EAHCP
EDWARDS AQUIFER
HABITAT CONSERVATION PLAN

2024 EAHCP Annual Expanded Water Quality Report

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1 | Introduction

The Edwards Aquifer Habitat Conservation Plan (EAHCP) Expanded Water Quality Monitoring Program was developed to monitor surface water and groundwater quality of the San Marcos and Comal spring systems and act as an early detection mechanism for water impairments that may negatively affect EAHCP Covered Species. From 2013 – 2016, the Expanded Water Quality Program deployed a broad range of sampling activities including surface water (base flow) sampling, groundwater sampling, sediment sampling, real-time water quality monitoring, and stormwater sampling. A Work Group was assembled in 2016 and charged to review the expanded water quality monitoring program and evaluate the recommendations from the National Academies of Sciences review of the EAHCP. The Work Group prepared a final report that included adjustments to the program including the incorporation of fish tissue analysis, reduced sampling frequency of sediment and stormwater sampling, removal of surface water and groundwater sampling, and the addition of one real-time water quality monitoring station per system. More information can be found in the *Report of the 2016 Expanded Water Quality Monitoring Program Work Group*. During the transition from Phase I to Phase II of the EAHCP, a second review of the program was conducted in 2020 that analyzed the results of contaminant detections among stormwater, sediment, and passive diffusion sampling activities and evaluated the parameters monitored in the real-time water quality network. Overall, the number of contaminant detections was low among sampling events 2013-2020. This is in part due to the focus on industrial and commercial contaminants that may not pose substantial risks to the Edwards Aquifer spring communities. Therefore, suggestions from the EAHCP Science Committee were implemented in 2021 that shifted sampling to focus on nutrients and pharmaceutical and personal care products (PPCPs). Additionally, sampling for sucralose, an artificial sweetener, was initiated in 2021 as measure of human and wastewater influence on the San Marcos and Comal spring systems. The current sampling type and activities can be viewed in Table 1-1. Sampling location and activity are displayed in Figure 1-1 for the San Marcos system and Figure 1-2 for the Comal system.

Table 1-1. EAHCP Expanded Water Quality Monitoring Program Sampling Activities

Sample Type	Activities and Sampling Locations
Real-Time Network	Continuous 15-minute interval, telemetered measurements Analytes include temperature, dissolved oxygen, and conductivity Locations include 3 San Marcos and 3 Comal stations
Surface water	Twice annual sampling in conjunction with Biological Monitoring activities Laboratory analyses are focused on nutrients including total phosphorus, orthophosphate, orthophosphate as P, TOC, DOC, DIC, kjeldahl nitrogen, nitrate at N, and ammonia Locations include upper and lower stations at each spring system
Groundwater	Twice annual sampling in conjunction with EAA springs sampling activities Laboratory analyses are focused on geochemical analytes and industrial, commercial, and emerging contaminants. The analytes include cations, anions, nutrients, metals, VOCs, SVOCs, herbicides, pesticides, bacteria, TOC, PCBs, and PPCPs Locations include Spring 1, Spring 3, and Spring 7 (Comal), Hotel, and Deep (San Marcos)
Sediment	Every other year sampling in even numbered years Laboratory analyses are focused on PAHs Locations include 6 San Marcos and 5 Comal stations
Fish Tissue	Every other year sampling in odd numbered years Laboratory analyses are focused on metals and PPCPs in two fish species Locations include upper and lower stations at each spring system

1.1 Real-Time Network

Real-time water quality (RTWQ) instruments have been deployed within the San Marcos and Comal systems for the entirety of the water quality monitoring program. From 2013-2020, real-time instruments consisted of Eureka Manta+ 30s containing five water quality sensors including, dissolved oxygen (mg/l), specific conductivity (µs/cm), turbidity (NTU), water temperature (°C), and pH (SU). Turbidity sensors were discontinued in 2020, excluding Sessom Creek, due to the high rate of malfunction and cost of replacement. In 2021, pH sensors were also discontinued due to the sensor variability being greater than environmental variability. In 2021, Eureka Manta+30s were replaced with InSitu AT 600 real-time instruments. Measurements are recorded every 15 minutes (excluding the Sessom Creek site that is measured every five minutes) and subjected to quality control measures prior to storage in EAHCP and EAA databases. Table 1-2 describes the stations within each river system including station ID, location from headwaters (i.e., Spring Lake Hotel at San Marcos and Headwaters of Landa Lake at Comal River), and period of data record.

Presently, three RTWQ sites are located in the San Marcos system, including Aquarena Springs Drive (ASD), Texas Parks and Wildlife Department (TPWD) hatchery, and Sessom Creek (Figure 1-1). ASD was deployed and brought online by late May 2013, the TPWD hatchery site was installed in January 2016, and the Sessom Creek station began collecting data in January 2018.

Three RTWQ sites are located in the Comal system, including two locations in Landa Lake (i.e., Spring run 3 (SR 3), and Spring run 7 (SR 7)), and one site in the Old Channel (OC, Figure 1-2). Spring run 3 and SR 7 were installed in 2013 whereas the OC station was installed in April 2018.

Table 1-2. EAA real-time water quality station ID, location, and period of record for the San Marcos and Comal spring systems.

River system	Station ID	Location (river km from headwaters)	Period of record
San Marcos	Sessom Creek	0.5 rkm from SMR confluence	1/1/2018 - present
	Aquarena Springs	0.8	5/30/2013 - present
	Rio Vista	1.9	5/30/2013 – 12/31/2020
	TPWD hatchery	4	1/8/2016 - present
Comal	Upper Spring Run	0.1	4/1/2019 – 12/31/2020
	Spring Run 7	1.0	9/10/2013 - present
	Spring Run 3	1.2	4/11/2013 - present
	Landa Lake	1.2	6/10/2013 – 3/31/2018
	Old Channel	1.5	4/20/2018 - present
	New Channel	2.7	5/30/2013 – 12/31/2020

Real-time water quality stations assist in discerning when and what river conditions result in water quality exceeding critical biological standards. One of EAHCP's long-term management objectives is to maintain water quality conditions that do not deviate > 10% from historical water quality conditions recorded during the EAA Variable Flow Study. Additionally, specific EAHCP water quality thresholds include, maintaining water temperature < 25°C as to not inhibit fountain darter reproduction and recruitment rates (McDonald et al. 2007) and maintaining dissolved oxygen concentrations > 4.0 mg/L throughout fountain darter habitat. EAHCP's RTWQ stations are designed to track water quality conditions within the San Marcos and Comal systems to monitor whether river conditions remain within historic conditions and under specific thresholds.

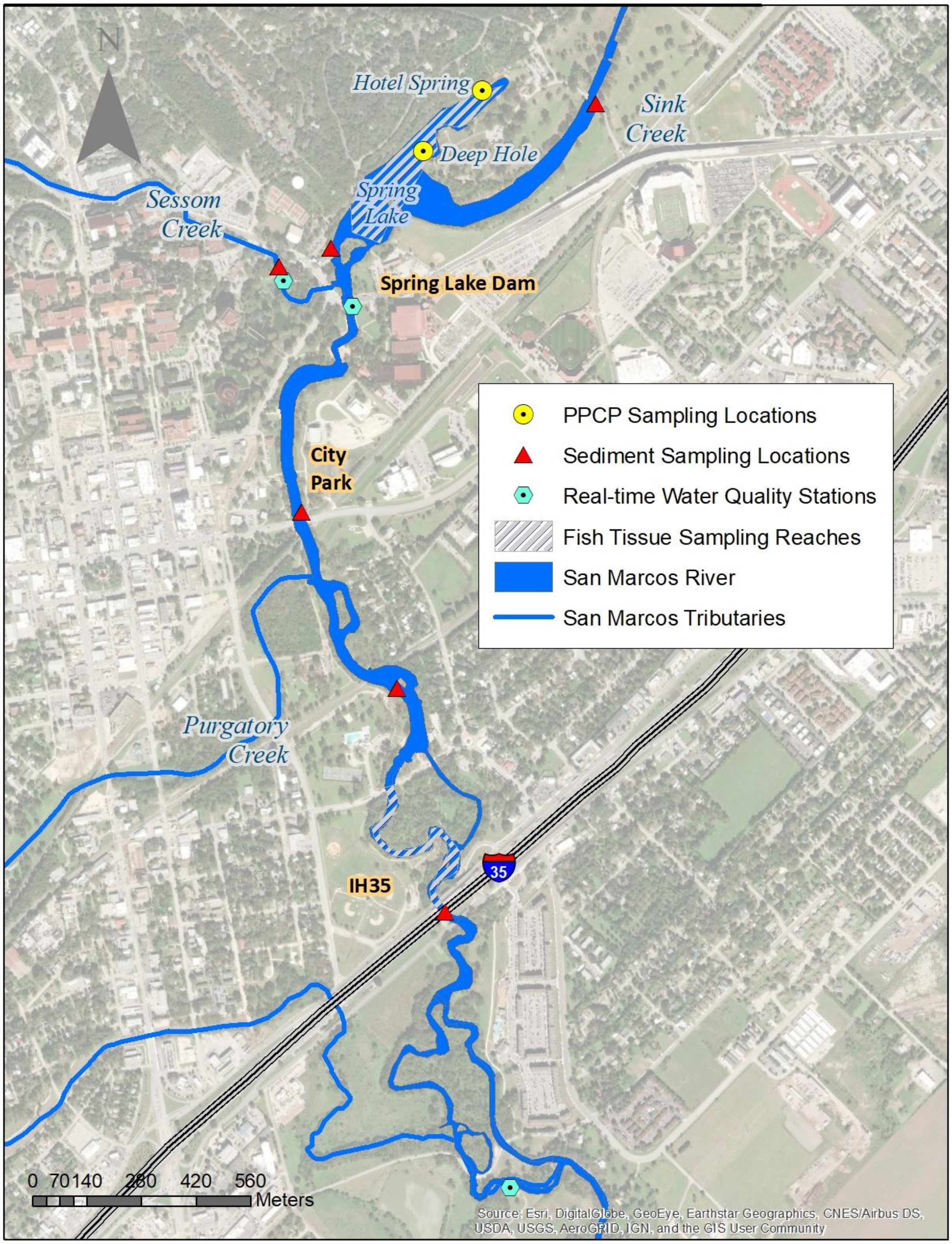

Figure 1-1. Expanded Water Quality Sampling Locations in the San Marcos system.

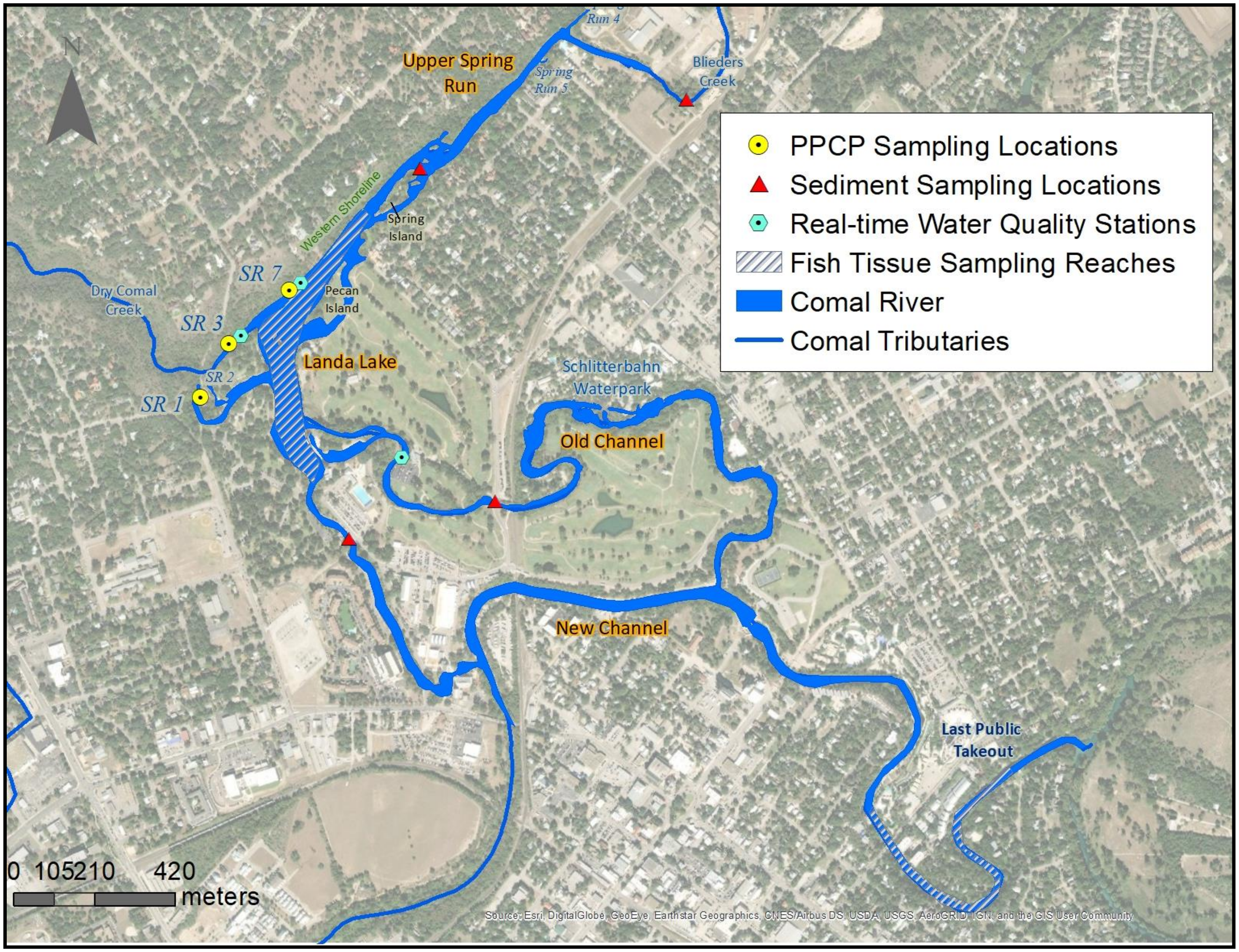

Figure 1-2. Expanded Water Quality Sampling Locations in the Comal system.

1.2 Surface water sampling

Monthly sucralose sampling occurs at one location in each spring system (i.e., Hotel Spring in San Marcos and Spring Run 3 in Comal). Sucralose, an artificial sweetener found in many diet beverages and candies, is not efficiently processed by the body, and subsequently ends up in septic and city wastewater effluent (Whitall et al. 2021). Sucralose has shown minimal degradation when processed through wastewater facilities, is relatively stable in the environment, and has demonstrated reliable detection rates (Oppenheimer et al. 2011). Therefore, monitoring the occurrence and levels of sucralose systems has proven to be a suitable indicator of wastewater input among rivers and groundwater systems.

Additional surface water samples are collected on a biannual basis under normal flow conditions in conjunction with the Biological Monitoring program (Spring and Fall). Sampling locations consist of upper and lower river stations in both systems. For the Comal system, Landa Lake near Spring Island serves as the upper location, and the lower station is located at the last public river take out just upstream of the confluence with the Guadalupe River. In San Marcos, Hotel Spring in Spring Lake serves as the upper location, and the downstream location is located at the most downstream real-time water quality monitoring station (i.e., TPWD hatchery). Samples are submitted to a laboratory for analysis of nutrients (Table 1-3). During the collection event, field parameters are collected that include dissolved oxygen, pH, conductivity, and temperature.

Table 1-3. List of Nutrients Analyzed during Surface Water Sampling

Analyte
Ortho-phosphate as P
Phosphorus (total)
Dissolved Inorganic Carbon (DIC)
Dissolved Organic Carbon (DOC)
Kjeldahl Nitrogen
Nitrate as N
Ammonia

1.3 Groundwater sampling

Groundwater sampling is conducted by the EAA Aquifer Science Division and is part of their routine water quality monitoring of streams, wells, and springs in the Edwards Aquifer Region (Edwards Aquifer Water Quality Summary 2024 Report). Two spring orifices in the San Marcos system (i.e., Hotel Spring and Deep Hole) and three springs within the Comal system (ie., Spring Run 1, Spring Run 3, and Spring Run 7) are sampled on a biannual basis in conjunction with the EAHCP Biological Monitoring program (i.e, Spring and Fall). Beginning in 2022, PPCP samples were also collected every other month at Hotel Spring and Spring Run 3 locations. Groundwater samples are submitted to a laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and PPCPs. The analyte list for laboratory analyses along with the methods are shown in Table 1-4. During the collection event, field parameters will be collected that include dissolved oxygen, pH, conductivity, temperature, and alkalinity.

Table 1-4. List of Items Analyzed during Groundwater Sampling

Analyte
Volatile Organic Compounds (VOCs)
Semi-volatile Organic Compounds (SVOCs)
Organochlorine Pesticides
Polychlorinated Biphenyls (PCBs)
Organophosphorous Pesticides
Herbicides
Metals (Al, Sb, As, Ba, Be, B, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, V, and Zn)
General Chemistry (GWQP) Total Alkalinity (as CaCO3), Bicarbonate Alkalinity (as CaCO3), Carbonate Alkalinity (as CaCO3); (Cl, Br, NO_3, SO_4, Fl, pH, TDS, TSS, Ca, Mg, Na, K, Si, Sr, CO_3,)), and Total Suspended Solids (TSS).
Phosphorus (total)
Total Organic Carbon (TOC),
Dissolved Organic Carbon (DOC)
Kjeldahl Nitrogen
Bacteria Testing (*E coli*)
PPCPs

Method	**Method Description**	**Protocol**
8260B	Volatile Organic Compounds	(GC/MS) SW846
8270C	Semivolatile Organic Compounds	(GC/MS) SW846
8081B	Organochlorine Pesticides	(GC) SW846
8082A	Polychlorinated Biphenyls (PCBs)	by Gas Chromatography SW846
8141A	Organophosphorous Pesticides	(GC) SW846
8151A	Herbicides	(GC) SW846
6010B	Metals	(ICP) SW846
6020	Metals	(ICP/MS) SW846
7470A	Mercury	(CVAA) SW846
300.0	Anions,	Ion Chromatography
340.2	Fluoride	MCAWW
365.4	Phosphorus,	Total EPA
9040C	pH	SW846
9060	Organic Carbon,	Total (TOC) SW846
SM 2320B	Alkalinity	SM
SM 2540C	Solids,	Total Dissolved (TDS) SM
SM 2540D	Solids, Total Suspended (TSS)	SM
351.2	Nitrogen, Total Kjeldahl	MCAWW
1694	PPCPs	LC-MS/MS

Protocol References:
EPA = US Environmental Protection Agency
MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.
SM = "Standard Methods For The Examination Of Water And Wastewater",
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

1.4 Sediment and Fish Tissue sampling

Sediment and fish tissue sampling occurs on an every other year basis with sediment sampling completed in even years and fish tissue sampling in odd years. Sampling collections for sediment and fish tissue occur in the Spring during the EAHCP Biological Monitoring surveys.

Collection of sediment samples within in each spring system was included in the program to help determine potential effects on EAHCP covered species via direct or indirect exposure to sediment contaminants. Sediment samples are collected once from four locations within the Comal system and six locations in San Marcos system (Figures 1-1 and 1-2). Samples were collected at each sample site and composited into one sample for analysis. Sediment samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) and other contaminants listed in Table 1-5.

