EMSUB solution-widened fractures have a major trend north northeast to south southwest, with minor trends extending both northeast to southwest and northwest to southeast. In the northwest part of AGU solution-widened fractures have a strong trend north to south and lesser trend northeast to southwest. Solution-widened fractures were observed in EMSU but were not mapped.

Pyritized Fractures
Pyritized vertical fractures are shown along the northwest corner of the CBP (Figures 18 and 19). Only a few pyritized fractures were identified in EMSUB that trend northeast to southwest. Whereas in EMSU pyritized fractures are common, with a major trend northwest to southeast with two lesser trends northeast to southwest and east northeast to west southwest. In the northwest part of AGU pyritized fractures are less common and trend north northwest to south southeast and northeast to southwest.

Collapse Breccias and Solution Pipes
Vertical fractures bounding collapse breccias and solution pipes are difficult to identify in a 4 inch core. However, in EMSU a few were identified that trend northeast to southwest and east northeast to west southwest (Figures 20 and 21). No vertical fractures bounding collapse breccias and solution pipes were identified in EMSUB and AGU.

Stylolitic Tension Gashes

As core studies in EMSUB, EMSU, and AGU progressed, small stylolitic tension gashes were identified (Figures 22 and 23). Surprisingly, as more and more cores were described the more important and more common these small stylolitic tension gashes became. To the point that these small stylolitic tension gashes may represent upward of 90% of all fractures in EMSUB, EMSU, and AGU.

In the northwest part of AGU stylolitic tension gashes were mapped, with a strong fracture trend north northeast to south southwest, lesser trends northwest to southeast, northeast to southwest, with minor trends west northwest to south southeast and east northeast to west southwest (Figures 22 and 23).

When the EMSU assymetric anticline formed during the Laramide orogeny. As strata folded, stylolitized intervals were slightly fractured to create stylolitic tension gashes. Late-stage fluid flow during the Late Eocene to Early Miocene solution-widened some of the stylolitic tension gashes.

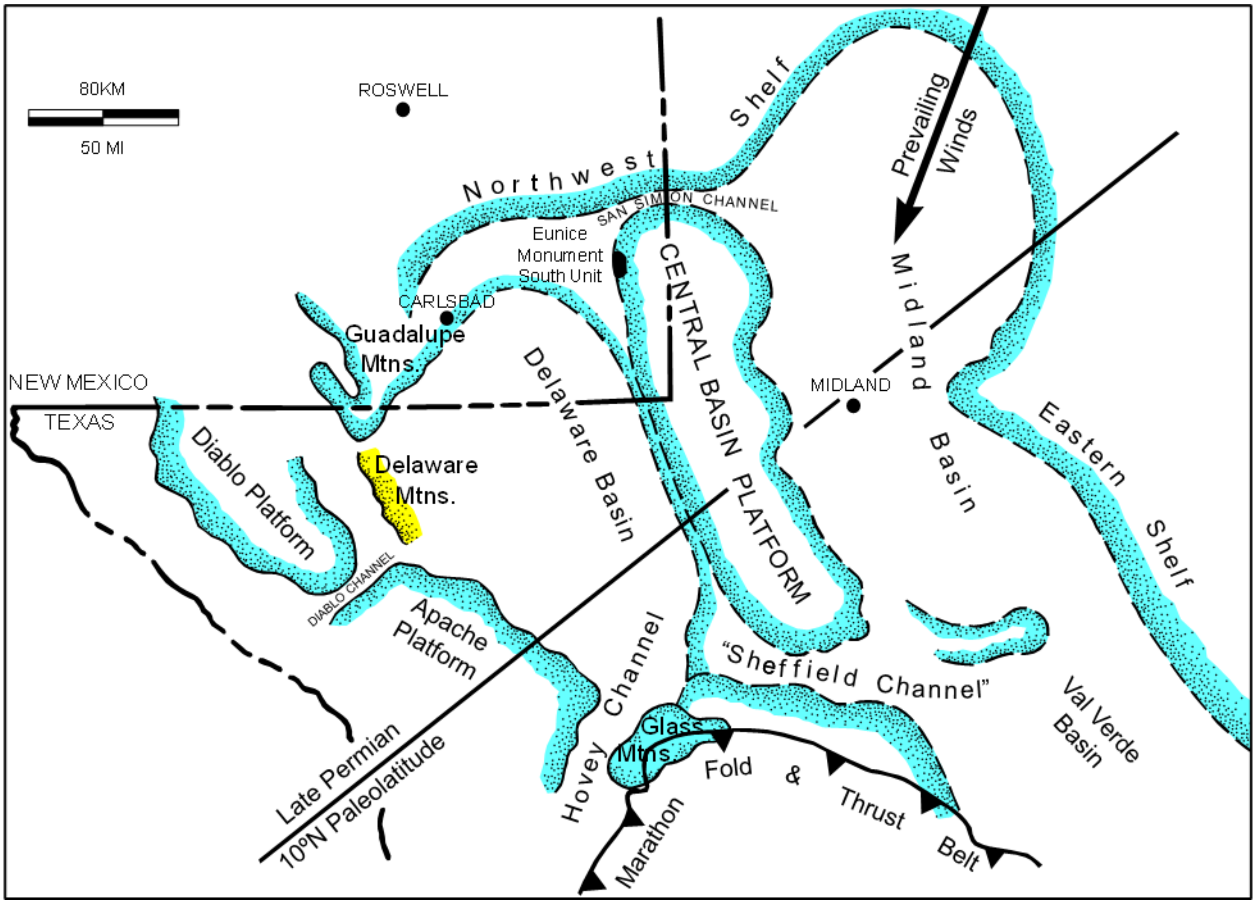


Figure 1. Index map of the Permian Basin and the position of Eunice Monument South Unit (EMSU) in the northwest corner of the Central Basin Platform (CBP). The darkened area representing EMSU also includes Eunice Monument South Unit Expansion Area B (EMSUB) and Arrowhead Grayburg Unit (AGU).

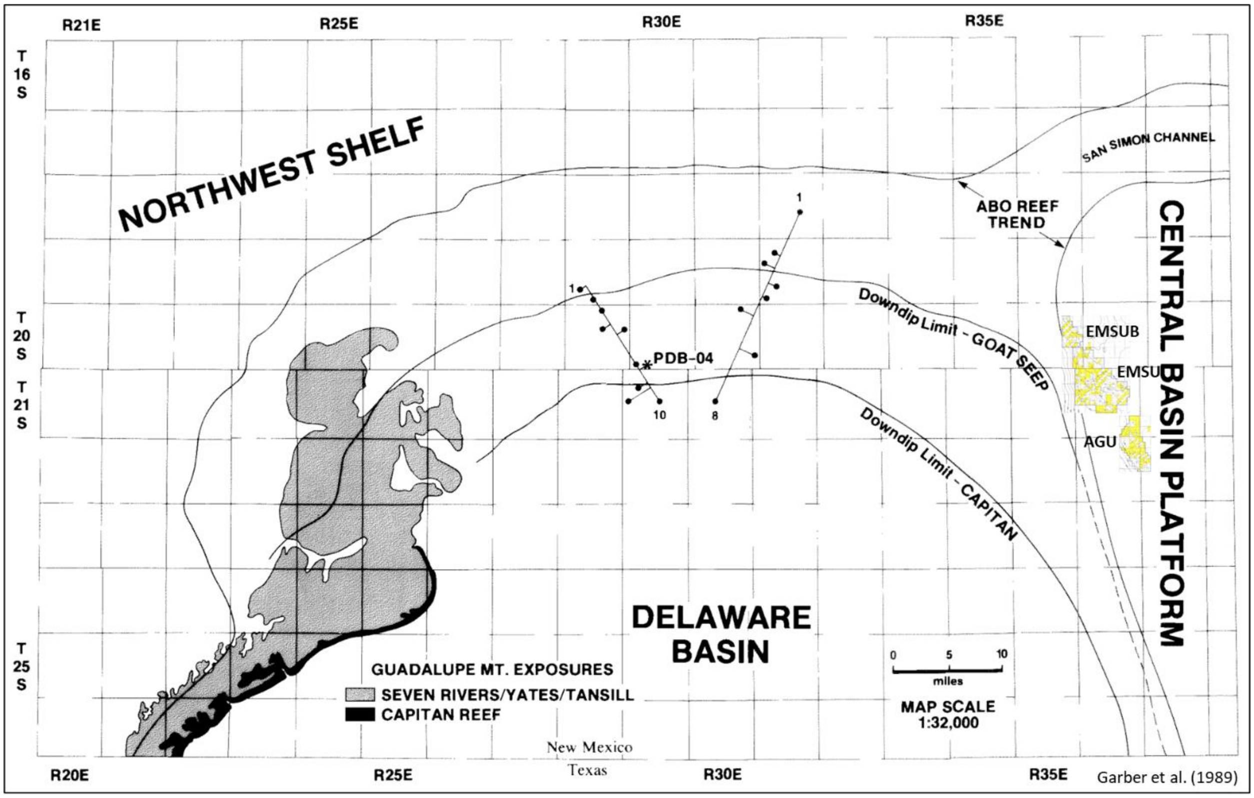


Figure 2. Index map of the northern end of the Delaware Basin and northwest corner of the Central Basin Platform (CBP). The position of EMSUB, EMSU, and AGU are shown along the northwest corner of the CBP. Down-dip limits of both the Capitan and Goat Seep aquifers are also shown. The Goat Seep aquifer is in fluid communication with EMSU. However, the Capitan aquifer is too far down-dip, is stratigraphically younger (Queen, Seven Rivers, and Yates), and is not in fluid communication with EMSU.

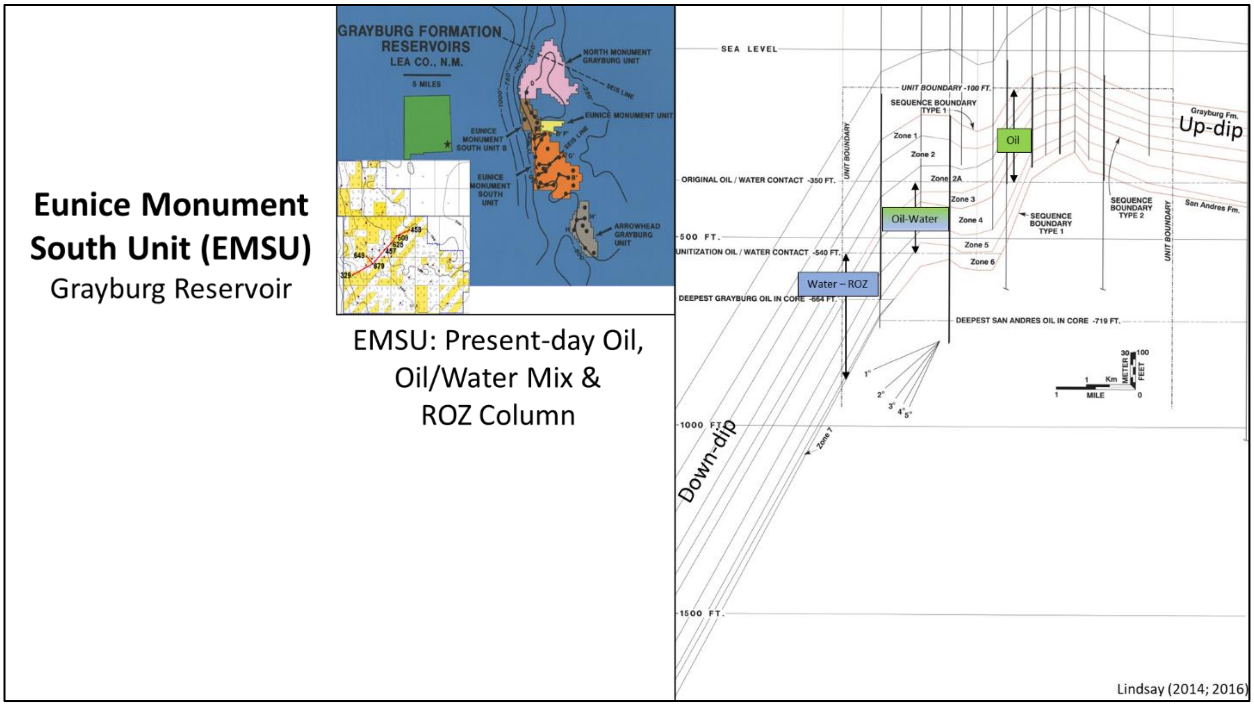


Figure 3. West to east structural cross section through EMSU. The Eunice Monument asymmetric anticline is not a simple anticline but a double-humped asymmetric anticline. Differential movement of basement-cored fault blocks formed the double-humped shape of the asymmetric anticline. Additional bending of the Eunice Monument asymmetric anticline placed additional stress on brittle dolostone strata to form numerous fractures, with many but not all fractures solution-widened.

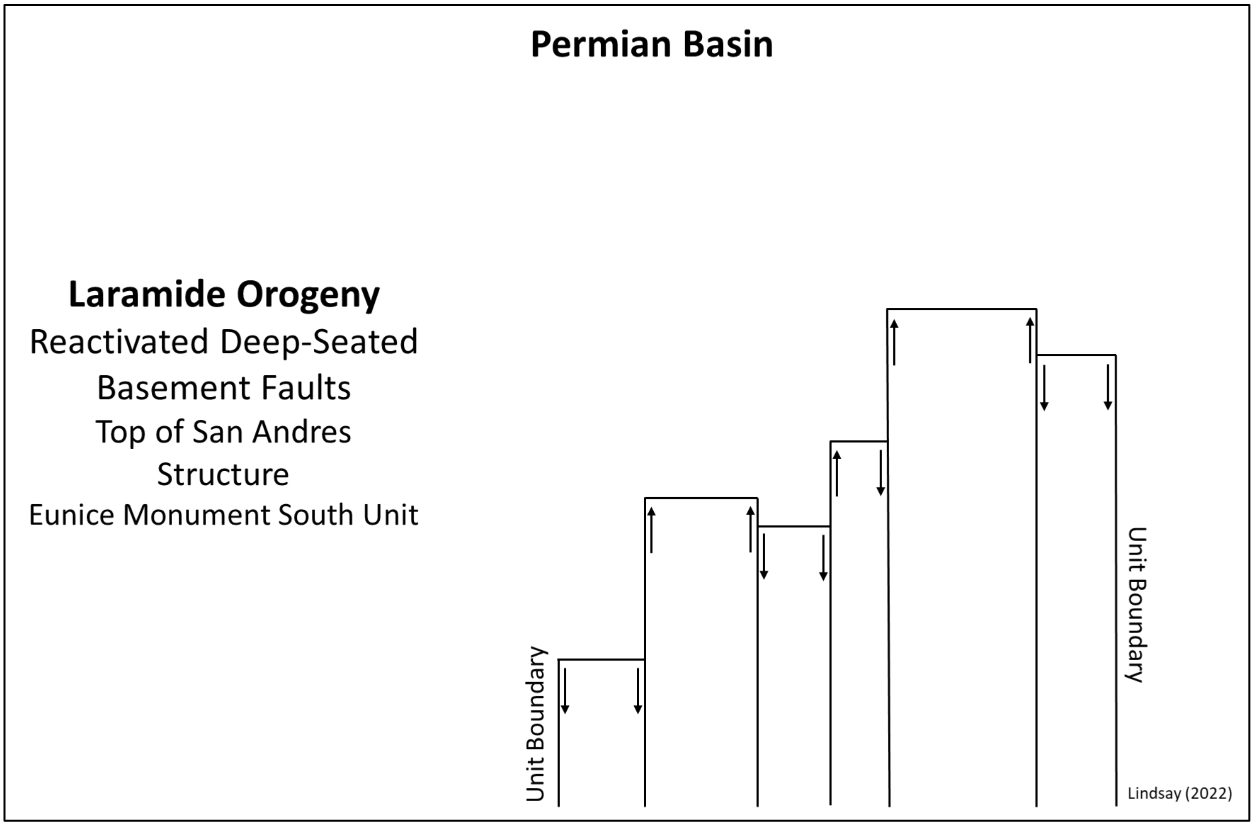


Figure 4. An interpretation of basement-cored fault blocks beneath Eunice Monument South Unit (EMSU). These structural blocks moved into this present configuration during the Laramide orogeny (Cretaceous-Early Tertiary) to create the odd looking double-humped Eunice Monument asymmetric anticline seen in Figure 3.

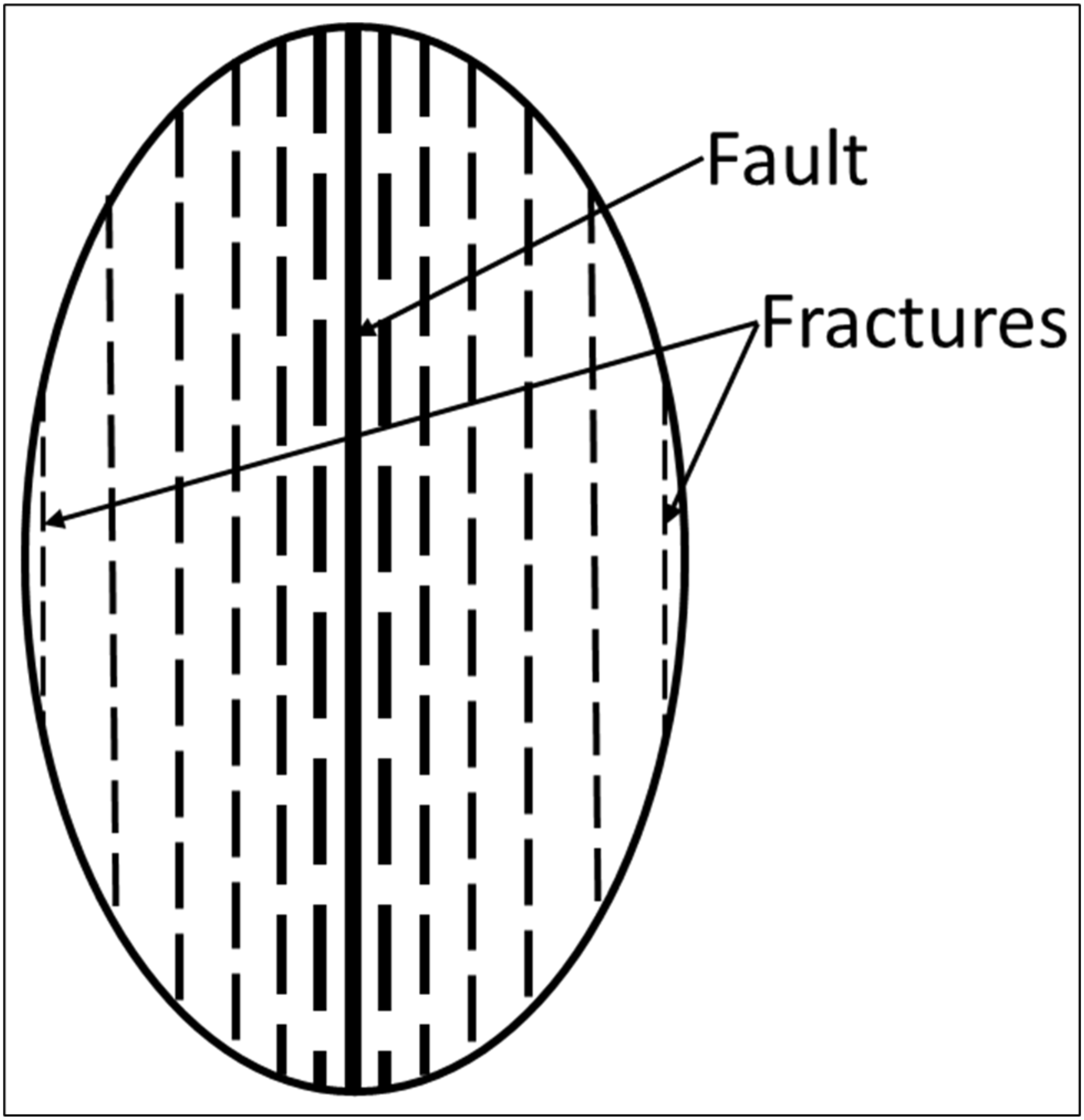


Figure 5. Fracture halo surrounding a fault. No lateral dimensions are intended. Fracture halos form swarms of en echelon fractures. Though not being able to be seen in a 4-inch core, fracture halos are connected. Late-stage fluid flow in the Late Eocene to Early Miocene solution-widened many but not all fractures within the halo.

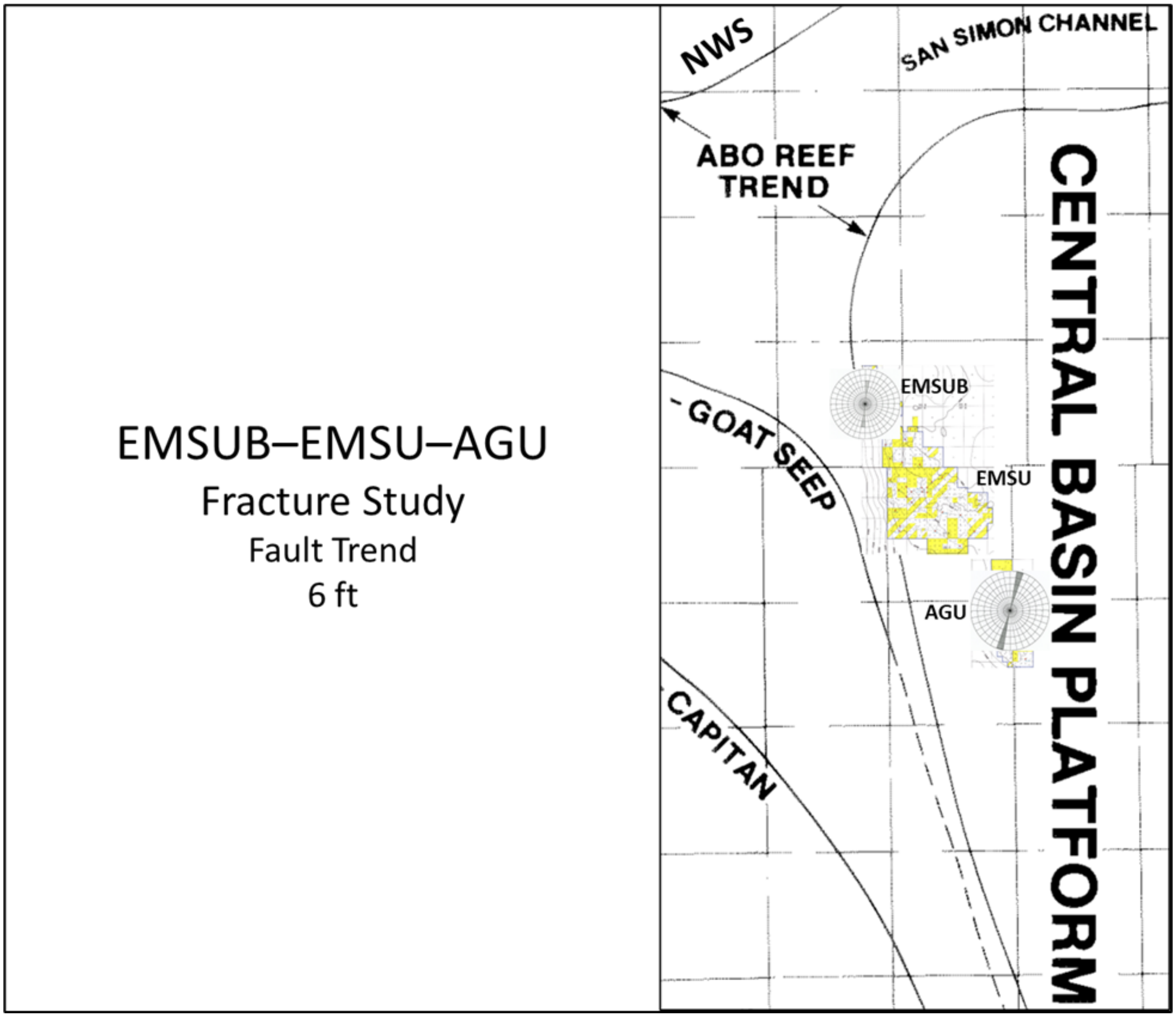


Figure 6. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows two fault trends that were identified in core. Fault trends are north to south in EMSUB and north northeast to south southwest in AGU. Faults are difficult to identify in a 4-inch core.

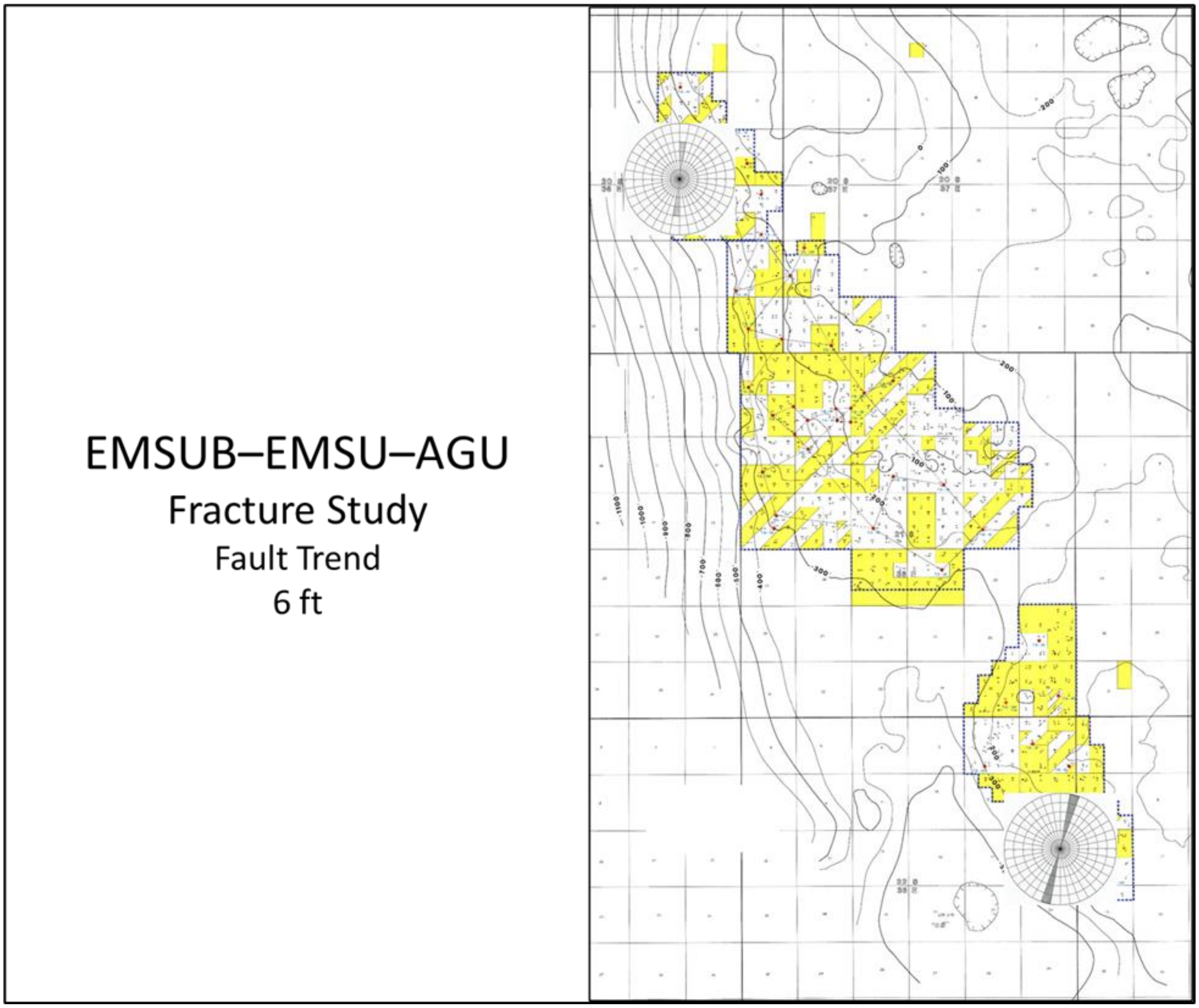


Figure 7. Close-up view of the northwest corner of the Central Basin Platform (CBP), showing EMSUB, EMSU, and AGU. The map shows two fault trends that were identified in core. Fault trends are north to south in EMSUB and north northeast to south southwest in AGU.

This close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure at Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored fault blocks.

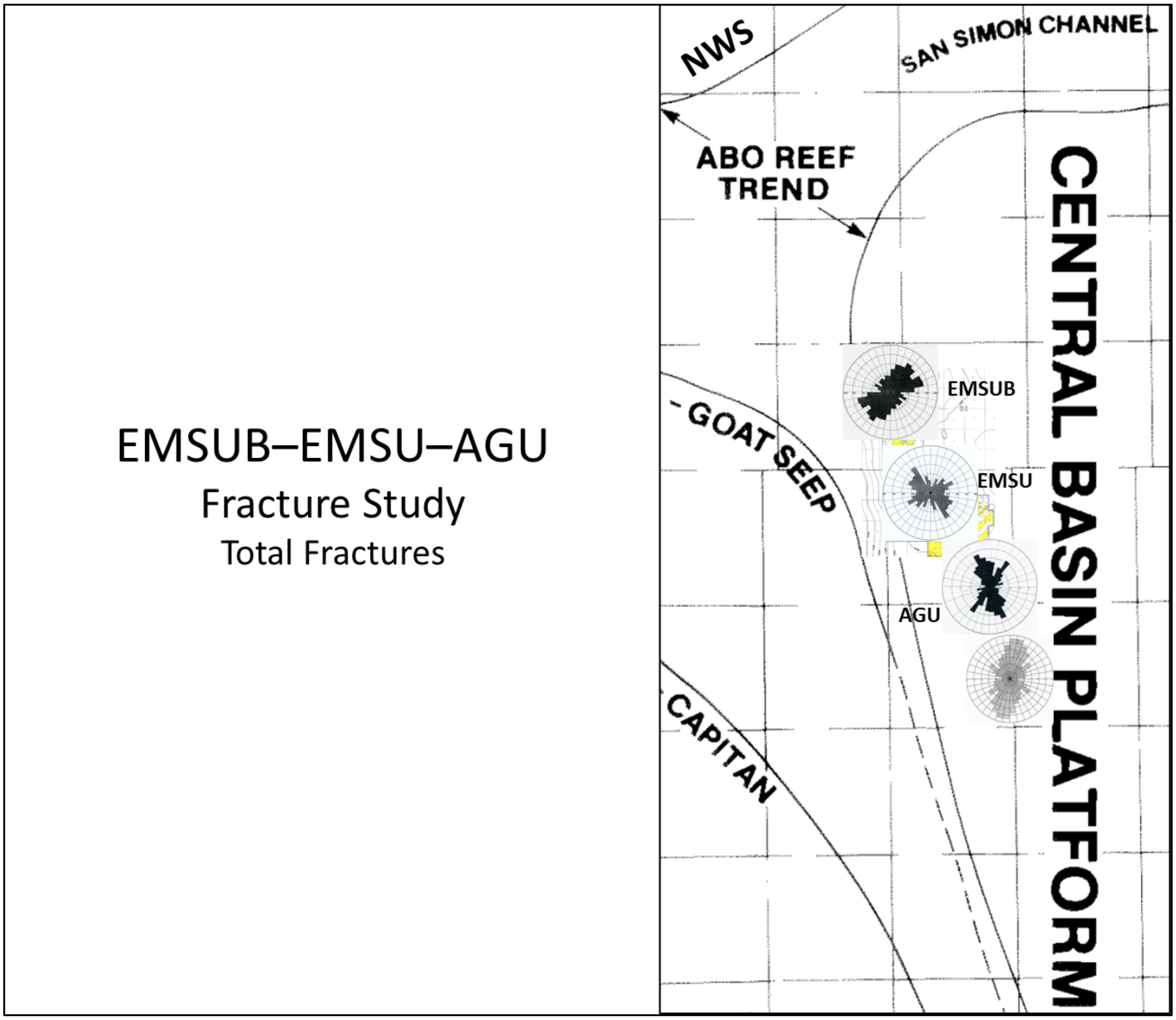


Figure 8. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. The map shows total vertical fractures that were identified in core. In EMSUB two major fracture trends are northeast to southwest and east northeast to west southwest, with minor trends northwest to southeast. In EMSU fracture trends are northwest to southeast and northeast to southwest. In the northwest part of AGU total fracture trends are north northwest to south southeast and northeast to southwest. In the southwest part of AGU there is a strong trend north northeast to south southwest, with minor trends northeast to southwest and northwest to southeast.

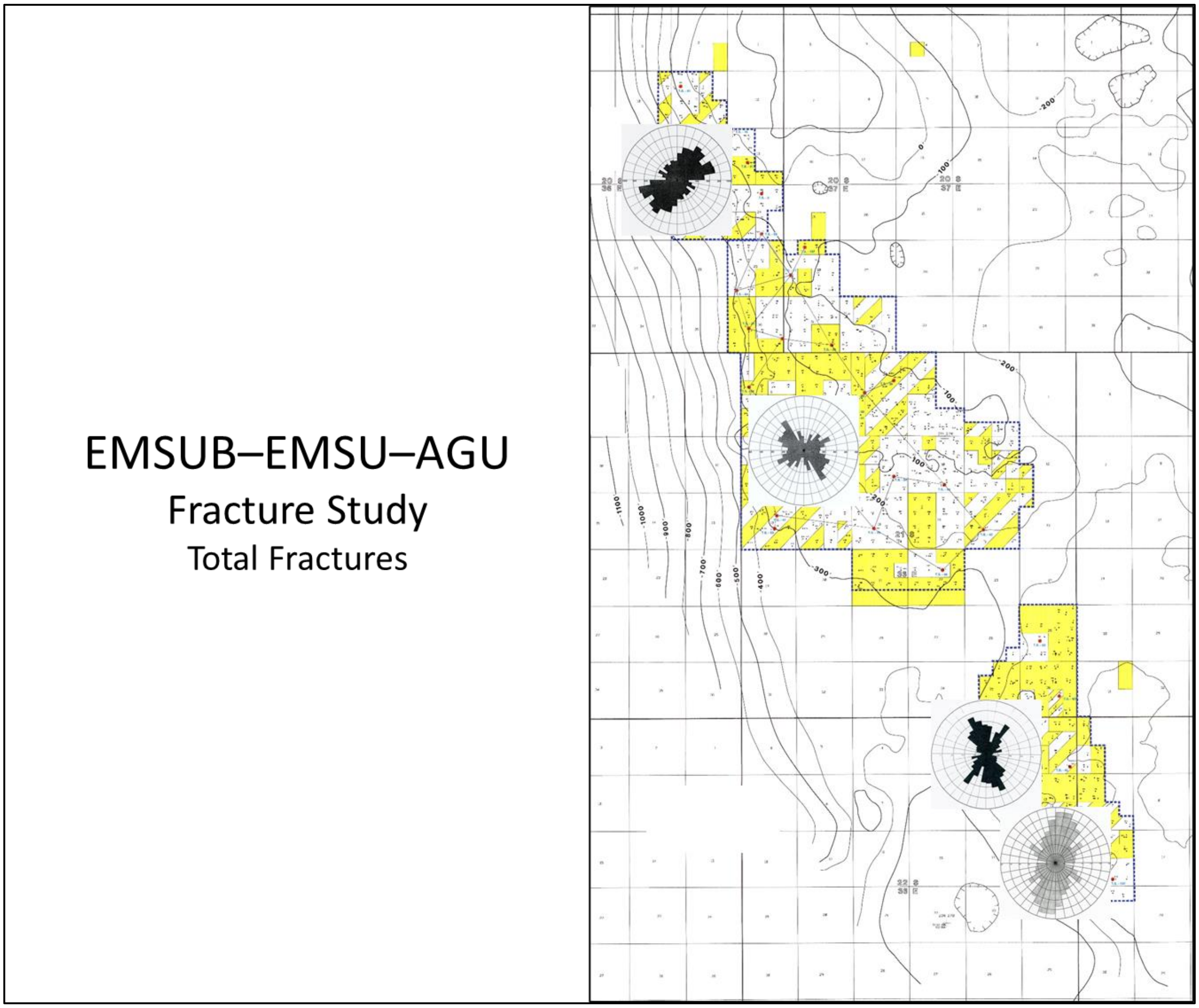


Figure 9. Close-up view of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. The map shows total vertical fractures that were identified in core. In EMSUB two major fracture trends are northeast to southwest and east northeast to west southwest, with minor trends northwest to southeast. In EMSU fracture trends are northwest to southeast and northeast to southwest. In the northwest part of AGU total fracture trends are north northwest to south southeast and northeast to southwest. In the southwest part of AGU there is a strong trend north northeast to south southwest, with minor trends northeast to southwest and northwest to southeast. Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure at Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

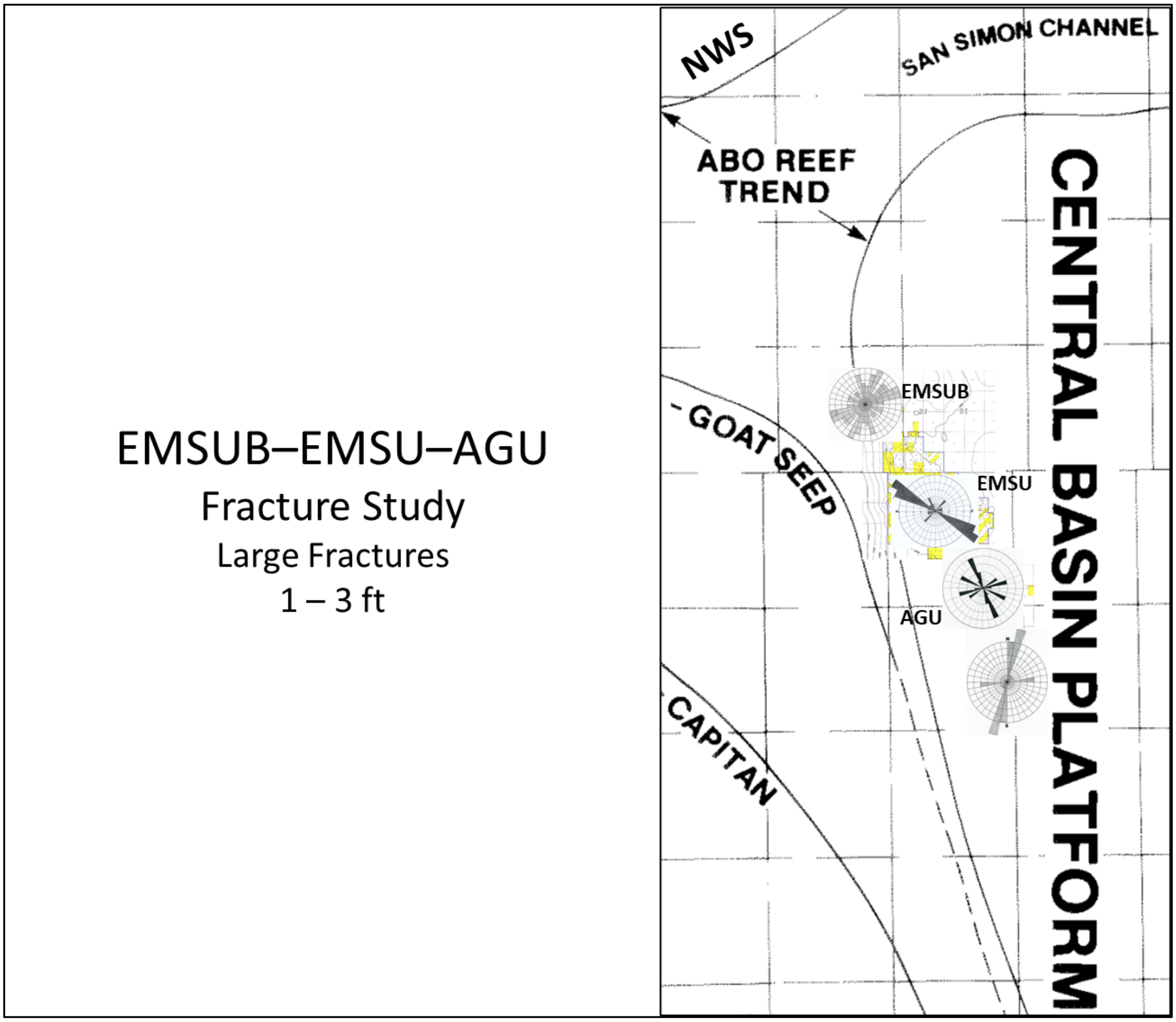


Figure 10. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows large vertical fractures, 1 – 3 ft in length, that were identified in core. In EMSUB fracture trends are northeast to southwest and north northeast to south southwest and north northwest to south southeast, with a minor trend northwest to southeast. In EMSU fracture trends area northwest to southeast, with a minor trend northeast to southwest. In the northwest part of AGU there are two fracture trends northwest to south east and another north northeast to south southwest. In the southwest part of AGU there is a strong fracture trend to the north northeast to south southwest, with a minor trend east northeast to west southwest.

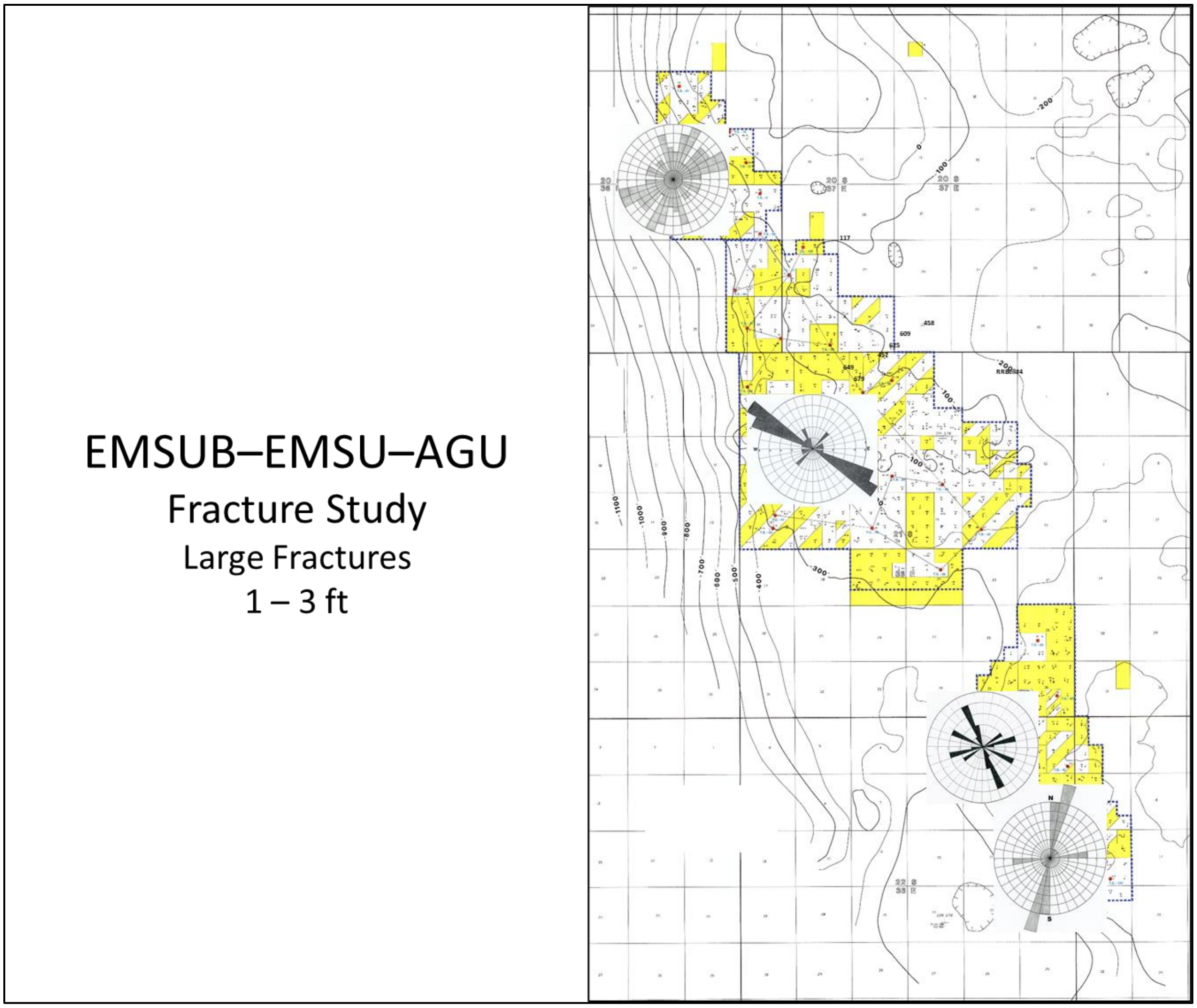


Figure 11. Close-up view of index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. The map shows large vertical fractures, 1 – 3 ft in length, that were identified in core. In EMSUB fracture trends are northeast to southwest and north northeast to south southwest and north northwest to south southeast. In EMSU fracture trends area northwest to southeast, with a minor trend northeast to southwest. In the northwest part of AGU there are two fracture trends are northwest to southeast and another north northeast to south southwest. In the southwest part of AGU there is a strong fracture trend to the north northeast to south southwest, with a minor trend east northeast to west southwest.

Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure in Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

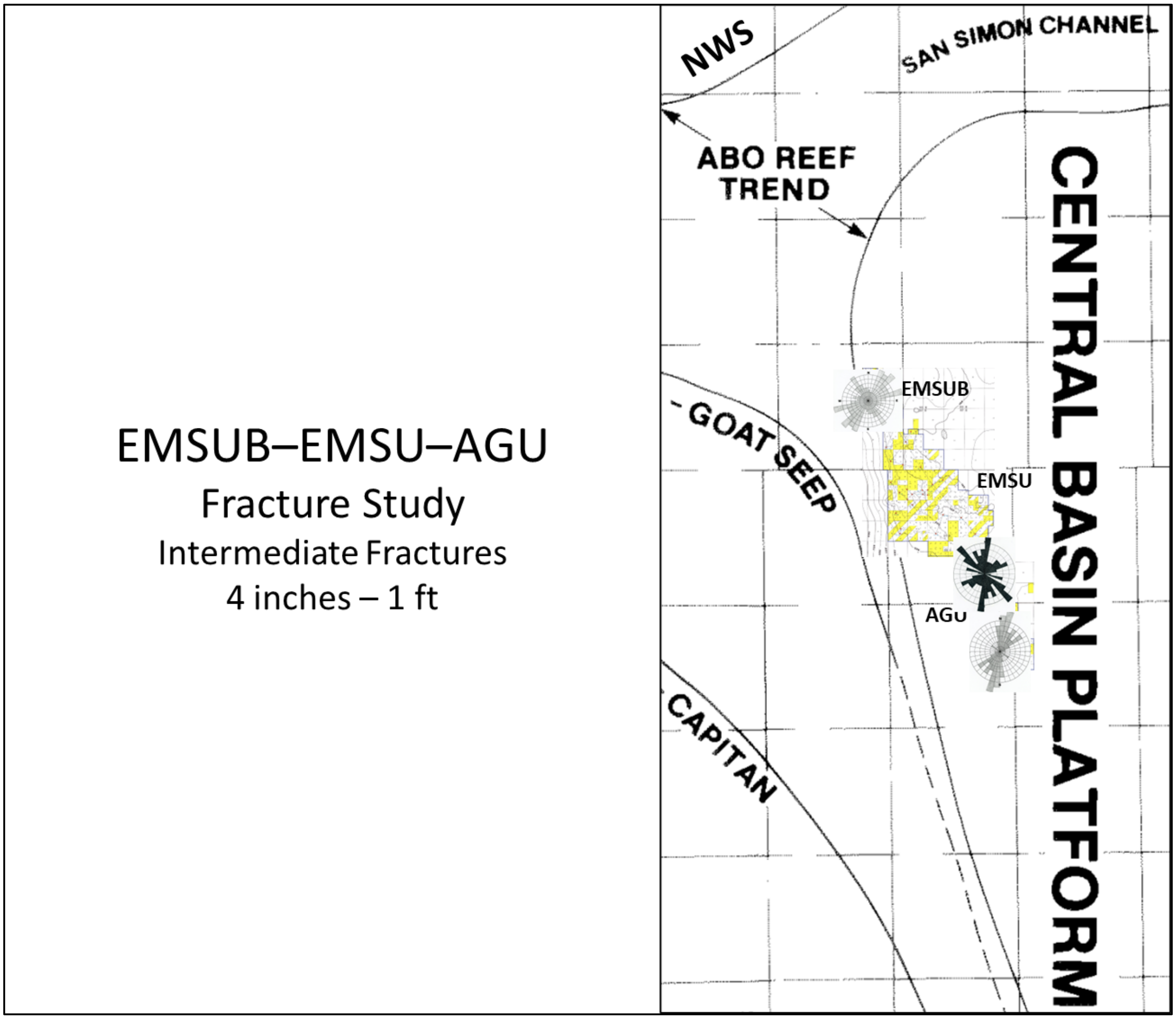


Figure 12. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. The map shows intermediate vertical fractures, 4 inches – 1 ft in length, that were identified in core. In EMSUB fracture trends are northeast to southwest and east north northeast to west southwest and northwest to southeast. In EMSU fracture trends were lumped into either large or small fractures. It was not until later during studies of EMSUB and AGU that intermediate sized fractures were identified and mapped. In the northwest part of AGU fracture trends are north northeast to south southwest, northwest to southeast, and northeast to southwest. In the southwest part of AGU there is a strong fracture trend north northeast to south southwest, and a lesser trend northeast to southwest.

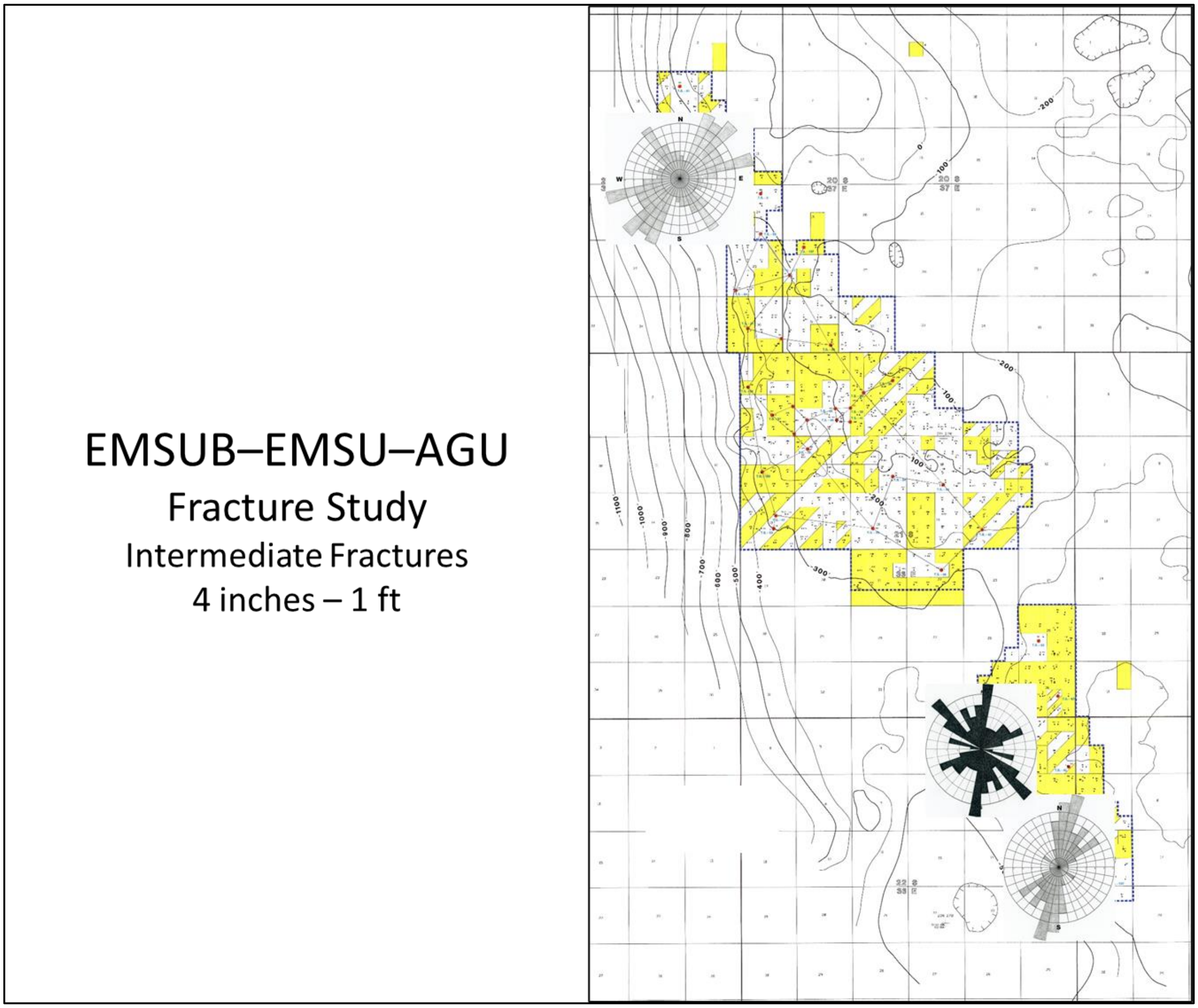


Figure 13. Close-up of index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. The map shows intermediate vertical fractures, 4 inches – 1 ft in length, that were identified in core. In EMSUB fracture trends are northeast to southwest, east north northeast to west southwest and northwest to southeast. In EMSU fracture trends were lumped into either large or small fractures. It was not until later during studies of EMSUB and AGU that intermediate sized fractures were identified and mapped. In the northwest part of AGU fracture trends are north northeast to south southwest, northwest to southeast, and northeast to southwest.

Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure at Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

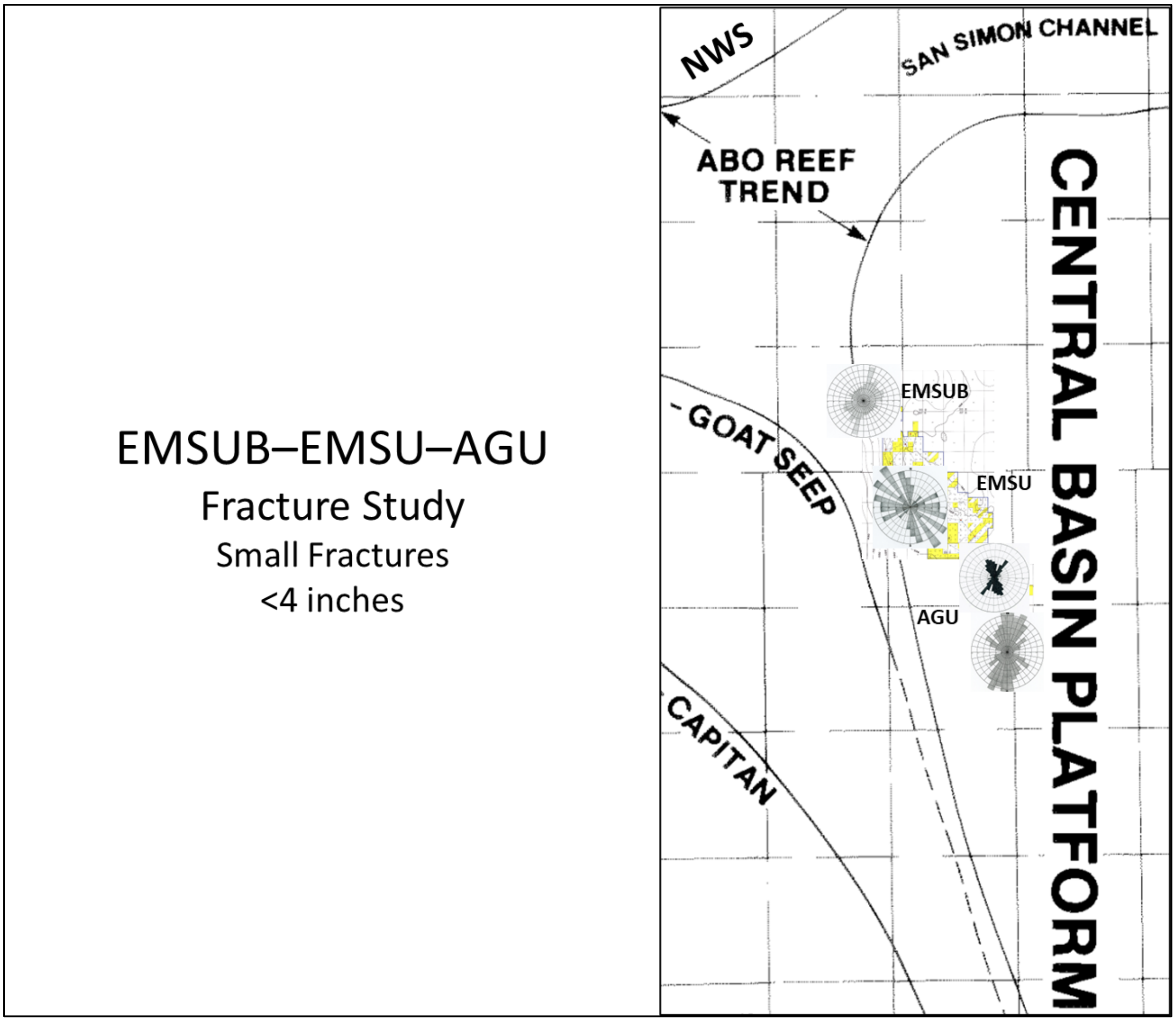


Figure 14. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows small vertical fractures, <4 inches in length, that were identified in core. In EMSUB fracture trends are north northeast to south southwest and northeast to southwest. In EMSU fracture trends are northwest to southeast, west to east, and east northeast to west southwest. In AGU fracture trends north northeast to south southwest, with minor trends northeast to southwest and northwest to southeast.

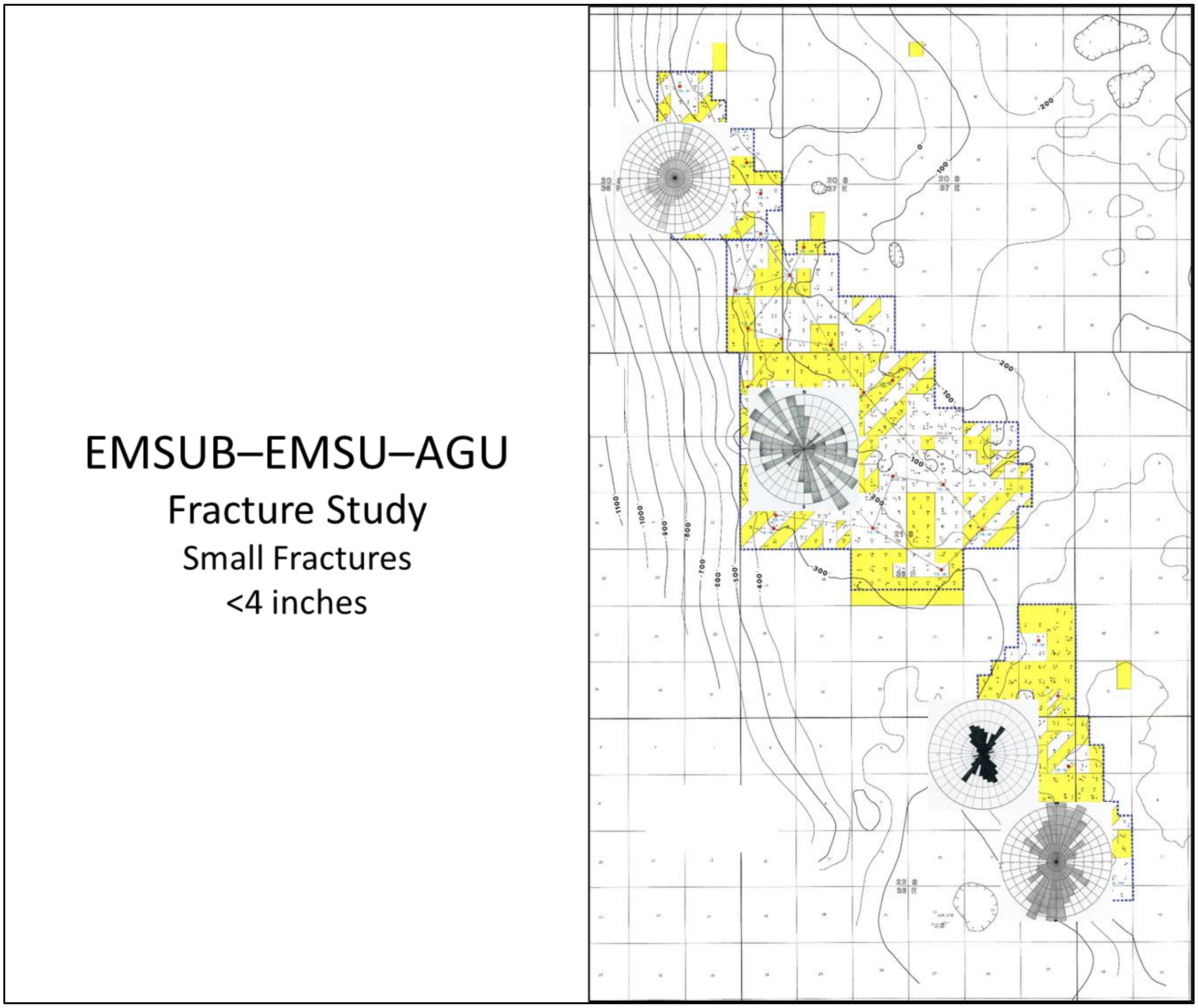


Figure 15. Close-up view of index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows small vertical fractures, <4 inches in length, that were identified in core. In EMSUB fracture trends are north northeast to south southwest and northeast to southwest. In EMSU fracture trends are northwest to southeast, west to east, and east northeast to west southwest. In the northwest part of AGU fracture trends are north northwest to south southeast and northeast to southwest. In the southwest part of AGU fracture trends are north northeast to south southwest, with minor trends northeast to southwest and northwest to southeast.

Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

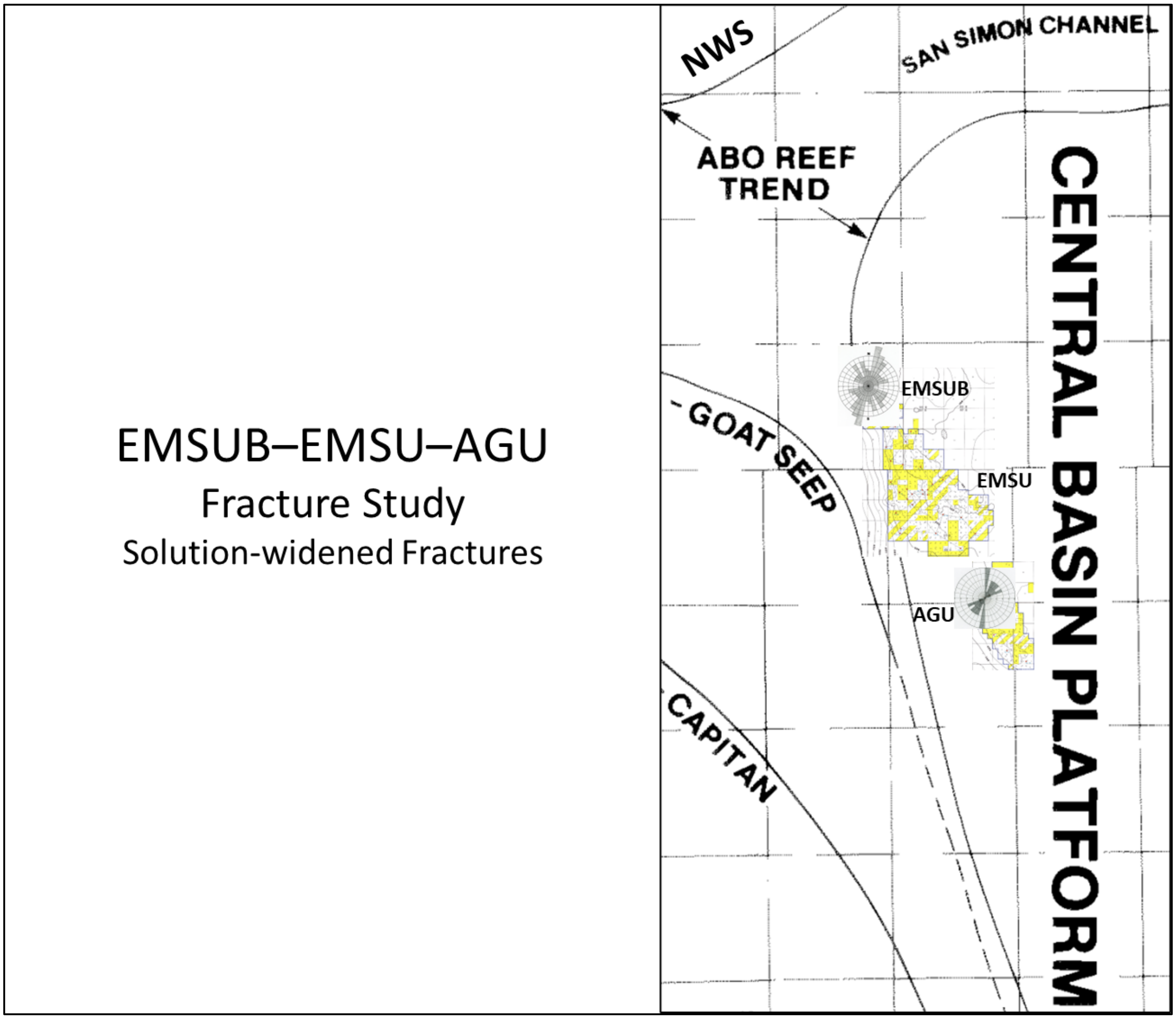


Figure 16. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows solution-widened vertical fractures that were identified in core. In EMSUB a strong fracture trend is north northeast to south southwest, with lesser trends northwest to southeast and northeast to southwest. In AGU solution-widened fractures trend north to south and northeast to southwest. Solution-widened fractures were observed in EMSU but were not mapped.

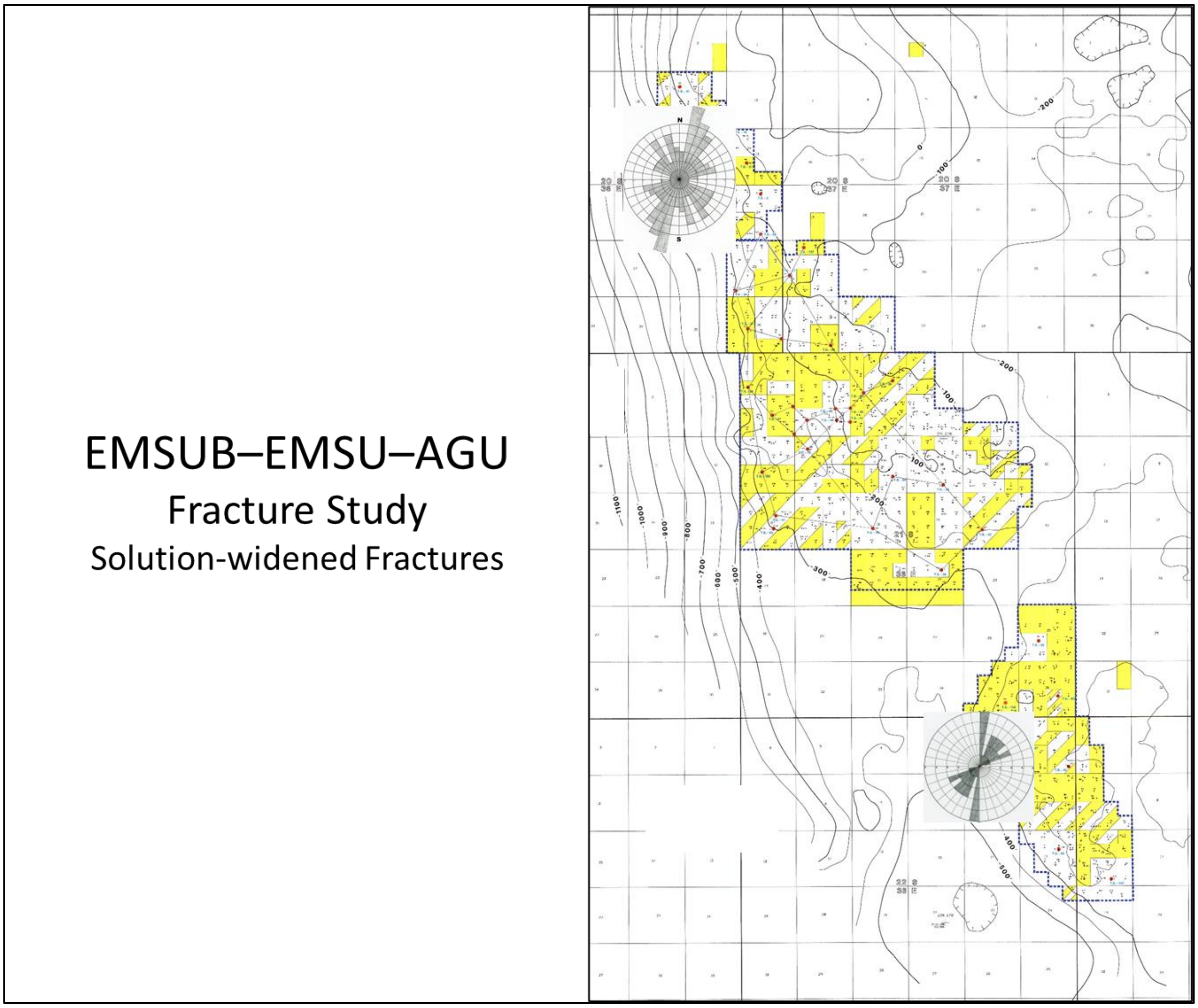


Figure 17. Close-up view of index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows solution-widened vertical fractures that were identified in core. In EMSUB a strong fracture trend is north northeast to south southwest, with lesser trends northwest to southeast and northeast to southwest. Solution-widened fractures were observed in EMSU but were not mapped. In AGU solution-widened fractures trend north to south and northeast to southwest.

Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure at Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

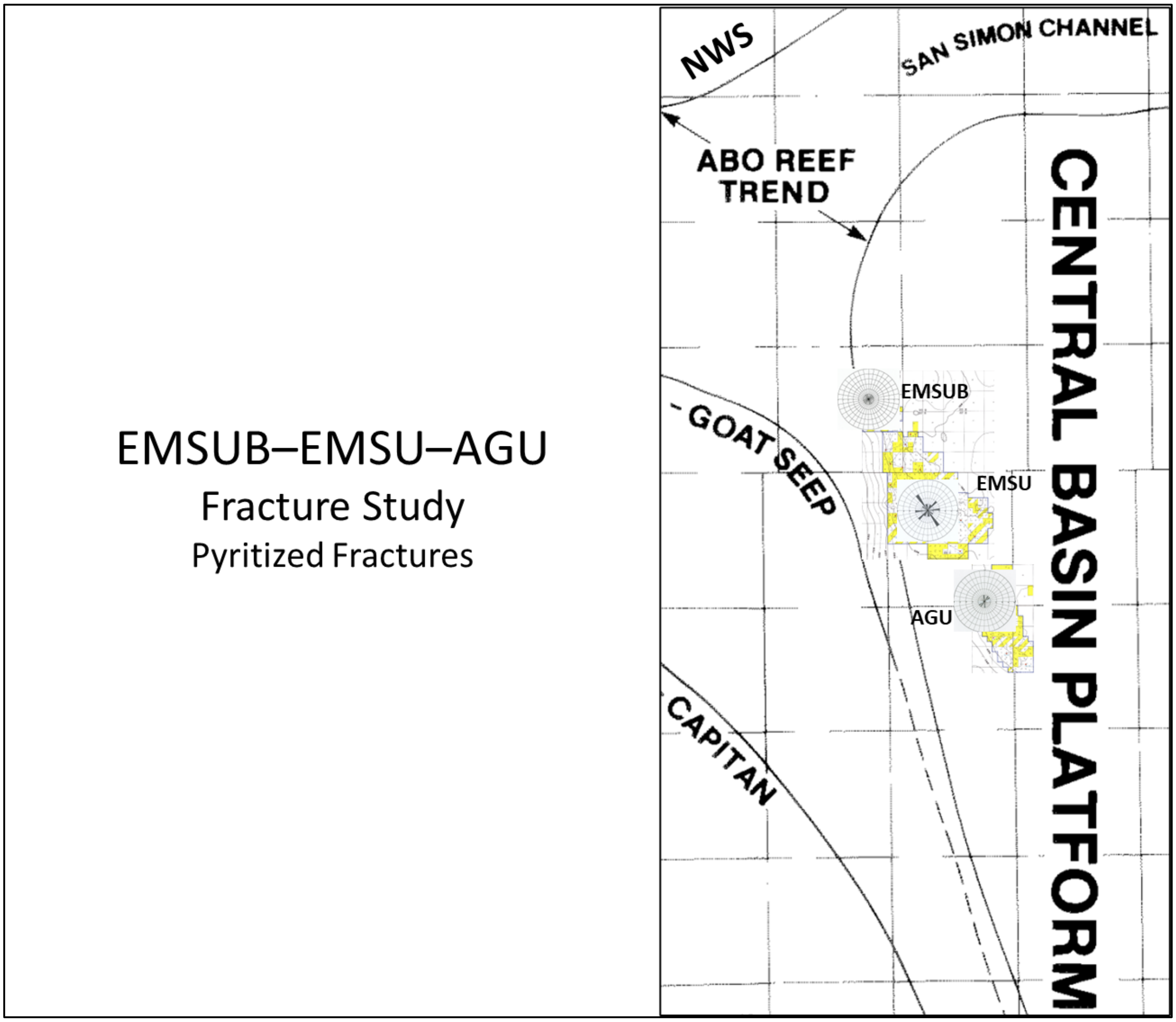


Figure 18. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows pyritized vertical fractures that were identified in core. In EMSUB pyritized fracture trends are northeast to southwest and northwest to southeast. In EMSU pyritized fracture trends are northwest to southeast, northeast to southwest, and east northeast to west southwest. In AGU pyritized fractures trend north northwest to south southeast and northeast to southwest.

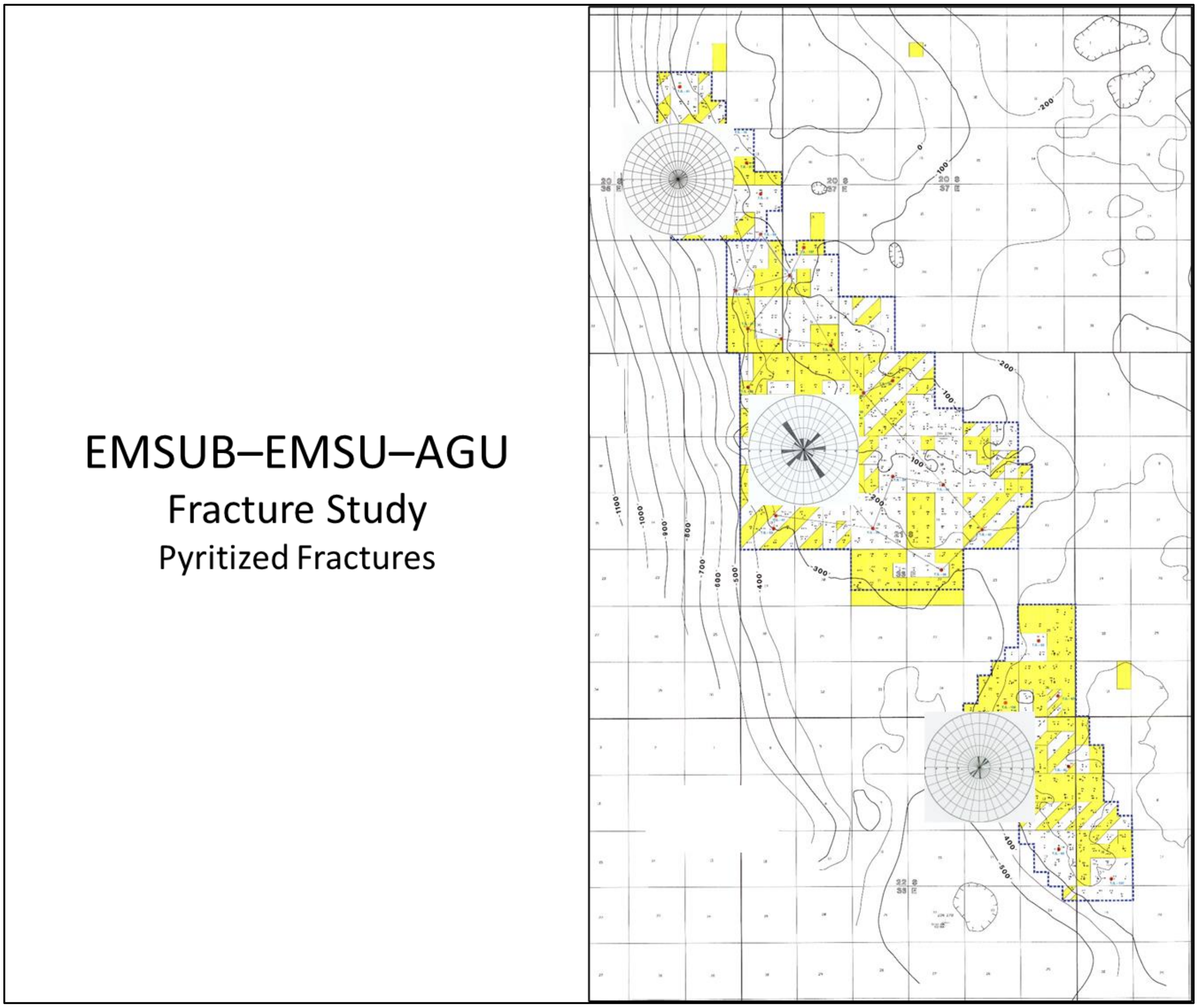


Figure 19. Close-up view of index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows pyritized vertical fractures that were identified in core. In EMSUB pyritized fracture trends are northeast to southwest and northwest to southeast. In EMSU pyritized fracture trends are northwest to southeast, northeast to southwest, and east northeast to west southwest. In AGU pyritized fractures trend north northwest to south southeast and northeast to southwest.

Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure at Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

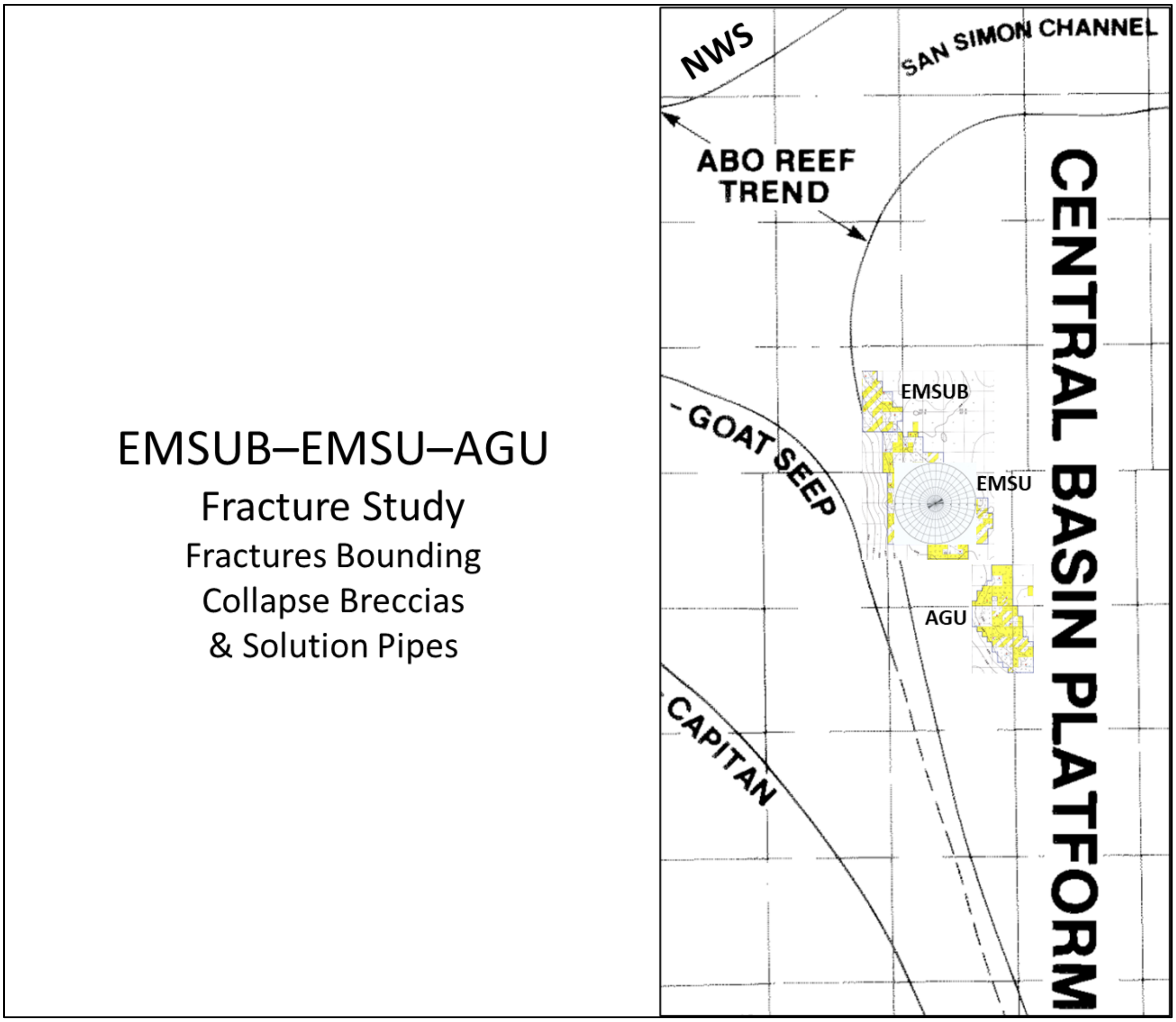


Figure 20. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows vertical fractures bounding collapse breccias and solution pipes that were identified in core. In EMSUB no collapse breccias and solution pipes were identified. In EMSU fracture trends are northeast to southwest. In AGU no collapse breccias or solution pipes were identified.

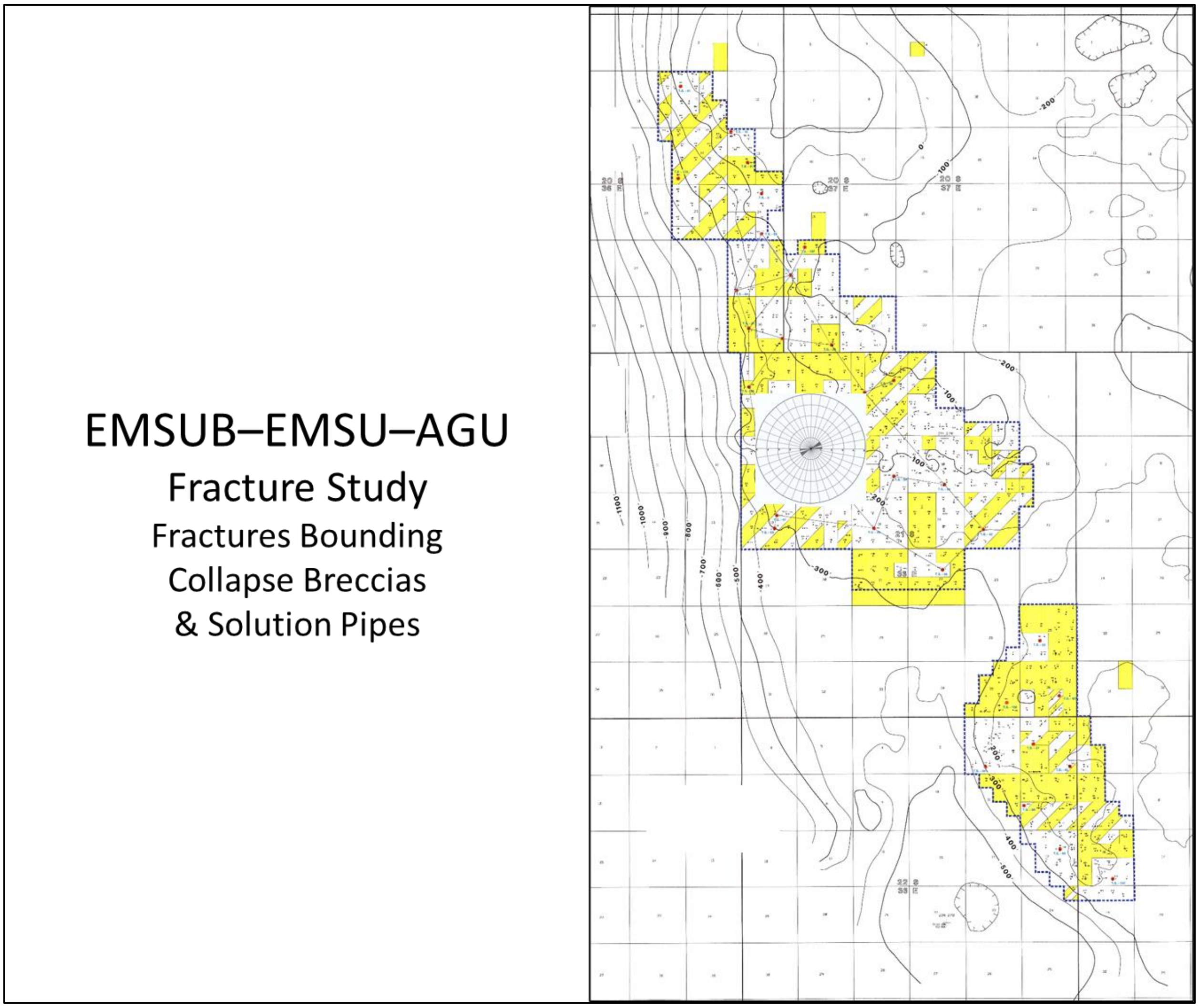


Figure 21. Close-up view of index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows vertical fractures bounding collapse breccias and solution pipes that were identified in core. In EMSUB no collapse breccias and solution pipes were identified. In EMSU fracture trends are northeast to southwest. In AGU no collapse breccias or solution pipes were identified.

Close-up view is overlain on top of the Grayburg Formation structure throughout the greater Eunice Monument area. The large structure at Eunice Monument is referred to as the Eunice High, a large structural pop-up block. However, the Eunice High is composed of a series of smaller fault bounded, basement-cored blocks.

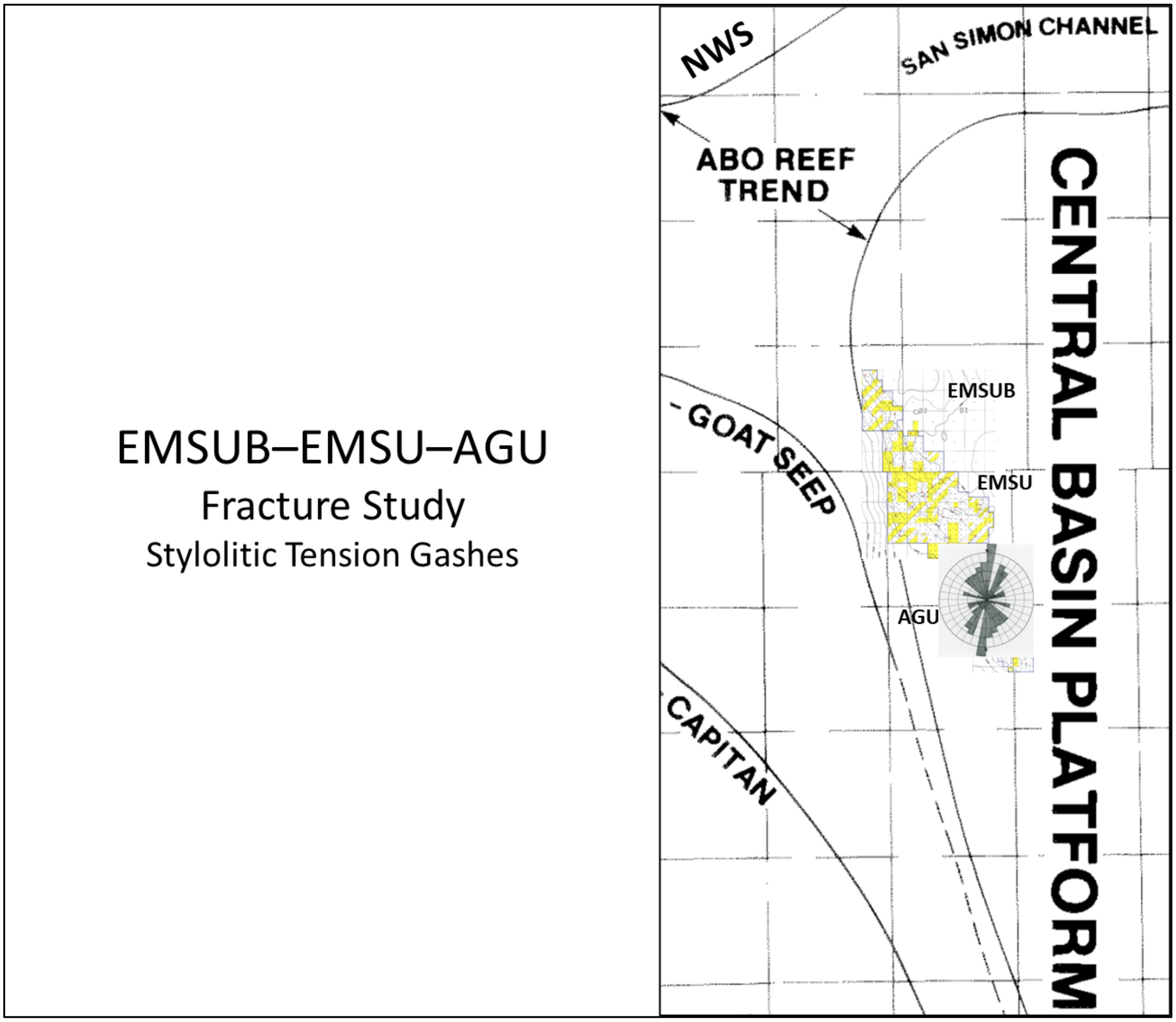


Figure 22. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows vertical fractures that bound stylolitic tension gashes that were identified in core. In EMSUB and EMSU stylolitic tension gashes were identified in core but were not mapped. Tension gashes formed along stylolites as the Eunice Monument asymmetric anticline formed during the Laramide orogeny. Stylolitic tension gashes were found to be the most common type of fractures in EMSUB, EMSU, and AGU. In AGU stylolitic tension gashes trend north northeast to south southwest, northwest to southeast, northeast to southwest, with minor trends west northwest to south southeast and east northeast to west southwest.

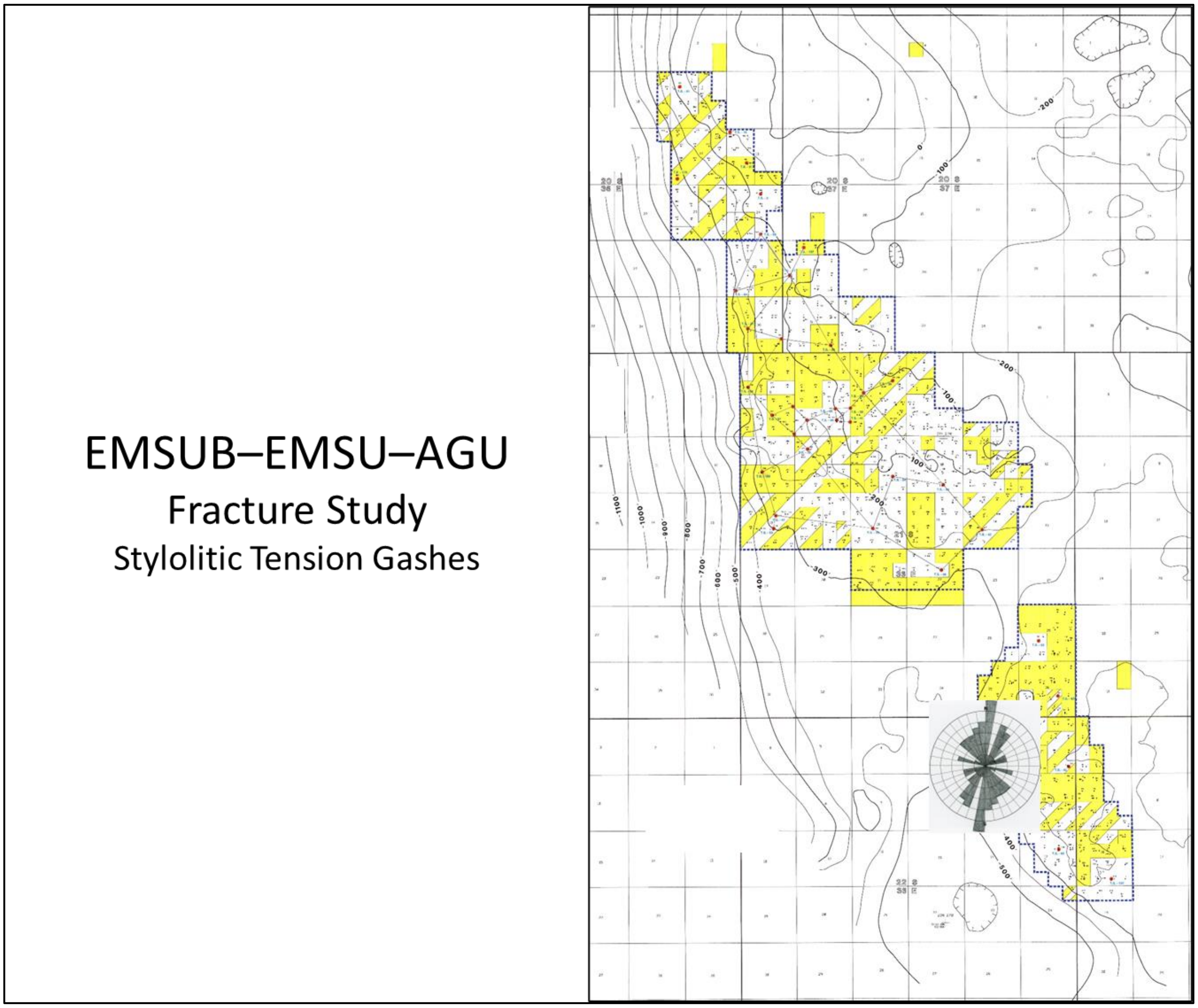


Figure 23. Index map of the northwest corner of the Central Basin Platform, showing EMSUB, EMSU, and AGU. This map shows vertical fractures bounding stylolitic tension gashes that were identified in core. In EMSUB and EMSU stylolitic tension gashes were identified in core but were not mapped. Tension gashes formed along stylolites as the Eunice Monument asymmetric anticline formed during the Laramide orogeny. Stylolitic tension gashes were found to be the most common type of fracture in EMSUB, EMSU, and AGU. In AGU stylolitic tension gashes trend north northeast to south southwest, northwest to southeast, northeast to southwest, with minor trends west northwest to south southeast and east northeast to west southwest.

STATE OF NEW MEXICO
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES
OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO — **CASE NO. 24123** **ORDER NO. R-22869-A**

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS LEA COUNTY, NEW MEXICO — **CASE NOS. 23614-23617**

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO. — **CASE NO. 23775**

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO — **CASE NOS. 24018-24020, 24025**

SELF-AFFIRMED STATEMENT OF RYAN M. BAILEY – REBUTTAL

I, Ryan M. Bailey, make the following self-affirmed statement:

1. I am over the age of 18, and have the capacity to execute this affirmation, which is based on my personal knowledge.

2. I am Co-founder and Vice President of Ops Geologic, LLC in The Woodlands, Texas and I am a geologist with over 17 years of experience in the petroleum industry.

3. I submit this statement on behalf of Empire New Mexico, LLC in connection with the above-referenced matters, in accordance with paragraph 7 of the Pre-Hearing Order issued in these matters on December 5, 2024.

4. I have not previously testified before the New Mexico Oil Conservation Commission. A copy of my curriculum vitae is attached as Exhibit K-56. In short, I graduated

EXHIBIT K

from the University of Alabama with a BS and MS in geology. My academic course work and thesis focused on understanding structural styles within the Appalachian-Ouachita fold and thrust belt, interpreting seismic and well log data to structurally restore a seismic profile in the Southern Appalachian thrust belt in Alabama. I co-authored a paper in the Gulf Coast Association of Geological Societies 2012 (Vol. 1) titled Structure of the Alleghanian Thrust Belt under the Gulf Coastal Plain of Alabama. I am a member of the American Association of Petroleum Geologists and the Houston Geological Society.

5. I reviewed the available literature and utilized Dr. Lindsay's lifelong work in the field and core to define a stratigraphic model based on Dr. Lindsay's original stratigraphic model. I correlated the Grayburg and all zones within the Grayburg, Upper San Andres, Lovington Sand, Lower San Andres, and Glorieta formations across the EMSU unit. In addition, I worked with Ops Geologic petrophysicist, Scott Birkhead, who generated a petrophysical model over the EMSU and mapped the resultant reservoir properties across the EMSU, including structure, isopach, porosity, water saturation, pore volume, hydrocarbon pore volume, and oil in place.

6. I have reviewed the testimony of Mr. Preston McGuire previously filed on August 26, 2024, on behalf of Goodnight Midstream Permian, LLC ("Goodnight"). I make this statement in rebuttal to some of the opinions stated therein by Mr. McGuire's testimony, particularly the items described below.

Summary

- I reviewed the testimony of Preston McGuire and provide a stratigraphic model in rebuttal to Mr. McGuire's opinions. Scott Birkhead responds in rebuttal to the opinions expressed by Dr. Davidson.

