

**Application Summary and Staff Review**  
(Board Meeting September 10, 2020)

**DESCRIPTION OF APPLICATION**

Applicant: Ruby Ranch Water Supply Corporation

Type of Application: Storage and Recovery Permit Application

Request: RRWSC is requesting a Class D Conditional Permit to withdraw up to 15,000,000 gallons/year from the Edwards Aquifer for the purposes of injection, storage, and recovery from an ASR recovery well.

**Summary**

Ruby Ranch Water Supply Corporation (RRWSC) filed an application for an Aquifer Storage and Recovery (ASR) permit on January 3, 2020. This permit would authorize the production of Class D Conditional Edwards Aquifer water during times of non-drought periods for the purposes of injection, storage, and recovery from an ASR recovery well completed in the Middle Trinity Aquifer (Cow Creek limestone). The RRWSC ASR project involves the production of Edwards Aquifer water for injection into the Middle Trinity Aquifer for subsequent recovery and use as public water supply (**Figure 1**). Technical information and pilot studies have been conducted (Smith et al., 2017; Rauschuber and Vickers, 2019). This is the 4<sup>th</sup> ASR system approved and permitted by the TCEQ for the state of Texas.

RRWSC has an existing Edwards Aquifer well (#4) and Middle Trinity well (#5) pair that are currently being used for public water supply. Due to higher mineral constituents (e.g. total dissolved solids [TDS], sulfate, etc.) in the Middle Trinity, RRWSC must blend its Edwards and Trinity water to satisfy water-quality standards. By injecting fresh Edwards water that can be permitted by the District when there is not a District-declared drought, RRWSC can have a greater quantity of water available during peak demand (summertime) for their customers and reduce the undesired TDS and sulfate constituents. RRWSC plans to produce, inject, and store Class D Conditional Edwards water during the low domestic water use period between November and April and recover and distribute the stored Edwards water during the usually high domestic water use period between May and October of each calendar year, and to have water available for long periods of drought.

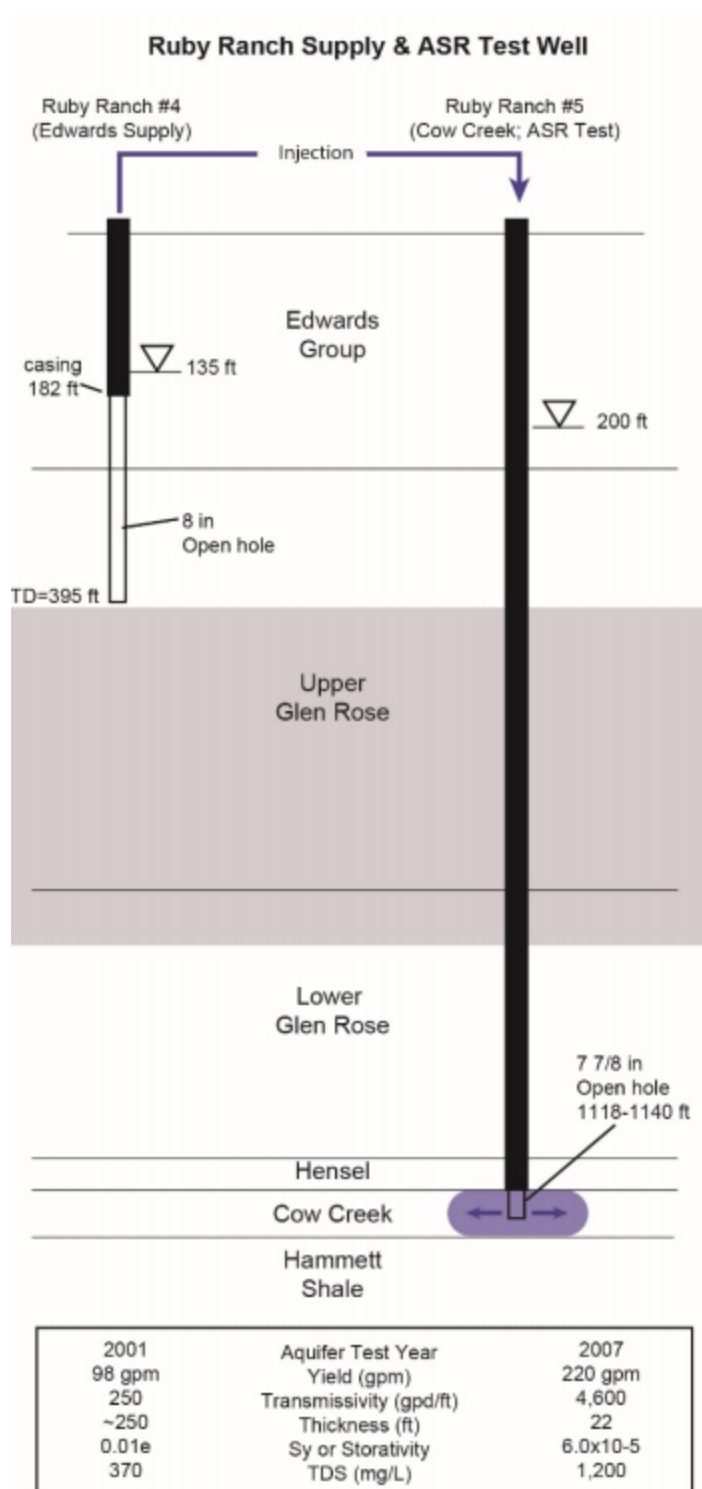


Figure 2. Schematic diagram of the RRWSC ASR system. Figure from Smith et al., 2017.

### Requested Edwards (Class D) Permit

RRWSC is requesting a Class D Conditional Permit to withdraw up to 15,000,000 gallons/year from the Edwards Aquifer. The Edwards well #4 has a production rate of 95 gpm. At 6 months a year, at an operational 60% runtime, that equates to approximately 15,000,000 gallons/year. Class D requires 100% curtailment upon the declaration of Stage II Alarm Drought, but more importantly, it is only available for groundwater production from wells associated with ASR projects where stored water is recovered and used to supplement or substitute freshwater Edwards Aquifer supplies during District-declared drought (District Rule 3-1.24.F).

The total storage volume (TSV) is the sum of the stored water plus the buffer zone volume(**Figure 2**). The estimated TSV for the ASR project is approximately 50 to 60 million gallons with an annual recovery volume of 15 million/gallons and a target buffer zone volume of 30 to 45 million/gallons (see Appendix A). The buffer zone will continue to be built up and is estimated to be established within the next 3 to 5 yrs.