Table 1-5. List of Contaminants Analyzed during Sediment Sampling.

Analyte
Benzo[a]anthracene
Chrysene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Fluoranthene
Dibenz(a,h)anthracene
Indeno[1,2,3-cd]pyrene
Pyrene
Phenanthrene
Fluorene
Benzo[g,h,i]perylene
Anthracene
Acenaphthene
Acenaphthylene
Benzo[g,h,i]perylene
Carbazole
2-Methylnaphthalene
Naphthalene
Total Organic Carbon (TOC)

Fish tissue sampling within in each spring system was included to the program in 2017 to serve as a direct link between water quality impairments and their potential effects on EAHCP covered species. Prior to 2017, the linkage between contaminants and metals found in the spring systems and their accumulation in EAHCP covered species was unknown. Surrogate species were selected to represent EAHCP covered species and the two species selected for analysis are *Gambusia* (mosquito fish) and *Micropterus salmoides* (largemouth bass). The mosquito fish serves as a short-lived species, similar to the EAHCP covered fountain darter, whereas the largemouth bass represents the longer-lived species. Mosquito fish and largemouth bass were collected from upper and lower sections in both spring systems. In the San Marcos, fish were collected in Spring Lake (i.e., upper section) and in the San Marcos River near IH35 (i.e., lower section). For the Comal, both species were collected from Landa Lake (i.e., upper section) and in the Comal River near the last public take out (i.e., lower section). For each section, whole body organisms were combined to create a mosquito fish composite sample. Composites for largemouth bass were created from individual fillet aliquots from each fish. Tissue samples were submitted to a laboratory and analyzed for metals and PPCP contaminants listed in Table 1-6.

Table 1-6. List of Metals and Contaminants Analyzed among Fish Tissue Samples.

Analyte
Metals (Al, Sb, As, Ba, Be, B, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, V, and Zn)
PPCPs

Method	**Method Description**	**Protocol**
6010B	Metals	(ICP) SW846
6020	Metals	(ICP/MS) SW846
7470A	Mercury	(CVAA) SW846
1694	PPCPs	LC-MS/MS

Protocol References:
EPA = US Environmental Protection Agency
MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.
SM = "Standard Methods For The Examination Of Water And Wastewater",
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates

2 | Methods

2.1 Real-Time Network

The near continuous (15-minute interval) raw data collected at San Marcos River and Comal system RTWQ sites underwent a quality assurance review process before being utilized for this assessment. Water quality sonde data was overlayed with river streamflow and precipitation data to verify significant increases and decreases in measured values. The data from each site within the basins were also compared to ensure validity. The multiparameter water quality instruments were switched out at 5 to 6-week intervals, with the unit returned to the EAA office for data download, calibration checks, and cleaning. Data obtained from independent field visit measurements and post-deployment sensor calibration checks were used to determine any necessary adjustments to the near continuous raw data sets. Additional quality control was completed to the data in the Power BI Pro License software.

Turbidity data recorded at Sessom Creek were edited for any values in the continuous raw data interpreted as not being representative of actual ambient water quality conditions. Sporadic spikes in turbidity values without any corresponding change in other parameters (i.e. Specific Conductance, Temperature, or Dissolved Oxygen) were deleted from the finalized continuous data sets before their use in this assessment.

Mean daily, maximum daily, and minimum daily values for water quality parameters at each of the San Marcos River and Comal system RTWQ sites were exported from AQUARIUS database. Hydrographs since the start of the EAHCP (2013) for the two systems were constructed using surface water discharge data (recorded in 15-minute intervals) obtained for the San Marcos River at San Marcos (USGS Station 08170500) and the Comal River at New Braunfels (USGS Station 0816900). Mean daily springflow (cfs) for the San Marcos springs (USGS Station 08178710) and the Comal springs (USGS Station 0816900) were used to construct springflow hydrographs for 2013-2021. Differences in maximum daily temperatures and minimum daily dissolved oxygen among sites and seasons were assessed using boxplots. Seasons were defined as: Winter (January, February, December), Spring (March – May), Summer (June – August), and Fall (September – November). For sites exceeding water temperatures > 25°C, 15-minute interval data (5-minute interval data for Sessom Creek) were used to assess the number of days and percent of day a site exceeded 25°C. Similar analysis was completed for sites that dropped below the 4.0 mg/L dissolved oxygen threshold.

2.2 Surface water sampling

Water samples for sucralose were collected from Hotel Spring in the San Marcos system and Spring run 3 in the Comal system monthly January – December 2024. Prior to water sample collection, an Insitu AquaTroll 600 water quality sonde was placed directly in each location to measure water quality parameters (i.e., pH, specific conductivity, dissolved oxygen, and temperature) for a ten-minute period. Sample bottles were submerged directly into the springs to be filled. Field duplicates and field blanks (i.e., bottles filled with DI water) were also filled following sampling protocols. All sample bottles were kept chilled during transport in an ice chest frozen until later shipment to the laboratory that occurred on a quarterly basis.

Surface water samples for nutrient analysis were collected in April and September 2024 at upper and lower sites in the San Marcos and Comal systems. During sampling collections, water quality parameters were measured following same protocols as monthly sucralose sampling. Filtration for methods 6010B (metals), 6020 (metals), and 7470A (mercury) were performed at the sample locations by using a 0.45 micron high capacity cartridge filter inserted into syringe. Preservatives were placed in the bottles (as appropriate) by the contracted laboratory. Field duplicates and field blanks were also filled following sampling protocols. All sample bottles were kept chilled during transport in an ice chest frozen and immediately shipped to the contract laboratory for analysis.

All water quality data were exported to excel and medians values were calculated for field measured water quality parameters collected during sucralose and bi-annual surface water sampling collections.

2.3 Groundwater sampling

Groundwater samples for PPCPs and other analyses were collected from Hotel and Deep Hole springs in the San Marcos system and from Spring Run 1, 3, and 7 within the Comal Spring system in March and September 2024. Additional PPCP samples were also collected every other month (i.e., January, May, July, and November) at Hotel and Spring Run 3 locations. Prior to groundwater collections, an Insitu AquaTroll 600 water quality sonde was placed directly into the spring orifice to measure water quality parameters (i.e., pH, specific conductivity, dissolved oxygen, turbidity, and temperature). Sample bottles were then submerged directly into the spring to obtain samples, except for Deep Hole Spring where EAA staff utilized a peristaltic pump with 30 feet of sample tubing inserted into the spring orifice to collect field parameters and fill sample bottles. Samples were collected in accordance with the criteria set forth in the *EAA Groundwater Monitoring Plan*.

Filtration for methods 6010B (metals), 6020 (metals), 7470A (mercury) and field alkalinity were performed at the sample locations by utilizing a 0.45 micron high capacity cartridge filter inserted into a weighted single sample disposable bailer or sample tubing (if peristaltic pump was used).

Preservatives were placed in the bottles (as appropriate) by the contracted laboratory. Ice was placed into the cooler immediately after sampling and later shipped to the contract laboratory. When not in use or after collection, sampling equipment and/or coolers containing samples were secured inside the EAA vehicles to maintain appropriate sample custody and security.

Analyses for field alkalinity were conducted at EAA's Camden Building using Hach Titralab® AT1000. The method used for field alkalinity is discussed in detail in the *EAA Groundwater Monitoring Plan.*

A full report of groundwater sampling results at Hotel and Deep Hole springs will be available under the Science and Aquifer Protection section on the EAA website and entitled Water Quality Summary Report 2024. Sampling results for PPCPs are reported in Section 3.3.

2.4 Sediment sampling

Sediment samples were collected in August 2024 at six locations in the San Marcos system and four locations in the Comal system (Figures 1-1 and 1-2). At each location, fine sediment was targeted and collected using an aluminum scoop. Once collected, the sediment was sorted to remove as much coarse sediment and other debris as possible before being placed into a 1L glass container. Sample bottles were transported in coolers and frozen before being shipped to contract laboratory.

3 | **Results and Discussion**

3.1 Real-Time Network

3.1.1 San Marcos

Hydrology

Average springflow for the San Marcos Springs calculated from the period of record (i.e., 1956 – present) was 175 cfs. Since 2013, San Marcos springflow ranged from below average in 2013-2014 to above average from mid-2015-2017 (Figure 3-1). During 2013, the San Marcos springflow dropped down to as low as 99 cfs on May 21st. A flow pulse on October 30th, 2013, estimated at 5,400 cfs, resulted in a temporary spike in above average springflow. No substantial rain events occurred in 2014 and consequently, springflow dropped below average. Increased springflow in 2015 occurred following two large precipitation events in late May and October with above average springflow continued into 2016 - 2017. In 2018, springflows dropped below average, reaching 117 cfs in late August. However, several small rain events in the early fall resulted in springflows increasing and becoming above average (~250 cfs). Springflows were largely above average in 2019, but with a lack of large flow pulses (> 500 cfs), springflows lessened throughout the year and dropped just below average beginning in October. With no large flow pulses in 2020, springflows continued to decrease and dropped below 120 cfs by December. Springflow in early 2021 continued to decline and dropped briefly below 100 cfs in April before rain events in late spring resulted in springflow rising to average flows. Springflows dropped slightly during early fall but increased again after significant rain events (i.e., 1,070 cfs pulse on October) to end 2021 at average springflow. No significant rainfall events occurred in 2022 with springflows at critical period monitoring levels during most of the year. Springflows dropped down to ~85 cfs from the end of September-December and is the lowest discharge observed since the start of the EAHCP. Springflows remained below 100 cfs during all of 2023 (median 88 cfs), dropping in August to the lowest observed springflow (66cfs) since 1956. Springflows increased at the beginning of 2024, but steadily decreased and remained below average throughout the year, ending at ~85 cfs in December.

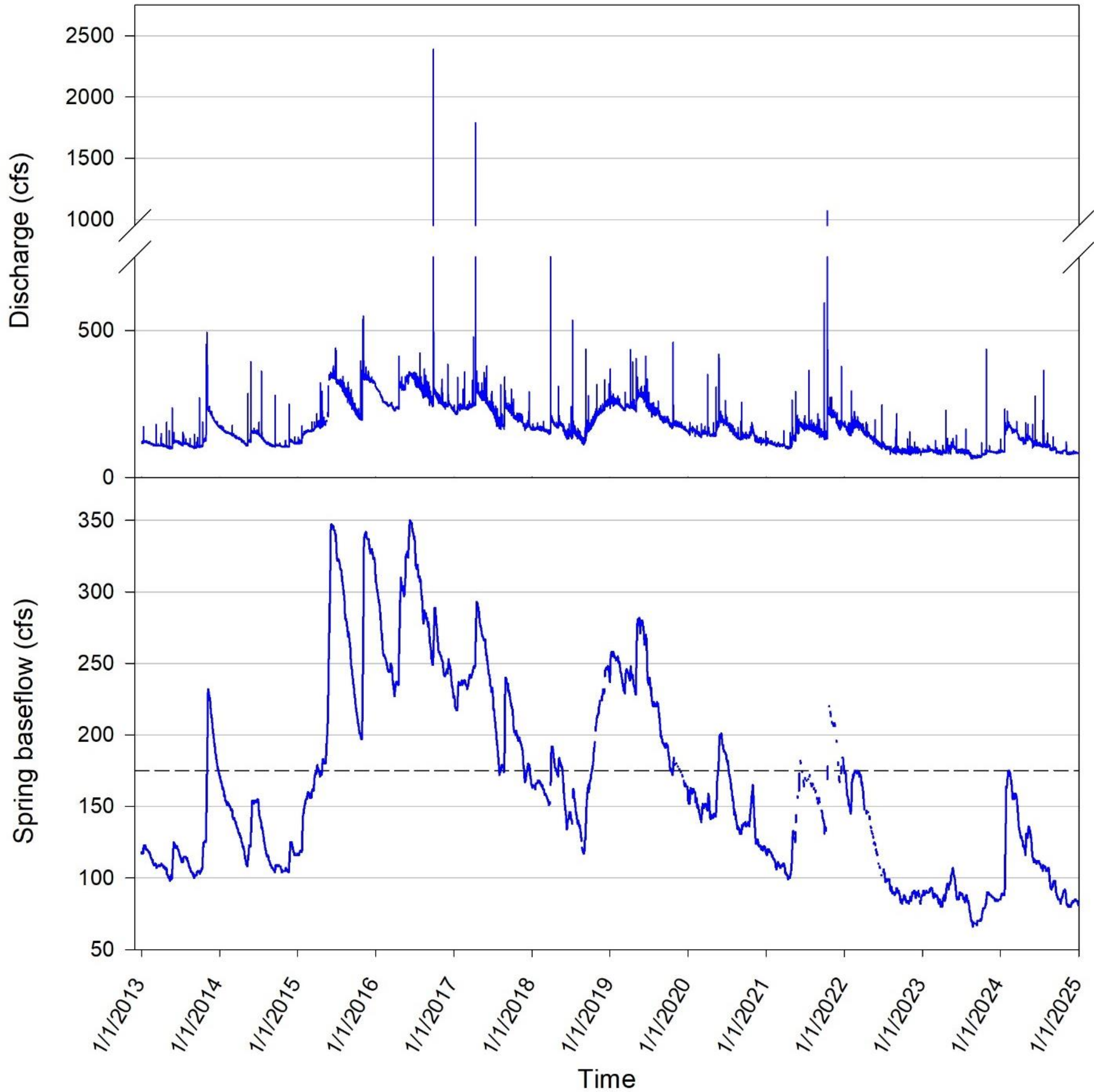

Figure 3.1-1. Hydrographs for the San Marcos River at San Marcos (USGS station 08170500) and mean daily springflow for the San Marcos springs (USGS Station 08170000) 2013 – 2024. Dashed line denotes the long-term average springflow (175 cfs) in the San Marcos River.

Temperature

Table 3.1-1 displays monthly summary statistics (i.e., monthly mean and 15 minute minimum and maximum values reported that month) for water temperatures recorded in 2024 at the San Marcos River RTWQ sites. Slightly more variation in mean water temperatures (~3-4 °C) was observed this year and is likely attributed to lower than average springflows in the system during 2024. The TPWD hatchery site continued to display greater variability in water temperature with minimum daily water temperatures reaching lower temperatures in winter months and warmer maximum daily water temperatures during summer months. Maximum daily water temperatures recorded in 2024 reached the 25°C threshold with the highest temperature (26.98°C) recorded at the TPWD hatchery in August. The lowest temperature (8.89°C) in 2024 was observed at the TPWD hatchery site in January and is associated with a rainfall event when ambient temperatures were cold.

Table 3.1-1. Monthly mean, minimum, and maximum water temperatures among San Marcos River RTWQ (2024).

	Water temperature (°C) at San Marcos Water Quality Sites					
Month (2024)	**Aquarena Springs**			**TPWD hatchery**		
	Mean	Min	Max	Mean	Min	Max
Jan	20.17	12.09	22.21	18.87	8.89	22.35
Feb	21.43	19.87	23.21	21.31	19.16	23.62
Mar	21.88	20.37	23.62	21.81	19.97	24.07
Apr	22.40	20.55	24.74	22.39	20.42	24.43
May	23.20	21.68	24.92	23.28	19.36	25.80
Jun	23.35	22.46	24.89	24.06	22.60	26.75
Jul	23.27	22.39	24.98	23.97	22.49	26.75
Aug	23.48	22.45	25.60	24.22	22.63	26.98
Sept	23.18	21.44	25.05	23.57	21.28	25.73
Oct	22.67	20.88	24.46	22.78	20.21	24.73
Nov	21.70	19.64	23.46	21.40	18.55	23.47
Dec	21.16	19.00	23.02	20.62	16.82	23.06

Box plots for maximum daily temperatures (i.e., highest 15-minute interval recorded daily) observed at San Marcos RTWQ sites from time of equipment deployment (i.e., 2013 for Aquarena Springs Drive (ASD) and 2016 for TPWD hatchery) through 2024 compared to maximum daily temperature observed in 2024 are shown in Figure 3.1-2. The median of maximum daily temperatures for 2024 were slightly higher than the median of maximum daily temperatures from time of equipment deployment at both San Marcos sites but this was not unexpected with sprinflows remaining below average for most of the year.

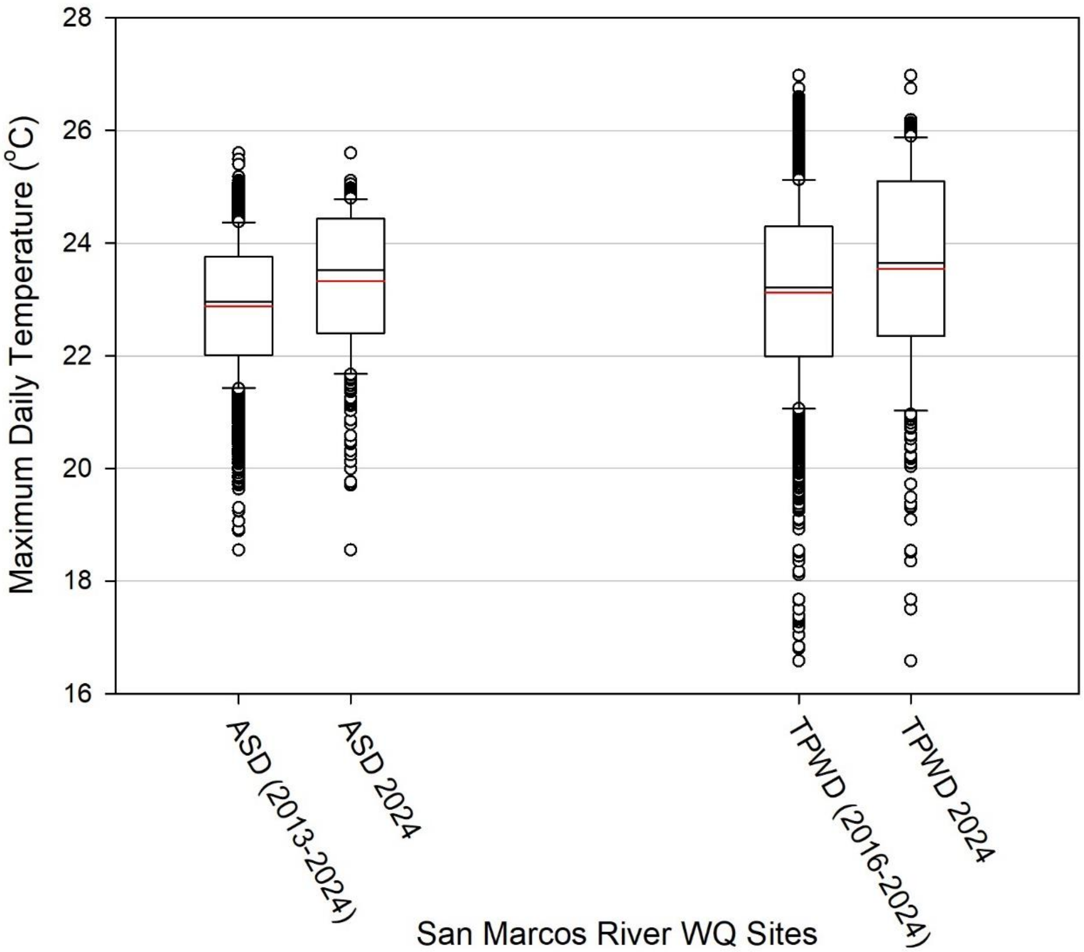

Figure 3.1-2. Box plots of maximum water daily temperatures (°C) among San Marcos River RTWQ sites from time of equipment deployment through 2024 compared to 2024 values. Black lines represent median values and red lines denote mean values. Whiskers represent maximum and minimum temperature values, excluding outliers (open circles).

