Identification of a Deep Superior Quality Aquifer in Several Transboundary Counties of Texas

Texas RRC
Groundwater Advisory Unit
November 2021
Table of Contents

- Approximate Geographic Location of Aquifer/Reservoir
- Present the Data and Geologic Maps as Discovered in Chronological Order
- Define the Extent of the Aquifer and Quantify Certainty and Uncertainty
- Identify the Probable Source of the Superior Quality Water
- Discuss Risk and Benefit’s associated with an Aquifer/Reservoir
- Discuss Hypothetical Options for reducing Uncertainty
- Next Steps
- Questions
Key Oil Field Terms & Concepts

- **Aquifer’s** contain economic quantities of Groundwater
  - Deep or remote fresh groundwater may not qualify
- **Reservoir’s** contain Oil & Gas and *Produced Water*
  - Produced Water is not typically reported to the State
  - Produced Water is an Expense and Nuisance to Operators
  - Aquifers can Transition to Reservoirs & Vice Versa
- **Oil and Gas wells** are Water Excluders
  - Optimized to Keep Water Out
  - Produced Water Production Biased 10 to 1 over Oil
  - Water always occurs below oil and gas
- **Only Natural Source of Fresh Water is Rain**
- **Groundwater** is typically Fresh at Surface Increasing in Salinity with Depth & Age
MAVERICK COUNTY, TEXAS
New Aquifer Detection Incident

Background

- Maverick County > 1,000 Oil & Gas wells
  - Different depths, Zones, & Formations
  - GAU Groundwater Maps 100’–250’ bls
  - Occasional reports of deep superior quality produced water since mid 1990’s in Oil Field
  - Reports of a High Temperature Gradient

- August 2021 Driller applies to convert a 6,200’ Oil well to a Water Well
  ✓ Reports Artesian Flow <500 TDS
  ✓ P-13 Application lists drilling not plugging

- Skeptical GAU Investigation Begins
  ✓ Target zone Glen Rose Fm.
P-13 Permit Water Quality Results

- Dispatched RRC Outrider with Test Equipment to P-13 well in Maverick County
- Pressure Tested Well Casing
- Formation Water < 500 TDS
- Artesian Flow, High Temperature
Are there other freshwater O&G wells nearby?

- We checked the P-13 Data base and contacted Wintergarden GCD
  - An additional P-13 well was identified 30 miles East in Dimmit in the Glen Rose Fm.
- Inventoried all Oil & Gas wells with Glen Rose freshwater discharge permits in region
- Searched for Glen Rose Water Wells in TWDB's WDI (most likely P-13's)
  - Found several in Zavalla
- Inventoried all wells in the Transborder Area that penetrate the Glen Rose
- Conducted a literature search for any deep transborder aquifers
  - Some Shallow Aquifer's reported but no Deep Aquifers were identified
- Searched Mexican Government Agency publications for wells in the Glen Rose
  - Found several geotechnical publications about the Mexican side of the basin
  - Found a Pemex well log 50 miles to the West of Stone Ranch


- Hamilton Fee P-13 Application Dimmit Co.
  - Currently in violation of SWR 18
  - Cert Letter Sent out Oct. 2021

- Railroad Commission of Texas
  - Oil and Gas Division
  - Application of Landowner to Condition an Abandoned Well for Fresh Water Production

- Form P-13
  - Effective Date: 1977

- Field Name: Fee P-13
  - Field No.: 29

- Operator Name: Hamilton Fee P-13
  - Operator P-13 No.: B-3
  - Location: Dimmit Co.

- Land Use (a) Agricultural, (b) Rural, (c) Industrial, (d) Residential: Agricultural

- Cert Letter Sent out Oct. 2021

- Currently in violation of SWR 18

- For Completion by Landowner: Information concerning groundwater conservation districts may be found at www.groundwater.texas.gov

- Water (R): 20.1
  - Water Date of Test: 8-3-19

- Gas (E): 16
  - Gas Date of Test: 8-2-19

- Production Method: Depth or Fresh Water Well:
  - Depth: 8,500

- Groundwater Conservation District:
  - Groundwater Conservation District: No
  - Groundwater Conservation District: No

- The undersigned Operator and Landowner hereby make application for the Operator to be authorized to plug the well in such a manner that the well bore is left open to the above depth so that the Landowner may condition and equip such well bore to that depth for production of fresh water.