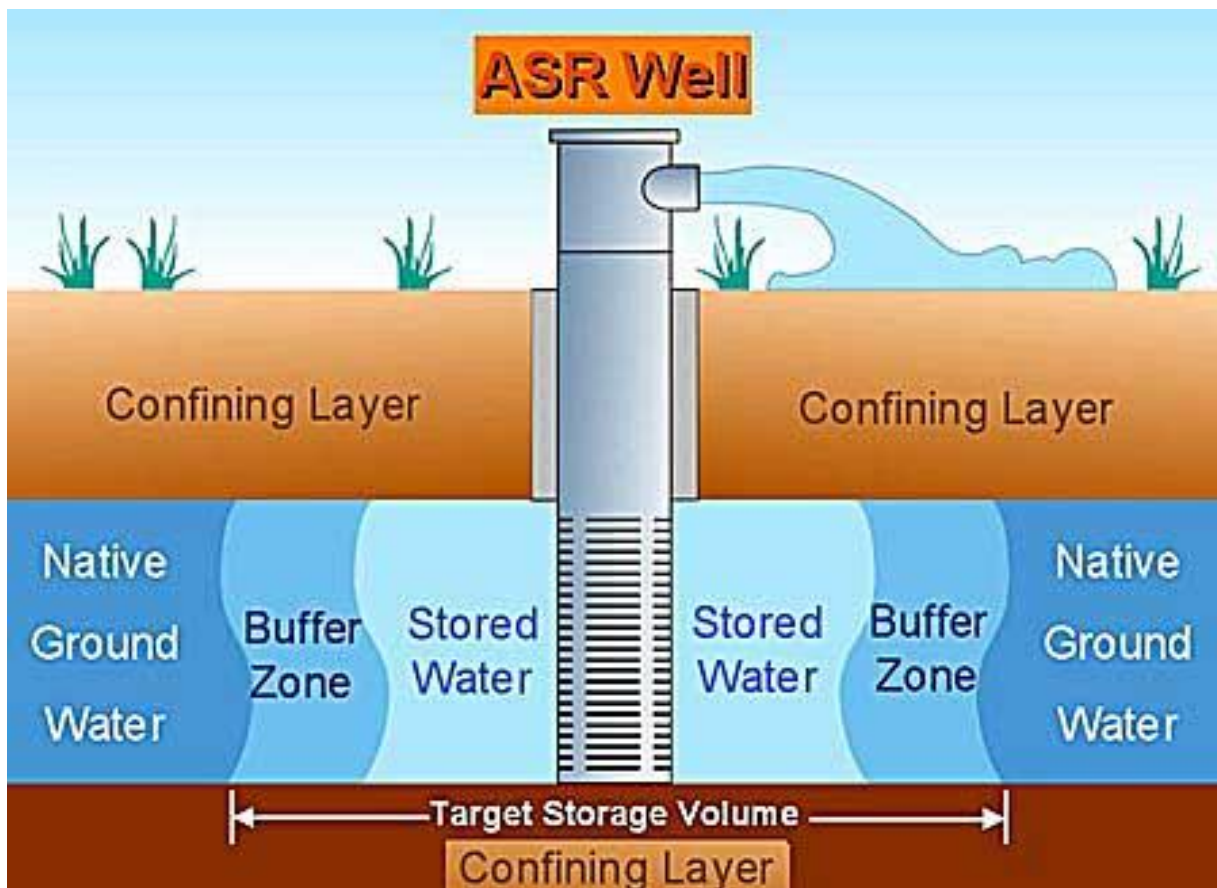


Figure 2. ASR Schematic Diagram

## **Well Location and Receiving Area**

The existing wells and ASR project is located at 2053 Ruby Ranch Road, Buda, TX 78610 on a 0.76-acre lot (water-well easement) within the Ruby Ranch subdivision (Appendix B). The recovered water from well #5 is delivered to the ground storage tank where it is blended with 50% Edwards water from well #4 before it is distributed to the Ruby Ranch service area and subdivision for public-water supply (Appendix C).

The existing Trinity well #5 will be used for injection and recovery and will be considered the ASR well. ASR well #5 is completed in the Cow Creek unit of the Middle Trinity Aquifer at a total depth of 1,140 ft and is about 120 feet from the Edwards source water well (#4). The Edwards well #4 was drilled in 2001 to a depth of 405 feet and is completed within the Edwards Group and Upper Glen Rose.

## **Hydrogeologic Report and ASR Pilot Test**

In accordance with District rules, applicants for permits seeking more than 2 MGY shall conduct an aquifer test and submit a hydrogeologic report addressing the potential impacts associated with the project. The Aquifer Science staff reviewed the hydrogeologic reports and aquifer test for the RRWSC (Geos, 2011; Smith et al., 2017; and Rauschuber and Vickers, 2019). In their professional opinion, these reports satisfy the District's aquifer test and hydrogeologic report requirements for the permit applications. Impacts to water levels in the Edwards and Middle Trinity Aquifers from the permitted pumping will be minor. Water-quality issues (regulated by the TCEQ) will be addressed by the operation of the ASR buffer zone and public water supply (PWS) operational procedures. A summary of these findings includes:

- Middle Trinity Aquifer testing for the original production well (Geos, 2011) provided good aquifer characterization data. A historic permit was granted to the RRWSC for the Middle Trinity production (20.3 MGY) and the well has been in operation for over 8 years.
- Additional pumping from the Edwards well requires a Class D conditional permit, which allows pumping only during non-severe drought conditions. Furthermore, RRWSC already holds an Historic Edwards permit for 24.2 million gallons/year and a Class A Conditional for 7.8 million gallons/year. The operation of the ASR system will result in net zero extraction from the Middle Trinity Aquifer. There are no existing Middle Trinity wells in the vicinity. Therefore, the impact to water levels and springflow will not produce an unreasonable impact.

- Concerns of water quality have been addressed by the aquifer testing and reporting and the TCEQ has approved the ASR system for public water-supply use.

Aquifer Science staff consider that the previous reports satisfy the District’s requirements for hydrogeologic testing prior to issuance of a Class D permit.

**ASR Pilot Test Summary**

In 2017, RRWSC and the District started cooperating on a project to test the Middle Trinity Aquifer as a reservoir for storage and recovery of fresh Edwards Aquifer groundwater (Smith et al., 2017). The pilot project consisted of multi-step tests with increasing volumes of injected water in each successive step predicated upon successful results at each step. Major objectives of the first two phases of the project were to characterize the suitability of the two aquifers, to determine any impact to water chemistry and to the formation, and to clarifying the physical parameters governing the injected water “bubble”. In the last two phases, an additional objective to assess how much of the water that is injected can be recovered “recoverability” was considered. The pilot testing consisted of four phases or cycles that occurred between April 2017 and August 2019. The District drafted a report for the project at the completion of two phases (Smith et al., 2017; Appendix D) and RRWSC’s consultant, Don Rauschuber, completed a final report at the end of phase 4 (Rauschuber and Vickers, 2019; Appendix E).

**Pilot Testing Injection and Recovery Volumes**

<b>Phases</b>	<b>Volume Injected (gallons)</b>	<b>Volume Recovered (gallons)</b>	<b>Volume in storage at end of phase (gallons)</b>
<b>Phase 1</b>	50,000	84,000	-34,000
<b>Phase 2</b>	280,000	380,000	-100,000
<b>Phase 3</b>	9,000,000	4,500,000	4,500,000
<b>Phase 4</b>	11,000,000	2,600,000	12,900,000
<b>Total</b>	20,330,000	7,564,000	12,900,000

**Injection/Extraction Water Levels, Pressure, and Bubble Radius**

During the testing, Edwards Aquifer water was injected into the ASR well #5 a rate of about 40 to 100 gallons per minute (gpm). The water level in the well rose between 6 and 18 ft during the testing. Once injection stopped, the water level in the well quickly returned to pre-injection levels. The injected water was pumped from the ASR well #5 at a rate of approximately 90 to 100 gpm during the extraction period and water levels dropped in the well between 4 and 14 ft

during the testing. At the max injection rate of approximately 100 gpm the water level increased 18 ft. No water-level response could be attributed to the testing project in the nearest Middle Trinity monitor well (5764613). This well is a multiport monitor well located about 1.5 miles to the west of the Ruby Ranch subdivision.

The estimated radial distance of the TSV bubble (45 to 60 million/gallons) is 420 ft and the velocity is 0.3 ft per day with flow to the southeast. The bubble is expected to become elongated to the southeast over time. The ASR project is located on a 0.76-acre triangle shape property owned by the RRWSC and dedicated as a water-well easement. A circle with a 420 ft radius has an area of 12.7 acres, therefore the TSV radius is expected to extend off the property. However, the applicant has initialed a declaration indicating they understand a landowner owning surface property over the TSV radius owns the water unless ownership has been severed.