Maximum daily water temperatures were plotted for San Marcos River RTWQ sites for 2024 (Figure 3.1-3). In 2024, the maximum daily water temperature reached or exceeded 25°C at both EAHCP water quality stations in the San Marcos River. At ASD, the maximum daily water temperature reached 25°C for only three days (August – September) for a period of 0.25-1.25 hours per day. At the TPWD hatchery location, the maximum daily water temperature reached or exceeded 25°C for 98 days during the months of May–September. Within those 98 days, time spent at or above 25°C ranged from 1.25 to 13.25 hours (mean = 6.27 hours; median = 6.75 hours).

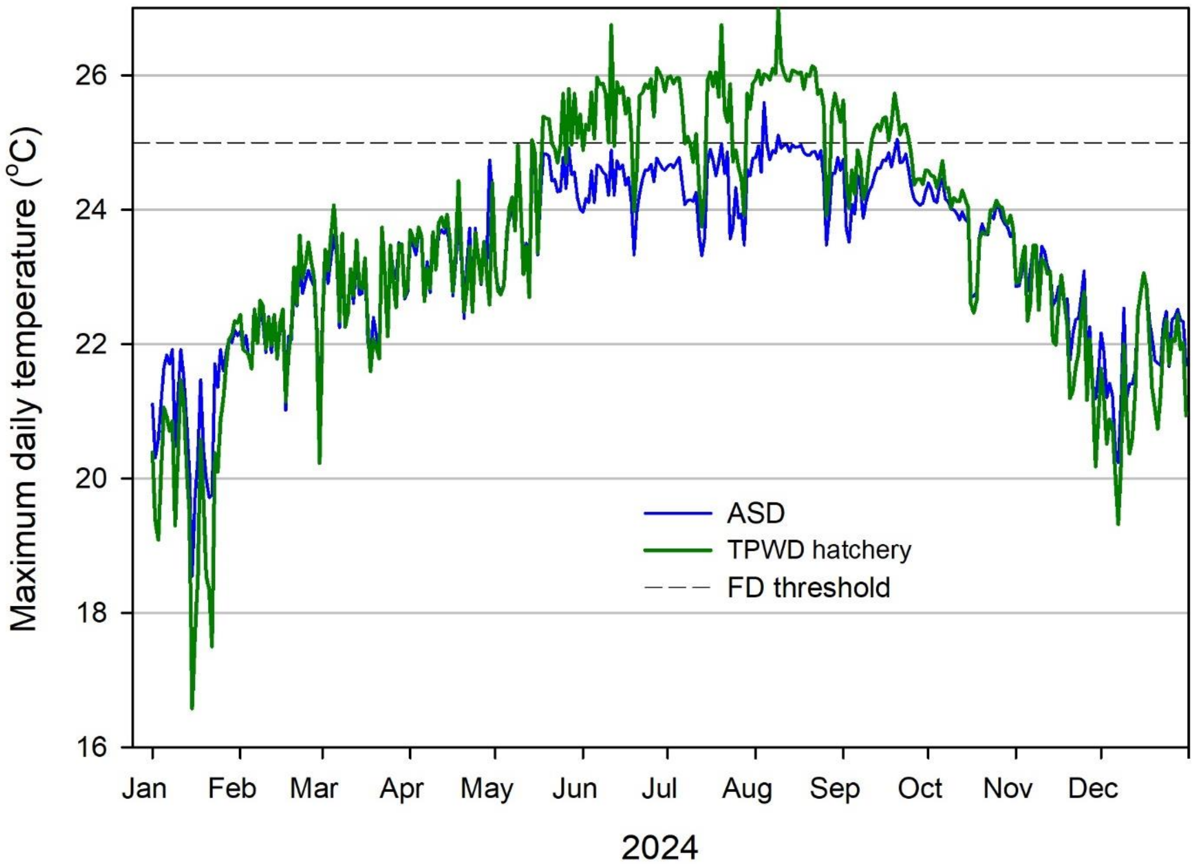

Figure 3.1-3. Maximum daily water temperatures (°C) among San Marcos River RTWQ sites (2024). Dashed line represents temperature threshold for reduced reproduction for the fountain darter (25°C).

Box plots for seasonal maximum daily water temperatures at San Marcos RTWQ sites for 2024 are shown in Figure 3.1-4. Across seasons, median maximum daily temperatures varied by ~3-4°C among San Marcos River WQ sites with some more outlier temperatures observed in winter and fall. Greater variability in temperatures across seasons corresponds with the decrease of springflow that occurred as the year progressed. Winter and Fall showed the greatest range in maximum daily temperatures for San Marcos WQ sites with summer months exhibiting less variability but higher median temperatures.

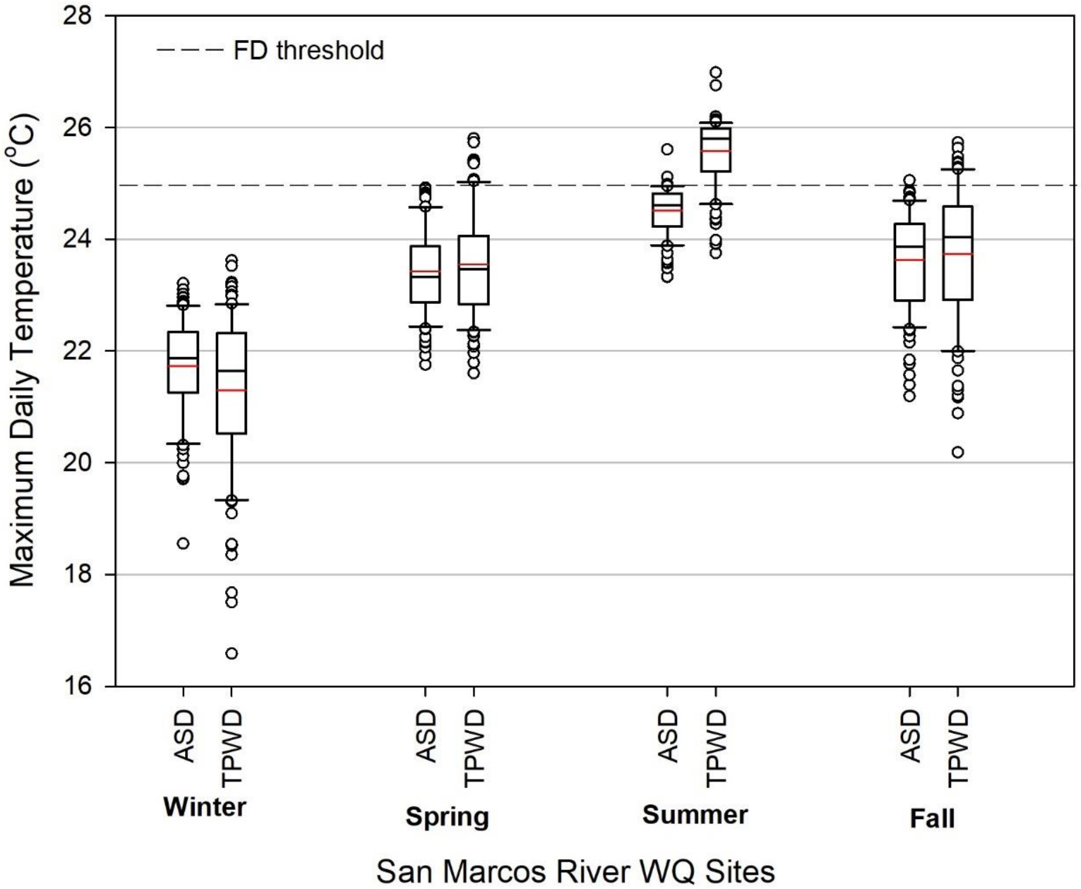

Figure 3.1-4. Box plots of maximum daily water temperatures (°C) among seasons at San Marcos River RTWQ sites in 2024. Black lines represent median values and red lines denote mean values. Whiskers represent maximum and minimum temperature values, excluding outliers (open circles).

Dissolved Oxygen

Table 3.1-2 displays monthly summary statistics for dissolved oxygen (DO) recorded in 2024 at the San Marcos River RTWQ sites. Mean monthly DO remained relatively consistent with variations averaging 1 mg/l within a site and did not vary greatly between the two sites. The TWPD hatchery site demonstrated greater variability in DO in 2024 than the upper ASD site. The highest DO recorded in 2024 was 11.18 mg/l at TPWD hatchery in January, and the lowest DO (5.98mg/l) occurred in May at the ASD site.

Table 3.1-2. Monthly mean, minimum, and maximum DO (mg/l) among San Marcos River RTWQ sites (2024).

	Dissolved oxygen (mg/l) at San Marcos Water Quality Sites					
Month (2024)	**Aquarena Springs**			**TPWD hatchery**		
	Mean	Min	Max	Mean	Min	Max
Jan	8.25	7.34	10.18	8.87	7.66	11.18
Feb	8.07	6.68	9.98	8.56	7.46	10.56
Mar	8.00	6.61	10.06	8.40	7.31	10.42
Apr	7.95	6.67	9.85	8.17	7.14	9.82
May	7.70	5.98	9.46	8.00	6.70	9.67
Jun	7.72	6.67	9.11	7.98	6.75	9.46
Jul	7.88	6.78	9.24	8.11	7.04	9.57
Aug	7.90	6.96	9.30	8.19	6.69	9.75
Sept	7.90	7.04	9.38	8.18	7.22	9.80
Oct	8.00	7.15	9.59	8.33	7.41	9.95
Nov	8.14	7.15	9.67	8.44	6.96	10.10
Dec	8.16	7.20	9.59	8.56	7.62	10.07

Box plots for minimum daily DO (i.e., lowest DO reported for one 15-minute interval in a 24 hour period) observed at San Marcos RTWQ sites from time of equipment deployment (i.e., 2013 for ASD and 2016 for TPWD hatchery) through 2024 compared to minimum daily DO observed in 2024 are shown in Figure 3.1-5. The medians of minimum daily DO for 2024 were lower than the medians of minimum daily DO from time of equipment deployment for San Marcos River RTWQ sites and is likely associated with below average sprinflows experienced for most of 2024.

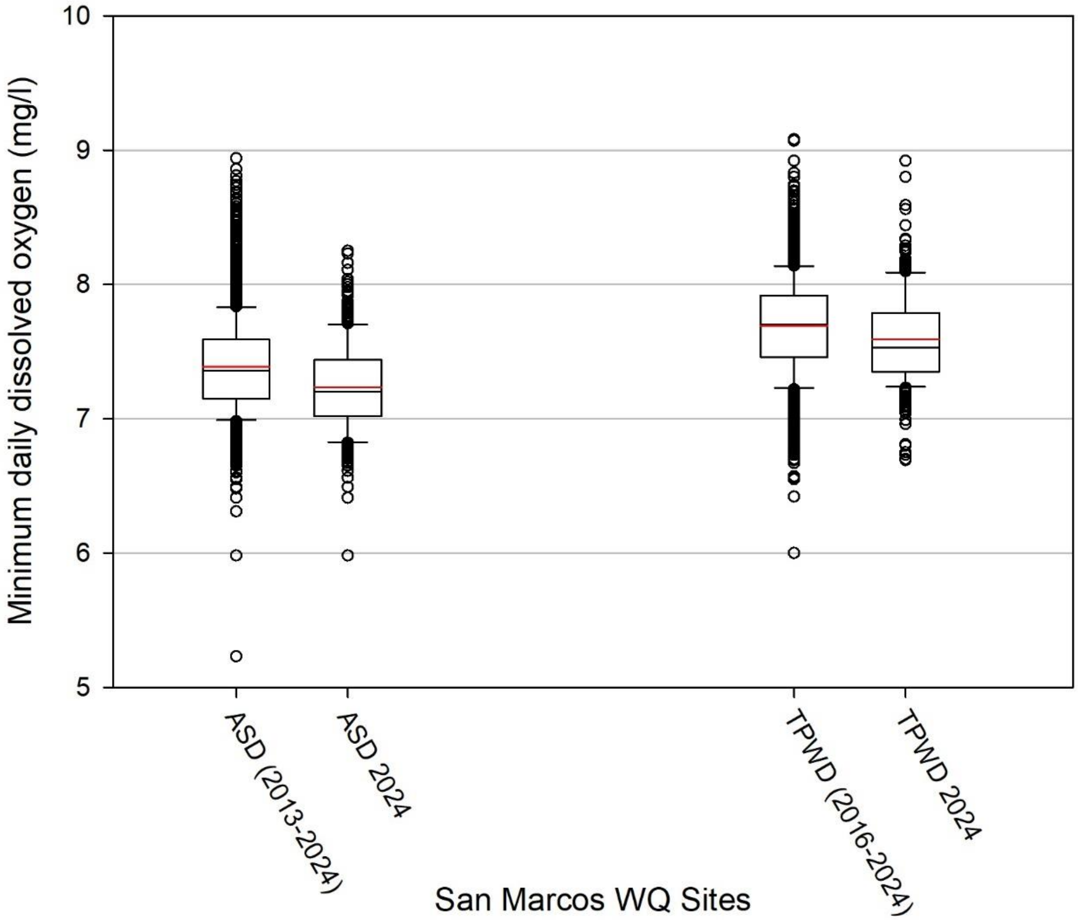

Figure 3.1-5. Box plots of minimum daily DO (mg/l) among RTWQ sites in the San Marcos River from time of equipment deployment through 2024 compared to 2024 only. Black lines represent median values and red lines denote mean values. Whiskers represent maximum and minimum DO values, excluding outliers (open circles).

Minimum daily DO recorded in 2024 were plotted for San Marcos River RTWQ sites (Figure 3.1-6). Similar to previous years, the TPWD hatchery site maintained higher minimum daily DO levels compared to the ASD site. The minimum DO threshold (4 mg/l) was not reached at either San Marcos River RTWQ site in 2024.

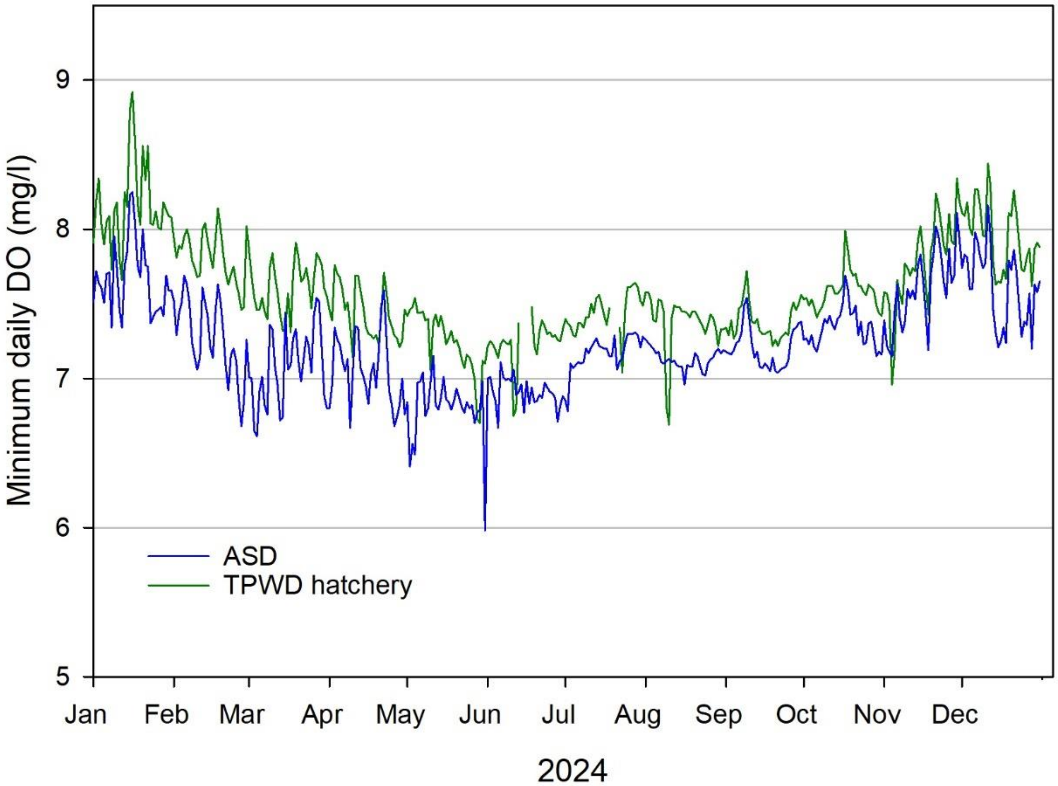

Figure 3.1-6. Minimum daily DO (mg/l) among San Marcos River water quality stations (2024).

Conductivity

Table 3.1-3 displays monthly summary statistics for conductivity (µs/cm) recorded in 2024 at the San Marcos River RTWQ sites. Mean monthly conductivity remained consistent among sites and throughout the year. The highest conductivity in 2024 was recorded at the ASD site in February (655 µs/cm) and the lowest conductivity (171 µs/cm) was also at the TPWD hatchery recorded in January.

San Marcos River discharge and mean daily conductivity were plotted for San Marcos River RTWQ sites for 2024 (Figure 3.1-7). Mean daily conductivity was influenced by rain events in the San Marcos River with decreases in conductivity corresponding with influxes of run-off entering the river. Outside of rain events, mean conductivity generally ranged between 600-640 µs/cm at the two San Marcos RTWQ sites.

Table 3.1-3. Monthly mean, minimum, and maximum conductivity (µs/cm) among San Marcos River RTWQ sites (2024).

