

# **Railroad Commission of Texas**



## **Final Report**

### **State of Texas Aquifer Exemption Project**

**November 2017**

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## I. Executive Summary

In 1974, the U.S. Congress enacted the federal Safe Drinking Water Act (SDWA) to protect public drinking water supplies throughout the nation. This act established a framework for the U.S. Environmental Protection Agency (EPA) to develop an Underground Injection Control (UIC) program to protect underground sources of drinking water (USDWs). The Act also provided for state implementation of the UIC program with EPA oversight.

UIC regulations subsequently adopted by EPA define certain aquifers as USDWs, but allow for an aquifer to be exempted if the likelihood of the aquifer being used for drinking water is extremely remote, the aquifer contains commercially producible mineral or hydrocarbon resources, or the aquifer is contaminated. Exempted aquifers are, by definition, not USDWs. In the case of aquifers containing commercially producible hydrocarbon resources, aquifer exemptions allow hydrocarbon producing zones to be used for injection, whether to enhance recovery of oil and gas or for disposal purposes, in compliance with EPA's UIC requirements.

EPA approved the Railroad Commission of Texas' (Commission's) Class II UIC program on April 23, 1982, which is commonly referred to as the date of primacy. Class II wells are injection wells that are associated with oil and gas production. On the date of primacy, EPA granted aquifer exemptions for all existing Class II injection wells and all existing hydrocarbon producing zones.

With EPA grant assistance, the Commission initiated the State of Texas Aquifer Exemption Project to improve the efficiency and effectiveness of its Class II UIC program. The project involved research of historical data related to the approximately 62,500 Class II injection well permits that the Commission issued after the date of primacy to identify and verify records for injection wells permitted to inject into potential USDWs (zones determined to contain water with less than 10,000 milligrams per liter (mg/l) total dissolved solids (TDS)).

The Commission's research found:

- no evidence of permits issued after the date of primacy for injection into non-hydrocarbon-productive zones determined to be USDWs;

- 16 wells permitted after the date of primacy for injection into 11 oil or gas new fields discovered after the date of primacy that contain water with less than 10,000 mg/l TDS; and

- 38 wells permitted after the date of primacy for injection into an expansion area of one of 13 pre-primacy oil or gas fields covered by an aquifer exemption.

The Commission reviewed any water well within five miles of each of the 54 identified injection wells. Only four of the injection wells have water wells within five miles that are screened in the injection interval. In each instance, the water well is separated from the injection well by another well producing hydrocarbons from the same interval.

The permits for all of the injection wells include a Fluid Source Limit (FSL) condition. An FSL condition limits injection to waters produced with hydrocarbons and then returned to the zone from which they were produced or waters with a lesser TDS concentration. This FSL condition allows the oil and gas operator to safely manage the produced fluids, maintain the water drive in a producing field, and produce the hydrocarbons in that field.

Through this project, the Commission has compiled more detailed information, including maps, related to hydrocarbon productive zones that are exempted aquifers and an internally searchable database to support future regulatory actions. In addition, the Commission has established procedures described in this report to ensure future permitting activities are consistent with current aquifer exemption procedures of the UIC regulations. This project has confirmed the Commission's UIC program provides substantial and effective groundwater protection in compliance with Section 1425 of the Safe Drinking Water Act and the 1982 primacy agreement between the Commission and EPA.

## **II. Background**

### **History of the Commission's Class II UIC Program**

The Railroad Commission of Texas (Commission) was granted authority to regulate the oil and gas industry in Texas by the Texas Legislature in 1917. Shortly afterwards, the Commission adopted regulations to implement this authority. The Commission began regulating injection wells used for enhanced oil recovery in the 1930's and began regulating disposal wells in the 1950's.

In 1974, the U.S. Congress enacted the federal Safe Drinking Water Act (SDWA) to protect public drinking water supplies throughout the nation. This act established a framework for the U.S. Environmental Protection Agency (EPA) to develop an Underground Injection Control (UIC) program to protect underground sources of drinking water (USDWs). The Act also provided for state implementation of the UIC program with EPA oversight. Section 1425 of the SDWA allows EPA to approve an existing state Class II UIC program if the state shows that the program is effective in preventing endangerment of USDWs. Class II wells are injection wells that are associated with oil and gas production. EPA approved the Commission's Class II UIC program on April 23, 1982, which is commonly referred to as the date of primacy.