- Base maps for the study area are shown in exhibits K-1 and K-2. Exhibit K-1 is a base map that shows all wells within the Eunice Monument South Unit ("EMSU") and exhibit K-2 is a base map that shows all wells that were used to map the San Andres structure, all active disposal wells colored by operator, and the core and petrophysical wells that were utilized to develop reservoir property maps. Several publications document that the Lovington sand lies within the Upper San Andres formation. (Foster, 1976; Fitchen, 1993; Dutton et al., 2011; Trentham, 2011). Goodnight has incorrectly chosen to place the top of the San Andres below the Lovington sand based on pressure differences above and below the sand. Goodnight has chosen to use this model to argue there are not any ROZ zones within the San Andres and thereby support the case for water disposal in the San Andres. Our analysis demonstrates that Goodnight's model is incorrect, as explained below.
- Exhibits K-3 and K-4 are type sections for the cored wells from the R.R. Bell 4 and EMSU 679 and are the basis for our stratigraphic model. This model is of critical importance as it shows a ROZ in the Upper San Andres as opposed to Goodnight's model of the ROZ being in the Lower Grayburg.

In addition, I worked with Scott Birkhead to generate a petrophysical model for the Grayburg and San Andres across the EMSU unit. Ops Geologic petrophysical model analyzed 29 wells - 18 wells were used to map the reservoir properties for the Upper San Andres and 12 wells were used for the Lower San Andres. The resultant reservoir properties were mapped for the Upper and Lower San Andres, inclusive of Net Reservoir, Pore Volume (PHIH), Oil Saturation (So), Hydrocarbon Pore Volume (HCPV), and Original Oil in Place (OOIP). As explained by Mr. Birkhead, the petrophysical model clearly identifies oil saturations over 20% throughout the Upper San Andres as well as several potential zones within the Lower San Andres. Determining the oil saturations (SOIL LO and SOIL HI) as shown in the type logs in Track 6 of Exhibits K-3 and K-4 were critical to identifying potential ROZ zones within the San Andres. The resultant petrophysical model allowed for understanding the potential ranges of oil saturations throughout the San Andres which, along with the reservoir property maps, allowed for developing and mapping out potential ranges for original oil in place (OOIP). These reservoir property maps, along with cross sections across the EMSU unit, will be utilized throughout to rebut Mr. McGuire's testimony.

Preston McGuire Statement

- On page 3 bullet 2 of Preston McGuire's summary, he states: "Substantial data on the sustained and geographically extensive pressure differentials between the Grayburg and San Andres aquifer confirm (1) the presence of an effective geologic barrier between the two formations, and (2) that the Grayburg reservoir and San Andres aquifer are distinct geologic zones that are functionally severed and do not act, and cannot be considered, as a single reservoir."

Rebuttal

- I agree that the Grayburg and San Andres are separate geologic intervals. However, based on fluid communication between the San Andres and Grayburg in wells within the EMSU, it is undisputed that these reservoirs are in communication with one another. In Dr. Lindsay's fracture study to G.W. Burg on the EMSU 679 well core (Exhibit K-5), he measured 313 fractures. Four intervals of collapse breccia were present along with small fractures. The study shows a well-developed northwesterly and a poorly developed northeasterly set of fractures as part of a conjugate joint system in EMSU 679 well. Fractures and oil staining from a cored interval below the top of the San Andres from 4,229-4,239' is shown in the core photo in Exhibit K-5. Similar fracturing, most likely higher frequency, would be expected to be seen on the flanks and crest of the Eunice Monument anticline given the flexuring of stratigraphy up onto the structure. In addition, based on Chevron's analysis in the EMSU (Strickland et al., 1996), which is referenced by Mr. McGuire on page 6 bullet 19 of his testimony, there does not seem to be a consistent, continuous regional geologic barrier between the Grayburg and San Andres. It is noted:

- "During the time of primary production prior to unitization and initiating the waterflood in the Eunice Monument field, barium sulfate scale deposition was experienced in a number of producing wells. Although the drilling was confined to the Penrose and Grayburg formations, apparently some San Andres water was finding its way into the wellbore of these wells and resulted in a barium sulfate scale, barite, deposition problem. Production experience strongly suggests that mixing of water occurs in the producing wellbores rather than in the formation. This problem was and continues to manifest itself in downhole pump problems. Inflow of fluids into the wells is not affected, thus leading to the conclusion that sulfate rich water found its way into some producing wells before the waterflood was initiated.

  Barium sulfate scale has also been detected in the surface vessels that are used to process the produced fluids."

- More importantly, Goodnight's stratigraphic model is inaccurate. Based on Dr. Lindsay's field work on outcrop and core descriptions and literature across the Northwest shelf and Central Basin Platform (Foster, 1976; Fitchen, 1993; Dutton et al., 2011; Trentham, 2011) it is understood that the Lovington sand sits within the Upper San Andres. Foster work regarding San Andres stratigraphy states, "the upper part is dolomite with an interval of sandstone and black shale, known as the Lovington sand, about 150' below the top" (Exhibit K-6). Fitchen's work states, "On the platform, this unit contains several sandstone beds, the lowermost of which lies 25-47m below the top of the San Andres formation". I have also provided Upper San Andres type logs from the BEG study and Bob Trentham's work, illustrating the Lovington Sand sitting within the upper San Andres (Exhibit's K-7 and K-8). These statements are consistent with the outcrop analysis and stratigraphic model provided by Dr. Lindsay and are the basis for how our stratigraphic model was built.
- We define the top of the San Andres as the tight dolomite sequence approximately 130-150' above the Lovington Sand and thinning to the east onto the Eunice Monument anticline, where it is approximately 100' below the top of the San Andres in the R.R. Bell 4. The top of the San Andres is correlated by a tight dolostone/anhydrite sequence identified using gamma ray (GR), density (RHOB), density/neutron porosity (DPHI/NPHI), sonic (DT), and photoelectric (PE) log curves. This is illustrated in the type-log sections for the R.R. Bell 4 and EMSU 679 (Exhibits K-3 and K-4). Both wells were cored down into the San Andres and allowed Dr. Lindsay to define the top of the San Andres based on his core

descriptions, which provided the basis for our stratigraphic model. Goodnight has generally defined the top of the San Andres below the Lovington Sand marker except for in the EMSU 679 well, where the define the top as 40' above the Lovington sand marker and 125' below the OCD and Ops Geologic top of the San Andres. However, in the Ryno SWD 1, Goodnight defines the top exactly where we define the top of the San Andres.

- Exhibit K-9 is a base map showing the location of cross sections across EMSU. Exhibits K-10 through K-12 are strike and dip sections across the field illustrating our correlations and, exhibit K-13 is a structural dip section through the Ryno SWD, EMSU 679, EMSU 001, EMSU 628, and EMSU 660 illustrating the difference between Goodnight's correlations and ours.
- In addition, the reported perforated intervals for EMSU 628 and EMSU 658 and the bridge plug for EMSU 713 further support our model. In the EMSU 628, the reported perforated intervals by XTO from 3,918'-3,924', 3,935-3,950', 4,030'-4,040', and 4,057-4,067 are designated as San Andres. The upper perforation sits directly below our top of San Andres. These perforations are well above Goodnight's top of 4,089' MD for the San Andres. In EMSU 658, the reported perforated intervals by XTO from 3,995-4,004', 4,018-4,030', and 4,074-4,084' are designated San Andres and again sit well above Goodnight's top of 4,145' MD for the San Andres. The OCD has the top of the San Andres at 3,949' MD, which matches the depth of our San Andres top. In EMSU 713, the bridge plug that was set for this well from 4,042-4052' is designated Grayburg Zone 6. Our top of the San Andres sits directly below this bridge plug and is consistently correlated with

the EMSU 628 and 658 as shown in Exhibit K-14. Goodnight did not provide a pick for the San Andres formation top in the EMSU 713, but the OCD top sits well above our top at 3,942.

- Based on Dr. Lindsay's analysis, the cited literature, and the perforated intervals discussed above, wells with logs across the field were correlated, and structure and isopach maps were generated for the Lower and Upper San Andres and Grayburg (Exhibits K-15 through K-20). Based on log coverage over the intervals, the following number of wells were used to generate the structure and isopach maps across the EMSU unit for the Lower and Upper San Andres and Grayburg: 79 wells were used to generate the Lower San Andres structure and 65 wells were used to generate the isopach maps; 90 wells were used to generate the Upper San Andres structure and 78 wells were used to generate the isopach maps; and 131 wells were used to generate the Grayburg structure and 90 wells were used to generate the isopach maps. The Eunice monument anticline is clearly shown in the structure maps, oriented NW-SE across the east-central part of the EMSU (Exhibits K-15-K17). The Lower San Andres maintains fairly consistent thickness across the EMSU with slight thickness variations upwards of 30-60' in spots. Both the San Andres and Grayburg thicken into the basin, though the Grayburg thickens more rapidly (Exhibits K-18-K20). The Grayburg was deposited on a distally steepening ramp (Lindsay, 2017) so expansion of the section into the basin is expected.
- Reservoir property maps for low and high cases for the Lower and Upper San Andres net pay, average porosity above 4% cutoff (PHIT), average water saturation below 80% cutoff (SWT), oil saturation (So), pore volume (PHIH), hydrocarbon

pore volume (HCPV), and original oil in place (OOIP) are shown in exhibits K-21-K46. In addition, combined maps for the Upper and Lower San Andres Net Pay, PHIH, HCPV, and OOIP are shown in exhibits K-47 through K54. As mentioned in the summary above, the low and high cases were based on low and high cases Mr. Birkhead developed for the water saturation to determine the potential ranges for oil saturations within the San Andres. Net pay calculations for both the Upper and Lower San Andres were determined using a 4% PHIT cutoff, 80% water saturation cutoff, and 60% volume of clay cutoff (VCL). Oil saturation maps were generated using 1-Sw for each case. PHIH maps were generated by multiplying the average porosity above the 4% cutoff with the net pay maps. HCPV maps were generated by multiplying the PHIH maps by the So maps to give the total hydrocarbon filled pore volume. OOIP maps were generated in millions of barrels/section using the standard OOIP calculation of:

OOIP=7,758*A*HCPV/Bo

Where 7,758 is the constant that converts the results from acre-feet to barrels, A is the area which is 640 acres/section, HCPV comes from the maps generated for each formation, and 1.3 was used for the Bo known as the oil formation volume factor which was provided by Empire's engineers. For the Lower San Andres, OOIP ranges from 5-40+ MMBLS/Section for the low case and 10-60+ MMBLS/Section for the high case. For the Upper San Andres, OOIP ranges from 3-20+ MMBLS/Section for the low case and 5-30+ MMBLS/Section for the high case. Total San Andres OOIP volumes range from 8-60+ MMBLS for the low case and 15-90+ MMBLS for the high case. OOIP was also calculated for the entire EMSU unit utilizing the HCPV maps, an area of 14,179.85 acres (hand drawn polygon, the actual unit size from Gulf Oil's Case No. 8399 is 14,189.84 more or less), and a Bo of 1.3. Total OOIP volumes for the Upper San Andres in the EMSU unit range from 191 MMBL for the low case to 331 MMBLS for the high case. For the Lower San Andres, OOIP volumes for the EMSU unit range from 439 MMBLS for the low case to 718 MMBLS for the high case. That brings the OOIP volumes for the total San Andres to 630 MMBLS for the low case and 1,049 MMBLS for the high case (Exhibit K-55)

Preston McGuire Statement

- On page 3 bullet 3 of Preston McGuire's summary, he states: "Analysis of core data and historical production tests confirms that the San Andres does not meet the criteria for a ROZ because San Andres oil saturations are well below the defined 20% cutoff as defined by Empires' own ROZ experts, confirming that Goodnight's disposal operations will not cause waste or impair correlative rights in the San Andres disposal zone."

Rebuttal

- The cross sections I've provided (Exhibits K10 throughK-14) clearly show that oil saturations are above 20% and potentially above 40% throughout the Upper San Andres. And while we have fewer wells available for evaluation in the Lower San Andres, there are clear zones of interest with oil saturations over 20% and potentially in the range of 40-60%. In addition, the oil saturation maps generated for the low and high cases for both the Lower San Andres (Exhibits K-26 and K-

27) and Upper San Andres (Exhibits K-39 and K-40) clearly illustrate oil saturation averages above 20% across the EMSU.

Preston McGuire Statement

- On page 3 bullet 4 of Preston McGuire's summary, he states: "Because Goodnight's San Andres disposal zone is confined to intervals below any potential ROZ that may exist in the Grayburg and is isolated by a sustained and geographically extensive geologic seal, disposal operations will not interfere with Eunice Monument South Unit ("EMSU") operations in the Grayburg main pay zone or ROZ intervals based on the effective seal of the disposal zone."

Rebuttal

- First, disposal is impacting the potential ROZ zones within the San Andres as I have shown in the cross section exhibits. Second, I have also shown in my summary from the literature (Strickland et al., 1996), that barium sulfate scale was causing downhole pump problems and was detected in surface vessels. Chevron concluded that sulfate rich water made its way into the producing wellbores before the water flood. San Andres water is sulfate rich, and Grayburg water contains barium. If the two are mixing prior to the waterflood, it can only be concluded that San Andres water is migrating into the Grayburg. On face value this shouldn't seem surprising given that the Grayburg was the main producing zone, and the likely pressure drop associated with Grayburg production allowed for fluids to migrate from the San Andres into the Grayburg. In addition, the documented fracturing within the EMSU 679 core and the likelihood of higher frequency fracturing on the Eunice Monument anticline would only enhance the potential for fluid communication. The information provided here certainly doesn't lead one to conclude that there is a geographically extensive geologic seal across the EMSU.

Preston McGuire Statement

- On page 11 bullet 25 of Preston McGuire's testimony, he states: "The San Andres at the EMSU has never been prospective for hydrocarbons and has been the defined water management zone for the area, both for disposal and water supply, since as early as the 1960s."

Rebuttal

- Mr. McGuire ignores that to date, there have been no tertiary enhanced oil recovery (EOR) efforts made in the San Andres within the EMSU unit. There are currently several active CO2 floods in the San Andres along the same trend across the Northwest Shelf and Central Basin Platform (Hobbs, Wasson, Seminole, Vacuum, Means, Hanford, and Goldsmith-Landreth Units). I have illustrated the potential oil saturations within the San Andres through our petrophysical modeling and I have shown oil staining within the Upper San Andres from the EMSU core. It is unreasonable to deny the possibility that the San Andres has potential for tertiary recovery.

Preston McGuire Statement

- On page 15 bullet 36 of Preston McGuire's testimony, he states: "While a ROZ does not occur in the San Andres aquifer at the EMSU, one potentially exists below the oil-water contact within the Grayburg but is entirely limited to the Grayburg. There has never been any evidence that San Andres disposal operations have interfered with the Grayburg producing zone in the 60 plus years since San Andres disposal began at the EMSU."

Rebuttal

- I have clearly shown from literature and through our correlations that what Goodnight has determined to be the lower Grayburg is the Upper San Andres. What Goodnight defines as a regional geographically extensive seal is difficult to determine given Goodnight's inconsistency in correlations, which I have illustrated in Exhibit K-13. If we assume that the base of the Lovington sand is Goodnight's top seal, then I would question Goodnight's description of a tight dolomite/anhydrite interval as there is greater than 4% porosity and generally increased porosity at the top of the interval, especially in wells on the Eunice Monument anticline. If we assume Goodnight's regional seal is the Lovington sand, then Goodnight's lithologic description of this interval as a tight dolomite/anhydrite is inaccurate because the Lovington sand is a mix of dolomitic sand and mudstone. Goodnight's model is inconsistent with the outcrop and core analysis by Dr. Lindsay and others, as well as the studies of the geoscientists whose literature I have discussed in my testimony. On that basis, Goodnight's testimony about the formation in which ROZ zones exist and regarding regional seals between the Grayburg and San Andres is incorrect because Goodnight's model is wrong lithologically and stratigraphically. In addition, I have exhibited potential ROZ intervals well down into the San Andres that are currently being impacted by Goodnight's disposal. Goodnight has included cross sections in testimony but has not provided any structure, isopach, or reservoir property maps to support their geologic analysis.

Preston McGuire Statement

- On page 35 bullet 94 of Preston McGuire's testimony, he states: Goodnight Midstream defines the boundary between the Grayburg and the San Andres as the location of the mappable permeability barrier that prevents flow from occurring between those two formations. This is a functional "Top of San Andres." Everything above performs and behaves together as a single unit and reservoir and is isolated and distinct from everything below this barrier."

Rebuttal

- In Mr. McGuire's geologic overview of Goodnight's existing injection in the EMSU, he describes the Upper San Andres being capped by tight dolomite and anhydrite which serves as the upper geologic seal to prevent migration to the formations above. However, on Exhibit K-13 as well as the cross-section exhibits provided by Mr. McGuire, one can see where Goodnight places the top of the San Andres. Goodnight's top is inconsistent across the field but in general it is below the Lovington sand marker. The Lovington sand interval above Goodnight's top is a mixture of mudstone and dolomitized sands. The hotter gamma ray signature is indicative of not only the mudstones but of the arkosic nature of the Lovington sand. In addition, the Lovington sand interval has average porosities well over 4%. Below Goodnight's top is a dolomite/anhydrite unit, but this interval contains porosities well over 4% as well. Goodnight's statement on the lithology at the top of the San Andres is more in-line with where I have placed the top of the San

Andres, which has porous intervals but is a tighter interval than Goodnight's top of San Andres and is consistent with the work on outcrop, core, and literature I have provided.

Preston McGuire Statement

- On page 35 bullet 96 of Preston McGuire's testimony, he states: "It appears Empire is seeking to create a conflict with Goodnight's disposal operations by calling a potential Grayburg ROZ (the zone below the Grayburg oil-water contact at -325 feet subsea) the San Andres. It is not San Andres. It is Grayburg because it is in an interval that is geologically and functionally isolated and distinct from the underlying San Andres. That means any residual oil in this zone is Grayburg oil and it is Grayburg oil below the Grayburg oil-water contact. Because it is isolated by the well-defined permeability barrier that separates the San Andres from the Grayburg, the oil in this zone, and any current or proposed operations, will not be affected by San Andres water management operations below."

Rebuttal

- Mr. McGuire has chosen to ignore the work of many technical experts in the field and their subsurface analyses. Goodnight is using an engineering approach to define the top of the San Andres based on a purported pressure boundary as opposed to utilizing lithostratigraphic or chronostratigraphic correlations. This theory is akin to what would be utilized offshore to correlate compartmentalized sands over long distances where paleo data is not readily available to chronostratigraphically tie the sands. This methodology is inappropriate for this area given the amount of existing outcrop and subsurface studies, the available well data, and the pre-existing stratigraphic models that were built based on these analyses. Mr. McGuire's opinion demonstrates that Goodnight lacks a basic understanding of the stratigraphy and has built an incorrect model based on reservoir engineering. I would presume it is also why they have picked inconsistent tops across the EMSU.

Preston McGuire Statement

- On page 37 bullet 102 of Preston McGuire's testimony, he states: "Unlike the majority of the EMSU producers and waterflood injection wells, the tops that were reported in the WSW's were consistent with the unitization exhibits and the Chevron SPE publication discussed above, except for the EMSU #461. The top that is reported for #461 is 4,002 feet, making the Grayburg only 255 feet thick. This is inconsistent with the reported thickness for the Grayburg in the unitization case file and with its thickness at the other WSW's. Goodnight picked the San Andres top in this well at 4,195', which is consistent with the Grayburg thickness reported in the unitization case file and with the other water supply wells that picked the top of the San Andres at a mappable confining layer."

Rebuttal

- The Grayburg is on a distally steepening ramp thickening into the basin (Lindsay, 2017; Lindsay 1991). The Grayburg does not have a consistent thickness across the EMSU, especially from the basin onto the Eunice Monument anticline. This is part of the fallacy in Goodnight's top picks and Goodnight's failure to understand the stratigraphic model for the Grayburg/San Andres. OCD's pick for the EMSU #461 well is actually 20' shallower than our top pick of 4,022' but certainly more in line with our stratigraphic model for the San Andres than Goodnight's pick of 4,195' below the Lovington sand.

Preston McGuire Statement

- On page 37 bullet 103 of Preston McGuire's testimony, he states: "Goodnight has consistently used this method of picking the San Andres top at the mappable barrier that separates the Grayburg from the San Andres. This top is confirmed to be the barrier that separates two different pressure systems, one associated with the Grayburg and the other associated with the San Andres aquifer. Because of the difficulty identifying stratigraphic intervals within the San Andres carbonate ramp system that exists within the EMSU, the best method for accurately picking the top of the San Andres and the strongest evidence it is correct is not necessarily geologic but engineering based data.

Rebuttal

- Mr. McGuire's correlations illustrate the pitfalls with using an engineering-based methodology to identify tops that cross chronostratigraphic surface boundaries. The pick can be made very clearly across EMSU both lithologically and chronostratigraphically as illustrated in Exhibits K-10 through K-14. Our model relies on the previous work of many geologists who have spent decades defining the stratigraphic framework. Throughout this rebuttal and in my exhibits, I have illustrated the stratigraphic model and how the top is defined. It is incorrect to construct a model to fit an agenda, and doing so shows a lack of basic research and ignores fundamental geology. If Goodnight had argued that field rules designated the top of the San Andres based on a type log and that top fit their model, then that would be fine. But that is not the case here. Similarly, if Goodnight had utilized a different stratigraphic model from a nearby field that they could argue supports their model, then that would be fine as well. But they have not done that either. So, we must rely on the previous work that has been done and documented in the literature and apply it to the EMSU. That is what I have done and illustrated throughout this rebuttal.

I affirm under penalty of perjury under the laws of the State of New Mexico that this statement is true and correct.

Ryan Bailey

Ryan M. Bailey
Vice President Geoscience
OPS GEOLOGIC

2-8-2025
DATE

References

Strickland et al. "Utilization of Geological Mapping Techniques to Track Scaling Tendencies in the Eunice Monument South Unit Waterflood, Lea County, New Mexico" March 1996
Foster, R. "Geology of Loco Hills Sand, Loco Hills Field Eddy County, New Mexico", December 1976

Fitchen W.M. "Sequence Stratigraphic Framework of the Upper San Andres Formation and Equivalent Basinal Strata in the Brokeoff Mountains, Otero County, New Mexico", 1993 https://doi.org/10.56577/FFC-44.185

Dutton et al. "Play Analysis and Digital Portfolio of Major Oil Reservoirs in the Permian Basin: Application and Transfer of Advanced Geological and Engineering Technologies for Incremental Production Opportunities", May 2004

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Lindsay, R.F., April 2017, Grayburg Formation Reservoir-Scale Architecture and Sequence Stratigraphy, Permian Basin: AAPG 2017 Annual Convention and Exhibition, Houston, TX

Lindsay, R.F., 1991, Grayburg Formation (Permian-Guadalupian): Comparison of reservoir characteristics and sequence stratigraphy in the northwest Central Basin Platform with outcrops in the Guadalupe Mountains, New Mexico, in MeaderRoberts, S., Candelaria, M.P., and Moore, G.E., eds., Sequence stratigraphy, facies, and reservoir geometries of the San Andres, Grayburg, and Queen formations, Guadalupe Mountains, New Mexico and Texas: Permian Basin Section Society of Economic Paleontologists and Mineralogists, Publication 9132, p. 111-118.

Exhibit K-1

EMSU Base Map

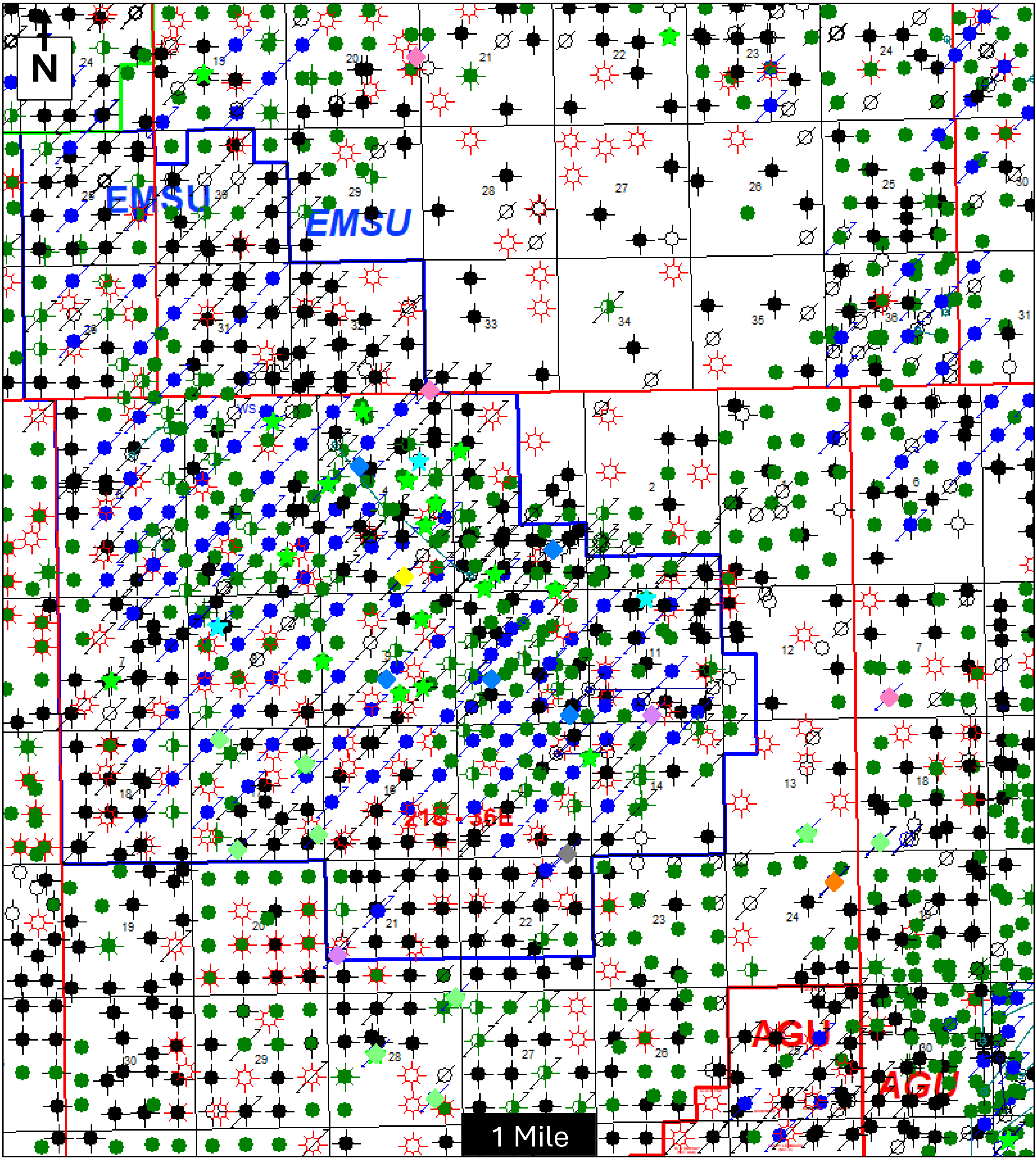
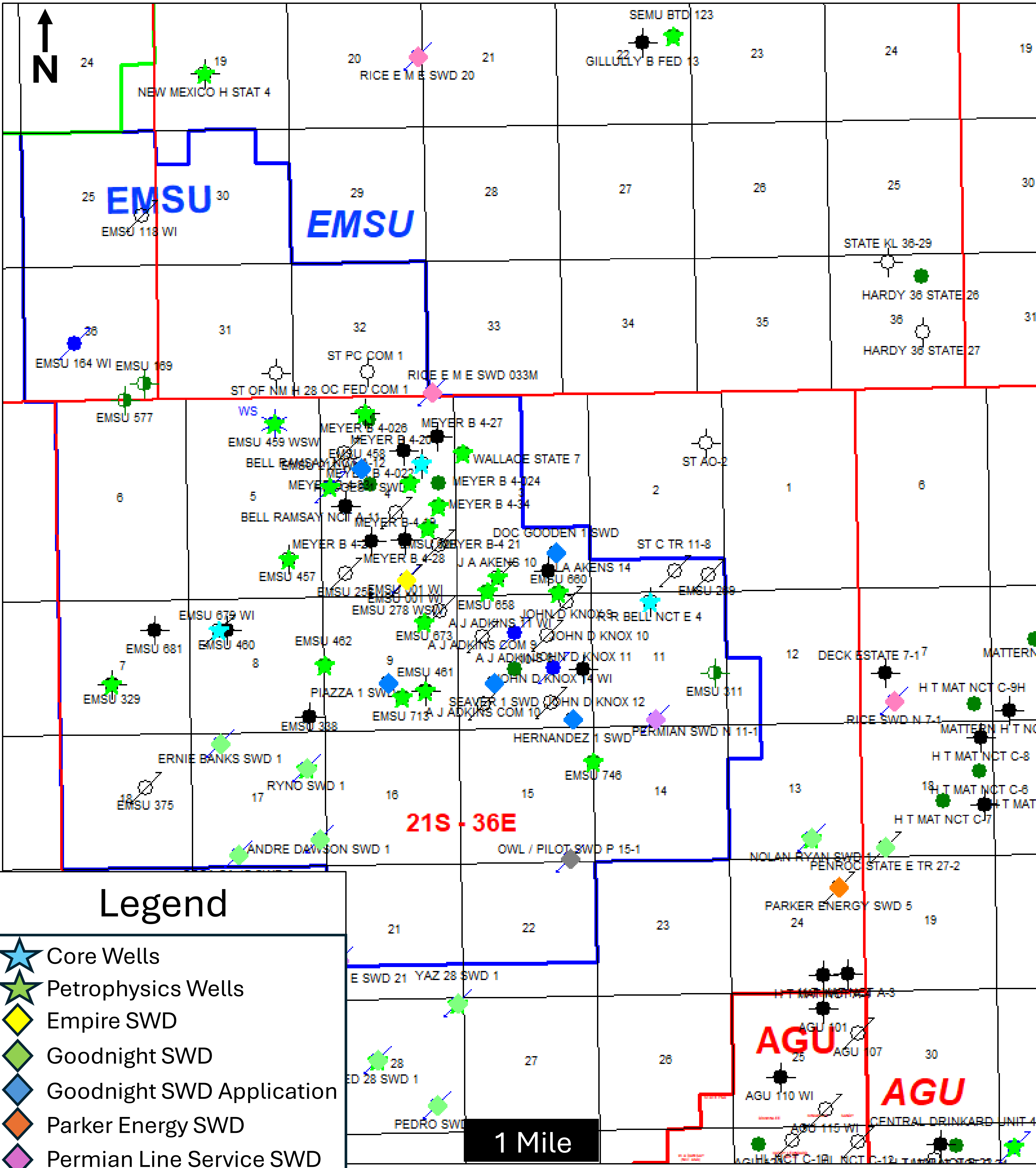


Exhibit K-2

EMSU Base Map w/ San Andres Structure and Disposal Wells

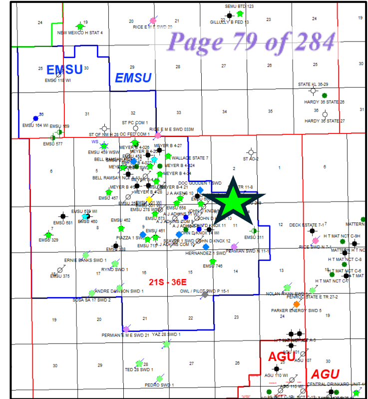


Legend

- Core Wells
- Petrophysics Wells
- Empire SWD
- Goodnight SWD
- Goodnight SWD Application
- Parker Energy SWD
- Permian Line Service SWD
- Pilot Water Solutions SWD
- Rice Operating SWD

Exhibit K-3

R.R. Bell NCT E 4 Type Log
30025275040000
Spud Date: 10/2/1981



Cored Interval Box in Track 1
RES Shaded Above 200 Ohms
DPHI_DOL Shaded Above 4%

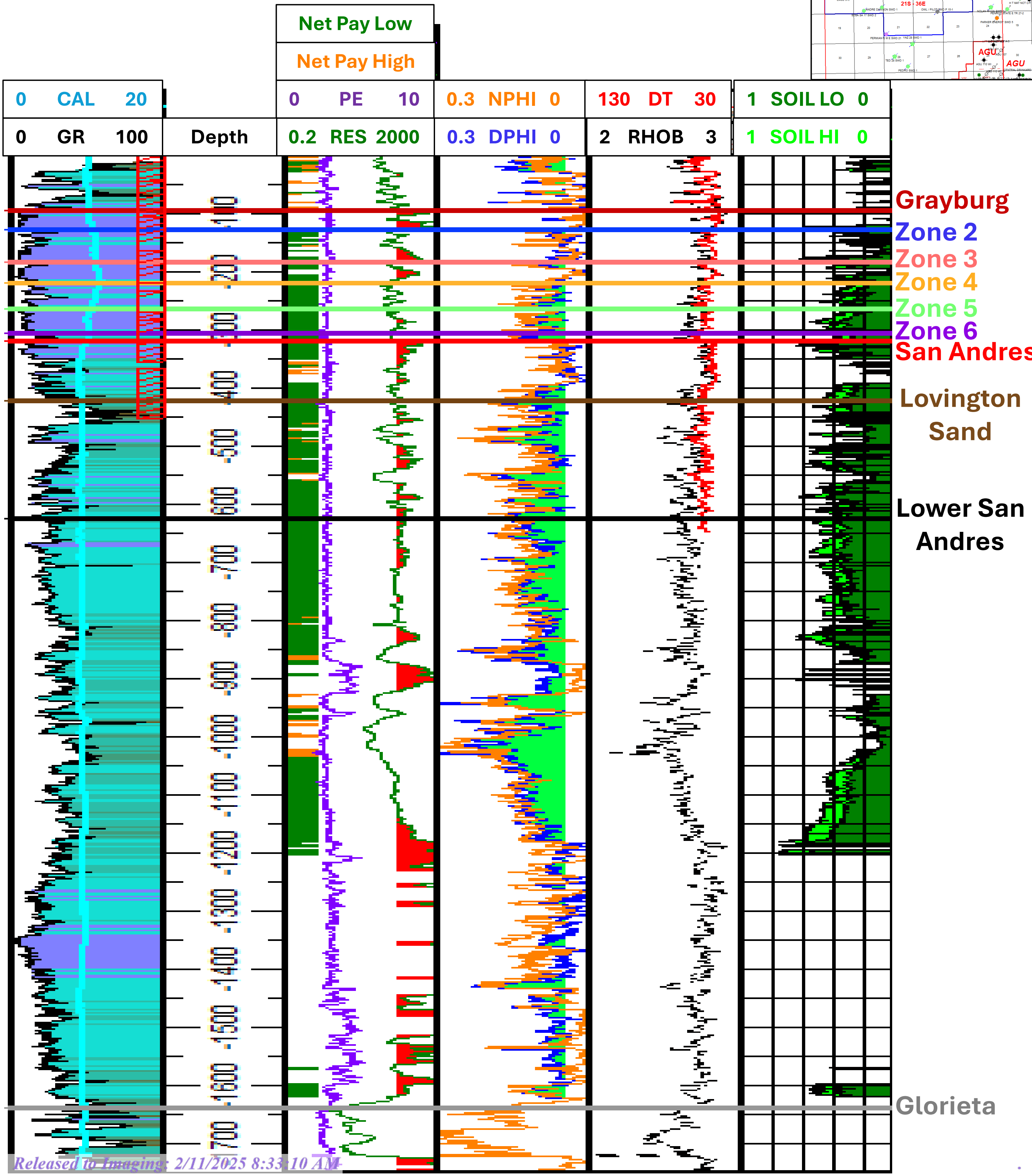
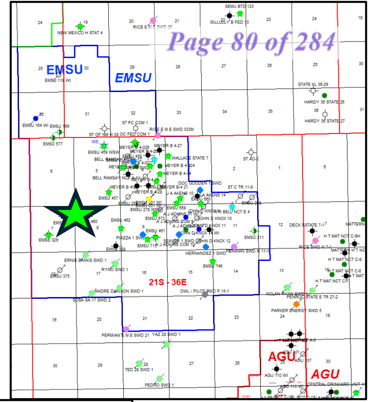


Exhibit K-4

EMSU 679 Type Log
30025310090000
Spud Date: 10/9/1990

Cored Interval Box in Track 1
RES Shaded Above 200 Ohms
DPHI_DOL Shaded Above 4%



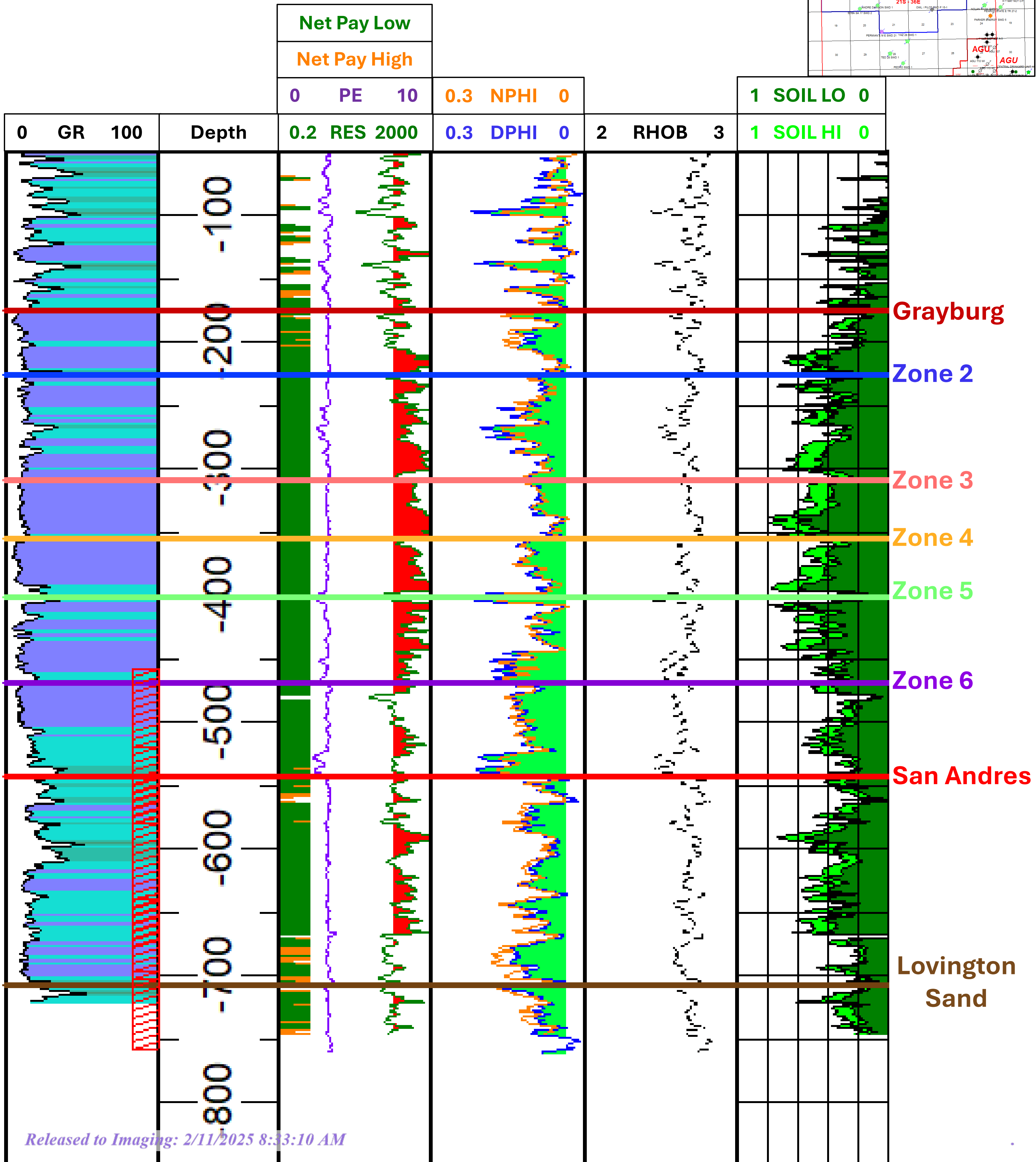


Exhibit K-5

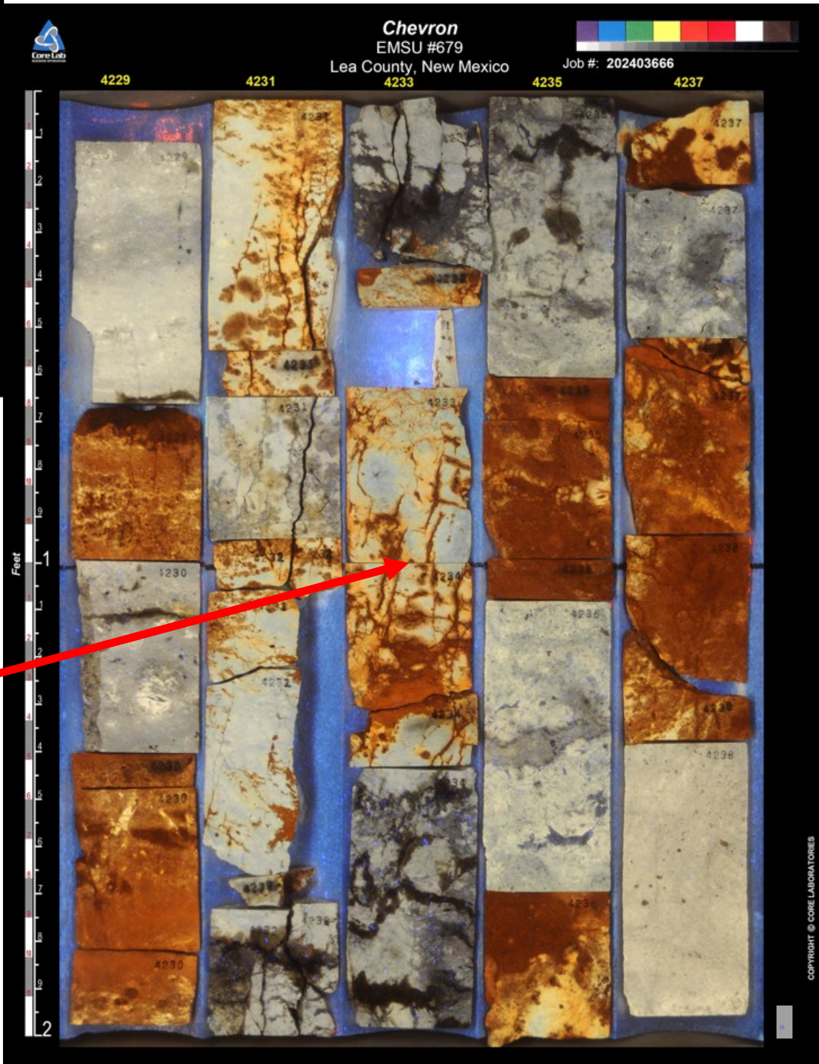
EMSU 679 Core Photo Below the Top of San Andres

Visible Light: Core Depths 4,229-4,237

EMSU 679 Top of San Andres is at 4,142' MD

Note the fractures and oil staining within the cored interval

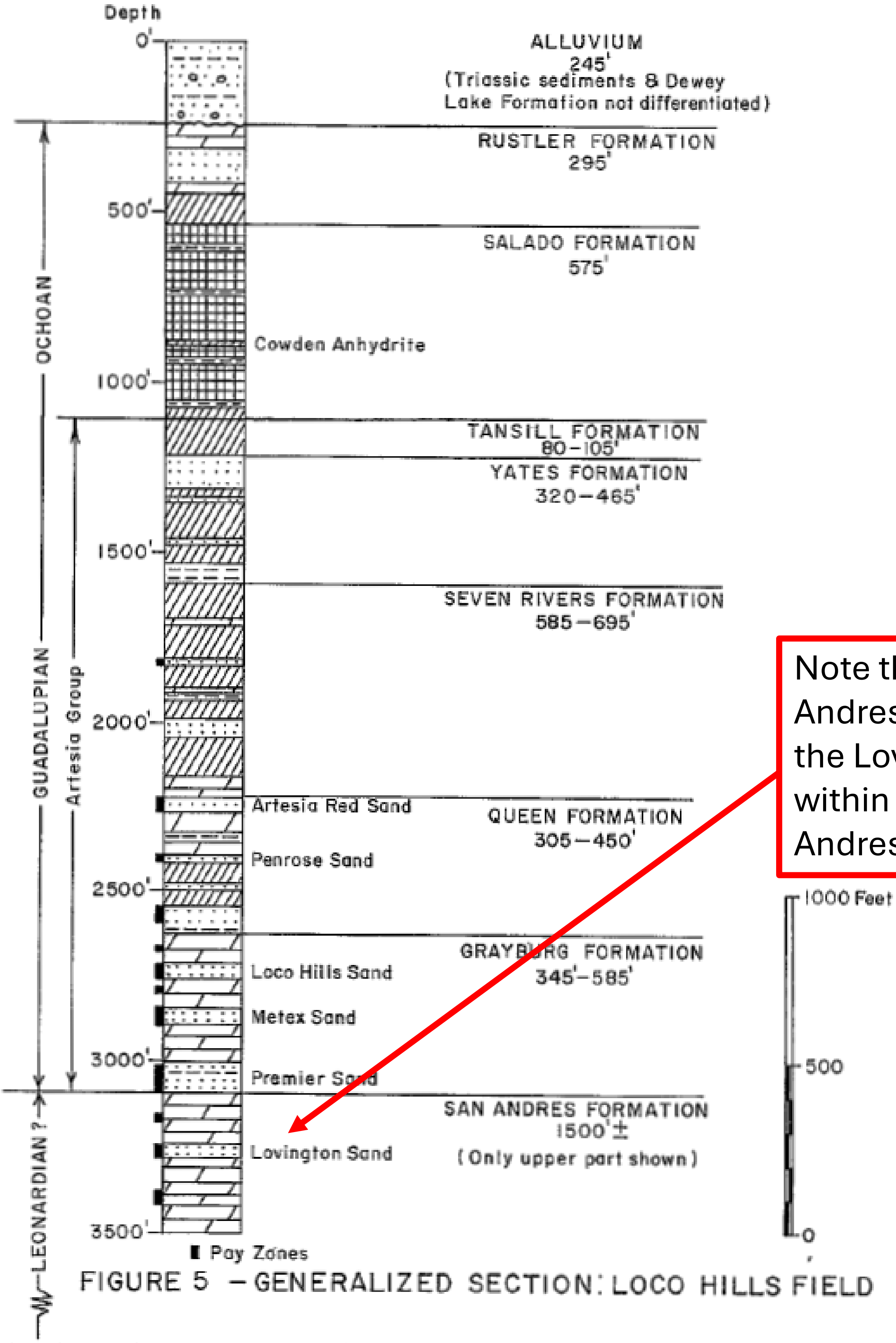
Ultraviolet: Core Depths 4,229-4,237



Note the fractures and oil staining within the cored interval

Exhibit K-6

Foster Type Log Loco Hills Field Oterro County, NM



Note the top of the San Andres is dolomite and the Lovington Sand sits within the Upper San Andres

FIGURE 5 — GENERALIZED SECTION: LOCO HILLS FIELD

Exhibit K-7

BEG Study Type Log for Jackson-Grayburg field on the Northwest Shelf Eddy County, NM

Note the tight dolomitic section of the Upper San Andres on the density/neutron labeled Vacuum and the Lovington Sand sitting within the Upper San Andres

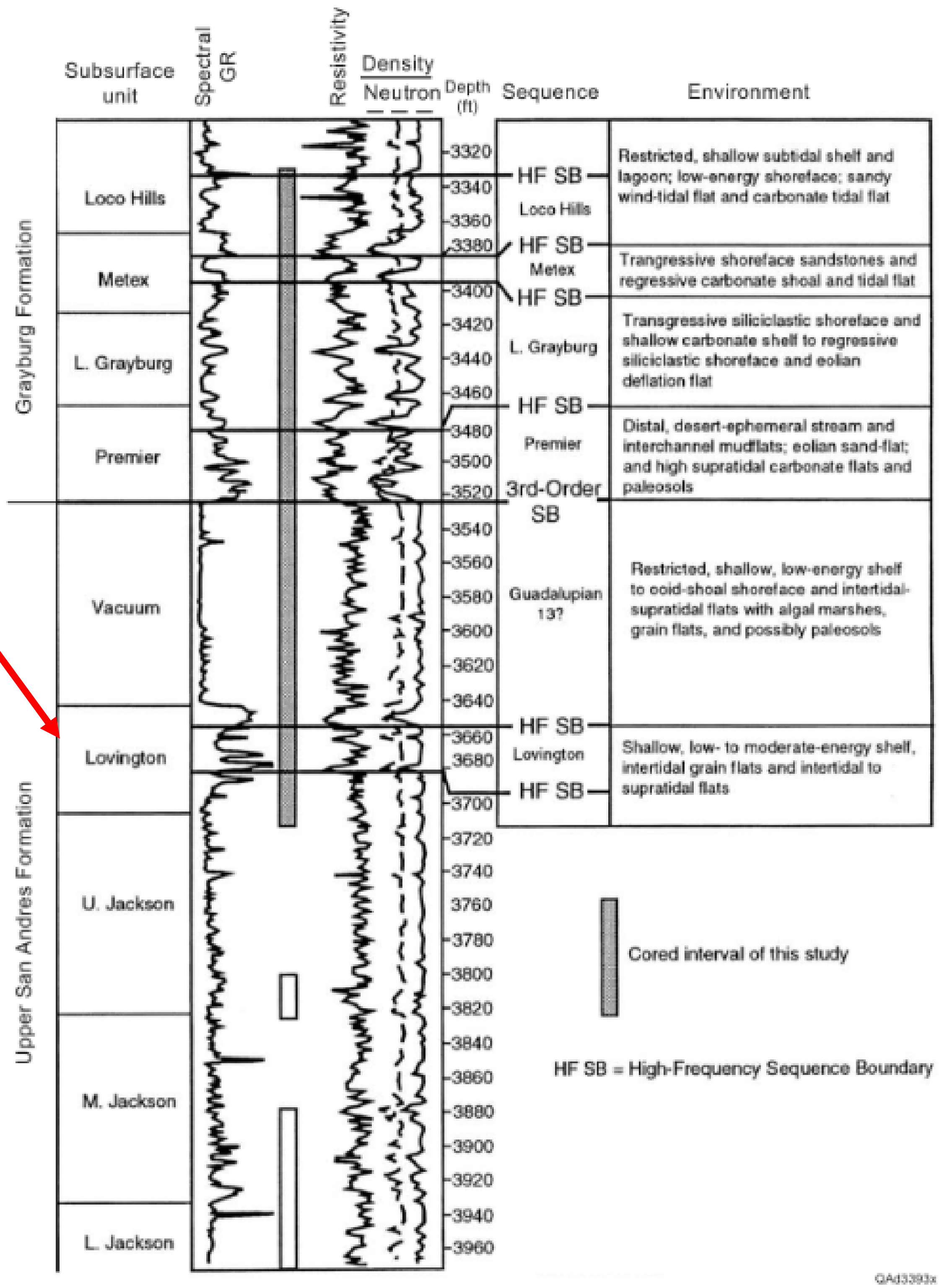


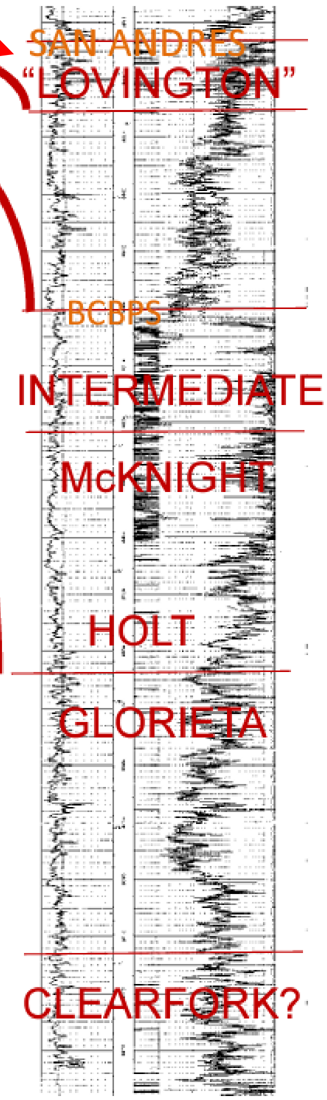
Figure 90. Stratigraphic column for the H. E. West "A" No. 22 well in Jackson-Grayburg field on the Northwest Shelf, Eddy County. From Handford and others (1996).

Exhibit K-8

Type Log for the Central Basin Platform from Bob Trentham's Enhanced Oil Recovery in the Permian Basin Study

Note the Lovington Sand within the Upper San Andres

The major San Andres Sequence Stratigraphic boundaries may act as the boundaries for the original O/W (base of ROZ) and between the present day Main Pay and TZ/ROZ.



G 9	Lovington Sand / Lime
G 8	Pre- Lovington / Judkins
G 5 – 7	Brushy Canyon BPS
G 3 – 4	Intermediate
G 1 – 2	McKnight
L 7 – 8	Holt
L 5 – 6	Glorieta

Nomenclature, based on Gulf Oil's Central Basin Platform "Formations"

Exhibit K-9

Cross Section Base Map on San Andres Structure (SSTVD)

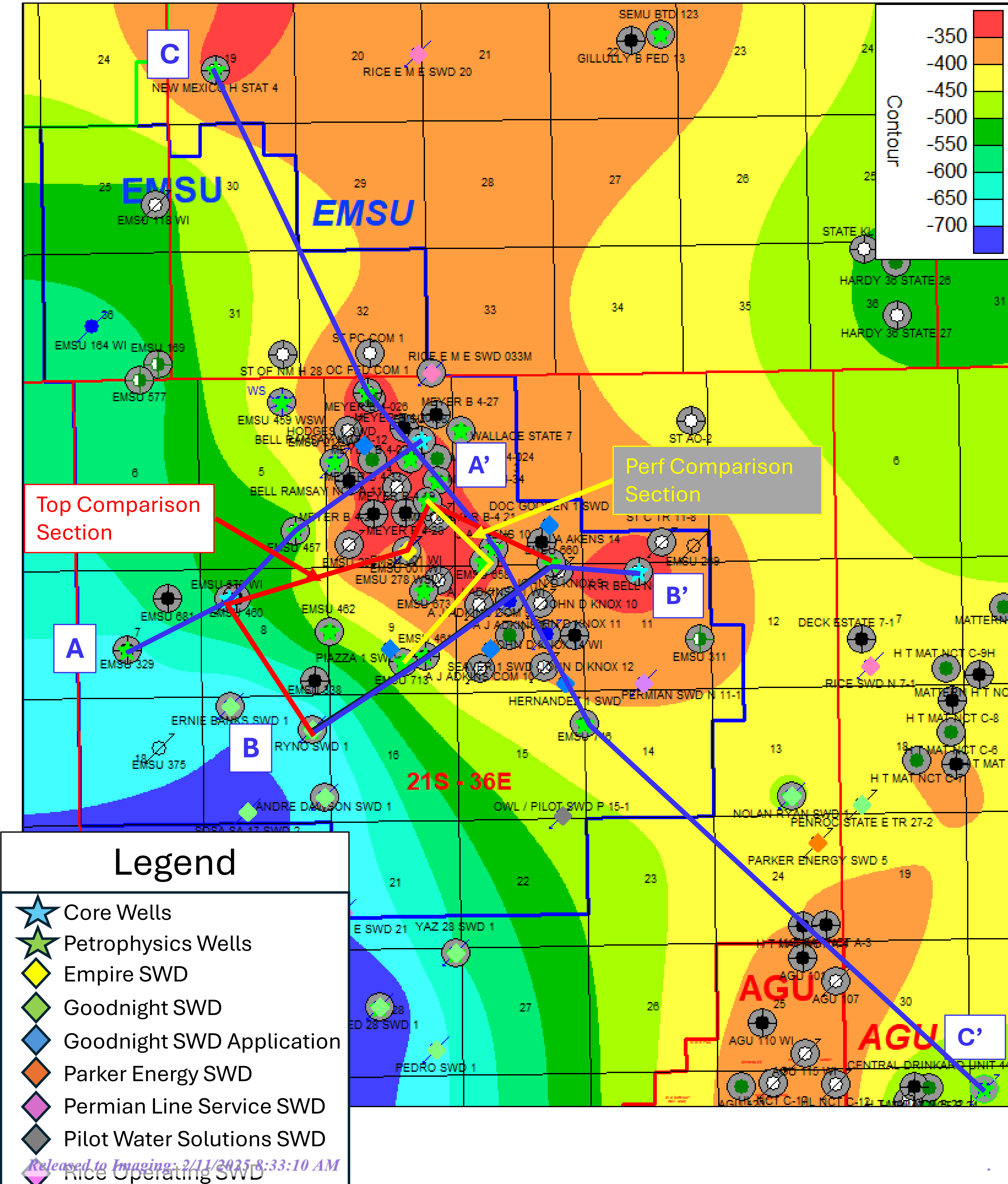
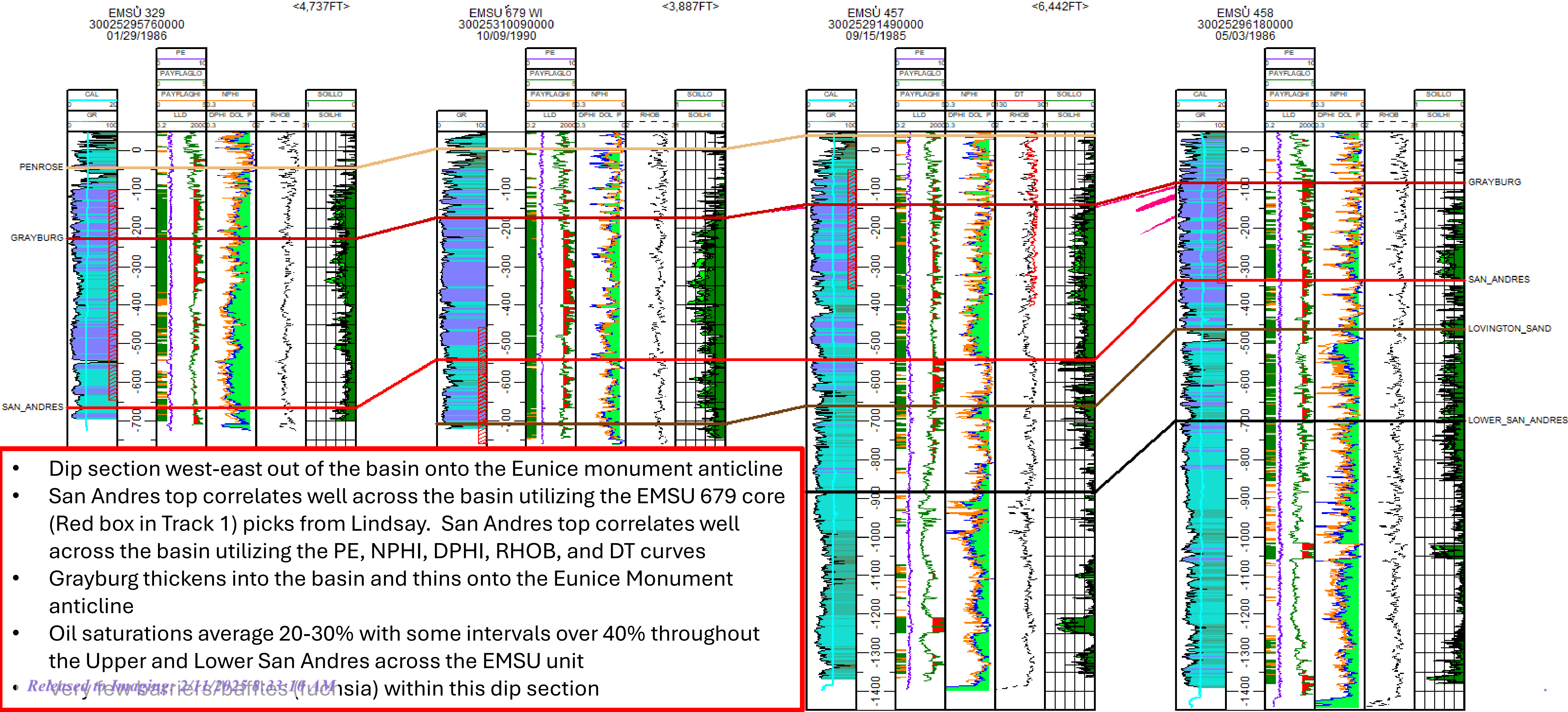


Exhibit K-10

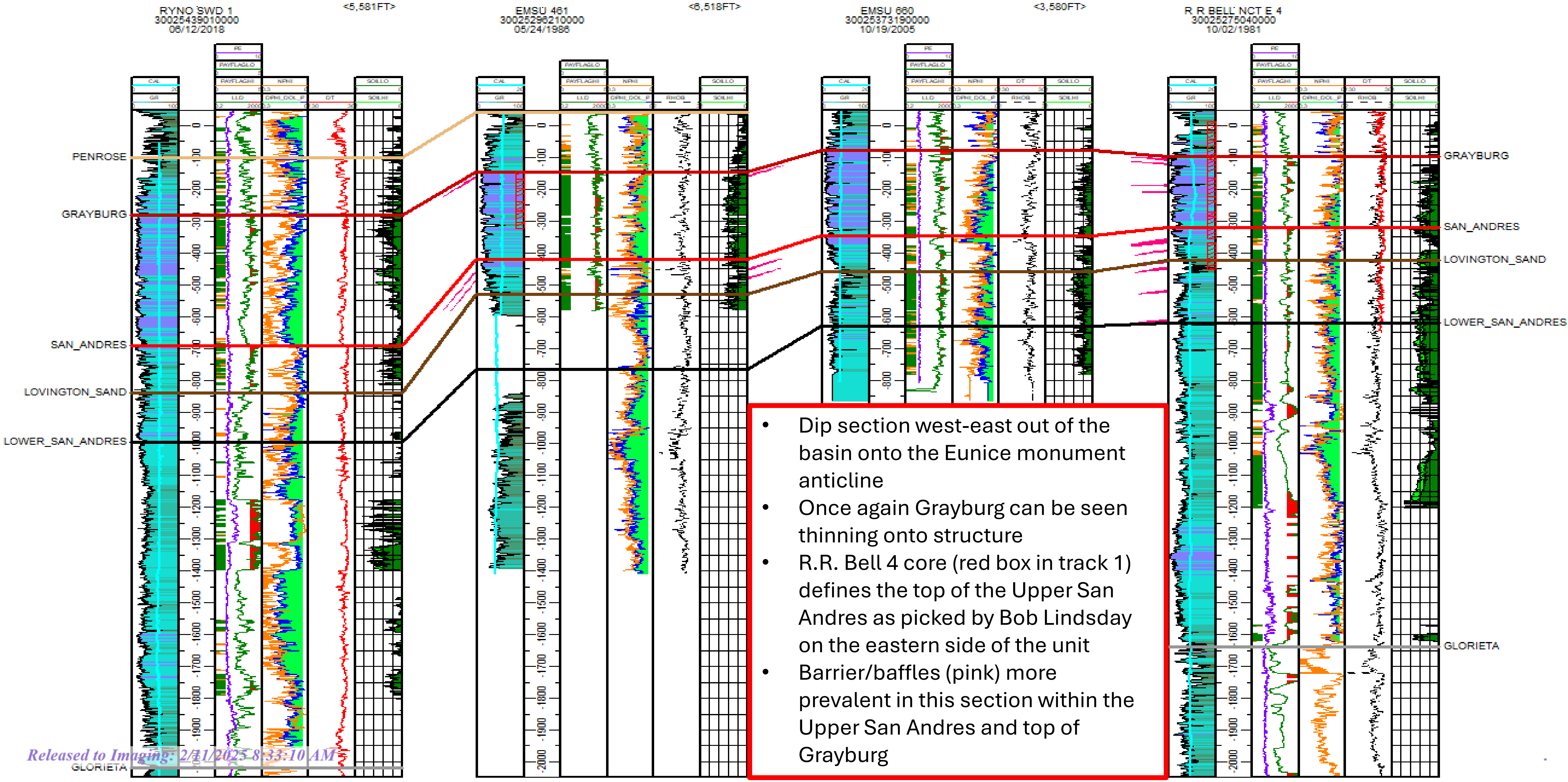
Dip Section A-A’



- Dip section west-east out of the basin onto the Eunice monument anticline
- San Andres top correlates well across the basin utilizing the EMSU 679 core (Red box in Track 1) picks from Lindsay. San Andres top correlates well across the basin utilizing the PE, NPHI, DPHI, RHOB, and DT curves
- Grayburg thickens into the basin and thins onto the Eunice Monument anticline
- Oil saturations average 20-30% with some intervals over 40% throughout the Upper and Lower San Andres across the EMSU unit
- Very few barriers/baffles (fuchsia) within this dip section

Exhibit K-11

Dip Section B-B’



- Dip section west-east out of the basin onto the Eunice monument anticline
- Once again Grayburg can be seen thinning onto structure
- R.R. Bell 4 core (red box in track 1) defines the top of the Upper San Andres as picked by Bob Lindsday on the eastern side of the unit
- Barrier/baffles (pink) more prevalent in this section within the Upper San Andres and top of Grayburg

Exhibit K-12

NW-SE Strike Section C-C' Across EMSU into AGU

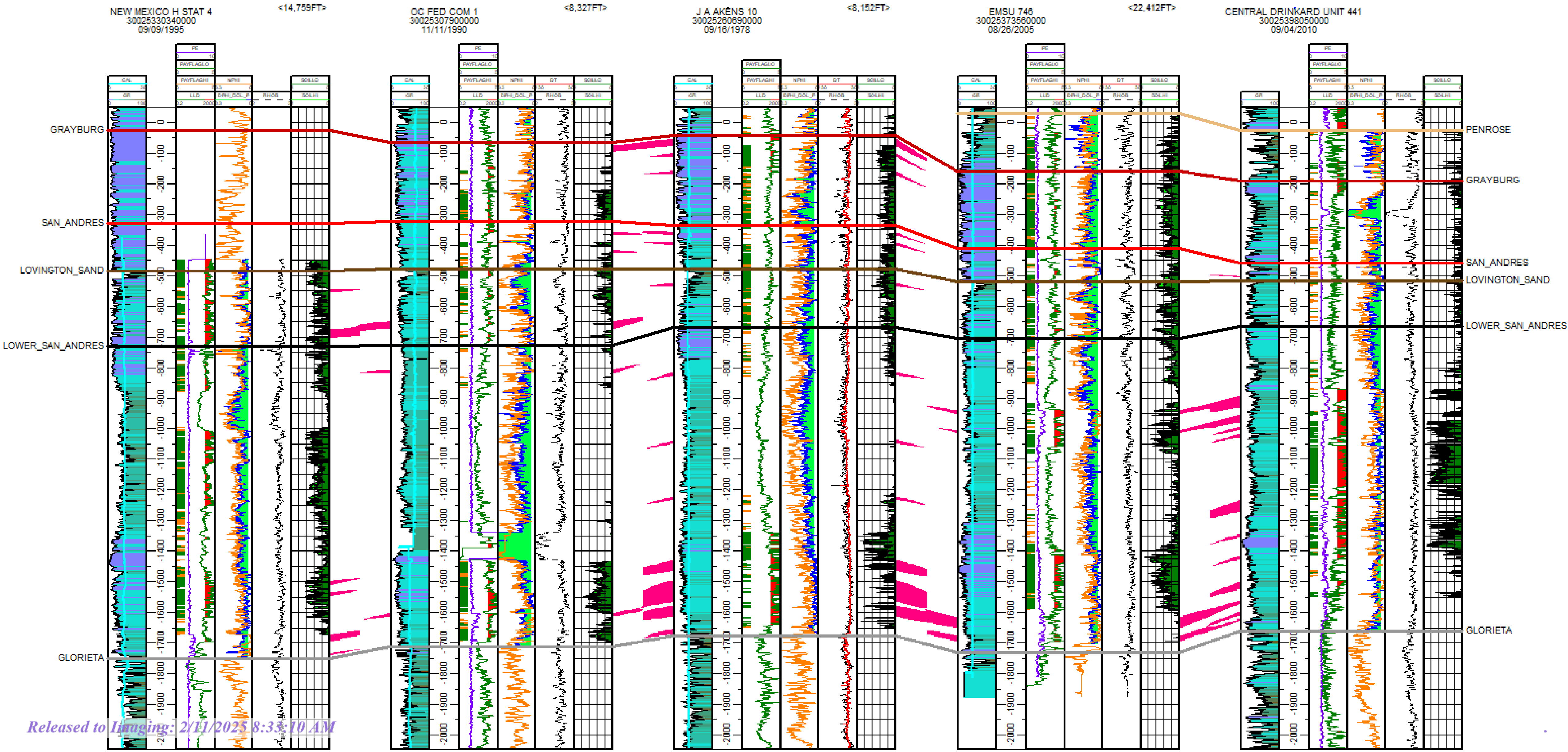
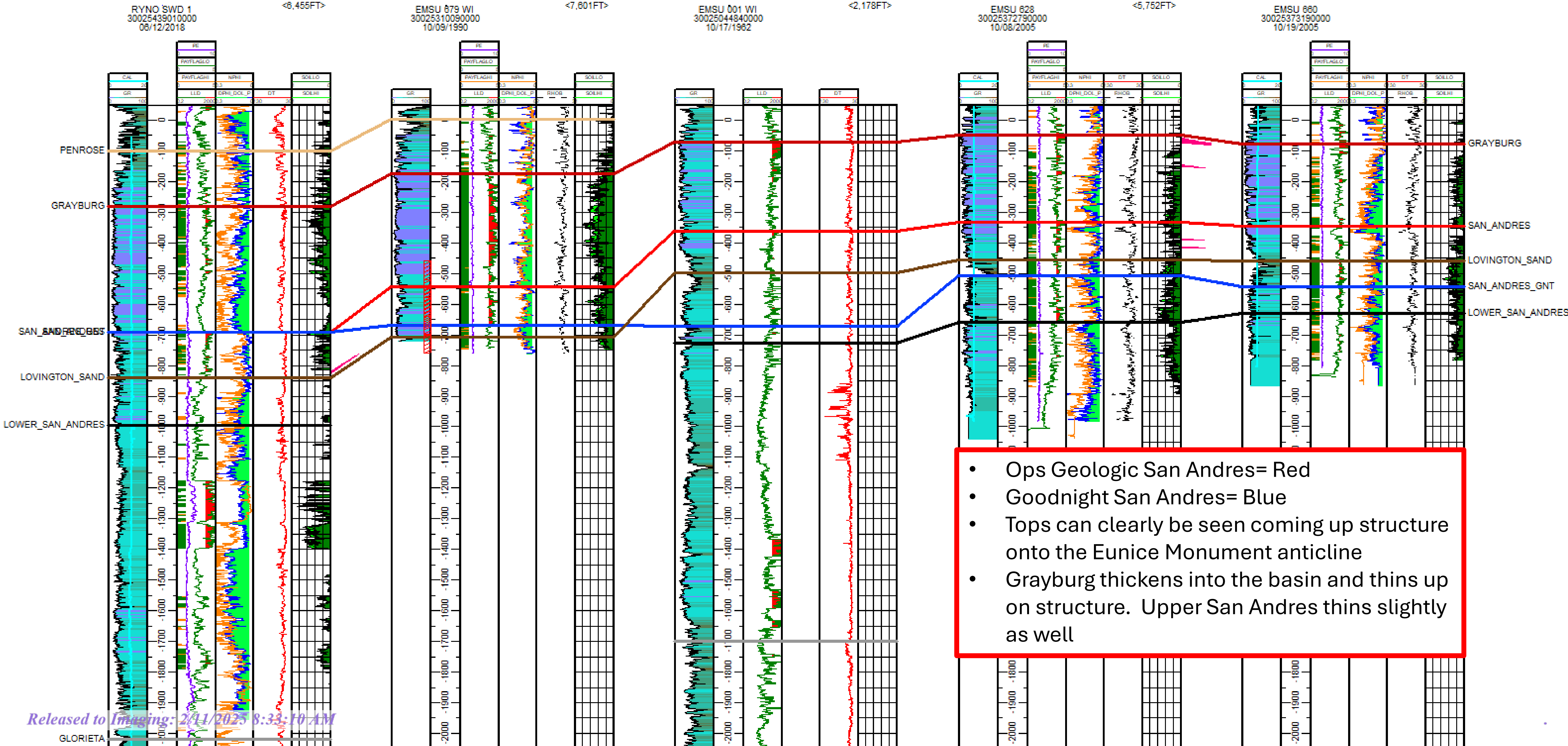


Exhibit K-13

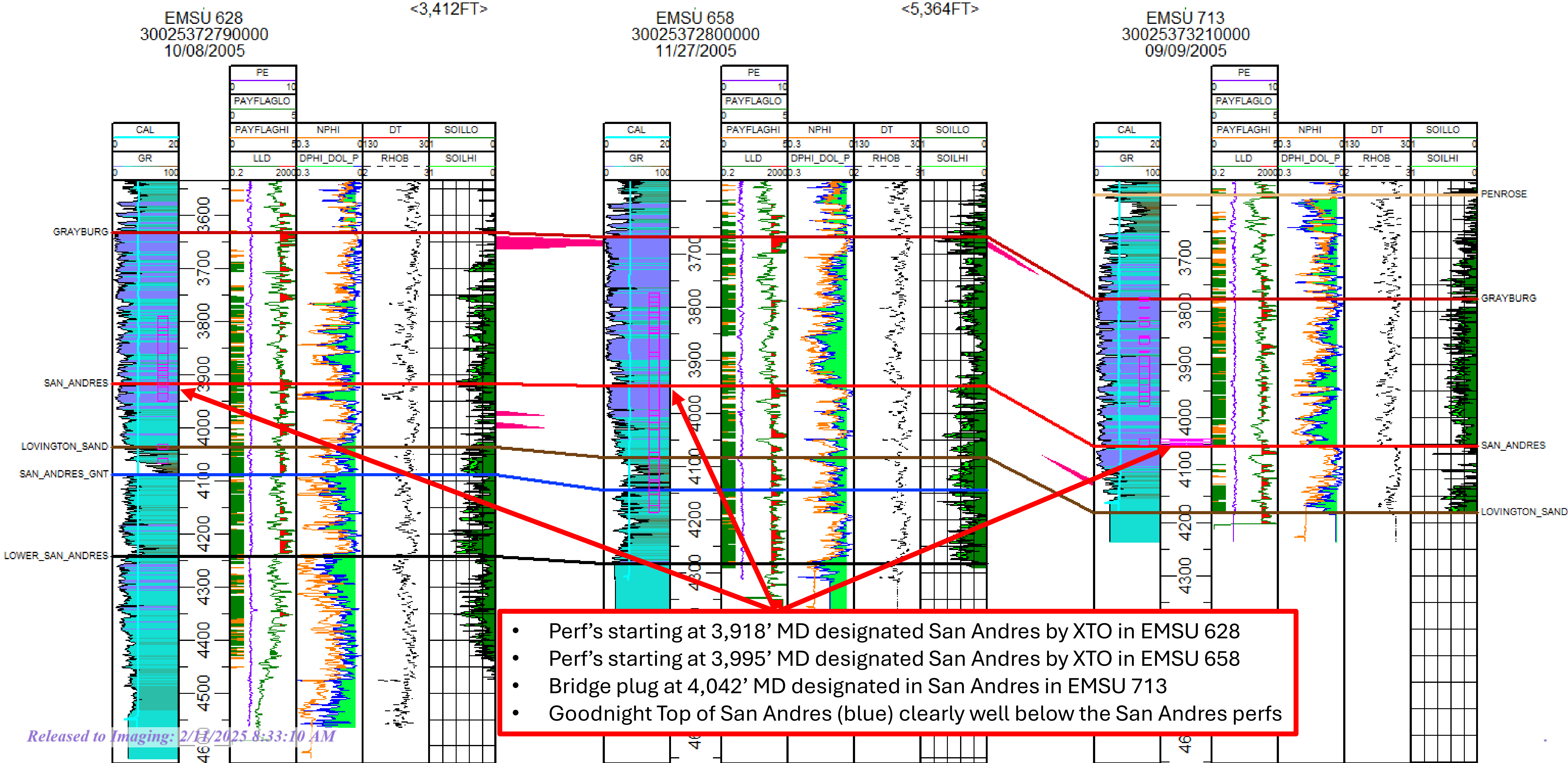
Comparison of Ops Geologic (Red) vs. Goodnight San Andres Top (Blue)



- Ops Geologic San Andres= Red
- Goodnight San Andres= Blue
- Tops can clearly be seen coming up structure onto the Eunice Monument anticline
- Grayburg thickens into the basin and thins up on structure. Upper San Andres thins slightly as well

Exhibit K-14

Comparison of Perf Designations with Goodnight Top



- Perf's starting at 3,918' MD designated San Andres by XTO in EMSU 628
- Perf's starting at 3,995' MD designated San Andres by XTO in EMSU 658
- Bridge plug at 4,042' MD designated in San Andres in EMSU 713
- Goodnight Top of San Andres (blue) clearly well below the San Andres perfs

Exhibit K-15

Lower San Andres Structure Map (SSTVD)

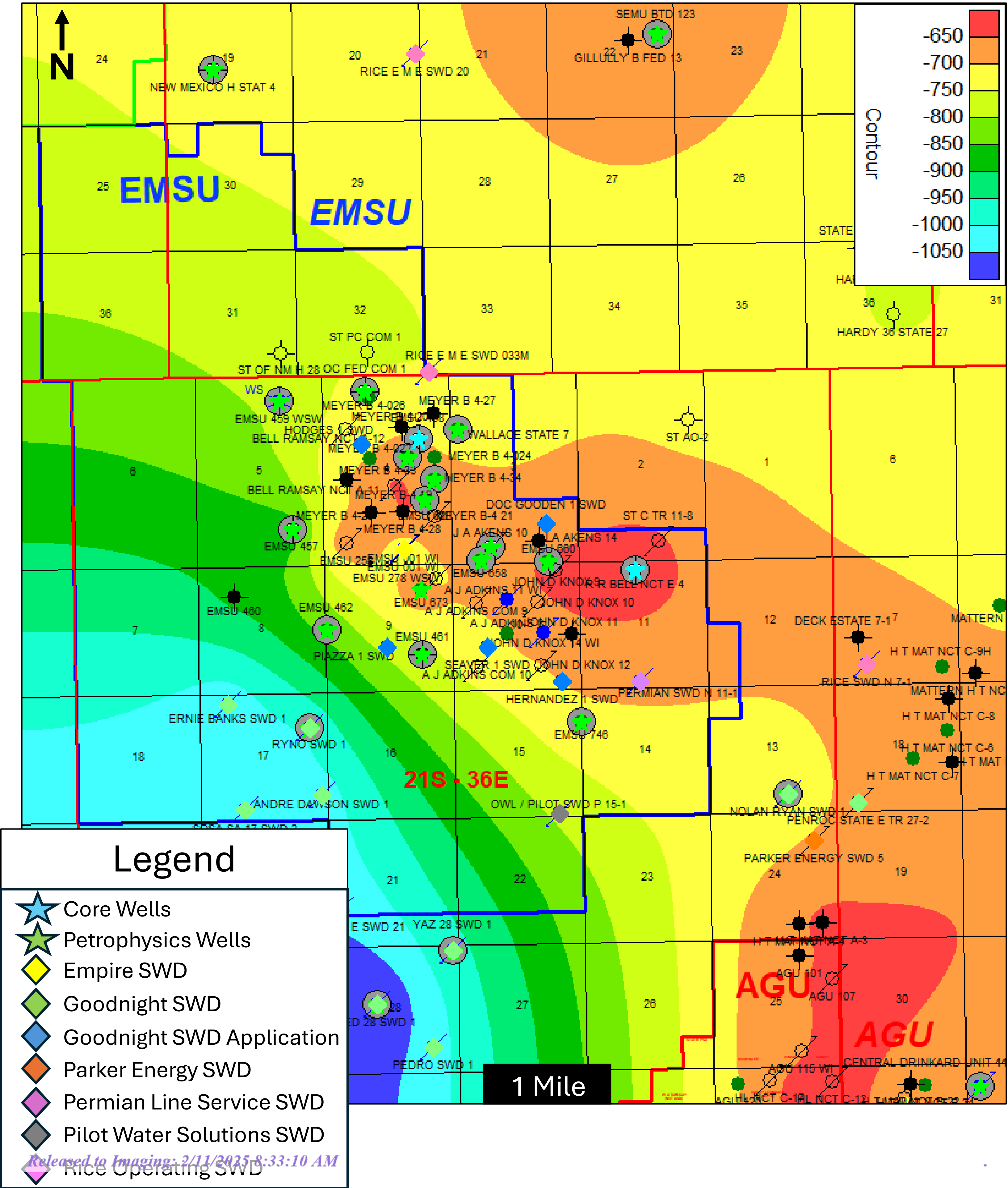


Exhibit K-16

Upper San Andres Structure Map (SSTVD)

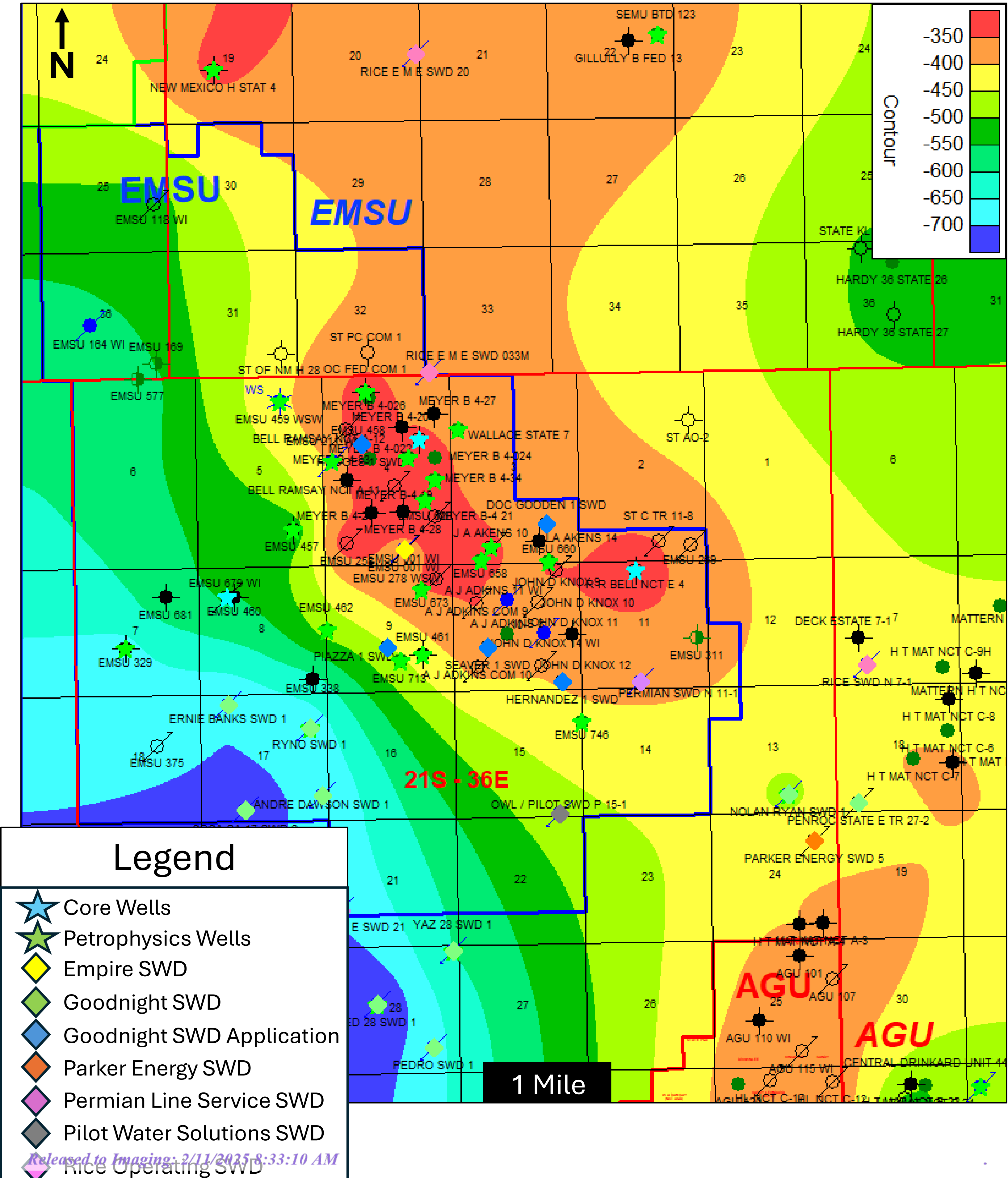


Exhibit K-17

Grayburg Structure Map (SSTVD)

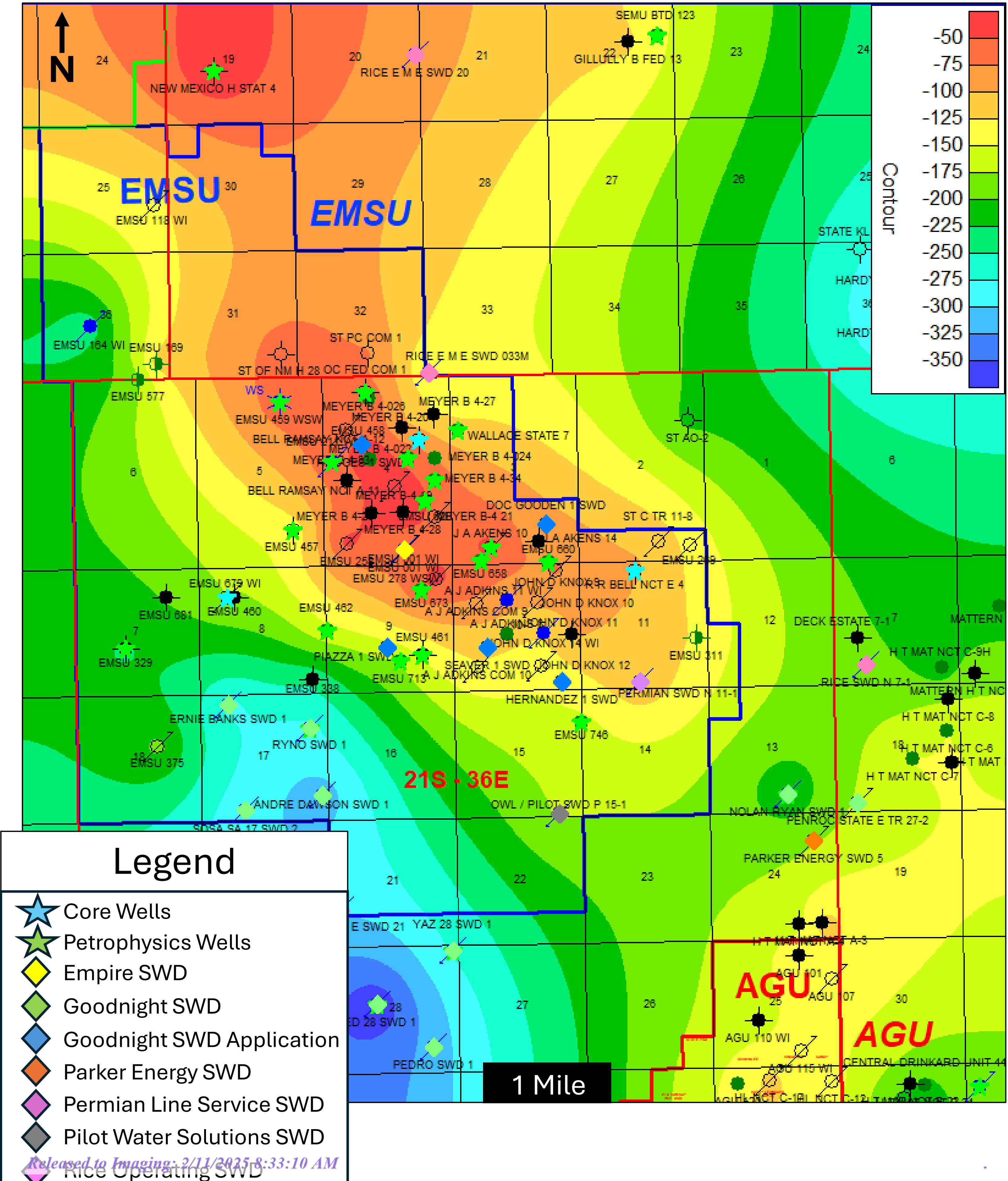


Exhibit K-18

Lower San Andres Isopach Map (FT)

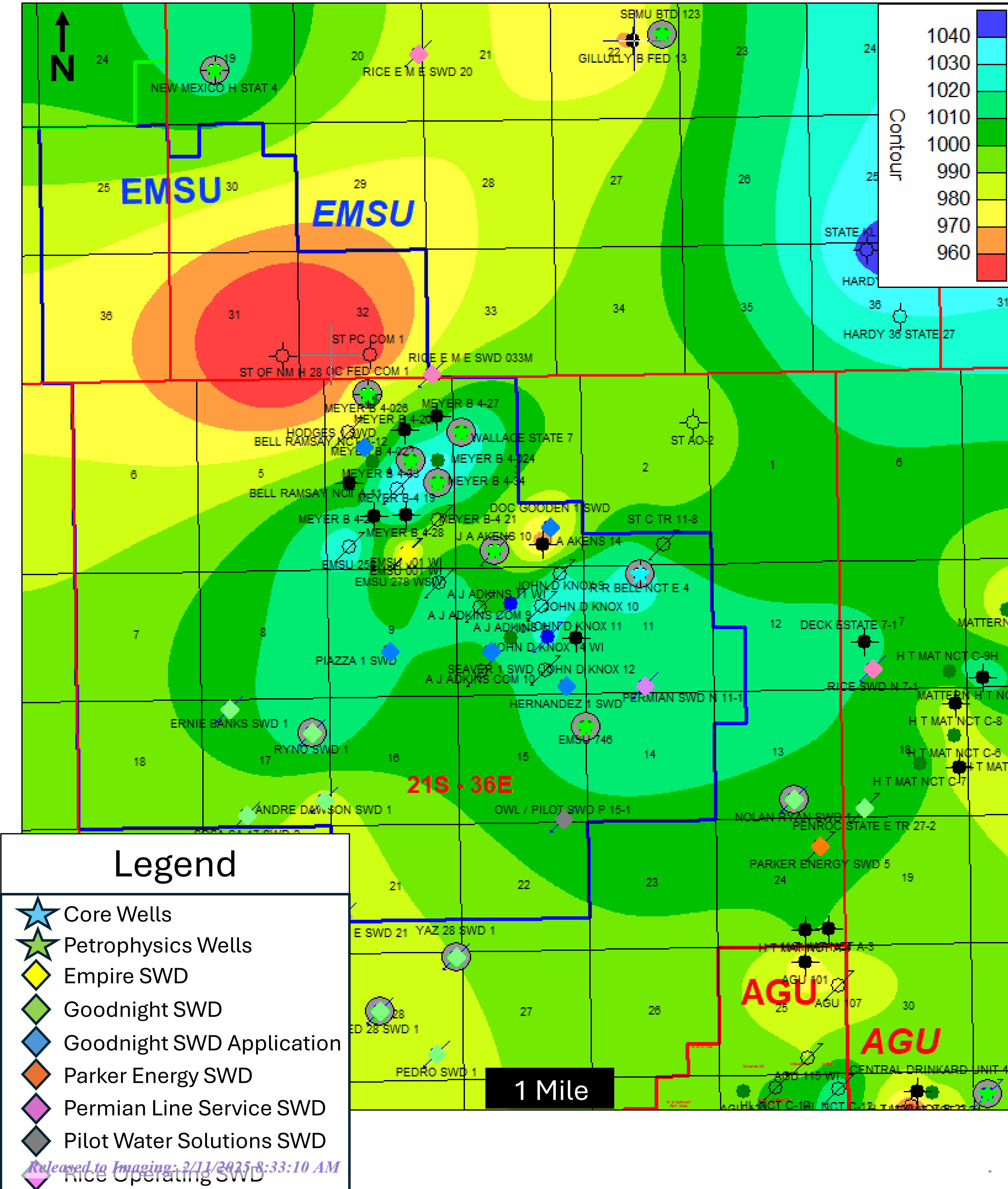


Exhibit K-19

Upper San Andres Isopach Map (FT)

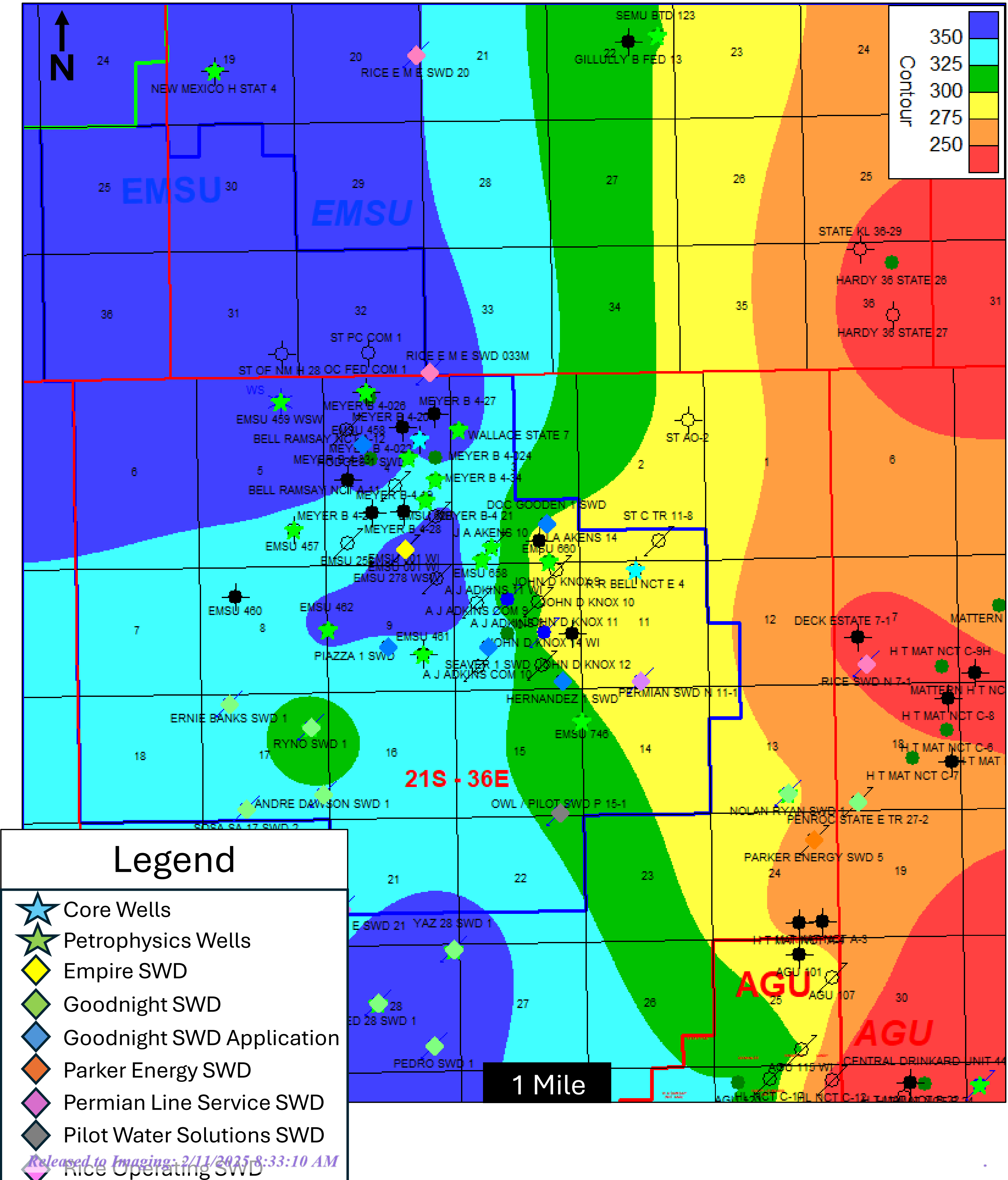


Exhibit K-20

Grayburg Isopach Map (FT)

