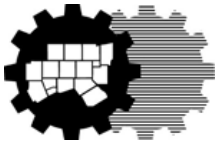
YEAR 3
JANUARY 2020 – DECEMBER 2020

REGIONAL WET WEATHER CHARACTERIZATION PROGRAM

ANNUAL MONITORING REPORT FOR NORTH CENTRAL TEXAS



North Central Texas Council of Governments

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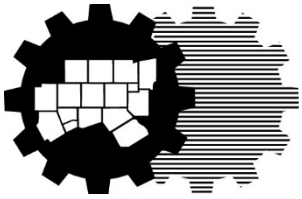
Regional Wet Weather Characterization Program Annual Monitoring Report for North Central Texas

- Year 3 -
(January 2020 – December 2020)



Prepared by the
North Central Texas Council of Governments
Submitted to Texas Commission on Environmental Quality
March 1st, 2021

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The Regional Wet Weather Characterization Program Annual Monitoring Report was prepared by the North Central Texas Council of Governments (NCTCOG) on behalf of eight regional participants. The Annual Monitoring Report is submitted to the Texas Commission on Environmental Quality (TCEQ), either directly or by reference, along with each participant's annual report of their stormwater management programs to comply with the Regional Wet Weather Characterization Plan Proposal for the Fourth Term (2018 – 2022), approved by TCEQ on June 30th, 2017. The Monitoring Report was submitted to TCEQ on March 1st, 2021.

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Table of Contents

List of Tables

List of Figures

REGIONAL WET WEATHER CHARACTERIZATION PROGRAM

Since 1996, a regional stormwater monitoring program has been ongoing in the North Central Texas region among the Phase 1 entities for compliance with Federal and State stormwater permit requirements. The Dallas-Fort Worth Regional Wet Weather Characterization Program (RWWCP) was first negotiated with the United States Environmental Protection Agency (USEPA) and incorporated into each entity's permit for the first term in 1996. The negotiated program reduced the number of sampling stations from the application phase of sampling but increased the number of samples per station to obtain better statistical representation. While several of the participants have changed through the years, the RWWCP has been a successful regional partnership, with eight participating entities currently undergoing chemical and bioassessment sampling during a Fourth Monitoring Term, 2018 – 2022.

First Monitoring Term

During the initial monitoring term (1996 - 2001), seven municipalities (Dallas, Fort Worth, Arlington, Irving, Garland, Plano, and Mesquite), and the Dallas and Fort Worth Districts of the Texas Department of Transportation (TxDOT), received joint approval from the U.S. Environmental Protection Agency (EPA) for a regional monitoring program. The program utilized the assistance of a shared consultant team and the U.S. Geological Survey (USGS), to sample and analyze stormwater runoff from 22 outfalls in primarily small watersheds of a single land use type. The participants worked through the North Central Texas Council of Governments (NCTCOG) to form a regional partnership and strategy to conduct wet-weather monitoring activities for the regional monitoring program. The sample collections served to characterize typical urban runoff from these limited land use types and were useful for estimating general pollutant loadings. However, they did little to evaluate impacts on actual receiving streams.

Second Monitoring Term

In the second monitoring term (2006 - 2010), the Regional Wet Weather Characterization Program (RWWCP) was administered by the Texas Commission on Environmental Quality (TCEQ) and implemented through NCTCOG, with a consultant team led by Atkins. The program obtained approval to utilize in-stream stations for the regional monitoring program to better assess the impact on receiving streams. The revised program was termed the Regional Wet Weather Characterization Program (RWWCP). It was added as an option in Part IV.A.3 of the Texas Pollutant Discharge Elimination System (TPDES) Municipal Separate Storm Sewer System (MS4) permits issued to the Phase I North Central Texas governmental entities. Since the RWWCP language existed outside of each permit, it allowed greater flexibility for making changes to the program.

During the second term, the North Texas Tollway Authority (NTTA) joined the regional program. All other participants remained the same, except TxDOT-Fort Worth District, who became a co-permittee with the cities of Fort Worth and Arlington and was no longer required to conduct wet weather monitoring. According to the original RWWCP protocol, municipal participants collected data from three sample sites in the watershed (upstream, midstream, and downstream). The transportation agencies collected data from two sites (upstream and downstream only). Samples were collected quarterly from each site during a qualifying rainfall event and were analyzed for 18 parameters. The primary goal of the new in-stream monitoring program was to obtain baseline data on receiving streams in North Central Texas for use in determining long-term water quality trends.

Dallas and Fort Worth used their staff to collect samples, while the consultant team assisted the remaining partners with field data collection, stormwater sample analysis, and technical assistance. As an added component, the City of Fort Worth selected the Representative Rapid Bioassessment Monitoring option (Part IV.A.2) in their permit, which allowed the sampling frequency to be reduced from four times a year per site to once per year per site. In place of chemical sampling at all sampling sites, Fort Worth conducted two bioassessments each year at a minimum of nine sites. These bioassessments were based on protocols developed by the EPA. A summarization of this

bioassessment data was included along with the regional monitoring report's chemical data for each year of the monitoring term.

Third Monitoring Term

In the third monitoring term (2011-2015), the Cities of Arlington, Dallas, Fort Worth, Garland, Irving, Mesquite, and Plano, together with the North Texas Tollway Authority (NTTA) and TxDOT-Dallas District, agreed to continue their regional partnership and work cooperatively through NCTCOG to develop a revised RWWCP. This revised plan effectively monitored at least 50% of each entity's jurisdictional area by the end of the monitoring term. This extension of jurisdictional coverage allowed a reasonable assessment of each entity's jurisdictional watersheds while also achieving a balance among the various goals of obtaining valid scientific information, meeting permit compliance, and addressing what is practicable for each entity. During this permit term, the primary goal of the RWWCP was to continue assessing the urban impact on receiving stream water quality and document any improvement presumably resulting from local best management practices (BMP) implementation. The data collected during the monitoring term built upon the set of regional data needed from each site for meaningful trend analysis. Since assessing the impact of urban runoff on receiving stream quality is a primary focus of this program, assessing the biological integrity of the streams was deemed fundamental in the third term. During the third term, 24 watersheds were chemically monitored, and 12 watersheds were bio-assessed across the region, with substantial overlap between the two sampling approaches.

At the end of the sampling effort, a final summary report was prepared by Atkins to assess the sampling effort. The report found that more than half of the watersheds sampled had high bacteria exceedances, with an average number of nine exceedances in the studied watersheds. The consultant team noted stream degradation in about half of the sampled watersheds based on the analyzed data. Additional monitoring was recommended at these sites. The final report also analyzed the specific characteristics of the monitored watersheds. This approach provided participants individual watershed information that could be used to implement BMPs and other monitoring practices in the future. Due to the data collected in the third permit term, many of the watersheds studied were classified as a high priority for continued monitoring. Watersheds classified as a high priority were generally those with stream degradation, those with a high number of monitored parameter criteria exceedances, and those with existing Total Maximum Daily Loads (TMDLs).

As a result of the third monitoring term findings, several recommendations were made for modifying the RWWCP for the fourth term, including the following:

- Impaired Waterbodies Focus – Focused monitoring of impaired water bodies to assist with TMDL efforts underway in North Central Texas by the participants.
- Rapid Bio-Assessment Improvements – Continue to implement rapid bio-assessments and encourage additional participants to undertake rapid bio-assessments as part of the RWWCP. To allow for comparisons, parameters to record during the bio-assessment chemical monitoring activities should be expanded to include/match those of the wet weather monitoring.
- Revise Monitored Pollutants – During the third term, Carbaryl was chosen to replace Diazinon that was undetected in the second term. Carbaryl was not detected in any watershed during the third term, and therefore was recommended that it no longer needed to be monitored for the fourth term, but possible replacements could be dieldrin or atrazine.
- Revise Monitored Pollutants – Due to no recognized correlation between total coliforms and freshwater pathogens by TCEQ or EPA, it was recommended that total coliforms be removed from the list of monitoring parameters. It was also recommended to add ammonia nitrogen, nitrate-nitrogen, and orthophosphate to the monitoring parameters for wet weather chemical monitoring. The addition of these nutrients would allow for better comparisons between bioassessment and wet weather chemical monitoring results. Additionally, for the Duck Creek, Johnson Creek, and White Rock Creek (headwaters) subwatersheds, it was recommended that sampling of dissolved fractions of metals be included in determining the concentration of bioavailable metals.

REGIONAL WET WEATHER CHARACTERIZATION PROGRAM – CURRENT MONITORING TERM

This report documents the third year of the fourth monitoring term (2018 – 2022) involving continuing revised approaches to both the chemical and bioassessment monitoring protocols. The North Central Texas Regional Wet Weather Characterization Plan Proposal for the Fourth Term, dated October 11th, 2016, was approved by TCEQ on June 30th, 2017. The approved plan can be found in Appendix A. Upon agreement of the RWWCP participants, the resulting third monitoring term recommendations were incorporated in the approved fourth monitoring term proposal.

For the fourth term (2018-2022), the cities of Arlington, Dallas, Fort Worth, Garland, Irving, Mesquite, and Plano, and the NTTA (herein referred to as participants), agreed to continue their regional partnership and continue working through the NCTCOG to develop a revised regional monitoring program. As a result of TxDOT obtaining a statewide permit incorporating both the Dallas and Fort Worth Districts, their requirement to conduct wet weather monitoring was removed. Therefore, they are not included in the current RWWCP fourth monitoring term.

The fourth term of the RWWCP began on January 1st, 2018. Phase I stormwater permit information for each participant is included in Table 1. The permits defer to the approved RWWCP for sampling protocols and the final list of parameters to be tested.

Table 1: Permit Term Four RWWCP Participants

Permittee	TPDES Permit Number	Date Issued	Expiration Date
Arlington	WQ0004635000	08/15/2019	05/15/2024
Dallas	WQ0004396000	08/06/2019	08/06/2024
Fort Worth	WQ0004350000	03/08/2018	03/08/2023
Garland	WQ0004682000	10/15/2019	10/15/2024
Irving	WQ0004691000	12/10/2019	12/10/2024
Mesquite	WQ0004641000	05/24/2018	05/24/2023
Plano[1]	WQ0004775000	12/02/2015	12/02/2020
North Texas Tollway Authority	WQ0004400000	08/15/2018	08/15/2023

[1] Plano has submitted for their new permit and is waiting for renewal information.

The RWWCP participants selected Atkins (herein referred to as the consultants) as the lead contractor, and sub-consultants Freese and Nichols, Inc. and Dougherty Sprague Environmental, Inc., to provide regional stormwater monitoring services for the fourth term. The consultants will complete a variety of stormwater monitoring compliance activities for the cities of Arlington, Garland, Irving, Mesquite, Plano, and NTTA, including stormwater monitoring, bioassessments, and a Best Management Practices (BMP) Analysis and Evaluation Plan for all participating entities, including Dallas and Fort Worth. A Monitoring Program and Quality Assurance Project Plan for Wet Weather Equipment Deployment and Sampling Protocol (Appendix B), and Monitoring Program and Quality Assurance Project Plan for Bioassessments (Appendix C) have been documented and provided for the fourth term. For the fourth term's duration, the cities of Dallas and Fort Worth will collect their stormwater samples and bioassessments. This report includes the results of their data collection efforts, Appendices F, H, and I.

The regional participants use a sampling plan that will effectively monitor at least 50% of their jurisdictional area by the end of the monitoring term. As in the third monitoring term, in-stream watershed monitoring will be conducted at each location for a minimum of two years to provide greater statistical robustness of the data. The participants will maintain fixed sampling stations to the extent practical. Fixed sample stations will enable the data to be examined for trends and show improvements or decline in water quality within the fixed sampling period.

Monitored subwatersheds were prioritized based on TMDLs and Clean Water Act Section 303(d) streams located within the watersheds covering the jurisdictional area of the municipalities. Participants are monitoring these impaired waterbodies to assess the impacts of stormwater on these impaired streams. Monitored subwatersheds were also prioritized to match those that have been historically monitored in previous terms. However, some additional subwatersheds were added based on the TMDLs and impairments discussed above. Over the fourth monitoring term, 26 subwatersheds will be monitored chemically, and 15 subwatersheds will be monitored biologically, according to the sampling schedule in Table 2.

Table 2: Regional Wet Weather Characterization Program Sampling Schedule

Jurisdiction Subwatershed	Number of Samples to be Collected[1]				
	2018	2019	2020	2021[2]	2022[2]
Arlington					
Johnson Creek	4C	4C			
Fish Creek – Mountain Creek Lake	4C	4C			
Rush Creek – Village Creek			8C	8C	
Dallas					
Floyd Branch – White Rock Creek	2B	2B	2B	2B	
Five Mile Creek – Trinity River		12C		12C	
Headwaters Five Mile Creek	2B	2B	2B	2B	
Headwaters Turtle Creek	12C		12C		
White Rock Creek – White Rock Lake	2B	2B	2B	2B	
City of Dallas – White Rock Creek		12C		12C	
Bachman Branch – Elm Fork Creek	2B	2B	2B	2B	
Turtle Creek – Trinity River	12C		12C		
Fort Worth					
Headwaters Sycamore Creek	2C/4B	4B	6B	4B	4B
Lake Como-Clear Fork Trinity River	4B	2C/4B	6B	4B	4B
Marine Creek-West Fork Trinity River	4B	2C/4B	6B	4B	4B
Mary's Creek	2C/4B	4B	6B	4B	4B
Sycamore Creek-West Fork Trinity River	4B	4B	2C/6B	4B	4B
Whites Branch-Big Fossil Creek	4B	4B	2C/6B	4B	4B
Garland					
Duck Creek	12C	12C			
Rowlett Creek – Lake Ray Hubbard	2B	2B	12C/2B	12C/2B	
Irving					
Delaware Creek – West Fork Trinity River	8C/2B	8C/2B			
Grapevine Creek – Elm Fork Trinity River			4C	4C	
Estelle Creek – Bear Creek			4C/2B	4C/2B	
Mesquite					
South Mesquite Creek	4C	4C	4C	4C	
North Mesquite Creek	4C	4C	4C	4C	
Plano					
Spring Creek	4C	4C			
Headwaters Rowlett Creek	2B	2B	4C	4C	
Brown Branch Rowlett Creek			4C/2B	4C/2B	
North Texas Tollway Authority					
Cotton Branch – Hackberry Creek	4C	4C	4C	4C	
Cotton Creek – Mountain Creek Lake	4C	4C	4C	4C	

Note: [1] B-Signifies Bioassessment Samples; C-Signifies Chemical Samples
[2]The City of Fort Worth will conduct additional chemical sampling during 2021 and 2022 at watersheds selected after sampling 2020 and based on the chemical, physical, and biological assessment results were done in 2018-2020.

Chemical Sampling

Arlington, Garland, Plano, and Irving perform chemical sampling on one or two subwatersheds within their jurisdiction for two consecutive years, then move to another one or two subwatersheds for another two years. Due to the size of their jurisdictional area, Dallas selected eight subwatersheds, and Fort Worth selected six subwatersheds for chemical and/or biological monitoring that rotate. Mesquite has a unique situation where only two subwatersheds and the two creeks of those subwatersheds are almost wholly contained within the city limits. Mesquite has chosen to establish permanent in-stream monitoring stations in each of the two creeks and to sample them concurrently all four years. NTTA has also chosen to establish in-stream monitoring stations in two creeks within NTTA rights-of-way and to sample them concurrently all four years. Figure 1 displays the monitored subwatersheds for the year 2020. Appendix A provides additional documentation of the chemical sampling occurring for all participants.

For chemical monitoring, grab samples will be collected during the first flush (defined as the 30 minutes following a quantifiable rise in stream level) and analyzed for *E. coli*, oil and grease, and pH. An additional first flush sample and four subsequent samples collected at equal time intervals will be taken over the first two hours of the event and combined for a composite sample. Samples will be collected for no more than two hours, regardless of storm duration. Grab samples will be obtained either manually or through an automated collection device.

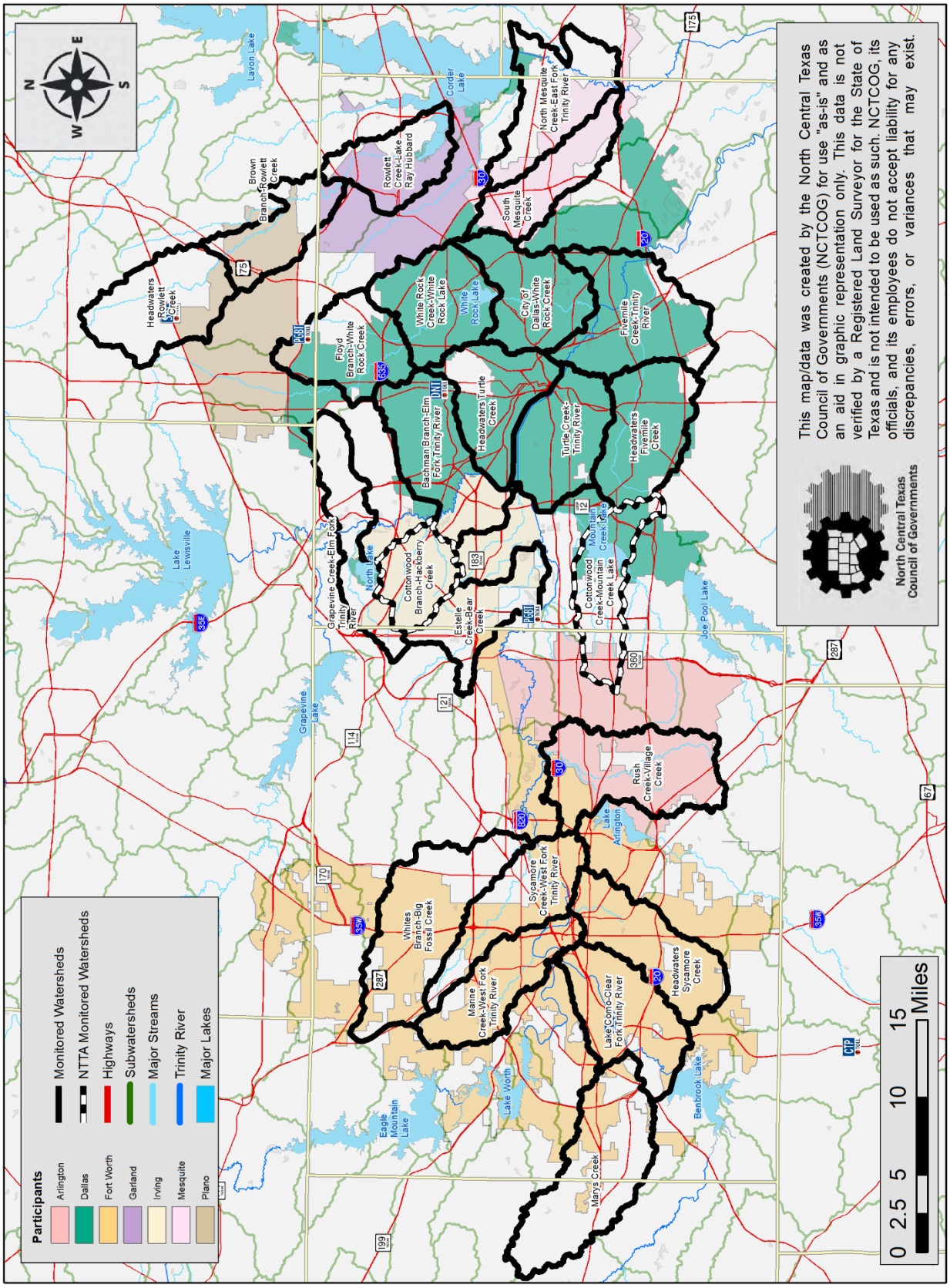
Sampling will be conducted only on qualifying events, which are defined as satisfying the following requirements: 1) antecedent dry period of 72 hours minimum; 2) rainfall volume of 0.10-inch minimum; and 3) a quantifiable increase in water surface elevation attributable to stormwater runoff. Rain gauges were deployed in each watershed to support the assessment of local wet weather conditions.

