Recreational Use Attainability Analysis for the Lower Seven Miles of Walnut Creek (Segment 0838C), Mansfield, Tarrant County, Texas

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Acronyms and Abbreviations

AU	assessment unit
cfs	cubic feet per second
DFW	Dallas/Fort Worth
FDC	flow duration curve
ml	milliliter
MS4	municipal separate storm sewer system
NWS	National Weather Service
RUAA	Recreational Use Attainability Analysis
SH	State Highway
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TRA	Trinity River Authority
TSWQS	Texas Surface Water Quality Standards
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WWTP	domestic wastewater treatment plant

Maps and aerial photo prepared by Dania Grundmann, TMDL Team, Planning and Implementation Section, TCEQ Water Quality Planning Division.

Cover Photograph: Walnut Creek near James McKnight Park East, Mansfield, Tarrant County, Texas on 15 June 2010 (John Mummert, TCEQ Region 4).

Introduction

Walnut Creek (Segment 0838C) – located in northeastern Johnson and Southeastern Tarrant Counties – is an unclassified tributary to Joe Pool Lake (Segment 0838) in the Trinity River Basin. The lower seven miles of Walnut Creek was added to the State of Texas §303(d) list in 2006 due to exceedance of the surface water quality standard for bacteria. Contaminated waters and elevated levels of indicator bacteria have been associated with illnesses in persons participating in aquatic contact recreation activities that involve a significant risk of water ingestion (Rosenberg *et al.* 1976; Fewtrell *et al.* 1992; Dwight *et al.* 2004; Schijven and de Roda Husman 2006; USEPA 2009a).

Texas recently completed a revision to the Texas Surface Water Quality Standards (TSWQS; Title 30 Texas Administrative Code (TAC) Chapter 307) that added additional categories of recreational use and a corresponding bacteria standard for each category. The revised standards (TCEQ 2010), which at this time are under review by the U.S. Environmental Protection Agency (USEPA), include four recreational use categories (Table 1):

- *Primary contact recreation* activities are those involving a significant risk of ingestion of water, such as wading by children, swimming, water skiing, diving, tubing, surfing, and whitewater kayaking, canoeing, and rafting (30 TAC 307.3(a)(47)).

- *Secondary contact recreation 1* activities are those that commonly occur in the water body, but have limited body contact incidental to shoreline activity and pose a less significant risk of water ingestion than primary contact recreation. Included are activities such as fishing, canoeing, kayaking, rafting and motor boating (30 TAC 307.3(a)(53)).

- *Secondary contact recreation 2* activities are those similar to secondary contact recreation 1, such as fishing, canoeing, kayaking, rafting and motor boating; but that occur less frequently and pose a less significant risk of water ingestion than secondary contact recreation 1 due to physical characteristics of the water body and/or limited public access to the water body (30 TAC 307.3(a)(54)).

- *Noncontact recreation* activities do not involve a significant risk of water ingestion, such as those with limited body contact incidental to shoreline activity, including birding, hiking, and biking. Noncontact recreation use may also be assigned where primary and secondary contact recreation activities should not occur because of unsafe conditions, such as ship and barge traffic (30 TAC 307.3(a)(38)).

Earlier versions of the TSWQS included only the primary contact and noncontact categories (Table 1).

Escherichia coli (*E. coli*), a common bacteria present in the digestive tracts of humans and other warm-blooded animals, is used as an indicator for the potential presence of pathogenic microorganisms in most freshwater systems. TSWQS recreation criteria (Table 1) are based on the long-term geometric mean of the number of *E. coli* per 100 milliliters (ml) of water in samples collected in a water body.

Table 1. Summary of freshwater recreational use categories and corresponding bacteria criteria in former and current TSWQS. *#E. coli refers to colony forming units, most probable number, or other applicable reporting units. Current criteria are contained in 30 TAC 307.7(b)(1)(A), and are based on a long-term geometric mean of applicable samples.*

Recreation Category	Definition Summary (30 TAC 307(a))	Former Criteria (#*E. coli*/100ml)	2010 Criteria (#*E. coli*/100ml)
Primary Contact	Significant risk of ingestion of water (e.g. swimming, wading by children, water skiing, etc.)	126	126
Secondary Contact 1	Less significant risk of ingestion of water; activities commonly occur but have limited body contact (e.g. fishing, canoeing, etc.)	n/a	630
Secondary Contact 2	Similar to secondary contact recreation 1, but activities occur less frequently and pose a less significant risk of water ingestion	n/a	1030
Noncontact	No significant risk of ingestion of water; contact recreation should not occur because of unsafe conditions	605	2060

The 2010 §303(d) list contains more than 250 freshwater streams that do not meet the primary contact recreation standard for bacteria, including just over 200 unclassified streams. Because the TSWQS now include four possible recreational use categories, it is necessary to determine which category applies to the many unclassified streams in the state, particularly those on the §303(d) list due to a failure to meet the bacteria standard for primary contact recreation. Determination of the appropriate use category allows stream bacteria densities to be compared with the standard for that use. This will allow selection of the appropriate target for a total maximum daily load (TMDL) or watershed protection plan in those streams that do not meet the revised standard, and for the removal of streams from the §303(d) list where the standard has been attained.

Recreational use categories and bacteria criteria for classified segments are specified in 30 TAC 307.10 (Appendix A). Site-specific recreational use categories and criteria for selected unclassified water bodies are specified in 30 TAC 307.10 (Appendix G). For water bodies not specifically listed in Appendix A or G of 30 TAC 307.10, primary contact recreation is presumed to apply to intermittent

streams, intermittent streams with perennial pools, and perennial freshwater streams and rivers, except where site-specific information indicates that recreational activities that involve a significant risk of ingestion have little to no likelihood of occurring (30 TAC 307.4(j)(2)(A)). At this time, the primary contact recreation use is presumed to apply to Walnut Creek. The most recent (2010) assessment of Walnut Creek determined the long-term geometric mean for *E. coli* in the lower seven miles of the stream to be 257 per 100ml, which exceeds the primary contact recreation criteria of 126 per 100ml.

Assignment of uses other than primary contact recreation requires that a reasonable level of inquiry be conducted to determine if a different presumed use is appropriate for a water body (30 TAC 307.4(j)(3)(A)). Support for designating a recreational use category less stringent than the presumed primary contact use requires a Recreational Use Attainability Analysis (RUAA) that supports the alternate designation. RUAAs are assessments of the factors affecting attainment of a designated recreational use of a water body, and are used to identify and assign the attainable recreational use and bacteria criteria to individual water bodies.

The assignment of recreational uses to unclassified water bodies such as Walnut Creek is outlined in 30 TAC 307.4(j)(3). Secondary contact recreation 1 applies to intermittent and perennial freshwaters where site-specific information demonstrates that primary contact recreation has little to no likelihood of occurring (30 TAC 307.4(j)(2)(B)). At a minimum, the following characteristics must be demonstrated for a presumed use of secondary contact recreation 1 to apply:

(1) during dry weather flows, the average depth at the thalweg (mid-channel) is less than 0.5 meters and there are no substantial pools with a depth of one meter or greater; and

(2) there are no existing recreational activities that create a significant risk of ingestion or a use for primary contact recreation.

A presumed secondary contact recreation 1 use is included in any public notice of a regulatory action that could affect recreational water quality, and the assigned recreational use is subject to applicable public comment and approval by USEPA. A presumed secondary contact recreation 1 use in a particular water body will be listed in 30 TAC 307.10 (Appendix G) when the TSWQS are revised (30 TAC 307.4(j)(3)(B)).

No water body is presumed to have a use of secondary contact recreation 2 or noncontact recreation (30 TAC 307.4(j)(2)(C and D)). These uses are applicable only where site-specific information demonstrates that one of these uses is appropriate and when the use designated for an individual water body listed in 30 TAC 307.10 (Appendix G).

This report constitutes the findings of a RUAA conducted on the lower seven miles of Walnut Creek in Mansfield in southeastern Tarrant County. The intent of the RUAA is to provide documentation for the assignment of an appropriate use category, either by retention of the existing primary use designation or assignment of another use category if appropriate.

Study Area

General Description of Water Body

Walnut Creek is an 18.9-mile stream with a 15.1 feet per mile slope (Lanning-Rush 2000) that drains a 67.6 square mile watershed southeastern Tarrant County and northeastern Johnson County (Figure 1). The watershed lies within the Cross Timbers Ecoregion, which is a mosaic of forest, woodland, savanna, and prairie (Griffith *et al.* 2004). The lower 7.6 of the stream lies within the City of Mansfield, and the watershed associated with the lower six miles contains a substantial amount of urban land uses. The upstream portion of the watershed consists largely of scattered rural development, rangeland, and pastureland.

The RUAA study area covers the impaired lower seven miles of Walnut Creek, from its downstream terminus at Holland Road upstream to the confluence with Willow Branch. This seven-mile reach lies within the City of Mansfield and constitutes a single assessment unit (AU) of the creek (AU 0838C_01). An AU is the smallest geographic area of use support reported in the TCEQ surface water quality assessment.

Walnut Creek enters Joe Pool Lake (Segment 0838) at Holland Road. Joe Pool is a major recreational and water supply reservoir, with designated uses of primary contact recreation, high aquatic life use, and public drinking water supply (30 TAC 307.10 (Appendix A)). TSWQS presume a primary contact recreation use for lakes and reservoirs (30 TAC 307.4(j)(2)(A)). Segment 0838 is not on the 2010 §303(d) for any parameter.

The areas immediately surrounding AU 0838C_01 are largely residential in the lower six miles, but more rural in nature along the upstream mile (see Figure 2). There currently are six municipal parks and recreational complexes, a linear park and trail, and a private country club located adjacent to AU 0838C_01 (Figure 1 and Table 2). An additional park and expansion of the linear park trail system is proposed. Each of these sites provides facilities for a variety of recreation-related uses (Table 3).

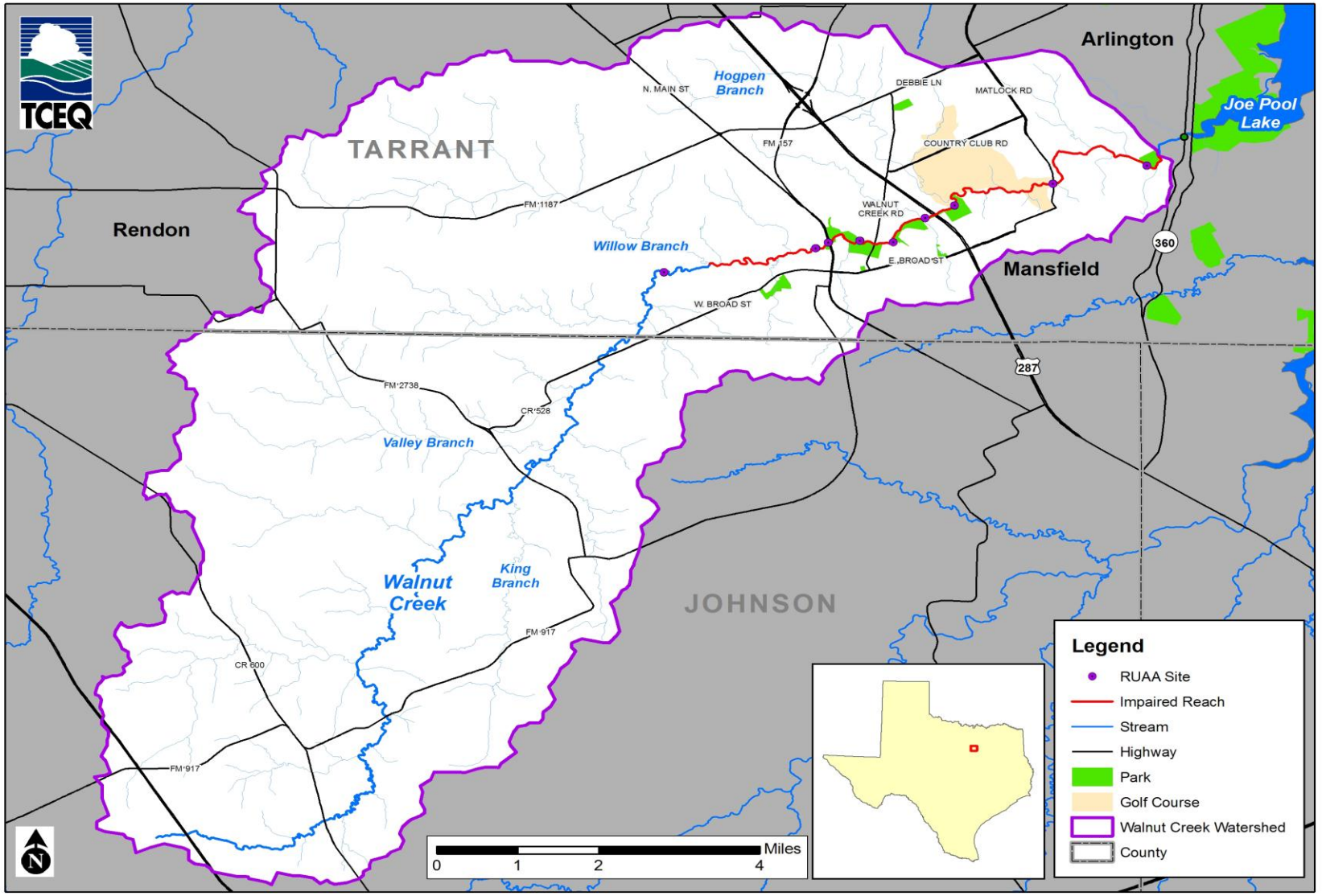

Figure 1. Walnut Creek (Segment 0838C) watershed.

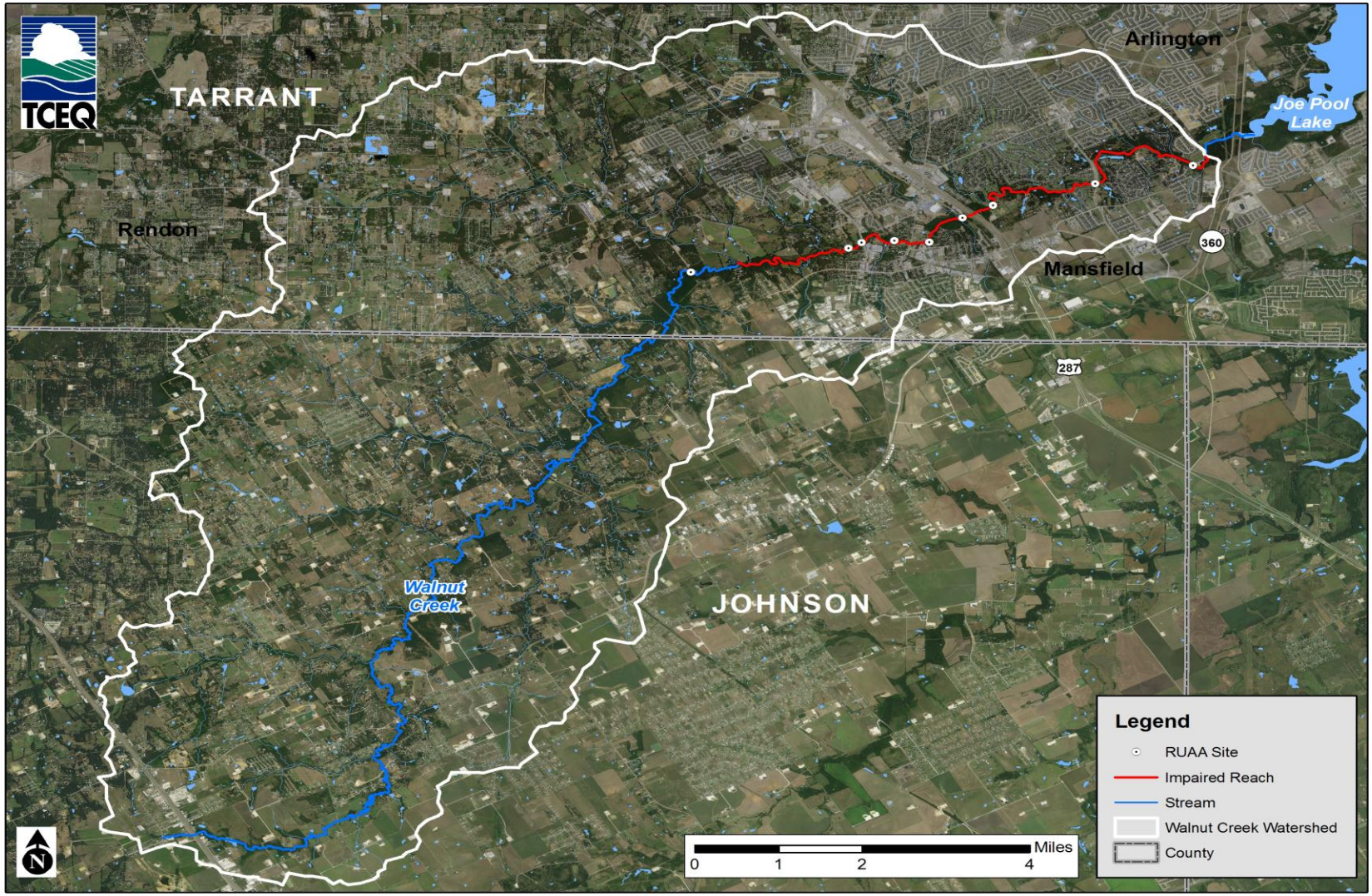

Figure 2. Aerial photograph of the Walnut Creek watershed. *Photo obtained from National Agricultural Imagery Program - 2008 Texas Aerial Imagery Project.*

