Medina River Watershed Protection Plan

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A document developed by the stakeholders of the Medina River Watershed to restore and protect water quality in the Medina River (1903_05, 1903_03, 1903_04), Medio Creek (1912A_01, 1912_01), and Polecat Creek (1903A_01).

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Acknowledgements

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- Texas State Soil and Water Conservation Board

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List of Acronyms

A.U.	Assessment Unit
CWA	Clean Water Act
DEM	Digital Elevation Model
DO	Dissolved Oxygen
ECHO	Enforcement and Compliance History Online
EPA	Environmental Protection Agency
GSI	Green Stormwater Infrastructure
HSG	Hydrologic Soil Groups
LULC	Land Use Land Cover
MGD	Million Gallons per Day
MPN	Most Probable Number
MSGP	Multi-Sector General Permit
MSL	Mean Sea Level
NASS	National Agricultural Statistics Service
NLCD	National Land Cover Database
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSSF	On-site Sewage Facilities
PCR	Primary Contact Recreation
RUAA	Recreational Use Attainability Analysis
RMU	Resource Management Unit
SARA	San Antonio River Authority
SSO	Sanitary Sewer Overflow
SNC	Significant Non-Compliance
SSURGO	Soil Survey Geographic Database
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
USDA	United States Department of Agriculture

USGS	United State Geological Survey
WWTF	Wastewater Treatment Facility

Executive Summary

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Chapter 1
Introduction to Watershed Management

Definition of a Watershed

A watershed comprises a "land area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ocean." Any land surface surrounding the water body is considered a part of the watershed. These land surfaces, ranging in size from small geological features to large portions of the country, contribute to the water system during runoff and rainfall events. For example, several sub-watersheds combine to form the Medina River Watershed, which is part of the larger San Antonio River Basin. These sub-watersheds include Medio and Polecat Creek, along with the Medina River.

The Watershed Approach

State and federal water resource management agencies widely accept the watershed approach to facilitate water quality management. The U.S. Environmental Protection Agency (EPA) describes the watershed approach as "a flexible framework for managing water resource quality and quantity within a specified drainage area or watershed" (EPA 2008). This process requires engaging stakeholders to make management decisions supported by sound science (EPA 2008). One critical aspect of this approach is that it focuses on hydrologic boundaries rather than political boundaries to address potential water quality impacts affecting all potential stakeholders.

A stakeholder is anyone who lives, works, or has an interest within the watershed or may be affected by efforts to address water quality issues. Stakeholders may include individuals, groups, businesses, organizations, or agencies. Continuous involvement of stakeholders throughout the watershed approach is critical for effectively selecting, designing, and implementing management measures that address watershed water quality.

Watershed Protection Plan

Watershed protection plans (WPPs) are voluntary, locally driven mechanisms that address complex water quality problems across political boundaries. A WPP is a framework to better leverage and coordinate private, nonprofit, local, state, and federal agency resources.

The Medina River Watershed WPP follows EPA's nine key elements, which are designed to guide the development of an effective WPP (EPA 2008). WPPs vary in methodology, content, and strategy based on local priorities and needs. However, successful plans have common fundamental elements (see Appendix C – Elements of Successful Watershed Protection Plans). These include:

1.) Identification of causes and sources of impairment,

2.) Expected load reductions from management strategies,
3.) Proposed management strategies,
4.) Technical and financial assistance needed to implement management measures,
5.) Information, education, and public participation needed to support implementation,
6.) Schedule for implementing management measures,
7.) Milestones for progress of WPP implementation,
8.) Criteria for determining success of WPP implementation, and
9.) Water quality monitoring

Watershed and Water Quality

Natural processes and human activities affect water quality and quantity within a watershed. Runoff initially begins as surface or subsurface water flow from a rainfall event in a land area ranging from agricultural, industrial, and urban to undeveloped. Runoff water may contain pollutants from different land uses as it flows into waterways. A WWTF can also release directly into a water body, emitting contaminants. Potential contaminants are classified as originating from point or nonpoint source pollution to effectively identify and manage different pollutants entering a watershed and water body.

Point Source Pollution

Point source pollution is discharged from a defined point or location, such as a pipe or a drain, and can be traced to a single point of origin. Such pollution is directly discharged into a water body and contributes to the waterbody's flow. Point sources of pollution permitted to discharge their effluent within specific pollutant limits must hold a permit through the Texas Pollutant Discharge Elimination Systems (TPDES).

Nonpoint Source Pollution

Pollution that comes from a source that does not have a single point of origin is defined as nonpoint source (NPS) pollution. The pollutants are generally carried by runoff from stormwater following rainfall events.

Adaptive Management

Adaptive management involves developing a natural resource management strategy to facilitate decision-making based on an ongoing, science-based process. Such an approach includes results of continual testing, monitoring, evaluating applied strategies, and revising management approaches to incorporate new information, science, and societal needs (EPA 2000). Adaptive management promotes flexibility for stakeholders in their decision-making process to account for uncertainty and to improve the performance of specific management measures (William et al. 2009). Using the process of adaptive management will help to implement strategies to address pollutant loadings and to promote efforts to understand further uncertainties in the watershed.

Education and Outreach

The development and implementation of a WPP depends on effective education, outreach, and engagement efforts to inform stakeholders, landowners, and residents of the activities and practices associated with the WPP. Education and outreach events provide the platform for the delivery of the new and/or improved information to stakeholders through the WPP implementation process. Education and outreach are integrated into many of the management measures that are detailed in this WPP.

Sources

EPA. (United States Environmental Protection Agency). 2000. EPA Office of Water. Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management. Federal Register, October 18, 2000

Williams, B.K., Szaro, R.C., Shapiro, C.D. 2009. Adaptive management: the U.S. Department of the Interior Technical Guide. Washington D.C

EPA. (United State Environmental Protection Agency). 2008. EPA Office of Water, Nonpoint Source Control Branch. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. Federal Register, March 2008

Chapter 2
Watershed Characterization

Introduction
This chapter provides geographic, demographic and water quality overviews of the current condition of the Medina River Below Medina Lake Watershed hereafter called the Medina River Watershed. Development of the information within this chapter relied heavily on state and federal data resources as well as local stakeholder knowledge. The collection of this information was a critical component to the reliable assessment of potential sources of water quality impairment and the recommendation of beneficial management measures.

Watershed Description
The Medina River Watershed belongs to the larger San Antonio River Basin. The upper reach of this watershed extends north of State Highway 16 in Bandera County and the lower reach extends south of the City of Somerset in Atascosa County. According to the National Hydrography Dataset (NHD), there are approximately 381 miles of perennial and intermittent streams and rivers within the watershed.

Table 1. County and watershed area summary.

County	Area Within Watershed (sq mi)	Watershed County Composition
Bexar	241.6	58.6%
Medina	148.2	35.9%
Atascosa	15.8	3.8%
Bandera	7	1.7%
Total Area	412.6	

These water bodies capture runoff from approximately 412.6 square miles of mostly shrub and agricultural land. The watershed is composed of area within Bexar, Medina, Bandera, and Atascosa counties (Table 1). However, the majority of this watershed lies within Bexar and Medina Counties (Figure 2). The watershed includes the cities of Somerset, Lacoste, Von Ormy, and Castroville. There are three named waterbodies within the Medina River Watershed, the Medina River, Medio Creek, and Polecat Creek.

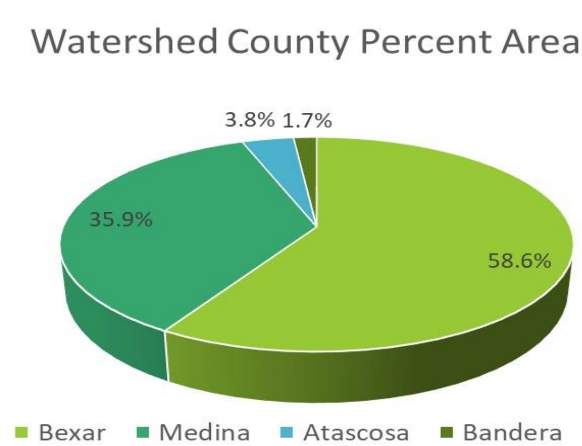

Figure 1

Medina River
The Medina River Below Diversion Lake begins just south of Medina Lake at Diversion Lake at Paradise Canyon in

Medina County. It flows south until the city of Castroville and then west until Texas State Highway Loop 1604. The section of the river within the watershed then turns southeast and flows until it meets Leon Creek (Table 2). In total the Medina River (Medina River Below Diversion Lake) flows approximately 69 miles within the identified Medina River Watershed (Figure 2).

Medio Creek

Medio Creek, composed of both Upper Medio Creek and Medio Creek, is a main tributary of the Medina River downstream of Lake Medina. It begins just west of State Highway 211 near the border of Bexar and Medina County (Table 2). This river flows for approximately 26 miles downstream until it meets the Medina River. Urban sprawl from San Antonio affects the northeast portion of the watershed, especially along Medio Creek (Figure 2)

Polecat Creek

Polecat Creek is a much smaller tributary of the Medina River, upstream of the confluence of Medio Creek and Medina River (Table 2; Figure 2). It starts just west of the city of La Coste and flows eastwards downstream for 11.7 miles until it meets the Medina River at Texas State Highway Loop 1604.

Table 2. Summary of watershed waterbodies.

Segment ID	Name	Description	A.U.s	A.U.s Impaired
1903	Medina River Below Medina Diversion Lake	From the confluence with the San Antonio River in Bexar County to the Medina Diversion Dam in Medina County	1903_03 1903_04, 1903_05	1903_03
1912A	Upper Medio Creek	From approximately 1.0 km (0.6 mi) upstream of I.H. 35 at San Antonio (Bexar County) to approximately 1.0 mi upstream of the Bexar/Medina County Line	1912A_01	none
1912	Medio Creek	From the confluence with the Medina River in Bexar County to a point 1.0km (0.6 miles) upstream of I.H. 34 in San Antonio in Bexar County	1912_01	1912_01
1903A	Polecat Creek	From 6.4 km above confluence with the Medina River to the spring source 1.3 km above FM 2790 southeast of La Coste	1903A_01	none

Sub-watersheds

Sub-watersheds were created to better analyze the watershed and help identify key areas of interest. The watershed is divided into eleven hydrologically unique sub-watersheds (Figure 3). This will allow time and funding to be directed to the areas that will have the highest impacts on water quality. The sub-watersheds were derived from Hydrological Unit Code 12s.

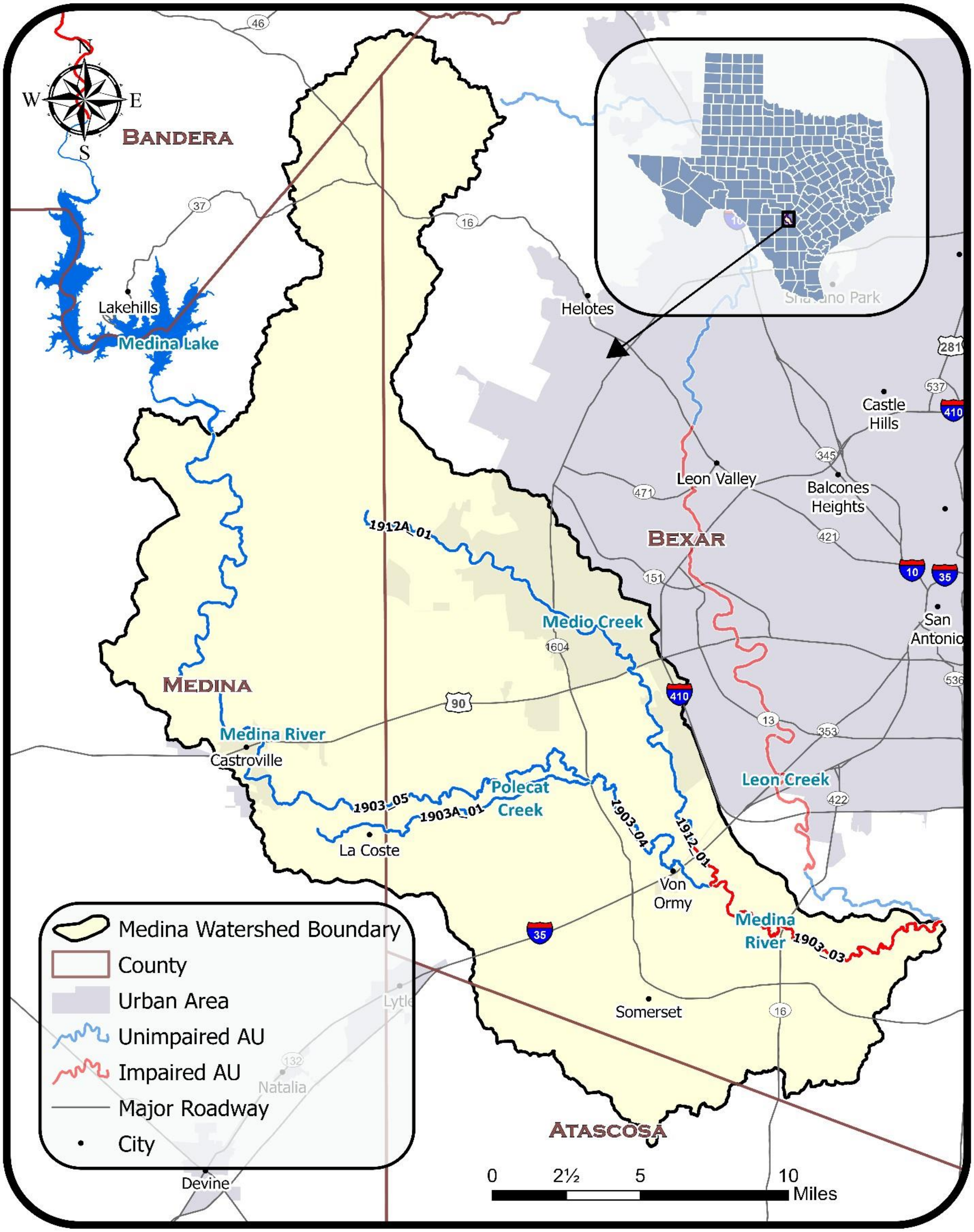

Figure 2. Extent of the Medina River Watershed and it's Assessment units (A.U.'s). Map data from TCEQ Surface water Assessment Unit Shapefile 2020.