Chemical samples will be collected with automatic sampling equipment that will collect water through stainless steel strainer and flexible sampling tubing using a peristaltic pump. Samples will then be pumped into four 1-gallon glass containers located in a stormwater sampler shelter. The automatic samplers will also be equipped with bubbler flow modules that activate the samplers based on an increase in water surface elevation in the stream conveyance channel. Upon successful collection, the samples are preserved in ice and shipped immediately to the laboratory for analysis. Each sample is analyzed for 19 parameters, which are listed in Table 3.

Table 3: RWWCP Fourth Monitoring Term Regional Parameter Set

Parameter	Method of Collection
Oil & Grease	Grab
pH	Grab
E. coli	Grab
Total Dissolved Solids (TDS)	Composite
Total Suspended Solids (TSS)	Composite
Biochemical Oxygen Demand (BOD5)	Composite
Chemical Oxygen Demand (COD)	Composite
Total Nitrogen	Composite
Dissolved Phosphorus	Composite
Total Phosphorus	Composite
Atrazine	Composite
Total Arsenic	Composite
Total Chromium	Composite
Total Copper	Composite
Total Lead	Composite
Total Zinc	Composite
Ammonia Nitrogen	Composite
Nitrate Nitrogen	Composite
Orthophosphate	Composite

Figure 1: RWWCP Fourth Monitoring Term - Monitored Subwatershed



Bioassessments

In the fourth monitoring term, the cities of Dallas, Fort Worth, Garland, Irving, and Plano are conducting bioassessments, representing a substantial increase in the use of bioassessments as a component of the RWWCP. EPA and TCEQ have developed an array of methods and approaches that can be used in conducting bioassessments. As EPA states in their manual, *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*, 2nd Ed. (1999), the protocols described are not intended to be used as a rigid protocol without regional modifications. Instead, they provide options for agencies or groups that wish to implement rapid biological assessment and monitoring techniques.

The regional program participants that are implementing bioassessments will be performing bioassessments based upon EPA and TCEQ protocols. Specific protocols are detailed in manuals provided by each agency, but generally, program participants will be conducting bioassessments involving habitat assessment, a measurement of standard field physical conditions, and the collection and identification of macroinvertebrates and other biota. Habitat parameters will be compared to baseline standards for a reference site or reference conditions to determine the habitat's overall health.

OVERVIEW OF CHEMICAL AND BIOASSESSMENT PROTOCOLS

The consultant team prepared the *Monitoring Program and Quality Assurance Project Plan for Wet Weather Equipment Deployment and Sampling Protocol: 2018–2021* and *Monitoring Program And Quality Assurance Project Plan For Bioassessments: 2018–2021,* as the protocols for the RWWCP participants. These protocols are included as Appendix B and Appendix C, respectively. The protocol documents include detailed location information for the stormwater sampling and bioassessment sites for Arlington, Garland, Irving, Mesquite, Plano, and the NTTA.

All chemical sampling sites are equipped with automatic samplers (ISCO 6712, ISCO 730 Bubbler Module) that contain four 1-gallon glass sample containers. The sampler collects 0.5-gallon aliquots every 30 minutes after the initial sample for 120 minutes. Sample container one, or the grab sample container, contains one 1-gallon aliquot, sample containers two and three contain two 0.5-gallon aliquots, and sample container four contains one 0.5-gallon aliquot. All the upstream sampling sites include a tipping bucket rain gauge (ISCO 674) to verify rainfall amounts and antecedent dry periods. Graduated cylinder rain gauges are used at some of the other sites. If the on-site rain gauge information is not applicable (e.g., malfunction or qualifying storm is only at the mid- or downstream stations), an online rain gauge is used to verify the rainfall amount and antecedent dry period. The consultants used Pace Analytical Services Laboratories and their subcontracted laboratories, Armstrong Forensic Laboratory, Inc. and ALS Laboratory, to analyze the samples. Appendix E includes the applicable laboratory certifications.

The cities of Dallas and Fort Worth conducted their sampling operations and have developed protocol documents to address the minor variances in their programs. Their respective protocols are described below.

City of Dallas Protocol

The City of Dallas uses the Regional Stormwater Monitoring and Bioassessment Protocols as their base protocols for stormwater sampling and bioassessment activities per Appendix B and Appendix C. The City of Dallas utilizes city personnel to operate their equipment and to collect stormwater samples. City staff also conducts bioassessment activities. The protocol documents include maps of Dallas' 2012 through 2015 stormwater sampling and bioassessment sites. No changes have been made to this protocol for Year 3 activities.

The City of Dallas uses the ISCO 6712 model with ISCO 674 Rain Gauge and ISCO 750 Flow Meter for stormwater sample collection. The City of Dallas uses a program script designed to collect and analyze samples for parameters with short hold time from the three sampling stations in one rain event. Sampler equipment is programmed to activate at a 1/10-inch level rise recorded by the rain gauge within a two-hour period. At activation, the sampler collects two one-gallon samples (1st flush). After fifteen minutes, the sampler fills the remaining two one-gallon jars (composite) over an hour period in five equal aliquots. The City of Dallas used Pace Analytical Laboratories to carry out analyze the collected samples. Appendix E includes the laboratory certifications.

City of Fort Worth Protocol

The City of Fort Worth has developed a separate protocol, *City of Fort Worth RWWCP Monitoring Plan*, Appendix I, for conducting their stormwater sampling and bioassessment activities. Fort Worth utilizes city personnel to operate their equipment and to collect stormwater samples. City staff also conducts bioassessment activities. The protocol document includes location information for Fort Worth's stormwater sampling and bioassessment sites. Fort Worth has updated their protocol for the fourth monitoring term, 2018-2022. The updated City of Fort Worth protocol is included as Appendix I.

The City of Fort Worth has identified chemical sampling sites for the years 2018-2020. Automatic water samplers (ISCO 3700 or other) are deployed at the site(s) to be monitored before the rain event. The samplers are programmed to initiate sampling at a 1.0-inch rise in receiving stream water level. Upon activation, the sampler collects a "first flush" grab sample and the first of four sub-samples for a time-weighted composite sample. Subsequent sub-samples are collected at 30-minute intervals. Pace Analytical Services Dallas and Pace Analytical Services Forth Worth Laboratory analyzed all parameters. Appendix E includes the laboratory certifications.

YEAR 3 CHEMICAL SAMPLING AND BIOASSESSMENT ACTIVITIES

Figure 2, RWWCP Fourth Monitoring Term, Year 3 (2020) Subwatersheds, and Monitoring Sites, depicts the subwatersheds sampled in Year 3 (2020) as well as the location of the chemical sampling stations and bioassessment sites. Table 4 contains the corresponding list of Year 3 chemical monitoring and bioassessment sites that are part of the RWWCP, along with location information.

Figure 2: RWWCP Fourth Monitoring Term, Year 3 (2020) Subwatersheds and Monitoring Sites

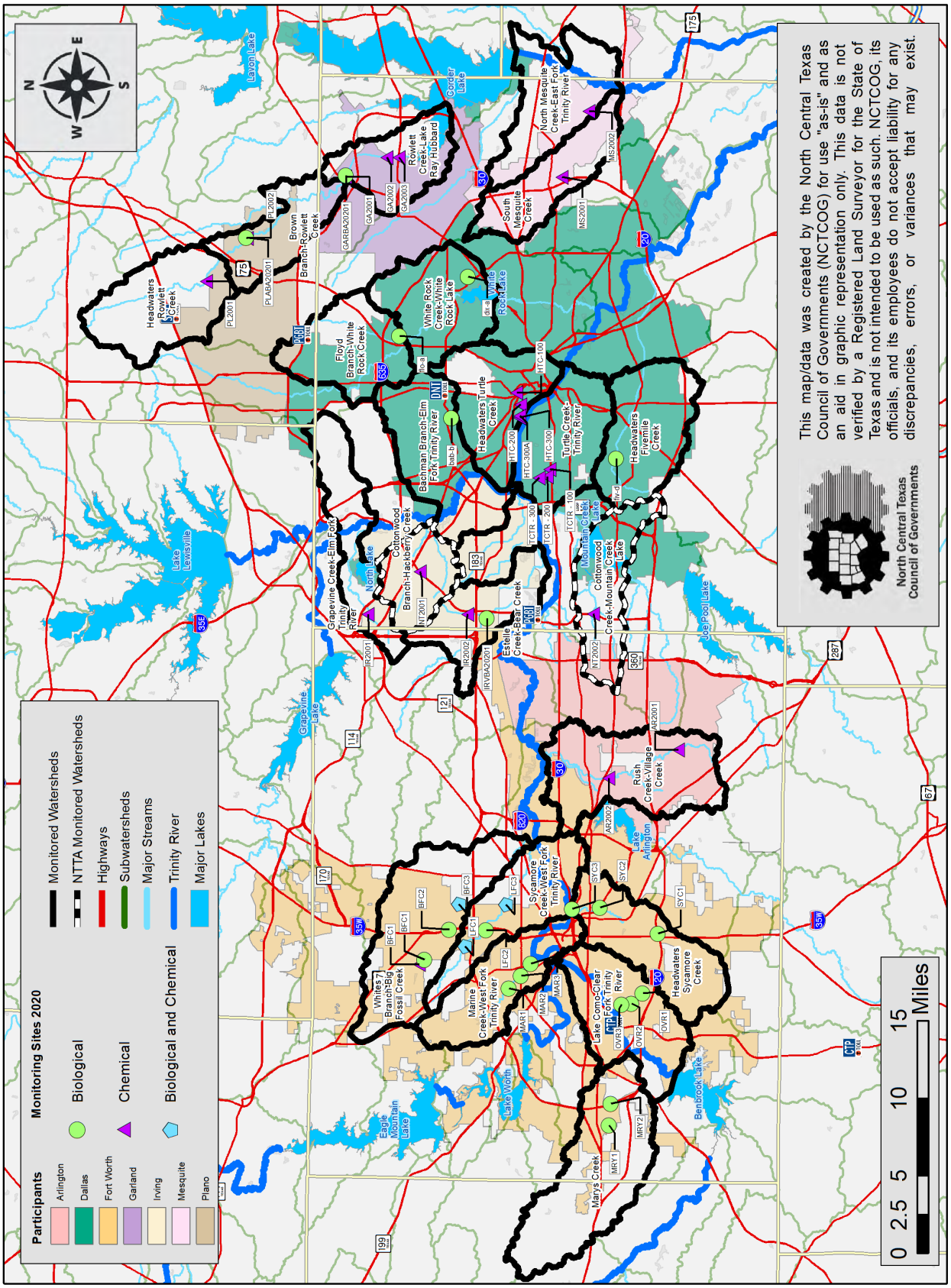


Table 4: RWWCP Year 3 (2020) Chemical Sampling and Bioassessment Site Locations

Jurisdiction Watershed	Station ID	Location	Latitude / Longitude	# of samples in 2020[1]
ARLINGTON				
Rush Creek	AR2001	Rush Creek at West Sublett Road	32.648889/-97.146389	4C
	AR2002	Rush Creek at Woodland Park Boulevard	32.713889/-97.172778	4C
DALLAS[3]				
Turtle Creek – Trinity River	TCTR-100	3805 Pipestone Road at Mican Channel	32.768494 / -96.884368	4C
	TCTR-200	3951 La Reunion Parkway at Mican Channel	32.771135 / -96.891362	4C
	TCTR-300	4300 Singleton Boulevard at Mican Channel	32.778860 / -96892632	4C
Headwaters Turtle Creek	HTC-100	3505 Maple Avenue at Turtle Creek	32.799577 / -96.813045	4C
	HTC-200	1201 Turtle Creek Boulevard at Turtle Creek	32.795850 / -96.824203	4C
	HTC-300	2240 Irving Blvd.	32.79653494 / -96.834769	4C
Bachman Branch – Elm Fork Trinity	bab-b	8900 Midway Rd.	32.86044179 / -96.83695217	2B
Floyd Branch – White Rock Creek	flo-a	8300 Forest Lane	32.90906899 / -96.76013679	2B
White Rock Creek – White Rock Lake	dix-a	900 Peavy Rd	32.84469605 / -96.70475864	2B
Headwaters Five Mile Creek	fiv-d	3235 S. Westmoreland Rd.	32.7064408 / -96.87451384	2B
FORT WORTH[2]				
Marine Creek – West Fork Trinity River	FWMAR1	West of Angle Avenue in Buck Sansom Park	32.8079/-97.3691	2B
	FWMAR2	Lincoln Park, north of the 28th St crossing	32.7955/-97.3572	2B
	FWMAR3	Saunders Park south of Mule Alley and downstream of JV1A	32.7862/-97.346	2B
Lake Como - Clear Fork Trinity River	FWOVR1	NW of Granbury Rd and Trail Lake Dr	32.6820 / -97.3738	2B
	FWOVR2	East of 3808 Overton Park West, near Tanbark Trail intersection	32.6925 / -97.3831	2B
	FWOVR3	Overton Park West south of the intersection with Bellaire	32.7017 / -97.3839	2B
Sycamore Creek – West Fork Trinity River	FWLFC1	2200 block Cantrell Sansom	32.8478 / -97.3297	1C/2B
	FWLFC2	100 yards west of and upstream of I-35W crossing	32.8279 / -97.3146	2B
	FWLFC3	Dead end of Mesquite Rd. South of 3800 Long Ave.	32.8095 / -97.2909	1C/2B
White's Branch – Big Fossil Creek	FWBFC1	West of parallel to Pepperidge Lane	32.8854 / -97.3421	2B
	FWBFC1	7764 N Blue Mound Road	32.8906 / -97.3464	1C
	FWBFC2	I-35W crossing, north of Western Center Blvd	32.8625 / -97.3142	2B
	FWBFC3	N. Beach St. north of Paula Ridge	32.8536 / -96.2904	1C/2B

Jurisdiction Watershed	Station ID	Location	Latitude / Longitude	# of samples in 2020[1]
Headwaters Sycamore Creek	FWSYC1	I-35W northbound frontage road beneath SE Loop IH-820 eastbound	32.6677 / -97.3178	2B
	FWSYC2	Cobb Park West south of US-287 at low water crossing	32.7217/ -97.2935	2B
	FWSYC3	Dead end of Scott St. west of Beach St.	32.7475 / -97.2949	2B
Mary's Creek	FWMRY1	3900 block Longvue (FM 2871)	32.7133 / -97.4966	2B
	FWMRY2	Loop IH-820 SW crossing, 0.5 mile south of Chapin Rd	32.7117 / -97.4767	2B
	FWMRY3	Winscott Road (Vickery Blvd) crossing in South Z Boaz Park	32.6954/-97.4477	2B
GARLAND				
Rowlett Creek – Lake Ray Hubbard	GA2001	Rowlett Creek at Ben Davis Bridge	32.9593500 / -96.611373	4C
	GA2002	Rowlett Creek at Centerville Road/Castle Drive	32.9205190 / -96.593322	4C
	GA2003	Rowlett Creek at Highway 66	32.9093670 / -96.593372	4C
	GARBA20201	Below State Highway 78	32.96 / -96.615	2B
IRVING				
Grapevine Creek - Elm Fork Trinity River	IR2001	Grapevine Creek at N. Royal Lane	32.9382140 / -97.019672	4C
Estelle Creek - Bear Creek	IR2002	Estelle Creek at W. Rochelle Road	32.8452560 / -97.019568	4C
	IRVBA20201	Below W. Pioneer Dr.	32.8294 / -97.022	2B
MESQUITE				
South Mesquite Creek	MS2001	North of New Market Road	32.7572500 / -96.6119444	4C
North Mesquite Creek	MS2002	North Mesquite Creek at Edward's Church	32.7321111 / -96.55055000	4C
PLANO				
Headwaters Rowlett Creek	PL2001	Rowlett Creek at Alma Drive	33.0890760 / -96.708830	4C
Brown Branch Rowlett Creek	PL2002	Rowlett Creek in Oak Point Park	33.0510280 / -96.668944	4C
Brown Branch Rowlett Creek	PLABA20201	Rowlett Creek at Oak Point Park	33.0523 / -96.6701	2B
NORTH TEXAS TOLLWAY AUTHORITY				
Cottonwood Branch – Hackberry Creek	NT2001	Unnamed Tributary at SH 161 N. of Gateway Dr.	32.889808 / -96.980065	4C
Cotton Creek – Mountain Creek Lake	NT2002	Cottonwood Creek at SH 161 S. of Dickey Road	32.728181 / -97.019460	4C

Notes:
[1]B-Signifies bioassessment samples; C signifies chemical samples.
[2]Table 4 includes the primary bioassessment sites for the City of Fort Worth for each watershed. The City of Fort Worth Sampling Protocol identifies an additional bioassessment site for each watershed that may be used as an alternative depending on local conditions at the time of sampling.
[3]Due to construction activities, HTC-300 was relocated to the nearest access point.

Chemical Sampling

All samples were successfully collected and analyzed in Year 3, January 2020 – December 2020, of the fourth term. Due to construction in the fourth quarter, the sampling of HTC-300 was relocated to the nearest access point. The sampling data and summary statistics for Year 3 of the monitoring term are included in Year 3 Regional Chemical Sampling Data. The complete raw sampling data and sample collection reports are provided in Appendix F and Appendix G, respectively.

Bioassessments

The Cities of Dallas, Fort Worth, Garland, Irving, and Plano conducted bioassessment activities in Year 3. All scheduled bioassessments were successfully conducted. An overview of each entity's bioassessment activities is provided below. For complete details, refer to bioassessment reports for Dallas (Appendix H), Fort Worth (Appendix I), and Garland, Irving, and Plano (Appendix D).

City of Dallas

The City of Dallas performs rapid bioassessment protocol (RBP) monitoring as a part of the RWWCP and conducts additional RBP monitoring beyond the regional program as part of their individual MS4 Permit Stormwater Management Program. The City uses the RBP as outlined in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data (TCEQ, 2007, RG-416)*. The RBP monitoring evaluates the chemical, physical, and biological in-stream features that promote a healthy and diverse habitat; as such, they provide a good assessment of overall watershed health. The RBP monitoring program involves performing an Aquatic Life Use (ALU) assessment through benthic macro-invertebrate collection, habitat assessment, and evaluating water quality samples.