The term underground source of drinking water (USDW) is defined in federal regulations as:

an aquifer or its portion:

- (a)
  - (1) Which supplies any public water system; or
  - (2) Which contains a sufficient quantity of ground water to supply a public water system; and
    - (i) Currently supplies drinking water for human consumption; or
    - (ii) Contains fewer than 10,000 mg/l total dissolved solids; and
- (b) Which is not an exempted aquifer.

The federal UIC regulations allow EPA to exempt aquifers that do not currently, and will not in the future, serve as a source of drinking water, based on certain criteria. Aquifer exemptions allow the interval to be used for oil or mineral extraction or disposal purposes in compliance with EPA's UIC regulations. By definition, an exempted aquifer is not a USDW.

EPA developed criteria (40 CFR §146.4), application standards (§144.7), and procedures (§144.7) for aquifer exemptions. Operators apply for an aquifer exemption to the primacy state, which reviews the request and forwards the state's recommendation to EPA. Most aquifer exemptions are limited to a specific portion of an aquifer. Most exempted aquifers contain significant mineral deposits or oil reservoirs that require injection methods for recovery.

The issue of aquifer exemptions was an important part of the discussions between the EPA and the Commission during EPA's review of the Commission's application for primacy. In the Commission's Program Description, the Commission laid out its proposed procedure for aquifer exemptions as follows:

#### AQUIFER EXEMPTION

The review and approval process for Class II wells assures aquifer protection on a case by case basis. Aquifer exemption will be considered as part of the review process, when applicable, in lieu of listing aquifers or portions of aquifers for exemption.

The reasons for reviewing on a case by case basis are the occurrences of numerous hydrocarbon-producing reservoirs that contain or may contain water with less than 10,000 ppm [parts per million, which are equivalent to milligrams per liter (mg/l)] total dissolved solids and the existence of extensive, undelineated aquifers that contain water with less than 10,000 ppm total dissolved solids.

The case by case aquifer exemption consideration will be conducted as a part of the technical review. The technical review process is discussed elsewhere in the program description.

The review procedure for injection wells will authorize injection in the vertical and horizontal portion of a geologic formation that is hydrocarbon productive and contains fresh water. This procedure allows for the maximum recovery of hydrocarbons. The limit of the productive formation is determined by the perimeter wells that have shown producing potential. An injection well may be permitted within the productive formation and in the equivalent interval not further than one-half mile outside the perimeter of productive or potentially productive wells.

The case by case review process may authorize completion of salt water disposal wells in aquifers that contain more than 3,000 ppm but less than 10,000 ppm total dissolved solids under conditions where the aquifer cannot now or will not in the future serve as a source of drinking water. These circumstances will exist when the depth and location make recovery of water for drinking water purposes economically impractical. Economics can prohibit the producing and treating of water from an aquifer in comparison to developing alternative, abundant water sources in an area. Even when costs of producing drinking water are prohibitive, aquifer exemption would not be considered if alternative disposal zones are economically and technically practical.

In a letter dated March 29, 1982, from the EPA to the Commission (Appendix I), both agencies agreed to the following:

1. EPA will recognize and approve aquifer exemptions for all existing production zones with the initial program approval. As stated in your letter of March 21, 1982 [also attached in Appendix I], you will supply maps of the productive zones.
2. If any expansion of current production zones necessitates the extension of an exempted aquifer in the same horizon, the TRC [Commission] will send the permit application for any proposed injection into this extended area to EPA Region 6 for concurrence prior to issuance of the permit.
3. EPA will take action on any application submitted under item #2 above within five working days.
4. Extension of aquifer exemptions for production zones will not be granted if the area proposed for exemption is currently being used as a drinking water source. This will be examined in the area of review for any proposed injection well in the area proposed for exemption.
5. Aquifer exemptions for any new production fields, or for any non-producing zones, will be submitted for EPA concurrence as outlined in 40 CFR 122.35(b) [now 144.7].