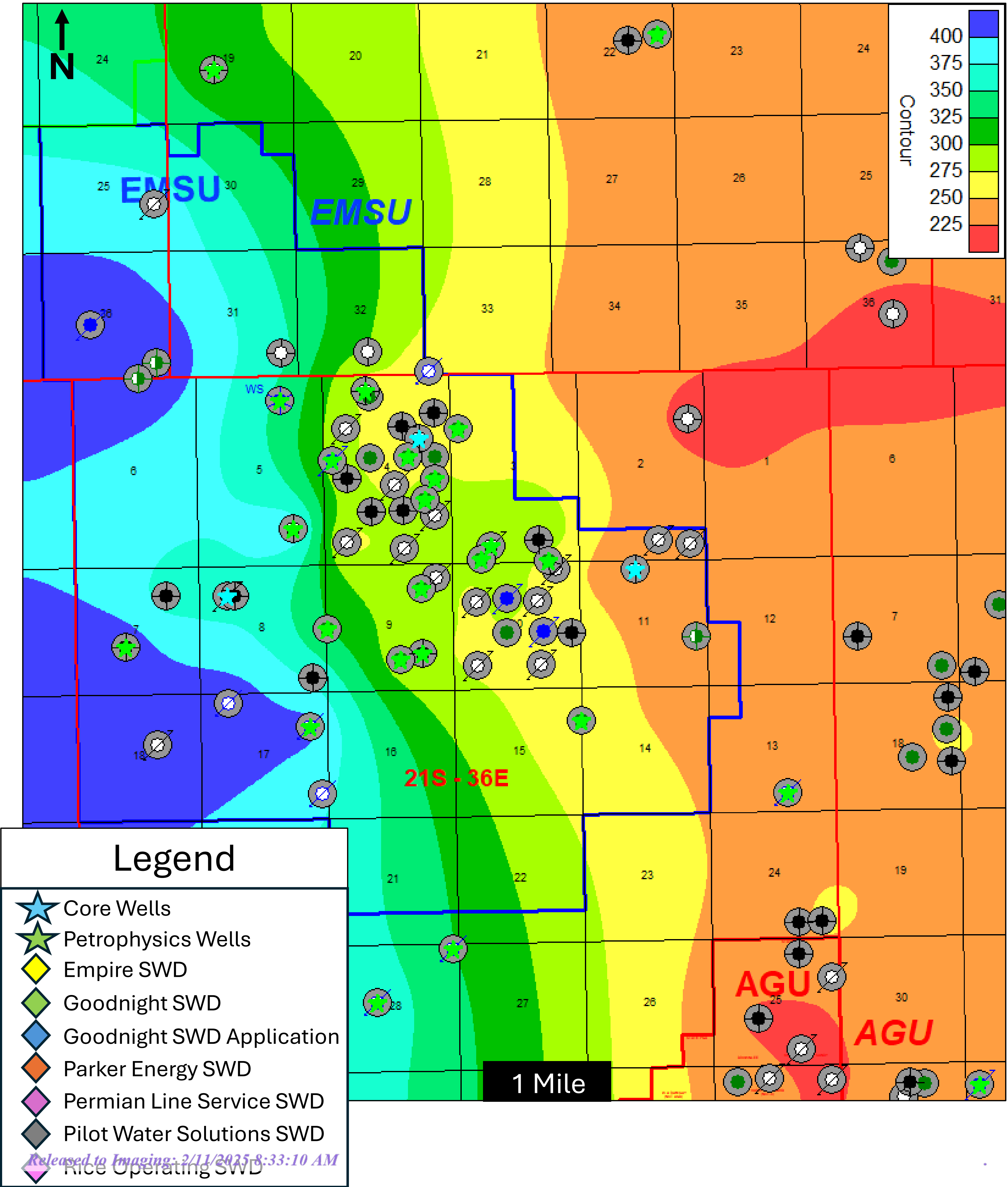


Exhibit K-21

Lower San Andres Net Pay (FT) Low Case

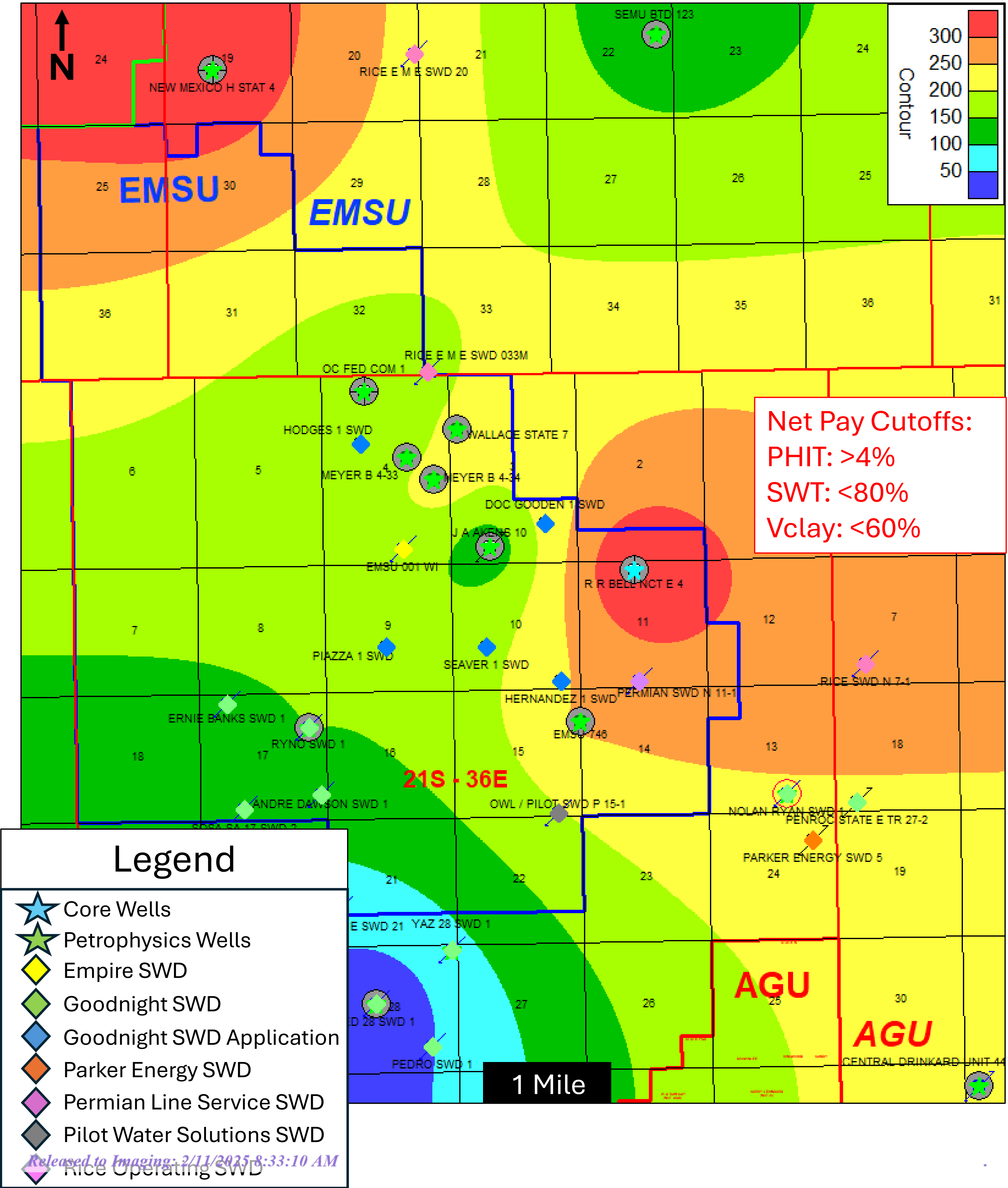


Exhibit K-22

Lower San Andres Net Pay (FT) High Case

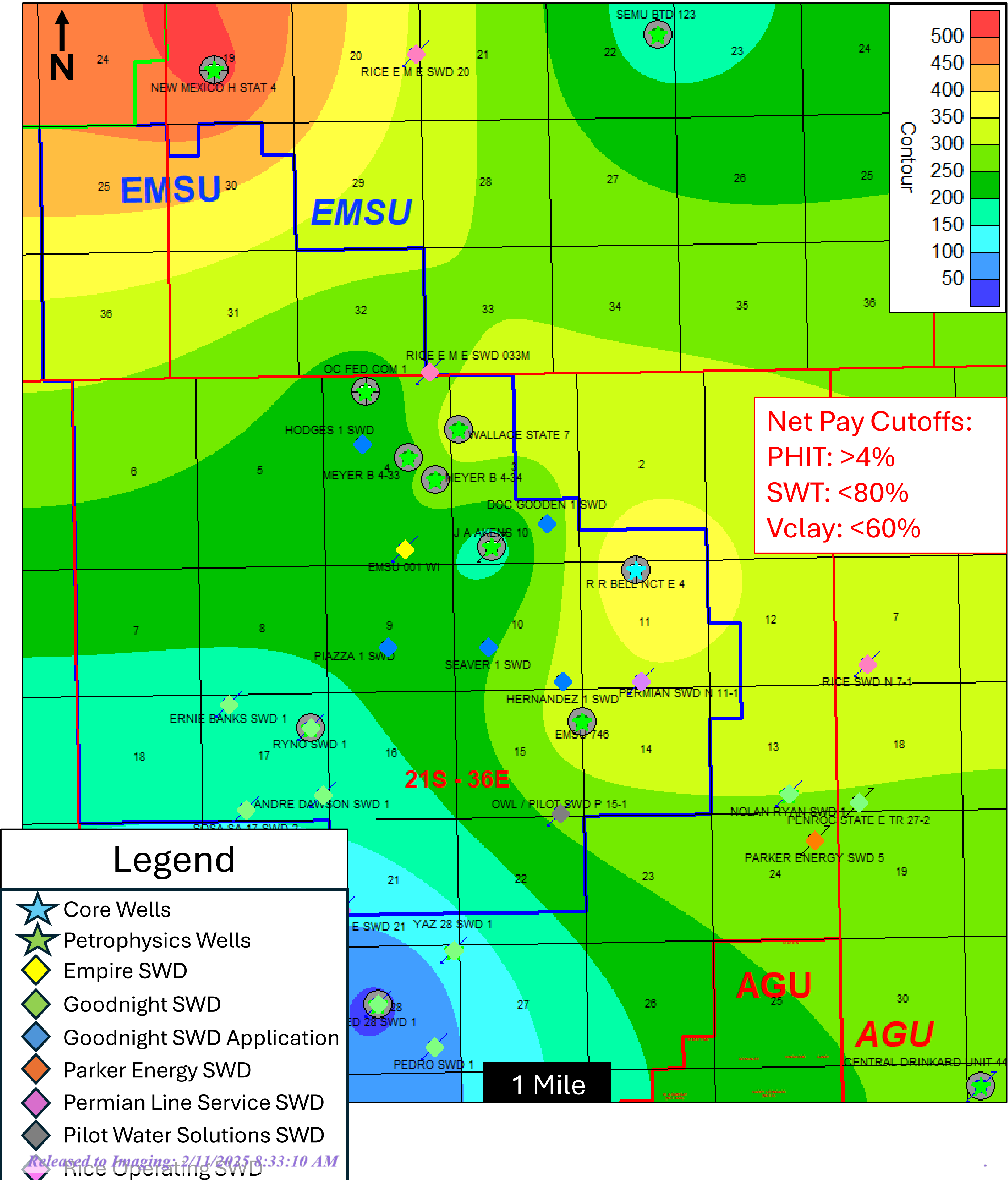


Exhibit K-23

Lower San Andres Average PHIT (%) Above 4% Cutoff

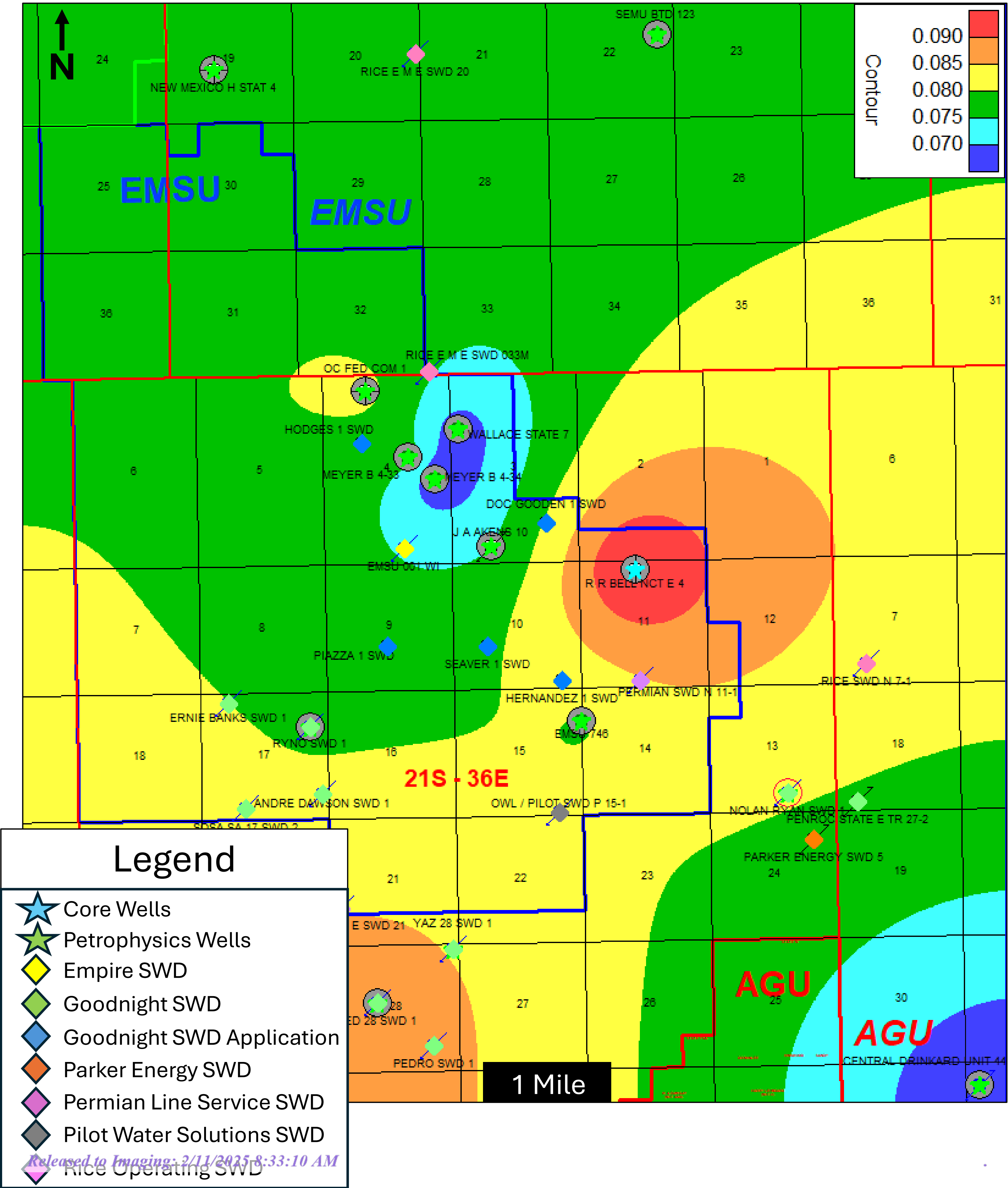


Exhibit K-24

Lower San Andres Average SWT (%) Low Case

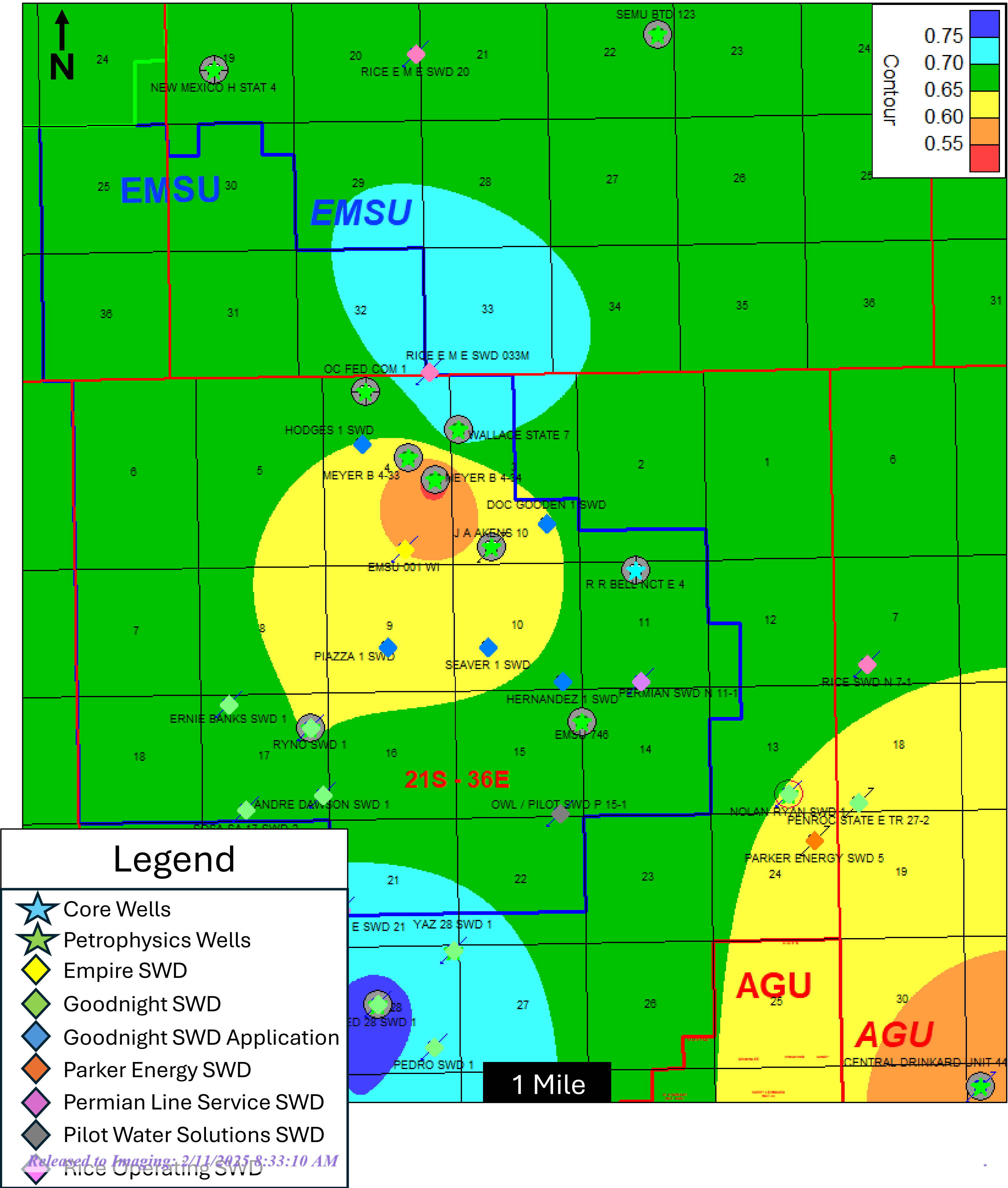


Exhibit K-25

Lower San Andres Average SWT (%) High Case

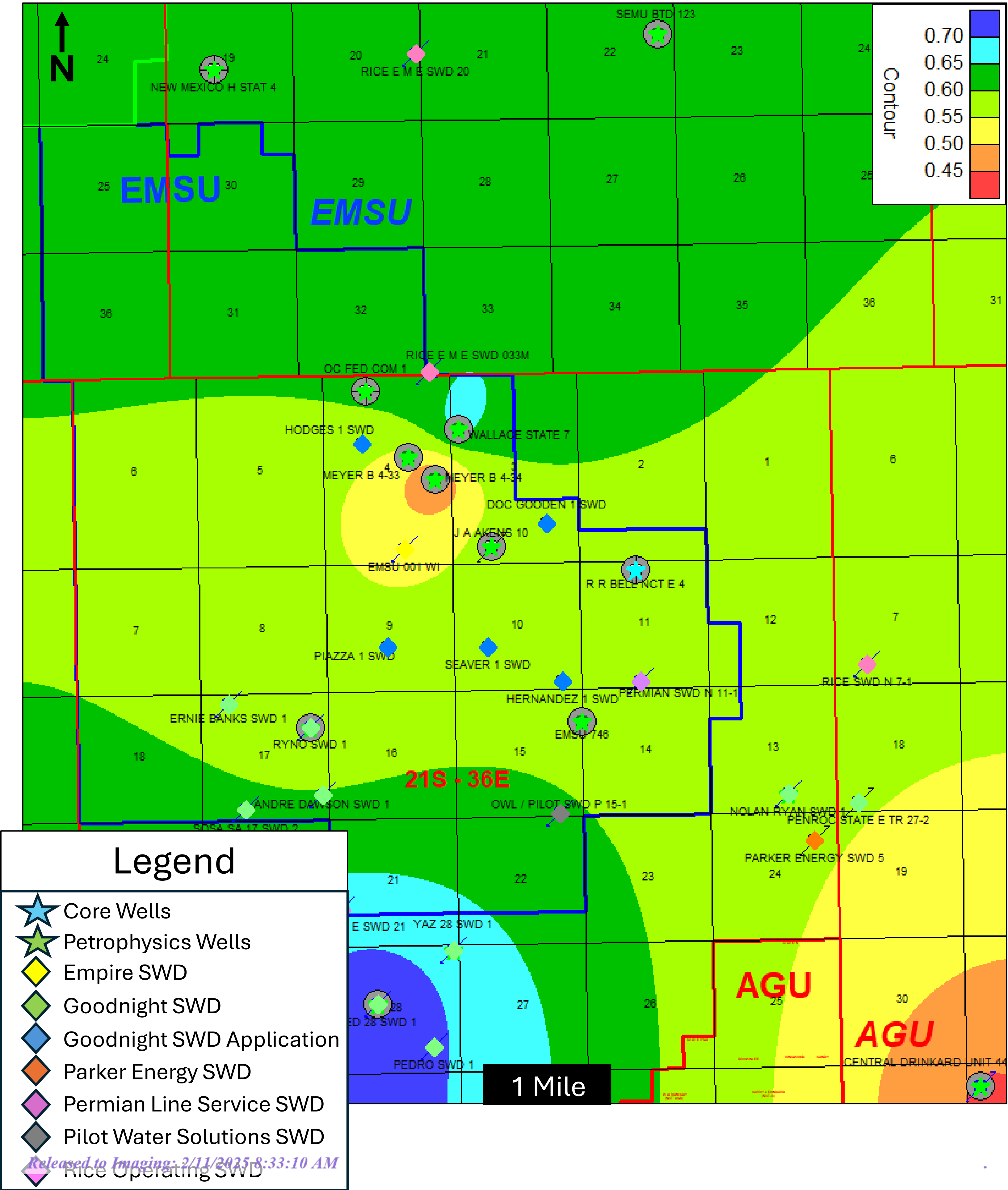


Exhibit K-26

Lower San Andres Average So (%) Low Case

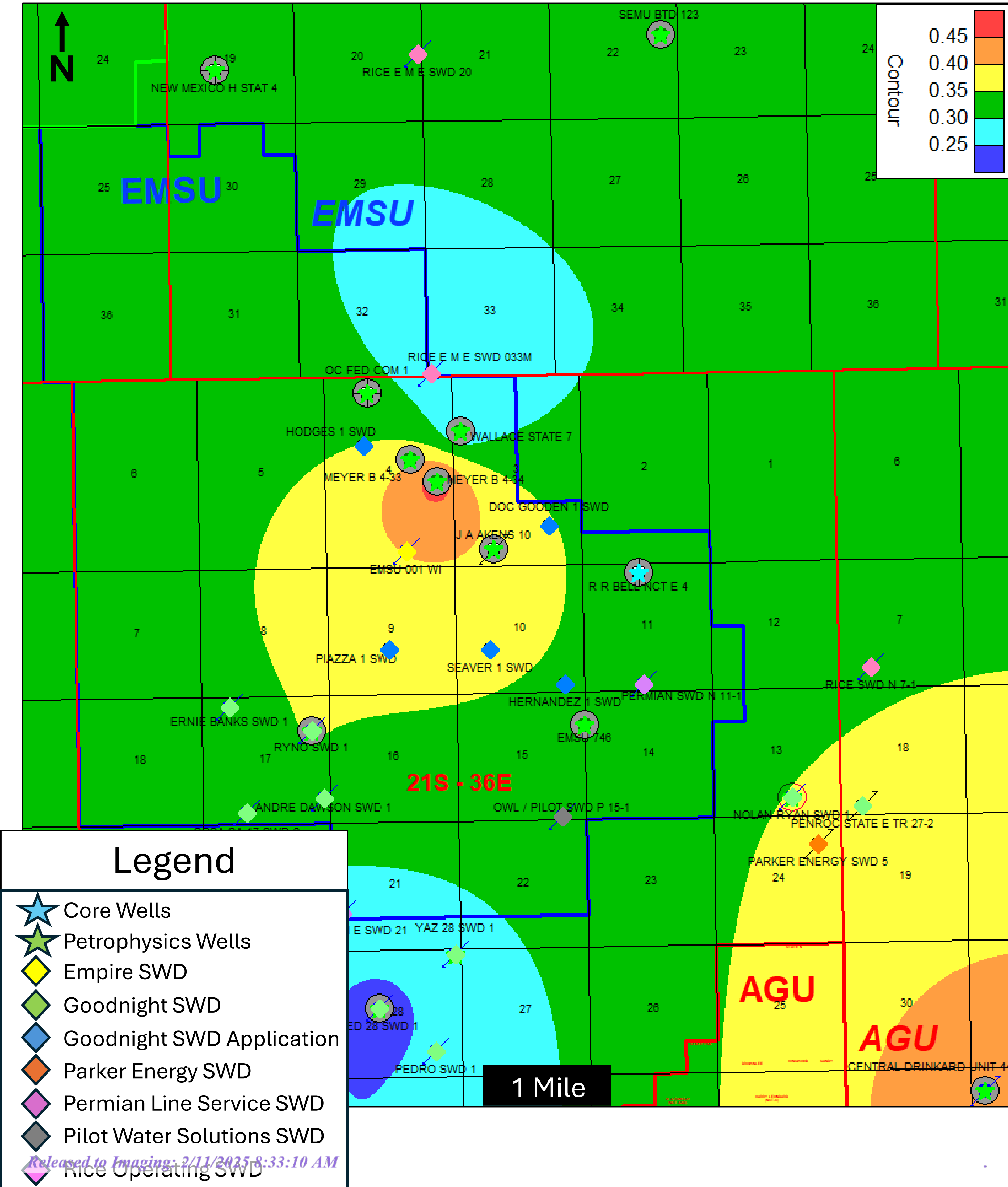


Exhibit K-27

Lower San Andres Average So (%) High Case

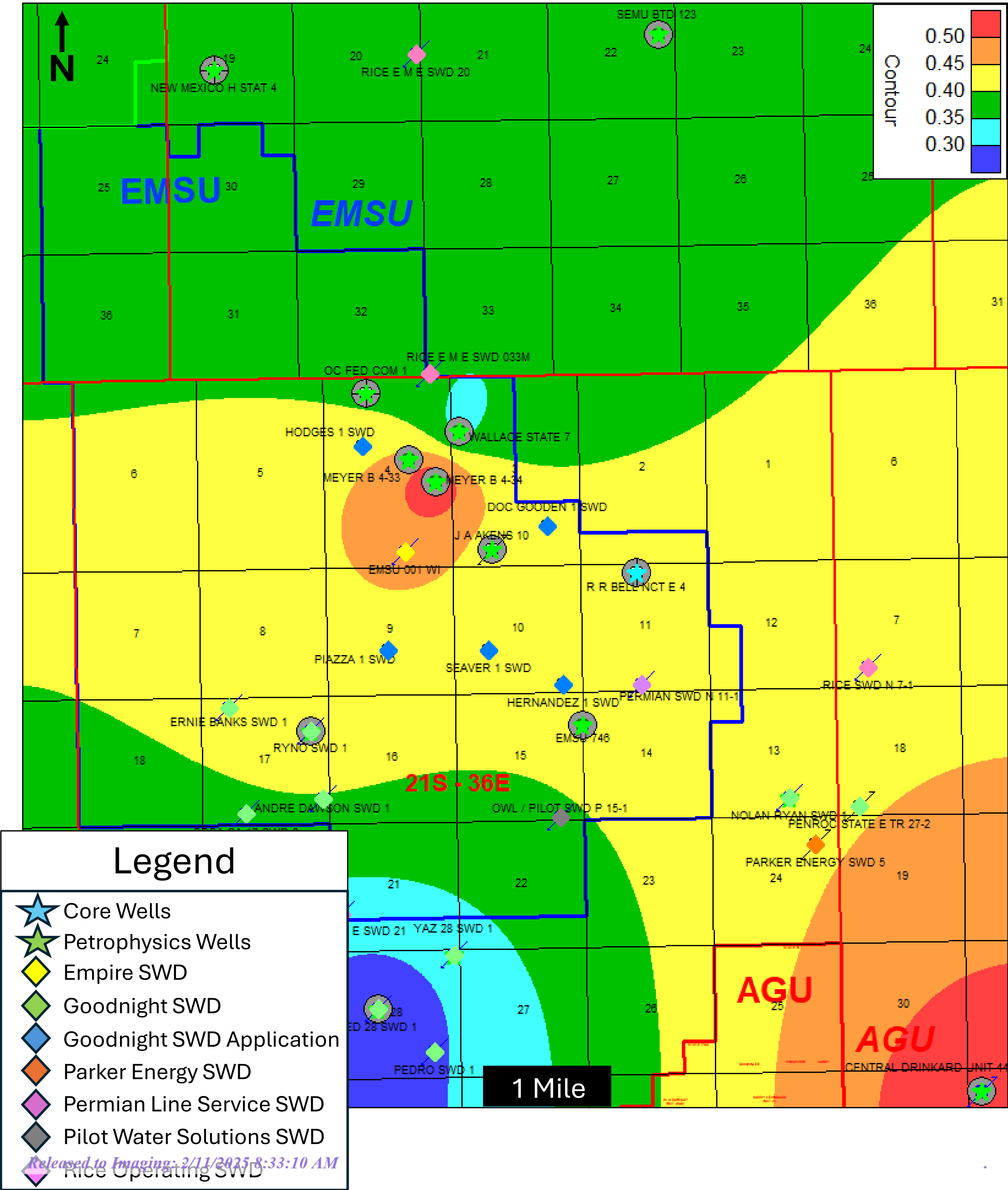


Exhibit K-28

Lower San Andres PHIH (FT) Low Case

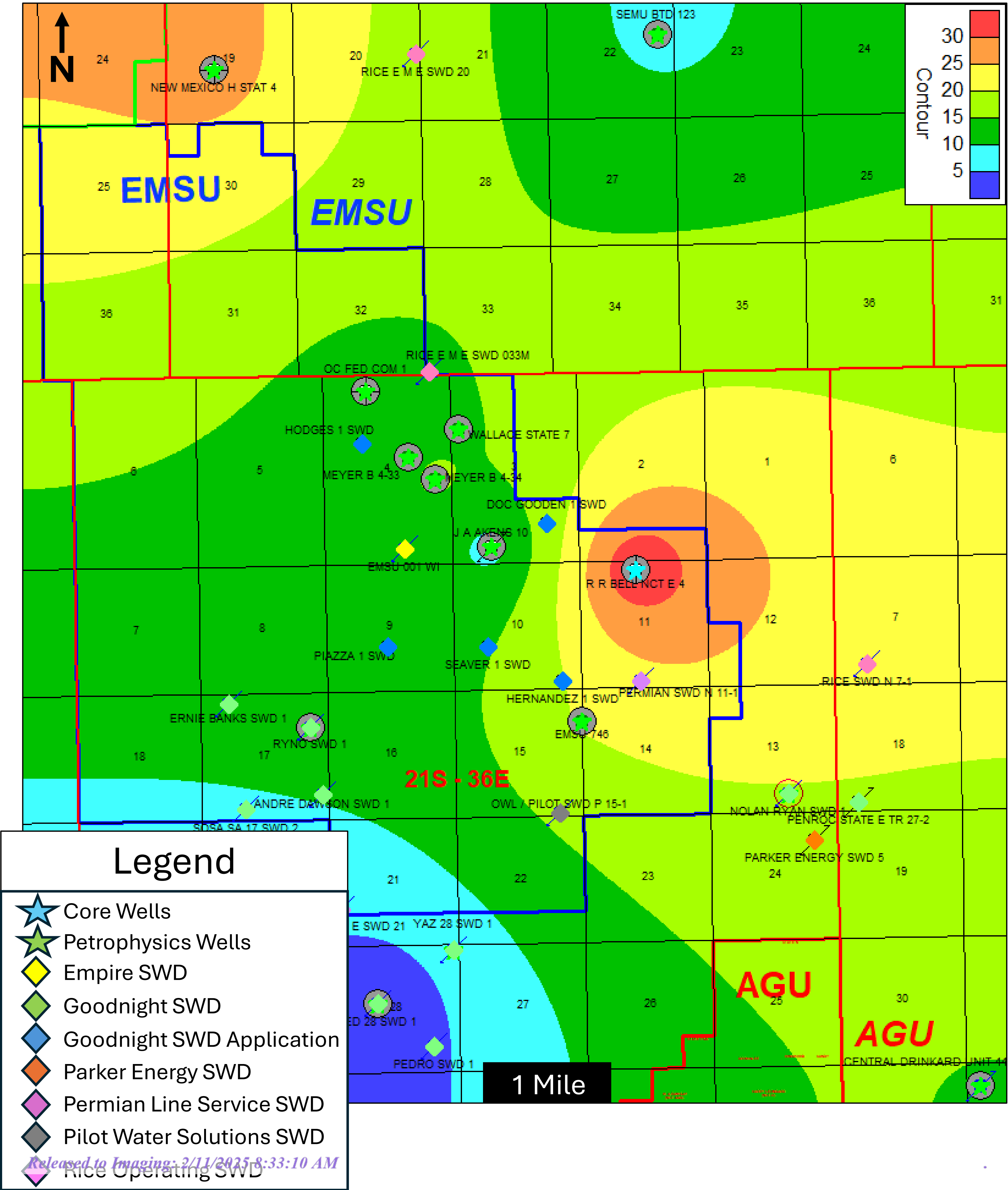


Exhibit K-29

Lower San Andres PHIH (FT) High Case

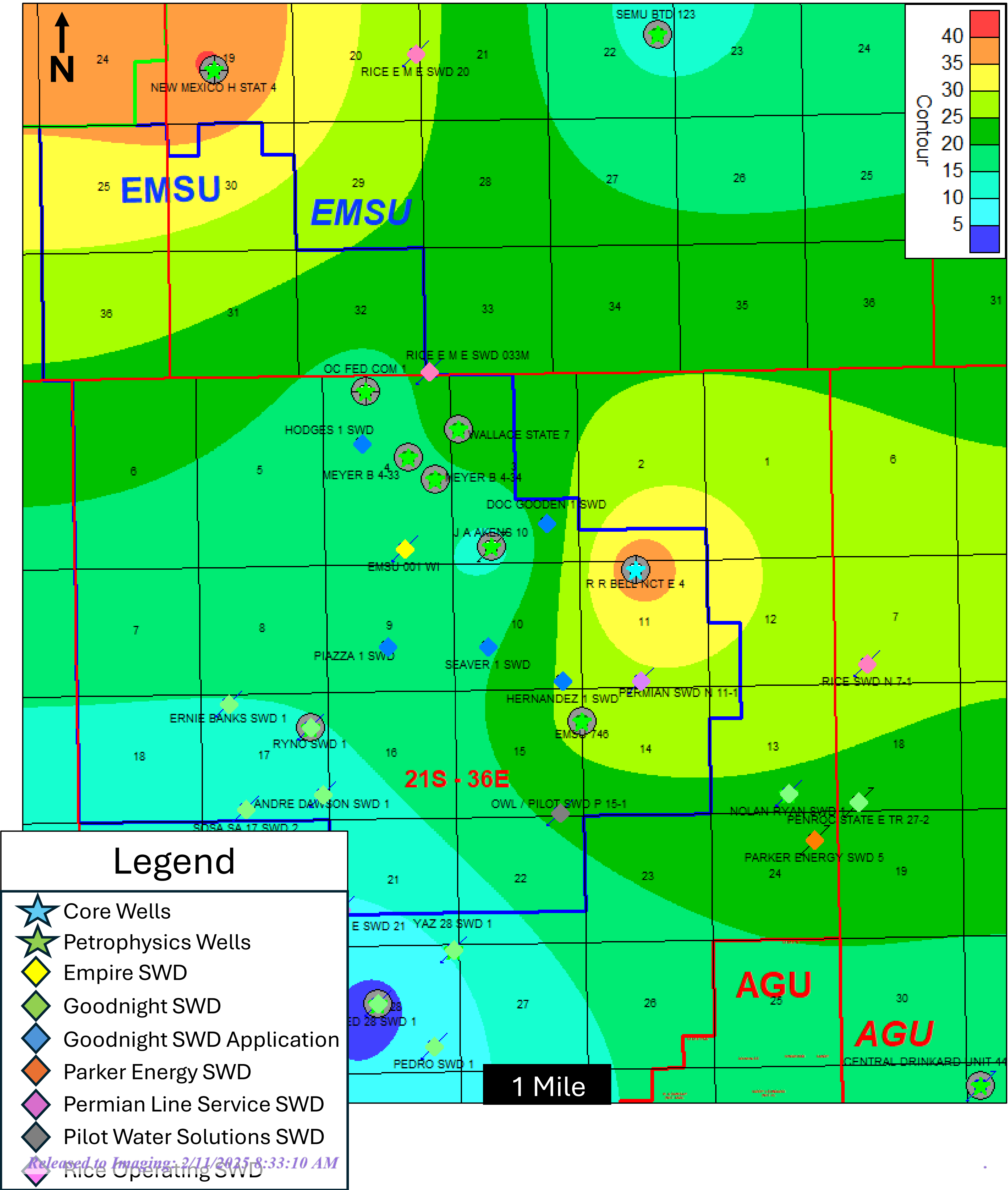


Exhibit K-30

Lower San Andres HCPV (FT) Low Case

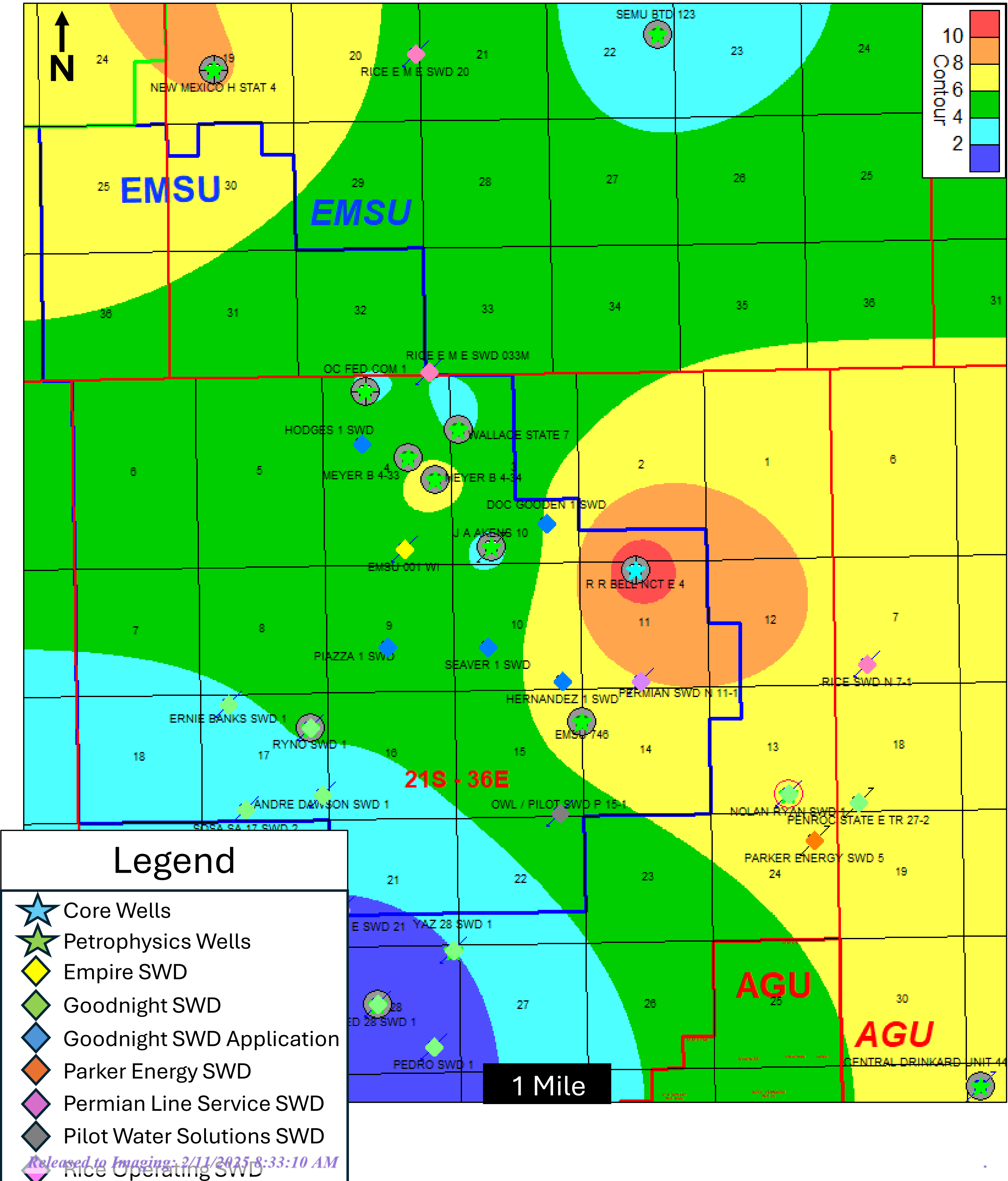


Exhibit K-31

Lower San Andres HCPV (FT) High Case

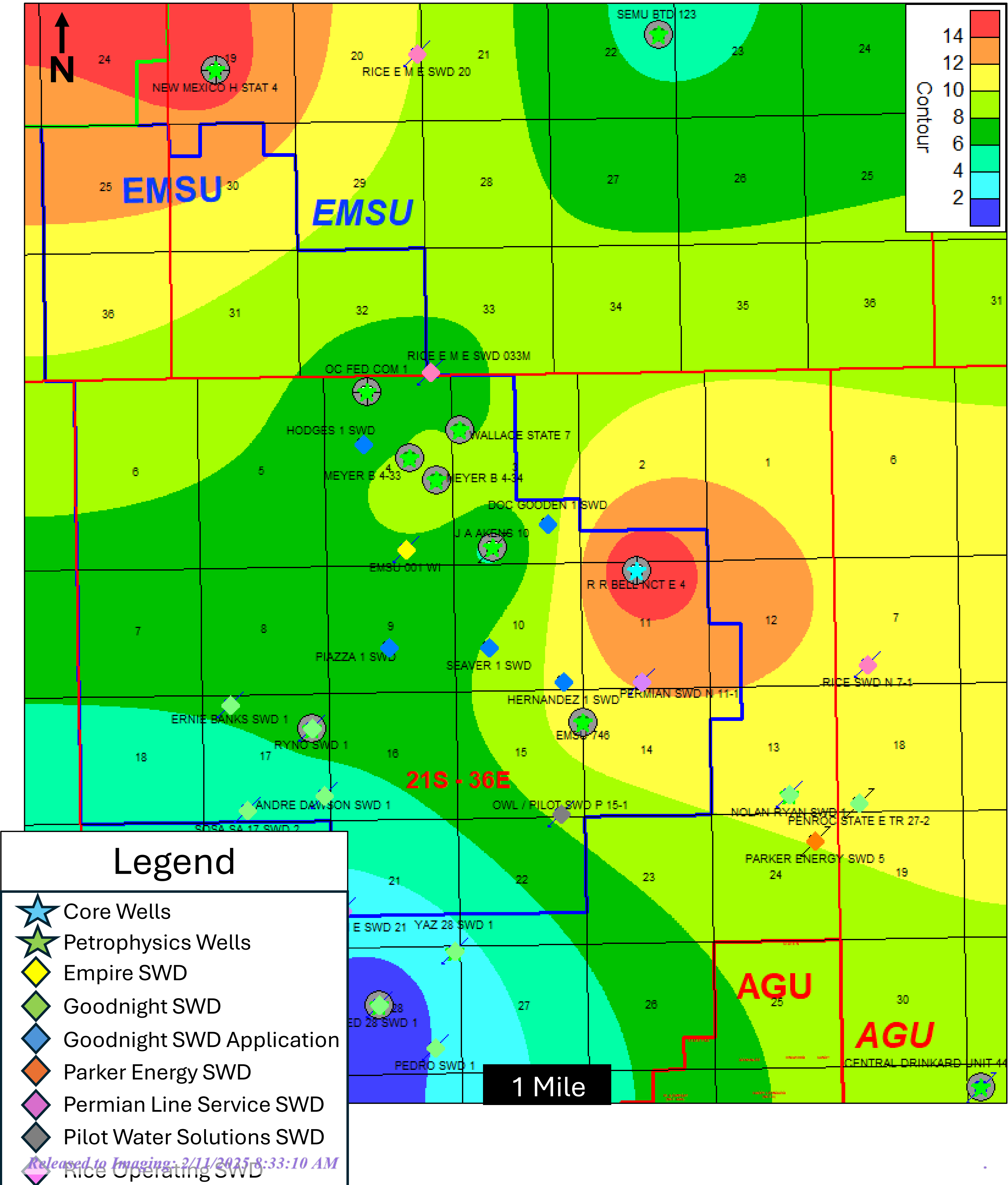


Exhibit K-32

Lower San Andres OOIP (MMBLS/Section) Low Case

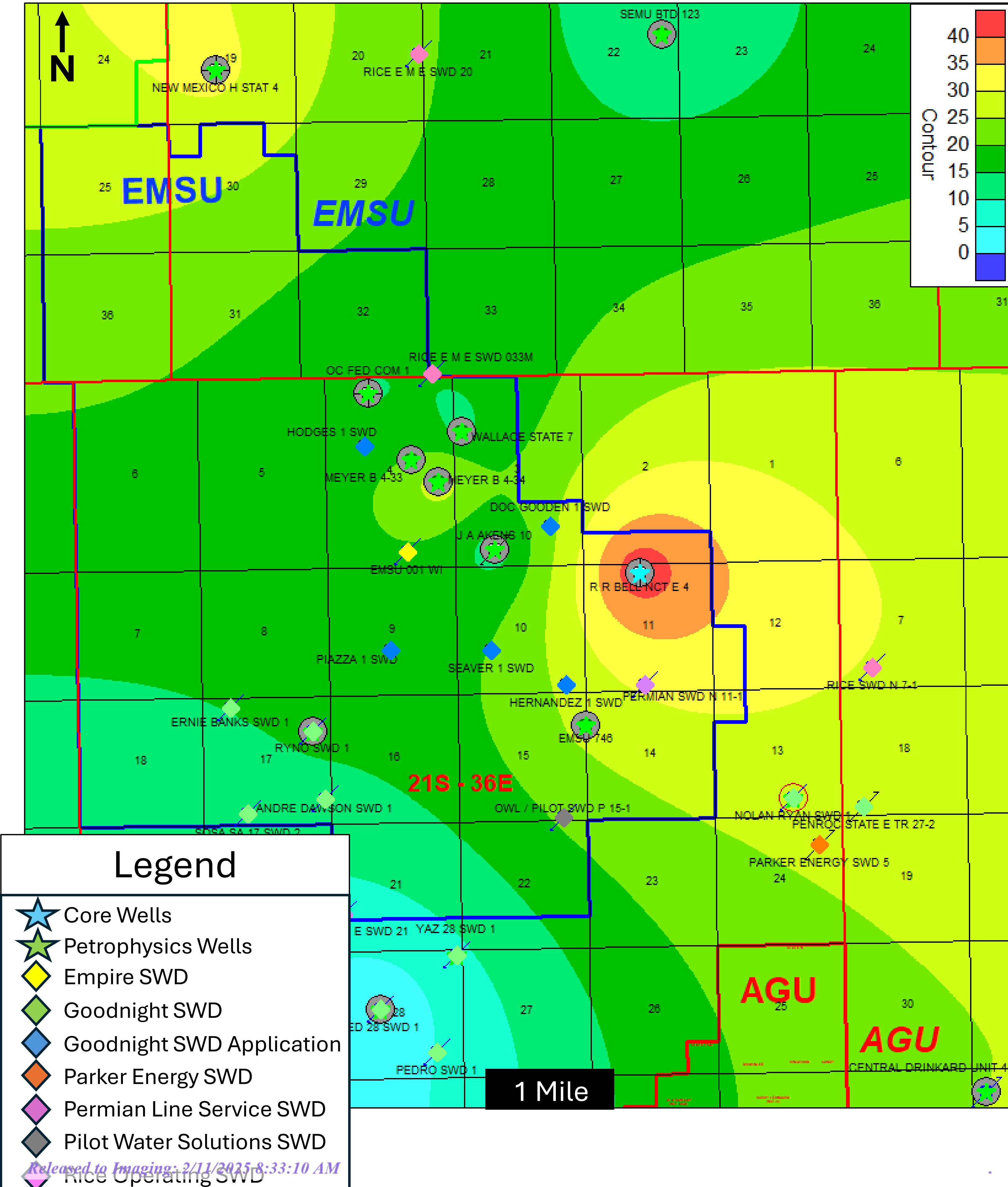


Exhibit K-33

Lower San Andres OOIP (MMBLS/Section) High Case

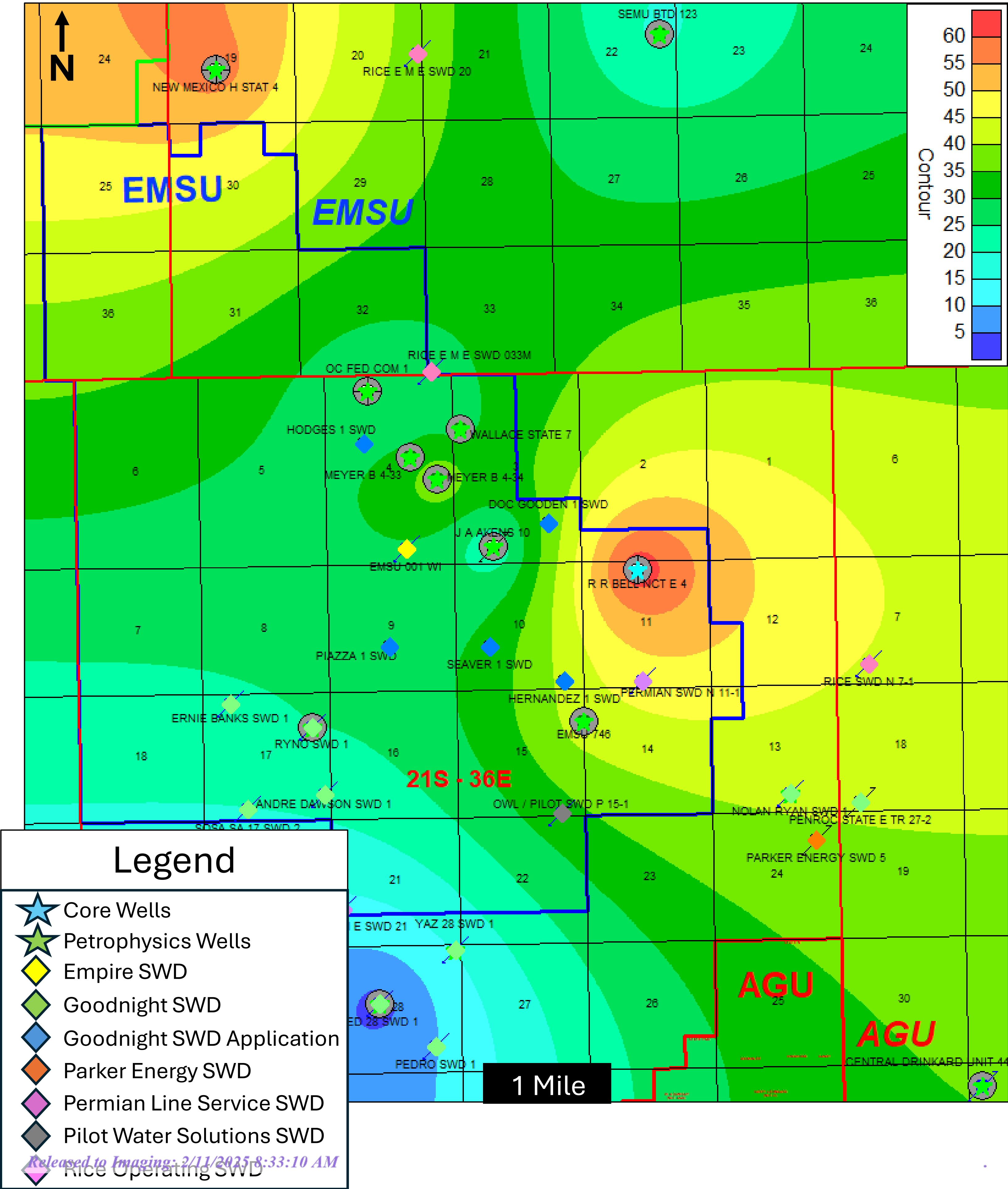


Exhibit K-34

Upper San Andres Net Pay (FT) Low Case

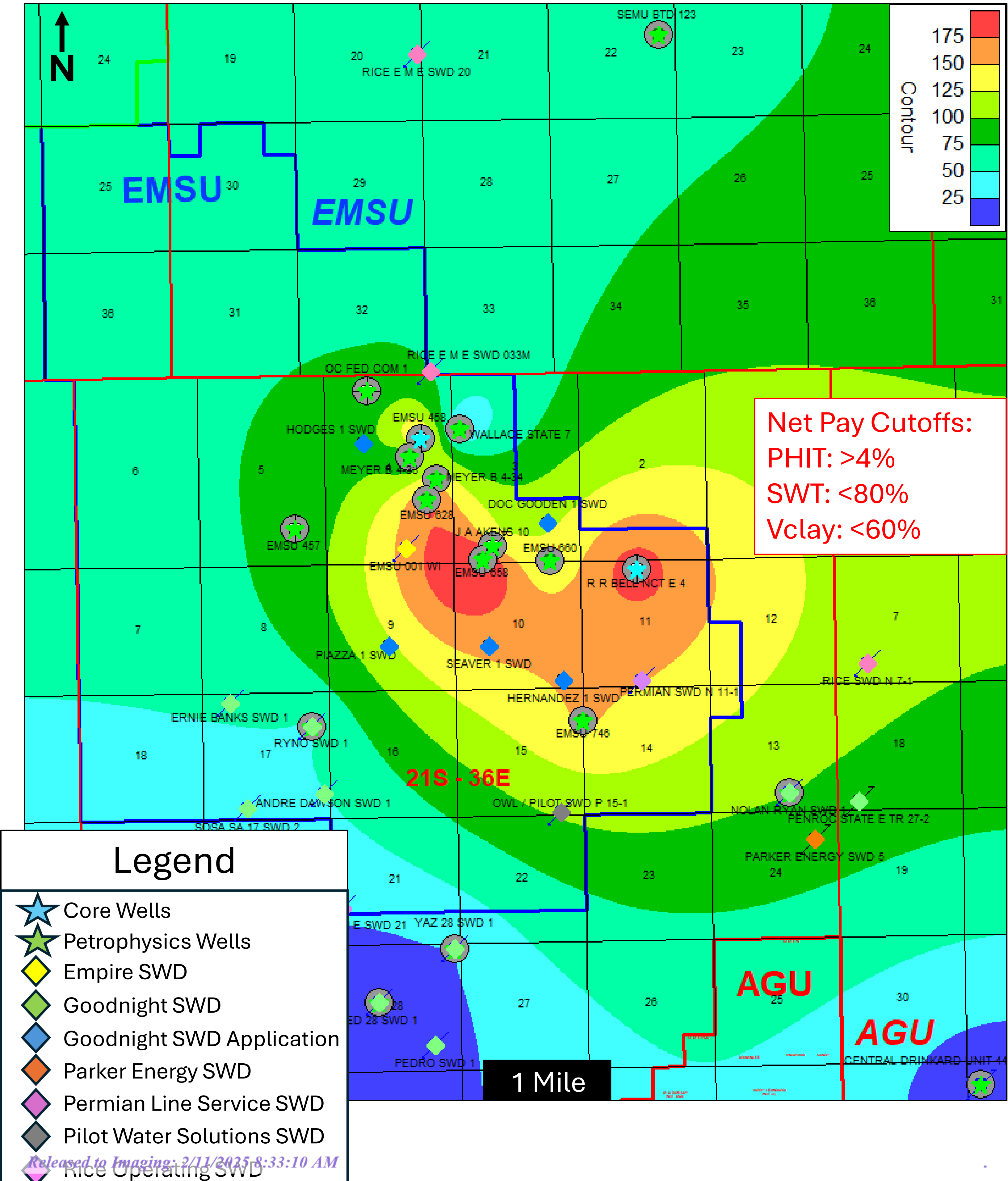


Exhibit K-35

Upper San Andres Net Pay (FT) High Case

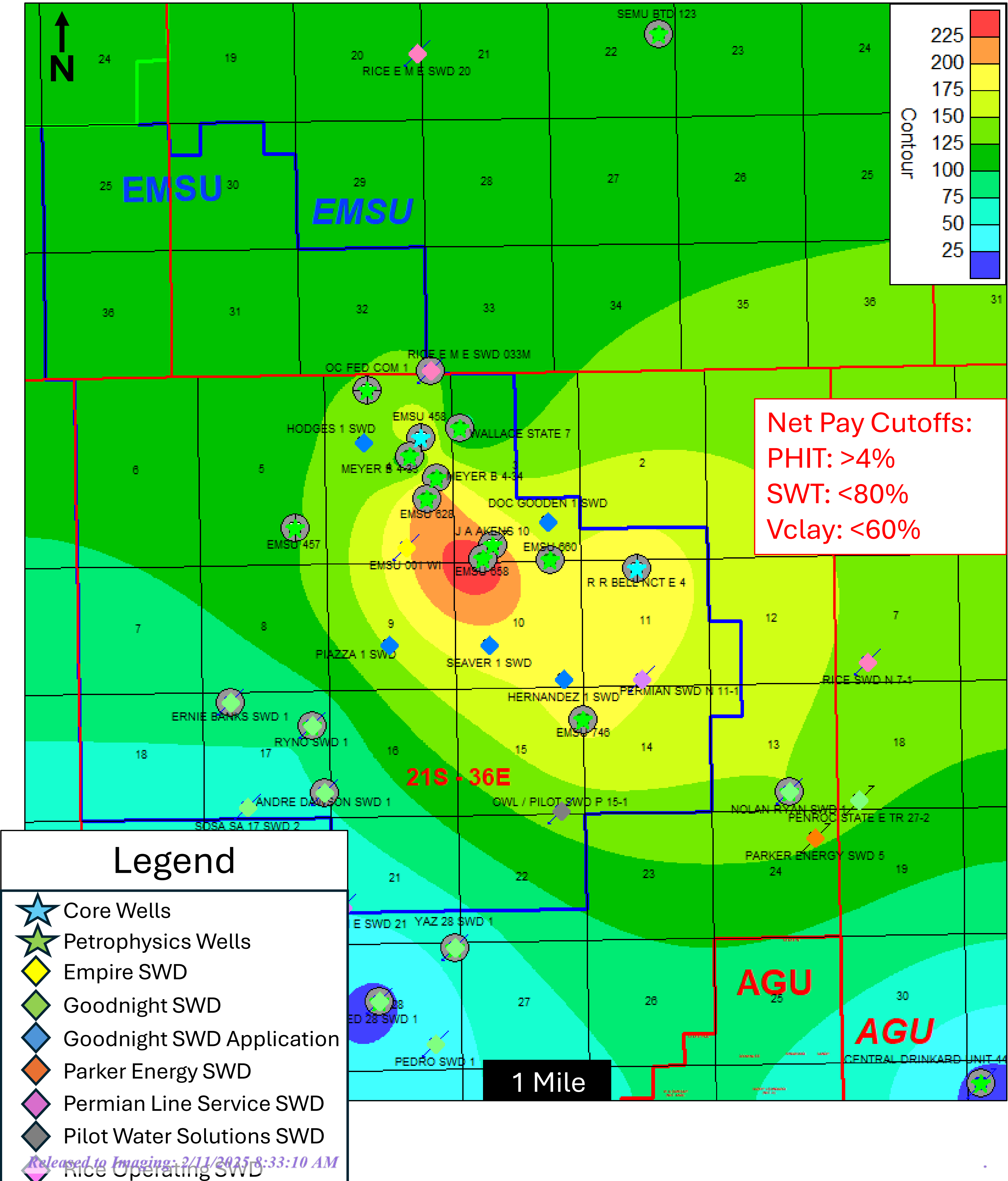


Exhibit K-36

Upper San Andres PHIT (%) Above 4% Cutoff

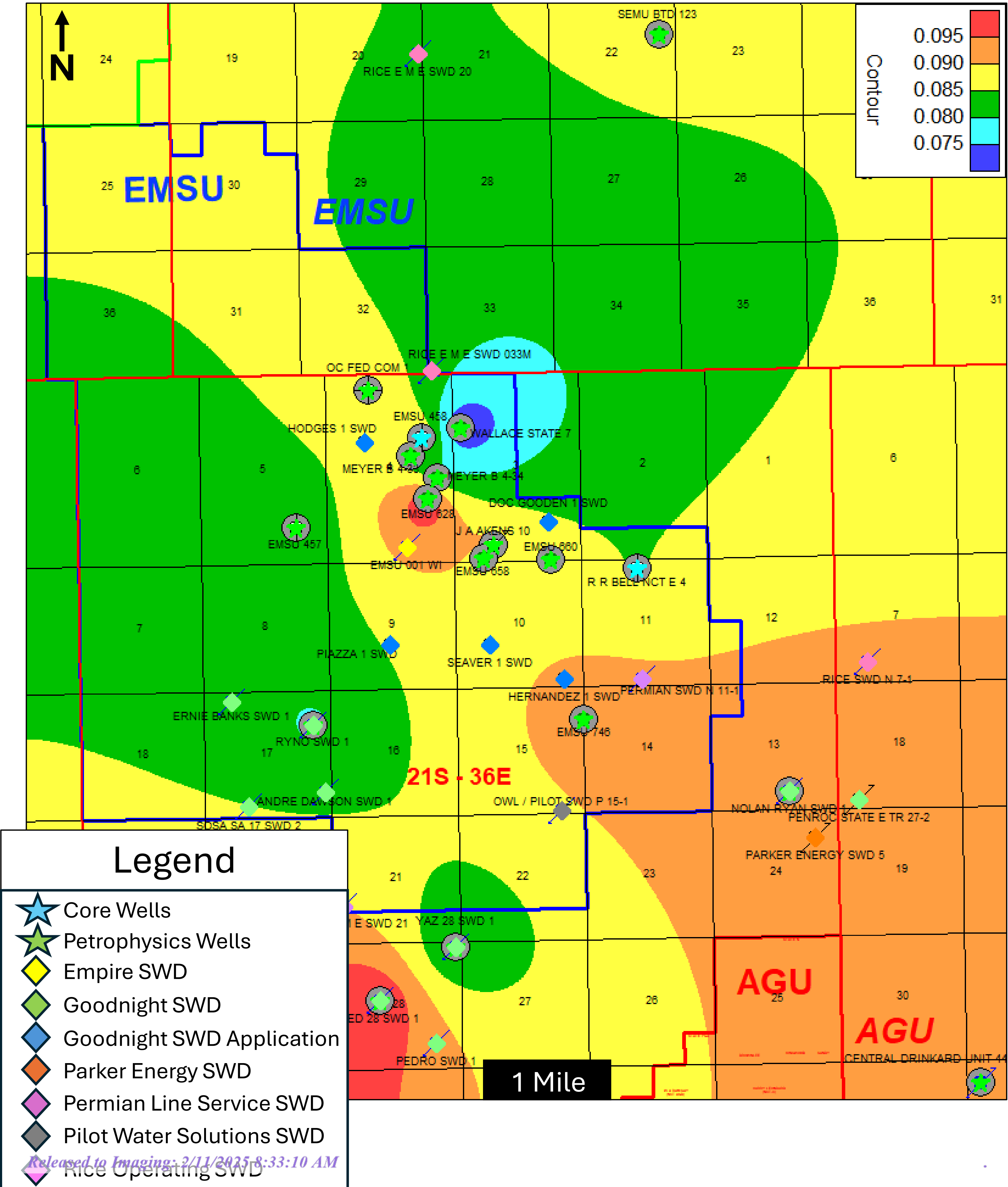


Exhibit K-37

Upper San Andres Average SWT (%) Low Case

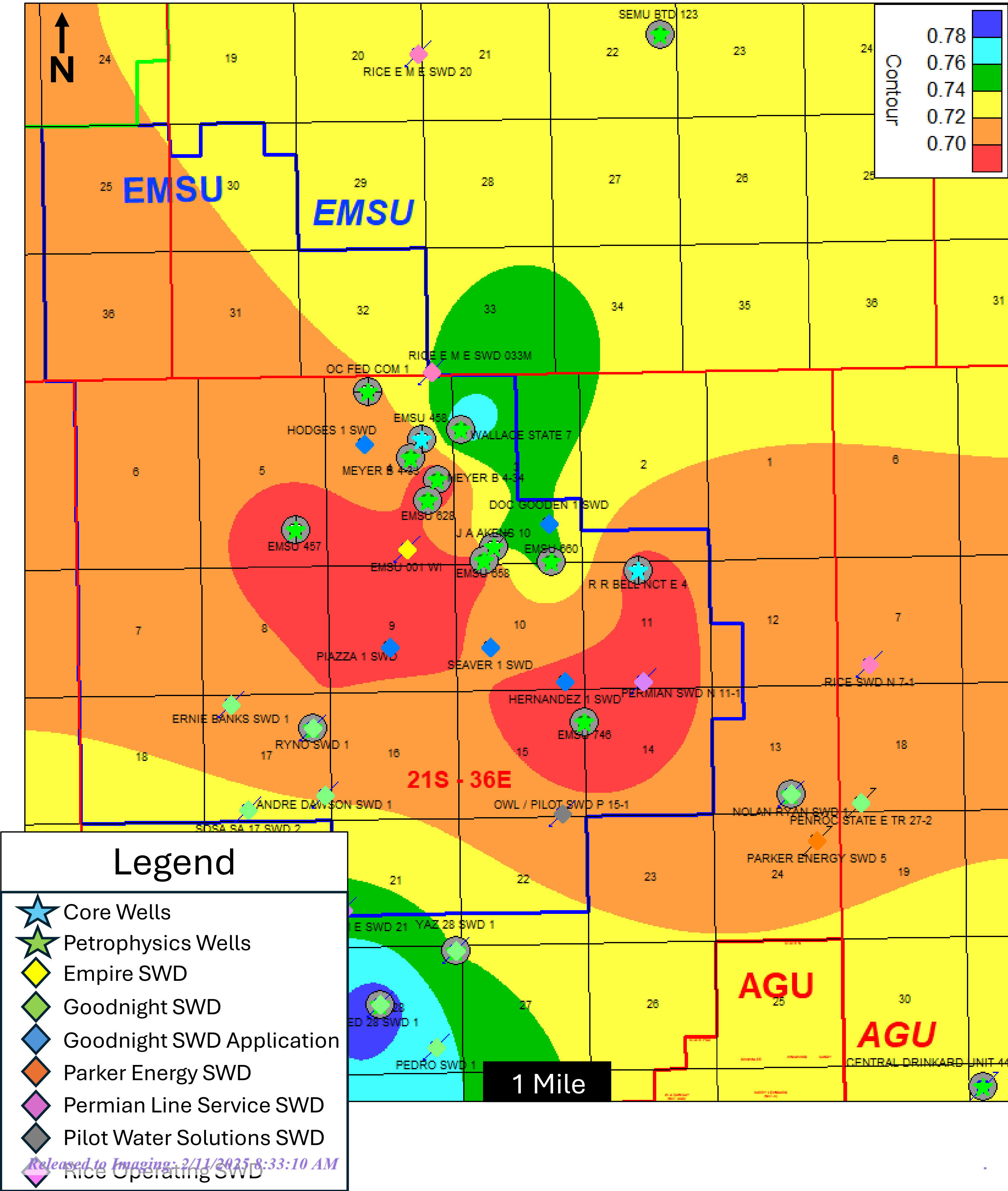


Exhibit K-38

Upper San Andres Average SWT (%) High Case

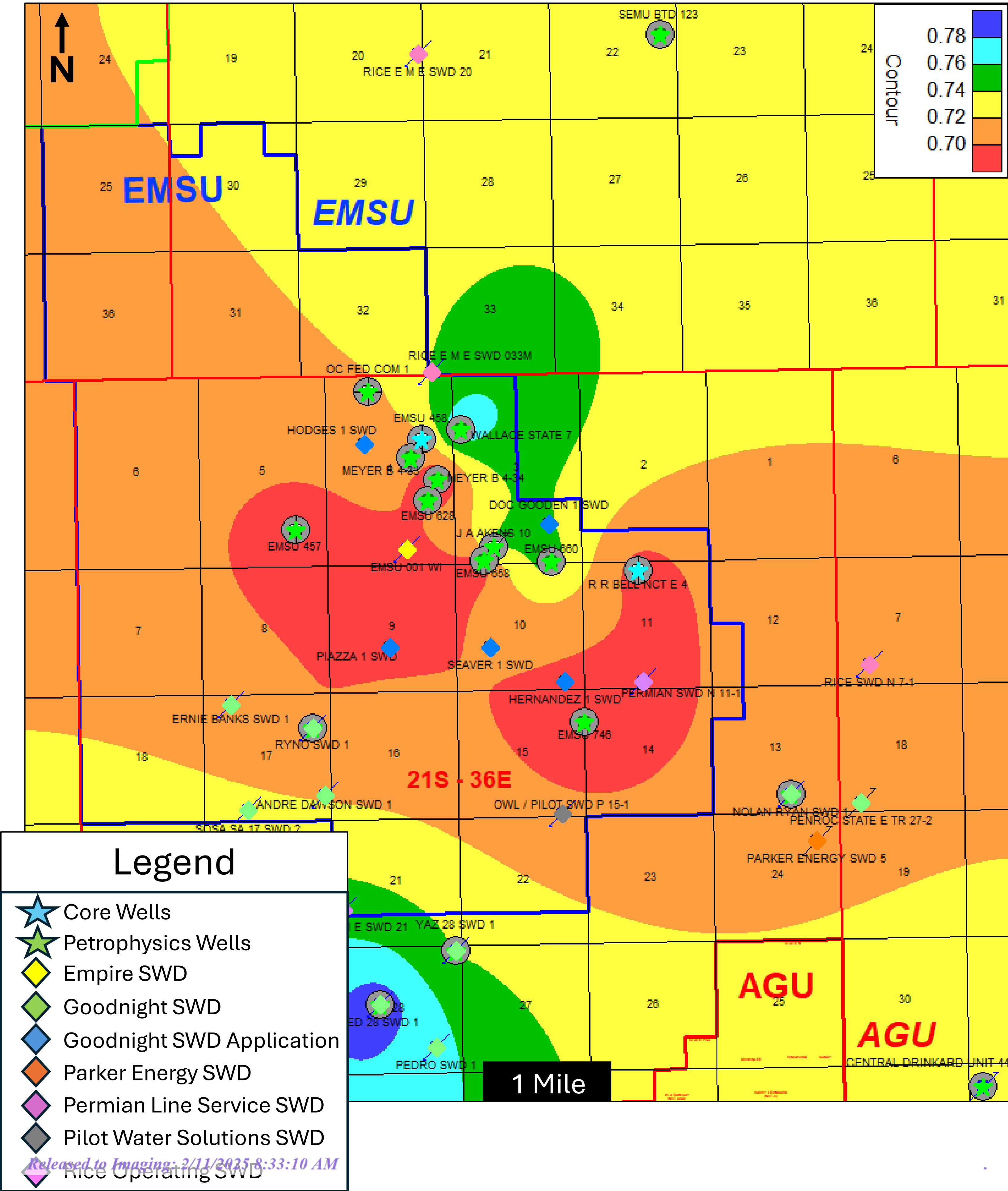


Exhibit K-39

Upper San Andres Average So (%) Low Case

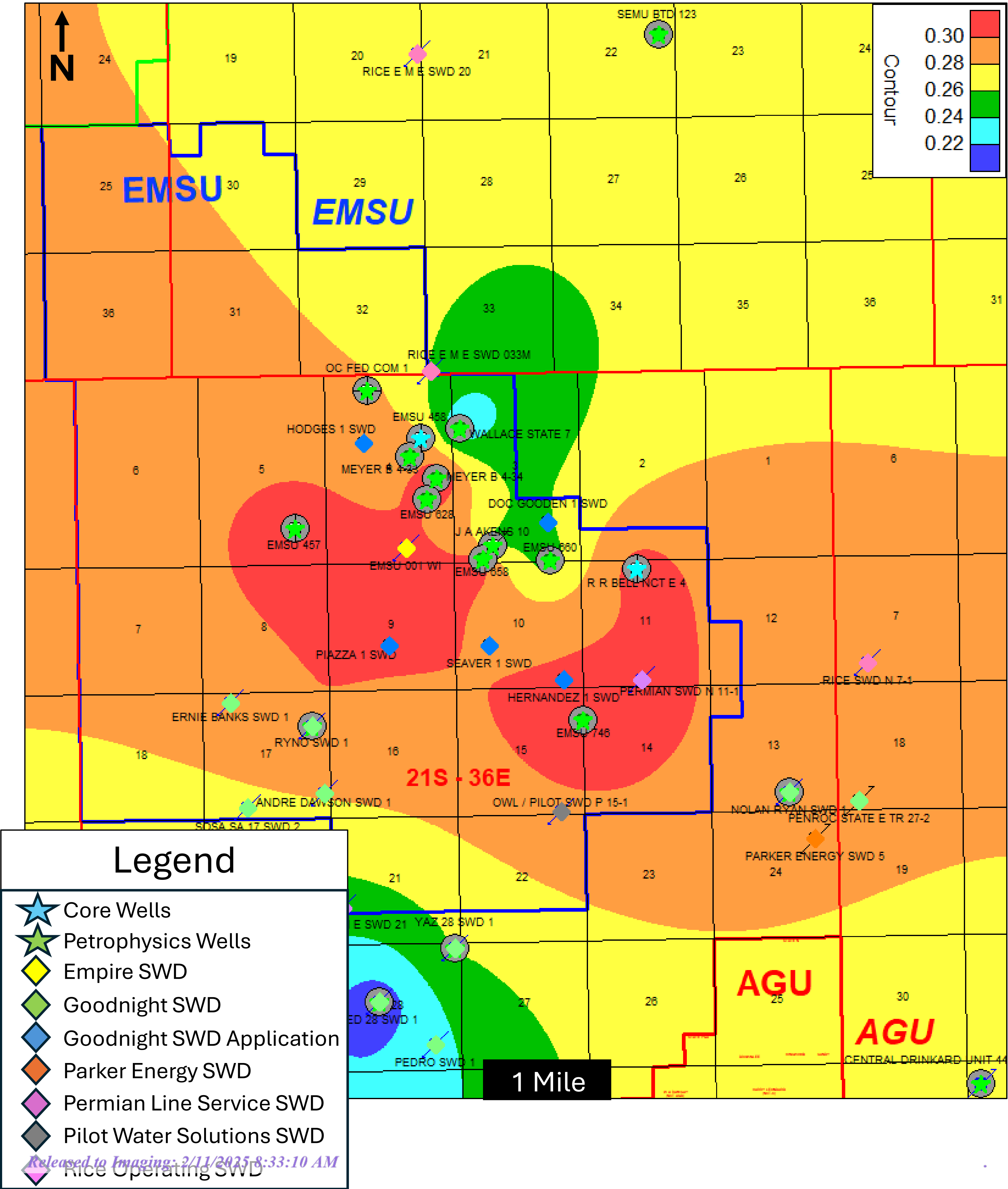


Exhibit K-40

Upper San Andres Average So (%) High Case

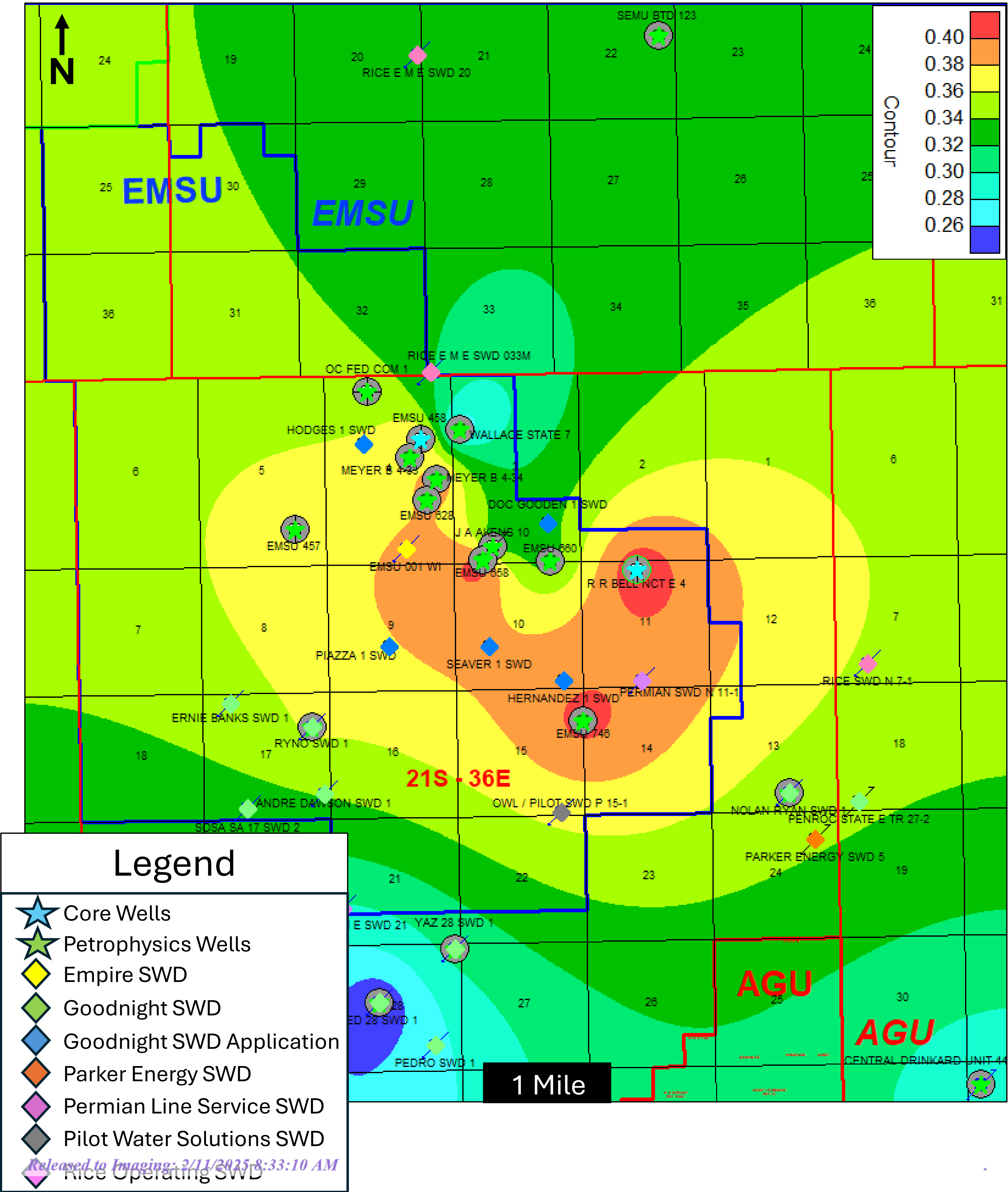


Exhibit K-41

Upper San Andres PHIH (FT) Low Case

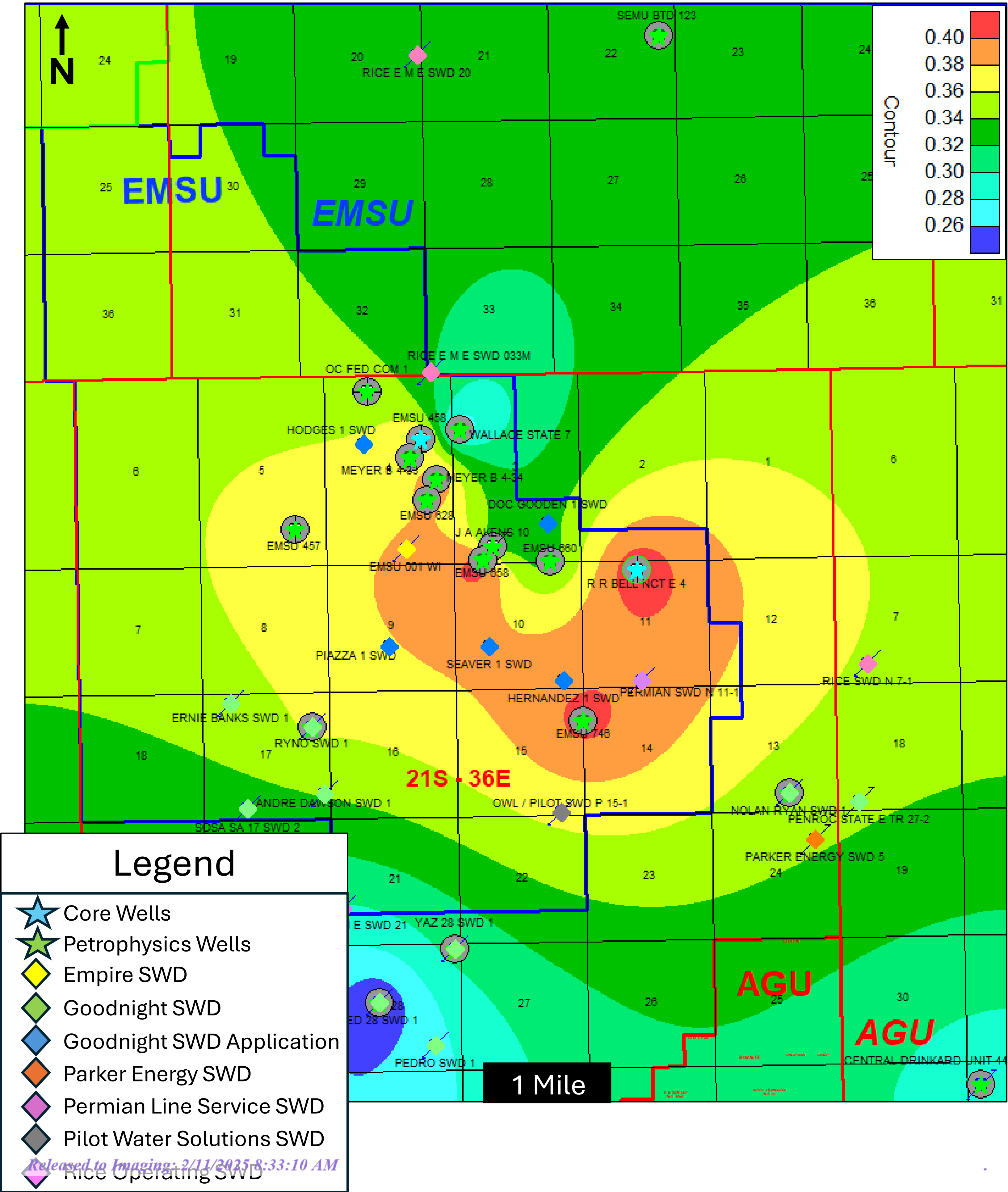


Exhibit K-42

Upper San Andres PHIH (FT) High Case

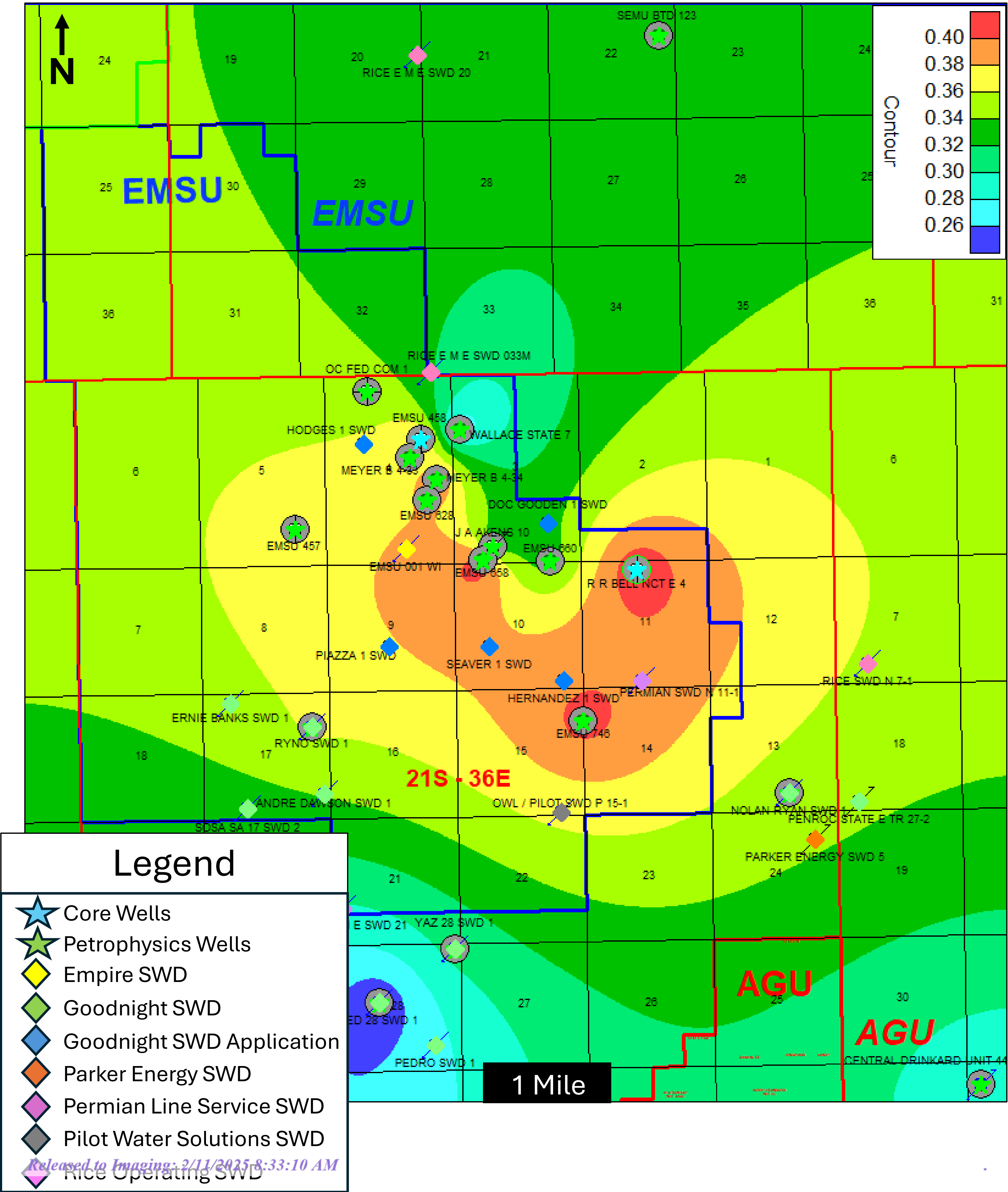


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Exhibit K-43

Upper San Andres HCPV (FT) Low Case

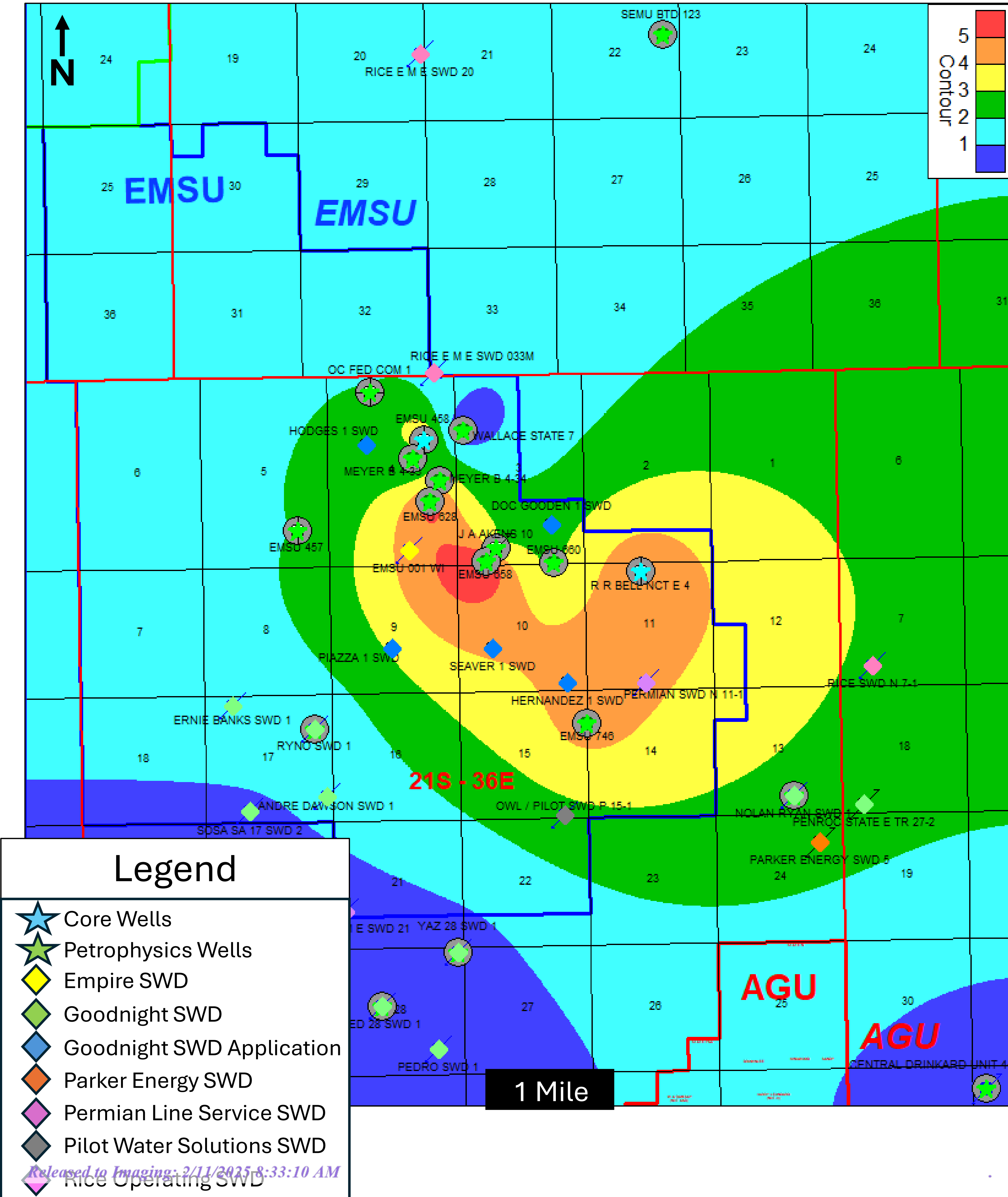

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Exhibit K-44

Upper San Andres HCPV (FT) High Case

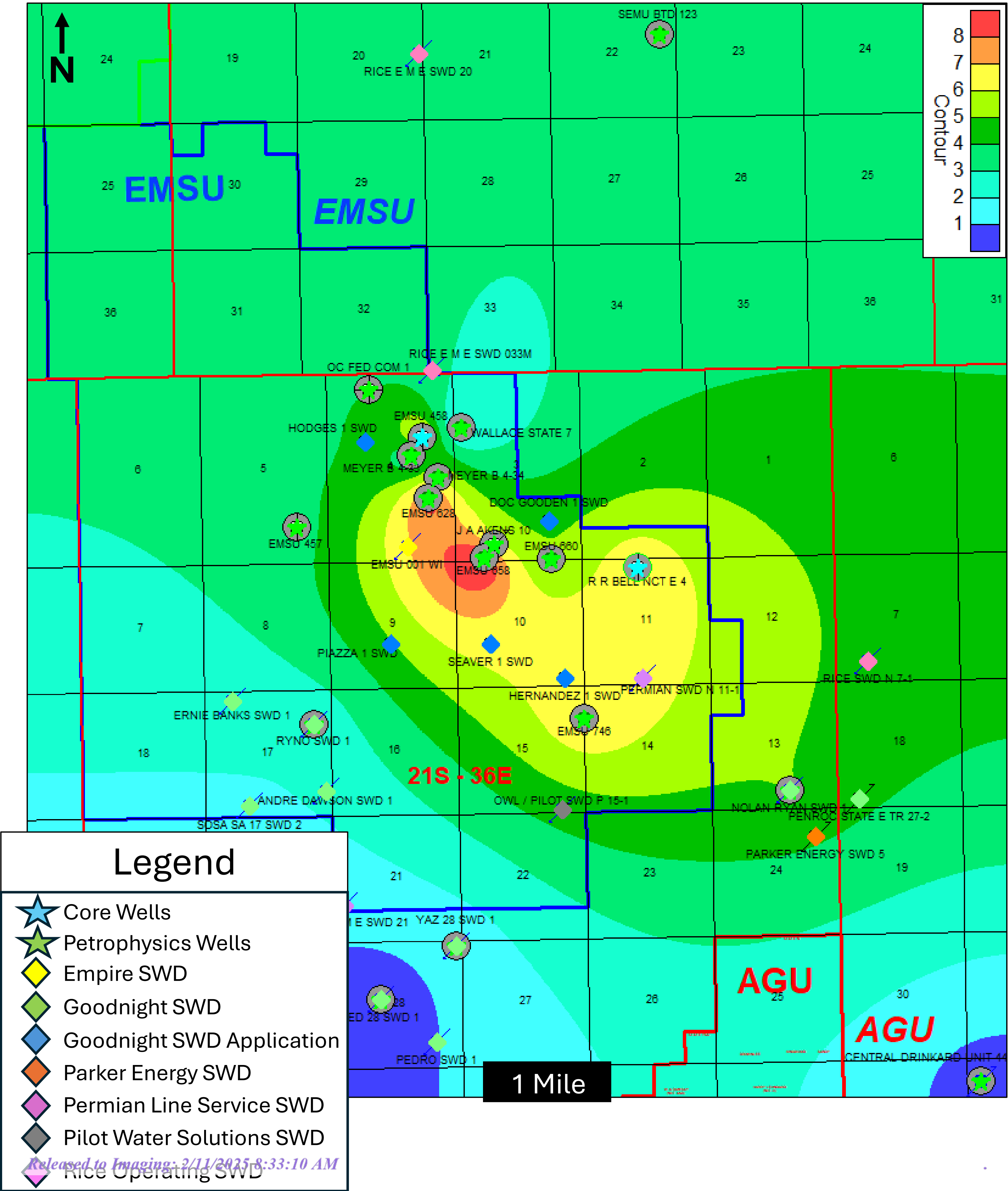


Exhibit K-45

Upper San Andres OOIP (MMBLS/Section) Low Case

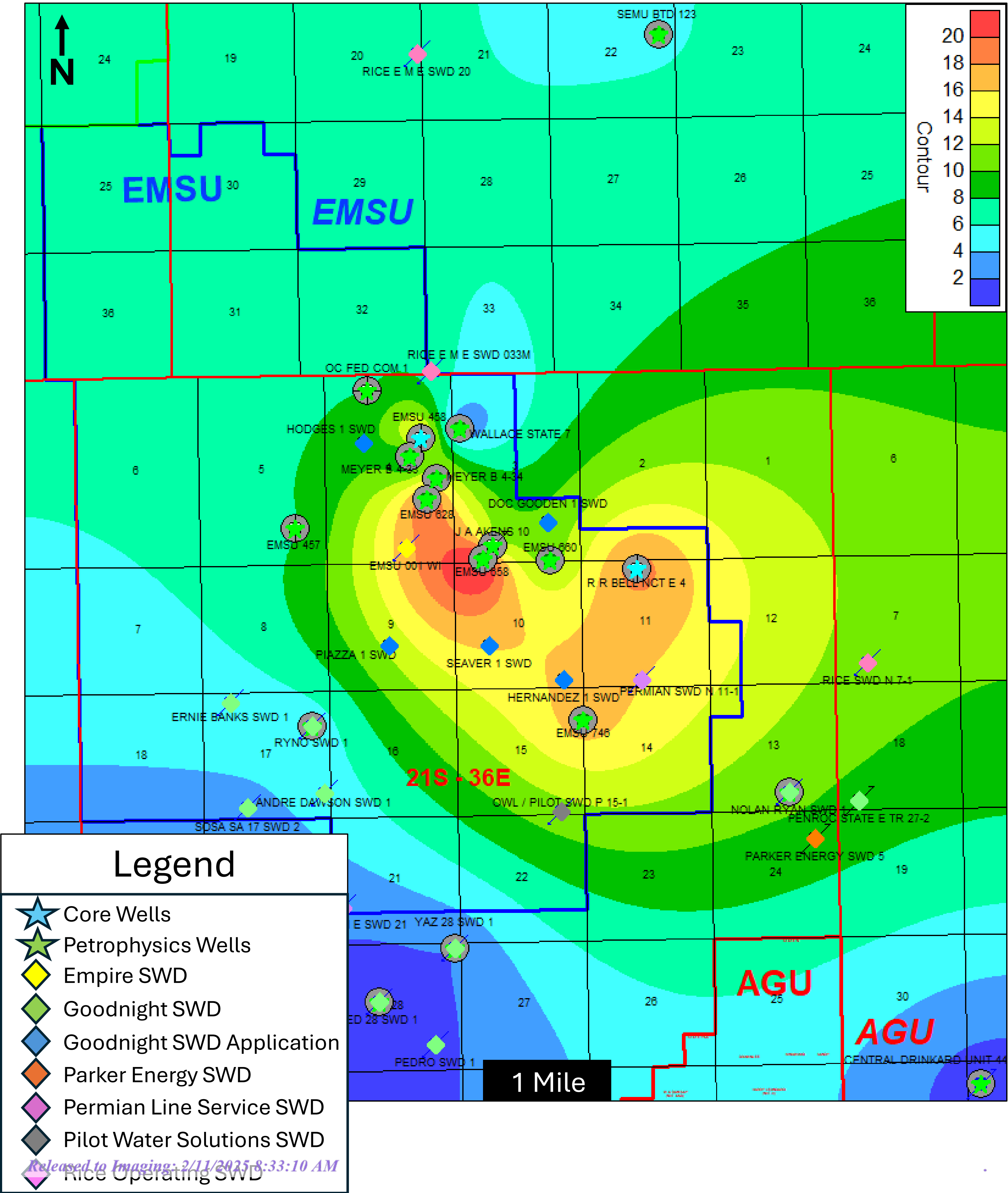


Exhibit K-46

Upper San Andres OOIP (MMBLS/Section) High Case

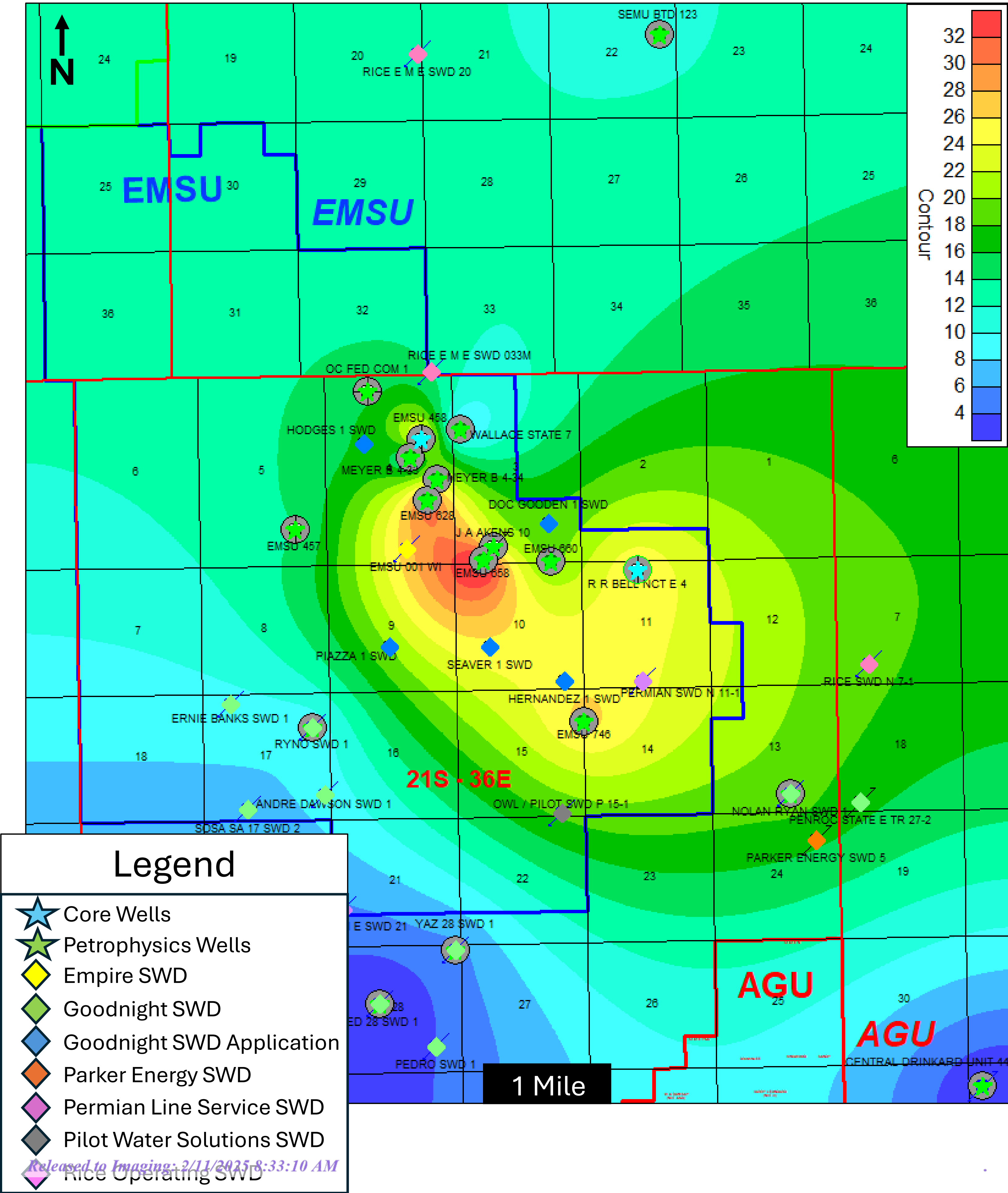


Exhibit K-47

Total San Andres Net Pay (FT) Low Case

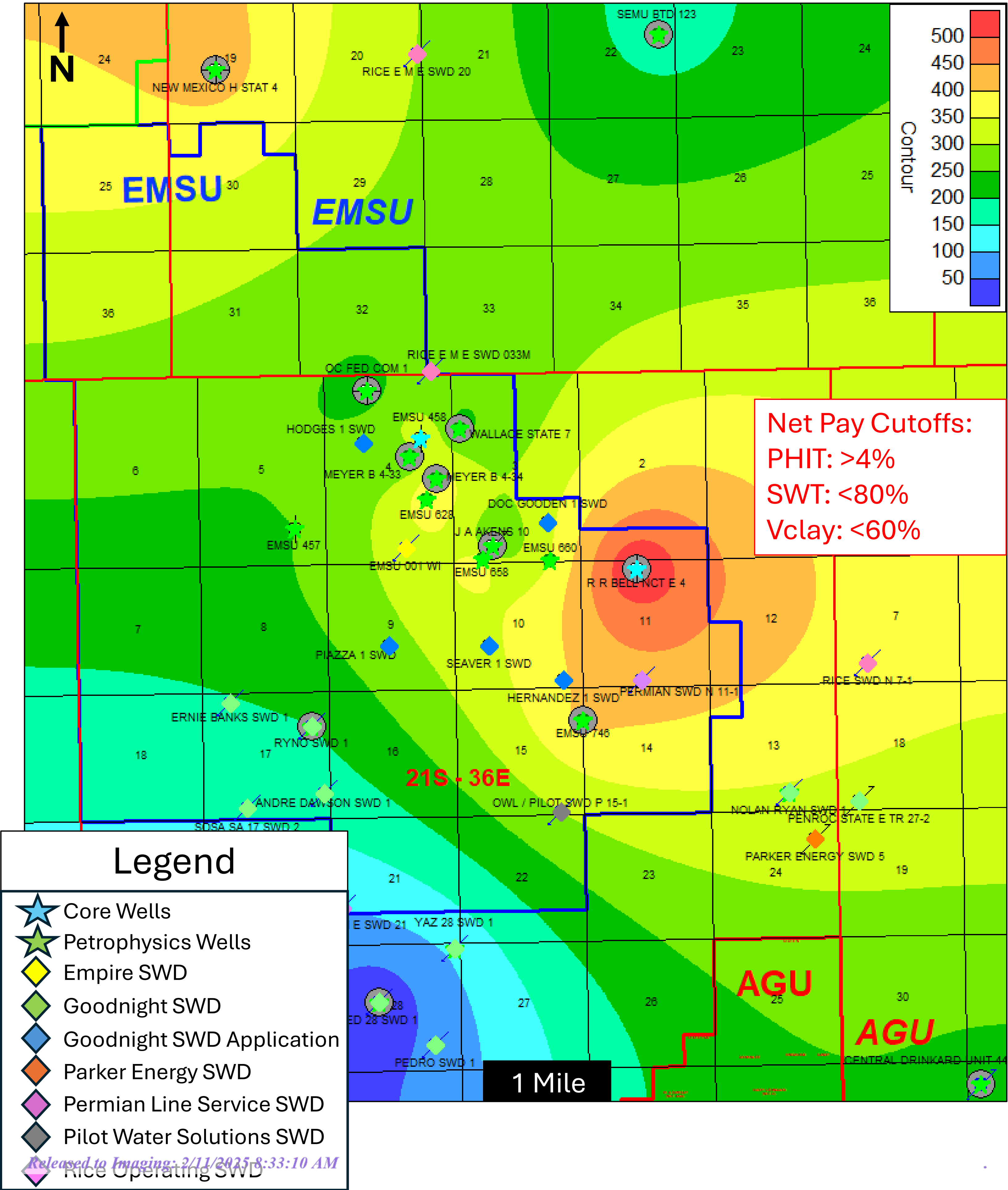


Exhibit K-48

Total San Andres Net Pay (FT) High Case

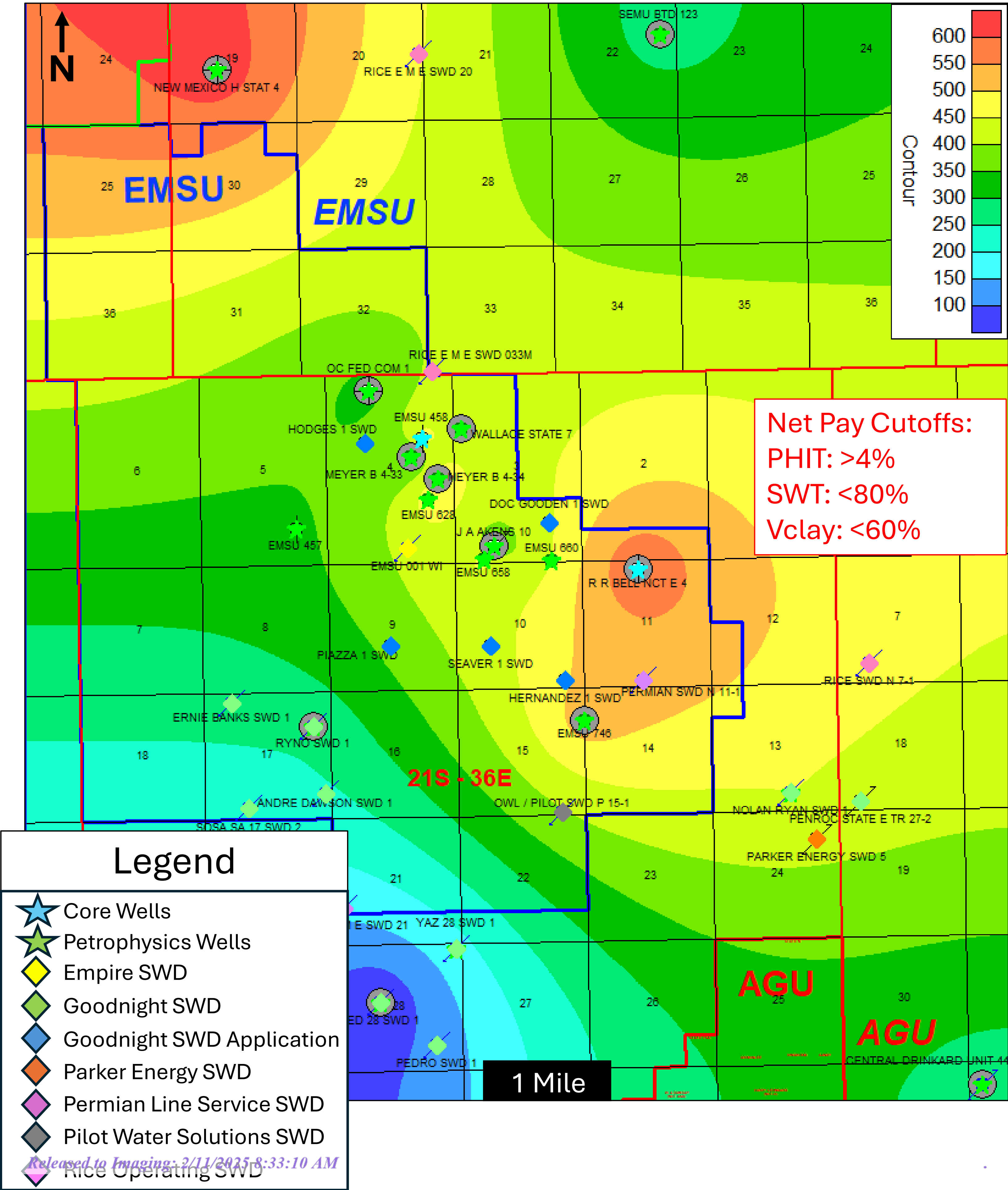


Exhibit K-49

Total San Andres PHIH (FT) Low Case

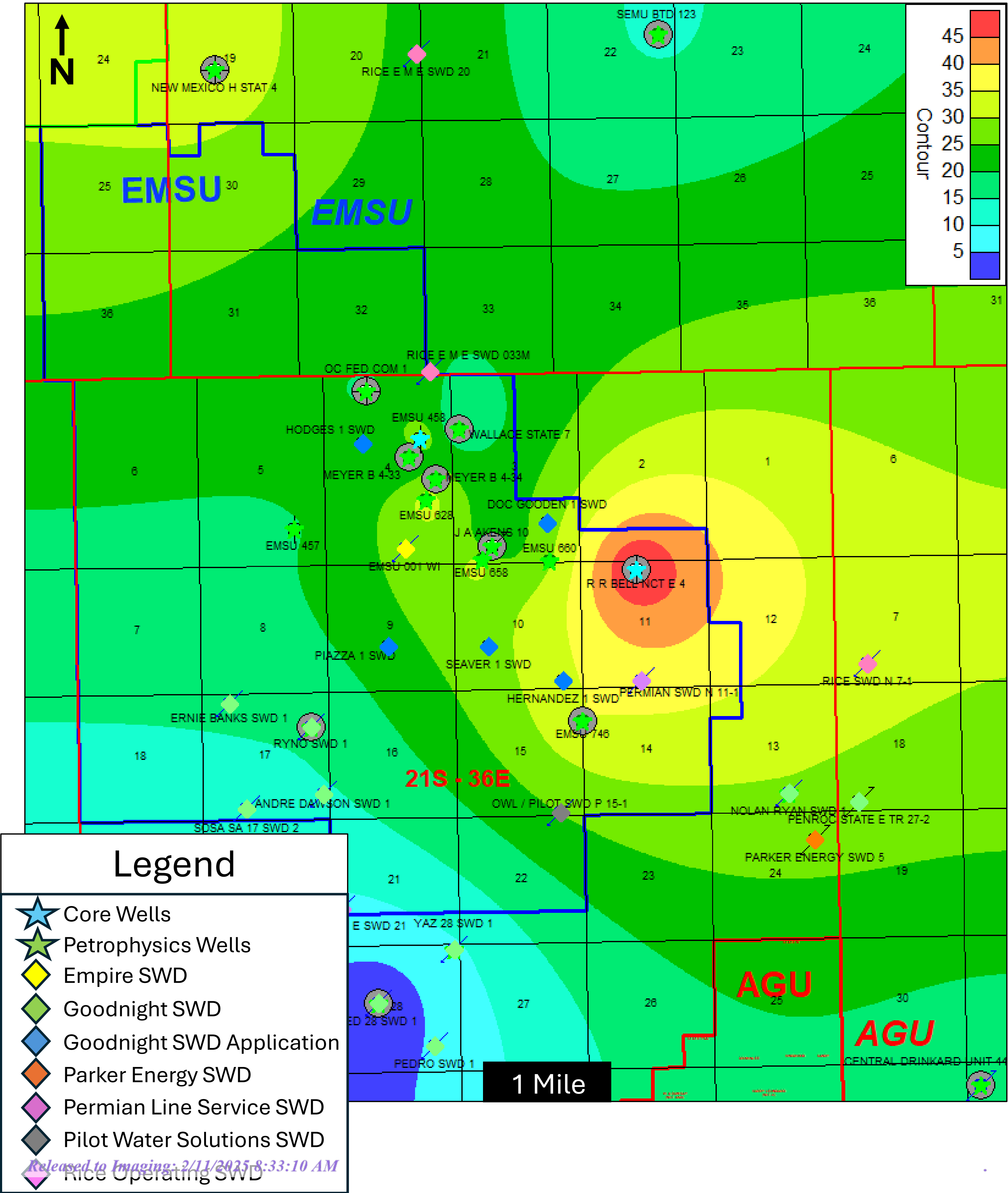


Exhibit K-50

Total San Andres PHIH (FT) High Case

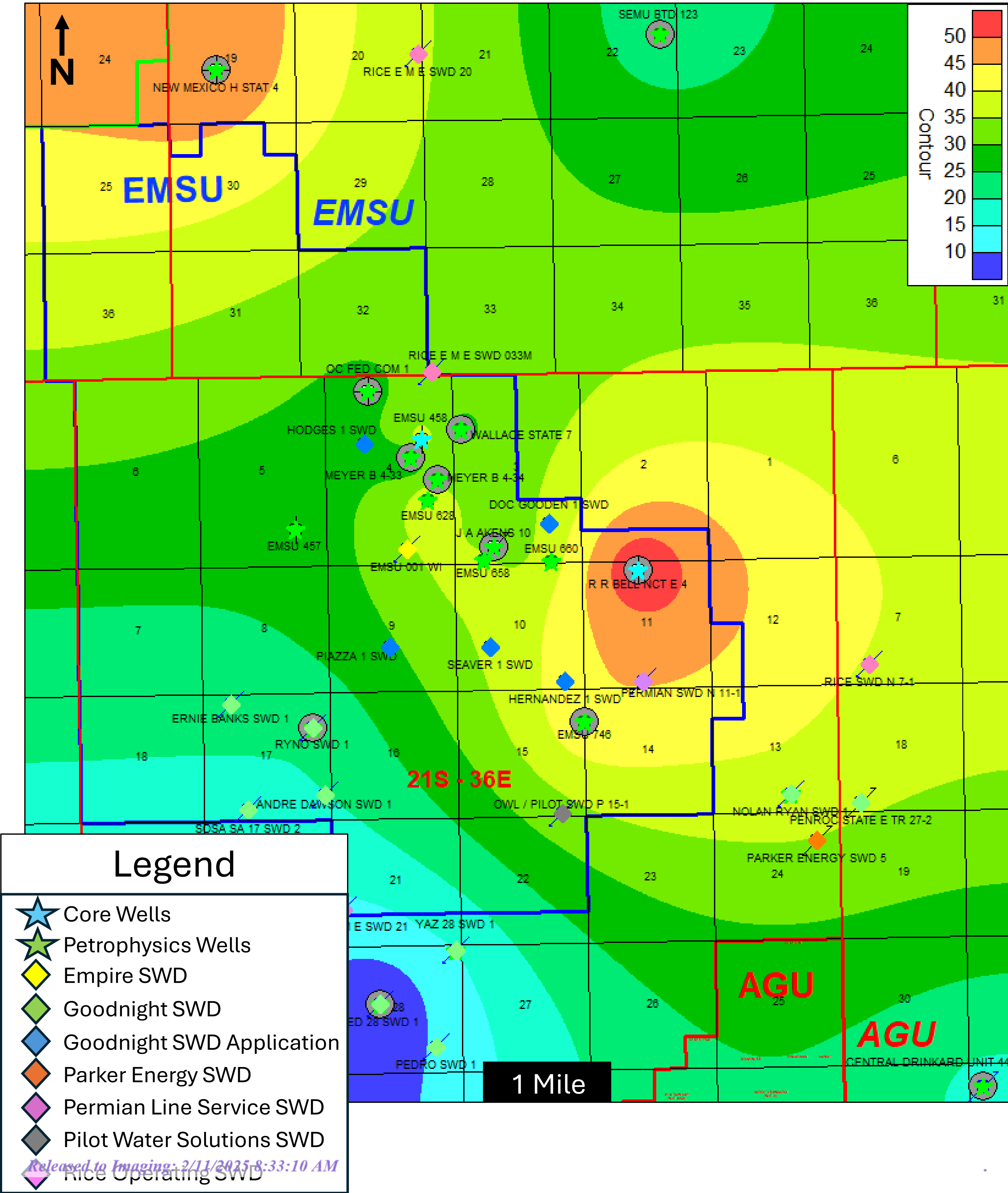


Exhibit K-51

Total San Andres HCPV (FT) Low Case

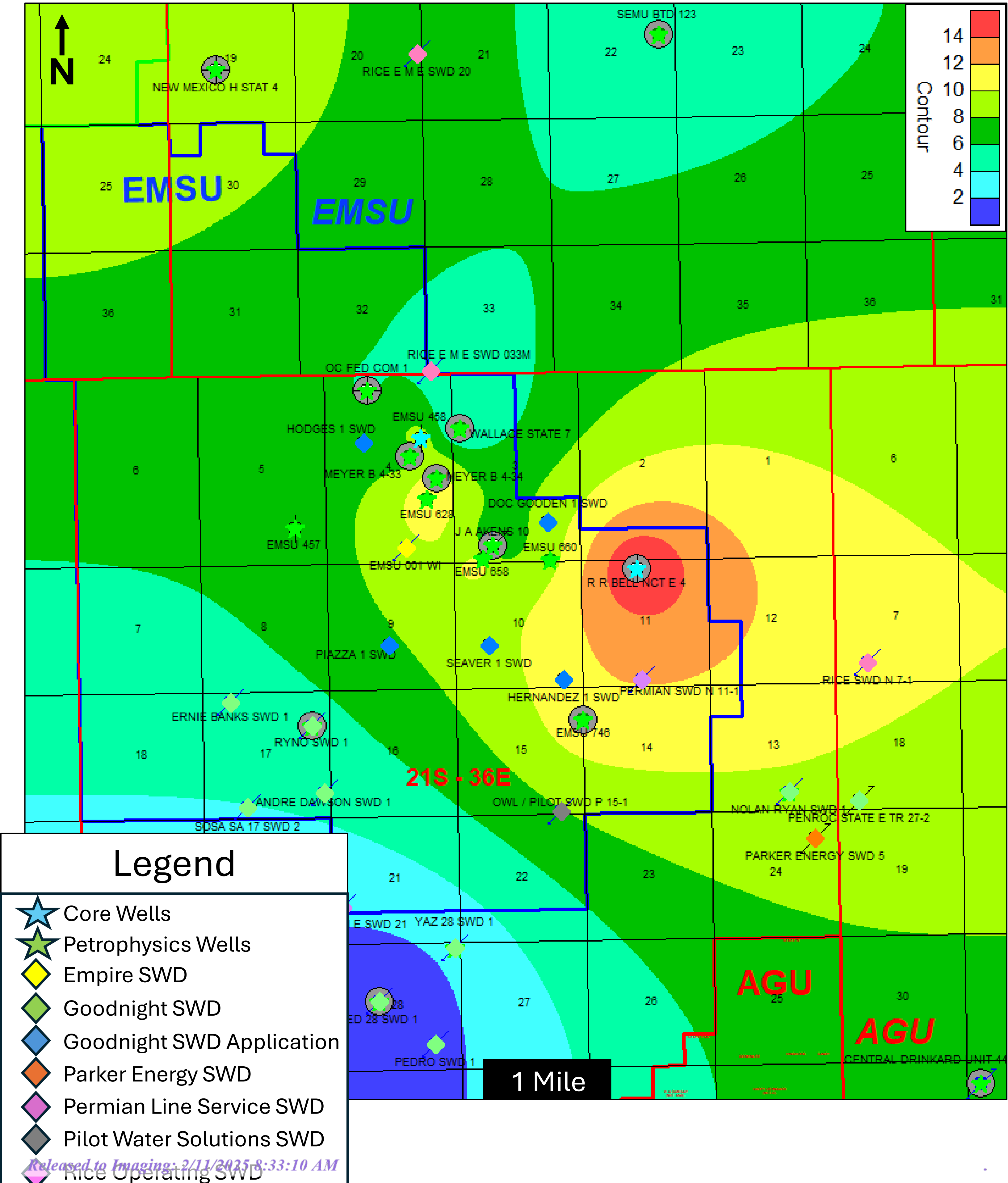


Exhibit K-52

Total San Andres HCPV (FT) High Case

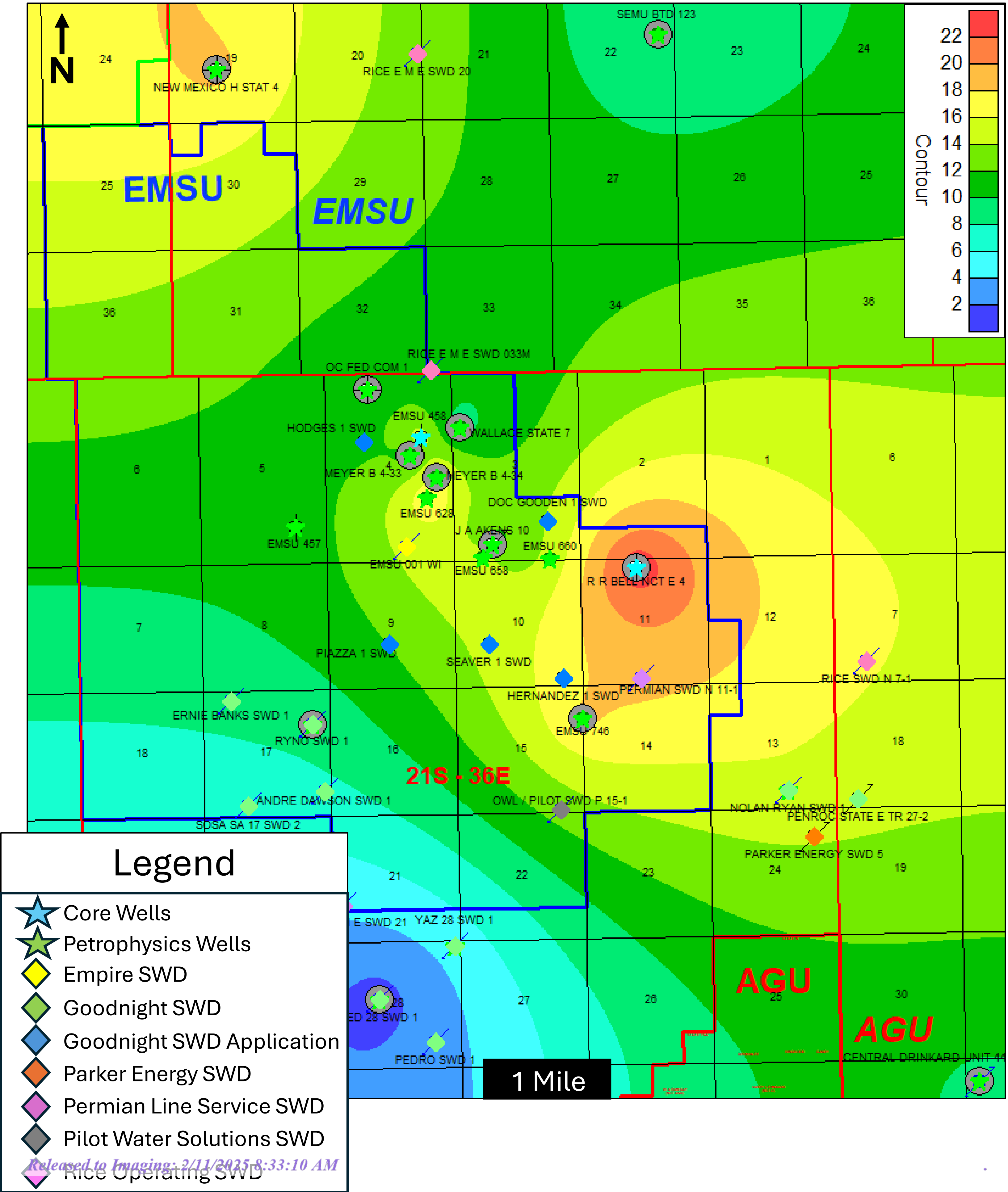
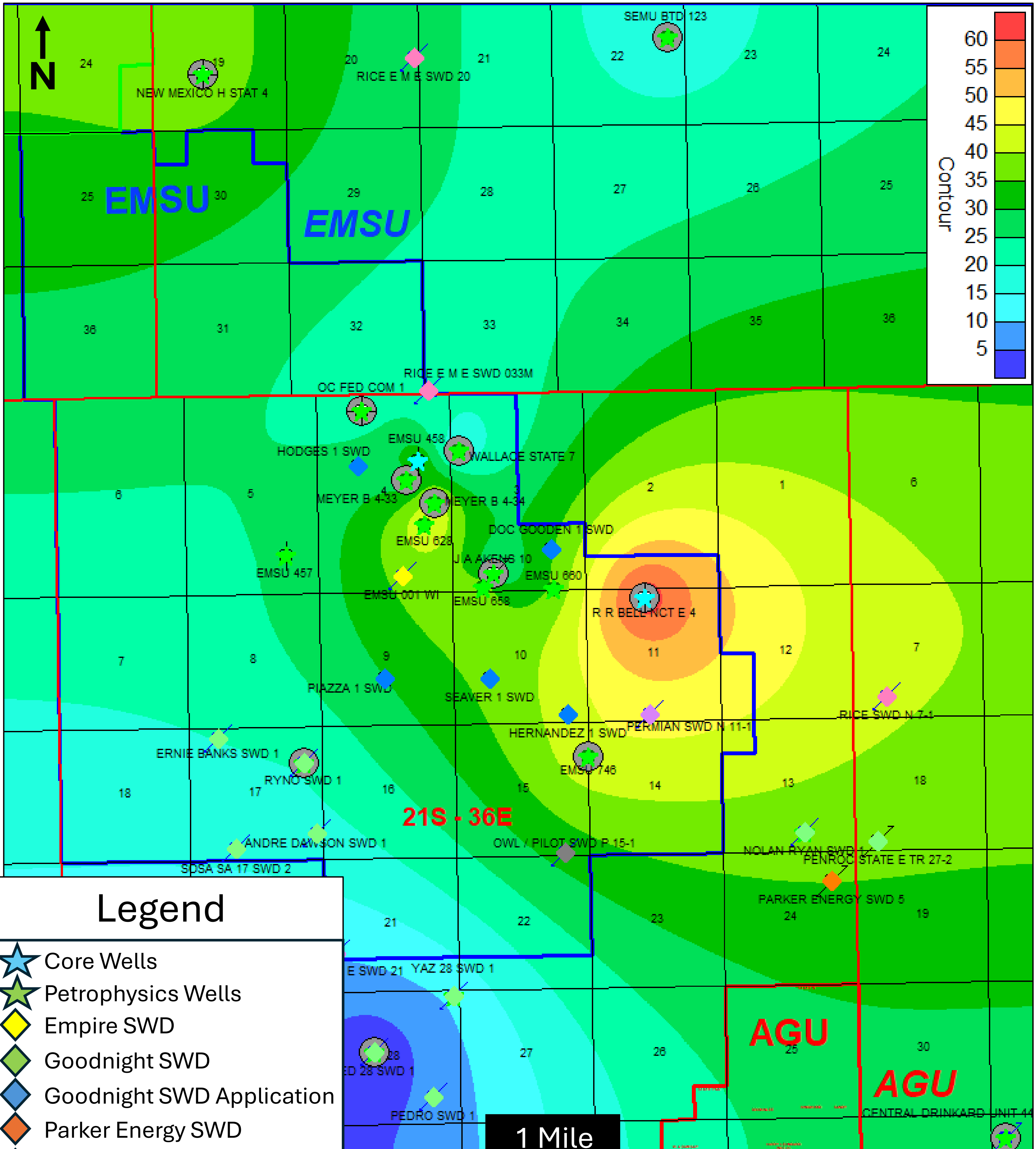


Exhibit K-53

Total San Andres OOIP (MMBLS/Section) Low Case



Legend

- Core Wells
- Petrophysics Wells
- Empire SWD
- Goodnight SWD
- Goodnight SWD Application
- Parker Energy SWD
- Permian Line Service SWD
- Pilot Water Solutions SWD
- Rice Operating SWD

Exhibit K-54

Total San Andres OOIP (MMBLS/Section) High Case

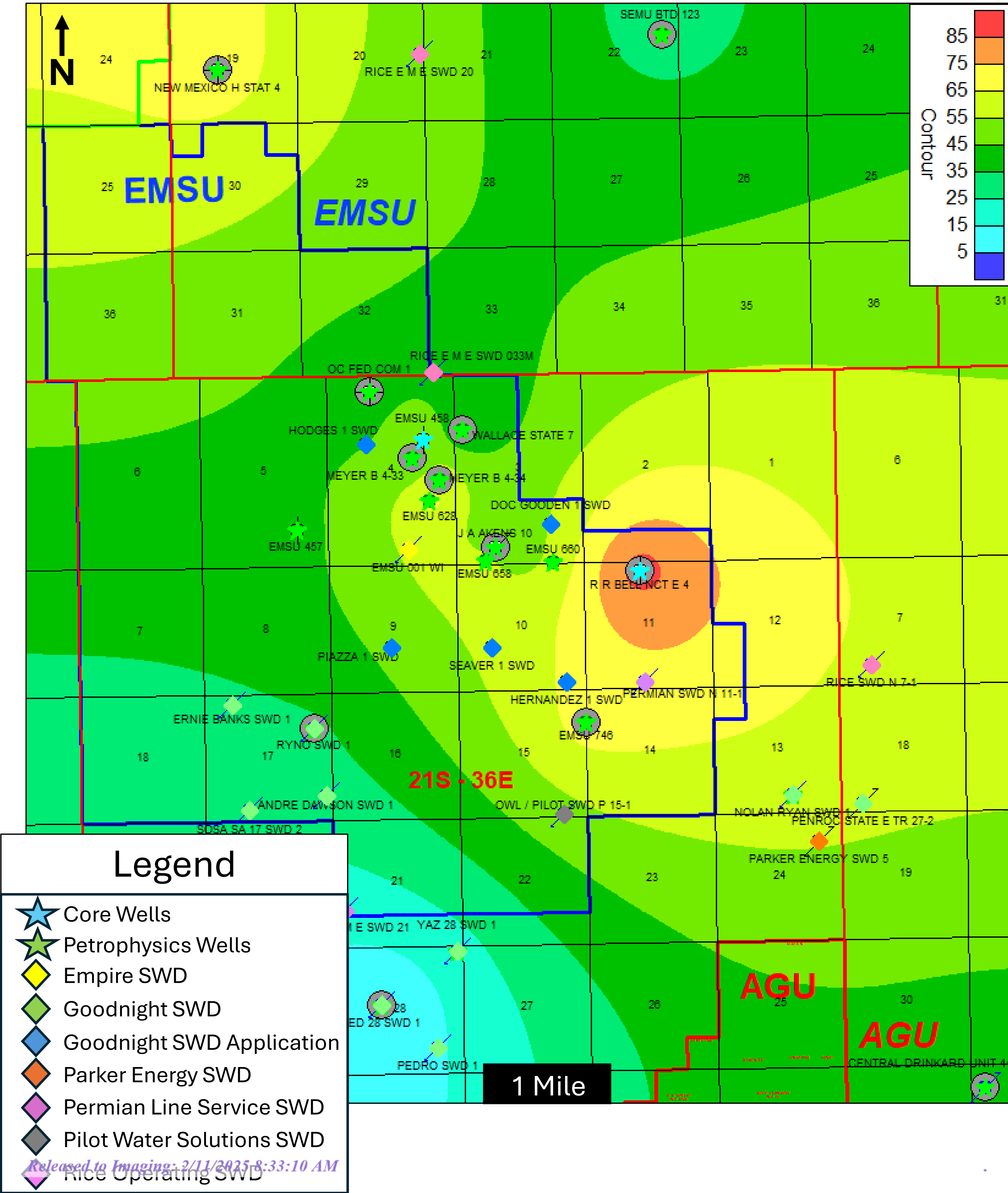


Exhibit K-55

San Andres EMSU OOIP Volumes

Formation	OOIP Low Case MMBLS	OOIP High Case MMBLS
Upper San Andres	190.86	331.41
Lower San Andres	438.76	718.34
Total San Andres	629.62	1,049.75

Exhibit K-56

Ryan Bailey

39 N Lansdowne Cir., The Woodlands, TX 77382
Phone: 832-585-6865 Business E-Mail: rbailey@opsgeologic.com Personal E-Mail: rmb4112@gmail.com

Summary Qualifications

- 17 years of geology and multi-disciplinary management experience in field development and exploitation of conventional and unconventional oil and gas resources across US Onshore.
- Team oriented leader with the ability to motivate staff to perform at a high level.
- Proven track history of leading multiple disciplines to execute active drilling programs.
- Delivered high quality mapping and geologic interpretations under short deadlines with technical excellence.

Experience: Ops Geologic (May 2021-Present)

Co-founder and Vice President Geoscience

- Responsible for generating client driven geoscience products from play fairway analysis and prospect generation to field development plans, data acquisition, and ultimately execution of operations.
- Recent projects include multiple M&A process evaluations of the Eagle Ford and Austin Chalk across South Texas from Gonzales to Webb County, evaluation of the Bone Spring and Wolfcamp across Lea and Eddy County, New Mexico, and exploration projects across the East Texas Basin and Texas Gulf Coast.
- Manage multi-disciplinary team of geoscientists and engineers to ensure quality, completion, and delivery of client driven projects.

Arkatex Energy Advisors (August 2020-Present)

Founder and CEO

- Provide contract geoscience services including play fairway analysis, prospect generation, field development, data acquisition, and operations support.
- Developed West Haynesville exploration prospect in the East Texas basin which included reservoir characterization utilizing log, petrophysical, and core analysis to identify the sweet spot of the play. Third party funding has secured leases on ~40k acres to date with plans to operate soon.

JBL Energy Partners (January 2020-August 2020)

Vice President Geology

- Responsible for generating regional geological and rock property maps for Pennsylvanian sands within the Ft. Worth basin, identifying prospect areas, and generating development plans for ~50k acres.
- Managed geological operations for horizontal drilling inclusive of identifying target intervals, generating geoprogs, and coordinating mudlogging, geosteering, and wireline operations.
- In addition, responsible for generating prospects, screening potential prospects, and providing geological analysis for potential acquisitions.

Anadarko Petroleum (July 2007-November 2019)

Area Asset Manager - Delaware Basin (Midland, TX) **June 2019-November 2019**

- Responsible for developing & delivering a value-based business strategy for the exploitation of Anadarko's Blacktip-Monroe asset area (55k gross acres). Identified & recommended strategic business options such as acquisitions, divestitures, trades & facility buildouts. Coordinated the efforts of multiple disciplines including geology, reservoir, drilling, completions, production, and regulatory teams to focus on critical tasks.

G&G Manager Delaware Basin (Midland, TX) **September 2016-June 2019**

- Managed a multi-disciplinary geology & geophysics staff focused on generating a series of regional geologic interpretations for the key development horizons of the Delaware Basin. Integrated the results into a multivariate analysis process to isolate key productivity drivers for each formation.
- Designed & managed appraisal studies to better describe the resource potential & development recipes for key geologic areas across the basin including the Department of Energy sponsored HFTS #2 study.
- Implemented comprehensive test programs to optimize well spacing and completion designs. Tests included production, open-hole & lateral logs, micro-seismic, fiber optic and bottom-hole pressure surveys, fluid & time-lapse geochemistry sampling.
- Sponsored the acquisition and negotiated contracts for 1,800 sq. miles of new 3D seismic data (900 sq. miles of multicomponent data) to better understand geomechanical properties and their influence on productivity.

G&G Manager - Base Assets (The Woodlands, TX) **January 2016 – September 2016**

- Managed a team of geoscientists responsible for the development of Anadarko's Eaglebine, Marcellus, East Chalk, Ozona, and Hugoton assets. Assisted with divestment of assets by providing geologic assessments of future development and potential upside targets to prospective buyers.

G&G Supervisor - Appalachian Basin (The Woodlands, TX) **September 2013 – December 2015**

- Responsible for the geoscience staff in the Appalachian Basin which delivered more than 100,000 BOEPD production.
- Identified additional deep and shallow exploitation plays within the basin.
- Assisted in the prediction of "sweet spots" through multivariate regression analyses of geologic and completions data. This model workflow was integrated into other assets.
- Mentored young staff to facilitate their understanding of operations and development as well as advancing mapping and interpretation skill sets.

Senior Geologist - Maverick Basin (The Woodlands, TX) **May 2011 – September 2013**

- Assisted the team with development of the Eagleford shale horizontal program to deliver 200,000 BOEPD of production to the company.
- Responsible for the geosteering of two rigs, designing field development plans for ~100,000 acres, and regional mapping for the Eagleford shale petrophysical and core properties.
- Presented well proposals for management approval and partner meetings.

- Mentored new geologists on development and operational roles and responsibilities and led several core workshops.
- Led an exploitation team to test two separate targets both of which were geologic successes.

Geologist I & II - US Onshore (The Woodlands, TX) July 2007 – May 2011

- Appalachian Basin – Lead development geologist for the start-up of the Marcellus shale horizontal drilling program. Responsibilities included designing development plans, geosteering wells for four rigs, presenting wells to management for funding, and regional mapping of core and petrophysical properties.
- East Texas/Carthage - Recommended & managed an active development drilling program as lead geologist for the Cotton Valley sand & Haynesville shale horizontal program in Oak Hill and Henderson Fields.
- Performed detailed geologic mapping studies of the Hugoton field, Kansas and Golfino field offshore Brazil.

Education

University of Alabama- M.S. & B.S. Geology July 2007

M.S. Thesis: Seismic Interpretation And Structural Restoration Of A Seismic Profile Through The Southern Appalachian Thrust Belt Under Gulf Coastal Plain Sediments

Undergraduate Research: Analysis of Acid Mine Drainage on The Water Quality of Lake Harris Via Geochemical Analysis

Skills

- Exceptional leadership and management ability to implement business strategy
- Excellent interpersonal and communication skills at all levels
- Strong organizational and time management skills leading geoscience & asset teams
- Experienced in managing large data acquisition & appraisal programs for value optimization
- High level community involvement in charity/fundraising (Midland Junior Achievement Board)
- Software expertise in Microsoft Office, Petra, Kingdom Suite, and Rockpilot steering software

STATE OF NEW MEXICO
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES
OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO — **CASE NO. 24123 ORDER No. R-22869-A**

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS LEA COUNTY, NEW MEXICO — **CASE NOS. 23614-23617**

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO. — **CASE NO. 23775**

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO — **CASE NOS. 24018-24020, 24025**

SELF-AFFIRMED STATEMENT OF STANLEY SCOTT BIRKHEAD -REBUTTAL

1. My name is Stanley Scott Birkhead. I am working with Ops Geologic, LLC as a Consulting Petrophysicist. I have been working as a professional petrophysicist since 2006. I am also the sole proprietor of Petrobrane Petrophysical Consulting, LLC founded in October of 2022 in the state of Colorado.

2. This is my first time to testify before the New Mexico Oil Conservation Division or Commission. Highlighting my degrees, experience, geographic areas worked, and responsibilities, please find my curriculum vitae attached as Empire Exhibit L-53.

3. I graduated from Texas A&M University in 2001 with a Bachelor of Arts in Geology, and in 2005 with a Master of Science in Geology. My academic course work and thesis focused on sedimentology with field work conducted on tidally influenced sandstones within the Upper Sego Sandstone Member of the Mesaverde Group. I am a member of the Society of Petrophysicists and Well Log Analysts, and volunteer with the Unconventional Resources Technology Conference (URTEC) as a reviewer and moderator in special topics and petrophysical themes.

EXHIBIT L

4. In 2005 I started my career at Kerr McGee Oil and Gas as a geologist in Gulf of Mexico Development. As part of their training program, I was chosen to do a rotation in the Petrophysics group for a fixed time. Due to an interest, a recognized aptitude in Petrophysics, as well as a merger between Anadarko Petroleum Corporation and Kerr McGee, I chose to follow the petrophysical career path. After the acquisition of Anadarko by Occidental Petroleum, I chose to leave Occidental. My next assignment was with DeGolyer and MacNaughton as a Senior Petrophysicist where I gained experience working petrophysics from the consultant's perspective with several international projects. In 2022 I founded Petrobrane Petrophysical Consulting, LLC where I have worked for several small to mid-size clients. The client base has expanded from typical oil and gas work to alternative energy development such as geothermal and energy storage and carbon sequestration.

5. I have been fortunate enough to have widespread exposure to different plays and play types across the world. Geographic locations of wells interpreted include all continents save for Antarctica.

6. My experience includes working different play types including conventional, carbonates, granite wash, and tight sandstones, as well as unconventional objectives such as shale oil and gas. The objectives of the work included rank exploration, multiwell field studies, model building, wireline and core analysis planning, core-log integration, rock typing, log quality control, wireline witnessing and management, operational well interpretation, partner and vendor communication, uncertainty analysis, reserves and dataroom assessment and presentation.

7. I have also been fortunate enough to teach internal corporate classes at Anadarko Petroleum Corporation, assisted in directing the past Unconventional Resources Special Interest Group over several years as well as volunteering with a small group (Petrophysical Interest Group) to teach occasional one day courses at smaller universities to expose students to petrophysical methods.

Ops Geologic Rebuttal's to James A. Davidson's Self Affirmed Statement

8. The following discussion was derived as a response to assertions made by the Consulting Petrophysicist for Goodnight, Dr. James A. Davidson. The main takeaway from the discussion that follows can be summarized as such: There are significant indications shown in the following document that validate the likelihood of an ROZ in the San Andres of Eunice Monument

South. While the absolute oil saturation of the Upper and Lower San Andres are currently unknown, petrophysical interpretation of the wells reveals oil saturations that fall within the range of an ROZ. Overly pessimistic interpretations by Goodnight ignore existing positive evidence. This is reflected especially in wells where Goodnight has picked the San Andres deeper than stratigraphically possible. Above their pick, and within the Ops Geologic interpreted San Andres top, Goodnight interprets oil saturations similar to Ops Geologic. The EMSU 628 and EMSU 673 are two examples of this sharp transition in interpretations. The Ops Geologic interpretation of these wells was done with the goal of exploring realistic volumes based on all the data included. The remainder of this report will first list the Goodnight statement(s) being rebutted in red text, followed by the Empire/Ops Geologic response in black text.

9. **Dr. Davidson's statement at page 3:** "The remaining oil saturations in both the San Andres and Grayburg are significantly lower than estimated by Empire."

10. Oil saturation of the ROZ should be viewed as a spectrum, not an absolute value. The zones with core establish the lowest the oil saturation in the San Andres could be. As explained herein, the sum of the evidence points to higher oil saturations than Goodnight posits. The available mudlogs establish shows, fluorescence and even cases of oil seen in the pits (Exhibit L-1, L-2) (EMSU 660) which matches described properties published in ROZ recognition checklists. The wireline data established very high resistivities parallel with porosity development denoting hydrocarbon, along with comparative zones of porosity with low resistivity denoting water. Core residual oil saturations are lower than the in-situ value due to degassing and flushing by water-based mud (Egbogah et al, 1997; Wisenbaker, 1973, Tu et al, 2017). Egbogah wrote, "Most authors conclude that the oil saturation in the reservoir is at least as great as, and probably appreciably greater than, the saturation measured on the core samples. Therefore, core analyses should, if possible, be supplemented by laboratory waterflood and water-oil relative permeability studies and by specific log studies." It would only increase oil saturations to use the additional studies. Published corrections for core residual to in situ oil saturation are utilized here to establish the Ops Geologic spectrum of oil saturations.

11. **Dr. Davidson's statement at page 3:** "A residual oil zone analogous to those where CO2 enhanced oil recovery operations have been employed exists only in the Grayburg Formation in the Eunice Monument South Unit."

12. Empire/Ops Geologic response: The recognition of a residual oil zone within a specific formation is dependent upon the data available, how it is interpreted, and how the top and base of the formation is picked. Dr. Davidson relied on formation tops for the San Andres, as picked for Goodnight by Preston McGuire. As explained by Ryan Bailey in his testimony (Exhibit K), Mr. McGuire's tops were inconsistently correlated across the study wells. Exhibit L-3 highlights the inconsistency in the Goodnight tops picked by Preston McGuire. This cross section shows a surface created from their San Andres pick. This surface shows their top of San Andres crossing the Lovington Sand in a geologically impossible manner. This sand is defined as being within the San Andres as discussed and referenced by Mr. Bailey in Exhibit K. There are several examples of the top appearing to drive the saturation and not the rest of the data. An example is in the EMSU 628 (Exhibit L-4) where the Sw from Goodnight is a relative match to Ops Geologic's Swlo curve, that is, Ops Geologic's low case of the spectrum. Goodnight appears to use their tops to artificially reduce the oil saturation in the San Andres. It appears as if Goodnight determined the saturation of the San Andres with an assumption of facies change and did not utilize the other data. In other wells, we continue to see a suspicious interpretation change happen just above Goodnight's top of San Andres. Interpretation of the ROZ as shown by Dr. Davidson, shows a change in interpretation methods driven by their deeper pick of the Grayburg base and a presumption of much poorer reservoir quality (rock types) over most of the San Andres (Exhibits L-5 –L-8). This assumption of poorer quality results in a pessimistic outcome that is inconsistent with the common definition of an ROZ and the significant evidence shown by data from these wells.

13. Table 1 highlights the impact of this tops difference. In the table the OOIP is shown as calculated by Goodnight in one column for certain provided wells. In the next column over is an OOIP calculated using their data but with the more consistent tops provided by Ops Geologic. In many cases, we see large increases in OOIP just by using the new top set with their curves. This shows two things, first, that the Goodnight interpretation of oil saturation changes based on where the tops are picked, and second, Goodnight's assertion that a barrier exists between the Grayburg and San Andres falls apart. It is important to add that regardless of the tops used, there is still an ROZ in the Upper and Lower San Andres.

Upper San Andres	Ops Geologic	Ops Geologic	Goodnight	Goodnight
	OOIP Low case	OOIP High Case	Tops and base for San Andres calculations unknown for Davidson. Ops Geologic interpreted tops used for Ops geologic OOIP calculations. Goodnight calculations show the extreme pessimistic case.	Tops and Base of San Andres and Lower San Andres based on consistently picked Ops Geologic picks. Results show increase in mmboe from Goodnight when using Ops Geologic Tops. Bo used is 1.3. Goodnights original Bo unknown. Cutoffs SW<80%
	mmboe/section	MMBOE/section		
SNYDER Ryno SWD #1	4.05	7.94		
EMSU 746	16.12	25.59		
EMSU 713	4.05	6.45		
EMSU 673	12.76	19.94		
EMSU 660	10.31	19.25		
EMSU 658	25.36	37.77		
EMSU 628	20.55	31.47		
Lower San Andres				
SNYDER Ryno SWD #1	15.81	25.09		
EMSU 746	25.55	43.88		
EMSU 660	3.67	9.17		
EMSU 628	8.10	15.81		
EMSU 658	0.90	1.11		
All San Andres			**Goodnight their tops	Goodnight/OG tops
SNYDER Ryno SWD #1	19.86	33.03	6.9	6.9
EMSU 746	41.67	69.47	13.3	14.78
EMSU 713	4.05	6.45	0	0.11
EMSU #673	12.76	13.76	3.1	8.94
EMSU 660	13.98	28.42	2.7	5.84
EMSU 628	28.65	47.28	6.8	8.4
EMSU 658	26.26	38.88	0	5.31
shading denotes incomplete section/no base seen			**from Davidson's testimony point 83	

Table 1 Comparison of OOIP volumes from Ops Geologic, and Goodnight. Ops Geologic cutoffs for calculation were SWT>= 80%, Phit>=4%. And Vcl<=60%.

14. **Dr. Davidson's statement at page 4:** "The intervals of residual oil in the San Andres aquifer are too thin, too widely spaced, and are not likely areally continuous enough to support efficient enhanced recovery operations."

15. Empire/Ops Geologic response: The presumption that any oil saturations are not areally continuous is purely based upon opinion, interpretive assumptions, convenience, and the contradiction of extensive saltwater injection. This subjective statement by Goodnight is not sufficient to show lack of fluid and pressure communication or areal extent. The concept of, "natures waterflood" is that a large, connected volume of rock had a significant amount of water flow through the section reducing the oil saturations down to residual, or remaining oil saturation levels. We see in the interpretation of the wireline, as well as shows in mudlogs and core for the available wells that the ROZ zone consistently appears in the same intervals with oil saturations greater than 20%. This suggests large amounts of continuity across the interval. In fact, the statements made by Dr. Davidson in his point 77 regarding water injection volumes support the conclusion that significant connected volumes exist within and across the San Andres.

16. Dr. Davidson's statement at page 4: "The likely presence of long intervals of karsts and collapse breccias in the San Andres would further compromise the effectiveness of enhanced oil recovery operations."

17. Empire/Ops Geologic response: Intervals of karsts and collapse breccias are well known through carbonate reservoirs such as the San Andres (Trentham et al, 2015). Reviewing the "possible" karst flags provided in the report by Dr. Davidson Appendix B, the number of flags in the San Andres is relatively minimal and are discontinuous. A paper by Love et al. (1998) referenced by William J. Knight in the Revised Expert Report of: William J. Knight, P.G. January 16, 2025 reviews the existence of high perm pathways or "thief zones" and their impact on waterflood conformance and oil production. Large amounts of water were going in without a consequent increase in oil production. Results of the field test showed that of the six mitigations applied to the waterflooded wells, all of them significantly increased production. This paper was used as evidence by Goodnight to show that karst and collapse breccia fills will not allow for successful CO2 EOR. On the contrary, the paper shows that while these zones clearly exist, issues can be avoided or mitigated. Important points from the paper also include that the study only included the Grayburg formation and this quote describing the Area below zone 5 when the author wrote describing the San Andres, "*Zone 5 is typically water drive (3 to 20% oil cut) and Zone 6 overlies the top of the San Andres and contains an unconformity in its upper part. There are oil shows well down into the San Andres.*" This shows that combinations of karst and collapse breccias are not at all showstoppers for enhanced recovery.

