Watershed Characterization of the Thompsons Creek Watershed

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Texas Water Resources Institute
make every drop count

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Segments: 1242B, 1242C, 1242D

Prepared for
Total Maximum Daily Load Program
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List of Abbreviations

AU	Assessment Unit
AVMA	American Veterinary Medical Association
ALU	Aquatic Life-Use
CWA	Clean Water Act
cfs	cubic feet per second
cfu	Colony Forming Units
DO	Dissolved Oxygen
ECHO	Enforcement and Compliance History Online
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
FIB	Fecal Indicator Bacteria
HSG	Hydrologic Soil Groups
km	Kilometer
L	Liter
LULC	Land Use and Land Cover
MGD	Million Gallons per Day
mL	Milliliter
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-Sector General Permit
NASS	National Agricultural Statistics Service
NOAA	National Oceanic Atmospheric Administration
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
SCR	Secondary Contact Recreation

SSO	Sanitary Sewer Overflow
SNC	Significant Non-Compliance
SSURGO	Soil Survey Geographic Database
SWMP	Stormwater Management Program
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TPDES	Texas Pollutant Discharge Elimination System
TWDB	Texas Water Development Board
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WWTF	Wastewater Treatment Facility

Executive Summary

The Brazos River Basin extends from the confluences of the Salt and Double Mountain forks in Stonewall County to the Gulf of Mexico and is the second largest river basin by area in Texas. The Brazos River is the third longest river in the state and has the largest average annual flow volume of all state rivers (TWDB 2020a). The Brazos River above Navasota (Segment 1242) flows approximately 183 miles from an upstream confluence of the Navasota River in the Brazos/Grimes/Washington counties area to the lower dam forming Lake Brazos in McLennan County (TCEQ 2002). The Thompsons Creek watershed lies within the greater Brazos River above Navasota watershed and includes three tributaries that are listed as impaired. The three tributaries, including portions of Cottonwood Branch (1242B_01 and 1242B_02), Still Creek (1242C_02) and Thompsons Creek (1242D_01 and 1242D_02), are all identified as impaired for elevated concentrations of *Escherichia coli* (*E. coli*) in the *2020 Texas Integrated Report of Surface Water Quality for the Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report) (TCEQ 2020a). Of the three tributaries, only Thompsons Creek (Segment 1242D) discharges directly into the Brazos River (Segment 1242). Elevated levels of *E. coli* have been identified in the Thompsons Creek watershed since as early as 2002 (TCEQ 2020a). The upper assessment unit (AU) of Thompsons Creek (AU 1242D_02) is also listed as impaired for depressed dissolved oxygen. The watershed is located entirely in Brazos County adjacent to the cities of Bryan and College Station, TX (Figure 1). This characterization report addresses the *E. coli* impairments in the Thompsons Creek watershed with supplementary water quality monitoring and a review of the current demographic, climatic, physical and hydrological conditions of the watershed.

Activities for the project have included water quality monitoring, characterization development and meetings with local stakeholder individuals to discuss the goals and objectives of addressing the bacteria impairments in the watershed. Existing data for water quality parameters, flow, livestock, wildlife, stormwater permits and a number of on-site sewage facilities have been analyzed to develop a better understanding of potential causes and sources of bacteria pollution. Stakeholder engagement will continue in the watershed as the Technical Support Document, a document that provides technical and supporting information for the development of bacteria Total Maximum Daily Loads, is developed.

Background Information

Description of Watershed

The three individual tributaries that encompass the Thompsons Creek, Still Creek and Cottonwood Branch watershed (collectively termed Thompsons Creek watershed in the report) span nearly 33,297 acres in Brazos County. The Texas Commission on Environmental Quality (TCEQ) describes surface water bodies (called segments) with a specific "identifier" (segment ID) and will further divide segments in hydrologically distinct assessment units (AUs).

Cottonwood Branch (Segment 1242B) is a 7-mile long intermittent stream with perennial pools from the confluence of Still Creek upstream 0.95 kilometers (km) to the confluence with an unnamed tributary. The stream is composed of two AUs, 1242B_01 and 1242B_02, which are both listed as impaired for bacteria (TCEQ 2020a and 2020b). Still Creek (Segment 1242C) is a 9-mile perennial stream segment from the confluence with Thompsons Creek upstream to the headwaters in Brazos County near US190 and includes one impaired AU, 1242C_02. Both AUs 1242B_01 and 1242C_02 have nutrient concerns for nitrate and total phosphorus (TCEQ 2020c). Still Creek (Segment 1242C) also has a concern for depressed dissolved oxygen (DO). Thompsons Creek (Segment 1242D) flows 18 miles from the confluence of the Brazos River upstream to the confluence of Thompsons Branch, north of FM 1687. There are two AUs, 1242D_01 and 1242D_02, for Thompsons Creek that are impaired for bacteria but only the upstream AU 1242D_02 is impaired for DO (TCEQ 2020a). Thompsons Creek also has concerns for ammonia, chlorophyll-a, nitrate, total phosphorus, impaired fish community and impaired macrobenthic community (TCEQ 2020c). The Thompsons Creek watershed is adjacent to the cities of Bryan (population 85,445) and College Station (population 116,218) (U.S. Census Bureau 2020a and 2020b). The unincorporated town of Smetana exists in the watershed as well (Texas Almanac 2018). A total of five AUs in the watershed are listed as impaired for bacteria within the three different streams. The individual streams and their AUs are described in Table 1 and displayed in Figure 1.

Table 1. Descriptions of segments and AUs included in the Thompsons Creek watershed (TCEQ 2020b).

Segment ID	Name	Description	AUs	AUs Impaired
1242B	Cottonwood Branch	Intermittent stream with perennial pools from the confluence of Still Creek upstream 0.95 km to the confluence with an unnamed tributary	1242B_01, 1242B_02	1242B_01, 1242B_02
1242C	Still Creek	Perennial stream segment from the confluence with Thompsons Creek upstream to the headwaters in Brazos County near US190.	1242C_01, 1242C_02	1242C_02
1242D	Thompsons Creek	Intermittent stream with perennial pools from the confluence with the Brazos River upstream to the confluence with Thompsons Branch north of FM 1687.	1242D_01, 1242D_02	1242D_01, 1242D_02

Water Quality Standards and Monitoring

Water quality monitoring by TCEQ and its designees is conducted throughout the state of Texas to identify water bodies that are failing to meet or expected not to meet designated water quality uses and their standards, according to sections 303(d) and 305(b) in the Clean Water Act (CWA). The Texas Surface Water Quality Standards section of the Texas Administrative Code, Title 30, Chapter 307 (30 TAC § 307) and the 2020 Texas Integrated Report: Assessment Results for Basin 12, list the water quality standards for each segment. Water quality standards were initially established by TCEQ to protect aquatic life and human health. The Texas Surface Water Quality Standards describes the requirements and rationale for water bodies to meet designated uses, of which four of the most common designated uses include contact recreation, domestic water supply, aquatic life-use (ALU) and general use.

Fecal indicator bacteria (FIB) are used to assess the human health risk, described as the risk of contracting a gastrointestinal illness during contact recreation involving ingestion of water. *E. coli* and Enterococcus spp. are two types of FIB used to assess water quality due to their natural presence in the intestinal tracts of warm-blooded organisms, including humans. Detecting FIB, such as *E. coli*, in a water body indicates the potential presence of associated fecal pathogens and therefore an increased risk for human health. For freshwater bodies, *E. coli* is the FIB standard, while Enterococci is frequently used in tidal or marine environments.

Revisions to the Texas Surface Water Quality Standards adopted by TCEQ on February 7, 2018 and approved by the U.S. Environmental Protection Agency (EPA) on May 19, 2020, approved the use of different categorical levels and criteria for recreational uses (TCEQ 2018a). Criteria are expressed as the number of bacteria per 100 milliliters (mL) of water (in terms of colony forming units (cfu), most probable number (MPN) or other appropriate reporting measures). The laboratory method used in this project to enumerate bacteria uses MPN; however, the units MPN and cfu are used interchangeably in this document. The four recreational uses and their criteria include:

- Primary contact recreation (PCR) 1: activities that involve a significant risk of ingestion of water (i.e. swimming, diving, wading and whitewater sports) and has a geometric mean criterion for *E. coli* of 126 per 100 mL.
- PCR 2: activities that involve a significant risk of ingestion of water (i.e. swimming, diving, wading and whitewater sports) but occur less frequently than for PCR 1 due to physical characteristics of the water body or limited public access. The geometric mean criterion *for E. coli* is 206 per 100 mL.
- Secondary contact recreation (SCR) 1: activities that involved limited body contact with water and less significant risk of water ingestion (i.e. fishing, canoeing and boating) and have a geometric mean criterion for *E. coli* of 630 per 100 mL.
- SCR 2: activities that are similar to SCR 1 but occur less frequently due to limited public access or physical constraints of the water body. The geometric mean criterion for *E. coli* is 1,030 per 100 mL.

- Noncontact recreation: a designation used when there is no significant risk of ingestion of water, or where contact recreation should not occur due to unsafe conditions. The geometric mean criterion for *E. coli* is 2,060 per 100 mL (TCEQ 2018a).

A recreational use attainability analysis (RUAA) is conducted to assess the recreational activities occurring in a water body and determine if the appropriate standards have been applied. RUAAs include information concerning historical and current uses as well as important physical characteristics of the water body (TCEQ 2018b). Not all water bodies in the Thompsons Creek watershed are currently presumed to meet PCR standards (Table 2). All three segments (Thompsons Creek, Still Creek and Cottonwood Branch) had RUAAs completed in 2009. The RUAA for Still Creek identified evidence of PCR and recommended that the water body retain its recreational standard for PCR 1. The RUAAs for both Cottonwood Branch and Thompsons Creek resulted in recommending the contact recreation use be revised to SCR 1 due to limiting physical characteristics (shallow depths or lack of pools) (TCEQ 2010). Cottonwood Branch (segment 1242B) was recently designated as a SCR 1 water body. Still Creek (segment 1242C) is designated as a PCR 1. Thompsons Creek (segment 1242D) is listed to meet PCR 1 standards, but the proposed recreational use change to SCR 1 is currently pending EPA approval.

Table 2. Contact recreation standards for AUs in the watershed.

Water body	AUs	Contact Recreation Standard (cfu/100mL)
Thompsons Creek	1242D_01*	126
	1242D_02*	126
Still Creek	1242C_02	126
Cottonwood ranch	1242B_01	630
	1242B_02	630

*AUs still under review for recreational use changes.

assessment unit, AU; colony forming unit, cfu.

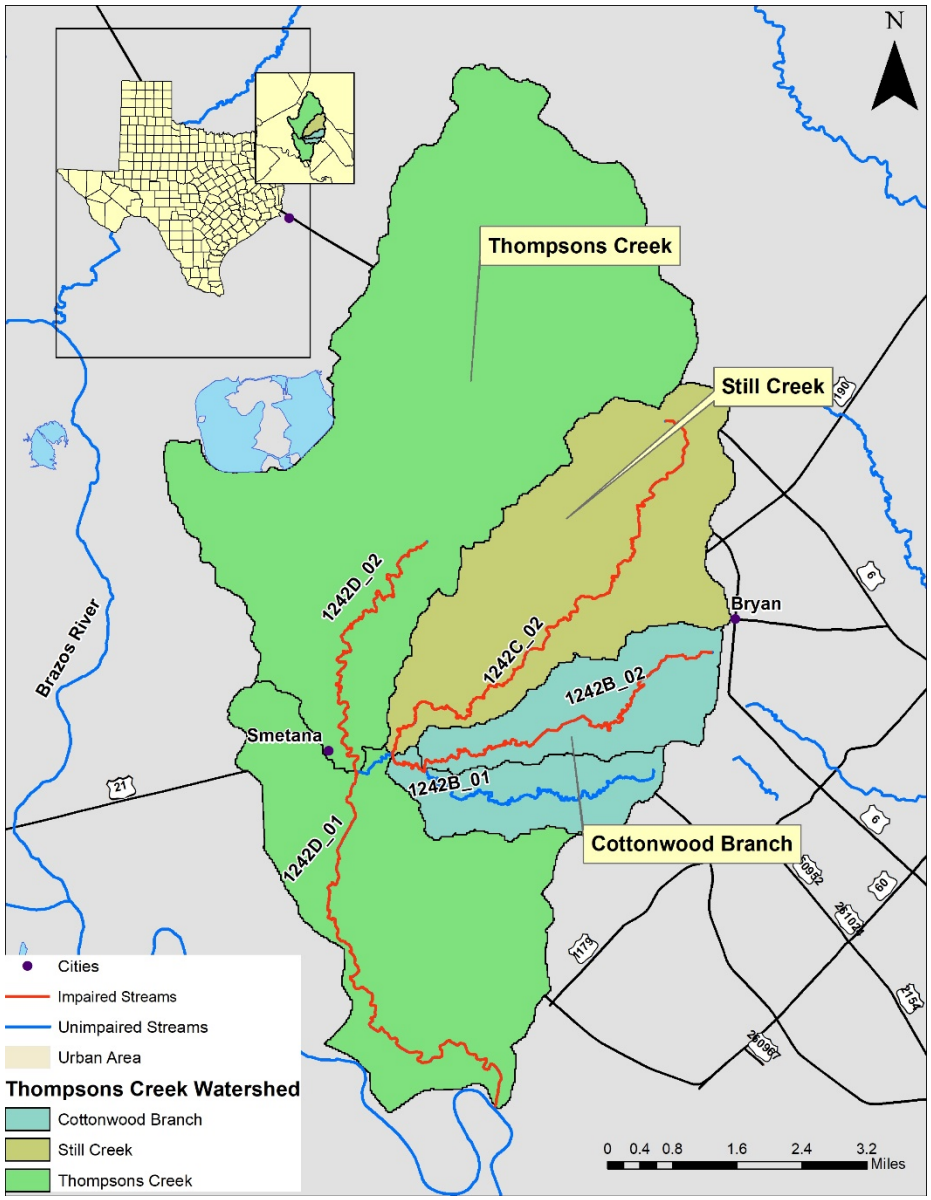

Figure 1. Overview of the Thompsons Creek watershed and its tributaries.
Sources: NHDPlusV2 and USGS; TXDOT and TNRIS; TCEQ and USGS

Land Use and Land Cover

Land use and land cover (LULC) data was obtained from the 2016 National Land Cover Database at a 30-meter raster resolution. LULC is categorized into 14 different classifications for the Thompsons Creek watershed (Table 3 and Figure 2). The different land covers are not evenly distributed across all five subwatersheds; therefore, quantitatively describing the land use classifications for each subwatershed is necessary for future planning decisions.

