

# Navigating Regulatory Hurdles for Induced Seismicity

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How to maneuver  
through the process

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It is no secret that the Permian Basin is the busiest oil patch in the nation. All you have to do is get a big cup of coffee and head this way. The amount of oil and gas traffic will shock you into believing me.

At the beginning of 2020, it hosts more than half of all rigs in the United States. It spans 86,000 square miles in two states and parts of 30 counties—slightly smaller than the state of Oregon.

Since 2010, total produced fluid has increased from 1 MM bbls/day to 4 MM bbls/day. Total fluids include produced water. Produced water as a waste has been historically and continues to be deep-well injected across the basin. Unrecycled flowback water from hydraulic fracturing and drilling operations only adds to the volumes.

Fear of the volumes injected inducing unintended seismic activity has driven new and evolving regulations for permitting new and operating existing saltwater disposals. Now that I have preached to the choir, let's dig into the details.

## INDUCED SEISMICITY

Induced seismic activity associated with deep-well injection reared its ugly head on a grand scale in western Oklahoma. Only a couple of seismic events above a magnitude 3 on the Richter scale were recorded in 2008. By 2015, more than 900 were recorded.

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EIA map of Permian Basin structural and tectonic features

In the Permian, seismic events greater than 2.5 tripled to more than 60 in 2015. In an effort to control future induced seismic events, the Railroad Commission of Texas (RRC), the governing body of oil and gas operations in Texas, has adopted a more hands-on approval process for new disposal well permits. Texas Administration Code (TAC) Title 16 Part 1 Chapter 3, Rule 3.9, which regulates disposal wells, seems to be under constant revision. It was updated in late 2019.

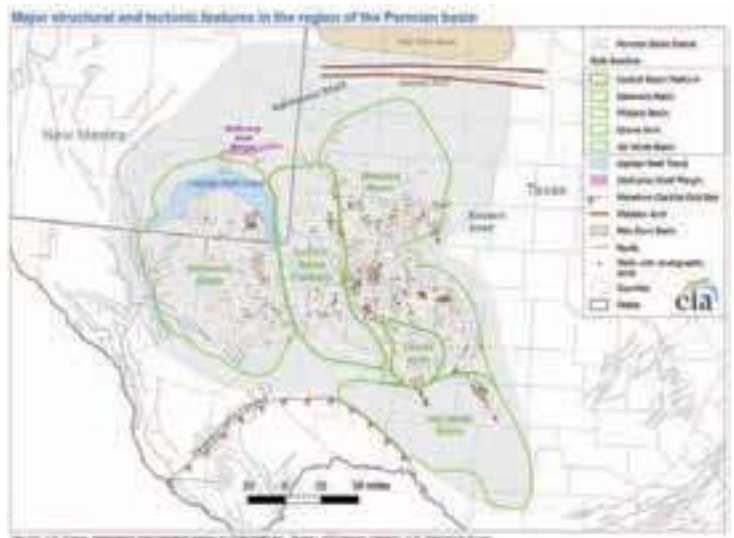
Launched in 2017, Texas created a seismological network called TexNet. It, along with the United States Geological Survey (USGS), compiles seismic data, which can be useful in determining the location and magnitude of events in these production areas.

Even though the review of seismic data has been on the books of the RRC for years, recently, the reviewer of new permits and permit renewals of existing disposal wells has taken a more active role in requiring producers to comply.

## SEISMIC REVIEW

The RRC has added new permit reviewers. This has allowed a more thorough review of the disposal permits and has created more follow-up data gathering.

The RRC seismic review of a permit is triggered if TexNet and/or USGS data indicate a magnitude 2.0 or greater event within the area of interest (AOI), which is just more than five miles from the proposed location as prescribed by the RRC.





◀ TexNet seismometers placed throughout the state, like this one in Dallas, monitor seismic activity across Texas. Courtesy The University of Texas at Austin Bureau of Economic Geology

The seismic review queue can take a few months. Once the application is graded (A, B, C), an RRC Request for Additional Data (RAD) letter will be issued in response:

- A. Application is sent through for review of data
- B. Request the applicant to review more thoroughly the geology; will ask for lowered injection volumes/pressures; USUALLY requests for Fault Slip Potential (FSP)
- C. Request the applicant to consider lowered injection volumes/pressures; ALWAYS results in a request for FSP

To expedite the review process, the initial permit submittal should include geologic structure maps representing the top and bottom of the proposed injection interval, an isopach map of the injection interval and cross sections oriented along strike and dip of the formation(s) proposed for injection.