18. Dr. Davidson's statements at pages 4, 28:

- "Given the sparse nature of the residual oil accumulations and the presence of significant karsting, Goodnight's San Andres disposal zone does not meet any reasonable definition of an ROZ."
- "Given the sparse, intermittent oil saturations, the saturation profile in the San Andres aquifer is more likely representative of abandoned oil migration pathways than of a previous oil-saturated interval."
- "The San Andres Formation, both inside the EMSU and in the areas outside the EMSU where Goodnight operates salt-water disposal wells, has an oil saturation profile that

appears to be more representative of paleo oil migration pathways. Thick, continuous intervals of oil saturation exceeding 20 percent are not present in the San Andres within the EMSU." (Davidson J. paragraph 71)

- **"**Based on the results of the core flood experiments carried out by the BEG (discussed above), the residual oil saturations in the San Andres would be expected to be higher (in the 20 to 40 percent range) if those intervals had been saturated to higher levels in the past." (Davidson J paragraph 70)

19. Empire/Ops Geologic response: There are several pieces of evidence pointing towards the existence of multiple continuous ROZs in the Upper and Lower San Andres as discussed in this document. Table 1 shows the results of OOIP calculations based upon the bracketed low and high oil saturation cases. In the table there are dramatic differences between the interpretations. While Goodnight proposed a San Andres nearly devoid of hydrocarbons, Ops Geologic provides a range of residual oil saturations that <u>does</u> meet the reasonable definition of an ROZ. The difference in volumes is exacerbated by the cutoff of eighty percent water saturation. Because Goodnight maintains a saturation above 80% from its facies/Sw assumptions, oil in place is often not calculated. This creates even larger differences. In Table 1, the data is for the section of San Andres logged and the calculated OOIP. The entire section was not always penetrated explaining the lower OOIP number in some wells on both sides. This is especially true in the EMSU 679 and 713 where very little was penetrated. Importantly, there are clearly defined ROZ intervals in the Upper and Lower San Andres (Table 2).

Well	San Andres Estimated Logged Interval (ft)
EMSU 628	674
EMSU 658	397
EMSU 660	464
EMSU 673	400
EMSU 679	220
EMSU 713	140
EMSU 746	1343
Ryno (Snyder SWD 1	1328

Table 2 Estimated number of feet of Upper and Lower San Andres logged in each well.

20. Differences in interpretation are highlighted in wells such as the EMSU 746. In this well, the saturations are similar in the Grayburg and Upper San Andres until a depth of ~4107 ft. Deeper than this point, the saturations diverge. The Ops Geologic solution continues to follow the resistivity and porosity while the Goodnight water saturation immediately increases to largely above 80% with no defined seal or change in resistivity to support the assertion.

21. The same thing holds true for the majority of the comparative wells. With the Goodnight saturation reduced to conveniently less than 80% near their top of San Andres, no pay, and thus no OOIP can be calculated. Dr. Davidson often states during his November deposition that for his interpretation, the tops were inconsequential. From the REMOTE ORAL DEPOSITION OF JAMES A. DAVIDSON, November 22, 2024, page 55 starting on line 6, Davidson asserts that the definition of two broad rock types, shallow water facies, and deepwater facies is based on the gamma ray. There is a critical problem using rock typing to define water saturation in an area where you have little data. (Exhibit L-9) Figure A10 from Davidson's self-affirmed statement illustrates the problem. By choosing the facies first in a field with limited data, the petrophysicist has told the logs what the water saturation will be instead of letting the logs speak for themselves. For example, looking at Exhibit L-9 (Figure A10) of Dr. Davidson, the simple choice of Wackestone or Wackestone/Packestone for facies, results in the water saturation never being lower than about ninety-two percent. Likewise, if you choose Packestone then you are limited to an Sw that maxes out in the sixties. To be clear, the use of facies to define water saturation without local, field-specific calibration is not accepted practice. In fact, it gives you an answer before much if any of the actual work that should be done. The testimony from Dr. Davidson's deposition clearly states that they did not look into uncertainty. For fields with limited data such as this, decisions are controlled by the range of properties.

22. Oil saturation measured from core is naturally biased towards the lowest possible oil saturation that could be seen in the reservoir. In other words, it is the minimum amount of oil possible. The likelihood of the reservoir condition saturations being higher than the core measured values is almost certain. Corrections of core oil saturation can vary. Future core must be taken in the EMSU to ascertain what the correction should be to get to an accurate reservoir saturation. However, the presence of reservoir oil in the core cannot be debated. The whole core photos provided by Bob Lindsay show oil in the reservoir (Exhibits L-10, L-11, and L-12). The photos show continuous staining, as well as oil in fractures that have been dissolution widened by reservoir fluids. These are not the characteristics of a failed migration pathway or of immature toc/kerogen. Regardless of the San Andres, the agreement of oil saturation in the Grayburg clearly suggests successful migration through the San Andres at a minimum, and at other levels reservoir storage pre-(natures) waterflood. Several of the mud logs also show fluorescence, cut, and oil on the pits (Exhibits L-1, L-2). Gas chromatographs also show increased gas over these zones. Looking at the range of oil saturations interpreted by Ops Geologic in Exhibits L-13 shows that the averages of the zones with greater than 20% oil saturation. This is the same cutoff as used by Dr. Davidson with Netherland Sewell and fits with much of the literature. In the low case, the average S_oil hovers around 30%, while in the high case it approaches and sometimes exceeds 40%. Exhibit L-14 certainly illustrates the point that the net pay using those cutoffs is significant and results in a potential large volume of hydrocarbon. Large enough to meet the definition of a residual oil zone in the high case as well as the low cases. Exhibit L-15 is a visualization of the water saturation of the EMSU interpreted wells vs tvdss. This plot highlights the presence of oil saturations not only exceeding 20%, but also having oil saturation in the Lower San Andres and at TVDSS's below the -500 tvdss discussed in Revised Expert Report of: William J. Knight, P.G. January 6th, 2025. Mr. Knight discusses the lack of OIP below -500 and -700 ft tvdss. Exhibit L-15 clearly shows higher volumes than what Knight assumes. Knight's report is dependent on the pessimistic petrophysical interpretation from Goodnight. For the data available, these wells absolutely meet the criteria for several boxes of the ROZ cookbook (Trentham et al, 2019; Melzer, 2016). This data comes from drilling, logging, mudlogging, and core analysis. (Exhibit L-16)

23. Several arguments made by Goodnight are predicated on Dr. Davidson's interpretation of low hydrocarbon volumes and the assumption that the top San Andres is much lower than previously described and currently picked by Ops Geologic and Empire.

24. General statements on Goodnight's water saturation interpretation and the use of other water saturation models below:

Dr. Davidson's statement at page 22: "Preserved organic matter has been identified in several areas of the San Andres Formation in the Northern Shelf region in West Texas. It is possible that it could be found in the Northwest shelf region of New Mexico as well."

25. Empire/Ops Geologic response: The best approach for determining the range of oil saturations integrates the local core, mudlog, and wireline data. Alternatively, Dr. Davidson's approach presumes a rock type based on limited data which results in higher Sw simply due to this choice. Dr. Davidson's analysis is unreliable because it fails to incorporate this available data and information. This faulty evaluation is evident in paragraph 33 in Appendix A, Figure A10, and Figure 8 of his testimony. The plot shows at least one of these rock types (Wackestone) with no possibility of significant oil saturations. This seems convenient, especially when defining a rock type is listed as the first element of his analysis workflow. Presumptions of the rock type as the first step of the process assumes the absolute answer and results in low oil saturations for the San Andres. Unfortunately, this also ignores the many direct hydrocarbon indicators, such as core fluorescence, oil saturation, oil seen in the pits, and increased gas over the interval. A slightly lower gamma ray in a zone is not sufficient evidence. In the North Monument Grayburg San Andres Unit #522 ("NMGSAU #522"), the Gamma ray in the San Andres slightly exceeds the peak Gamma ray in the Grayburg, and both the San Andres and the lower San Andres still show ROZ level oil saturations, some exceeding forty percent. In contrast, Empire/Ops Geologic's water saturation strategy integrates the local core, mudlog, and wireline data as the strongest way to understand the range of potential oil saturations, which is necessary to view the whole picture.

26. Dr. Davidson's suggestion that the appearance of hydrocarbons could be explained away as organic matter in the San Andres of the Northwest Shelf of West Texas is a bit grasping. I would be hard pressed to think of any ubiquitous formation that would not have organic matter somewhere. It being somewhere does not prove it is everywhere. Exhibit L-17 displays an RI versus water saturation crossplot. This crossplot shows different trends (possibly related to rock types) largely because we had the benefit of a whole core across the entire San Andres in this North Monument well. With just wireline, we would not be able to see this relationship. In the EMSU, there is not enough core coverage over the San Andres to absolutely define a rock type and its saturation and especially not enough to discount an entire formation as Dr. Davidson suggests. The NMGSAU #522 does show residual (ROZ level) hydrocarbons in all the different slopes presented in the plot. This means that whatever rock type exists, there can still be an oil saturation greater than twenty percent.

27. In the figures (Exhibits L-18, L-19) there is a comparison of the high and low case effective water saturation (as taken as a portion of the SWT from Archie) with the output Swe from Goodnight. The results show a large variation in the degree of agreement between the interpreters across the wells. These crossplots suggest that the Upper and Lower San Andres were treated differently by Dr. Davidson, implemented through assumptions of rock quality. Dr. Davidson appears to have used bad tops he was simply given. This leads to a fatal flaw in his interpretation and his derivative assumptions when those tops are shown as not correct.

28. From the work Empire/Ops Geologic has done, there is significant evidence showing their flaws. When we investigate the direct comparison between Ops Geologic and Goodnight, we see many similarities where the Sw converges between the interpreters in the Grayburg zones as well as within the zone labeled by Empire as top of San Andres and the Goodnight top of San Andres (Exhibit L-7). Upon exiting the Goodnight top of San Andres into what Empire labels as the Lovington Sand, the good visual comparison does not continue. The Goodnight interpretation estimates higher water saturations of greater than eighty percent while the Empire interpretation continues to correlate to the mudlogs, shows, and cutting descriptions (Exhibit L-20) by showing higher hydrocarbon saturations.

29. We know that we have a least-possible oil saturation from the core that must be observed and then corrected to in situ values as well as larger core oil saturations seen in a nearby field well NMGSAU #522 where we see core saturations greater than 40% in the San Andres. That, along with the resistivity and porosity profiles that show water saturations from 100% water bearing to residual percentages of oil seen in the wells, the high and low case oil saturations presented by Ops Geologic are more reasonable than the Goodnight interpretations.

30. I could not find a specific mention of the Rw used in Dr. Davidson's testimony except for mention of Seminole Field and experimenting with the Simandoux equation to illustrate a point. Otherwise, the only mention I see in his testimony is with the use of a Pickett plot (Dr. Davidson's testimony, Paragraph 35 page 15). I presume he has established a range of values. This method is standard practice. My values for Rw were established using a calculated Rw apparent and from Pickett plot analysis from where the reservoir appears to be 100% water saturated. The salinities in the San Andres commonly varied from 18.8 kppm NaCl equivalent to around 28 kppm. In the RR Bell well, a much higher salinity had to be used due to the resistivity tool that was run. There were a few outliers that required a higher salinity of around 37 kppm and one zone of the Grayburg and top of San Andres in the EMSU 746 that went up to 46 kppm. For all of Dr. Davidson's calculations, a formation water resistivity must be determined. A key part of this study is that there are multiple parameters changing with every foot of the well. A range of possibilities regarding oil saturation is the only feasible way of assessing the potential. In the Empire/Ops Geologic EMSU field study, the low case and high case both evidence sufficient oil saturation and continuity to define an ROZ.

31. **Dr. Davidson's statements at page 29: "**Thick, impermeable anhydrites and anhydritic dolostones found near the top of the San Andres aquifer likely isolate the water disposal intervals in the Goodnight-operated wells from the overlying Grayburg residual oil zones."

32. Empire/Ops Geologic response: In this study, it is rare to find the San Andres capped by an anhydrite or anhydritic dolostone with no porosity that would significantly baffle the flow between the San Andres and the Grayburg. Actually, the predicted commonality of karsted and karsted/collapse breccias as mentioned by Dr. Davidson would have the opposite effect of a seal and would enhance communication in many cases. Points 76 and 77 from his testimony ran the gamut from describing karst events as creating enhanced communication to making great seals. Goodnight statement: "Loss circulation problems consistently experienced during drilling operations through the San Andres aquifer and the fact that high volumes of water can be injected on a vacuum in the Goodnight disposal wells, indicate that large karsted intervals are likely present." (point 77 of: SELF-AFFIRMED STATEMENT OF JAMES A. DAVIDSON). Looking at the EMSU 746 as an example in Exhibit L-7 shows a baffle flag created by Ops Geologic to show where effective porosity drops below 1.5%. The rarity of this flag on the plot suggests more continuity of pathways than extensive baffling. Honarpour et al (2010) writes regarding the presence of Anhydrites, "*The vertical permeability, measured on full-diameter cores was mostly between 0.1 and 100% of horizontal permeability, occasionally showing much lower vertical to horizontal permeability, attributed to local* discontinuous *baffles. Discontinuous stylolites and anhydrites at bedding-scale create a more tortuous path for fluid flow in vertical direction. The impact of these stylolite and anhydrite baffles can be seen in vertical permeability measured on full-diameter cores. One to two orders of magnitude reduction in vertical permeability are measured when stylolite and anhydride layers appear*." Honarpour goes on to state that whole core diameter analysis often shows much higher permeabilities than at the plug scale (Exhibit L-21). These vertical to horizontal permeability ratios are not only seen in Seminole field, but also in the nearby well of NMGSAU #522 (Exhibit L-22). This plot made from data transcribed from a pdf of an old copy of the core data highlights the same type of ratios. These ratios from a nearby well, along with the comments from Honarpour quoted above suggests very limited baffling and even more limited pressure separation. The Computer Processed Interpretation (cpi's) listed as Exhibits L-25 to L-52 in Appendix A interpreted by Ops Geologic shows the continuity of porosity from most wells between the San Andres and the Grayburg. I would be remiss to not mention the differences in the top of San Andres as picked by Ops Geologic and by Goodnight. The top of the San Andres was defined by Bob Lindsay from two cored wells in the EMSU, the RR Bell 4, and the EMSU 679 shown as Exhibits B-23 and B-24. The stratigraphic detail of the top San Andres is discussed at length by Mr. Ryan Bailey in his Self-Affirmed Statement of Ryan M. Bailey-Rebuttal. The Goodnight-defined top of San Andres is typically significantly lower than what has been geologically defined in literature, core, and outcrop discussed in Mr. Bailey's rebuttal. A key point being the definitive placement of the Lovington Sand well within the Upper San Andres.

33. **Dr. Davidson's statements at page 10: "**Well log measurements were available for two of the three wells, R. R. Bell and EMSU 679. There is uncertainty concerning the coring interval for the core from R. R. Bell and due to the vintage of the resistivity measurements for this well, it is unlikely that the logs have a vertical resolution that would be sufficient for quantitative core analysis. The analysis for petrophysical model calibration relied primarily on the core data from EMSU 679."

34. Empire/Ops Geologic response: The significant valuable data that the core does provide should not be ignored. Goodnight ignores the fact that the top of the San Andres is evident in the R.R. Bell core data and limits its use of data to the EMSU 679.

35. Dr. Davidson suggests that the RR Bell core should not be used for modeling. In this case, we disagree, the core was still extremely productive as a source of information for porosity and oil saturation. The resistivity acquired is absolutely a nuisance, which makes the core data even more valuable as a measure of the minimum possible oil saturation.

I affirm under penalty of perjury under the laws of the State of New Mexico that this statement is true and correct.

Stanley Scott Birkhead
Principal Petrophysicist
Petrobrane Petrophysical Consulting, LLC

2/10/2025
DATE

Data

1. All well data was transmitted to Ops Geologic by Empire Petroleum Corporation. Data was provided for over twenty-nine wells. Core data was provided for three wells with limited contextual information for lab protocols. A large number of the wells had sufficient data for a reasonable interpretation (Table 3). The Meyer B4 #22 well did not include a density or neutron curve that would allow for the exploration of a variable grain density. Fewer wells would be used in the mapping due to incomplete coverage in either the Upper or Lower San Andres. CPI's for wells are available as Exhibits L-25-through L-52 in Appendix A.

	Well	Core	GR	SP	Resistivity	Density	Pe	Neutron	Sonic	Mudlogs
1	EMSU 458	✓	✓		LLD	✓	✓	✓		
2	EMSU 459		✓		RLLD	✓		✓		
3	EMSU 679	✓	✓		LLD	✓	✓	✓		
4	Meyer B4 22		✓		LL3				✓	
5	Snyder SWD 1		✓		LLD	✓	✓	✓	✓	
6	EMSU 746		✓		LLD	✓	✓	✓		
7	EMSU 713		✓		LLD	✓	✓	✓		✓
8	EMSU 673		✓		LLD	✓	✓	✓		✓
9	EMSU 660		✓		LLD	✓	✓	✓		✓
10	EMSU 658		✓		LLD	✓	✓	✓		✓
11	EMSU 628		✓		LLD	✓	✓	✓		✓
12	RR Bell NCT E 4	✓	✓		ILD	✓	✓	✓	✓	
13	EMSU 211		✓		LLD	✓	✓	✓		
14	EMSU 457		✓		LLD	✓	✓	✓	✓	
15	EMSU 461		✓		LLD	✓	✓	✓		
16	EMSU 462		✓		LLD	✓	✓	✓		
17	EMSU 329		✓		LLD	✓	✓	✓		

18	Central Drinkard 441		✓	✓	RLA	✓	✓	✓	✓	
19	JA Akens 10		✓		LLD	✓		✓	✓	
20	SEMO 123		✓		LLD	✓	✓	✓	✓	
21	Meyers B4-33		✓		RLA	✓	✓	✓		
22	Meyers B4-34		✓		HLLD	✓	✓	✓	✓	
23	Yaz 28 SWD 1		✓		RLA	✓	✓	✓		
24	Nolan Ryan SWD 1		✓	✓	RLA	✓	✓	✓	✓	
25	OC Fed Com 1		✓		LLD	✓	✓	✓	✓	
26	Ted SWD 1		✓		LLD	✓	✓	✓	✓	
27	Wallace State 7		✓		✓	✓		✓	✓	
28	New Mexico State 4		✓	✓	AHF	✓	✓	✓		
29	NM GSA unit 5 #22	✓	✓		LLD	✓	✓	✓	✓	

Table 32 Data Inventory for wells provided for field study.

2. Core data was available for the EMSU 458, EMSU 679, and the RR Bell NCT E 4 (full diameter samples). The data was limited to porosity, horizontal, vertical perms, and fluid saturations for the three wells. In addition to this, the RR Bell NCT E 4 also included lithologic descriptions and grain density. From the whole core, several one-foot full diameter sections were measured. From Honarpour et al, (2010) we understand that properties of full diameter cores from Seminole field exceeded the properties of smaller plugs (Exhibit L-21). Differences in the two porosity measurements are to be expected and are representative of heterogeneities in properties

due to differences in rock fabric and the porosity types seen in carbonates. This extends to permeability as well. Comparisons of KH and KV for the foot plugs suggests excellent connectivity that may not be seen in smaller plugs (Exhibit L-22). The full diameter samples had two porosity measurements for each sample. The measurements were taken using a low temperature cleaning process and then following with a higher temperature pass. The difference in porosity between the two measurements may suggest either insufficient cleaning or the possibility of some damage due to potential gypsums being dehydrated and inflating the porosity (Exhibits L-23, L-24).

Appendix A
Well Logs

EMSU 679	Exhibit L-25
EMSU 746	Exhibit L-26
RR Bell NCT E-4	Exhibit L-27
Snyder SWD 1 Ryno	Exhibit L-28
EMSU 211	Exhibit L-29
EMSU 461	Exhibit L-30
EMSU 628	Exhibit L-31
EMSU 660	Exhibit L-32
EMSU 673	Exhibit L-33
EMSU 329	Exhibit L-34
EMSU 457	Exhibit L-35
EMSU 458	Exhibit L-36
EMSU 459	Exhibit L-37
EMSU 462	Exhibit L-38
EMSU 658	Exhibit L-39
Eunice Monument 713	Exhibit L-40
JA Aken 10	Exhibit L-41
Meyr B4 33	Exhibit L-42
Meyer B4 34	Exhibit L-43
New Mexico state NCT 4	Exhibit L-44
OC Fed Com 1	Exhibit L-45
Nolan Ryan SWD 1	Exhibit L-46
SEMO No 123	Exhibit L-47
NMGSA unit 5 22	Exhibit L-48
Ted SWD 1	Exhibit L-49
Yaz 28 SWD 1	Exhibit L-50
Central Drinkard 441	Exhibit L-51
Wallace State 7	Exhibit L-52

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Exhibit L-1

Signs of ROZ from mudlogs

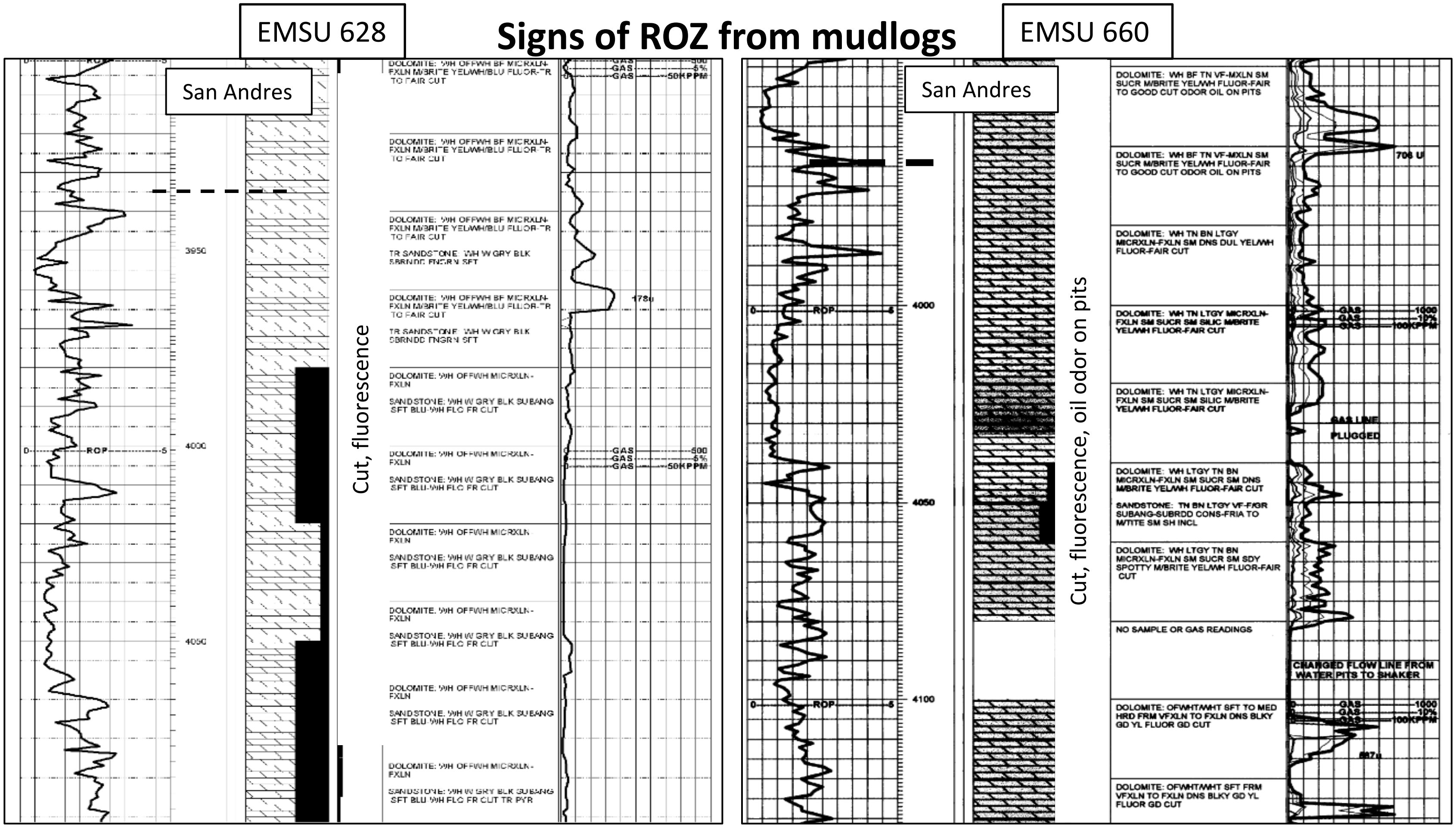

Exhibit L-1: Gas increases and with consistent reporting of fluorescence and cut as well as oil on pits.

Geologic

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Exhibit L-2

Existence of ROZ

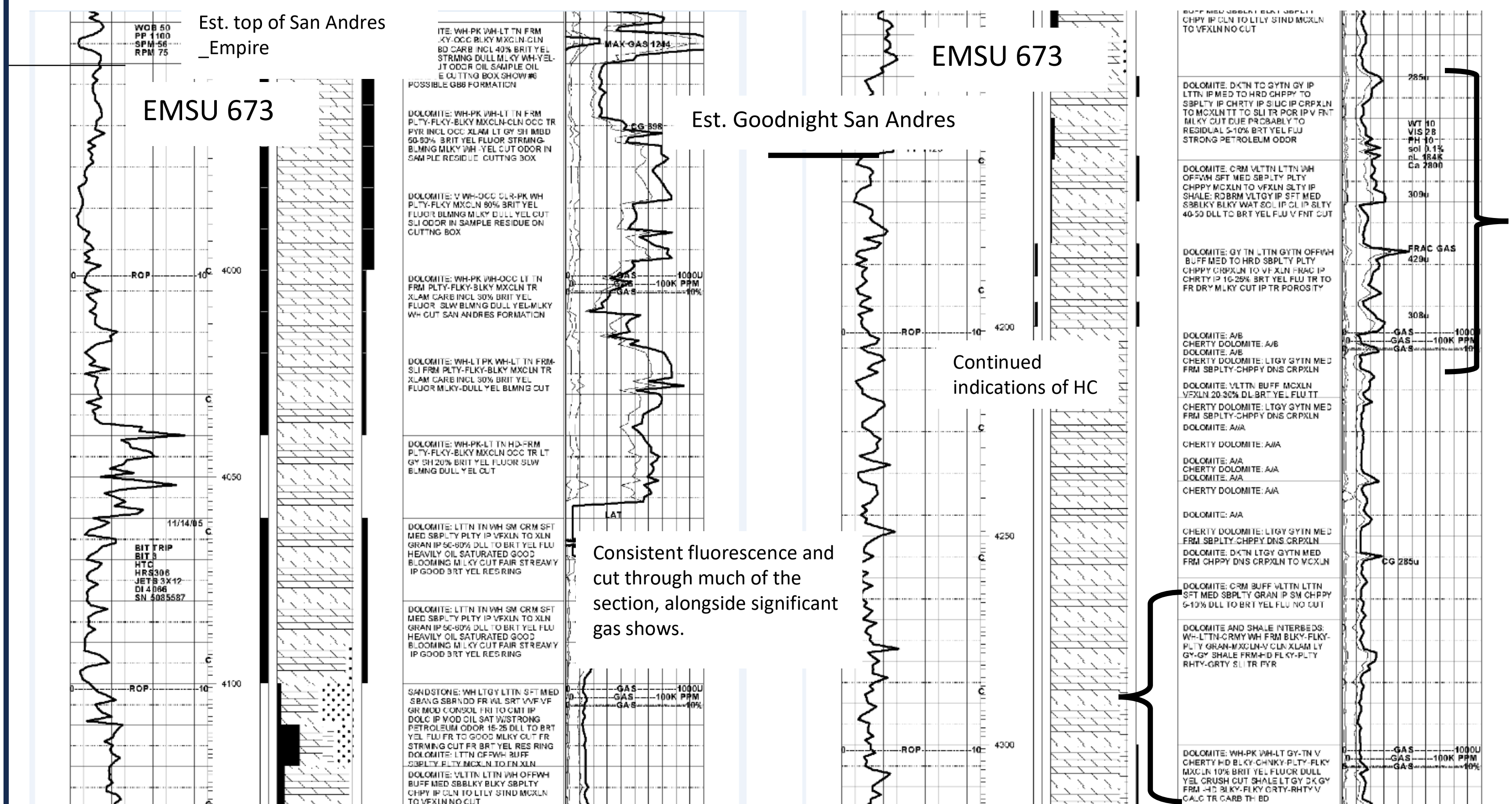


Exhibit L-2: Top of San Andres from Empire and Goodnight interpreters. Reporting of cut fluorescence suggests ROZ or better below each top pick.

Exhibit L-3

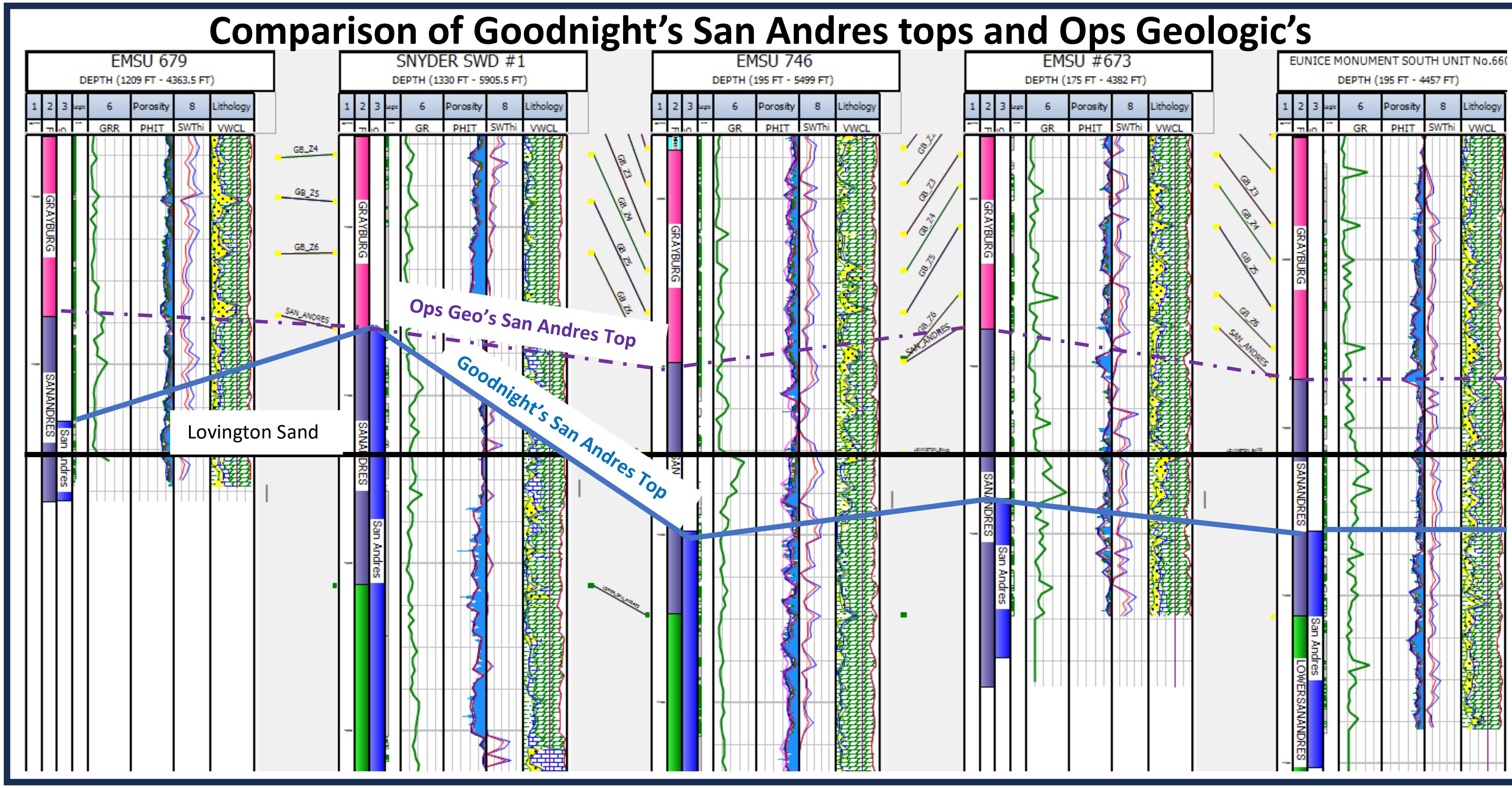


Exhibit L-3: Selection of EMSU wells where Goodnight tops were available. Results show the inconsistency of the pick sometimes above and below the Lovington Sand. Goodnight tops estimated from the Self affirmed statement of James A Davidson Appendix B.

Ops Geologic

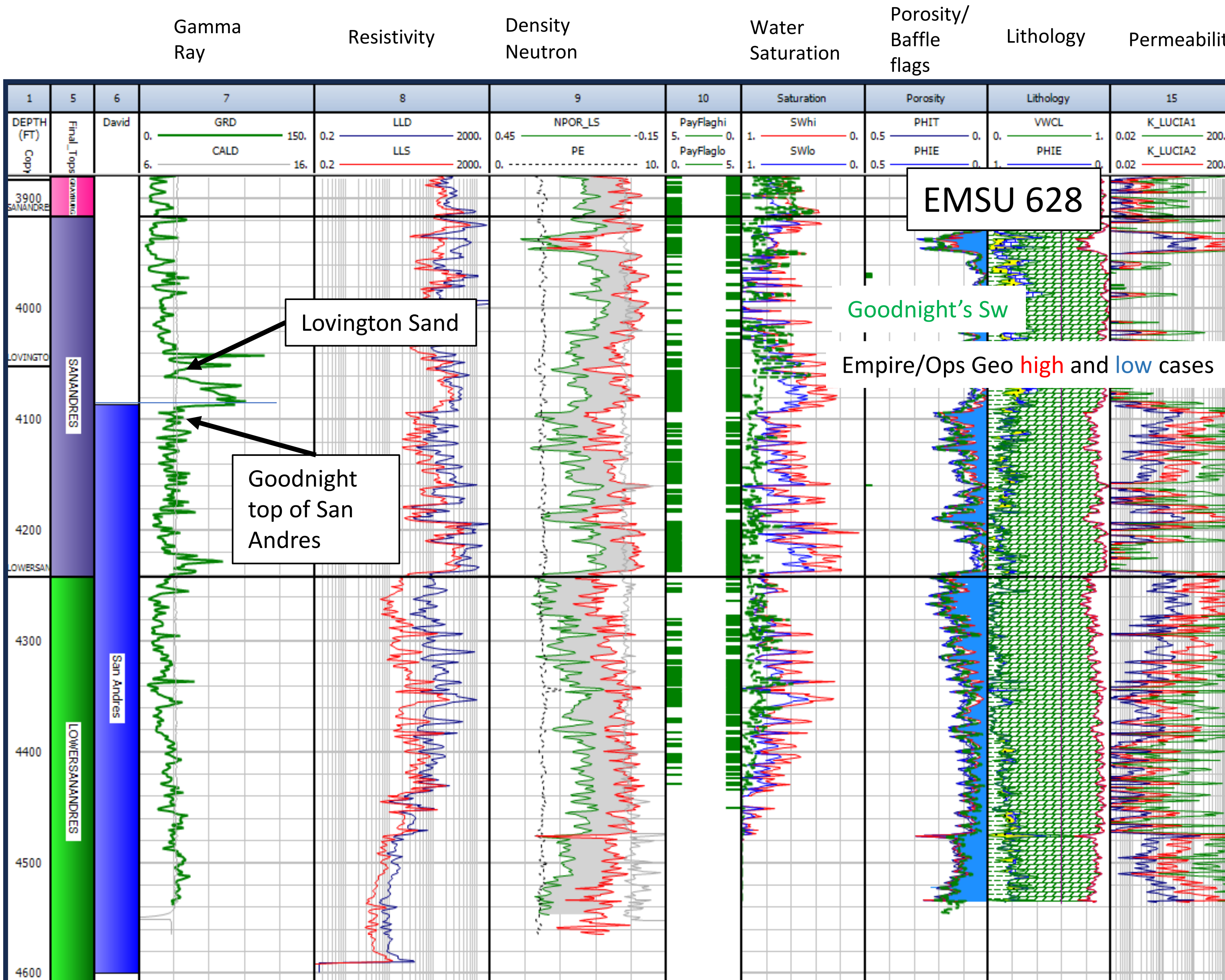


Exhibit L-4: Example of interpretive comparison between Empire and Goodnight showing the relative agreement between the Empire low case and Goodnight interpretation until reaching their top of San Andres. Lovington Sand is within the San Andres.

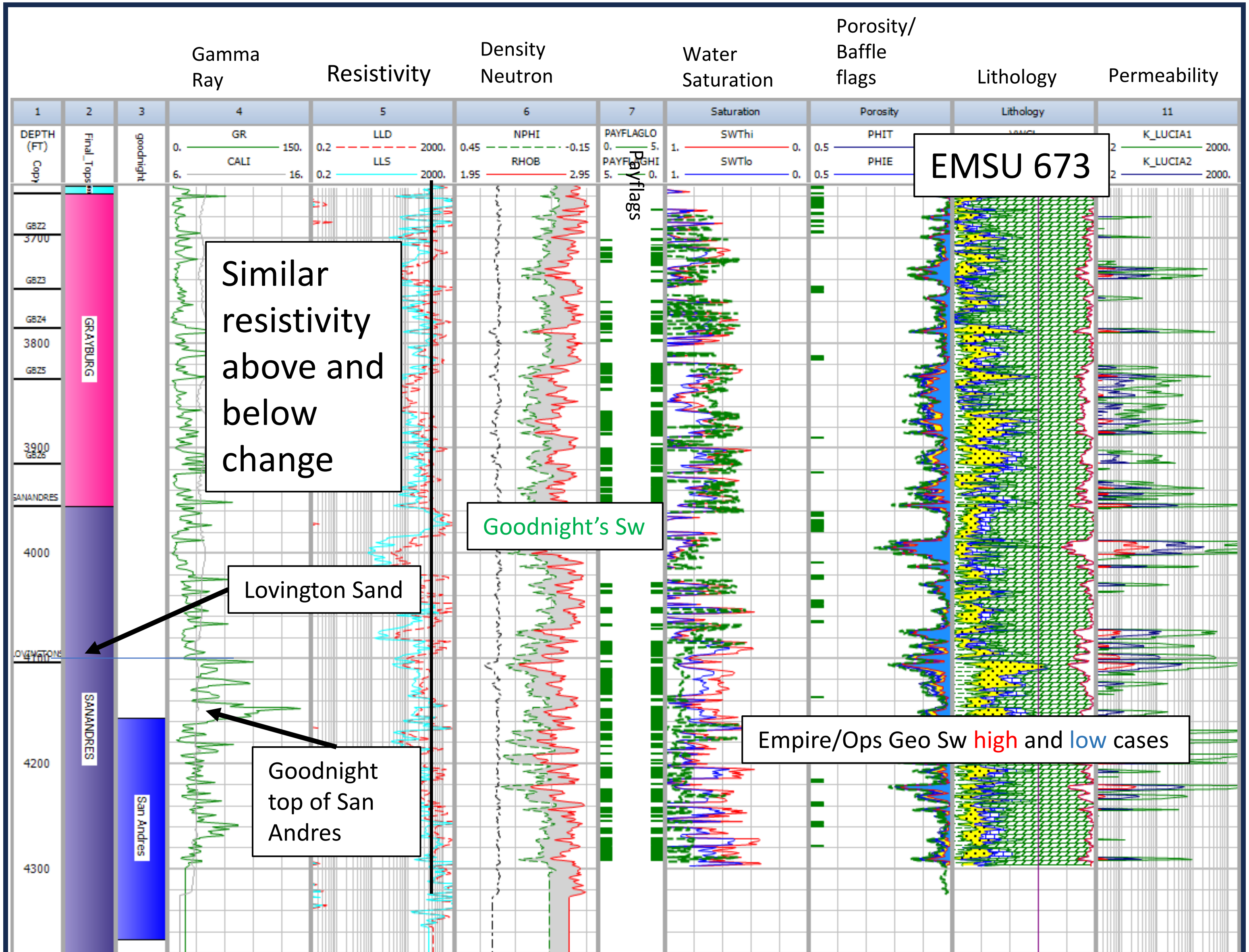


Exhibit L-5: Example of interpretive comparison between Empire and Goodnight showing the relative agreement between the Empire low case and Goodnight interpretation until reaching their top of San Andres. Lovington Sand is within the San Andres.

EMSU 679

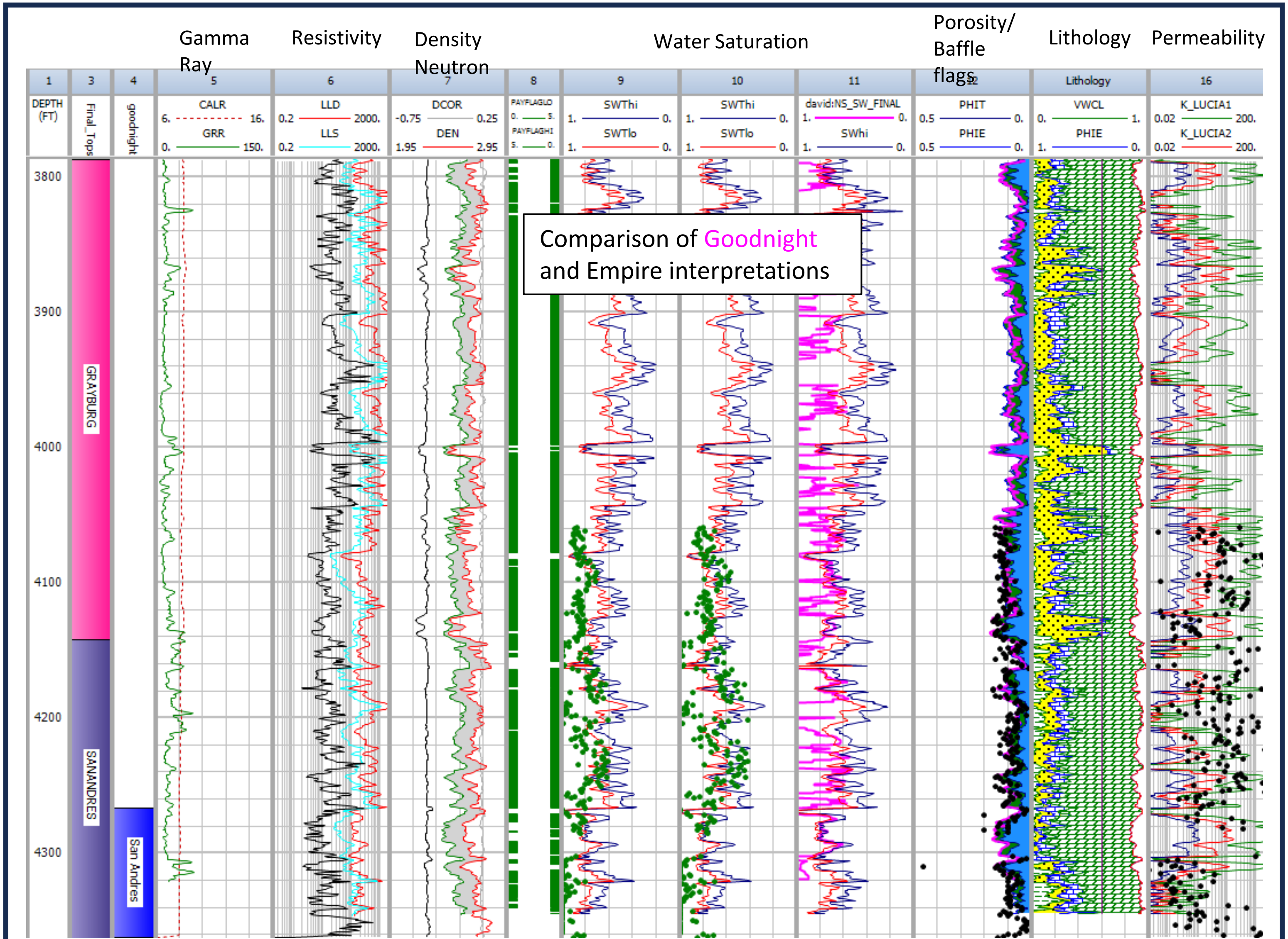


Exhibit L-6: Example of interpretive comparison between Empire and Goodnight showing the relative agreement between the Empire lo case and Goodnight interpretation until reaching their top of San Andres

EMSU 746

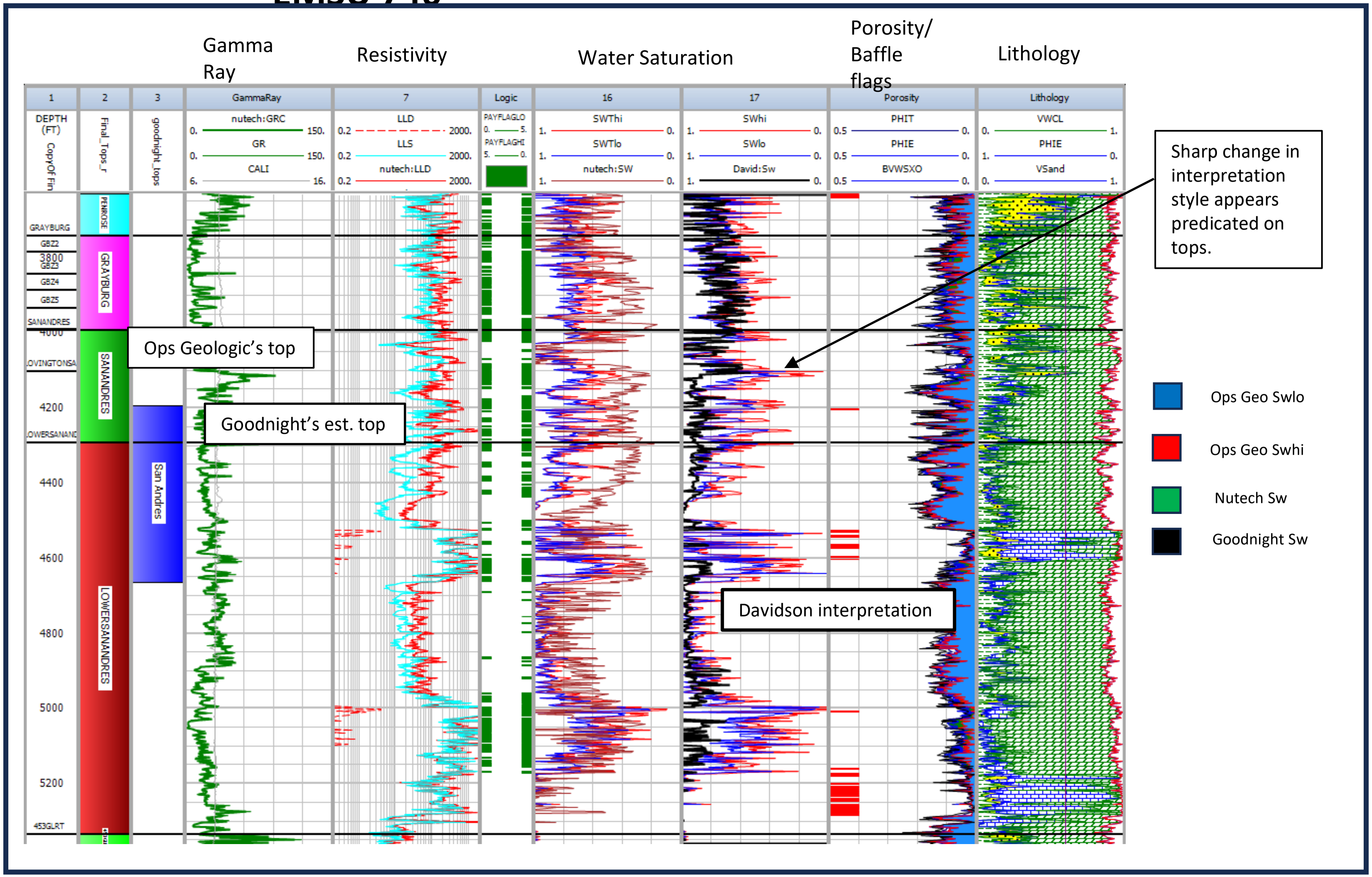


Exhibit L-7: Comparison of interpretations between Ops Geologic's and Goodnight's. Please note the range of outcomes for water saturation developed by Ops Geologic. The presumed change in facies near the top of the San Andres means that the contrast between Ops Geologic and NSAI results in a relative match in the Grayburg and a divergence for the San Andres.

