Analysis of Historical Data

for the

Village Creek-Lake Arlington Watershed Protection Plan

January 2017

Village Creek
Lake Arlington
WATERSHED
PROTECTION

Trinity River Authority of Texas

On the cover:
Looking upstream at a historical
data collection site on Village Creek
at the Rendon Road crossing.

Analysis of Historical Data

for

The Village Creek-Lake Arlington Watershed Protection Plan

Funded by

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Investigating Entities

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List of Acronyms

AU	Assessment Unit
BMP	best management practice
BSR	Basin Summary Report
CCN	Certificate of Convenience and Necessity
Cl^-	chloride
COG	Council of Governments
CRP	Clean Rivers Program
DO	dissolved oxygen
DOQQ	Digital Orthogonal Quarter Quadrangle
DFW	Dallas-Fort Worth metropolitan area
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FWS	U.S. Fish & Wildlife Service
GIS	geographic information system
GLO	General Land Office
LAMP	Lake Arlington Master Plan
LDC	load duration curve
LULC	land use/land cover
MSL	mean sea level
NAIP	National Aerial Imagery Program
NASS	National Agricultural Statistics Service
NH_3	ammonia
NHD	National Hydrography Dataset
NO_2^-	nitrite
NO_3^-	nitrate
NCTCOG	North Central Texas Council of Governments
NRCS	U.S. Department of Agriculture - Natural Resource Conservation Service
NWS	National Weather Service
OP	orthophosphate
OSSF	on-site sewage facility
PLOAD	Pollutant Load Allocation Model
POR	period of record
ROW	right-of-way
RRC	Texas Railroad Commission
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SO_4^{-2}	sulfate
SWCD	Soil & Water Conservation District
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TAC	Texas Administrative Code
TAG	Technical Advisory Group
TCEQ	Texas Commission on Environmental Quality
TCWSP	Tarrant County Water Supply Project
TDS	Total Dissolved Solids

TIAER	Texas Institute for Applied Environmental Research
TKN	total Kjeldahl nitrogen
TNRIS	Texas Natural Resource Information System
TOP	Texas Orthoimagery Program
TP	total phosphorous
TPWD	Texas Parks and Wildlife Service
TRA	Trinity River Authority of Texas
TRWD	Tarrant Regional Water District
TSS	total suspended solids
TSSWCB	Texas State Soil & Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWDB	Texas Water Development Board
USDOT	U.S. Department of Transportation
USGS	U.S. Geological Survey
VCLA	Village Creek-Lake Arlington Watershed
WPP	watershed protection plan
WTP	water treatment plant
WWTF	wastewater treatment facilities