- The undersigned Landowner further obligates himself, heirs, assigns, and assigns, as a condition to the Commissioner's approval of this application, to complete the plugging of the well if and when the well is abandoned as a fresh water well, or when the condition of the well is found to constitute a menace to any oil, gas, or fresh water source in that area, such plugging is to be ordered by the Commissioner.

- Under §93.011, Tex. Nat. Res. Code, the owner is properly plug the wells only when the well has been properly plugged in accordance with Commissioner's requirements as to the basis of underground water standards. No Commission has approved the application to condition the well to return quality water production operations, and the landowner has completed the well with, or obtains a permit for the well from, the groundwater conservation district, if applicable.

- The authority to complete the well in the manner prescribed shall not be construed as authority for any party to produce fresh water from the well.

- CERTIFICATION
  - I declare under penalties prescribed in §93.143, Tex. Nat. Res. Code, that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that the data and facts stated therein are true, correct, and complete, to the best of my knowledge.

- Name of Landowner: J.R. Hamilton
  - Address of Landowner: 123 Main St, Dimmit Co.
  - Signature of Landowner: J.R. Hamilton
  - Date: 8-3-19

- Name of Operator: J.R. Hamilton
  - Address of Operator: 123 Main St, Dimmit Co.
  - Signature of Operator: J.R. Hamilton
  - Date: 8-3-19

- Telephone (T): 555-555-5555
  - Filing Instructions:
    1. The completed original of this form must be recorded in the county in which the well is located. SEE the back of this form.
    2. Form P-13 showing the recording date, along with the Notice of Intent to Plug and Abandon (Form V-13) must be filed in the appropriate Commission District Office, along with a copy of the TNRCC/DSC surface survey. Any letter or other acceptable evidences of location.
    3. All plugging back the well, the Operator shall file a copy of the Commission-approved Form P-13 with the original and one copy of Form V-13 (Plugging Records) in the appropriate Commission District Office.
Communications with Surface Discharge Lease Operator

- All wells in Lease flowing to surface (Artesian Flow)
- Production Formation Exhibits Primary, Karst, and Fractur Porosity
- Formation Pressure relatively constant throughout production history
- Initial Oil Production Tests Yield Produced Water with > 80K TDS
- Production Quickly Waters Out to Fresh
  - Major clue to the aquifer and reservoir system
- Geophysical Information was Provided
- Produced Water Quantity and History was Provided
# Water Production Volumes From the Glen Rose Formation (Example from a Single Lease BBL’s)

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10
Water Production From the Glen Rose Formation

Avg Water=95.44 BBLs/Day = Avg 4008.48 Gallons/Day
All Well Tests in or thru the Glenn Rose
(Potential solution set >100 Wells)
P13 Wells (Oil Well to Water Well Conversion)
Direct Evidence 2 wells, 30 mi/apart
Produced Water Surface Discharge Well Locations
Direct Evidence 28 Wells, 30 x 25 Mi apart
Deep Glen Rose Fm. Aquifer

Direct vs. Speculative Evidence

- Karst Channel of high Porosity/Permeability
- Bracketed by the Known Wells

Finding the Source
Vertical Cross Section of Production & Injection Zones

Glen Rose Structure

- Majority of Production and Injection in Region
- Minor Production Unconventional
  - Minor Production
  - Fresh water source
  - No Injection taking place
- Groundwater data in Kinney County
- Some Production in Maverick

Basement Non-Conformity

Basement Faulting

High Geothermal Gradient
Southwest to Northeast Cross Section
7 Wells Direct Evidence

Maverick
Zavala
Dimmit

900 – 1,000 Sq Miles
1,000 Ft thickness
Southwest to Northeast Cross Section
Direct Evidence 30 Miles of Aquifer 1,000 Feet Thick
Northwest to Southeast Cross Section
3 Wells out of 10 have Direct Evidence

Currently gathering direct water quality analytics from gas cap wells in the North