Table 2. Existing and proposed parks and recreational facilities along Walnut Creek. Facilities are listed from downstream to upstream. *Information obtained from City of Mansfield (2010) and Walnut Creek Country Club web site (26 July 2010) at <www.clubcorp.com/club/scripts/section/section.asp?NS=PCH&SUBGRP=15&MFCODE=WACCC>.*

Facility	Control	Location	Year Opened
Phillip Thompson Soccer Complex	City of Mansfield	1701 North Holland on north side of Walnut Creek	1989
Proposed park and nature center	City of Mansfield	North side of Walnut Creek and east side of Matlock Road	Proposed
Walnut Creek Country Club	ClubCorp, Dallas, Texas	Privately-owned facility at 1151 Country Club Drive; facility is intermingled with residential areas between Matlock Road and the confluence of Hogpen Branch	1974
James McKnight Park East	City of Mansfield	East of US 287 on south side of Walnut Creek	1987
James McKnight Park West	City of Mansfield	West of US 287 off north end of Wisteria Street on south side of Walnut Creek	1987
Hardy Allmon Soccer Complex	City of Mansfield	310 North Walnut Creek Drive at Magnolia Street on south side of Walnut Creek, across from Katherine Rose Memorial Park	1984
Katherine Rose Memorial Park	City of Mansfield	303 North Walnut Creek Drive on south side of Walnut Creek, across from the Hardy Allmon Soccer Complex	1996
Town Park	City of Mansfield	500 North Main Street on north side of Walnut Creek	2006
Walnut Creek Linear Park	City of Mansfield	Existing trail: 1.9 mile trail from Town Park downstream to James McKnight Park East Phase I and II extensions: James McKnight Park East downstream to Joe Pool Lake Phase III extension: Town Park to west (upstream) city limits	2007 Proposed Proposed

Table 3. Facilities available at existing parks and recreational facilities along Walnut Creek. *Information obtained from City of Mansfield (2010) and Walnut Creek Country Club web site (26 July 2010) at <www.clubcorp.com/club/scripts/section/section.asp?NS=PCH&SUBGRP=15&MFCODE=WACCC>.*

Facilities	Town Park	Katherine Rose Park	Walnut Creek Linear Park[a]	Hardy Allmon Soccer Complex	James McKnight Park West	James McKnight Park East	Walnut Creek Country Club	Phillip Thompson Soccer Complex
Playground	X	X				X		
Covered Pavilion	X	X			X	X		
Picnic Tables	X	X	X		X	X		
Grills	X	X	X		X	X		
Campsites								
Restrooms	X	X				X	X	
Nature/walking trails	X	X	X	X	X	X		
Jog/bike trail	X	X	X	X	X	X		
Swimming beach								
Fishing pond/pier		pond						
Boat ramp								
Softball fields						X		
Basketball court	X	X						
Sand volleyball court	X	X						
Soccer field				X				X
Horseshoe pits	X	X						
Tennis courts							X	
Swimming pool							X	
Golf course							X	

[a] Walnut Creek Linear Park and trail currently extends from Town Park on the west to James McKnight Park East, and runs roughly parallel to Walnut Creek. The park/trail also runs through or past Katherine Rose Park, the Hardy Allmon Soccer Complex, and James McKnight Park West.

Figure 3 presents a closer view of the locations of the parks and recreational facilities along AU 0838C_01, as well as the RUAA study sites (described below under *Methodology*). The City of Mansfield Phillip Thompson Soccer Complex is located off Holland Road on the north side of Walnut Creek at the downstream end of AU 0838C_01. The facility was constructed in 1989 and used for Mansfield Soccer Association games until 1996. It has served generally as a practice facility since that time (City of Mansfield 2010), although games are occasionally played at the site.

The approximately 1.75-mile reach between the Phillip Thompson Soccer Complex and the upstream Matlock Road is surrounded largely by a narrow forested buffer area with adjacent residential areas and private property. Matlock is the first road crossing on Walnut Creek above Joe Pool Lake, although steep, eroded banks and surrounding private property impede public access at this time. The City of Mansfield has plans to develop a new municipal park and nature center east of Matlock Road on the north side of Walnut Creek.

The 1.4-mile reach between Matlock Road and the confluence with Hogpen Branch is bordered on both sides by a mixture of residential housing and the Walnut Creek Country Club. Stream access is limited by private property. A very narrow forested buffer exists in much of the area, although only a grass buffer is present in some places. There are no road crossings along this reach aside from a golf course bridge approximately 0.3 mile upstream from Matlock Road. Walnut Creek Country Club is a private facility that opened in 1974, initially as a nine-hole golf course. An additional nine holes were added in 1984-85 and again in 1995 for a current total of 36 holes (Berry 1999). Housing construction began in the late 1970s. The country club occupies 134 acres, including approximately 30 acres of fairway and two acres of greens (Berry 1999). The club also has 14 tennis courts and an Olympic-size swimming pool. There are ten ponds located within the golf course and intermingled subdivisions. City staff report that there are often waterfowl on many of these ponds. Some of these ponds can overflow to Walnut Creek via small tributaries and/or storm water connections. Hogpen Branch drains mostly residential and commercial areas, and also flows through the golf course below Country Club Drive.

The two-mile reach between the Hogpen Branch confluence and North Street is the most accessible portion of AU 0838C_01. This reach has four road crossings, three municipal parks, another soccer complex, and a linear park trail that parallels the creek. James McKnight Park East is located at the east end of this reach, on the east side of U.S. Highway 287 and the south side of Walnut Creek. The expanded park was completed in 1987 and includes four lighted softball fields, a playground, and pavilions and picnic tables (City of Mansfield 2010). The park is the current eastern terminus of the Walnut Creek Linear Park.

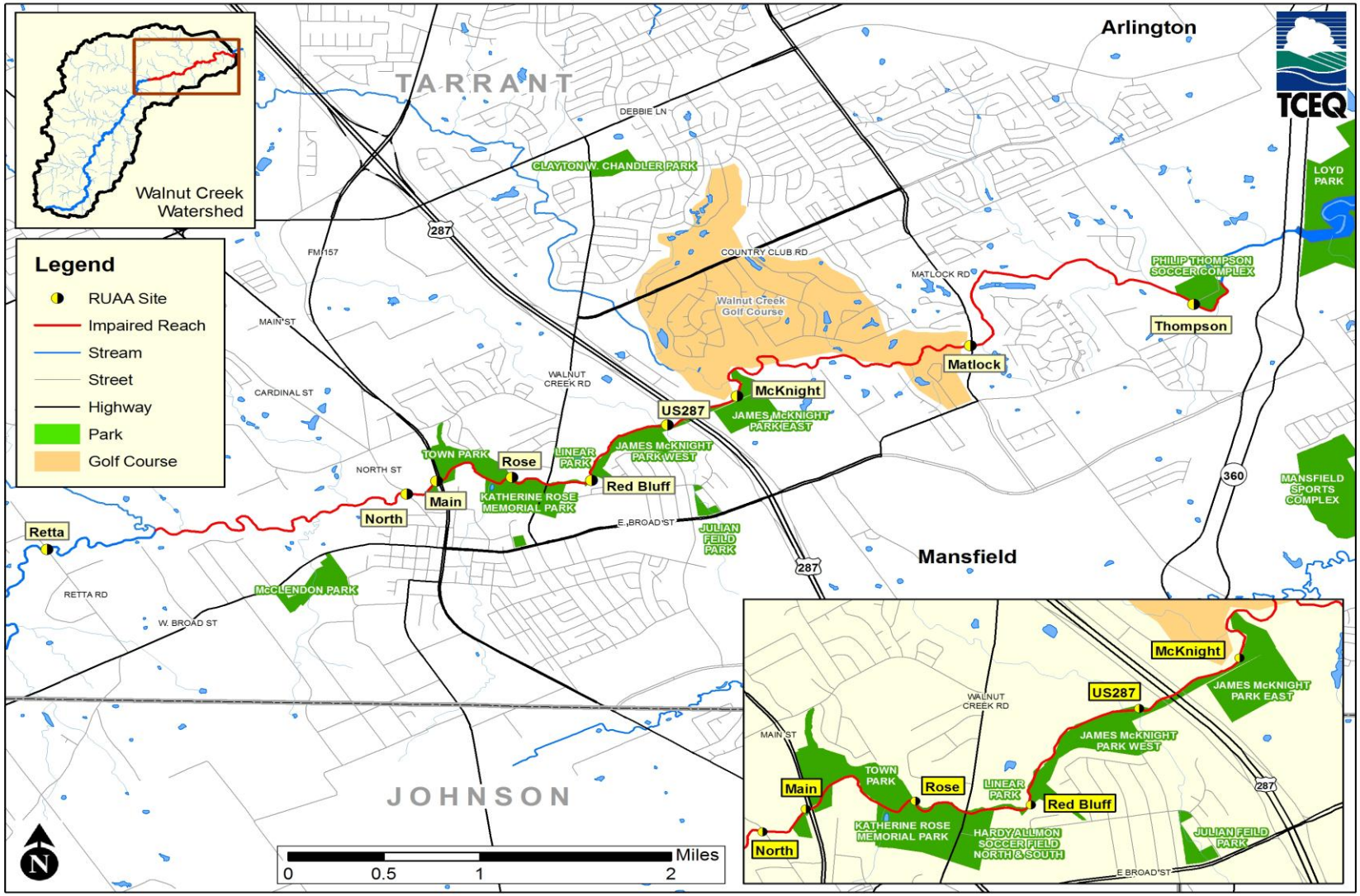

Figure 3. Location of parks and recreational facilities along AU 0838C_01 in Walnut Creek. Inset is a close-up of the area between Main Street and James McKnight Park East. RUAA study site locations are also indicated.

James McKnight Park West, also developed in 1987, is located west of U.S. Highway 287 off the north end of Wisteria Street on the south side of Walnut Creek. This park contains a pavilion with picnic tables and serves as an access point to the Walnut Creek Linear Park trail.

The Hardy Allmon Soccer Complex is located south of the creek on the east side of Walnut Creek Drive. The facility opened in 1984 and was used for Mansfield Soccer Association games until 1996. It has served as a practice facility since that time (City of Mansfield 2010). This site also provides access to the Walnut Creek Linear Park trail.

Katherine Rose Memorial Park, opened in 1996, is located on the south side of Walnut Creek and the west side of Walnut Creek Drive, directly across from the Hardy Allmon Soccer Complex. This is a heavily used park that includes a 0.5-mile walking/biking trail that connects to the Walnut Creek Linear Park trail, four covered pavilions with picnic tables, a large covered event pavilion with picnic tables, ten additional picnic tables with grills, six lighted basketball courts, two lighted sand volleyball courts, eight horseshoe pits, restroom facilities, and a large playground (City of Mansfield 2010). A fishing pond at the west end of the park is stocked by the Texas Parks and Wildlife Department and fed by overflow from a small tributary to Walnut Creek known locally as Pond Branch.

Katherine Rose Park includes some of the more easily accessible points along Walnut Creek:

- Under Walnut Creek Drive at the northeast corner of the park;
- Creek overlook point at the northwest corner of the park;
- Low-water crossing over Walnut Creek at the northwest corner of the park; and
- Footpath on the north side of fishing pond that leads to the confluence of Walnut Creek and Pond Branch.

Town Park, opened in 2006, is located east of Main Street on the north side of Walnut Creek. This park is the current western terminus of the Walnut Creek Linear Park trail, and includes a 600-seat amphitheater, two playgrounds, a large covered corporate pavilion, three covered picnic areas with tables, seven additional picnic tables with grills, restroom facilities, two lighted basketball courts, a sand volleyball court, two horseshoe pits, wildflower nature areas, and concrete trail connections to downtown Mansfield and to residential areas located to the north off Pleasant Ridge Drive (City of Mansfield 2010).

Walnut Creek Linear Park opened in January 2007 and consists of a 12-foot wide concrete trail that runs generally parallel to Walnut Creek from Town Park to James McKnight Park East. The trail is 1.9 miles long and connects five parks, four neighborhoods and two schools. In addition to the locations described above, access to the trail is also available from Palm Court between James McKnight Park West and the Hardy Allmon Soccer Complex. Amenities along the

trail include bird watching stations, several nature overlook points, a wildflower area, and several picnic stations (City of Mansfield 2010).

A forested buffer within Walnut Creek Linear Park lies along the south side of Walnut Creek from James McKnight Park East upstream to the low-water crossing at the northwest corner of Katherine Rose Park. The Linear Park and associated buffer lie along the north side of Walnut Creek from the low-water crossing upstream to Town Park. Walnut Creek opposite the Linear Park is bordered generally by a narrow forested buffer, with adjacent golf course and residential areas between McKnight Park East and Walnut Creek Drive, and with adjacent pasture and residential/commercial areas upstream from this point.

The City of Mansfield has plans to extend Walnut Creek Linear Park in three phases (City of Mansfield 2010). The Phase I extension will be approximately 2.8 miles from Matlock Road to Joe Pool Lake, and will include the proposed park east of Matlock Road. This extension will connect at least two parks and three neighborhoods, and is expected to connect with trails around Joe Pool Lake. The Phase II extension will be from James McKnight Park East to Matlock Road, and will connect two parks, a school, and five neighborhoods. The Phase III extension will include approximately two miles of trail running from Main Street in Town Park to the western (upstream) city limits, and will connect the downtown area and several parks and neighborhoods.

The upper 1.5 miles of AU 0838C_01, between North Street and the confluence with Willow Branch, is bordered largely by a mix of forest and pasture located on private property (see Figure 2). North Street is the most upstream road crossing in the impaired AU 0838C_01.

Watershed Characterization

Population and Land Use

Elevated microbial levels are common in urban runoff (Schueler 1999), and streams draining watersheds with more urban and residential development have been found to have higher *E. coli* densities (Traister and Anisfeld 2006). Population, impervious cover, urban and residential development, density of housing, and domestic animal density have been associated with elevated stream bacteria densities (Young and Thackston 1999; Mallin *et al.* 2000).

Land uses in the Walnut Creek watershed as of 2005 are illustrated in Figure 4. The percentages of land in the major use categories are shown in Table 4 for the upstream and more rural Johnson County portion of the watershed, the downstream Tarrant County portion, and the Walnut Creek watershed as a whole. Developed land uses make up a considerably greater percentage (60.9) of the Tarrant County portion of the watershed – which includes part of the City of Mansfield - in comparison with the lesser developed Johnson County portion (41.7 percent).