- Open Water: areas of open water that are generally less than 25% vegetation or soil cover.
- Developed, Open Space: areas that have a mixture of constructed materials, but mostly vegetation in the form of lawn grasses exist. Impervious surfaces account for less than 20% of total cover. Such areas typically include large-lot single-family housing units, parks, golf courses and vegetation planted in developed settings for recreation, erosion control or aesthetic purposes.
- Developed, Low Intensity: areas that consist of a mix of constructed materials and vegetation. Impervious surfaces account for 20% to 49% of total cover. These areas commonly include single-family housing units.
- Developed, Medium Intensity: areas that consist of a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas commonly include single-family housing units.
- Developed, High Intensity: highly developed areas where people reside or work in high numbers. Areas include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
- Barren Land: areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
- Deciduous Forest: areas dominated by trees generally greater than 5 meters tall and greater than 20% of total vegetation cover. More than 75% of tree species shed foliage simultaneously in response to seasonal change.
- Evergreen Forest: areas dominated by trees generally greater than 5 meters tall and greater than 20% total vegetation cover. More than 75% of the tree species maintain their leaves year-round. Canopy is never without green foliage.
- Mixed Forest: areas dominated by trees generally greater than 5 meters tall and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
- Shrub/Scrub: areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in early successional stage or trees stunted from environmental conditions.

- Herbaceous: areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These types of areas are not subject to intensive management such as tilling but can be used for grazing.
- Hay/Pasture: areas of grass, legumes or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
- Woody Wetlands: areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
- Emergent Herbaceous Wetlands: areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

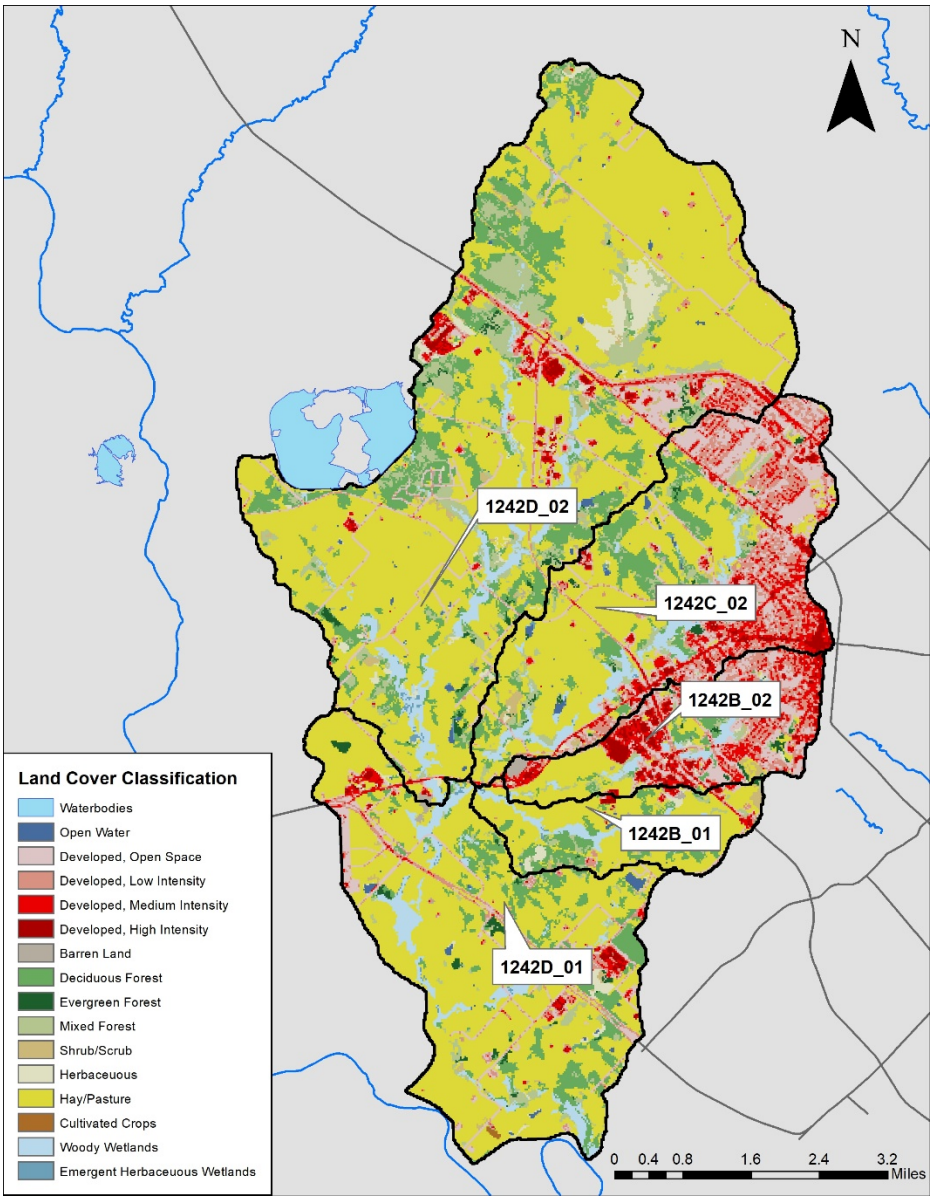

Figure 2. Land use and land cover classifications in the watershed.

The Thompsons Creek watershed (including Thompsons Creek, Still Creek and Cottonwood Branch) is predominantly Hay/Pasture (52.82% or 17,590 acres), followed by Deciduous Forest (10.80% or 3,597 acres). While High Intensity Developed only covers 478 acres or 1.44% of the watershed, when considering all levels of development (Open Space, Low, Medium and High Intensity), 7,161 acres or 21.51% of the watershed is impacted. The entire developed land use category is the second greatest land use type to Hay/Pasture in the watershed. The land use category with the least amount of acres in the watershed is Cultivated Crops with only 8 acres or

0.03% of the watershed. Acres per land use category for the entire watershed and each individual subwatershed is listed in Table 3. AU 1242D_02 is the largest subwatershed (15,568.28 acres), followed by AUs 1242D_01 (7,158.43 acres), 1242C_02 (6,422.75 acres) and 1242B_02 (2,419.43 acres). AU 1242B_01 is the smallest subwatershed with only 1,728.01 acres and is predominantly Hay/Pasture (940.06 acres or 54.40%). Developed land only accounts for 8.37% of this watershed (144.56 acres). AU 1242B_02 is predominantly an urban subwatershed with 65.08% (1,574.55 acres) categorized as developed. Hay/Pasture only accounts for 17.40% (420.99 acres) in the subwatershed. AU 1242C_02 land use is primarily developed (43.39% or 2,787.05 acres), followed by Hay/Pasture (34.39% or 2,215.27 acres). AU 1242D_01 is a predominantly rural subwatershed as well with nearly two thirds of the watershed being classified as Hay/Pasture (64.39% or 4,609.57 acres). Developed land accounts for 12.72% (910.26 acres), followed by Deciduous Forest (10.82% or 774.38 acres). Lastly, AU 1242D_02 is predominantly rural with Hay/Pasture covering most of the subwatershed (60.38% or 9,400.62 acres) followed by Deciduous Forest (11.54% or 1,796.95 acres) and developed (11.21% or 1,744.69 acres).

Table 3. Land use and land cover classifications in the Thompsons Creek watershed.

	Subwatersheds										Total Watershed	
Classification	1242B_01		1242B_02		1242C_02		1242D_01		1242 D_02			
	Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage
Open Water	6.45	0.37%	0.22	0.01%	30.25	0.47%	44.92	0.63%	54.04	0.35%	135.88	0.41%
Developed, Open Space	41.37	2.39%	441.90	18.26%	995.44	15.50%	471.25	6.58%	837.76	5.38%	2,787	8.37%
Developed, Low Intensity	48.93	2.83%	528.19	21.83%	1045.03	16.27%	278.66	3.89%	509.51	3.27%	2,410	7.24%
Developed, Medium Intensity	38.03	2.20%	439.23	18.15%	606.25	9.44%	115.65	1.62%	285.55	1.83%	1,485	4.46%
Developed High Intensity	16.23	0.94%	165.24	6.83%	140.33	2.18%	44.70	0.62%	111.86	0.72%	478.37	1.44%
Barren Land	8.45	0.49%	27.35	1.13%	8.90	0.14%	19.35	0.27%	31.14	0.20%	95.18	0.29%
Deciduous Forest	302.23	17.49%	123.43	5.10%	600.24	9.35%	774.38	10.82%	1796.95	11.54%	3,597	10.80%
Evergreen Forest	9.56	0.55%	35.58	1.47%	53.15	0.83%	74.06	1.03%	91.18	0.59%	264	0.79%
Mixed Forest	69.39	4.02%	81.17	3.36%	298.68	4.65%	157.23	2.20%	1318.80	8.47%	1,925	5.78%
Shrub/Scrub	29.58	1.71%	32.25	1.33%	69.61	1.08%	28.91	0.40%	155.68	1.00%	316	0.95%
Grassland/Herbaceous	34.03	1.97%	19.13	0.79%	25.35	0.39%	66.94	0.94%	389.19	2.50%	535	1.61%
Hay/Pasture	940.06	54.40%	420.99	17.40%	2215.27	34.49%	4609.57	64.39%	9400.62	60.38%	17,590	52.82%
Cultivated Crops	0.00	0.00%	0.00	0.00%	0.00	0.00%	8.01	0.11%	0.44	0.00%	8.45	0.03%
Woody Wetlands	176.58	10.22%	102.75	4.25%	318.25	4.95%	437.89	6.12%	549.98	3.53%	1,585	4.76%
Emergent Herbaceous Wetland	7.12	0.41%	2.00	0.08%	16.01	0.25%	26.91	0.38%	35.58	0.23%	87.62	0.26%
Total Acres	1,728	100.00%	2,419	100.00%	6,423	100.00%	7,158	100.00%	15,568	100.00%	33,299	100.00%

* Sum of acreage slightly differs from the total acreage in the watershed due to GIS analyses conducted in ArcMap.

Climate

The Thompsons Creek watershed is located in east-central Texas and is characterized as having a subtropical humid climate. Figure 3 presents the average monthly values for precipitation and temperature as reported by the National Oceanic and Atmospheric Administration (NOAA) at the Easterwood Airport in Brazos County (NOAA 2014). From 1981 to 2010, the average annual temperatures in the watershed ranged from a low of 50°F (January) to a high of 82°F (August). Monthly average lows range from 38°F (January) to 72°F (August), and the monthly average highs range from 60°F (January) to 94°F (August). The average monthly precipitation ranges from 2 to 5 inches, with the greatest precipitation occurring in October and the lowest precipitation occurring in July. While the airport is located southeast of the watershed, near College Station, Texas, it was the only location that had consistent data collection from 1981-2010.

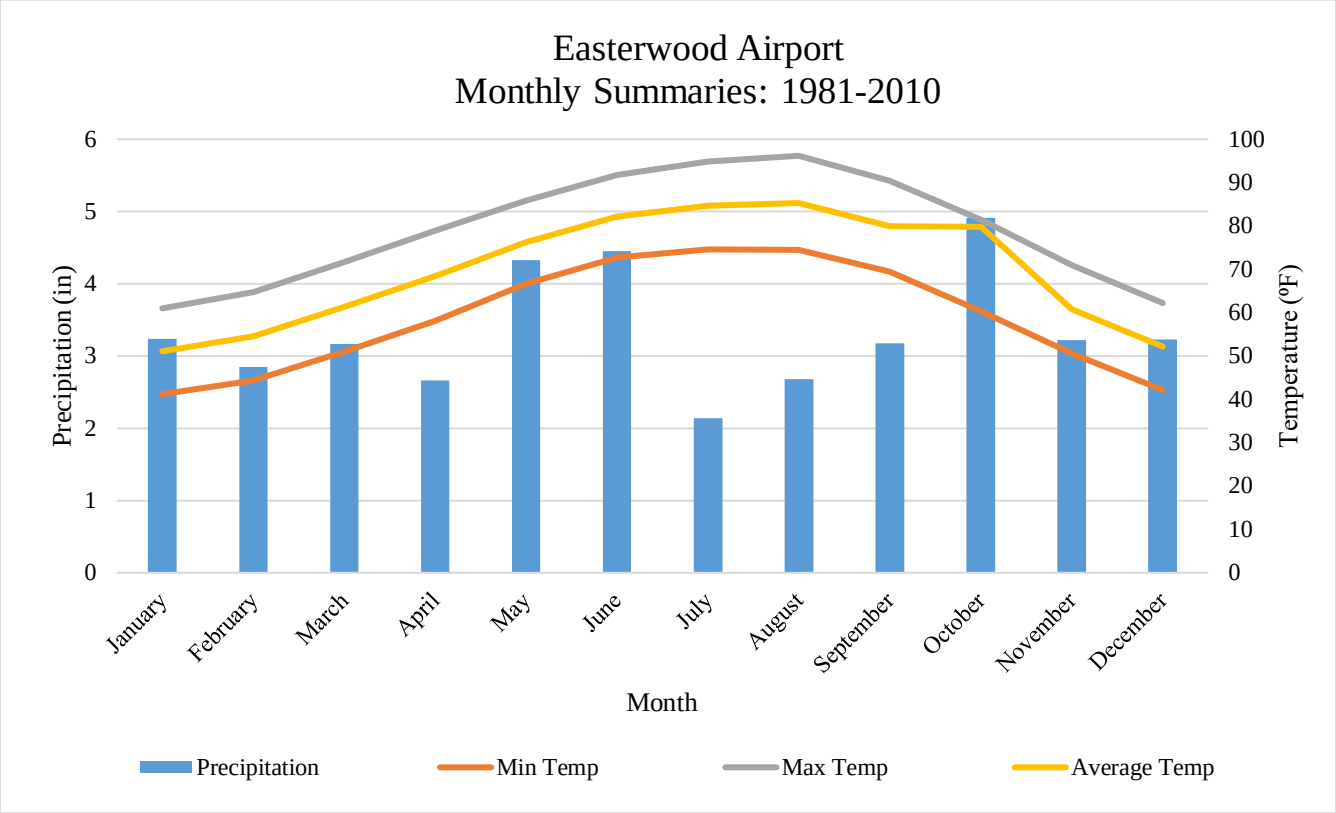

Figure 3. Monthly climate data, including precipitation, average, maximum and minimum air temperature, for Easterwood Airport in College Station, TX from 1981-2010.
Source: NOAA