Two sampling events were conducted in accordance with the index periods established by TCEQ for biological sampling:

- Spring Period (March 15th to June 30th): Targets optimal biological community growth conditions.
- Summer Period (July 1st to September 30th): Reflects impacts from typical summer low flows and higher water temperatures.

Under the RBP, each water body is given a composite score determined by evaluating numbers and diversity of macroinvertebrates, water quality parameters, stream habitat features, and other metrics. A sample of each monitoring site's macroinvertebrate community determines the sites Aquatic Life Use (ALU) metric. Since 2005, the City of Dallas has used the Benthic Macroinvertebrate Index of Biotic Integrity (IBI) to test ALU. A sample from each monitoring site is tested according to the IBI. The City of Dallas 2020 bioassessment report is included as Appendix H of this report. Note that the report contains data for all the sites monitored by Dallas in 2020.

City of Fort Worth

The City of Fort Worth performs rapid bioassessments on representative creeks within six subwatersheds twice per year as a part of the RWWCP monitoring program and to satisfy their stormwater monitoring program requirements. Methods for bioassessments are based on protocols set forth in TCEQ, EPA, and Texas Parks and Wildlife guidance documents. A description of methodology may be found in the full bioassessment report in Appendix I. Regional rapid bioassessments included habitat assessment, chemical, and physical water quality parameter evaluation, sample collection, and analysis of benthic macroinvertebrate. Sampling was conducted during spring (May) and fall (October) 2020 on three sites on all creeks. Rapid bioassessments were performed on stream sites within nine watersheds in Fort Worth during spring and fall 2020.

Habitat assessments are based on USEPA guidelines for high gradient streams as outlined in *Rapid Bioassessment Protocol for Use in Streams and Wadeable Rivers*, second edition (EPA 841-B-99-

002). Macroinvertebrate data were analyzed using methods for the TCEQ-based Texas Index of Biotic Integrity (IBI) for kick net samples. The metric calculation scores at a site for the IBI are compared to values in TCEQ guidelines, and each site is assigned an aquatic life use rating. The values for the aquatic life use ratings found in the TCEQ guidelines were developed based on data collected from ecoregional reference sites. This method gives each site an individual value without a direct comparison to a specific reference site but to values from ecoregional reference sites. Individual sites may be compared to themselves year to year on a seasonal basis (spring to spring and fall to fall) to demonstrate community changes within each reach.

Garland, Irving, and Plano

Stream rapid bioassessments were conducted on Rowlett Creek in Garland, Estelle Creek-Bear Creek in Irving, and Brown Branch-Rowlett Creek in Plano, in 2020. All three creeks were sampled once between June 16 and 18, 2020, during the "Index" period and another time between September 23 and 25, 2020, during the "Critical" period. The TCEQ (2012) recommends one sample be collected during the Index period and one during the Critical period when two samples are collected at the same site during the same year. The TCEQ (2012) also recommends samples be collected at least one month apart, when flows are relatively low and not recently impacted by rainfall runoff. Benthic macroinvertebrate and fish communities were sampled, and data compared with metrics from the TCEQ. Habitat, water chemistry, and flow were also measured in each trip.

The streams are in the Texas Blackland Prairie ecoregion (Ecoregion 32). Within an ecoregion, soils, climate, landforms, and vegetation are expected to be similar. TCEQ describes reference conditions for benthic macroinvertebrates and fish inhabiting wadeable streams in the Texas Blackland Prairie ecoregion. Evaluating benthic macroinvertebrates and fish communities with the TCEQ-established metrics to calculate aquatic life use may indicate whether the streams have been impacted by human activities. Appendix D contains the detailed bioassessment report for Garland, Irving, and Plano.

YEAR 3 REGIONAL MONITORING PROGRAM CHEMICAL SAMPLING DATA SUMMARY

Analytical results and field measurements from all storm events sampled during Year 3 (January-December 2020) are summarized for each parameter in Table 5. The table includes descriptive statistics of minimum, maximum, mean (average), median, and standard deviation. Note that for each of the chemical sampling sites, i.e., AR2001, four samples were collected during the year (i.e., n=4). The arithmetic mean has been provided for all the parameters except for *E.coli*; the geometric mean was calculated for all bacteria samples. The raw (unmodified) data is provided in Appendix F.

The data includes cases where concentrations of some parameters for samples are below the detection limit (BDL) of the analytical equipment. When data for all samples collected during the year for a given parameter at a sample site (dataset) contained values below the detection limit ("< "), values are reported as "BDL" in Table 5. In cases where datasets contained values both below and above the detection threshold, the value of one-half the detection limit was used in the statistical calculations. The City of Fort Worth emphasizes its bioassessment activities and collects one sample per year at its designated sampling sites. Therefore, summary statistics are not included in Table 5 for the City of Fort Worth (raw data is provided in Appendix F).

Table 5: Year 3 (2020) Stormwater Data Summary

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		PLANO		NTTA		DALLAS					
	AR2001	AR2002	GRA2001	GRA2002	GRA2003	IR2001	IR2002	MS2001	MS2002	PL2001	PL2002	NT2001	NT2002	TCTR-100	TCTR-200	TCTR-300	HTC-100	HTC-200	HTC-300
TDS (mg/L)																			
Minimum	150	271	471	427	462	232	111	216	140	181	140	77	131	311.0	263.0	100.0	128.0	202.0	301.0
Maximum	877	650	492	705	561	476	251	341	342	385	432	177	216	967.0	355.0	512.0	495.0	505.0	528.0
Mean	491	455	484	533	494	335	173	303	252	265	301	124	164	563.5	314.8	277.3	335.3	404.8	419.3
Median	468	449	486	499	476	317	164	327	264	246	316	122	154	488.0	320.5	248.5	359.0	456.0	424.0
Std. Dev	317	187	10	127	45	104	65	59	84	88	130	48	37	293.5	46.0	187.7	180.7	140.8	117.9
TSS (mg/L)																			
Minimum	3.8	6.8	1.4	70.0	18.9	21.3	23.8	7.1	4.4	37.5	4.7	55.2	58.8	67.0	83.0	92.0	40.0	21.0	50.0
Maximum	211.0	72.5	158.0	182.0	39.6	349.0	147.0	1010.0	317.0	1440.0	1120.0	1570.0	108.0	190.0	222.0	182.0	178.0	108.0	83.0
Mean	124.0	40.4	51.6	125.5	25.4	140.8	66.6	274.2	107.7	593.4	485.6	454.5	87.8	140.3	159.0	140.8	102.5	68.0	70.8
Median	140.5	41.1	23.4	125.0	21.6	96.5	28.9	39.9	54.7	448.0	408.8	96.4	92.1	152.0	165.5	144.5	96.0	71.5	75.0
Std. Dev	88.0	37.0	72.1	46.5	9.5	149.3	69.7	490.8	141.7	629.3	561.4	744.1	20.9	52.5	57.3	42.9	62.9	38.8	15.4
BOD (mg/L)																			
Minimum	1.00	2.10	1.00	8.40	1.00	1.00	3.40	2.00	3.60	1.00	1.00	5.40	2.40	4.80	4.10	3.80	5.60	5.60	5.00
Maximum	46.20	24.00	6.30	106.00	5.60	6.30	7.80	5.20	10.90	24.90	11.80	16.80	9.50	35.40	22.60	10.30	10.80	12.90	11.20
Mean	15.50	8.40	2.33	33.78	2.65	3.90	5.17	3.65	5.65	10.28	5.08	10.18	6.60	14.53	10.15	6.15	7.43	8.20	7.13
Median	7.40	3.75	1.00	10.35	2.00	4.15	4.30	3.70	4.05	7.60	3.75	9.25	7.25	8.95	6.95	5.25	6.65	7.15	6.15
Std. Dev	20.69	10.47	2.65	48.17	2.18	2.80	2.32	1.32	3.51	10.79	5.18	4.81	3.06	14.23	8.66	2.86	2.33	3.22	2.88
COD (mg/L)																			
Minimum	5.0	5.0	5.0	5.0	5.0	5.0	5.0	17.7	5.0	5.0	5.0	5.0	5.0	17.5	17.5	17.5	BDL	0.0	17.5
Maximum	93.0	110.0	30.9	217.0	26.5	15.6	33.1	138.0	35.3	127.0	24.7	39.6	37.5	95.2	88.8	52.5	BDL	37.5	37.5
Mean	34.7	42.6	16.2	67.9	14.8	9.9	17.4	51.1	20.0	41.0	13.7	22.9	18.9	36.9	35.3	26.3	BDL	18.1	22.5
Median	20.3	27.7	14.5	24.7	13.8	9.5	15.7	24.3	19.9	15.9	12.5	23.6	16.5	17.5	17.5	17.5	BDL	17.5	17.5
Std. Dev	41.5	49.8	10.8	99.9	8.9	5.7	14.5	58.3	13.4	58.3	10.2	15.6	14.3	38.9	35.7	17.5	BDL	15.3	10.0
TOTAL NITROGEN (mg/L)																			
Minimum	0.47	0.41	4.60	4.70	1.20	1.10	1.50	0.15	0.22	2.60	2.10	1.20	1.00	1.20	0.30	0.44	1.00	1.90	1.30
Maximum	4.90	2.10	9.50	10.20	12.10	1.60	1.70	4.20	2.40	4.70	3.80	6.60	1.90	2.50	3.70	2.60	2.80	2.70	2.00
Mean	2.64	1.01	7.70	7.68	6.98	1.28	1.60	1.53	1.24	3.48	3.10	3.25	1.53	1.73	1.70	1.30	2.13	2.30	1.58
Median	2.60	0.76	8.35	7.90	7.30	1.20	1.60	0.89	1.17	3.30	3.25	2.60	1.60	1.60	1.40	1.09	2.35	2.30	1.50
Std. Dev	1.85	0.75	2.27	2.46	4.56	0.22	0.08	1.83	0.91	0.94	0.72	2.44	0.39	0.55	1.43	1.01	0.86	0.34	0.30
NITRATE N (mg/L)																			
Minimum	0.110	0.140	3.600	0.013	4.800	0.310	0.420	0.110	0.220	0.640	0.510	0.460	0.190	0.610	0.540	0.410	0.520	1.600	0.190
Maximum	0.520	0.550	8.600	8.000	11.200	0.760	1.200	0.270	0.720	2.000	2.100	1.100	0.770	1.100	1.900	0.700	2.100	2.200	1.500
Mean	0.385	0.325	6.550	3.648	7.575	0.523	0.725	0.170	0.465	1.125	1.228	0.743	0.483	0.765	0.923	0.525	1.255	1.850	0.958
Median	0.455	0.305	7.000	3.290	7.150	0.510	0.640	0.150	0.460	0.930	1.150	0.705	0.485	0.675	0.625	0.495	1.200	1.800	1.070
Std. Dev	0.187	0.180	2.183	3.874	2.659	0.202	0.350	0.069	0.208	0.638	0.751	0.294	0.272	0.230	0.654	0.138	0.693	0.265	0.560
AMMONIA N (mg/L)																			
Minimum	0.014	0.014	0.059	0.057	0.076	0.064	0.063	0.014	0.014	0.014	0.014	0.014	0.120	BDL	0.050	0.130	0.120	0.050	0.050
Maximum	0.290	0.130	0.600	7.600	0.200	0.130	0.160	0.071	0.088	0.320	0.150	0.500	0.310	BDL	0.300	0.440	0.520	0.240	0.200
Mean	0.161	0.069	0.205	2.157	0.138	0.100	0.113	0.033	0.053	0.144	0.071	0.241	0.175	BDL	0.145	0.230	0.300	0.175	0.115
Median	0.170	0.066	0.080	0.485	0.139	0.103	0.115	0.014	0.055	0.120	0.061	0.224	0.135	BDL	0.115	0.230	0.280	0.205	0.105
Std. Dev	0.114	0.048	0.264	3.645	0.066	0.031	0.042	0.033	0.036	0.128	0.061	0.232	0.091	BDL	0.108	0.144	0.166	0.085	0.077
ORTHOPHOSPHATE (mg/L)																			
Minimum	0.010	0.010	0.065	0.130	0.050	0.010	0.010	0.010	0.020	0.010	0.010	0.051	0.010	0.020	0.020	0.020	0.074	0.020	0.020
Maximum	0.130	0.190	0.310	0.390	0.460	0.160	0.150	0.130	0.120	0.320	0.340	0.130	0.120	0.130	0.200	0.180	0.140	0.078	0.064
Mean	0.069	0.071	0.166	0.263	0.213	0.080	0.087	0.043	0.068	0.113	0.170	0.085	0.055	0.054	0.065	0.071	0.116	0.055	0.047
Median	0.069	0.043	0.145	0.265	0.170	0.075	0.093	0.015	0.067	0.061	0.165	0.080	0.046	0.033	0.020	0.043	0.125	0.060	0.051
Std. Dev	0.060	0.081	0.120	0.112	0.175	0.064	0.058	0.059	0.046	0.141	0.164	0.033	0.046	0.052	0.090	0.075	0.029	0.026	0.020

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		PLANO		NTTA		DALLAS					
	AR2001	AR2002	GRA2001	GRA2002	GRA2003	IR2001	IR2002	MS2001	MS2002	PL2001	PL2002	NT2001	NT2002	TCTR-100	TCTR-200	TCTR-300	HTC-100	HTC-200	HTC-300
DISSOLVED PHOSPHORUS (mg/L)																			
Minimum	0.009	0.008	0.069	0.009	0.057	0.040	0.082	0.009	0.042	0.009	0.009	0.080	0.032	0.025	0.025	0.025	0.063	0.025	0.025
Maximum	0.120	0.150	0.320	0.460	0.450	0.066	0.260	0.058	0.110	0.310	0.053	0.190	0.078	0.071	0.052	0.110	0.650	0.059	0.093
Mean	0.062	0.060	0.212	0.189	0.207	0.055	0.135	0.026	0.069	0.103	0.029	0.119	0.055	0.037	0.032	0.057	0.278	0.042	0.049
Median	0.059	0.042	0.230	0.143	0.160	0.056	0.099	0.019	0.061	0.046	0.027	0.103	0.055	0.025	0.025	0.046	0.200	0.042	0.040
Std. Dev	0.048	0.062	0.105	0.214	0.171	0.013	0.084	0.023	0.032	0.141	0.023	0.051	0.024	0.023	0.014	0.041	0.264	0.020	0.032
TOTAL PHOSPHORUS (mg/L)																			
Minimum	0.049	0.024	0.095	0.009	0.120	0.038	0.091	0.056	0.042	0.210	0.051	0.180	0.140	0.025	0.083	0.100	0.120	0.110	0.110
Maximum	0.740	0.300	0.360	0.670	0.550	0.280	0.310	0.099	0.240	0.940	1.700	0.850	0.220	0.220	0.320	0.260	0.420	0.240	0.260
Mean	0.362	0.163	0.249	0.385	0.280	0.167	0.218	0.077	0.156	0.623	0.798	0.368	0.188	0.154	0.216	0.203	0.280	0.178	0.178
Median	0.330	0.163	0.270	0.430	0.225	0.175	0.235	0.077	0.170	0.670	0.720	0.220	0.195	0.185	0.230	0.225	0.290	0.180	0.170
Std. Dev	0.292	0.138	0.111	0.285	0.189	0.106	0.110	0.022	0.092	0.303	0.784	0.323	0.034	0.088	0.098	0.071	0.123	0.067	0.067
ATRAZINE (µg/L)																			
Minimum	0.060	0.050	0.050	0.051	0.050	0.050	0.050	0.050	0.050	0.044	0.065	0.050	0.050	BDL	BDL	BDL	0.049	0.050	0.049
Maximum	0.914	0.892	0.300	0.085	0.226	1.650	0.076	0.806	1.960	0.602	0.338	0.172	0.210	BDL	BDL	BDL	0.160	0.200	0.130
Mean	0.376	0.399	0.138	0.070	0.133	0.458	0.057	0.242	0.634	0.251	0.172	0.081	0.100	BDL	BDL	BDL	0.077	0.115	0.070
Median	0.265	0.328	0.100	0.072	0.128	0.067	0.051	0.055	0.264	0.178	0.142	0.050	0.070	BDL	BDL	BDL	0.055	0.105	0.050
Std. Dev	0.372	0.362	0.114	0.017	0.078	0.795	0.013	0.376	0.898	0.244	0.123	0.061	0.076	BDL	BDL	BDL	0.049	0.077	0.040
TOTAL ARSENIC (mg/L)																			
Minimum	0.0010	0.0009	0.0010	0.0018	0.0009	0.0014	0.0013	0.0011	0.0017	0.0008	0.0008	0.0019	0.0019	BDL	BDL	BDL	BDL	BDL	BDL
Maximum	0.0160	0.0020	0.0031	0.0240	0.0021	0.0082	0.0060	0.0060	0.0039	0.0086	0.0095	0.0063	0.0037	BDL	BDL	BDL	BDL	BDL	BDL
Mean	0.0062	0.0012	0.0018	0.0116	0.0014	0.0037	0.0029	0.0024	0.0026	0.0052	0.0054	0.0033	0.0026	BDL	BDL	BDL	BDL	BDL	BDL
Median	0.0039	0.0011	0.0016	0.0104	0.0013	0.0026	0.0022	0.0013	0.0023	0.0057	0.0056	0.0026	0.0025	BDL	BDL	BDL	BDL	BDL	BDL
Std. Dev	0.0068	0.0005	0.0010	0.0111	0.0005	0.0031	0.0021	0.0024	0.0010	0.0035	0.0046	0.0020	0.0008	BDL	BDL	BDL	BDL	BDL	BDL
TOTAL CHROMIUM (mg/L)																			
Minimum	0.0003	0.0005	0.0003	0.0012	0.0006	0.0019	0.0038	0.0006	0.0006	0.0006	0.0006	0.0036	0.0019	0.0035	0.0035	0.0035	0.004	BDL	0.0035
Maximum	0.0048	0.0025	0.0020	0.0046	0.0018	0.0059	0.0190	0.0220	0.0059	0.0270	0.0290	0.0270	0.0052	0.0093	0.0093	0.035	0.008	BDL	0.0084
Mean	0.0028	0.0013	0.0012	0.0025	0.0011	0.0035	0.0120	0.0066	0.0024	0.0147	0.0141	0.0113	0.0038	0.005	0.005	0.013	0.005	BDL	0.005
Median	0.0031	0.0010	0.0013	0.0022	0.0010	0.0032	0.0126	0.0020	0.0016	0.0155	0.0134	0.0073	0.0040	0.004	0.004	0.006	0.004	BDL	0.004
Std. Dev	0.0019	0.0009	0.0009	0.0015	0.0005	0.0019	0.0068	0.0103	0.0024	0.0112	0.0140	0.0106	0.0014	0.003	0.003	0.015	0.002	BDL	0.002
TOTAL COPPER (mg/L)																			
Minimum	0.0005	0.0012	0.0005	0.0024	0.0021	0.0050	0.0061	0.0009	0.0027	0.0014	0.0016	0.0081	0.0023	BDL	BDL	BDL	0.010	BDL	BDL
Maximum	0.0140	0.0100	0.0039	0.0062	0.0044	0.0120	0.0120	0.0200	0.0089	0.0290	0.0250	0.0420	0.0090	BDL	BDL	BDL	0.023	BDL	BDL
Mean	0.0071	0.0042	0.0027	0.0046	0.0030	0.0088	0.0083	0.0072	0.0050	0.0164	0.0131	0.0170	0.0064	BDL	BDL	BDL	0.013	BDL	BDL
Median	0.0069	0.0028	0.0032	0.0049	0.0027	0.0091	0.0076	0.0040	0.0043	0.0175	0.0129	0.0090	0.0071	BDL	BDL	BDL	0.010	BDL	BDL
Std. Dev	0.0060	0.0039	0.0015	0.0016	0.0010	0.0030	0.0027	0.0087	0.0029	0.0117	0.0116	0.0167	0.0030	BDL	BDL	BDL	0.007	BDL	BDL
TOTAL LEAD (mg/L)																			
Minimum	0.0001	0.0003	0.0001	0.0009	0.0002	0.0006	0.0011	0.0003	0.0002	0.0003	0.0001	0.0024	0.0022	0.0005	0.0050	0.0050	0.0050	0.0050	0.0150
Maximum	0.0044	0.0024	0.0014	0.0028	0.0015	0.0042	0.0054	0.0220	0.0057	0.0170	0.0190	0.0220	0.0040	0.0180	0.0190	0.0170	0.0230	0.0200	0.0240
Mean	0.0028	0.0011	0.0007	0.0017	0.0007	0.0027	0.0030	0.0062	0.0023	0.0086	0.0093	0.0078	0.0030	0.0096	0.0133	0.0100	0.0115	0.0120	0.0200
Median	0.0034	0.0008	0.0007	0.0016	0.0005	0.0029	0.0027	0.0013	0.0017	0.0085	0.0092	0.0035	0.0030	0.0100	0.0145	0.0090	0.0090	0.0115	0.0205
Std. Dev	0.0020	0.0010	0.0006	0.0008	0.0006	0.0016	0.0020	0.0105	0.0024	0.0071	0.0095	0.0095	0.0009	0.0072	0.0066	0.0060	0.0085	0.0081	0.0042
TOTAL ZINC (mg/L)																			
Minimum	0.0130	0.0042	0.0046	0.0140	0.0068	0.0250	0.0210	0.0028	0.0053	0.0095	0.0060	0.0520	0.0490	0.0125	0.0125	0.0710	0.0125	0.0125	0.0360
Maximum	0.0490	0.0590	0.0200	0.0270	0.0260	0.0750	0.0520	0.1300	0.0420	0.1200	0.1100	0.3000	0.0610	0.0670	0.0880	0.0830	0.1200	0.0930	0.0810
Mean	0.0375	0.0228	0.0112	0.0198	0.0132	0.0470	0.0373	0.0402	0.0211	0.0679	0.0558	0.1215	0.0535	0.0431	0.0576	0.0788	0.0455	0.0476	0.0495
Median	0.0440	0.0140	0.0101	0.0190	0.0101	0.0440	0.0380	0.0140	0.0185	0.0710	0.0535	0.0670	0.0520	0.0465	0.0650	0.0805	0.0248	0.0425	0.0405
Std. Dev	0.0170	0.0248	0.0066	0.0056	0.0087	0.0207	0.0129	0.0601	0.0153	0.0473	0.0519	0.1192	0.0053	0.0230	0.0322	0.0054	0.0510	0.0345	0.0211
OIL AND GREASE (mg/L)																			
Minimum	0.18	0.18	0.18	0.18	0.39	0.56	0.20	0.20	0.18	0.18	0.18	0.19	0.50	BDL	BDL	BDL	BDL	BDL	BDL