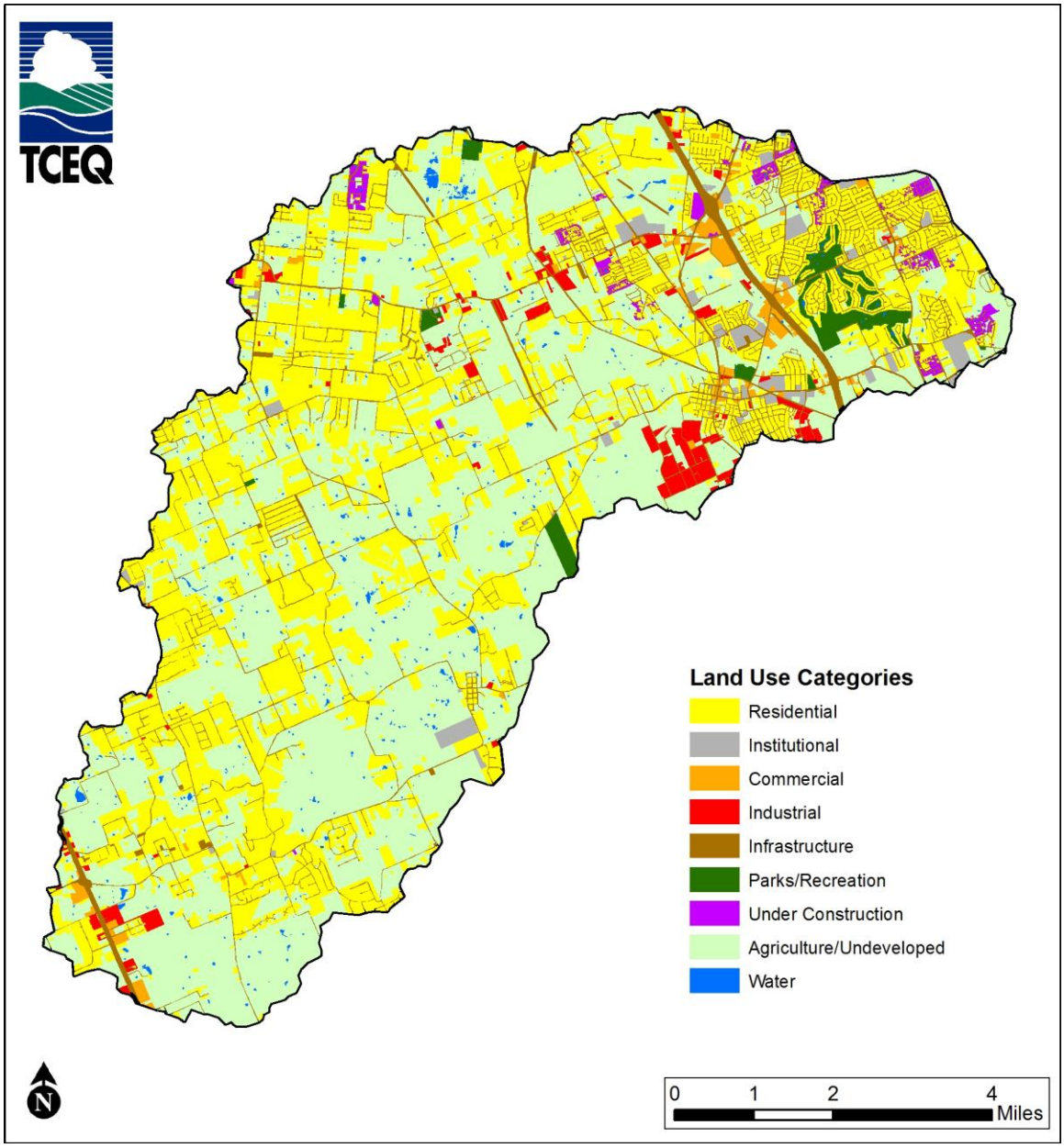

Figure 4. Land use in the Walnut Creek watershed in 2005. *Land use data retrieved in January 2011 from North Central Texas Council of Governments at <www.nctcog.org/ris/demographics/landuse.asp>.*

Table 4. Percent land use composition in the Walnut Creek watershed in 2005. *Percentages calculated from county and watershed land use data obtained from North Central Texas Council of Governments at <www.nctcog.org/ris/demographics/landuse.asp> in January 2011. Columns may not add to exactly 100 percent due to the effects of rounding.*

Land Use	Percent of Total Land (2005) – Walnut Creek Watershed		
	Johnson Co. Portion of Watershed	Tarrant Co. Portion of Watershed	Entire Watershed
Residential	34.2	37.3	35.8
Commercial	0.9	1.9	1.4
Industrial	1.1	2.4	1.7
Institutional	0.4[a]	2.5	1.4
Infrastructure[b]	4.0	12.8	8.3
Parks/Recreation	0.4	2.3	1.3
Under Construction	0.006	1.7	0.8
Total Developed	*41.0*	*60.9*	*50.7*
Water	0.8	0.6	0.7
Agricultural/Undeveloped	58.1	38.4	48.5

[a] Area estimated from land use map.

[b] Roadway portion of infrastructure area for each county estimated by assigning 75 percent of composite roadway area to Tarrant County and 25 percent to Johnson County portion of watershed.

The lower seven miles of Walnut Creek and much of the watershed directly associated with that reach lie within the City of Mansfield. The population of Mansfield has nearly quadrupled since 1990 following relatively slow growth prior to that time (see Table 5). The recent rapid growth coincides with the time following the completion of Joe Pool Lake. Available undeveloped land – both within Mansfield and in surrounding areas – and current population projections suggest that relatively rapid population growth will continue over the next 10 to 20 years. Although a substantial portion of the city lies outside the Walnut Creek watershed, the parks and recreational facilities adjacent to Walnut Creek are accessible to the entire population.

Increased urbanization associated with population growth is reflected in the more than doubling of developed land uses within Mansfield between 1995 and 2005 (Table 6). Although differences in methodology used to compile the data prevent an exact comparison between years, a substantial increase in developed acreage is apparent. Additional development has occurred since 2005 and is expected to continue.

Table 5. Population growth in the City of Mansfield.

YEAR	POPULATION	SOURCE OF POPULATION DATA
1880	249	HPCTC (1990)
1890	400	
1900	700	
1940	774	
1960	1375	MPRG (2002)
1970	3658	NCTCOG (2011) http://www.nctcog.org/ris/census/2010/City_Pop_1970_2010.pdf
1980	8102	
1990	15,607	
2000	28,031	
2010	56,368	

Table 6. Percent land use composition in the City of Mansfield. *Sources: Data for 1995 and 2005 retrieved 22 July 2010 from North Central Texas Council of Governments Demographic Data for North-Central Texas at <www.nctcog.org/ris/demographics/index.asp>. Data for 2000 are from MPRG (2002). Data are intended to illustrate general land use changes. Category values may not be directly comparable between years due to differences in methodologies used to compile the data. Columns may not add to exactly 100 percent due to the effects of rounding.*

Land Use	Percent of Total Land in City of Mansfield		
	1995	2000	2005
Residential	13.0	16.9	21.8
Commercial	1.1	1.4	1.8
Industrial	2.8	2.9	4.1
Institutional	0.9	2.2	2.5
Infrastructure	2.1	10.2	11.6
Parks/Recreation	1.6	3.5	4.0
Under Construction	0.2	na	2.3
Total Developed	*21.7*	*37.1*	*48.1*
Water	0.4	0.4	0.4
Undeveloped	77.8	62.4	51.7

Climate

Climate in the Dallas/Fort Worth (DFW) area is humid subtropical with hot summers and generally mild winters. Periods of extreme cold may occur, but are generally short-lived. Snowfall occurs on average only 6.4 days per year, with more than a trace amount on an average of only 1.8 days per year. The average length of the warm season (freeze-free period) in the area is about 249 days. Temperatures reach 90°F or greater an average of 101 days each year. The annual mean daily minimum and maximum temperatures, as measured at DFW International Airport, are 55.0°F and 76.3°F, respectively, over a 66-year period of record (NWS 2010).

Essentially all precipitation in the area is rain. Although the area has moderate rainfall and runoff on average, these events can be erratic. Much of the rain and streamflow is in late spring, followed by hot, dry weather from mid-June through August (Ulery *et al.* 1993). Summer hot spells may be broken into three to five day periods by thunderstorm activity. Thunderstorms occur on an average of 46.3 days per year, most frequently in the spring, and produce a large portion of the annual precipitation. Rainfall occurs more frequently during the night (NWS 2010). On average, the area experiences a winter surplus and a summer deficiency of precipitation (Ulery *et al.* 1993). Annual rainfall in the Walnut Creek area is approximately 35 to 38 inches:

▪ Lanning-Rush (2000) reports an average annual precipitation of 35.1 inches in the Walnut Creek basin based on a 1961-1990 period of record.

▪ Average annual rainfall at the Arlington Municipal Airport, located approximately 6.5 miles from the center of the RUAA project area, is 38.0 inches based on a 62-year period of record (NWS 2010).

▪ Average annual rainfall at the Joe Pool Lake dam, available for the 26-year period since dam construction, is 37.9 inches (NWS 2010).

Hydrology and Streamflow Characteristics

Variations in streamflow can influence both primary and secondary recreational activities. For example, swimming, wading, and fishing are inhibited by elevated flows, while whitewater activities are inhibited by flows below a certain level. Two major and relatively recent events have affected the hydrology of the lower end of Walnut Creek:

(1) Prior to the construction of Joe Pool Lake, Walnut Creek was a tributary to Mountain Creek, with the confluence approximately ten miles downstream from Holland Road. Construction of the lake as an impoundment of Mountain Creek was completed in December 1985. The lake filled between January 1986 and June 1989, forming the Mountain Creek and Walnut Creek arms. The lake covers 7470 surface acres and has a conservation storage capacity of 176,900 acre-feet (Ulery *et al.* 1993). Backup from the lake may maintain water in the lower end of Walnut Creek in greater volume and for a longer time period than prior to impoundment.

(2) The population of Mansfield has nearly quadrupled and the amount of developed land has approximately doubled since the completion of Joe Pool Lake. Increased urbanization and associated impervious cover can affect stream flows by reducing the lag time between rainfall events and the resulting increases in streamflow; increasing the total volume of runoff; and increasing the frequency, duration, and amount of peak flows (Spinello and Simmons 1992; Liscum 2001; Konrad 2003; Line and White 2007). If the lower reaches of a basin are urbanized and the upper are not – as is the case with Walnut Creek – runoff in the lower portion may flow out of the basin prior to the arrival of flow from upstream (Hirsch *et al.* 1990), although the presence of a reservoir at the lower end may slow that outflow.

Base flows may decrease with urbanization due to lowering of the groundwater table through extensive pumping (Prince 1981) and a decrease in infiltration due to increased impervious cover (Hirsch *et al.* 1990; Spinello and Simmons 1992). Base flows may be increased through urban recharge to shallow groundwater from septic tanks, leaking water and sewer lines, and dry-weather runoff from landscape watering and overwatering (Hirsch *et al.* 1990; Lerner 2002; Meyer 2002). Leaks from water lines are probably important in cases where a large amount of water is imported from outside the basin of use (Lerner 2002), as is the case in the lower Walnut Creek watershed.

Records from U.S Geological Survey (USGS) stream flow measurement gage 08049700, located approximately two miles upstream from Joe Pool Lake on Walnut Creek at Matlock Road, were used to evaluate flow characteristics (see <http://waterdata.usgs.gov/nwis/nwisman/?site_no=08049700&agency_cd=USGS>). Data were retrieved for the period from 1 October 1960 (initial gage operation) through 30 September 2009, which corresponds with USGS water years 1961 through 2009. This time period allows examination of data for 25 years before and 20 years after the construction of Joe Pool Lake and the rapid growth in Mansfield.

Mean annual flow in Walnut Creek generally has increased since impoundment (Figure 5). Asquith *et al.* (2007a) found this trend to be significant ($p = 0.006$) on data evaluated through 2003. This increase may be due to increased base flow and/or storm flows.

USGS records show that Walnut Creek flows reach zero during dry periods in most years. This pattern is typical of smaller, tributary streams in the area, which may cease to flow after a few days or weeks without rain (Land *et al.* 1998; TRA 2010). However, the number of zero-flow days per year in Walnut Creek has decreased since impoundment and accompanying urbanization (Figure 6), suggesting an increase in base flow. Asquith *et al.* (2007b) determined this decreasing trend in zero-flow days to be significant ($p = 0.001$) on data evaluated through 2003.

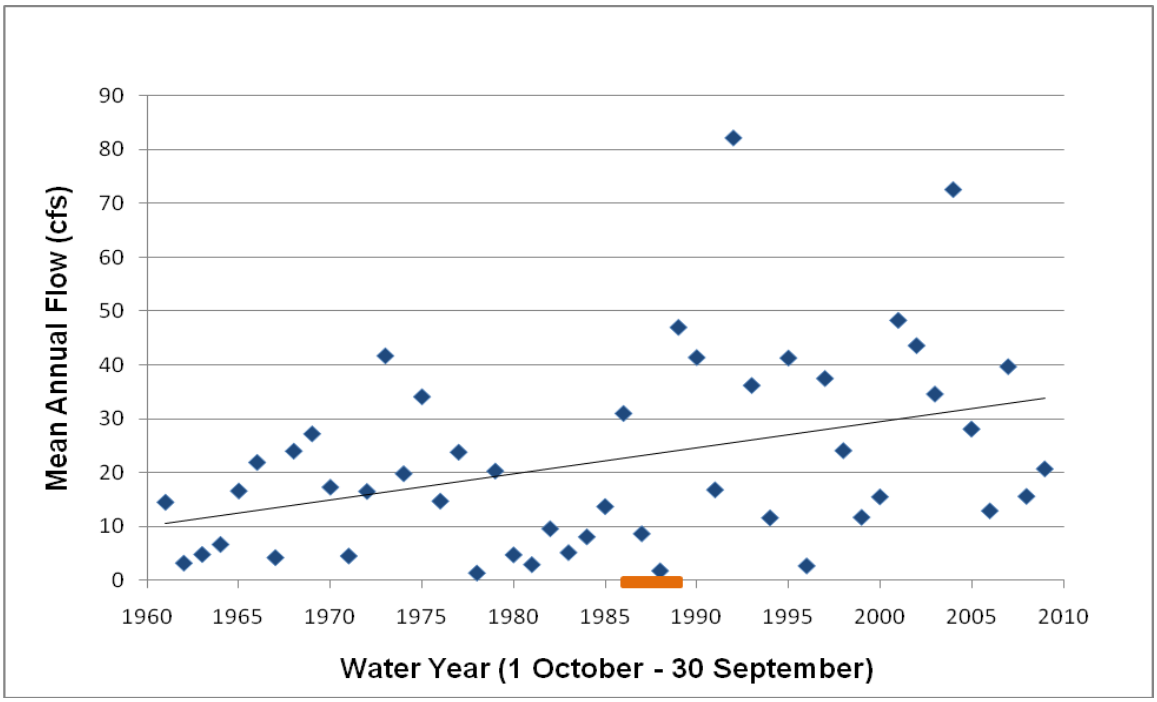

Figure 5. Mean annual flow (cfs = cubic feet per second) at USGS gage 08049700 in Walnut Creek at Matlock Road. Orange bar denotes period when Joe Pool Lake was filling. Trend line was fit by Microsoft Office 2007 Excel spreadsheet.

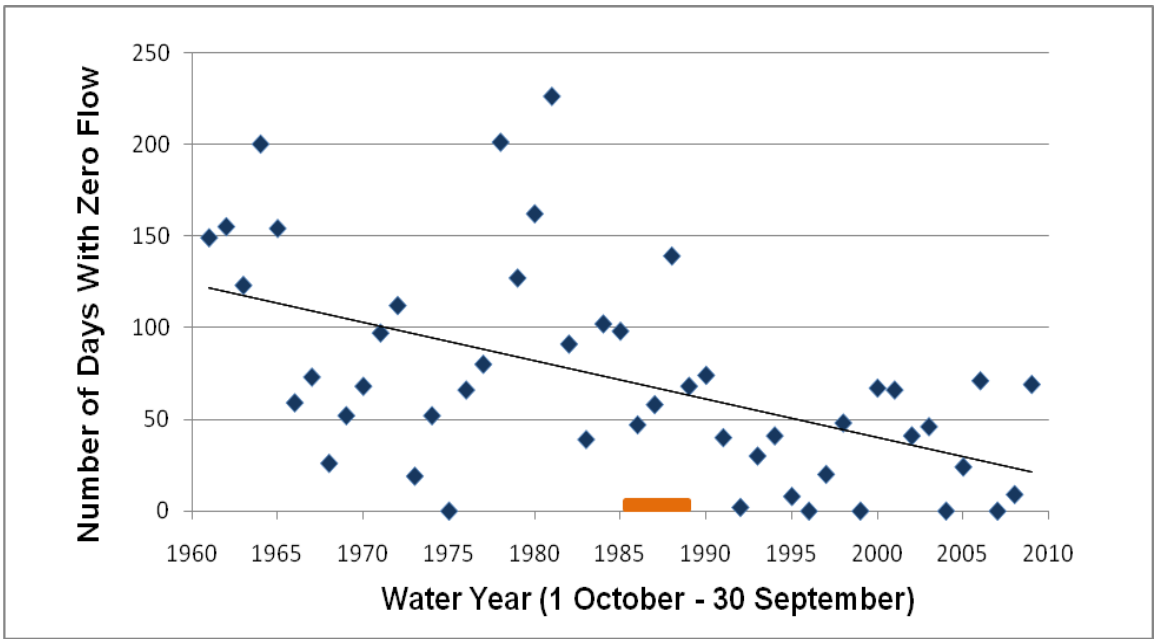

Figure 6. Number of days with zero flow measured at USGS gage 08049700 in Walnut Creek at Matlock Road. Orange bar denotes period when Joe Pool Lake was filling. Trend line was fit by Microsoft Office 2007 Excel spreadsheet.

It is not clear how far upstream this increase in annual flow and decrease in zero-flow days is evident. Pools are present in the lower watershed even at zero flow, and AU 0838C_01 can be considered intermittent with perennial pools.

Wet weather Walnut Creek flows can be quite flashy. During a 14-15 September 2010 storm event, the flow at Matlock Road rose 645 cubic feet per second (cfs) in approximately 2.5 hours in response to a 0.35-inch rain. USGS flow records show that there has been an overall increase in the annual number of daily mean flows of 100 cfs or greater over the period of record (Figure 7).