Ecoregions

Ecoregions are distinct land areas with similar ecosystems and natural resources. Four different ecoregion levels exist, ranging from less defined (Level I) to highly detailed (Level IV) (U.S. EPA 2013). The Thompsons Creek watershed is located in the Level III Ecoregion 33 of the East Central Texas Plains and more specifically in 33b, Southern Post Oak Savanna and in 33c, San Antonio Prairie (Griffith, Bryce, Omernik and Rogers 2007). The Southern Post Oak Savannah ecoregion is described as having more forest and hardwoods than other prairies or East Texas forests. Current land cover includes post oak woods, rangeland, improved pasture and mesquite trees in the southern area of the region. The San Antonio Prairie is a much narrower region that is characterized by woodlands, rangeland, improved pastures and cropland (Griffith, Bryce, Omernik and Rogers 2007).

Soils and Topography

Soils and topography are key characteristics influencing the hydrology of a watershed and can determine the types of land use and activities possible. The topography of a landscape will dictate the slope and elevation and therefore the direction and speed of runoff. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) provides information about soils through the Soil Survey Geographic Database (SSURGO). Soils are categorized into specific hydrologic soil groups (HSG), based upon similar rainfall, runoff and infiltration characteristics. The HSG ratings are particularly useful when determining runoff potential under consistent precipitation and cover conditions. Soils within the watershed are primarily categorized as Group B (36%) and D (26%) (Figure 4; Table 4). When wet, Group B soils have moderate infiltration potential while Group D soils have a higher runoff potential when wet and water movement is restricted (NRCS 2018). Overall, the soils in the watershed are characterized as predominantly being clay and loam. The varieties of HSGs vary between each subwatershed, with Group B soils being more predominant in AUs 1242B_01, 1242C_02 and 1242D_01. Group D soils are found to be more dominant in AUs 1242B_02 and 1242D_02.

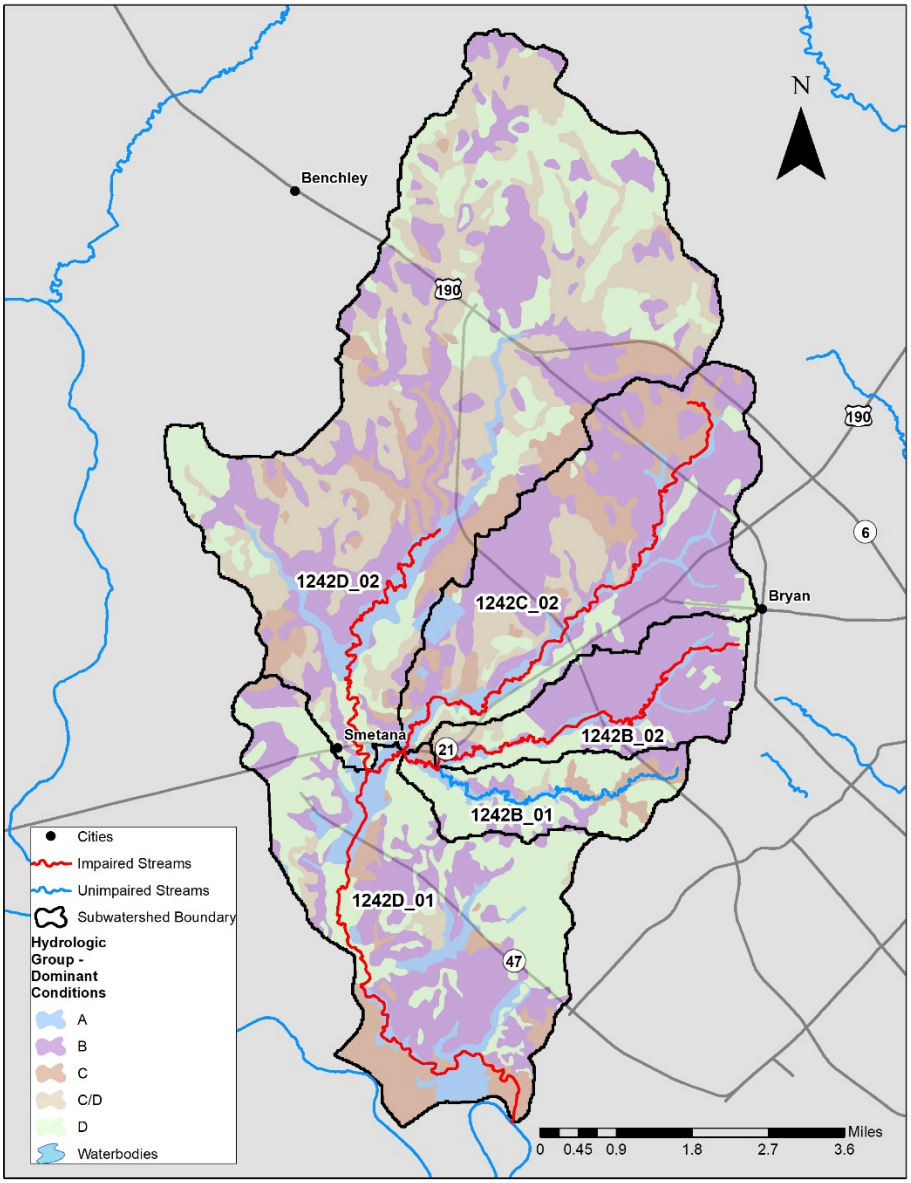

Figure 4. Hydrologic soil groups in the Thompsons Creek watershed.
Sources: SSURGO and NRCS

Table 4. Descriptions of the hydrologic soil groups in the Thompsons Creek watershed.

Hydrologic Soil Group	Description[1]	Acres	Percentage in Watershed (%)
A	Less than 10% clay, more than 90% sand or gravel. Soils have a high infiltration rate (low runoff potential) when thoroughly wet. These soils consist mainly of deep, well drained to excessively drained sands or gravelly sands.	2,771	8%
B	Between 10 and 20% clay, 50 to 90% loam. Soils having a moderate infiltration rate when wet. These consist chiefly of moderately deep or deep, moderately well drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.	11,983	36%
C	Between 20 and 40% clay, less than 50% sand. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.	3,811	12%
C/D	See below[2]	6,059	18%
D	Greater than 40% clay, less than 50% sand. Soils having a slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay layer at or near the surface and soils that are shallow over a nearly impervious material. These soils have a very slow rate of water transmission.	8,464	26%

[1] All descriptions are from the USDA NRCS Updated Hydrologic Soils Group

[2] According to NRCS (2018): "Certain wet soils are placed in Group D based solely on the presence of the water table within 60 centimeters [24 inches] of the surface, even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, they are assigned to dual HSGs (A/D, B/D and C/D) based on their saturated hydraulic conductivity and water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state."

Populations and Projections

According to the 2010 Census (U.S. Census Bureau 2012), the population in the Thompsons Creek watershed is estimated at 24,630 individuals, which is influenced by the City of Bryan. Figure 5 displays the population density per acre in each subwatershed. Population projections are developed using the 2010 Census data and the Texas Water Development Board County Population Projections (TWDB) (U.S. Census Bureau 2012; TWDB 2020b) (Table 5). Since U.S. Census Block boundaries do not directly follow the boundaries of the watershed, population estimates were calculated by multiplying the census block population by the percent of each block located in the watershed. Between 2010 and 2020, the population in the county, and therefore each subwatershed, was projected to increase by 17%. Population projections between 2020 and 2070 assumes the population for each subwatershed will increase by 113%, most likely

due to the growth of the cities of Bryan and College Station, which are located east and south of the watershed, respectively. Still Creek (AU 1242C_02) appears to have the greatest population of all subwatersheds, while the downstream AU of Cottonwood Branch, 1242B_01, has the smallest estimated population (Table 6).

Table 5. Population projections in Brazos County.

Population Projections							
County	**2010 U.S. Census Population**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Brazos	194,851	227,654	282,453	342,487	401,051	433,781	484,546

Table 6. Population projections for each subwatershed.

Watershed	AU	Estimated 2010 Population	Estimated 2020 Population	Estimated 2070 Population
Cottonwood Branch	1242B_01	447	523	1,114
	1242B_02	7,792	9,117	19,419
Still Creek	1242C_02	12,273	14,359	30,585
Thompsons Creek	1242D_01	857	1,003	2,136
	1242D_02	3,261	3,815	8,126

assessment unit, AU.

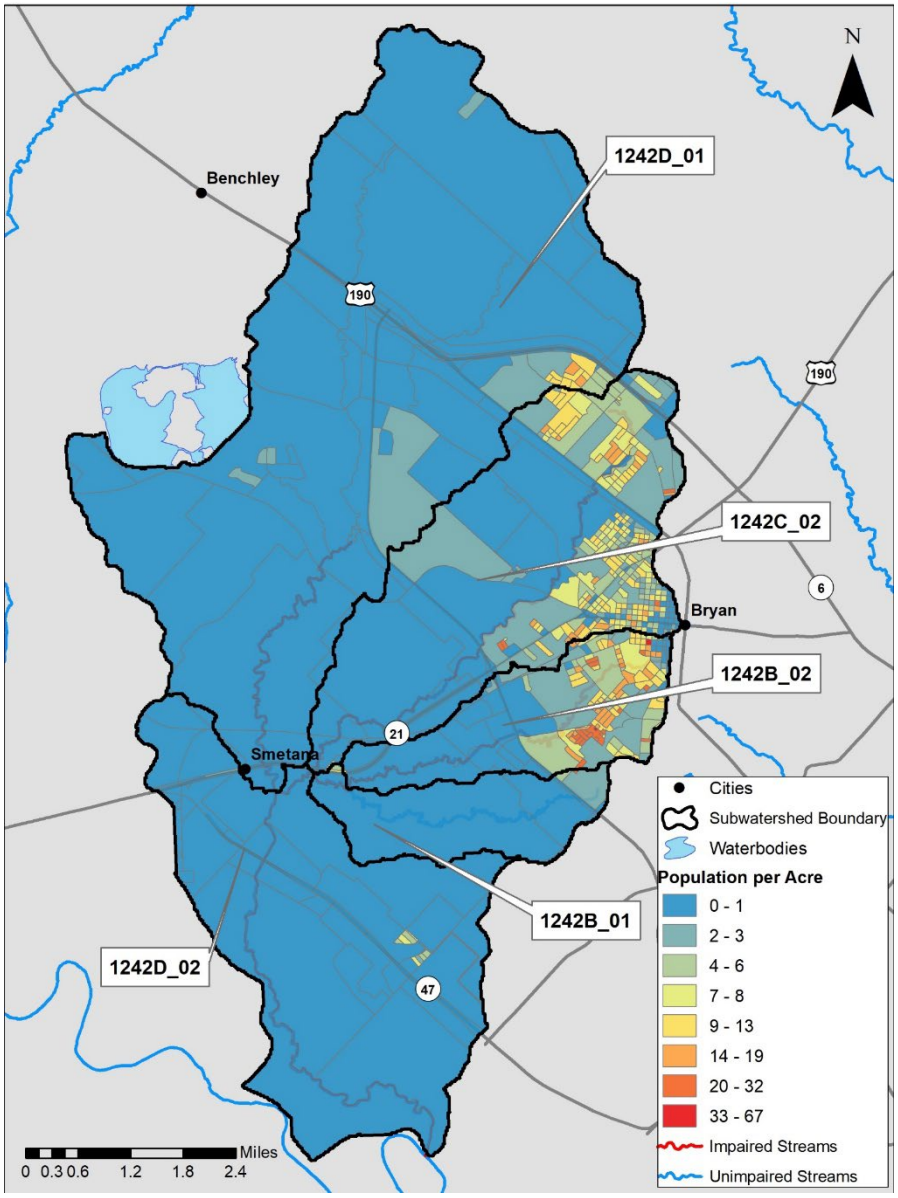

Figure 5. Population census block data for each subwatershed in the Thompsons Creek watershed. Source: U.S. Census Bureau

Water Quality

The state of Texas is required to identify water bodies that do not meet the designated water quality standards for their uses, as directed by the CWA, sections 303(d) and 305(b). AUs that do not meet their water quality standards are included on the Texas 303(d) List of the Texas Integrated Report, which is released every two years. All water bodies in the Thompsons Creek watershed are assessed for general, contact recreation and ALUs, with Thompsons Creek also assessed for fish consumption use (TCEQ 2002 and TCEQ 2020a). Thompsons Creek, Still

Creek and Cottonwood Branch do not meet bacteria standards for their respective recreational use standards. Thompsons Creek is also impaired for depressed DO levels in AU 1242D_02 (TCEQ 2020a). Both Still Creek and Cottonwood Branch were first listed on the Texas 303(d) list in 2006. Thompsons Creek was first listed for a bacteria impairment in 2002 and later listed for a depressed DO impairment in 2006.

