Permitting Disposal Wells in the Permian Basin

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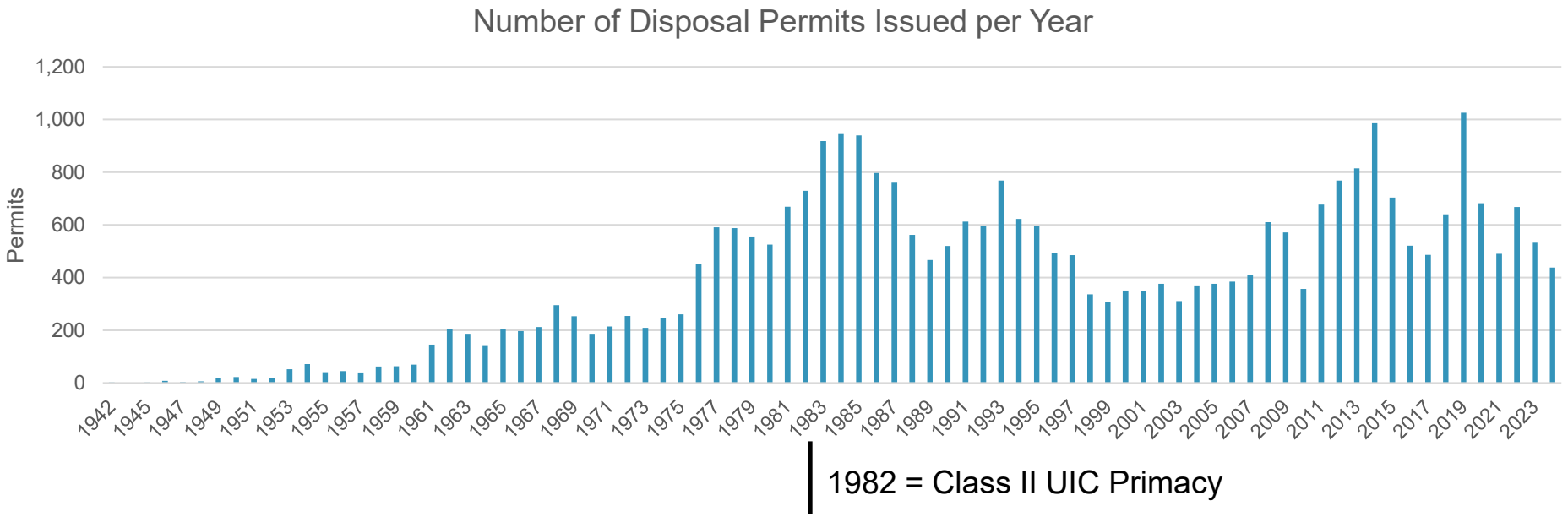
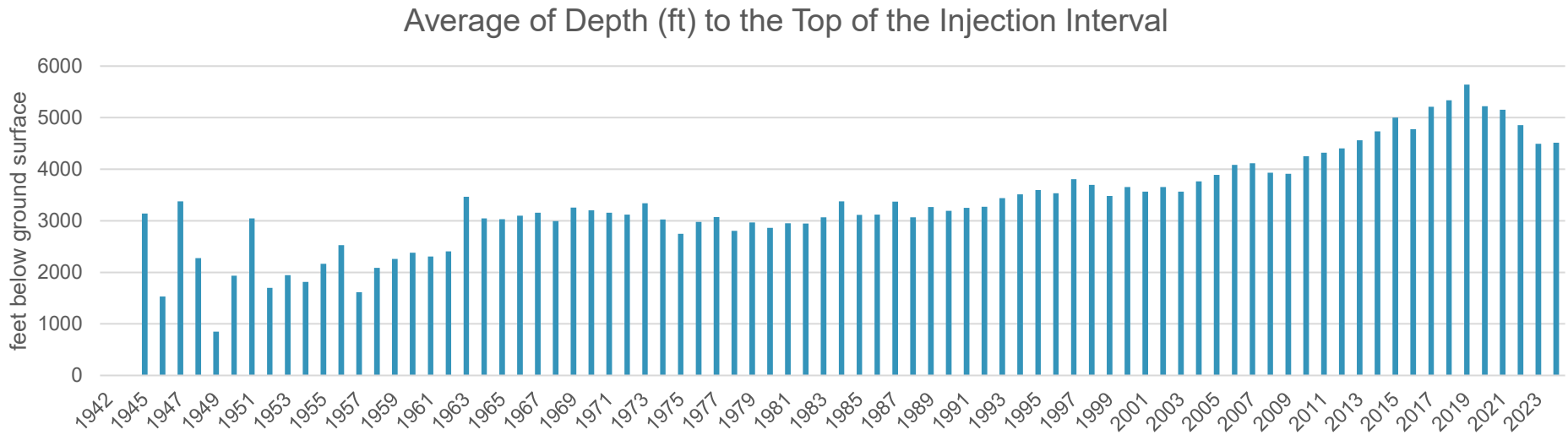
July 2025

Today's Agenda

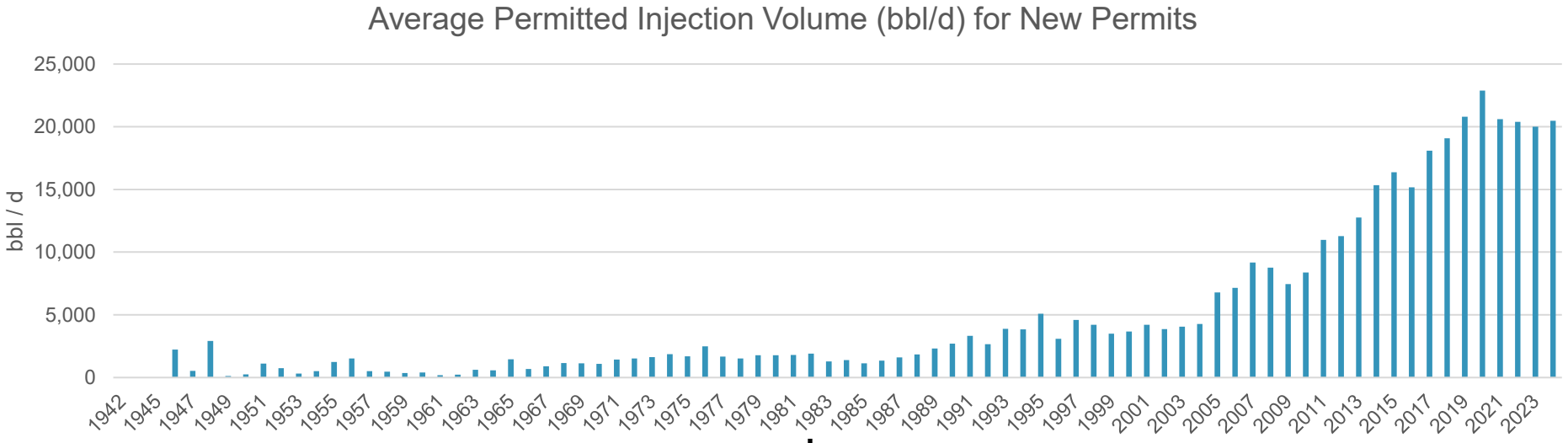
- History
- Applicability
- Elements of the Review
- Post-Permitting Requirements and Special Conditions
- Seismicity
- Demonstration