### **Water Quality/Geochemical**

The pilot test was designed to carefully assess any water-quality changes, geochemical reactions and the mixing characteristics of the native and stored water. Baseline samples were taken prior to testing and water-quality samples and field parameters were taken during extraction for each phase of the testing. Because of concerns about mobilization of arsenic from host rocks, additional analyses for arsenic were made during the extraction phases of the tests.

Water-quality results indicate that:

- The source Edwards water and the native Trinity water are mixing, indicating that a buffer is not fully formed or is currently of insufficient volume;
- The level of iron and manganese is elevated in the recovered water; the source of the iron is likely the well casing and not the aquifer;
- Dissolved oxygen concentrations in the Edwards water are relatively high (as expected) due to the unconfined recharge zone setting, and ranges from approximately 6 to 8 mg/L while dissolved oxygen is relatively low (about 0.2 mg/L) in the Middle Trinity due to its deeply confined setting; and
- A small amount of arsenic was mobilized during each testing phase and concentrations in the recovered water ranged from approximately 2 µg/L during the first phase to 5 µg/L during the fourth phase; all values are below the maximum contaminant level (MCL) of 10.0 µg/L regulated by the EPA and TCEQ; this illustrates that arsenic is available and mobile in the formation.

The sources of arsenic from the Cow Creek are not well understood at this time. Geochemical analysis show that arsenic is present within the predominantly dolomite matrix, but the analyses do not show the specific mineral or minerals with which arsenic occurs. Under conditions observed, the primary factor accounting for the occurrence of arsenic in the recovered water is oxidative dissolution of ferrous iron due to the oxygenated Edwards water injected.

The U.S. Environmental Protection Agency lists the MCL of arsenic as 10.0 µg/L. It is important to note that the arsenic concentrations in the recovered water have not exceeded the MCL and are reduced even further when blended with 50% Edwards water in the storage tank before going to the distribution system. For example, sampling results from phase 4, submitted to TCEQ Drinking Water Section, show arsenic concentrations in the recovery water of 5.15 µg/L and 2.78 µg/L in the blended water. It will be necessary to monitor arsenic concentrations on a regular basis, especially with increasing storage time in the Cow Creek.

Iron and manganese concentrations are elevated and exceed TCEQ's secondary contaminant level (SCL) in the recovered water and iron remains above SCL when blended. RRWSC is working with the TCEQ Drinking Water Division on methods to reduce the iron concentration. Regarding elevated iron concentrations, RRWSC has had issues with elevated iron in well #5 prior to ASR testing and it is anticipated that this related to the well casing. District well construction standards require non-corrosive casing for new wells, but these wells were existing before standards were in place. District consultant and geochemist, Dr. Bruce Darling, ran mixing models during the first two phases which revealed that phase 1 consisted of a mixture of 20% Edwards and 80% Trinity water and phase 2 consist of 35% Edwards and 65% Trinity water. While the mixing model was not run during phase 3 and 4, the recoverability analysis indicates that the native and source waters are still mixing.

## **Hydrogeology**

The hydrogeology at the site is described in detail in Smith et al., 2017. The Cow Creek limestone is the target hydrogeologic unit of the ASR testing. The Cow Creek is very porous and permeable and is the primary water-bearing unit within the Middle Trinity Aquifer. The thickness of the Cow Creek in the study area averages about 75 ft. From the results of the pilot testing and four phases of injection and extraction, it was clear that the Middle Trinity Aquifer is capable of receiving the injected Edwards water at the planned flow rates and of storing the injected Edwards water. The Middle Trinity Aquifer within the study area is hydrologically isolated from the overlying Edwards Aquifer due to the presence of aquitard units.

## Recoverability

One of the biggest questions regarding ASR projects is “how much of the water that I inject will I get back?” ASR applicants must assess the volume of water (recoverable volume) that can be recovered compared to the volume of water injected. ASR operators must not withdraw a volume of water that exceeds the recoverable volume without a permit for the native water.

Recoverability or recovery efficiency can be assessed based on aquifer and operational parameters and movement, as well as water-quality criteria. TCEQ worked with the University of Texas (UT) to develop a recoverability model (appendix F) based on operational parameters such as injection and pumping rate, and aquifer parameters such as hydraulic conductivity and gradient, porosity, and thickness. However, the District defines recovery efficiency as the percentage of stored water volume that is subsequently recovered based on satisfying, and not exceeding, a set of water-quality criteria for the recovered water.

The estimated recovery efficiency for the Ruby Ranch ASR project is different for the two assessment methods. TCEQ estimated, based on the UT model, a recovery efficiency of 82%. The recovery efficiency based on water-quality criteria (conductivity of 1200 to 1500 uS/cm or TDS of 100 mg/l) is estimated to be between 30 -to 50% for the pilot project. For example, in phase 3, of the 9 million gallons injected, only 4.5 gallons could be recovered before the water quality criteria was exceeded. As mentioned above, this is due to mixing between the source water and native water and indicates the buffer zone is not fully formed or of sufficient size. Mixing of the waters is not a problem as long as the degree of mixing is within the limitations of the water-quality criteria. Recovery efficiency tends to improve with successive cycles when water is stored in each phase or cycle; this is because water not recovered becomes a transition or buffer zone of marginal quality surrounding the stored water (Pyne, 1995). At most ASR sites, up to 100% recovery efficiency is attainable after an adequate buffer has been established. Once the buffer zone has been formed, a common strategy is to avoid recovering the groundwater buffer zone because of water-quality concerns. However, that is not always the case and in fact, Ruby Ranch has a Trinity permit for the native groundwater.

The District expects Ruby Ranch’s recovery efficiency to improve significantly once the buffer zone is established by the end of FY 2022. Therefore, for permitting purposes the District recommends a recovery efficiency goal of 100% until which time there is enough actual data and an operational report to reassess the recoverability efficiency. RRWSC plans to operate the ASR project seasonally and inject 15 million gallons/year and recover between 10 million gallons to 15 million gallons each fiscal year. However, if RRWSC decides to bank water for multiple years and operates the system for drought purposes as opposed to seasonal purposes,



the volume recovered in a fiscal year could be substantially higher and would be based on the cumulative volume injected minus the buffer volume.

### **ASR Systems LLC – David Pyne**

The District consulted with David Pyne of ASR System LLC on the RRWSC ASR project in July 2020. Mr. Pyne has written multiple books on ASR and worked on many ASR projects in Florida, and around the world. Mr. Pyne reviewed the application material and pilot project reports and indicated that the RRWSC ASR project is the smallest seen to date and was impressed with the pilot testing reports and results.

Ultimately, Mr. Pyne recommended the formation of an adequate buffer zone as it is essential to increasing recoverability and reducing the mobilization of arsenic and other constituents. Establishment of a buffer zone, which is achieved by leaving some recharge water in the aquifer, ensures that no reaction products are allowed close to the well during recovery and minimizes the mixing. Based on Florida ASR experience, Mr. Pyne recommended that an adequate buffer zone would be at least the volume associated with recovery at the design capacity of the well for 70 days, ie:  $0.32 \text{ MGD (220 GPM)} \times 70 \text{ days} = 22 \text{ million gallons}$ . RRWSC is expected to have 22 million gallons stored by the end of FY 2022.

Mr. Pyne went on to indicate that Florida ASR projects that met at least this minimum buffer zone volume criteria did not have an arsenic problem and high levels of recoverability. Forming and maintaining a buffer zone is a proven and inexpensive “rule of thumb” that works in Florida, avoiding the need for deoxygenation of the recharge water, which is complex, expensive, and impractical for larger ASR operations.

Mr. Pyne also indicated that if the recovery efficiency after buffer zone formation is any less than 100%, it would likely be due to lateral movement of the stored water. He indicated that the estimated lateral velocity of 0.3 ft/day for the Cow Creek limestone is moderately high (110 ft/year).