Historical Water Quality Data

Historical water quality was retrieved from the Surface Water Quality Monitoring (SWQM) Information System for six different monitoring stations in the watershed (Table 7, Figure 6). Historical *E. coli* data and all other parameters were reviewed from January 1, 2001 to April 30, 2020. Sampling for most sites occurred quarterly due to being monitored under the Clean Rivers Program monitoring schedule (however, most sites had a 10-year gap in data collection).

Table 7. Monitoring stations and segments reviewed for historical water quality data in the Thompsons Creek watershed.

Segment	Station ID	Description	AU
1242B	17598	Cottonwood Branch at the confluence with Still Creek 50 meters downstream of SH 21	1242B_01
	17597	Cottonwood Branch at Industrial Blvd West of FM 2818 in Bryan	1242B_02
1242C	17378	Still Creek at FM 2818	1242C_02
	16882	Still Creek at SH 21	1242C_02
1242D	16396	Thompsons Creek immediately upstream of Silverhill Road 765 meters upstream of SH 47 West of Bryan	1242D_01
	16397	Thompsons Creek at SH 21 West of Bryan	1242D_02

state highway, SH; assessment unit, AU.

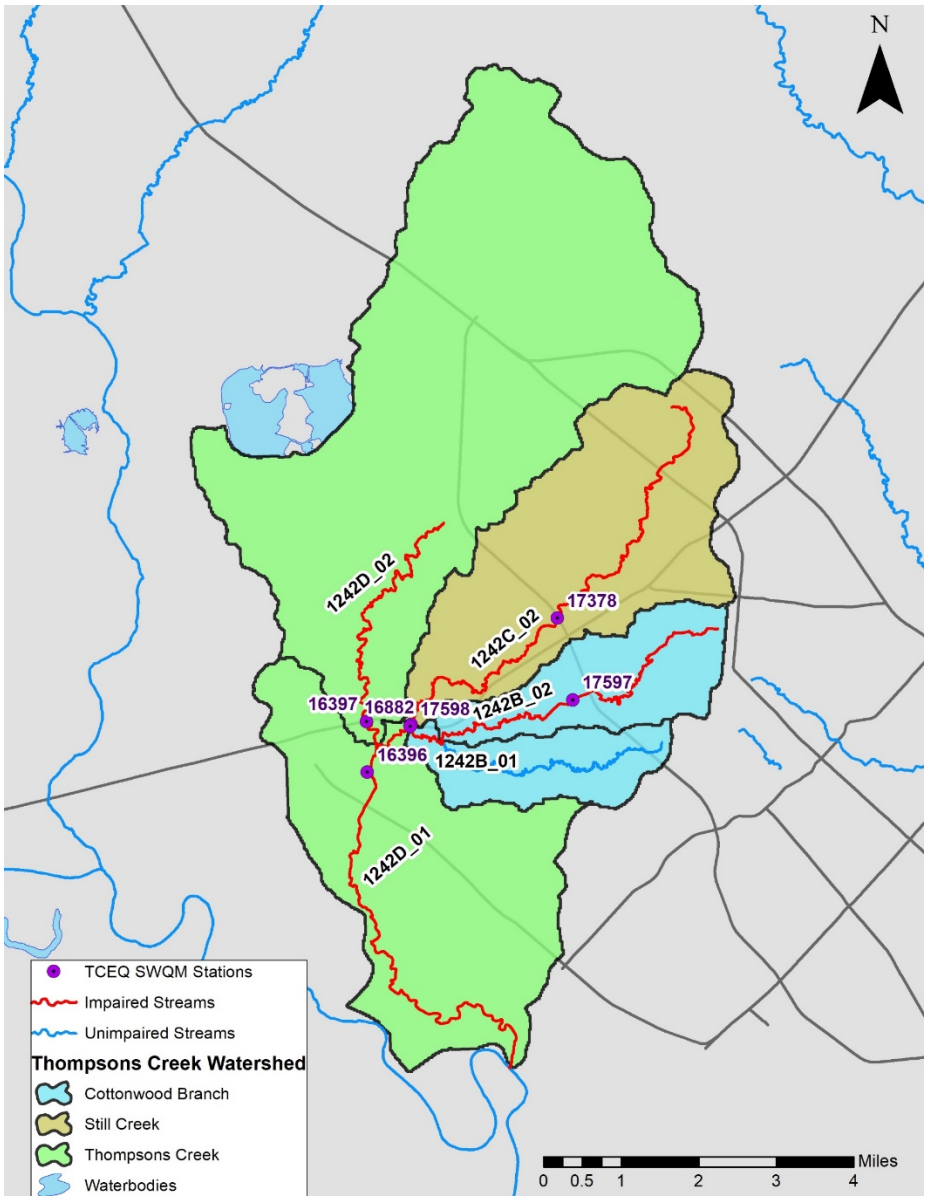

Figure 6. Locations of TCEQ Surface Water Quality Monitoring stations in the Thompsons Creek watershed.
Source: TCEQ

Bacteria

Concentrations of *E. coli* are used to assess the risk of illness during contact recreation in a water body. The PCR I standard, in which Still (segment 1242C) and Thompsons (segment 1242D) Creek tributaries are expected to meet, is a geometric mean of 126 per 100 mL for *E. coli.* Cottonwood Branch (segment 1242B) is expected to meet the SCR I standard of 630 per 100 mL. Currently, all water bodies are listed as impaired for elevated concentrations of *E. coli*

(Table 8; Figure 7). The upper AU of Thompsons Creek (1242D_02) had no data evaluated in the 2020 Integrated Report but is still listed as not supporting its designated use for contact recreation (TCEQ 2020b). Almost all sites had a paucity in data collection from 2006 to 2016 (Stations 17598, 17597, 17378 and 16882). Station 16396 had consistent data collection from 2001 to 2020, while Station 16397 had an absence of data collection between 2006 and 2020.

Table 8. Geometric means for historical *E. coli* data.

AU	Station ID	Description	Number of Samples	Data Range	***E. coli*** Geometric Mean (MPN/100 mL)
1242B_01	17598	Cottonwood Branch at the confluence with Still Creek	41	5/2002-2/2020	1,141.96
1242B_02	17597	Cottonwood Branch at Industrial Blvd	31	10/2002-2/2020	167.89
1242C_02	17378	Still Creek at FM 2818	32	8/2002-2/2020	168.8
	16882	Still Creek at SH 21	50	9/2001-2/2020	348.86
1242D_01	16396	Thompsons Creek immediately upstream of Silverhill Road	85	9/2001-2/2020	863.25
1242D_02	16397	Thompsons Creek at SH 21	27	9/2001-2/2020	448.91

assessment unit, AU; state highway, SH; most probable number, MPN, milliliter, mL.

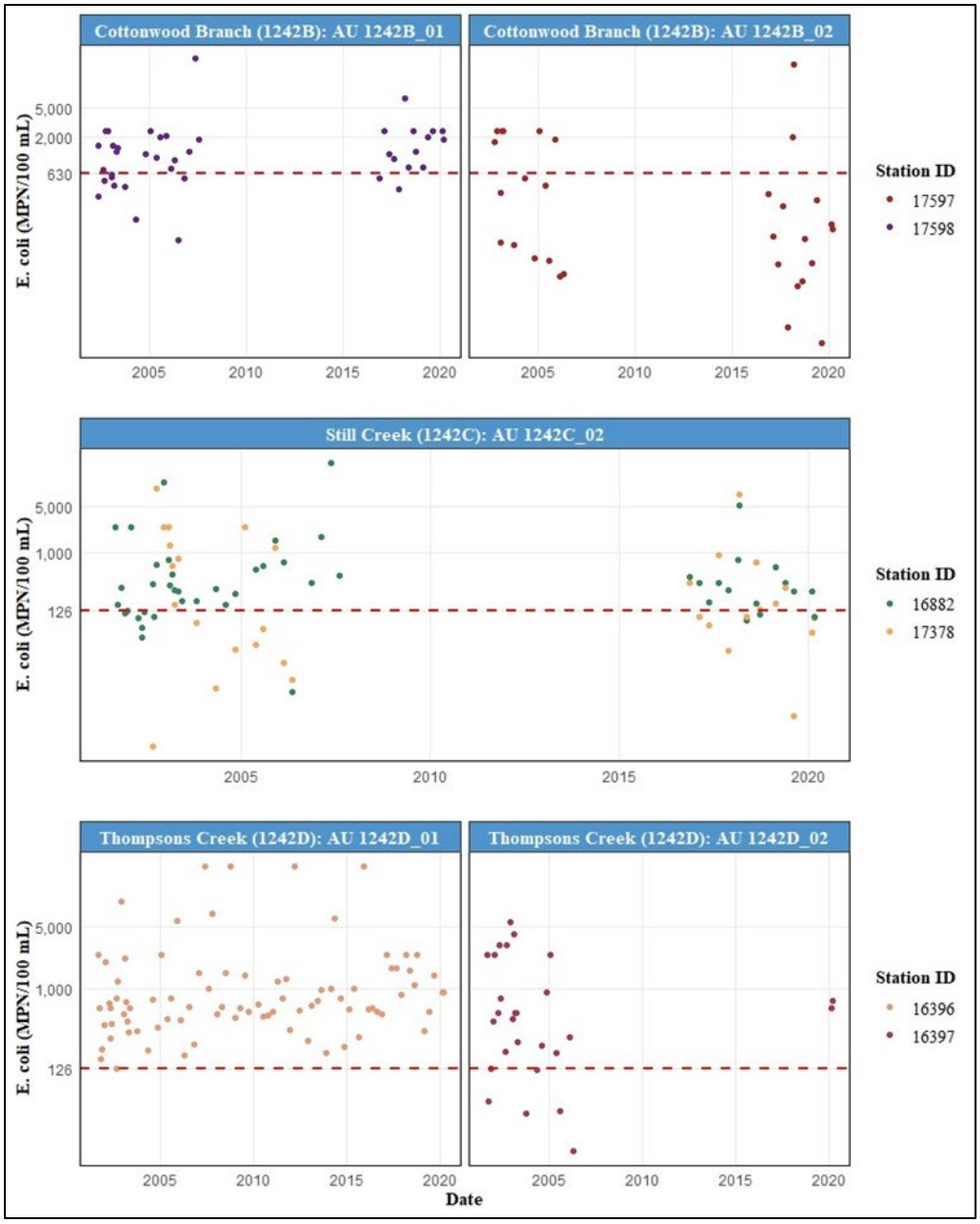

Figure 7. Historical *E. coli* concentrations at monitored segments and stations in the Thompsons Creek subwatersheds from 2000-2020.The dotted red line indicates the PCR 1 standard of 126 per 100 mL for *E. coli* for Still and Thompsons Creeks and SCR 1 standard of 630 per 100 mL for Cottonwood Branch.

DO

DO is essential for aquatic organisms to survive and refers to the concentration of oxygen incorporated into water. DO concentrations naturally fluctuate in the environment, but anthropogenic activities can contribute excessive organic matter and nutrients, consequently depressing DO concentrations. Every water body assessed by the Texas State Water Quality

Standards is assigned an ALU category of either minimal, limited, intermediate, high or exceptional. Classified water bodies are required to meet an average DO criterion measured over 24 hours and a minimum DO criterion (TCEQ 2015). Unclassified streams are assigned an ALU based upon the flow-type for the specific segment, which are categorized as perennial, intermittent with perennial pools and intermittent without perennial pools. Specific DO criteria are associated with each unclassified stream type, unless a site-specific ALU has been assigned to the unclassified water body. The 24-hour average DO criteria are measured over 24 hours and sampling events occur at various times throughout the year to represent unbiased and seasonally representative data. When 24-hour average DO is not available, grab DO measurements are utilized and include a minimum criterion and screening level criterion (TCEQ 2015). While the upper AU (1242D_02) of Thompsons Creek (Station 16397) has a 24-hour average and minimum DO criteria, no 24-hour average DO data was assessed between 2011-2018. All segments in the Thompsons Creek watershed are assumed to support a subcategory of ALU. AU 1242D_02 is classified as an intermediate ALU but has a secondary 24-hour DO standard from June to September, with a 24-hour DO average criterion of 2.0 milligram (mg)/liter (L) and a 24-hour DO minimum of 1.0 mg/L (TCEQ 2015). The ALU categories and DO screening levels are listed for each water body in Table 9 and plotted in Figure 8. Still Creek (segment 1242C) has a concern for depressed DO while Thompsons Creek (segment 1242D) does not support its DO standards and criteria.

Table 9. ALU and DO criteria for the Thompsons Creek watershed.
Source: TCEQ 2018a

Segment	Water Body	AU	ALU Category	DO Screening Level Criteria (mg/L)	DO Grab Minimum (mg/L)	24 Hour DO Average (mg/L)	24 Hour DO Minimum (mg/L)
1242B	Cottonwood Branch	1242B_01	Minimum	2	1.5	-	-
		1242B_02	Minimum	2	1.5		
1242C	Still Creek	1242C_02	High	5 (CS)	3	-	-
1242D	Thompsons Creek	1242D_01	High	5	3	-	-
		1242D_02	Intermediate	4	3	4 (NS)	3 (NS)

assessment unit, AU, aquatic life-use, ALU, milligram, mg; liter, L; concern for screening level, CS; not supporting, NS.