Exhibit L-8

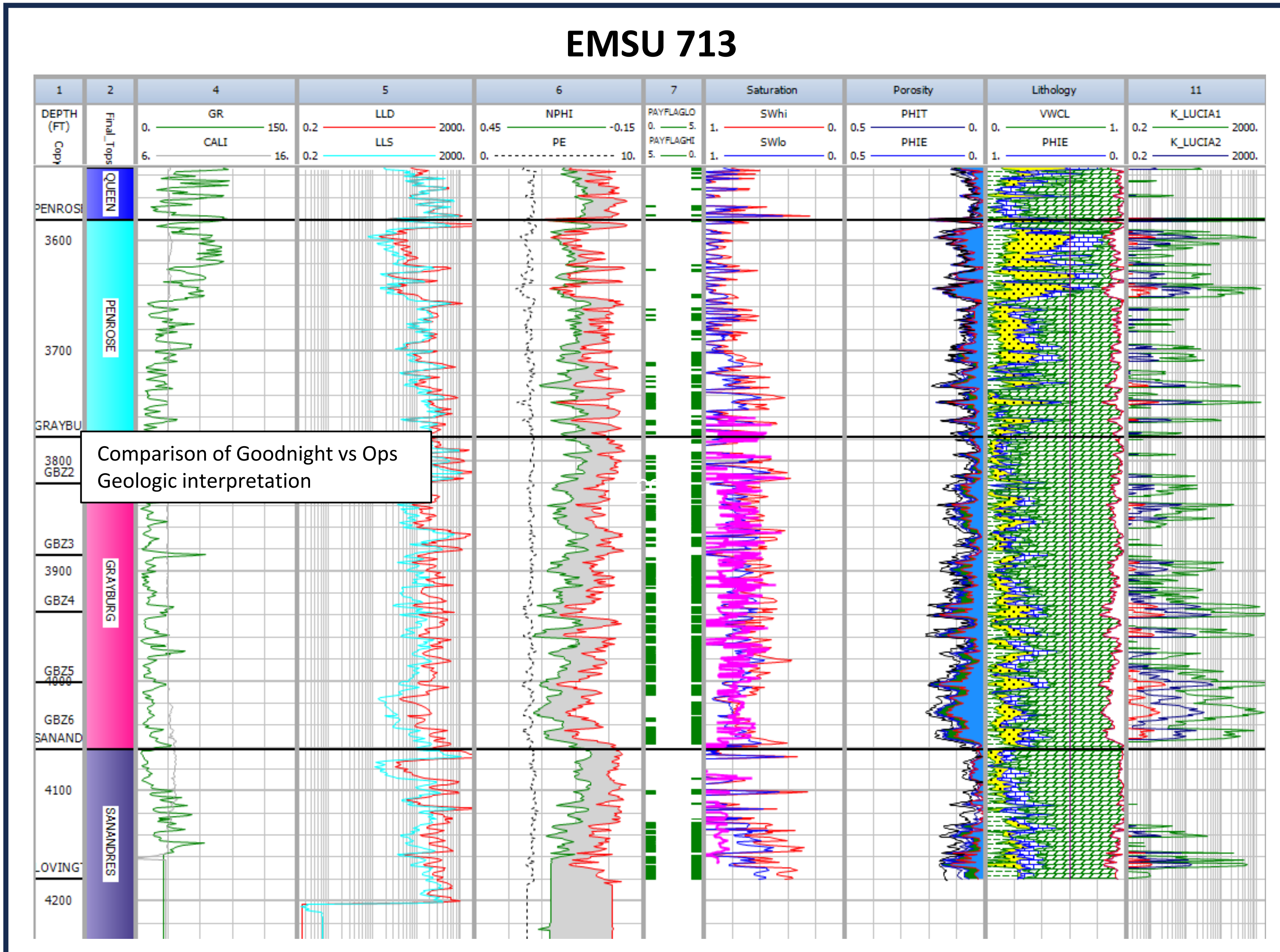


Exhibit L-8: Another comparison of Ops Geologic's and Goodnight's interpretations, highlighting the branch in interpretation style at the San Andres Top.

Ops Geologic

Additions to slide by ops geo in red:

If facies is considered Wackestone this plot suggest Sw > ~92%
If facies is considered Packestone this plot suggest Sw > ~64%
The choice of facies using this plot predetermines a negative outcome ignoring other positive indicators

NSAI NETHERLAND, SEWELL & ASSOCIATES, INC.

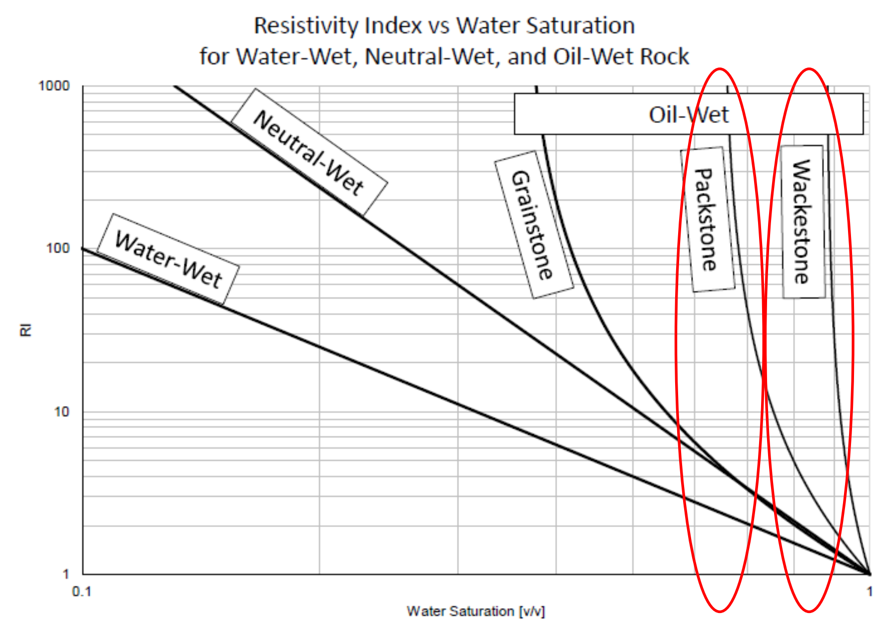


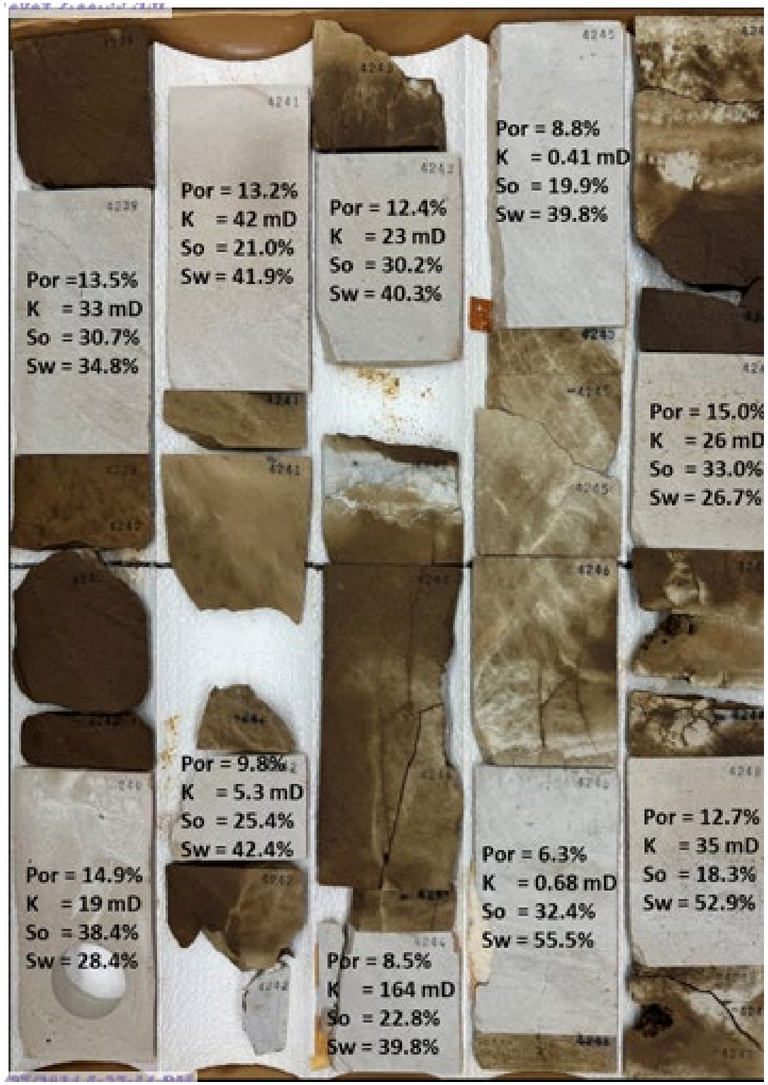
Figure A10

All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Exhibit L-9: Adapted plot provided by Mr. Davidson shows how the shift in saturation happens directly below the San Andres based on an assumption of facies changes

Adapted from: Self-Affirmed statement of James A. Davidson (Figure A10)

Exhibit L-10



Oil saturation seen in the EMSU 679 shows significant residual oil staining in the core.

Exhibit L-10: One of the key indicators of an ROZ, the staining of the core with oil over the San Andres is strong evidence for the ROZ in the EMSU San Andres.

https://ocdimage.emnrd.nm.gov/Imaging/FileStore/SantaFe/CF/20240827/23616_08_27_2024_05_27_16.pdf

GPS Geo1ogic

Exhibit B-9

EMSU R.R. Bell #4 San Andres core containing fair to good porosity, low permeability, and fair to good oil saturation. Core photograph is from the base of the cored interval from 3996 to 4002 ft (-445 to -451 ft). Well location was adjacent to the up-dip stratigraphic trap where porosity, permeability, and oil saturation decreased.

Exhibit L-11: One of the key indicators of an ROZ, the staining of the core with oil over the San Andres is strong evidence for the ROZ in the EMSU San Andres.

Exhibit L-12

EMSU 679

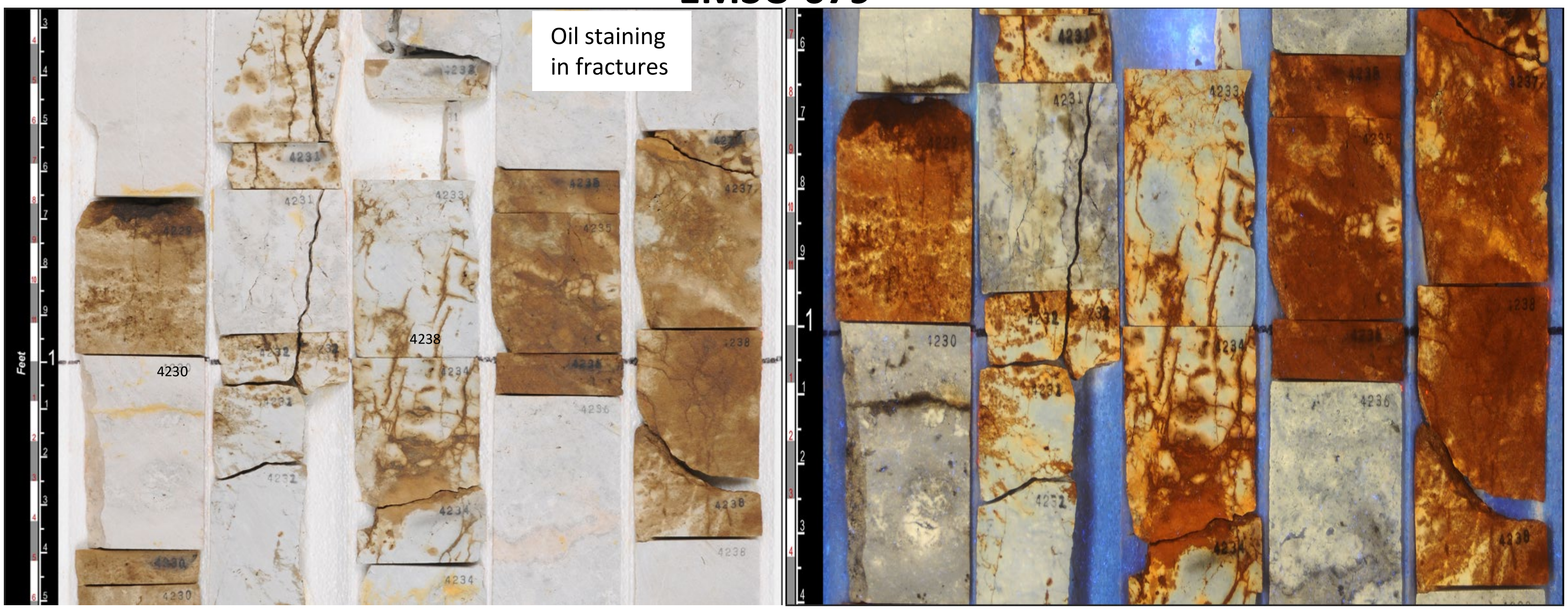
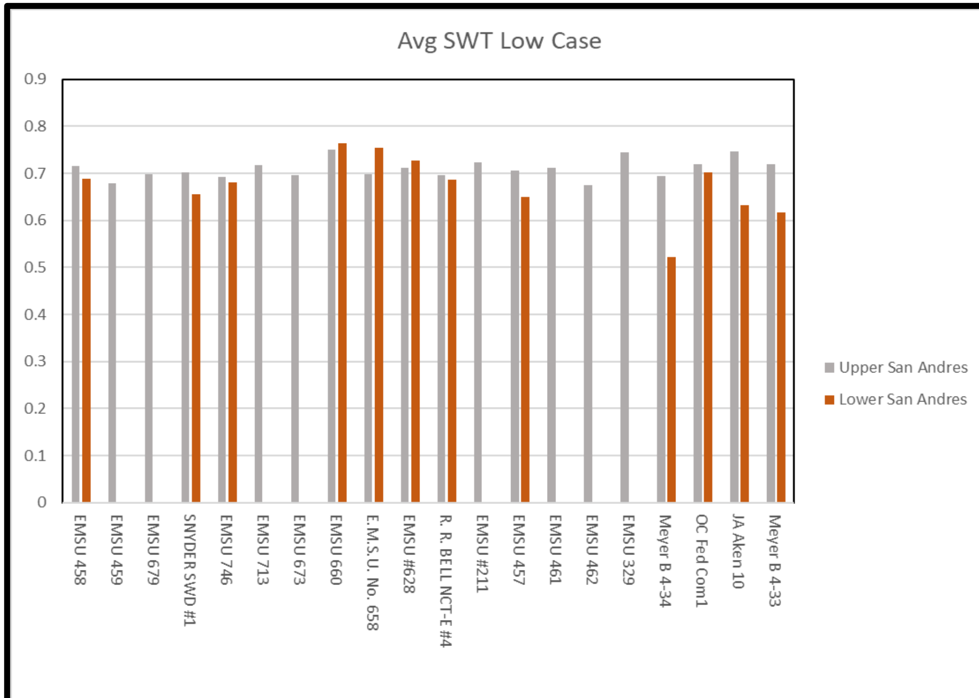


Exhibit L-12: A classic picture of oil staining in porous reservoir. This paired with fractures also stained with hydrocarbons suggesting transmissibility.

Exhibit L-13



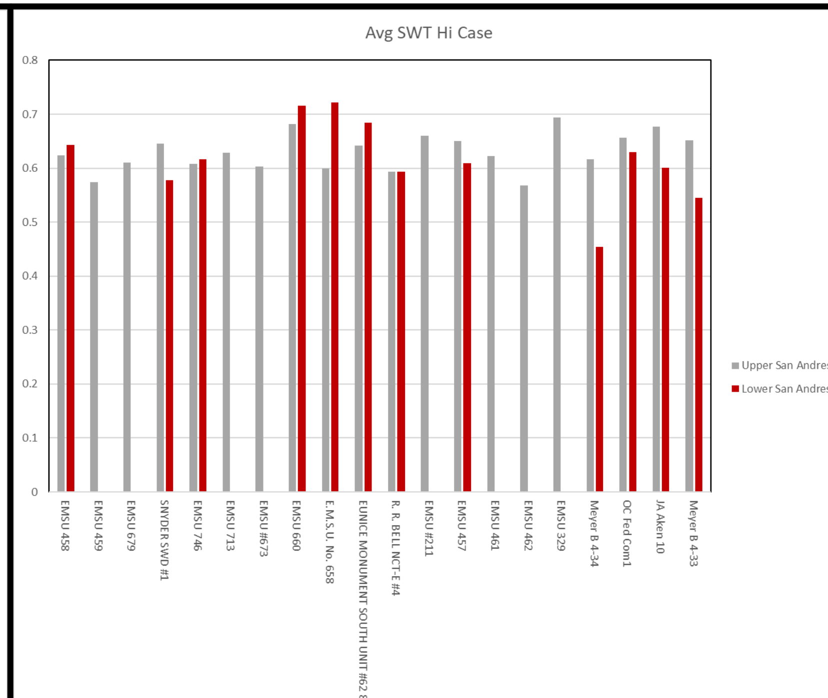
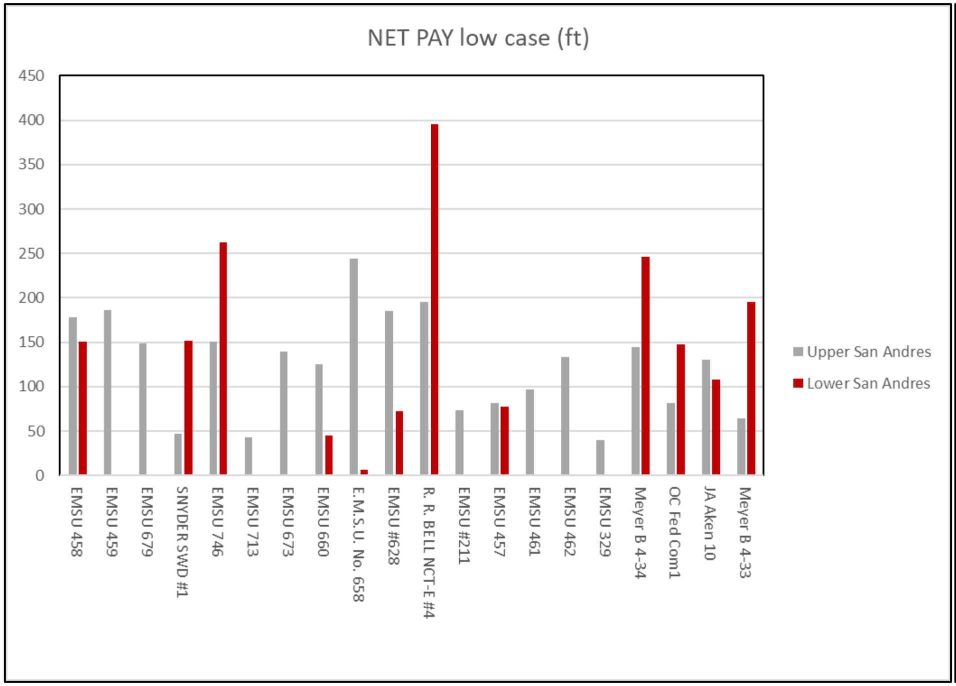


Exhibit L-13: Average total water saturation for wells interpreted by Ops Geologic for Low and High Case. Averages are well withing the typical range for an ROZ.

Exhibit L-14



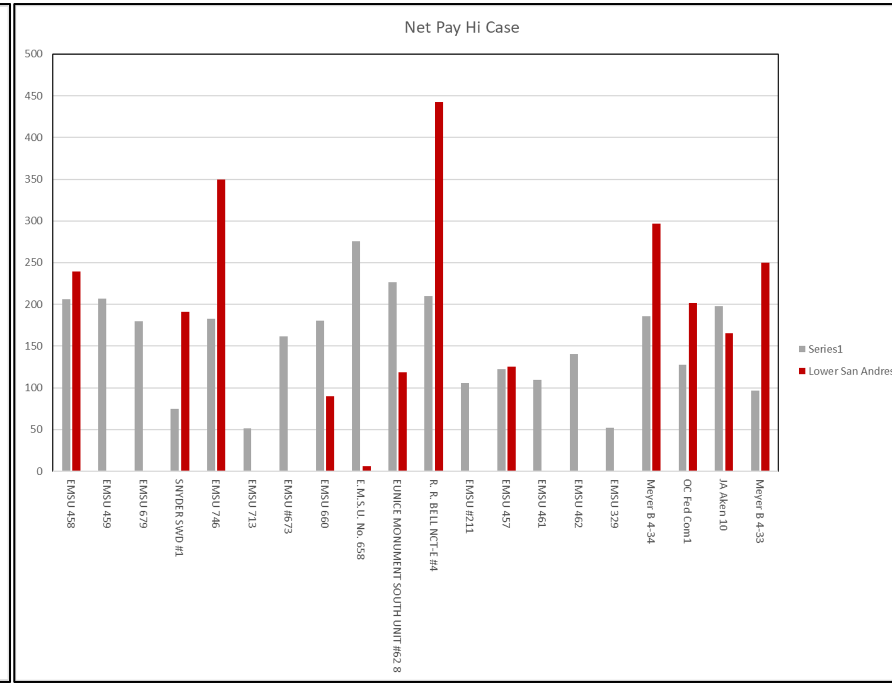
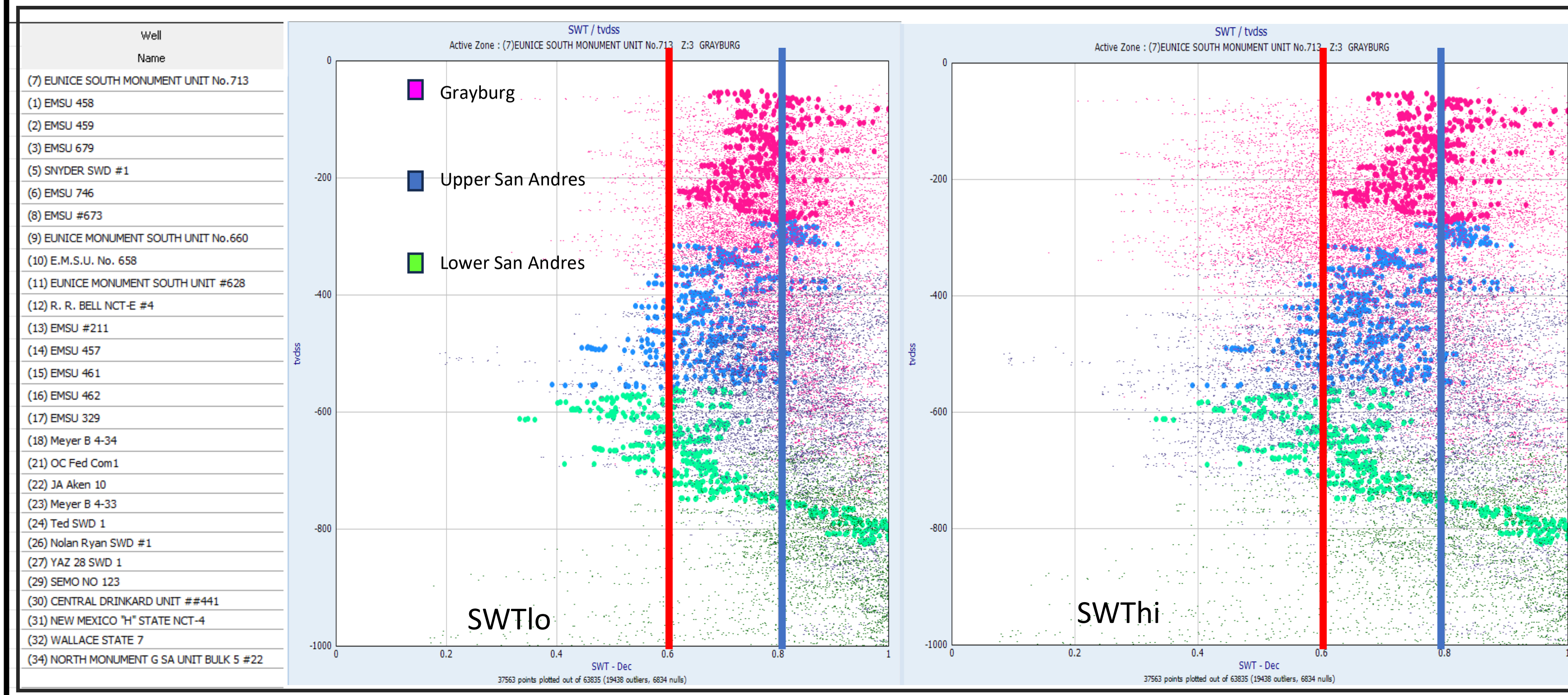


Exhibit L-13: Net pay for wells interpreted by Ops Geologic for Low and High Case

Exhibit L-15



Larger diameter points from NMGSA Unit 5#22
Data from this well hand transcribed from poor quality pdf and may have some errors

Exhibit L-15: Display of calculated saturations using the low and high case saturations. The results of the study show a significant omount of oil saturation in the low(pessimistic) and Hi (Optimistic) cases. large continuous intervals of saturation shown. Large diameter points from a North Monument well that required an adaption to the used model but had core covering the entire San Andres allowing for more complexity.

Exhibit L-16

TABLE 5.1 - Summary of "Classic" Observations of ROZ's and the ROZ-based Revised Interpretation of the Observations

ACTIVITY	EVIDENCE	CLASSIC INTERPRETATION	ROZ INTERPRETATION	ROZ EXPLAINATION
Drilling	Oil on pits	Transition zone/MP remnant oil	Presence of ROZ highly likely	Oil wet reservoir. Oil is released during drilling. Often seen in Roz's
	Drilling Break	Aquifer / No Significance	Good Reservoir	Open marine environment. Good cycles and flow units.
Mud Logging	Cut in samples	Transition Zone / MP Remnant	Oil saturation present	Residual Oil Saturation is present
	Dull gold Fluorescence in samples	Transition Zone / MP Remnant	"Water washed" oil	Indicative of Mother Nature's Waterflood. Reduced Saturation of oil.
	Odor in samples	Transition Zone / MP Remnant	Oil saturation present	Indicative of Mother Nature's Waterflood. Reduced Saturation of oil.
	Gas show	Not expected. From Oil Zone above if present.	Oil saturation present	Indicative of Mother Nature's Waterflood. Reduced Saturation of oil.
	"Free" Sulfur crystals	Suggest at or below O/W contact	Mother Natures Waterflood	Result of activity of Sulfate Reducing Bacteria. Indicates Meteoric Derived Flushing.
	Sulfur and Anhydrite	No significance	Mother Natures Waterflood	Result of activity of Sulfate Reducing Bacteria. Indicates Meteoric Derived Flushing.
	Sulfur and Calcite	No significance	Mother Natures Waterflood	Result of activity of Sulfate Reducing Bacteria. Indicates Meteoric Derived Flushing.
DST	Sulfur or Black Sulfur water	Not unusual / No significance	To be Expected.	Result of activity of Sulfate Reducing Bacteria. Indicates Meteoric Derived Flushing.
	Salty Sulfur water	Not unusual / No significance	To be Expected	Result of activity of Sulfate Reducing Bacteria. Indicates Meteoric Derived Flushing.
	Lower Salinity than expected	Not unusual / No significance	Meteoric Derived Flushing.	Indicative of Mother Nature's Waterflood. Meteoric Derived Flushing.
	"Skim" of Oil	Not unusual / No significance	To be Expected. Never significant oil	Oil Wet reservoir. Small amounts of Oil is released during pressure drop.
	Good to Excellent Pressure	Not unusual / No significance	To be Expected	ROZ is not in pressure communicationwith a Main Pay
Logging	Rw different than MP	Not unusual / No significance	ROZ water chemistry different than MP	Rw is different because the meteoric derived sweep is composed of lower salinity water
	So > 30% in calculations	Might be productive	ROZ. Residual to waterflood and MNW	Rw is different because the meteoric derived sweep is composed of lower salinity water
	Different M an N than MP needed	Not unusual / No significance	fabric destructive dolomitization in ROZ only	Rocks have undergone a second diagenetic event
	Excellent Porosity in dolomite	Not unusual / No significance	Open Marine + Sweep associated dolomitization	Thicker open marine cycles and Secondary dolomitization in ROZ during sweep
	"Looks like a Winner"	set casing	ROZ can have appearance of producable on completion	ROZ thicker cycles, secondary dolomitization, salinity differences make calculations difficu
Core Analysis	5 - 40% oil saturation	Zones with higher water saturation non-productive	Saturations expected following MNW	Expected. So after Mdeteoric Derived Sweep
	Oil Wet Core	Consider log analysis	Sweep related fabric destructive dolomitization >> Oil wettin	Expected after Sweep related fabric destructive dolomitization
	Open marine facies	Not unusual / No significance	Good Quality reservoir, thick cycles and flow units	ROZ's tend to be found in more open marine settings
	SHR near base and/or top	Suspect oil/water contact(s)/water washing	Water Washing from Meteoric Derived Flushing	Multiple SHR Zone suggest Multiple O/W contact, both Paleo and recent
	Better Porosity and Perm than main pay	Not unusual / No significance	Good Quality reservoir, thick cycles and flow units	ROZ's tend to be found in more open marine settings
	Sulfur Crystals	Diagenesis - no interpretation	Free sulfur often found in ROZ	Conversion by Sulfate reducing bacteria results in free sulfur
	Sulfur and Anhydrite	Diagenesis - no interpretation	Free sulfur often found in ROZ	Conversion by Sulfate reducing bacteria results in free sulfur
	Sulfur and Calcite	Diagenesis - no interpretation	Free sulfur often found in ROZ	Conversion by Sulfate reducing bacteria results in free sulfur
	Spotty Oil Stain	Consider Log Analysis	Intervals with low perm in ROZ	Intervals with low perm in ROZ can have remnat high saturations
	Leached molds	Not unusual / No significance	Leaching during MNW	Leaching during MNW
	Leached Fracture	Not unusual / No significance	Leaching during MNW	Leaching during MNW
	Fabric Destructive dolomite	Not unusual / No significance	Secondary dolomitization in ROZ during sweep	Secondary dolomitization in ROZ during sweep
	Limestone below oil stained interval	Not unusual / No significance	Zone is below Swept ROZ	Zone is below Swept ROZ
Completion	large volumes of fluid (sulfur water)	expect a decrease in water production over time	Large volumes of water cut on IP indicates an ROZ	Swept down to residual to waterflood, good porosity and perm in open marine
	Less than 5% oil	expect an increase in oil production over time	>85% water cut on IP indicateds an ROZ	Swept down to residual to waterflood
	Good Pressure	Not unusual / No significance	ROZ not drained, to be expected	Thinner cycles in MP don't reduce pressure in ROZ
	Lower Salinity than expected	Suspect water flow	Meteoric Derived water	Meteoric Derived water has lower salinity
	Different Scale than in Main Pay	Suspect water flow	Different water chemistry	MNW changes water chemistry significantly

Exhibit L-16: Summary of rock, fluid, and production properties common to several ROZ intervals (Melzer et al 2016)

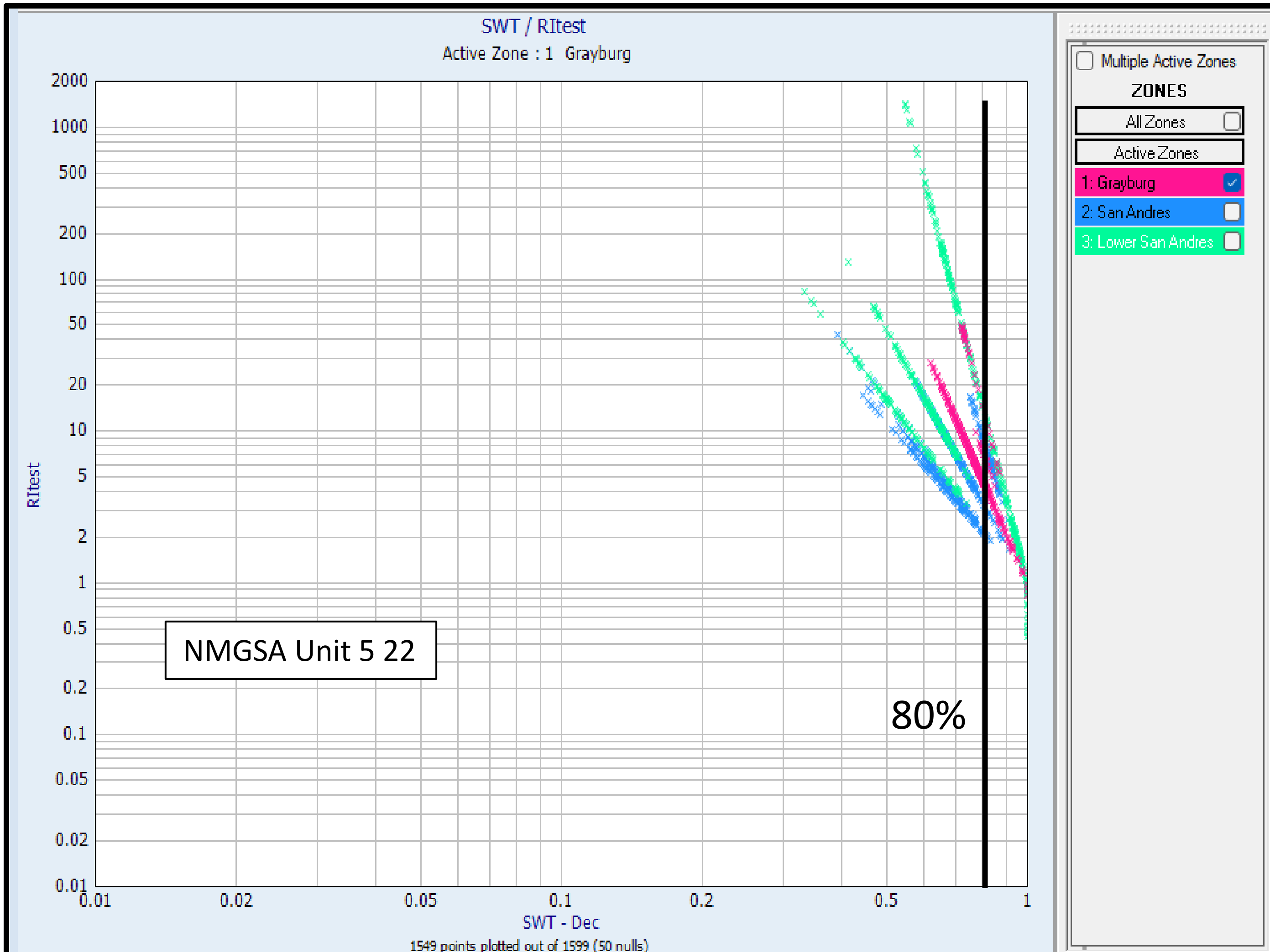


Exhibit L-17: Full core across the San Andres in the NMGSA Unit 5 22 allows the careful exploration of varying n values. The RI/Sw crossplot shows the varying slopes related to changing ‘n’

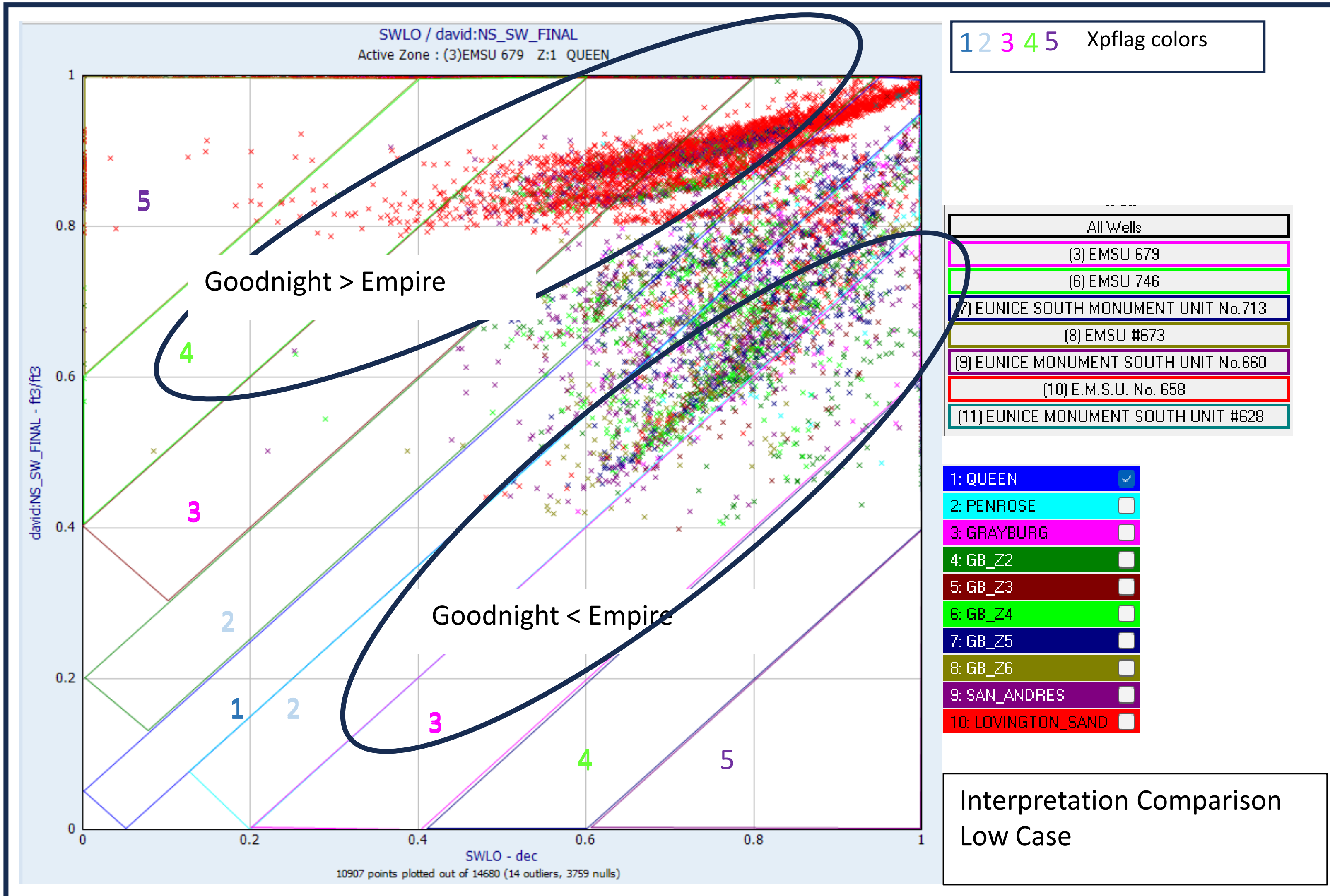
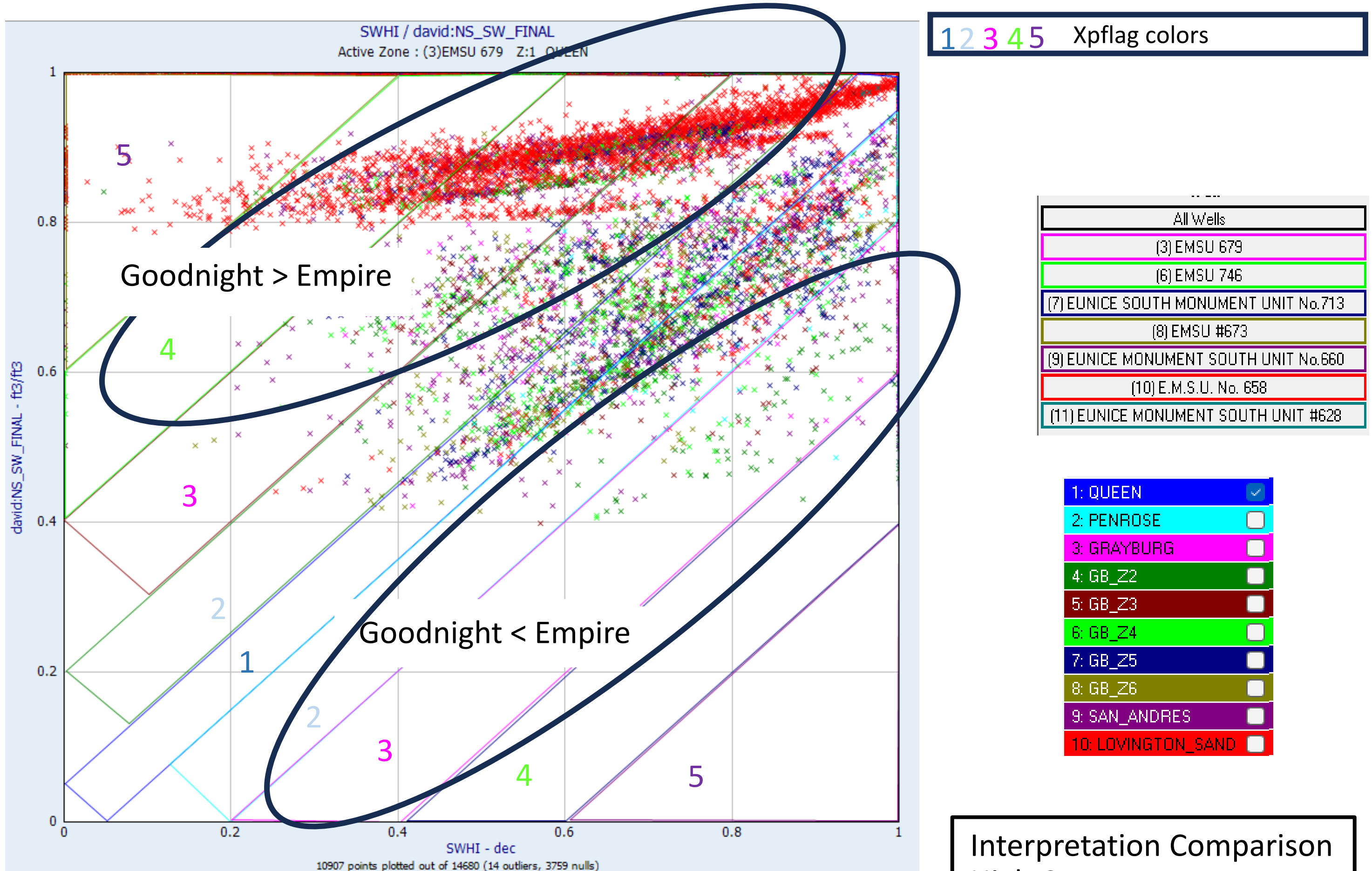


Exhibit L-18: Comparison of Goodnight's interpretation vs the High case saturation from Empire. Comparison of Goodnight and Empire Petrophysical interpretation. A large divergence of the data occurs with the San Andres and the Lovington Sand.

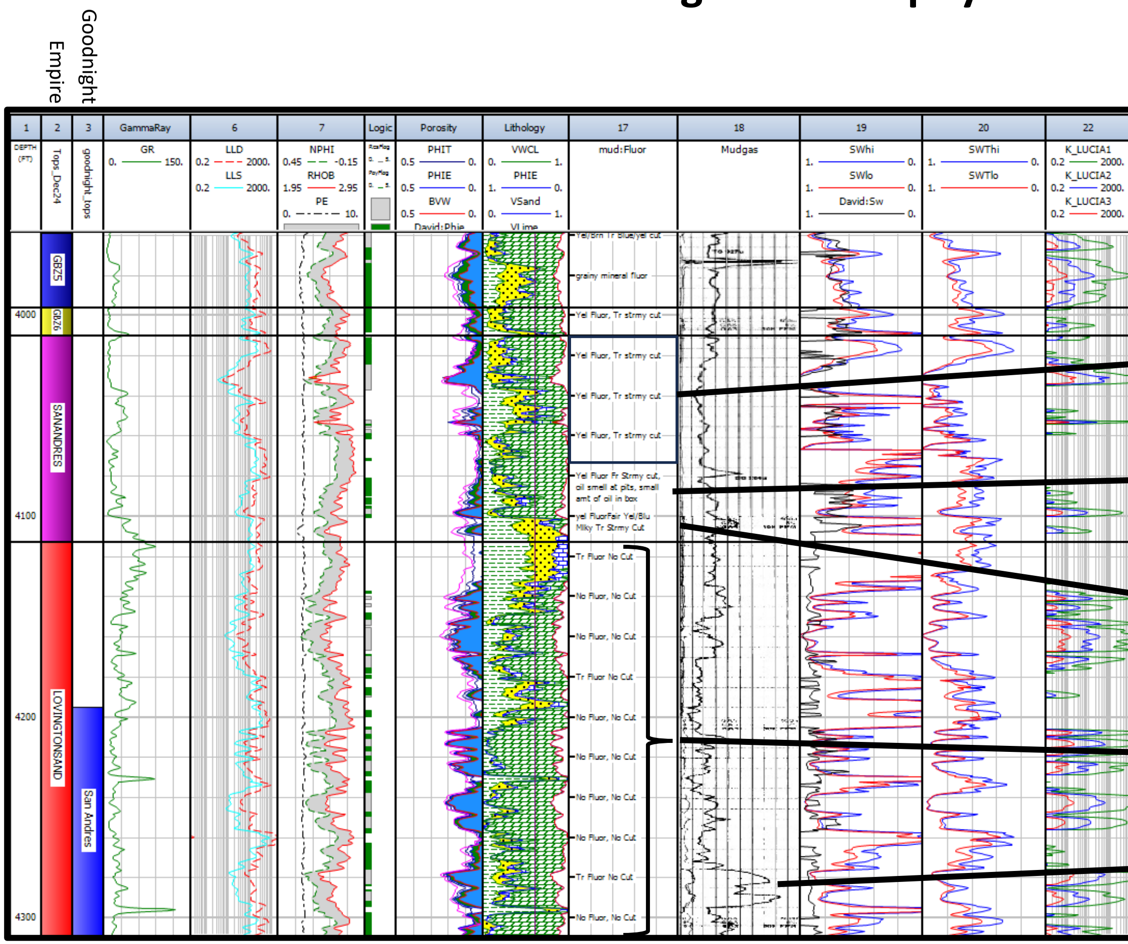


Interpretation Comparison
High Case

Exhibit L-19: Comparison of Goodnight's interpretation vs the High case saturation from Empire. Comparison of Goodnight and Empire petrophysical interpretation. A large divergence of the data occurs with the San Andres and the Lovington Sand.

Exhibit L-20

EMSU 746 mudlog and Petrophysical comparison



Significant difference in tops between Empire and Goodnight

Yellow fluor strm cut

Yellow fluor Fr strm cut, oil smell at pit, small amt of oil in box

Yellow fluor fair yel/blu milky tr streaming cut

Mix of tr fluor/no cut, and no fluor no cut thru section

Start of large increase in gas with further fluor and cut posted below 4325 ft MD

Exhibit L-20: Several indications of hydrocarbon presence and ROZ.

Exhibit L-21

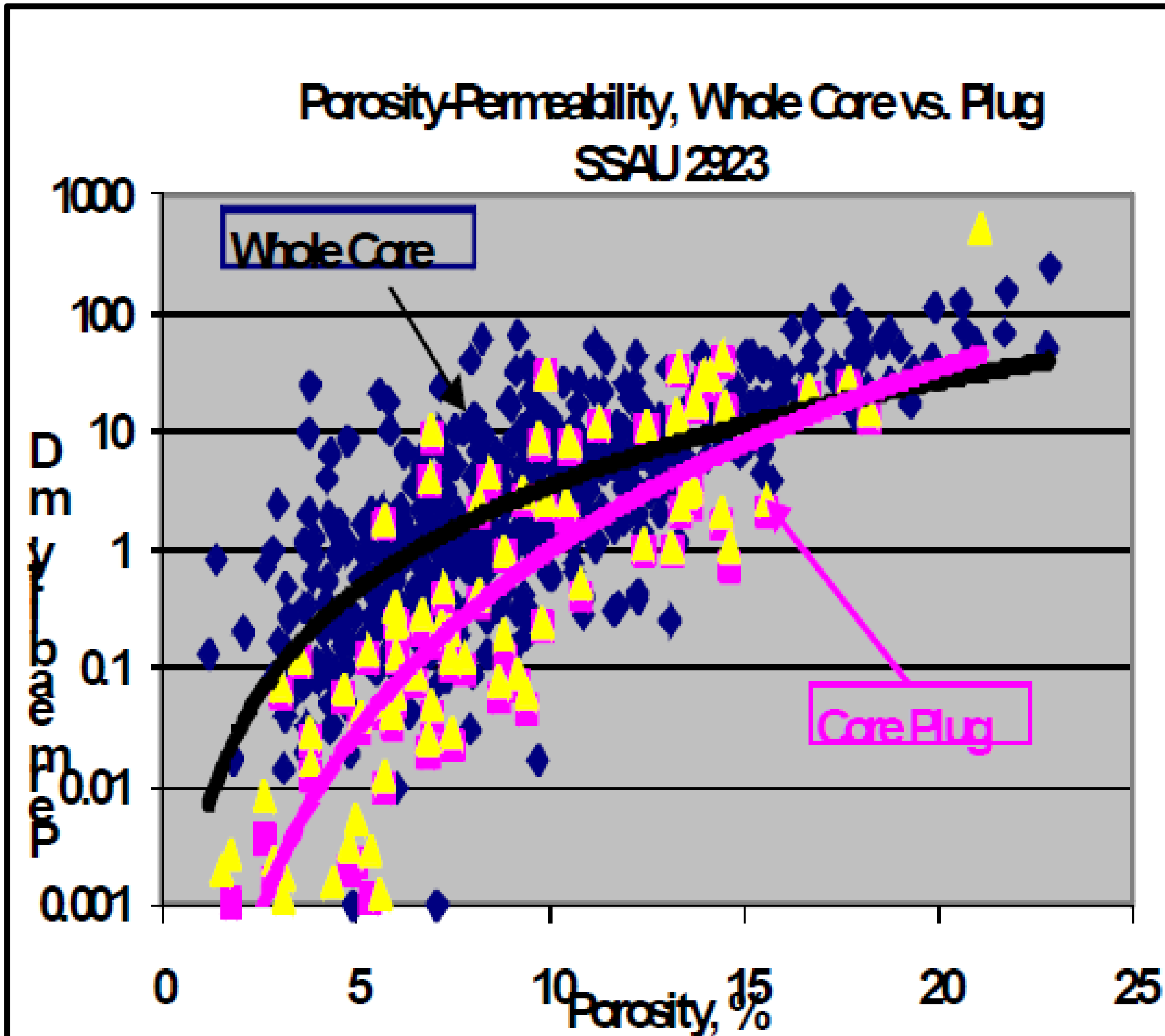
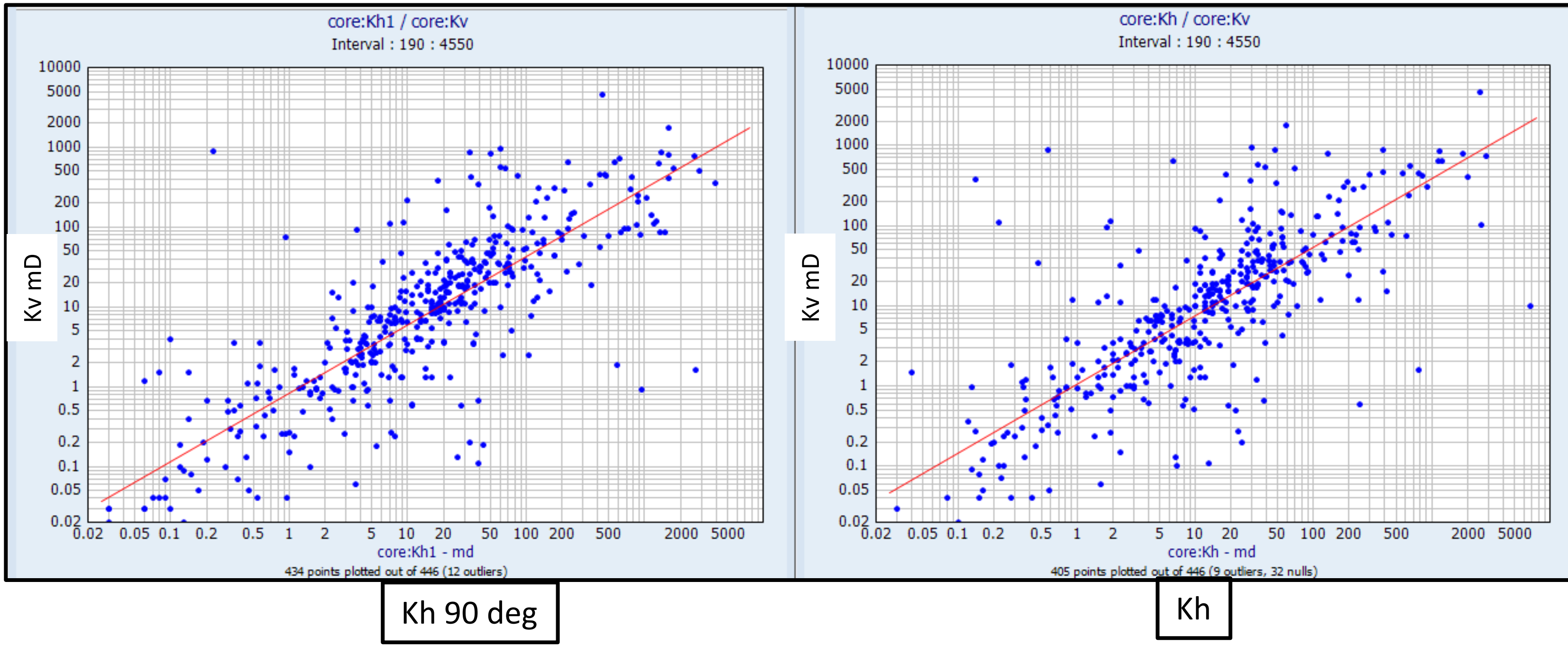


Exhibit L-21: Crossplot of porosity vs permeability for conventional vs full diameter core samples from Honarpour et al (2010). The crossplot highlights the permeability bias based on sample size. It also highlights the overall better connectivity of the well not shown through smaller sample sizes

Geo1ogic

NMGSAU Bulk 5 #22



Core points transcribed by hand from pdf with poor resolution. Best efforts were made to correctly transfer data.

Exhibit L-22: Crossplots of vertical (y) and Horizontal permeabilities (x) to show the wide range of KV/KH ratio in the reservoir. This suggests strong vertical communication between zones in contrast to comments by Mr. Davidson

Exhibit L-23

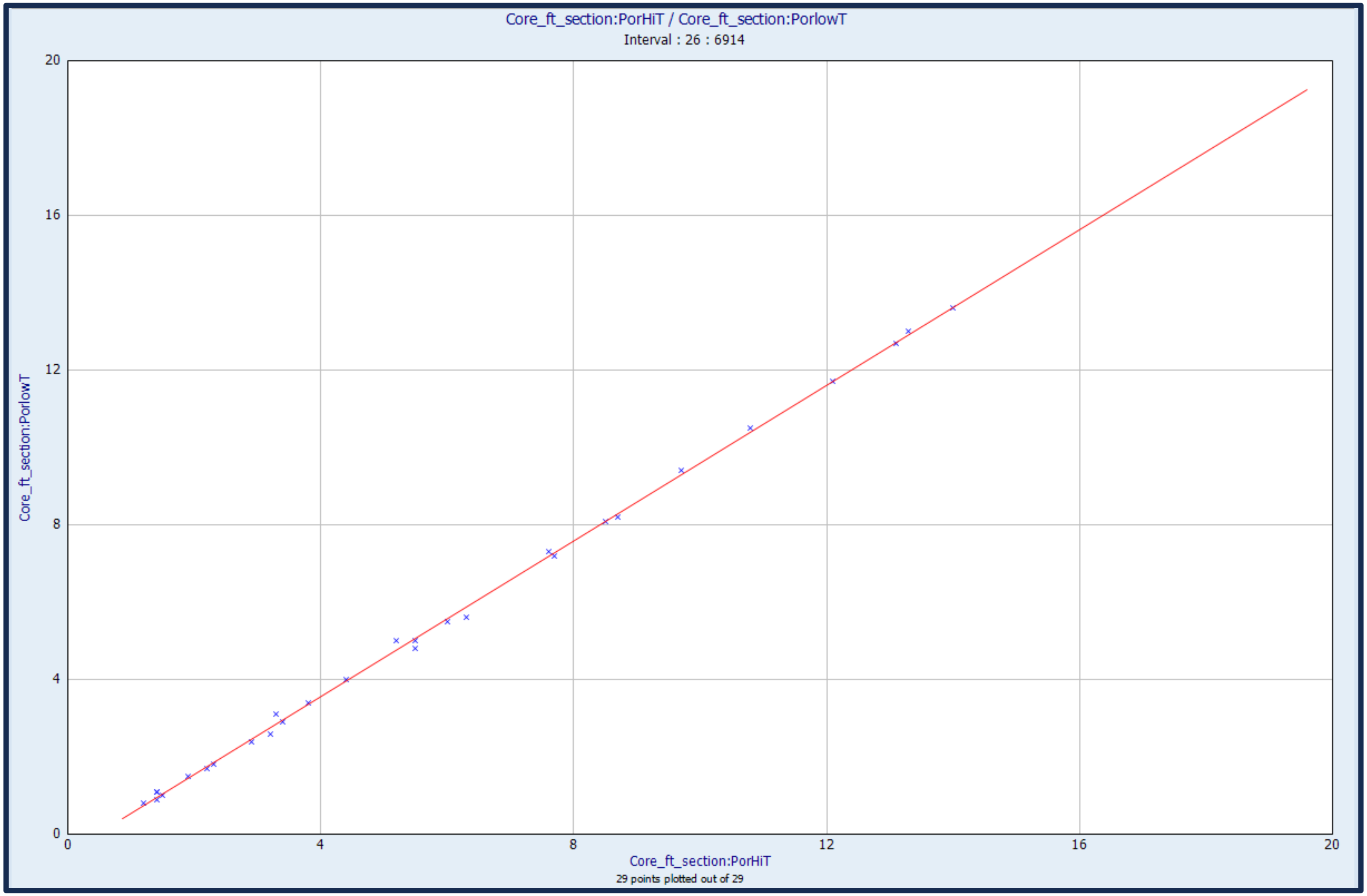


Exhibit L-23: QC plot of porosities measured using two different temperatures.

	Low temp. analysis	High temp. analysis	Increase in porosity
Gypsum (%)	Porosity (%)	Porosity (%)	Porosity (%)
4.3	2.8	3.7	0.9
14.6	2.5	8.4	5.9
14.9	3.4	8.9	5.5
11.0	6.4	11.2	4.7

$$\text{Gypsum } (CaSO_4 2H_2O) + \text{heat} = \text{Bassanite } (CaSO_4 \cdot 0.5H_2O) + 1.5H_2O$$

(Density 2.35) (Density 2.70)

Exhibit L-24: Example of porosity increase due to increased heat during cleaning as originally attributed to Hurd and Fitch, 1959. (Lucia, 2001)

Adapted from (Lucia Carbonate Reservoir Characterization book, 2001)

Petrophysical Analysis

Company	Empire New Mexico LLC
Well Name	EMSU 679
Field	EUNICE MONUMENT
Country	US State New Mexico
Location	TWP 21 S - Range 36 E - Sec 8

Exhibit L-25

Scale : 1 : 1200

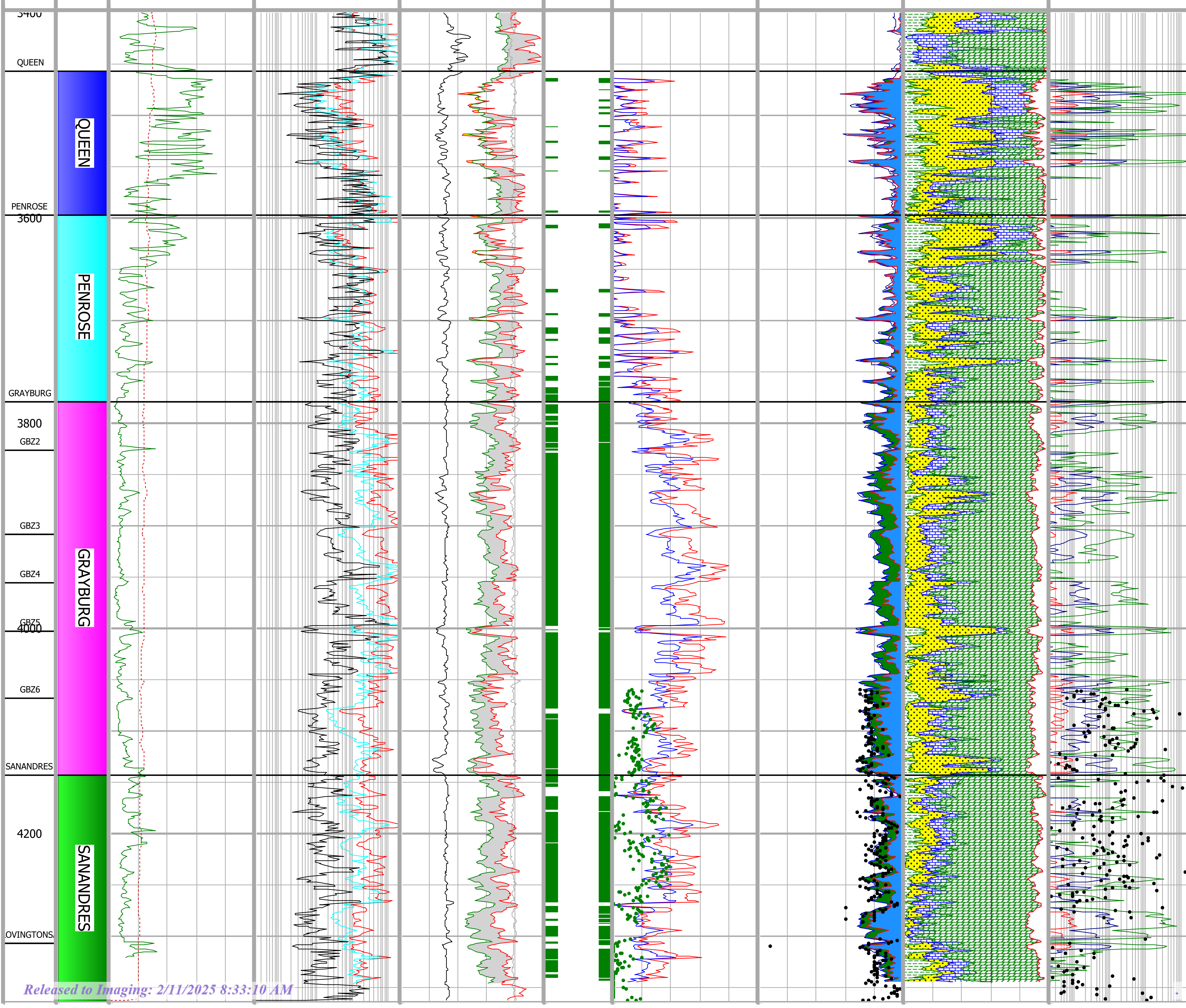
EMSU 679

DB : IP_Empire (3)

DEPTH (3400FT - 4363.5FT)

01/14/2025 17:38

1	2	3	4	5	6	7	8	Lithology	12
DEPTH (FT)	Final_Tops_r	CALR 6. – 16.	LLD 0.2 – 2000.	DCOR -0.75 – 0.25	PAYFLAGLO 0. – 5.	SWThi 1. – 0.	PHIT 0.5 – 0.	VWCL 0. – 1.	K_LUCIA1 0.2 – 2000.
CopyOf Final_Tops_r		GRR 0. – 150.	LLS 0.2 – 2000.	DEN 1.95 – 2.95	PAYFLAGHI 5. – 0.	SWTlo 1. – 0.	PHIE 0.5 – 0.	PHIE 1. – 0.	K_LUCIA2 0.2 – 2000.
			MGUARD 0.2 – 2000.	NPOR_LS 0.45 – -0.15		core:Soilds (dec) 0 – 1	BVW 0.5 – 0.	VSand 0. – 1.	K_LUCIA3 0.2 – 2000.
				PE 0. – 10.			core:Porosityds (dec) 0.5 – 0	VLime 0. – 1.	core:K_E-Wds (mD) 0.2 – 2000
								VDol 0. – 1.	core:Kmaxds (mD) 0.2 – 2000
								VCOAL 0. – 1.	
								VSALT 0. – 1.	
								VANHY 0. – 1.	
								KillFlag 0. – 1.	



Received by OCD: 2/10/2025 5:08:43 PM

Petrophysical Analysis

Company	XTO ENERGY INCORPORATED
Well Name	EMSU 746
Field	EUNICE MONUMENT SOUTH
Country	USA State NEW MEXICO
Location	380' FNL & 10' FEL

Exhibit L-26

IP 2024

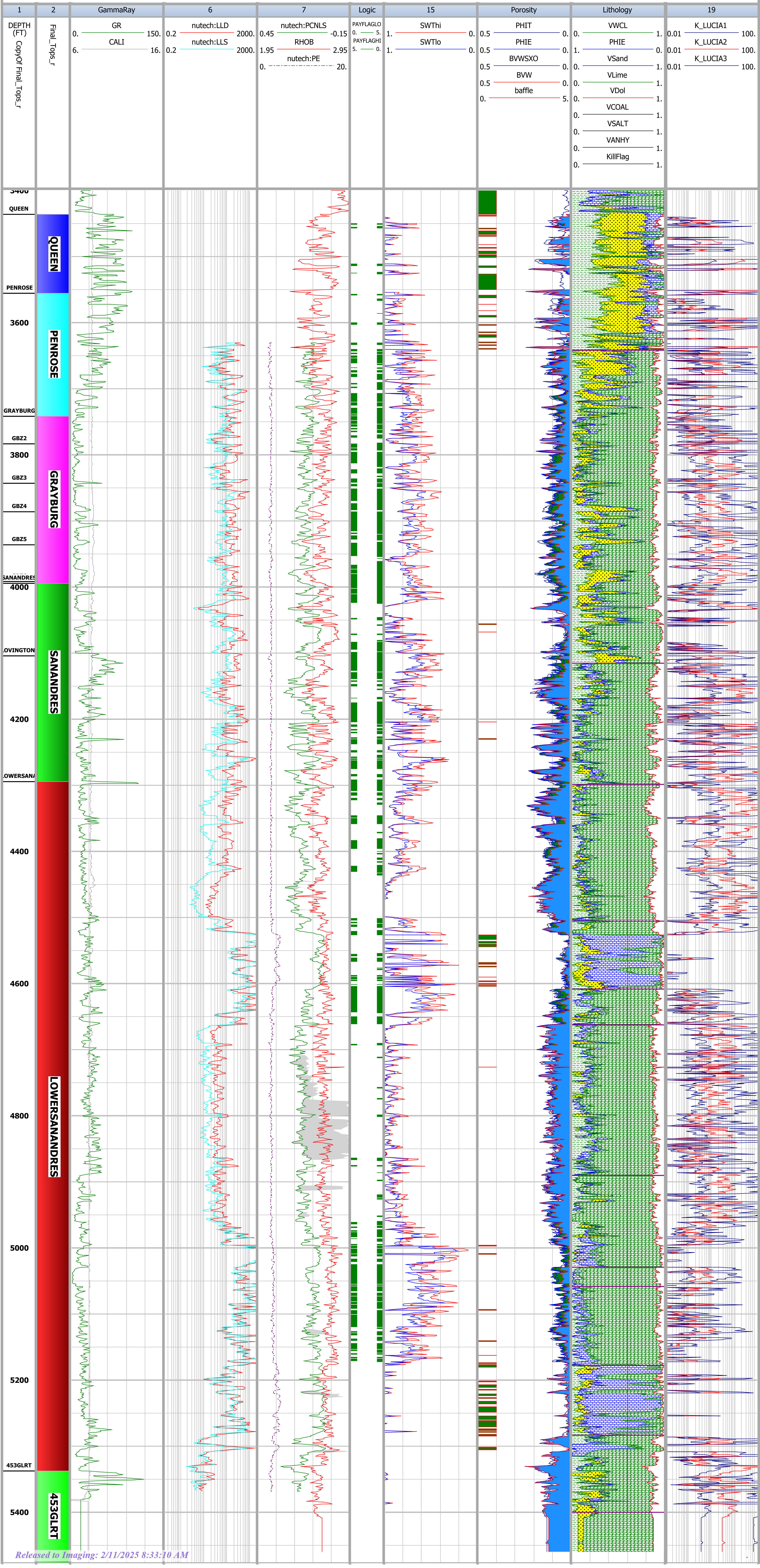
Scale : 1 : 1200

EMSU 746

DB : IP_Empire (6)

DEPTH (3400FT - 5476FT)

01/19/2025 17:46



Released to Imaging: 2/11/2025 8:33:10 AM

Petrophysical Analysis

Exhibit L-27

Company	GULF EXPLORATION AND PRODUCTION COMPANY
Well Name	R. R. BELL NCT-E #4
Field	
Country	USA — State NEW MEXICO
Location	S11 T21S R36E

IP 2024

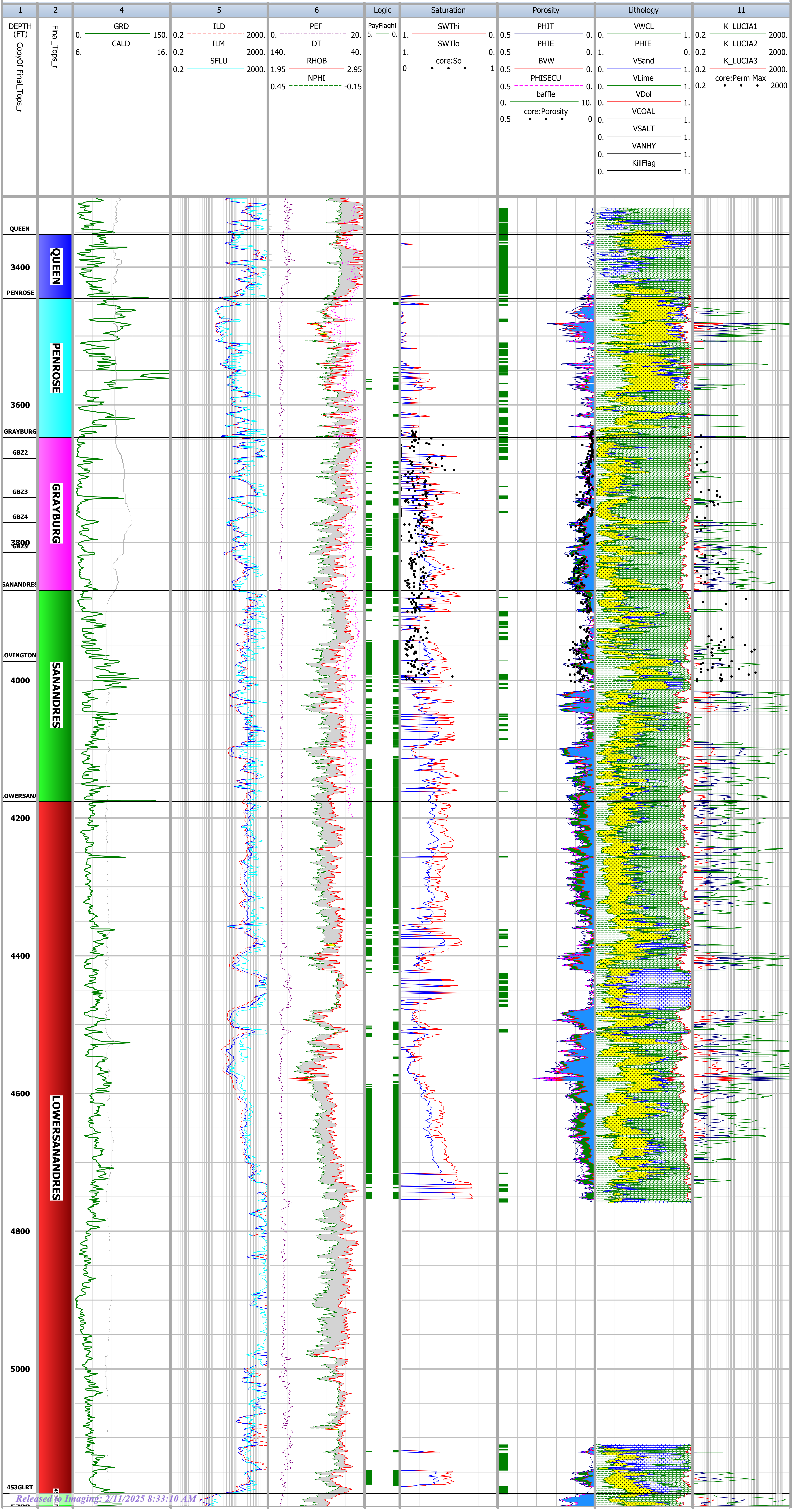
Scale : 1 : 1200

R. R. BELL NCT-E #4

DB : IP_Empire (12)

DEPTH (3300FT - 5200FT)

01/15/2025 08:01



Petrophysical Analysis

Company	GOODNIGHT MIDSTREAM PERMIAN LLC
Well Name	SNYDER SWD #1
Field	JESS BURNER
Country	USA
State	NEW MEXICO
Location	1450' FNL & 708'FEL

Exhibit L-28

IP 2024

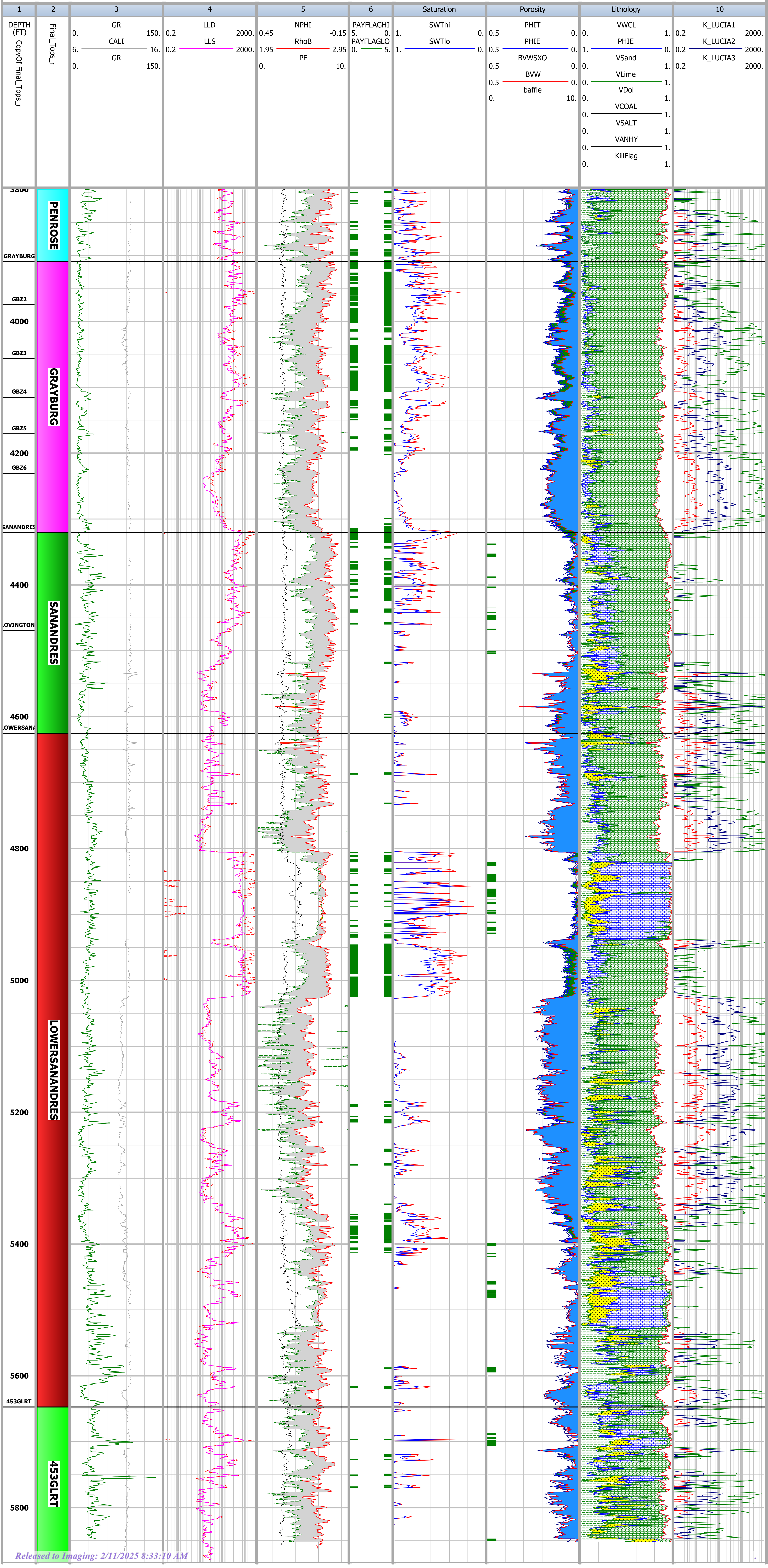
Scale : 1 : 1200

SNYDER SWD #1

DB : IP_Empire (5)

DEPTH (3800FT - 5884FT)

01/24/2025 14:32



Received by OCD: 2/10/2025 5:08:43 PM

Petrophysical Analysis

Company	CHEVRON U.S.A. INC.
Well Name	EMSU #211
Field	EUNICE MONUMENT
Country	UNITED STATES OF AMERICA
State	NEW MEXICO
Location	S4 T21S R36E

Exhibit L-29

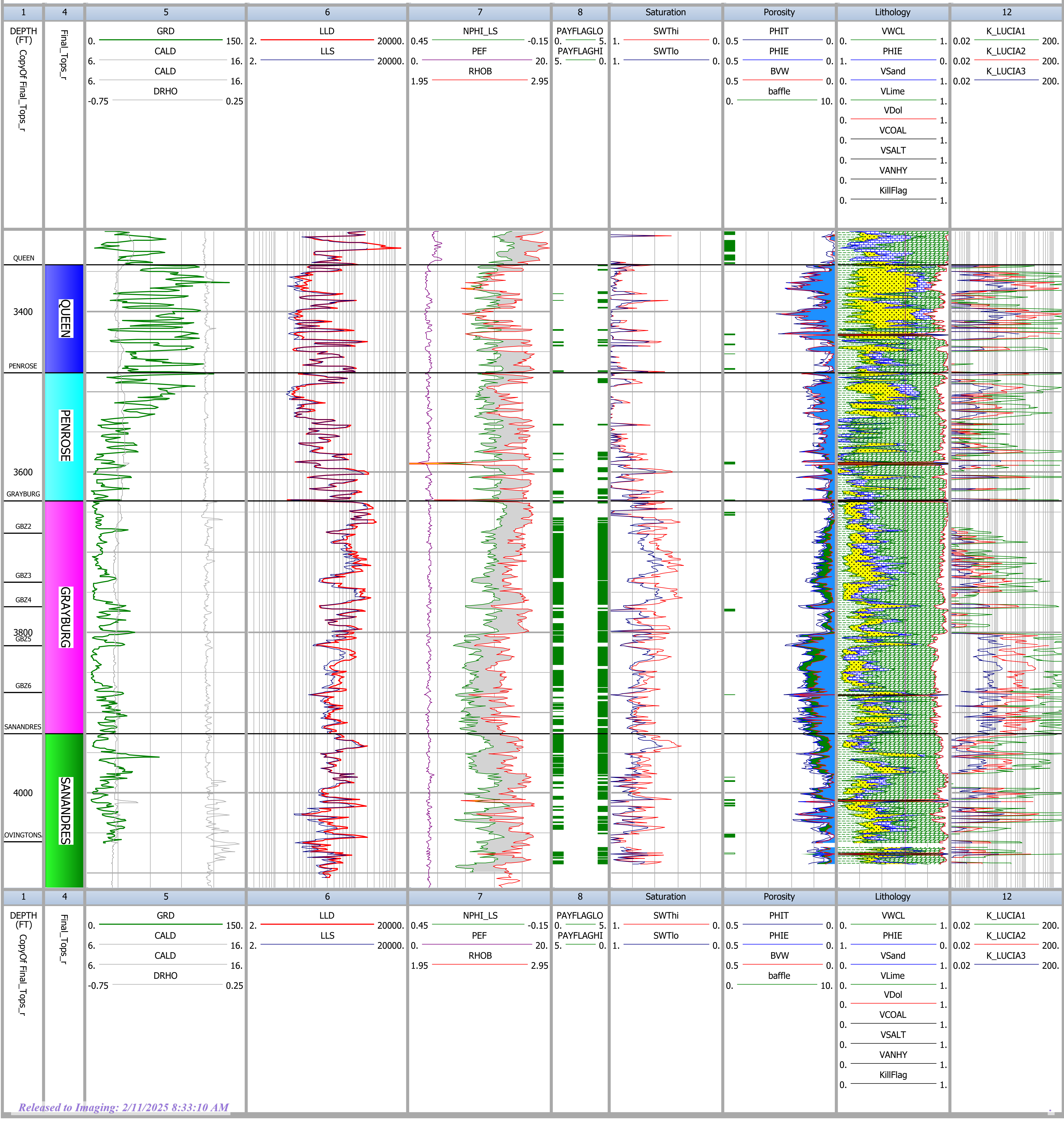
Scale : 1 : 1200

EMSU #211

DB : IP_Empire (13)

DEPTH (3300FT - 4120FT)

01/15/2025 08:06



Released to Imaging: 2/11/2025 8:33:10 AM

Petrophysical Analysis

Company

Well Name: EMSU 461

Field: EUNICE MONUMENT

Country

State

Location

Exhibit L-30

IP 2024

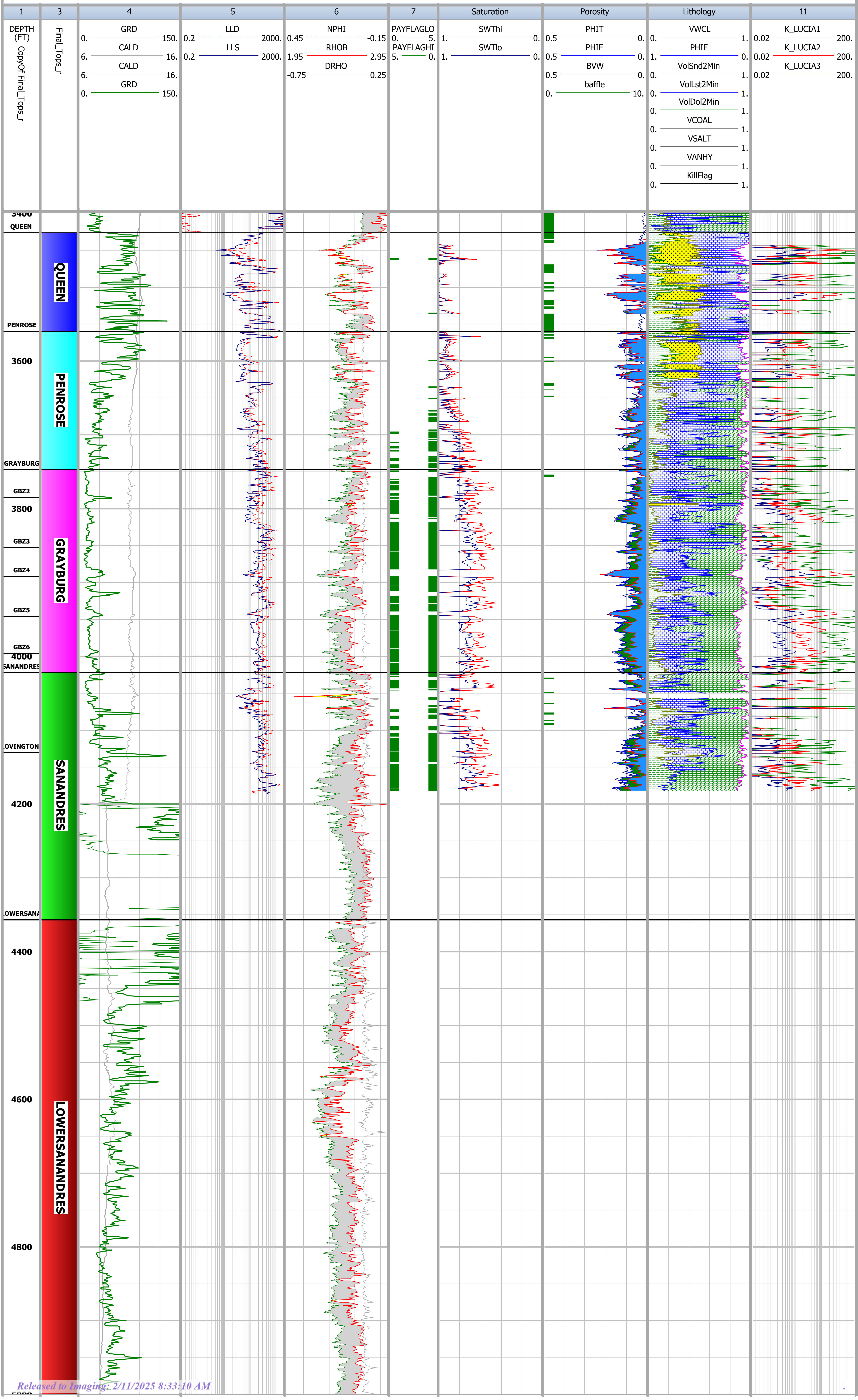
Scale : 1 : 1200

EMSU 461

DB : IP_Empire (15)

DEPTH (3400FT - 5000FT)

01/15/2025 08:33



Petrophysical Analysis

Company	XTO ENERGY
Well Name	EUNICE MONUMENT SOUTH UNIT #628
Field	EUNICE MONUMNET; GRAYBURG-ANDRES
Country	USA
State	NEW MEXICO
Location	2550' FSL & 1085' FEL

Exhibit L-31

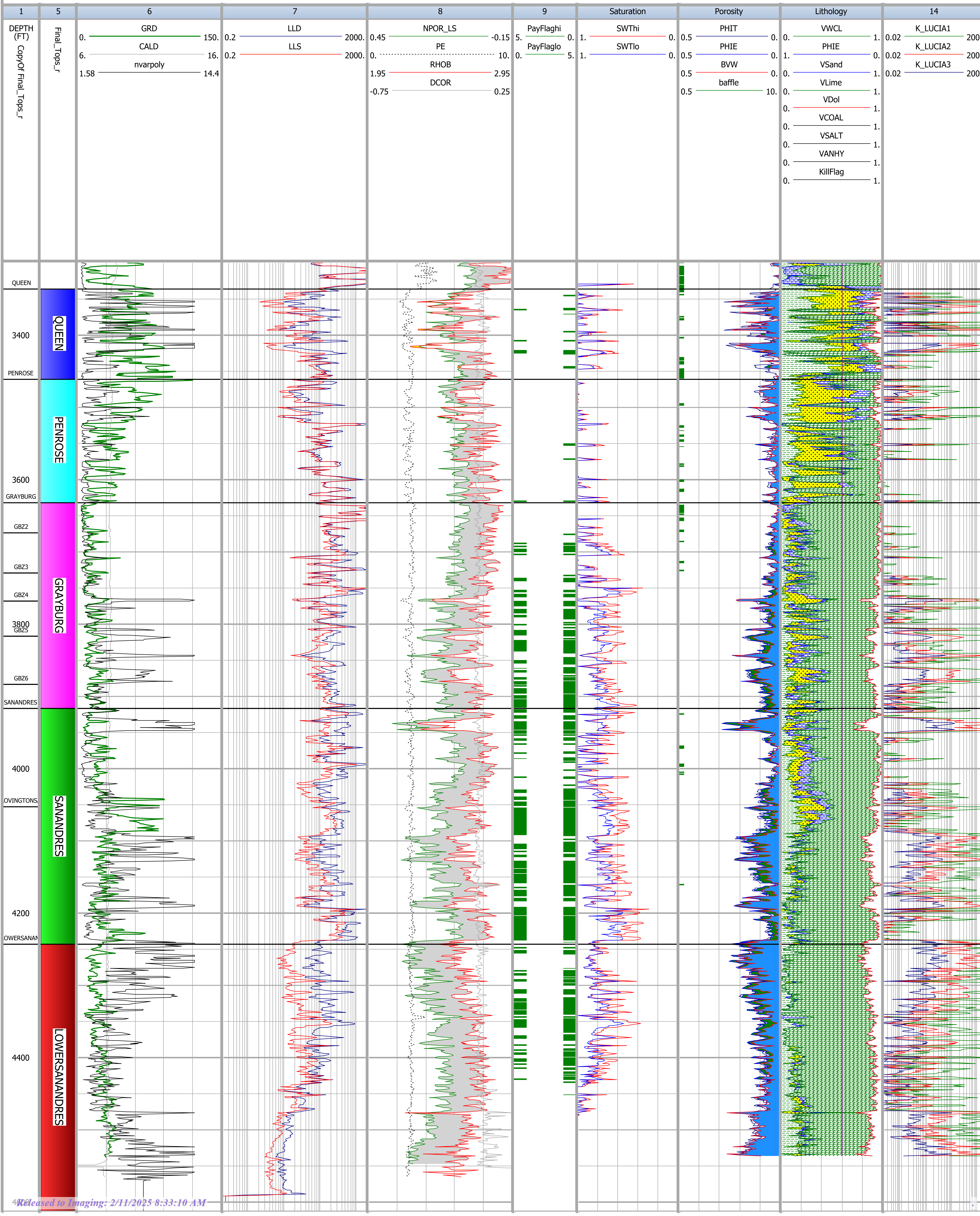
Scale : 1 : 1200

EUNICE MONUMENT SOUTH UNIT #628

DB : IP_Empire (11)

DEPTH (3300FT - 4612FT)

01/14/2025 18:36



Petrophysical Analysis

Company	XTO ENERGY
Well Name	EUNICE MONUMENT SOUTH UNIT No.660
Field	EUNICE MONUMENT; GRAYBURG-ANDRES
Country	US
State	NEW MEXICO
Location	10' FSL & 1250' FWL

Exhibit L-32

IP 2024

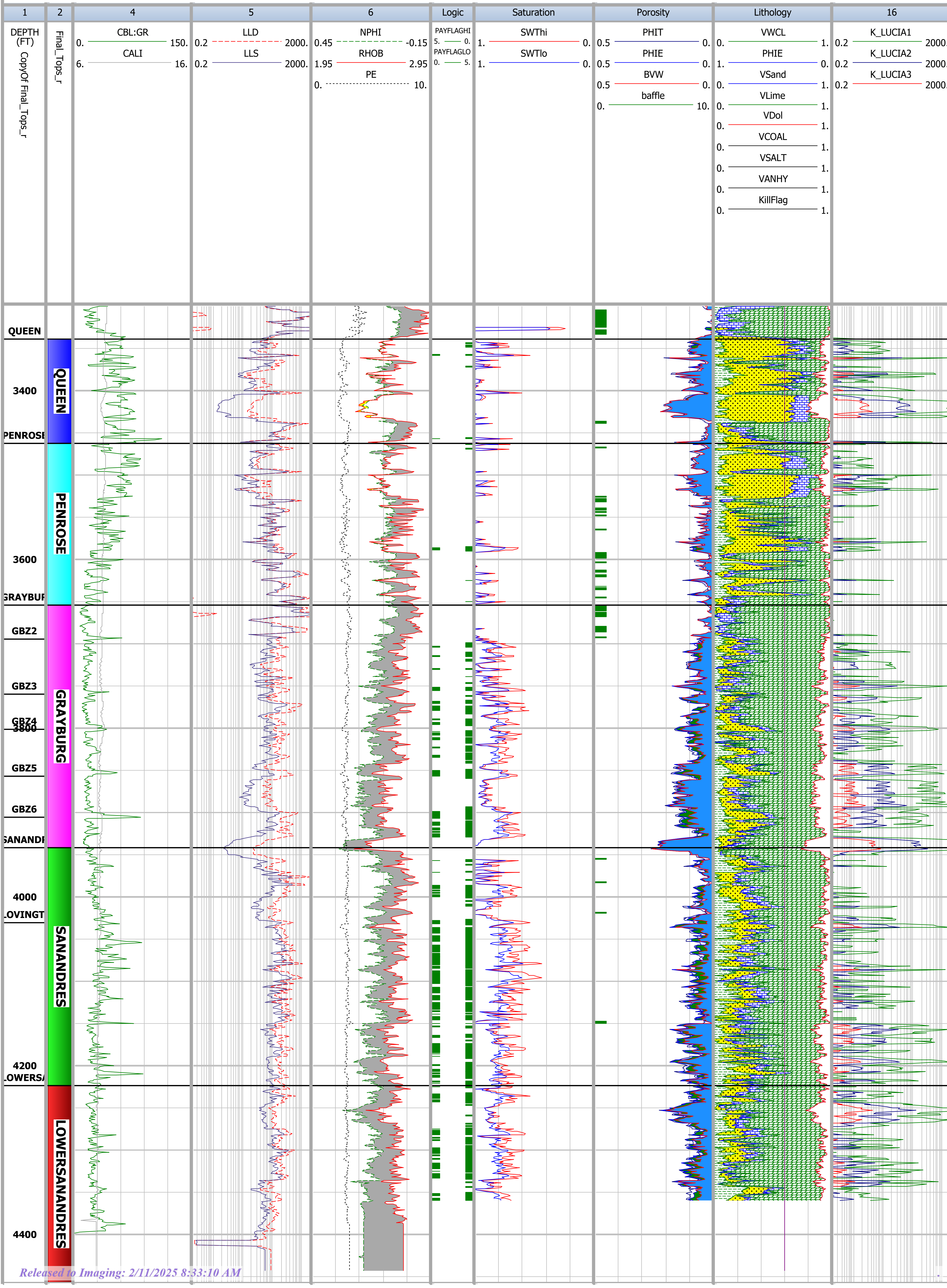
Scale : 1 : 1200

EUNICE MONUMENT SOUTH UNIT No.660

DB : IP_Empire (9)

DEPTH (3300FT - 4457FT)

01/14/2025 18:24



Received by OCD: 2/10/2025 5:08:43 PM

Petrophysical Analysis

Company	XTO Energy, Inc
Well Name	EMSU #673
Field	Eunice Monument; Grayburg-Andres
Country	US
State	NEW MEXICO
Location	1060' FNL & 1305' FEL