### **TCEQ Authorizations**

The District and TCEQ (UIC) share authority over ASR projects, with the District having authority over the recovery side of the system. Therefore, RRWSC was required to obtain authorizations from TCEQ UIC Division for pilot testing and the ASR project. In addition, since the recovered water is used for public drinking-water supply, the TCEQ’s Drinking Water Division also

reviewed the project and water-quality data and will be reviewing periodic water quality samples.

- In March 2017, the TCEQ granted permission to conduct an ASR pilot project (Ruby Ranch's Class V UIC authorization no. 5X2500126).
  - o Extension granted in March 2019.
- In December 2019, the TCEQ Water Supply Division granted authorization to use ASR water recovered from Well No. 5 as a public water supply (appendix G)
- In February 2020, the TCEQ granted authorization to RRWSC to own and operate a Class V Aquifer Storage and Recovery Well (appendix H).
  - o Include special provisions for sampling arsenic.

### **Application Review**

- Staff has reviewed the above referenced application and has determined that the application has satisfied all the requirements pursuant to District Rule 3-1.4.A and that the required documentation and payment of fees have been satisfied.
- The permit request does not exceed the Fresh Edwards All-Conditions MAG of 16 cfs (11,600 ac-ft/yr).
- Staff has confirmed that the applicant filed proper notice and the required 20-day public comment period has expired in accordance with District Rule 3-1.4.B. (Attachment ). The noticed was published in the Austin American Statesman on July 21<sup>st</sup>, 2020 and in The Hays Free Press on July 29, 2020. The 20-day comment expired on August 10, 2020 and the District received one question regarding ASR from a Ruby Ranch resident. Staff spoke with the resident on the phone and provided information on ASR.
- The District filed public hearing notice pursuant to District Rule 3-1.4.C.

### **BASIS FOR APPLICATION REVIEW**

The following items were considered in the review of the application:

1. Application submitted on January 3, 2020
2. Supplemental information submitted on July 7, 2020
3. District Rules and ByLaws.
4. District Aquifer Test Guidelines.

## Staff Recommendation

The District's staff recommends approval of the ASR Source and Recovery Permit which authorizes 1) the annual production of 15,000,000 gallons per year under an Edwards Class D Conditional Production Permit and 2) the recovery of 100% of total stored volume. District staff recommends approval of the above-referenced ASR Source and Recovery Permit with the following special provisions:

1. Ruby Ranch WSC shall submit a revised recoverability analysis along with the submittal of the required operations report within five years of permit issuance (September 2025). The analysis should be conducted once the target buffer volume is established and should be based on any data collected from the previous five years.
2. Ruby Ranch WSC shall comply with and submit to the District in a timely manner, copies of any and all water-quality sampling requirements or reports as identified in authorization letters from TCEQ's Water Supply Division (dated December 11, 2019) and Underground Injection Control Division (dated February 18, 2020).
3. Additional samples shall be collected from ASR well #5 upon commencement of recovery and at the conclusion of each three-month recovery cycle or any recovery cycle that is less than three months in duration. The samples should be analyzed for water quality parameters that include *arsenic, conductivity, total dissolved solids, dissolved oxygen, iron, and manganese*.
4. Additional samples shall be collected from Edwards well #4 prior to injection at the conclusion of each three-month injection cycle or any injection cycle that is less than three months in duration. The samples should be analyzed for water quality parameter *dissolved oxygen*.
5. All applicable results and reports (identified in provisions 2- 4 above) shall be compiled and submitted to the District within 30 days of collection and no later July 1<sup>st</sup> of each year. TCEQ sampling parameters or requirements do not need to be duplicated.
6. Ruby Ranch shall take all necessary steps to ensure water quality of the native aquifer (Cow Creek Formation) is protected due to operations of an ASR project. If arsenic concentrations in the recovered water from ASR well #5 exceed 8.0 µg/L for two consecutive sampling periods or exceeds the MCL of 10 µg/L in any single sampling period Ruby Ranch WSC shall:
  - i. Notify District staff in writing within 10 business days of lab results if the arsenic concentrations exceeds the above thresholds;
  - ii. Collect arsenic samples from the ASR well #5 every month during recovery;

- iii. Schedule meeting(s) with TCEQ and the District to discuss and specify what operational controls or treatment would be adequate to reduce the mobilization of arsenic and reduce any risk to the aquifer; and
7. Following implementation of operational controls or treatment identified by TCEQ and the District (provision 6 iii & iv above) and in the event that arsenic concentrations exceed 10 µg/L in the recovered water for 3 consecutive sampling months, Ruby Ranch WSC will submit plans to the District for implementing additional controls, treatment, and monitoring to reduce the arsenic concentrations and to assess movement of arsenic within the aquifer.
8. Ruby Ranch WSC shall coordinate with the District to obtain groundwater monitoring data for District scientific multiport monitoring well 58-57-513.

## References

Geos, 2011, Hydrogeologic Report in Support of an Application for a Pumpage Permit Volume Amendment, Report prepared for the Ruby ranch Water Supply Corporation, Buda, Texas. Submitted to the Barton Springs/Edwards Aquifer Conservation District. Geos Project No. 09-04, February 24, 2011. 44 p.

Rauschuber, D.G. and J. Vickers, 2019, Ruby Ranch Water Supply Corporation Aquifer Storage and Recovery Pilot Project Hays County, Texas. Report for TCEQ UIC Class V Injection Authorization No. 5X2500126. September 2019. 29 p.

Smith, B.A., B.B. Hunt, J. Camp, and B.K. Darling, 2017, Status Report for Aquifer Storage and Recovery Pilot Project: Ruby Ranch Water Supply Corporation, Hays County, Central Texas. BSEACD Technical Note 2017-0930. September 2017. 28 p. [https://bseacd.org/uploads/RubyRanchASR\\_Status-Report\\_FINAL.pdf](https://bseacd.org/uploads/RubyRanchASR_Status-Report_FINAL.pdf)

Pyne, R. David G, 1995, Groundwater Recharge and Wells: A Guide to Aquifer Storage and Recovery.

Appendix A  
RRWSC TSV Table and 10-yr Plan

<b>PHASE NO./YEAR</b>	<b>YEAR</b>	<b>Volume of Edwards Aquifer Injected into Well No. 5 (Gallons)</b>	<b>Volume of Water Extracted from Well No. 5 (Gallons)</b>	<b>Volume of Water in Storage Inclusive of Recoverable Water and Buffer Zone Water (Gallons)</b>
Pilot Phase 1	17-Apr	50,000	0	50,000
Pilot Phase 1	27-Apr	0	65,000	0
Pilot Phase 2	17-May	280,000	0	280,000
Pilot Phase 2	17-Jun	0	300,000	0
Pilot Phase 3	Oct. 11, 2017 to May 16, 2018	9,000,015	0	9,000,015
Pilot Phase 3	July 27, 2018 to Nov. 8, 2018	0	4,613,100	4,386,915
Pilot Phase 4	Dec. 12, 2018 to May 12, 2019	11,000,000	0	15,386,915
Pilot Phase 4	July 1, 2019 to Nov. 11, 2019	0	5,371,500	10,015,415
ASR Year 2020	Jan. 1 2020 to April 30, 2020	9,000,000	0	19,015,415
ASR Year 2020	July 1, 2020 to Aug. 31, 2020	0	4,700,000	14,315,415
ASR Year 2021	Oct. 1, 2020 to Mar. 31, 2021	15,000,000	0	29,315,415
ASR Year 2021	April 1, 2021 to Sept. 2021	0	10,000,000	19,315,415
ASR Year 2022	Oct. 1, 2022 to Mar. 31, 2022	15,000,000	0	34,315,415
ASR Year 2022	April 1, 2022 to Sept. 30, 2022	0	10,000,000	24,315,415
ASR Year 2023	Oct. 1, 2023 to Mar. 31, 2023	15,000,000	0	39,315,415
ASR Year 2023	April 1, 2023 to Sept. 30, 2023	0	10,000,000	29,315,415
ASR Year 2024	Oct. 1, 2024 to Mar. 31, 2024	15,000,000	0	44,315,415
ASR Year 2024	April 1, 2024 to Sept. 30, 2024	0	10,000,000	34,315,415
ASR Year 2025	Oct. 1, 2025 to Mar. 31, 2025	15,000,000	0	49,315,415
ASR Year 2025	April 1, 2025 to Sept. 30, 2025	0	10,000,000	39,315,415
ASR Year 2026	Oct. 1, 2026 to Mar. 31, 2026	15,000,000	0	54,315,415