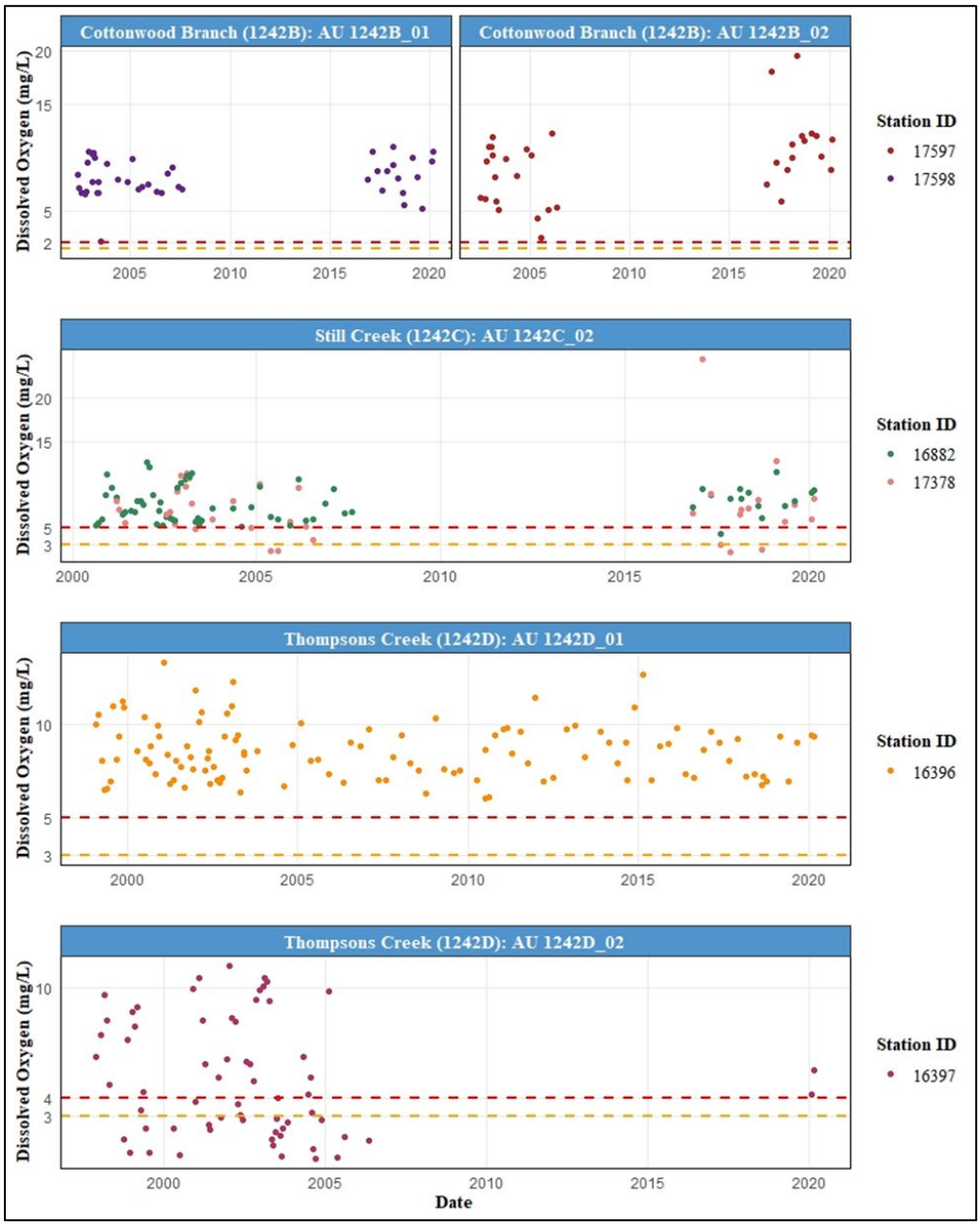

Figure 8. DO concentrations at each AU in the Thompsons Creek watershed from 1997-2020.The red dashed line represents the DO screening level (mg/L) for each segment and the yellow dashed line represents the minimum DO grab sample level (mg/L). The points are measured DO grab samples.

Nutrients

Aquatic algae and plants utilize nutrients (i.e. nitrogen and phosphorus) for growing, yet excessive nutrients in a water body can result in plant and algal blooms. These blooms can be harmful to aquatic health by depressing DO levels. Sources for nutrients include fertilizers

transported by surface runoff, effluent from wastewater treatment facilities (WWTFs) and eroded sediment. A screening level is used to assess nutrient levels in water bodies since a numeric criteria is not available. TCEQ applies screening levels of 1.95 mg/L for nitrate and 0.69 mg/L for total phosphorus. Figures 9 and 10 display measured nitrate and phosphorus samples in the watershed. Station 16882 on Still Creek and Station 16396 on Thompsons Creek exhibited elevated concentrations of nitrate that exceeded the nitrate screening level from 1997-2019. For total phosphorus, Station 17598 on Cottonwood Branch, Station 16882 on Still Creek and Station 16396 on Thompsons Creek also exceeded the screening level between 2003 and 2019.

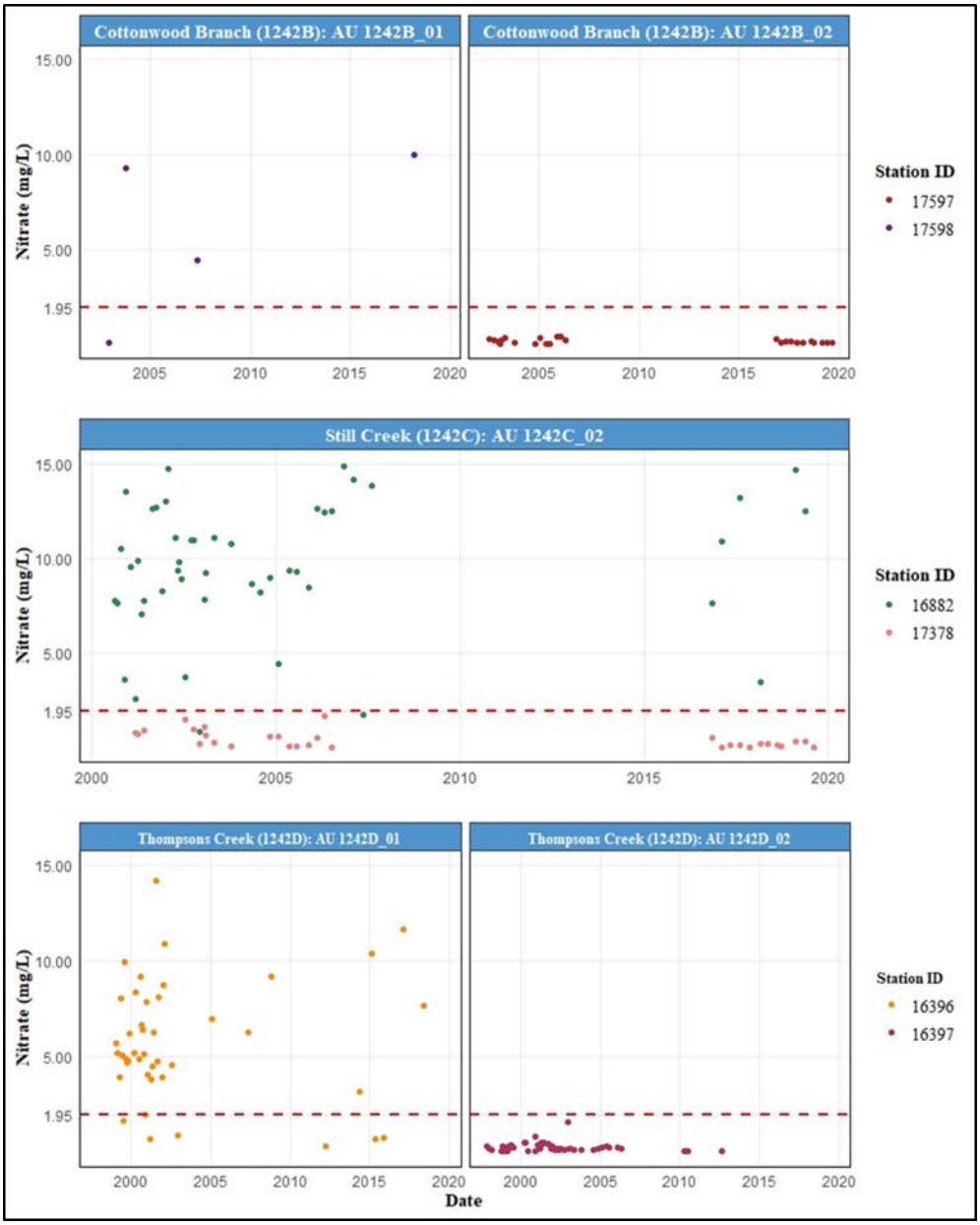

Figure 9. Nitrate concentrations measured in the Thompsons Creek watershed from 1997-2019.

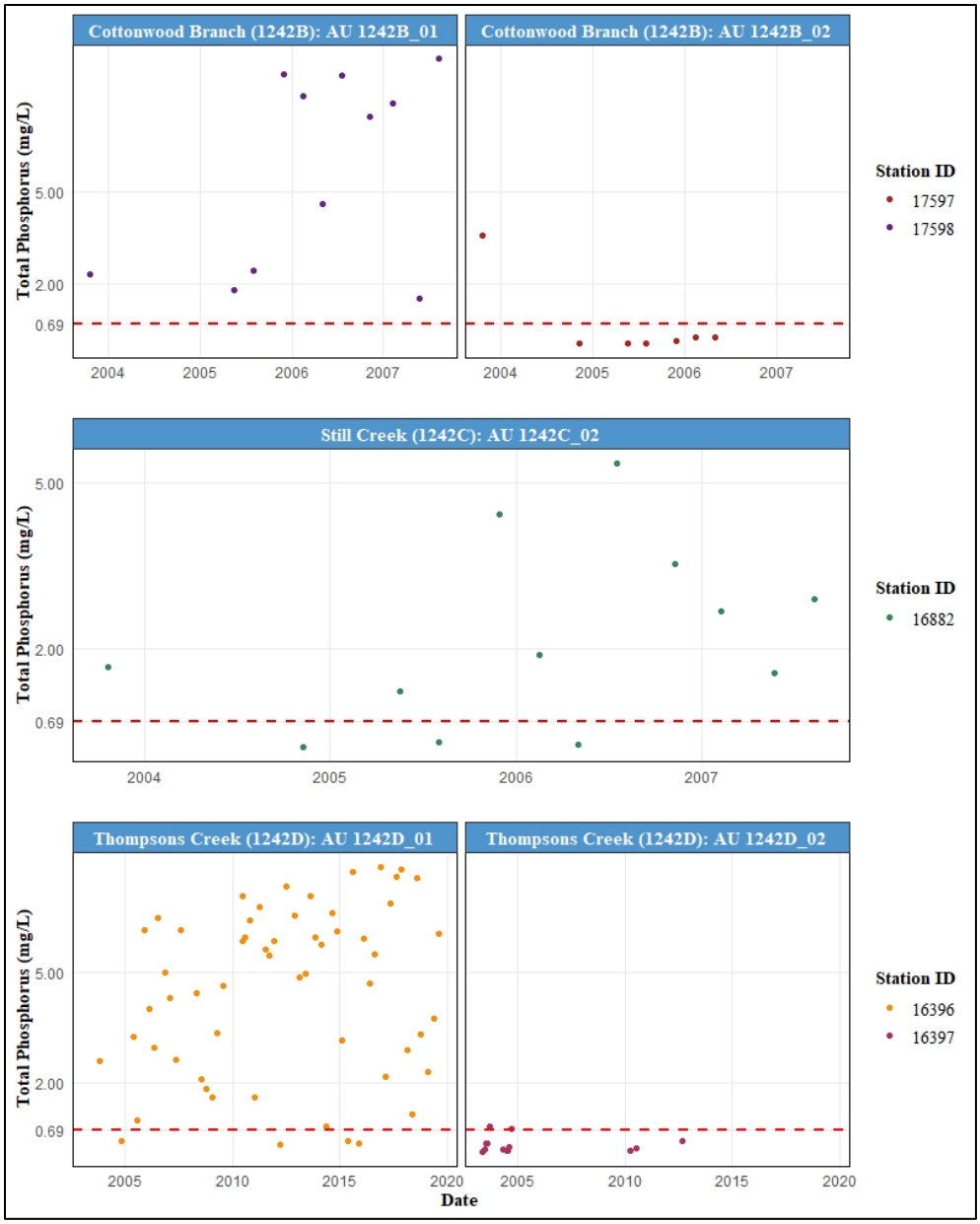

Figure 10. Total phosphorus concentrations measured at stations in the Thompsons Creek watershed from 2003-2019.

Specific Conductance

Specific conductance reflects the ability of water to carry an electric current and is directly related to the concentration of ions in water. Dissolved salts and other inorganic chemicals conduct an electrical current. A water body tends to have a relatively constant range of specific conductivity and, once determined, the range can be used as a baseline comparison for specific conductance measurements. Changes in the specific conductance may be indicative of discharges

or a disturbance that is impairing the health of the water body (U.S. EPA 2016a). Specific conductance measurements for the watershed are displayed in Figure 11.