Interest in gathering direct water quality analytics from orphan wells in the North
Northwest to Southeast Cross Section

Direct Evidence of 1,000 Sq. Mi. Potential for 3,000 Sq. Mi.
Transboundary aquifers between Chihuahua, Coahuila, Nuevo Leon and Tamaulipas, Mexico, and Texas, USA: Identification and categorization

Rosario Sanchez, Laura Rodriguez, Cecilia Tortajada

* Texas Water Resources Institute, Texas A&M University, MS 2360 TAMU, College Station, TX, 77845, United States
* Water Management and Hydrological Sciences Program, Texas A&M University, College Station, TX, 77845, United States
* Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore, Singapore

**Finding the Source Should Improve Certainty!**

Transboundary Aquifer Area Maps and Technical Reports

Texas Water Resources Institute
Cross Section Mexico to Texas

SERRANIA DEL BURRO

PEMEX Refugio #11

CMR Energy #1-58H

>50 Miles

<46.38 Mi>
Buda Limestone Through Mexico
- Deep Superior Quality Aquifer
- Karst Outcrop Glen Rose Fm. [Intake Zone ~ Well Head]
- Drainage & High Peak Elevation 12,000 [H2O Supply & Pump]
- Plunging Fm./Faults to Basement [Conduit ~ Well Bore]

Extremely Unusual Natural Fresh Water Reservoir Flood
**Risk Benefit**

**Oil & Gas Reservoir/Superior Quality Aquifer**

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**Risks**

- Injection into USDW waters
  - ✓ No Injection Permits Issued into Glen Rose
  - ✓ Some into Georgetown Fm.
- Status Quo Change to Casing and Cementing Operations
  - ✓ Nominal impact processing as is mainly simple and immediate
- P-13’s renewed production risk
  - ✓ Operators leave separators on site
  - ✓ Several Fee Simple Operators
- Water production capabilities derived from oilfield data
- All Existing Wells Completed as Oil and Gas Wells
  - ✓ Completed as Water Excluders
  - ✓ Future Wells require Oil Field Drilling Technology and Skills
  - ✓ GAU has oil and gas well performance measurements and water production estimation information
- Recent minor seismic activity in the vicinity

**Benefits**

- Get information out sooner rather than later
  - ✓ Keep GCD’s and Municipalities informed
- Wells are deep but artesian so low cost to operate
- Operators reduce plugging costs using the P-13
  - ✓ Existing P-13’s offer affordable water well $20K
- Beneficial Economic Source of Water (conditional)
  - ✓ Provable 1,000 Sq Mi 1,000’ average thickness
  - ✓ Probable 3,000 Sq Mi
- Potential for Drilling Deep Water Wells
  - ✓ Could cost upwards of $800K require Oil Field Tech.
- The high temperature of waters may lend themselves to geothermal potential
  - ✓ Reports of > 200°F; water boils at 212°F
Deep Aquifer Hypothetical Evaluation Options

• Investigate using Literature & Geophysical Data (Low Cost, High Uncertainty)
  ✓ Investigate and better map the Probable Source(s) and additional direct evidence in Mexico

• Drill A New Well in A desirable location (High Cost, High Risk, Certainty)

• Acquire Abandon wells for P-13 Conversions (low Cost, Low Risk, Certainty)

• Acquire existing drilled Oil/gas Wells (Medium Cost, High Risk, Certainty)
  - Take over existing Orphan Well(s) in the Glen Rose Fm.
  - Acquire Private Temporally Abandon or Plugged Well(s) in the Glen Rose Fm.
NEXT STEPS:

• The RRC is protecting the Maverick Basin Aquifer
  ✓ No injection currently taking place

• BEG Casing Estimator Site updated with Maverick Aquifer

• Working with San Antonio District Office & Operators’ GSD’s
  ✓ minimize impact to the Aquifer and Oil Field’s

• Presented GAU findings to TWDB Technical Staff in October

• RRC Published High Level Public Interest Article in November

• Sharing Geo Technical Information with interested Stake Holders
  ✓ City of Eagle Pass Department of Water Works
  ✓ Private Mining and Energy Businesses
Questions?

James Harcourt
512-463-2980