Permian Basin Disposal Well Permitting History (1 of 3)





Permian Basin Disposal Well Permitting History (2 of 3)



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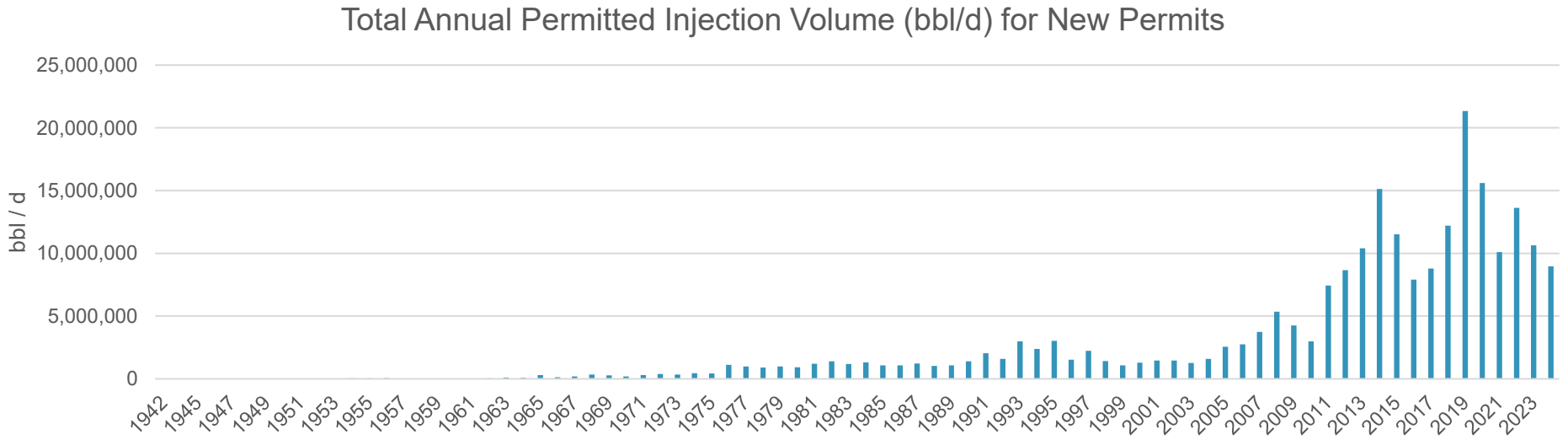
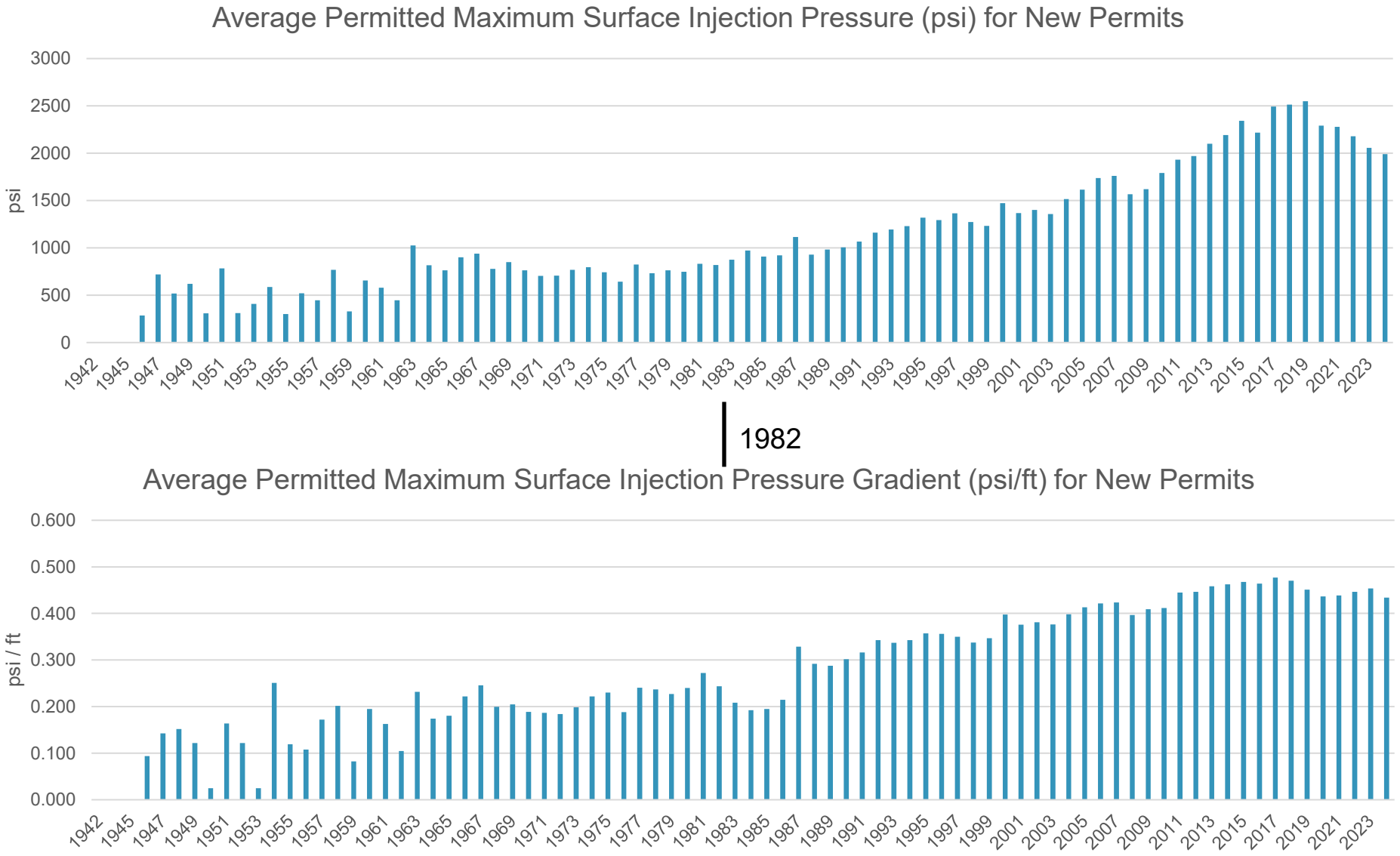


Permian Basin Disposal Well Permitting History (3 of 3)



End Points

- Current rules and permitting program do not adequately address these risk drivers and challenges.

