Texas Disposal Wells And Seismicity

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Railroad Commission of Texas Jurisdiction

Permitting, monitoring & testing of injection wells

- Class II
  - Enhanced recovery
  - Disposal of oil and gas wastes
- Class III – Brine mining
- Class V – Geothermal

Underground Injection Control (UIC)

Program Goals:

- Confine fluids to the permitted strata
- Protect groundwater (USDWs)
- Protect surface water
- Protect strata productive of hydrocarbons

Texas Disposal Well Rules

- Seismologist on staff since 2014
- Amended disposal well rules November 2014 in 16 Tex. Admin. Code §§ 3.9 and 3.46
  - Required seismicity screen for all disposal well applications in Texas
  - Historical USGS seismic events within a circular area of 100 square miles (5.64 mi or 9.08 km).

TexNet

- House Bill 2, 84th Texas Legislature (2016–17), Section 16 provides funding for TexNet:

  "…for the purchase and deployment of seismic equipment, maintenance of seismic networks, modeling of reservoir behavior for systems of wells in the vicinity of faults, …"

- Developed and operated by Bureau of Economic Geology (BEG), UT Austin

TexNet Seismic Monitoring System

- Denser seismic monitoring array will result in:
  - Increased detection of smaller events
  - More accurate location of suitably oriented, critically stressed faults
  - More accurate location of epicenter/hypocenter
  - Better definition of suitably oriented, critically stressed faults

Science and Application

- **BEG**
  - Operates TexNet
  - Conducts Basic Seismicity Research
- **BEG, Academia, Industry**
  - Conducts Seismicity Research
  - Conducts Related Studies

The Long Run

- **RRC**
  - Regulates Industry Activity
  - Permits Disposal Wells

Immediate Need

Reeves County

Year	All Drilling Permits (injection wells)	USGS Earthquakes >3.0 M
2012	433 (27)	1
2013	478 (27)	0
2014	652 (56)	1
2015	384 (30)	5
2016	466 (42)	6
2017	1082 (125)	37
2018	1211 (101)	36