ASR Year 2026	April 1, 2026 to Sept. 30, 2026	0	10,000,000	44,315,415
ASR Year 2027	Oct. 1, 2027 to Mar. 31, 2027	15,000,000	0	59,315,415
ASR Year 2027	April 1, 2027 to Sept. 30, 2027	0	15,000,000	44,315,415
ASR Year 2028	Oct. 1, 2028 to Mar. 31, 2028	15,000,000	0	59,315,415
ASR Year 2028	April 1, 2028 to Sept. 30, 2028	0	15,000,000	44,315,415
ASR Year 2029	Oct. 1, 2029 to Mar. 31, 2029	15,000,000	0	59,315,415
ASR Year 2029	April 1, 2029 to Sept. 30, 2029	0	15,000,000	44,315,415



Appendix B  
Site Location

**RUBY RANCH SUBDIVISION**

**RRWSC ASR PROJECT SITE**

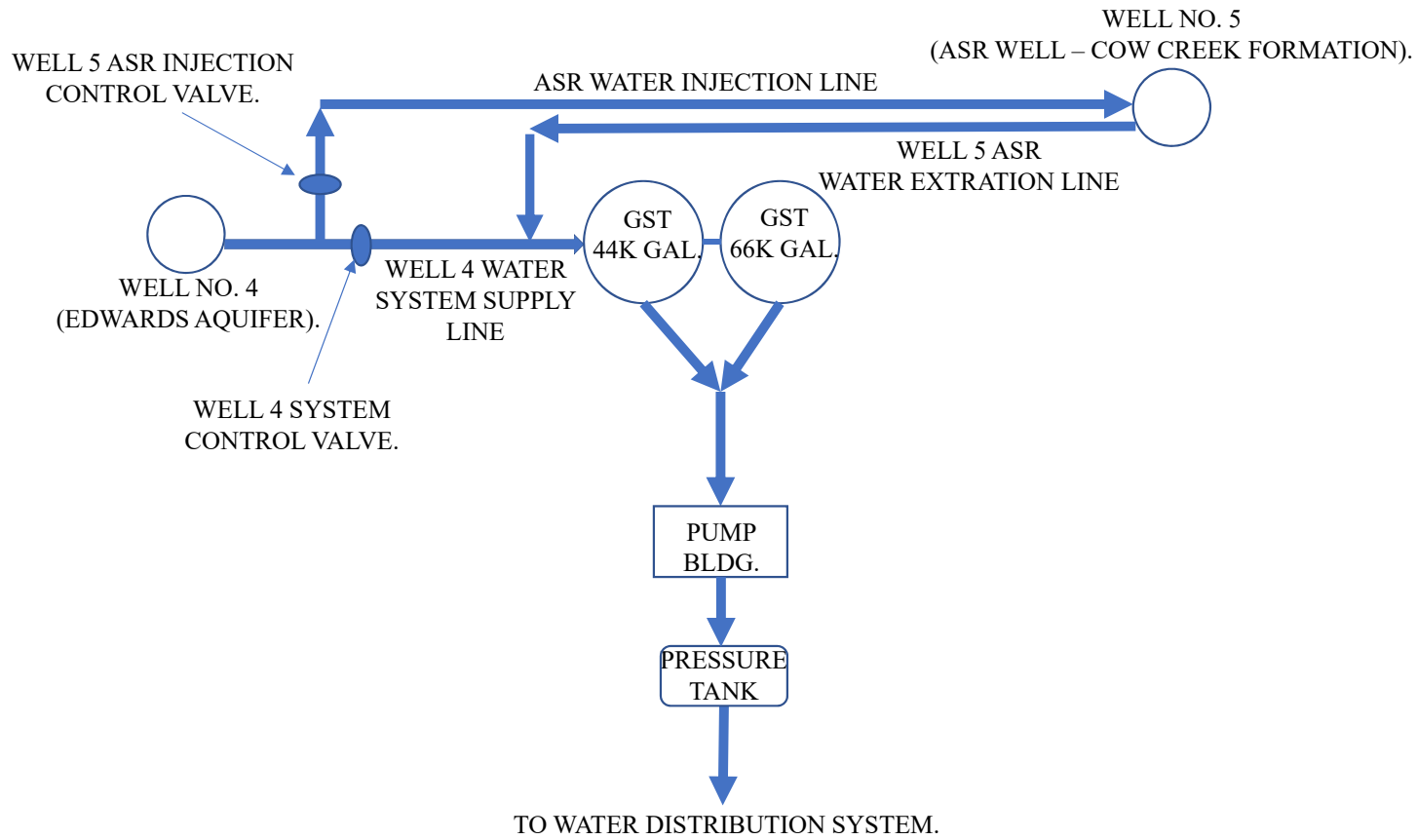


Google Earth

to Market Road 150



Appendix C  
Site Plan and Flow Schematic





RUBY RANCH ROAD

WELL NO. 4  
EDWARDS AQUIFER WELL  
(ASR SOURCE WATER)

PUMP STATION

WELL NO. 4 ASR  
INJECTION LINE TO  
WELL NO. 5

PRESSURE TANK

WATER SUPPLY LINE  
TO GROUND STORAGE TANKS

WELL NO. 5  
COW CREEK FORMATION  
(ASR INJECTION AND  
EXTRACTION WELL)

Appendix D  
District Pilot Project Report (Phases 1&2)

Appendix E  
RRWSC Pilot Project Report (Phases 3&4)

Appendix F  
UT Recoverability Analysis



# TxASR App



## Texas Aquifer Storage & Recovery (ASR) Applet

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Main

More info

How to use

The **TxASR app** provides a simple way to assess the feasibility of water recharge, storage, and recovery.

See the *More info* and *How to use* tabs to get started.

[Download the ASR Application Guide](#)

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*click and drag slider-handles to select desired parameter values (toggle keyboard arrows for fine adjustment)*