1.0 Introduction

1.1 Project Overview and Objectives

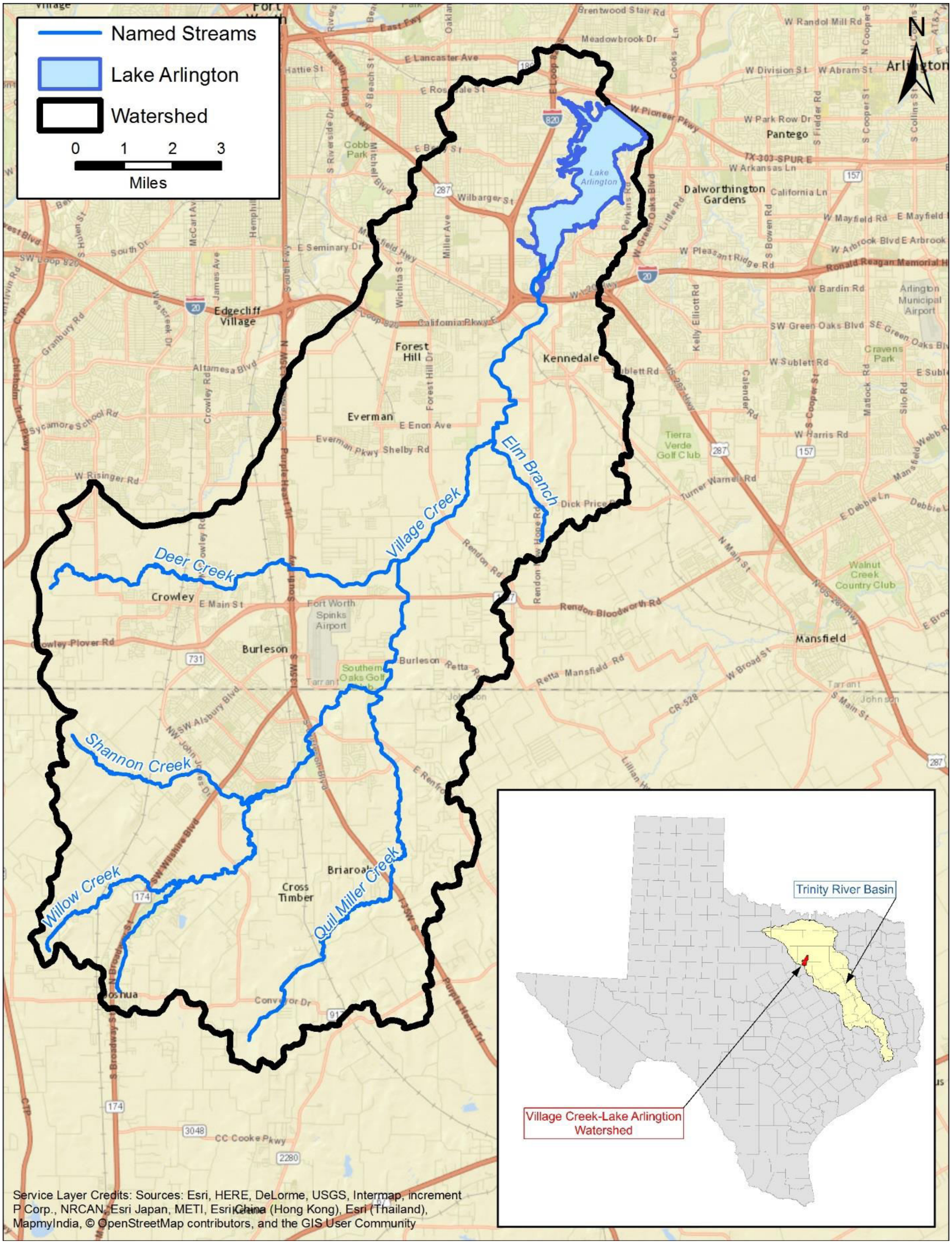
This analysis of historical data was performed as part of an effort to restore water quality within Village Creek, with a further goal of protecting water quality in Lake Arlington, which utilizes the creek as its main tributary. This analysis will support the development of the Village Creek-Lake Arlington Watershed Protection Plan (WPP) by assessing existing water quality data in the watershed and analyzing it within the context of various watershed characteristics (e.g., climate, land use, land cover, geology, ecology) to ascertain current and historical conditions and trends.

Due to Village Creek's classification as an impaired waterbody due to elevated levels of bacteria, there will be an emphasis on that constituent throughout the report. However, several other constituents of interest have also been identified through historical data review and stakeholder interaction. These include several nutrients, as well as other in-stream parameters that may indicate concerns for one or more designated uses of Village Creek and Lake Arlington. Quality assured data retrieved from the Texas Commission on Environmental Quality (TCEQ) Surface Water Quality Monitoring Information System (SWQMIS) database will be processed with the use of statistical and geospatial analyses to evaluate temporal/spatial trends and relationships. Specific analyses to be run will include:

1) Regression of *E. coli* concentrations against other water quality constituents as well as flow (or a surrogate such as precipitation);
2) Evaluation of occurrences of high *E. coli* values and other constituents of interest spatially within the watershed via geographic information systems (GIS) analysis to determine likely sources or subwatersheds for further evaluation; and
3) Plotting data spatially to identify temporal trends.

The overall goal of this WPP is to restore water quality in Village Creek and thus protect the water quality in Lake Arlington. In pursuit of this goal, the analyses conducted using the results of this historical data report will be used to achieve several objectives, which include:

1) Developing a dataset to support modeling and assessment activities for quantifying pollutant loadings to the lake, especially for those constituents of interest where water quality standards are not being met;
2) Performing the modeling and assessment activities necessary to identify potential pollutant sources and quantifying the loadings of the constituents of interest for all segments;
3) Providing watershed stakeholders with the tools needed to take a proactive approach to watershed protection by engaging them through public outreach and education efforts; and
4) Utilizing stakeholder recommendations and expert technical knowledge within the watershed to develop a WPP that describes specific best management practices (BMPs) intended to reduce pollutant loadings and achieve target reductions for the watershed.