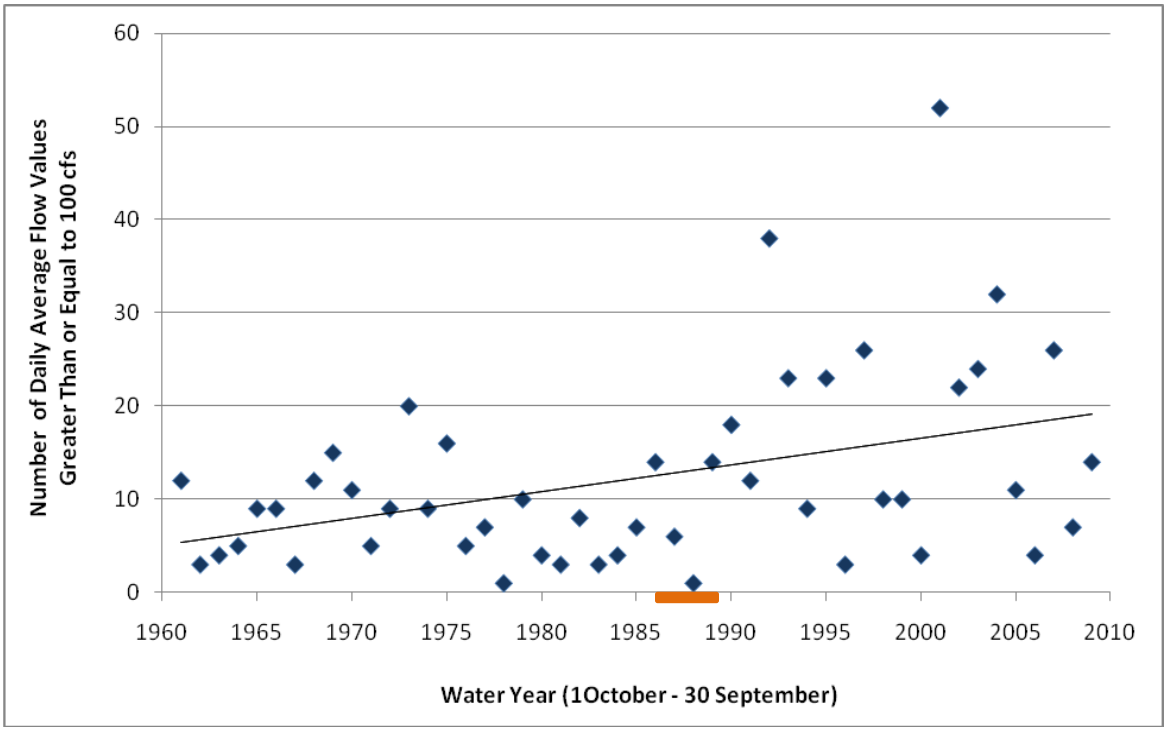

Figure 7. Number of days each year when the daily average flow at USGS gage 08049700 in Walnut Creek at Matlock Road was at least 100 cubic feet per second (cfs). Orange bar denotes period when Joe Pool Lake was filling. Trend line was fit by Microsoft Office 2007 Excel spreadsheet.

Examination of the number of high-flow pulses, defined as the annual number of daily mean flows greater than the 75th percentile of flows over the period of record (Kiesling 2003) (3.5 cfs in Walnut Creek), finds an increasing trend over time (Figure 8). An increasing trend also exists in the annual number of flow pulses exceeding the 85th percentile (9.1 cfs). The 85th percentile has been exceeded on more than 100 days in eight different years since impoundment, while this did not occur in any year prior to that time (Figure 8). The increase in the number of flow pulses and in the number of daily average flows exceeding 100 cfs are likely a reflection of increased flashiness and runoff following urbanization in the lower watershed.

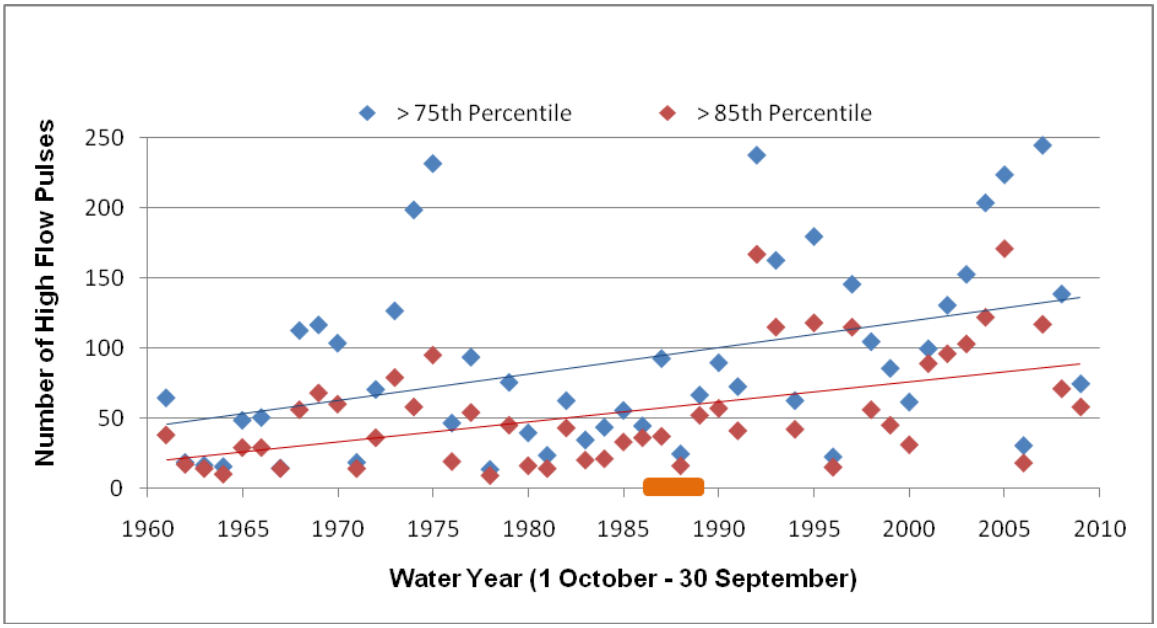

Figure 8. Number of high flow pulses per year in Walnut Creek at Matlock Road (*i.e.* number of days each year when the daily average flow at USGS gage 08049700 exceeded the 75th and 85th flow percentiles). Corresponding trend lines were fit by Microsoft Office 2007 Excel spreadsheet. Orange bar denotes period when Joe Pool Lake was filling.

Stream bacteria densities are generally higher in storm flows (McDonald and Kay 1981; Traister and Ainsfield 2006) and a substantial amount of the total bacterial load results from extreme runoff events (Kistemann *et al.* 2002). Flow and depth conditions can make a stream unsafe for primary contact recreation, a condition that may be exacerbated by rapidly increasing urban runoff flows. USGS staff guidance for wading while conducting stream measurements (USGS 1999) uses a general rule of thumb that wading should not be attempted if stream depth (feet) multiplied by flow velocity (feet per second) is greater than ten.

Flow Duration Curves

Flow patterns were also evaluated using flow duration curves (FDCs), a common method for examining streamflow and pollutant loads (Searcy 1959; USEPA 2007). FDCs depict the percentage of time that a given flow was equaled or exceeded over a period of time. A total record of 49 years is available for the USGS Walnut Creek streamflow gage; however, the construction of Joe Pool Lake and subsequent growth in Mansfield make the first 25 years of data less representative of current conditions. These events do, however, allow examination of changes that have occurred since lake construction and increased urbanization. FDCs for Walnut Creek were therefore constructed for two time periods:

▪ Water years 1961 through 1985 (25 years), prior to the filling of Joe Pool Lake and the rapid growth of Mansfield; and

▪ Water years 1990 through 2009 (20 years), after the lake was filled and covering the period of rapid growth in Mansfield.

FDCs were generated via the following steps:

(1) Mean daily flow data were obtained for USGS gage 08049700.

(2) Daily flow values for each time period were ranked from highest to lowest.

(3) The percent of the total days in each time period on which each daily flow value was exceeded was calculated as:

Percent exceedance = [(Rank of flow value) / (Total number flow values + 1)] x 100

(4) Each daily flow value was plotted (y-axis) against its exceedance value (x-axis) for the relevant time period (Figure 9). Because the flow scale is logarithmic, the zero flow point is set to 0.01 cfs.

The exceedance values along the x-axis represent the percent of days that flow was at or above the associated flow value on the y-axis. Exceedance values near 100 percent occur during low flow conditions while values approaching zero percent occur during periods of higher flow.

The relatively steep FDCs for Walnut Creek (Figure 9) are generally indicative of urbanization and storm flow influences. Steepness at the lower end, particularly apparent in the 1961-85 FDC, and the substantial amount of time with zero flow indicate a lack of groundwater contribution (Spinello and Simmons 1992), at least during drier times of the year. Steepness at the upper end (0-10 percent exceedance) of both curves reflects the effect of storm water runoff and the variability in higher flows.

Flow values at the one and five percent exceedance levels increased by 131 and 285 percent, respectively, from pre- to post-impoundment and urbanization. Daily mean flows of 100 cfs or more increased from approximately 2.4 to 5.0 percent of the time. As noted above, there has been an increasing trend in the number of high-flow pulses and in the number of daily mean flows of 100 cfs or more (Figures 7 and 8). The FDCs also illustrate the decrease in zero-flow conditions from approximately 28 to 12 percent of the time since lake construction and urbanization.

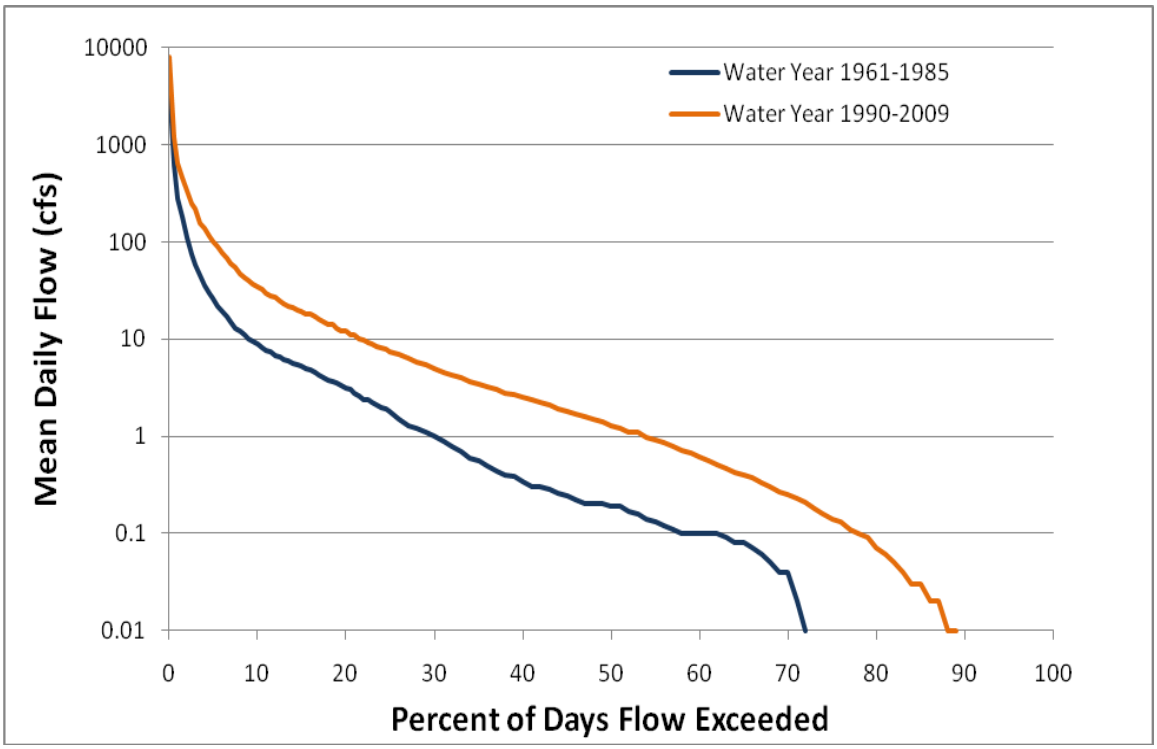

Figure 9. Flow duration curves for Walnut Creek at Matlock Road before and after the impoundment of Joe Pool Lake (Water Years 1961-1985 and 1990-2009, respectively). Data obtained from USGS flow gage 08049700. cfs = cubic feet per second.

TPDES-Regulated Discharges

The Texas Pollutant Discharge Elimination System (TPDES) program has regulatory authority over discharges of pollutants to Texas surface water, with the exception of discharges associated with oil, gas, and geothermal exploration and development activities that are regulated by the Railroad Commission of Texas and/or USEPA. TPDES-permitted facilities include:

▪ municipal and private domestic wastewater treatment plants (WWTPs);

▪ industrial facilities with individual permits authorizing the discharge of treated industrial wastewater and/or storm water and/or groundwater;

▪ Phase I and Phase II municipal separate storm sewer systems (MS4s) that collect and convey runoff from defined urbanized areas, but are not connected with a wastewater collection system or treatment plant; and

▪ construction sites and industrial facilities covered under a TPDES general permit authorizing the discharge of process wastewater and/or storm water.

Domestic and Industrial Wastewater Discharges

There are four TPDES-permitted wastewater discharges within the Walnut Creek watershed (Table 7). All are small domestic WWTPs that discharge into upstream tributaries in the Johnson County portion of the watershed. None discharge directly to Walnut Creek. The closest facility to AU 0838C_01 is approximately eight miles upstream from the confluence of Walnut Creek and Willow Branch. The other three WWTPs are approximately 15 miles upstream from the confluence. There are no TPDES-permitted industrial wastewater discharges in the watershed. The City of Mansfield wastewater collection system is connected to the Trinity River Authority (TRA) Central regional system. The TRA Central WWTP discharges to the Lower West Fork Trinity River (Segment 0841).

Table 7. TPDES-permitted wastewater discharges in the Walnut Creek watershed. *Source: TCEQ Water Quality Permit Applications database at <http://www4.tceq.state.tx.us/wqpaq/> on 14 July 2010.*

TPDES Permit No.	Permittee	Approximate Miles Upstream[a]	Permit Flow (MGD)[b]
WQ0013769-001	Country Vista Limited (Country Vista Mobile Home Park)	15	0.042
WQ0013868-001	Creek Park Corporation (Walnut Creek Mobile Home Park)	14	0.0225
WQ0014101-001	Alvarado Independent School District	8	0.035
WQ0014790-001	TX Department of Transportation (I-35W Northbound Rest Area)	15	0.006
	Total Permitted Wastewater Flow (MGD) =		*0.1055*

[a] Approximate distance from the upstream end of AU 0838C_01 at the confluence of Walnut Creek and Willow Branch.

[b] MGD = millions of gallons per day.

Sanitary sewer overflows (SSOs) are unauthorized discharges from a wastewater collection system that must be addressed by the responsible party, either the TPDES permittee or the owner of the collection system that is connected to a permitted system. SSOs in dry weather most often result from blockages in sewer collection pipes caused by tree roots, grease and other debris. Inflow and infiltration (I/I) are typical causes of wet weather SSOs. Blockages in a line may exacerbate the I/I problem. Other causes, such as a collapsed sewer line, may occur under any condition. SSOs can contribute pathogenic organisms that increase the risk of illness to those coming in contact with an affected water body (Vonstille *et al.* 1993)

The TCEQ Region 4 Office maintains a database of SSOs reported by responsible parties. A review of the database for a six-year period from September 2004 through August 2010 noted only one SSO in the Walnut Creek watershed. There does not appear to be a significant SSO problem in the watershed.

Phase I and II MS4 Storm Water Discharges

The seven-mile portion of Walnut Creek addressed by this RUAA is within the jurisdiction of the City of Mansfield Phase II storm water permit (TPDES General Permit No. TXR040000). The City of Mansfield storm water program is administered through the Environmental Services Department within the Public Works Division (<www.mansfield-tx.gov/departments/es/>). No other entities within the Walnut Creek watershed are covered by a TPDES Phase I or Phase II MS4 permit.

General Wastewater and Storm Water Permits

In addition to individual wastewater discharge permits, discharges of process wastewater from certain types of facilities may require coverage under one of seven TPDES general permits (Table 8). A review of active general permit coverage in the Walnut Creek watershed as of 31 October 2010 did not find any facilities authorized to discharge process wastewater under these general permits.

In addition to the Phase II MS4 storm water permit, discharges of storm water from individual facilities involved in certain activities may require coverage under one of four additional TPDES general permits that address storm water (Table 8). Two of these permits – concrete production facilities and petroleum bulk stations and terminals – also authorize the discharge of process wastewater. As noted above, there are no facilities in the watershed covered under these two permits. Three sites were covered under the multi-sector general permit for industrial storm water as of 31 October 2010 (Table 8), although only one of these is within the watershed of AU 0838C_01.

Table 8. Number of entities in the Walnut Creek watershed with discharges covered under a TPDES General Permit as of 31 October 2010. *Data obtained from the TCEQ Water Quality General Permits database at <www5.tceq.state.tx.us/wq_dpa/index.cfm> on 3 November 2010.*

TPDES General Permit No.	Type of Activity Covered	Effluent Type[a]	No. Sites
TXG110000	concrete production	WW / SW	0
TXG130000	aquaculture production	WW	0
TXG340000	petroleum bulk stations and terminals	WW / SW	0
TXG670000	hydrostatic test water discharges	WW	0
TXG830000	water contaminated by petroleum fuel/ substances	WW	0
TXG920000	concentrated animal feeding operations	WW	0
WQG20000	livestock manure compost operations	WW	0
TXR040000	Phase II municipal separate storm sewer systems	SW	1
TXR050000	multi-sector general permit for industrial facilities	SW	3
TXR150000	construction activities disturbing more than one acre	SW	62[b]

[a] WW = process wastewater; SW = storm water

[b] Approximate number of construction sites within the Walnut Creek watershed covered by a Notice of Intent filed during the period 1 January 2005 through 31 October 2010.