- Water Code §27.051(b)(1-4)

  "The Commission …may issue the permit if it finds:"

  – The disposal well is in the public interest,

  – The disposal well will not endanger or injure any hydrocarbon resources,

  – With adequate safeguards, the disposal well will protect freshwater resources from pollution, and

  – The applicant has made a satisfactory showing of financial responsibility per Water Code §27.073.

Overview of Changes

- Maximum Surface Injection Pressure (MSIP) limited by confinement zone in-situ stress and stress contrast.
- Maximum Daily Injection Volume (MDIV) limited by initial average reservoir pressure.
- Maximum Injection Rate (MIR) – Instantaneous Rate limitation.
- 2-mile radial Area of Review (AOR):
  - Strict limits within ½ mile
  - MSIP reduction within 2-mile on condition

A Note About Public Safety and the Public Interest

- We are asking for PE/PG sealing of certain information.
- This is consistent with our traditional practice. See our web guidance https://www.rrc.texas.gov/oil-and-gas/applications-and-permits/injection-storage-permits/oil-and-gas-waste-disposal/injection-disposal-permit-procedures/technical-review/
  - Engineering and geologic studies
  - Pressure front calculations
  - Closure cost estimates for pits associated with commercial disposal wells
  - Well log formation correlation and analysis which may be performed for the Area of Review
  - Well log interpretation for geologic isolation from freshwater, effective reservoir thickness, etc.
- This is the law.
  - The practice of engineering is regulated by the *Texas Occupations Code, Title 6, Chapter 1001.*
  - The practice of geoscience is regulated by the *Texas Occupations Code, Title 6, Chapter 1002.*

Texas Occupations Code Title 6 Subtitle A § 1001.004. **LEGISLATIVE PURPOSE AND INTENT**; LIBERAL CONSTRUCTION OF CHAPTER.

(a) The legislature recognizes the vital impact that the rapid advance of knowledge of the mathematical, physical, and engineering sciences as applied in the practice of engineering has on the lives, property, economy, and security of state residents and the national defense.

(b) The purpose of this chapter is to:

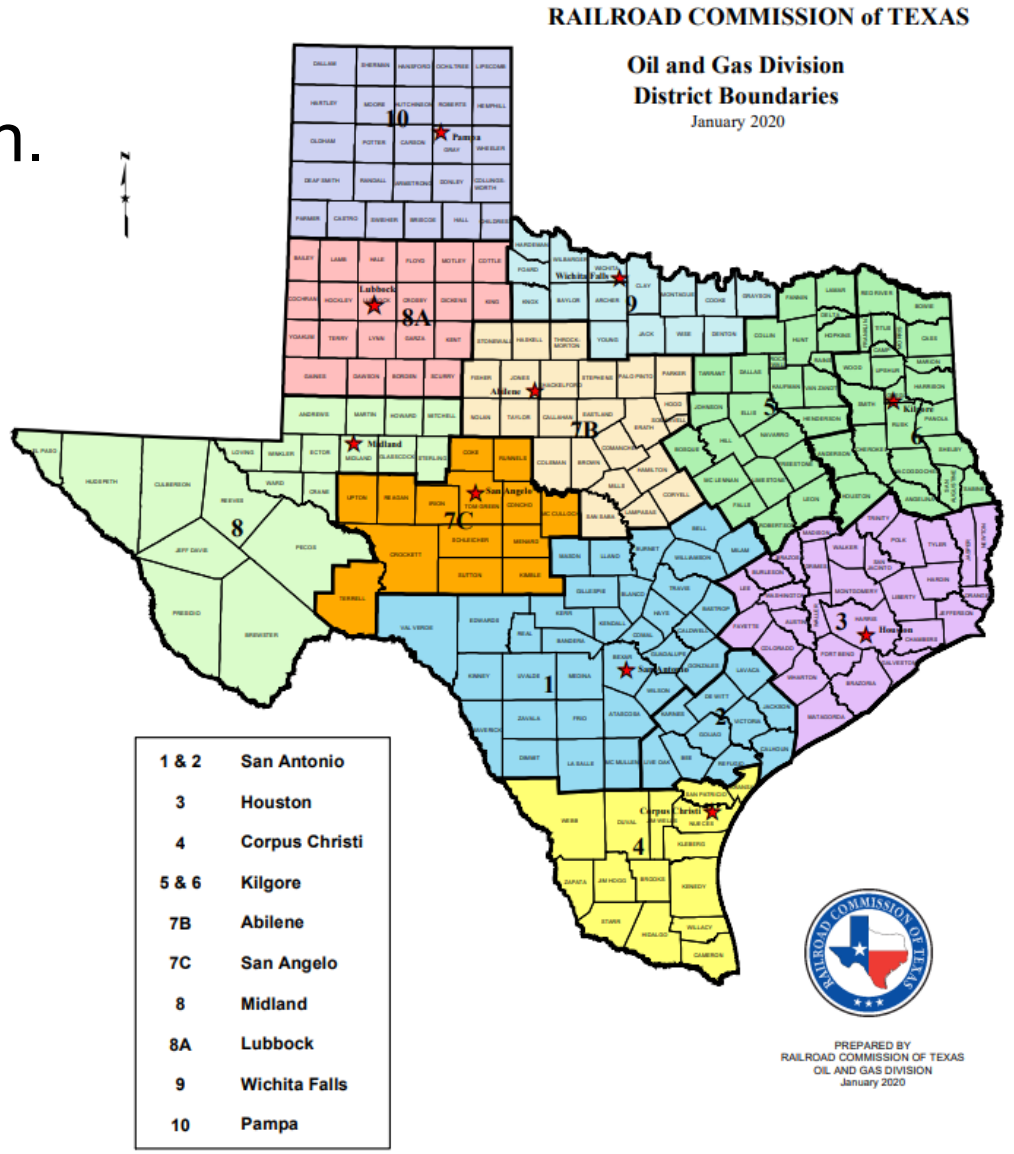
(1) protect the public health, safety, and welfare;

…

Applicability

- All disposal wells in the Permian Basin.
  - All SWR 9 Applications
  - All SWR 46 Applications with Line 21 box checked for “Disposal”
- Permian Basin is defined by RRC Districts 7C, 08, and 8A.