On the date of primacy, EPA approved aquifer exemptions for all existing Class II injection wells and all existing hydrocarbon-producing zones. A search of Commission records found no documentation concerning aquifer exemptions for additional hydrocarbon-producing zones. However, a letter dated July 14, 2015 (see Appendix II) documents the agreement between EPA and the Commission that, going forward, the Commission “will pursue aquifer exemptions for new oil and gas related injection operations in any new applicable field prior to granting injection well permits for these operations.”

### **The Commission's UIC Procedures with Respect to USDWs**

Injection into a non-productive zone is regulated under the Commission's Statewide Rule 9, relating to Disposal Wells. Applicants for permits for disposal into a non-hydrocarbon-productive zone (Type 1 wells) are required to submit a letter from the Commission's Groundwater Advisory Unit (GAU) stating that the well will not endanger freshwater strata in that area and that the formation used for disposal does not contain freshwater. The Commission's EPA-approved program description states that a disposal well is considered to endanger freshwater strata if the proposed disposal zone contains water with less than 10,000 milligrams per liter (mg/l) total dissolved solids (TDS).

For Type I injection wells permitted under Statewide Rule 9, the GAU provides geologic interpretation of the base of strata that contains groundwater with a TDS content of less than 10,000 mg/l. The GAU does not determine whether the proposed injection interval contains a sufficient quantity of ground water to supply a public water system or whether the aquifer supplies drinking water for human consumption. Therefore, the GAU's determination is more conservative than the EPA definition for USDW.

Injection into a productive zone is regulated under the Commission's Statewide Rule 46, relating to Fluid Injection into Productive Reservoirs. Fluid injection wells are wells in which fluid is injected into formations that are productive of oil, gas, or geothermal resources. The purpose of the injection is typically for enhanced recovery (Type III wells), but may include disposal (Type II wells).

When the proposed injection interval is a productive zone that contains water with less than 10,000 mg/l TDS, the Commission limits injection to waters produced with hydrocarbons and then returned to the zone from which they were produced or waters with a lesser TDS concentration. This Fluid Source Limit (FSL) allows the oil and gas operator to safely manage the produced fluids, maintain the water drive in a producing field, and produce the hydrocarbons in that field. In addition, the proposed injection well must be within a two-mile radius of a producing well to be considered under Statewide Rule 46.

### **The Commission's UIC Data Management Program**

Throughout its history, the Commission has issued permits for approximately 115,000 injection wells. The Commission's current inventory of permitted injection wells includes approximately 56,000 permitted injection wells, 36,000 of which currently report active injection of fluids. The remaining 20,000 wells are permitted but not completed, completed but not yet injecting, injecting but not yet reporting, temporarily abandoned for repairs, or producing.

In 1984, the Commission implemented a mainframe database to manage the records that had previously been maintained in paper format. At that time, information for approximately 40,000 existing UIC wells was gathered statewide from operators, district offices, and archives in Austin and manually entered in the mainframe. Information for new injection wells was manually entered as permits were issued.

In 2011, the Commission implemented a Graphic User Interface (GUI) to standardize and automate mainframe entries and to automate drafting and distribution of permits. The GUI includes permit template language and basic permit information, and facilitates searches of permit data.

In 2013 and early 2014, staff searches of the mainframe revealed that groundwater information was lacking in the Commission's mainframe database for thousands of permitted wells. Historical aquifer information was maintained in the form of copies of permit applications that were either scanned into pdf's accessible online, or filed in the original permit files in the Commission's Central Records in Austin. Aquifer information was available by accessing the scanned images or the original permit files.

By mid-to-late 2014, the Commission further enhanced the GUI with new scripts that automated and standardized common special permit conditions. The Commission also enhanced the GUI to include the depth of the base of strata containing water with a TDS concentration less than 10,000 mg/l, allowing storage of this data in the mainframe on a date-forward basis to make this information more easily accessible.