Exhibit L-33

IP 2024

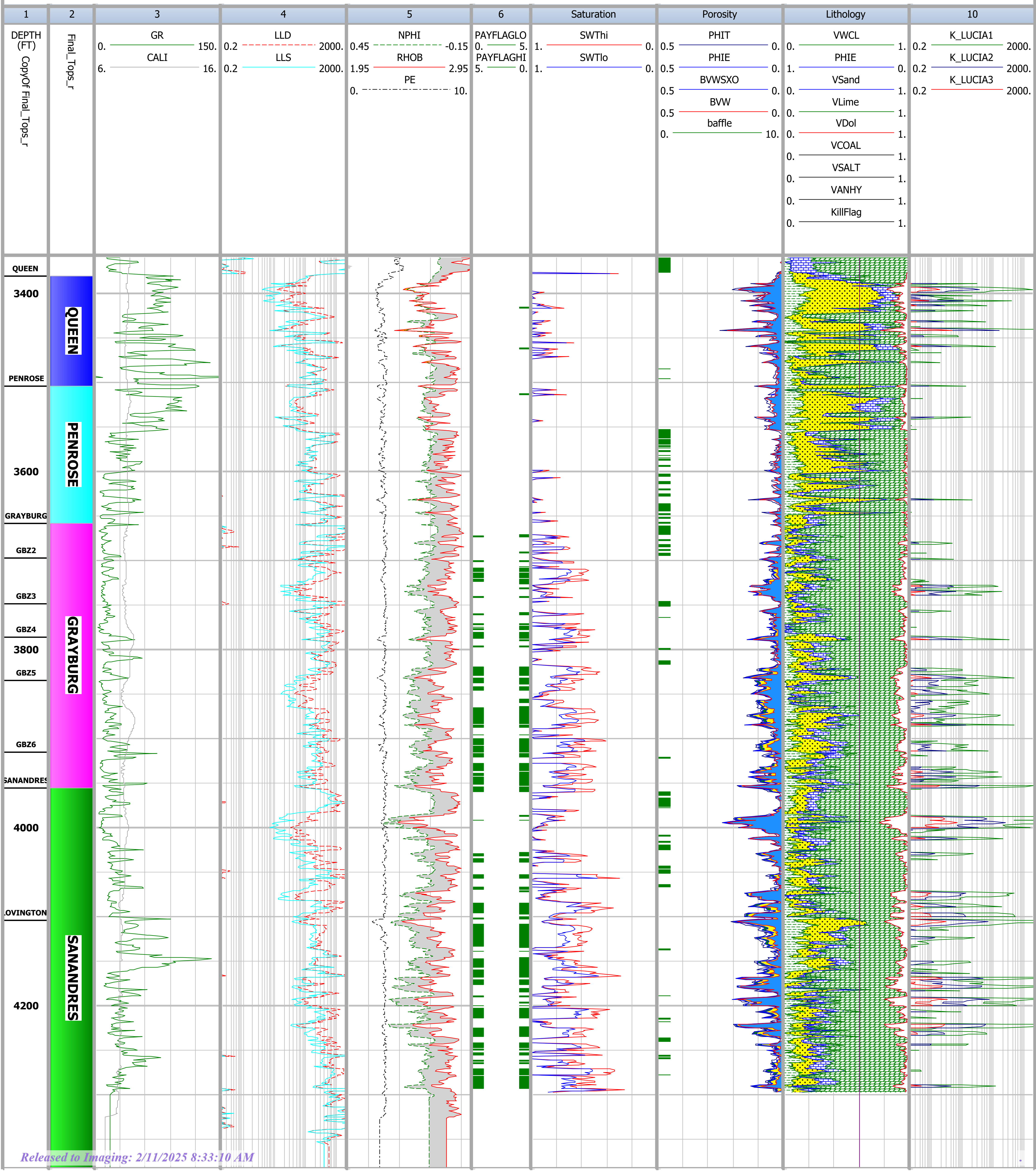
Scale : 1 : 1200

EMSU #673

DB : IP_Empire (8)

DEPTH (3360FT - 4382FT)

01/14/2025 18:12



Released to Imaging: 2/11/2025 8:33:10 AM

Petrophysical Analysis

Company
Well Name EMSU 329
Field EUNICE MONUMENT
Country
State
Location

Exhibit L-34

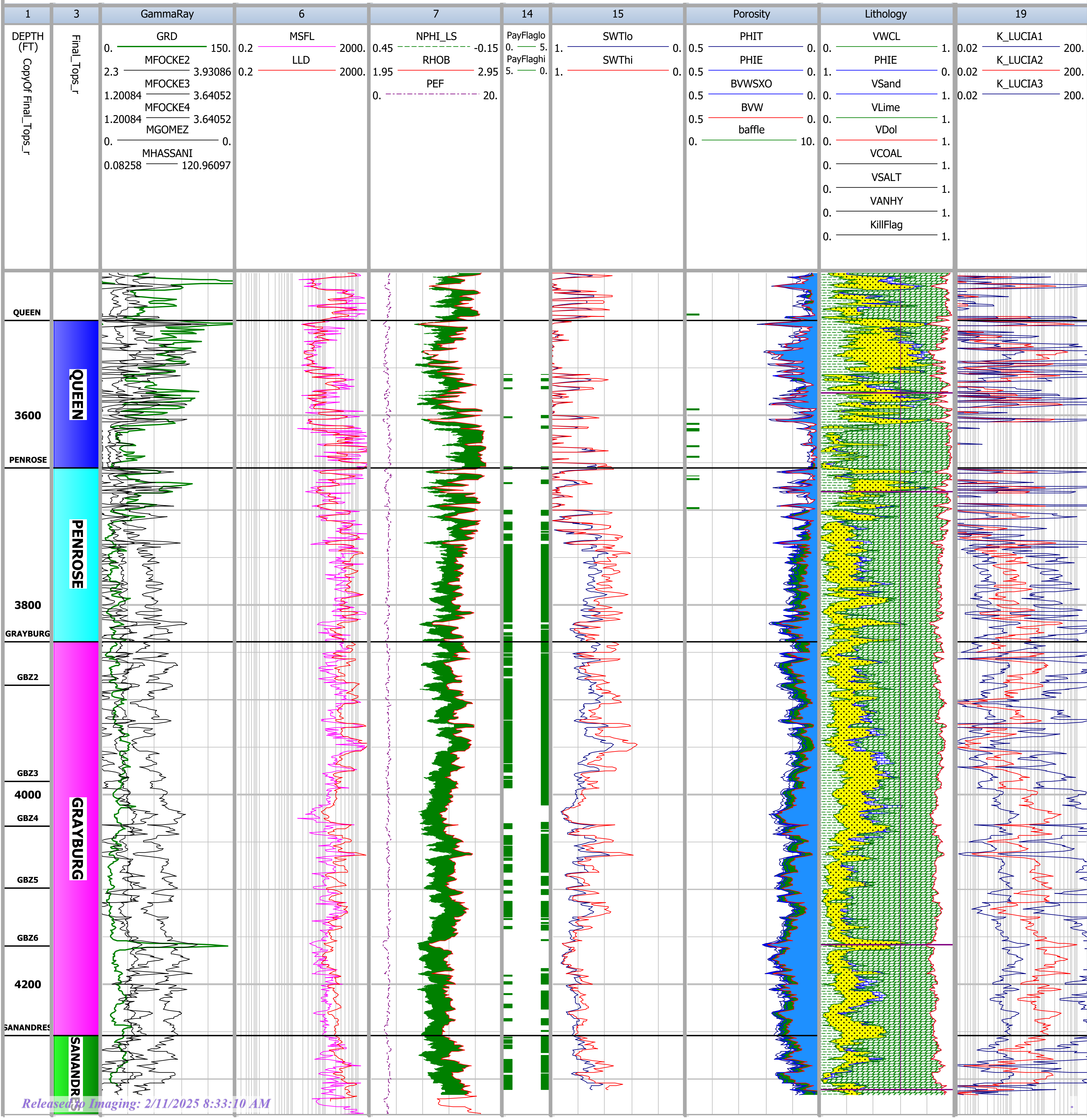
Scale : 1 : 1200

EMSU 329

DB : IP_Empire (17)

DEPTH (3450FT - 4337.5FT)

01/15/2025 08:55



Petrophysical Analysis

Company			
Well Name	EMSU 457		
Field	EUNICE MONUMENT		
Country		State	
Location			

Exhibit L-35

IP 2024

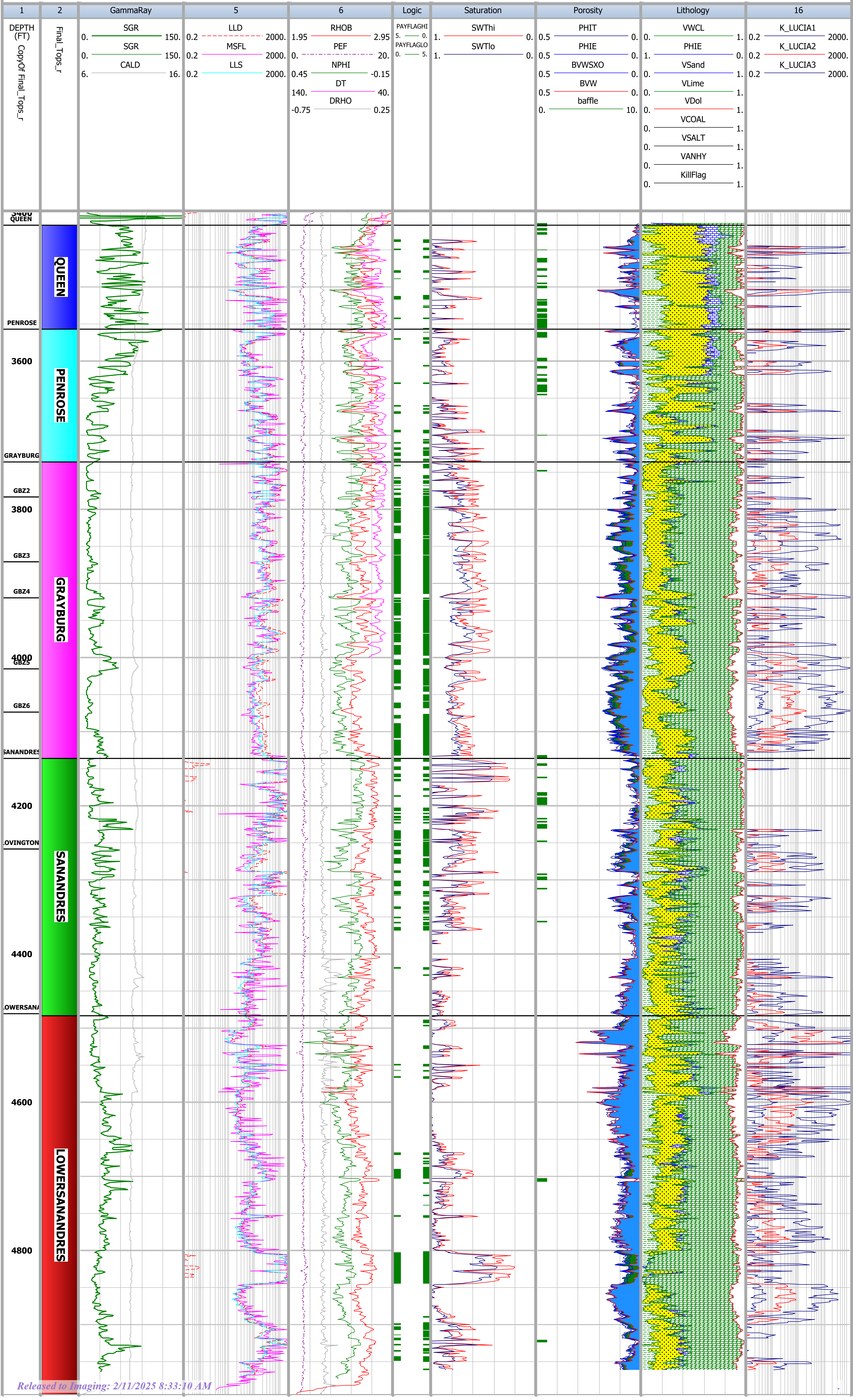
Scale : 1 : 1200

EMSU 457

DB : IP_Empire (14)

DEPTH (3400FT - 4994.5FT)

01/15/2025 08:26



Petrophysical Analysis

Company	
Well Name	EMSU 458
Field	EUNICE MONUMENT
Country	State
Location	

Exhibit L-36

IP 2024

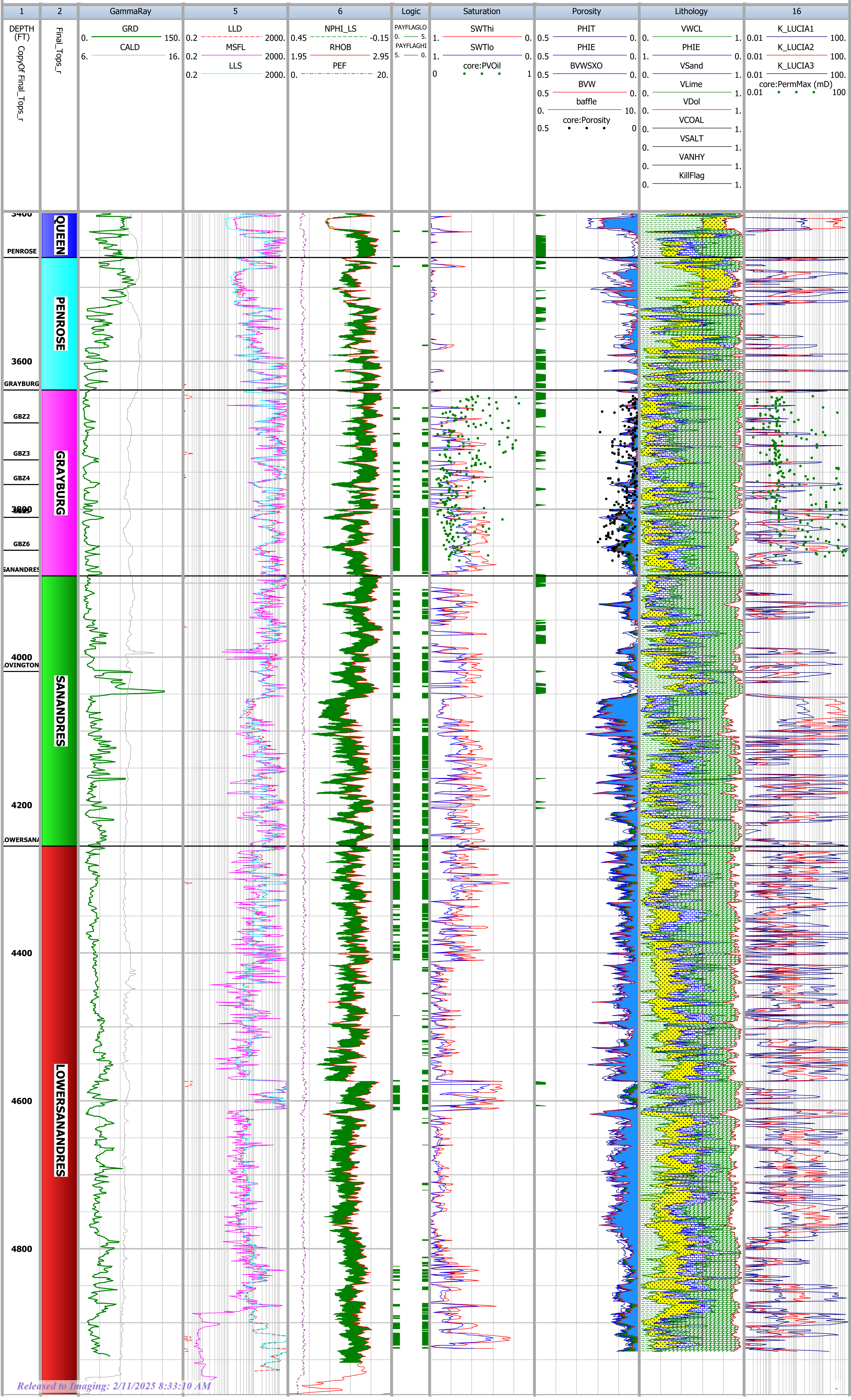
Scale : 1 : 1200

EMSU 458

DB : IP_Empire (1)

DEPTH (3400FT - 4997.5FT)

01/19/2025 17:52



Petrophysical Analysis

Company

Well Name EMSU 459

Field EUNICE MONUMENT

Country State

Location

Exhibit L-37

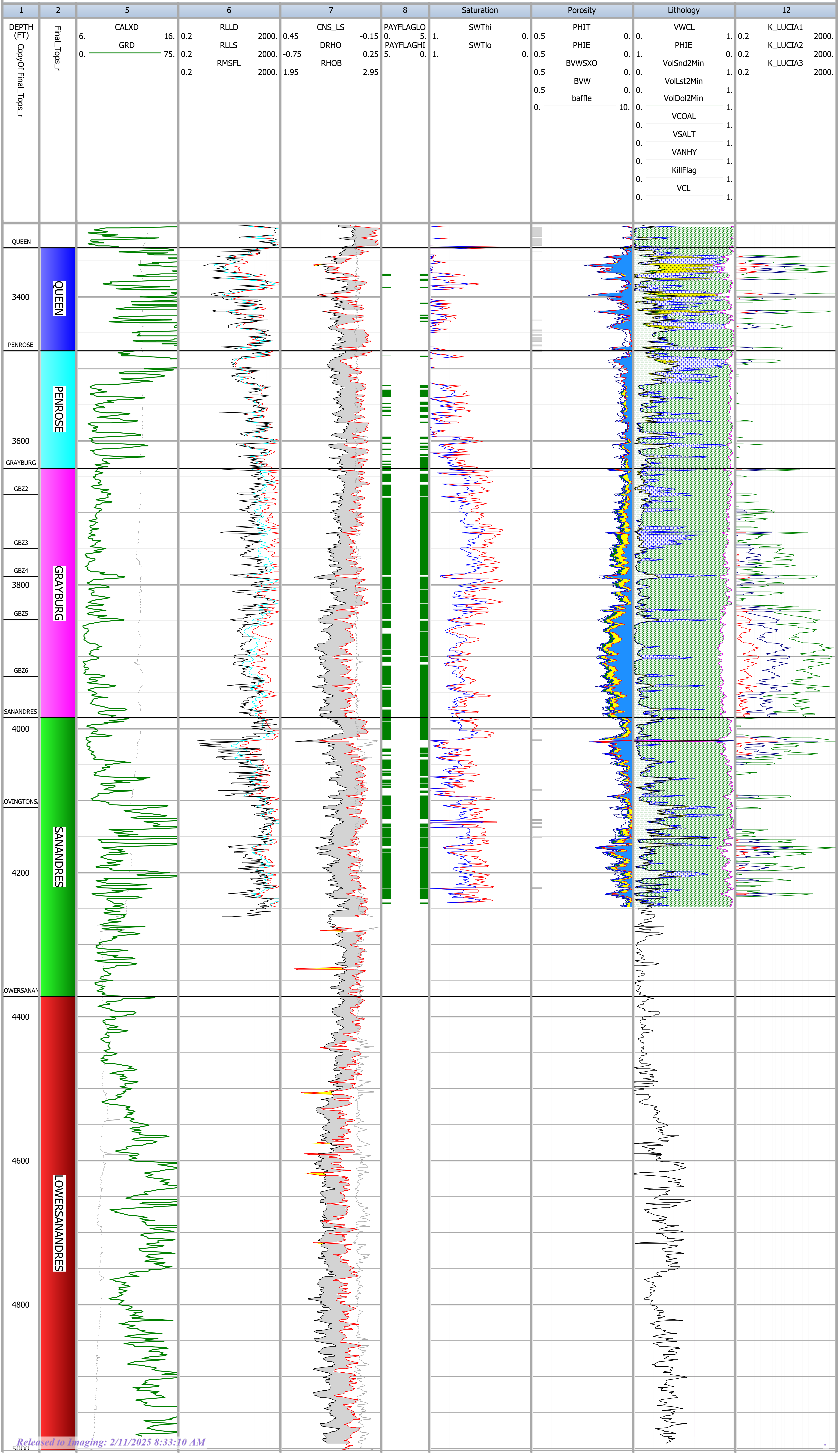
Scale : 1 : 1200

EMSU 459

DB : IP_Empire (2)

DEPTH (3300FT - 5002.5FT)

01/14/2025 17:36



Petrophysical Analysis

Company
Well Name EMSU 462
Field EUNICE MONUMENT
Country State
Location

Exhibit L-38

Scale : 1 : 1200

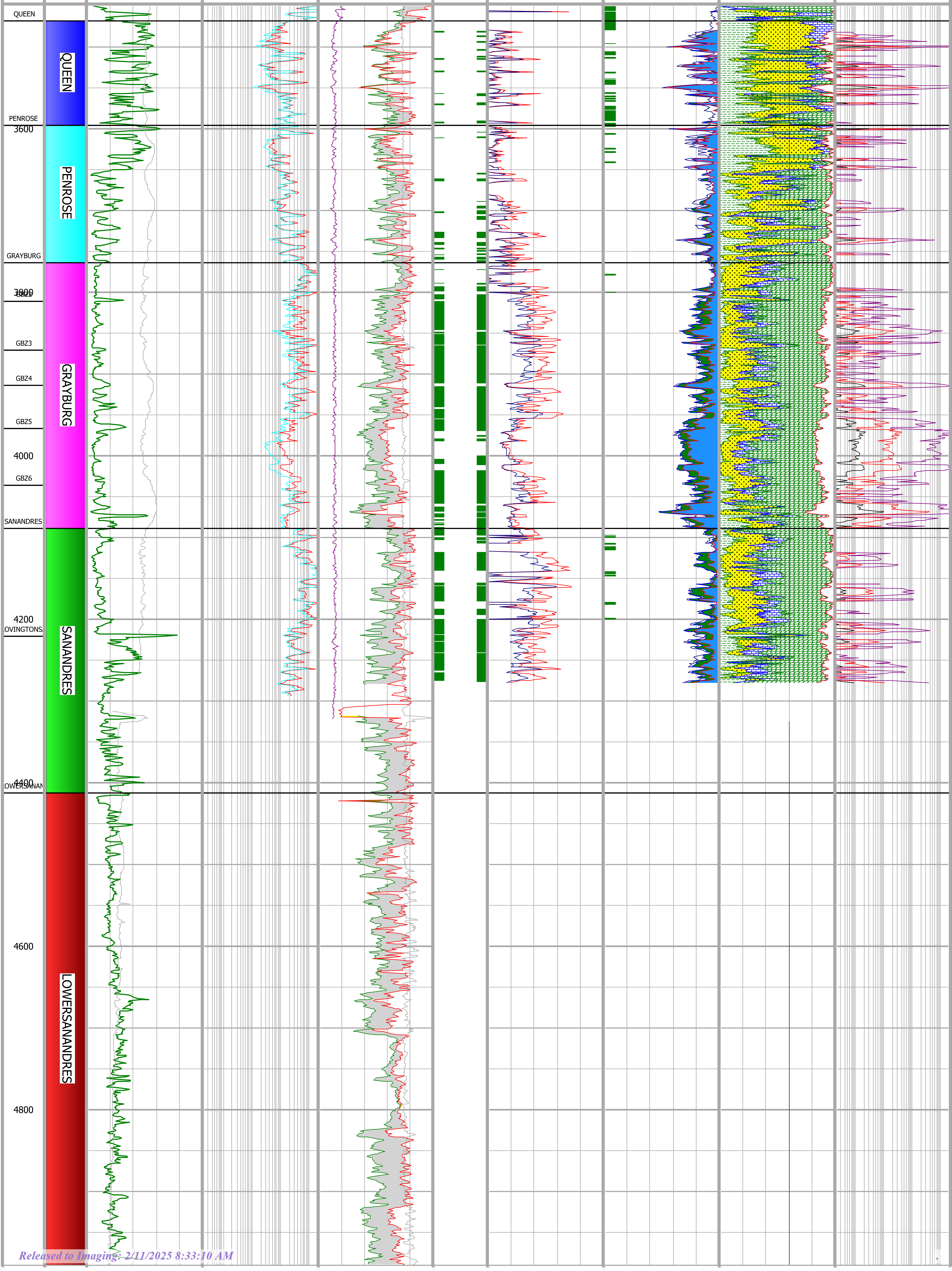
EMSU 462

DB : IP_Empire (16)

DEPTH (3450FT - 4990FT)

01/15/2025 08:48

1	2	5	6	7	8	Saturation	Porosity	Lithology	12
DEPTH (FT) CopyOf Final_Tops_r	Final_Tops_r	GRD_spl 0. – 150. CALD_SPL 6. – 16.	LLD 0.2 – 2000. LLS 0.2 – 2000.	NPHI_spl 0.45 – -0.15 DRHO_SPL -0.75 – 0.25 RHOB_spl 1.95 – 2.95 PEF 0. – 20.	PAYFLAGLO 0. – 5. PAYFLAGHI 5. – 0.	SWThi 1. – 0. SWTlo 1. – 0.	PHIT 0.5 – 0. PHIE 0.5 – 0. BVW 0.5 – 0. baffle 0. – 10.	VWCL 0. – 1. PHIE 1. – 0. VSand 0. – 1. VLime 0. – 1. VDol 0. – 1. VCOAL 0. – 1. VSALT 0. – 1. VANHY 0. – 1. KillFlag 0. – 1.	K_LUCIA1 0.2 – 2000. K_LUCIA2 0.2 – 2000. K_LUCIA3 0.2 – 2000.



Petrophysical Analysis

Exhibit L-39

Company	XTO ENERGY
Well Name	E.M.S.U. No. 658
Field	E.M.S.U.
Country	USA
State	NEW MEXICO
Location	155 FSL AND 1240 FWL

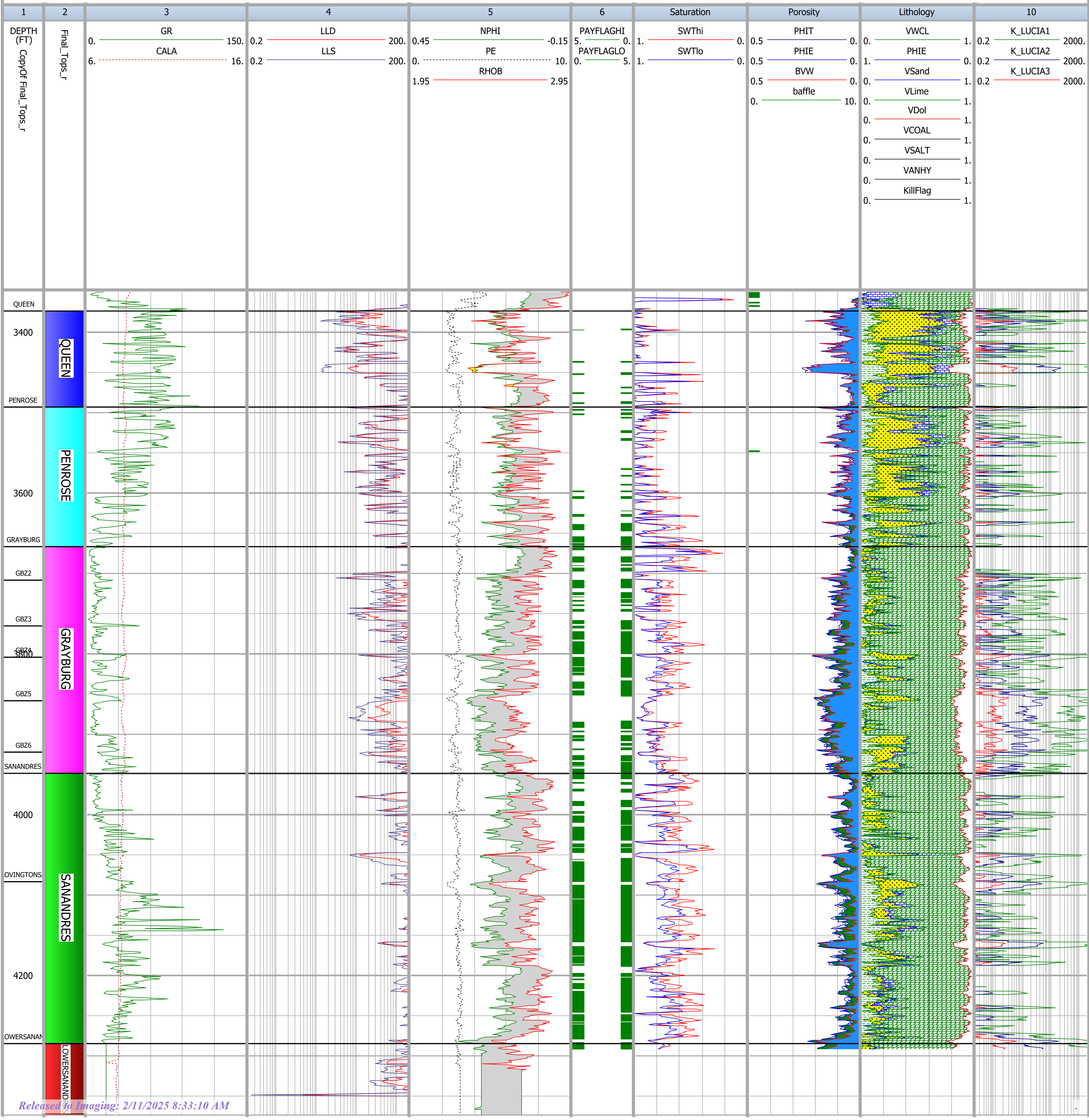
Scale : 1 : 1200

E.M.S.U. No. 658

DB : IP_Empire (10)

DEPTH (3350FT - 4373FT)

01/14/2025 18:30



Petrophysical Analysis

Company	XTO ENERGY
Well Name	EUNICE SOUTH MONUMENT UNIT No.713
Field	EUNICE MONUMENT; GRAYBURG-ANDRES
Country	USA — State NEW MEXICO
Location	1310' FSL & 2205' FEL

Exhibit L-40

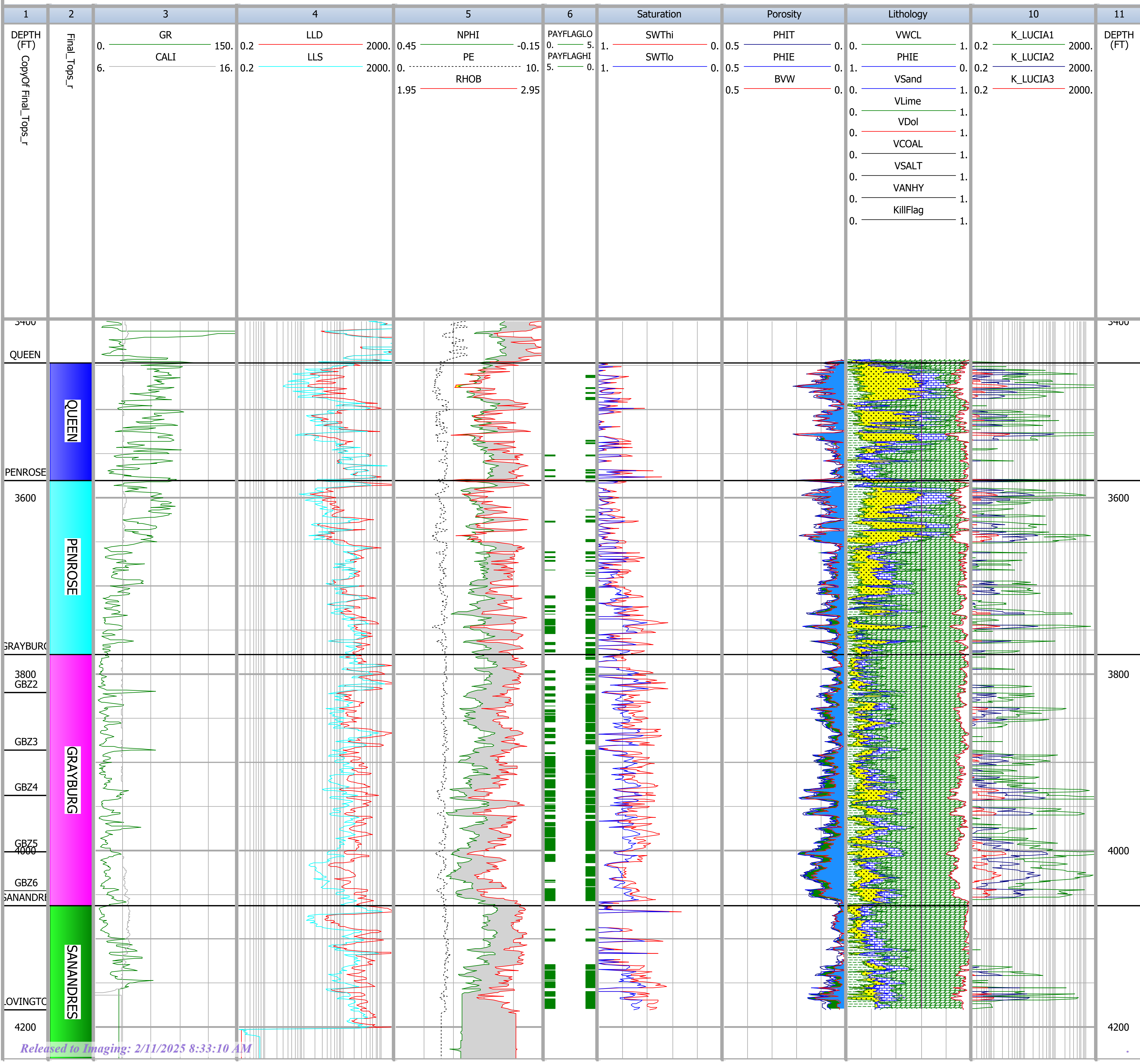
Scale : 1 : 1200

EUNICE SOUTH MONUMENT UNIT No.713

DB : IP_Empire (7)

DEPTH (3400FT - 4236FT)

01/14/2025 18:06



Petrophysical Analysis

Company

Well Name JA Aken 10

Field OIL CENTER

Country State

Location

Exhibit L-41

IP 2024

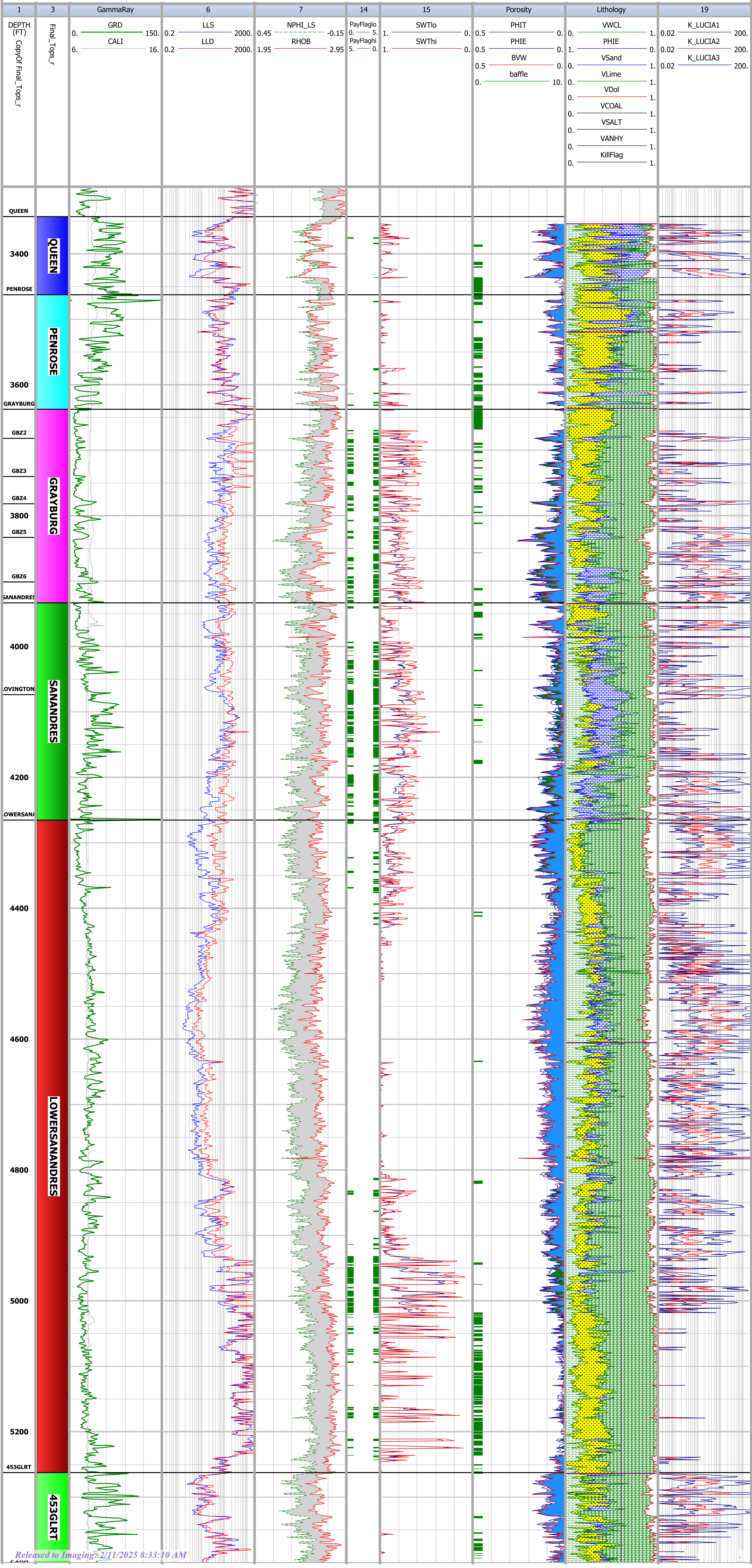
Scale : 1 : 1200

JA Aken 10

DB : IP_Empire (22)

DEPTH (3300FT - 5400FT)

01/15/2025 09:51



Petrophysical Analysis

Company
Well Name: Meyer B 4-33
Field: OIL CENTER
Country
State
Location

Exhibit L-42

IP 2024

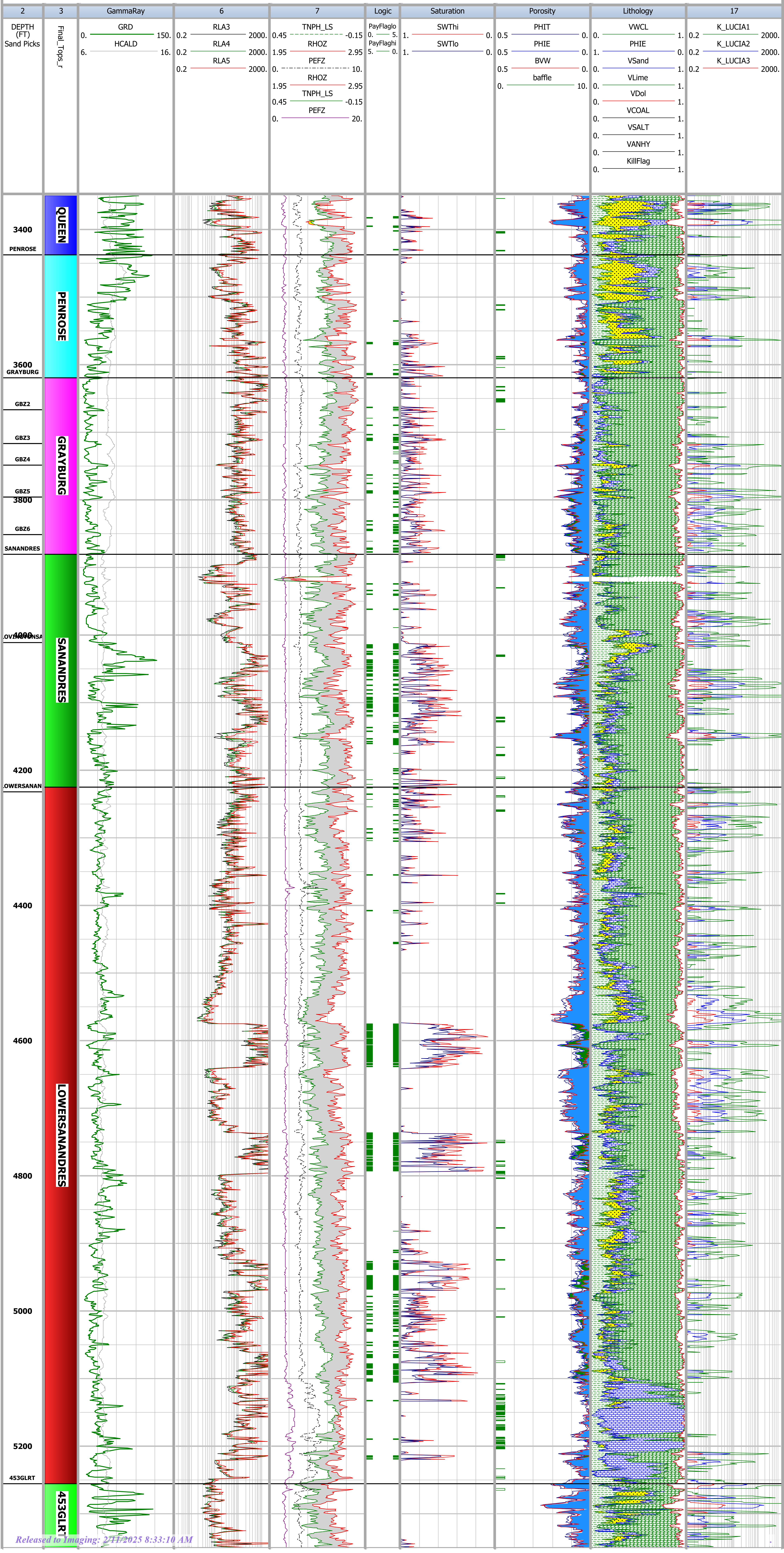
Scale : 1 : 1200

Meyer B 4-33

DB : IP_Empire (23)

DEPTH (3350FT - 5350FT)

01/15/2025 09:54



Petrophysical Analysis

Company	
Well Name	Meyer B 4-34
Field	OIL CENTER
Country	State
Location	

Exhibit L-43

IP 2024

Scale : 1 : 1200

Meyer B 4-34

DB : IP_Empire (18)

DEPTH (3350FT - 5460FT)

01/15/2025 09:02

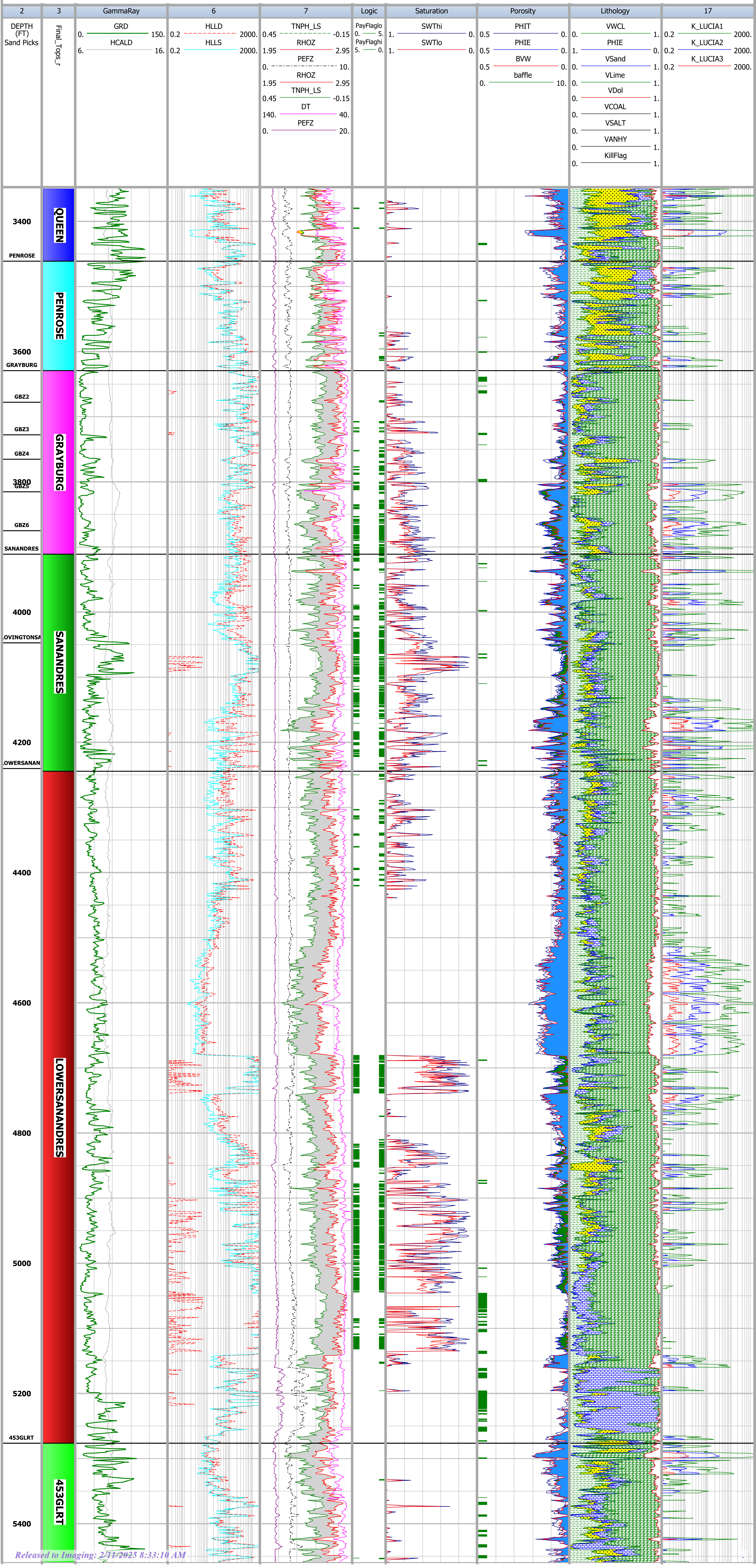


Exhibit L-44

Petrophysical Analysis

Company	TEXACO E&P INC.
Well Name	NEW MEXICO "H" STATE NCT-4
Field	PERMIAN DEVONIAN
Country	USA — State NEW MEXICO
Location	2200' FSL & 1960' FWL NESW

IP 2024

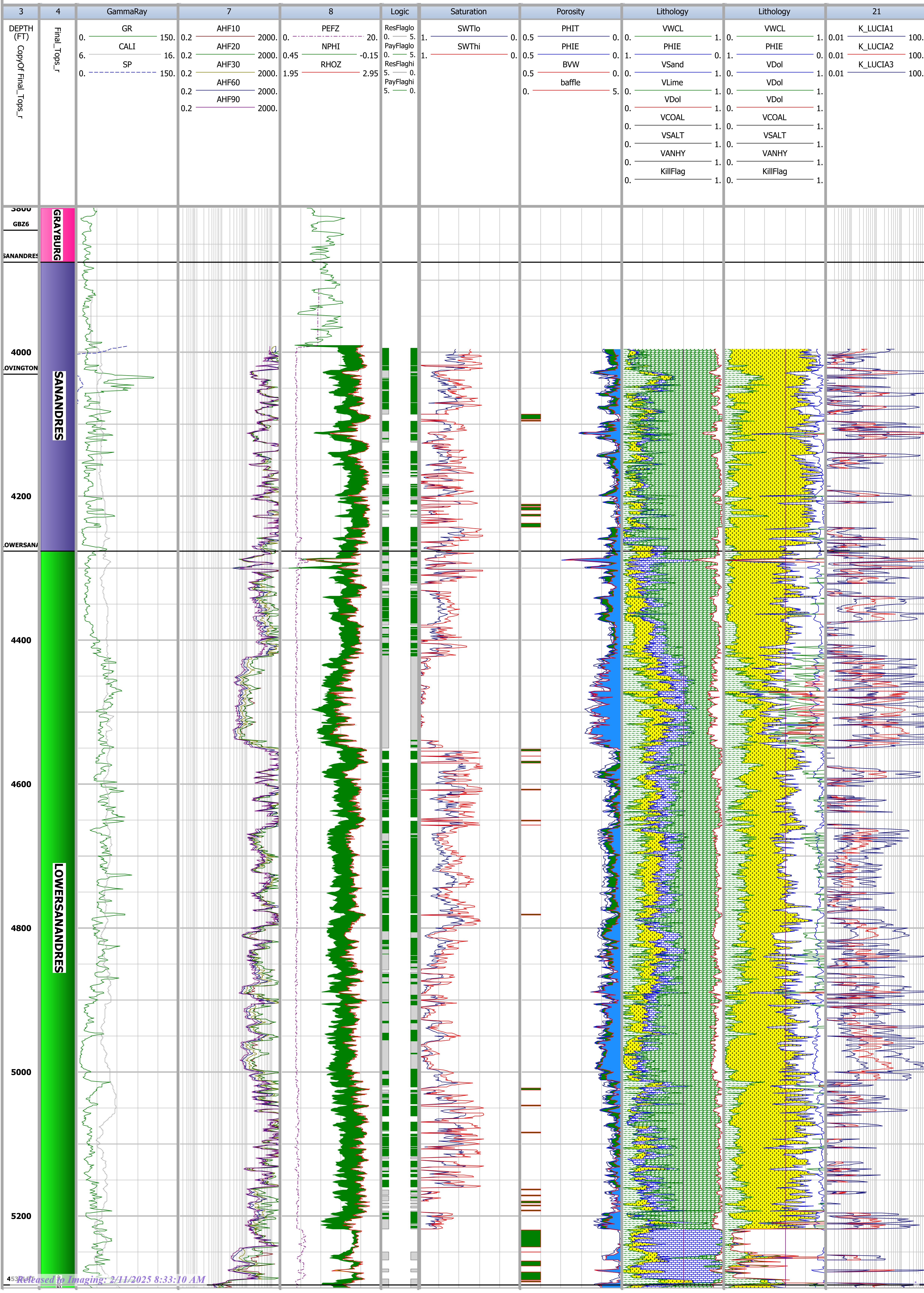
Scale : 1 : 1200

NEW MEXICO "H" STATE NCT-4

DB : IP_Empire (31)

DEPTH (3800FT - 5300FT)

01/28/2025 21:38



Petrophysical Analysis

Company	
Well Name	OC Fed Com1
Field	WILDCAT
Country	State
Location	

Exhibit L-45

IP 2024

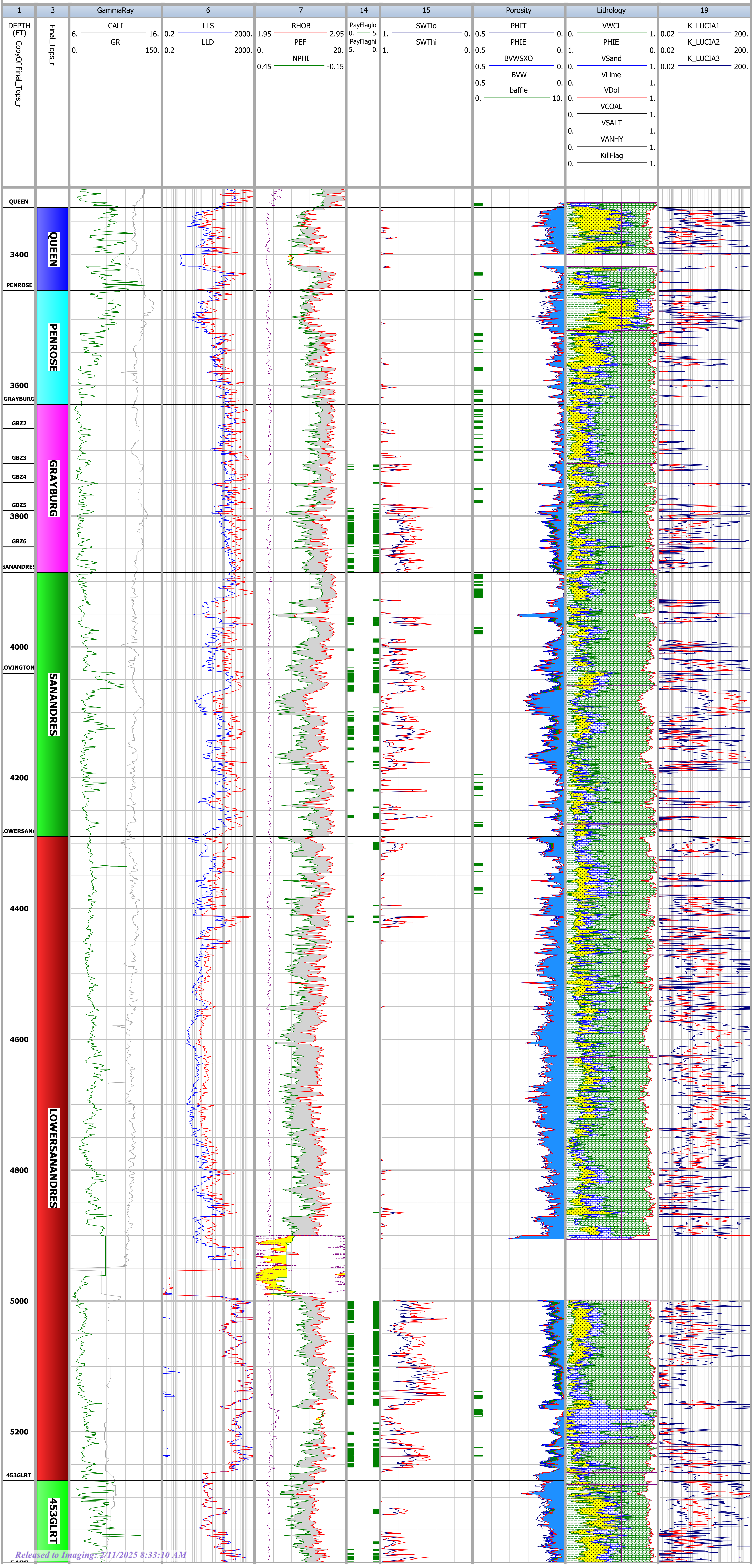
Scale : 1 : 1200

OC Fed Com1

DB : IP_Empire (21)

DEPTH (3300FT - 5400FT)

01/15/2025 09:48



Petrophysical Analysis

Company	Goodnight Midstream Permian, LLC
Well Name	Nolan Ryan SWD #1
Field	Eunice
Country	State New Mexico
Location	779' FSL & 1995' FEL

Exhibit L-46

IP 2024

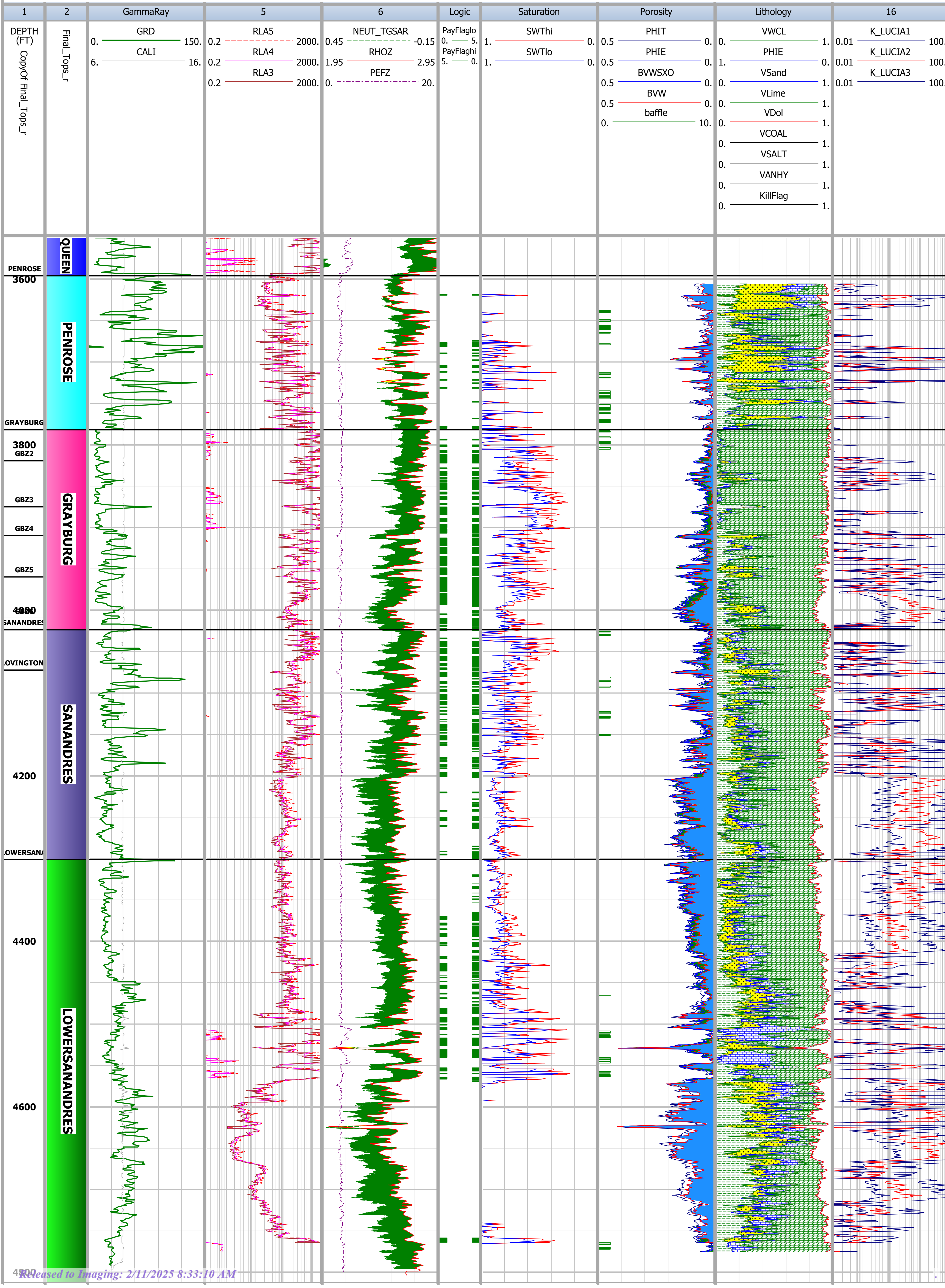
Scale : 1 : 1200

Nolan Ryan SWD #1

DB : IP_Empire (26)

DEPTH (3550FT - 4813FT)

01/28/2025 21:12



Petrophysical Analysis

Company	CONOCO INC
Well Name	SEMO NO 123
Field	MONUMENT TUBB /HEIR DRINKAR
Country	USA — State NM
Location	1860 AL AND 660 FEL SENE

Exhibit L-47

IP 2024

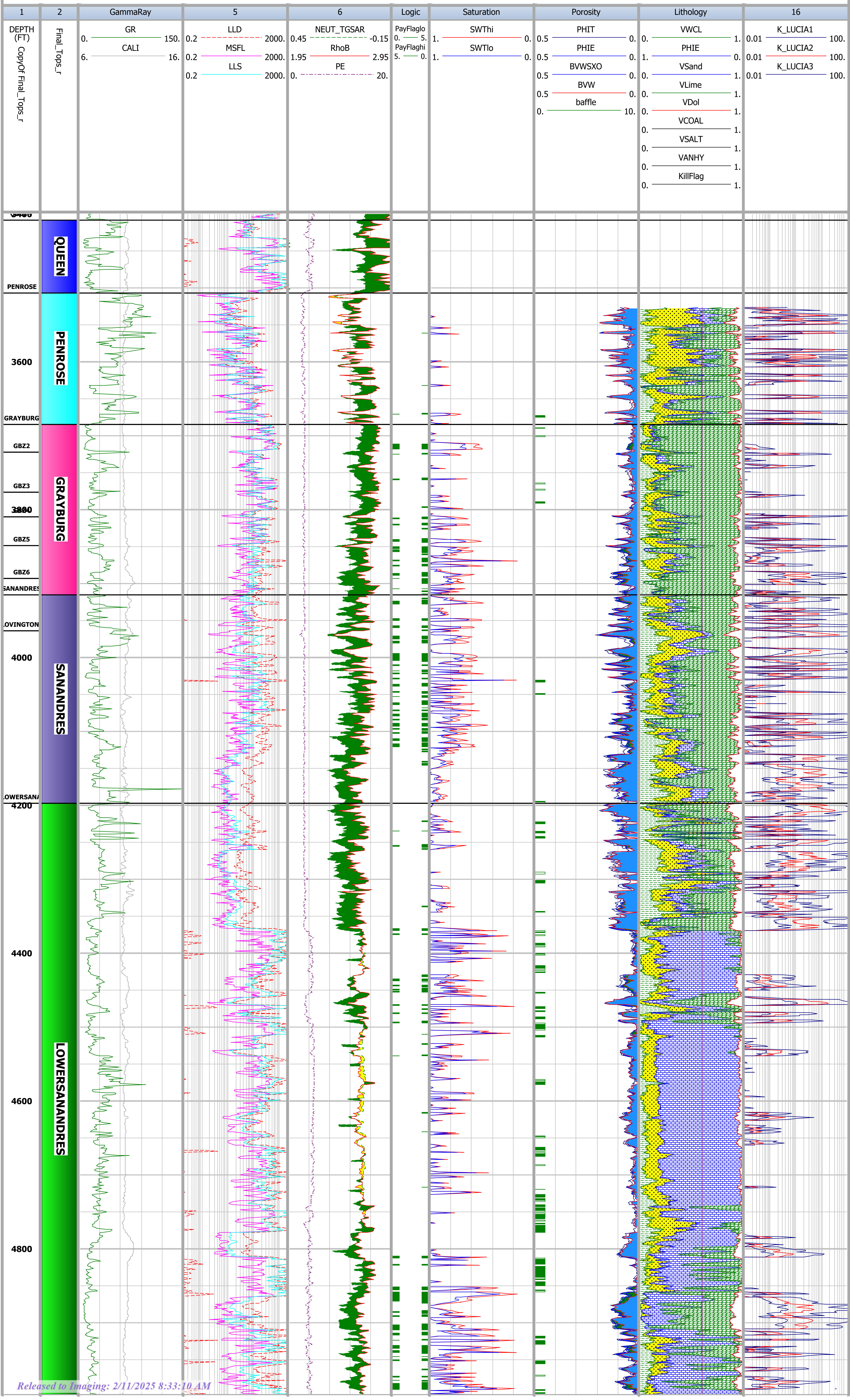
Scale : 1 : 1200

SEMO NO 123

DB : IP_Empire (29)

DEPTH (3400FT - 4997.5FT)

01/28/2025 20:34



Petrophysical Interpretation

Company	AMERADA HESS CORPORATION
Well Name	NORTH MONUMENT G SA UNIT BULK 5 #22
Field	EUNICE-MONUMENT
Country	UNITED STATES OF AMERICA — State NEW MEXICO
Location	S19 T19S R37E

Exhibit L-48

IP 2024

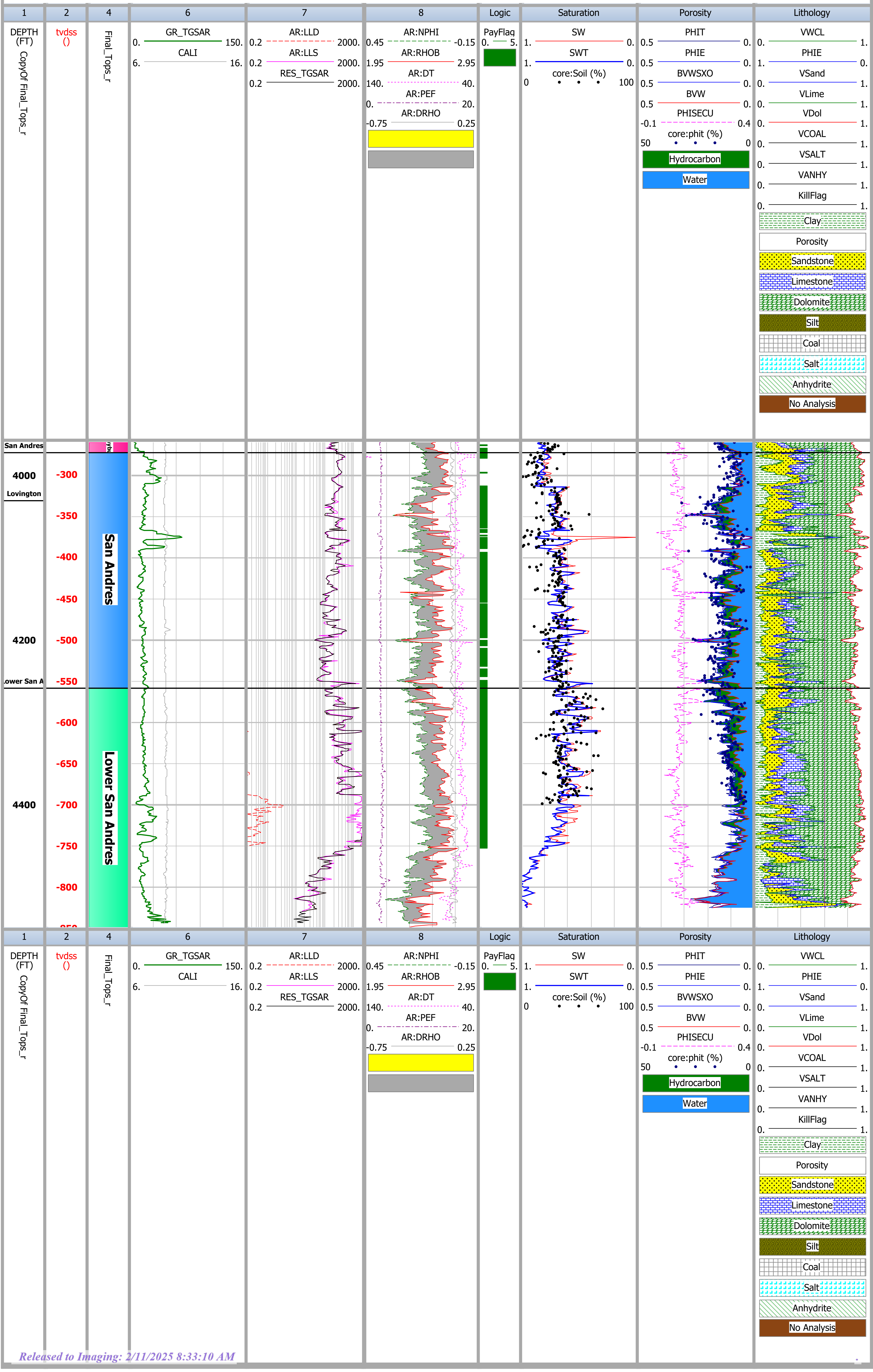
Scale : 1 : 1200

NORTH MONUMENT G SA UNIT BULK 5 #22

DB : IP_Empire (34)

DEPTH (3960FT - 4550FT)

01/28/2025 21:17



Petrophysical Analysis

Company	Goodnight Midstream Permian, LLC
Well Name	Ted SWD 1
Field	SWD
Country	State New Mexico
Location	2,402' FNL & 1,911' FWL--Sec 28, T21S, R 36E.

Exhibit L-49

IP 2024

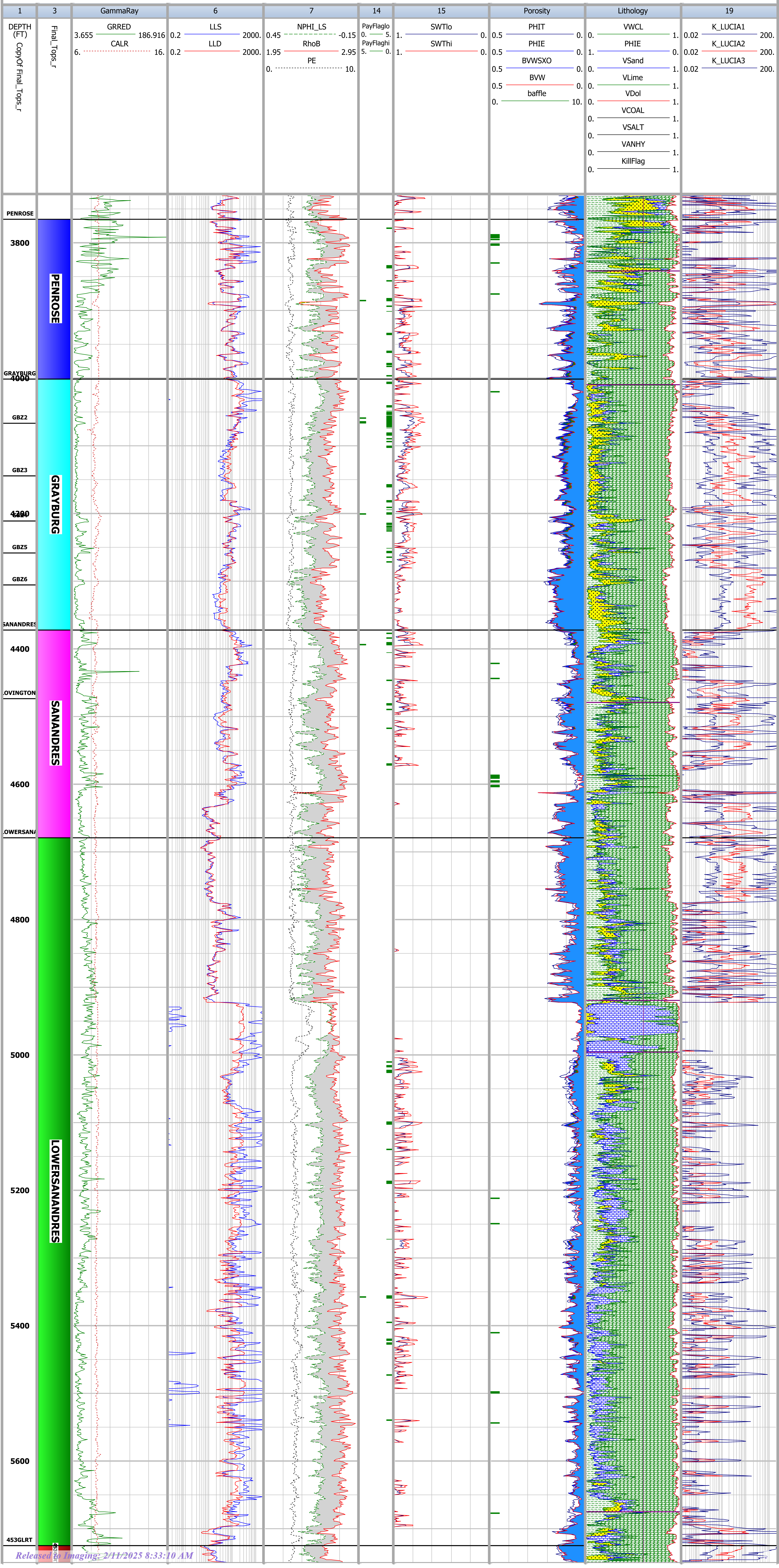
Scale : 1 : 1200

Ted SWD 1

DB : IP_Empire (24)

DEPTH (3730FT - 5750FT)

01/15/2025 10:03



Petrophysical Analysis

Company	GOODNIGHT MIDSTREAM PERMIAN, LLC
Well Name	YAZ 28 SWD 1
Field	Eunice
Country	USA
State	New Mexico
Location	230' FNL & 236' FEL

Exhibit L-50

IP 2024

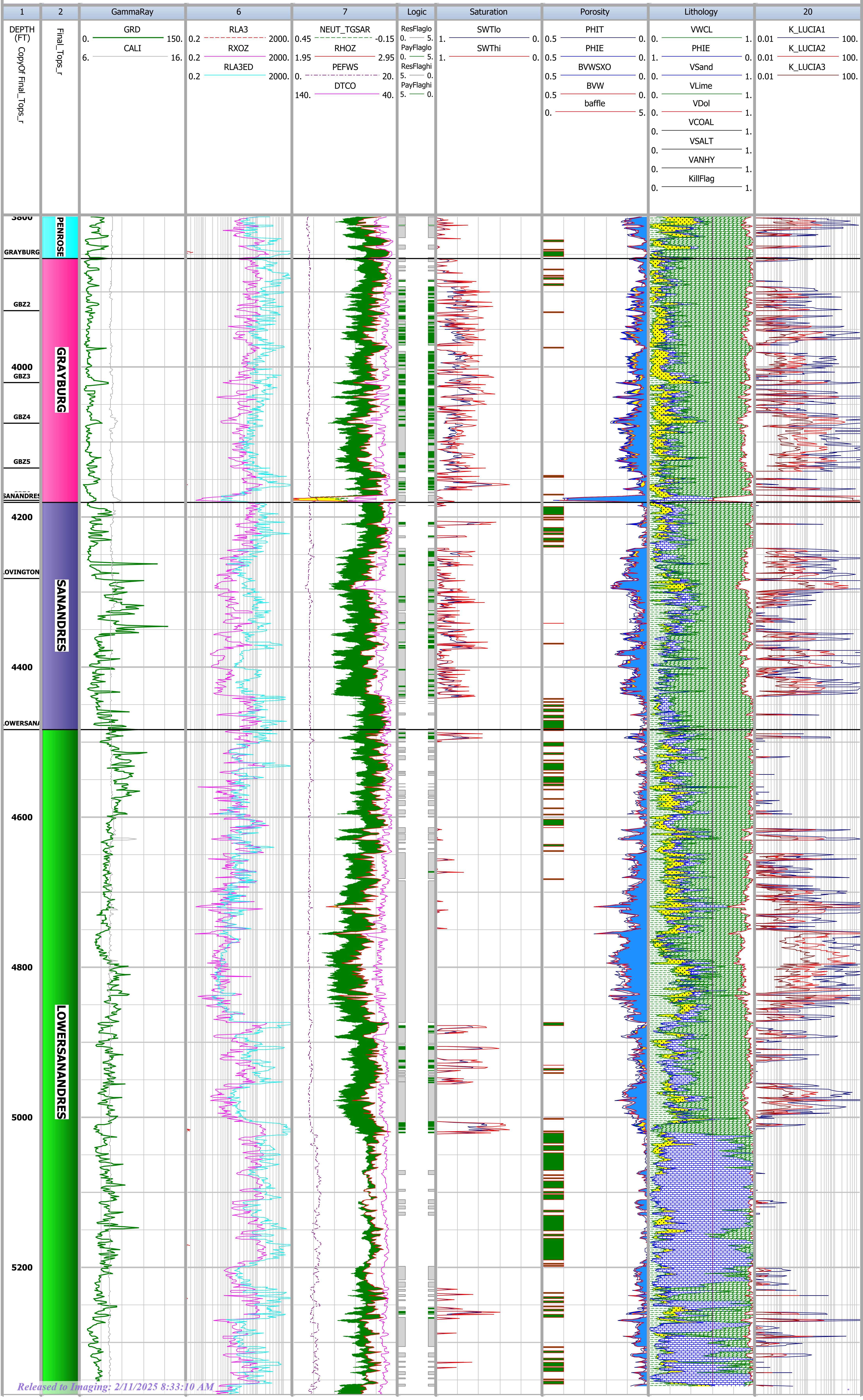
Scale : 1 : 1200

YAZ 28 SWD 1

DB : IP_Empire (27)

DEPTH (3800FT - 5370FT)

01/28/2025 21:06



Petrophysical Analysis

Company	CHEVRON USA INC
Well Name	CENTRAL DRINKARD UNIT ##441
Field	DRINKARD
Country	U.S.A.
State	NEW MEXICO
Location	SWNWNW

Exhibit L-51

IP 2024

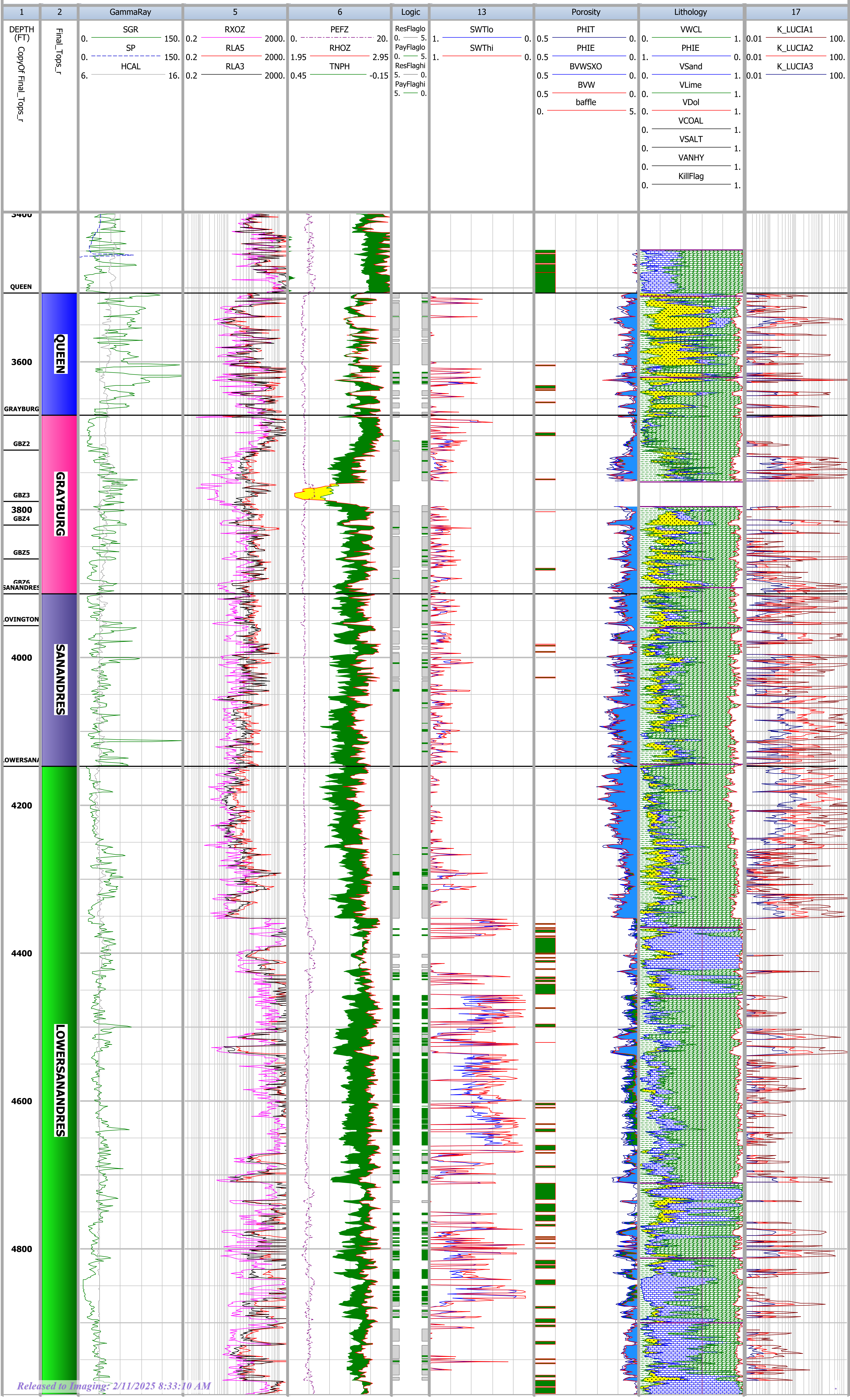
Scale : 1 : 1200

CENTRAL DRINKARD UNIT ##441

DB : IP_Empire (30)

DEPTH (3400FT - 4997.5FT)

01/28/2025 20:26



Petrophysical Analysis

Company

Well Name WALLACE STATE 7

Field OIL CENTER

Country State

Location

Exhibit L-52

IP 2024

Scale : 1 : 1200

WALLACE STATE 7

DB : IP_Empire (32)

DEPTH (3600FT - 5300FT)

01/28/2025 21:36

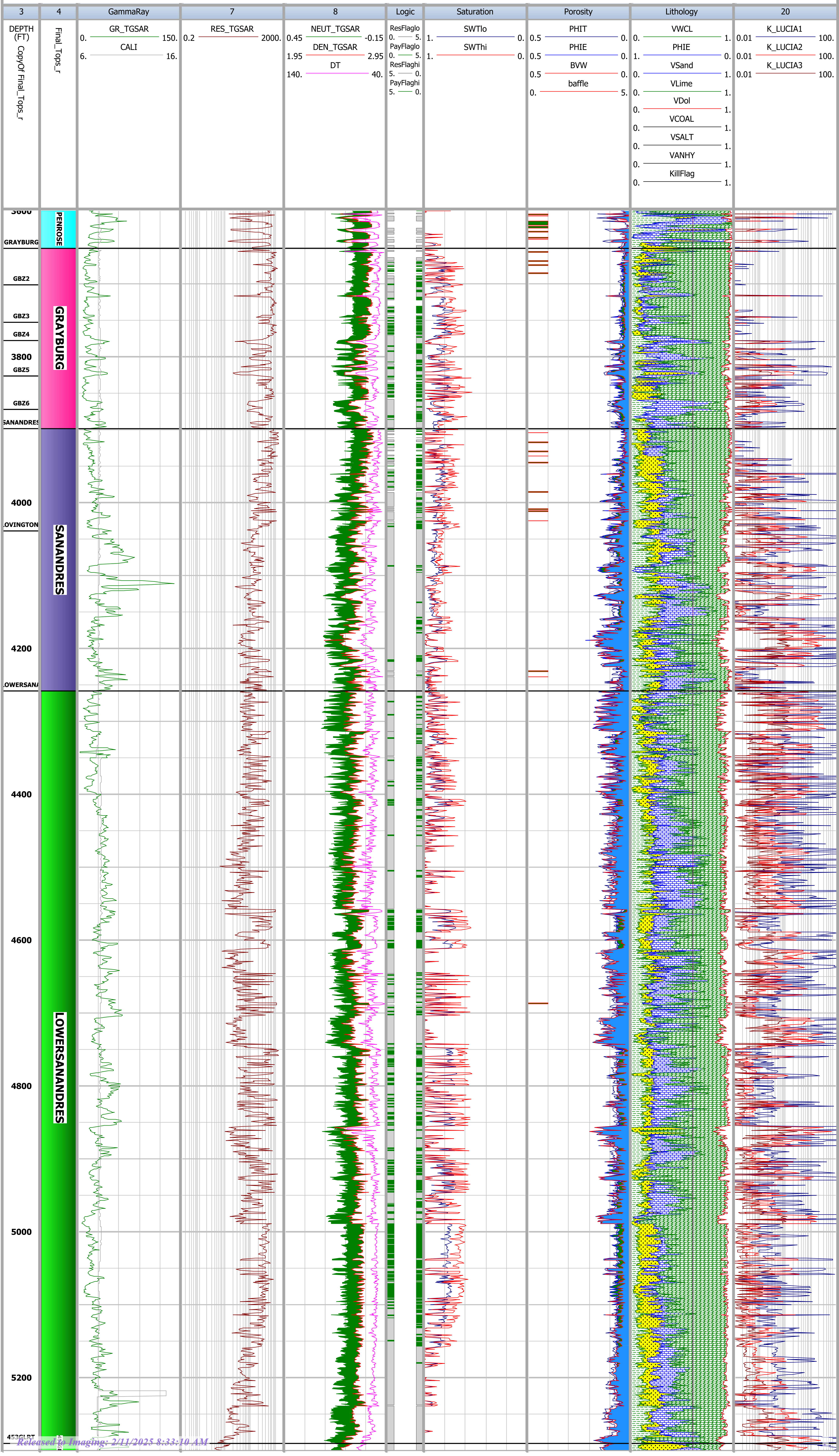


EXHIBIT L-53

Curriculum Vitae

Stanley 'Scott' Birkhead (M.Sc.)
Principal Petrophysicist/Owner
Petrobrane Petrophysical Consulting LLC

Profile

Extensive knowledge and experience in the petrophysical evaluation and assessment of conventional, unconventional, carbonate, multimineral, CO2 injection, and geothermal wells	Wide experience working with core data and with core/log integration including mudlogs
Field studies, Operational Petrophysics, Reserves calculation, Experimental Design	Low Resistivity Low Contrast Pay evaluation expertise
Formation Evaluation Planning, wireline tendering and execution	Exploration and development petrophysics
Years of experience and great love of training and mentoring in Petrophysics from the intern to the classroom level	Broad experience working with modern, historic, as well as Eastern European logs

Education

Texas A&M University
2001 Bachelor of Arts: Geology
2005 Master of Science: Geology
Thesis: Architecture of the Upper Sego Sandstone, Book Cliffs, Utah
Advisor: Dr. Brian Willis

Professional Experience

Independent Petrophysical Consulting
Principal Petrophysicist (full time) 9/15/22 – 10/05/2022

Petrobrane Petrophysical Consulting LLC
Owner, Principal Petrophysicist 10/05/2022 - current
Clients:

Projeo Corporation 07/2024

- Petrophysical consultant evaluating the petrophysical potential for upcoming CCUS project and for input into reservoir models

ARI (Advanced Resources International, Inc) 07/2024 - current

- Petrophysical mentoring
- Evaluating planned logging programs for operational wells, meeting with vendors
- Recommendations for logging strategies, sticking mitigation, etc.

- Evaluating the petrophysical potential for upcoming CCUS project and for input into reservoir models

Alpha Energy 06/2024 - 08/2024

- Petrophysical field study for field optimization

Armstrong Oil and Gas 12/2023 - present

- Petrophysical consultant for spring drilling campaign on North Slope of Alaska
- Worked wellsite wireline operations on company's behalf
- Consulted on Wireline program with operator and partners
- Troubleshot wellsite issues and ensured data quality
- Petrophysical interpretation

Quidnet Energy 11/2023 - present

- Petrophysical consultant reviewing appropriateness of reservoirs for application and testing of new technology

Ops Geologic 9/2022 - present

- Petrophysical consultant to clients of Ops Geologic
- Projects include exploration, field studies, bypassed pay, LRLC, conventional, and unconventional reservoirs
- Worked on multiple projects in the continental US

Criterion Energy Partners 9/2022-7/2023

- Consulting Petrophysicist to Criterion geothermal projects
- Projects include exploration, field studies, outputs for modelling, correlation, delineation of objective zones for production and salt water disposal

Talos Low Carbon Solutions 10/2022-4/2024

- Planned, executed, and interpreted the formation evaluation of the first offshore CCUS well in the Gulf Coast
- Consulting Petrophysicist for Talos Low Carbon Solutions
- Assessed viability of several areas in the Gulf Coast arena for CCUS
- Petrophysical support and guidance for multiple projects
- Wireline tendering, vendor selection, program design
- Formation evaluation related Class VI permitting experience
- Communication and integration with partners
- Work with modelers to ensure proper distribution of properties

Western Midstream 10/2022-present

- Operations Petrophysics for Western Midstream salt-water disposal wells
- Communication and instruction to wireline crews regarding logging
- Interpretation of data in near real time for wells being evaluated.
- Deliver high quality interpretation to client.
- Detailed work on Geomechanics to support permitting and geology
- Petrophysical support for assessing new objectives for water injection

DeGolyer and MacNaughton
Independent Consultant 11/2/20 - 4/19/21
Senior Petrophysicist (full time) 4/19/21 – 5/20/22

Highlights: Work in the Reservoir Studies Division included petrophysical reserve reviews, reserve upgrades, exploration concept assessment, and uncertainty analysis. Part of a select group that developed a new workflow to correctly bracket client uncertainty deterministically. Also improved communication and morale between petrophysicists by instigating monthly technical Zoom meetings.

Responsibilities:

- Developed petrophysical models and characterized reservoir properties for numerous projects
- Quality control of well logging data from modern, vintage, and Russian sources
- Managed simultaneous projects while maintaining stakeholder communication
- Utilized data specific petrophysical techniques to deal with poor and/or uncalibrated data
- Communicated results through detailed and peer reviewed technical documentation and figures, verbally with clients using translators when necessary, and through a series of presentations documenting the phases of the project.
- Collaborated closely with geologists to ensure quality results with tight deadlines

Kerr McGee | Anadarko Petroleum Corporation | Occidental Petroleum
9/26/2005 – 6/25/2020
Senior Staff Petrophysicist

Highlights: Principal petrophysicist for major assets at different times during their life cycle including Ghana, Mozambique, and unconventional assets. In Mozambique, I worked the multi-billion dollar project to the Final Investment Decision. Post FID and sale of the asset to Total, I finalized the complex multiscale petrophysical model and transferred the knowledge to the new owners. I also have extensive experience in fresh water and low resistivity/low contrast reservoirs.

Responsibilities:

- Extensive international experience
- Developed petrophysical models, characterized reservoir properties for numerous projects, and presented results to management, partners, and NOCs.
- Communicated with drilling rig regarding operations and evaluation program.
- Characterized reservoirs for geologic environments using an array of petrophysical techniques.
- Developed workflows for new techniques and new experiments in log and core analysis.
- Integrated with the teams for major studies, technical documentation, data analytics, peer reviews, wireline tendering, dataroom evaluation, asset sales, and new ventures work.
- Handed off projects, interpretations, and data to new companies such as Total post-acquisition of multi-billion dollar assets such as Golfinho and Prosperidade.
- Trained and mentored staff and secondees.

Regions worked

International: Algeria, Australia, Benin, Brazil, China, Colombia, Equatorial Guinea, The Falklands, Gabon, Ghana, India, Indonesia, Ivory Coast, Kenya, Liberia, Madagascar, Mozambique, Namibia, Newfoundland, New Zealand, Nigeria, Nova Scotia, Peru, Poland, Russian Federation, Senegal, Sierra Leone, South Africa, Trinidad and Tobago, Tunisia, U.K., Ukraine, Uzbekistan, and others

US: Marcellus, Carthage, GOM Deepwater, Gulf Coast (Texas, Louisiana), Natural Buttes, Haynesville, Wamsutter, Eagleford, Eaglebine, Wattenberg, Alaska, Permian Basin, South Texas, Delaware Basin, Wyoming, Mississippi, and more

External Experience

URTEC
Member of volunteer group planning the technical program for the Petrophysical portion of the conference. Involved for 2023, 2024, and starting planning for 2025.
Responsibilities: Part of committee in charge of building Theme 2 (Petrophysics) for the program. Also part of the committee to build a program of special topics and lunches.

Unconventional Resources Special Interest Group/SPWLA
Steering Committee Member holding various officer positions.
Responsibilities: Key planning member of the group that hosted several annual one-day conferences and funded several college scholarships focused on unconventional petrophysical topics. The special interest group has now been dissolved.

Petrophysical Interest Group/AAPG
Steering Committee Member / Instructor
Responsibilities: While still in its formational years, an established goal of the group is education and awareness. Group is currently on hiatus.

Leukemia and Lymphoma Society's Light the Night Walk
Team Captain
Responsibilities: A key leader in Anadarko's main fundraising efforts for this charity for several years.

URTEC 2023-2024

Session Chair/Reviewer/moderator volunteering within the Petrophysical themes and topicals for the conventions

Professional Interests

Teaching, mentoring, research/data integration, freshwater aquifers, low resistivity/low contrast pay, upscaling, modern sedimentary processes, uncertainty analysis, unconventional reservoirs, CO2 sequestration and capture, multimineral analysis, bridging between geology and data science.

References

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Honarpour, M. M., Nagarajan, N. R., Grijalba, A. C., Valle, M., and K. Adesoye. "Rock-Fluid Characterization for Miscible CO2 Injection: Residual Oil Zone, Seminole Field, Permian Basin." Paper presented at the SPE Annual Technical Conference and Exhibition, Florence, Italy, September 2010. doi: https://doi.org/10.2118/133089-MS

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Trentham, Melzer, A "Cookbook" Approach to Evaluating Residual Oil Zones Completed as Horizontal Depressurizing (DUROZ) Wells in the San Andres Formation* Search and Discovery Article #51570 (2019)** Posted May 27, 2019 *Adapted from oral presentation given at 2019 AAPG Southwest Section Annual Convention, Dallas, Texas, April 6-9, 2019

Trentham, Robert C., et al. "Case Studies of the ROZ CO2Flood and the Combined ROZ/MPZ CO2Flood at the Goldsmith Landreth Unit, Ector County, Texas. Using "Next Generation" CO2EOR Technologies to Optimize the Residual Oil Zone CO2Flood." , Jun. 2015. https://doi.org/10.2172/1224947

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STATE OF NEW MEXICO
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES
OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO — **CASE NO. 24123, ORDER NO. R-22869-A**

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS LEA COUNTY, NEW MEXICO — **CASE NOS. 23614-23617**

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO. — **CASE NO. 23775**

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO — **CASE NOS. 24018-24020, 24025**

SELF-AFFIRMED STATEMENT OF JAMES L. BUCHWALTER – REBUTTAL

I, James L. Buchwalter make the following self-affirmed statement:

1. I am over the age of 18, and have the capacity to execute this affirmation, which is based on my personal knowledge.

2. I am President of Gemini Solutions Inc. (“GSI”) in Richmond, Texas and I am a practicing Petroleum and Reservoir Engineer with 43 years of experience in the petroleum industry, with special emphasis on reservoir simulation. My curriculum vitae is attached to my self-affirmed Statement filed as Exhibit E on August 26, 2024, in these matters.

EXHIBIT M

3. I submit this rebuttal statement on behalf of Empire New Mexico LLC in connection with the above-referenced matters, in accordance with paragraph 7 of the Pre-Hearing Order issued in these matters on December 5, 2024.

4. I built a reservoir simulation model for the EMSU, EMSU-B, and AGU waterflood units in Lea County, New Mexico and discussed the results of this work in my August 26, 2024 testimony.

5. I have reviewed the testimonies of Mr. Preston McGuire, Dr. Larry Lake, Mr. John McBeath, and Mr. William Knights filed on August 26, 2024 on behalf of Goodnight Midstream Permian, LLC ("Goodnight"). I make this statement in rebuttal to some of the conclusions drawn by these witnesses, particularly the items described below.

6. On page 3 of Preston McGuire's testimony he states: "Substantial data on the sustained and geographically extensive pressure differentials between the Grayburg and San Andres aquifer confirm (1) the presence of an effective geologic barrier between the two formations, and (2) that the Grayburg reservoir and San Andres aquifer are distinct geologic zones that are functionally severed and do not act, and cannot be considered, as a single reservoir." This testimony is incorrect for the following reasons:

- There must be an outlet for San Andres fluids prior to April-1986 to allow a 28.7% drop in San Andres reservoir pressure from 1747 psi to 1245 psi at 4006' measured depth as shown by the openhole Repeat Formation Test ("RFT") pressure measurement in the EMSU-211. This pressure drop was reproduced in the reservoir model by allowing communication in certain areas of the reservoir which experienced high water production prior to the waterflood by increasing the vertical permeability between the San Andres to Grayburg from 0 millidarcy to a positive value. The magnitude of the vertical permeability was based upon the amount of water produced by the wells in the area. I updated the model following my December 13, 2024 deposition to account for the change in initial reservoir pressure discussed by William West during his deposition (Initial pressure 1450 psi @ 250' subsea and opposed to -250' subsea as originally assumed), but this had little bearing on the results and conclusions drawn from the original model. (Exhibits M-12 to M-13)

- Chevron's 1996 paper entitled "Utilization of Geologic Mapping Techniques to Track Scaling Tendencies in the Eunice Monument South Unit Waterflood, Lea County, New Mexico" indicated that "Although the drilling was confined to the Penrose and Grayburg formations, apparently some San Andres water was finding its way into the wellbore of these wells and resulted in a barium sulfate scale, barite, deposition problem." This is historical evidence that communication is occurring between the Grayburg and San Andres intervals.
- There must be an external source of water entering the Grayburg reservoir in the crestal area where natural fractures occur and high water production was seen prior to 1986 when the waterflood was started. I reviewed the April 1983 Technical Committee Report entitled "Proposed Eunice Monument South Unit," and Figures 11 and 12 showed the 1981 water production that was occurring in some wells in the crestal area far from the western edge where a partial edge water drive occurred in the bottom of the Grayburg due to Goat Seep and Grayburg aquifer expansion. (Exhibit M-3, M-7, and M-8). I used this information along with a full history of water production in these wells in the history matching process. The only way I

could match this water production in the reservoir model was to increase the vertical permeability between the San Andres and Grayburg from 0 millidarcies to some small positive value at various locations near the high water producers. This allowed for the pressure drop in the San Andres to be matched and allowed for the water production to be matched.

- The Grayburg and San Andres intervals are connected by natural fractures and low (non-zero) permeability layers of carbonate rock. Significant volumes of water can move through low permeability reservoir (~0.5 md vertical permeability) where a pressure differential exists. The reservoir pressure dropped from 1616 psi to 364 psi at 3707' measured depth (-131' subsea) in EMSU-211's upper Grayburg layers by 1986 (see William West rebuttal Exhibit N-8) while the Upper San Andres layer dropped from 1747 psi to 1245 psi at a depth of 4006' (-430' subsea). This created a pressure differential of 881 psi and the original reservoir model indicates that 161 million barrels of water had entered the Grayburg from the San Andres by 1/1/1986. The Grayburg in October, 2024 had a measured pressure of 951 psi at a depth of 4050' (0.235 psi/foot) in the shut-in EMSU-378 water injector well. Goodnight has reported that the San Andres has a reservoir pressure gradient of 0.381 psi/foot near their four SWD wells inside the EMSU, therefore the San Andres currently has a pressure of 1543 psi at an equivalent depth of 4050'. With the top of San Andres being at approximately 4321' measured depth (-692' subsea) in the Ryno SWD #1, the San Andres pressure would be 1646 psi at the top, exerting a 695 psi differential across the low (non-zero) permeability carbonate layers and natural fractures between the San Andres and Grayburg. As Goodnight continues to build this pressure differential by injecting large volumes of water, water influx will increase in the Grayburg. (Exhibit M-6) These two intervals act as a single unit, with one interval impacting the performance of the other.

7. Goodnight witness Mr. William Knights recognized on page 2 of his testimony that "Early water encroachment from the south and east areas of the field supplied only a minor amount of aquifer pressure support" for the Grayburg producing interval. To the contrary, Goodnight witness Mr. Tomastik states on page 10 (item #26) that "Below these pay zones was the lower Grayburg and San Andres formations, which are strong water drive reservoirs and prolific water producers."

- Since the size and strength of the Goat Seep / Grayburg aquifer was raised during my deposition as a potential weakness to the model, the grid for the Penrose and Grayburg intervals was extended out the same 38.5 miles that the San Andres aquifer uses. This increased the water in place for the Penrose from 161 million barrels to 5242 million barrels and the Grayburg from 1343 million barrels to 28,159 million barrels. (Exhibits M-14 to M-16). The vertical communication between the San Andres and Grayburg was shut off. The problem with this is that the row of downdip producers on the western side of the model watered out too quickly and did not match historical oil production volumes.
- An attempt was made to history match the model using a larger Penrose/Grayburg aquifer than the Base Case model, but this still required water influx from the San Andres to match the water production and pressure in the crestal areas. The final model had a Penrose aquifer of 963 million barrels and Grayburg aquifer of 5581 million barrels. (Exhibits M-17 to M-19) The San Andres aquifer was reduced in size from

158 billion barrels of water to 82 billion barrels with KZ modifications of Layer 8 remaining the same.

8. Goodnight may claim that my model did not use the actual perforations for each of the 638 wells in the model. My response is as follows:

- The perforation history for 638 wells over an 86 year life span is very difficult to construct and adds significant complexity in building the model.
- Most Grayburg producers were completed throughout the oil column interval and my simulator allows me to perforate the oil column only.
- All of the Grayburg water injectors injected into all layers of the Grayburg interval and this is the assumption used in the model.
- My model results match the oil, water, and gas production history as well as the water injection history and reservoir pressure by zone.
- The simulation model is far more advanced than a material balance equation and allows for the proper amount of fluids to be transferred between the San Andres and Grayburg while obtaining an excellent match of historical volumes and pressures.