### Operational Parameters:

#### Injection Rate ( $Q_i$ ), $\text{ft}^3/\text{day}$



You have selected an injection rate of 10000  $\text{ft}^3/\text{day}$

#### Pumping Rate ( $Q_p$ ), $\text{ft}^3/\text{day}$



You have selected a pumping rate of 10000  $\text{ft}^3/\text{day}$

#### Injection Time ( $t_i$ ), days



You have selected an injection time of 133 days

#### Delay Time ( $t_d$ ), days



You have selected a delay time of 0 days

#### Pumping Time ( $t_p$ ), days



You have selected a pumping time of 133 days

### Physical Parameters:

#### Hydraulic Conductivity ( $K_d$ ), $\text{ft}/\text{day}$



You have selected a hydraulic conductivity of 8.18  $\text{ft}/\text{day}$

#### Hydraulic Gradient ( $dh/dx$ ), $\text{ft}/\text{ft}$



You have selected a hydraulic gradient of 0.008  $\text{ft}/\text{ft}$

#### Porosity ( $n$ )



You have selected a porosity of 0.2

#### Aquifer Thickness ( $B$ ), $\text{ft}$



You have selected an aquifer thickness of 80  $\text{ft}$

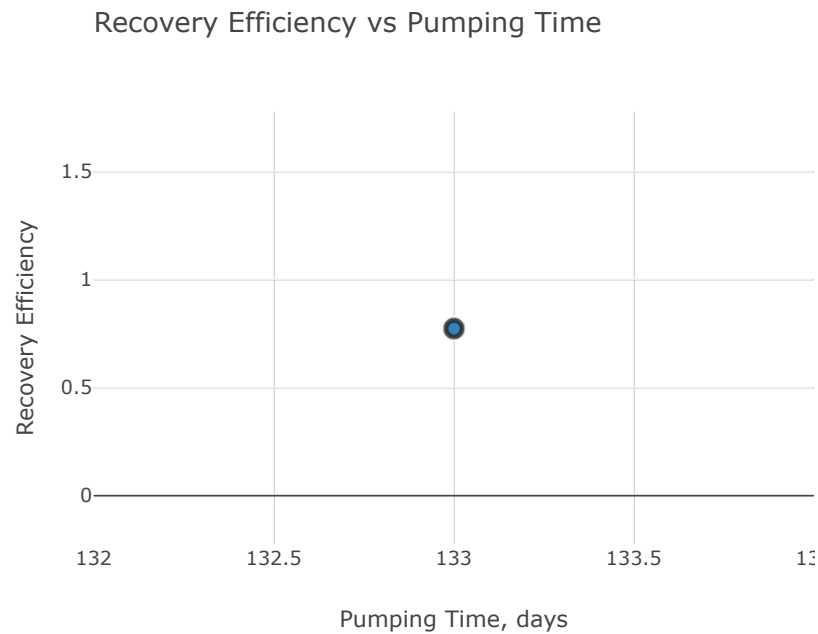
**More Options:**

- Single time point entries
- Ranged pumping time entry
- Ranged injection & pumping time entries
- Ranged delay & pumping time entries

**SUBMIT**

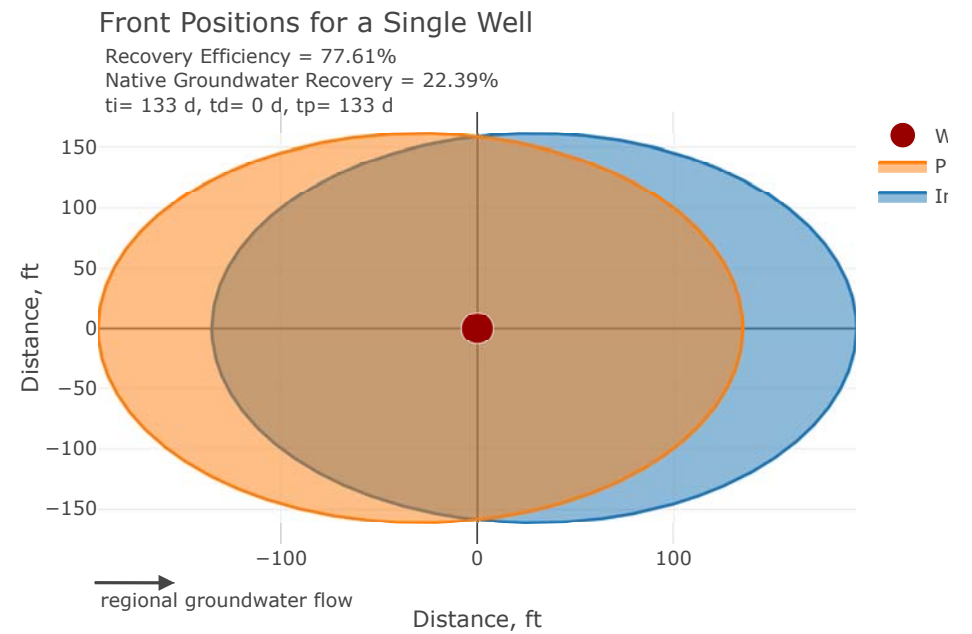
click button to generate graphs below

click data points to generate corresponding "Front Positions for a Single Well" graph



DOWNLOAD CSV

download data for "Recovery Efficiency vs Pumping Time" graph



DOWNLOAD CSV

download data for selected "Front Positions for a Single Well" graph

Appendix G  
TCEQ Drinking Water Division Authorization Letter

Jon Niermann, *Chairman*  
Emily Lindley, *Commissioner*  
Bobby Janecka, *Commissioner*  
Toby Baker, *Executive Director*



PWS\_1050122\_CO\_20191211\_Plan Ltr

## TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

*Protecting Texas by Reducing and Preventing Pollution*

December 11, 2019

Mr. Donald G. Rauschuber, P.E.  
Donald G. Rauschuber & Associates, Inc.  
P.O. Box 342707  
Austin, Texas 78734-0046

Re: Ruby Ranch WSC - Public Water System ID No. 1050122  
Completion Data for Aquifer Storage and Recovery (ASR) Pilot Test Well at  
Water Plant No. 2 (TP19607)  
Engineer Contact Telephone: (512) 413-9300  
Plan Review Log No. P-10112019-061  
Hays County, Texas

CN: 603033564; RN: 102681285

Dear Mr. Rauschuber:

On October 11, 2019, the Texas Commission on Environmental Quality (TCEQ) received well completion material with the letter dated October 7, 2019 from Ruby Ranch WSC for the ASR Pilot Test Well. Based on our review of the information submitted, the project generally meets the minimum requirements of Title 30 Texas Administrative Code (TAC) Chapter 290 - Rules and Regulations for Public Water Systems and the constructed well is **approved for use** based on the conditions noted below and may now be **temporarily** placed into service. The well's continued use is contingent upon the following conditions:

1. The chemical analysis report submitted shows that the concentration(s) of several constituents require ongoing monitoring:
  - a. **The level of arsenic in the recovered water was 0.00515 mg/l.** The maximum contaminant level (MCL) for arsenic is 0.01 mg/l. The water when blended with Well #4 was 0.00278 mg/l. The WSC must monitor the level of arsenic in the recovered water and take immediate action (stop usage or install treatment) should water delivered to distribution exceed the MCL.

December 11, 2019

- b. **The level of iron, and manganese was very elevated in the recovered water and iron remained above the Secondary Contaminant Level (SCL) when blended with well #4.** When drinking water that does not meet secondary constituent levels is accepted for temporary use, such acceptance is valid only until such time as water of acceptable chemical quality can be made available at reasonable cost to the area(s) in question (30 TAC Chapter 290.118(a)). Continual efforts to address these issues must be made. TCEQ may revoke this authorization at any time should public health or service come into question.

  - i. **The recovered ASR well #5 water must be blended with Well #4 if iron and manganese levels are above the SCL.**
  - ii. The Corporation has the ability to feed a blended phosphate at Water Plant No. 2 (TP19607). **This chemical injection has not been approved by the TCEQ.** Please provide a submittal describing the size of the equipment and injection point(s). Please provide a chemical suppliers recommendation of use regarding only for Well #5 in recovery or continuous. It was noted that iron levels decrease after continued use of the ASR well. Please provide an analysis of the iron levels from beginning of ASR recovery over a period of time and describe the need for iron sequestration as continuous or just during a start-up period.
2. Ruby Ranch was authorized to do an ASR Pilot Study by TCEQ Underground Injection Control (UIC) on March 16, 2017. That authorization has been terminated (enclosed letter of December 3, 2019). The ASR Pilot Study and request for permanent use is presently under review by UIC staff. The injection of water from Well No. 4 to Well No. 5 can only resume with approval of the UIC staff and must be in conformance with any conditions of the forthcoming TCEQ Class V ASR Authorization.
3. A representative of TCEQ's Drinking Water Quality Team will contact the public water system to arrange for the collection of the official chemical samples. It is the water systems responsibility to contact the **Drinking Water Quality Team at (512) 239-4691** if they have not had the official sample collection within **180 days** of the date of this letter. **Please note that this sampling must be done when the ASR Well (#5) is being operated in recovery.**
4. If official chemical analysis testing confirms that a regulated constituent does not meet primary or secondary standards, additional treatment, blending, or public notice may be required. The Drinking Water Quality Team will notify the water system of any additional special requirements for this public water supply source. Plans for any proposed water treatment and blending must be reviewed and approved by the Plan Review Team.