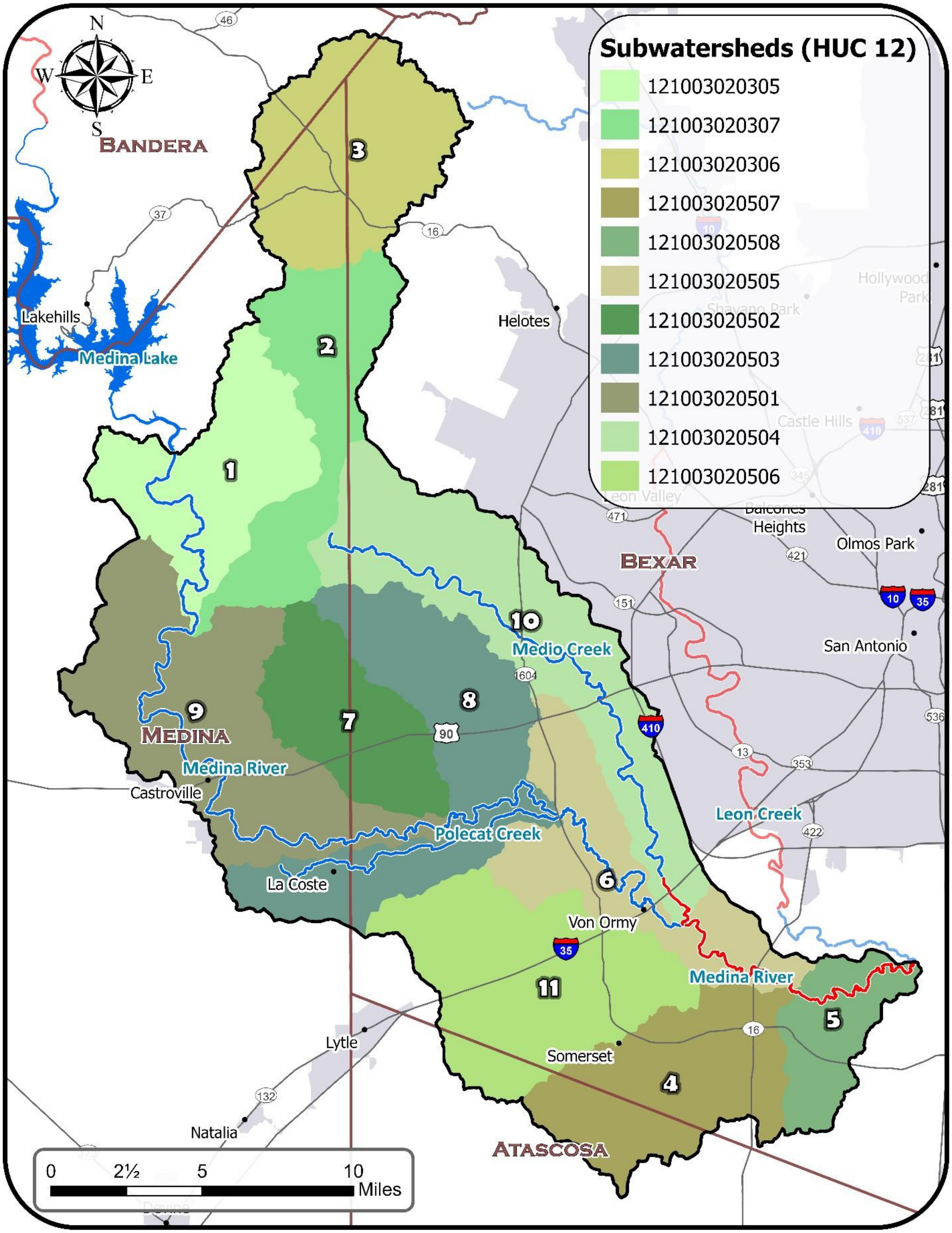

Figure 3. Medina River Watershed Hydrologic Unit Code (HUC) 12 sub-watersheds. Map data available from the USGS National Hydrography Dataset.

Physical Characteristics

Topography and Soils

Watershed topography and soils are important components of watershed hydrology. Topographical properties like slope and elevation define where water will flow to and soil properties influence water infiltration rates, runoff generation, and may limit the types of land development that can occur in some areas.

Watershed elevation ranges for the Medina River Watershed from a maximum elevation of 1899 feet above sea level in the north to a minimum elevation of 456 feet above sea level in the southeast (Figure 4). Elevation was determined using USGS 10-meter 3D Elevation Program. The northeast Medina River Watershed Below Medina Lake starts at the edge of the Edwards Plateau then crosses the Balcones Fault and rapidly decreases in elevation to the Texas Blackland Prairie at approximately 980 feet above sea level and gradually lowers to the Texas Claypan Area.

Hydrologic soil groups add to the understanding of soil within the watershed. Hydrologic soil groups indicate runoff potential and are determined based on the measure of precipitation, runoff, and infiltration. The primary hydrologic soil groups A, B, C, and D are found in this watershed (Figure 5). Soil Group D has a high clay content which results in soil that has a high runoff potential with very slow infiltration rates. The most common soil group in the watershed is Soil Group D, making up 46% of the watersheds soils, comprising a majority of the central and northern regions. Soil Group C is the second most common hydrologic soil group, making up approximately 32% of the watershed. Group C consists of finer soils and slow infiltrations rates and is located throughout the watershed but is concentrated in the southernmost region. The Medina River Watershed is only composed of 17% of Group B. Group B is composed of silt loam or loam types of soils and is consequently well draining. This group follows waterbody channels throughout the watershed. Soil Group A is the smallest portion of the watershed by area at about 5%. This group contains sand, loamy sand, or sandy loan and has very low runoff potential and high infiltration rates. There is some Group A soil within waterbody channels, but the greatest concentration is located at the southernmost tip of the watershed.

Dominant soil orders within the Medina River watershed are mollisols [44%], alfisols [21%], vertisols [16%], and inceptisols [12%] (Figure 6). Mollisols cover about 182 square miles in the central-northern region of the watershed. They are characterized by a dark surface layer indicative of high amounts of organic material. This makes these soils very fertile for agricultural purposes. Alfisols cover approximately 86 square miles of the southern region of the watershed. This soil is the result of the weathering process leaching clay mineral beneath the surface. Alfisols are found underneath mixed vegetative cover of forests or savannahs and tend to retain water. Vertisols make up a smaller portion (66 square miles) along the central eastern border of the watershed. This soil order is clay-rich and therefore exhibits a shrink-swell effect when there is a change in moisture. Inceptisols cover only 50 square miles of the watershed concentrated mostly in the northern most region of the watershed in areas of higher elevation. Inceptisols often have weakly developed subsurface horizons.

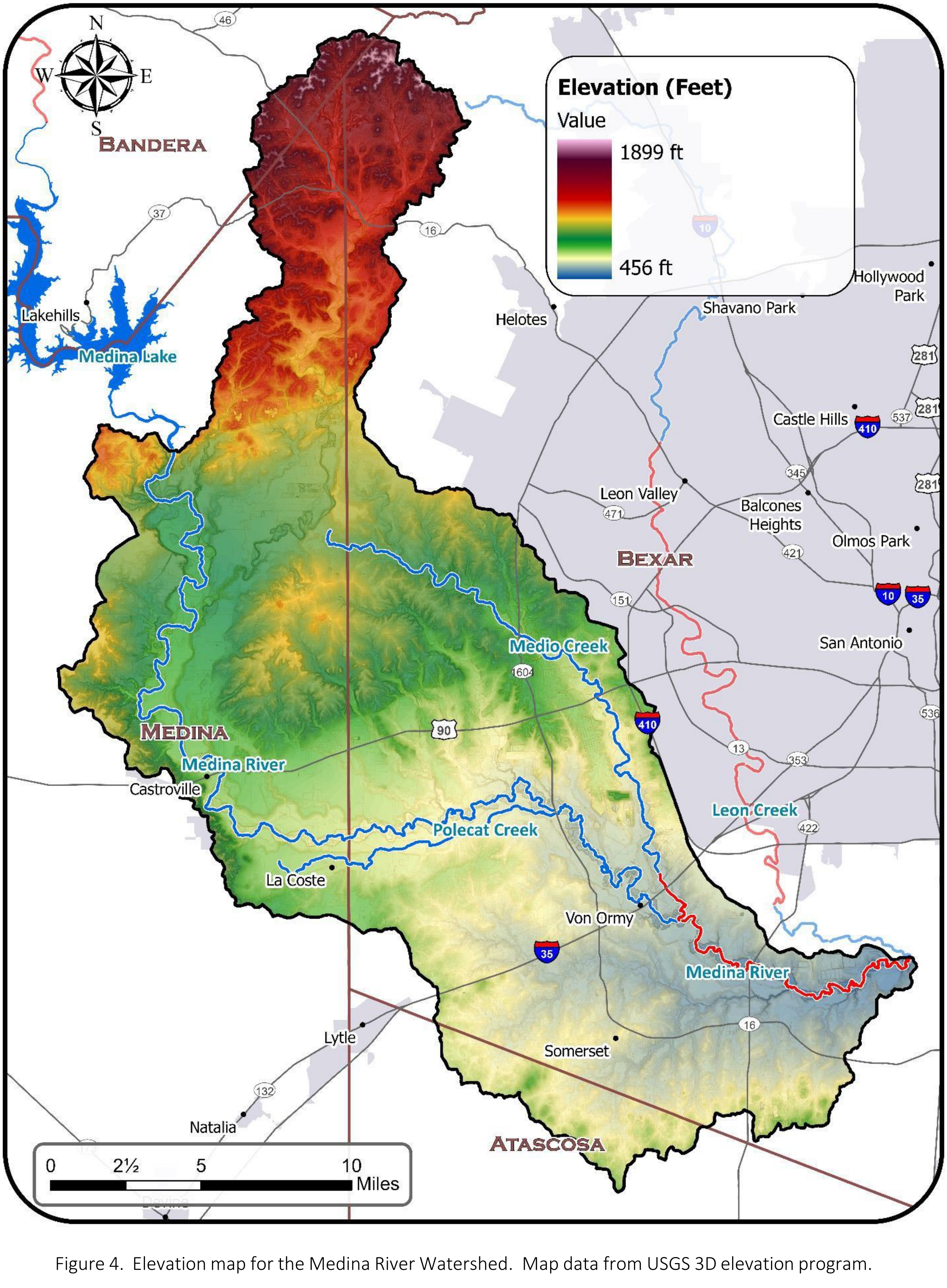

Figure 4. Elevation map for the Medina River Watershed. Map data from USGS 3D elevation program.

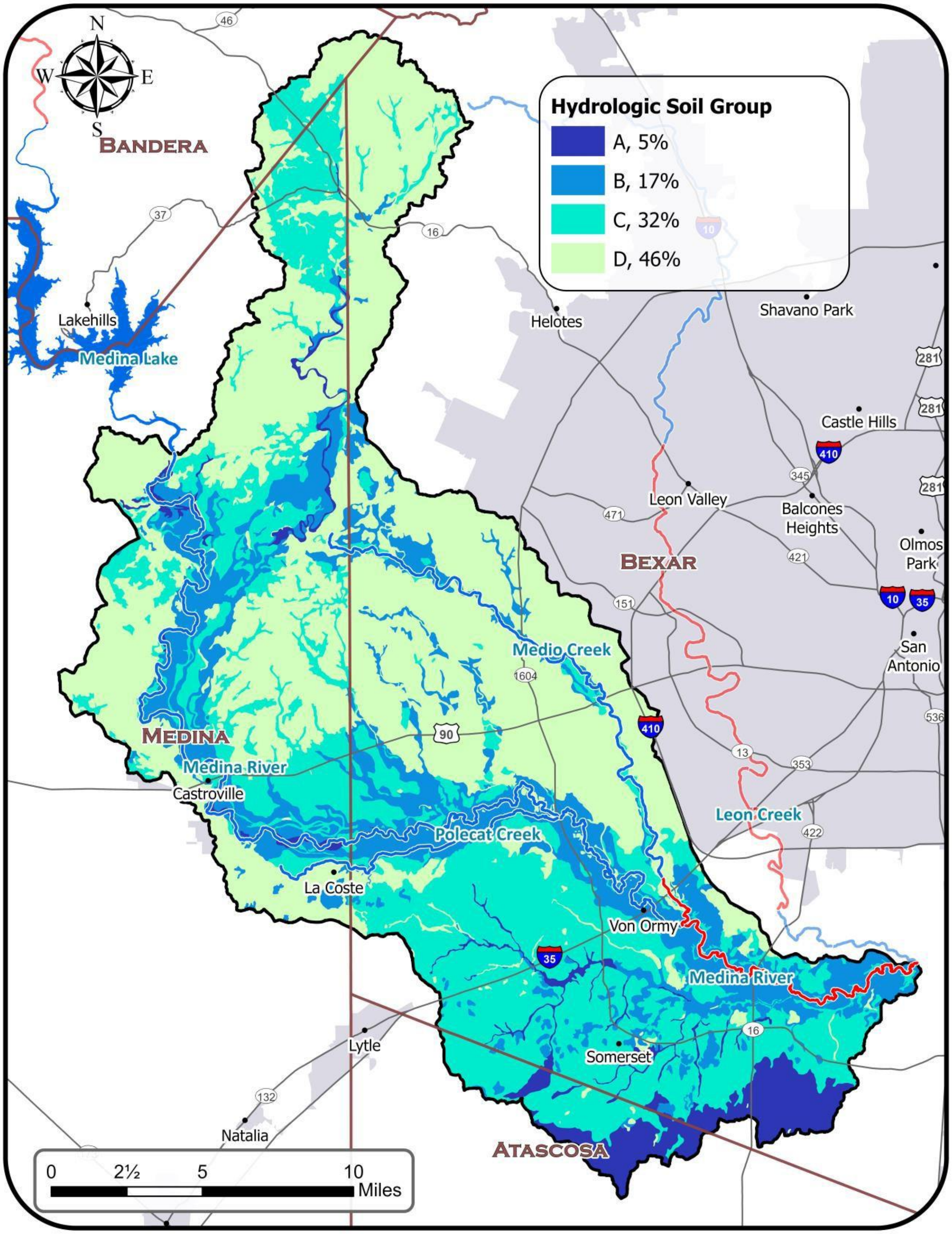

Figure 5. Hydrologic Soil Groups of the Medina River Watershed. Map data from Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture.

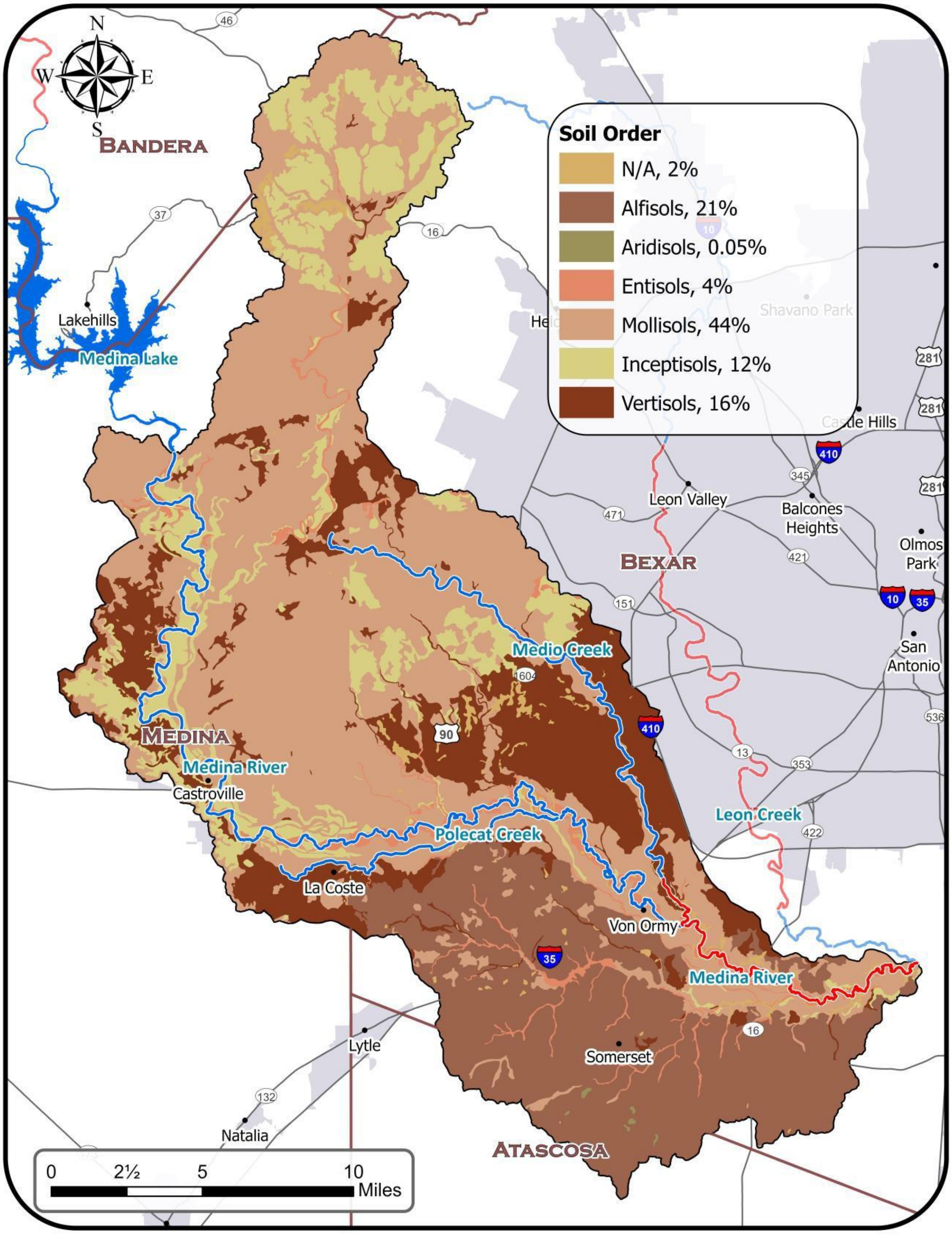

Figure 6. Soil order of the Medina River Watershed. Data was available from Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture.