I affirm under penalty of perjury under the laws of the State of New Mexico that this statement is true and correct.

James L. Buchwalter ___2/10/2025_____
James L. Buchwalter DATE
President
GEMINI SOLUTIONS INC.

JIM BUCHWALTER

GEMINI SOLUTIONS INC

JIMB@GEMINISI.COM

281-2216993

1-31-2025

EMPIRE EUNICE MONUMENT STUDY PRESENTATION

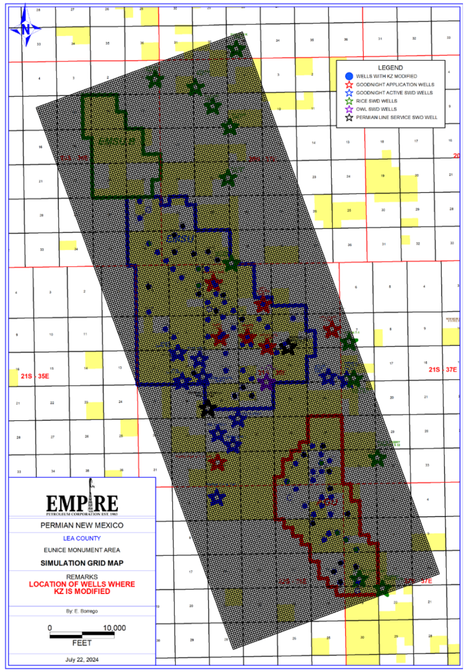
Exhibit M-1

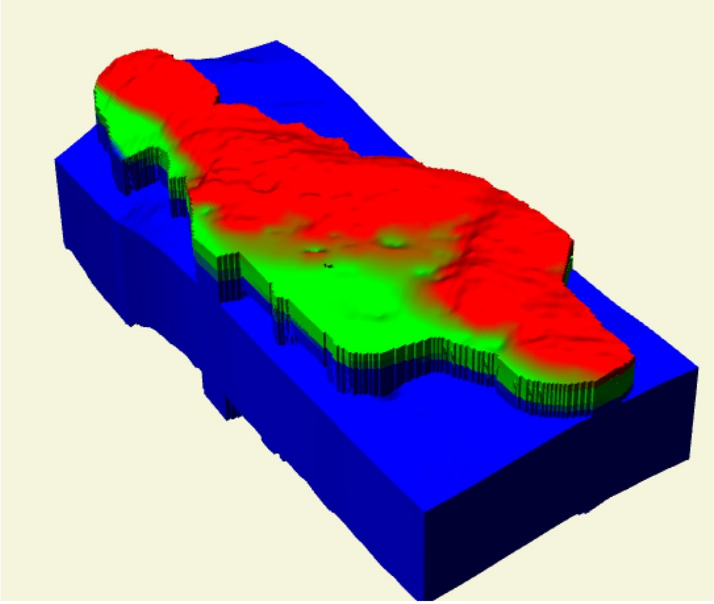
MODEL CONSTRUCTION

- Built detailed full field model including Penrose/Grayburg/San Andres ROZ and include all wells within the Eunice monument EMSUB/EMSU/AGU units
  - 638 wells
  - 10 layers & 345K cells
    - 2 Penrose, 5 Grayburg, 3 San Andres ROZ
- Integrate well production/injection/saltwater disposal data/water supply well data and well pressure data from 1938 to 2025
  - 24K startups (well rates)
- Final match model shown at right in 1938
  - Top of model is Penrose gas cap/oil reservoir
  - Base of model is San Andres ROZ
  - Grid was extended 38 miles to the west (San Andres)

Exhibit I-1: Simulation Grid with areas (Blue Dots) where Vertical Permeability Has Been Modified

Columns 1 through 5 along western edge of model were enlarged (not shown) to represent San Andres aquifer





Match model view from top of Penrose/Grayburg
San Andres ROZ extent limited to area under Grayburg for viewing

Exhibit M-2

HISTORY MATCH WORKFLOW

HISTORICAL DOCUMENTS PROVIDED CONFIRM SOURCE OF PROBLEMS IN FIRST PASS MODEL

- Chevron report in 1989 confirms Grayburg is primarily depletion drive reservoir
- Reports and production bubble plot confirm San Andres water support through limited fracture network
- Communication confirmed by pressure drop in San Andres from 1527 psia to 1245 psia in April 1986
- Water influx from the bottom layers of Grayburg and San Andres

Technical Committee Repo
Proposed Arrowhead Grayburg
Lea County, New Mexico

Chevron

Although the Arrowhead Pool has produced a significant volume of water, which could indicate a water-drive type recovery, solution gas drive is believed to be the predominant recovery mechanism. This conclusion is based on the pressure depletion of the pool and on the lack of an identifiable water production trend.

September 1989

A portion of the water production is probably attributable to communication of Zones 4 and 5 with the Lower Grayburg and San Andres aquifers. Although siliciclastics between each zone generally prevent vertical communication, in some localized areas of the field they do not act as permeability barriers. When the barriers break down in the lower Grayburg members, the prolific San Andres aquifer can influx into the oil productive horizons resulting in large volumes of water production.

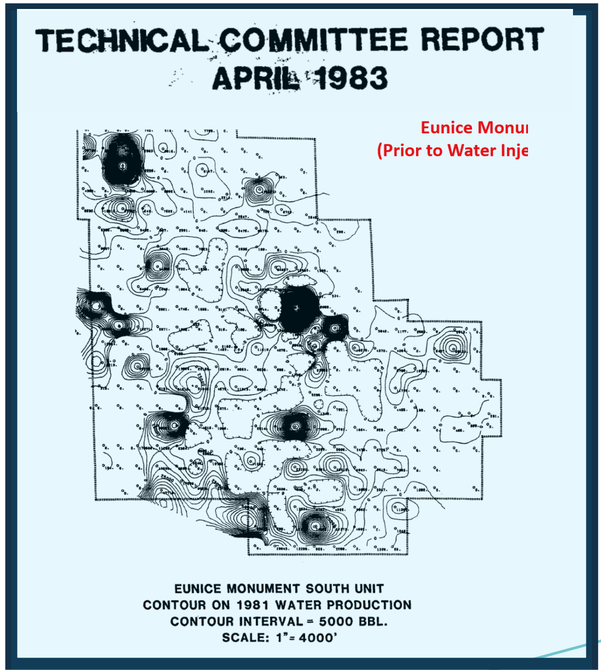
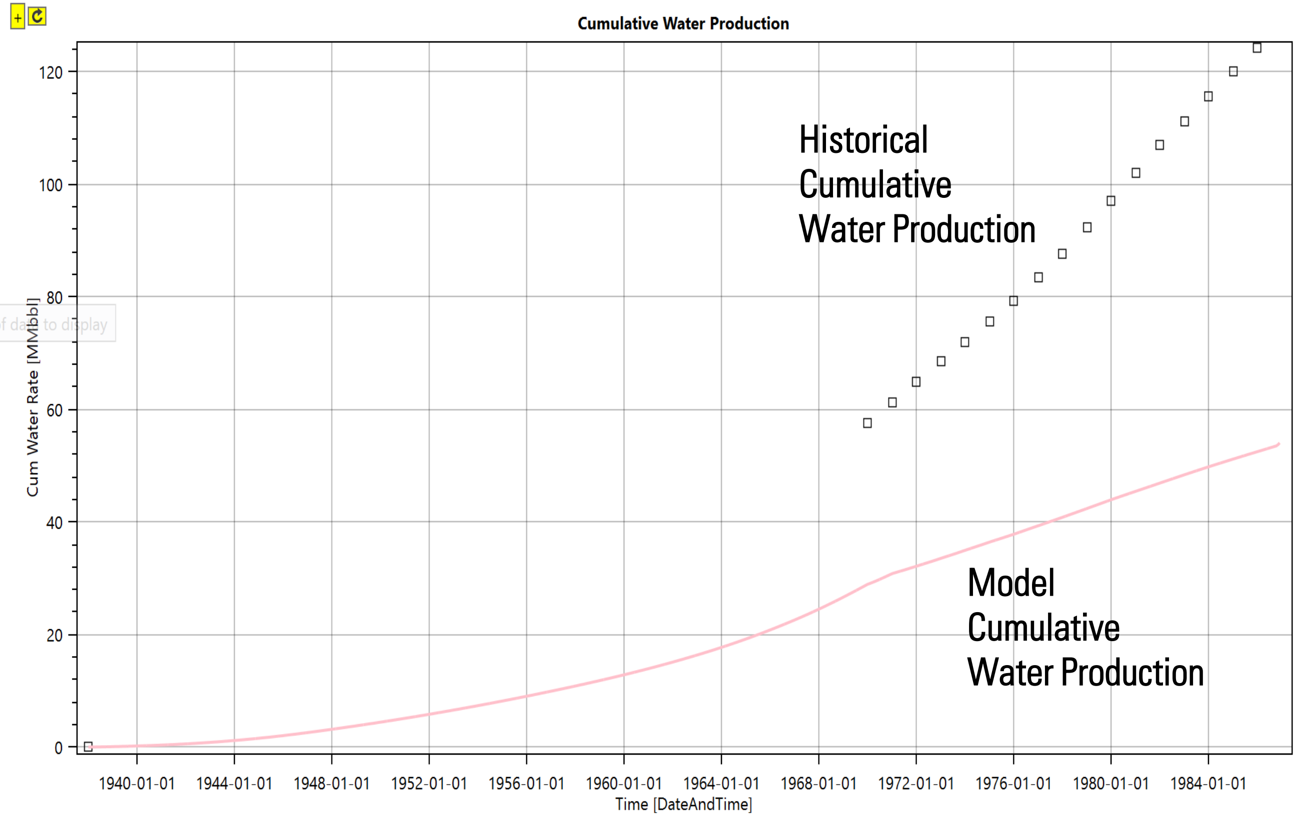


Exhibit M-3

HISTORY MATCH WORKFLOW FIRST PASS MODEL

500+ MODELS & 2000+CPU HOURS FROM START TO CURRENT BEST FIT MODEL

- First pass model description
  - Establish model that matches oil/gas production in Grayburg from 1938 to 2025
    - Model cannot match water production recorded in Grayburg and confirms water production from another source
    - Conclusions
      - Deeper wells in Grayburg did not produce more water than updip wells confirming Grayburg aquifer support is small
      - Small fraction of wells throughout the reservoir (<5%) produced at high water-oil ratios throughout the reservoir independent of depth
        - Confirms water from source other than Grayburg



Match model with communication removed between Grayburg and San Andres

Cumulative water production prior to waterflooding absent San Andres water influx

Solid line = model data & points = historical data

Exhibit M-4

HISTORY MATCH WORKFLOW FINAL MATCH MODEL

- Final match model requirements
  - Add communication between Grayburg and San Andres ROZ at locations of wells with high water-oil ratios prior to waterflooding
  - Adjust San Andres ROZ and Grayburg volumes and vertical Kz communication between the reservoirs to match all production and historical pressures
- Final match model results
  - Fits field wide historical production and saltwater disposal volumes
  - Fits historical pressures

Exhibit M-5

HISTORY MATCH WORKFLOW FINAL MATCH MODEL RESULTS

- Field match of production and injection (shown at right) with forecast with future SWD wells
- Field pressure matched
  - Starting pressures
    - Grayburg
      - 1460 psia (Chevron Sept. 1989 report)
      - 1747 San Andres
  - 1986 pressures
    - 1245 psia in San Andres
    - 346-569 psia in Grayburg
  - 2024 pressures
    - Grayburg
      - 951 psia (EMSU#378 on 10/8/2024)
    - San Andres
      - 1447 psia (EMSU#278 & EMSU#459)
    - Pressure gradient increase in San Andres confirms model aquifer size
      - *4 psi per million barrels SWD injected in model*
        - *Matches value range cited in Dr. Larry Lake testimony shown below for current pressure increase rate in San Andres*

Andres aquifer is a water disposal unit. The San Andres aquifer has had a large volume of water injected into it with little pressure rise: 4-10 psi/MMbbl of water. They do not appear to be in

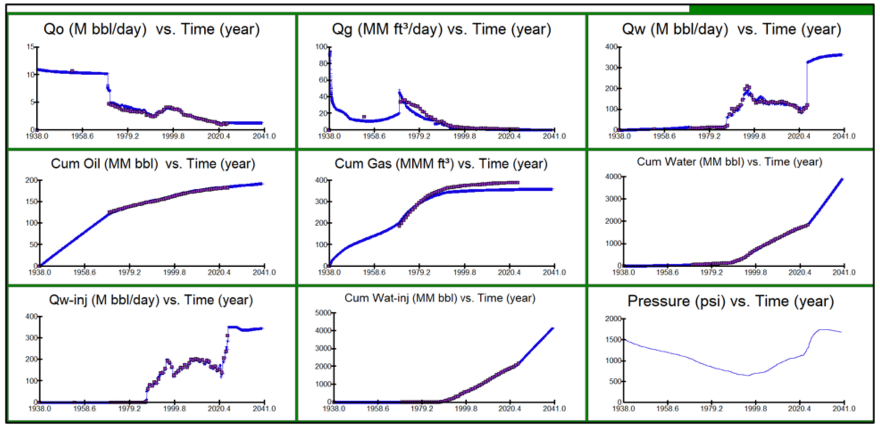
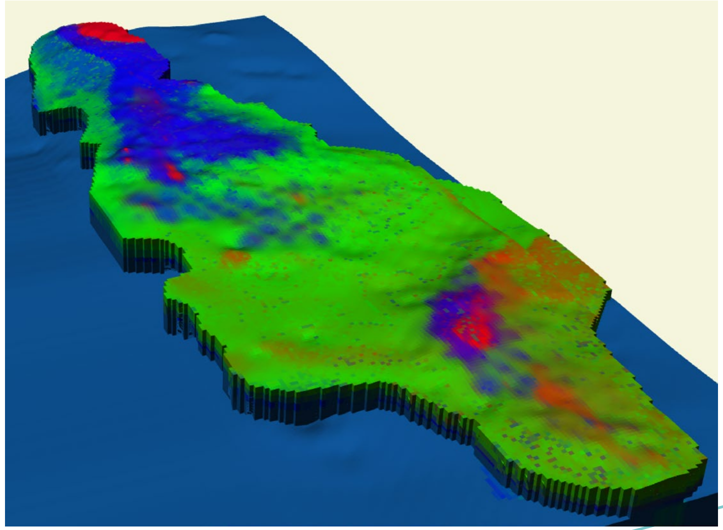
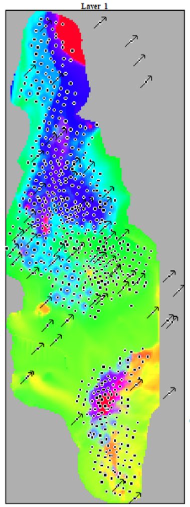


Exhibit I-11: Location of Spillover San Andres Producers in Model (220,000 BWPD withdrawal)



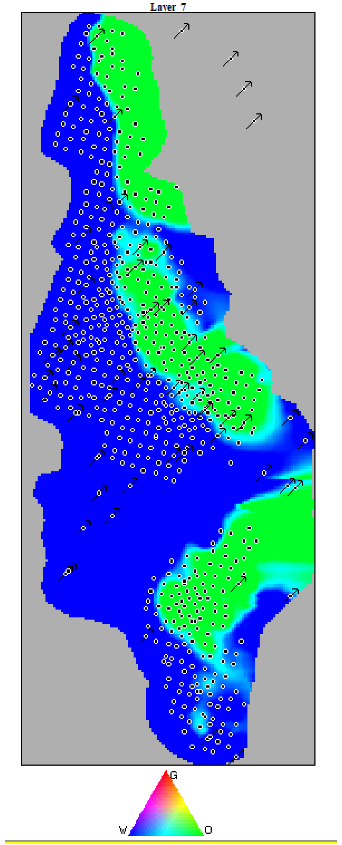


2024 Penrose top ternary 2D/3D views

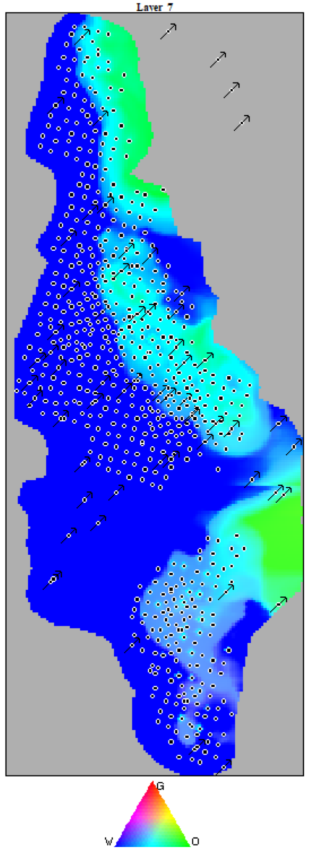
Exhibit M-6

HISTORY MATCH WORKFLOW
FINAL MATCH MODEL RESULTS – AFFIDAVIT MATCH MODEL

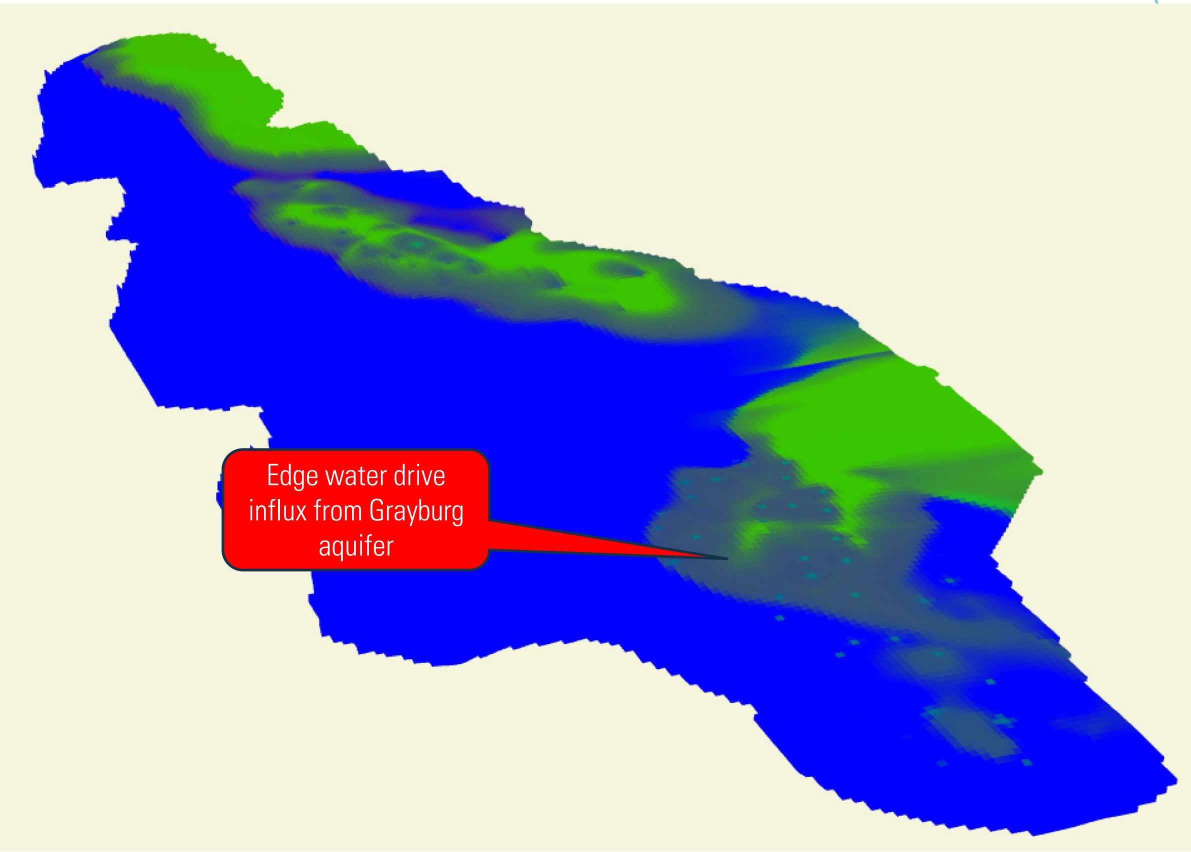
- 1986 edge drive water influx into bottom of Grayburg from small aquifer attached to the Grayburg
- Aquifer size comparison – **(99% of total aquifer volume in San Andres)**
  - Penrose + Grayburg = 1.5 MMMBW
  - San Andres = 157 MMMBW



1938 ternary map



1986 ternary map



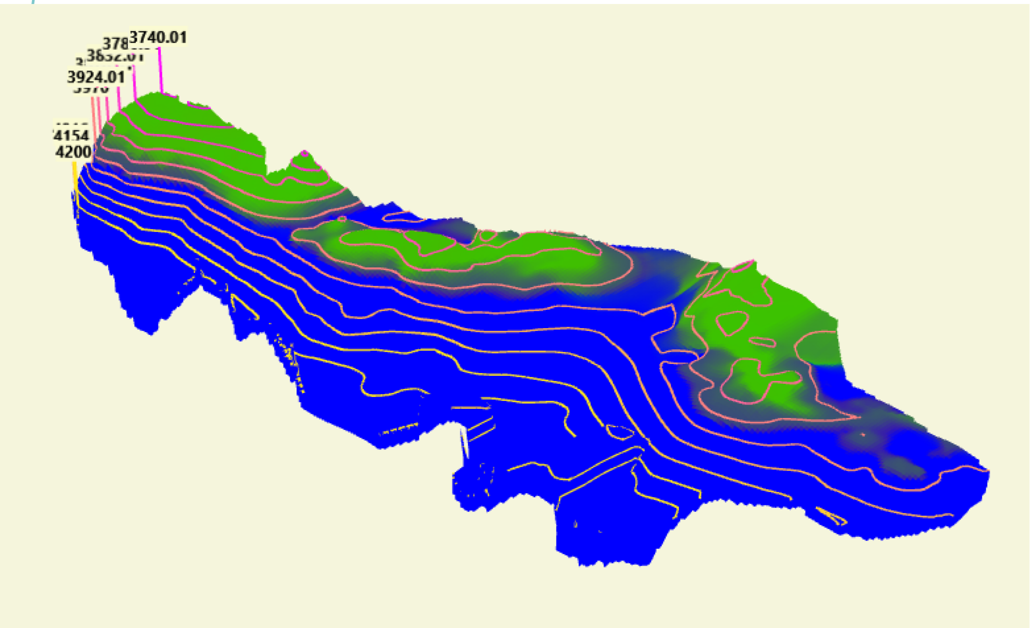
1986 ternary map including Grayburg aquifer

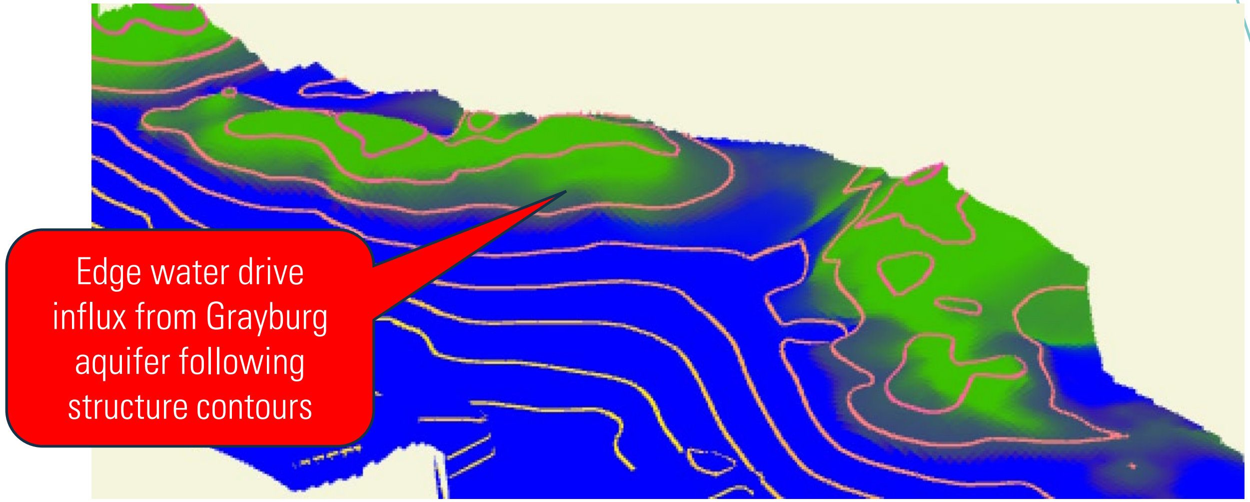
Water influx map into bottom of Grayburg in 1986 before waterflood commenced

Exhibit M-7

HISTORY MATCH WORKFLOW
FINAL MATCH MODEL RESULTS – AFFIDAVIT MATCH MODEL WITH NO SAN ANDRES INFLUX

- 1986 edge water influx following contours into bottom of Grayburg from small aquifer attached to the Grayburg





1986 ternary map including Grayburg aquifer & San Andres ROZ aquifer removed

Water influx map into bottom of Grayburg in 1986 before waterflood commenced

Exhibit M-8

FORECASTS

- Added Goodnight proposed SWD wells (5 wells)
- Added 11 "spillover" wells to model undocumented future leaks in the system
  - 11 wells added producing 220 MBW/day in 2025 at the western side of the aquifer

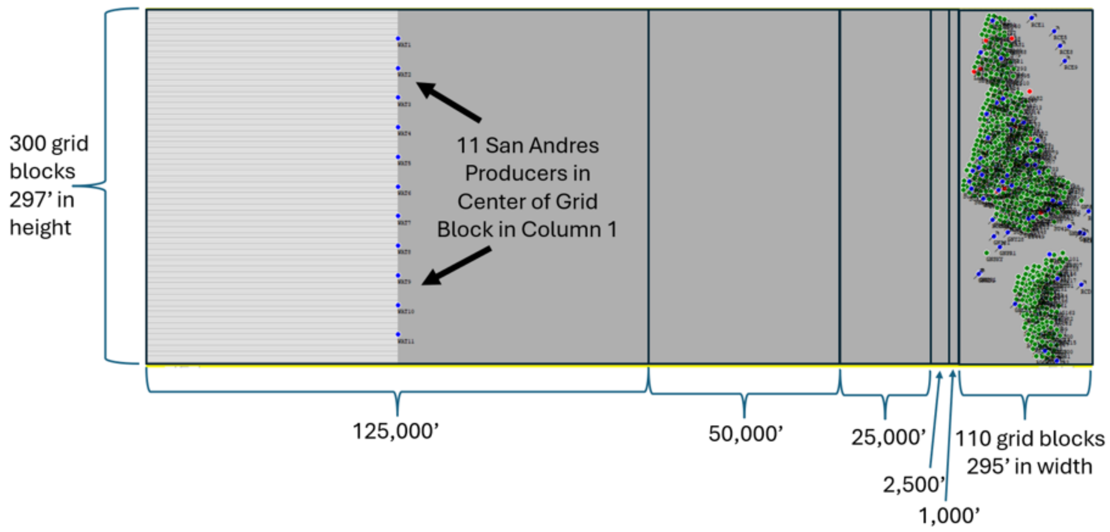


Exhibit I-11: Location of Spillover San Andres Producers in Model (220,000 BWPD withdrawal)

Exhibit M-9

FORECASTS – MATCH MODEL

WATER DISPOSAL RATES & WATER INFLUX INTO GRAYBURG
FUTURE WATER INFLUX RATES INCREASE TO 50 MBW/DAY

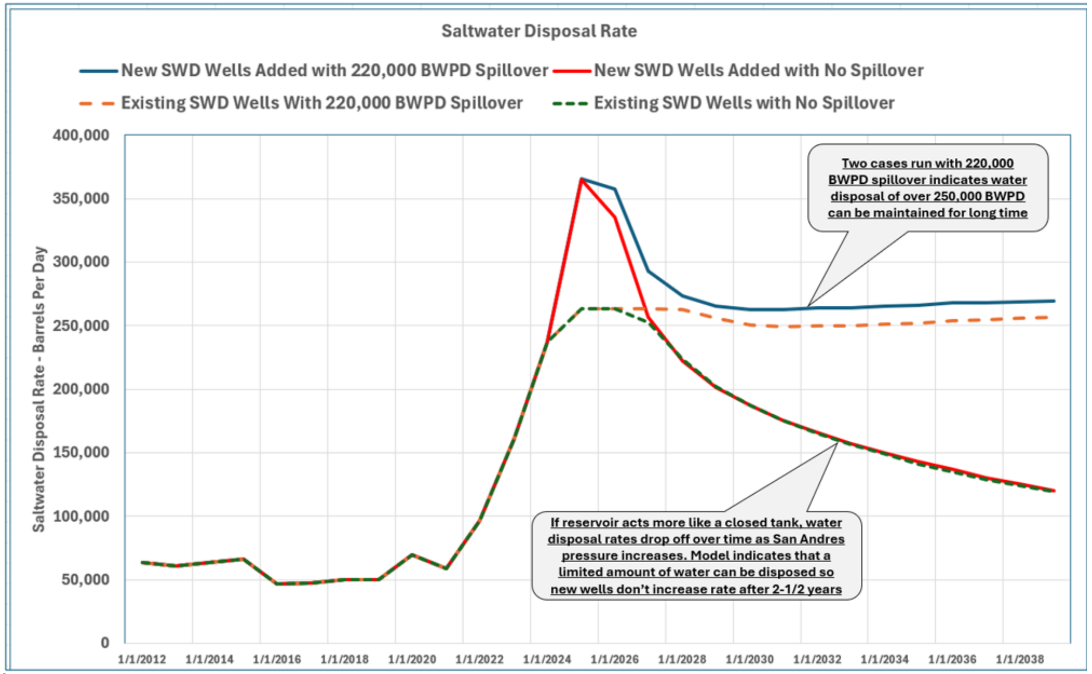


Exhibit I-18: Water Disposal Rates for Various Cases

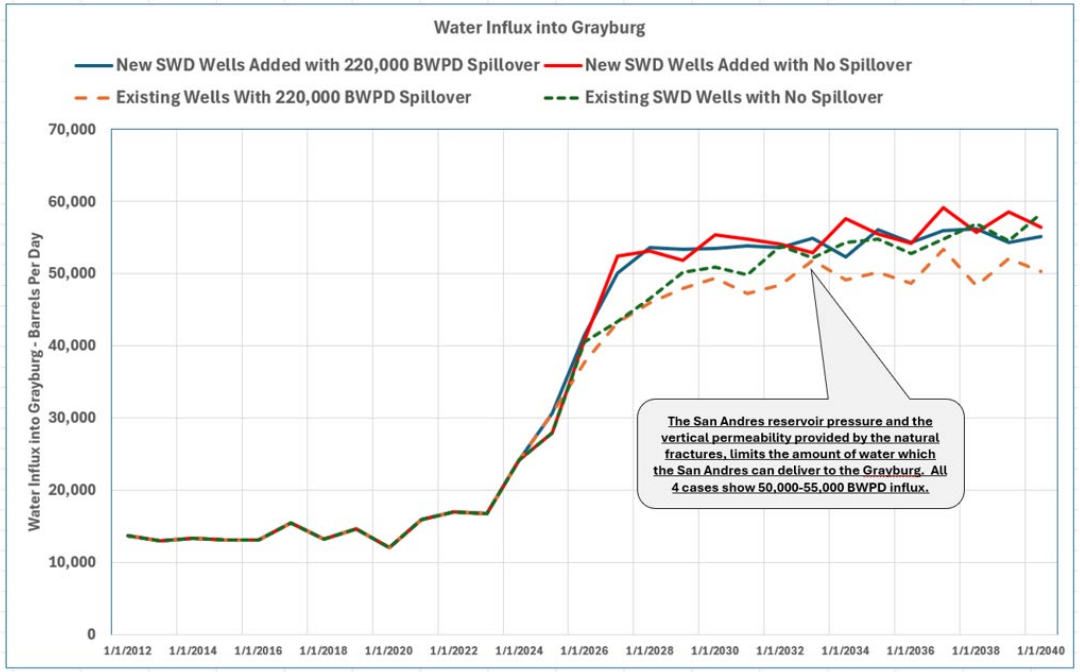


Exhibit I-19: Water Influx into Grayburg at EMSU, EMSU-B, and AGU for Various Cases

Exhibit M-10

WHY DOES GRAYBURG WATER PRODUCTION RATE RISE IN THE FUTURE ?

- Future WSW volume is less than 1% of SWD injected water
  - Currently 77% of all SWD well has been produced by WSW's for injection
- Future pressure difference increase between the reservoirs will increase SWD influx into the Grayburg
  - Future WSW volume less than 1% of SWD volume
- Future SWD rate will increase with new SWD wells

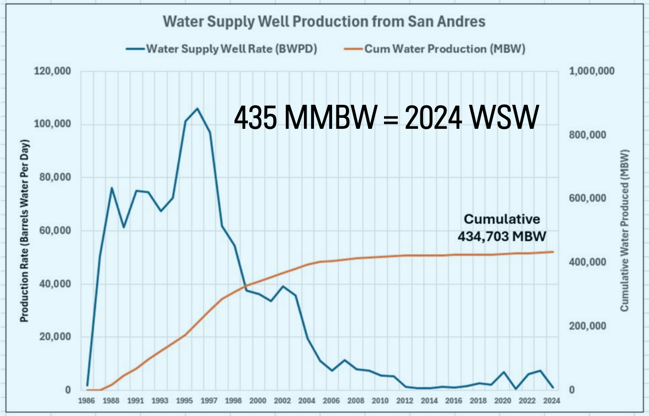


Exhibit I-5: Salt Water Disposal Volumes

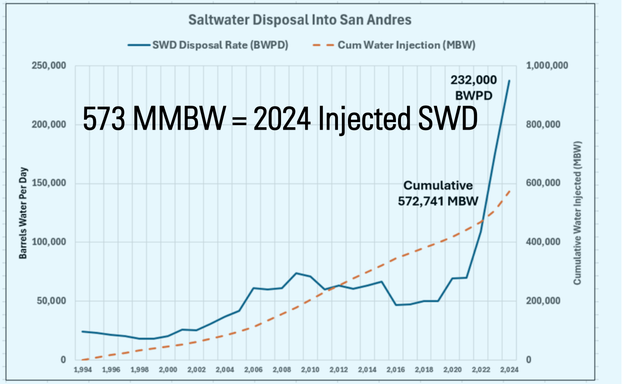
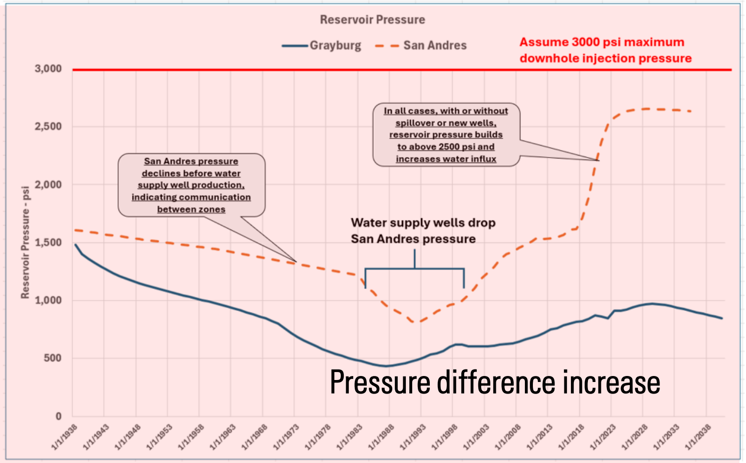


Exhibit I-6: Water Influx Entering Grayburg – Impacted By Water Supply Wells & SWD Volumes

14



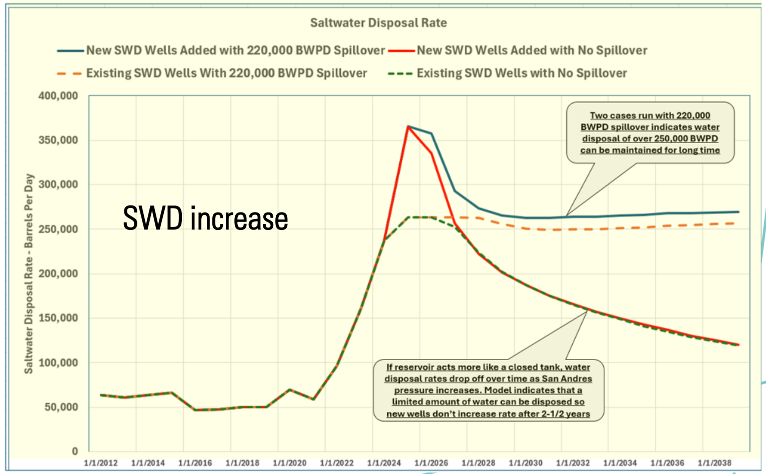


Exhibit I-8: EMSU High Water Producers Prior to Waterflood 1/1/1986 Cumulative Volumes

Exhibit I-18: Water Disposal Rates for Various Cases

Exhibit M-11

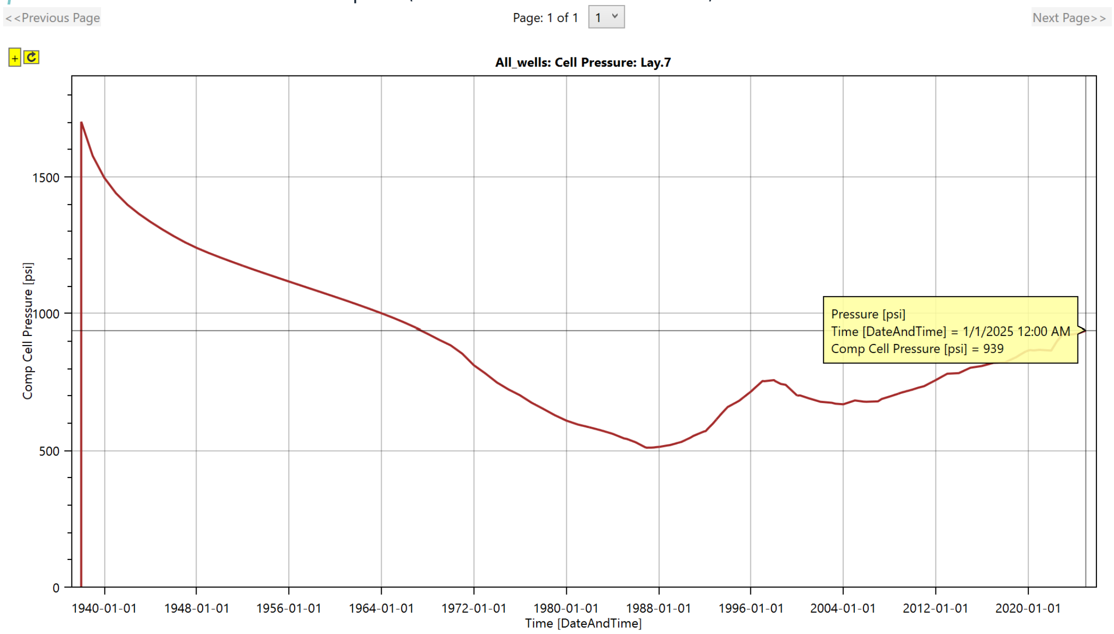
ALTERNATE MATCH MODEL CREATED AFTER DEPOSITION

- Adjusted initial reservoir pressure based upon 1450 psi @ 250' subsea (documented pressure)
- Added SWD wells (Empire's EMSU SWD #1 & Parker Energy SWD #5)

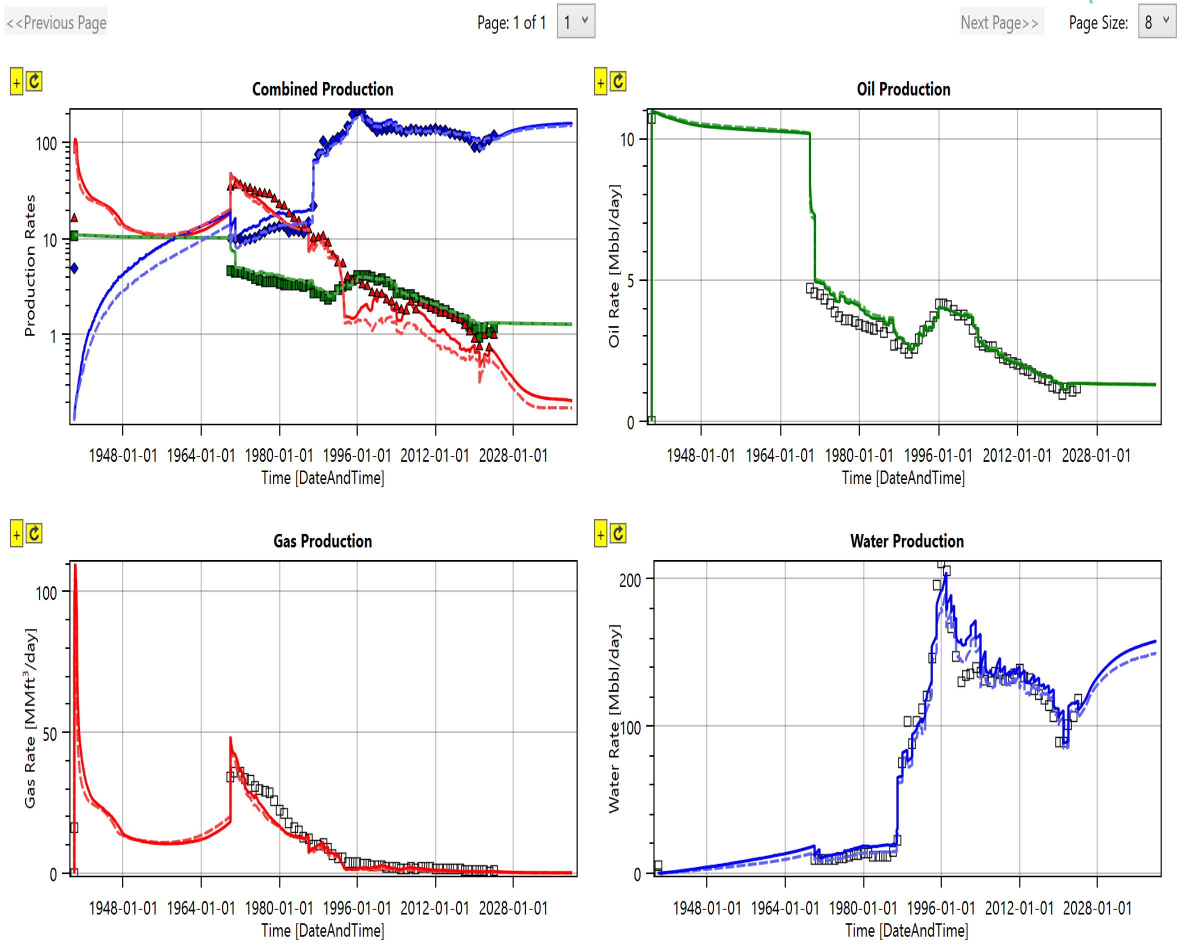
ALTERNATE MATCH MODEL AFTER DEPOSITION
EMPIRE EMSU SWD #1 & PARKER ENERGY SWD #5ADDED, INCLUDE FUTURE SWD WELLS

Exhibit M-12

- Adjust starting pressures
  - 0.436 psi/ft gradient in all layers
  - 1450 psia SS @ 250 ft. SS
- Add SWD well injection wells per Goodnight requests
  - Add SWD injection from Parker#5 and EMSU#1
  - Solid lines = alternate match model & dashed lined = hearing match model
- 2024 pressures
  - Model = 939 psi
  - Measured = 951 psia (EMSU#378 on 10/8/2024)



Grayburg historical pressure history
Grayburg + San Andres aquifers affidavit match model including future SWD wells



Solid line = Grayburg + San Andres aquifers affidavit match model including future SWD wells
Dashed line = San Andres match model in affidavit including future SWD wells

Exhibit M-13

ALTERNATE MATCH MODEL CREATED AFTER DEPOSITION

- Increase Grayburg aquifer & 0.436 psi/ft gradient
- Remove San Andres aquifer support to Grayburg
- Include Parker#5 & EMSU#1 SWD's

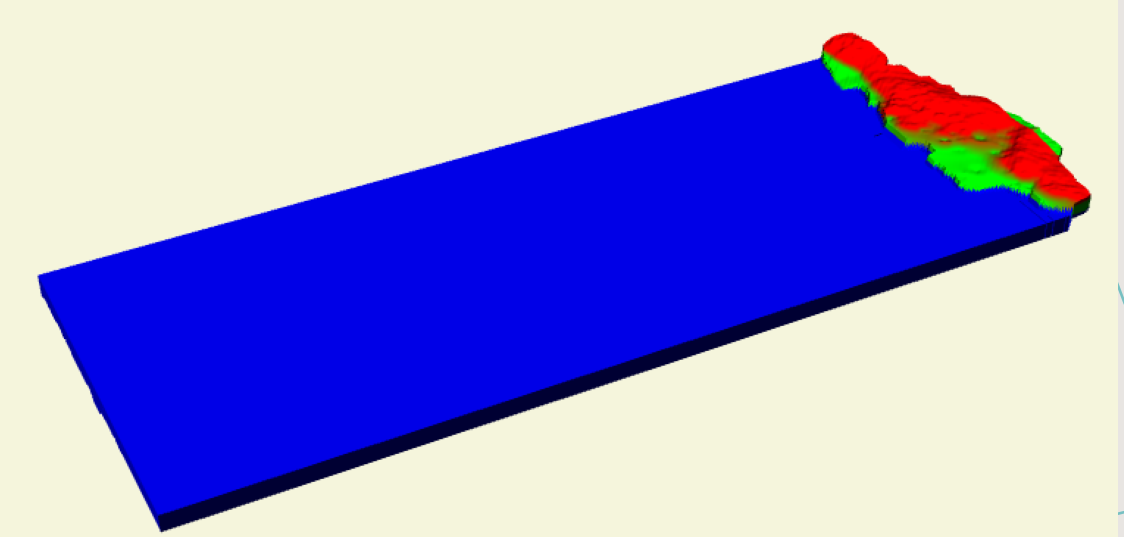
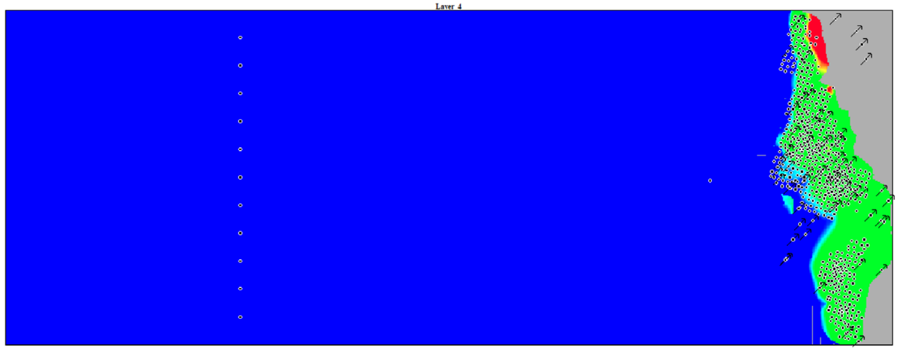
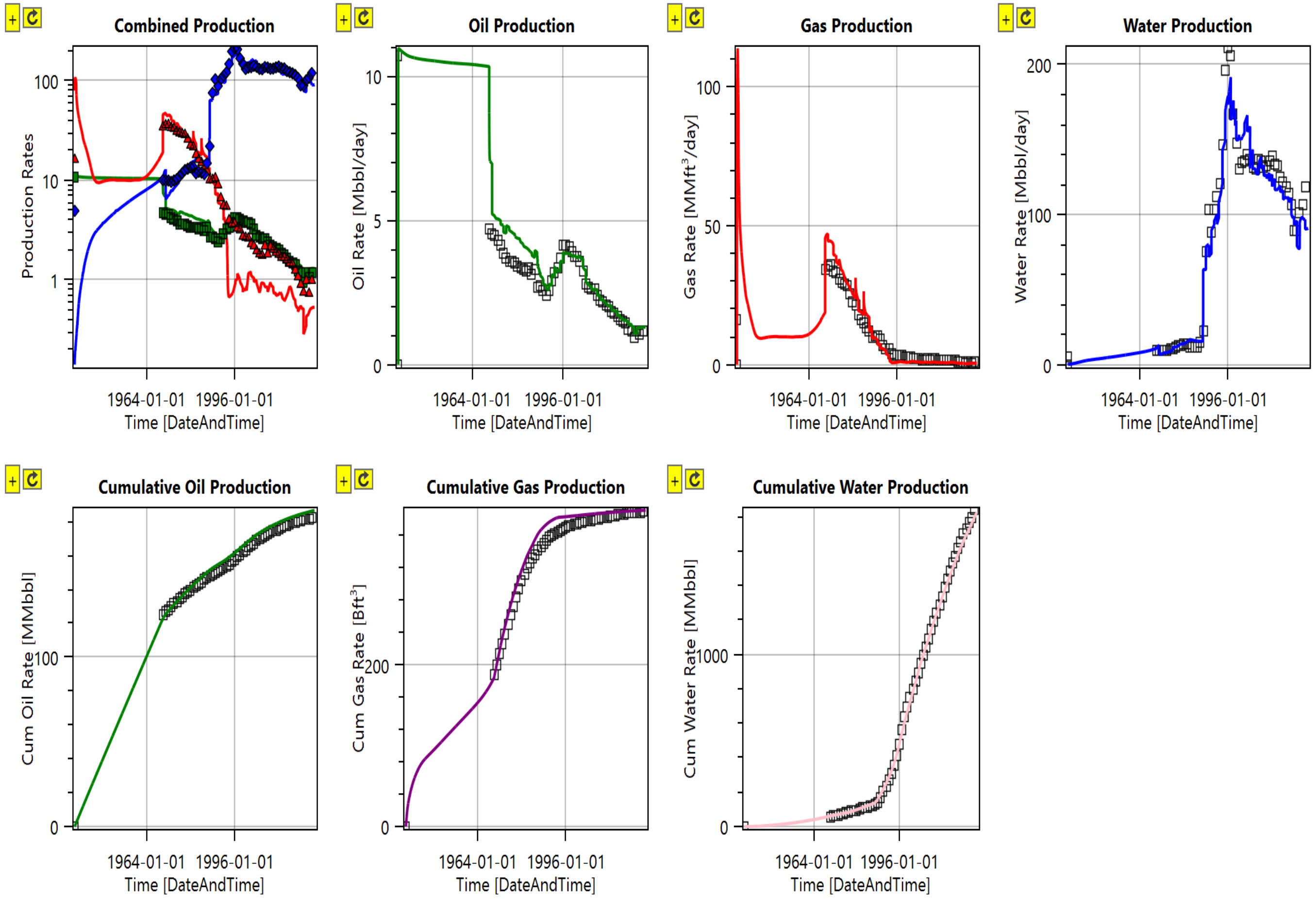


Exhibit M-14

ALTERNATE GRAYBURG AQUIFER MINUS SAN ANDRES ROZ WATER AQUIFER

- Grayburg aquifer
  - 33 MMMBW attached to Penrose / Grayburg
    - Aquifer extends 33 miles to the west matching the San Andres aquifer extent in the affidavit match model
  - 159 MMMBW San Andres ROZ aquifer in match model presented in affidavit
  - KZ = 0 for Layer 8 (no San Andres communication)





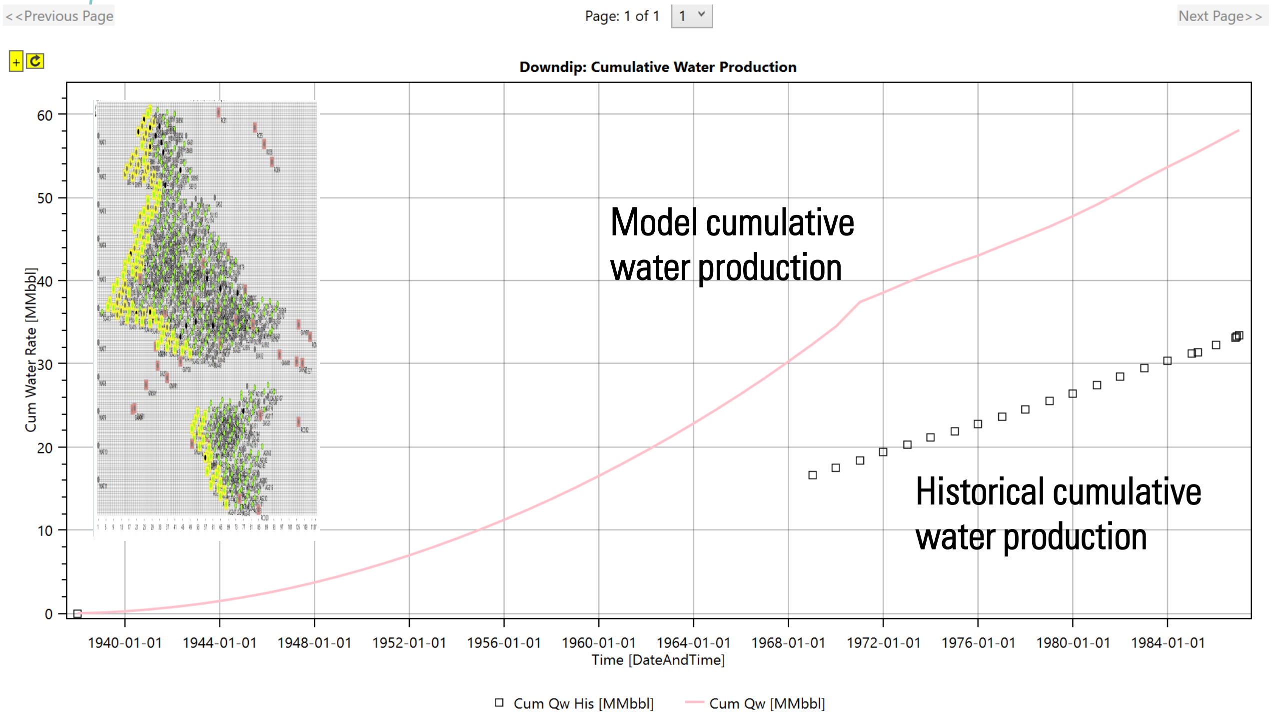
Match model with only Grayburg aquifer and no San Andres ROZ aquifer

ALTERNATE GRAYBURG AQUIFER MINUS SAN ANDRES ROZ WATER INFLUX MATCH MODEL

PLOT OF TOP OF SAN ANDRES ROZ PRESSURE HISTORY

Exhibit M-15

- 1987 cumulative water of yellow downdip well group is high
- 2024 model pressure in San Andres ROZ higher than the recorded pressure
  - San Andres ROZ
    - 1447 psia (EMSU#459)
  - Model pressure
    - 2221 psia (11/8/2024)



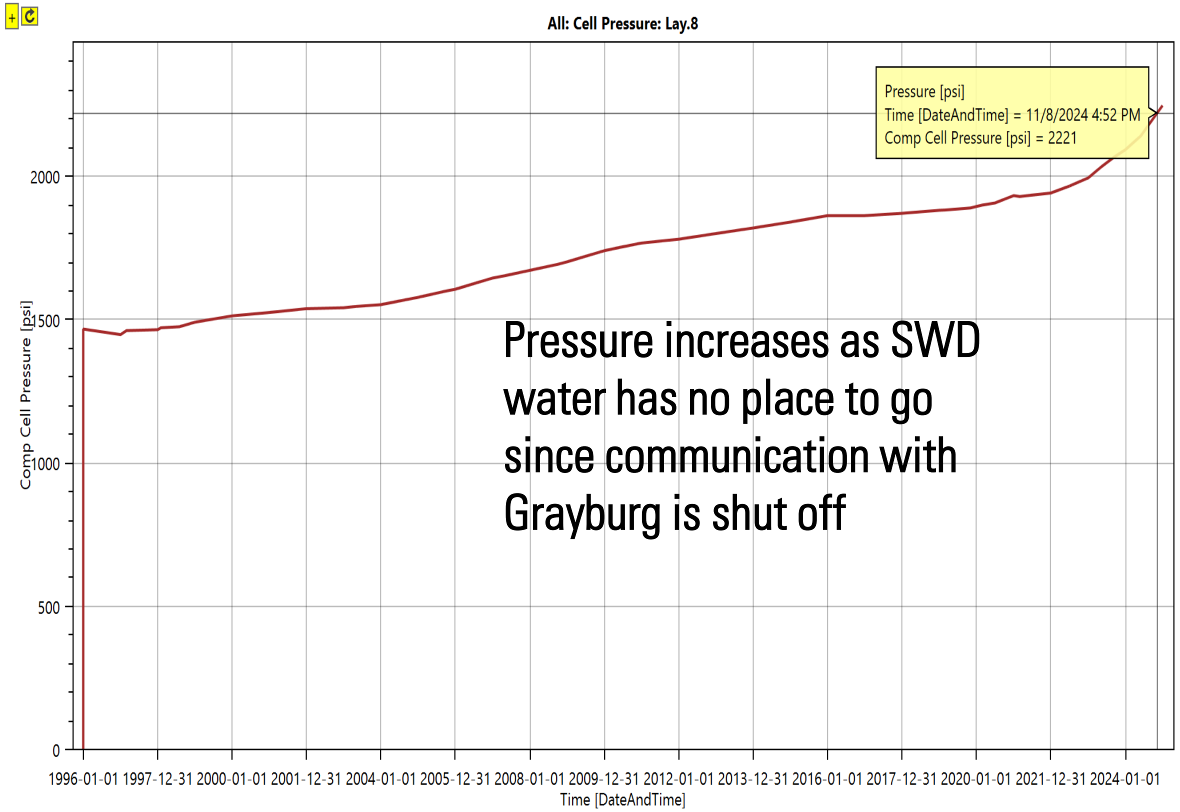


Exhibit M-16

ALTERNATE MATCH MODEL CREATED AFTER DEPOSITION

- Grayburg + San Andres combined aquifers
- 0.436 psi/ft gradient
- Include Parker#5 & EMSU#1 SWD's
- Aquifer area extent/position equal in all layers

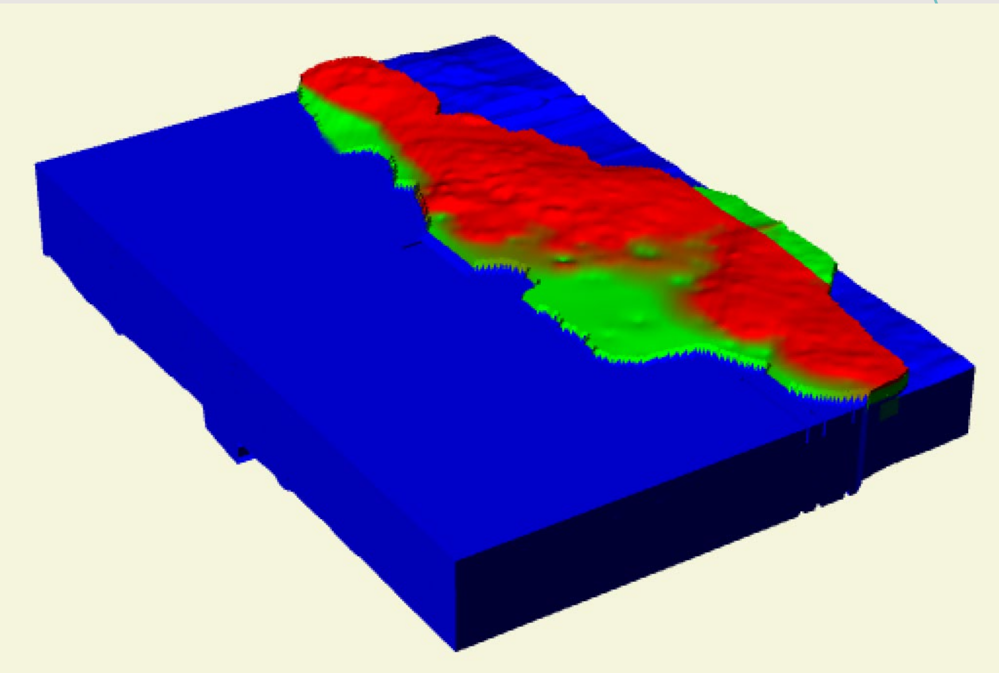
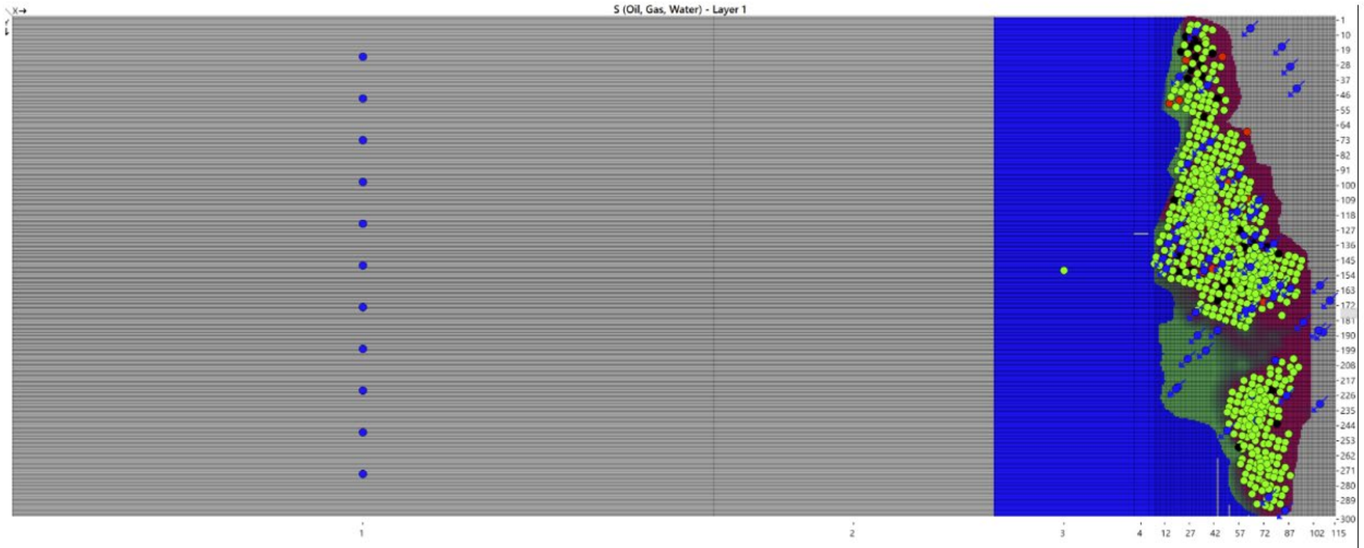


Exhibit M-17

OTHER MATCH MODEL ATTEMPTS TO DETERMINE GRAYBURG AQUIFER CONTRIBUTION

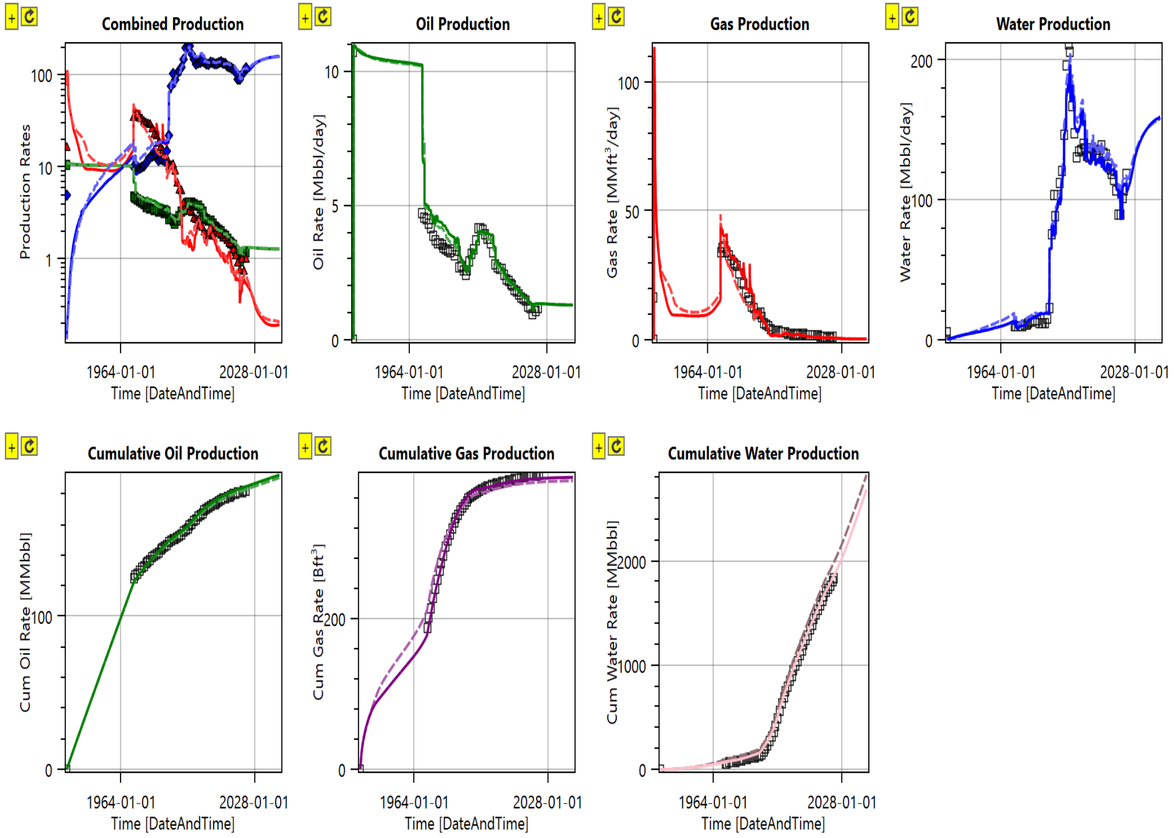
- Create models with Grayburg aquifer and San Andres ROZ aquifer contribution
  - Matches field production
  - Grayburg field pressure in 2024 low
  - Match of water for downdip wells in Grayburg high confirming large aquifer in Grayburg not present

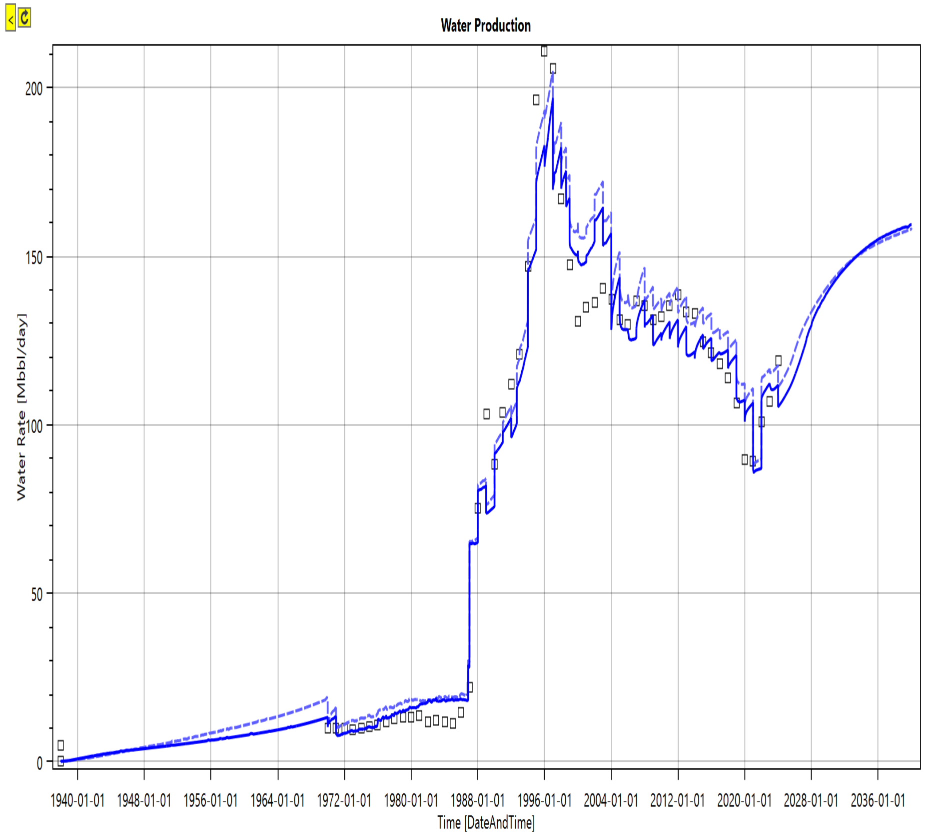


GRAYBURG AQUIFER PLUS SAN ANDRES WATER INFLUX MATCH MODEL ABSENT FUTURE SWD WELLS

Exhibit M-18

- Match of field rates possible





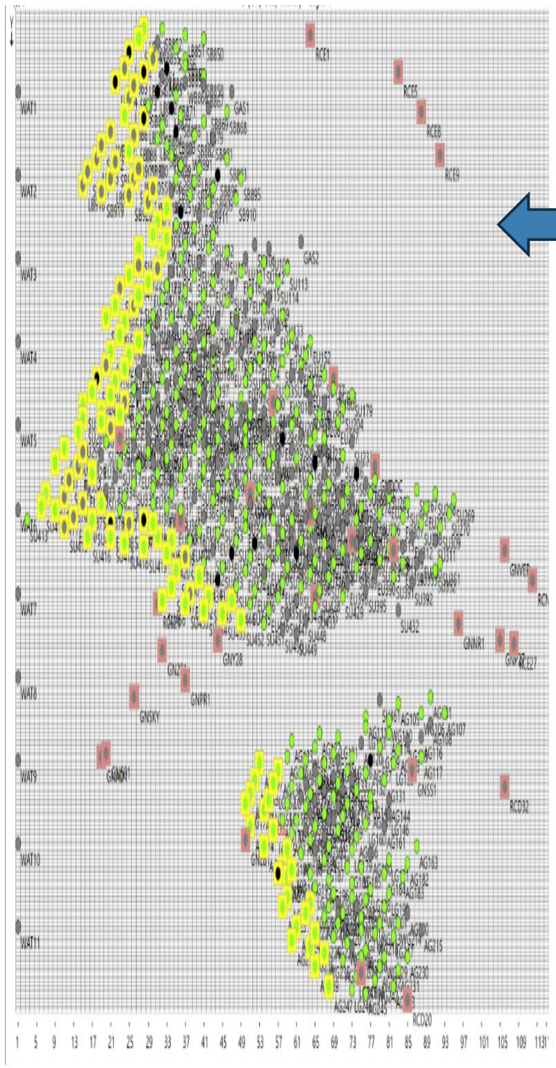
Future SWD wells absent proposed future water supply wells

Solid line = Grayburg+San Andres aquifers affidavit match model
Dashed line = San Andres match model with 0.436 psi/ft gradient correction

GRAYBURG AQUIFER PLUS SAN ANDRES WATER INFLUX MATCH MODEL

Exhibit M-19

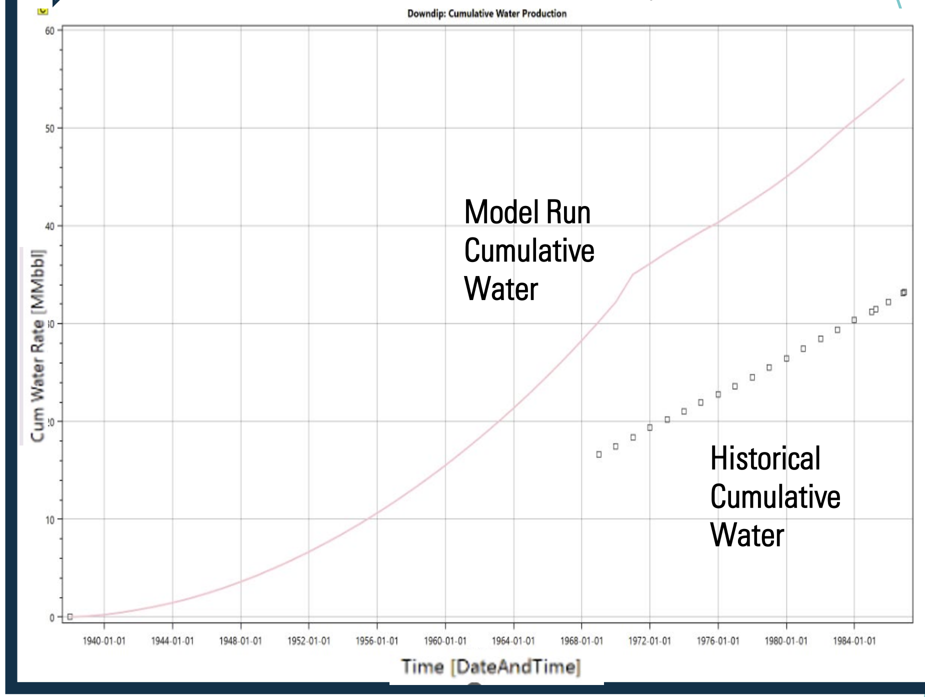
- Match of downdip well water rates not possible:
  - Smaller total aquifer size combining both reservoirs required because all wells on western side of Grayburg making water compared to small fraction of wells in the San Andres match model presented at the hearing
  - Group of wells at deeper elevations in Grayburg exceed total historical water production confirming that larger Grayburg aquifer is not possible
- Aquifer volume 45% smaller that affidavit match model
  - San Andres match model aquifer volume = 159 MMMBBLS
  - Alternate match model aquifer volume = 88 MMM BBLS
    - Grayburg aquifer = 6 MMM BBLS
    - San Andres aquifer = 82 MMM BBLS



Group of deeper Grayburg wells highlighted in yellow

Total water produced from group of deeper wells

Model data = line
Historical data = points



CONCLUSIONS

Exhibit M-20

- With 87 years of historical production and pressures the match model offers an accurate representation of the reservoir physics and excellent field forecasts for future assumptions made
- Simulation model matching production volume changes and historical pressures establishes:
  - Original in place
    - 894 MMBO OOIP & 1.5 MMMBW aquifer in Penrose/Grayburg
    - 898 MMBO & 157 MMMBW in San Andres ROZ
  - Water communication between the Penrose/Grayburg and the San Andres through a limited fracture network
- Forecasts establish:
  - Future water moving from San Andres ROZ to the Penrose/Grayburg will reach 50 MBW/day with or without the future Goodnight SWD wells
- Alternative match model absent communication with the San Andres ROZ with a larger Grayburg aquifer is not possible because:
  - Match model shows water influx into the downdip Grayburg wells far exceeds the recorded water for the wells
  - Match model current pressure in the San Andres exceeds recent recorded cell pressure
    - Measured pressure = 1447 psia (EMSU#459)
    - Model pressure = 2221 psia
- San Andres ROZ aquifer is increasing pressure at a rapid rate (4-10 psi/MMBW injected) which confirms:
  - SWD water injected into the San Andres ROZ exceeds water leaking from San Andres ROZ aquifer from ALL sources
  - San Andres pressure will increase rapidly by 400-1000 psi/yr for proposed future SWD injection rate of 300 MBW/day
  - SWD injection rates will drop drastically in future years as San Andres approaches maximum bottom hole injection pressure (absent new leaks)

STATE OF NEW MEXICO
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES
OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO — **CASE NO. 24123, ORDER No. R-22869-A**

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS LEA COUNTY, NEW MEXICO — **CASE NOS. 23614-23617**

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO. — **CASE NO. 23775**

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO — **CASE NOS. 24018-24020, 24025**

SELF-AFFIRMED STATEMENT OF WILLIAM WEST – REBUTTAL

I, William West make the following self-affirmed statement:

1. I am over the age of 18, and have the capacity to execute this affirmation, which is based on my personal knowledge.

2. I am employed as Senior Vice President of Operations for Empire Petroleum Corporation ("Empire").

3. I submit this statement on behalf of Empire New Mexico LLC in connection with the above-referenced matters, in accordance with paragraph 7 of the Pre-Hearing Order issued in these matters on December 5, 2024.

4. I previously submitted direct testimony and exhibits in this matter on August 26, 2024.

EXHIBIT N

5. I have reviewed the testimonies of Mr. Preston McGuire, Dr. Larry Lake, Mr. John McBeath, and Mr. William Knights previously filed on August 26, 2024 on behalf of Goodnight Midstream Permian, LLC ("Goodnight"). I make this statement in rebuttal to some of the conclusions drawn by these testimonies, particularly the items described below.

6. On page 3 of Preston McGuire's testimony, he states "Analysis of core data and historical production tests confirms that the San Andres does not meet the criteria for a ROZ because San Andres oil saturations are well below the defined 20% cutoff as defined by Empire's own ROZ experts, confirming that Goodnight's disposal operations will not cause waste or impair correlative rights in the San Andres disposal zone." This testimony is incorrect for the following reasons:

- Oil saturations obtained in the EMSU-679 (**Exhibit N-1**) conventional core and shown in Preston McGuire's Exhibit B-32 (pages 2 and 3) show oil saturations greater than 20% in the San Andres down to 4252' MD (measured depth) or -652'. Goodnight uses an incorrect San Andres top of -672' subsea whereas Empire's corrected top of San Andres is -548' subsea. This demonstrates the problem with Goodnight picking the top of San Andres deep to avoid saltwater disposal into the Grayburg interval. By selecting a proper San Andres depth for this downdip well, a 104' ROZ oil column exists.
- The San Andres is found at 3899' MD or -299' subsea in EMSU-278, demonstrating this well has a 353' oil column with oil saturation greater than 20%. Intervals that have less than 20% oil saturation will still have some of the oil recovered during CO_2 flood, as the entire interval in the San Andres down to -652' subsea will be perforated.

- Goodnight indicated during the Piazza hearing on Exhibit C-18 (**Exhibit N-2**) that while selecting the top of San Andres for water disposal, "Goodnight was asked by OCD to use the deeper pick as it would give greater offset to the Grayburg production above". Even if we use Goodnight's top of San Andres structure map shown in **Exhibit N-3**, which is incorrect, one can see that there is over 100' of ROZ interval in many of the wells down to -652' subsea where oil saturations were greater than 20% in the EMSU-679. This map shows that the Meyer B4 #28 would contain 144' ROZ interval due to its structure top of -538' subsea based on Goodnight's map. Goodnight's map does not honor the OCD top for the San Andres in the Meyer B-4 #23 (currently EMSU SWD #1) well, which was the type log for field unitization.
- Goodnight confirms there is a ROZ from -350' to -500' subsea but due to its selection of deeper tops for the San Andres does not recognize that a large part of this interval is San Andres. As shown by **Exhibit N-4** the unitization used the Meyer B-4 #23 as the type log of the field and OCD records show the top of San Andres at 3942' (-347' subsea) putting the San Andres in this ROZ interval. Goodnight shows the top of San Andres at 4150' (-555' subsea) on its Exhibit B-36, indicating a 208' discrepancy. This 208' contains a ROZ, which Goodnight has excluded from its calculations.
- Mr. McGuire is relying on log analysis by Mr. Davidson, who improperly accounted for the oil lost while recovering this conventional core in the EMSU-679 well by assuming the San Andres had been depleted to the same state as the Grayburg, which is not true. If correct adjustments had been made, the oil

saturations shown by core analysis would actually increase by 30% to 35% instead of the 20% to 25% used by Davidson.

- If we correct the oil saturations shown on the core by this 30% to 35% increase, then the interval with oil saturation greater than 20% extends down to near the bottom of the core at 4357' MD or -757' subsea, resulting in a 215' oil column in the San Andres in EMSU-679 and 458' oil column in EMSU-278.

7. On page 3 of Mr. McGuire's testimony, he also states that "Because Goodnight's San Andres disposal zone is confined to intervals below any potential ROZ that may exist in the Grayburg and is isolated by a sustained and geographically extensive geologic seal, disposal operations will not interfere with Eunice Monument South Unit ("EMSU") operations in the Grayburg main pay zone or ROZ intervals based on the effective seal of the disposal zone." This conclusion is incorrect for the following reasons:

- As shown by **Exhibits N-5 and N-6**, the EMSU structural high in the San Andres is reached northeast of Goodnight's Ryno #1 SWD well. Water injected into the downdip portion of the San Andres will make its way up to the upper portions of the San Andres where there is a defined ROZ, both in the -350' to -500' subsea interval defined by Goodnight and into the -500' to -762' subsea interval defined by EMSU-679 core. Empire's production of San Andres water for make-up water in the EMSU-459 and AGU-600 water supply wells, and the influx of San Andres water into the Grayburg due to the pressure difference and natural fractures pathway, provides a pressure sink for this disposal water to move up-dip.
- Goodnight believes that the Grayburg reservoir pressure is higher than the San Andres pressure, but this is incorrect based on fluid level measurements taken on

eight shut-in Grayburg producers during 2024 and wireline pressure measurement taken on October 8, 2024 in shut-in water injector EMSU-378 (**Exhibit N-7**). The pressure measurement in EMSU-378 showed a Grayburg pressure of 951 psi at 4050' (0.235 psi/ft reservoir pressure gradient), while Goodnight reported and Empire confirmed that the San Andres has a 0.381 psi/ft reservoir pressure gradient, which would be 1543 psi at 4050' measured depth, 592 psi higher than the Grayburg.

- Empire corrected its estimate of the original San Andres pressure during my deposition in December, 2024 as it was assumed that the original pressure taken in the Grayburg / San Andres interval of 1450 psi was measured at -250' subsea when in fact it was measured at 250' subsea. This clarification shows the San Andres pressure at 4006' measured depth in EMSU-211 is 1747 psi (0.4361 psi/ft gradient), which is a reasonable estimate of pressure in the region during discovery in 1929. As shown by **Exhibit N-8**, this would indicate that the reservoir pressure in the San Andres had actually declined by 28.7% prior to any significant production in April, 1986, thus indicating communication between the San Andres and Grayburg.
- In Mr. McGuire's Exhibit B-22, he used tubing pressures which he thought were shut-in pressures, to calculate static bottomhole pressure for the Grayburg, whereas in most cases, the pressures were measured upstream of the wellhead and a valve was closed downstream of the pressure sensor, thus measuring pipeline pressure instead of wellhead pressure. It is understandable that Mr. McGuire could have mistaken these as shut-in tubing pressures since the well had no reported flow on those days and yet there was tubing pressure recorded. Empire has instructed field

personnel to shut the well in upstream of the pressure sensor so that true wellhead pressures can be recorded during shut-in of the well. The Grayburg has much lower permeability than the San Andres in most layers, therefore mud losses while drilling usually do not occur until drilling reaches the San Andres high permeability intervals. Low vertical permeability coupled with natural fractures and this pressure difference between Grayburg and San Andres, results in a large volume of water entering the Grayburg from the San Andres.

- To demonstrate that the Grayburg has low reservoir pressure and not the high pressure calculated by Mr. McGuire, water injectors EMSU-378, 380, 380, and 404 were all shut-in during January, 2025 and their wellhead pressures went to zero. The pressure sensors which record the data and store it in the SCADA system were installed upstream of the wellhead by Chevron when the waterflood was installed, so field personnel must follow proper guidelines when shutting the well in so that the SCADA will record proper wellhead pressure.
- Goodnight does not take into account that natural fractures exist in the San Andres and Grayburg intervals and this allows fluid flow and pressure communication between the two intervals. Chevron conducted oriented core fracture studies on EMSU-679, EMSU-B #887, and AGU-225 (included with Robert Lindsay rebuttal) which showed natural fractures in the San Andres and Grayburg intervals. The high water production of some of the crestal Grayburg producers can only be explained by San Andres water influx. This is also supported by the sulfate rich San Andres water entering the Grayburg interval prior to the waterflood, thus causing barium sulfate scale.

- The San Andres reservoir pressure dropped prior to any significant production, demonstrating there is communication between the San Andres and Grayburg intervals. As stated above and during my deposition, the original San Andres pressure was 1747 psi at 4006' measured depth and it declined to 1245 psi by April, 1986 prior to any significant fluid withdrawals by the water supply wells. This 28.7% depletion is also supported by the pressure taken in the EMSU-458 WSW at 3929' measured depth (top of San Andres at 3893') which showed San Andres pressure dropped from 1713 psi to 1225 psi, a 28.5% drop. The drop in San Andres pressure prior to significant fluid withdrawals is also supported by the fluid level of 1128' below surface seen in EMSU-457 WSW in April 1987 when the ESP was run. Using a 0.436 psi/ft fluid gradient, this drop in fluid level would indicate 492 psi pressure depletion which is close to the 502 psi drop shown in the EMSU-211. EMSU-460 WSW also showed a fluid level of 1200' below surface in February 1987 indicating 523 psi pressure depletion prior to producing the well.
- Empire has seen an increase in chlorides from Grayburg oil producers near the four Goodnight SWD wells inside EMSU since April, 2024 (**Exhibit N-9**). EMSU-377 has increased 8.1% (11,371 to 12,291 ppm), EMSU-407 has increased 6.2%, (11,310 to 12,013 ppm) EMSU-440 has increased 25.4% (10,390 to 13,014 ppm), and EMSU-441 (8,943 to 10,596 ppm) has increased 18.5%. The water analyses through November, 2024 have been provided to Goodnight and we are awaiting final lab results for January, 2025 samples indicating increases in EMSU-407 and EMSU-440. As chlorides continue to increase, Empire will be required to adjust its chemical treating program to protect against increased corrosion and scaling.

Empire's chemical consultant indicates that we may need to pump freshwater to reduce TDS and this would require that biocide, oxygen scavenger, and scale inhibitor be used.

8. On page 7 of Mr. McGuire's testimony, he indicates that during the Piazza hearing in Case No. 22626, Empire provided no evidence that the San Andres disposal zone was productive, that San Andres disposal had interfered with any Grayburg production or EMSU operations, or that there is a ROZ in the San Andres. Since the hearing in June 2022, Empire has provided this evidence and Goodnight has chosen to continue with its efforts to drill new wells and inject large volumes of saltwater into the unitized Grayburg / San Andres interval at EMSU. Once this evidence was submitted in September 2023, the Commission denied the drilling of the Piazza well and Goodnight's other applications should similarly be denied due to this clear evidence that there is a Residual Oil Zone (ROZ) in the San Andres and water disposal will violate Empire's correlative rights and damage these reserves. The evidence includes:

- Provided core reports and photos for EMSU-679 and R.R. Bell No. 4 inside the EMSU and core report for Amerada Hess (Apache/Hilcorp) North Monument Well No. 522 (30-025-31585) which shows the San Andres has a trap across the Eunice Monument structure and has a ROZ which extends below -700' subsea. Goodnight acknowledges that there is a ROZ from -350' -500' subsea but they have it mapped as the Grayburg. Empire will show clear evidence during the hearing that the San Andres extends to a subsea elevation of approximately -300' subsea at EMSU and therefore there is a ROZ in the San Andres.

- Provided evidence that some wells at EMSU and AGU have produced oil from the San Andres, and Goodnight's Mr. William Knights on page 4 of his testimony indicated the EMSU-658 tested 2 BO and 1856 BW from the subsea interval -395' to -576' (Top of San Andres -338' subsea) and the EMSU-660 tested 7 BO and 4056 BW from the subsea interval -548' to -661' (Top of San Andres -350' subsea). These tests clearly show that there is moveable oil in the San Andres and water disposal will push this oil off lease and outside the EMSU. The oil volumes indicate that these perforated intervals are slightly above the residual oil saturation to water, hence the high water cut. This indicates that the reservoir is saturated to residual oil saturation down to -661' subsea. By definition, a ROZ should not produce any oil under primary conditions and this explains why there was no oil, or no documented oil production, with the water supply wells.
- Provided evidence by recent water samples that high salinity Delaware Basin water is starting to reach our Grayburg production wells. By us seeing an increase in chlorides in the Grayburg producers we know that the Delaware Basin water is starting to reach our wells. In addition, we no longer have to produce the water supply well (EMSU-459 WSW) continuously to maintain reservoir pressure, and this indicates that water influx from the San Andres is offsetting the voidage caused by oil and free gas production, with all produced water being re-injected. Since the total fluid on our producers is somewhat limited by the size pumping unit or ESP installed, our total fluid has remained somewhat constant and therefore the Grayburg reservoir pressure is increasing

due to water influx from the San Andres. This will worsen as San Andres reservoir pressure builds.

- Goodnight's Mr. Steve Drake stated in the June 14, 2019 Nolan Ryan SWD #1 hearing (Case No. 20555) transcript on page 33 (**Exhibit N-10**) that "Since the unit has passed from its flood stage now into depletion recovery, there are a couple of wells where there are perforations now in the very top of the structure where they have commingled some San Andres production with Grayburg." This is evidence that Goodnight knew that there is some moveable oil in the San Andres and still chose to dispose of saltwater into the interval.
- XTO provided additional evidence in its Executive Summary (**Exhibits N-11 and N-12**) that the San Andres and Grayburg have ROZ intervals. XTO indicates that the San Andres ROZ extends from -400' to -700' subsea and contains 965 million barrels of oil.
- As the Division found in conclusion #8 regarding Goodnight's application to drill the Piazza Well No. 1, the North Monument Grayburg-San Andres Unit which adjoins EMSU-B was unitized with San Andres included because "there is a potential tertiary production, additional tertiary production from the San Andres." (**Exhibit N-13**)

9. Mr. McGuire on page 9 of his testimony stated "Empire presented no evidence that the proposed injection would encroach on the water supply wells or that disposal fluids would impair its EMSU operations or may not be compatible with the San Andres." This is not a true statement for the following reasons:

- In my affidavit submitted August, 2023 and in August, 2024 (Exhibit I-8), we clearly showed that one of the major concerns with San Andres water disposal is that the high salinity Delaware Basin water will be produced by our water supply well EMSU-459. We also have a water supply well at Arrowhead Grayburg Unit (AGU-600) and this well will also be impacted by the water disposal.
- In Goodnight's expert witness Mr. John McBeath's testimony, he indicates on page 3 that "The status of the EMSU water supply wells is relevant to this dispute." He recognizes that Goodnight SWD water entering the Empire Water Supply Wells is a problem and then he and Mr. Thomas Tomastik both write lengthy well histories on the water supply wells. It is obvious that Goodnight's expert witnesses see this as a problem as it is impacting Empire's Grayburg waterflood operations and will become worse after breakthrough of the high salinity and toxic Delaware Basin waters being disposed of. Goodnight has also requested that we report water supply well volumes on our EMSU monthly production updates, so we believe the message is clear on this subject.
- The increase in TDS and chlorides seen in at least three Grayburg producers (EMSU-407, EMSU-440, and EMSU-441) indicates that Delaware Basin water has already entered the Grayburg interval through natural fractures and is changing the composition of the produced waters. This should give Goodnight major concern with continued water disposal in the San Andres.
- In Dr. Robert Lindsay's testimony of August, 2024 he states on page 5 that "If produced water is injected into the San Andres ROZ and that the water contains

ions such as Ca, Na, K, Ba these ions will mix with the SO4 to precipitate cement (scale) within the ROZ, which will reduce reservoir quality and damage future ROZ productivity." He went on to state that the water analysis from Goodnight's Wrigley SWD showed high levels of sodium and calcium, thus causing major concern for scale precipitation in the San Andres ROZ interval.

- A recent well activity report (**Exhibit N-14**) provided by Goodnight on their Ryno SWD No. 1 showed scale build-up at the surface in the wellhead and corrosion at the pin ends with threads of the tubing string starting to break and separate. This shows the corrosivity and scaling tendency of the Delaware Basin water.

10. Mr. McGuire on page 11 of his testimony indicates "The San Andres at the EMSU has never been prospective for hydrocarbons and has been the defined water management zone for the area, both for disposal and water supply, since as early as the 1960's." Mr. McGuire fails to mention that there is San Andres oil production on the Central Basin Platform near EMSU and AGU.

- **Exhibit N-15** shows the net oil pay map for the South Eunice San Andres field 3.5 miles east of AGU. This area has produced approximately 3 million barrels of oil from completions deep into the San Andres interval.
- Anadarko's Wortham C #1 tested 188 BOPD and 912 BWPD during 1971 (see OCD Case #4575) from interval -506' to -822' subsea. Wortham C #2 tested 100 BOPD and 145 BWPD from perforations -738' to -873' subsea. Wortham #5 tested 183 BOPD and 297 BWPD from perforations -741' to -875' subsea.

- This demonstrates that the San Andres has moveable oil and the contact could be below -873' subsea at EMSU.

11. Mr. McGuire indicates in his testimony on pages 37-38 that "Because of the difficulty identifying stratigraphic intervals within the San Andres carbonate ramp system that exists within the EMSU, the best method for accurately picking the top of the San Andres- and the strongest evidence it is correct – is not necessarily geologic but engineering based." This statement is not true for the following reasons:

- Mr. McGuire bases his pick of the top of San Andres on mud losses reported during drilling of the Andre Dawson SWD No. 1. The point at which a well experiences mud losses is inconsistent between wells, and the mud losses often occur hundreds of feet below the top of the San Andres. Further, the pressure depletion seen in the Upper San Andres while drilling indicates that the water supply wells impacted the reservoir pressure throughout the San Andres interval, even with the wells being completed lower in the interval. This is hard evidence that there are no barriers to fluid flow within the San Andres, with the Upper and Lower San Andres being in communication.
- Goodnight does not recognize that the Lovington sand divides the Upper San Andres into two intervals with roughly equivalent thicknesses. This is a known feature of the San Andres deposit and many of the earlier Chevron and XTO picks of the San Andres picked this sand as the top of the San Andres.

- The San Andres also has a "PI marker" which is a siltstone bed which divides the Upper San Andres from the Lower San Andres. It is typically found 400-650 feet below the top of the San Andres.
- As discussed in the rebuttal testimony of Dr. Lindsay and Ryan Bailey, Empire has now made an exhaustive review of logs and core data, incorporating the Lovington sand and "PI marker" to properly pick the top of San Andres. This information clearly shows there is a ROZ in the San Andres.

12. On page 47 of Mr. McGuire's testimony, he indicates that the high water production from EMSU-239 which occurred prior to the waterflood was caused by the well having an openhole section below the oil-water contact. This conclusion is impacted by Goodnight's use of a San Andres top that is too deep and an oil-water contact that is too shallow (-325' subsea). As shown By **Exhibits N-16, N-17, N-18, and N-19**, the following facts demonstrate that a portion of this high water production was caused by San Andres water entering the Grayburg formation through natural fractures and low permeability carbonate rock:

- The EMSU-239 was deepened to the top of the San Andres during 1973 to total depth of 3946' (-358' subsea).
- With Dr. Robert Lindsay indicating that the EMSU original Grayburg oil-water contact being -540' subsea and transition zone up to -350' subsea, the fact that the well made high watercut when produced during 1973 indicates that there was a rise in the Grayburg oil-water contact as shown in **Exhibit N-18**.
- It is improbable that this change in oil-water contact within the Grayburg provided sufficient water volume to account for the 2.5 million barrels of water

produced prior to the waterflood. As discussed in the rebuttal testimony of Dr. James Buchwalter, some San Andres water influx had to be a factor in this water production.

- **Exhibit N-19** is a map provided by Dr. Lindsay showing that four beds of high porosity, high permeability dolograinstones (L1, L2, M1, M2) allowed for water to be pulled up-dip into the Grayburg as reservoir pressure dropped at AGU. The map also shows that similar to the EMSU, there were two areas where bottom water drive from the San Andres entered the Grayburg and provided pressure support for the crestal areas. The Grayburg acted under a combination drive of edge water from Goat Seep aquifer and bottom water from San Andres.

13. Goodnight witness Dr. Larry Lake misinterpreted some of the information contained in Empire's "Eunice Monument & Arrowhead Field CO_2 Development Plan" dated January 15, 2024, and this led to inaccurate assumptions regarding the connection of the San Andres interval with the Grayburg. The following items in his testimony are incorrect:

- The report listed current Grayburg producers and water injectors and did not provide the completion intervals for new wells to be drilled to target the San Andres ROZ interval during the CO_2 flood.
- Dr. Lake's Exhibit G-3 shows the completion intervals for the Grayburg producers and water injectors, San Andres water supply wells, and San Andres SWD wells. The existence of limited perforations in the interval -350' to -704' subsea cannot be construed to mean that there is a barrier to fluid flow between

the intervals. The lack of perforations result from the fact that this interval is mostly ROZ and by definition, a ROZ will not produce oil under primary or waterflood conditions. Tests within this interval show some moveable oil and these perforations are not shown on Exhibit G-3.

14. Many of Goodnight's expert witnesses argue that the oil produced from the San Andres was non-commercial and that wells were plugged back to the Grayburg. Goodnight ignores that oil is present in the San Andres in the form of a ROZ, with some moveable oil in the crestal area as shown by **Exhibit N-12**.

- Chevron and XTO recognized that oil is present in the San Andres on logs and core (EMSU-679, R.R. Bell No. 4, North Monument No. 522) and therefore wanted to test the San Andres interval during the drilling campaign of 8 new wells in 2005.
- XTO in its November 2020 sales package for the Eunice Assets showed a ROZ containing 965 million barrels of oil across the EMSU, EMSU-B, and AGU area. (**Exhibits N-11 and N-12**)
- Exxon in the 2021 Purchase and Sale Agreement included a provision that would provide CO_2 to Empire when the CO_2 project is conducted for the Grayburg and San Andres ROZ intervals.