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		PLANO		NTTA		DALLAS					
	AR2001	AR2002	GRA2001	GRA2002	GRA2003	IR2001	IR2002	MS2001	MS2002	PL2001	PL2002	NT2001	NT2002	TCTR-100	TCTR-200	TCTR-300	HTC-100	HTC-200	HTC-300
Maximum	1.20	1.80	0.85	3.90	3.10	3.80	3.20	1.10	6.30	2.00	1.30	4.20	2.40	BDL	BDL	BDL	BDL	BDL	BDL
Mean	0.67	0.97	0.48	2.04	1.46	1.87	1.50	0.50	2.42	0.64	0.46	2.10	1.40	BDL	BDL	BDL	BDL	BDL	BDL
Median	0.64	0.96	0.45	2.05	1.17	1.55	1.29	0.20	1.59	0.19	0.18	2.00	1.35	BDL	BDL	BDL	BDL	BDL	BDL
Std. Dev	0.56	0.90	0.35	1.53	1.17	1.39	1.29	0.52	2.91	0.91	0.56	1.91	0.80	BDL	BDL	BDL	BDL	BDL	BDL
pH (su)																			
Minimum	6.50	7.90	7.45	7.00	8.05	8.60	8.40	7.20	7.68	7.97	7.61	7.91	8.30	6.46	7.45	7.5	7.34	7.55	7.84
Maximum	8.20	8.50	8.38	8.28	8.38	9.20	9.20	8.50	8.50	8.38	8.41	8.90	9.00	7.81	8.36	9.08	8.11	8	8.05
Mean	7.63	8.20	8.08	7.68	8.27	8.83	8.75	8.15	8.12	8.21	8.17	8.50	8.63	7.33	7.88	8.09	7.68	7.83	7.95
Median	7.90	8.20	8.25	7.72	8.32	8.75	8.70	8.45	8.15	8.24	8.33	8.60	8.62	7.52	7.85	7.88	7.63	7.89	7.96
Std. Dev	0.76	0.24	0.43	0.67	0.15	0.26	0.34	0.64	0.39	0.18	0.37	0.45	0.39	0.60	0.39	0.72	0.35	0.21	0.10
E. COLI (col/100 mL)																			
Minimum	131	10	5	120	97	331	323	5	5	1414	154	631	959	1986	1986	1986	261	261	862
Maximum	12033	1414	2489	9208	464	8164	10462	2481	8664	8664	24196	24196	2359	10462	3448	6488	1145	2420	1553
Mean	3151	452	735	3056	239	4654	4711	758	2888	4853	6647	15505	1672	5777	2717	3811	632	1252	1208
Median	220	192	223	1447	198	5060	4030	273	1442	4667	1119	18597	1685	4884	2717	3386	488	1163	1208
Std. Dev	5922	657	1175	4219	163	3885	4240	1169	3990	3650	11710	11234	613	4308	1034	2059	459	1001	489

SUBWATERSHED LAND USE ANALYSIS

The land use composition of watersheds often significantly impacts the pollutant loads generated in stormwater runoff. Various studies have associated certain types of pollutants with particular land use types. A similar correlation was found in the North Central Texas area during the first permit term's sampling effort (Alan Plummer & Associates, Inc. & Camp Dresser & McKee, 1994; Pitt, 2005; USEPA, 1983; UWRRC, ASCE, & WEF, 1992). Higher levels of metals, oil and grease, and total suspended solids were found in predominantly industrial areas. In contrast, higher levels of nutrients, biochemical oxygen demand (BOD), pesticides, and herbicides were associated with predominantly residential watersheds. Studies have also correlated pollutant runoff levels to the degree of impervious surface coverage, and these have, in turn, been associated with various land use types (CWP, 2003). For example, heavy industrial areas are recognized for their expansive buildings surrounded by large parking lots and are on average 80% impervious. Residential areas customarily have lots that are only partially covered with dwellings, driveways, and sidewalks, and the rest is usually grassy or wooded. Impervious estimates for these areas are usually in the range of 50-75%.

Land Use Classification and Composition for Subwatershed and Drainage Areas

This report provides land use classifications for each subwatershed containing the 2020 sampling sites. Land use classifications were determined for each subwatershed using the 2015 NCTCOG Regional Land Use data. NCTCOG's standard 42 land use categories were combined into the following six categories for the purpose of this analysis: commercial, industrial, open space, residential, roads, and water. Table 6 shows the land use classifications used for this analysis and the percentage of impervious cover typically related to each land use type.

Table 7 includes land use composition estimates of drainage areas for each of the chemical sampling sites. Land use category percentages were calculated based on the proportion of each land use type over the total area for that site's drainage area and expressed as a percent. Note that the sampling sites are arranged as upper, middle, and lower sites within a subwatershed in most cases. However, the drainage area and associated land use percentages provided in Table 7 for the midstream and downstream sampling sites exclude the upstream site's drainage area(s). The total drainage area and land use for the midstream and downstream sites may be calculated by adding in the area for the upstream site(s). While it may be expected that some portion of pollutant loading is cumulative as pollutants travel towards the midstream and downstream sites, it is also recognized that pollutant attenuation through degradation, settling, and dilution could also occur.

Table 8 provides detailed watershed descriptions of land use composition estimates for each chemical sampling site's subwatershed and site drainage area. Figures 3 through 16 depicts the 2016 Watershed Boundary Dataset HUC12 subwatersheds, 2015 NCTCOG land use categories, chemical sampling site drainage areas, 2020 sampling sites, and airports, lakes, streams, Trinity River, and city and county boundaries. Figures 3 through 16 depicts the land use composition of subwatersheds where chemical sampling took place. The land use composition of the watersheds in figures 3 through 16 can often significantly impact the pollutant loads generated in stormwater runoff.

Table 6: 2015 NCTCOG Regional Land Use Classifications

LAND USE CATEGORIES	MONITORING LAND USE CATEGORIES	% IMPERVIOUS COVER
Office	Commercial	70 - 90%
Commercial		
Educational		
Large Stadium		
Railroad		
Communication		
Transit		
Mixed Use		
Retail		
Hotel/Motel		
Institutional/Semi-Public		
Utilities		
Parking		
Airport	Road	90%
Primary Highways		
Secondary Highway		
Major Arteries		
Minos Arteries		
Connecting		
Private Roads		
Service Roads		
Access Ramps		
Driveways		
Trails		
Industrial	Industrial	80%
Parks/Recreation	Open	10 - 45%
Landfill		
Cemeteries		
Residential Acreage		
Ranchland		
Timberland		
Farmland		
Improved Acreage		
Flood Control		
Under Construction		
Vacant		
Group Quarters	Residential	50 - 75%
Single Family		
Multi-Family		
Mobile Homes		
Water	Water	N/A
Small Water Bodies		

Table 7: Land Use Composition Estimates for Chemical Sampling Drainage Areas

Watershed	Site ID	Location	Drainage Area Total (Acres)	Commercial (Acres %)	Industrial (Acres %)	Open (Acres %)	Residential (Acres %)	Water (Acres %)	Roads (Acres %)
Arlington									
Rush Creek	AR2001	Rush Creek at West Sublett Road	5,900.8	676.9/11.5	75.3/1.3	2,025.8/34.3	2,345.3/39.7	7.3/0.1	770.2/13.1
	AR2002	Rush Creek at Woodland Park Boulevard	18,358	2,447.7/13.3	160.8/0.9	3,512.3/19.1	8,957.5/48.4	48.2/0.3	3,231.5/17.6
Dallas									
Turtle Creek	TCTR-100	3805 Pipestone Road at Mican Channel	9.8	1.9/19.4	2.6/26.5	1.3/13.3	0/0	0/0	4/40.8
	TCTR-200	3951 La Reunion Parkway at Mican Channel	9.6	0/0	4.2/43.8	3.4/35.4	0/0	0/0	2/20.8
	TCTR-300	4300 Singleton Boulevard at Mican Channel	1,814.2	226.2/12.5	667.4/36.8	582.3/32.1	94.2/5.2	8.8/0.5	235.3/13
Headwaters Turtle Creek	HTC-100	3505 Maple Avenue at Turtle Creek	4,392.1	481.8/11.0	2.6/0.1	399.9/9.1	2,475.8/56.4	22.4/0.5	1,009.6/23
	HCT-200	1201 Turtle Creek Boulevard at Turtle Creek	155.0	79.8/51.5	16.9/10.9	20.8/13.4	0/0	0.3/0.2	37.1/23.9
	HCT-300	2240 Irving Boulevard at Turtle Creek / 2240 Irving Blvd.	8,160.5	1,517.5/18.6	55.1/0.7	753.4/9.2	3,623.9/44.4	65.3/0.8	2,145.4/26.3
Fort Worth									
Sycamore Creek	FWLFC1	2200 block Cantrell Sansom	3,257.9	781.2/24	475.9/14.6	901.4/27.7	699.6/21.5	0.7/0.02	399/12.2
	FWLFC3	Dead end of Mesquite Rd. south of 3800 Long Ave.	8,153.2	1,958.6/24	1,173.6/14.4	2,825.6/34.7	974.5/12	7/0.1	1,214.1/14.9
Big Fossil Creek	FWBFC1	7764 N Blue Mound Road	6,065.8	699.7/11.5	70.5/1.2	3,565.1/58.8	1,328.8/21.9	48.9/0.8	370.7/6.1
	FWBFC3	N. Beach St. north of Paula Ridge	19,707.7	2,046.4/10.4	148.2/0.8	9,425/47.8	5,432.5/27.6	140.9/0.7	2,532.5/12.9
Garland									

Watershed	Site ID	Location	Drainage Area Total (Acres)	Commercial (Acres %)	Industrial (Acres %)	Open (Acres %)	Residential (Acres %)	Water (Acres %)	Roads (Acres %)
Rowlett Creek – Lake Ray Hubbard	GA2001	Rowlett Creek at Ben Davis Bridge	566.4	41.8/7.4	0/0	86.6/15.3	349/61.6	0.8/0.14	88.2/15.6
	GA2002	Rowlett Creek at Centerville Road/Castle Drive	5,297.5	536.8/10.1	40.1/0.8	2,089.1/39.4	1710.7/32.3	8.9/0.2	912/17.2
	GA2003	Rowlett Creek at Highway 66	5,916.6	568.8/9.6	40.1/0.7	2,311/39.1	1,926.9/32.6	29.3/.05	1,040.4/17.6
Irving									
Grapevine Creek – Elm Fork Trinity River	IR2001	Grapevine Creek at N. Royal Lane	2,296	0/0	596.2/26	210.3/9.2	0/0	0/0	1,489.6/64.9
Estelle Creek – Bear Creek	IR2002	Estelle Creek at W. Rochelle Road	1,458.7	156.8/10.7	0/0	445.5/30.5	215.6/14.8	0/0	640.8/43.9
Mesquite									
South Mesquite Creek	MS2001	North of New Market Road	9,964.4	2,302.5/23.1	456.4/4.6	1,641.1/16.5	3,291.6/33	12.2/0.1	2,260.6/22.7
North Mesquite Creek	MS2002	North Mesquite Creek at Edward's Church	6,240.8	824.4/13.2	229.3/3.7	1,920.2/30.8	2,165.5/34.7	15.4/0.2	10,86/17.4
Plano									
Headwaters Rowlett Creek	PL2001	Rowlett Creek at Alma Drive	16,626.7	1,379.1/8.3	80.5/0.5	6,814.5/41.0	5,633.4/33.9	42.4/0.3	2,676.9/16.1
Brown Branch Rowlett Creek	PL2002	Rowlett Creek in Oak Point Park	2,234.5	352.6/15.8	147.4/6.6	856.5/38.3	492.1/22	5.7/0.3	380.2/17
North Texas Tollway Authority									
Cottonwood Branch - Hackberry Creek	NT2001	Unnamed Tributary at SH 161 N. of Gateway Dr.	1,509.4	278.1/18.4	0/0	557.8/37	18.1/1.2	0/0	655.3/43.4
Cottonwood Creek - Mountain Creek Lake	NT2002	Cottonwood Creek at SH 161 S. of Dickey Road	3,318.8	464.9/14	399/12.0	659.7/19.9	1,184.4/35.7	0/0	610.7/18.4