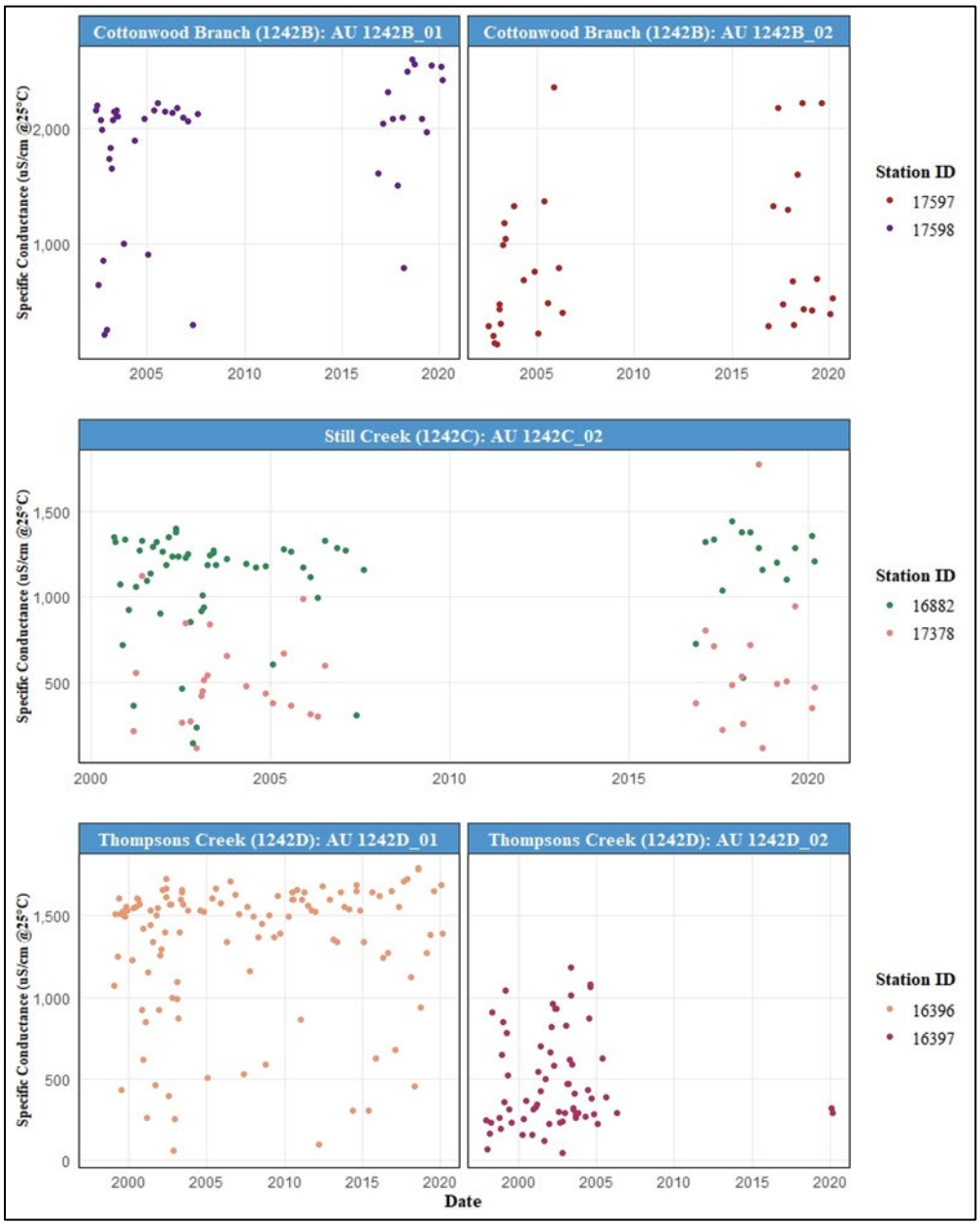

Figure 11. Specific conductance concentrations measured in the Thompsons Creek watershed from 1997-2020.

Flow

The streamflow for a watershed, which is defined as the volume of water that is moving over a designated point over a period of time, consistently changes due to natural and anthropogenic activities. Weather, seasons, water withdrawals and land cover changes all affect water flow. Streamflow is critical for assimilating pollutants in a water body to improve water quality conditions. While no United States Geologic Survey streamflow gauges exist in the watershed, instantaneous streamflow measurements have been recorded sporadically at the monitoring sites. Historical recorded flow measurements were taken during low or normal baseflow conditions. Average, median, minimum and maximum streamflow conditions measured for routine monitoring at selected sites between 2000 and 2020 are listed in Table 10.

Table 10. Instantaneous streamflow in cubic feet per second (cfs) characteristics in the Thompsons Creek watershed.

Station	AU	Site Location	# Measurements	Pooled Samples	Average	Median	Minimum	Maximum	Available Data
16397	1242D_02	Thompsons Creek at SH 21 west of Bryan	18	7	0.59	0.05	0	3.9	2000-2004, 2006, 2020
16396	1242D_01	Thompsons Creek immediately upstream of Silverhill Road 765 meters upstream of SH 47 west of Bryan	6	0	4.81	5.8	0.05	3.9	2003, 2010, 2020
17378	1242C_02	Still Creek at FM 2818 west of Bryan	7	7	0	0	0	0	2002-2004, 2018-2019
16882	1242C_02	Still Creek at SH 21	10	0	3.06	2.84	0.05	9.5	2001-2004, 2020
17598	1242C_02	Cottonwood Branch at the Confluence with Still Creek 50 meters downstream of SH 21	9	1	1.82	1.5	0	4.6	2002-2005, 2020
17597	1242B_02	Cottonwood Branch at Industrial Blvd west of FM 2818 in Bryan	12	8	0.16	0	0	1.7	2002-2003, 2005-2006, 2018-2019

state highway, SH; farm-to-market, FM

Potential Sources of Pollution

Point source

A point source of pollution is defined as any confined, discrete or discernible conveyance, such as a ditch, pipe, tunnel, channel or conduit, which a pollutant may be discharged (U.S. EPA 2018). Point sources of pollution include any regulated "end-of-pipe" outfall that is used for wastewater, stormwater or cooling water (TCEQ and TSSWCB 2013). The National Pollutant Discharge Elimination System (NPDES) and Texas Pollutant Discharge Elimination System (TPDES) regulate point sources of pollution via permits. Within the watershed, permits have been issued for municipal and poultry processing WWTFs (3), construction (23), Multi-Sector general permits (MSGPs) for stormwater (20), concrete production (3) and Phase II municipal separate storm sewer systems (MS4s) (3). Sanitary sewer overflow (SSO)/illicit discharges have also occurred in the watershed. This source of pollution is not regulated but is an unintentional discharge from a permitted system.

WWTFs

Three WWTFs (two treated domestic wastewater and one poultry processing wastewater) exist in the watershed and are permitted to discharge treated wastewater into one of the tributaries in the watershed. Still Creek WWTF is found in the Still Creek (AU 1242C_02) subwatershed and discharges directly into AU 1242C_02. Sanderson Farms WWTF discharges to an unnamed tributary (AU 1242G_01) that drains into the impaired Cottonwood Branch (AU 1242B_01) subwatershed, while Riverside WWTF discharges to an unnamed tributary that drains into Thompsons Creek (AU 1242D_01) downstream of all sampling stations in the watershed (Figure 12). Thompsons Creek WWTF, while located in the watershed, does not directly discharge into segment 1242D but rather into the Brazos River (segment 1242). This WWTF is not included as a bacteria pollution source in this characterization. All WWTFs are permitted to discharge bacteria in their effluent. Permit numbers, facility names, description of receiving waters, permitted flow rates and recently measured flow rates (as of March 2020) are listed in Table 11. Recent *E. coli* averages and the number of grab samples exceeding the grab sample bacteria limit from February 2016 to January 2020 are presented in Table 12.

Compliance of WWTFs

A review of the EPA Enforcement and Compliance History Online (ECHO) database from February 2016 to January 2020 revealed non-compliance issues for all three WWTFs. Riverside WWTF had three exceedances for *E. coli* grab samples exceeding the daily maximum limit (399 MPN/100 mL) and one exceedance for low DO. Sanderson Farms WWTF had one exceedance for fecal coliform and two exceedances for total suspended solids (exceeding the daily max) and Still Creek had three exceedances for flow (2-hour peak).

The ECHO database was also reviewed for Significant Non-Compliance (SNC) violations, which result from discharges above facilities' permitted limitations and late or missing reports. Riverside WWTF had three SNC violations for failing to submit discharge monitoring reports in the last 12 quarters. All facilities had at least one quarter with non-compliance violations.

Table 11. Permitted point source discharge facilities in the Thompsons Creek watershed.

TPDES Permit No.	NPDES No.	Facility	Receiving Waters	Final Permitted Discharges (MGD)	Recent Discharges (MGD)
WQ0011778001	TX0071145	Riverside WWTF	to an unnamed tributary; thence to Thompsons Creek; thence to Brazos River above Navasota River in Segment No. 1242 of the Brazos River Basin	0.045	0.017
WQ0010426002	TX0025071	Still Creek WWTF	to Still Creek; thence to Thompsons Creek; thence to Brazos River above Navasota River in Segment No. 1242 of the Brazos River Basin	4.0	1.7
WQ0003821000	TX0113603	Sanderson Farms Inc.	to an unnamed tributary of Cottonwood Branch; thence to Cottonwood Branch; thence to Still Creek; thence to Thompsons Creek; thence to Brazos River above Navasota River in Segment No. 1242 of the Brazos River Basin	1.678	0.81

Texas Pollutant Discharge Elimination System, TPDES; National Pollutant Discharge Elimination System, NPDES; million gallons per day, MGD.; wastewater treatment facility, WWTF.

Table 12. Bacterial monitoring requirements and compliance status for WWTFs in the Thompsons Creek watershed from February 2016 – January 2020.

TPDES Permit No.	NPDES No.	Facility	Receiving Water body	Discharge Type	Min. Self-Monitoring Requirement -Frequency	Permit Limits		Recent Reported Values	
						Daily Avg (MPN/100 mL)	Daily Max per Sample (MPN/100 mL)	Daily Avg (MPN/100 mL)	# of Grab Samples exceeding Daily Max
WQ0011778001	TX0071145	Riverside WWTF	to an unnamed tributary; thence to Thompsons Creek; thence to Brazos River above Navasota River in Segment No. 1242 of the Brazos River Basin	treated domestic wastewater	one/quarter	126	399	1	3
WQ0010426002	TX0025071	Still Creek WWTF	to Still Creek; thence to Thompsons Creek; thence to Brazos River above Navasota River in Segment No. 1242 of the Brazos River Basin	treated domestic wastewater	one/week	126	399	6	0
WQ0003821000	TX0113603	Sanderson Farms	to an unnamed tributary of Cottonwood Branch; thence to Cottonwood Branch; thence to Still Creek; thence to Thompsons Creek; thence to Brazos River above Navasota River in Segment No. 1242 of the Brazos River Basin	poultry processing wastewater	one/week	126	399	1	0

Texas Pollutant Discharge Elimination System, TPDES; National Pollutant Discharge Elimination System, NPDES; most probably number, MPN, milliliter, mL; wastewater treatment facility, WWTF

TPDES Water Quality General Permits

Facilities that discharge processed wastewater, much like WWTFs, are also required to have a TPDES permit. TPDES general permits are issued for an array of different activities:

- TXG110000 - concrete production facilities
- TXG130000 - aquaculture production
- TXG340000 - petroleum bulk stations and terminals
- TXG670000 - hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG870000- pesticides (application only)
- TXG920000 - concentrated animal feeding operation
- WQG100000 - wastewater evaporation
- WQG200000 - livestock manure compost operations (irrigation only)

A review of active permits in the Thompsons Creek watershed (April 8, 2020) retrieved three general permits, which included three concrete production permits (Table 13). The concrete production facilities are authorized to discharge stormwater and are considered a source of regulated stormwater.

Table 13. Water quality general permits in the Thompsons Creek watershed.

Permit No.	Permittee	Facility	Permit Type	Receiving Water body	Status
TXG111340	TXI Operations, LP	TXI Bryan Independence Ready Mix	Concrete Production Plant	Unnamed tributary to Cottonwood Branch (1242B_02)	Active
TXG111947	Boyd Ready Mix, Inc.	BRM 4/Bryan Plant	Concrete Production Plant	Thompsons Creek (1242D_02)	Active
TXG112144	Texcrete, Inc.	Bryan CBP	Concrete Production Plant	Still Creek (1242C_02)	Active

TPDES Regulated Stormwater

Stormwater general permits are required for areas or activities that stormwater discharges would originate from, such as industrial facilities, construction sites and Phase II MS4 urbanized areas. The following TPDES general permits are required for certain activities that release stormwater:

- TXR040000 - Phase II MS4 general permit for small MS4s located in urban areas
- TXR050000 - MSGP for industrial facilities
- TXR150000 - construction general permit from construction activities disturbing one acre or more

Phase I and II MS4 permits are typically associated with larger urban areas and require municipalities to obtain permits for their stormwater systems. These systems include any conveyance such as ditches, curbs, gutters or storm sewers that do not connect to a wastewater collection system or treatment facility. Phase II permits are for smaller communities within a U.S. Census Bureau defined urbanized area that are regulated by a general permit. The MS4 permit is utilized to reduce pollutant discharges in stormwater to the "maximum extent practicable" by developing and implementing a Stormwater Management Program (SWMP). The SWMPs require best management practices for six minimum control measures:

- Public education, outreach and involvement;
- Illicit discharge detection and elimination;
- Construction site stormwater runoff control;
- Post-construction stormwater management in new development and redevelopment;
- Pollution prevention and good housekeeping for municipal operations; and
- Industrial stormwater sources.

The Thompsons Creek watershed area covered by Phase II MS4 permits is the portion of area that is within the U.S. Census Bureau Urbanized Area designation. Three Phase II MS4 permits were identified in the watershed. Two of the permits are held by the City of Bryan and Brazos County, while a statewide MS4 permit held by the Texas Department of Transportation was identified for the designated U.S. Census Bureau Urban Areas (Figure 12, Table 14). These three permits cover approximately 7,936 acres or 23.8% of the Thompsons Creek watershed, including the subwatersheds of Cottonwood Branch (segment 1242B), Still Creek (segment 1242C) and Thompsons Creek (segment 1242D).

Table 14. Phase II MS4 permits in the Thompsons Creek watershed.

NPDES Permit No.	Permittee
TXR040172	Brazos County
TXR040336	City of Bryan
TXS002101 **(TPDES Permit No. WQ0005011000)**	Texas Department of Transportation

National Pollutant Discharge Elimination System, NPDES; Texas Pollutant Discharge Elimination System, TPDES.