	Conductivity (µs/cm) at San Marcos Water Quality Sites					
Month (2024)	**Aquarena Springs**			**TPWD hatchery**		
	Mean	Min	Max	Mean	Min	Max
Jan	621	352	635	601	171	637
Feb	630	571	655	625	432	632
Mar	631	574	636	629	459	641
Apr	635	561	650	628	396	642
May	631	541	642	618	211	642
Jun	634	397	639	628	231	643
Jul	629	402	639	621	177	645
Aug	635	526	647	636	265	647
Sept	633	560	645	638	456	645
Oct	635	621	647	642	635	646
Nov	634	490	648	636	389	646
Dec	640	588	645	636	508	644

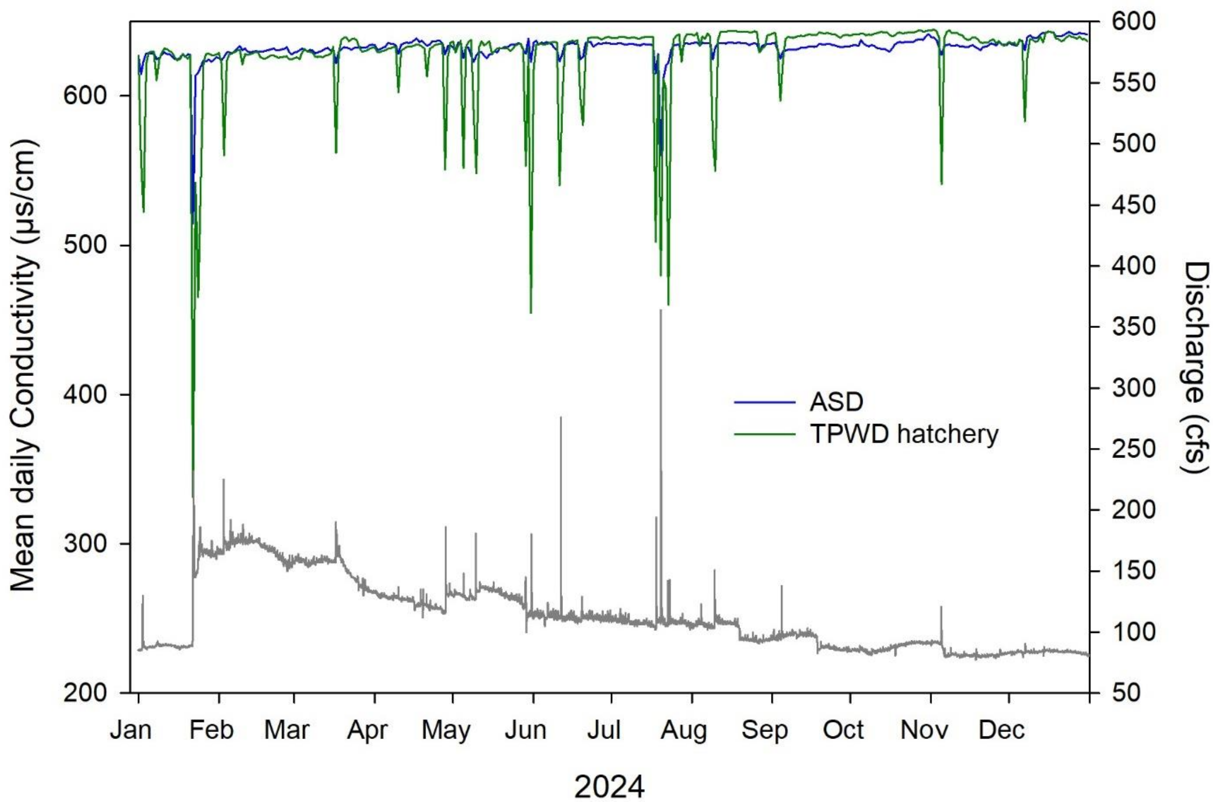

Figure 3.1-7. Mean daily conductivity (µs/cm) among San Marcos River RTWQ sites and San Marcos River discharge (USGS Gage#08170500) in 2024.

Sessom Creek Water Quality Characterization

Table 3.1-4 displays monthly summary statistics for water quality parameters measured in Sessom Creek for 2024. Figures 3.1-8 to 3.1-10 illustrate the daily values for water quality parameters in Sessom Creek (maximum daily temperature, minimum daily DO, mean daily turbidity and conductivity, respectively). Sessom Creek displayed more variability in water quality conditions than the San Marcos River RTWQ sites. The highest maximum daily water temperature reported in Sessom Creek for 2024 was 32.61°C in August. Maximum daily water temperatures exceeded 25°C for 91 days (May – September) in 2024, ranging from 0.1 hours – 20.6 hours (mean = 3.6 hours, median = 2.6 hours) at or above 25°C during those 91 days. DO dropped below 4.0 mg/l in Sessom Creek for 38 days in April – December ranging from 0.1 hours – 24.0 hours (mean = 14.0 hours, median = 13.9 hours). The lower minimum daily DOs observed in Sessom Creek likely corresponded with minimal springflow experienced in the creek towards the end of 2024. Spikes in mean daily turbidity were observed with corresponding drops in conductivity, indicating an influx of run-off from a rain event (Figure 3.1-10).

Table 3.1-4. Monthly mean, minimum, and maximum for water quality parameters in Sessom Creek (2024).

Month (2024)	**Temperature (°C)**			**DO (mg/l)**			**Conductivity (µs/cm)**			**Turbidity (NTU)**		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Jan	15.56	5.05	20.91	7.56	4.12	12.91	661	47	814	12.53	0.00	548
Feb	20.82	15.84	23.16	6.83	5.40	9.79	663	53	788	6.19	0.21	645
Mar	21.35	18.20	23.34	5.98	4.35	9.07	642	70	687	2.75	0.00	324
Apr	21.90	16.73	23.93	5.64	3.88	9.40	611	48	699	4.81	0.27	607
May	23.18	17.79	26.34	5.33	3.23	9.58	617	57	684	11.55	0.13	493
Jun	23.87	22.94	28.69	5.74	4.65	8.66	627	48	926	5.96	0.39	552
Jul	24.12	22.87	27.76	6.01	4.58	8.75	639	42	709	15.58	0.00	493
Aug	23.98	22.99	32.61	5.78	4.05	9.07	640	56	733	4.06	0.14	336
Sept	23.43	21.40	29.09	5.84	4.01	8.95	649	44	681	4.42	0.00	269
Oct	22.63	19.82	24.53	5.68	4.73	8.40	666	601	699	3.14	0.08	20
Nov	21.02	17.51	23.75	5.22	3.16	9.24	656	56	673	3.78	0.00	248
Dec	19.52	9.27	22.82	3.80	0.50	11.40	634	56	699	2.84	0.00	166

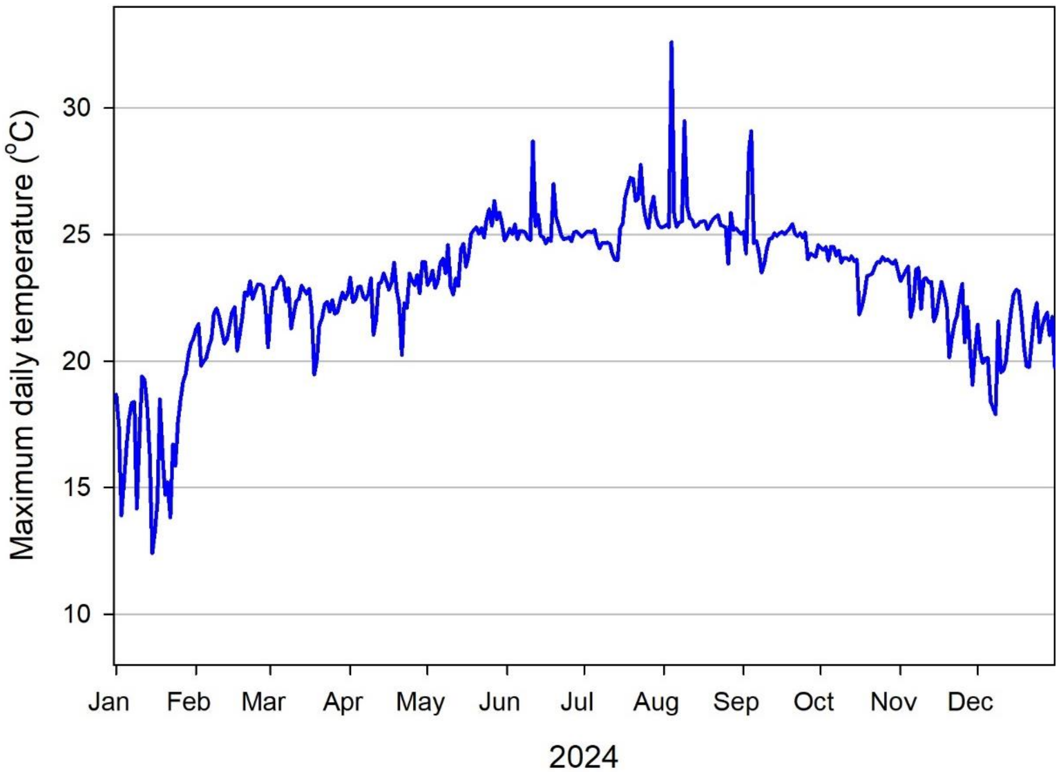

Figure 3.1-8. Maximum daily water temperatures (°C) in Sessom Creek (2024).

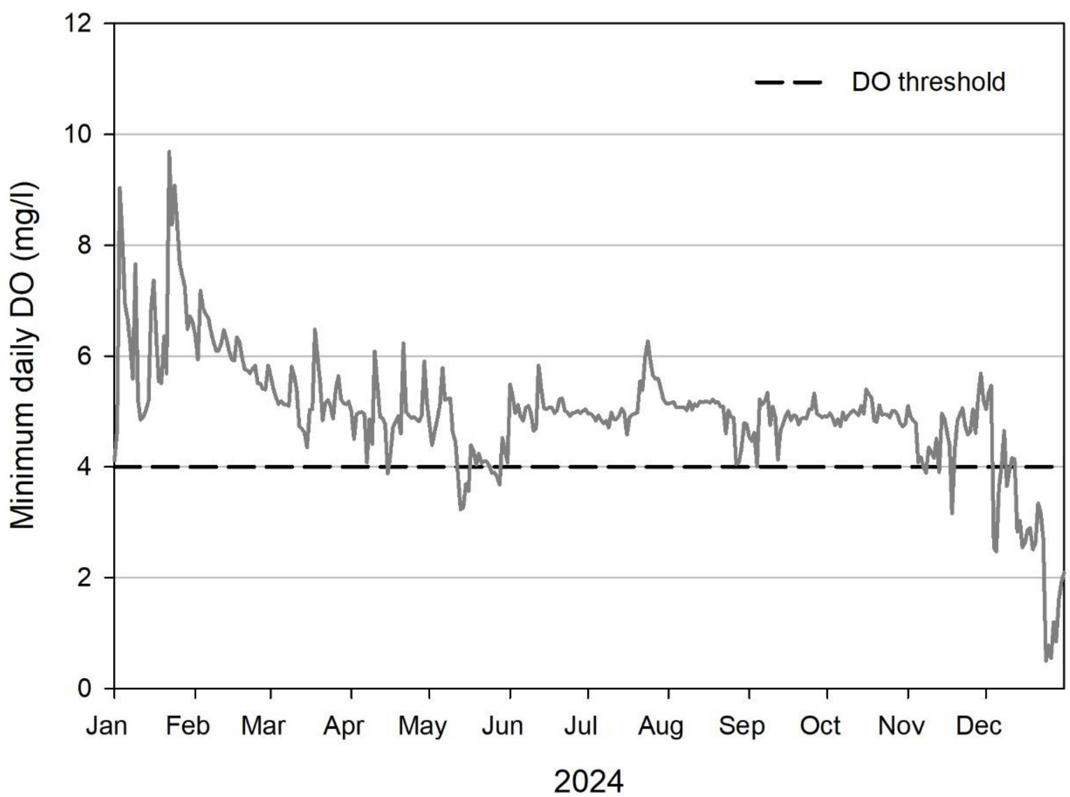

Figure 3.1-9. Minimum daily DO (mg/l) in Sessom Creek (2024).

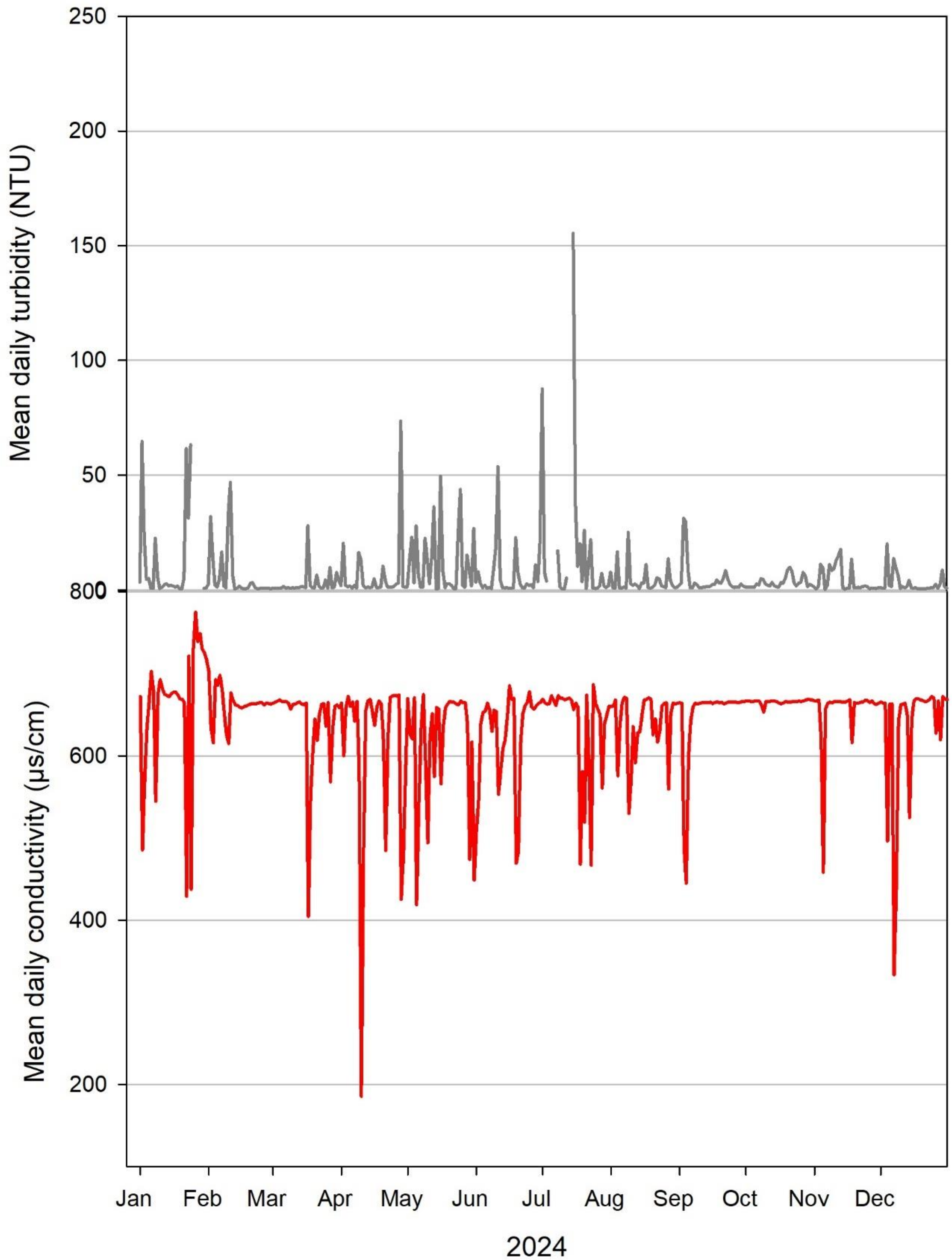

Figure 3.1-10. Mean daily turbidity (NTU) and mean daily conductivity (µs/cm) in Sessom Creek (2024).

3.1.2 Comal

Hydrology

Average springflow at Comal Springs for the period of record (i.e., 1927 – present) was 288 cfs. Since 2013, Comal springflow ranged from below average in 2013-2014 to above average from mid-2015-2017 (Figure 3.1-11). Extended low flow conditions occurred in 2014 and Comal springflow dropped down to as low as 65 cfs on August 29, 2014. In 2015, rainfall throughout the course of the year, particularly two large precipitation events in late May and October, resulted in above average springflow. The large flood pulse on October 30, 2015 had a peak discharge reaching 14,100 cfs. Springflows remained above average in 2016 through 2017 due to several moderate rain events. In 2018, springflow dropped below average, reaching 161 cfs in late August. However, multiple rain events in the early fall resulted in increased springflow and subsequent above average springflow rates. Springflow in 2019 was generally above 350 cfs until July when springflow decreased to average by mid-August but rose above 300 cfs before the end of the year. No substantial flow events occurred in 2019. The absence of large flow event continued into 2020 and springflows continued to decrease, dropping below the long-term average from May to December. Sprinflows continued to decline in early 2021 to just below 200 cfs in April, but rain events in late spring resulted in sprinflows increasing to above average. Additional rain events in fall (i.e., 5,030 cfs pulse in October) helped maintain near average springflows through December 2021. Springflows decreased and remained below average during 2022, dropping below 100 cfs in July and hitting 90 cfs in mid-August. Similar to the San Marcos system, no major run-off events occurred in 2022. In 2023, no large rain events led to springflows declining to levels not observed since 2014 with the lowest flow of 55 cfs recorded in August. Rain events in January 2024 resulted in briefly higher springflows but springflows decreased for the remainder of the year as a result of no major rainfall events occurring.

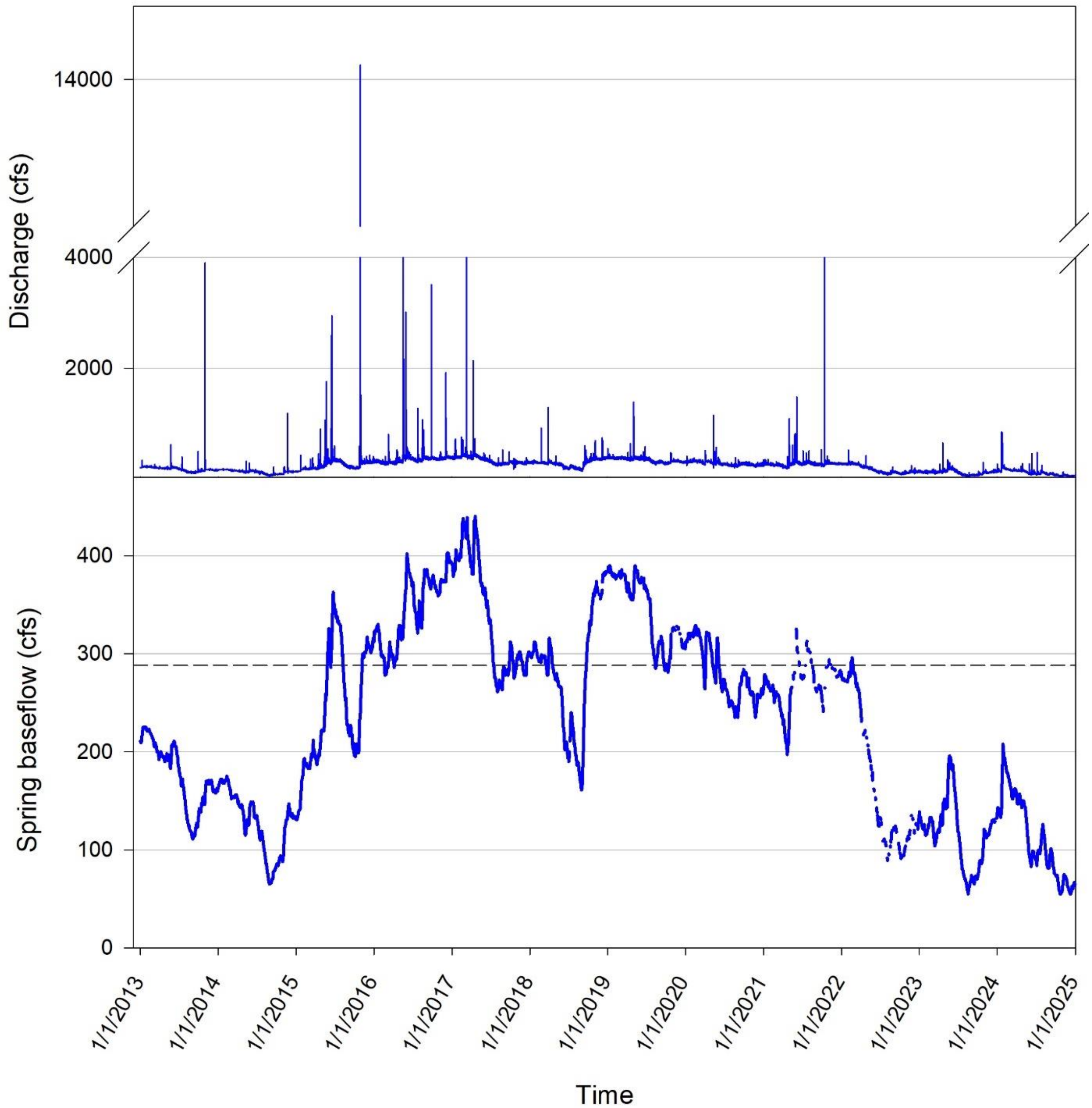

Figure 3.1-11. Hydrographs for the Comal River at New Braunfels (USGS station 08169000) and mean daily springflow for Comal springs (USGS Station 08168710) 2013 – 2024. Dashed line denotes long term average springflow (288 cfs) in the Comal River.