Note: The Comprehensive Compliance Inspection (CCI) at Ruby Ranch conducted on January 4, 2018 noted the ability to draw water from the Ground Storage Tank (GST) at Water Plant #2 for injection into Well #5 (ASR). **This line was not described in the submittal and is not approved for use by the Corporation.**

The submitted materials consisted of the following:

- Existing Well No. 4 (G1050122D),
  - Latitude and Longitude: Lat. 30°03'30.7"N: Long. 97°55'16"
  - 405 feet deep into Edwards Aquifer (bottom 182 feet open hole)
  - Well rated for 90 gallons per minute (gpm)
  - State of Texas Well Report Tracking No. (not available)
  - TCEQ Completion Data approval September 6, 2002 (Plan Review Log No. 207-134)
  
- Existing Well No. 5 (G1050122E),
  - Latitude and Longitude: Lat. 30°03'30"N: Long. 97°55'15"
  - 1140 feet deep into Middle Trinity Aquifer, Cow Creek Formation (bottom 75 feet open hole)
  - Well rated for 150 gpm
  - State of Texas Well Report Tracking No. 217472
  - TCEQ Completion Data approval February 15, 2011 (Plan Review Log No. P-02092011-026)
  
- Technical drawings and pictures to describe as-built piping, controls, and valving to deliver up to 100 gpm of water from well #4 to inject into Well #5 (wells are 125 feet apart and located at Water Plant No. 2 (TP19607)
  
- ASR study including testing data for volume stored and volume pumped for four phase testing;
  
- Chemical analysis results from LCRA Environmental Laboratory Services dated July 23, 2019 (sample results are enclosed):

Primary Contaminants		Results		
Contaminant	MCL (mg/L)	Well No. 4 (Edwards/injection)	Well No. 5 (ASR Recovery)	Blended (EP 002)
Arsenic	0.01	<0.001	0.00515	0.00278
Fluoride	4.0	0.256	0.684	0.481
Nitrate	10 (as N)	0.518	<0.01	0.253
Nitrite	1 (as N)	<0.01	<0.01	<0.01

Secondary Contaminants		Results		
Contaminant	SCL (mg/L)	Well No. 4 (Edwards/injection)	Well No. 5 (ASR Recovery)	Blended (EP 002)
Aluminum	0.2	<0.005	<0.005	0.00517
Chloride	300	12.8	13.6	15.6
Copper	1.0	0.00387	0.00145	0.00481
Fluoride	2.0	0.256	0.684	0.481
Iron	0.3	<0.05	1.59	0.482
Manganese	0.05	<0.001	0.0578	0.0264
pH	≥7 (Standard Unit)	7.6	7.52	7.56
Sulfate	300	36	206	118
Total Dissolved Solids	1,000	298	557	378
Zinc	5.0	0.00864	0.00823	0.0146

ASR Recovery Corrosive Water Parameters	
Parameter	Result (mg/L)
Alkalinity as CaCO <sub>3</sub>	285
Calcium as CaCO <sub>3</sub>	267
Sodium	11
Lead	<0.001

This approval is for the above listed items only. Any wastewater components contained in this design were not considered.

The Ruby Ranch WSC public water system provides water treatment.

The project is located at the end of Ruby Ranch Road, 250 feet south of the intersection of Ruby Ranch Road and Bartlett Drive West in Hays County, Texas.

Texas Water Code Section 36.0015 allows for the creation of groundwater conservation districts (GCDs) as the preferred method of groundwater management. GCDs manage groundwater in many counties and are authorized to regulate production and spacing of water wells. **Public water systems drilling wells within an existing GCD are responsible for meeting the GCD's requirements.** The authorization provided in this letter does not affect GCD authority to manage groundwater or issue permits.

Please refer to the Plan Review Team's Log No. **P-10112019-061** in all correspondence for this project.

Please complete a copy of the most current Public Water System Plan Review Submittal form for any future submittals to TCEQ. Every blank on the form must be completed to minimize any delays in the review of your project. The document is available on TCEQ's website at the address shown below. You can also download the most current plan submittal checklists and forms from the same address.

<https://www.tceq.texas.gov/drinkingwater/udpubs.html>

For future reference, you can review part of the Plan Review Team's database to see if we have received your project. This is available on TCEQ's website at the following address:

<https://www.tceq.texas.gov/drinkingwater/planrev.html/#status>

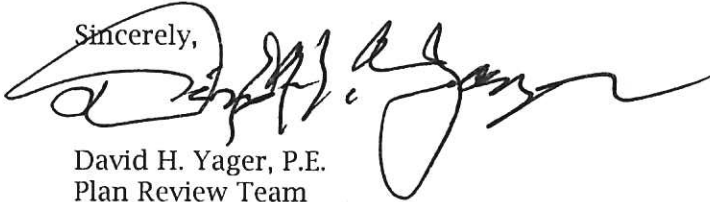
You can download the latest revision of 30 TAC Chapter 290 - Rules and Regulations for Public Water Systems from this site.

Mr. Donald G. Rauschuber, P.E.  
Page 5  
December 11, 2019

If you have any questions concerning this letter or need further assistance, please contact David Yager at 512-239-0605 or by email at david.yager@tceq.texas.gov or by correspondence at the following address:

Plan Review Team, MC-159  
Texas Commission on Environmental Quality  
P.O. Box 13087  
Austin, Texas 78711-3087

Sincerely,



David H. Yager, P.E.  
Plan Review Team  
Plan and Technical Review Section  
Water Supply Division  
Texas Commission on Environmental Quality



Vera Poe, P.E., Team Leader  
Plan Review Team  
Plan and Technical Review Section  
Water Supply Division  
Texas Commission on Environmental Quality

VP/DY/sg

Enclosure: Sample Results  
TCEQ UIC Letter of December 3, 2019

cc: Ruby Ranch WSC, Attn: Steve Selger, PO Box 1585, Buda, Texas 78610-1585



Appendix H  
TCEQ Underground Injection Control Authorization Letter

Jon Niermann, *Chairman*  
Emily Lindley, *Commissioner*  
Bobby Janecka, *Commissioner*  
Toby Baker, *Executive Director*



## TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

*Protecting Texas by Reducing and Preventing Pollution*

February 18, 2020

Mr. Steve Selger, President  
Ruby Ranch Water Supply Corporation  
P.O. Box 1585  
Buda, Texas 78610

RE: Authorization of a Class V Aquifer Storage and Recovery Injection Well  
TCEQ Authorization No. 5R2100053  
CN603033564/RN102681285  
Ruby Ranch Water Supply Corporation  
Plant No. 2  
2053 Ruby Ranch Road  
Buda, Texas 78610

Dear Mr. Selger:

The Texas Commission on Environmental Quality (TCEQ) Underground Injection Control (UIC) Permits Section staff has completed review of the authorization application dated November 13, 2019, prepared by David Jeffery and Donald Rauschuber for the above referenced Class V Aquifer Storage and Recovery (ASR) authorization.