Title 16	ECONOMIC REGULATION
Part 1	RAILROAD COMMISSION OF TEXAS
Chapter 3	OIL AND GAS DIVISION
Rule §3.46	Fluid Injection into Productive Reservoirs



Application Information and Excel Workbook

https://www.rrc.texas.gov/oil-and-gas/applications-and-permits/injection-storage-permits/oil-and-gas-waste-disposal/injection-disposal-permit-procedures/pb-disposal-review/

Checklist:

- Completed UIC Permian Pressure Review V1.0 Workbook:

Permian Basin Disposal Well Application Checklist

- Excel Application Workbook (available for download on the RRC Website, Permian Basin Disposal Well Review Page):
  - Well Template
  - AOR Template
- Data Appendix and Report
  - Well Data
  - AOR Data
- Map
- Cross Section
- Seal of P.E./P.G.

Well Template - Data Input

ALL DATA PROVIDED FROM AN OFFSET WELL, MUST BE EXPLAINED IN DETAIL BY APPLICANT IN SUPPLEMENTAL REPORT.
ALL DATA PROVIDED MUST BE REFERENCED ON A CROSS SECTION THAT INCLUDES REFERENCE WELL EVEN IF IT FALLS OUTSIDE THE 2-MILE AOR
SUPPLEMENTAL REPORT, INCLUDING THE ANALYSIS CONDUCTED TO GENERATE DATA, MUST BE SIGNED BY A PROFESSIONAL ENGINEER/GEOLOGIST

Today's date is 05/13/2025

			SOURCE OF DATA (PAGE REFERENCE FROM SUPPLEMENTAL REPORT)
RRC UIC TRACKING NUMBER		12345	
OPERATOR		WE HAVE WATER	
LEASE		TOO MUCH H2O	
LEASE/GAS ID NO.		DBM 54-1-40	
WELL NO.		5th 1	
API NO.		000-00000	
LATITUDE IN NAD83 COORDINATES		31.903859	NEED NAD83 COORDINATES
LONGITUDE IN NAD83 COORDINATES		-103.656344	NEED NAD83 COORDINATES
INJECTION TBG/CSG I.D.	(inches)	4.49	NOTE IT'S THE INTERNAL DIAMETER IN INCHES
TOP OF UPPER CONFINING ZONE	(feet)	4,880	
TOP OF PERMITTED INJECTION INTERVAL	(feet)	4,922	
BOTTOM OF PERMITTED INJ INTERVAL	(feet)	7,039	
BOTTOM OF LOWER CONFINING ZONE	(feet)	7,500	
FRAC GRADIENT ABOVE	(psi/ft)	0.75	
FRAC GRADIENT INJECTION INTERVAL	(psi/ft)	0.7	
FRAC GRADIENT BELOW	(psi/ft)	0.75	
PORE PRESSURE	(psi)	3,300	
DEPTH OF PORE PRESSURE MEASUREMENT	(feet)	4,922	
DATE OF PORE PRESSURE MEASUREMENT	(MM/DD/YYYY)	4/22/2025	
TOP OF PERFORATED INTERVAL	(feet)	4,922	
BOTTOM OF PERFORATED INTERVAL	(feet)	7,039	
ACTUAL FLUID DENSITY (0.468) psi/ft	lb/gal	9.00	
DAILY INJECTION VOLUME REQUESTED	(bwpd)	30,000	
MSIP REQUESTED	(psi/ft)	0.5	
POROSITY	unitless	12.00%	
PERMEABILITY	(millidarcy)	85	
CALCULATED VALUES BELOW			
NET INJECTION INTERVAL THICKNESS	(ft)	2,117	
NET UPPER CONFINEMENT THICKNESS	(ft)	42	
NET LOWER CONFINEMENT THICKNESS	(ft)	461	
AVERAGE PORE PRESSURE GRADIENT	(psi/ft)	0.670	

- Basic Info.
- Technical Data
- Source of Data, Page Numbers to Appendix

Well Template - Confinement

- Upper and lower boundaries of the permitted injection interval must prevent fracture growth out the injection interval, as well as act as a permeability barrier.

- In-situ minimum stresses (frac gradients): step rate test, sonic log interpretation, diagnostic fracture injection test (DFIT).

Remember: add reference wells to cross-section.

Create report and appendix of source data (show your work).

Well Template – Pore Pressure

- Average reservoir pressure: BHP measurements, injection / fall-off testing.
- Depth Reference for Measurement
- Date of Measurement

Remember: add reference wells to cross-section.

Create report and appendix of source data (show your work).

Well Template – Permit Interval

Continuous confining interval

- Bottom of upper confining interval is assumed to be top of permitted injection interval.
- Similarly, bottom of permitted injection interval is assumed to be top of the lower confinement.
- Permeability contrast
- Stress contrast
- Confining intervals above or below: minimum of 25 ft w/ adequate mechanical properties.