Temperature

Table 3.1-5 displays monthly summary statistics for water temperature at Comal RTWQ sites for 2024. In general, mean monthly water temperatures remained fairly stable within a site with deviations averaging ~1-2 °C and did not vary greatly among sites. Between Spring Run sites, water temperature at SR 7 continued to be slightly warmer than SR 3. Outside the direct influx of spring runs, the Old Channel (OC) exhibited more variability in minimum and maximum monthly water temperatures. The highest water temperature recorded in 2024 was 27.02°C in the OC during July whereas the lowest temperature (19.81°C) occurred in the OC during December.

Table 3.1-5. Monthly mean, minimum, and maximum water temperatures (°C) among Comal RTWQ (2024).

Month (2024)	Spring Run 3			Spring Run 7			Old Channel		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Jan	23.42	21.94	23.54	23.88	23.86	23.90	22.08	19.81	23.92
Feb	23.51	23.46	23.59	23.89	23.84	23.91	22.92	21.22	24.85
Mar	23.52	23.45	23.61	23.84	23.81	23.86	23.27	21.60	25.19
Apr	23.53	23.41	23.61	23.84	23.83	23.87	23.65	22.16	25.87
May	23.55	23.41	23.69	23.83	23.78	23.86	24.21	23.00	26.69
Jun	23.59	23.51	23.80	23.80	23.77	23.83	24.74	23.54	26.96
Jul	23.60	23.54	23.87	23.79	23.76	23.85	24.64	23.50	27.02
Aug	23.60	23.54	23.87	23.79	23.74	23.83	24.77	23.62	26.91
Sept	23.58	23.44	23.83	23.79	23.76	23.83	24.42	22.79	26.70
Oct	23.53	22.96	24.11	23.76	23.73	23.80	24.01	21.91	26.03
Nov	23.37	22.76	23.99	23.78	23.75	23.81	23.13	20.87	25.07
Dec	23.21	22.52	23.67	23.77	23.74	23.80	22.58	20.58	24.40

Box plots for maximum daily water temperatures observed at Comal RTWQ sites from time of sensor deployment (i.e., 2013 for SR 3, SR 7 and 2018 for OC) through 2024 compared to maximum daily water temperatures observed in 2024 are shown in Figure 3.1-12. The medians of maximum daily temperatures for 2024 were slightly higher than the medians of maximum daily temperatures from time of equipment deployment at Comal RTWQ sites. Higher median maximum daily temperatures were most notable at SR 3.

Maximum daily temperatures were plotted for Comal system RTWQ sites for 2024 (Figure 3.1-13). Throughout 2024, maximum daily water temperatures were more variable at the OC river site whereas little variation in maximum daily water temperature was observed at SR 7. More variability and lower maximum daily water temperatures were observed at SR 3 towards the end of 2024 and is likely associated with a combination of cooler ambient temperatures and lower springflow in the run. Maximum daily temperatures reached or exceeded 25°C at the Old Channel station for 172 days during the months of March–November in 2024. Within those 172 days, time spent at or above 25°C ranged from 1.0 to 10.75 hours (mean = 7.17 hours; median = 7.75 hours).

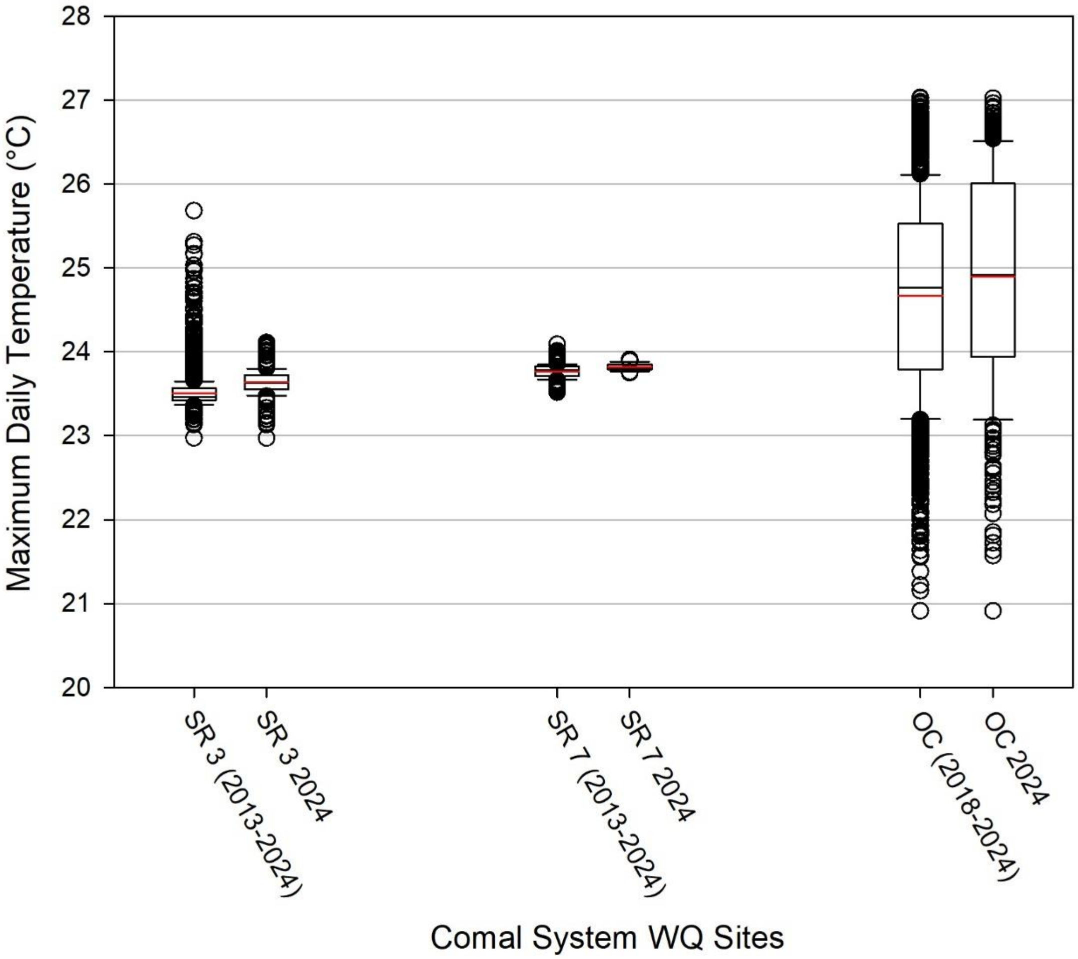

Figure 3.1-12. Box plots of maximum water daily temperatures (°C) among Comal system RTWQ sites from time of deployment through 2024 compared to 2024. Black lines represent median values and red lines denote mean values. Whiskers represent maximum and minimum temperature values, excluding outliers (open circles).

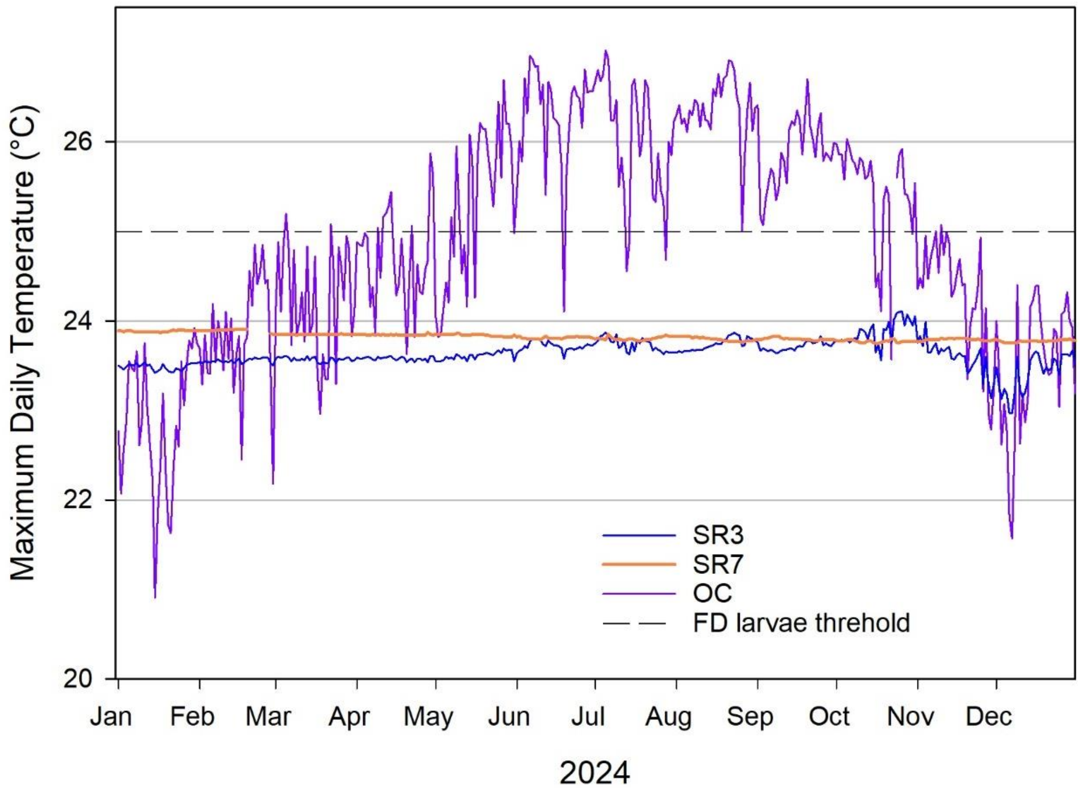

Figure 3.1-13. Maximum daily water temperature (°C) among Comal RTWQ sites (2024).

Box plots for seasonal maximum daily temperatures at the Comal system RTWQ sites for 2024 are shown in Figure 3.1-14. Less seasonal variation in maximum daily temperature (i.e., <1.0°C) was observed at the two spring run sites. However, the OC river site exhibited a wider range in seasonal variation with median values differing ~3 °C. Spring, fall, and winter also showed more variability in maximum daily temperature at the OC site while summer months showed less variability but recorded the highest maximum daily temperatures.

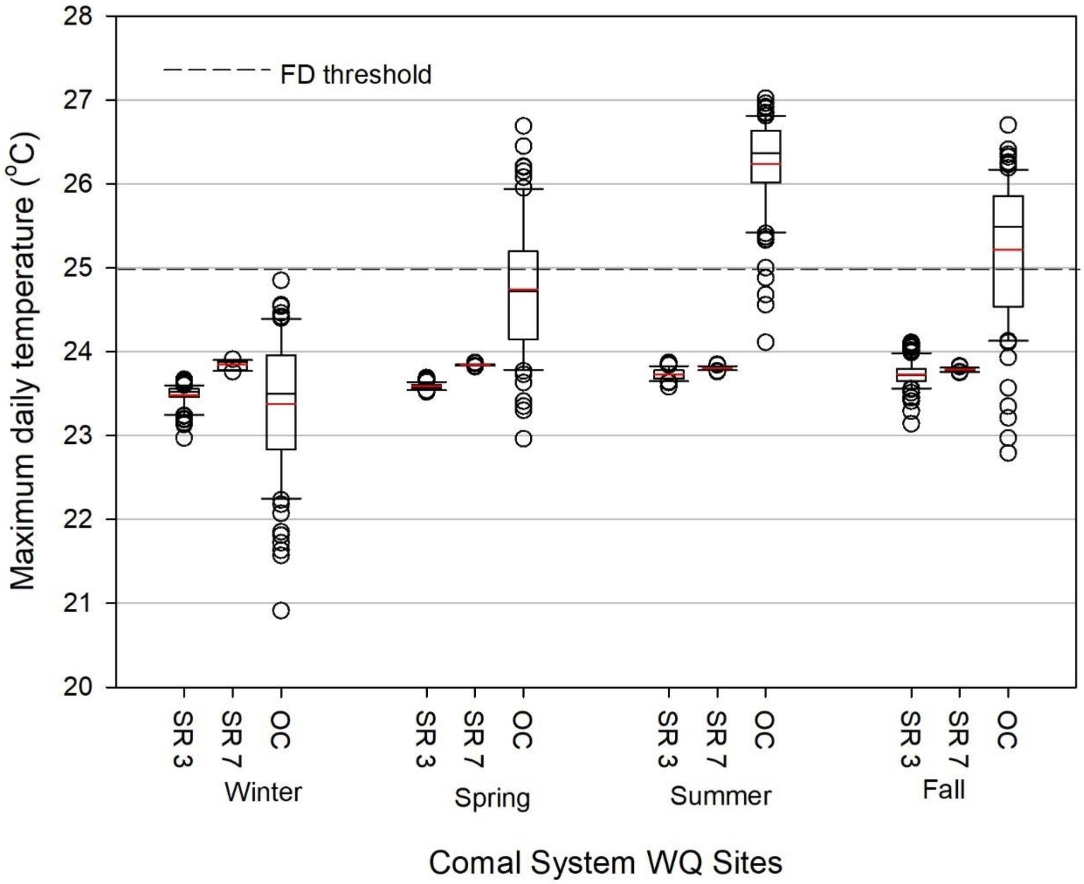

Figure 3.1-14. Box plots of maximum daily water temperatures (°C) among seasons at Comal system RTWQ sites in 2024. Black lines represent median values and red lines denotes mean values. Whiskers represent maximum and minimum temperature values, excluding outliers (open circles).

Dissolved Oxygen

Table 3.1-6 displays monthly summary statistics for dissolved oxygen (DO) recorded for Comal RTWQ sites in 2024. Mean monthly dissolved oxygen remained consistent within a site with variations averaging ~ 1 mg/l. Similar to previous years, mean monthly DO was lower in the spring run sites than the OC river site. The highest DO recorded in 2024 was 10.03 mg/l in the OC during February and the lowest DO (4.85mg/l) occurred at SR 7 in September.

Table 3.1-6. Monthly mean, minimum, and maximum DO (mg/l) among Comal system RTWQ sites (2024).

Month (2024)	**Spring Run 3**			**Spring Run 7**			**Old Channel**		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Jan	5.32	5.16	6.31	5.05	5.03	5.08	7.38	6.03	10.02
Feb	5.23	5.13	5.45	5.04	5.00	5.06	7.37	5.80	10.03
Mar	5.23	5.12	5.47	5.04	5.03	5.05	7.16	5.65	9.73
Apr	5.24	5.14	5.48	4.98	4.92	5.04	7.08	5.64	9.61
May	5.25	5.14	5.77	4.95	4.91	4.97	7.06	5.57	9.41
Jun	5.36	5.21	5.93	4.95	4.93	4.97	7.10	5.41	9.49
Jul	5.37	5.13	5.94	4.94	4.92	4.96	6.86	5.15	9.50
Aug	5.37	5.18	6.06	4.94	4.91	4.96	6.89	5.35	9.05
Sept	5.37	5.11	5.92	4.92	4.85	4.94	7.03	5.40	9.70
Oct	5.60	5.08	6.88	4.93	4.90	4.96	7.16	5.78	9.67
Nov	5.60	4.95	6.65	4.90	4.88	4.93	7.21	5.82	9.49
Dec	5.49	5.03	6.65	4.90	4.88	4.95	7.23	5.95	9.57

Box plots for minimum daily DO observed at Comal system RTWQ sites from time of equipment deployment (i.e., 2013 for SR3, SR7 and 2018 for OC) through 2024 compared to minimum daily DO observed in 2024 are shown in Figure 3.1-15. The medians of minimum daily DO for 2024 were generally consistent with medians of minimum daily DO since time of sensor deployment at Comal system RTWQ sites. However, the median minimum daily DO in the OC for 2024 was slightly lower than minimum daily DO observed since 2018.

Minimum daily DO was plotted for Comal RTWQ sites in 2024. (Figure 3.1-16). Spring run 3, and SR 7 demonstrated relatively constant DO whereas the OC river site was more variable in DO with seasonally drops in minimum daily DO during the summer months. Although greater in variability, the OC maintained higher minimum daily DO compared to the spring run sites and no sites recorded a minimum daily DO below 4.0 mg/l in 2024.