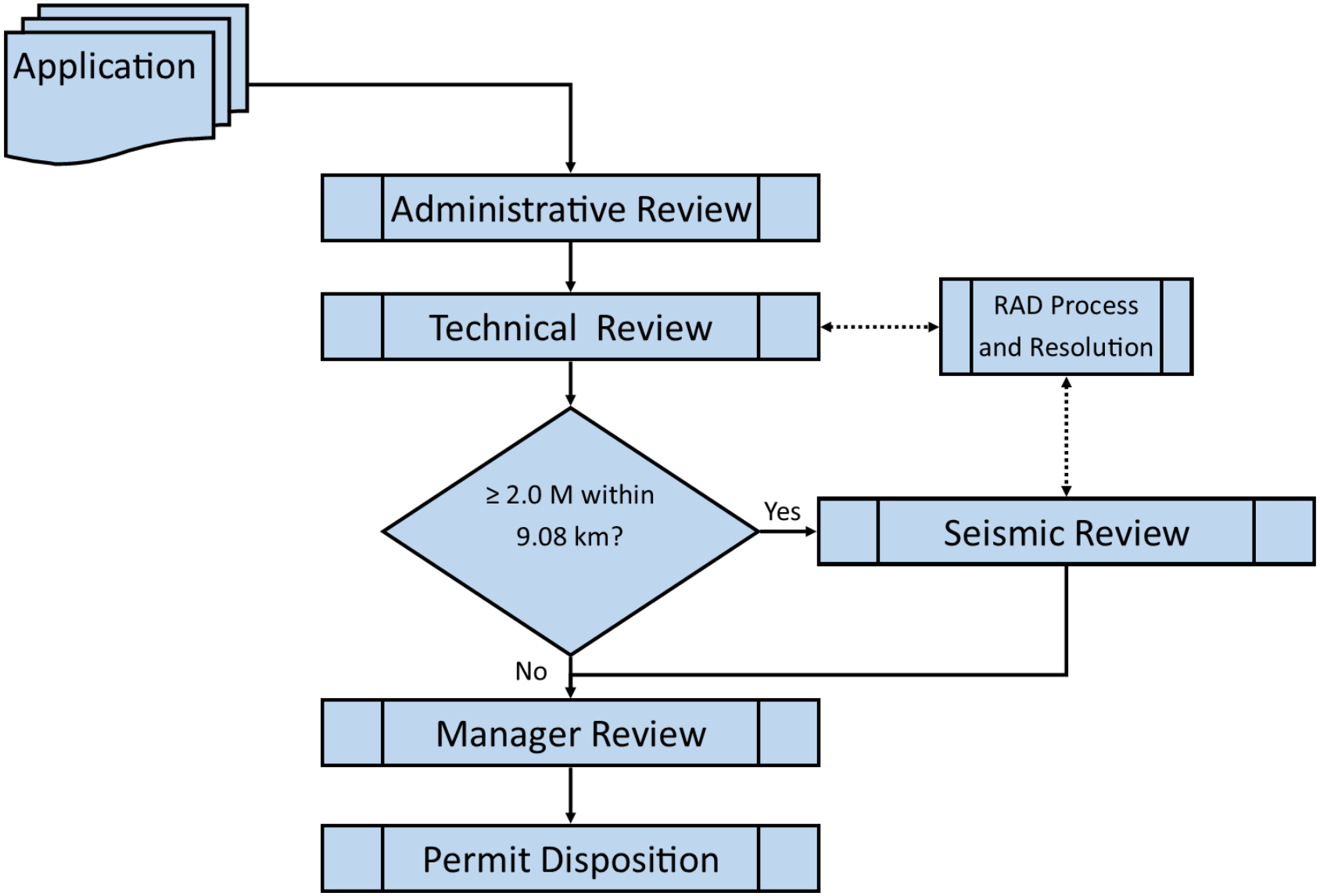
We Need Guidelines

- Internal guidelines to assist RRC staff with administrative processing and permitting of disposal well applications in areas of the Permian Basin that are experiencing seismic activity.
- Not written to be guidance or instruction for industry applicants.

Guidelines Status

- Development began early 2018
- Development accelerated Summer 2018
- Aides briefings in September 2018
- Limited external peer review Fall 2018
- Continued peer review January 2019
- Green light to pilot February 2019
- Anticipate full implementation Summer 2019

UIC High-Level Processes



UIC Review Elements

- **Administrative**: Are the required elements of the application present and complete?
- **Technical**: Do the elements of the application meet the requirements of Rule & Statute?
- **Seismic**: Based on an assessment of potential seismic hazard, what is appropriate seismic mitigation?
- **Manager**: Final decision.
- **Permit Disposition**: Approve, deny, or refer to hearing.

Disposal Well Application Elements

- Rule 9 disposal well (non-productive zone)
- Rule 46 disposal well (productive zone)
- Notice and publication
- Well Log (preferably annotated)
- Groundwater Depth Letter
- No Harm Letter (W-14 applications only)
- Area of Review (“AOR”) Analysis
  - Map
  - Table of Wells

Disposal Well Application Elements

- Seismicity screen
  - See Statewide Rules 9(3)(B) & 46(b)(1)(C):
  - Historical USGS seismic events within a circular area of 100 square miles (5.64 mi or 9.08 km).
- ***An earthquake event of 2.0 M or greater within the 5.64 km area of interest ("AOI") will trigger the seismic review***
  - RRC Staff will consider both USGS and TexNet catalogs in assessing the seismic trigger.

Elements of a Disposal Well Application

If seismicity screen is positive, supplemental information is required to assess the state of the disposal zone and adjacent strata:

- Structure map(s)
- Isopach map(s)
- Cross-section(s)
- Other relevant information
- Fault stress analysis (may be required)

Seismic Review

- **The purpose of the supplemental information is to enable staff to conduct the seismic review.**
- The seismic review is a scoring system that considers:
  - 8 Faulting and Seismicity Factors
  - 2 Operational Factors
  - 3 Reservoir Factors

Seismicity and Faulting Factors

- Number of mapped faults in AOI
- Horizontal distance to nearest mapped fault
- Distance to basement
- Number of earthquakes in AOI
- Horizontal distance to nearest earthquake
- Maximum seismic event magnitude in AOI
- Years since last seismic event in AOI
- Data confidence

Seismicity and Faulting Factors (cont.)