Table 8: Detailed Subwatershed and Drainage Area Land Use Descriptions

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
Arlington	Rush Creek - Village Creek	Located in South East Tarrant County and has a total area of 31,007.3-acre. The land is predominantly residential (39.7%), open space (34.3%), commercial (11.5%) and is composed by 2.5% of roads, which includes primary and secondary highways, major and minor arteries, connecting, private and service roads, access ramps, driveways, trails, and airports. 14.0% of this subwatershed is open space areas and 0.3% are water bodies. Industrial areas are found throughout the subwatershed.	AR2001 - West Sublett Road	The delineated drainage area coves 5,900.8-acres and consists predominantly of 39.7% residential property and 34.3% of open space. There are also several commercial (11.5%) properties and roads (2.5%) near the sampling site. Industrial land use accounts for 1.3% and is concentrated in the southeast direction of this delineated drainage site. An estimation of 0.1% water features is present in this drainage site.
			AR2002 - at Woodland Park Boulevard	The delineated drainage area coves 18,358-acres and consists predominantly of 48.8% residential property and 19.1% of open space. There are also several commercial (13.3%) properties and roads (17.6%) near the sampling site. Industrial land use accounts for 0.9% and is concentrated in the southeast direction of this delineated drainage site. An estimation of 0.3% water features is present in this drainage site.
Dallas	Turtle Creek - Trinity River	Turtle Creek is in Dallas County on the Trinity River and is estimated at 22,443-acres. Residential is the predominant land use, it is estimated at 31.3%. Residential landuse is in the southern portion of the subwatershed. Open space is estimated at 27.5% due to the open areas along the trinity river and throughout the subwatershed. IH-35W and Hwy 30 cross through the subwatershed and is estimated at 21.2%. Commercial land uses are estimated at 11.4%. Water features and industrial sites are estimated at 1.2% and 7.5%.	TCTR-100 - Pipestone Road at Mican Channel	The delineated drainage site has a total area of 9.8-acres and consists predominantly of industrial (43.8%). Open space account for 35.4% of the subwatershed, while roads account (19.4%) is found in the center of the subwatershed. Open space (12.5%) is along the stream bank. There is one industrial (0.1%) site in the lower watershed. There are no water features in the subwatershed.
			TCTR-200 - La Reunion Parkway at Mican Channel	The delineated drainage site has a total area of 9.6-acres and consists predominantly of industry (43.8%). Roads account for 20.8% of the subwatershed, while open space (35.4%) is along the stream bank. There are no water features, residential and commercial in the subwatershed.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
			TCTR-300 - Singleton Boulevard at Mican Channel	The delineated drainage site has a total area of 1,814.2-acres and consists predominantly of industrial (36.8%). Open space account for 32.1% of the subwatershed, while roads account (13%) as Hwy-30 runs through the drainage site. Commercial (12.5%) property can be found along Hwy-30. There is one industrial (0.1%) site in the lower watershed. Water features can be found on .5% of the site.
	Headwaters Turtle Creek	Headwaters Turtle Creek is in Dallas County and is estimated to have 21,888-acres. Residential (28.4%), commercial (27.4%) and roads (28.7%) are evenly distributed throughout the site. Open space is estimated at 11% and industrial land uses are estimated are 3.5%. water features are estimated at 0.9%	HTC-100 - Maple Avenue at Turtle Creek	The delineated drainage site has a total area of 481.8 acres. Residential (56.4%) and roads (23%) make up the majority of this subwatershed. Commercial land use accounts for 11.0%, and open space for 9.1%. Industrial and water features occupy 0.1% and 0.5% respectively.
			HTC-200 - Turtle Creek Boulevard at Turtle Creek	The delineated drainage site has a total area of 155.0 acres. Commercial (51.5%) and roads (23.9%) make up the majority of this subwatershed. Industrial land use accounts for 10.9%, and open space for 13.4%. Water features occupy 0.2% respectively. There are no residential land uses in the drainage area.
			HTC-300 - Irving Boulevard at Turtle Creek	The delineated drainage site has a total area of 8,160.5 acres. Residential (44.4%) and roads (26.3%) make up the majority of this subwatershed. Industrial land use accounts for 18.6%, and open space for 9.2%. Water features occupy 0.8% respectively. Commercial accounts for 26.3% of the drainage site.
Fort Worth	Sycamore Creek - West Fork Trinity River	Sycamore Creek is in the middle of Tarrant County and is estimated to have 22,339-acres. Open space (29.6%) is the predominate land use in the watershed and is in the eastern portion of the subwatershed. Residential (25.4%) land use is the second most common land use type and is in the middles and western portion of the subwatershed. Commercial land use is estimated at 19.4%. Roads 820, 35W 30 and 108 all cross through the subwatershed giving it an estimated land use at 15.2%. Industrial land uses are mixed through the	FWLFC1 - 2200 block Cantrell Sansom	Has a total area of 3,257.9 acres and primarily consist of commercial property (24%). Open space is the second largest feature in this watershed and make up 27.7% of the total area. Hwy 20 goes through the southern portion of the watershed. Residential, industrial and roads occupy 21.5%, 14.6% and 12.2% respectively. There are no water features in this drainage area.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
		subwatershed and is estimated at 9.2%. Water features is estimated at 1.2%.	FWLFC3 - Mesquite Rd. south of 3800 Long Ave.	Has a total area of 8,123.2 acres. Commercial (24.0%) and open space (34.7%) make up the majority of this subwatershed. Residential land use accounts for 12.0%, and roads for 14.9%. Industrial and water features occupy 14.4% and 0.1% respectively.
	Whites Branch - Big Fossil Creek	Whites Branch subwatershed is in North Tarrant County and is estimated at 35,840-acres. Open space is in the north portion of the watershed and is estimated at 36.3%. Residential is the second larger land use and is estimate at 34.5%. Major roads that cross through the subwatershed are Hwy 30 and Hwy 35W, its land use is estimated at 15%. Commercial land use is estimated at 12.3%. Industrial land use is estimated at 1.2% and water features are estimated at 0.6%.	FWBFC1 - N Blue Mound Road	The subwatershed delineated for this sampling location covers a 6,065.8 -acre area and over half of the area consists of open space (58.8%), followed by residential (21.9%) properties. Roads (6.1%) consist of minor arterials and commercial (11.5%) properties comprise most of the remaining areas. Water (0.8%) features and industrial (1.2%) areas round out the balance of this area.
			FWBFC3 - N. Beach St. north of Paula Ridge	The subwatershed delineated for this sampling location covers a 1,9707.7 -acre area and almost half of the area consists of open space (47.8%), followed by residential (27.6%) properties. Roads (12.9%) major arterials such as N. Beach Street, Denton Hwy and commercial (10.4%) properties comprise most of the remaining areas. Water (0.7%) features and industrial (0.8%) areas round out the balance of this area.
Garland	Rowlett Creek – Lake Ray Hubbard	Rowlett Creek – Lake Ray Hubbard subwatershed is in Dallas County on the west side of lake Ray Hubbard and is estimated at 1,7257-acres. The subwatershed is predominantly residential which is estimated at 34.%. Open space is estimated at 26.9% and is located around Rowlett Creek. Roads are estimated at 16.9% with President George Bush Turnpike and other minor and major arterials. Commercial land use can be found throughout the site and is estimated at 10.9%. Water features are estimated at 9.3%	GA2001 - at Ben Davis Bridge	This delineated drainage site has a total area of 566.4-acres. The predominant land use is residential properties (61.6%) and roads (15.6%), Lavon Dr. and minor arterial streets. Commercial properties (7.4%) are in the north portion of this drainage site. Open space composes 15.3% of the drainage area and 0.1% of water features are found in this watershed. There are no industrial uses in the drainage area.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
		due to Rowlett Creek and Lake Ray Hubbard. Industrial land uses are estimated at 1.7%.	GA2002 - at Centerville Road/Castle Drive	This delineated drainage site has a total area of 5,297.5-acres. The predominant land use is residential properties (32.3%) and open space (39.4%). Commercial properties (10.1%) can be found throughout this drainage site, and industrial areas (0.8%) can be found south east and south west in the site. Roads composes 17.2% of the drainage area with President George Bush Turnpike and other minor and major arterials. 0.2% of water features are found in this watershed.
			GA2003 - at Highway 66	This delineated drainage site has a total area of 5916.6-acres. The predominant land use is residential properties (32.6%) and open space (39.1%). Commercial properties (10.1%) are in the south and south east portion of this drainage site. Roads composes 15.6% of the drainage area and 0.8% of water features are found in this watershed. The industrial uses in the drainage area account for 0.7%.
Irving	Grapevine Creek – Elm Fork Trinity River	Located in Tarrant and Dallas Counties this watershed contains 19,441-acres. The subwatershed has a mix of open space (26.1%), residential (19.2%) and commercial (20.5%) land use throughout the site. Roads are estimated at 19.2% due to DFW Airports location in the subwatershed. Industrial land uses are estimated at 11.5%. Water features are 3.6% of the site.	IR2001 - at N. Royal Lane	The drainage area delineated for this site covers 2,296-acres and is mainly composed of roads (64.9%) due to DFW Airport runways. Industrial properties (26.0%) and a few open spaces (9.2%) are in this site. There are no residential, commercial or water features in this site area.
	Estelle Creek – Bear Creek	Estelle Creek subwatershed is in west Dallas County and east Tarrant Count. It is 16,957-acres and is predominantly open space (32.3%) located around Bear Creek. Roads land use is estimated to be 30.6% due to its proximity to DFW Airport. Residential (17%) land use can be found in the east and west of the watershed. Commercial land uses are estimated at 10.7% while industrial land use at 6.2%. Water features make up 3.2% of the site.	IR2002 - at W. Rochelle Road	The drainage area delineated for this site covers 1,458.7-acres and is mainly composed of roads from DFW Airport and President George Bush Turnpike (43.9%). Commercial properties (10.7%) and open space (30.5%) are found throughout. Residential composes 14.8% of the drainage site and no industrial land use features are present or water features.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
Mesquite	South Mesquite Creek	Located in eastern Dallas County, southwest of Lake Ray Hubbard. South Mesquite Creek covers a 17,840-acre area and the land use is predominantly made up of residential (30.5%) and open space (31.1%) areas which are dispersed across the entire watershed. The majority of commercial (17.1%) areas are located along roads (18.2%). The industrial sites (2.6%) are concentrated in the western part of the watershed. This watershed has 0.6% water features.	MS2001 - North of New Market Road	The drainage area delineated for this site covers 9,962.1 acres and is mainly composed of residential (33.0%) and commercial (23.1%) properties. Roads also participate in a reasonable portion of the drainage area with 22.7% of the land use. Open space (16.5%) is centralized and becomes denser towards south of the drainage area. Clusters of industrial (4.6%) land use are located west of the drainage area. 0.1% of water compose the land use in this drainage area.
	North Mesquite Creek	Located between the far eastern edge of Dallas County and northwestern tip of Kaufman County. North Mesquite Creek Watershed covers a 21,862.5-acre area and consists mostly of open space (64.3%) and residential (20.9%) property. Residential property is primarily located on the western side of the subwatershed with a small section along the southern edge. Roads land use estimate for this subwatershed is 10.9%, including Mesquite Metro Airport. Industrial (1.5%) sites are mostly located in the central portion of this watershed. Most of the commercial (10.5%) areas are located throughout the watershed along roads and residential areas. This subwatershed contains 1.3% of water features.	MS2002 - at Edward's Church	The drainage area delineated for this site covers 6,239.4 acres and is mainly composed of residential properties (34.7%) and open space (30.8%). Commercial properties (13.2%) are spread over the drainage area. Clusters of industrial land use (3.7%) are concentrated towards the middle east of the drainage area. Roads compose 17.4% of land use and water bodies only 0.2%.
Plano	Headwaters Rowlett Creek	The subwatershed is in Collin County and is 24,773-acres. The site is predominantly residential (35.9%) and open space (36.9%). Water features and industrial land uses are low on the site with 0.3% and 0.7% estimates. Commercial land use is estimated at 8.4% and roads and estimated at 17.6%.	PL2001 - at Alma Drive	The drainage area delineated for this site covers a 16,626.7-acre area and primarily consists of residential properties (33.9%) and open space (41.0%). Industrial space (0.5%) is scattered throughout the drainage area but is mostly located along Sam Rayburn Tollway. Clusters of commercial (8.3%) properties is dispersed in this drainage area. There is a very small section of water bodies (0.3%) present.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
	Brown Branch Rowlett Creek	Located in Collin and Dallas Counties the subwatershed is 16,252-acre and is predominantly residential (32.7%). Open space accounts for 28.9% of the area and can mostly be found around Rowlett creek. Commercial properties (13.1%) are located throughout the site. Road land use estimates fir this subwatershed are 17.3% and include major highways such as President George Bush Turnpike and Sam Johnson Hwy. Industrial sites make up 7.5% of the site white water features make up 0.5%.	PL2002 - in Oak Point Park	The drainage area delineated for this site covers a 2,234.5-acre area and primarily consists of residential properties (22.0%) and open space (38.3%). Industrial property (6.6%) is in the north section of the drainage area. Clusters of commercial (15.8%) properties is dispersed along Sam Johnson Hwy in this drainage area. There is a very small section of water bodies (0.3%) present. Roads consist of major hwy Sam Johnson, major and minor arterials, collectors, and smaller roads.
North Texas Tollway Authority	Cottonwood Branch - Hackberry Creek	A 13,325-acre subwatershed located in northeast Dallas County. This subwatershed is composed predominately of roads acreage (39.0%) which is due to a large portion of the DFW International Airport residing in the western side of the subwatershed. Throughout the subwatershed, there are patches of open areas (22.7%) and clusters of commercial (23.1%) areas. Some of the residential (13.2%) areas are scattered along the southern edge of the watershed. The water bodies composition for this subwatershed is 1.2% and industrial land use is 0.7%.	NT2001 - at SH 161 N. of Gateway Dr.at SH 161 N. of Gateway Dr.	The delineated drainage area covers 1,509 acres. It is in the center of the Cottonwood Branch – Hackberry Creek subwatershed, and east of the Dallas/Fort Worth International airport. This drainage area is composed of 36.9% open space and 18.4% commercial. 43.4% of road land use incudes the west side property of DFW International airport. 1.2% of area is designated as residential. There are no industrial or water features in this watershed.
	Cottonwood Creek - Mountain Creek Lake	Located in southwestern Dallas County and southeastern Tarrant County. This subwatershed has a total area of 18,857.1-acres and is predominantly residential (24.2%) and open space (23.8%). Roads acreage contributes with 17.3% of land use composition, which includes Dallas NAS (Hensley/Millennium Dallas), and part of Grand Prairie Municipal airport. Commercial (13.1%) and industrial (8.5%) areas are dispersed throughout the subwatershed. Mountain Creek Lake is located inside of this subwatershed, and the water body percentage of 13.1%.	NT2002 -at SH 161 S. of Dickey Road	The delineated drainage area covers 3,318.1 acres, and the predominant land use is residential properties (35.7%) and open space (20.2%). Industrial sites (16.2%) and open space areas are mainly concentrated on the east side of the drainage area near the chemical sampling site. Commercial properties (14.0%) are dispersed throughout the drainage area and roads compose 18.0 % of the land use. There is no area designated as water body.

Figure 3: Arlington, Rush Creek Subwatershed, AR2001, AR2002

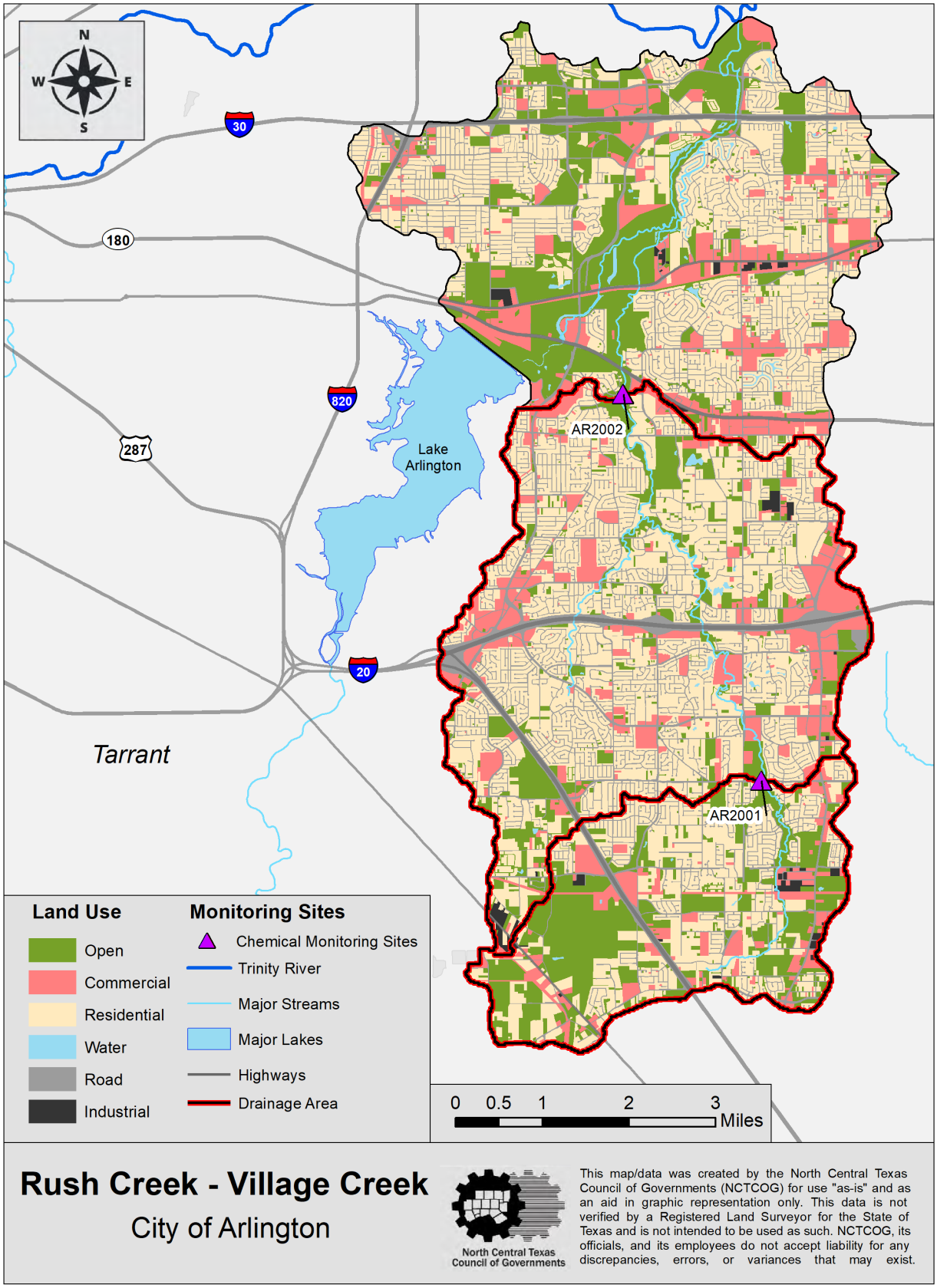


Figure 4: Dallas, Headwaters Turtle Creek – Headwaters Subwatershed, HTC-100, HTC-200, HTC-300

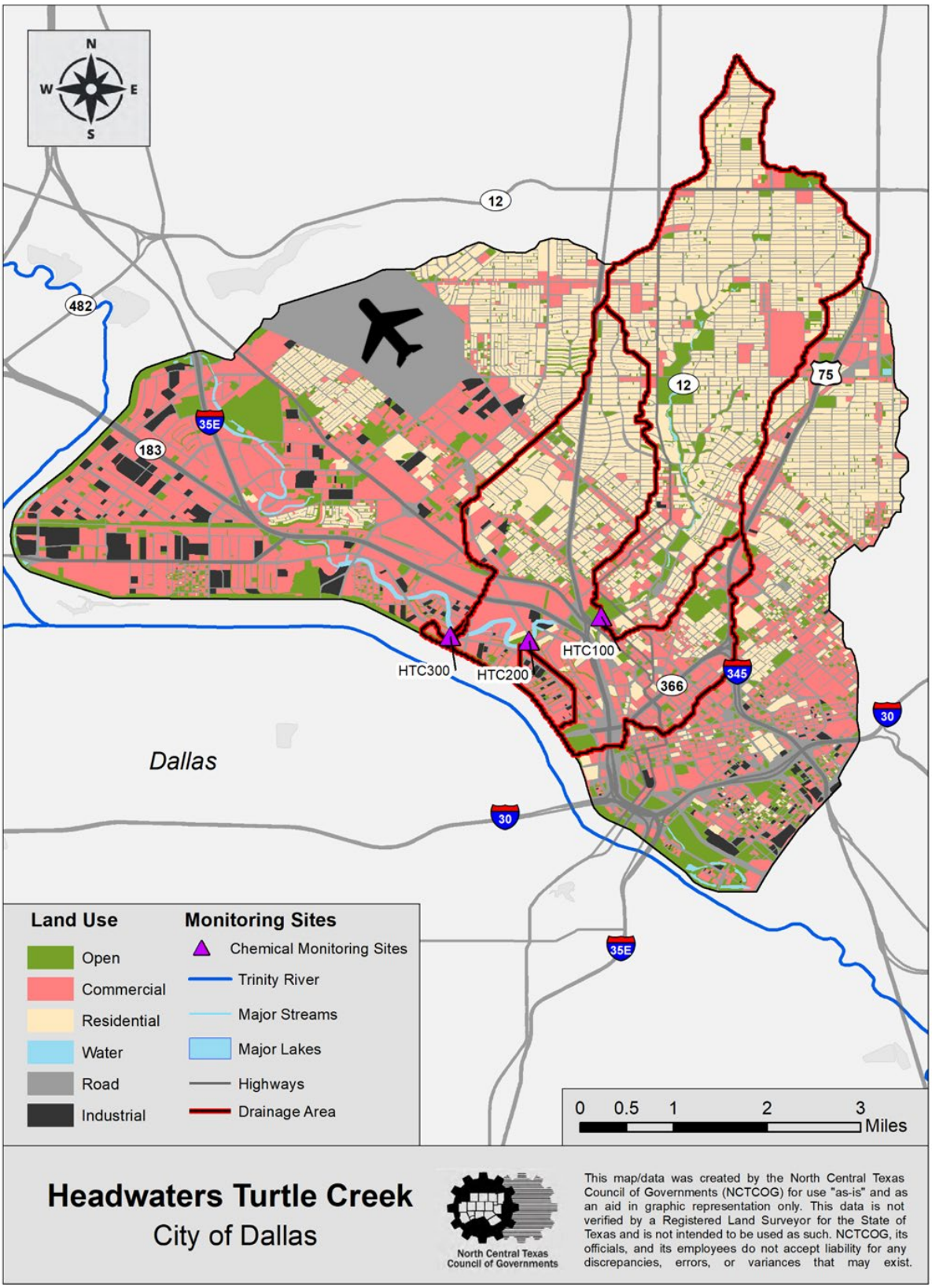


Figure 5: Dallas, Turtle Creek - Trinity River Subwatershed, TCTR-100, TCTR-200, TCTR-300