Basemap: ESRI World Streetmap.

Figure 1. Location of Village Creek-Lake Arlington watershed.

1.2 Review of the Watershed and Impairments

The Village Creek-Lake Arlington watershed begins at Village Creek's headwaters near the town of Joshua in northern Johnson County, extending approximately 35 miles before emptying into Lake Arlington in southeastern Tarrant County (Figure 1). Urban and suburban areas dominate the northern end of the watershed, with a few industrial and municipal complexes near its center, and trending more towards agricultural use in the southern extent.

Lake Arlington serves as a drinking water source to over 500,000 people in the Dallas-Fort Worth (DFW) Metroplex. Village Creek, Lake Arlington's main tributary, is listed on TCEQ's *2014 Texas Water Quality Inventory-303(d) List* (TCEQ 2015b) as impaired for bacteria (first listed in 2010), and several segments within Lake Arlington are listed on TCEQ's *2014 Water Quality Inventory—Water Bodies with Concerns for Use Attainment and Screening Levels* (TCEQ 2015c) for chlorophyll-a and nitrate (NO_3^-). Past studies conducted within the watershed and rapid development indicate that water quality has and will continue to be negatively affected unless more vigorous management measures are put in place.

2.0 Data Inventory

2.1 Geographic and Spatial Data

Data from a wide variety of sources will be used to characterize the Village Creek-Lake Arlington watershed and support the development of the WPP. Data related to water quality/quantity, potential point sources, land use/land cover, soils/geology, and climate were identified, with relevant datasets compiled. In addition to watershed characterization, the datasets listed in Table 1 will be used to characterize potential pollutant sources throughout the watershed, to be analyzed using the Spatially Explicit Load Enrichment Calculation Tool (SELECT) analysis. More information about this analysis is provided in Section 8.3.

Table 1. Geospatial data sources used for source assessment analysis

Geospatial Data Type	Source	Date(s)	Analysis and/or Processing	Data Use
Aerial imagery	National Aerial Imagery Program (NAIP), Texas Orthoimagery Program (TOP)	2014, 1996	Mosaic and clip raster files to watershed	Determine ground conditions of watershed
Topographic maps (1:24,000 scale)	U.S. Geological Survey (USGS)	1996	Isolate DOQQs situated inside/tangent to watershed boundary	Characterize watershed, reference for hydrologic features
Detailed streets and highways	Environmental Systems Research Institute (ESRI)	2016	None	Public outreach component, orient map viewers to watershed extents
City boundaries	TCEQ	2012	Clip features to watershed boundary	Public outreach component
County boundaries	TCEQ	2012	Clip features to watershed boundary	Public outreach component
Lake Arlington-Village Creek watershed	National Hydrography Dataset (NHD)	2009	Aggregate of HUC 12 subwatersheds upstream of the Lake Arlington dam and outlet structure	Clipping boundary for isolating other data sources
Census data	U.S. Census Bureau	2010	Distribute population density characteristics appropriately to watershed	Determine population characteristics, base data for several *E.coli* loading components
911 address structures points	North Central Texas Council of Governments (NCTCOG)	2015	Clip source points to watershed boundary	Determine location, density of structures
SWQM stations	TRA, TCEQ	Varies (2012)	Relate to surface water quality data sampling results	Document locations of surface water quality monitoring stations
County Soils Maps	Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO)	2014	Identify areas that may prove problematic for modeling and/or pollutant transport	Characterize watershed, watershed delineation
General Soils Maps	NRCS State Soil Geographic Database (STATSGO)	1997	Identify areas that may prove problematic for modeling and/or pollutant transport	Characterize watershed, watershed delineation
National Land Cover Database (NLCD)	Texas Natural Resource Information System (TNRIS)	2011	Clip database to watershed boundary, identify areas that may prove problematic for modeling and/or pollutant transport	Determine land use/land cover in watershed, watershed delineation