15. Mr. Tomastik's direct testimony extensively discusses corrosion at EMSU and argues that the corrosion history at EMSU will cause problems during the implementation of a CO_2 flood. His position is contrary to the actual history of corrosion at EMSU for the following reasons:

- The H2S corrosion present at EMSU is a corrosion mechanism which is well understood by the chemical industry and has been effectively treated at EMSU for decades. It is for this reason that no major due diligence was done for corrosion because Chevron and XTO effectively treated for it and Empire adapted the same treatment program.
- On page 6 of Mr. Tomastik's testimony, he indicates "Gulf Oil and Chevron elected to use the San Andres as the EMSU water supply source despite knowing that San Andres water was not compatible with the Penrose or Grayburg formation waters because it was the only source with sufficient volumes for the waterflood." **Exhibit N-20** shows the compatibility study Gulf Oil provided during the unitization. The study indicates that calcium carbonate or calcium sulfate scaling was not a concern but failed to identify that the Grayburg produced water had barium ions which resulted in barium sulfate when exposed to the San Andres sulfate water. Gulf Oil recognized that barium sulfate was an issue since some of the San Andres water was entering the Grayburg formation prior to the waterflood, but the Goat Seep aquifer had been partially depleted by the Grayburg production and at the time, the San Andres was the most logical source of make-up water. Barium sulfate is a minor problem at EMSU after 40 years of water injection, so Mr. Tomastik's discussion on this matter has little bearing on the anticipated major corrosion issues to be faced by production of Delaware Basin water.
- Mr. Tomastik indicated on page 12 of his testimony that the corrosion problem was so significant that 49 new replacement wells had to be drilled for the

waterflood project. However, as stated in the document "Proposed Eunice Monument South Unit" on pages 30-31, 5 of the wells were drilled on locations which had no previous wells, 16 wells were drilled to complete the injection pattern, and 25 wells were drilled to replace wells that had been plugged and abandoned. These 25 wells could have been plugged for many reasons, such as uneconomic production due to low reservoir pressure. The document also states that Gulf Oil planned to utilize 208 of the existing wells for the waterflood.

- During 1996-2005, approximately 52 wells were used to reduce the spacing from 40-acres to 20-acres patterns to improve oil recovery. If any of these wells were drilled as replacement wells, the number was small.
- CO_2 is a corrosive fluid when it is saturated with water but noncorrosive when it is free of water. Many CO_2 injectors use carbon steel tubing during the injection process because the CO_2 is free of water, but since the injection wells at EMSU will likely use a Water-Alternating-Gas (WAG) process where CO_2 and then water is injected, the tubulars will be either cement lined or an internal coating applied to protect against corrosion. The producers will have corrosion resistant internal coating if they flow or have ESP's, but if rod pumps are used, the well will be batch treated with corrosion inhibitor down the tubing/casing annulus so that the rods will not damage any internal coating. Corrosion management during a CO_2 flood increases the cost of operations but can be effectively handled using industry standard practices developed in other CO_2 floods in the Permian Basin.

16. Mr. Tomastik indicates in his testimony on page 14 that "The chemistry of the Grayburg produced water varies widely across the EMSU field with the northern part having about 90,000 mg/L chlorides and the southern part having about 5,000 mg/L chlorides." While this may have been true at some point in the life of the reservoir, water chlorides for the most part are under 15,000 mg/L across the field. This is due to the injection of large volumes of San Andres water during the waterflood. Grayburg produced water chemistries are shown in Exhibits I-12 and I-13 of my direct testimony. As discussed previously, Empire has seen an increase in chlorides in some wells near the Goodnight SWD wells, with the Delaware Basin water having chlorides over 100,000 mg/L and in some wells as high as 245,270 mg/L.

17. During his deposition, Mr. Tomastik claimed that the water disposal must fill a void in the San Andres reservoir before it starts pressuring up. However, Dr. Larry Lake and Mr. John McBeath each utilized a spreadsheet (Bates # Goodnight-Lake_000056 and Goodnight-McBeath_001586) which indicates the San Andres pressure is already pressuring up an average of 7.05 psi for every million barrels of water injected, with the Ernie Banks pressuring up 10.44 psi per million barrels injected. At the current rate of water disposal of approximately 276,000 BWPD (215,000 BWPD by Goodnight, 30,000 BWPD by Permian Line Service, 18,000 BWPD by Rice Operating, and 1,300 BWPD by Parker Energy), the San Andres will pressure up 7 psi in 3-4 days and after one year could be over 500 psi higher pressure. Goodnight witnesses Tomastik, Lake, and McBeath fail to mention this

in their testimony but only during their depositions, likely because this uncontrolled re-pressurization of the San Andres is damaging to Goodnight.

18. In Mr. John McBeath's testimony, he indicates on page 15 that "Mr. West relies upon his assertion that the San Andres pressure was 18.5% depleted as of April 8, 1986. This calculation is based on the comparison of a single repeat formation tester ("RFT") measurement and an "original" reservoir pressure calculated by Mr. West. It is also based on Mr. West's contention that the RFT measurement was in fact made in the San Andres." Mr. McBeath attempts to discredit this information and uses some inaccurate information to do so. As shown in Exhibit N-8, I have made some adjusted calculations for original reservoir pressure and have identified additional information that corroborates depletion in the San Andres prior to any significant fluids having been produced. These facts are:

- Mr. McBeath indicated the pressure was not taken in the San Andres by using an average Grayburg thickness of 490' contained in the unitization document to calculate the top of San Andres. As shown by **Exhibit N-21**, he did not honor the true thickness of the Grayburg at the EMSU-211 location, where Dr. Robert Lindsay shows that the Grayburg thins northeast of the Goodnight SWD wells. This fact is confirmed by the core taken in the R.R. Bell No. 4.
- The original reservoir pressure for the San Andres at a depth of 4006' MD (-430' subsea) is estimated to be 1747 psi based on an original reservoir pressure of 1450 psi (February 27, 1990 EMSU Working Interest Owner's Meeting) taken in the Grayburg interval at 250' subsea (3326' MD in EMSU-211) and a fluid gradient of 0.436 psi/ft utilized. This is higher than originally

estimated because the 1450 psi was assumed to be taken at a subsea depth of negative 250' subsea instead of positive 250' subsea as indicated in Table 1 of September 1989 Technical Committee Report entitled "Proposed Arrowhead Grayburg Unit". AGU showed to be 10 psi higher at this subsea depth but this will have little impact upon the conclusions presented.

- Using this corrected original reservoir pressure of 1747 psi and the RFT pressure point for EMSU-211 of 1245 psi, the pressure depletion was actually 502 psi or 28.7%.
- EMSU-458 had a pressure point taken in the San Andres at 3929' MD (-373' subsea) on May 29, 1986 and it showed a pressure of 1225 psi indicating 488 psi pressure depletion or 28.5% depletion.
- Further, the well files for water supply wells EMSU-457 and EMSU-460 showed static fluid levels of 1128' and 1200' respectively when the ESP's were being run and prior to any production. Using a fluid gradient of 0.436 psi/ft would indicate 492 psi pressure depletion in EMSU-457 in April, 1987 and 523 psi pressure depletion in EMSU-460 in February, 1987, pretty consistent with the RFT measurements.
- We therefore have sufficient evidence that the San Andres reservoir pressure had depleted approximately 500 psi before any significant withdrawals had been made, thus confirming there is communication between the San Andres and overlying Grayburg intervals.

19. In Mr. McBeath's self-affirmed statement on page 18, he indicates "Empire's CO_2 plan is very general in nature and lacks the rigor and detail normally seen to justify

such large-scale projects and investments." The "Eunice Monument & Arrowhead Field CO_2 Development Plan" was prepared over a 2-3 month period, and Empire recognizes that much more work needs to done to prepare for the CO_2 flood. Empire provided a 72-pattern and 250-pattern design with oil forecast and estimated economics in its August, 2024 submittal, but will prepare additional information and analyses prior to implementing a CO2 flood. Empire is currently producing the Grayburg waterflood reserves. As shown by **Exhibit N-22**, Empire has approximately 105 wells with 7" casing set through the Grayburg and can be deepened to the San Andres. This will reduce development cost and provide additional data (additional coring, openhole logging, RFT pressure measurements, etc.). Empire's main priority currently is to make sure that no new SWD wells are drilled inside the EMSU and that water disposal operations be terminated in the four SWD wells (Sosa, Dawson, Ryno, Banks) inside EMSU. Re-pressurization of the San Andres impacts Empire's CO_2 design and increases cost, and this uncertainty must be resolved before Empire can fully plan and develop its CO2 flood.

I affirm under penalty of perjury under the laws of the State of New Mexico that this statement is true and correct.

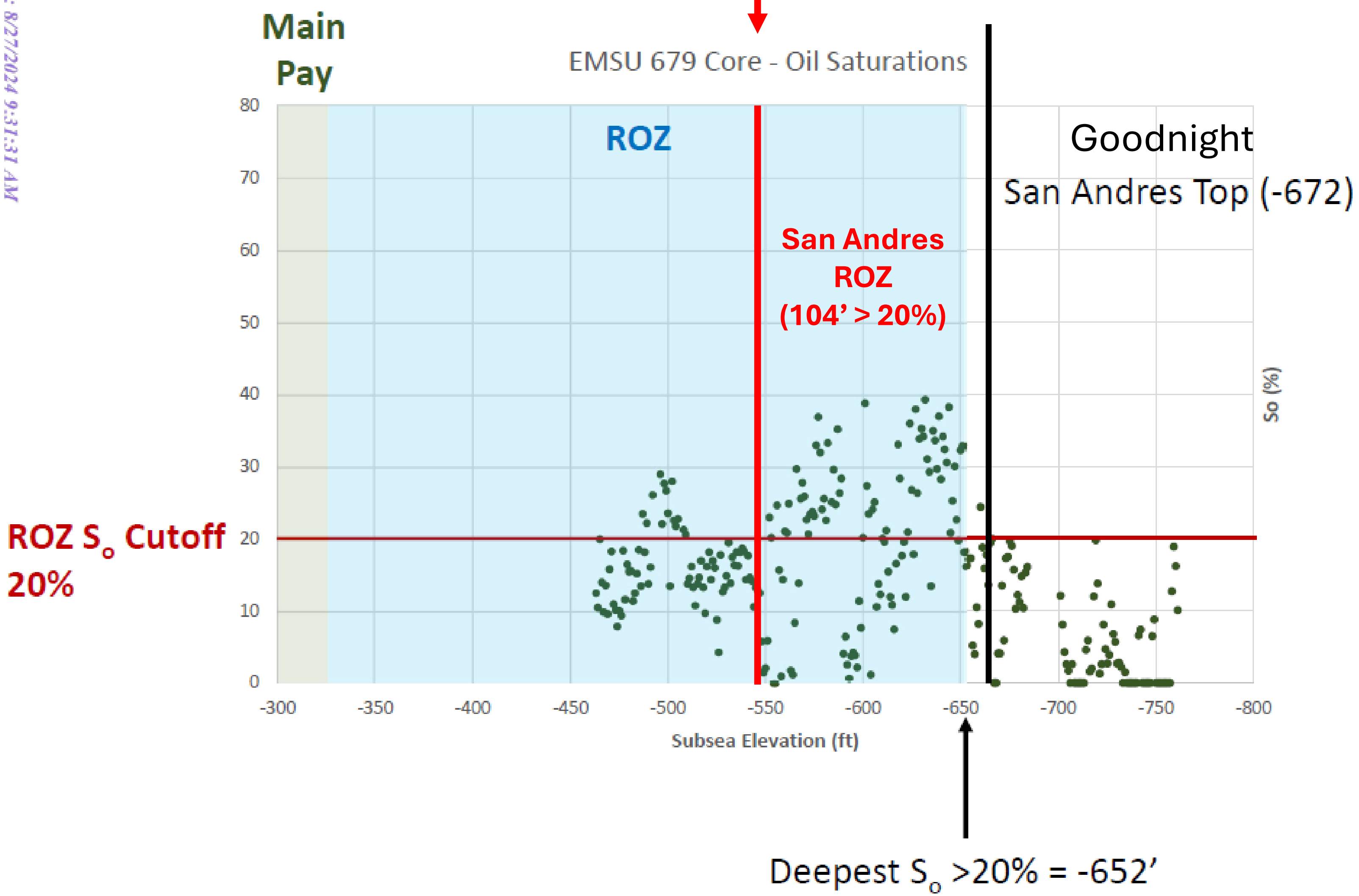
William West
Senior Vice President Operations
EMPIRE PETROLEUM CORPORATION

2/10/25
DATE

Exhibit N-1

Empire New Mexico LLC San Andres Top (-548')

Preston McGuire Exhibit B-32 (Page 2)



- Goodnight uses San Andres top of -672' in their Exhibit B-32 shown here, however the core actually showed top of San Andres at -548', 124' higher.
- If we use Goodnight's estimate of where oil saturation is greater than 20%, this indicates there is 104' of ROZ which Goodnight has excluded from their estimate of oil-in-place

Exhibit N-2

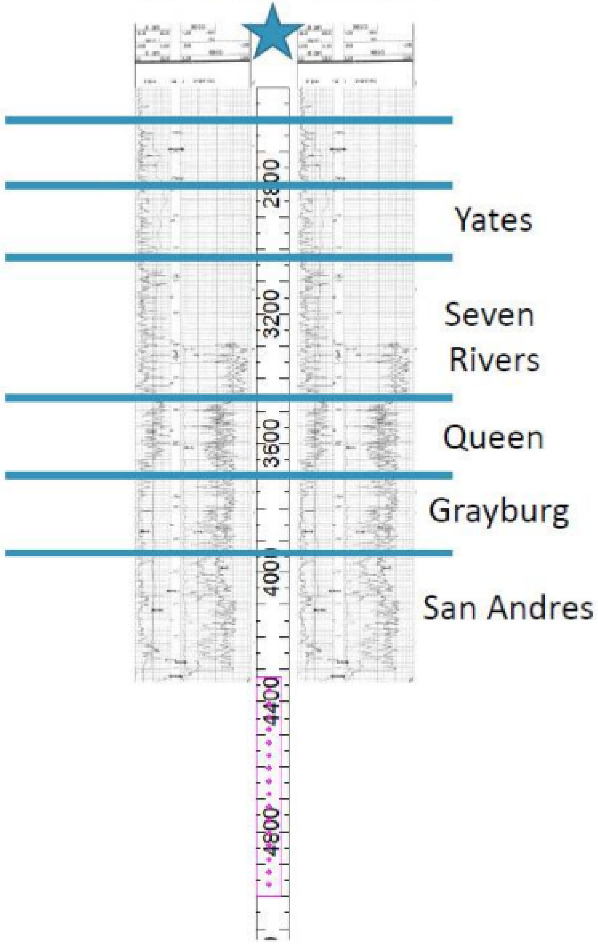
Document: Goodnight SWD Application_EP Exhibit.PDF

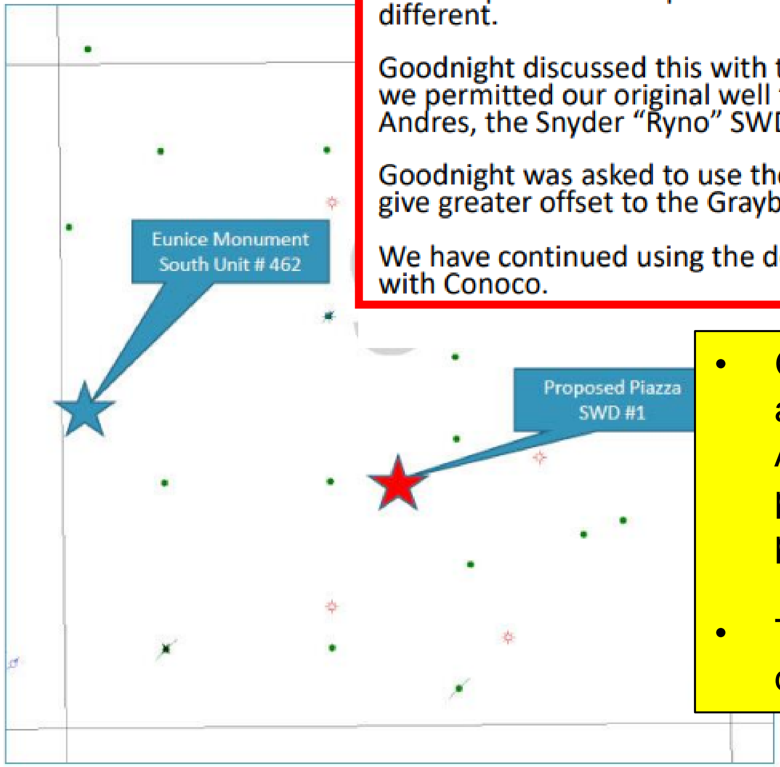
Discussion: Empire Petroleum has picked the top of the San Andres too shallow in this well.

They have the San Andres top above 4000 feet. The top should be at 4168.

On average the Grayburg is greater than 400 feet thick across the EMSU.

Goodnight SWD Application





Historical Context: Gulf Oil and Conoco disagreed on where to pick the top of the San Andres. The Conoco pick was deeper. Both companies were consistent but different.

Goodnight discussed this with the OCD, Phil Goetze, when we permitted our original well for disposal in the San Andres, the Snyder "Ryno" SWD.

Goodnight was asked to use the deeper pick as it would give greater offset to the Grayburg production above.

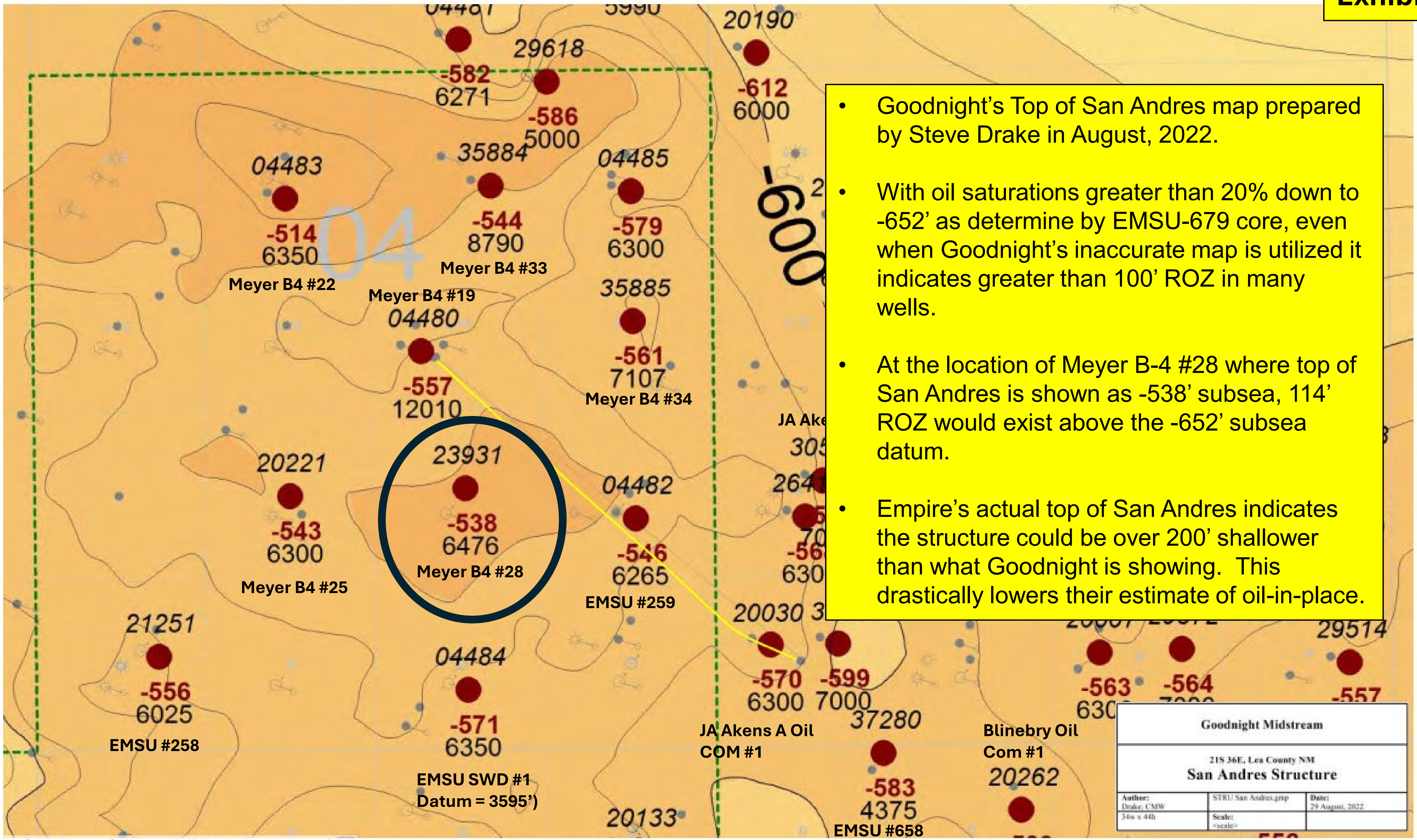
We have continued using the deeper pick; compatible with Conoco.

- Goodnight confirmed in their Piazza #1 SWD application that they selected a deeper San Andres pick that what could be normal to provide greater offset to the Grayburg production above.
- They indicate they continue to use these deeper picks.

BEFORE THE OIL CONSERVATION DIVISION
Santa Fe, New Mexico
Revised Exhibit No. C-18
Submitted by: Goodnight Midstream, LLC
Hearing Date: September 15, 2022
Case No. 22626

Geologic Consultants

Exhibit N-3



- Goodnight's Top of San Andres map prepared by Steve Drake in August, 2022.
- With oil saturations greater than 20% down to -652' as determine by EMSU-679 core, even when Goodnight's inaccurate map is utilized it indicates greater than 100' ROZ in many wells.
- At the location of Meyer B-4 #28 where top of San Andres is shown as -538' subsea, 114' ROZ would exist above the -652' subsea datum.
- Empire's actual top of San Andres indicates the structure could be over 200' shallower than what Goodnight is showing. This drastically lowers their estimate of oil-in-place.

Received by OCD: 2/10/2025 5:08:43 PM

Exhibit N-4

WELEX ACOUSTIC VELOCITY LOG

COMPANY CONTINENTAL OIL COMPANY

WELL MEYER B-4 # 23

FIELD OIL CENTER-BLINEBRY

COUNTY LEA STATE NEW MEXICO

Location 660'FSL 1980'FEL

Other Services: Guard

Sec. 4 Twp. 21-S Rge. 36-E

Permanent Datum Bradenhead Flg. Elev. 35.4

Log Measured From K. B. 11 Ft. Above Perm. Datum

Drilling Measured From Kelly Bushing

Elev.: K.B 3595, D.F 3594, G.L

Date	10-30-62			
Run No.	- One -			
Depth Driller	6350			
Depth Welex	6362			
Btm. Log Interval	6358			
Top Log Interval	Surf.			
Casing Driller	8-5/8 @ 1305	@	@	@
Casing Welex	-			
Bit Size	7-7/8"			
Type Fluid in Hole	Mud			
Dens. / Visc.	9.2 / 69			
pH / Fluid Loss	6 / 10.2 ml	ml	ml	ml
Source of Sample	Circulated			
R @ Meas. Temp.	.16 @ 80 °F	@ °F	@ °F	@ °F
R @ Meas. Temp.	.13 @ 70 °F	@ °F	@ °F	@ °F
R @ Meas. Temp.	.19 @ 80 °F	@ °F	@ °F	@ °F
Source R / R	Measured			
R @ BHT	.115 @ 112 °F	@ °F	@ °F	@ °F
Time Since Circ.				
Max. Rec. Temp.	112 °F @ BH	°F @	°F @	°F @
Equip. / Location	7121 Hobbs			
Recorded By	J. E. Pharr			
Witnessed By	Mr. Levine			

Reproduced By
West Texas Electrical Log Service
Dallas 8, Texas

REFERENCE W2483M

ELSI

16 COMPLETION RECORD

SPUD DATE

COMP DATE

DST RECORD

EXHIBIT NO. 13
Case No. 8397
November 7, 1984

Meyer B-4 #23 (now EMSU SWD #1) 30-025-04484 was used as Type Log during unitization hearing in 1984.

- **Top of San Andres is shown to be at 3942' whereas Goodnight shows it at 4150' in their Exhibit B-36.**
- **This is 208' low to actual San Andres structure top. This 208' contains a San Andres ROZ interval which Goodnight has excluded from their analysis. Based on 640 acres, 10% porosity, 75% net-to-gross, 30% oil saturation, and 1.3 reservoir barrels per stock tank barrel, this 208' of ROZ could contain 17.87 million barrels of oil-in-place.**

16—43094-3 U. S. GOVERNMENT PRINTING OFFICE

HISTORY OF OIL OR GAS WELL

It is of the greatest importance to have a complete history of the well. Please state in detail the dates of redrilling, together with the reasons for the work and its results. If there were any changes made in the casing, state fully, and if any casing was "sidetracked" or left in the well, give its size and location. If the well has been dynamited, give date, size, position, and number of shots. If plugs or bridges were put in to test for water, state kind of material used, position, and results of pumping or bailing.

TD 6350 LM, PB 6100, DF 10, ELEV 3594, CSG PT 5 1/2" AT 6350 FT, LOG COMPARISON 6142 FT ON G/R SONIC IS 6143 FT ON G/R NEUTRON - COLLAR LOG. TOPS....RUSTLER 1285, SALADO 1380, TANSILL 2540, YATES 2672, 7-RIVERS 2944, QUEEN 3368, PENROSE 3512, GRAYB 3666, SAN ANDRES 3942, GLORIETA 5284, BLINEBRY 5906. BLINEBRY ZONE, PAY UPPER BLINEBRY, 5906-6100, NET EFFECTIVE PAY 16 FT. PERFS...5898-5901 FT, 5913-18 FT, 5923-27 FT, 5930-34 FT, 5946-54 FT, 5957-60 FT, 5968-72 FT, 5976-80 FT W/2 JSPF BY G/R - NEUTRON-COLLAR LOG. TRTD PERFS 5898-5980-W/2000 GALS ACID, 10,000 GALS LSE CRUDE, 10,000 LBS SD, 500 LBS ADOMITE. IP PMPD 39 BBLS 42 DEG GRAV OIL, 8 BWS, IN 24 HRS, W/40.8 MCFGPD, GOR 1046, EST DAILY ALLOW 39 BO. PL CONN ATLANTIC. TSTD 11-17-62. DRLG STARTED 10-17-62, COMP 10-30-62, RIG RELEASED 10-31-62.

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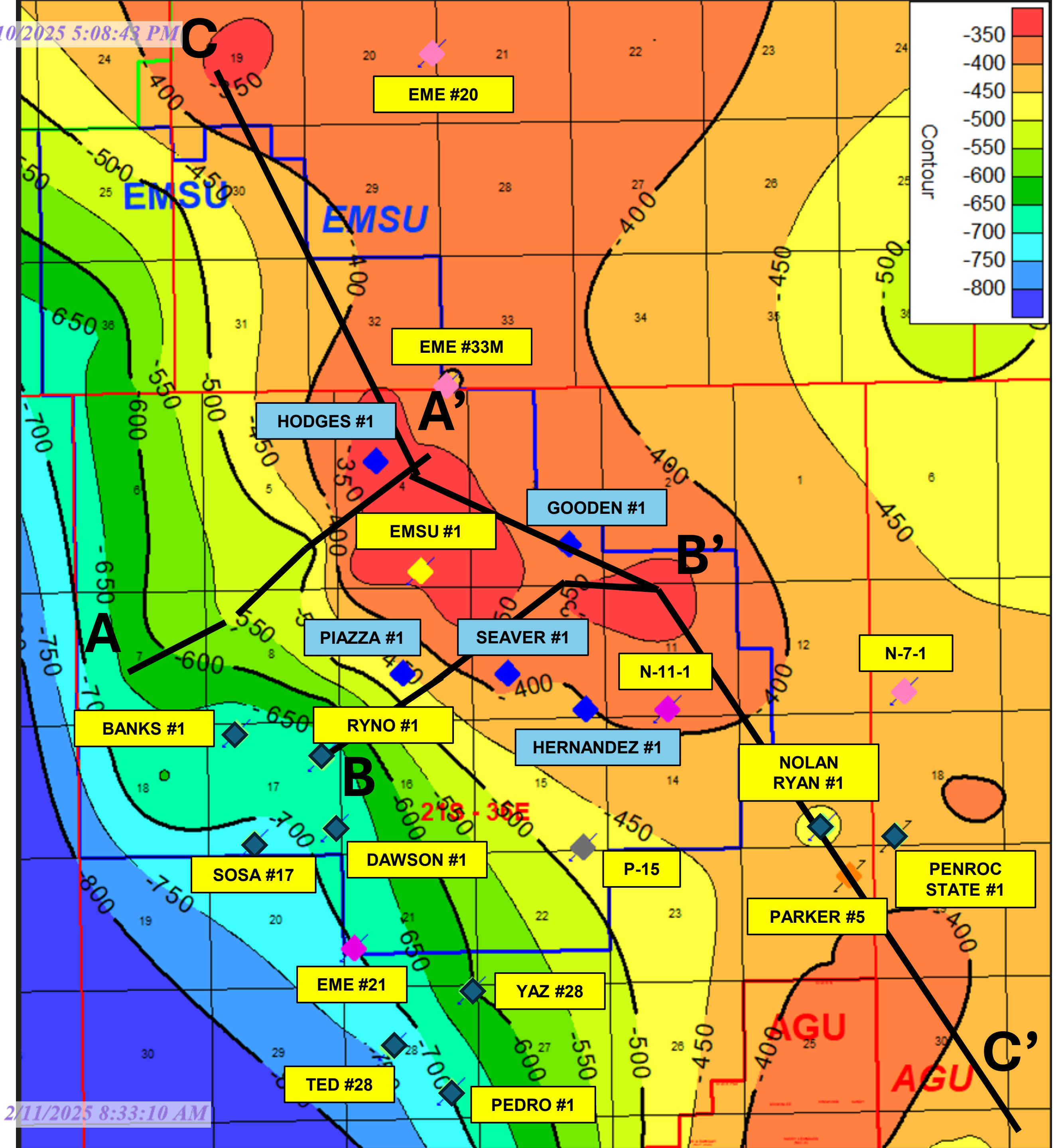
Exhibit N-5



San Andres Structure Map with Existing & Planned SWD Wells

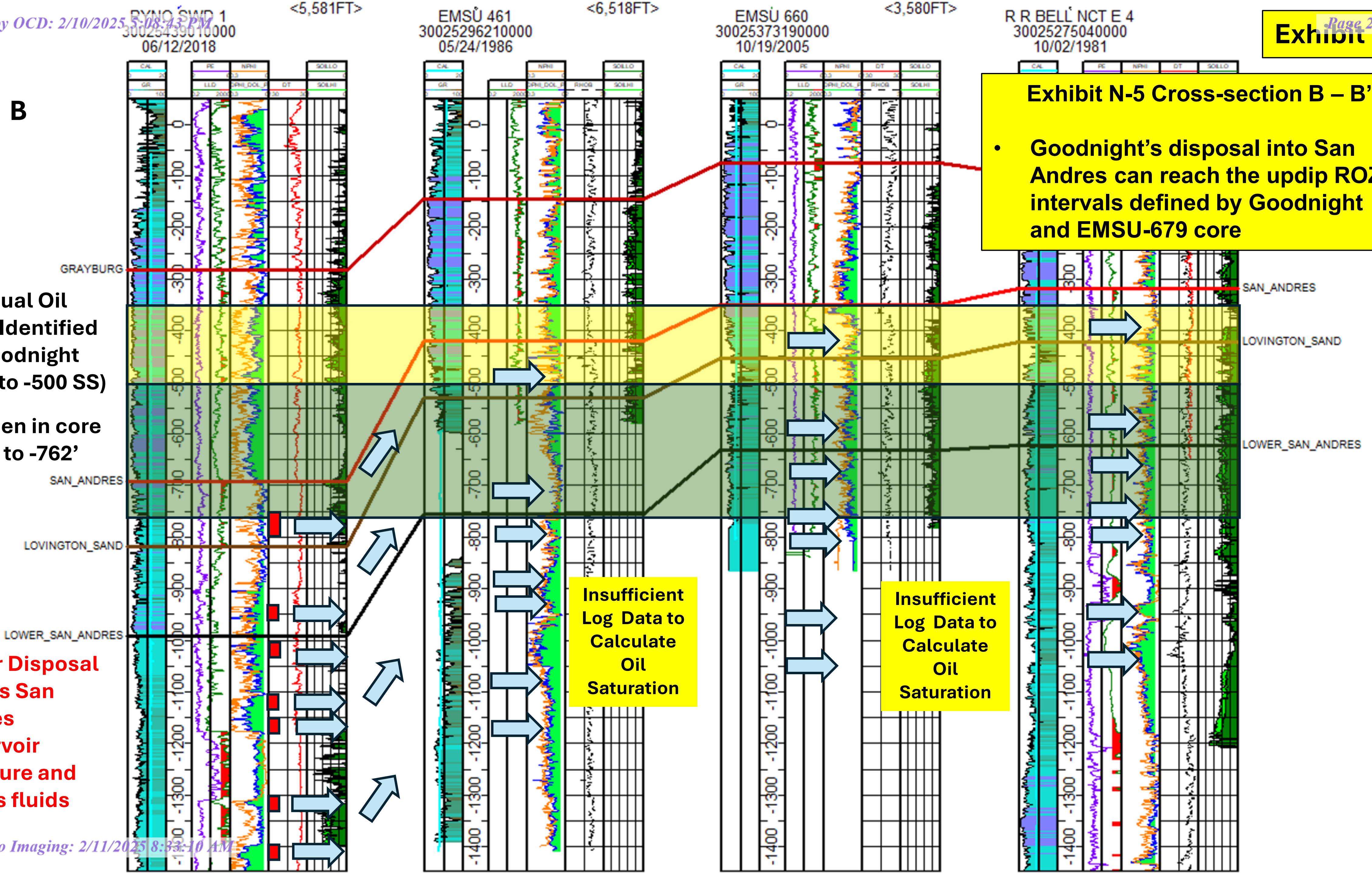
- Top of San Andres at EMSU reaches a high northeast of the Ryno #1 SWD and near where the 5 application wells are proposed
- Cross-section B – B' is shown on Exhibit N-6 and demonstrates how water injected into Goodnight's 4 downdip SWD wells (Ryno, Banks, Dawson, and Sosa) can access the upper intervals with known ROZ.

Exhibit N-6

Exhibit N-5 Cross-section B – B'

- Goodnight's disposal into San Andres can reach the updip ROZ intervals defined by Goodnight and EMSU-679 core

B



Residual Oil Zone Identified by Goodnight (-350 to -500 SS)

Oil seen in core down to -762'

Water Disposal Raises San Andres Reservoir Pressure and forces fluids updip

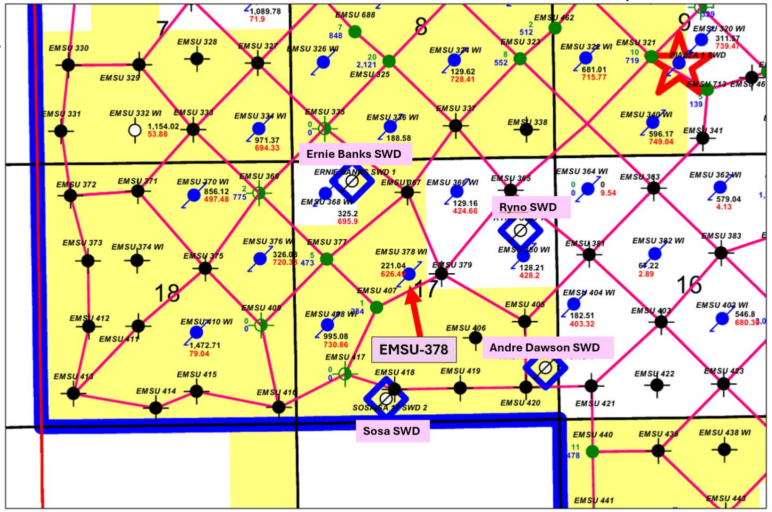
Exhibit N-7

UNDERDOG WIRELINE

Client:	Empire Petroleum Corporation	Well Name:	Empire EMSU 378
Test Date:	10/08/2024 - 10/08/2024	Location:	
Tool Serial:	DC9276	Field / Pool:	

Gradients

	Real Time (MM/dd/yyyy HH:mm:ss)	Stop Type	Depth (ft)	TVD (ft)	Pressure (psia)	Pressure Gradient (TVD)	Temp. (degF)	Temp. Gradient (TVD)
1	10/08/2024 12:00:26	Static	0	0	8.909	0.000000	80.296	0.000000
3	10/08/2024 12:06:14	Static	2000	2000	73.718	0.032405	81.187	0.000445
4	10/08/2024 12:13:00	Static	3000	3000	493.979	0.420261	84.502	0.003315
5	10/08/2024 12:20:19	Static	4000	4000	932.980	0.439001	87.371	0.002869
6	10/08/2024 12:22:26	Static	4050	4050	950.860	0.357600	88.811	0.028800



- **Static bottomhole pressure was taken in EMSU-378 on Oct-8-2024**
- **The well is located in the middle of the 4 SWD wells Goodnight operates inside EMSU.**
- **The static shut-in wellhead pressure is 9 psia (-5.7 psig) and downhole pressure is 951 psia at 4050' measured depth.**
- **The pressure gradients are calculated from point to point indicating fluid level is slightly below 2000'.**
- **This 0.235 psi/ft pressure gradient confirms that the Grayburg pressure is less than the San Andres pressure gradient of 0.381 psi/ft, therefore increasing the likelihood that water is moving from the San Andres into the Grayburg.**

Exhibit N-8

Pressure Depletion Prior To Water Injection (Original Pressure in 1929 compared to 1986 pressure)

KEY POINTS

- The original 1929 reservoir pressure was 1450 psi @ 250' subsea depth as provided on page 8 of the April 1983 Technical Committee Report. To adjust the pressure with depth, a 0.436 psi/ft gradient is used.
- The April-1986 reservoir pressure of the San Andres interval measured by an openhole pressure probe at 4006' measured depth indicates a decline of 28.7% prior to any production from the interval.
- This confirms that the Grayburg and San Andres intervals are in pressure communication, therefore any water injection into San Andres will impact Grayburg oil recovery.

REPEAT FORMATION TEST (RFT) PRESSURE DATA

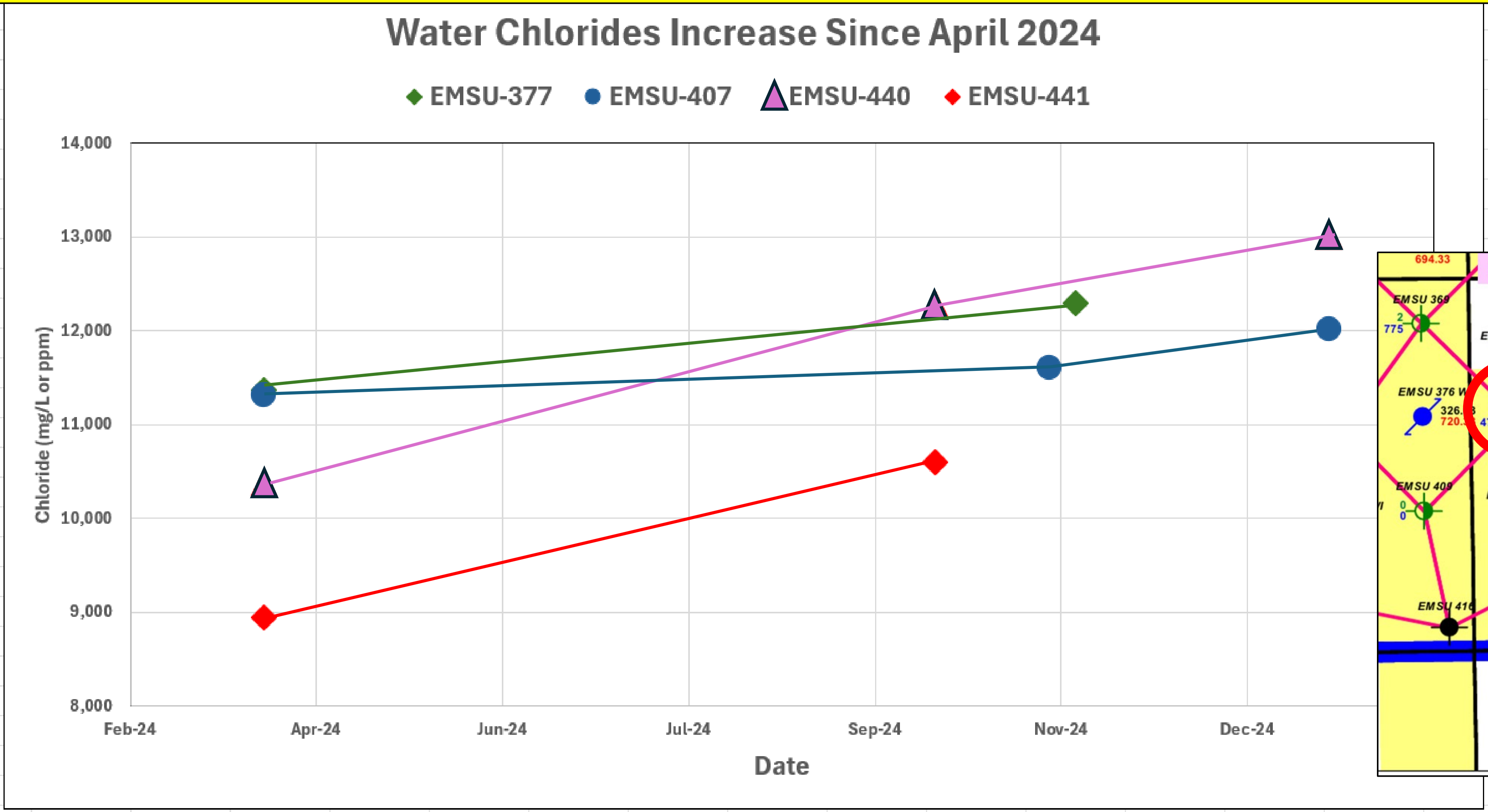
		API:	WELL NAME:	DATE TAKEN:	
	ELEV = 3576'	30-025-29615	EMSU #211 RFT	4/8/1986	
DEPTH: (FEET)	SUBSEA ELEVATION (FEET)	ORIGINAL RESERVOIR PRESSURE (PSI)	APRIL 8, 1986 SHUT IN PRESSURE (PSI)	PRESSURE DEPLETION (PSI)	PRESSURE DEPLETION (PERCENT)
3707	-131	1616	364	1252	77.5%
3749	-173	1635	360	1275	78.0%
3807	-231	1660	402	1258	75.8%
3834	-258	1672	544	1128	67.5%
3852	-276	1679	579	1100	65.5%
3873	-297	1689	735	954	56.5%
3884	-308	1693	997	696	41.1%
4006	-430	1747	1245	502	28.7%

Original reservoir pressure was 1450 psi @250' subsea. Assumes 0.436 psi/foot gradient during original conditions

Top of San Andres at 3975' MD (-399' subsea)

Exhibit N-9

- Empire has seen an increase in water chlorides in Grayburg producing oil wells near the Goodnight SWD wells since April 2024.
- EMSU-377 has increased 8.1% from 11,371 to 12,291 ppm.
- EMSU-407 has increased 6.2% from 11,310 to 12,013 ppm.
- EMSU-440 has increased 25.4% from 10,390 ppm to 13,014 ppm.
- EMSU-441 has increased 18.5% from 8,943 to 10,596 ppm.
- This is a clear indication that high salinity Delaware Basin water is entering the Grayburg formation and impacting operations.



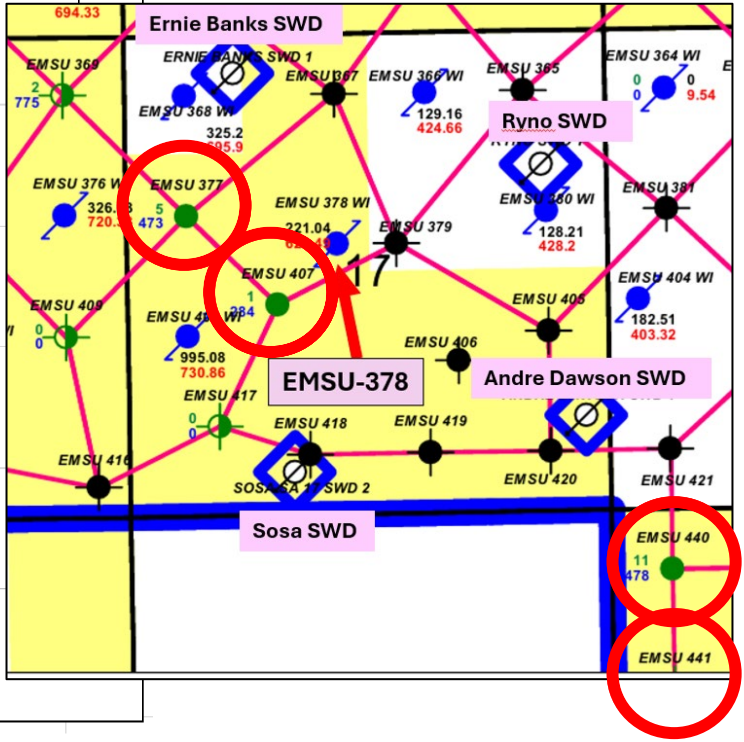


Exhibit N-10

Q. Now, is the San Andres prospective for hydrocarbons in this area?

A. In general and at large, it is not. The San Andres is pooled with the Grayburg as the name of the unit for the South Monument -- Southeast Monument Unit. The proper name, I may not have said it correctly. But the San Andres is pooled with it so that they could manage the source of water to create the flood, as well as the hydrocarbon interval which was the Grayburg and the Penrose.

Since the unit has passed from its flood stage now into depletion recovery, there are a couple of wells where there are perforations now in the very top of the structure where they have commingled some San Andres production with Grayburg. It's commingled, so it's not -- separately. We would have to judge that it is a fairly insignificant amount of oil that's been recovered.

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO.

CASE NO. 20555

REPORTER'S TRANSCRIPT OF PROCEEDINGS

EXAMINER HEARING

June 14, 2019

Santa Fe, New Mexico

- Goodnight knew that the San Andres had some oil production prior to drilling the Nolan Ryan SWD No. 1 as indicated in this Examiner Hearing transcript of Geologist Steve Drake taken in June, 2019.
- They later drilled wells within the EMSU and are disposing of water in the Grayburg / San Andres unitized interval. This injected water pushes the moveable oil to other portions of the reservoir and outside EMSU.
- This is a violation of Empire's correlative rights.

XTO Eunice Opportunity Overview

Exhibit N-11

XTO Energy Inc. ("XTO") is offering for sale a large operated package with assets that include certain oil and gas properties, infrastructure, offices, and personnel located in southeastern Lea County , New Mexico.

ASSET HIGHLIGHTS

Proven Resource & Cash Flow
- Three legacy operated waterflood units (Eunice Monument South Unit A and B, Arrowhead Grayburg Unit)
- An additional ~270 operated lease wells with ~90% working interest
- All leasehold is held by production

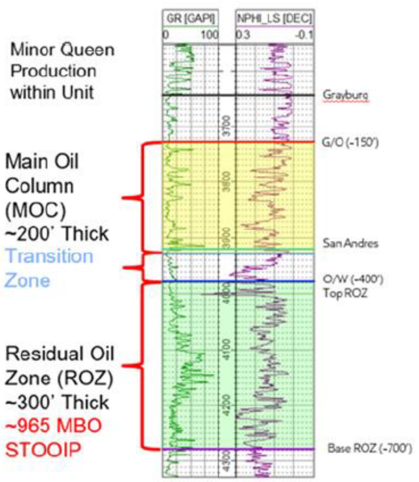
Low-Risk Development Potential
- Numerous workover repair opportunities
- Optimization of waterfloods through conformance work
- Opportunities to reduce operating costs

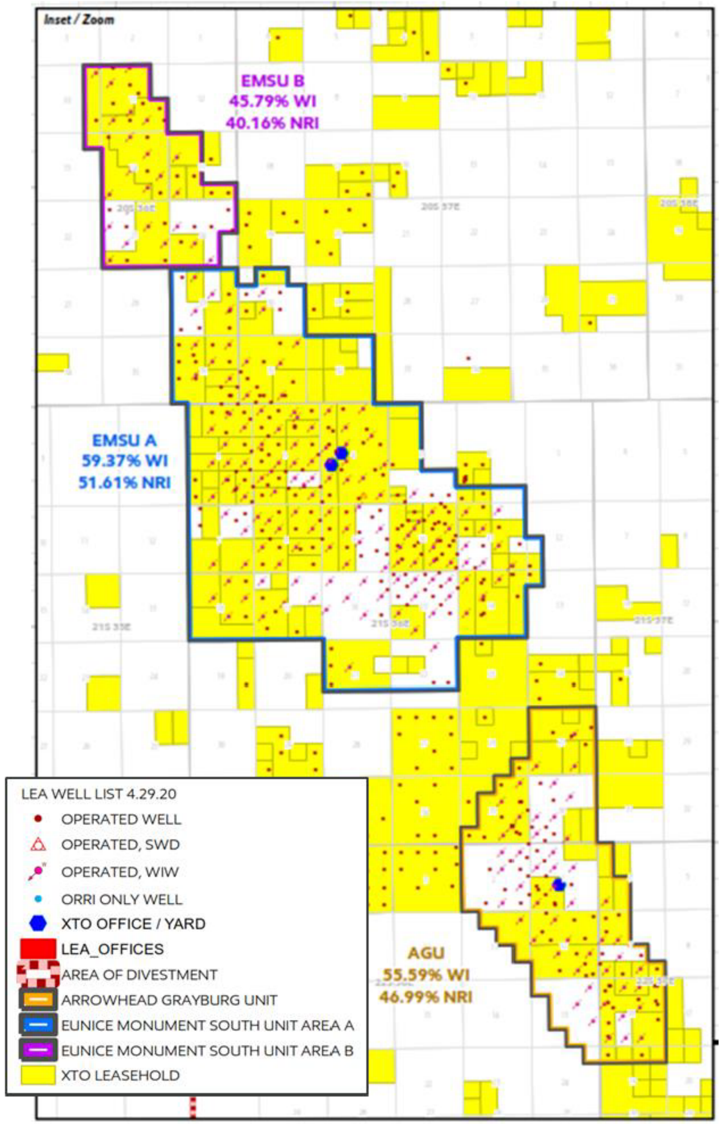
Attractive Upside Opportunities
- Infill drilling locations at 20 acre spacing
- Potential CO2 flooding in the Residual Oil Zone Recent in three units

XTO Eunice Opportunity Snapshot

Acres (Approx.)	GROSS	47k
	NET	40k
PDP Well Count (Approx.)	OP	688
	NON-OP	0
	ROY	14
2019 Net Production	OP	1566 OEBD (23% Gas)
	NON-OP	NONE
	ROY	8 OEBD (90% Gas)

TYPE LOG



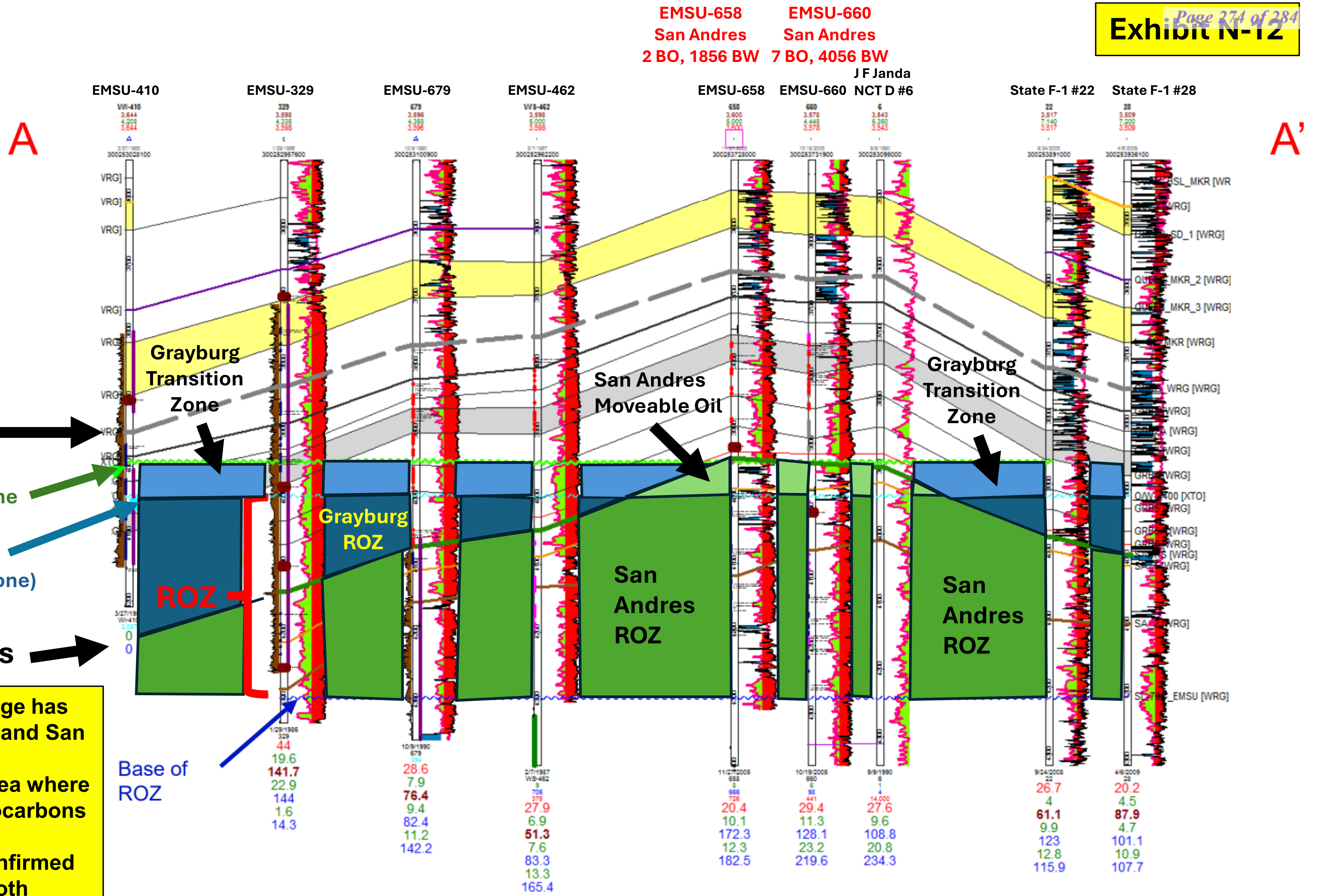


- **XTO dedicated a significant portion of their sales package for EMSU discussing the ROZ interval in the San Andres.**
- **They indicate that the oil-in-place is 965 million barrels oil and the thickness is 300'.**

Exhibit N-12

Cross-section Description

- Porosity Cutoff 6% Green Shading
- Sw < 50% Red Shading
- Core So > 5% Brown Shading
- Top of Grayburg Gray Dash
- Top of San Andres Dark Green

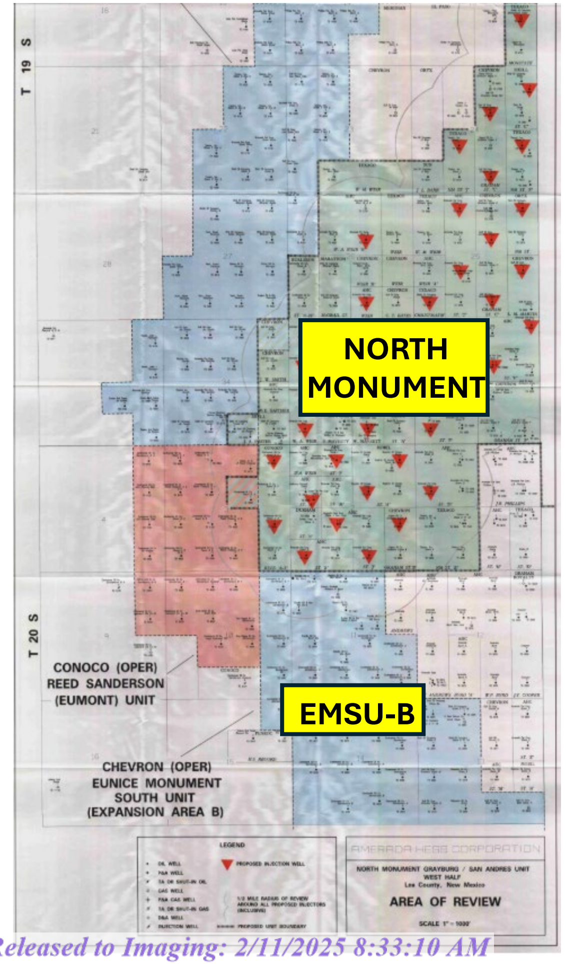


- This slide from XTO sales package has been colored to show Grayburg and San Andres ROZ intervals.
- Grayburg transition zone and area where San Andres has moveable hydrocarbons is also depicted.
- Goodnight's William Knights confirmed that EMSU-658 and EMSU-660 both tested oil in this updip portion of the San Andres.

Exhibit N-13

North Monument Grayburg / San Andres Unit

Transcript from Unitization Hearing. Case No. 10253 which resulted in Order No. R-9494



IN THE MATTER OF THE HEARING CALLED)
BY THE OIL CONSERVATION DIVISION FOR)
THE PURPOSE OF CONSIDERING:)
) CASE NO. 10253
APPLICATION OF AMERADA HESS)
CORPORATION FOR STATUTORY UNITIZATION,)
LEA COUNTY, NEW MEXICO.)

REPORTER'S TRANSCRIPT OF PROCEEDINGS
EXAMINER HEARING
BEFORE: DAVID R. CATANACH, Hearing Examiner
April 4, 1991
12:28 p.m.
Farmington Fe, New Mexico

26

The primary target for this injection are the lower two zones, Zones 3 and 3C.

Q. Why is the San Andres included in this application?

A. The San Andres is included for three reasons: Number one, the San Andres may be a source of water for the injection. Number two, there is a potential for tertiary production, additional tertiary production from the San Andres. And thirdly, this interval is comparable to the unitized intervals in Eunice Monument South.

Q. And this exhibit also shows the thickness of each of these formations?

A. Yes. The San Andres here is approximately 1,000 feet, and the Grayburg varies from 350 to 400 feet thick.

- North Monument Grayburg / San Andres Unit adjoins to EMSU-B to the north.
- The unit was formed like EMSU where Grayburg and San Andres intervals were included.
- In the unitization transcript, Amerada Hess indicates the San Andres is included because "there is a potential for tertiary production, additional tertiary production from the San Andres."
- This unit has a core well (NMGSU #522) with high oil saturations in the San Andres down to -700' subsea, bottom of the core.

Exhibit N-14

Well activity report for Ryno SWD No. 1 showing build-up of scale in the wellhead at surface and corrosion of the pin ends of the tubing downhole. Shows the corrosivity and scaling tendencies of the Delaware Basin disposal water.

San Antonio 210-828-8117 Fax 210-828-5274
8620 N. New Braunfels, Suite 315
San Antonio, Texas 78217

BRUINGTON ENGINEERING, LLC

DAILY WORKOVER REPORT

Date:	10/19/24	**Operator:**	Goodnight Midstream, LLC		**Well Name:**	Ryno SWD 1			
Field:	San Andres	**County:**	Lea, NM	**Consultant:**	Ronnie McWhirter		**Phone:**	903-930-0282	
Present Operation:	Preparing to release packer seal assembly.				**Contractor & Rig No.:**	Mesa 219			
Production Casing OD:	7"	**Depth:**	10,556'	**Wt.:**	26 lb/ft	**Grade:**	HCL80	**PBTD:**	5625'
Tubing OD:	4-1/2"	**Wt:**	11.6 lb/ft	**Grade:**	L80	**Coupling:**	8R, LTC	**Perfs:**	4380' - 5560'

From	To	Hrs	
7:00	8:30	1.5	Arrived at location, met with Goodnight, American safety, Renegade slickline crew, and Mesa.
			Held safety orientation. Checked casing and tubing pressures, both at 0 psi.
8:30	9:00	0.5	Rigged up slickline truck and lubricator. Made up 2.86" gauge ring.
9:00	10:30	1.5	Zeroed slickline at ground level. Went in hole with gauge ring, tagged packer at 4337', repaired slickline
			by tightening chain on drum. Pulled out of hole with gauge ring, fluid level at 900'.
10:30	11:00	0.5	Went in hole with 2.75" R plug and set below packer, pulled out of hole with slickline and setting tool.
11:00	12:00	1.0	Calculated 15 bbls of fluid to fill pipe, pumped 20 bbls down tubing and caught pressure. Increased
			pressure to 500 psi. Pressure was dropping off, tied into casing and pumped 9 bbls to 500 psi.
12:00	12:30	0.5	Monitored pressure on tubing and casing at 500 psi for 15 min. No change.
12:30	1.:00	0.5	Rigged down and released Pate pump truck and Renegade slickline truck.
1:00	2:00	1.0	Attempted to nipple down and remove injection tree from tubing head, would not break free, pulled with
			the rig blocks, talked with Encore wellhead tech and ordered flange splitter tool to separate flanges.
2:00	4:00	2.0	Waited on Encore flange splitter tool.
4:00	5:00	1.0	Used Encore tool to separate and remove tree from tubing hanger, lots of scale and rust on top tubing
			and flange, sent tree back to Encore for repairs and clean up.
5:00	6:30	1.5	Nippled up BOPs, tested blind rams to 1500 psi, good test.
6:30	7:00	12.5	Shut down for night.
			Received and unloaded 119 joints 4-1/2" 11.6 lb/ft L-80 BTC lined tubing yellow band, 1 - 4-1/2" pup joint
			Cleaned, drifted and tallied with Bodark services (4705.58') + 10.09 pup jt.

San Antonio 210-828-8117 Fax 210-828-5274
8620 N. New Braunfels, Suite 315
San Antonio, Texas 78217

BRUINGTON ENGINEERING, LLC

DAILY WORKOVER REPORT

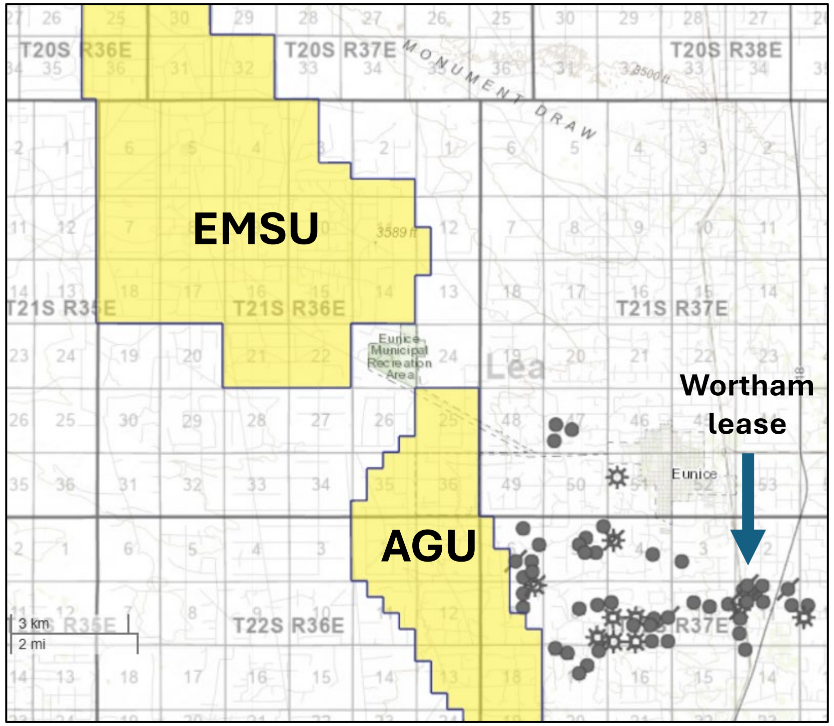
Date:	10/20/24	**Operator:**	Goodnight Midstream, LLC		**Well Name:**	Ryno SWD 1			
Field:	San Andres	**County:**	Lea, NM	**Consultant:**	Ronnie McWhirter		**Phone:**	903-930-0282	
Present Operation:	Preparing to pull BOPs to inspect tubing head.				**Contractor & Rig No.:**	Mesa 219			
Production Casing OD:	7"	**Depth:**	10,556'	**Wt.:**	26 lb/ft	**Grade:**	HCL80	**PBTD:**	5625'
Tubing OD:		**Wt:**		**Grade:**		**Coupling:**		**Perfs:**	4380' - 5560'

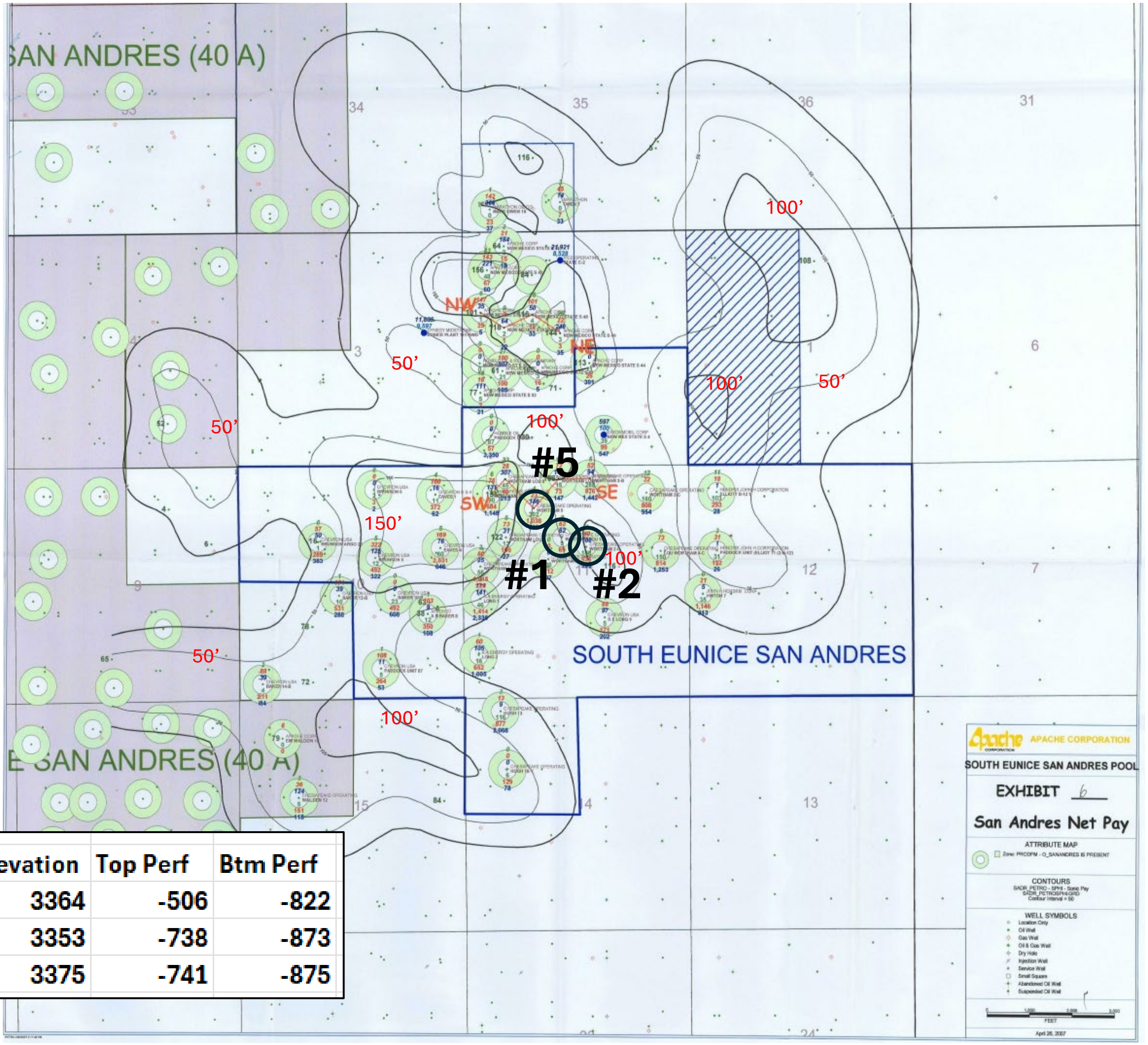
From	To	Hrs	
7:00	8:00	1.0	Arrived at location, waited on daylight
8:00	8:30	0.5	Conducted Goodnight Midstream orientation with Mesquite Tool hand and Byrd power tong crews.
8:30	9:00	0.5	Rigged up lay down machine and power tongs.
9:00	12:00	3.0	Waited on crossover sub for TIW valve.
12:00	1:00	1.0	Worked tubing to find neutral weight, turned tubing to right 12 rounds and unlatched and released
			tubing from packer. Pulled hanger and rigged up to circulate.
1:00	2:30	1.5	Circulated and cleaned well with reverse unit at 5 bpm for 200 bbls, returns were clean after one
			circulation (67 bbls).
2:30	6:30	4.0	Pulled out of hole laying down 107 joints of tubing and 2 pup joints while looking for corrosion, holes or
			damage to tubing. Broke connections with power tongs and rotated at no more than 25 rpms.
			Found several damaged (corroded) pins with threads starting to break and separate, liner damage on
			several joints as well from corrosion, did not see any holes.
			Sent packer latch assembly in with Mesquite tool hand for repairs and redress.
6:30	7:00	12.5	Shut down for night.

Exhibit N-15

Oil production from San Andres is obtained from South Eunice San Andres Pool 3.5 miles east of AGU. Anadarko's Wortham lease had three wells completed at depths of -506' to -875' subsea making high oil rates during initial completion. This shows the San Andres has been sourced with oil in the area and that moveable hydrocarbons exists. Approx. 3 million barrels oil produced.

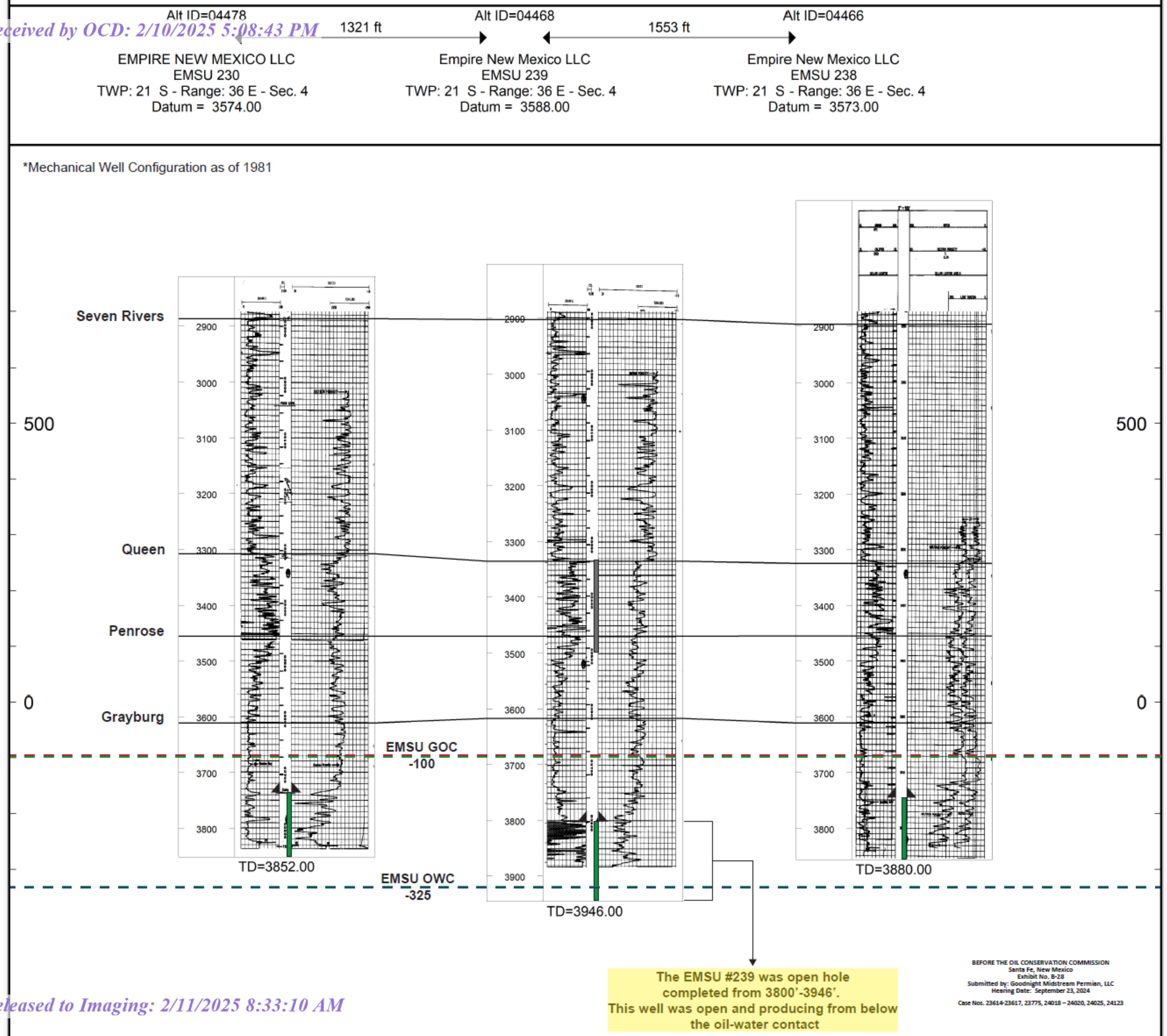
Location of offsetting San Andres oil production





Well Name	API #	Top Perf	Btm Perf	BOPD	BWPD	MCFPD	Elevation	Top Perf	Btm Perf
Wortham C #1	30-025-23422	3870	4186	188	912	367	3364	-506	-822
Wortham C #2	30-025-23473	4091	4226	100	145	241	3353	-738	-873
Wortham #5	30-025-23606	4116	4250	183	297	344	3375	-741	-875

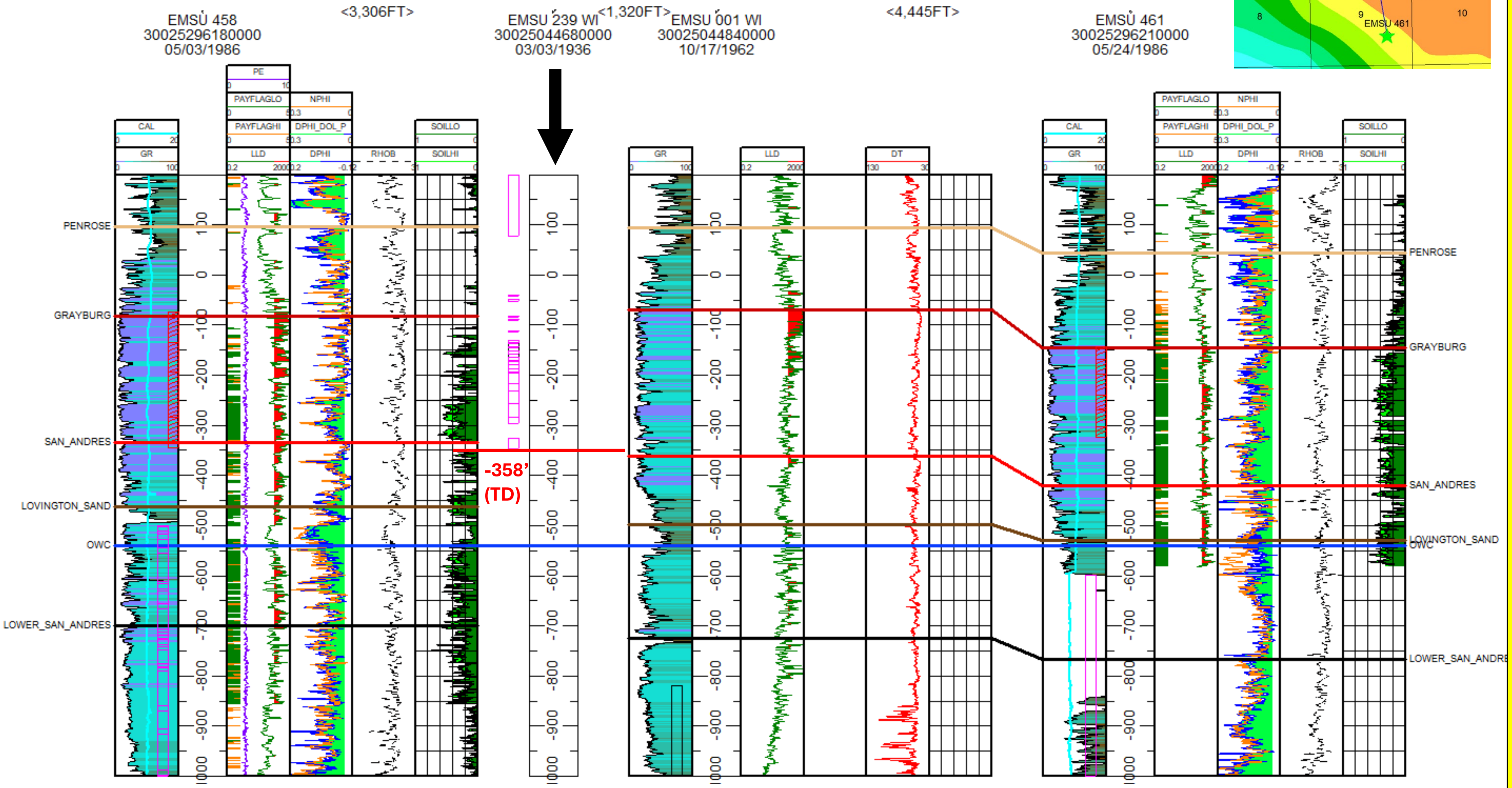
Exhibit N-16

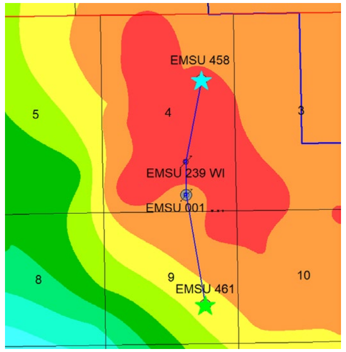


- **Goodnight's Exhibit B-28 argues that EMSU-239 made large volumes of water before the waterflood due to it having an openhole section below the original oil-water contact.**
- **The well was deepened to 3946' measured depth (-358' subsea) during 1973 and when they ran the 4-1/2" liner it stuck off bottom at 3800' (-212' subsea), exposing 146' of openhole.**
- **Goodnight's claim is based upon an original oil-water contact of -325' subsea whereas Dr. Robert Lindsay indicates the true oil-water contact for EMSU was -540' subsea and there was a transition zone up to -350' subsea. Empire's reservoir model uses an oil-water contact at -366' subsea indicating the openhole section was above the contact.**
- **Empire currently estimates top of San Andres near the total depth of this well, therefore access to water production in 1973 was limited unless there was influx of water from the San Andres.**

Exhibit N-17

EMSU-239





- **North-south cross-section shows EMSU-458 and EMSU-239 are updip wells with top of San Andres around -350' subsea.**
- **With the oil-water contact being at -540' subsea and transition zone above that to -350' subsea, there is very little pore space for water to present around the EMSU-239 at discovery of the field.**
- **Bottom water from the San Andres had to be a major factor in the production of high water volumes from EMSU-239 prior to the waterflood.**

Exhibit N-18

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Page 45 of 50

Approximate Location of EMSU-239

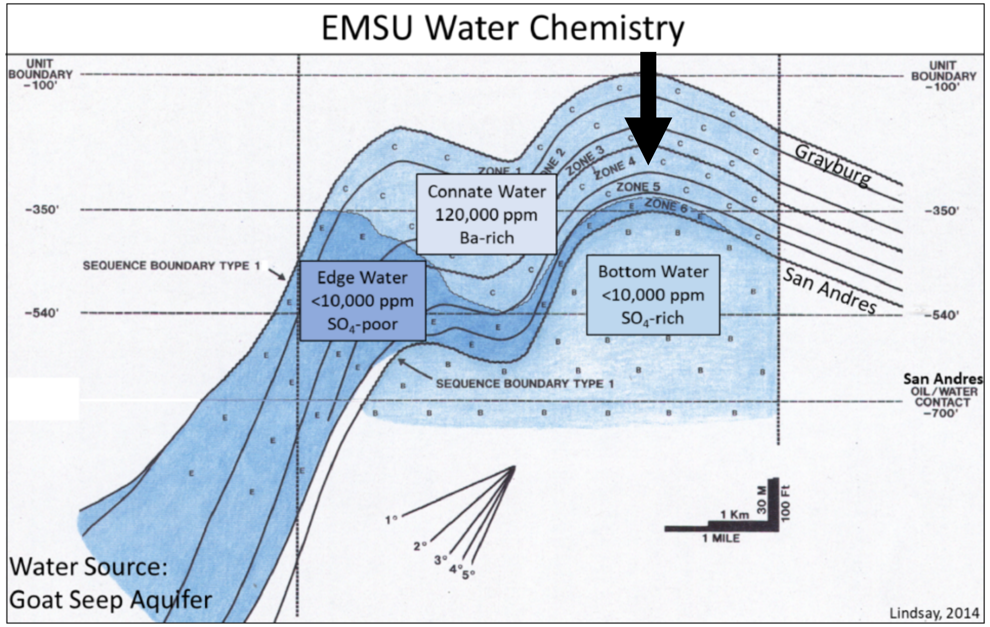

Exhibit B-21

A Chevron water chemistry study in EMSU revealed three water chemistries. First, connate water (120,000 ppm) in the Grayburg reservoir contains barium (Ba). Second, low salinity (<10,000 ppm) edge water entered the west side of the Grayburg reservoir. Edge water contains no sulfate. Edge water is sourced from the Goat Seep Aquifer, which is 1.5 to 2 miles down-dip of the west unit boundary of EMSU. Edge water entry into the Grayburg reservoir was by a drop in reservoir pressure due to production through time. Edge water is sourced from the present-day Guadalupe and Glass mountains. Third, low salinity (<10,000 ppm) bottom water, in the San Andres reservoir residual oil zone (ROZ) is sulfate rich. San Andres water was sourced from the Southern Rocky Mountain Epeirogen west of the Sacramento Mountains by meteoric recharge, which dissolved evaporite beds ($CaSO_4$) as it recharged into the subsurface and added sulfate (SO_4) to the low salinity water.

- **Exhibit B-21 from Dr. Robert Lindsay's testimony and his 2014 PhD dissertation indicating oil-water contact at -540' subsea and free water contact at -350' subsea.**
- **Edge water from Goat Seep and Grayburg formations entered the Grayburg reservoir and brought water into the bottom layers of the Grayburg.**
- **Dr. Lindsay also indicates that the San Andres was a bottom water drive entering the Grayburg and was evident by sulfate rich waters.**
- **EMSU-239 was therefore impacted by Grayburg edge waterdrive and San Andres bottom waterdrive.**

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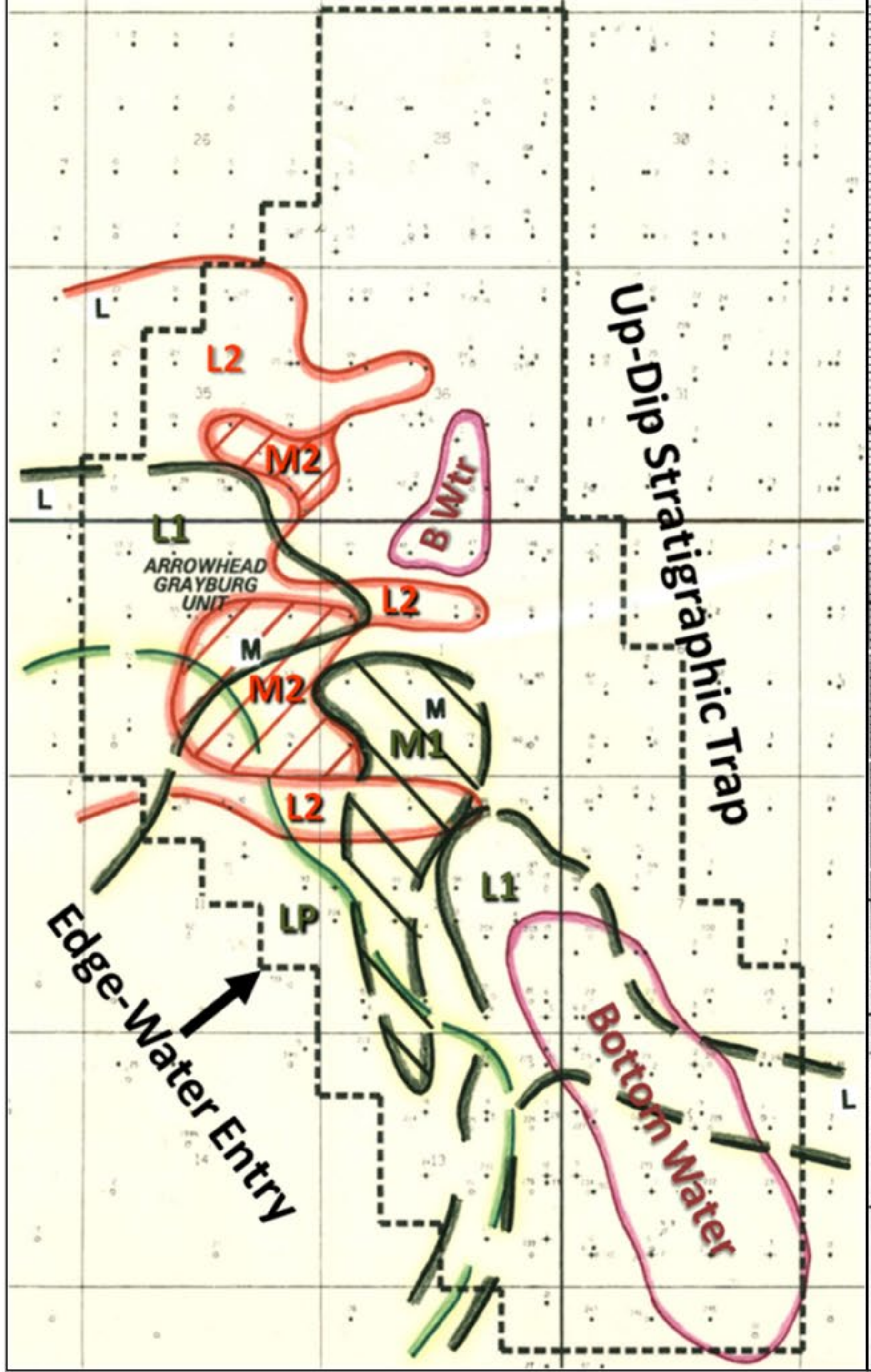
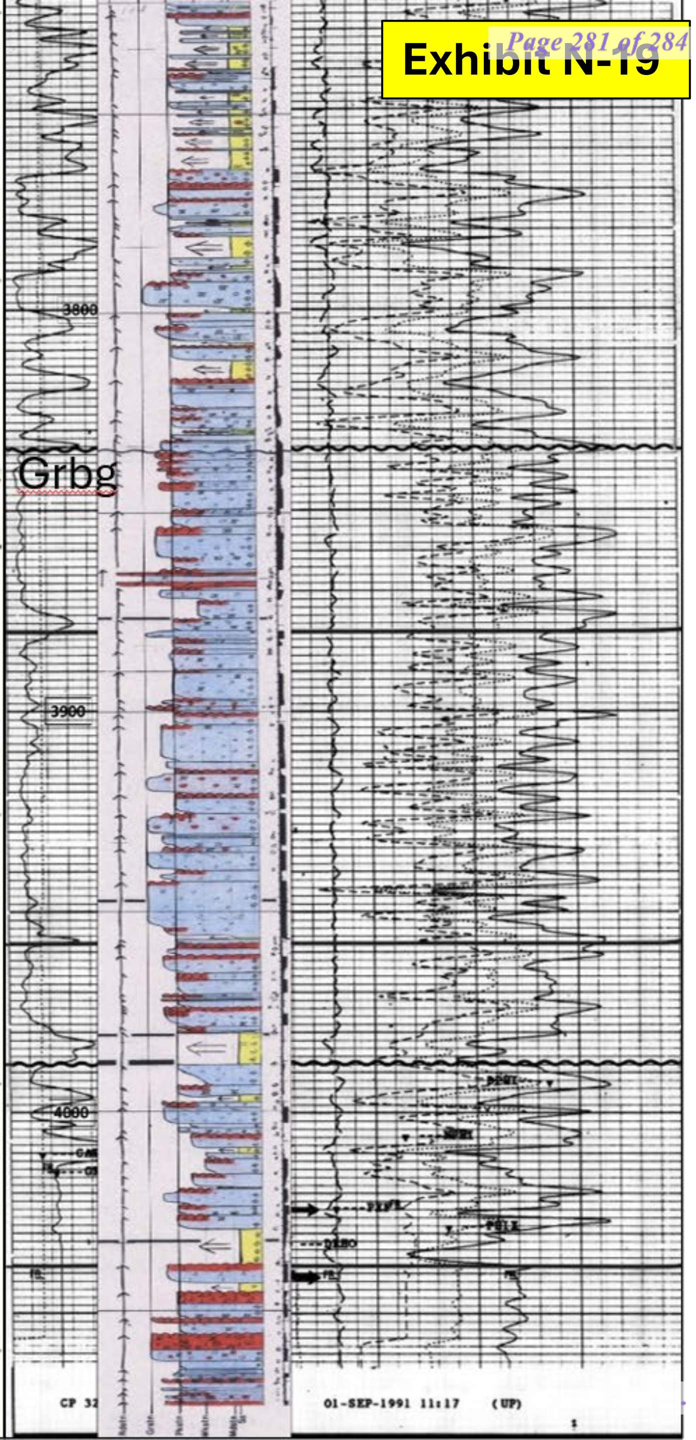
Exhibit N-19

Reservoir Connectivity

Arrowhead Grayburg Unit

Grayburg Fm. Arrowhead Grayburg Unit (AGU) with bottom water and 4 beds of high porosity-permeability dolograinstone that are each 1.5 ft (0.5 m) thick. These high perm streaks pulled water up-dip into the reservoir by a drop in reservoir pressure during field production. To avoid high water production these beds were not utilized as part of the waterflood.





Lindsay (2014)

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Exhibit N-20

P O BOX 1468
MONAHANS TEXAS 79756
PH 943-3234 OR 563-1040

Martin Water Laboratories, Inc.

709 W INDIANA
MIDLAND TEXAS 79701
PHONE 683-4521

RESULT OF WATER ANALYSES

LABORATORY NO. 284226
SAMPLE RECEIVED 2-15-84
RESULTS REPORTED 2-20-84

TO: Mr. Stan Chapman
P.O. Box 670, Hobbs, NM

COMPANY Gulf Oil Exploration & Production Company LEASE
FIELD OR POOL
SECTION BLOCK SURVEY COUNTY STATE

SOURCE OF SAMPLE AND DATE TAKEN:

NO. 1 Make-up water.
NO. 2 Produced water.
NO. 3
NO. 4

REMARKS:

CHEMICAL AND PHYSICAL PROPERTIES

	NO. 1	NO. 2	NO. 3	NO. 4
Specific Gravity at 60° F.	1.0465	1.0051		
pH When Sampled				
pH When Received	6.80	7.22		
Bicarbonate as HCO_3	964	1,830		
Supersaturation as $CaCO_3$	75	120		
Undersaturation as $CaCO_3$	---	---		
Total Hardness as $CaCO_3$	5,400	800		
Calcium as Ca	1,400	144		
Magnesium as Mg	462	107		
Sodium and/or Potassium	23,244	2,308		
Sulfate as SO_4	3,432	300		
Chloride as Cl	36,575	2,841		
Iron as Fe	0.27	7.5		
Barium as Ba				
Turbidity, Electric				
Color as Pt				
Total Solids, Calculated	66,077	7,530		
Temperature °F.				
Carbon Dioxide, Calculated				
Dissolved Oxygen, Winkler				
Hydrogen Sulfide	600	325		
Resistivity, ohms/m at 77° F.	0.126	0.935		
Suspended Oil				
Filtrable Solids as mg/				
Volume Filtered, ml				
Calcium Carbonate Scaling Tendency	NONE	NONE		
Calcium Sulfate Scaling Tendency	NONE	NONE		

Results Reported As Milligrams Per Liter

Additional Determinations And Remarks We see no evidence in the above results that would indicate any incompatibility when mixing these two waters in any proportion. Please contact us if we can be of any additional assistance in this regard.

Form No. 3

By [signature]
Waylan C. Martin, M.A.

Received by OCD: 2/10/2025 5:08:43 PM

Exhibit N-21

Geological Data
Injection Zones
in the
Proposed Eunice Monument South Unit

Mr. McBeath uses the average thickness of 490' for the Grayburg to determine the top of San Andres for EMSU-211. If you read closely the Grayburg is only 200' thick in some parts of the field and the bottom of the interval occurs at around 3700' instead of 3900' as we move up structure near the EMSU-211.

Penrose - Approx. depth 3,400'-3,800*, approx. 170 gross feet.

The Penrose is the lower portion of the Queen formation and overlies the Grayburg. The Penrose is composed of alternating layers of hard dolomite and sand lenses. The Penrose is productive of oil and/or gas, depending on structural position.

Grayburg - Approx. depth 3,500'-3,900*, approx. 490 gross feet.

The Grayburg is a massive dolomite with thin stringers of sand interspersed within it. The majority of oil production comes from intercrystalline porosity in the dolomite.

The range in depths to the top of the Grayburg is due to an asymmetrical anticlinal structure running NW to SE through the Eunice-Monument Pool. The structure dips steeply along the western and southern flanks and therefore the Grayburg top runs deeper, approximately 3,700'-3,900'. Along the axis and the gently dipping eastern flank of the anticline the Grayburg depths run at approximately 3,500-3,700 feet.

San Andres - Approx. depth 4,100'-4,500*, approx. 1,130 gross feet.

The San Andres is a massive dolomite with intercrystalline porosity, which lies directly below the Grayburg. The contact between the Grayburg and the San Andres is gradational and there is no clear marker for the top of the San Andres which can be traced across the field. The San Andres contributes very little if any oil production to the field and serves primarily as a source for injection make-up water and as a zone for salt water disposal.

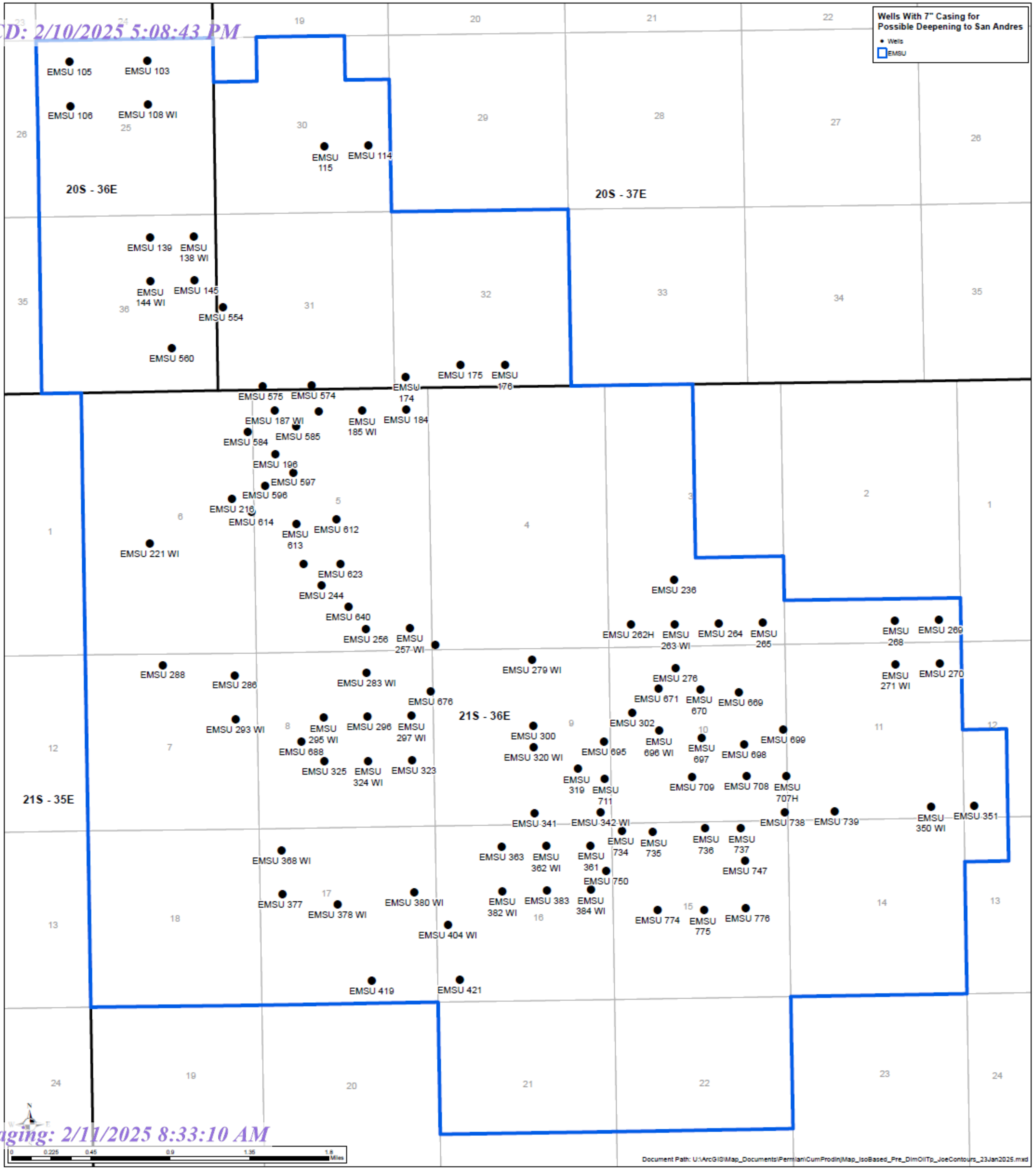
There are no known faults cutting through the San Andres and Grayburg which would act as a conduit for gas, oil or injection water to seep into fresh water horizons above the injection zones in the Grayburg and San Andres.

* Depth depends upon structural position of the well.

EXHIBIT NO. 34 a
Case No. 8397
November 7, 1984

Released to Imaging: 2/11/2025 8:33:10 AM

Exhibit N-22



- **Preliminary review of wellbores at EMSU indicates that there are approximately 105 wells which have 7" casing set at total depth in the Grayburg.**
- **Some of these wells can be deepened and used as San Andres CO_2 injectors and producers, thus reducing development cost.**