Seismicity & Faulting Data Confidence

A: High

Site specific, high resolution, compelling, and filed.

B: Medium

Intermediate resolution, interpreted derivatives from high quality data.

C: Low

Publicly available regional data with no new insights.

Operational Factors

- Combined Permitted Injection Rate within 2.8 mi
- Distance to Nearest Injection Well in Same Interval(s)

Reservoir Factors

- Disposal Zone Static Permeability
- Disposal Zone Cumulative Thickness
- Disposal Zone Lithology

Scoring

Factor Category Scores (A, B or C)

The non-numerical center of distribution of factor scores in each category.

Overall Score (A, B or C)

The non-numerical center of distribution of factor category scores, in which the seismicity and faulting factor category is weighted twice.

Fault Stress Modeling

Is a known fault oriented to slip?

For "B" Applications

Fault stress analysis (for example, Fault Slip Potential) may be required if evidence of faulting (mapped faults or seismic event clustering) is within 2.8 mi.

For "C" Applications

Fault stress analysis is required if evidence of faulting is within the AOI.

Permit Conditions

Score A:

- 30,000 bpd max
- Daily Records (volume, max pressure)
- Initial Static Bottom-hole Pressure Test
- Step Rate Test

Permit Conditions

Score B:

- 20,000 bpd max
- Daily Records (volume, max pressure)
- Initial Static Bottom-hole Pressure Test
- Step Rate Test

Permit Conditions

Score C:

- 10,000 bpd max
- Daily Records (volume, max pressure)
- Initial Static Bottom-hole Pressure Test
- Step Rate Test
- Seismologist Review and Approval with Additional Conditions as Necessary

Mitigation Opportunities

Disposal wells scored as “B” or “C” may be authorized to inject an **additional 10,000 bpd**, provided:

- Operator actively implementing a **seismic monitoring plan** that augments the open public data network
- Operator develops and implements a **seismic event response plan** (submitted to RRC)

Seismic Monitoring Plan

- Implement a seismic monitoring plan that provides for the **contribution of data to an existing public seismic network** (e.g., TexNet).
- Monitoring to **contribute to the body of public knowledge** available to better resolve earthquake locations, especially depth.
- Include method of monitoring, type of instrumentation, reporting of data analysis, and an archive of the data in a public seismic database.

Seismic Monitoring Plan

- The minimal sensor and datalogger requirements for instrumentation are as follows.
  - Sensor:
    - 3 Component orthogonal axis
    - Response: 1Hz to 100Hz
  - Datalogger:
    - 24 bit digitizer
    - Sampling rate at least up to 200 sps
    - Integrated seedlink server
    - Timing using Global Positioning System (GPS).

Earthquake Response Plan

- Implement an earthquake response plan.
- Identify the actions that will be taken to inspect for damage, mitigate and/or manage risk by modifying operations, and establish thresholds for suspension of injection activity.
- Specific elements of the earthquake response plan should include:
  - Monitoring plan will be filed with the Commission before disposal activities begin.
  - Operator will monitor TexNet and USGS catalogs.

Earthquake Response Plan

- Elements of the response plan (continued):
  - Response plan triggered when a 3.5 M event is detected with a reported hypocenter location within the 9.08 km AOI.
  - Response plan will identify the actions the well operator will take when a 3.5 M event is detected with a reported hypocenter location within the 9.08 km AOI.
  - Operator will notify the Commission within 24 hours of a seismic event posting on an earthquake catalog that triggers the response plan.
  - Within 30 days of an earthquake trigger, the operator will file a report with the Commission documenting the event.

Guidelines – Going Forward

- Anticipate full guidelines implementation Summer 2019
- RRC Response Plan design began March 2019
- For General UIC Guidance: https://www.rrc.texas.gov/oil-gas/applications-and-permits/injection-permit-types-and-information/oil-and-gas-waste-disposal/