Storm water permit coverage for construction sites is in flux as new construction begins and other projects are completed. Permit coverage is required for any construction project one acre or more in size. Table 8 indicates the number of Notices of Intent filed for construction permit coverage between 1 January 2005 and 31 October 2010 at sites that appear to be within the Walnut Creek watershed. It is intended only to provide some indication of the amount of surface disturbance due to construction. As noted previously in this report, Mansfield has grown considerably in the past 20 years. A substantial amount of construction has occurred and continues to occur in the area.

On-Site Sewage Facilities

With the exception of the sewered portions of the City of Mansfield and the locations served by the upstream WWTPs (Table 7), the Walnut Creek watershed is not served by organized wastewater collection and treatment systems. Properties in unsewered portions of the Walnut Creek watershed are served by individual on-site sewage facilities (OSSFs). Discharges from failing OSSFs can be a source of bacteria to nearby water bodies. The Tarrant County Public Health Department – Environmental Health Division has jurisdiction over OSSF-related permitting and complaint investigations in unincorporated areas of Tarrant County, and in unsewered areas of the City of Mansfield within Tarrant County through an inter-local agreement with the City. The Johnson County Public Works Department has jurisdiction over OSSF-related issues within the unincorporated areas of Johnson County in the Walnut Creek watershed.

Regulated Waste Disposal

A review was conducted on 15 July 2010 of the North Central Texas Council of Governments Closed and Abandoned Municipal Solid Waste Landfill Inventory (<www.nctcog.org/envir/SEELT/disposal/facilities/index.asp>) to determine the numbers of permitted-active, permitted-closed, and unauthorized-closed municipal landfills in the Walnut Creek watershed. There are no permitted-active or permitted-closed landfills in the watershed. There are 11 unauthorized-closed sites. Only one of those 11 sites, located in the Hogpen Branch tributary drainage, is inside the AU 0838C_01 portion of the watershed.

Potential Unregulated Sources

Unregulated sources are those that contribute pollutants to a water body through diffuse, nonspecific locations and are generally not regulated through the TPDES program. Unregulated bacteria sources can include storm water runoff not subject to TPDES regulations, pastured livestock, avian and mammalian wildlife, unmanaged feral animals, and domesticated pets (USEPA 2009b). Dog-walking is a common activity in Mansfield parks. The City of Mansfield provides “dog mitts” at stations within its parks, which likely reduces the amount of dog manure that would otherwise be present in these locations. The watershed upstream from the City of Mansfield is largely rural. With the exception of sites subject to the TPDES general permits for storm water (Table 7), runoff in this portion of the watershed generally is unregulated rural and agricultural runoff.

Summary of Historical Information

Mansfield's origins are generally said to coincide with the construction of a steam-powered grist mill and general merchandise store on the corner of what are now Main and Broad Streets in 1856, although the beginnings of a community may have existed as early as the 1840s and a cluster of houses was likely present by 1854 (HPCTC 1990) A post office was established in 1860 and the Fort Worth & New Orleans railroad arrived in 1885. The city was incorporated in August 1890 with a reported population of 418. The town developed initially along Main Street, north from Broad Street to Oak Street; and east along Broad Street between Pond and Brown Streets. Walnut Creek was seen as a barrier to development toward the north (HPCTC 1990), probably due to flooding concerns.

The first public water system was installed in 1904, supplied by a well in the middle of Water Street (now Main Street). Raw water for the Mansfield public water supply system has been obtained from the reservoir system operated by the Tarrant Regional Water District since about 1973. Most of the Mansfield supply is obtained from Cedar Creek and Richland Chambers Reservoirs. Walnut Creek is not used as a public water supply.

The first sewer system in Mansfield was installed in 1926 (HPCTC 1990; Mansfield Historical Society 1996). A sewage treatment plant was once located on the current site of the Hardy Allmon Soccer Complex (see USGS Mansfield Quadrangle, 7.5 Minute Series Topographic Map, 1959/photorevised 1968) and probably discharged into Walnut Creek between Walnut Creek Drive and the Red Bluff area. The Mansfield sewage collection system was connected to the TRA Central WWTP regional system sometime in the 1970s, and the city treatment plant was removed sometime prior to 1981.

Little information is available concerning the historical contact recreational use of Walnut Creek. Baptisms were performed in the early twentieth century near the confluence of Pond Branch and Walnut Creek on property then owned by Jake Back. Red Bluff, a scenic overlook area located immediately east of the current Hardy Allmon Soccer Complex, was a popular picnic area in the late 19th and early 20th century (Mansfield Historical Society 1996), but there is no record of any primary contact recreation at the site.

A swimming hole reportedly existed in the 1930s and 40s in Walnut Creek at the railroad crossing located approximately 75 meters upstream from North Street (per Mansfield Historical Society staff). The bridge was constructed in 1885 when the railroad first arrived in Mansfield, and was renovated in 1906 (HPCTC 1990). There is a deep pool at a bend immediately downstream from the railroad bridge, but no evidence of any recent contact recreation at the site was observed during the RUAA survey.

The City has plans to build a park and nature center east of Matlock Road along the north side of Walnut Creek. A recent article in the *Mansfield News-Mirror*

reported that the children of the previous owners of the property swam in the creek, probably in the 1960s-70s (Rogers 2010). No additional historical recreational areas were identified, although another site was discovered near James McKnight Park East during the RUAA surveys (see *Results and Discussion* section).

The City of Mansfield has sponsored a series of stream clean-ups to remove trash from portions of Walnut Creek and one of its tributaries (dates obtained from City of Mansfield web sites, including the *Mansfield Citizen Newsletter* at <www.mansfield-tx.gov/departments/pio>):

- Walnut Creek in Katherine Rose Park in September 2006;
- Walnut Creek between Town Park and McKnight Park West in October 2007;
- Walnut Creek north of Pleasant Ridge in April 2008;
- Hogpen Branch in October 2008; and
- Walnut Creek adjacent to the Thompson Soccer Complex in October 2010.

These clean-ups may involve contact with the water, although participants generally are wearing some protective clothing such as boots and work gloves, and the activities are not those typically associated with recreation.

The following additional sources were reviewed for any information concerning recreation on Walnut Creek:

(1) The *Texas Fishing Forum*, an online discussion of fishing topics in Texas (<http://texasfishingforum.com/forums/ubbthreads.php>), was searched for topics related to Walnut Creek, Joe Pool Lake, and the Mansfield area as suggested by Raphael Brock, TPWD District Fisheries Biologist. The Forum also includes discussions of boating, canoeing, and kayaking. No mention was found of any activities upstream from the Walnut Creek arm of Joe Pool Lake in the vicinity of SH 360, a location approximately 0.4 mile downstream from the end of AU 0839C_01 at Holland Road (see Figure 3). Evidence of fishing (tackle and bait container litter) is typically present at SH 360 and Forum items refer to the use of boats and kayaks in that area.

(2) Mansfield produces the *Mansfield Citizen Newsletter* on a variable basis (up to quarterly; see <www.mansfield-tx.gov/departments/pio>). Available on-line issues (2002 through Summer 2010) were reviewed. Newsletters contained a substantial amount of information and updates on city parks, stream clean-ups, and other city activities. There was no mention of any aquatic recreation activities related to Walnut Creek.

(3) Available on-line issues of *Mansfield NOW Magazine* were reviewed on 27 October 2010 (<http://nowmagazines.com/online-editions>). No mention was found of any aquatic recreation activities related to Walnut Creek.

(4) The Mansfield Historical Society (<www.mansfieldhistory.org/>) was contacted at 102 North Main Street in Mansfield for any historical information concerning recreational activities and other uses of Walnut Creek. Information concerning baptisms on the Back property and the swimming hole near the railroad bridge and North Street has been included in this report.

(5) Several publications (HPCTC 1990; Berry 1999; Mansfield Historical Society 1996) were located and reviewed in the Mansfield Public Library. Pertinent information has been included in this report.

(6) Articles on many of the parks in Mansfield were found on a local review and news web site at <www.examiner.com/recreation-in-fort-worth>. None of the articles mentioned any aquatic recreation activities related to Walnut Creek.

(7) The Handbook of Texas Online (<www.tshaonline.org>) was searched for topics related to Walnut Creek, Joe Pool Lake, and the Mansfield area. No mention was found of any aquatic recreation activities related to Walnut Creek.

(8) The Portal to Texas History (< http://texashistory.unt.edu/>) was searched for topics related to Walnut Creek, Joe Pool Lake, and the Mansfield area. No mention was found of any aquatic recreation activities related to Walnut Creek.

Although there are no specific efforts to encourage contact recreation in Walnut Creek, potential public access to the creek has been enhanced by the construction of municipal parks and recreational facilities beginning in 1984 (see Table 1). Alternatively, the opening of the Walnut Creek Country Club swimming pool in 1974, Joe Pool Lake and its associated parks beginning in 1989, and the Hawaiian Falls Waterpark in south Mansfield (<www.hfalls.com/mansfield/index.html>) in May 2008 have provided aquatic recreation alternatives to the smaller creeks in the area.

Methodology

General methodology for this project was based on the TCEQ (2009) document *Recreational Use-Attainability Analyses (RUAAs): Procedures for a Comprehensive RUAA and a Basic RUAA Survey*.

Local Notification and Contacts

Initial notification of and requests for input from other agencies and local authorities were made as follows (see Appendix A for RUAA Contact Information Form, list of initial contacts, and copies of related e-mails):

(1) An initial meeting was held on 20 April 2010 with staff from the City of Mansfield Environmental Services Department and Parks & Recreation Department. Items discussed included the current status of the bacterial impairment on Walnut Creek, changes to the TSWQS, the addition of an upstream sampling site on Walnut Creek, staff knowledge of recreational uses

along Walnut Creek, and potential survey sites for the RUAA. A site visit along the Walnut Creek Linear Park trail was made on 29 April 2010 with a staff member from the Mansfield Parks & Recreation Department.

(2) E-mail notification of and request for input on the Walnut Creek RUAA was made on 30 April 2010 to the Trinity River Authority Clean Rivers Program, the Texas State Soil and Water Conservation Board, the Texas Parks and Wildlife Department (TPWD), and the North Central Texas Council of Governments.

(3) E-mail notification of and request for input on the Walnut Creek RUAA was made on 18 and 20 May 2010 to additional suggested TPWD staff.

Site Descriptions

Eight sites were used to evaluate recreational uses and/or channel conditions within the impaired portion of Walnut Creek (Table 9; Figure 10) A ninth site located upstream from the impaired AU 0838C_01 was used for additional observations. Latitude/longitude readings were made at each location using a Garmin GPSmap 60CS global positioning receiver to an accuracy of ±4 meters. Five of the eight sites within AU 0838C_01 were used for instream surveys of channel conditions (see Table 9).

Table 9. Sites used in the Walnut Creek RUAA. Sites are listed from downstream to upstream. O = activity observations; S = instream survey; A = additional site used to characterize upstream channel.

Site Code	Site Location	Latitude	Longitude	Survey Format
Thompson	Walnut Creek at the southwest corner of the Phillip Thompson Soccer Complex	32.5845	97.08529	O/S
Matlock	Walnut Creek at Matlock Road	32.58092	97.10221	O
McKnight	Walnut Creek in James McKnight Park East	32.57658	97.11986	O/S
US287	Walnut Creek upstream from U.S. Highway 287, adjacent to the Walnut Creek Linear Park trail	32.57409	97.12513	O
Red Bluff	Walnut Creek at Red Bluff, downstream from Walnut Creek Drive and the Hardy Allmon Soccer Complex	32.56930	97.13084	O
Rose	Walnut Creek at creek overlook in northwest corner of Katherine Rose Memorial Park	32.56956	97.13686	O/S
Main	Walnut Creek at Main Street in Town Park	32.56923	97.14256	O/S
North	Walnut Creek at North Street	32.56811	97.14483	O/S
Retta	Walnut Creek at Retta Road (upstream from AU 0838C_01)	32.56335	97.17204	A

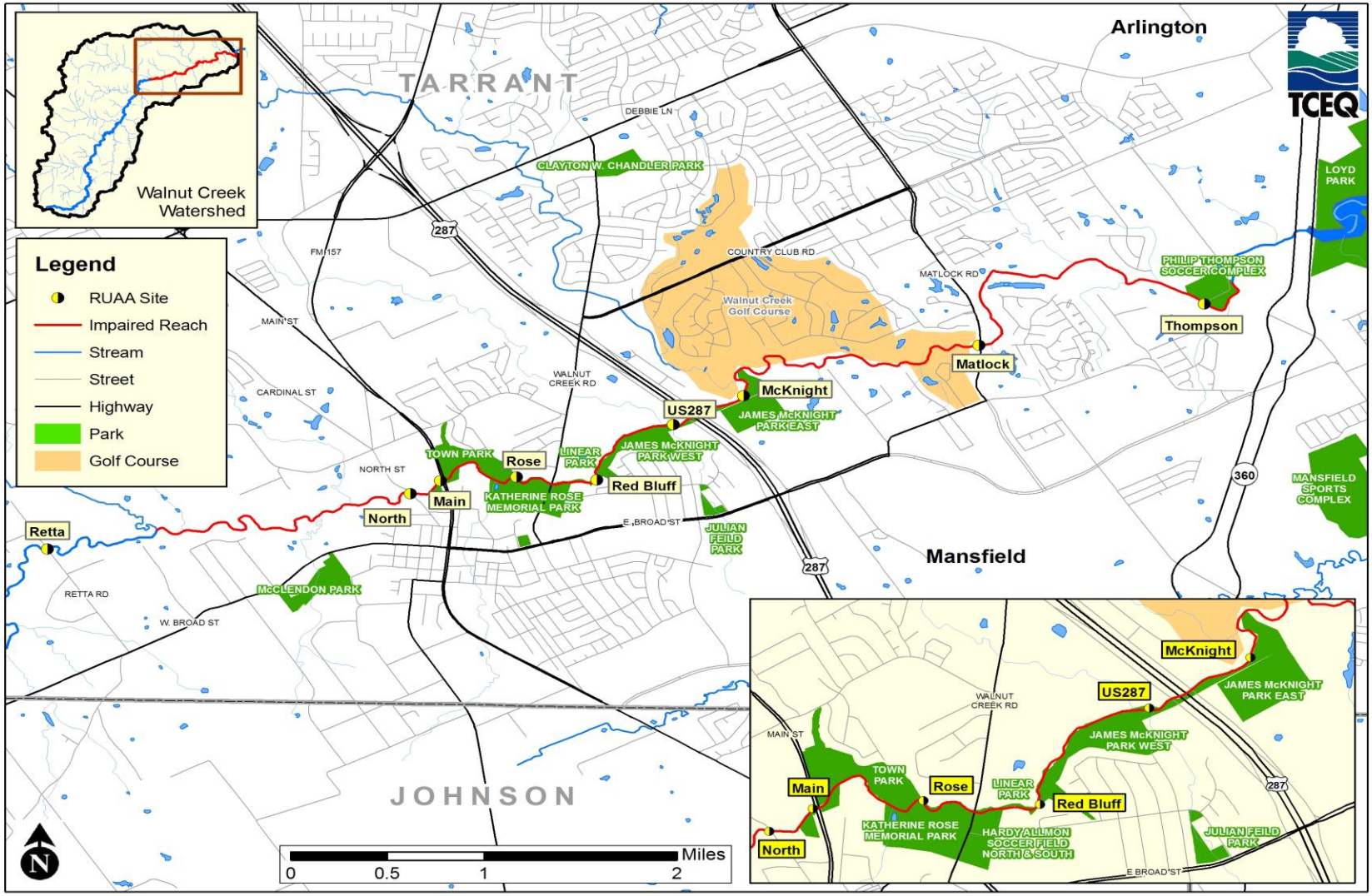

Figure 10. Location of RUAA observation and survey sites. Inset is a close-up of area between the Main and McKnight sites. Parks and recreational facilities along Walnut Creek are also indicated.

(1) Walnut Creek at the southwest corner of the Phillip Thompson Soccer Complex (**Thompson**) is located approximately 350 meters upstream from the former Holland Road bridge site. The site was chosen because of the presence of the soccer fields and some accessibility to the creek. The evaluated reach started at the southwest (upstream) corner of the soccer complex property and ran downstream toward Holland Road. The site was used both for general observation of any aquatic recreation activities and for the instream survey.