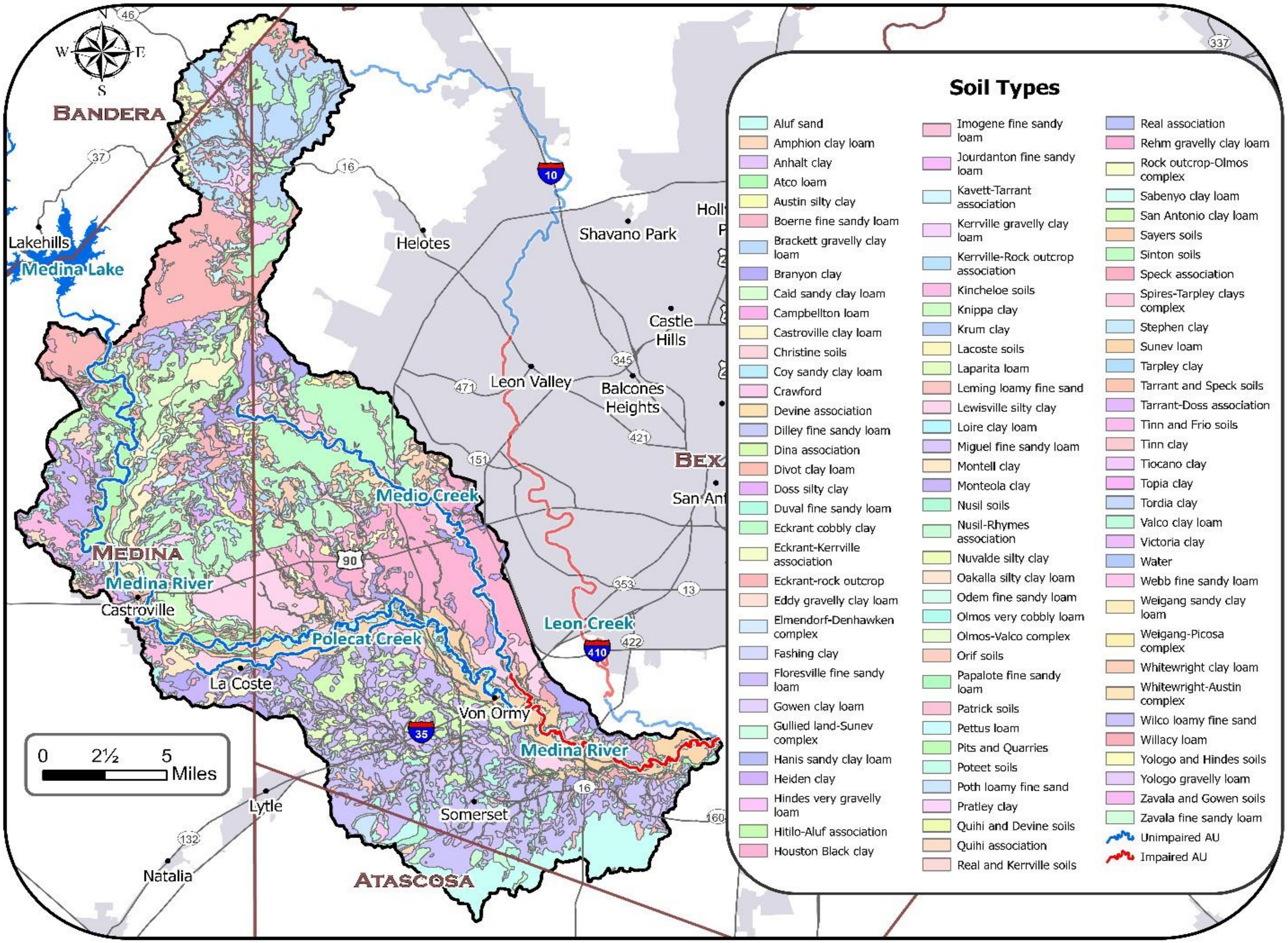

Figure 7. Soil types of the Medina River Watershed. Map data from Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture.

Land Use and Land Cover

Overall, the Medina River Watershed is predominately rural except for the central-eastern edge of the watershed boundary. According to the 2019 National Land Cover Database (NLCD), the three dominant land use and land cover (LULC) categories within the watershed are shrub/scrub, cultivated crops, and evergreen forest (Figure 8; Table 3). Some areas of the Medina River Watershed are classed as urban areas or developed, such as open space and low, medium, or high intensity. Including all subcategories of development, the watershed is approximately 14.8% developed.

Table 3. Land use and land cover summary.

2019 NLCD	**Medina River Watershed**	
Classification	**Sq Mi.**	**% Total Area**
Open Water	1.7	0.4%
Developed, Open Space	20.7	5.0%
Developed, Low Intensity	18.5	4.5%
Developed, Medium Intensity	16.9	4.1%
Developed, High Intensity	5.1	1.2%
Barren Land	3.8	0.9%
Deciduous Forest	24.5	5.9%
Evergreen Forest	55.4	13.4%
Mixed Forest	6.6	1.7%
Shrub/Scrub	152.4	36.9%
Grassland/Herbaceous	12.1	2.9%
Hay/Pasture	17.1	4.2%
Cultivated Crops	67.7	16.5 %
Woody Wetlands	9.5	2.3%
Emergent Herbaceous Wetlands	0.6	0.1%
Total	**412.6**	**100%**

The shrub/scrub land cover is comprised of shrubs, young trees, or stunted trees under 5 meters tall. Conversely, the evergreen forest class is dominated by trees over 5 meters tall, with most species retaining their leaves year-round. The top three commonly cultivated crops within the watershed are corn, sorghum, and oats (Figure 9).

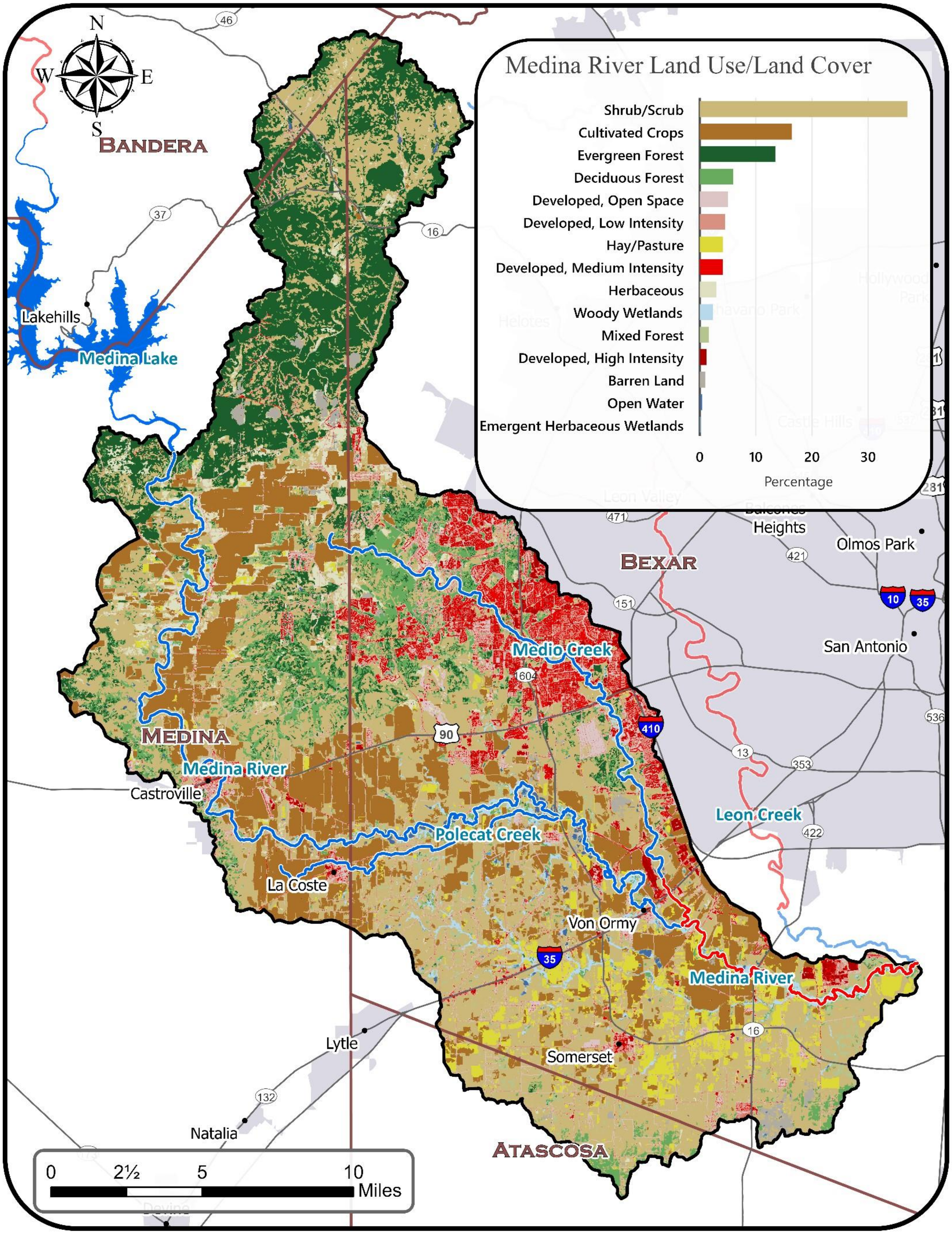

Figure 8. Land Use and Land Cover for the Medina River Watershed. Map data from the National Land Cover Database (NLCD), 2019 Land Cover Conterminous United States, USGS.

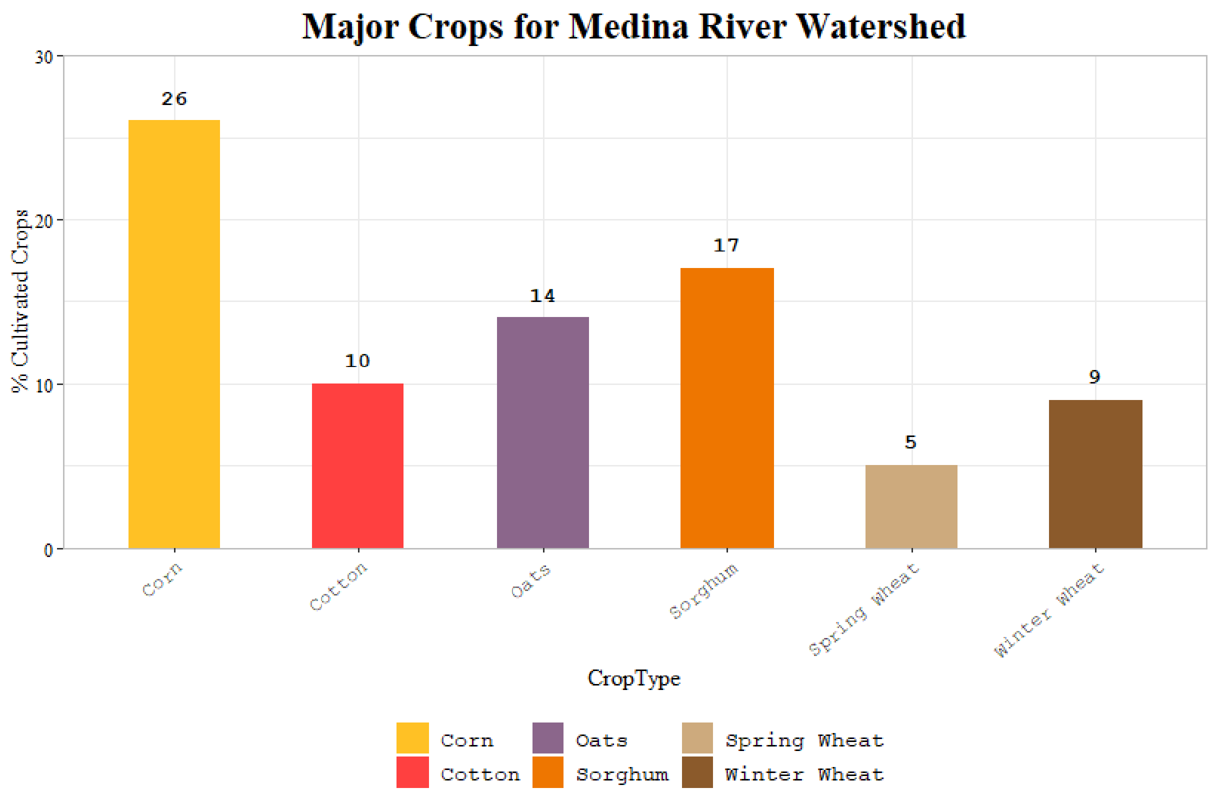

Figure 9. Most common crops cultivated within the Medina River Watershed. Map data available from United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), 2022 Cropland Data Layer, https://croplandcros.scinet.usda.gov/.

Ecoregions

Ecoregions are land areas that contain similar quality and quantity of natural resources (Griffith, 2004). There are four levels of ecoregions, starting with the coarsest classification at level I to the most refined at level IV. The Medina River Watershed has four level IV ecoregions: Northern Blackland Prairie, Balcones Canyonlands, Northern Nueces Alluvial Plains, and Southern Post Oak Savanna (Figure 10). Most of the watershed is composed of the Northern Blackland Prairie, covering 285 sq miles consisting of rolling slopes with grasslands underlain by rich soil. The next largest ecoregion, the Balcones Canyonlands, is composed of a highly variable landscape due to the uplifting of the Edwards Plateau via the Balcones Fault Zone and covers around 67 sq miles. This ecoregion is exclusively located in the northern region of the watershed. The Northern Nueces Alluvial Plains, a subcategory of the parent ecoregion Southern Texas Plain, has higher precipitation than other subcategories and copious streamflow from the Balcones Canyonlands. It covers around 32 sq miles of the central west area of the watershed. The southernmost ecoregion, Southern Post Oak Savanna, covers around 27 sq miles and is composed of hardwood forests, pastures, and rangeland.

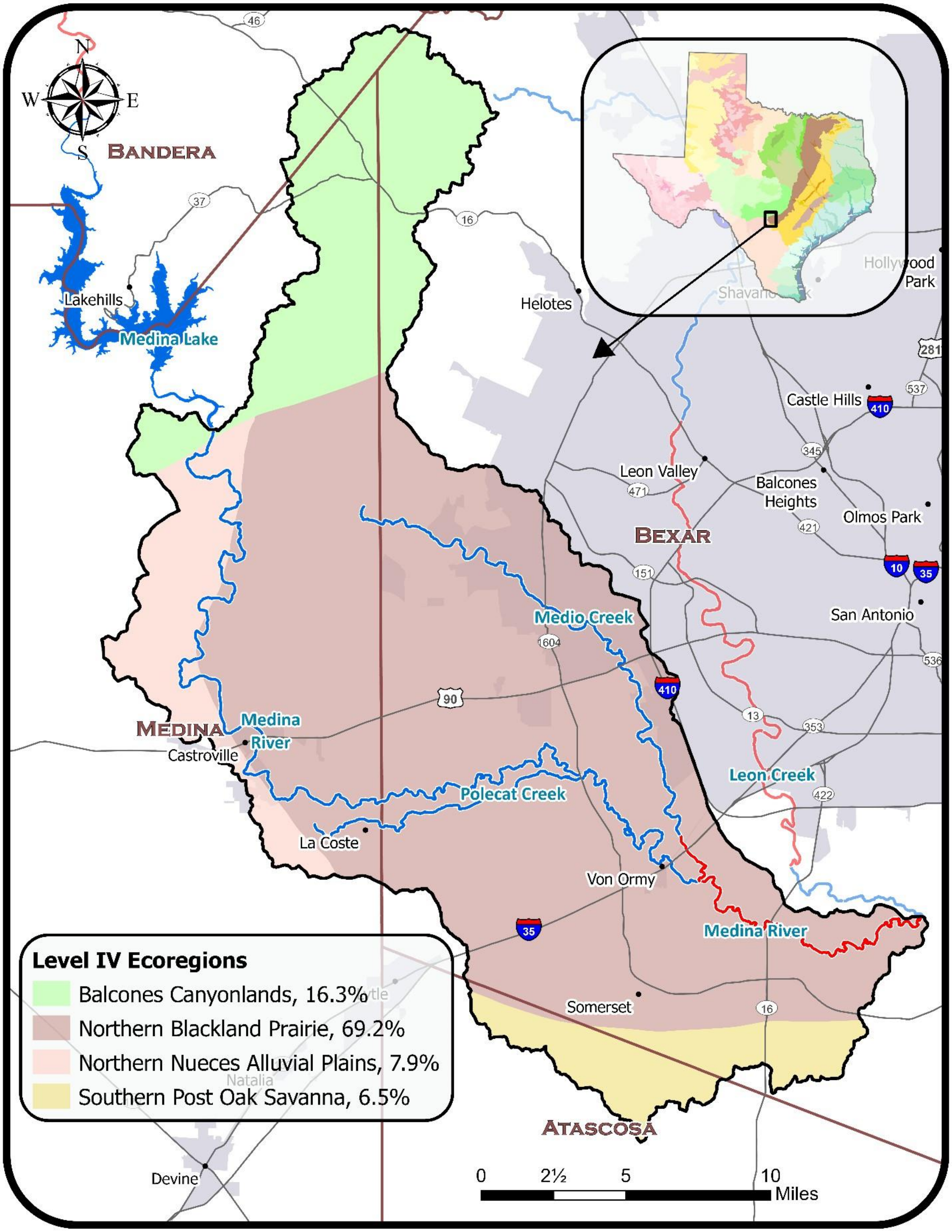

Figure 10. Level IV Ecoregions of the Medina River Watershed. Map data available from US EPA. http://edg.epa.gov.