Geospatial Data Type	Source	Date(s)	Analysis and/or Processing	Data Use
LULC field verification points	TRA	2016-2017	Compare to NLCD data	Determine accuracy of NLCD data
Soil/Water Conservation District (SWCD) boundaries	Texas State Soil & Water Conservation Board (TSSWCB)	2014	Isolate Dalworth/Johnson SWCDs	Public outreach strategy
List of steering committee member locations	TRA	2016	Gather geographic information at stakeholder meetings, personal communication, email	Determine distribution of committee member locations to ensure adequate watershed representation
Recreational Use Attainability Analysis (RUAA) sampling locations	TCEQ	n/a	Generalize sampling location results to applicable extents within watershed – **no formal RUAA report for watershed located**	Determine extent of recreational use in watershed for bacteria standards applicability
Digital Elevation Models (DEMs)	USGS	2015	Mosaic and clip raster files to watershed mask, process to develop stream network.	Watershed delineation
Weather data	National Weather Service (NWS)	2006-2017	Isolate precipitation, evaporation, and temperature data; isolate for time period dictated by modeling constraints	Watershed delineation
Hydrology - existing lakes and reservoirs	NHD	2009	Ground truth feature margins for accuracy	Watershed delineation
Hydrology – streams	NHD	2009	Clip NHD features to watershed boundary	Watershed delineation
Named streams	NHD	2009	Generalize NHD data for streams, isolate named streams to new layer	Public outreach – use for general information maps
TCEQ stream segments	TCEQ	2016	Clip features to watershed boundary	Watershed delineation
TCEQ assessment units (AUs)	TCEQ	2016	Clip features to watershed boundary	Watershed delineation
Aquifers – major and minor	Texas Water Development Board (TWDB)	2006	None	Public outreach component
New TCEQ surface water quality monitoring stations	TRA/TCEQ	Created through project	Identify new/existing station locations at strategic points along stream path	Watershed delineation

Geospatial Data Type	Source	Date(s)	Analysis and/or Processing	Data Use
Floodplain data	National Flood Hazard Layer – Federal Emergency Management Agency (FEMA)	2015	Compare and adjust LULC maps as appropriate	Used to update LULC maps as necessary, public outreach component
Oil & natural gas wells, pipelines, leases	Railroad Commission (RRC) of Texas; Texas General Land Office (GLO)	Varies	Clip features to watershed boundary	Locate and determine density of oil/natural gas wells for potential pollutant point source identification
Public water system wells & surface water intakes	TCEQ	2016	Append well constituent tables to spatial network of wells	Determine if wells may be subject to pollution from nearby sources
Bridge locations	National Bridge Inventory (USDOT)	2012	Append bridge location data to well information tables, apply to watershed	Component of approximating *E. coli* loading rate from avian sources
Municipal solid waste (MSW) sites/landfills	TCEQ	2007	Verify activity & history of sites clipped to watershed	Potential pollutant point source identification
Solid waste sites/landfills/ illegal dump site field verification	TRA	Created through project	Compare to MSW/landfill database points, add points for illegal dump sites found in watershed	Determine accuracy of municipal solid waste sites/landfills data, identify other dump site point sources
Water control structures database	NRCS/TRA	Created through project	Comparison and integration of TRA and NRCS records	Identify and verify significant impoundments in watershed
Superfund sites	TCEQ	2015	Clip database to watershed boundary	Potential pollutant point source identification
Petroleum storage tanks	TCEQ	2014	Clip database to watershed boundary	Potential pollutant point source identification
Permitted industrial/ hazardous waste sites	TCEQ	n/a	Clip database to watershed boundary – **none in watershed**	Locate sites for potential pollutant point source identification
Concentrated Animal Feeding Operations (CAFOs)	TCEQ	n/a	Clip database to watershed boundary – **none in watershed**	Locate sites for potential pollutant point source identification
Cattle – population density	USGS National Agricultural Statistics Service (NASS)	2016	Clip database to watershed boundary	*E. Coli* load calculation