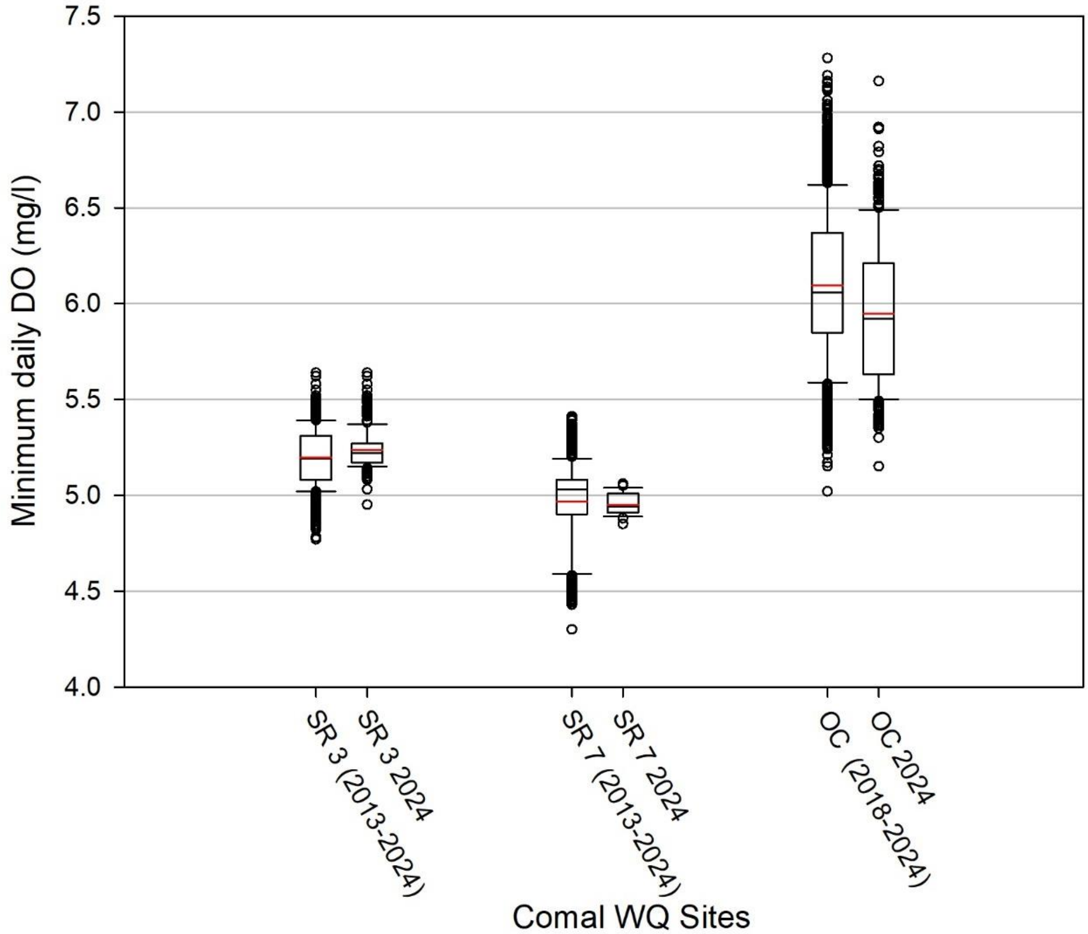

Figure 3.1-15. Box plots of minimum daily DO (mg/l) among Comal system RTWQ sites from time of equipment deployment through 2024 compared to 2024. Black lines represent median values and red lines denotes mean values. Whiskers represent maximum and minimum DO values, excluding outliers (open circles).

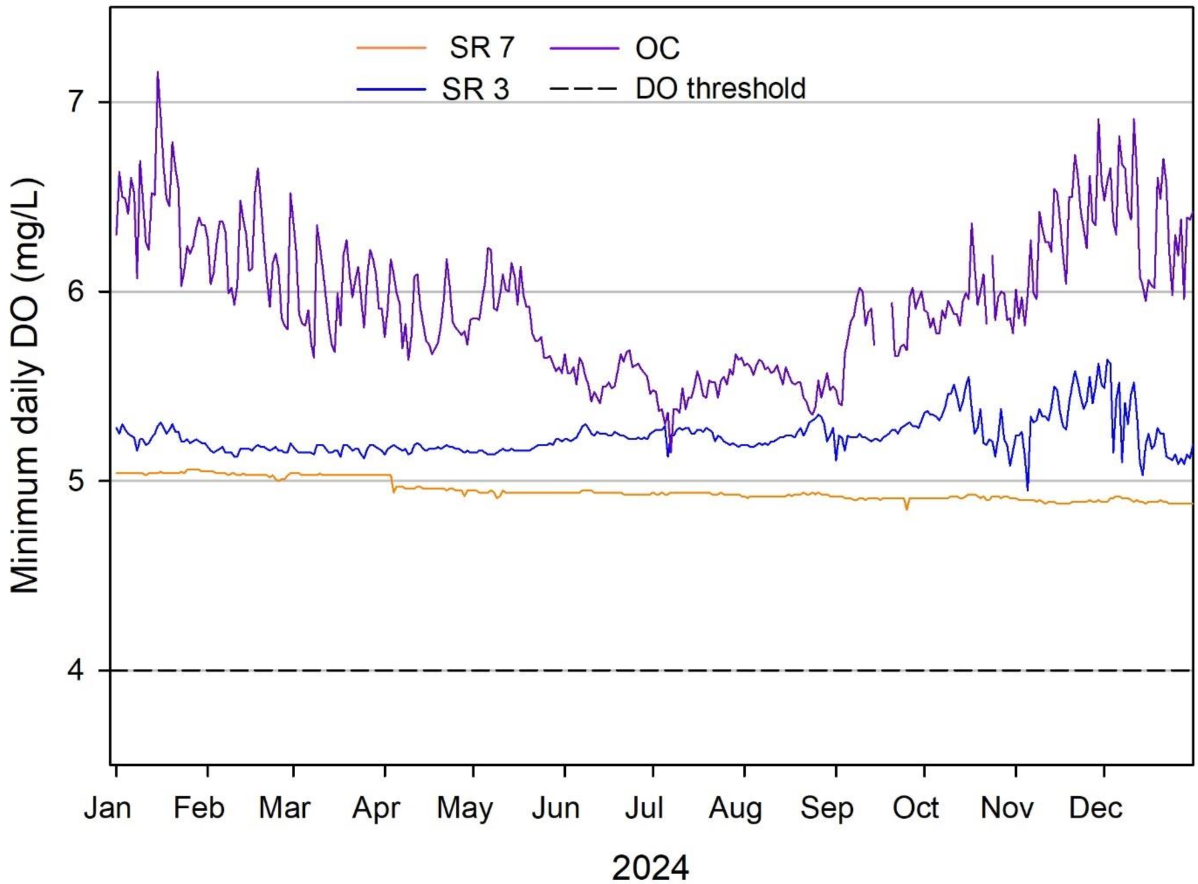

Figure 3.1-16. Minimum daily DO (mg/l) among Comal RTWQ sites (2024).

Conductivity

Table 3.1-7 displays monthly summary statistics for conductivity (µs/cm) recorded at Comal system RTWQ sites during 2024. Mean monthly conductivity remained consistent at the three WQ sites throughout the year with little variability between sites. In general, mean conductivity ranged between 570-575 µs/cm among all Comal system RTWQ sites. The lowest conductivity in 2024 was recorded in the SR 3 in August (461 µs/cm) (Figure 3.1-17).

Comal River discharge (cfs) and mean daily conductivity were plotted for Comal system RTWQ sites for 2024 (Figure 3.1-17). Little variation in mean daily conductivity for all three RTWQ sites occurred in 2024. Since the Comal discharge gage location is located downstream from the confluence of the Old and New Channel of the Comal, some rain events in the system do not result in conductivity drops in the Old Channel. Additionally, the Comal River has slightly lower conductivity than the San Marcos River.

Table 3.1-7. Monthly mean, minimum, and maximum conductivity (µs/cm) among Comal system RTWQ sites (2024).

Month (2024)	Spring Run 3			Spring Run 7			Old Channel		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Jan	573	488	585	573	569	577	572	506	589
Feb	575	571	585	575	568	582	578	565	585
Mar	573	569	578	576	570	579	577	565	585
Apr	574	528	579	573	565	580	576	565	585
May	574	478	577	574	565	580	570	517	585
Jun	573	470	581	574	565	580	569	502	584
Jul	574	461	580	574	560	588	570	504	585
Aug	574	560	581	573	566	582	572	565	580
Sept	575	566	581	572	567	580	570	550	584
Oct	574	565	584	574	565	577	572	558	585
Nov	572	565	584	575	567	578	573	550	581
Dec	572	565	586	576	571	581	573	565	580

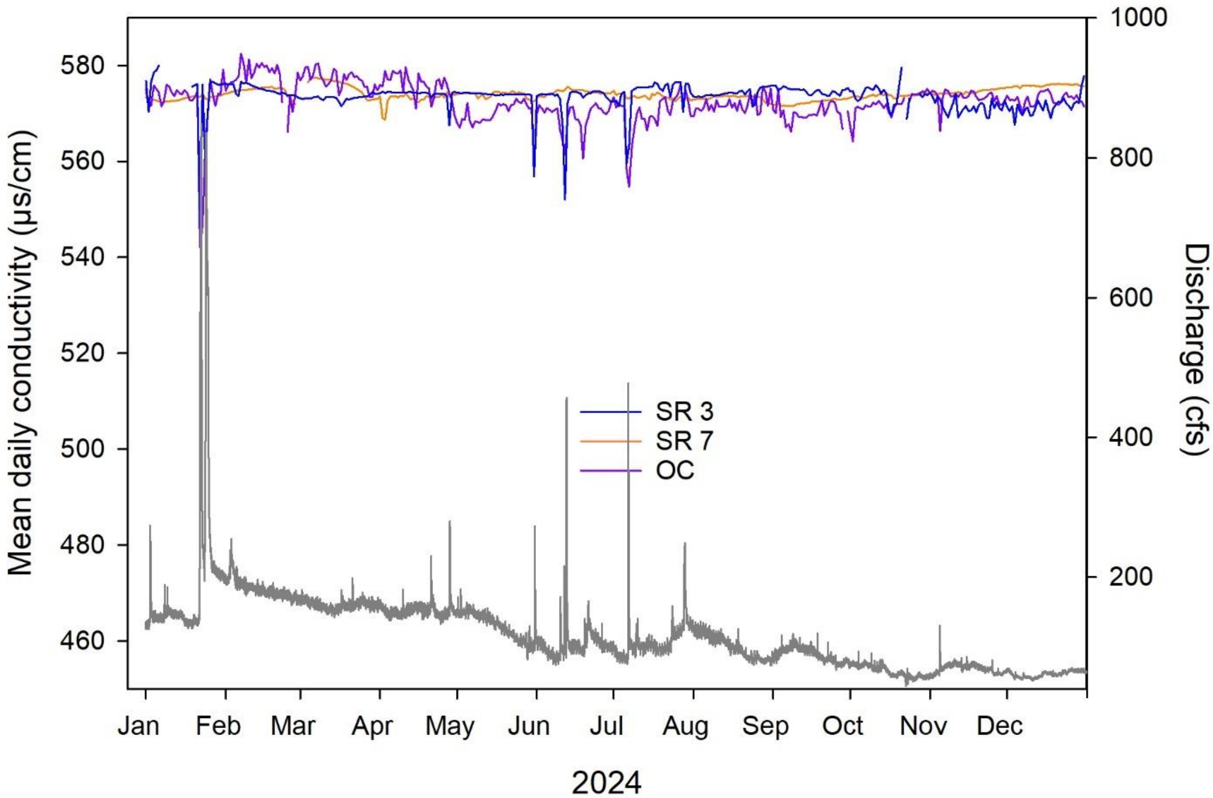

Figure 3.1-17. Mean daily conductivity (µs/cm) among Comal system RTWQ sites and Comal River discharge (Gage#08169000) in 2024.

3.2 Surface water sampling

3.2.1 San Marcos

Table 3.2-1 denotes the water quality parameters collected at Hotel Spring during monthly sucralose collections. Water quality parameters measured during monthly sampling events were consistent with measurements collected by the RTWQ network station at Aquarena Springs.

Table 3.2-1. Monthly (2024) water quality parameters measured at Hotel Spring (Spring Lake, San Marcos).

Month	Conductivity (µs/cm)	DO (mg/l)	pH (SU)	Temperature (°C)
Jan	611	4.45	6.97	22.21
Feb	620	3.74	6.91	21.83
Mar	614	4.02	6.89	21.84
Apr	611	4.32	6.97	21.88
May	617	4.44	6.85	21.94
Jun	611	4.32	6.95	22.29
Jul	NA	NA	NA	NA
Aug	625	4.58	7.05	21.89
Sep	629	4.58	6.99	22.00
Oct	615	4.58	7.03	22.04
Nov	620	4.59	NA	22.09
Dec	625	4.59	NA	22.11

A total of 12 sucralose samples were collected during monthly collections at Hotel Spring in 2024, including one duplicate sample in August and one DI (i.e., deionized water) blank in March. Sucralose was detected in all collected samples at Hotel Spring in 2024 (Table 3.2-2). Quality control spike recoveries for all sampling events were between 68.5 – 124.0 %.

Table 3.2-2. Sucralose concentrations (ng/L) and QC spike recovery (%) measured at Hotel Springs in Spring Lake (2024). Samples with detectable concentrations denoted in bold. Spike recovery amounts shown in parentheses.

Month	Sample (ng/L)
January	**13.3** (83.3)
February	**23.7** (87.9)
March	**23.4**[A] (77.5)
April	**17.9**[R] (124)
May	**15.7** [R] (104)
June	**16.0** [R] (123)
July	**17.0** (85.1)
August	**13.0**[B] (85.3)
September	**28.4** (68.5)
October	NA
November	NA
December	NA

[A] Not detected in DI blank
[B] Detected in duplicate sampling
[R] peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration

During Spring and Fall sampling events, nutrient samples and one duplicate sample per site per season (i.e., upper in Spring and lower in Fall) were taken. Nutrient concentrations measured at the upper and lower sites (i.e., Hotel Springs and near the TPWD hatchery) in the San Marcos system during Spring and Fall are denoted in Table 3.2-3.

Table 3.2-3. Nutrient concentrations measured at the upper and lower sites in the San Marcos system during Spring and Fall (2024). Samples with detectable concentrations denoted in bold.

		Spring		Fall	
Nutrients	**Units**	**Upper**	**Lower**	**Upper**	**Lower**
Total Phosphorus	mg/L	0.01[UA]	0.01[UA]	**0.039**	**0.019[JA]**
Orthophosphate as P	mg/L	0.006[UHAC]	0.006[UHAC]	**0.008**	**0.008[B]**
Total Organic Carbon	mg/L	0.5[UA]	0.5[UA]	**0.57[J]**	**0.644[JB]**
Dissolved Inorganic Carbon	mg/L	**65.5[BC]**	**64.9[BC]**	**62.5**	**63.0[B]**
Dissolved Organic Carbon	mg/L	**1.27[BC]**	**1.42[BC]**	**0.49[JC]**	**0.47[JBC]**
Kjeldahl Nitrogen	mg/L	**0.104[JB]**	**0.111[JB]**	0.089[UF1]	0.089[UB]
Nitrate as N	mg/L	**0.75[BC]**	**0.664[BC]**	**1.18[C]**	**1.35[BC]**
Ammonia	mg/L	0.05[UA]	0.05[UA]	0.05[U]	0.05[UA]

[U] Non-detect
[H] Sample was prepped and analyzed past holding time
[F1] MS and/or MSD recovery exceeds control limits
[J] Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
[A] Not detected in duplicate sample
[B] Detected in duplicate sample
[C] Detected in laboratory or field blank

3.2.2 Comal

Table 3.2-4 denotes the water quality parameters collected at Spring Run 3 in Landa Lake during monthly sucralose collections in 2024. Water quality parameters measured during monthly sampling events were consistent with measurements collected by the RTWQ network station in Spring Run 3.

Table 3.2-4. Monthly (2024) water quality parameters measured at Spring Run 3 (Landa Lake).

Month	Conductivity (µs/cm)	DO (mg/l)	pH (SU)	Temperature (°C)
Jan	569	5.00	7.03	23.61
Feb	571	5.08	6.93	23.55
Mar	571	5.15	6.89	23.57
Apr	573	5.04	7.00	23.58
May	571	5.02	6.88	23.59
Jun	569	4.84	6.98	24.04
Jul	NA	NA	NA	NA
Aug	579	5.25	7.15	23.51
Sep	585	5.06	NA	23.66
Oct	566	5.03	7.07	23.59
Nov	565	5.07	7.09	23.55
Dec	567	6.37	NA	23.06

A total of 12 sucralose samples were collected during monthly collections at Spring Run 3 in 2024, including one field duplicate sample in June and one DI blank in August. Among monthly collections, sucralose was detected during all sampling events at Spring Run 3 (Table 3.2-5). Quality control spike recoveries for all sampling events were between 77.0 – 115.0 %.

Table 3.2-5. Sucralose concentrations (ng/L) measured at Spring Run 3 in Landa Lake (2024). Samples with detectable concentrations denoted in bold. Spike recovery amounts shown in parentheses.

Month	Sample (ng/L)
January	**5.89**[J] (93.2)
February	**9.61** (104)
March	**9.99** (91.0)
April	**7.83**[J] (133)
May	**7.19**[J] (120)
June	**14.2**[BR] (112)
July	**10.2** (94.2)
August	**6.78**[CJ] (78)
September	**8.8** (79.7)
October	NA
November	NA
December	NA

[A] Non detected in DI blank
[B] Detected in duplicate sample
[C] Detect in DI blank
[J] Concentration < limit of quantification

During Spring and Fall sampling events, nutrient samples were taken including a duplicate sample in the upper site in Spring and a duplicate sample in both upper and lower sites in Fall. Nutrient concentrations measured at the upper and lower sites (i.e., Spring Run 3 and at the last public exit) in the Comal system during Spring and Fall are denoted in Table 3.2-6.

Table 3.2-6. Nutrient concentrations measured at the upper and lower sites in the Comal system during Spring and Fall (2024). Samples with detectable concentrations denoted in bold.

		Spring		Fall	
Nutrients	**Units**	**Upper**	**Lower**	**Upper**	**Lower**
Total Phosphorus	mg/L	0.01UA	0.01U	0.01UA	0.01UA
Orthophosphate as P	mg/L	0.006UHAC	0.006UHC	0.005UB	0.005UB
Total Organic Carbon	mg/L	0.5UA	0.5U	0.05UB	**0.526JB**
Dissolved Inorganic Carbon	mg/L	**59.9BC**	**59.1C**	**58.7B**	**56.2B**
Dissolved Organic Carbon	mg/L	**0.707BC**	**0.935C**	**0.345JBC**	**1.05BC**
Kjeldahl Nitrogen	mg/L	**0.565B**	**0.206**	0.089UA	0.089UB
Nitrate as N	mg/L	**0.777BC**	**0.557C**	**1.69BC**	**1.61BC**
Ammonia	mg/L	0.05UA	0.05U	0.05UA	0.05UA

U Non-detect
H Sample was prepped and analyzed past holding time
F1 MS and/or MSD recovery exceeds control limits
J Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
A Not detected in duplicate sample
B Detected in duplicate sample
C Detected in laboratory or field blank

3.3 Groundwater sampling

3.3.1 San Marcos

A total of six PPCP samples (i.e., one sample at each sampling site and event) were collected during 2024, including one duplicate sample at Deep Hole in Spring and one DI blank at Hotel in Fall. Samples were taken at Hotel in the months of January, May, July, August, and November (November results not available yet). However, Deep Hole was only sampled in March and August. Results for PPCP sampling during the regular Spring (March) and Fall sampling (August) events are denoted in Table 3.3-1 and 3.3-2. Results for PPCP sampling at Hotel for January, May, and July are denoted in Table 3.3-3 and Table 3.3-4. Flumequine, Oxolinic acid, and Penicillin G were detected during the Spring sampling event at Deep Hole but were flagged as "B", indicating that a concentration was also detected in the lab blank and the sample concentration was 10x less than the blank concentration.