Climate

The Medina River Watershed is a humid subtropical climate with very warm summers and mild winters. According to data from the San Antonio Stinson Municipal Airport, August is typically the warmest month, with an average maximum temperature of 98 °F, while January is the coldest, with a minimum temperature of 41 °F (Figure 11). The wettest months are May, September, and October averaging over 3 inches in precipitation, and the driest month is February averaging 1.1 inches. The average annual precipitation ranges from 29 to 35 inches across the watershed (Figure 11.).

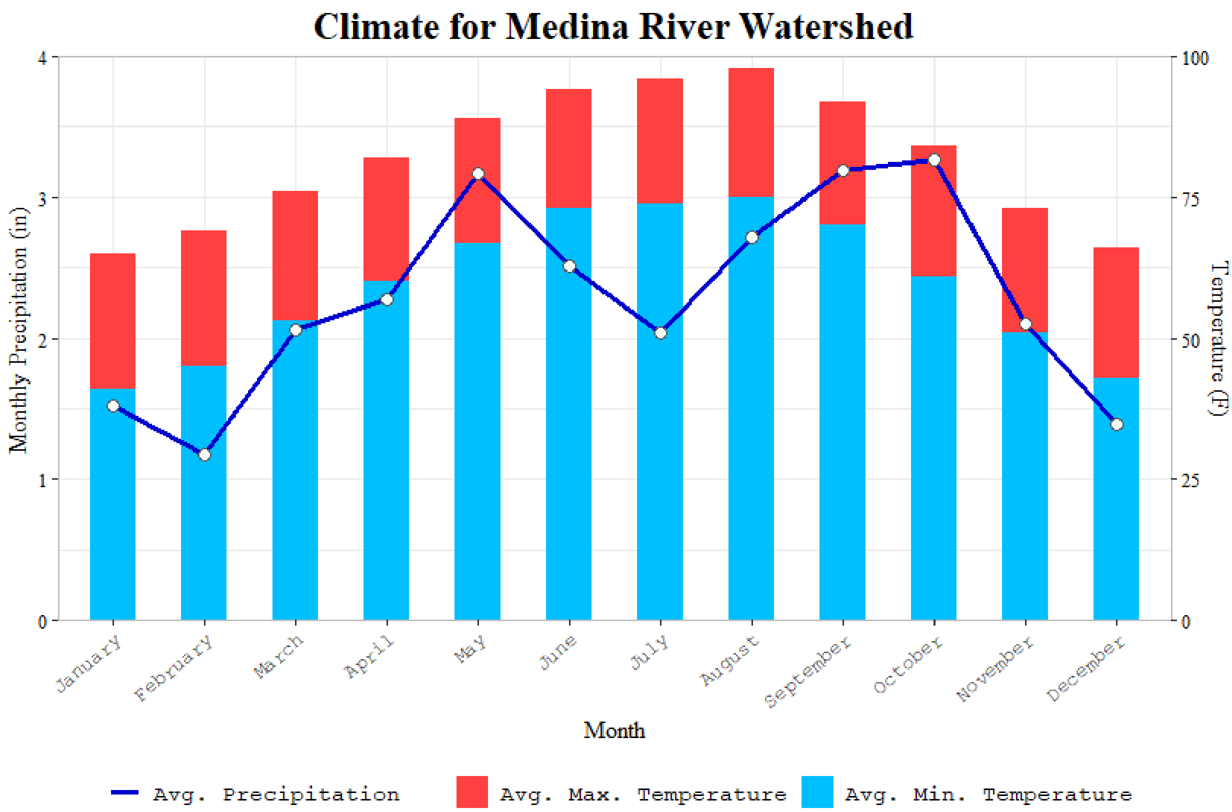

Figure 11. Monthly mean maximum and minimum air temperatures (°F) and monthly mean rainfall (inches) from 1998 -2023 for from the National Oceanic and Atmospheric Administration (NOAA) weather station at San Antonio Stinson Municipal Airport, TX US (GHCND: USW00012970).

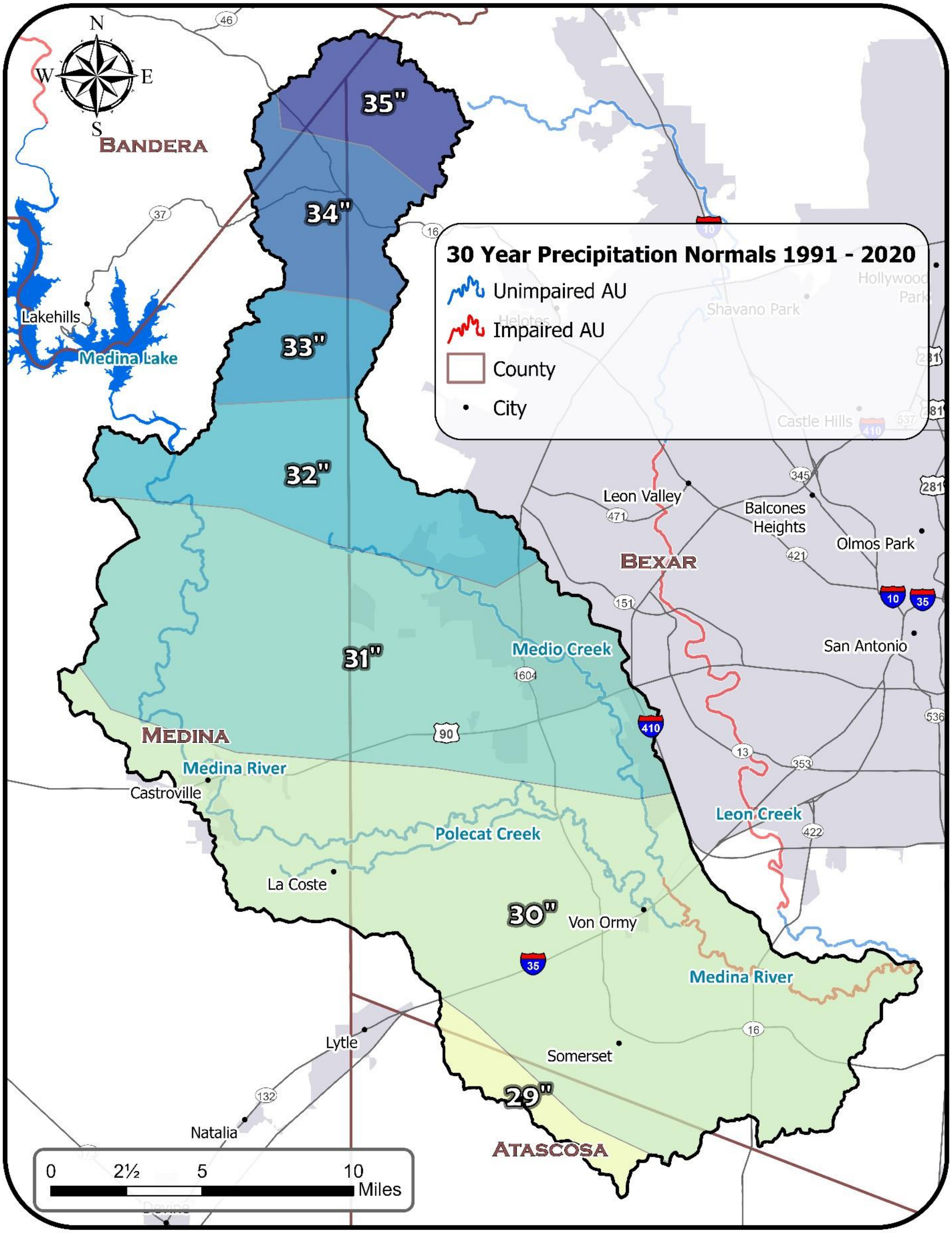

Figure 12. Precipitation normals for the Medina River Watershed from 1991 through 2020. Map data available from the PRSIM Climate Group.

Population

According to the 2020 U.S. Census data, the highest population densities in the watershed are located north of the intersection of US-90 and TX-1604 Loop in Bexar County (Figure 13). This densely populated area is on the outskirts of the City of San Antonio. These major roadways connect two of the four largest cities within the watershed, Castroville and Somerset. The total population of the watershed is approximately 229,830, based on the 2020 U.S. Census data from the U.S. Census Bureau (USCB). Between 2025 and 2060, a significant population growth is expected for most counties within the watershed. The largest growth is expected in Bexar and Atascosa Counties (Table 4). With population growth, increases in residential and commercial development are expected. This development could adversely affect natural watershed function, further straining existing drainage and wastewater infrastructure, and generally increasing adverse water quality effects across the watersheds.

Much of the population in the watershed has at a minimum a high school education, and approximately 10-20% have a college degree (Table 5). Over half of all residents speak English as a primary language and between 12.2% and 39.7% do not speak English as a primary language. These demographics are highlighted because understanding the unique and differing needs of target audiences within the watershed is critical to successful stakeholder engagement for WPP development and subsequent implementation.

Table 4. Population projections for counties residing within the Medina River Watershed. Projection data is for a migration rate equal to rates from 2010 – 2020. Data can be found at the Texas Demographic Center.

County	2025	2030	2040	2050	2060	Percent Increase
Bexar	2,153,582	2,302,829	2,599,727	2,865,834	3,102,720	44.1%
Medina	52,752	54,536	57,772	60,148	61,719	17.0%
Atascosa	51,198	53,324	57,374	61,473	64,960	26.9%
Bandera	21,060	21,272	21,701	22,139	22,586	7.2%

Table 5. Population demographics for the entire county according to the 2020 U.S. Census.

County	Population within Watershed	English Primary (%)	Non-English Primary (%)	Highschool Diploma (%)	Bachelor's Degree (%)
Bexar	209,575	61.3%	38.7%	57.0%	18.9%
Medina	15,218	70.2%	29.8%	60.5%	14.5%
Atascosa	701	60.3%	39.7%	53.8%	9.8%
Bandera	766	87.8%	12.2%	78.2%	19.4%

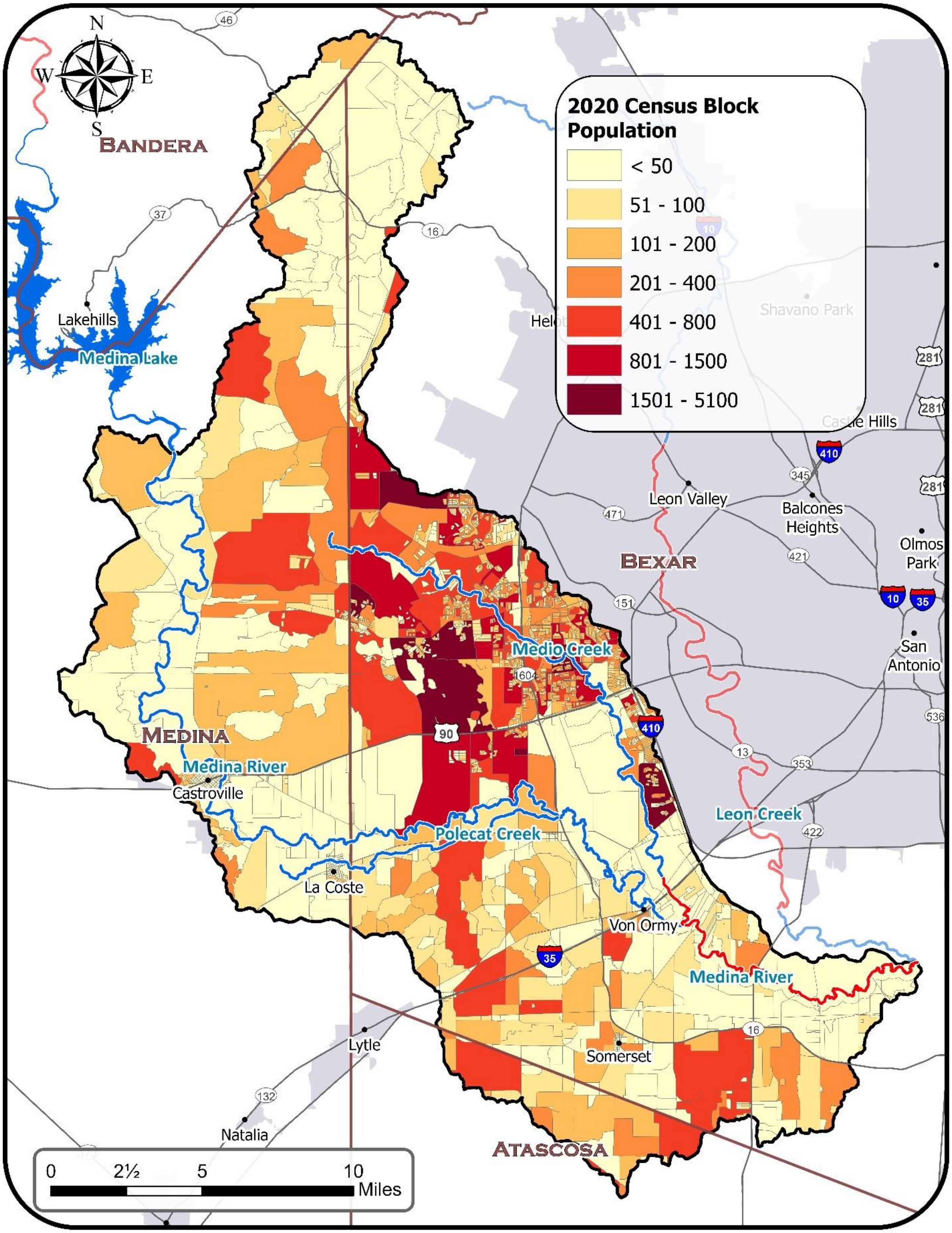

Figure 13. Census block population within the Medina River Watershed. Map data available at the U.S. Census Bureau, TIGER dataset.

Groundwater Resources

While Texas has nine major and 22 minor aquifers, the Medina River Watershed only contains three major aquifers: the Carrizo-Wilcox, the Trinity, and the Edwards Balcones Fault Zone Aquifers (Figure 14).

The Carrizo-Wilcox Aquifer has the largest outcropping area, estimated to be around 117 square miles at the southern tip of the watershed. This aquifer is mostly composed of sands with an overall saturated thickness depth of nearly 3,000 ft. However, only 670 ft of this aquifer contains freshwater. Below that level, the water becomes saline. Total dissolved solids range from 1,000 to 7,000 mg/L.

The Trinity Aquifer outcrop is found in the northern tip of the watershed, encompassing 45 square miles. This aquifer also contains several productive water-bearing formations, like the Glen Rose, Antlers, and more, all covered within the Trinity Group. These formations are composed of limestone, clay, gravel, and conglomerates, and when combined, they have a saturated thickness ranging from 600 to 1,900 ft. The water within this aquifer is hard, with total dissolved solids ranging from under 1,000 to 5,000 as depth increases. This aquifer is highly utilized for municipalities and irrigation and therefore sees some of the largest water level declines.