Geospatial Data Type	Source	Date(s)	Analysis and/or Processing	Data Use
Sheep – population density	USGS NASS	2015	Clip database to watershed boundary	*E. Coli* load calculation
Goats – population density	USGS NASS	2015	Clip database to watershed boundary	*E. Coli* load calculation
Horses – population density	USGS NASS	2012	Clip database to watershed boundary	*E. Coli* load calculation
Deer – population density	Texas Parks & Wildlife Department (TPWD) deer density study (Lockwood 2007)	2007	Clip database to watershed boundary	*E. Coli* load calculation
Waterfowl – population density	Stakeholder input, using other WPP data as benchmarks	Created through project	Bias to riparian buffers, other areas of interest identified by stakeholders	*E. Coli* load calculation
Other avian – population density	Stakeholder input, using other WPP data as benchmarks	Created through project	Bias to bridge crossings, other areas of interest identified by stakeholders	*E. Coli* load calculation
Feral Hogs – population density	Stakeholder input, using peer-reviewed literature and other WPP data as benchmarks	Created through project	Bias to riparian buffers, other areas of interest identified by stakeholders	*E. Coli* load calculation
wastewater treatment facilities (WWTFs)	TCEQ	2016	Clip to watershed boundary, verify operational state	*E. Coli* load calculation
Certificates of Convenience and Necessity (CCNs)	Public Utility Commission of Texas (PUC)	2014	Clip to watershed, verify extents	*E. Coli* load calculation
On-site sewage facilities (OSSFs)	Census Bureau	2010	census data, total households – CCNs = total households w/OSSFs	*E. Coli* load calculation
Domestic dogs	Census Bureau and stakeholder input	2010	Census data, households *0.8 = dogs	*E. Coli* load calculation

Note: Metadata that contains the Federal Geographic Data Committee (FGDC) minimum documentation requirements will be created for any acquired spatial data manipulated through data analysis and/or processing.

2.2 Other Studies and Reports

The proposed project seeks to build upon several past and ongoing initiatives in the watershed with water quality improvement components. These projects will be supported and/or progressed by developing an effective WPP. This WPP is expected to identify and provide the groundwork for implementation of strategies to address the current water quality issues of bacteria in Village Creek, nutrients and chlorophyll a in Lake Arlington, and other potential constituents of interest identified during the project and sampling activities. The watershed stakeholders have demonstrated a long-term commitment towards this goal and have asked TRA to work with them to produce such a WPP. The WPP will not only provide specific direction towards meeting current challenges, but will also provide a holistic framework for protecting water quality as the watershed develops.

2.2.1 Lake Arlington Master Plan

Stakeholders within the watershed are active and have demonstrated their concern about water quality issues within the watershed through several past projects. The Lake Arlington Master Plan (LAMP) is one such project, which included water quality modeling for nutrients, sediment, and fecal bacteria. It also illustrated how the various forms of development may impact water supply and quality. BMPs to mitigate impacts from future development in the watershed (rather than existing impairments) were suggested based on the results of a screening-level water-quality modeling effort (Malcolm Pirnie 2011). Since being adopted by Arlington's City Council in April 2011, many development standards from the LAMP have been codified into Arlington ordinances. LAMP was also adopted by City of Fort Worth City Council. During the development of the LAMP, water quality samples were collected and analyzed and a Pollutant Load Application (PLOAD) model was developed. The results of the sampling and modeling effort identified nutrients and chlorophyll a as important parameters of concern. While well-suited to the objectives of the LAMP, the sampling and modeling performed is not of sufficient quantity and specificity to allow load reductions to be calculated for existing impairments. In addition, the LAMP served to aggregate a significant amount of information on land use and watershed activities that stakeholders may use to develop a WPP. For instance, numerous potential sources of pollution from salvage yards were identified in the immediate upstream floodplain of the reservoir.

As part of the process for developing LAMP, stakeholders were identified and stakeholder participation was elicited. Bimonthly meetings of the various stakeholders within Lake Arlington's watershed to discuss opportunities to collaborate on watershed protection initiatives were held beginning in 2011, and was instrumental in creating the Clean Water Act Section 319(h) grant application. An assessment of the LAMP was undertaken in May 2012 by these stakeholders to identify and prioritize the suggested projects.

2.2.2 Trinity River Greenprinting Study

As the trend of rapid urbanization continues throughout North Central Texas, impacts to water quality and quantity are expected to become increasingly apparent. The Trust for Public Land (TPL) has developed a GIS analysis technique called "Greenprinting" which is used to identify land areas that would provide increased levels of water quality protection if left undeveloped. This tactic was applied to two watersheds in North Texas, one of which being the Lake Arlington Watershed.