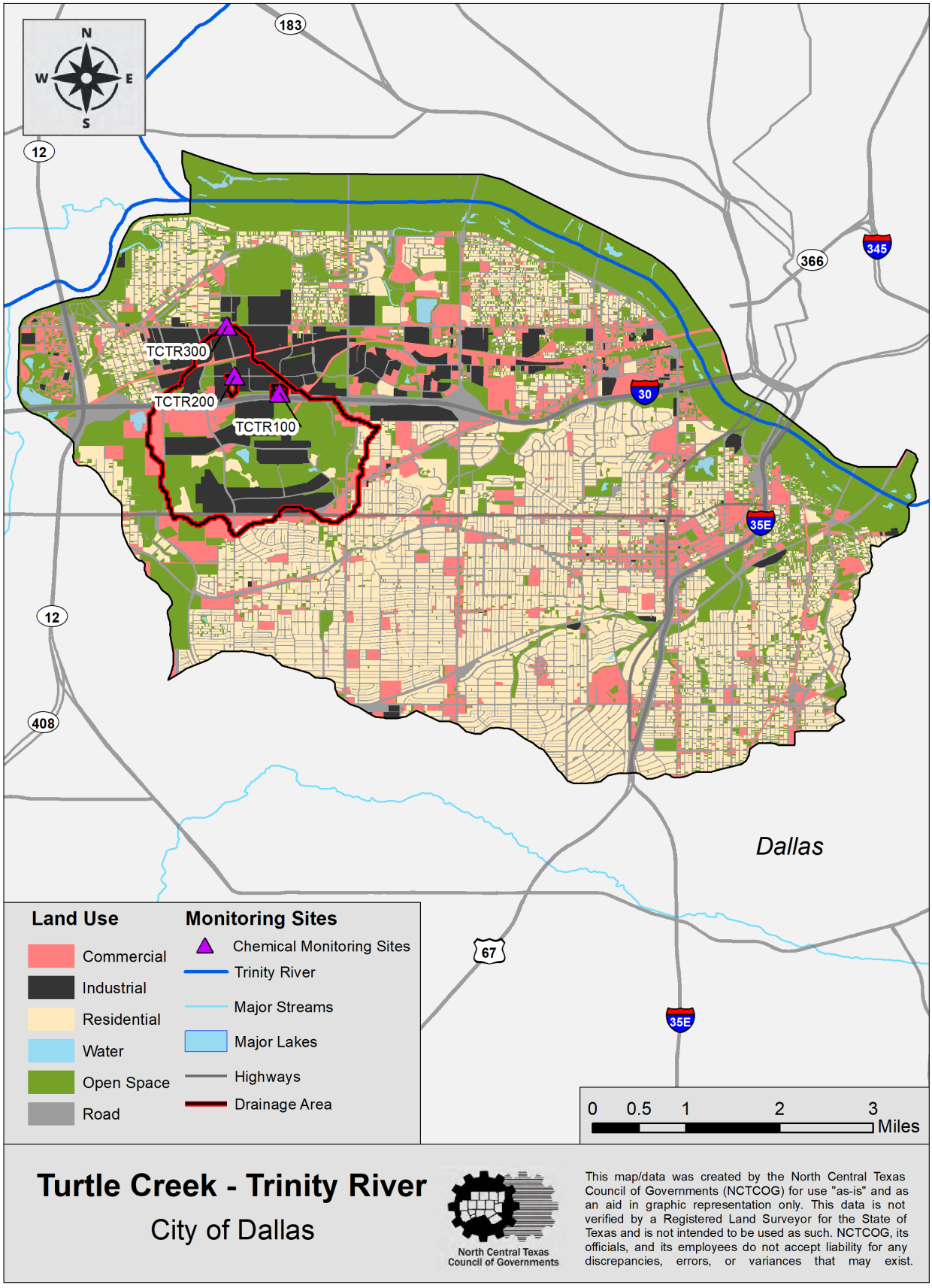


Figure 6: Fort Worth, Sycamore Creek – West Fork Trinity River, LFC1, LFC2, LFC3

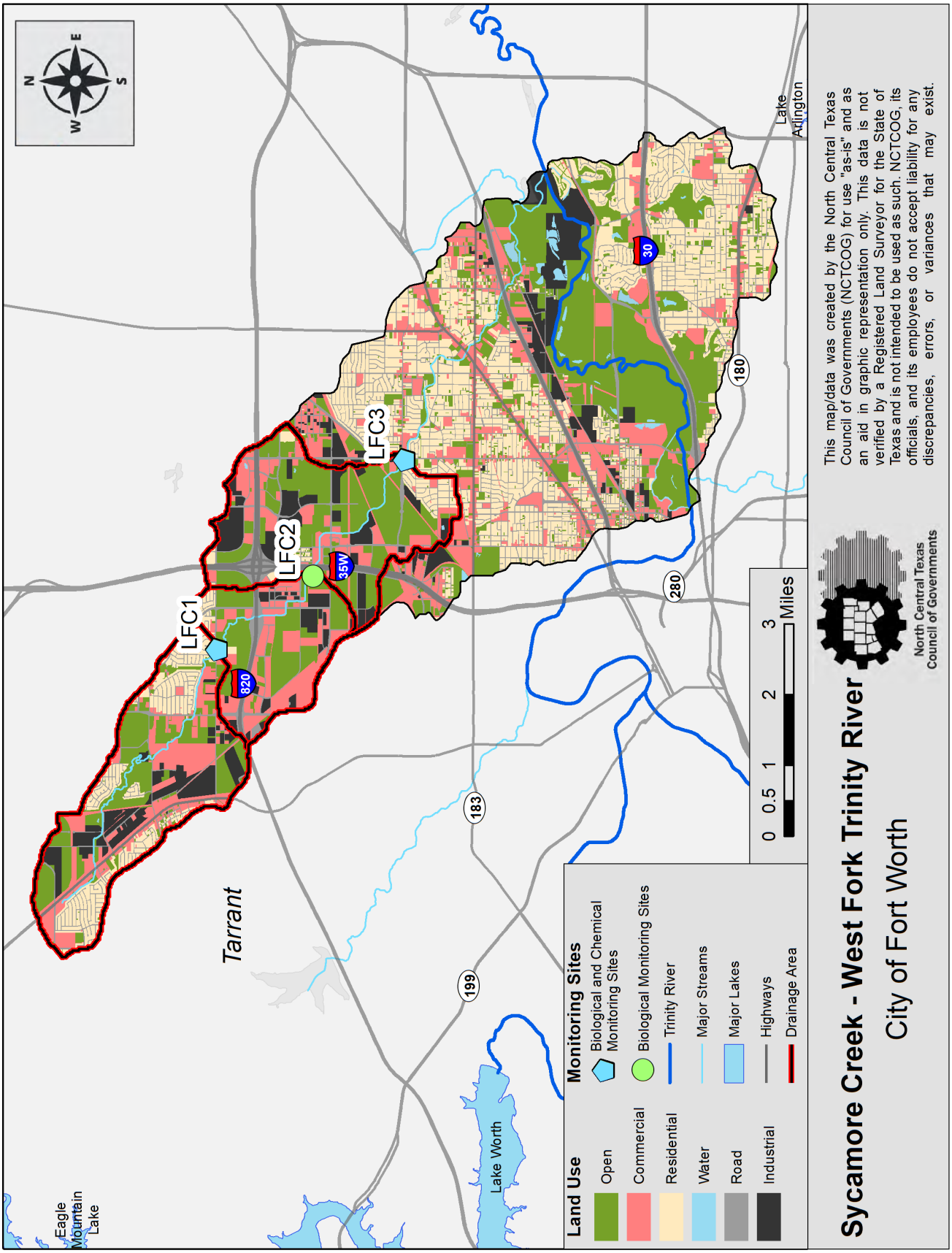


Figure 7: Fort Worth, Whites Branch – Big White Fossil Creek Subwatershed, BFC1, BFC3

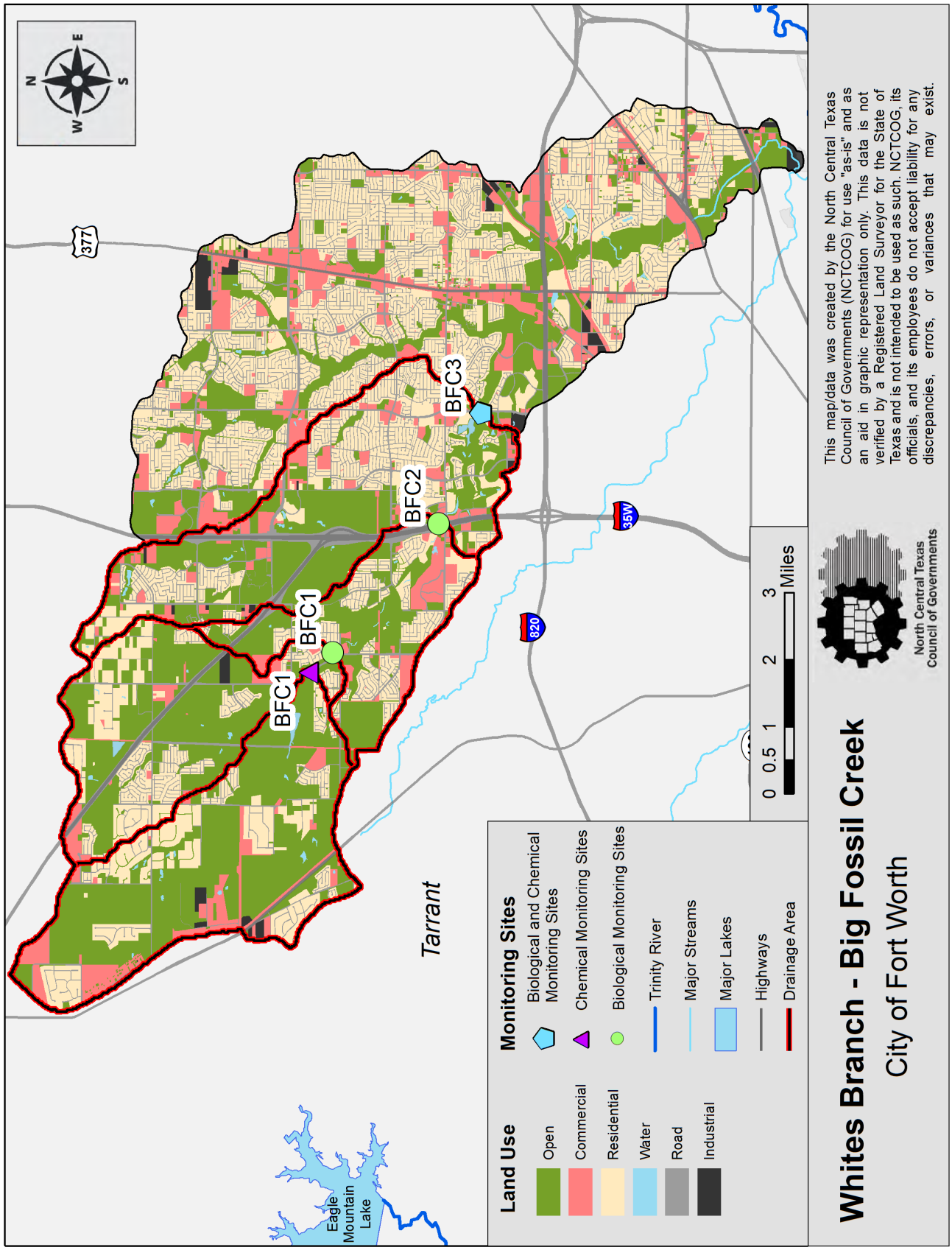


Figure 8: Garland, Rowlett Creek – Lake Ray Hubbard Subwatershed, GA2001, GA2002, GA2003