## **II. Project**

### **Objective and Resources**

With EPA grant assistance, the Commission initiated the State of Texas Aquifer Exemption Project to improve the efficiency and effectiveness of its Class II UIC program. The project involved research of historical data related to the approximately 62,500 Class II injection well permits issued by the Commission after the date of primacy to identify any injection wells permitted to inject into potential USDWs (zones that contain water with fewer than 10,000 mg/l TDS). The grant period began September 1, 2016 and ended August 31, 2017.

The Commission hired a geologist using these grant funds to assist with detailed permit application file reviews, completion reviews, spreadsheet sorting and related data analysis, research of field name changes, GIS reviews for groundwater information, detailed analysis of GAU letters, and mainframe database updates. The geologist researched the Commission's mainframe database, online well records, information from the Commission's GAU log library and water quality data, and historical hearing files. The geologist worked under the direction of the manager of the Commission's Injection-Storage Permits and Support Section.

Through this project, the Commission has compiled more detailed information, including digital maps, related to injection wells for which the injection interval contains water with a TDS concentration of less than 10,000 mg/l and an internally searchable database to support future regulatory actions.



## Methodology

The project consisted of multiple screenings of the Commission's databases, research in historical hard-copy files, and determination of water quality.

Initial screening of injection wells in the Commission's Class II injection well inventory included progressively more sophisticated searches of the data contained in the Commission's mainframe. Initial screening criteria included the following:

Plugged wells

Cancelled permits

Depth to the base of usable quality water

County maximum depth to strata with less than 10,000 mg/l TDS

Permitted depths to the top and bottom of the injection interval

Well type

The initial screening identified 10,205 permitted wells that required further review. These 10,205 wells fell into the following categories:

Type 1	Disposal into a non-productive zone	1,634
Type 2	Disposal into a productive zone	1,633
Type 3	Injection for enhanced recovery	6,938

Subsequent screening involved detailed reviews of the 10,205 wells remaining after the initial screening. These reviews included date of permit issuance (before or after the date of primacy); date of field discovery (before or after the date of primacy), depths of perforations, casing and well geometry, tops of cement, USDW determination letters giving both depth and date for each well, and GIS searches for nearby USDW information.

Since 1982, many of the field names have changed, although the productive zones remained the same. Staff performed research and analysis to identify producing zones in fields for which the discovery date in the mainframe was on or before April 23, 1982, but for which the field name did not match the name assigned prior to 1982. Staff termed these fields "child fields" of pre-primacy fields.

By letter dated March 21, 1982 (see Appendix I), the Commission informed EPA that maps of the aquifers to be exempted at the time of primacy were not available and would not be provided. The Commission agreed, however, to provide maps of the oil and gas fields within the State of Texas. By that time, there were thousands of Commission-designated fields. The only field maps we are aware were available to the Commission were published by the Bureau of

Economic Geology (BEG) at the University of Texas at Austin. BEG published a document titled "Energy Resources of Texas 1976" (Univ. of Tx, Austin, Bur. Econ. Geol., ERM Maps, 1976, Scale 1:1,000,000), which depicted, but did not name, the mapped fields. The BEG also published an "Atlas of Major Oil Reservoirs" in 1983 and an "Atlas of Major Gas Reservoirs" in 1989. These maps provided the horizontal extent of all productive fields in the state.

As part of the grant project, the Commission initiated a GIS mapping project to better define the fields (producing zones) for which EPA granted an aquifer exemption on April 23, 1982 (pre-primacy fields). The Commission compiled API well numbers and geographic coordinates for wells in each of the pre-primacy fields and plotted the wells using ArcGIS software. The Commission then mapped the producing zones in these pre-primacy fields by drawing a one-half mile buffer around the wells in each field. More information on the Field Boundary Map Review can be found in Appendix III.

As noted above, data on the depth to the base of strata containing water with a TDS concentration of less than 10,000 mg/l was not always found in the Commission's mainframe database. The Commission performed GIS searches and reviewed nearby wells with similar geology to assist in determining the depth of these strata. For those wells without specific information concerning the depth to the base of strata containing water with a TDS concentration of less than 10,000 mg/l, the Commission screened wells using the maximum depth to the base of these strata in the county. The remaining wells were individually reviewed by the Commission's GAU to determine well-specific depth to the base of strata containing water with a TDS concentration of less than 10,000 mg/l.