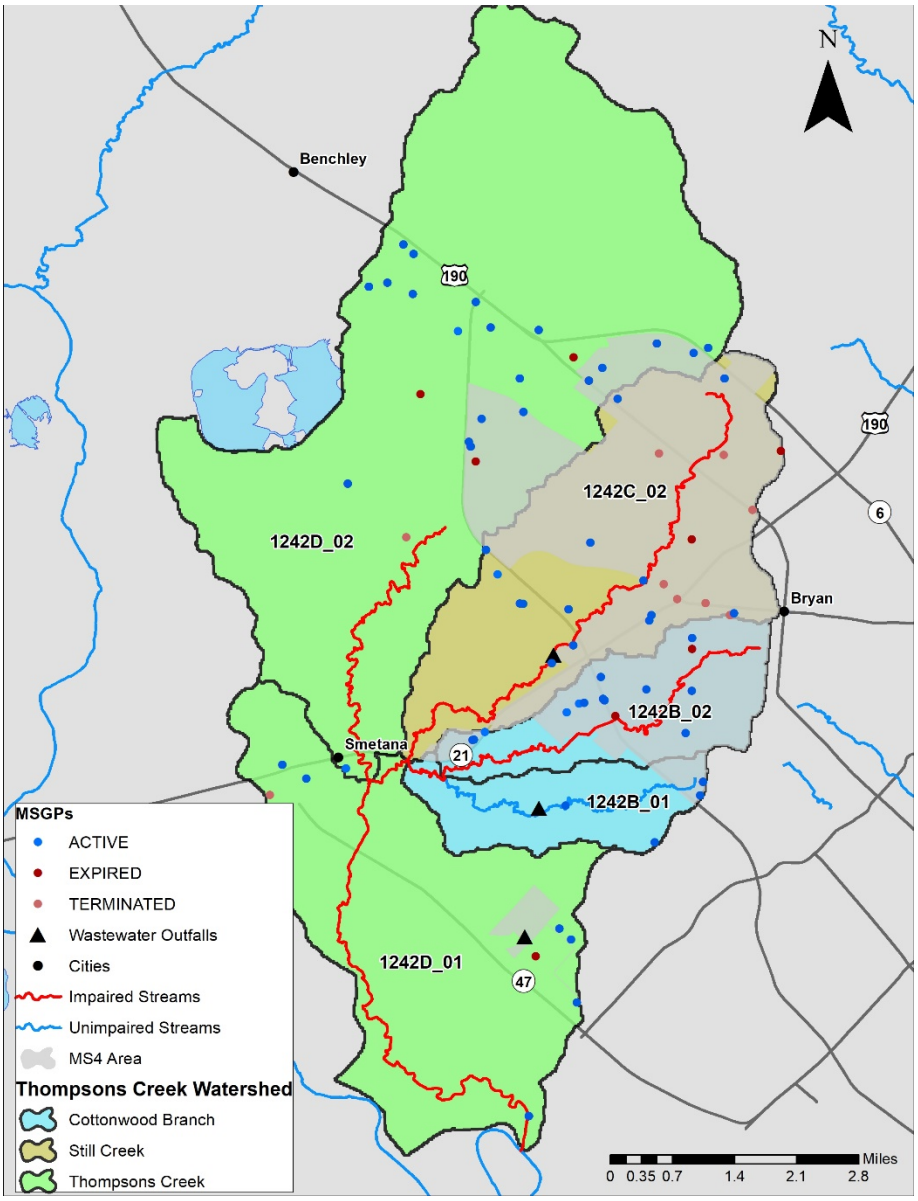

Figure 12. Locations of wastewater treatment facilities, Multi-Sector General Permits and regulated stormwater area covered by Municipal Separate Storm Sewer Systems in the Thompsons Creek watershed.
Source: U.S. Census Bureau and TCEQ

After a review of active stormwater permits in the Thompsons Creek watershed on April 8, 2020, 22 active construction permits, with an estimated disturbed area of 615.92 acres and 20 MSGPs were retrieved (Table 15). When reviewing expired and terminated construction permits since January 1, 2003, 25 expired and 21 terminated permits were retrieved (Table 16). Approximately 1,567.92 acres are regulated under MSGPs in the watershed for stormwater.

Table 15. Active stormwater general permits in the Thompsons Creek watershed.

Permit No.	Permittee	Facility Name	Permit Type	Receiving Water body	Acres Disturbed/ Covered	Permit Status
TXR05AL68	Knife River Corporation - South	Bryan Material Yard	Multi-Sector	1242B_02	64	active
TXR05AZ74	Bryan Iron & Metal, Ltd.	Bryan Iron & Metal	Multi-Sector	1242C_02	18	active
TXR05BF57	S-Con, Inc.	S-Con	Multi-Sector	1242D_01	80	active
TXR05BI60	Machine Works, Incorporated	Machine Works Inc.	Multi-Sector	1242B_02	20	active
TXR05BI74	Lubrizol Specialty Products, Inc.	Phillips Specialty Products	Multi-Sector	1242B_02	55	active
TXR05BJ53	Cobra Protective Coatings, LLC	Cobra Protective Coatings	Multi-Sector	1242B_02	14	active
TXR05BL97	Toyo Ink International Corporation	Bryan Industrial Park	Multi-Sector	1242D_02	39	active
TXR05BQ31	City of Bryan	Thompsons Creek WWTF	Multi-Sector	1242D_01	13	active
TXR05BY60	Enterprise Crude Oil LLC	Enterprise Crude Oil-Bryan	Multi-Sector	1242C_02	19	active
TXR05CH71/ TXR05CW2	Axis Pipe and Tube Inc.	Axis Pipe and Tube	Multi-Sector	1242D_02	196	active
TXR05CT98	Bryan Auto Recycling, Sales, & Glass, LLC	Bryan Auto Recycling Sales & Glass	Multi-Sector	1242D_02	61	active
TXR05CU02	Terrabon Research Company, LLC	Demonstration Plant	Multi-Sector	1242D_02	7	active
TXR05CU78	Kelly Burt Dozer, Inc	Kelly Burt Dozer, Inc.	Multi-Sector	1242C_02	150	active
TXR05DA29	Saint-Gobain Ceramics & Plastics, Inc.	Bryan Ceramics Plant	Multi-Sector	1242B_02	13	active
TXR05DR86	Texas Commercial Waste	M Lipsitz and Company Texas Commercial Waste	Multi-Sector	1242C_02	34	active
TXR05EB13	US Well Services	US Well Services	Multi-Sector	1242D_02	62	active
TXR05EM64	Mid South Baking Company LLC	Mid South Baking Company	Multi-Sector	1242D_02	8	active
TXR05M769	Sanderson Farms, Inc. (Production Division)	Sanderson Farms	Multi-Sector	1242B_01	64	active
TXR05Q530	City of Bryan	Still Creek WWTF	Multi-Sector	1242C_02	14	active
TXR05W509	North America Packaging Corporation	North America Packaging	Multi-Sector	1242B_02	21	active
TXR15001R	Kelly Burt Dozer, Inc.	NTA	Construction	1242D_02	10	active

TXR15013P	Collier Construction, LLC	Brazos County Juvenile Justice Center	Construction	1242C_02	9.8	active
TXR1507AB	Legend Classic Homes, Ltd.	Leonard Crossing Subdivision	Construction	1242B_02	45	active
TXR1514AB	Legend Classic Homes, Ltd.	Alamosa Springs Subdivision	Construction	1242D_01	40	active
TXR15152O	Larry Young Paving, Inc.	West 26th Street Rehabilitation	Construction	1242C_02	12.29	active
TXR1518BB	Continental Homes Of Texas, L.P.	Pleasant Hill Phase 1	Construction	1242C_02	50	active
TXR15233O	Camillo Properties Ltd.	Camillo-Oakwood Forest	Construction	1242D_02	20	active
TXR1529BS	Stylecraft Builders, Inc.	Connors Cove	Construction	1242C_02	7.07	active
TXR1534BT	Larry Young Paving, Inc.	Woodville Road Improvements	Construction	1242D_02	8.16	active
TXR15359W	Cervantez Construction, LLC	Connors Cove	Construction	1242C_02	8	active
TXR1539AN	Strategic Construction, Ltd.	Forest Grove Apartments	Construction	1242B_01	3	active
TXR1542AQ	Liquidpower Specialty Products Inc.	Liquidpower Specialty Products	Construction	1242B_02	12	active
TXR1543BQ	Wbw Construction, LLC	Pleasant Hill Section 2	Construction	1242C_02	124	active
TXR1547BO	Civil Constructors, Inc.	W 28th Street	Construction	1242B_02	65	active
TXR15638V	Wbw Construction, LLC	Pleasant Hill	Construction	1242C_02	60	active
TXR15707S	Texas Sterling Construction Co.	Domestic Water System Improvements Project 17-009 TAMU	Construction	1242D_01	30	active
TXR15734O	Kelly Burt Dozer, Inc	Leonard Road Substation	Construction	1242B_01	12	active
TXR15765W	Camillo Properties Ltd.	Camillo-Leonard Crossing	Construction	1242B_02	60	active
TXR15860Z	Tellepsen Builders, L.P.	Rellis Academic Campus Phase 2	Construction	1242D_01	8.5	active
TXR15915T	Moltus Building Group, LLC	Fedex Ground Package Distribution Facility E	Construction	1242D_02	15	active
TXR15945Q	Diffco LLC	Liquidpower Specialty Products	Construction	1242B_02	5	active
TXR1597BI	Civil Constructors, Inc.	Alamosa PH3	Construction	1242D_01	11.1	active

Table 16. Expired and terminated construction permits in the Thompsons Creek watershed.

Permit Number	Permittee	Facility	Receiving Water body	Acres Disturbed/Covered	Status
TXR150018	Kristen Distributing Co.	Kristen Distributing Remodel	1242D_02	0.42	Expired (6/30/2015-6/5/2018)
TXR150029	Larry Young Paving, Inc.	West 26th Street Rehabilitation	1242C_02	12.29	Expired (10/25/2016-5/31/2018)
TXR15186F	Camillo Properties Ltd.	Restever	1242D_02	16.5	Expired (11/4/2016-6/5/2018)
TXR15458P	U.S. Well Services, LLC	US Well Services	1242D_02	5	Terminated (6/27/2018-7/9/2018)
TXR15CA97	Hunt Construction Group Inc.	Hunt Construction Bryan Expo Center	1242B_01	6	Terminated (3/16/2006-11/5/2007)
TXR15CC22	Knife River Corporation - South	Young Contractors Beck Street Extension	1242B_02	30	Expired (3/26/2006-6/3/2008)
TXR15CE84	Bryan College Station Habitat for Humanity	Bryan College Station Habitat For Humanity Angels Gate Subdivision	1242B_02	22	Expired (3/7/2006-6/3/2008)
TXR15CK41	Hunt Construction Group Inc.	Hunt Construction Group Brazos County Sheriff's Department	1242C_02	9	Terminated (3/16/2006-10/5/2007)
TXR15DR62	Charles Taylor III Inc.	Charles Taylor Iii Jacks Grocery	1242C_02	1	Terminated (7/23/2006-2/7/2007)
TXR15EJ84	Collier Inc.	Collier Construction Aruthor I Davila Middle School	1242D_02	32	Expired (9/27/2006-6/3/2008)
TXR15EY33	Brazos Valley Service Co.	Brazos Valley Services Austin Colony Road Extension	1242D_02	8	Terminated (10/12/2006-6/14/2007)
TXR15F021	Brazos County	Brazos County Road And Bridge Department Brazos County Exposition Center	1242D_01	104	Expired (3/4/2004-6/3/2008)
TXR15FR98	CWA Construction Inc.	CWA Construction Texas Commercial Waste Bryan Texas	1242C_02	5	Expired (12/2/2006-6/3/2008)
TXR15H766	Brazos Paving Inc.	Brazos Paving Forest Park Apartments	1242C_02	14	Terminated (5/7/2004-1/12/2006)

TXR15IO48	CDS Enterprises Inc.	Cds Enterprises Toyo Ink	1242D_02	10	Expired (9/10/2007-6/3/2008)
TXR15L138	Main Street Ltd.	Main Street Northwood Sections One and Two	1242C_02	24	Terminated (7/24/2004-5/5/2005)
TXR15LK05	Texas Department of Public Safety	Department Of Public Safety Bryan District Office	1242D_02	6	Expired (4/29/2008-6/3/2013)
TXR15LW44	Imperial Construction Ltd.	Imperial Construction Department of Public Safety Bryan Dist. Office	1242D_02	6	Expired (6/6/2008-6/3/2013
TXR15LZ81	Crossland Construction Company Inc.	Fed Ex Ground-Distribution Center-Bryan TX	1242D_02	10	Terminated (7/31/2008-9/17/2008)
TXR15MV32	CDS Enterprises Inc.	Sierra Ridge Phase 1	1242C_02	7	Expired (10/23/2008-6/3/2013)
TXR15MV33	Dudley Construction Ltd.	Twin City Mission	1242C_02	6	Terminated (10/23/2008-8/7/2009)
TXR15NI37	Turner Construction Company	Brazos County Detention Center	1242C_02	24	Terminated (1/14/2009-9/16/2010)
TXR15OK13	Collier Inc.	Kemp Elementary And Carver Early Childhood Center	1242C_02	16	Expired (7/20/2009-6/3/2013)
TXR15OW78	Collier Inc.	Brazos County Exposition Complex Phase II Additions	1242B_01	17.96	Expired (11/13/2009-6/3/2013)
TXR15PF72	Tilson Home Corporation	Jo Ann VillaPando	1242B_02	5	Terminated (1/27/2010-8/24/2010)
TXR15PG76	Garney Companies Inc.	Parallel Wellfield and Well No 8 Collection Lines	1242D_02	12	Expired (1/20/2010-6/3/2013)
TXR15PH02	City of College Station	Parallel Wellfield and Well No 8 Collection Lines	1242D_02	12	Expired (1/18/2010-6/3/2013)
TXR15Q979	Dudley Construction Ltd.	Dudley Construction Still Creek Wastewater Improvements Phase I	1242C_02	2	Terminated (1/23/2005-2/28/2006)
TXR15QE67	Panattoni Construction Inc.	Fed Ex Ground-Distribution Center-Bryan TX	1242D_02	10	Terminated (7/9/2010-3/28/2011)
TXR15QH74	Texas Department of Transportation	TXDOT CBC 4704-00-760	1242C_02	9	Terminated (7/30/2010-11/5/2012)