The RRC encourages applicants to submit any additional information that would assist the reviewer's evaluation of the potential seismic hazard. Applicants should proactively review their AOI, and if they notice seismic events, possibly complete an FSP model and submit with the initial application.

If required by the regulators, the modeling process can make the disposal-well permitting cost and timing rise exponentially due to the back-and-forth communications and review-process timing.

As the regulations evolve and the RRC reviewers gain deeper experience with complicated situations, in the near

future, the process should become more predictable.

It is advised to be diligent in the proposed well placement, injection pressures and injection volumes to possibly avoid triggering fault-hazard analysis.

Understand, the commission has the authority to modify, suspend or terminate an injection-well permit of an existing disposal well if the injection well is found to be contributing or even likely to be contributing to seismic activity.

In coordination with the RRC seismologist, seismicity near injection wells will be monitored, and they can respond accordingly.

## PERMITTING IN THE PERMIAN

Texas regulations are somewhat more stringent for the Permian Basin. The RRC requires additional information be collected and submitted with the application. The additional information includes:

- **Seismicity and Faulting Data Factors**

The applicant must determine the number of mapped faults in the area of influence. The horizontal distance to the nearest mapped fault must be determined, as well as the distance from the base of the disposal zone to the basement or top of the basement formation faulting.

Reporting should include the number and distance of seismic events greater than 2.0 within the area of influence, the maximum event magnitude and length of time since the last event.



There may be only small issues that kick the proposed well into the unapproved/need more data status. With just a few tweaks and sharpening of the pencil, a solution can be found.



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- **Operational Data Factors**

The applicant must determine the cumulative injection rate of all permitted disposal wells within 2.82 miles of the proposed location. The distance to the nearest injection well should be determined in the same interval(s).

- **Reservoir Factors**

Data must be reported as to the disposal zone static permeability, disposal zone cumulative thickness and the disposal zone lithology.

- **Seismic Monitoring**

Operators are encouraged to perform seismic monitoring. In the Permian Basin ((Districts 7C, 08 and 8A), an operator may be permitted for a higher injection rate if an operator develops and implements an RRC-approved Seismic Monitoring Plan and an Earthquake Response Plan.

Ultimately, each permit is evaluated on a case-by-case basis.

## THE GOOD NEWS

This all seems like dry mumbo-jumbo, moving-targets and wishy-washy regulation, but the commission is learning about this topic as industry and science is. Upon review of the initial permit and possible RAD letters, it is still possible to get that well approved.

Based on ever-evolving data, the commission has updated the regulations as recently as August 2019. There may be only small issues that kick the proposed well into the unapproved/need more data status. With just a few tweaks and sharpening of the pencil, a solution can be found. Such as:

- Lower the permitted injection rate in accordance with seismicity review score
- Lower the injection pressure if the disposal is into a formation with a low fracture gradient
- Perform step-rate test(s)
- Perform bottom-hole pressure test(s)
- Keep a daily recording of injection volumes and pressures
- Adhere to permitting conditions recommended by the RRC seismologist

## THE BAD NEWS

Those of us who have spent a career working with the regulations and more importantly, the regulators, have run across occasions where regulator requirements outrun the regulation changes. This results in an unfortunate situation I call “Regulating by Response Letter.”

The good part is that when the response comes back, the path forward is prescribed. The bad part, the path forward is prescribed. That prescription could include time-consuming and rather costly data gathering.

As a consultant, it is nearly impossible to leave a client with the confidence that a permit can be approved in a timely manner and on an expected budget. As the regulations evolve, more wells are approved and more seismic events occur, the process will most likely continue to change.

## THE KEY TO SUCCESS

Relationships in business are important for building trust and knowledge. The best path in any state is to engage the regulators on every permit.

Since the regulations are ever evolving, start the conversation early. Sometimes, it can lead to a nice punch list in the early stages so when the initial permit hits her desk, the likelihood of a RAD letter is lower.

That is the best way to budget time and costs to meet the regulator’s needs, and get your precious, precious disposal well APPROVED. ■

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### About the Author

**John S. Sullivan**, P.G., is the Permian Basin regional manager for SCS Engineers and a professional geologist from Texas Tech University in Lubbock, Texas. He started his career as a geologist at the High Plains Underground Water Conservation District in Lubbock, working closely with the conservation and mapping of the Ogallala Aquifer.



For 25 years, he has worked in all manner of environmental consulting, including groundwater remediation, modeling and permitting of water systems. He was the national saltwater disposal asset manager for a leading energy service company, which entailed the management of SWDs in New Mexico, Oklahoma, Louisiana, North Dakota, and West, East and South Texas. He has permitted public water systems, pipelines, bulk fuel storage facilities, saltwater disposals and chemical manufacturing plants.