Several sources of information were utilized during the development of the analysis framework, including water quality inventories and the pollutant load information derived, watershed conditions, and supporting research from universities, agencies, and the private sector. Similar water quality protection analyses were also reviewed for comparison and applicability. Prioritization of the areas deemed critical for water quality protection was based on six key landscape characteristics: 1) land use with natural vegetated cover, 2) proximity to streams, 3) water erosion potential, 4) floodplains, 5) proximity to the reservoir, and 6) proximity to ponds and wetlands (TPL 2011).

2.2.3 Village Creek Master Plan and Flood Study

In the past decade, the City of Kennedale has initiated intensive local planning efforts within their city limits, which includes downstream portions of Village Creek. To support this effort, the City initiated a flood damage reduction alternative analysis to evaluate the runoff and flooding impacts of expanded development that has taken place since past rainfall-runoff and flood insurance studies were conducted.

Light Detection and Ranging (LIDAR) data from the Texas Natural Resources Information Systems (TNRIS) was used to update the previous hydraulic model for Village Creek. Model results were then used to develop a Flood Damage Analysis (FDA) model, which was used to develop several flood reduction plans. The City elected to adopt a phased approach to implement these plans, which involve the buyout and removal of properties within the effective Federal Emergency Management Agency (FEMA) floodplain with plans for redevelopment with lower-risk alternatives (Halff 2012).

3.0 Data Review Methods

3.1 TCEQ Water Quality Standards

TCEQ is responsible for establishing numeric and narrative goals for water quality in the state of Texas. These goals are described in TCEQ's Texas Surface Water Quality Standards (TSWQS) and are approved by the U.S. Environmental Protection Agency (EPA). These standards are codified in the Texas Administrative Code (TAC), Title 30, Chapter 307, hereto referred to as TAC 307 (TCEQ 2014) and are used by TCEQ regulatory programs to establish reasonable methods of assessing water bodies of the state with the intent of implementing targeted strategies aimed at specific water quality goals. Site-specific water quality criteria for Lake Arlington (Segment 0828) and Village Creek (Segment 0828A), as defined in TAC 307, are presented in Table 2. For additional information about the collection, preservation, and laboratory analysis of samples collected for these parameters, please consult TCEQ's *SWQM Procedures Manual, Volume 1: Physical and Chemical Monitoring Methods* (TCEQ 2012).

Table 2. Site-specific water quality criteria for the Village Creek-Lake Arlington watershed.

Parameter	Segment ID	
	0828	0828A
Cl^- (mg/L)	100	100
SO_4^{-2} (mg/L)	100	-
TDS (mg/L)	300	300
DO (mg/L) grab minimum	3.0	2.0
DO (mg/L) 24 hour average	5.0	3.0
DO (mg/L) 24 hour minimum	3.0	2.0
pH range	6.5-9.0	6.5-9.0
E. coli (#/100ml) geomean	126	126
Temperature (°F; °C)	95; 35	95; 35

3.2 Nutrient Screening Levels and Reference Criteria

Currently, no numeric criteria exist for nutrients in streams in the state of Texas. Numeric criteria for chlorophyll-a have been approved by EPA for 75 reservoirs in the state; however, Lake Arlington is not one of these reservoirs. In such situations where no water quality standards exist or are in the process of being developed, controls such as narrative criteria and antidegradation considerations are often used. Despite this lack of narrative criteria, TCEQ continues to screen for parameters such as nitrogen, phosphorus, and chlorophyll-a as preliminary indicators in waterbodies of possible concern for 303(d) impairments. To support this effort, nutrient screening levels and reference conditions are often used to compare a waterbody to reference values at a local, regional, or national level. Table 3 provides screening values from various sources. The Texas Nutrient Screening Levels are based on statistical analyses of SWQM monitoring data (TCEQ 2015) and the EPA Reference Criteria are regional values based on data from reservoirs and streams within specific ecoregion units and subunits (USEPA 2000a, USEPA 2000b). It is worth noting that these Reference Criteria differ from the Texas Nutrient Screening Levels in that EPA developed the Reference Criteria using conditions that are indicative of minimally impacted (or in some cases, pristine) waterbodies, attainment of which would result in protection of all designated uses within those specific units and subunits. As such, Reference Criteria thresholds are much lower than those for state screening levels, and surpassing them may not necessarily indicate a concern, as is the case with the state thresholds. Where state screening levels or national reference criteria were non-existent, other sources were used. In particular, other sources were used as a reference for screening values of nitrite (NO_2^-) (Mesner and Geiger 2010).