TXR15QH77	Braun and Butler Construction Inc.	Greater Texas Foundation	1242D_01	7	Terminated (7/30/2010-7/13/2011)
TXR15QQ45	Dudley Construction Ltd.	BMI Defense Systems	1242D_02	10	Expired (10/5/2010-6/3/2013)
TXR15QT03	Collier Inc.	Brazos County Exposition Center Paved Fairgrounds	1242B_01	9	Expired (9/17/2010-6/3/2013)
TXR15QU99	Solis Constructors Inc.	Moore Memorial Army Reserve Center	1242D_02	6.1	Expired (11/3/2010-6/3/2013
TXR15RN87	Kajima Building & Design Group Inc.	Toyo Ink Bryan Manufacturing Facility	1242D_02	2.4	Expired (3/4/2011-6/3/2013)
TXR15SH10	Doughtie Construction Co. Inc.	Thompsons Creek Wastewater Treatment Plant Offsite Utilities	1242D_01	8.7	Expired (6/24/2011-6/3/2013)
TXR15SS37	Bryan Construction Company	Thompsons Creek Wastewater Treatment Plant	1242D_01	5.1	Expired (8/29/2011-6/3/2013)
TXR15SS48	Texas Department of Transportation	TXDOT CSJ 0116-04-097	1242C_02	8.03	Terminated (9/20/2011-5/17/2012)
TXR15UL37	Joeris General Contractors Ltd.	Texas A&M Joint Library Facility	1242D_01	10	Terminated (6/21/2012-6/7/2013)
TXR15UZ42	Drymalla Construction Company Inc.	Gunler Inc New Industrial Facility	1242D_02	12	Expired (9/6/2012-6/3/2013)
TXR15VG89	Dudley Construction Ltd.	City of Bryan Rail Spur to Serve Next General Industrial Park	1242D_02	7	Expired (10/1/2012-6/3/2013)
TXR15WR72	Rhodes Building Systems Inc.	LOT 7R	1242D_02	4.65	Terminated (4/21/2013-3/27/2017)
TXR15X988	Madison Construction LP	Madison Construction Producers Cooperative Association	1242C_02	3	Terminated (8/2/2005-1/2/2007)
TXR15XT64	Axis Pipe and Tube Inc.	Axis Pipe and Tube	1242D_02	177	Terminated (8/1/2013-8/10/2016)
TXR15YE96	Prolamsa Inc.	Prolamsa	1242D_02	3.5	Expired (9/17/2013-6/5/2018)
TXR15341W	Navcon Group LLC	NTA	1242D_02	11	Terminated (3/27/2019-4/7/2020)

SSOs

SSOs are unauthorized discharges from a sewer system that must be addressed by the TPDES permittee or owner of the collection system connected to the permitted system. Under dry weather conditions, SSOs most likely occur from blockages in the sewer collection, resulting from tree roots, grease or other debris. Sewer overflow can also occur during severe storm events, sewer defects, power failures, vandalism and the improper operation and maintenance of the system (U.S. EPA 2016b). Inflow and infiltration events occur in which high water flows from excess water in sewer pipers or stormwater overburden the design capacity of WWTFs resulting in sewer overflows and water contamination (King County 2011).

According to the TCEQ Central Office and TCEQ Region 9 Office, 65 SSO events were reported, of which 59 events occurred at the Still Creek WWTF, between January 1, 2015 and December 31, 2019. The primary cause for most of the SSO events was from a non-grease related line blockage. Most SSO events occurred on Still Creek (AU 1242C_02), followed by events in the Thompsons Creek (AU 1242D_01) and Cottonwood Branch (AU 1242B_01) subwatersheds.

Nonpoint sources

Nonpoint sources of pollution are defined as any water pollution that does not originate from regulated or point sources (TCEQ and TSSWCB 2013). Nonpoint source pollution from leaking on-site sewage facilities (OSSFs), urban and agricultural runoffs, domestic pets, wildlife and livestock would potentially contribute as unregulated sources of FIB.

Failing OSSFs

OSSFs, commonly known as septic systems, can be a potential source of FIB due to inadequate design, inappropriate installation, neglectful operation or age of a system (U.S. EPA 2016b). The soils of an area or density of septic systems can also influence the likelihood of pollutants from an OSSF reaching a waterway. Estimating the number of OSSFs in a watershed is essential for assessing potential impacts on water quality.

Several limitations exist for OSSF management due to the lack of information about the number of septic systems, their locations, ages, types and functional statuses (U.S. EPA 2016b). Since

comprehensive data is not available, secondary sources of information must be used to approximate the number of OSSFs present. One method utilizes 911 address data points, aerial imagery, 2010 U.S. Census Block house unit data, Convenience and Necessity sewer area and city boundary data (Gregory et al. 2013). Approximately 507 OSSFs are estimated to be located in the Thompsons Creek watershed. Unfortunately, using this data requires assumptions regarding the presence of OSSFs, therefore carrying a level of uncertainty that can only be removed with on-site inspections. The locations of estimated OSSFs in the watershed are displayed in Figure 13. Further analysis of OSSF densities in the watershed will be reviewed with the City of Bryan as the project progresses.

Environmental factors, such as soil conditions, can also influence the risk for potential failure and pollution from an OSSF. NRCS developed a soil suitability ranking method, and based on soil characteristics, soils are categorized into: not limited, somewhat limited and very limited. OSSFs in “somewhat limited” or “very limited” soils face greater risks of failure. As tabulated in Table 17, 96.53% of soil in the watershed are categorized as very limited, 0.78% is somewhat limited and 2.69% of the soil does not have a rating.

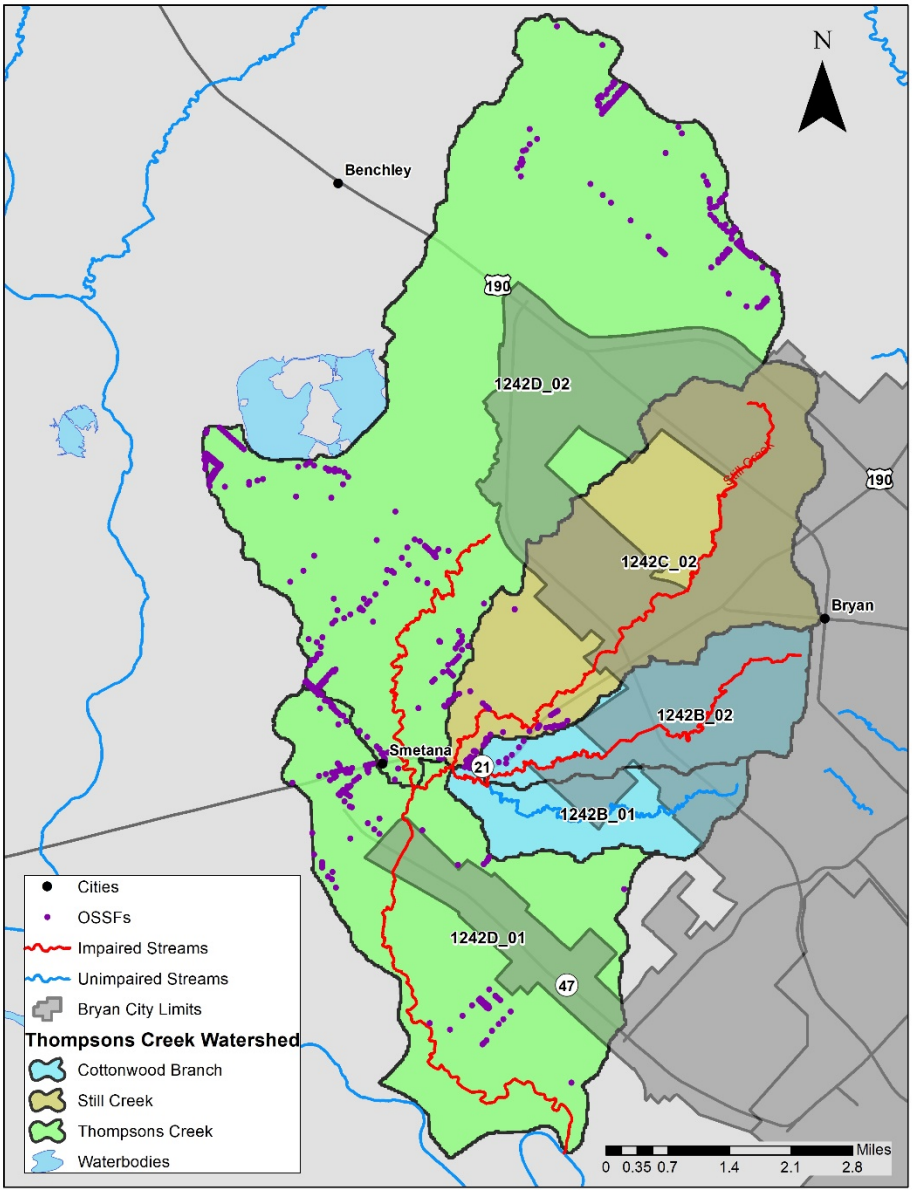

Figure 13. Estimated locations of OSSFs in the Thompsons Creek watershed.
Sources: 911 addresses and CCN data

Table 17. Soil suitability ratings in the watershed.

Soil Condition	Total Acres	Percentage of Watershed (%)
Not Rated	889	2.69%
Somewhat Limited	258.5	0.78%
Very Limited	31,940.6	96.53%

Grazing livestock

Grazing livestock in a watershed contributes to the overall *E. coli* load due to direct deposition of fecal waste in or near water bodies. The National Agricultural Statistics Service's (NASS) 2017 Census of Agriculture provides livestock populations for each county. This information can be scaled down to the watershed area of interest. For horses, goats, sheep and pigs/hogs, the ratio of acres between the watershed and county was multiplied by the total number of animals in the county, as reported by NASS (2017), to estimate the number of livestock in the watershed. For cattle, the county-level data was multiplied by the area ratio of the grazeable land in the watershed to the grazeable land across the county. Grazeable land for cattle is defined as an aggregate of Hay/Pasture, Shrub/Scrub and Herbaceous LULC classifications. Across the watershed, there is estimated to be 6,170 heads of cattle (Table 18).

Table 18. Estimated grazing livestock population in the watershed.

Area	Cattle	Horses	Goats	Sheep	Pigs/Hogs
Brazos County	63,394	1,856	1,388	2,450	1,468
Thompsons Creek watershed	6,170	181	135	239	143

Commercial poultry

Litter produced by commercial poultry can be another source of bacteria pollution in the watershed if inappropriate management measures for litter waste are practiced. The NASS (2017) statistics did not disclose the poultry numbers for Brazos County. Based on local watershed knowledge, the number of poultry in the watershed is assumed to be negligible. Commercial poultry operations are not included as a potential bacteria source because no commercial poultry houses are located in the watershed.

Pets

Dogs and cats can also be sources of fecal bacteria contamination in water bodies during stormwater runoff. According the American Veterinary Medical Association (AVMA), the estimated number of dogs per household is 0.614 and the estimated number of cats per household is 0.457 (AVMA 2018). Based on the 2010 census data, there are approximately 7,685 house

units located in this watershed, therefore the estimated number of dogs and cats are 4,719 and 3,512 respectively (Table 19).

Table 19. Estimated dog and cat populations in the watershed.

Pet	Household Count	Density (animal/household)	Counts in watershed
Dogs	7,685	0.614	4,719
Cats	7,685	0.457	3,512

Wildlife and Unmanaged Animal Contributions

Wildlife species can contribute a significant proportion of *E. coli* into a watershed due to riparian areas near water bodies providing suitable habitat. As a result, wildlife will spend the majority of their time in these areas and expel fecal waste near or in the water body. Estimating the potential contribution of fecal loading from wildlife is essential for evaluating the overall *E. coli* load; however, data on wildlife numbers is limited. White-tailed deer and feral hogs are two species that reasonable population estimates can be determined.

Feral hog population densities are challenging to estimate and values in the literature vary widely. A common estimate frequently used in the State of Texas is a density of one hog per 33.3 acres (Wagner and Moench 2009). Appropriate LULC classes for feral hogs in the watershed include Forest, Shrub/Scrub and Wetlands, resulting in an overall estimate of 233 feral hogs.

White-tailed deer estimates for the watershed are not available, therefore estimates from the Texas Parks and Wildlife resource management unit (RMU) 19, which includes the Post Oak Savannah ecoregion was utilized. The estimated deer population for RMU 19 from 2005-2015 is 41.7 acres per deer. Suitable LULC classes for deer habitat include Shrub/Scrub, Herbaceous, Forest, Hay/Pasture and Wetlands, resulting in an estimated 621 deer in the watershed. Table 20 describes the estimated feral hog and white-tailed deer populations.

Table 20. Estimated feral hog and white-tailed deer populations in the watershed.

Animal	LULC Classes	Acres in Watershed	Density (acre/animal)	Counts in Watershed
Feral Hogs	Deciduous Forest, Evergreen Forest, Mixed Forest, Shrub/Scrub, Woody Wetlands, Emergent Herbaceous Wetlands	7,775	33.3	233
Deer	Shrub/Scrub, Herbaceous, Mixed Forest, Deciduous Forest, Evergreen Forest, Woody Wetlands, Emergent Herbaceous Wetlands, Hay/Pasture, Cultivated Crops, Wetlands	25,896	41.7	621

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