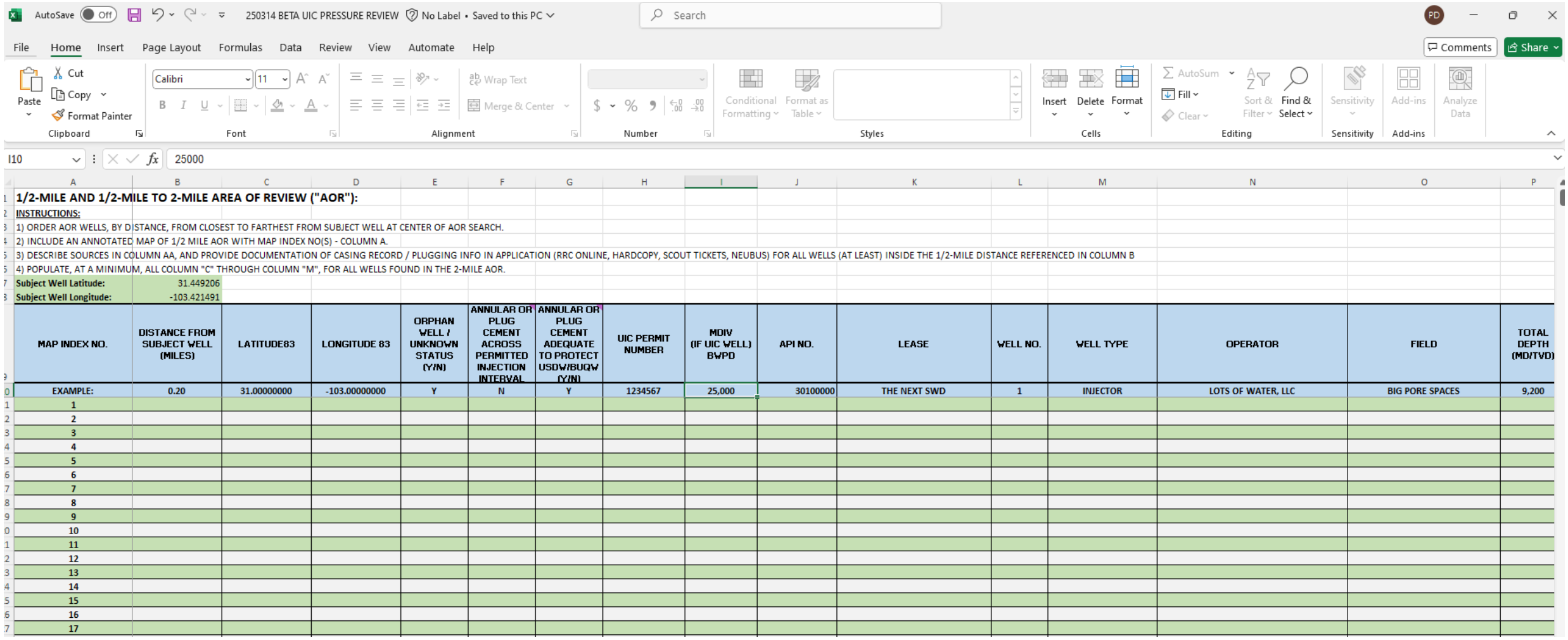
Well Template – Other

- **AVERAGE DENSITY** of injection fluids
- **POROSITY / PERMEABILITY**

Well Template – Data Appendix

- Well logs may be submitted as image files with the formation contact picks annotated.
- Most of the supplemental report documents and reference materials should be collated into a single .pdf file with a table of contents and page numbers.
- References on ‘Well Template – Sources of Data’

AOR Template – Input Data (1 of 2)



AutoSave Off | 250314 BETA UIC PRESSURE REVIEW | No Label • Saved to this PC | Search

File Home Insert Page Layout Formulas Data Review View Automate Help | Comments | Share

Paste | Cut | Copy | Format Painter | Clipboard | Calibri | 11 | Font | Wrap Text | Merge & Center | Alignment | Number | Conditional Formatting | Format as Table | Styles | Insert | Delete | Format | Cells | AutoSum | Fill | Clear | Sort & Filter | Find & Select | Editing | Sensitivity | Add-ins | Analyze Data

I10 | 25000

1/2-MILE AND 1/2-MILE TO 2-MILE AREA OF REVIEW ("AOR"):

INSTRUCTIONS:

1) ORDER AOR WELLS, BY DISTANCE, FROM CLOSEST TO FARTHEST FROM SUBJECT WELL AT CENTER OF AOR SEARCH.
2) INCLUDE AN ANNOTATED MAP OF 1/2 MILE AOR WITH MAP INDEX NO(S) - COLUMN A.
3) DESCRIBE SOURCES IN COLUMN AA, AND PROVIDE DOCUMENTATION OF CASING RECORD / PLUGGING INFO IN APPLICATION (RRC ONLINE, HARDCOPY, SCOUT TICKETS, NEUBUS) FOR ALL WELLS (AT LEAST) INSIDE THE 1/2-MILE DISTANCE REFERENCED IN COLUMN B
4) POPULATE, AT A MINIMUM, ALL COLUMN "C" THROUGH COLUMN "M", FOR ALL WELLS FOUND IN THE 2-MILE AOR.

Subject Well Latitude:	31.449206
Subject Well Longitude:	-103.421491

MAP INDEX NO.	DISTANCE FROM SUBJECT WELL (MILES)	LATITUDE83	LONGITUDE 83	ORPHAN WELL / UNKNOWN STATUS (Y/N)	ANNULAR OR PLUG CEMENT ACROSS PERMITTED INJECTION INTERVAL	ANNULAR OR PLUG CEMENT ADEQUATE TO PROTECT USDW/BUQW (Y/N)	UIC PERMIT NUMBER	MDIV (IF UIC WELL) BWPD	API NO.	LEASE	WELL NO.	WELL TYPE	OPERATOR	FIELD	TOTAL DEPTH (MD/TVD)
EXAMPLE:	0.20	31.00000000	-103.00000000	Y	N	Y	1234567	25,000	30100000	THE NEXT SWD	1	INJECTOR	LOTS OF WATER, LLC	BIG PORE SPACES	9,200
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															

AOR Template – Input Data (2 of 2)

‘AOR Template’ Worksheet:

- Sorted by distance
- Columns A-AD completed for ½-mile AOR
- Columns A-Q completed for 2-mile AOR
- If any information is unavailable or not applicable do not estimate, mark clearly as “unavailable” or “NA.”

AOR Criteria: 0 to ½ mile

- **PASS/FAIL RADIUS OF REVIEW**
  - Operator is required to assess completion and cementing records of all known wells in the ½-mile radius. Offset wells must:
    - have cement across the injection interval and the cement in the offset wells is adequate to keep injected fluids in the injection interval.
    - have all applicable plugging records to indicate the BUQW is protected from injection in the subject well.
    - contain no orphan wells, improperly plugged or abandoned wells within the ½-mile AOR.

AOR Criteria: ½ to 2 mile

- **WELLBORE DATA INTEGRITY RADIUS OF REVIEW**
  - If wells in the area between ½ and 2 miles are classified as orphan wells or have insufficient cementing, plugging or completion records, then the MSIP for that permit will automatically receive a 0.05 psi/ft reduction.