The third major aquifer outcropping within the Medina River Watershed is the Edwards Balcones Fault Zone (BFZ) Aquifer. This aquifer only outcrops for roughly 24 sq miles within the watershed, but similarly to the Trinity Aquifer, it extends below the surface until approximately Texas State Highway Loop 353 (Figure 14). This aquifer contains the highest quality water of the three aquifers. Total dissolved solids values are less than 500 mg/L and a saturated thickness depth ranges from 200 to 600 ft. The Edwards Aquifer is unique among the Texas Aquifers because it is primarily composed of partially dissolved limestone, called karstic limestone. The karstic limestone features large fissures that create preferential flow paths for water both in and out of the aquifer, resulting in a highly permeable saturated thickness. This gives the aquifer the ability to recharge rapidly while also making it more vulnerable to contamination by surface water runoff.

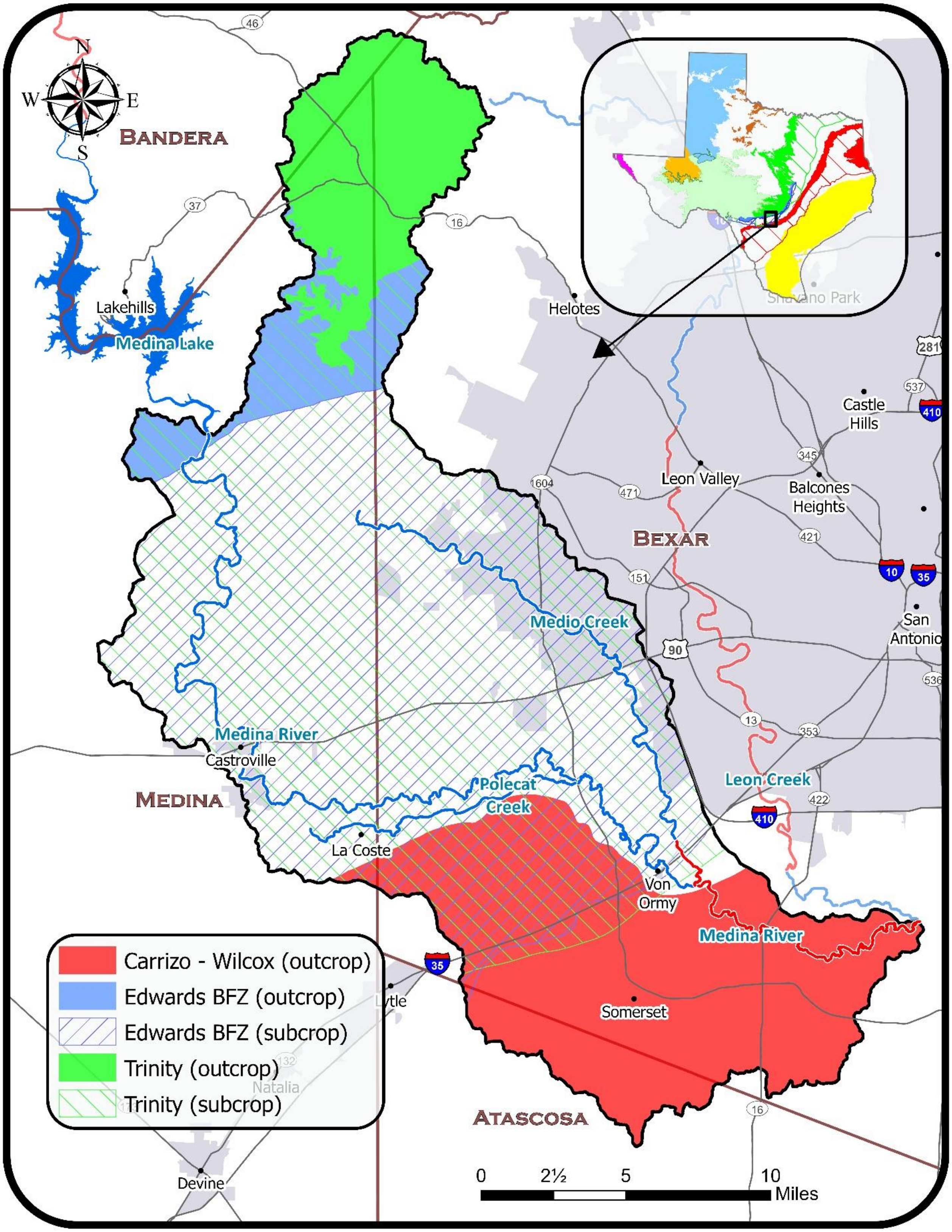

Figure 14. Major aquifers of the Medina River Watershed. Map data is available from the Texas Water Development Board (TWDB).

Water Management

The previously mentioned aquifers are managed by groundwater conservation districts (GCDs) within the Medina River Watershed (Figure 16). According to the Texas Constitution, these districts can be created by the Texas Legislature or the Texas Commission of Environmental Quality.

(Texas Water Code §36.013 - §36.015). The vast majority of the Medina River Watershed is managed by the Edwards Aquifer Authority while overlapping with some single county GCDs. These entities have the authority to either oversee water well production or regulate the spacing of these wells.

Surface water in this watershed is managed by public agencies called river authorities. The Texas Legislature relies on these agencies to conserve and distribute surface water. Some river authorities also have the authority to monitor and enforce water quality within their boundary, finance and conduct water projects, and manage wastewater systems. There are 24 Texas river authorities, and the Medina River Watershed resides within the management area of both the San Antonio and Nueces River Authority (Figure 17).

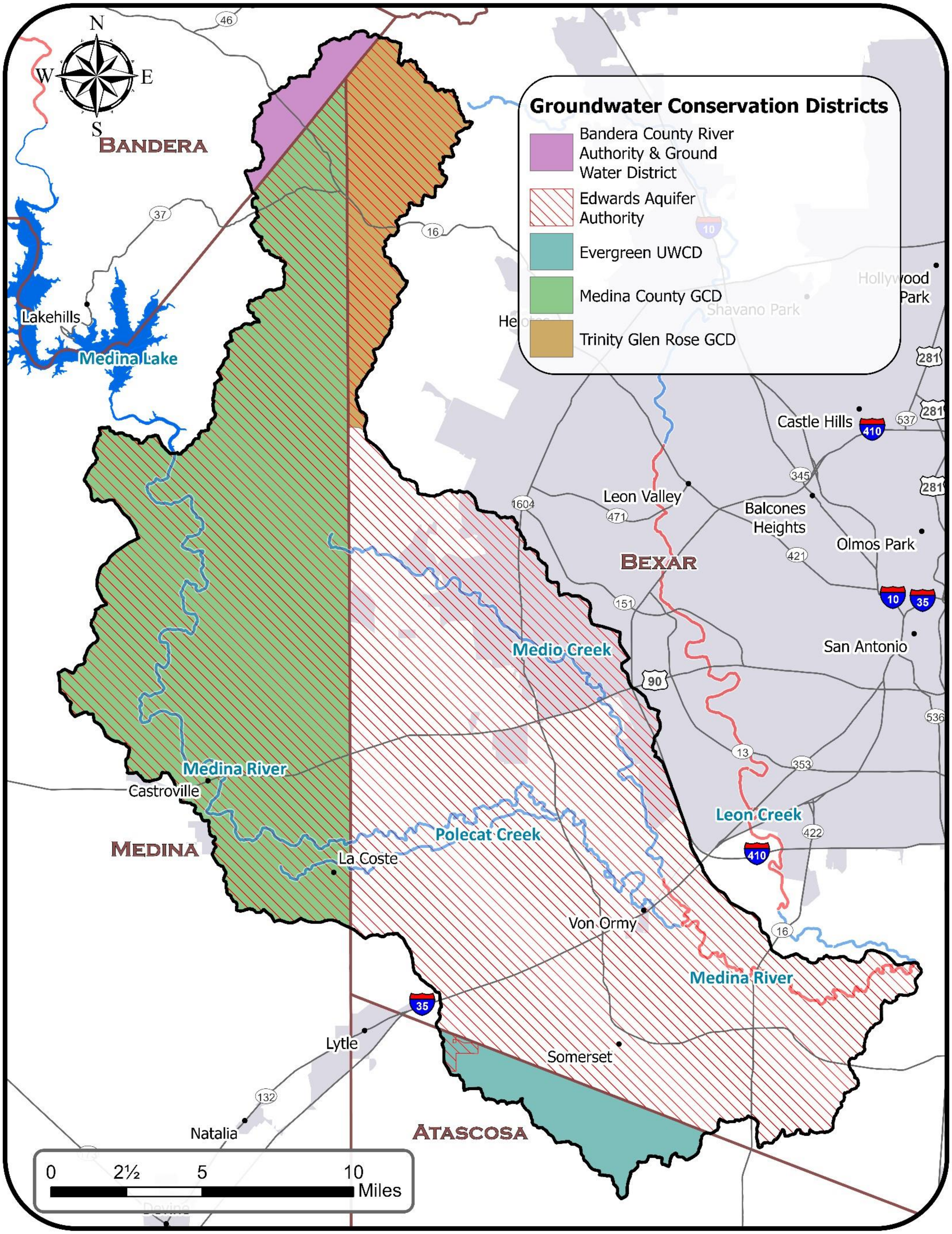

Figure 15. Groundwater conservation districts within the Medina River Watershed. Map data available at the Texas Water Development Board (TWDB).

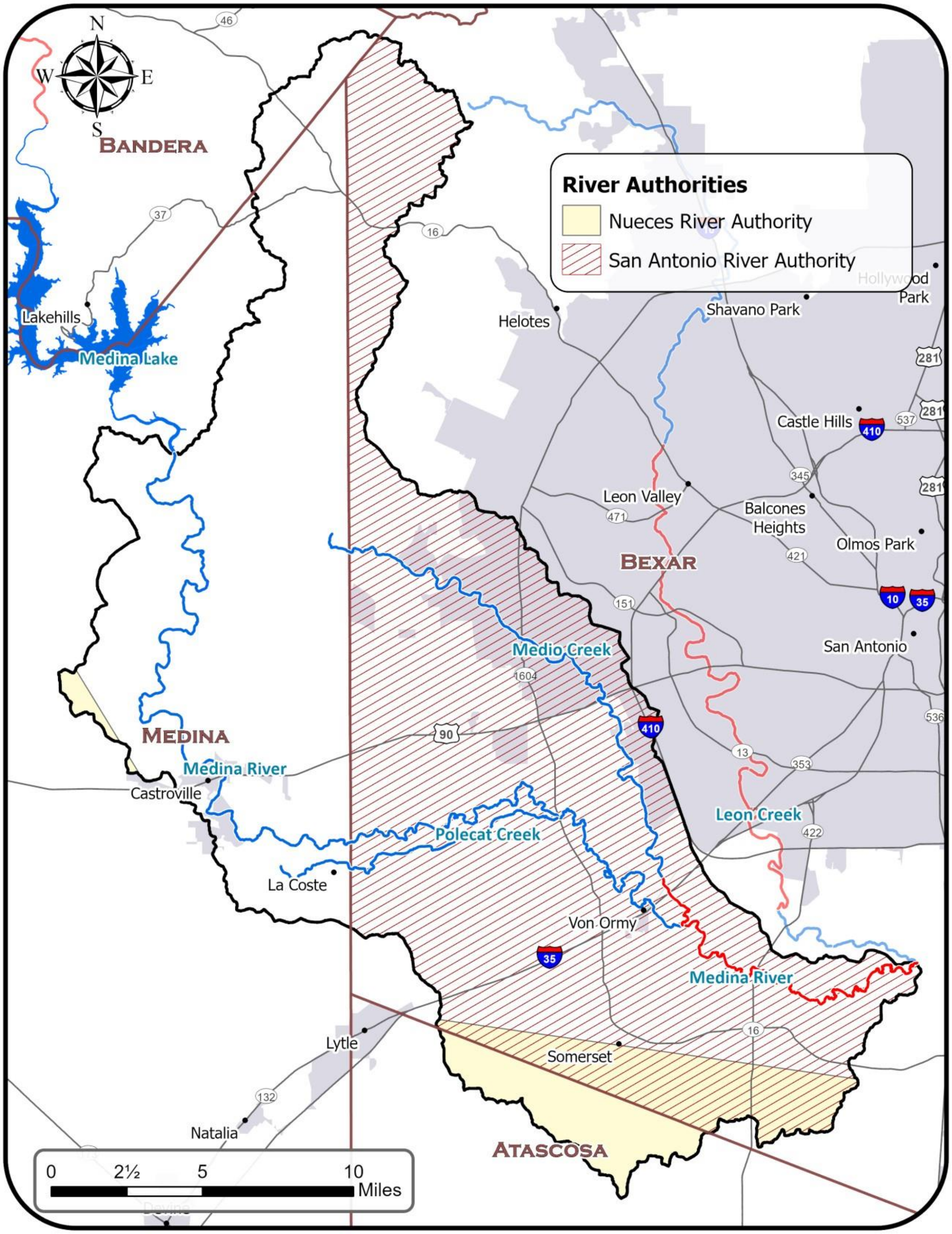

Figure 16. River Authority boundaries for the Medina River Watershed. Map data is available from the Texas Water Development Board (TWDB).

Chapter 3
Water Quality

Surface water is monitored in Texas to ensure its quality supports designated uses defined in the Texas Water Code. Designated uses and associated standards are developed by the Texas Commission on Environmental Quality (TCEQ) to fulfill the Clean Water Act (CWA) requirements, which addresses toxins and pollution in waterways and establishes a foundation for water quality standards. It requires states to set standards that maintain and restore biological integrity in the waters, protect fish, wildlife, and recreation in and on the water (must be fishable/swimmable), and consider the use and value of state waters for public supplies, wildlife, recreation, agricultural, and industrial purposes. The CWA (33 USC § 1251), administered by EPA (40 CFR § 130.7), requires states to develop a list that describes all water bodies that are impaired and are not within established water quality standards (commonly called "303(d) list" in reference to the Texas Water Quality Inventory and 303(d) List).

Water Body Assessments

TCEQ conducts water body assessments on a biennial basis to satisfy requirements of federal CWA sections 305(b) and 303(d). The resulting Texas Integrated Report of Surface Water Quality (*Texas Integrated Report*) describes the status of water bodies throughout the state. *The 2022 Texas Integrated Report* is the most recent version and includes an assessment of collected water quality data.

The Texas Integrated Report assesses water bodies at the assessment unit (A.U.) level. An A.U. is a sub-area of a stream segment, defined as the smallest geographic area of use support reported in the assessment (TCEQ 2022). Each A.U. is intended to have relatively homogeneous chemical, physical, and hydrological characteristics, which provides a way to assign site-specific standards (TCEQ 2022).

Table 1. Medina River Below Diversion Lake 2015 – 2022 bacteria. The San Antonio River Authority monitored all sites except for two samples by the Bandera County River Authority and Groundwater District.

Station	A.U.	Sample Quantity	Location
12814	1903_03	48	Medina River At Applewhite Rd
12813	1903_03	40	Medina River At Cassin Crossing
12817	1903_04	4	Medina River At Von Ormy
12819	1903_04	4	Medina River At FM 1604
12824	1903_05	45	Medina River Downstream of Diversion Dam
14200	1903_05	47	Medina River At CR 484

Table 2. Upper Medio and Medio Creek 2015-2022. The San Antonio River Authority monitored all samples except for one by the TCEQ Regional Office.

Station	A.U.	Sample Quantity	Location
12735	1912A_01	44	Medio Creek At U.S. 90 West
12916	1912_01	48	Medio Creek At Hidden Valley

There are six A.U.s within the Medina River Watershed (Figure 1). Monitoring stations are located on several A.U.s and typically allow independent water quality analysis for each A.U. within a segment (Figure 2). At least 10 data points within the most recent seven years of available data are required for all water quality parameters except bacteria, which requires a minimum of 20 samples. According to the Texas Integrated Report, two A.U.s in the watershed are impaired due to elevated bacteria, 1903_01 and 1912_01 (**Error! Reference source not found.**). The A.U.s within the Medina River and Medio Creek were first listed as impaired in 2010. The criteria for impairment used for non-tidal, fresh recreational waters is 126 colony-forming units (cfu) of *E. coli* per 100 milliliters (mL) of water. Furthermore, several nutrient concerns are identified in all six A.U.s in the watershed (Table 4).