Approval is hereby given for the operation of existing Water Well No. 5 for the injection of untreated groundwater from the Edwards Aquifer from Water Well No 4 into the Cow Creek Formation. The ASR operator may recover up to 82% of the total volume of water injected into the Cow Creek Formation during the six-month injection cycle. If the total volume of injected water recovered exceeds this quantity, the requirements of Texas Water Code (TWC) Chapter 36, Subchapter N will be applicable. The approved authorization is limited to the plans and specifications for this site as described by the Class V ASR authorization application dated November 13, 2019, as revised on November 22, 2019, December 23, 2019, January 7, 2020, and as revised in response to the February 11, 2020 clarification letter from Donald G. Rauschuber to TCEQ (Provision 6 of this authorization).

In order to maintain authorization by rule, injection operations must meet all requirements of 30 Texas Administrative Code (30 TAC) Chapter 331 (Underground Injection Control) as well as all applicable requirements of TWC, Chapter 27 and 30 TAC Chapters 290, 295, and 297. The express incorporation of the above rules as terms and conditions of this authorization does not relieve the authorization holder of an obligation to comply with all other laws or regulations that are applicable to the activities approved by this authorization. Requirements for the authorization include:

1. All injection wells are to be constructed to meet the standards provided in 30 TAC §331.132 or as approved otherwise. Mechanical integrity of the well(s) shall be maintained.
2. Ruby Ranch Water Supply Corporation (RRWSC) is authorized to inject up to 15 million gallons of groundwater from the Edwards Aquifer into the Cow Creek Formation and recover up to 12,300,000 gallons of the injected over a one-year period. Any volume of water recovered in excess of 12,300,000 gallons is subject to the requirements of TWC Chapter 36, Subchapter N.
3. Each calendar month, the executive director shall be provided either a written or electronic report containing the following information for the previous month:
  - the volume of water injected for storage;
  - the volume of water recovered for beneficial use; and
  - monthly average injection pressures.

One original and one copy of the report shall be submitted to the UIC Permits Section, Radioactive Materials Division, at mail code MC233.

4. Annual water quality testing shall be performed on water that is to be injected into the ASR system and on water that is recovered from the ASR system. The executive director shall be provided with either a written or electronic report of the results of the testing which shall include all parameters identified in the application. One original and one copy of the report shall be submitted to the UIC Permits Section, Radioactive Materials Division, at mail code MC233.
5. To meet the requirements for groundwater monitoring in 30 TAC §331.19(c)(5)(A)(ii), Ruby Ranch WSC shall coordinate with the Barton Springs Edwards Aquifer Conservation District (BSEACD) to obtain BSEACD's groundwater monitoring data for BSEACD's monitor well number 58-57-513. The groundwater monitoring protocols are detailed in the February 5, 2020 letter from BSEACD to TCEQ (attached). All results from the monitoring of this well shall be reported to the UIC Permits Section, Radioactive Materials Division, at mail code MC233.
6. Water quality testing for arsenic shall be performed on water that is to be injected into the ASR system and on water that is recovered from the ASR system as follows:

**Water Supply Well No. 4**

At the conclusion of each three-month injection cycle or at the conclusion of any injection cycle that is less than three months in duration, RRWSC shall collect one (1) water sample at the wellhead. This sample shall be tested for arsenic.

**ASR Well No. 5**

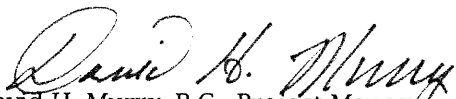
At the conclusion of each three-month recovery cycle or at the conclusion of any recovery cycle that is less than three months in duration, RRWSC shall collect one (1) water sample at the wellhead. This sample shall be tested for arsenic.

The executive director shall be provided with either a written or electronic report of the results of the testing for arsenic within 30 days of sample collection. The report shall be submitted to the UIC Permits Section, Radioactive Materials Division, at mail code MC233.

7. Changes to the authorization, including but not limited to the addition of wells, replacement of wells, different injectate, operational and status changes, require an amendment to the authorization. One original and one copy of an amendment request shall be submitted to the UIC Permits Section, Radioactive Materials Division, at mail code MC233 for approval prior to implementation of the changes.
8. Plugging of injection wells shall comply with standards provided in 30 TAC §331.133, Closure Standards for Injection Wells. One original and one copy of plugging reports shall be submitted to the UIC Permits Section, Radioactive Materials Division, at mail code MC233 upon completion of plugging of the wells or may be submitted with the subsequent status report.
9. When authorized injection activities have ceased, the injection well is either plugged or converted to a water supply well or a monitoring well, and no further injection activities will be conducted at the site, the Class V authorization should be terminated. One original and one copy of a request for termination shall be submitted to the UIC Permits Section, Radioactive Materials Division, at mail code MC233. If plugging reports for the injection well have not been previously submitted to the UIC Permits Section, the termination request must include the plugging information.
10. This Class V ASR authorization does not convey any property rights of any sort, nor any exclusive privilege, and does not become a vested right in the permittee.
11. The issuance of this Class V ASR authorization does not authorize any injury to persons or property or any invasion of other property rights, or any infringement of state or local laws or regulations.

If you have any questions or comments regarding this matter please contact me at [david.murry@tceq.texas.gov](mailto:david.murry@tceq.texas.gov) or (512) 239-6080. If you will be responding by letter, please include mail code MC233 in the mailing address.

Sincerely,



David H. Murry, P.G., Project Manager  
Underground Injection Control Permits Section  
Radioactive Materials Division  
Texas Commission on Environmental Quality

DHM/krh-d

Attachment

cc: David Jeffery  
Donald Rauschuber  
Joel Klumpp, TCEQ Water Supply Division



**Barton Springs  
Edwards Aquifer**  
CONSERVATION DISTRICT

Ruby Ranch Water Supply Corporation  
Class V Authorization No. 5R2100053  
Attachment 1

RECEIVED

FEB 6 2020

RADIOACTIVE MATERIALS  
DIVISION

February 5, 2020

Ms. Lorrie Council  
TCEQ  
Mail Code 233  
PO Box 13087  
Austin, Texas 78711-3087

Dear Ms. Council,

The District considers the Ruby Ranch multiport monitor well to be a monitor well for the purposes of monitoring aquifer conditions in the vicinity of the Ruby Ranch ASR system. The District installed this well in 2008 and it consists of 14 zones from which we can measure distinct water levels, water quality, and hydraulic conductivity in each zone (Wong et al., 2014).

Two of those zones are completed in the Cow Creek limestone, which is the injection zone for the Ruby Ranch ASR system. The multiport monitor well (state well number 58-57-513) is about 0.9 miles northwest of the Ruby Ranch ASR well. During testing of the Ruby Ranch Trinity Aquifer well (state well number 58-57-515) in February 2010, the District monitored water levels in the Cow Creek zone of the multiport well. Decreases in water levels of about 3 ft due to pumping of the Ruby Ranch ASR well were recorded at that time, establishing a clear hydrologic connection between the two wells.

Currently, the District monitors water levels in the Cow Creek zone on a continuous basis with a pressure transducer and the data are collected from all zones quarterly from the well. Water-quality samples are collected periodically from the well (see link below). For purposes of monitoring aquifer conditions related to operation of the Ruby Ranch ASR system, the District will continue to collect water-level data and once a year will collect a sample from one of the zones in the Cow Creek limestone which will be analyzed for conductivity and total dissolved solids (TDS). At the time of final permitting of the Ruby Ranch ASR system, a sample will be analyzed for a traditional suite of anions and cations. This analysis will be repeated every five years. Results of the monitoring will be shared with the operators of the Ruby Ranch ASR system annually.

Chemistry data are available at:

<https://www3.twdb.texas.gov/apps/waterdatainteractive//GetReports.aspx?Num=5857513&Type=GWDB>

Wong et al., 2014:

<https://www.researchgate.net/publication/256608062> Investigating Groundwater Flow Between Edwards and Trinity Aquifers in Central Texas

Sincerely,

Brian A. Smith, Ph.D., P.G.