Table 3.3-1. PPCP concentrations (ng/L) measured at Hotel and Deep Hole Spring (Spring Lake, San Marcos) during Spring and Fall sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List	Spring				Fall			
	Hotel spring		Deep Hole		Hotel spring		Deep Hole	
Acetaminophen	**3.46**		**0.711**	JC	0.225	U	0.319	U
Azithromycin	**0.345**	B J	**0.164**	B JC	0.116	U	0.0897	U
Caffeine	**3.55**	B J	**1.46**	B JC	**1.06**	B J	**0.924**	B J
Carbadox	0.0684	U	0.0978	U	0.0871	U	0.0642	U
Carbamazepine	0.0017	U	0.0023	U	0.0009	U	0.0011	U
Cefotaxime	2.56	U	1.21	U	5.78	U	6.2	U
Ciprofloxacin	**0.367**	B J	0.424	UC	0.207	U	0.35	U
Clarithromycin	0.0038	U	0.0047	UC	0.0016	U	**0.011**	B J
Clinafloxacin	0.697	U	0.632	U	0.81	U	0.764	U
Cloxacillin	0.276	U H	**8.28**	HC	2.92	U H	11.4	H
Dehydronifedipine	0.0099	U	0.0145	U	0.0067	U	**0.006**	J
Digoxigenin	0.202	U	0.268	U	0.154	U	0.174	U
Digoxin	**0.267**	J	0.223	U	**0.232**	B J	**0.174**	B J
Diltiazem	**0.003**	J	0.0029	U	**0.002**	J	**0.004**	J
Diphenhydramine	**0.111**	J	**0.006**	B JC	**0.007**	B J	**0.007**	B J
Enrofloxacin	0.162	U	0.119	U	0.201	U	0.133	U
Erythromycin-H2O	**0.062**	B H	**0.418**	B HC	1.46	U H	1.57	U H
Flumequine	0.0066	U	0.0086	U	0.0019	U	0.0035	U
Fluoxetine	0.0018	U	0.0011	UC	0.0005	U	**0.001**	B J
Lincomycin	0.0448	U	0.0159	U	0.0018	U	0.0047	U
Lomefloxacin	0.0163	U	**0.053**	B J	0.0171	U	0.0227	U
Miconazole	**0.111**	B J	**0.098**	B JC	**0.018**	B J	**0.034**	B J
Norfloxacin	0.584	U	0.576	U	0.603	U	0.347	U
Norgestimate	**0.31**	J	0.379	U	0.218	U	0.169	U
Ofloxacin	**0.04**	B J	**0.138**	B JC	0.0193	U	**0.107**	J
Ormetoprim	0.0042	U	0.0065	U	**0.004**	B J	0.0029	U
Oxacillin	**0.24**	H	0.4	U H	1.46	U H	1.57	U H
Oxolinic Acid	0.0295	U	0.0243	U	0.024	U	0.0156	U
Penicillin G	**5.08**	B H	**25.2**	B HC	**4.52**	H	**11.6**	H
Penicillin V	**0.29**	B J	**126**	C	**0.169**	B J	3.74	U
Roxithromycin	0.0195	U	0.0482	U	**0.001**	J	0.022	U
Sarafloxacin	0.272	U	0.235	U	**0.168**	J	0.159	U
Sulfachloropyridazine	0.0188	U	0.0253	U	0.0135	U	0.0129	U
Sulfadiazine	0.0078	U	0.015	UC	0.0069	U	0.0062	U
Sulfadimethoxine	0.0071	U	0.0099	U	0.005	U	0.0069	U
Sulfamerazine	0.0059	U	0.0181	U	0.0061	U	0.0059	U
Sulfamethazine	0.0068	U	0.0114	U	0.0058	U	**0.008**	J
Sulfamethizole	0.219	U	0.363	U	0.0364	U	0.095	U
Sulfamethoxazole	**0.081**	J	**0.286**	JC	**0.116**	B J	**0.26**	J
Sulfanilamide	**2.55**	J	**4.54**	JC	**3.07**	B J	**4.45**	J
Sulfathiazole	0.0112	U	0.024	U	0.0152	U	0.0107	U
Thiabendazole	0.0156	U	0.0655	UC	**0.003**	J	**0.018**	J
Trimethoprim	0.0063	U	**0.011**	B JC	0.0036	U	**0.006**	B J
Tylosin	**0.025**	B J	**0.021**	B J	**0.056**	B J	0.0111	U
Virginiamycin M1	0.15	U	1.1	U	**0.356**	J	0.258	U
1,7-Dimethylxanthine	**0.485**	B J	**0.457**	B JC	0.0853	U	**0.261**	B J

U Non-detect at reporting limit

B Analyte found in associated blank and concentration in sample <10x concentration in lab blank

C Detected in duplicate sample

H Concentration is estimated

J Concentration less than limit of quantification

Table 3.3-2. PPCP concentrations (ng/L) measured at Hotel and Deep Hole Spring (Spring Lake, San Marcos) during Spring and Fall sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List	Spring				Fall			
	Hotel spring		Deep Hole		Hotel spring		Deep Hole	
Alprazolam	0.0109	U	0.0098	UC	0.0126	U	0.0142	U
Amitriptyline	0.0099	U	0.0116	U	0.0055	U	0.0046	U
Amlodipine	0.0249	U	0.0186	UC	0.0249	U	0.0151	U
Benzoylecgonine	**0.024**	B J	**0.018**	B JC	**0.025**	B J	**0.047**	B J
Benztropine	**0.418**	B J	**0.403**	B JC	**0.426**	B J	**0.385**	B J
Betamethasone	0.101	U	0.191	U	0.0357	U	0.0376	U
Cocaine	**0.025**	B J	**0.225**	BC	**0.027**	B J	**0.061**	B J
DEET	**1.99**	B	**9.97**	BC	**2.62**	B	**11.6**	B
Desmethyldiltiazem	0.0357	U	**0.016**	B JC	**0.02**	B J	**0.015**	B J
Diazepam	0.0207	U	**0.048**	JC	0.0344	U	0.0198	U
Fluocinonide	0.286	U	0.549	U	0.0731	U	0.45	U
Fluticasone propionate	0.0846	U	0.0957	U	0.068	U	0.101	U
Hydrocortisone	**1.08**	B J	**3.61**	B JC	0.145	U	0.109	U
10-hydroxy-amitriptyline	0.0615	U	0.0878	U	0.0424	U	0.0297	U
Meprobamate	0.0348	U	0.0171	U	0.034	U	0.0214	U
Methylprednisolone	0.435	U	**0.599**	J	0.389	U	0.9	U
Metoprolol	0.0027	U	**0.19**	B JC	**0.005**	B J	**0.009**	B J
Norfluoxetine	0.0044	U	0.0069	U	0.0072	U	0.006	U
Norverapamil	0.0013	U	0.0028	U	0.0014	U	0.0015	U
Paroxetine	0.0205	U	0.0414	U	0.0187	U	0.0602	U
Prednisolone	0.0727	U	**0.151**	B J	0.034	U	0.106	U
Prednisone	**0.204**	J	**0.392**	JC	0.269	U	0.232	U
Promethazine	**0.009**	B J	**0.008**	B JC	0.0025	U	0.0099	U
Propoxyphene	0.0008	U	0.0006	U	0.0007	U	0.0005	U
Propranolol	0.0034	U	0.0108	U	0.0028	U	0.0047	U
Sertraline	0.0251	U	**0.017**	J	0.0052	U	0.0164	U
Simvastatin	0.156	U	0.176	U	0.0323	U	0.103	U
Theophylline	**1.63**	B J	**1.13**	B JC	**0.474**	B J	**0.66**	B J
Trenbolone	0.0081	U	**0.046**	J	0.0162	U	0.0355	U
Trenbolone acetate	0.0327	U	0.0498	U	0.0267	U	0.0325	U
Valsartan	0.0817	U	**0.232**	B JC	**0.047**	J	**0.173**	J
Verapamil	**0.004**	B J	**0.005**	B JC	**0.006**	B J	0.0029	U

[U] Non-detect at reporting limit
[B] Analyte found in associated blank and concentration in sample <10x concentration in lab blank
[C] Detected in duplicate sample
[H] Concentration is estimated
[J] Concentration less than limit of quantification

Table 3.3-3. PPCP concentrations (ng/L) measured at Hotel (Spring Lake, San Marcos) during January, May, and July sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List	January		May		July	
Acetaminophen	**0.869**	J	0.849	U	0.249	U
Azithromycin	**0.287**	B J	0.0928	U	0.0806	U
Caffeine	**37.3**		**217**		**3.43**	B J
Carbadox	0.0448	U	0.0561	U	0.0442	U
Carbamazepine	0.0019	U	0.001	U	0.0014	U
Cefotaxime	1.49	U	0.589	U	6.24	U
Ciprofloxacin	0.372	U	0.214	U	0.307	U
Clarithromycin	**0.003**	B J	0.002	U	**0.002**	B J
Clinafloxacin	0.481	U	0.851	U	0.516	U
Cloxacillin	0.167	U H	0.182	U H	3.15	U H
Dehydronifedipine	0.0108	U	0.0058	U	0.0124	U
Digoxigenin	0.134	U	0.197	U	0.164	U
Digoxin	**0.868**	J	**0.588**	J	**0.302**	B J
Diltiazem	**0.002**	J	**0.002**	B J	**0.004**	J
Diphenhydramine	**0.005**	B J	**0.119**	J	**0.002**	B J
Enrofloxacin	**0.123**	J	0.119	U	0.293	U
Erythromycin-H2O	**0.158**	B H	**0.089**	B H	1.58	U H
Flumequine	**0.026**	J	**0.005**	J	0.0044	U
Fluoxetine	0.0008	U	0.0006	U	**0.001**	B J
Lincomycin	0.0102	U	0.013	U	0.0068	U
Lomefloxacin	0.0071	U	0.013	U	0.0202	U
Miconazole	**0.138**	B J	**0.068**	B J	**0.033**	B J
Norfloxacin	0.456	U	0.64	U	0.816	U
Norgestimate	**0.279**	J	0.144	U	0.261	U
Ofloxacin	0.0084	U	0.0091	U	**0.0226**	U
Ormetoprim	0.003	U	0.0028	U	**0.0032**	U
Oxacillin	0.157	U H	0.113	U H	1.58	U H
Oxolinic Acid	0.0396	U	0.114	U	0.0251	U
Penicillin G	**4.5**	B H	4.26	R B H	**4.35**	H
Penicillin V	**0.284**	B J	0.172	U	**0.268**	B J
Roxithromycin	0.0049	U	0.0033	U	0.0025	U
Sarafloxacin	0.145	U	0.186	U	0.309	U
Sulfachloropyridazine	0.0151	U	0.0068	U	0.0223	U
Sulfadiazine	0.0084	U	0.004	U	0.0101	U
Sulfadimethoxine	0.0054	U	0.0045	U	0.0116	U
Sulfamerazine	0.0051	U	0.0037	U	0.0103	U
Sulfamethazine	0.0083	U	**0.026**	J	0.0141	U
Sulfamethizole	**0.21**	J	0.161	U	**0.03**	B J
Sulfamethoxazole	**0.122**	J	**0.141**	J	**0.185**	J
Sulfanilamide	**2.31**	J	**2.48**	J	**3.34**	B J
Sulfathiazole	0.0153	U	0.0137	U	0.021	U
Thiabendazole	**0.014**	B J	**0.074**	B J	**0.013**	J
Trimethoprim	**0.004**	B J	0.007	U	**0.011**	B J
Tylosin	0.0192	U	0.0178	U	**0.043**	B J
Virginiamycin M1	**0.253**	J	0.0844	U	**0.112**	J
1,7-Dimethylxanthine	**2.83**	B J	**0.849**	B J	**0.667**	B J

U Non-detect at reporting limit

B Analyte found in associated blank and concentration in sample <10x concentration in blank

H Concentration is estimated

J Concentration less than limit of quantification

Table 3.3-4. PPCP concentrations (ng/L) measured at Hotel (Spring Lake, San Marcos) during January, May, and July sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List Continued	January		May		July	
Alprazolam	0.0114	U	0.0082	U	**0.024**	J
Amitriptyline	0.008	U	0.038	U	0.0335	U
Amlodipine	0.0229	U	0.0086	U	0.0143	U
Benzoylecgonine	**0.009**	B J	**0.136**	B J	**0.036**	B J
Benztropine	**0.482**	B J	**0.384**	B J	**0.458**	B J
Betamethasone	0.154	U	0.0403	U	0.0481	U
Cocaine	**0.035**	B J	**0.571**		**0.028**	B J
DEET	**2.67**	B	**1.28**	B	**1.5**	B
Desmethyldiltiazem	**0.03**	B J	0.0023	U	**0.007**	B J
Diazepam	0.0561	U	0.0354	U	0.0158	U
Fluocinonide	0.472	U	0.412	U	0.202	U
Fluticasone propionate	0.0669	U	**0.124**	J	0.064	U
Hydrocortisone	**1.83**	B J	0.274	U	0.0891	U
10-hydroxy-amitriptyline	0.0597	U	0.0488	U	0.0495	U
Meprobamate	0.0602	U	0.0292	U	0.029	U
Methylprednisolone	0.467	U	0.476	U	0.4	U
Metoprolol	**0.009**	B J	0.0039	U	**0.005**	B J
Norfluoxetine	0.0049	U	0.0062	U	0.0079	U
Norverapamil	0.0022	U	0.0007	U	0.0018	U
Paroxetine	0.0162	U	0.0272	U	0.0064	U
Prednisolone	**0.071**	B J	0.142	U	0.112	U
Prednisone	**0.327**	J	0.211	U	0.116	U
Promethazine	**0.005**	B J	0.0029	U	0.0062	U
Propoxyphene	0.0013	U	0.0005	U	0.0013	U
Propranolol	**0.029**	J	0.0053	U	0.004	U
Sertraline	**0.027**	J	0.0178	U	0.0092	U
Simvastatin	0.154	U	0.189	U	0.127	U
Theophylline	**6.45**	J	**1.42**	B J	**0.751**	B J
Trenbolone	**0.033**	J	0.0447	U	0.0229	U
Trenbolone acetate	0.0312	U	0.0346	U	0.0207	U
Valsartan	**0.389**	B J	**0.331**	B J	**0.221**	J
Verapamil	**0.004**	B J	**0.005**	B J	0.0029	U

[U] Non-detect at reporting limit

[B] Analyte found in associated blank and concentration in sample <10x concentration in blank

[H] Concentration is estimated

[J] Concentration less than limit of quantification

3.3.2 Comal

A total of eight PPCP samples were collected during Spring and Fall collections in 2024, including one field duplicate sample during the Fall at Spring Run 3 and one DI blank taken at Spring Run 1 in the Spring. Samples were also collected at Spring Run 3 during the months of January, May, July, and November (November results not yet available). Samples were only taken at Spring Run 1 and Spring Run 7 during the standard Spring (March) and Fall (August) sampling events. Results for the Spring and Fall PPCP sampling at Spring Runs 1, 3, and 7 are denoted in Table 3.3-5 and 3.3-6 and PPCP results for Spring Run 3 for January, May, and July are noted in Tables 3.3-7 and 3.3-8.

Table 3.3-5. PPCP concentrations (ng/L) measured at Spring Run 1, Spring Run 3, and Spring Run 7 (Landa Lake) during Spring and Fall sampling events (2024). Samples with detectable concentrations denoted in bold.

	Spring			Fall		
PPCP List	Spring Run 1	Spring Run 3	Spring Run 7	Spring Run 1	Spring Run 3	Spring Run 7
Acetaminophen	0.278 U	0.392 U	**2.2** J	**4.72**	0.284 U	0.296 U
Azithromycin	**0.092** B J	**0.242** B J	**0.183** B J	0.139 U	0.166 U	0.0482 U
Caffeine	**1.07** B J	**0.772** B J	**4.04** B J	**124**	**2.53** B JC	**1.63** B J
Carbadox	0.0438 U	0.0694 U	0.065 U	0.181 U	0.561 U	**0.072** J
Carbamazepine	0.0024 U	0.002 U	0.0016 U	0.0012 U	0.0013 U	0.0014 U
Cefotaxime	2.77 U	0.538 U	0.682 U	5.81 U	6.27 U	6.35 U
Ciprofloxacin	0.195 U	0.289 U	0.312 U	**0.775** J	0.356 U	0.41 U
Clarithromycin	**0.023** B J	0.0037 U	0.0029 U	0.002 U	**0.016** B J	**0.004** B J
Clinafloxacin	0.435 U	0.671 U	1.26 U	0.429 U	0.829 U	0.333 U
Cloxacillin	0.333 U H	0.201 U H	0.246 U H	2.93 U H	3.17 U H	3.21 U H
Dehydronifedipine	0.0153 U	0.0107 U	0.008 U	0.0071 U	0.0083 U	**0.011** J
Digoxigenin	0.205 U	0.496 U	0.303 U	0.102 U	0.133 U	0.116 U
Digoxin	**0.326** J	**0.211** J	**0.203** J	**0.268** B J	**0.299** B JC	**0.288** B J
Diltiazem	0.0024 U	0.0012 U	**0.003** J	**0.003** J	**0.004** JC	**0.005** J
Diphenhydramine	**0.104** J	**0.003** B J	0.0023 U	**0.071** J	**0.009** B J	**0.004** B J
Enrofloxacin	0.117 U	0.136 U	0.148 U	0.128 U	0.107 U	0.126 U
Erythromycin-H2O	**0.064** B H	**0.081** B H	**0.098** B H	1.47 U H	1.58 U H	1.6 U H
Flumequine	0.0062 U	0.0047 U	0.0056 U	0.0041 U	**0.003** B JC	0.0039 U
Fluoxetine	0.0019 U	**0.002** B J	**0.002** B J	0.0007 U	0.0005 U	0.0007 U
Lincomycin	0.0069 U	**0.008** J	0.0051 U	0.0038 U	**0.004** J	0.0034 U
Lomefloxacin	0.0256 U	**0.054** B J	0.0111 U	0.014 U	0.0094 UC	0.0115 U
Miconazole	**0.092** B J	**0.114** B J	**0.118** B J	0.0087 U	0.0089 UC	**0.02** B J
Norfloxacin	0.34 U	0.461 U	**0.393** J	0.706 U	0.553 U	0.777 U
Norgestimate	0.446 U	0.553 U	0.481 U	0.35 U	0.298 U	0.18 U
Ofloxacin	0.0155 U	**0.057** B J	0.0327 U	0.0753 U	**0.044** J	0.0055 U
Ormetoprim	0.0036 U	0.0038 U	0.002 U	0.0043 U	**0.003** B J	0.0056 U
Oxacillin	0.508 U H	**0.24** H	0.147 U H	1.47 U H	1.58 U H	1.6 U H
Oxolinic Acid	0.0247 U	0.0404 U	0.0317 U	0.0249 U	0.0253 U	0.0112 U
Penicillin G	**1.69** B H	**5.04** B H	1.71 U H	2.93 U H	3.17 U H	3.21 U H
Penicillin V	0.2 U	0.206 U	**0.276** B J	**0.44** B J	0.208 UC	**0.235** B J
Roxithromycin	0.0065 U	**0.027** J	0.0038 U	0.0018 U	0.0022 U	0.0026 U
Sarafloxacin	0.149 U	0.107 U	0.162 U	0.174 U	0.18 U	0.094 U
Sulfachloropyridazine	0.0156 U	0.0208 U	0.0086 U	0.0138 U	0.0124 U	0.0251 U
Sulfadiazine	0.0155 U	0.0132 U	**0.017** B J	0.0086 U	0.0065 U	0.0067 U
Sulfadimethoxine	0.0114 U	0.0146 U	0.0071 U	0.0208 U	0.0068 U	0.0105 U
Sulfamerazine	0.0201 U	0.0134 U	0.0053 U	0.0066 U	**0.013** J	0.0102 U
Sulfamethazine	0.0158 U	0.0123 U	0.112 U	0.0079 U	0.0052 U	0.0084 U
Sulfamethizole	0.414 U	**0.379** J	0.324 U	0.0368 U	0.0151 U	0.0341 U
Sulfamethoxazole	**0.262** J	**0.538** J	**0.534** J	**0.421** J	**0.541** JC	**0.253** J
Sulfanilamide	**2.35** J	**2.24** J	**3.38** J	**2.64** B J	**3.89** JC	**2.56** B J
Sulfathiazole	0.0326 U	0.0367 U	0.0158 U	0.0427 U	0.0146 U	0.0239 U
Thiabendazole	**0.006** B J	**0.032** B J	**0.037** B J	**0.026** J	**0.017** JC	0.0091 U
Trimethoprim	**0.011** B J	0.0645 U	0.0046 U	0.0193 U	**0.006** B JC	**0.007** B J
Tylosin	0.0204 U	0.0169 U	0.0154 U	**0.025** B J	**0.193** J	0.011 U
Virginiamycin M1	0.0688 U	0.0703 U	0.183 U	**0.147** J	0.0345 U	**0.342** J
1,7-Dimethylxanthine	**0.405** B J	**0.664** B J	**1.01** B J	**2.13** B J	**0.303** B JC	**0.194** B J