(2) Walnut Creek at Matlock Road (**Matlock**) is located at the downstream end of the Walnut Creek Country Club, and is the most downstream road crossing in AU 0838C_01. It is also the monitoring station (TCEQ No. 13621) where samples were collected that led to Walnut Creek being added to the §303(d) list. Data from the USGS flow gage at Matlock were used to evaluate historical flow conditions in Walnut Creek. The evaluated reach started approximately 50 meters upstream from Matlock Road and ran downstream from that point. The site was established initially for both general observation of any aquatic recreation activities and for part of the instream survey; however, the general inaccessibility of the stream at this location hampered the latter effort.

(3) Walnut Creek in James McKnight Park East (**McKnight**) is located downstream from US Highway 287 and north of the current eastern terminus of the Walnut Creek Linear Park. The site was chosen because of the presence of the parks and because the creek is somewhat accessible at a point relatively close to the park softball fields. The evaluated reach was centered approximately on the access point to the creek just north of the softball complex, between US Highway 287 and the confluence with Hogpen Branch. The site was used both for general observation of any aquatic recreation activities and for the instream survey.

(4) Walnut Creek upstream from U.S. Highway 287 (**US287**), adjacent to the Walnut Creek Linear Park trail, is located near the trail access point from James McKnight Park West. The location is relatively close to the McKnight site, and was used only for general observation of the creek and any recreation activities.

(5) Walnut Creek at Red Bluff (**Red Bluff**) is located downstream from Walnut Creek Drive and the Hardy Allmon Soccer Complex, immediately adjacent to the Walnut Creek Linear Park trail. The creek was observed over a reach from the northeast corner of the adjacent soccer field downstream to an overlook area known as Red Bluff. The site was chosen because of the adjacent Linear Park trail and residential areas, and to provide another observation point between James McKnight Park East and Katherine Rose Memorial Park. The site was used for general observation of recreation activities, as it is very difficult to enter the stream in this area.

(6) Walnut Creek in Katherine Rose Memorial Park (**Rose**) is located off the creek overlook at the northwest corner of the park. City staff reported that Katherine Rose is the most heavily used park in the City of Mansfield. The Linear Park trail crosses Walnut Creek approximately 50 meters upstream from the

overlook. There is a fishing pond at the west end of the park that is stocked by the Texas Parks and Wildlife Department. The pond is fed by overflow from Pond Branch and drainage from the park. The evaluated reach of Walnut Creek began approximately 50 meters downstream from the overlook and ran upstream to the confluence with Pond Branch. The site was used both for general observation of any aquatic recreation activities and for the instream survey.

(7) Walnut Creek at Main Street in Town Park (**Main**) is located just off the current western terminus of the Walnut Creek Linear Park. The site was chosen because of the presence of the park and trail, and because graffiti under the Main Street bridge indicates activity adjacent to the creek. The evaluated reach ran downstream from Main Street. The site was used both for general observation of any aquatic recreation activities and for the instream survey.

(8) Walnut Creek at North Street (**North**) is the most upstream road crossing within AU 0838C_01. A railroad bridge crosses the creek approximately 75 meters upstream from North Street. The immediate adjacent area is on Union Pacific Railroad Company property. The site was chosen because it is the most upstream accessible point in the impaired AU, graffiti under the street and railroad bridges indicate activity adjacent to the creek, and Mansfield Historical Society staff report that the stream below the railroad bridge was used as a swimming hole in the 1930s and 40s. The evaluated reach ran upstream from North Street. The site was used both for general observation of any aquatic recreation activities and for the instream survey.

(9) Walnut Creek at Retta Road (**Retta**) is located at the western edge of the Mansfield city limits. Retta is the closest road crossing upstream from North Street, but it is located upstream from the Willow Branch confluence and is therefore outside the impaired AU 0838C_01. The site was used to help characterize the stream in the area between North Street and Retta Road.

Site Survey Methods

RUAA stream surveys were conducted in two main formats:

Activity observations were made on a varying number of occasions to document the presence or absence of water-related and other recreation activities (see Table 10). Sites with greater accessibility and a larger number of people present were visited more often than less accessible sites. Weekend and holiday observations focused most heavily on Katherine Rose Park, Town Park, James McKnight Park East, and the connecting portions of the Walnut Creek Linear Park. All observations were made in warm weather between 29 April and 21 September 2010, except for an 18 March observation at Katherine Rose Park during Spring Break. Baseflow conditions – defined as sustained or typical dry, warm-weather flows between rainfall events, excluding unusual antecedent conditions of drought or wet weather – were present on all dates except the 18 March 2010 observation at the Rose site when flow was elevated after a period of wet weather.

Instream surveys were conducted at selected locations on 15-17 July and on 21 September 2010 during baseflow conditions (Table 10). Overnight rains prevented continuation of the second instream survey effort on 22 September. The presence or absence of water-related recreation activities was also noted during the instream surveys. At wadeable sites, stream depth and width, the presence of substantial pools, and bank and substrate conditions were determined over a 300-meter reach, or as close to 300 meters as possible if the entire distance was not wadeable:

(1) Thalweg depth was measured every 30 meters to determine the average depth at the thalweg over the entire reach.

(2) Stream widths were recorded as (a) the width at a point that represented the typical average width of the reach; (b) the width at the narrowest point within the reach; and (c) the width at the widest point within the reach.

(3) The number of substantial pools was counted in each reach, and the length, maximum width, and maximum depth measured for each pool. Substantial pools were defined as being one meter or more in depth and ten meters or more in length (TCEQ 2009).

(3) Photographs were taken facing upstream, downstream, left bank, and right bank at 30 meters, 150 meters, and 300 meters along each reach as conditions allowed to document stream accessibility and bank conditions. Additional photos were taken as warranted to further document stream conditions and recreational activities.

At non-accessible and/or non-wadeable sites, stream width was approximated to obtain a width typical of the 300 meter reach. Photographs typical of these sites were taken as access allowed.

Air temperature and precipitation data for the RUAA observation and survey dates were obtained for the Arlington Municipal Airport weather station, located approximately 6.5 miles from the center of the RUAA project area, from the National Weather Service (NWS) Weather Forecast Office at <www.srh.noaa.gov/fwd/?n=ntexclima#coop>. The number of days since the last significant precipitation (defined as ≥0.10 inch) for each date was determined based on NWS precipitation data and the streamflow response at USGS gage 08049700 at Matlock Road. Palmer Drought Severity Index maps were obtained from the NWS Climate Prediction Center at <www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml>.

Streamflow measurements at sites other than Matlock Road were made using a Son Tek FlowTracker Doppler flow meter according to the methods described in TCEQ (2008). Stream temperatures on 15-17 June and 21 September were measured using a glass field thermometer with armor casing that had been verified against a National Bureau of Standards-calibrated thermometer in the

TCEQ Region 4 Office. The 15 September stream temperature measurements were made during routine surface water quality monitoring events using a Hydrolab Surveyor 4a MiniSonde multiprobe instrument maintained and calibrated in the TCEQ Region 4 Office as per TCEQ (2008). All survey photographs were taken with an Olympus Stylus Tough-6020 digital camera.

Table 10. RUAA activity observation and instream survey dates.

Site Code	Total No. Dates at Site	Observation/Survey Dates	Activity Observation	Instream Survey
Thompson	7	29 April 2010 (Thursday)	X	
		16 June 2010 (Wednesday)		X
		14 July 2010 (Thursday evening)	X	
		14 August 2010 (Saturday)	X	
		4-6 September 2010 (Labor Day weekend)	XX	
		21 September 2010 (Tuesday)		X
Matlock	6	29 April 2010 (Thursday)	X	
		15 June 2010 (Tuesday)	X	
		14 August 2010 (Saturday)	X	
		4-6 September 2010 (Labor Day weekend)	X	
		15 September 2010 (Wed - SWQM event)	X	
		21 September 2010 (Tuesday)	X	
McKnight	8	29-30 May 2010 (Memorial Day weekend)*	XX	
		15-16 June 2010 (Tuesday - Wednesday)		X
		14 July 2010 (Thursday evening)	X	
		14 August 2010 (Saturday)*	X	
		4-6 September 2010 (Labor Day weekend)*	XX	
		21 September 2010 (Tuesday)		X
US287	2	29 April 2010 (Thursday)*	X	
		14 August 2010 (Saturday)*	X	
Red Bluff	9	29 April 2010 (Thursday)*	X	
		29-31 May 2010 (Memorial Day weekend)*	XXX	
		3 June 2010 (Thursday – last week of school)*	X	
		14 July 2010 (Thursday evening)*	X	
		14 August 2010 (Saturday)*	X	
		4-6 September 2010 (Labor Day weekend)*	XX	
Rose	11	18 March 2010 (Thursday – Spring Break)*	X	
		29 April 2010 (Thursday)*	X	
		29-31 May 2010 (Memorial Day weekend)*	XXX	
		3 June 2010 (Thursday – last week of school)*	X	
		17 June 2010 (Thursday)		X
		14 July 2010 (Thursday evening)	X	
		14 August 2010 (Saturday)*	X	
		4-6 September 2010 (Labor Day weekend)*	XX	
Main	8	29 April 2010 (Thursday)*	X	
		29-30 May 2010 (Memorial Day weekend)*	XX	
		3 June 2010 (Thursday – last week of school)*	X	
		17 June 2010 (Thursday)		X
		14 August 2010 (Saturday)*	X	
		4-6 September 2010 (Labor Day weekend)*	XX	
North	4	15 June 2010 (Tuesday)	X	
		16 June 2010 (Wednesday)		X
		4-6 September 2010 (Labor Day weekend)	XX	
Retta	2	15 June 2010 (Tuesday)	X	
		15 September 2010 (Wed - SWQM event)	X	

*Observations also made along adjacent portions of the Walnut Creek Linear Park.

Results and Discussion

A summary of RUAA observation and instream survey dates is shown in Table 10. A greater number of observations were made in parks than at the other sites due to the greater amount of activity at those locations. Observation dates included the Memorial Day and Labor Day holiday weekends, a non-holiday weekend (14 August), and a Thursday (3 June) during the last week of school when class picnics were held in Katherine Rose Park. An evening observation (14 July) was made at the Thompson, McKnight, Red Bluff, and Rose sites in an effort to be present during organized sporting events such as softball or soccer games. Instream surveys were conducted during the weekday.

All observations and instream surveys were conducted in warm weather except for a Spring Break observation in Katherine Rose Park on 18 March. Average air temperatures on the summer survey dates (29 April through 21 September) ranged from 72 to 92 ^{o}F, and daily maximum temperatures ranged from 83 to 102 ^{o}F (Table 11). The 18 March date occurred during cooler weather (overnight low of 36 ^{o}F), although the daily maximum reached 65 ^{o}F and the park was crowded. Complete NWS air temperature data are attached in Appendix C.

June and September instream survey dates were hot and humid, with temperatures increasing throughout the day to a maximum of 95 to 97 ^{o}F in June and 87 ^{o}F in September. Stream temperatures measured in June and September were 24.5 to 26.3 ^{o}C (Table 11).

Observations and surveys were conducted during typically drier periods, with the exception of those on 18 March and 29 April that occurred during a wetter time of the year, with only two and five days, respectively, since the last significant precipitation (Table 12). For purposes of this discussion, significant precipitation has been defined as ≥0.10 inch. Palmer Drought Severity Index values for the time periods encompassing 18 March and 29 April were Extremely Moist and Very Moist, respectively (Table 12).

The 21 September survey date also fell during a wetter period (Palmer Drought Severity Index = Unusual Moist Spell), although there had been no significant precipitation for seven days. The 15 September date occurred the day after a rain, but this date was used only for channel observations at the Matlock and Retta sites during the collection of routine surface water quality samples unrelated to the RUAA.

For the remaining observation and survey dates (29 May through 6 September), Palmer Drought Severity Index values were Near Normal, and the number of days since the last significant precipitation ranged from 5 to 31 (Table 12). Except for 18 March and 15 September, streamflow did not appear to be influenced by recent precipitation and runoff. Precipitation data and Palmer Drought Severity Index maps are attached in Appendix C.

Table 11. Summary of air and water temperatures on Walnut Creek RUAA observation and instream survey dates.

Survey Date	Air Temperature[a]						Site	Stream Temperature[b]	
	°F			°C					
	Min	Max	Avg	Min	Max	Avg		°F	°C
18 March	36	65	51	2.2	18	11			
29 April	61	83	72	16	28	22			
29 May	70	94	82	21	34	28			
30 May	72	95	84	22	35	29			
31 May	69	93	81	21	34	27			
3 June	67	89	78	19	32	26			
15 June	70	95	83	21	35	28	McKnight	78.8	26.0
16 June	77	96	87	25	36	31	North	78.8	26.0
17 June	76	97	87	24	36	31	Rose	78.8	26.0
							Main	78.8	26.0
14 July	79	97	88	26	36	31			
14 August	81	102	92	27	39	33			
4 September	62	89	76	17	32	24			
6 September	67	94	81	19	34	27			
15 September	70	92	81	21	33	27	Matlock	79.3	26.3
							Retta	79.3	26.3
21 September	68	87	78	20	31	26	McKnight	76.1	24.5

[a] Air temperature data (°F) obtained for the Arlington Municipal Airport weather station from <www.srh.noaa.gov/fwd/?n=ntexclima#coop>, and converted to °C.
[b] Stream temperatures measured (°C) during instream surveys and 15 September SWQM events and converted to °F.

Table 12. Summary of precipitation, Palmer Drought Severity, and streamflow during RUAA surveys.

Survey Date (2010)	No. Days Since Last Significant Precipitation[a]	Total Precipitation in Preceding 30 Days (inches)[a]	Palmer Drought Severity Index[b]	Streamflow at Matlock Road (cfs)[c,d]		Site	Streamflow (cfs)[c]
				Minimum	Maximum		
18 March	2	1.93	Extremely Moist	18	29		
29 April	5	2.40	Very Moist	6.9	7.6		
29 May	12	2.52	Near Normal	2.3	2.5		
30 May	13	2.52	Near Normal	2.5	3.3		
31 May	14	2.52	Near Normal	3.3	3.5		
3 June	17	2.43	Near Normal	3.5	4.0		
15 June	29	1.46	Near Normal	3.1	3.3	Retta	0.0
16 June	30	1.46	Near Normal	3.1	3.3	McKnight North	0.3[e] 0.0
17 June	31	1.46	Near Normal	3.1	3.3	Rose	0.05[e]
14 July	5	5.81	Near Normal	1.1	1.5		
14 August	8	1.47	Near Normal	0.6	0.8	McKnight	<0.01[f]
4 September	17	1.62	Near Normal	0.08	0.7		
6 September	19	1.62	Near Normal	0.2	0.3	Rose	<0.1[f]
15 September[g]	<1	8.01	Near Normal	1.5	400[g]	Retta	8.8[f]
21 September	7	7.36[h]	Unusual Moist Spell[i]	0.0	0.2	McKnight	2.4[e]

[a] Significant precipitation defined as ≥0.10 inch (as measured by the NWS Arlington Municipal Airport weather station).

[b] Index is for a seven-day period that includes the survey date.

[c] cfs = cubic feet per second.

[d] Flow measured by USGS gage 08049700 at Matlock Road.

[e] Flow measured using a Son Tek FlowTracker Doppler flow meter.

[f] Flow was estimated.

[g] Overnight rain was 0.35 inch. Seventy-nine percent of 30-day total occurred on 7-8 September (5.06 and 1.26 inches, respectively). Maximum flow on 15 September occurred at midnight.

[h] Eighty-six percent of 30-day total occurred on 7-8 September (5.06 and 1.26 inches, respectively).

[i] Preceding three weeks were Near Normal.

Walnut Creek in AU 0838C_01 is largely a series of runs with few riffles and a number of deep pools that were impassable even in June. Many of the runs also contain unexpectedly deeper areas. These deeper areas can pose a risk to anyone attempting to wade in the creek. Only one site (McKnight) was wadeable over a full 300 meters in mid-June (Table 13). Two sites (Rose and North) were wadeable for more than 200 meters. The Main site was wadeable for only 90 meters, a stretch bracketed by deep pools on each end. The Thompson site was not wadeable at all. Matlock and Red Bluff may have been wadeable over at least some part of the area, but access to the channel is very difficult in those locations. Areas that could not be waded were generally observable from the banks.

Table 13. Summary of measurements made in 300-meter reach sites during instream surveys conducted for Walnut Creek RUAA on 15-17 June and a second effort at the McKnight site on 21 September 2010. Sites are listed from downstream to upstream. n/a = not applicable.

Site	Length of Wadeable Reach (meters)	Average Thalweg Depth (meters)	Substantial Pools[b]			Stream Width (meters)		
			No.	Length (meters)	Depth (meters)	Avg	Min	Max
Thompson	0	>1.5	n/a	n/a	n/a	10	10	10
McKnight (16 June)	300	0.4	1	18	1.0	4.0	1.5	8.6
McKnight (21 Sept)	300	0.5	2	10 / 20	1.3 / 1.7	4.6	1.8	10
Rose	225	0.8[a]	2	25 / >30	1.0 / >1.5	5.0	4.5	10
Main	90	>2.0	2	>10	>2.0	6.5	5	8
North	270	1.1[a]	2	18 – 45	1.1 / >2.0	5.0	4.0	6.3
Average of all Sites		0.75[a]						

[a] Measurements of >2.0 meters were treated as 2.0 meters for purposes of calculating the average depth. The true average is likely deeper than that shown.