AOR Data - Sources of Data

Plugging Reports

Plugging Record

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

FORM W-3
Rev. 08/2019

API No. (if available) 42-	1. RRC District
FILE IN DUPLICATE WITH DISTRICT OFFICE OF DISTRICT IN WHICH WELL IS LOCATED WITHIN THIRTY DAYS AFTER PLUGGING	4. RRC Lease or ID Number
2. FIELD NAME (as per RRC records) / 3. Lease Name	5. Well Number
6. OPERATOR / 6a. Original Form W-1 filed in name of:	10. County
7. ADDRESS / 6b. Any subsequent W-1's filed in name of:	11. Date Drilling Permit Issued
8. Location of well, relative to nearest lease boundaries of lease on which this well is located: feet from ___ line and ___ feet from ___ line of the ___ lease	12. Permit Number
9a. SECTION, BLOCK and SURVEY / 9b. Distance and direction from nearest town in this county	13. Date Drilling Commenced
16. Type Well (oil, gas, or dry) / Total Depth / If multiple completion list all field names and oil lease or gas id no.'s / Gas ID or Oil Lease # / Oil - O Gas - G / Well #	14. Date Drilling Completed
18. If gas, amt. of cond. on hand at time of plugging	15. Date Well Plugged

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7	PLUG #8
*19. Cementing Date								
20. Size of Hole or Pipe in which Plug Placed (inches)								
21. Depth to Bottom of Tubing or Drill Pipe (ft.)								
*22. Sacks of Cement Used (each plug)								
*23. Slurry Volume Pumped (cu. ft.)								
*24. Calculated Top of Plug (ft.)								
25. Measured Top of Plug (if tagged) (ft.)								
*26. Slurry Wt. # / Gal.								
*27. Type Cement								

28. **CASING AND TUBING RECORD AFTER PLUGGING** — 29. Was any non-drillable material (other than casing) left in this well? ☐ Yes ☐ No

Completion Reports

Form W-2

API No.: 42-

36. CASING RECORD

Row	Type of Casing (conductor, surface, intermediate, conventional production, tapered production, or other)	Casing Size (in.)	Hole Size (in.)	Setting Depth (ft.)	Multi-Stage Tool Depth (ft.)	Multi-Stage Shoe Depth (ft.)	Cement Class	Cement Amount (sacks)	Slurry Volume (cu. ft.)	Top of Cement	Top of Cement Determined By
1											
2											
3											
4											

37. LINER RECORD

Row	Liner Size (in.)	Hole Size (in.)	Liner Top (ft.)	Liner Bottom (ft.)	Cement Class	Cement Amount (sacks)	Slurry Volume (cu. ft.)	Top of Cement	Top of Cement Determined By
1									
2									

38. TUBING RECORD

Does this well currently have tubing set? ☐ **YES** ☐ **NO** ☐ **SWR 13 Exception (attach approval)**

(if NO & no SWR 13 Exception obtained, explain in remarks)

Size (in.)	Depth Set (ft.)	Packer Depth/Type

39. PRODUCING/INJECTION/DISPOSAL INTERVAL

Indicate top and bottom measured depths of completion interval(s) or open hole

From	To

Other Sources…

Additional Application Attachments

- **Map showing permit location and offset well locations**
  - Map should include annotations on well locations that correspond to the index numbers on ‘AOR TEMPLATE’ in Column A.

- **Cross section across 2-mile AOR**
  - Operator will provide a cross section, using the best well control available, illustrating the continuity of the primary lithologic units (i.e., bounding layers, injection intervals) across the 2-mile circular area of review.
    - Include annotations for the tops and bottoms of the injection and confining intervals.
    - Include annotations for the referenced pore pressure (measured pressure and depth reference)
    - Include fracture gradient reference with depth reference.
    - Include API No. / UIC# / Lat-Long (NAD83) for wells used.

AOR Data – Output

Impact of AOR Results:

PRIMARY AOR+ SCORE FOR 0.5 MILE (TOC REVIEW)	PASS	1	FAIL	0	
SECONDARY AOR+ SCORE FOR 0.5 MILE TO 2 MILE	PASS	1	REDUCE MSIP	0	
MSIP PRESSURE GRADIENT DEDUCT BASED ON AOR SCORE	-0.05	psi/ft			
RADIUS OF REVIEW	2	Miles			
MAX ALLOWABLE PORE PRESSURE GRADIENT	0.75	psi/ft			
MAX POSSIBLE MSIP	0.5	psi/ft			
MINIMUM BARRIER ZONE THICKNESS	25	ft			

PRIMARY AOR+ SCORE FOR 0.5 MILE (TOC REVIEW)	PASS	0	FAIL	1	
SECONDARY AOR+ SCORE FOR 0.5 MILE TO 2 MILE	PASS	0	REDUCE MSIP	1	
MSIP PRESSURE GRADIENT DEDUCT BASED ON AOR SCORE	-0.05	psi/ft	0		
RADIUS OF REVIEW	2	Miles			
MAX ALLOWABLE PORE PRESSURE GRADIENT	0.75	psi/ft			
MAX POSSIBLE MSIP	0.5	psi/ft			
MINIMUM BARRIER ZONE THICKNESS	25	ft			

MSIP & MDIV: Dashboard

RRC UIC TRACKING NUMBER		0
OPERATOR		SWD OPERATOR
LEASE		LARGE WATER VOLUMES
LEASE/GAS ID NO.		0
WELL NO.		3
API NO.		003-49114
LATITUDE IN NAD83 COORDINATES		32.142683
LONGITUDE IN NAD83 COORDINATES		-102.961589
INJECTION TBG/CSG I.D.	(inches)	5.5
TOP OF UPPER CONFINING ZONE	(feet)	4,400
TOP OF PERMITTED INJECTION INTERVAL	(feet)	4,500
BOTTOM OF PERMITTED INJ INTERVAL	(feet)	6,000
BOTTOM OF LOWER CONFINING ZONE	(feet)	6,050
FRAC GRADIENT ABOVE	(psi/ft)	1.1
FRAC GRADIENT INJECTION INTERVAL	(psi/ft)	0.65
FRAC GRADIENT BELOW	(psi/ft)	1.1
PORE PRESSURE	(psi)	2,700
DEPTH OF PORE PRESSURE MEASUREMENT	(feet)	4,500
DATE OF PORE PRESSURE MEASUREMENT	(MM/DD/YYYY)	4,500
TOP OF PERFORATED INTERVAL	(feet)	5,800
BOTTOM OF PERFORATED INTERVAL	(feet)	4/22/2025
ACTUAL FLUID DENSITY (0.468) psi/ft	lb/gal	9.00
DAILY INJECTION VOLUME REQUESTED	(bwpd)	30,000
MSIP REQUESTED	(psi/ft)	0.5
POROSITY	unitless	12.00%
PERMEABILITY	(millidarcy)	85