In some cases, the injection interval is between the shallow aquifers above the producing zones and deeper aquifers with a TDS concentration of less than 10,000 mg/L (split zones). Logs for these wells indicate low permeability zones (typically shales) that provide hydrologic isolation from the shallow and deep aquifers, such that injection into the more saline permitted intervals will not vertically migrate and degrade water with a TDS concentration of less than 10,000 mg/l.

## **IV. Findings**

The following findings resulted from the Commission's screening and review of approximately 115,000 wells found in the internal UIC mainframe database.

### **No Type 1 injection into a USDW authorized after primacy**

The Commission found no evidence of any permit issued after April 23, 1982 (the date of primacy) for injection into a zone that is not productive of hydrocarbons and that may be a USDW.

**Very limited Type 2 or 3 injection authorized into hydrocarbon productive zones that contain water with less than 10,000 mg/l TDS outside the pre-primacy boundaries of oil and gas fields**

The Commission found 16 wells permitted after the date of primacy for injection into 11 oil or gas fields discovered after the date of primacy that contain water with less than 10,000 mg/l TDS.

The Commission found 38 injection wells permitted after the date of primacy for injection into an expansion area of a pre-primacy oil or gas field covered by an aquifer exemption. These injection wells were permitted within 0.03 miles to 4.26 miles of the pre-primacy boundaries of one of 13 fields discovered before the date of primacy.

A spreadsheet with pertinent information on the identified injection wells can be found in Appendix IV.

The Commission reviewed any water wells within five miles of each of the 54 injection wells. Only four of the injection wells have water wells within five miles that are screened in the injection interval. In each instance, the water well is separated from the injection well by another well producing hydrocarbons from the same interval.

The permits for all of the injection wells include a Fluid Source Limit (FSL) condition. The FSL condition limits injection to waters produced with hydrocarbons and then returned to the zone from which they were produced or waters with a lesser TDS concentration. This FSL condition allows the oil and gas operator to safely manage the produced fluids, maintain the water drive in a producing field, and produce the hydrocarbons in that field.

## **Conclusions**

### **The Commission's UIC program provides substantial and effective groundwater protection**

This project confirmed the Commission's UIC program provides substantial and effective groundwater protection in compliance with Section 1425 of the Safe Drinking Water Act and the 1982 primacy agreement between the Commission and EPA.

### **Enhanced data management system assists in review of applications**

Research from this project has been used to update and enhance the Commission's data management systems. In addition, the Commission has enhanced its internal data management system to enable searches to assist in determining detailed information about

injection into a zone that may be an USDW in an oil or gas field that was discovered after EPA granted primacy to the Commission for the Class II UIC program. Commission staff is using the data and data management system enhancements for the review of new and amended permit applications and the monitoring of existing permitted injection wells.

### **The Commission can map exempted aquifers**

As part of this project, the Commission developed methodologies for mapping hydrocarbon productive zones and used those methodologies to identify injection wells outside the pre-primacy boundaries of oil and gas fields.

### **The Commission has developed procedures regarding review of applications with respect to aquifer exemptions**

This project has served to enhance staff knowledge regarding the UIC program requirements and the Commission's agreement with EPA. The Commission has developed procedures for ensuring that the Commission issues no permits for injection wells for which an aquifer exemption is required without concurrence from EPA. A description of the procedures can be found in Appendix V.

## **APPENDIX I**

**Letter dated March 21, 1982, from the Railroad Commission of Texas to the  
U.S. Environmental Protection Agency**

**Letter dated March 29, 1982, from the U.S. Environmental Protection  
Agency to the Railroad Commission of Texas**

## **APPENDIX II**

**Letter dated July 14, 2015 from the U.S. Environmental Protection Agency  
to the Railroad Commission of Texas**

## **APPENDIX III**

### **Field Boundary Map Review**

## **APPENDIX IV**

### **Spreadsheet**



## **APPENDIX V**

### **Process for ensuring injection well permits comply with RRC/EPA Agreement with respect to aquifer exemptions**