[U] Non-detect at reporting limit
[B] Analyte found in associated blank and concentration in sample <10x concentration in lab blank
[C] Detected in duplicate sample
[H] Concentration is estimated
[J] Concentration less than limit of quantification

Table 3.3-6. PPCP concentrations (ng/L) measured at Spring Run 1, Spring Run 3, and Spring Run 7 (Landa Lake) during Spring and Fall sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List Continued	Spring			Fall		
	Spring Run 1	Spring Run 3	Spring Run 7	Spring Run 1	Spring Run 3	Spring Run 7
Alprazolam	**0.017** B J	**0.014** B J	**0.022** B J	0.0106 U	0.0242 U	0.0135 U
Amitriptyline	**0.011** J	0.0128 U	0.0132 U	0.012 U	0.0281 U	0.012 U
Amlodipine	0.0178 U	0.0107 U	0.0281 U	0.009 U	0.0144 U	0.0488 U
Benzoylecgonine	**0.018** B J	**0.037** B J	**0.013** B J	**0.041** B J	**0.023** B JC	**0.088** B J
Benztropine	**0.4** B J	**0.451** B J	**0.386** B J	**0.444** B J	**0.482** B JC	**0.463** B J
Betamethasone	0.166 U	0.196 U	0.161 U	0.0332 U	0.0379 U	0.0561 U
Cocaine	**0.033** B J	**0.027** B J	**0.016** B J	**0.078** B J	**0.051** B JC	**0.048** B J
DEET	**1.72** B	**2.58** B	**1.87** B	**2.8** B	**3.18** BC	**3.19** B
Desmethyldiltiazem	**0.013** B J	**0.024** B J	**0.036** B J	**0.006** B J	**0.009** B JC	**0.003** B J
Diazepam	0.0403 U	**0.058** J	0.0489 U	0.0135 U	0.0171 U	0.0183 U
Fluocinonide	0.291 U	0.477 U	0.291 U	0.143 U	0.139 U	0.0768 U
Fluticasone propionate	0.108 U	0.0991 U	0.108 U	0.0496 U	0.0772 U	0.0425 U
Hydrocortisone	**2.3** B J	**2.61** B J	**2.06** B J	**0.215** J	0.0558 U	0.114 U
10-hydroxy-amitriptyline	0.0681 U	0.053 U	0.112 U	0.0433 U	0.0408 U	0.0564 U
Meprobamate	0.0148 U	**0.0321** B J	0.0247 U	0.0257 U	0.0385 U	0.0431 U
Methylprednisolone	0.457 U	0.699 U	0.264 U	0.546 U	0.528 U	0.429 U
Metoprolol	0.0067 U	**0.008** B J	0.0051 U	**0.004** B J	**0.009** B JC	**0.005** B J
Norfluoxetine	0.0052 U	0.0081 U	0.0115 U	0.0039 U	0.0071 U	0.0108 U
Norverapamil	0.0017 U	0.0087 U	0.0013 U	0.0013 U	0.0012 U	0.0011 U
Paroxetine	0.0174 U	0.029 U	0.0348 U	0.0268 U	0.0419 U	0.0119 U
Prednisolone	**0.105** B J	**0.044** B J	**0.066** B J	0.0561 U	0.0439 U	0.067 U
Prednisone	**0.186** J	**0.513** J	**0.161** J	0.167 U	0.141 U	0.191 U
Promethazine	0.0075 U	0.0196 U	0.018 U	0.0037 U	0.0012 U	0.0024 U
Propoxyphene	0.0009 U	**0.002** B J	**0.002** B J	0.0013 U	**0.003** J H	0.0005 U
Propranolol	**0.009** J	**0.007** J	0.0044 U	0.0042 U	0.0041 U	0.0038 U
Sertraline	0.0162 U	0.0285 U	**0.019** J	0.0076 U	**0.01** J	0.0102 U
Simvastatin	0.115 U	0.231 U	0.154 U	0.0831 U	0.059 U	0.0627 U
Theophylline	**0.876** B J	**0.574** B J	**2.05** B J	**4.19** J	**0.484** B JC	**0.364** B J
Trenbolone	**0.029** J	0.0129 U	**0.096** J	**0.086** J	0.0221 U	0.0459 U
Trenbolone acetate	**0.047** J	0.0448 U	0.0338 U	0.031 U	0.0274 U	0.0285 U
Valsartan	**0.079** B J	**0.365** B J	0.0797 U	**0.06** J	**0.17** JC	0.04 U
Verapamil	**0.005** B J	**0.018** B J	0.0071 U	0.0018 U	0.002 U	0.0015 U

U Non-detect at reporting limit
B Analyte found in associated blank and concentration in sample <10x concentration in lab blank
C Detected in duplicate sample
H Concentration is estimated
J Concentration less than limit of quantification

Table 3.3-7. PPCP concentrations (ng/L) measured at Spring Run 3 (Landa Lake, New Braunfels) during January, May, and July sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List	January		May		July	
Acetaminophen	**0.869**	J	0.849	U	0.249	U
Azithromycin	**0.287**	B J	0.0928	U	0.0806	U
Caffeine	**37.3**		**217**		**3.43**	B J
Carbadox	0.0448	U	0.0561	U	0.0442	U
Carbamazepine	0.0019	U	0.001	U	0.0014	U
Cefotaxime	1.49	U	0.589	U	6.24	U
Ciprofloxacin	0.372	U	0.214	U	0.307	U
Clarithromycin	**0.003**	B J	0.002	U	**0.002**	B J
Clinafloxacin	0.481	U	0.851	U	0.516	U
Cloxacillin	0.167	U H	0.182	U H	3.15	U H
Dehydronifedipine	0.0108	U	0.0058	U	0.0124	U
Digoxigenin	0.134	U	0.197	U	0.164	U
Digoxin	**0.868**	J	**0.588**	J	**0.302**	B J
Diltiazem	**0.002**	J	**0.002**	B J	**0.004**	J
Diphenhydramine	**0.005**	B J	**0.119**	J	**0.002**	B J
Enrofloxacin	**0.123**	J	0.119	U	0.293	U
Erythromycin-H2O	**0.158**	B H	**0.089**	B H	1.58	U H
Flumequine	**0.026**	J	**0.005**	J	0.0044	U
Fluoxetine	0.0008	U	0.0006	U	**0.001**	B J
Lincomycin	0.0102	U	0.013	U	0.0068	U
Lomefloxacin	0.0071	U	0.013	U	0.0202	U
Miconazole	**0.138**	B J	**0.068**	B J	**0.033**	B J
Norfloxacin	0.456	U	0.64	U	0.816	U
Norgestimate	**0.279**	J	0.144	U	0.261	U
Ofloxacin	0.0084	U	0.0091	U	**0.0226**	U
Ormetoprim	0.003	U	0.0028	U	**0.0032**	U
Oxacillin	0.157	U H	0.113	U H	1.58	U H
Oxolinic Acid	0.0396	U	0.114	U	0.0251	U
Penicillin G	**4.5**	B H	4.26	R B H	**4.35**	H
Penicillin V	**0.284**	B J	0.172	U	**0.268**	B J
Roxithromycin	0.0049	U	0.0033	U	0.0025	U
Sarafloxacin	0.145	U	0.186	U	0.309	U
Sulfachloropyridazine	0.0151	U	0.0068	U	0.0223	U
Sulfadiazine	0.0084	U	0.004	U	0.0101	U
Sulfadimethoxine	0.0054	U	0.0045	U	0.0116	U
Sulfamerazine	0.0051	U	0.0037	U	0.0103	U
Sulfamethazine	0.0083	U	**0.026**	J	0.0141	U
Sulfamethizole	**0.21**	J	0.161	U	**0.03**	B J
Sulfamethoxazole	**0.122**	J	**0.141**	J	**0.185**	J
Sulfanilamide	**2.31**	J	**2.48**	J	**3.34**	B J
Sulfathiazole	0.0153	U	0.0137	U	0.021	U
Thiabendazole	**0.014**	B J	**0.074**	B J	**0.013**	J
Trimethoprim	**0.004**	B J	0.007	U	**0.011**	B J
Tylosin	0.0192	U	0.0178	U	**0.043**	B J
Virginiamycin M1	**0.253**	J	0.0844	U	**0.112**	J
1,7-Dimethylxanthine	**2.83**	B J	**0.849**	B J	**0.667**	B J

[U] Non-detect at reporting limit
[B] Analyte found in associated blank and concentration in sample <10x concentration in blank
[H] Concentration is estimated
[J] Concentration less than limit of quantification

Table 3.3-8. PPCP concentrations (ng/L) measured at Spring Run 3 (Landa Lake, New Braunfels) during January, May, and July sampling events (2024). Samples with detectable concentrations denoted in bold.

PPCP List Continued	January		May		July	
Alprazolam	0.012	U	0.0154	U	0.0157	U
Amitriptyline	**0.021**	J	**0.01**	J	**0.012**	J
Amlodipine	0.035	U	0.0726	U	0.0174	U
Benzoylecgonine	**0.022**	B J	**0.027**	B J	**0.089**	B J
Benztropine	**0.424**	B J	**0.441**	B J	**0.459**	B J
Betamethasone	0.131	U	0.0848	U	0.0516	U
Cocaine	**0.006**	B J	**0.091**	B J	**0.1**	B J
DEET	**2.61**	B	**1.23**	B	**1.81**	B
Desmethyldiltiazem	**0.01**	B J	**0.027**	B J	**0.003**	B J
Diazepam	0.0386	U	0.0381	U	0.0208	U
Fluocinonide	0.388	U	0.54	U	0.148	U
Fluticasone propionate	0.0721	U	0.12	U	0.0679	U
Hydrocortisone	**1.16**	B J	0.325	U	0.284	U
10-hydroxy-amitriptyline	0.0912	U	0.0557	U	0.0429	U
Meprobamate	**0.024**	B J	0.0447	U	0.0382	U
Methylprednisolone	0.565	U	0.412	U	0.709	U
Metoprolol	0.0024	U	0.0035	U	**0.007**	B J
Norfluoxetine	0.0115	U	0.0065	U	0.0099	U
Norverapamil	0.0021	U	0.0018	U	0.0018	U
Paroxetine	0.0023	U	0.0115	U	0.0164	U
Prednisolone	**0.119**	B J	0.165	U	0.0845	U
Prednisone	**0.23**	J	0.213	U	0.16	U
Promethazine	0.0049	U	0.0101	U	0.0048	U
Propoxyphene	0.0009	U	**0.003**	J	0.0007	U
Propranolol	0.0046	U	**0.011**	J	0.0044	U
Sertraline	**0.024**	J	0.0117	U	0.0131	U
Simvastatin	0.0979	U	0.246	U	0.083	U
Theophylline	**0.914**	B J	**0.565**	B J	**6.83**	J
Trenbolone	**0.039**	J	0.0498	U	0.0278	U
Trenbolone acetate	0.0486	U	0.0477	U	0.0335	U
Valsartan	**0.454**	B J	**0.751**	B J	**0.275**	J
Verapamil	**0.005**	B J	**0.012**	B J	**0.008**	B J

[U] Non-detect at reporting limit
[B] Analyte found in associated blank and concentration in sample <10x concentration in blank
[J] Concentration less than limit of quantification

3.4 Sediment sampling

3.4.1 San Marcos

Table 3.4-1 denotes the contaminant results for sediment samples collected in 2024 at the San Marcos system sites. Overall, several of the same contaminants were detected at each site and many of the contaminants are associated with being a byproduct from combustion engines or is a product in dyes, insecticides, or preservatives.

Table 3.4-1. Contaminant concentrations (μg/Kg) measured in sediment samples collected from the San Marcos system in August 2024. Samples with detectable concentrations are denoted in bold.

Analyte	Sink Creek	Spring Lake	Sessom Creek	City Park	Rio Vista	IH35	IH35[2]	Lab Blank
1-Methylnaphthalene	<59.8 [U]	<132 [U]	<157 [U]	<123 [U]	<74.1 [U]	<45.7 [U]	<48.1 [U]	<2.31 [U]
2-Methylnaphthalene	<58.2 [U]	<128 [U]	<153 [U]	<119 [U]	<72.1 [U]	<44.5 [U]	<46.8 [U]	<2.24 [U]
Acenaphthene	<53.7 [U]	<118 [U]	<141 [U]	<110 [U]	<66.5 [U]	<41.0 [U]	<43.2 [U]	<2.07 [U]
Acenaphthylene	<37.2 [U]	<81.9 [U]	<97.6 [U]	<76.3 [U]	<46.1 [U]	<28.5 [U]	<29.9 [U]	<1.43 [U]
Anthracene	<51.7 [U]	<114 [U]	**475** [J]	<106 [U]	<64.1 [U]	<39.6 [U]	<41.6 [U]	<1.99 [U]
Benzo[a]anthracene	**114** [J]	**1300**	**3270**	**561**	**214**	**211**	**126**	<1.51 [U]
Benzo[a]pyrene	**113** [J]	**1600**	**3170**	**745**	**278**	**262**	**175**	<1.95 [U]
Benzo[b]fluoranthene	**152** [J]	**2450**	**4250**	**1140**	**455**	**374**	**255**	<2.14 [U]
Benzo[g,h,i]perylene	**99.8** [J]	**1510**	**2500**	**674**	**252** [J]	**232**	**161** [J]	<1.91 [U]
Benzo[k]fluoranthene	**64.1** [J]	**990**	**1820**	**486** [J]	**181** [J]	**161** [J]	**107** [J]	<1.95 [U]
Chrysene	**127** [J]	**1640**	**3450**	**894**	**300** [J]	**271**	**194** [J]	<1.82 [U]
Dibenz(a,h)anthracene	<52.3 [U]	**339**	**587**	**157** [J]	<64.8 [U]	**53.0** [J]	<42.1 [U]	<2.02 [U]
Fluoranthene	**185** [J]	**2150**	**7360**	**1290**	**435**	**346**	**233**	<2.48 [U]
Fluorene	<49.6 [U]	<109 [U]	<130 [U]	<102 [U]	<61.4 [U]	<37.9 [U]	<39.9 [U]	<1.91 [U]
Indeno[1,2,3-cd]pyrene	**107** [J]	**1610**	**2680**	**738**	**268** [J]	**258**	**181** [J]	<2.76 [U]
Naphthalene	<74.3 [U]	<164 [U]	<195 [U]	<152 [U]	<92.0 [U]	<56.8 [U]	<59.8 [U]	<2.86 [U]
Phenanthrene	<80.1 [U]	**358** [J]	**2720**	**348** [J]	<99.2 [U]	**70.9** [J]	<64.5 [U]	<3.09 [U]
Pyrene	**182** [J]	**1890**	**5800**	**1140**	**394**	**313**	**242**	<2.23 [U]

[U] non-detect at MDL (Method Detection Limit)

[J] Result is less than the RL (reporting limit) but greater than the MDL.

3.4.2 Comal

Table 3.4-2 denotes the contaminant results for sediment samples collected in 2024 at the Comal system sites. Many of the contaminants were detected at each of the Comal system sites but, in general, the Comal system reported fewer detections and lower values than the San Marcos system. Among sites, the Old Channel had the greatest number of detectable contaminants whereas Bleiders Creek and Spring Island in Landa Lake reported no contaminant detections.

Table 3.4-2 Contaminant concentrations (µg/Kg) measured in sediment samples collected from the Comal system in August 2024. Samples with detectable concentrations are denoted in bold.

Analyte	Bleiders Creek		Spring Island		Old Channel		Old Channel[2]		New Channel		Lab Blank	
1-Methylnaphthalene	<92.2	U	<82.0	U	<58.1	U	<40.4	U	<66.1	U	<2.31	U
2-Methylnaphthalene	<89.7	U	<79.8	U	<56.6	U	<39.3	U	<64.3	U	<2.24	U
Acenaphthene	<82.7	U	<73.6	U	<52.2	U	<36.3	U	<59.3	U	<2.07	U
Acenaphthylene	<57.4	U	<51.0	U	**51.5**	J	<25.1	U	<41.1	U	<1.43	U
Anthracene	<79.8	U	<70.9	U	<50.3	U	<35.0	U	<57.1	U	<1.99	U
Benzo[a]anthracene	<60.5	U	<53.8	U	**417**		**119**		**53.6**	J	<1.51	U
Benzo[a]pyrene	<78.0	U	<69.4	U	**319**		**79.9**	J	<55.9	U	<1.95	U
Benzo[b]fluoranthene	<85.7	U	<76.2	U	**580**		**151**	J	**75.2**	J	<2.14	U
Benzo[g,h,i]perylene	<76.3	U	<67.9	U	**172**	J	**46.9**	J	<54.7	U	<1.91	U
Benzo[k]fluoranthene	<77.9	U	<69.3	U	**238**	J	**66.5**	J	<55.8	U	<1.95	U
Chrysene	<72.6	U	<64.6	U	**501**		**143**	J	**64.2**	J	<1.82	U
Dibenz(a,h)anthracene	<80.7	U	<71.7	U	**53.6**	J	<35.3	U	<57.8	U	<2.02	U
Fluoranthene	<99.4	U	<88.4	U	**1200**		**283**		**79.8**	J	<2.48	U
Fluorene	<76.4	U	<68.0	U	<48.2	U	<33.5	U	<54.8	U	<1.91	U
Indeno[1,2,3-cd]pyrene	<110	U	<98.3	U	**210**	J	**57.1**	J	<79.2	U	<2.76	U
Naphthalene	<115	U	<102	U	<72.2	U	<50.2	U	<82.1	U	<2.86	U
Phenanthrene	<124	U	<110	U	**156**	J	**62.1**	J	<88.5	U	<3.09	U
Pyrene	<89.0	U	<79.2	U	**910**		**209**		**77.1**	J	<2.23	U

U non-detect at MDL (Method Detection Limit)

J Result is less than the RL (reporting limit) but greater than the MDL.

4 | References

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