CALCULATED VALUES BELOW

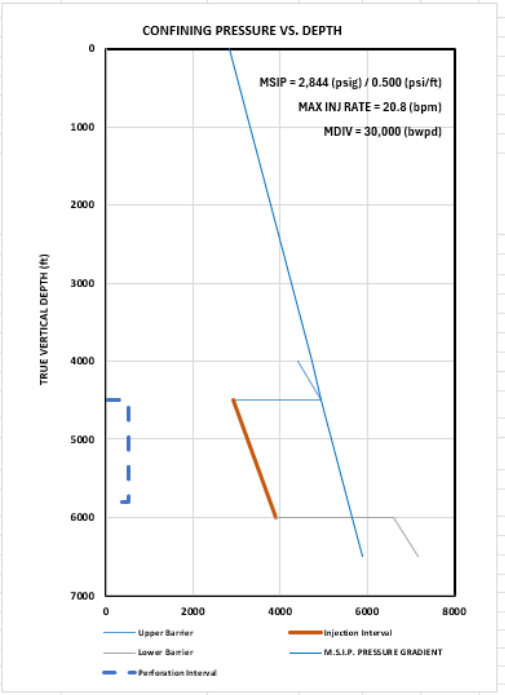
NET INJECTION INTERVAL THICKNESS	(ft)	1,500
NET UPPER CONFINEMENT THICKNESS	(ft)	100
NET LOWER CONFINEMENT THICKNESS	(ft)	50
AVERAGE PORE PRESSURE GRADIENT	(psi/ft)	0.600

PRIMARY AOR+ SCORE FOR 0.5 MILE (TOC REVIEW)	PASS	1	FAIL	0	
SECONDARY AOR+ SCORE FOR 0.5 MILE TO 2 MILE	PASS	1	REDUCE MSIP	0	
MSIP PRESSURE GRADIENT DEDUCT BASED ON AOR SCORE	-0.05	psi/ft	0		
RADIUS OF REVIEW	2	Miles			
MAX ALLOWABLE PORE PRESSURE GRADIENT	0.75	psi/ft			
MAX POSSIBLE MSIP	0.5	psi/ft			
MINIMUM BARRIER ZONE THICKNESS	25	ft			

MSIP DETERMINATION	ZONE DEPTHS FROM OPERATOR	FRAC GRADIENT FROM OPERATOR	CLOSURE / CONFINING PRESSURE	CLOSURE STRESS OF CONFINING INTERVAL - HYDROSTATIC HEAD	MSIP GRADIENT BASED ON UPPER CONFINING ZONE	PERMITTED MDIV
	(ft)	(psi/ft)	(psi)	(psi)	(psi/ft)	(bwpd)
Top of Upper Confining Zone	4,400	1.1	4,840			
Bottom of Upper Confining Zone	4,500	1.1	4,950	2,844	0.500	30,000
Top of Permitted Injection Interval	4,500	0.65	2,925			
Bottom of Permitted Injection Interval	6,000	0.65	3,900	3,792		
Top of Lower Confining Zone	6,000	1.10	6,600			
Bottop of Lower Confining Zone	6,050	1.10	6,655			

MDIV vs. Reservoir Pore Pressure	A	B	C	D
	40,000	30,000	20,000	10,000
AVE PORE PRESS FROM OPERATOR DATA = 0.600 psi/ft @ 4,500	<= 0.5 psi/ft	> 0.5 psi/ft & <= 0.6 psi/ft	> 0.6 psi/ft & <= 0.7 psi/ft	> 0.7 psi/ft
		30000		

FINAL MDIV BASED ON PORE PRESSURE	30,000	MAX INJ RATE	20.8
	(bwpd)		(bpm)



Output: Maximum Surface Injection Pressure (1 of 2)

- MSIP will be determined by calculating confining stresses of barriers:

PRIMARY AOR+ SCORE FOR 0.5 MILE (TOC REVIEW)	PASS	1	FAIL	0	
SECONDARY AOR+ SCORE FOR 0.5 MILE TO 2 MILE	PASS	1	REDUCE MSIP	0	
MSIP PRESSURE GRADIENT DEDUCT BASED ON AOR SCORE	-0.05	psi/ft			
RADIUS OF REVIEW	2	Miles			
MAX ALLOWABLE PORE PRESSURE GRADIENT	0.75	psi/ft			
MAX POSSIBLE MSIP	0.5	psi/ft			
MINIMUM BARRIER ZONE THICKNESS	25	ft			

MSIP DETERMINATION	ZONE DEPTHS FROM OPERATOR	FRAC GRADIENT FROM OPERATOR	CLOSURE / CONFINING PRESSURE	CLOSURE STRESS OF CONFINING INTERVAL - HYDROSTATIC HEAD	MSIP GRADIENT BASED ON UPPER CONFINING ZONE	PERMITTED MDIV
	(ft)	(psi/ft)	(psi)	(psi)	(psi/ft)	(bwpd)
Top of Upper Confining Zone	4,400	1.1	4,840		0.500	30,000
Bottom of Upper Confining Zone	4,500	1.1	4,950	2,844		
Top of Permitted Injection Interval	4,500	0.65	2,925			
Bottom of Permitted Injection Interval	6,000	0.65	3,900	3,792		
Top of Lower Confining Zone	6,000	1.10	6,600			
Bottop of Lower Confining Zone	6,050	1.10	6,655			

MDIV vs. Reservoir Pore Pressure	A	B	C	D
	40,000	30,000	20,000	10,000
AVE PORE PRESS FROM OPERATOR DATA = 0.600 psi/ft @ 4,500	<= 0.5 psi/ft	> 0.5 psi/ft & <= 0.6 psi/ft	> 0.6 psi/ft & <= 0.7 psi/ft	> 0.7 psi/ft
		30000		

FINAL MDIV BASED ON PORE PRESSURE	30,000	MAX INJ RATE	20.8
	(bwpd)		(bpm)

Output: Maximum Surface Injection Pressure (2 of 2)

- MSIP will be determined using the following methodology:

MSIP determination	Depth	Closure stress	MSIP
Upper confinement Parameters	4000	1.00 psi/ft	2,140
Lower confinement Parameters	6000	0.80 psi/ft	2,010

capped at 0.50 psi/ft

Example Calculation – (1.00 – 0.465) X 4,000 = 2,140 PSI (upper)

Example Calculation – (0.80 – 0.465) X 6,000 = 2,010 PSI (lower)

MSIP (gradient) allowed = lower of the two values determined – **2,010 PSI** (this time the lower layer with a cap of 0.50 psi/ft times the top of the zone) will be divided by the depth to the top of the permitted injection interval.