[b] Pools ≥1.0 meter in depth and ≥10 meters in length. Length and depth values are ranges.

The Thompson site may have been wadeable for a short distance on 21 September, but increased bank erosion had eliminated even the previous difficult access point at the site. Matlock also appeared wadeable for a short distance in September, but no access point is available at that location. McKnight was again wadeable for a full 300 meters, and despite having a greater flow, had a similar width and thalweg depth to those measured in June. Overnight rains prevented a second survey at the remaining sites (Rose, Main, and North); however, based on the experience with McKnight, it appears unlikely that those locations would have differed appreciably from what was observed in June.

Average thalweg depths ranged from 0.4 to >2.0 meters (Table 13), and were influenced by the deeper glides and pools along each reach. The overall average thalweg depth was 0.75 meter. Thalweg measurements at the Rose, Main, and North sites included points that were >2.0 meters in depth and could not be measured accurately. For purposes of calculating the overall average thalweg depth and the average site depths, these points were treated as 2.0 meters for the Rose and North sites, and therefore the true average thalweg depth was probably underestimated by an unknown amount. Because the wadeable portion of the Main reach was so short (90 meters), the average thalweg depth over that reach was considered to be >2.0 meters.

Stream widths were relatively uniform (4 to 10 meters) within each reach and along the length of the stream in general. Substantial pools were present in all four wadeable reaches, ranging in length from 10 to 45 meters and in depth from 1.0 to greater than 2.0 meters (Table 13). Shallower pools 0.5 to 1.0 meter deep, but 10 meters or more in length, were also encountered, as were pools less than 10 meters long but 1.0 meter or more deep.

Additional details regarding each RUAA site are provided below and in Tables 14 through 18. Photographs of the stream channel and recreational activities at each site are attached to this report as Appendix B, which is organized by RUAA site. Figure B-1 in Appendix B indicates the locations of the RUAA sites. Table B-1 in Appendix B is a reference table for the photographs. References to photographs in this discussion are by site name and photograph number (*e.g.* McKnight-6 refers to photograph number 6 taken at the McKnight RUAA site). Note that there are considerably more photographs in Appendix B than are specifically cited in the text. Organization of Appendix B by RUAA site, moving from downstream to upstream, allows viewing of each location along the length of the RUAA study area.

(1) Walnut Creek adjacent to the Phillip Thompson Soccer Complex (**Thompson**) was visited on seven dates. A subdivision off Holland Road is adjacent to the north side of complex (Thompson-17, -18), and a newer subdivision off Collins Street is immediately northeast of the site. There is also a residential area on the south side of Walnut Creek, opposite the soccer complex. A jogger was observed in the complex on one date, and soccer games were in progress on 4 September (Labor Day weekend) (Thompson-19, -20), but the site was deserted on other dates. Although the complex was crowded on 4 September, all activity was centered on the soccer fields. There was some evidence of past streamside activity in the form of a few beer cans and bottles at the southeast corner of the complex (Thompson-23). Evidence of relatively recent human defecation was noted on the stream bank at this point on 16 June (Thompson-24). This may have been a soccer player with no alternative as there are no restrooms at the facility. No evidence of water-related recreation was observed. Stream banks in the area are very steep and eroded, and access to the edge of the creek is difficult (Thompson-1 through -14 and -21 through -24). The creek was

not wadeable at this site in June, and erosion of the banks by subsequent high flows made the site inaccessible during a second survey attempt on 21 September.

(2) Walnut Creek at Matlock Road (**Matlock**) was visited on five dates. There was no evidence of water-related recreation or any other activity along the banks in this area. Stream banks are steep and eroded, and access is very difficult (Matlock-1 through -8, -13, -16 through -22). The stream banks under Matlock Road are rip-rap, some of which has eroded into the channel (Matlock-3, -4, -6, -10, -11). Caution tape had been placed at the northeast corner of the southbound bridge due to unstable banks (Matlock-12). The only recreational activities observed near this site were golfing at the adjacent Walnut Creek Country Club and jogging and bicycling on the sidewalks along Matlock Road. Golfers were observed on every date, but there was no activity along or in the creek. A portion of the reach may have been wadeable on 21 September, but the creek was not accessible. The area between the Matlock site and James McKnight Park East (McKnight) is surrounded largely by residential housing and the private Walnut Creek Country Club (Matlock-7, -10).

(3) Walnut Creek in James McKnight Park East (**McKnight**) was visited on eight dates. The creek is accessible at a point north of the outfield of the northwest softball field (McKnight-39 through -42), but access is difficult in other locations along this reach. Stream banks are generally very steep with exposed tree roots (McKnight-1 through -16). Tree roots and slippery banks present some risk of tripping and falling. An old rope swing was observed just upstream from the 150-meter point in the reach and upstream from the creek access point (McKnight-10 through -12). This suggests past use of this site for recreation. No evidence of recent use was observed. Short footpaths from the Linear Park trail to the edge of the stream bank were observed, but the banks are steep and the paths appear to be used as stream overlooks (McKnight-35, -36). The park was crowded during softball games on 14 July (evening) and 14 August (Saturday) (Matlock-40, -44); however, almost everyone present was watching the games and no one was near the creek. The softball fields and bleachers are centered on a concession area away from the creek. Except for some movement along the Linear Park trail, McKnight Park was largely deserted on the other dates.

Hogpen Branch flows through the west side of the Walnut Creek Country Club and enters Walnut Creek approximately 50 meters downstream from the end of the evaluated reach (McKnight-32 through -34). A deep, impassable pool is present at the confluence. A large log and debris jam was present between the end of the reach and the confluence on 15 June, but not on 21 September (McKnight-27, -28).

(4) The **US287** site near James McKnight Park West (US287-1, -2) was visited on two dates, but was not used as a regular survey site for the RUAA. This location is somewhat remote from McKnight Parks East and West, and people are likely passing by on the Linear Park trail with no intent to enter the creek. The portion of the Linear Park Trail under U.S. 287 between McKnight Parks East and West

was blocked during the summer and fall of 2010 due to construction on the highway frontage roads (McKnight-38). A small power line corridor runs parallel and nearly adjacent to the entrance trail from McKnight Park West (US287-3). Short footpaths from the Linear Park trail to the edge of the stream bank were observed, but the banks are steep (US287-5, -6, -9 through -11) and the paths appear to be used as stream overlooks or as a path to utility line crossings. A location immediately upstream from U.S. 287 adjacent to a utility line crossing is somewhat accessible (US287-7, -8), but there was no evidence of any activity in the creek at this spot. A commercial nursery is located on the north side of the creek adjacent to the west side of U.S. Highway 287.

(5) Walnut Creek downstream from Walnut Creek Drive (**Red Bluff**) was visited on nine dates. The stream banks through this area are steep, and there is a very high drop-off in the immediate vicinity of the Red Bluff overlook (Red Bluff-1 through -4). Most people in this area are passing by on the Linear Park trail or using the Hardy Allmon soccer fields with no intent to enter the creek. A residential area lies east of the soccer complex and immediately adjacent to the Linear Park trail (Red Bluff-5).

(6) Walnut Creek in Katherine Rose Memorial Park (**Rose**) was visited on 11 dates, the most of any location. City staff report that Katherine Rose is most heavily used park in Mansfield. School and day-care buses were observed at the site during the week. The playground, picnic pavilions, and basketball and volleyball courts were frequently in use (Rose-3, -4, -49, -50, -55, -56, -59, -60); however, none of these are located close to the creek. The park trails were heavily used for walking, jogging, bicycling, etc.

People were observed fishing in the pond at the west end of the park on most dates (Rose-1, -2, -23, -24, -57). No evidence of fishing was observed along Walnut Creek. The pond is stocked by the Texas Parks and Wildlife Department, probably making it more inviting than the creek. On Memorial Day weekend, children were observed dipping water in the drainage ditch leading to the fishing pond in an effort to catch tadpoles or invertebrates (Rose-47, -48). There was no evidence of anyone entering the drainage or the pond.

A footpath leads around the west (back) and north sides of the fishing pond, and along Pond Branch to its confluence with Walnut Creek (Rose-25 through -28). A deep pool, impassable on 17 June, is located in Walnut Creek at this point and marked the end of the wadeable reach used in this area. A large utility line crosses Walnut Creek immediately upstream from the Pond Branch confluence (Rose-43, -44). Graffiti was observed on this line near the right bank (Rose-27, -28). Access to that point could have been made either by crossing Pond Branch from the footpath or by coming through the pasture on private property on the south side of Walnut Creek.

Walnut Creek is accessible under Walnut Creek Drive (Rose-15 through-18) at the northeast corner of the park. A small boy was observed throwing rocks into the

creek at this point on one occasion, but no other activity was noted except people passing on the Linear Park trail that runs under the bridge. The creek is very deep on the upstream side of bridge, and it was not possible to wade upstream from that point on 17 June. The area between Walnut Creek Drive and the overlook has steep banks on both sides. The opposite (left) bank is bordered by private property and a barb-wire fence. Trash accumulates under Walnut Creek Drive and there is a utility line crossing on the downstream side of the bridge (Rose-7, -8, -14, -19, -20).

The most accessible location and one of the most frequently visited points along AU 0838C_01 is the creek overlook near the northwest corner of the park (Rose-5). Three teenage (approximate age 13) girls were observed sitting barefoot next to the creek on the rocks at the overlook during the Spring Break visit when the water level was relatively high. It is easier to sit on rocks at water's edge at high flow. Lower flows expose mud/soil banks in between the overlook rocks and the water (Rose-20, -37). A substantial number of people stop at the overlook, and kids were observed along the creek throwing rocks and looking for fish. Footprints and dog tracks were along the creek bank at the overlook on several occasions (Rose-6, -33, -58). No one was observed entering the creek, although footprints along the opposite shore (left bank) suggest that someone crosses in that area on occasion. Several people were contacted at this location on the various survey dates. No one reported engaging in or observing any contact recreation at this site.

There is a relatively deep area just off overlook, which may inhibit any routine wading. Trash was also observed in the creek at this point (Rose-34). The Walnut Creek Linear Park trail crosses Walnut Creek approximately 50 meters upstream from the overlook, but access to the creek from the crossing is difficult. Short footpaths from the Linear Park trail to the edge of the stream bank were observed between Rose and Town Parks, but the banks are steep and the paths appear to be used as stream overlooks (Rose-13).

(7) Walnut Creek at Main Street in Town Park (**Main**) was visited on eight dates. The creek parallel to the Linear Park trail between Katherine Rose and Town Parks is inaccessible due to steep banks along both sides (Main-3 through -6). A horse pasture and fence borders the right bank over much of this distance (Main-37 and Rose-26). There are a number of footpaths from the trail to the edge of the creek, but the banks are too steep for access and there was no evidence that anyone had attempted to enter the creek. The footpaths appear to function as creek overlook points (Main-1, -2).

The only accessible point in this area is under Main Street, which can be reached by crossing a field at the western end of the Walnut Creek Linear Park trail (Main-15). Footprints, bicycle tracks, and graffiti under the Main Street bridge indicate activity adjacent to the creek (Main-16 through -19), although no one was encountered there during any of the RUAA visits. Access to this location is possible without entering the water, although graffiti on both sides of the stream

suggest crossing may occur via bicycle, stepping across on tires and rocks, or jumping across. Walnut Creek is relatively shallow and narrow under the bridge during base flow (Main-20). Movement along the channel is difficult due to the presence of deep, impassable pools approximately 30 meters upstream and 90 meters downstream from Main Street (Main-25, -28).

(8) Walnut Creek upstream from North Street (**North**) was visited on four dates. This reach of Walnut Creek is bordered by private property, and contains steep banks and several deep holes (Main-5 through -8, -11 through -18). A railroad bridge crosses the creek approximately 75 meters upstream from North Street (North-3, -9). It is possible to park in an area between North Street and the railroad bridge and enter the creek; however, the area is on Union Pacific Railroad property and "No Trespassing" signs are present (North-3, -4). Graffiti under the street and railroad bridges indicate activity adjacent to the creek (North-2, -10), but both locations are accessible without entering the water and there was no evidence of any contact recreation. There was a substantial amount of trash, including a large number of tires, in this reach of Walnut Creek (Main-16 through -20). Mansfield Historical Society staff report that the area near the railroad bridge was used as a swimming hole in the 1930s and 40s. There is a deep (>2 meters) pool just downstream from the railroad bridge, but there was no evidence of any recent swimming or other aquatic recreation activities. The substrate in the vicinity of this pool is deep mud that emits a hydrogen sulfide odor when disturbed.

(9) Walnut Creek at Retta Road (**Retta**) was visited on two dates to obtain some perspective on the area upstream from the North Street site. The site lies outside AU 0838C_01. Steep, eroded banks were evident at the site. The site is surrounded by private property, and no evidence of any recreational activity was observed. Trash is dumped into the creek from the bridge on what appears to be a somewhat regular basis. The creek does not appear to flow in this location except in wet weather.

Details regarding activities and observations at each RUAA site are summarized in Tables 14 through 18. Access to Walnut Creek was relatively difficult in most locations due to steep and eroding banks (Table 14). Nearly vertical banks were observed in a number of locations. The increased flows that have followed urbanization may be contributing to additional erosion in some locations. The Thompson, Matlock, and Red Bluff sites are not accessible without a great amount of effort. Exit from the creek at any of these sites would prove even more difficult than entry. Areas of the creek parallel to the Linear Park trail generally have steep banks (McKnight-35, -36; US287-10, -11; Red Bluff-7; Rose-38; Main-3, -4, -23, -24).

Evidence of primary contact recreation (Table 15) was observed only at the McKnight site where an old rope swing was hanging over the creek just upstream from the access point to the creek. There was no evidence of recent use of the swing or of any other recent recreational activity at the McKnight site. No

evidence of primary contact recreation was observed in any other location within AU 0838C_01.

Observations and evidence of secondary contact recreation were documented at several sites, particularly at the parks and along the Linear Park trail (Table 16), although the activities were not always associated with Walnut Creek itself. The presence of the parks and the connecting Linear Park trail often places people in relatively close proximity to Walnut Creek (Table 17). Fishing was frequently observed in the stocked fishing pond in Katherine Rose Park, but no evidence of fishing was found in any other location along AU 0838C_01. Children were observed playing alongside the drainage ditch leading to the fishing pond, and along the stream bank at the overlook, but no one was observed entering the water. The footpath behind the fishing pond leads to the confluence of Pond Branch and Walnut Creek, where graffiti was observed on a utility pipe.

Table 18 provides a summary of all additional observations at the survey sites. The presence of parks and recreational sites with numerous amenities (see Table 2) results in a substantial amount of human presence. The most commonly observed activities were walking (with or without dogs), jogging, bicycling, and skateboarding. Most of this occurs in Town Park, Katherine Rose Park, McKnight Park East, and along the connecting Walnut Creek Linear Park (Table 18). Conditions that promote recreation are largely tied to the presence of public parks and an urban/suburban area with a large population.

The most common channel obstructions in Walnut Creek are aerial utility line crossings and log/debris jams (Thompson-15; Matlock-17, -19, -20; McKnight-14, -27, -30, -33; US287-8; Rose-18, -43, -44; North-15). The major impediment to aquatic recreation is the presence of steep, often eroding, banks. Other undesirable conditions include the presence of scum on the water surface in areas with minimal flow and the presence of trash along portions of the creek (Thompson-12; McKnight-4, -29 through -31; Red Bluff-7; Rose-17, -34, -39). Typical urban trash (plastic bags and bottles, etc.) was noted in many locations, sometimes accumulating behind log jams or brush in the channel as observed at the Thompson and McKnight sites. A substantial number of tires were also observed at some locations (North, Main, and McKnight).

Table 14. Summary of substrate, bank access, and riparian zone characteristics.

Site	Dominant Substrate	Bank Access		Riparian Zone	
		Left	Right	Left Bank	Right Bank
Thompson	[a]	Difficult	Difficult	Narrow forested buffer area and adjacent soccer fields and subdivision	Narrow forested buffer area and adjacent residential subdivision
Matlock	[a]	Difficult	Difficult	Upstream from Matlock Road: Very narrow forest buffer (no buffer in some areas) with adjacent golf course and residential area Downstream from Matlock Road: Forest, flood storage, and pasture	Upstream from Matlock Road: Very narrow forest buffer with adjacent golf course and residential area; forested area becomes thicker farther upstream Downstream from Matlock Road: Narrow forest buffer with adjacent subdivision
McKnight	Sand/gravel	Difficult	Moderately difficult[b]	Forest buffer and golf course	Forest that includes Walnut Creek Linear Park; residential areas downstream from McKnight Park East
US287	[a]	Difficult	Moderately difficult[b]	Narrow forest buffer and adjacent commercial area along US 287	Forest that includes Walnut Creek Linear Park and adjacent residential areas
Red Bluff	[a]	Difficult	Difficult	Very narrow forest buffer and pasture	Narrow forest buffer that includes Walnut Creek Linear Park, with adjacent residential/commercial area
Rose	Silt/gravel	Difficult	Easy[b]	Narrow forest buffer and adjacent residential area opposite Rose Park; Walnut Creek Linear Park upstream from Rose Park	Narrow forest buffer within Katherine Rose Park; narrow forest and pasture upstream from Katherine Rose Park
Main	Mud/clay	Moderately difficult[b]	Difficult	Forested portions of Town Park and Walnut Creek Linear Park; some adjacent residential area	Narrow forest and pasture downstream from Main Street; narrow forest and commercial development at Main Street
North	Mud/clay	Difficult	Moderately difficult[b]	Forest and pasture	Forest and pasture; Denuded bank between North Street and railroad tracks
Retta	Mud/clay	Difficult	Difficult	Forest and pasture	Forest and pasture

[a] Location too deep or inaccessible to determine substrate.