Table 3. Watershed impairments in the *2022 Texas Integrated Report.*

Parameter	Category	AU	Stream Reach	Criteria	Mean
Bacteria	5c*	1903_01 1903_02 1903_03	Medina River Below Medina Diversion Lake	126 cfu/100 mL	184.34 cfu/100 mL 238.63 cfu/100 mL 256.94 cfu/100 mL
Bacteria	5c*	1912_01	Medio Creek	126 cfu/100 mL	174.67 cfu/100 mL

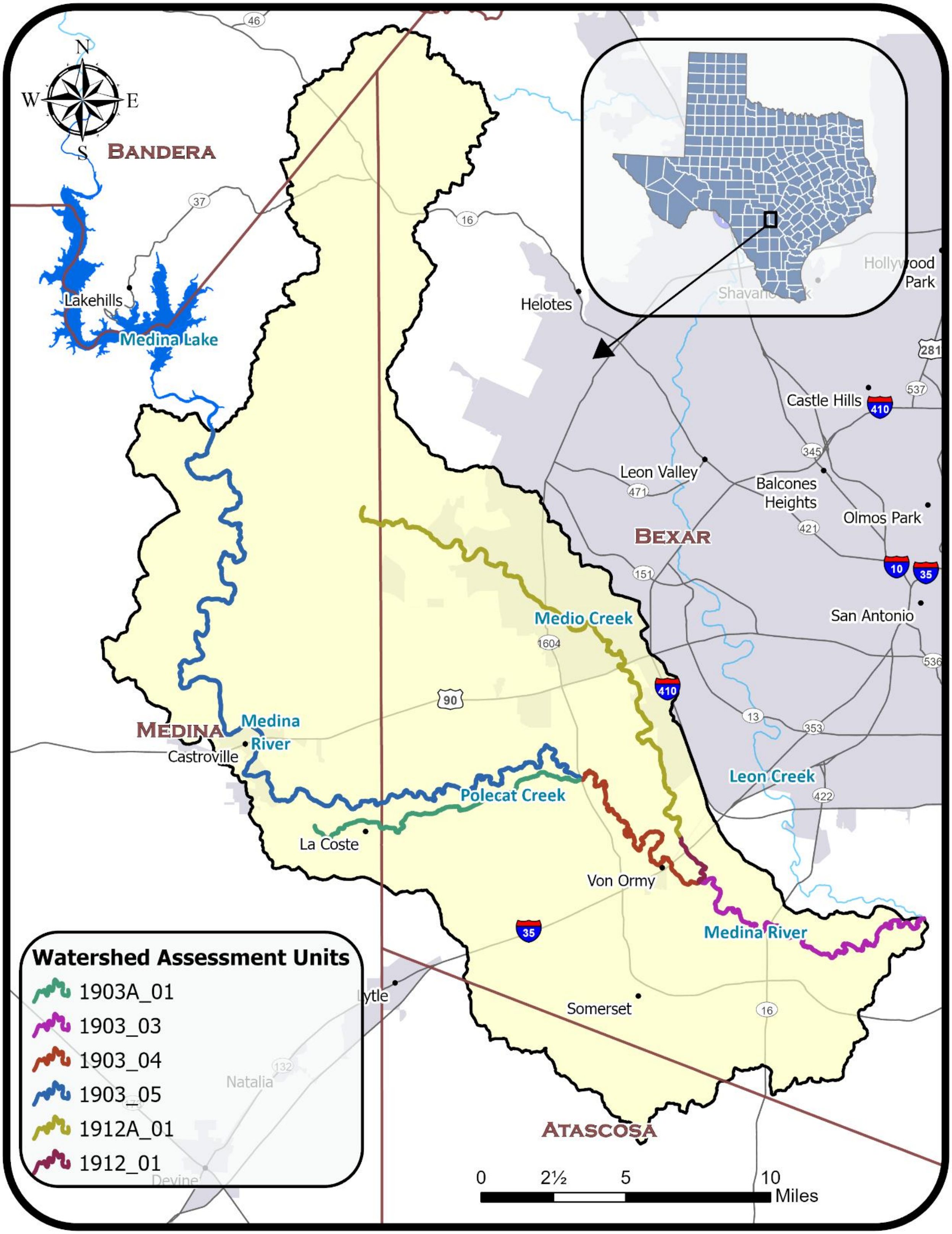

Figure 1. Medina River Watershed assessment units (A.U.s).

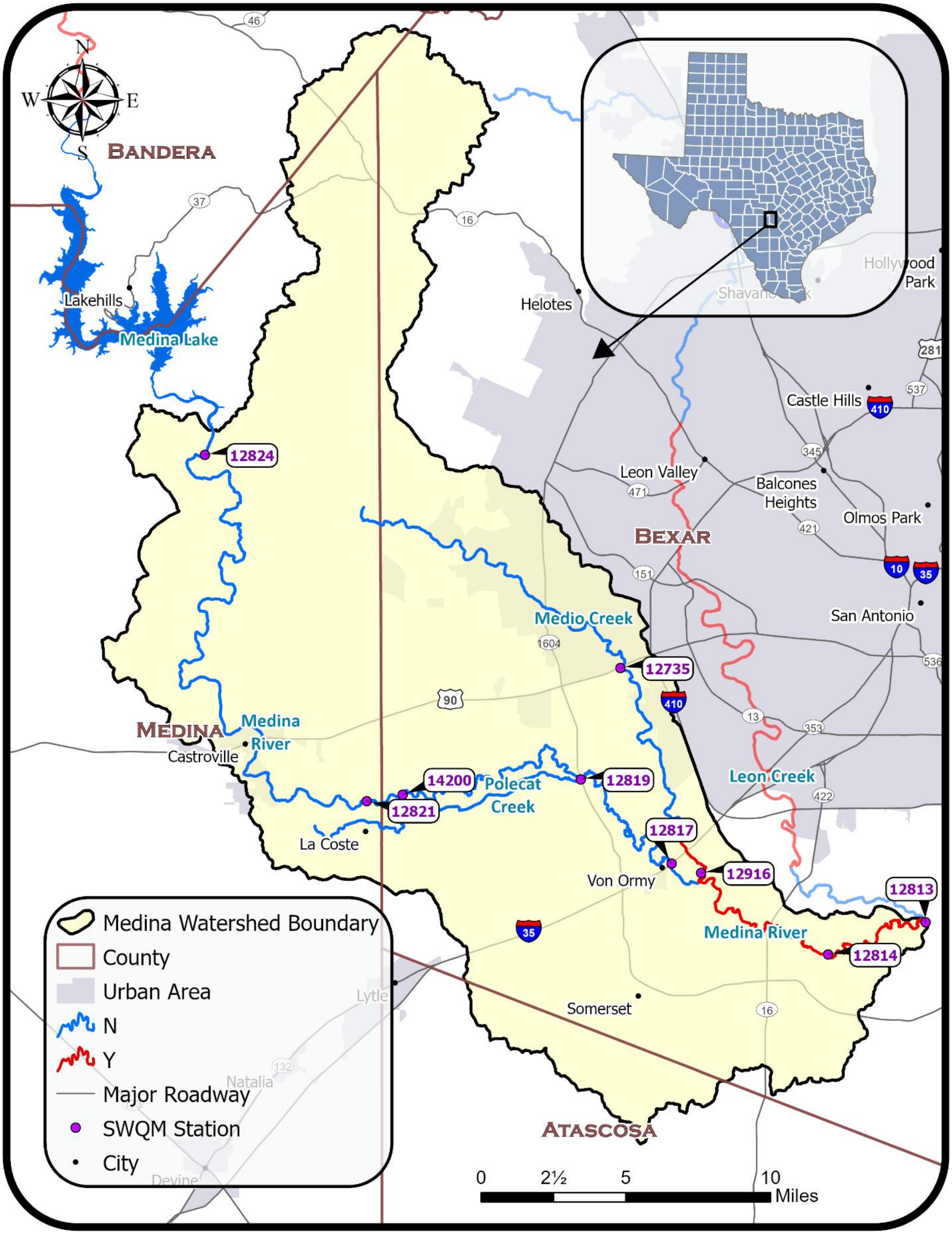

Figure 2. TCEQ monitoring stations and USGS gages within the bounds of Medina River Watershed.

Table 4. Nutrient concerns within the watershed as identified by the *2022 Texas Integrated Report*.

Parameter	AU	Stream Reach	Criteria	% Criteria Exceedance
Nitrate	1903_01 1903_02 1903_03	Medina River Below Medina Diversion Lake	1.95 mg/L	95 % 96 % 63%
Total Phosphorus	1903_01 1903_02 1903_03	Medina River Below Medina Diversion Lake	0.69 mg/L	86 % 75 % 12 %
Nitrate	1912_01 1912A_01	Medio Creek	1.95 mg/L	61 % 100 %
Total Phosphorus	1912_01 1912A_01	Medio Creek	0.69 mg/L	84 % 100 %

Texas Surface Water Quality Standards

Water quality standards are established by the state and approved by EPA to define a water body's ability to support its designated uses, which may include aquatic life use (fish, shellfish, and wildlife protection and propagation), primary contact recreation (swimming, wading by children, etc.), public water supply, and fish consumption. Water quality indicators for these uses include dissolved oxygen (D.O.; aquatic life use), E. coli (primary contact recreation), pH, temperature, total dissolved solids, sulfate, and chloride (general uses), and a variety of toxins (fish consumption and public water supply) (Table 5; TCEQ 2022).

Table 5. Designated uses use categories and criteria for water bodies in the Medina River Watershed.

Designated Use	AU	Stream Reach	Use Category	Criteria	Measurement
Aquatic Life Use	1903_01 1903_02 1903_03	Medina River Below Medina Diversion Lake	High High High	5.0/3.0 mg/L D.O.	<10% exceedance based on the binomial method
Public Water Supply/ Aquifer Protection	1903_01 1903_02 1903_03	Medina River Below Medina Diversion Lake	N/A	N/A	N/A
Recreation	1903_01 1903_02 1903_03	Medina River Below Medina Diversion Lake	Primary Contact	126 cfu/100 mL	7-year geometric mean
Aquatic Life Use	1912_01 1912A_01	Medio Creek	Intermediate	4.0/3.0 mg/L D.O.	<10% exceedance based on the binomial method

Designated Use	AU	Stream Reach	Use Category	Criteria	Measurement
Recreation	1912_01 1912A_01	Medio Creek	Primary Contact	126 cfu/100 mL	7-year geometric mean
Aquatic Life Use	1903A_01	Polecat Creek	High	5.0/3.0 mg/L D.O.	<10% exceedance based on the binomial method

Bacteria

Concentrations of fecal indicator bacteria are evaluated to assess a water body's ability to meet its contact recreation use. In freshwater environments, *E. coli* concentrations are measured to evaluate the presence of potential fecal contamination in water bodies. The presence of these fecal indicator bacteria may indicate that associated pathogens from the intestinal tracts of warm-blooded animals or other sources could be reaching water bodies and may cause illness in people that recreate in them. Water quality standards for bacteria in freshwater and tidal waters differ. The standard for primary contact recreation in freshwater is a geometric mean of 126 cfu of *E. coli* per 100 mL of water. This standard must be assessed from at least 20 samples (30 TAC § 307.7). Common sources that indicator bacteria can originate from include wildlife, domestic livestock, pets, malfunctioning on-site sewage facilities (OSSFs), urban and agricultural runoff, sewage system overflows, and direct discharges from wastewater treatment facilities (WWTFs). Currently, two A.U.s are listed as impaired due to elevated bacteria, 1903_03 and 1912_01 (Figure 3; Figure 4).

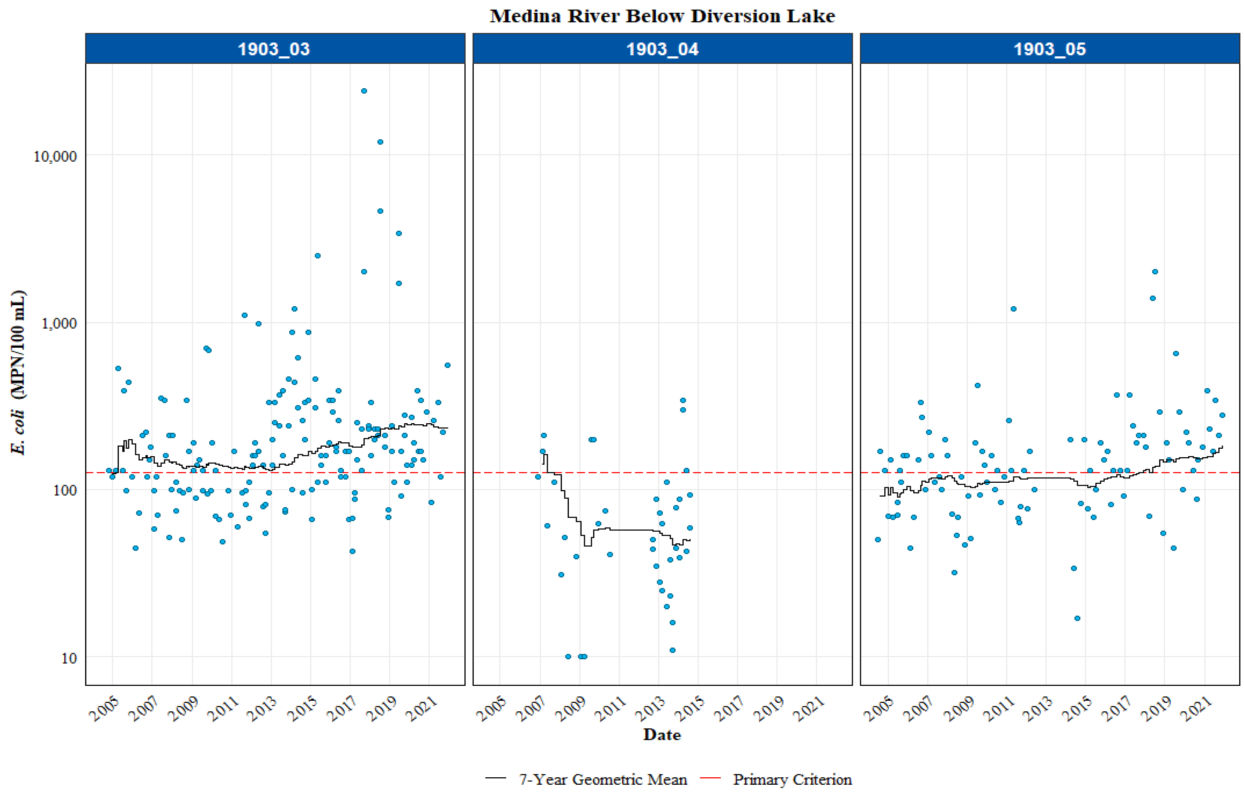

Figure 3. *E. coli* concentrations in all assessment units for Medina River Below Diversion Lake.