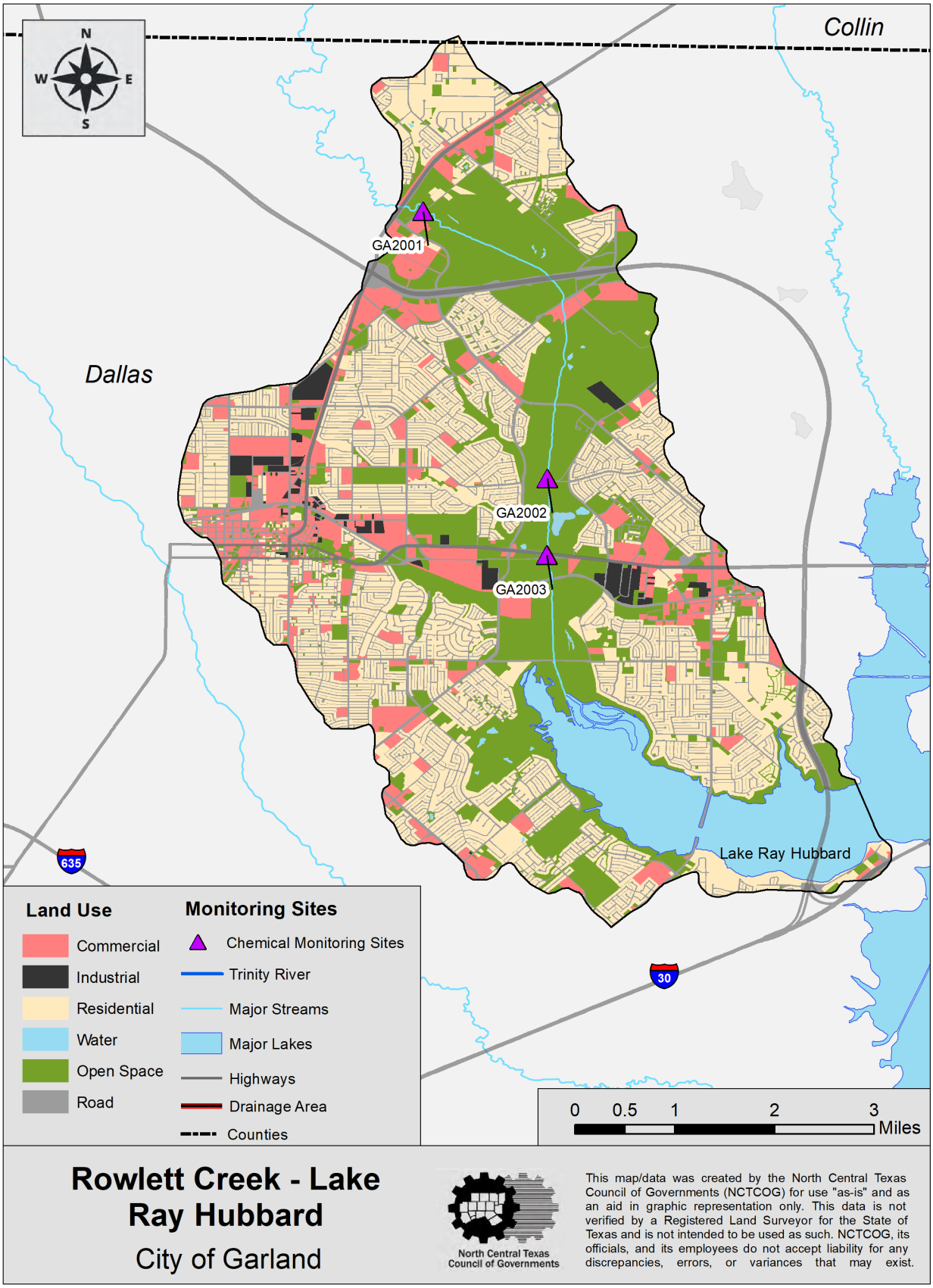


Figure 9: Irving, Grapevine Creek – Elm Fork Trinity River Subwatershed, IR2001

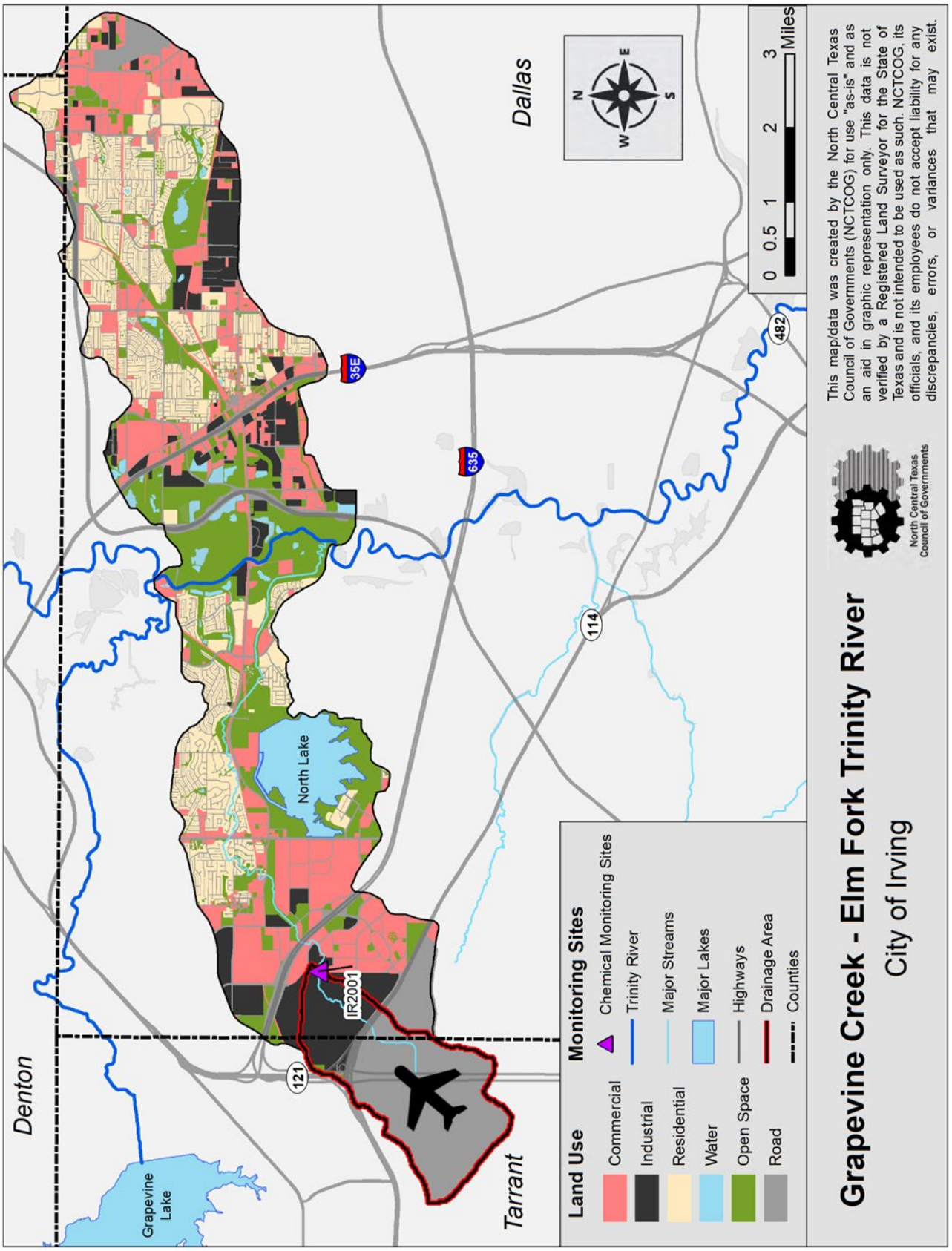


Figure 10: Irving, Estelle Creek – Bear Creek Subwatershed, IR2002

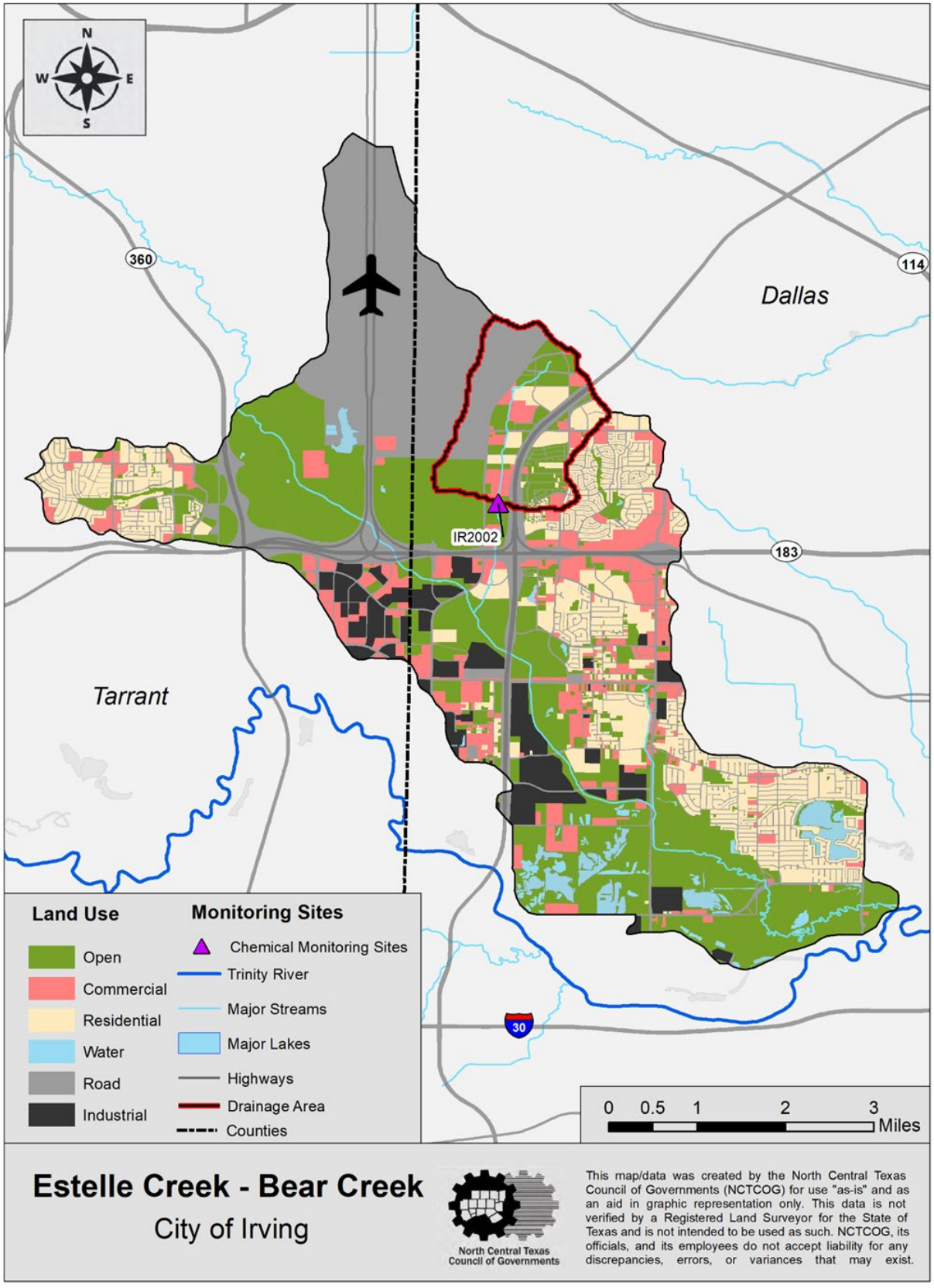


Figure 11: Mesquite, South Mesquite Creek Subwatershed, MS2001

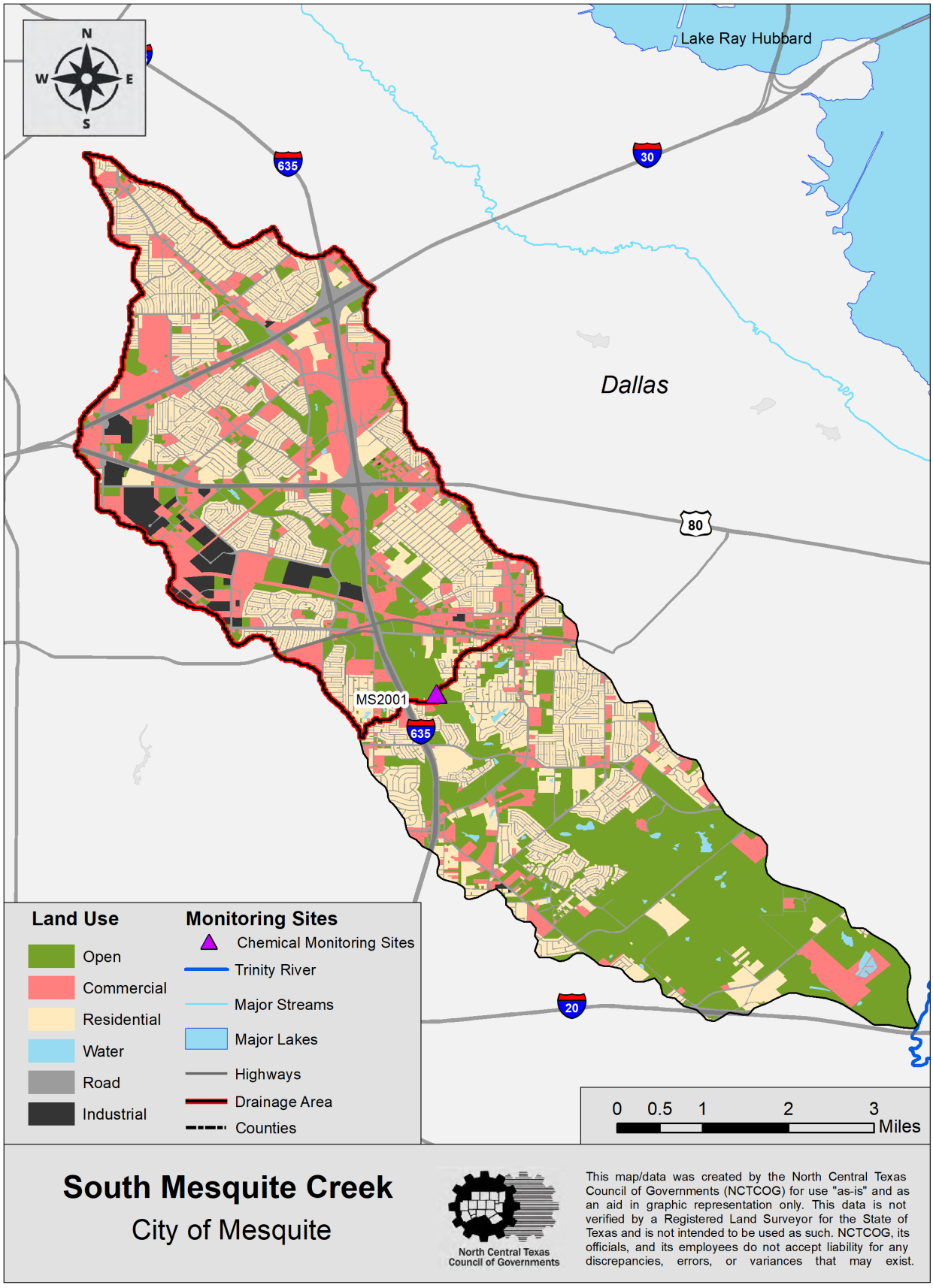


Figure 12: Mesquite, North Mesquite Creek Subwatershed, MS2002

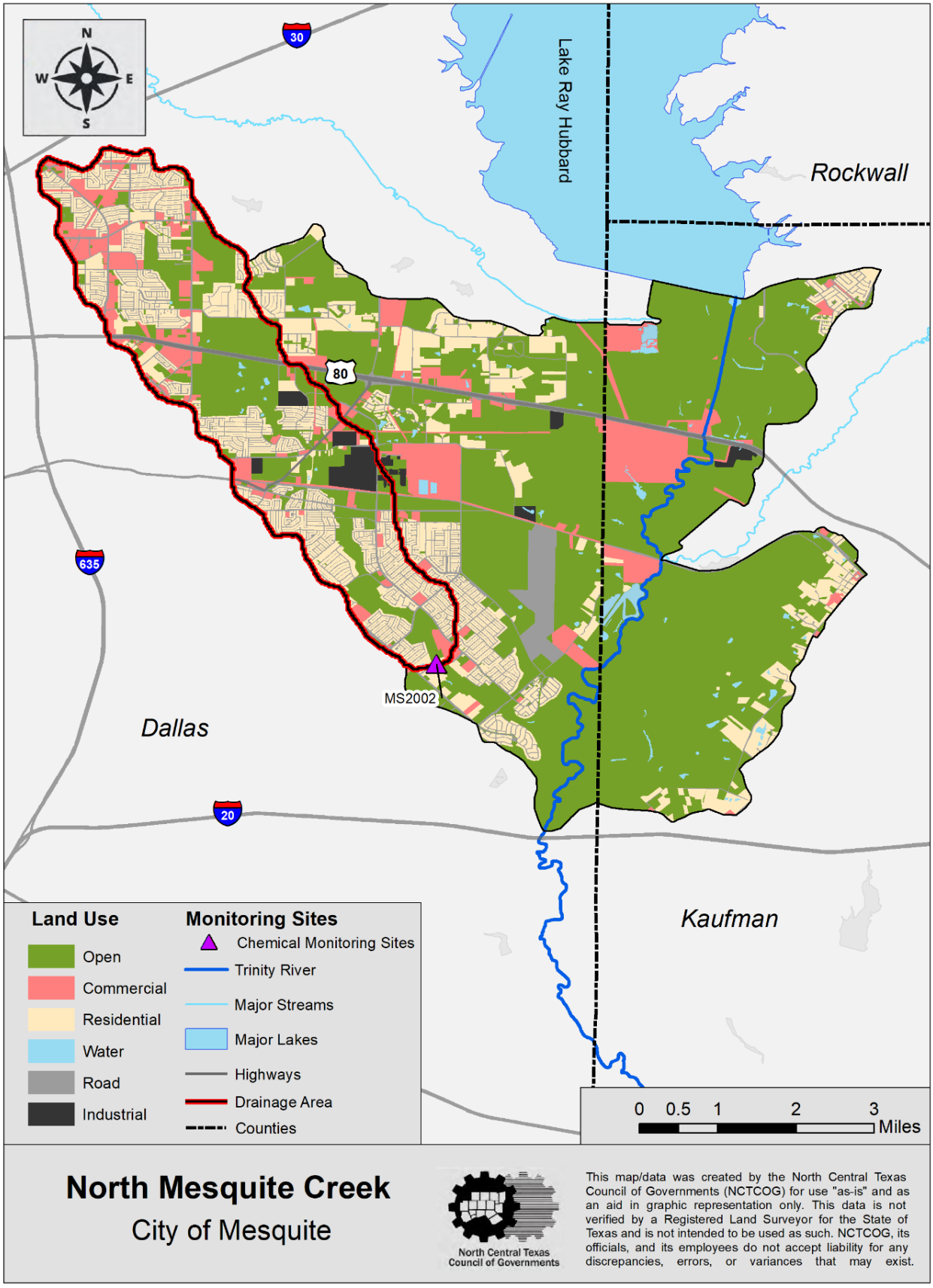


Figure 13: Plano, Headwaters Rowlett Creek Subwatershed, PL2001

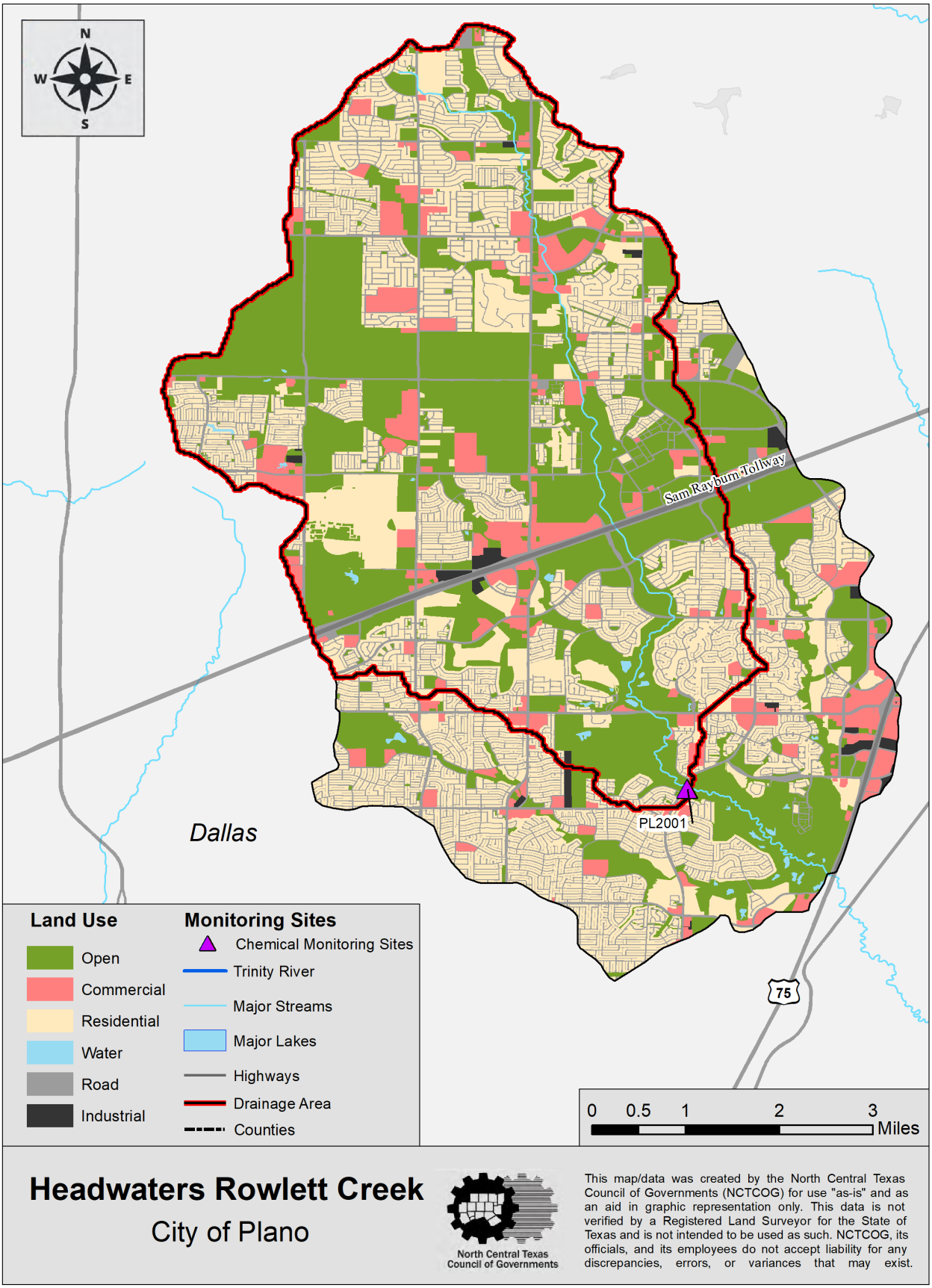


Figure 14: Plano, Brown Branch Rowlett Creek Subwatershed, PL2002

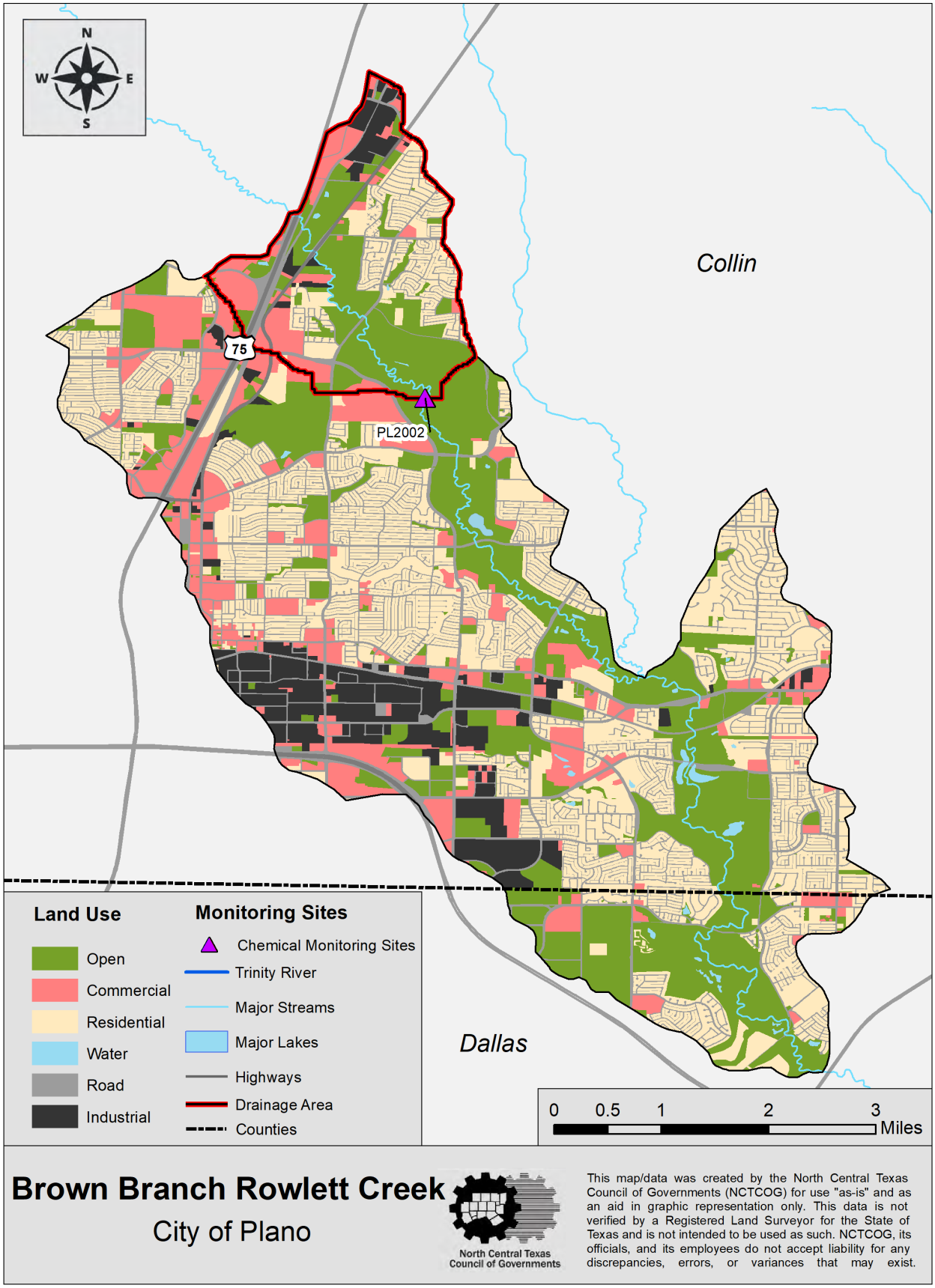


Figure 15: North Texas Tollway Authority, Cottonwood Branch – Hackberry Creek Subwatershed, NT2001