[b] Refers to point of easiest entry used for RUAA access. Bank access at most other locations within the area is Difficult.

Table 15. Summary of primary contact water recreation (Section B – Field Data Sheets (TCEQ 2009)).
E = *evidence* of activity observed during RUAA; N = *no* evidence of activity found during RUAA.

	RUAA Survey Site								
	Retta	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
No. Dates Site Observed	2	4	8	11	9	2	8	6	7
Public Access to the Site?	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
No. Individuals Observed at Site	0	0	15-40[a]	20-200[a]	0-15[a]	5-10[a]	0-200[a]	0[b]	0-200
Primary Contact Recreation Observed?	No	No	No	No	No	No	No	No	No
Swimming	N	N	N	N	N	N	E[c]	N	N
Wading – Children	N	N	N	N	N	N	N	N	N
Wading – Adults	N	N	N	N	N	N	N	N	N
Water Skiing	N	N	N	N	N	N	N	N	N
Diving/ Snorkeling	N	N	N	N	N	N	N	N	N
Tubing	N	N	N	N	N	N	N	N	N
Surfing	N	N	N	N	N	N	N	N	N
Whitewater kayaking/canoeing/rafting	N	N	N	N	N	N	N	N	N
Other	N	N	N	N	N	N	N	N	N
Public or Commercial Swimming Facility at the site?	No	No	No	No	No	No	No	No[d]	No
Primary contact recreation within 5 miles of the site?	No	No	No	No	No	No	No	Yes[e]	Yes[e,f]

[a] Numbers difficult to determine accurately due to movement along Linear Park trail.

[b] Golfers at adjacent country club and several joggers and bicyclists on sidewalk along Matlock Road, but no one observed near the stream.

[c] Rope swing [d] A large swimming pool is located at the Walnut Creek Country Club, but it has no connection with the creek.

[e] Rope swing at SH 360 at upper end of Joe Pool Lake.

[f] Swimming beach in Loyd Park on Joe Pool Lake (park operated by City of Grand Prairie under a lease from the U.S. Army Corps of Engineers).

Table 16. Summary of secondary contact water recreation (Section C – Field Data Sheets (TCEQ 2009)).
E = *evidence* of activity observed during RUAA; N = *no* evidence of activity found during RUAA; Unk = unknown

	RUAA Survey Site								
	Retta	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
No. Dates Site Observed	2	4	8	11	9	2	8	6	7
Public Access to the Site?	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
No. Individuals Observed at Site	0	0	15-40[a]	20-200[a]	0-15[a]	5-10[a]	0-200[a]	0[b]	0-200
Secondary Contact Recreation Observed?	No	No	No	Yes	No	No	No	No	No
Fishing	N	N	N	N[c]	N	N	N	N	N
Boating (commercial or recreational)	N	N	N	N	N	N	N	N	N
Non-whitewater kayaking/canoeing/rafting	N	N	N	N	N	N	N	N	N
Other evidence of secondary activity	N	E[d]	E[e]	E[f]	N	N	N	N	N
Frequency of Secondary Contact Recreation	never	unk	unk	daily	never	unk	unk	never	unk

[a] Numbers difficult to determine accurately due to movement along Linear Park trail.

[b] Golfers at adjacent country club and several joggers and bicyclists on sidewalk along Matlock, but no one near the stream.

[c] Fishing observed in stocked fishing pond at west end of park, but not in Walnut Creek.

[d] Graffiti under railroad bridge, although access to location is possible without entering creek.

[e] Graffiti under Main Street bridge and footprints/bicycle tracks along stream bank. Access to location is possible without entering stream, although graffiti on both sides of stream suggest crossing may occur via bicycle, stepping across on tires and rocks, or jumping across. Stream is relatively shallow and narrow at this location during base flow.

[f] Human footprints and children observed along stream bank near overlook; children observed dipping water in fishing pond drainage ditch in effort to catch tadpoles or invertebrates; path through woods behind fishing pond leads to confluence of Pond Branch and Walnut Creek where graffiti was observed on a utility pipe that crosses Walnut Creek on upstream side of the confluence.

Table 17. Summary of the proximity of individuals to Walnut Creek as observed during the RUAA (Sections B and C – Field Data Sheets (TCEQ 2009)). O = *observed* during RUAA; E = *evidence* observed during RUAA; N = *no* evidence found during RUAA.

Proximity of Individuals to Stream	RUAA Survey Site								
	Retta	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
No. Dates Site Observed	2	4	8	11	9	2	8	6	7
No. Individuals Observed at Site	0	0	15-40[a]	20-200[a]	0-15[a]	5-10[a]	0-200[a]	0[b]	0-200[c]
Water in mouth or nose	N	N	N	N	N	N	N	N	N
Body or portion immersed in water	N	N	N	N	N	N	N	N	N
Fishing, pets, and related contact with water	N	N	N	O/E[d]	N	N	N	N	N
Individual in boat touching water	N	N	N	N	N	N	N	N	N
On shore within 8 meters of water	N	N	N	O[d]	N	N	N	N	E[e]
Individual within 8-30 meters of water	N	N	O[f]	O[f]	O[f]	O[f]	O[f]	O[g]	N

[a] Numbers difficult to determine accurately due to movement along Linear Park trail. Higher numbers at McKnight are during softball games.

[b] Golfers at adjacent country club and several joggers and bicyclists on sidewalk along Matlock, but no one near the stream.

[c] Higher number an approximation of number present during Labor Day weekend soccer game.

[d] Fishing at stocked pond in park; footprints and dog tracks along stream bank near overlook at northwest corner of park.

[e] Beer cans/bottles and human waste on creek bank.

[f] In parks and along Linear Park trail.

[g] Golfers on adjacent golf course.

Table 18. Summary of additional observations made during RUAA surveys (Section F – Field Data Sheets (TCEQ 2009)).

	RUAA Site								
	Retta	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
No. Dates Site Observed	2	4	8	11	9	2	8	6	7
Activities									
Drinking or water in mouth									
Bathing									
Walking [a]			X	X	X	X	X		
Jogging/running [a]			X	X	X	X	X	X	
Bicycling [a]			X	X	X	X	X	X	
Skateboarding/Skating [a]			X	X	X		X		
Standing			X	X					
Sitting [a]			X	X			X		
Lying down/sleeping			X	X					
Walking/playing with pets [a]			X	X	X	X	X		
Playing on shoreline				X					
Picnicking [a]			X	X		X	X		
Motorcycle/ATV									
Hunting/Trapping									
Bird/wildlife watching [a]			X	X		X			
Other sports activities			basketball volleyball	basketball volleyball frisbee kickball	soccer		softball		soccer

Table 18, continued (2 of 6). Summary of additional observations made during RUAA surveys.

	Retta	North	Main	Rose	Red Bluff	US287	McKnight	Matlock	Thompson
Hydrologic modifications?	No	No	No	No	No	No	No	No	No
Channel Obstructions	**Retta**	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
Culverts[b]	X			X					
Fence/Barbed wire									
Utility pipe[c]				X	X	X	X	X	X
Dams									
Log jams		X		X			X	X	X
Thick vegetation									
Rip rap		X						X	
Low bridges[b]	X			X					
Water control structure									
Conditions Promoting Recreation	**Retta**	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
Campgrounds									
Playgrounds			X	X			X		
Rural area	X								
Residential		X	X	X	X	X	X	X	X
National Forests									
Urban/suburban location		X	X	X	X	X	X	X	X
Golf course								X	
Sports field/court			X	X	X		X		X

Table 18, continued (3 of 6). Summary of additional observations made during RUAA surveys.

Conditions Promoting Recreation, continued	Retta	North	Main	Rose	Red Bluff	US287	McKnight	Matlock	Thompson
Stairs/walkway				X[d]					
Boat ramp									
Beach									
Bridge crossing	X	X	X	X	X	X		X	
Commercial boating									
Hike/bike trails/paths			X	X	X	X	X		
Paved parking lot			X	X		X	X		
Gravel/Unimproved parking lot					X				X
Roads	X	X	X	X	X	X	X	X	X
Populated area	X	X	X	X	X	X	X	X	X
Docks or rafts									
Commercial outfitter									
Nearby school			X	X	X	X	X	X	
Power line corridor							X		
Park[e]			X	X	X	X	X		X
Public property[e]			X	X	X	X	X		X

Table 18, continued (4 of 6). Summary of additional observations made during RUAA surveys.

Conditions Impeding Recreation	Retta	North	Main	Rose	Red Bluff	US287	McKnight	Matlock	Thompson
Private property	X	X				X		X	
No trespassing sign		X							
Wildlife									
Steep slopes [f]	X	X	X	[g]	X	X	X	X	X
No public access	X	X						X	
No roads									
Fence	X	X	X					X	X
Barge/ship traffic									
Industrial									
Indicators of Human Use	**Retta**	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
Roads		X	X	X	X	X	X	X	X
Rope swing							X		
Dock/platform									
Footprints/footpaths		X	X[h]	X[h]		X[h]	X[h]		
RV/ATV tracks									
Camping sites									
Fire pit/ring									
Fishing tackle									
TPDES discharge		[i]	[i]	[i]	[i]	[i]	[i]	[i]	[i]
Gates on corridor									

Table 18, continued (5 of 6). Summary of additional observations made during RUAA surveys.

Indicators of Human Use, continued	Retta	North	Main	Rose	Red Bluff	US287	McKnight	Matlock	Thompson
Children's toys									
Remnants of kid's play							rope swing		
Organized events				X	X		X		X
Other		graffiti	graffiti						j
Water Characteristics	**Retta**	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
Aquatic vegetation	absent	absent	absent	Absent	absent	absent	absent	absent	absent
Algae cover	absent	absent	absent	Absent	absent	absent	absent	absent	absent
Odor	garbage	H_2S[k]	none	None	none	none	none	none	none
Color	brown	clear	clear	Clear	clear	clear	clear	clear	clear
Bottom deposit	none	none	none	None	none	none	none	none	none
Water surface	scum	scum	clear	Scum	clear	scum	scum	clear	clear
Vertebrates Observed	**Retta**	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
Snakes	none	none	none	Slight	none	slight	slight	none	none
Water-dependent birds	slight	slight	none	None	slight	none	moderate	large[l]	slight
Alligators	none	none	none	None	none	none	none	none	none
Mammalian wildlife[m]	none	none	slight	Slight	slight	slight	slight	none	none
Other birds	moderate	large	large	Large	large	large	large	moderate	moderate
Domesticated pets	none	none	large	Large	large	moderate	large	none	slight
Livestock	none	none	slight[n]	None	none	none	none	none	none

Table 18, continued (6 of 6). Summary of additional observations made during RUAA surveys.

Vertebrates Observed, continued	Retta	North	Main	Rose	Red Bluff	US287	McKnight	Matlock	Thompson
Feral hogs	none	none	none	None	none	none	none	none	none
Other evidence of animals	none	tracks	tracks	tracks fecal[o]	none	none	tracks bird nests	tracks	tracks
Site located in wildlife preserve?	No	No	No	No	No	No	No	No	No
Presence of Garbage	**Retta**	**North**	**Main**	**Rose**	**Red Bluff**	**US287**	**McKnight**	**Matlock**	**Thompson**
Large garbage in channel	common	common	rare	Rare	rare	rare	common	rare	rare
Small garbage in channel	common	common	common	Common	rare	common	common	common	common
Garbage along banks	common	rare	rare	Common	rare	common	common	common	common

[a] Activity also observed along Walnut Creek Linear Park trail at and between the Main, Rose, US287, and McKnight sites.

[b] Bridge culverts at Retta and low-water crossing across Walnut Creek on Linear Park trail at Rose.

[c] Includes utility pipes within the site reach and those observed just upstream and/or downstream from a site.

[d] Overlook at northwest corner of park.

[e] City parks and recreational facilities.

[f] Banks are generally steep and eroded throughout the impaired area, including that within Walnut Creek Linear Park.

[g] Accessible from overlook at northwest corner of park and under Walnut Creek Drive, but banks are steep elsewhere.

[h] Including numerous paths from the Walnut Creek Linear Park trail to creek banks and a path behind fishing pond at Katherine Rose Park.

[i] Impaired portion of Walnut Creek is within the Mansfield Phase II-permitted MS4. No other TPDES discharges are present.

[j] Beer cans and bottles and human waste.

[k] Hydrogen sulfide odor emitted when substrate is disturbed in vicinity of large pool downstream from railroad bridge.

[l] Waterfowl on ponds at the adjacent Walnut Creek Country Club.

[m] Mostly squirrels.

[n] A few horses in pasture on south side of Walnut Creek.

[o] Dog fecal matter. The City provides “dog mitts” at stations within its parks, which likely reduces the amount of dog manure that would otherwise be present.

There appears to be sufficient water in Walnut Creek during warm weather to allow for contact recreation. Substantial pools were present at all RUAA survey sites within AU 0838C_01. Other deep areas are often present even in summer, which although not always large enough to constitute substantial pools as defined by the RUAA procedures (TCEQ 2009), still present a sudden drop-off risk to anyone wading in the creek.

The overall average thalweg depth in AU 0838C_01 (0.75 meter) exceeded the 0.5 meter threshold. The thalweg depth within each reach exceeded 0.5 meter at all but one RUAA survey site (McKnight). The overall average thalweg depth was calculated based on the wadeable portions of the evaluated reaches. Depths of greater than two meters were encountered in many areas, and the actual overall average thalweg depth is probably greater than 0.75 meter.

The possibility for public access to Walnut Creek in AU 0838C_01 exists through municipal parks and recreational facilities. However, little evidence of contact recreation activity was found along AU 0838C_01, with the rope swing at the McKnight site being the major exception. Footprints and activity along the bank near the Katherine Rose Memorial Park overlook suggest some limited wading or dipping of water may occur, although these activities were not observed during the RUAA. There is a general lack of access to the creek at the Thompson, Matlock, Red Bluff, and North sites; and access is generally difficult due to steep banks at most of the other creek sites.

Substantial amounts of trash along the shore and in the creek (including a large number of tires), surface scum along some parts of the creek, and muddy bottoms in some pools generally are not inviting to contact recreation. The unexpected deep areas and the flashy nature of flow in the creek may pose safety concerns for some people. In addition, the nearby Walnut Creek Country Club swimming pool, Joe Pool Lake and its associated parks, and the new Hawaiian Falls Waterpark provide aquatic recreation alternatives to the smaller creeks in the area.

RUAA Summary Form

RUAA Summary (TCEQ 2009)

Name of Water Body: ___**Walnut Creek**___

Segment No.: ___**0838C**___

Classified Segment? __**No**__

County: ___**Tarrant**___

1. Observations on use
   a. Do primary contact recreation activities occur on the water body?
      □ frequently □ seldom **X**[a] not observed or reported □ unknown

   b. Do secondary contact recreation 1 activities occur on the water body?
      X frequently □ seldom □ not observed or reported □ unknown

   c. Do secondary contact recreation 2 activities occur on the water body?
      □ frequently □ seldom □ not observed or reported **X** unknown

   d. Do noncontact recreation activities occur on the water body?
      X frequently □ seldom □ not observed or reported □ unknown

2. Physical Characteristics of the Water Body
   a. What is the average thalweg depth? __0.75__ meters [b]

   b. Are there substantial pools deeper than one meter? **X** yes □ no

   c. What is the general level of public access?
      □ easy **X**[c] moderate □ very limited

3. Hydrologic Conditions (Palmer Drought Severity Index)
   □ Extreme drought □ Severe Drought □ Moderate Drought
   X[d] Near Normal □ Unusual Moist Spell □ Very Moist Spell
   □ Extremely Moist

[a] Rope swing observed at McKnight site, but primary contact activities were not in progress.

[b] Depth value was calculated based on the wadeable portions of the evaluated reaches. Depths of greater than two meters were encountered in many areas and the actual overall average thalweg depth is probably greater than 0.75 meter.

[c] There are many public access points in the general area via parks and recreational facilities, but entry to the creek is difficult at most locations. The major exception is the overlook in Katherine Rose Memorial Park.

[d] Near Normal conditions existed for 12 of 15 survey and observation dates, including the period from late May through mid-September (see Table 12).

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