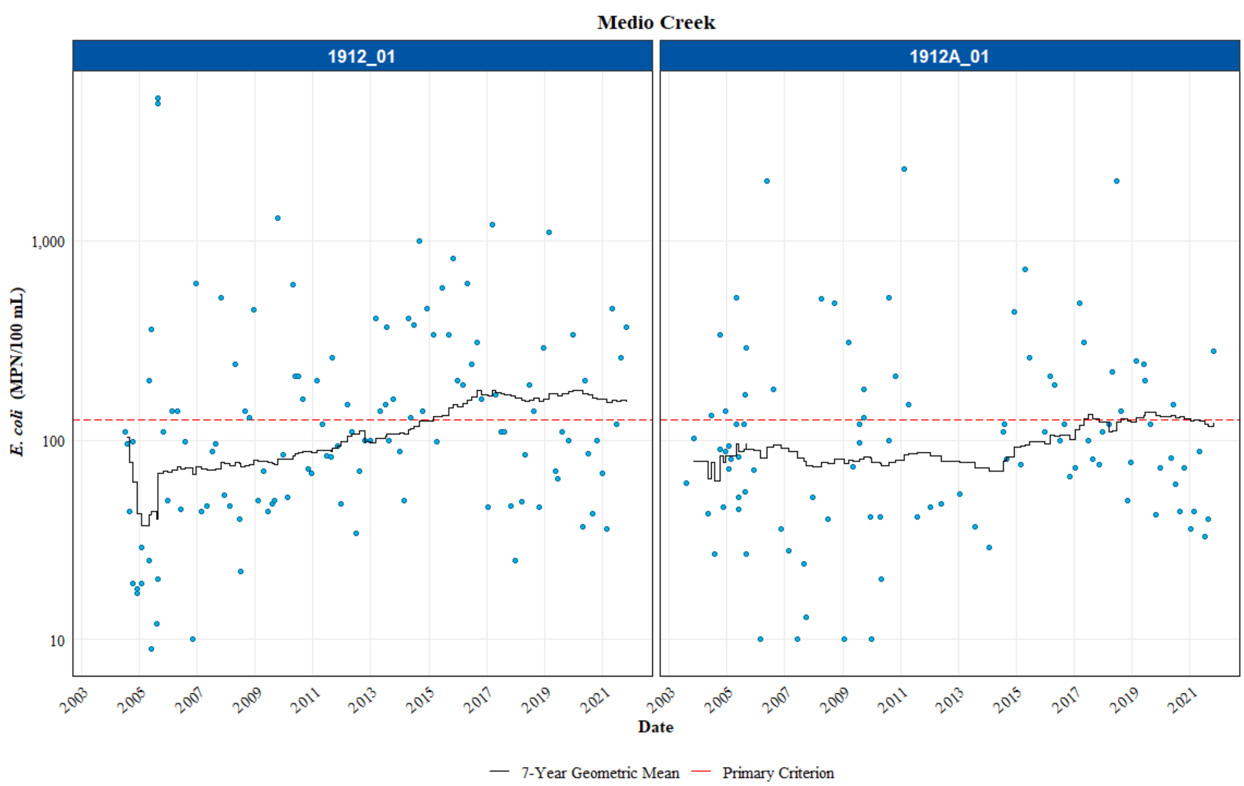

Figure 4. *E. coli* concentrations in all assessment units for Medio Creek.

Dissolved Oxygen

D.O. is the main parameter to determine a water body's ability to support and maintain aquatic life. If D.O. levels in a water body drop too low, fish and other aquatic species will not survive. Typically, D.O. levels fluctuate throughout the day, with the highest levels of D.O. occurring in mid to late afternoon due to plant photosynthesis. D.O. levels are typically lowest just before dawn as plants and animals in the water continue to consume oxygen while the natural production of D.O. typically slows overnight. Furthermore, seasonal fluctuations in D.O. are common because of decreased oxygen solubility in water as temperature increases; therefore, it is common to see lower D.O. levels during summer than the winter.

While D.O. can fluctuate naturally, human activities can also cause abnormally low D.O. levels. Excessive organic matter (vegetative material, untreated wastewater, etc.) can result in depressed D.O. levels as bacteria break down the materials and consume oxygen. Excessive nutrients from fertilizers and manures can also depress D.O. as aquatic plant and algae growth increase in response to nutrients. The increased respiration from plants and decay of organic matter as plants die off can also lower D.O. concentrations.

When evaluating D.O. levels in a water body, TCEQ considers that monitoring events need to be spaced over an index and critical period. The index period represents the warm-weather season of the year and spans from March 15th to October 15th. The critical period of the year is July 1st to September 30th and is the portion of the year when minimum streamflow, maximum temperatures, and minimum D.O. levels typically occur across Texas. At least half of the samples used to assess stream D.O. levels should be collected during the critical period, with one-fourth to one-third of the samples from the index period. D.O. measurements collected during the cold months are not considered because the flow and D.O. levels are typically highest during winter (30 TAC § 307.7). Under the *2022 Texas Integrated Report*, none of the A.U.s in the Medina River watershed were listed as impaired for depressed D.O.

Nutrients

Nutrients, specifically nitrogen and phosphorous, are used by aquatic plants and algae. However, excessive nutrients can lead to plant and algal blooms, reducing D.O. levels. High nitrate and nitrite levels can directly affect fish respiration. Nutrient sources include effluents from WWTFs and OSSFs, direct deposition of animal fecal matter, illegal refuse dumping, groundwater return flows, and fertilizers in runoff from yards and agricultural fields. Additionally, nutrients bind to soil and sediment particles; therefore, runoff and erosion events that result in heavy sediment loads can increase nutrient levels in receiving water bodies.

Nutrient standards have not been set in Texas; however, nutrient screening levels developed for statewide use were established to evaluate which water bodies may be experiencing excess nutrient loadings. Screening levels are set at the 85th percentile for parameters from similar water bodies. Suppose more than 20% of samples from a water body exceed the screening level. In that case, that water body is, on average, experiencing pollutant concentrations higher than 85% of the streams in Texas and is therefore considered to have an elevated nutrient concentration concern. Screening levels have been designated for ammonia, nitrate, orthophosphorus, total phosphorus, and chlorophyll-a (Table 4). The chlorophyll-a, total nitrate, and total phosphorus levels in several A.U.s within the watershed were analyzed, and results are shown in Figures 5 through 10.

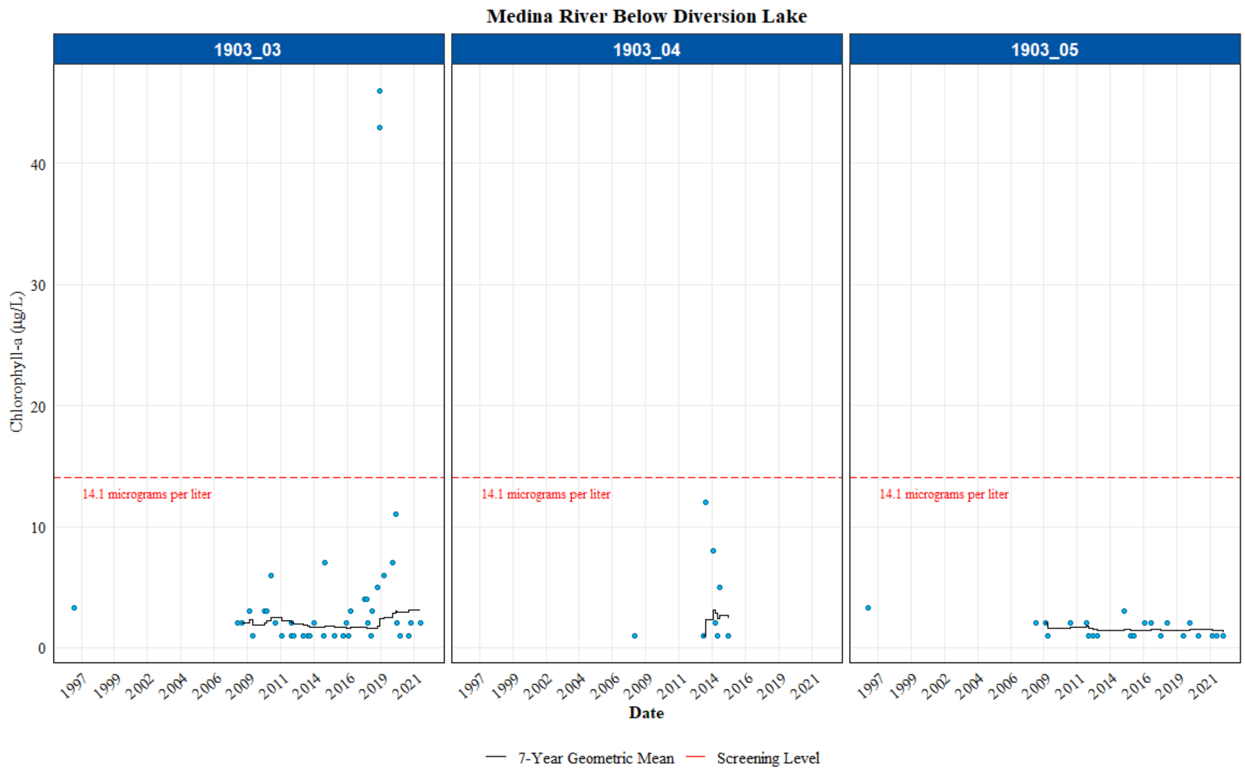

Figure 5. Chlorophyll-a concentrations in Medina River.

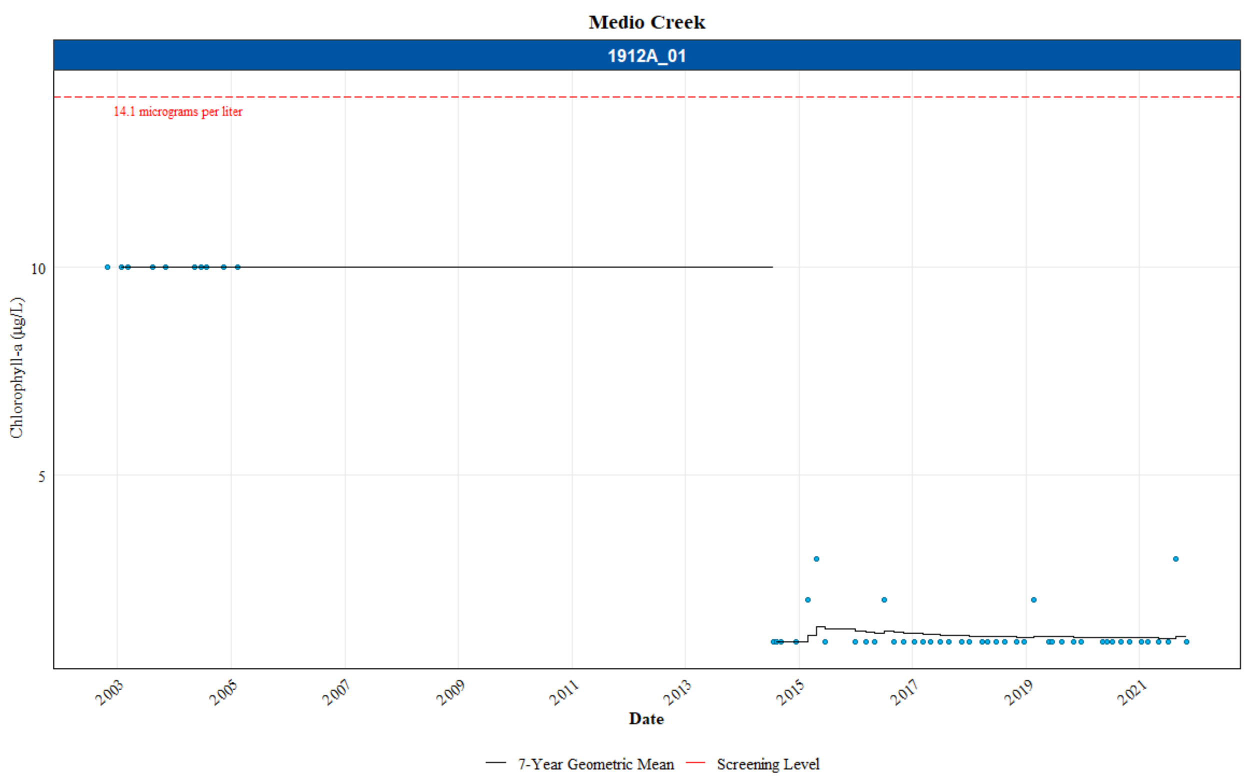

Figure 6. Chlorophyll-a concentrations in Medio Creek.

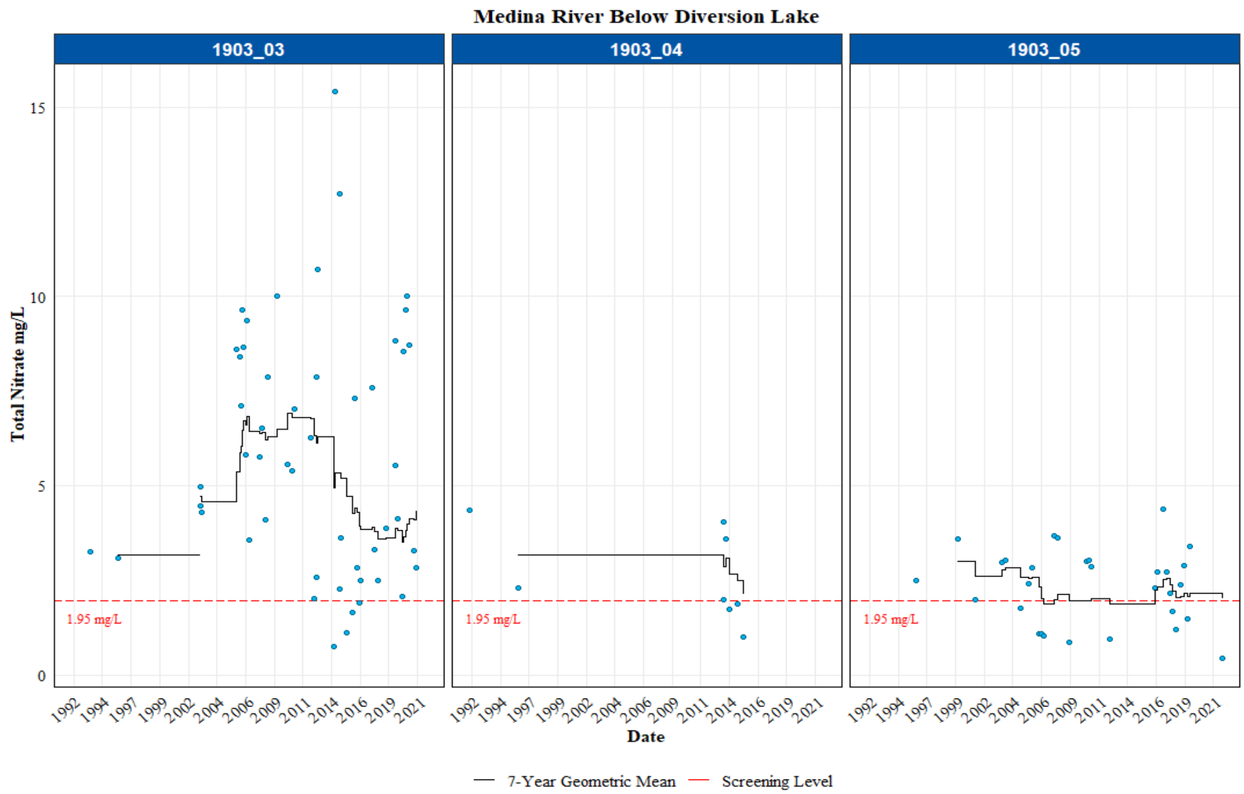

Figure 7. Total nitrate concentrations in Medina River.