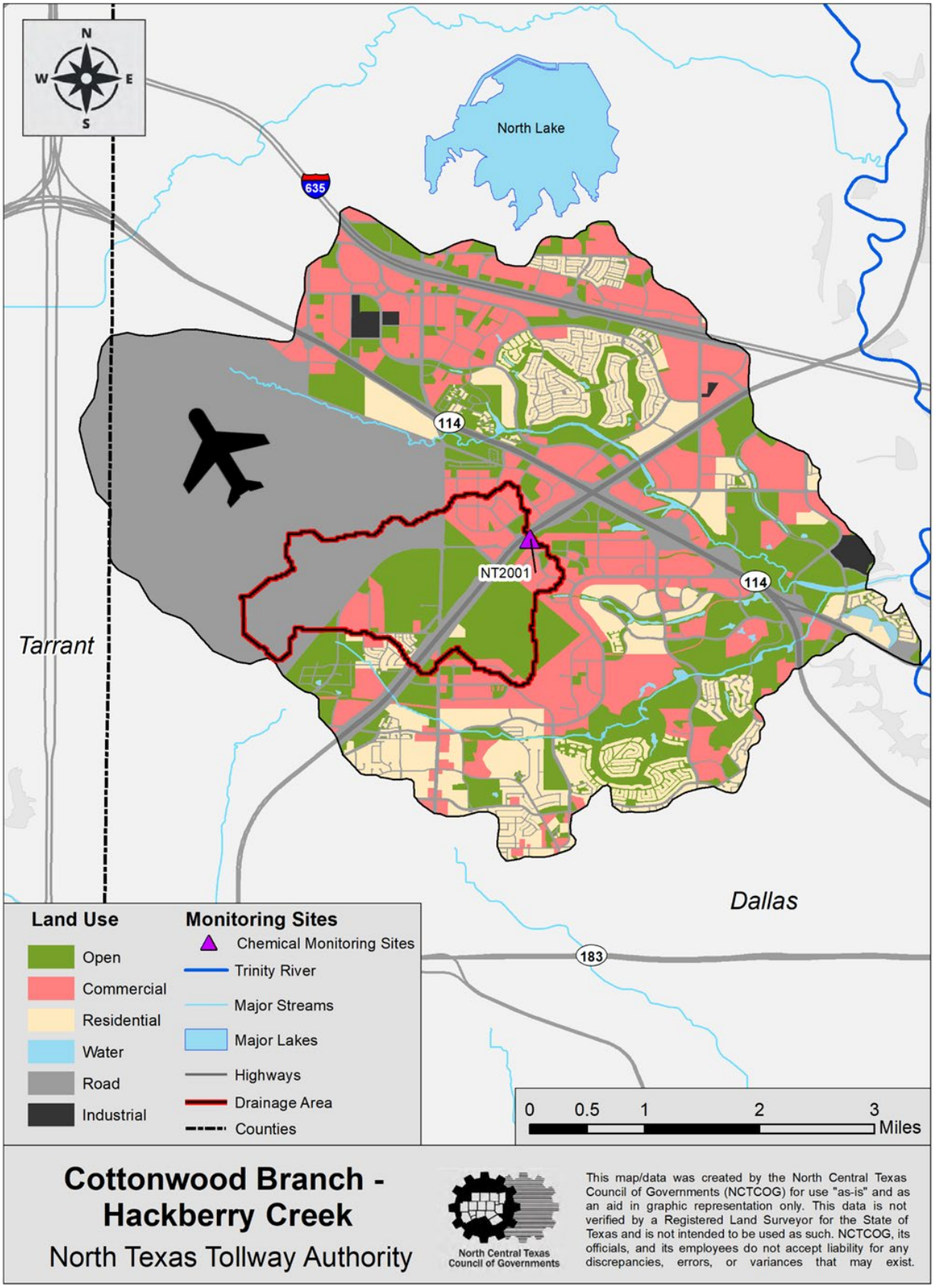
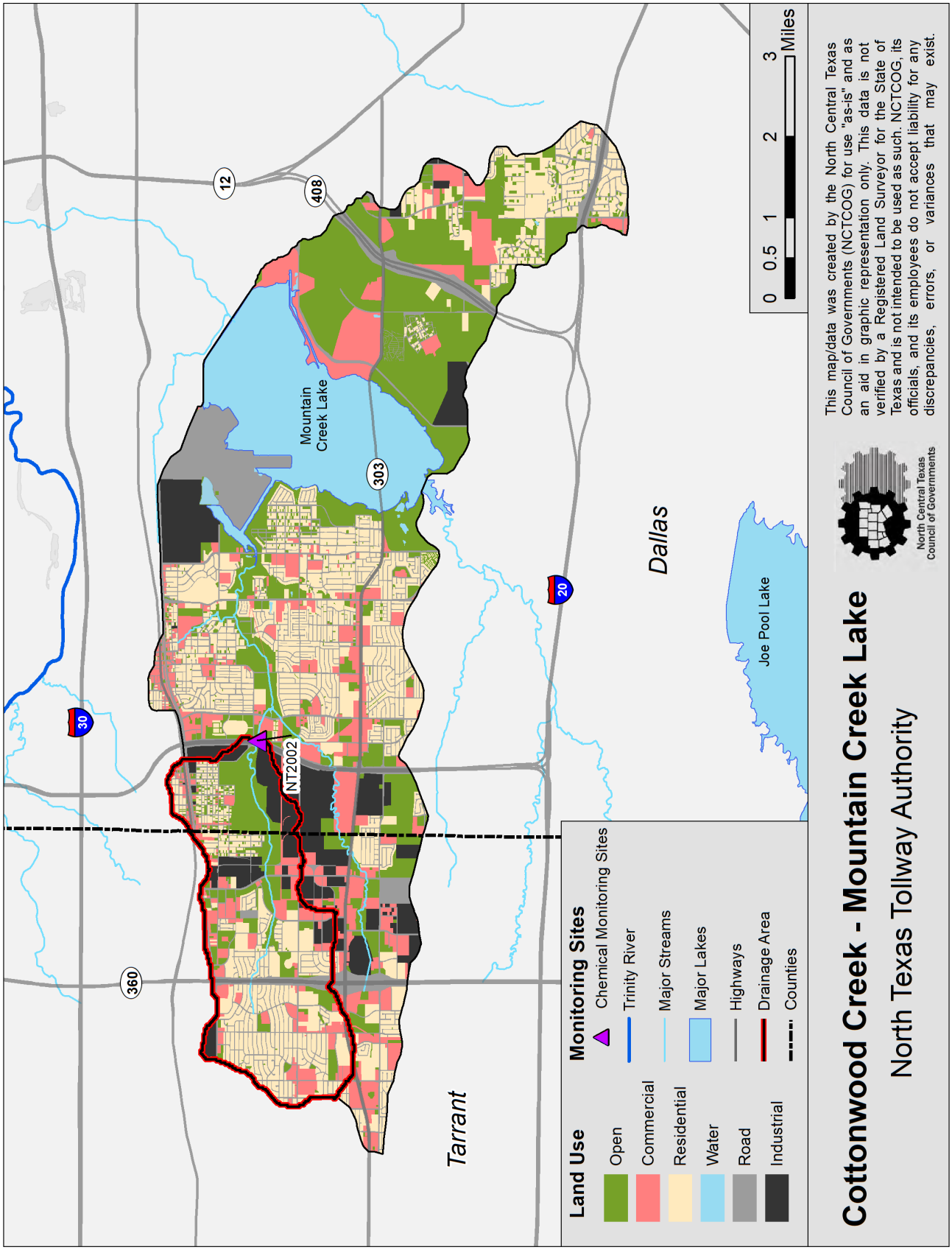


Figure 16: North Texas Tollway Authority, Cottonwood Creek - Mountain Creek Lake Subwatershed, NT2002



2020 STORM EVENTS AND MONTHLY RAINFALL

Table 9 includes each storm event by site, Rainfall Total, Peak 1-Hr Rate, Peak Depth, and Antecedent Dry Period. The Rainfall Total is the total amount of rainfall measured for a qualifying storm event that is sampled. The Peak 1-Hr Rate is the highest amount of measurable rainfall during a 1-hour time frame. The Peak Depth is the highest measurable level the stream rose during the sampling event. The Antecedent Dry Period is the dry period before a storm event in which more than 0.10 inch of rain occurred. This information is normally collected from the ISCO equipment (rain gauge and bubbler module) and graphed using ISCO's proprietary Flowlink software. Online internet rain gauges were used if the site rain gauge was not working. Sample collection reports are provided in Appendix G.

Table 9: Year 3 (2020) Storm Event Data

STORM EVENT DATE	SITE ID	RAINFALL TOTAL (IN)	Peak 1-HR RATE (in/hr)	PEAK DEPTH (ft)	ANTECEDENT DRY PERIOD (hrs)
1st QUARTER					
1/10/2020	AR2001	0.20	0.12	0.5	310
	AR2002	1.52	0.48	5.2	315
	IR2001	1.26	0.35	3.9	314.5
	MS2001	0.73	0.30	6.6	312
	MS2002	0.73	0.30	3.6	312
	NT2002	1.10	0.37	5.3	316
1/16/2020	IR2002	2.20	1.28	1.5	123
	NT2001	1.82	1.12	2.8	123
1/22/2020	GA2001	0.21	0.06	1.7	101
	GA2002	0.21	0.06	2.6	101
	GA2003	0.21	0.06	0.5	101
1/28/2020	PL2001	0.16	0.14	3.2	135
	PL2002	0.16	0.14	2.6	135
2ND QUARTER					
4/3/2020	AR2002	0.12	0.12	0.85	83
	IR2001	0.11	0.11	Unknown	81
	IR2002	0.11	0.11	0.16	81
4/11/2020	GA2001	0.16	0.11	1.3	179
	MS2001	0.10	0.08	1.8	179
4/12/2020	MS2002	0.52	0.36	2.1	196
	PL2001	0.40	0.28	6.8	182
	PL2002	0.40	0.28	4.4	182
4/19/2020	GA2003	0.14	0.13	1.0	188
4/28/2020	AR2001	0.28	0.28	1.085	372.5
	GA2002	0.52	0.50	4.7	227
	NT2001	0.18	0.18	1.6	209
	NT2002	0.40	0.40	2.3	382
3RD QUARTER					

STORM EVENT DATE	SITE ID	RAINFALL TOTAL (IN)	Peak 1-HR RATE (in/hr)	PEAK DEPTH (ft)	ANTECEDENT DRY PERIOD (hrs)
7/6/2020	AR2001	1.04	1.00	2.828	82
7/28/2020	AR2002	0.2	0.12	0.675	533
	GA2001	1.70	1.45	1.8	545
	IR2001	1	0.86	0.66	544.5
	IR2002	1	0.86	0.649	544.5
	MS2001	1.10	0.85	9.7	529
	MS2002	0.51	0.46	2.7	529
	NT2001	0.73	0.61	2.8	544
	NT2002	0.21	0.11	1.2	531
8/16/2020	GA2002	0.52	0.45	9.3	404
	GA2003	0.52	0.45	8.7	404
	PL2001	1.98	1.59	8.0 (est.)	403
8/30/2020	PL2002	2.21	1.09	20.0 (est.)	319
4TH QUARTER					
10/23/2020	AR2001	0.48	0.40	0.94	744
	AR2002	0.56	0.44	0.91	745
	GA2002	0.43	0.43	1.0	737
	IR2001	0.90	0.80	2.93	755.5
	PL2001	0.80	0.76	2.5 (est)	736
	PL2002	0.80	0.76	13.5	736
	NT2001	0.95	0.81	3.0	741
	NT2002	0.40	0.38	1.8	736
12/11/2020	GA2001	0.14	0.14	0.9	294
	GA2003	0.14	0.14	2.2 (est)	294
	IR2002	0.12	0.08	0.092	296
	MS2001	0.14	0.10	3.1	296
	MS2002	0.14	0.10	1.6	296

Monthly Rainfall Data for January 2020 – December 2020

The monthly rainfall totals for the 2020 sampling year were tracked using the Dallas/Fort Worth International Airport (DFW Airport Station) rain gauge and compared to long-term averages (National Oceanic and Atmospheric Administration, 2021). Figure 17 depicts monthly rainfall totals compared to the long-term monthly average rainfall at the DFW Airport Station. Figure 18 displays 2020 cumulative rainfall amounts versus the cumulative long-term monthly averages at the DFW Airport Station. The rainfall amounts during 2020 had two monthly rain events with greater than six inches of rain. The 2020 DFW Airport station monthly totals varied from the rainfall long-term averages (1974-2020). January 2020, March 2020 and May 2020 experienced more rain than the same months during the rainfall long-term averages (1974-2020). Small spikes in rainfall inches can be seen in September 2020 and December 2020. The remaining months had monthly rainfall totals that were lower than the long-term average rainfall for that month. As shown in Figure 18, the DFW Airport Station cumulative rainfall totals followed the same trend as the rainfall cumulative long-term averages from January through December 2020. December 2020 DFW airport station cumulative total (43.70 in) was 8.24 inches higher than the December 1994-2020 Rainfall Cumulative Long-Term Average (35.46 in).

2020 Rainfall Totals

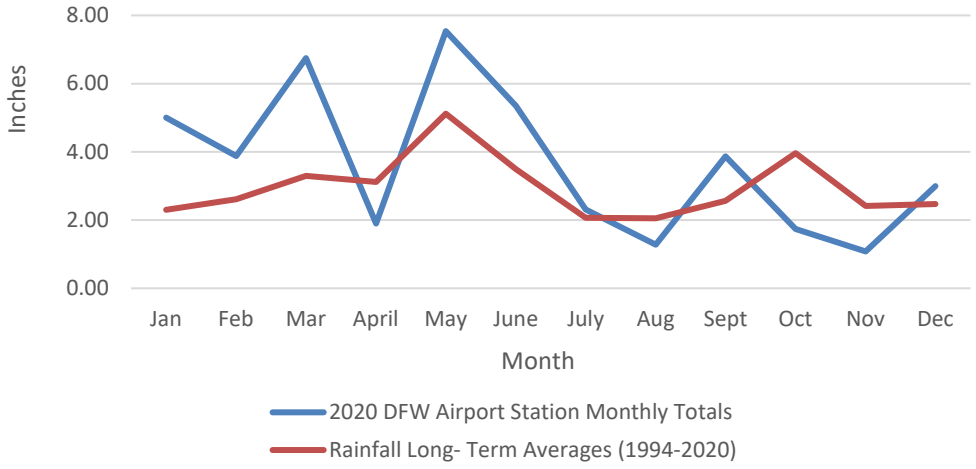


Figure 17: 2020 Monthly Rainfall Totals, Dallas/Fort Worth International Airport Rain Gauge (Source: NOAA Climatic Data Center, 2021)

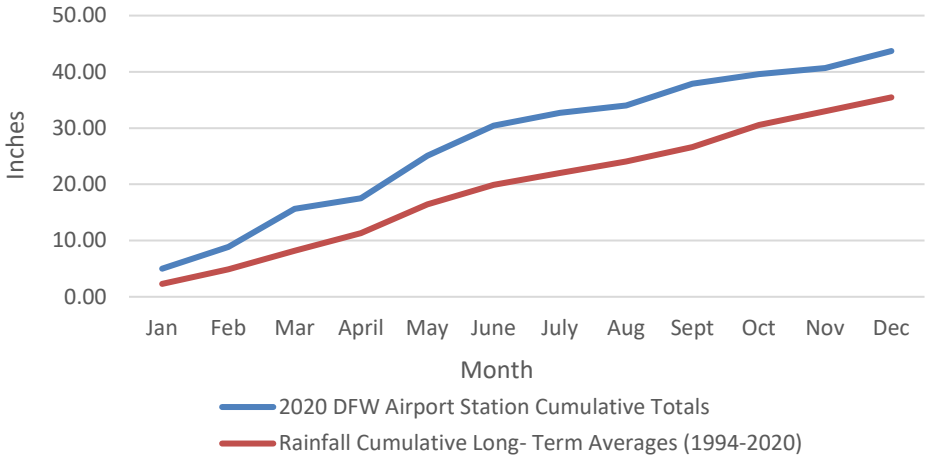


Figure 18: 2020 Cumulative Monthly Average Rainfall Totals, Dallas/Fort Worth International Airport Rain Gauge (Source: NOAA Climatic Data Center, 2021)

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Appendices

1. APPENDIX A: Regional Wet Weather Characterization Plan Proposal for the Fourth Term Submission and Letter of Approval from TCEQ
2. APPENDIX B: Monitoring Program and Quality Assurance Project Plan for Wet Weather Characterization Equipment Deployment and Sampling Protocol: 2018-2022
3. APPENDIX C: Monitoring Program and Quality Assurance Project Plan for Bioassessments: 2018-2022
4. APPENDIX D: 2020 Stream Bioassessment: Rowlett Creek, City of Garland, Rowlett Creek Headwaters, City of Plano, and Delaware Creek, City of Irving
5. APPENDIX E: Lab Certifications and Accreditations
6. APPENDIX F: Raw Sampling Data
7. APPENDIX G: Sample Collection Reports
8. APPENDIX H: Dallas Bioassessment Report
9. APPENDIX I: Fort Worth Bioassessment Report