Example Calculation: 2,010 ÷ 4,000 = **0.5025 psi/ft > 0.5** => MSIP = 0.5 psi/ft

Output: Maximum Daily Injection Volume

- MDIV will be determined using the following methodology:
  - Maximum Daily Injection Volume (MDIV) will be determined using
    - Initial Average Reservoir Pressure

PRIMARY AOR+ SCORE FOR 0.5 MILE (TOC REVIEW)	PASS	1	FAIL	0	
SECONDARY AOR+ SCORE FOR 0.5 MILE TO 2 MILE	PASS	1	REDUCE MSIP	0	
MSIP PRESSURE GRADIENT DEDUCT BASED ON AOR SCORE	-0.05	psi/ft			
RADIUS OF REVIEW	2	Miles			
MAX ALLOWABLE PORE PRESSURE GRADIENT	0.75	psi/ft			
MAX POSSIBLE MSIP	0.5	psi/ft			
MINIMUM BARRIER ZONE THICKNESS	25	ft			

MSIP DETERMINATION	ZONE DEPTHS FROM OPERATOR	FRAC GRADIENT FROM OPERATOR	CLOSURE / CONFINING PRESSURE	CLOSURE STRESS OF CONFINING INTERVAL - HYDROSTATIC HEAD	MSIP GRADIENT BASED ON UPPER CONFINING ZONE	PERMITTED MDIV
	(ft)	(psi/ft)	(psi)	(psi)	(psi/ft)	(bwpd)
Top of Upper Confining Zone	4,400	1.1	4,840		0.500	30,000
Bottom of Upper Confining Zone	4,500	1.1	4,950	2,844		
Top of Permitted Injection Interval	4,500	0.65	2,925			
Bottom of Permitted Injection Interval	6,000	0.65	3,900	3,792		
Top of Lower Confining Zone	6,000	1.10	6,600			
Bottop of Lower Confining Zone	6,050	1.10	6,655			

MDIV vs. Reservoir Pore Pressure	A	B	C	D
	40,000	30,000	20,000	10,000
AVE PORE PRESS FROM OPERATOR DATA = 0.600 psi/ft @ 4,500	<= 0.5 psi/ft	> 0.5 psi/ft & <= 0.6 psi/ft	> 0.6 psi/ft & <= 0.7 psi/ft	> 0.7 psi/ft
		30000		

FINAL MDIV BASED ON PORE PRESSURE	30,000	MAX INJ RATE	20.8
	(bwpd)		(bpm)

Output: Maximum Injection Rate

- MIR will be determined by MDIV (barrels/day) ÷ 1,440 minutes/day = (bbl/min.)

PRIMARY AOR+ SCORE FOR 0.5 MILE (TOC REVIEW)	PASS	1	FAIL	0		
SECONDARY AOR+ SCORE FOR 0.5 MILE TO 2 MILE	PASS	1	REDUCE MSIP	0		
MSIP PRESSURE GRADIENT DEDUCT BASED ON AOR SCORE	-0.05	psi/ft				
RADIUS OF REVIEW	2	Miles				
MAX ALLOWABLE PORE PRESSURE GRADIENT	0.75	psi/ft				
MAX POSSIBLE MSIP	0.5	psi/ft				
MINIMUM BARRIER ZONE THICKNESS	25	ft				

MSIP DETERMINATION	ZONE DEPTHS FROM OPERATOR	FRAC GRADIENT FROM OPERATOR	CLOSURE / CONFINING PRESSURE	CLOSURE STRESS OF CONFINING INTERVAL - HYDROSTATIC HEAD	MSIP GRADIENT BASED ON UPPER CONFINING ZONE	PERMITTED MDIV
	(ft)	(psi/ft)	(psi)	(psi)	(psi/ft)	(bwpd)
Top of Upper Confining Zone	4,400	1.1	4,840		0.500	30,000
Bottom of Upper Confining Zone	4,500	1.1	4,950	2,844		
Top of Permitted Injection Interval	4,500	0.65	2,925			
Bottom of Permitted Injection Interval	6,000	0.65	3,900	3,792		
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MDIV vs. Reservoir Pore Pressure	A	B	C	D
	40,000	30,000	20,000	10,000
AVE PORE PRESS FROM OPERATOR DATA = 0.600 psi/ft @ 4,500	<= 0.5 psi/ft	> 0.5 psi/ft & <= 0.6 psi/ft	> 0.6 psi/ft & <= 0.7 psi/ft	> 0.7 psi/ft
		30000		

FINAL MDIV BASED ON PORE PRESSURE	30,000	MAX INJ RATE	20.8
	(bwpd)		(bpm)

Well Completion & Permit Conditions (1 of 2)

- Initial Bottomhole Pressure (BHP): data point prior to injection.
- Initial fracture gradient: DFIT or STEP RATE TEST, prior to injection, submitted via sealed report to UIC & to TexNet - analysis to be included with a digital (i.e., txt, csv, EXCEL) copy of the entire test including time, rate, pressure.
- Radial CBLs on long string casing.
- Log Suite, or best available data source, with annotation of upper and lower confinement (if possible) and lithologic units, and net pay highlighted, confirming porosity-height product for entire permitted injection interval.

Well Completion & Permit Conditions (2 of 2)

- Bottomhole Pressure Reporting:
  - Annual Frequency.
  - Instantaneous shut-in pressure measurement.
  - 24-hour shut-in time.
  - BHP: Downhole gauge, Dip-in measurement, Calculated.
  - Reported to TexNet and UIC.
- TexNet Volume Reporting – Daily measurement /Monthly Reporting.

Seismicity (1 of 2)

- In the Permian Basin, we will continue to observe the “Shallow/Deep” conventions as currently practiced:
  - Delaware Basin: Shallow is above the base of the Wolfcamp; deep is below.
  - Midland Basin: Shallow is above the top of the Strawn; deep is below.

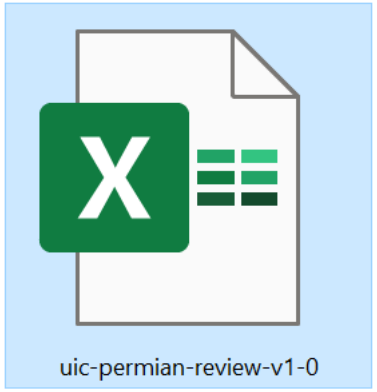
- Applications in seismically active areas will need to provide data required by seismic guidelines (ex. maps and cross sections)

Seismicity (2 of 2)

- “Shallow” applications will
  - Generally, not need Fault Slip Potential analysis.
  - Be evaluated under the Permian Review rubric, not the Seismic Guidelines (i.e. MDIV and MSIP determined by min. stress and $P_{pi.}$)

- However, the State Seismologists may identify an area in which seismicity from shallow injection is a concern and subject applications in such an area to evaluation under the seismic guidelines.

Demonstration



- UIC Permian Pressure Review V1.0 Workbook
  - uic-permian-review-v1-0