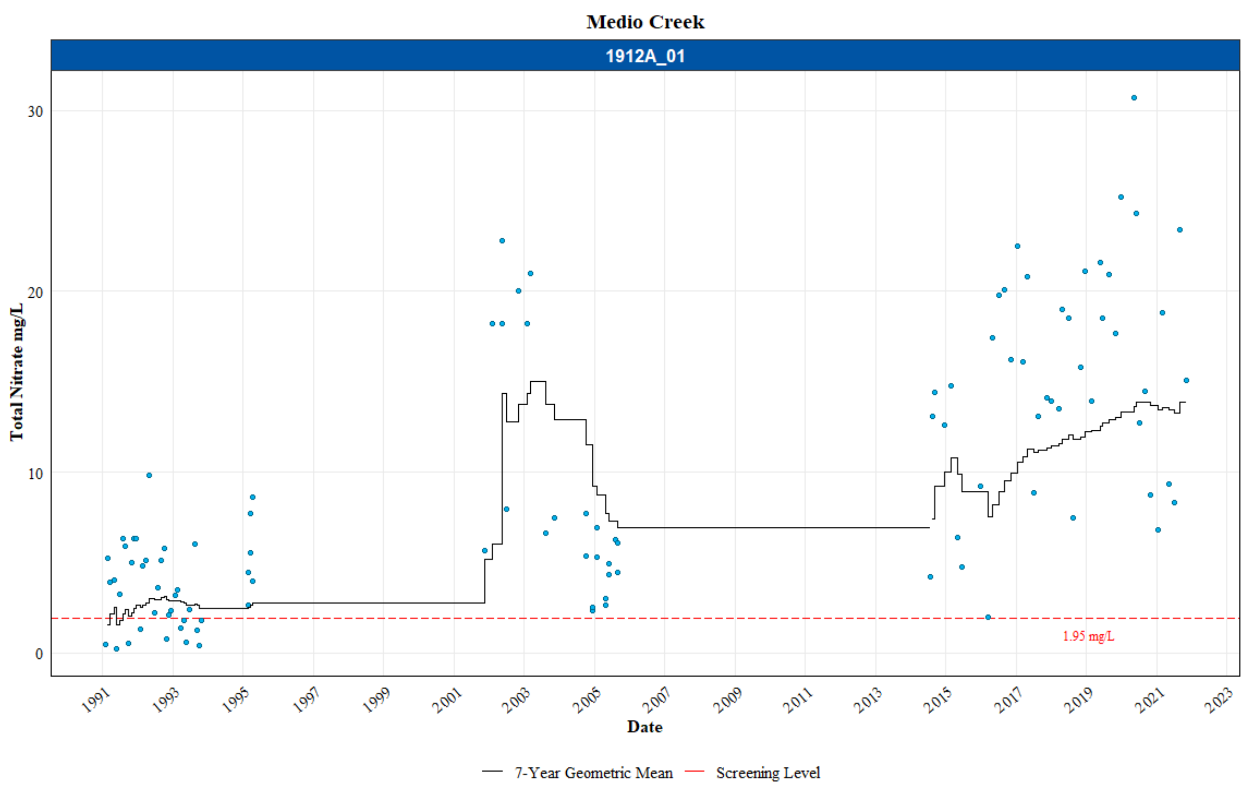

Figure 8. Total nitrate concentrations in Medio Creek.

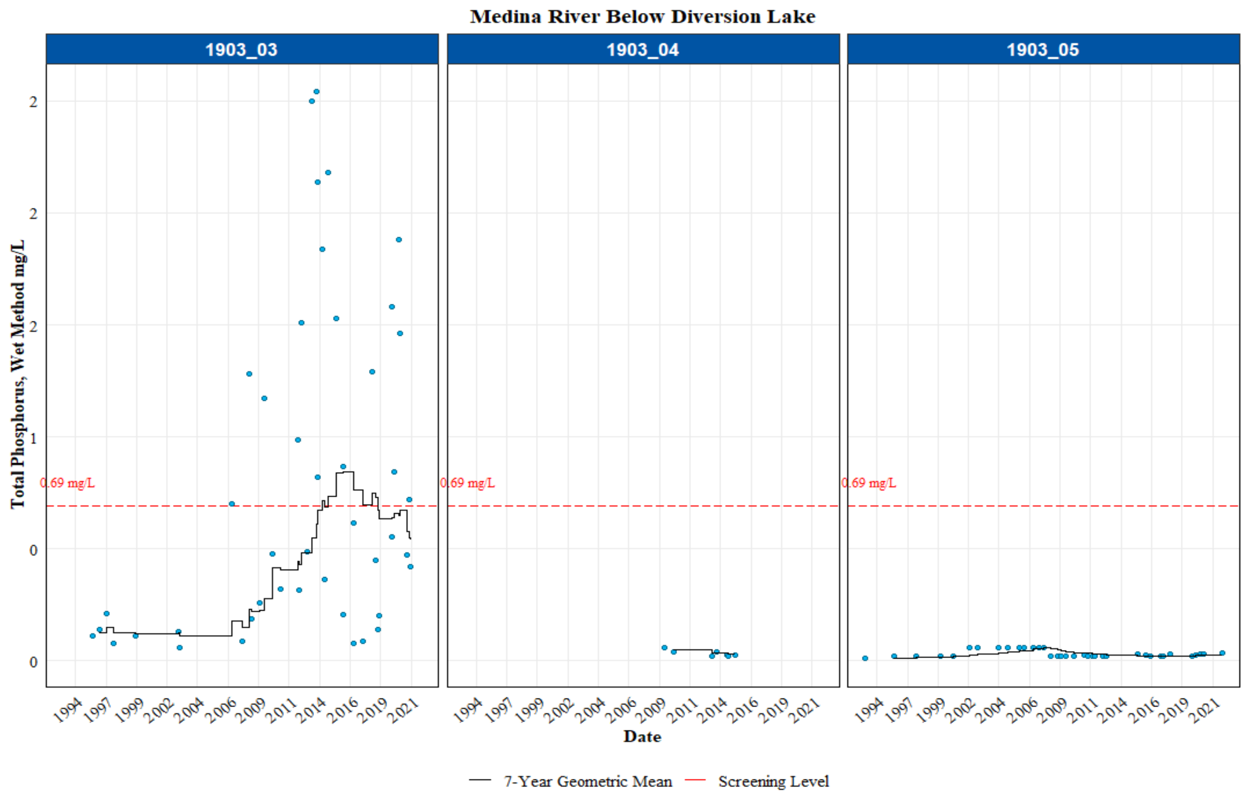

Figure 9. Total phosphorus concentrations in Medina River.

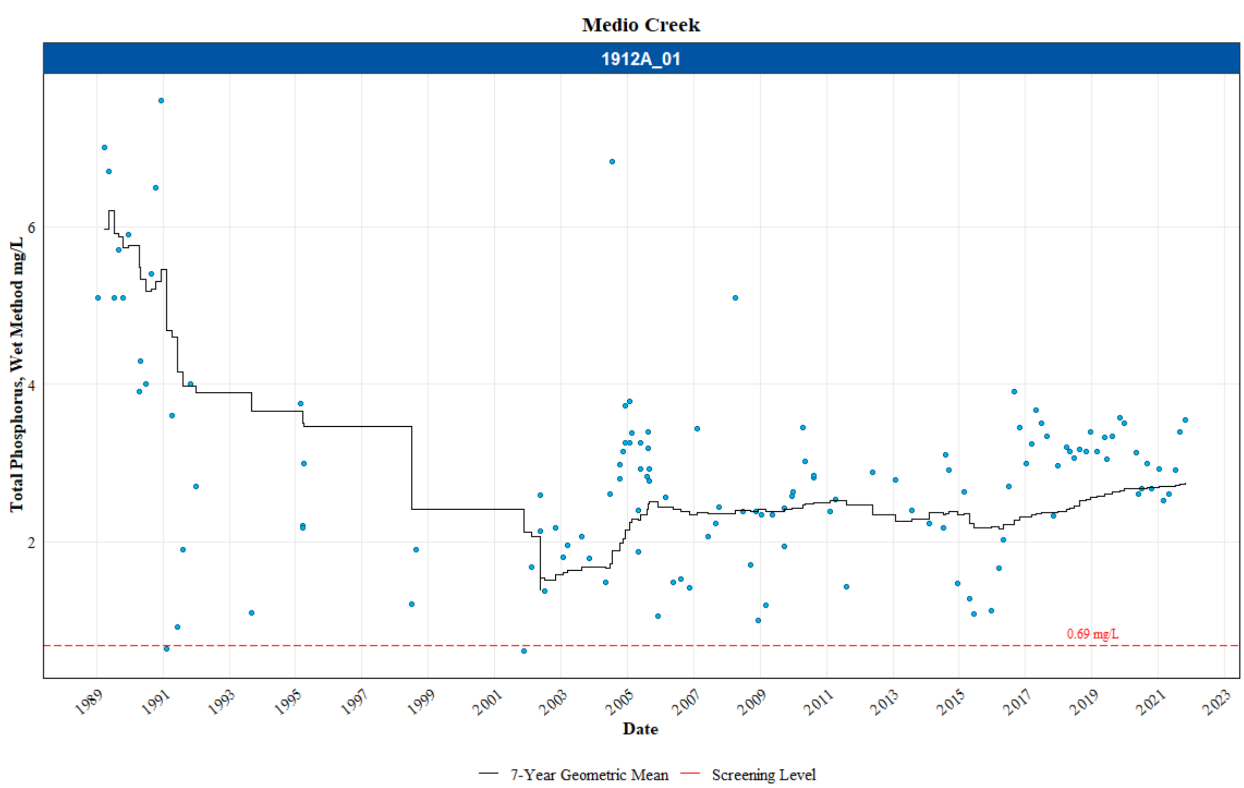

Figure 10. Total phosphorus concentrations in Medio Creek.

Flow

Generally, streamflow (the amount of water flowing in a river at a given time) is dynamic and always changing in response to both natural (e.g., precipitation events) and anthropogenic (e.g., changes in land cover or wastewater discharges) factors. From a water quality perspective, streamflow is important because it influences the ability of a water body to assimilate pollutants. Many USGS streamflow gages are within the watershed, although only two are currently active (Figure 12). Only one of the two active gages provides significant long-term instantaneous daily streamflow information. Since 1981, the streamflow gauge USGS-8180700 shows that for nine months out of the year, streamflow is typically between 100-200 cubic feet per second (Figure 12). However, monthly streamflow rapidly increases in April until it peaks in June and decreases to normal in August. The increase in May correlates loosely with monthly mean precipitation, although the continuing high flow in June and July does not follow precipitation trends. These trends are likely related to historic releases at Diversion Dam.

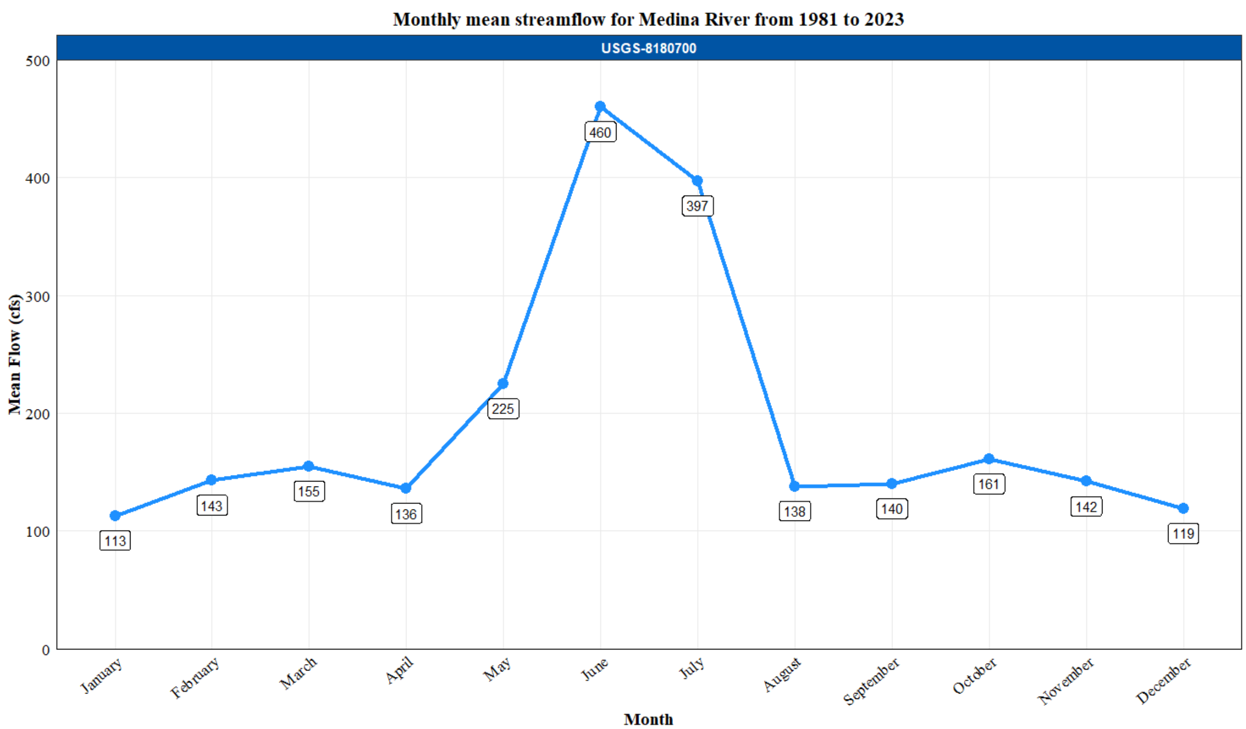

Figure 11. Mean monthly streamflow (cubic feet per second) from 1981 to 2023.

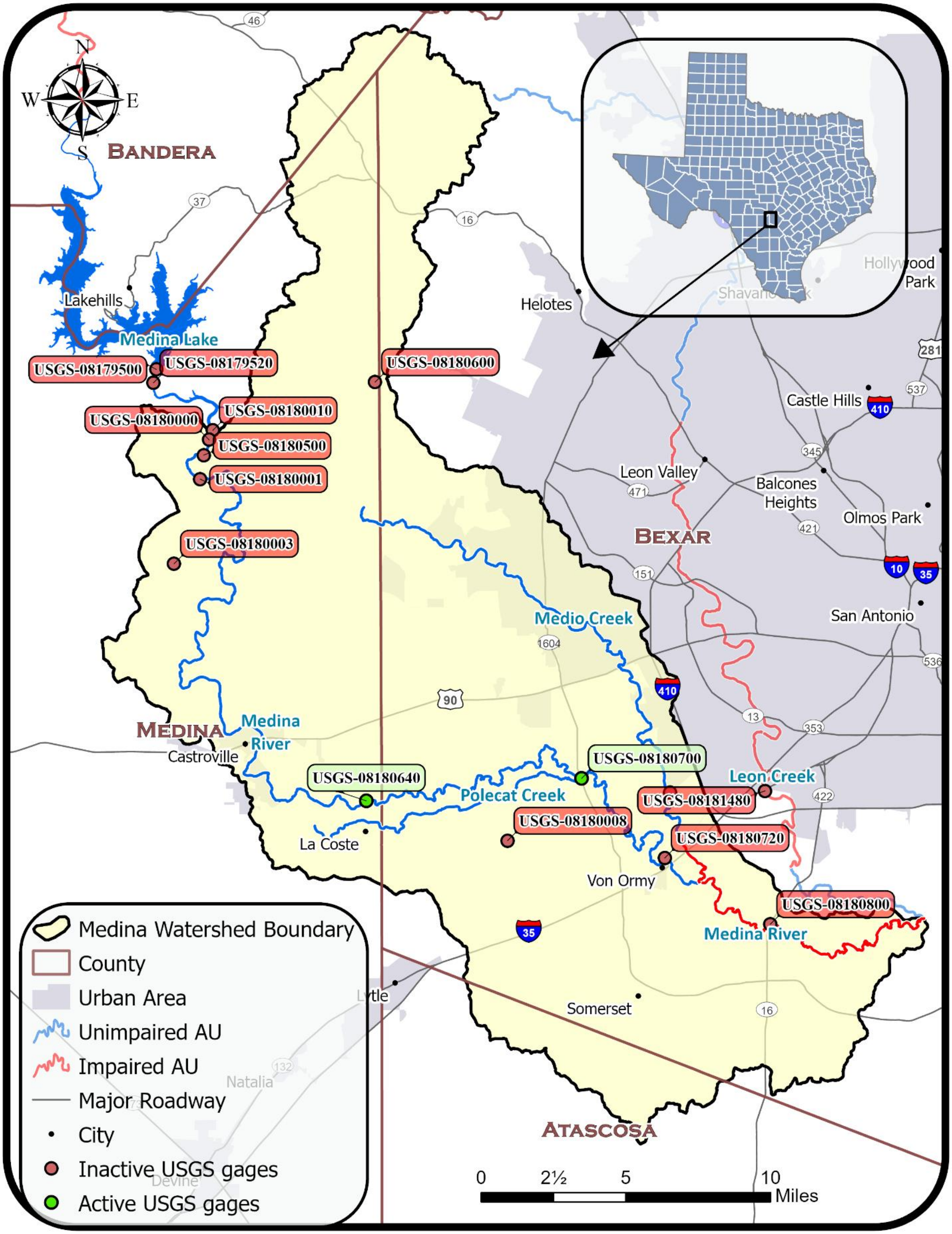

Figure 12. U.S. Geological Survey (USGS) active and inactive streamflow gages.