Table 3. Texas Nutrient Screening Levels and EPA Nutrient Reference Criteria.

Parameter		TCEQ Screening Levels		EPA Reference Criteria				Other Sources
		Lake/Reservoir	Stream	Lake/Reservoir		Stream		
TKN	(mg/L)	-	-	0.38[a]	0.41[b]	0.3[a]	0.4[b]	
NO_2^-	(mg/L)	-	-	-	-	-	-	0.02[c]
NO_3^-	(mg/L)	0.37	1.95	-	-	-	-	
$NO_2^-+NO_3^-$	(mg/L)	-	-	0.017[a]	0.01[b]	0.125[a]	0.078[b]	
TP	(mg/L)	0.20	0.69	0.02[a]	0.019[b]	0.037[a]	0.038[b]	
OP[d]	(mg/L)	0.05	0.37	-	-	-	-	
Chlorophyll a[e]	(µg/L)	26.7	14.1	5.18[a]	2.875[b]	0.93[a]	1.238[b]	

(a) Reference conditions for aggregate Ecoregion IX waterbodies, upper 25th percentile of data from all seasons, 1990-1999.

(b) Reference conditions for level III Ecoregion 29 waterbodies, upper 25th percentile of data from all seasons.

(c) For nitrite, concentrations above 0.02 mg/L (ppm) usually indicate polluted waters (Mesner, N., J. Geiger. 2010. Understanding Your Watershed: Nitrogen. Utah State University, Water Quality Extension.

(d) OP is no longer used for TCEQ screening purposes, as of the 2014 Texas Integrated Report.

(e) Chlorophyll a, as measured by Spectrophotometric method with acid correction.

3.3 Description of Assessments

3.3.1 TCEQ 2014 Texas Integrated Report

The TCEQ Draft 2014 Texas Integrated Report covers a seven-year assessment period from December 1, 2005 to November 30, 2012. In cases where additional data was needed to make an informed assessment, data from an additional three-year segment beginning December 1, 2003 were used. The methods used for this assessment are described in the TCEQ's 2014 *Guidance for Assessing and Reporting Surface Water Quality in Texas* (TCEQ 2015a).

Findings of the Integrated Report are classified as Fully Supporting, No Concern, Use Concern, Screening Level Concern, and Not Supporting. To simplify data presentation in this report, the Use Concern and Screening Level Concern classifications were combined into a single "Concern" category. Use Concern findings are given for assessments against designated use standards for water quality parameters such as dissolved oxygen (DO) and *E. coli*. Use Concerns can apply to datasets with limited data where the threshold number of exceedances are met or to datasets with adequate data where there are less than the threshold number of exceedances required for a Not Supporting finding. Screening Level Concerns apply to General Use parameters, such as nutrients and chlorophyll-a, as well as a few other parameters for other designated uses. These parameters have screening levels rather than standards.

3.3.2 TRA In-house Assessment

To determine the status of more recently collected data, TRA conducted an in-house assessment using the most recent available and complete data. This includes data collected between December 1, 2008 and November 30, 2013. Data were compared to standards and screening levels in a manner similar to TCEQ methods. The exception to this is for orthophosphate (OP), which is no longer assessed by TCEQ. However, because TRA and many other partners within the Trinity Basin still collect this parameter, it has been included in the in-house assessment and has been compared to old TCEQ screening levels. This in-house assessment may provide information on emerging issues that may not be readily apparent in the results of the TCEQ Integrated Report. The results of both assessments are shown in Table 4 below, which call out any impairments or concerns identified in each segment. The results are accompanied by an evaluation of which of a segment's designated uses have data that was available for a use assessment.

Table 4. 2014 Texas Integrated Report & 2015 TRA In-house Assessment information for the Village Creek-Lake Arlington watershed.

Waterbody	Assessment Unit	Designated Uses*					2014 TCEQ Report		5-year TRA In-house Review	
		Aquatic Life	Contact Recreation	General Use	Fish Consumption	Public Water Supply	Impairments	Concerns	Impairments	Concerns
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01			•	•	•				
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	•	•	•	•	•		• chlorophyll-a		• chlorophyll-a
Lake Arlington: Western half of lower portion of lake	0828_03			•	•	•				
Lake Arlington: Eastern half of lower portion of lake	0828_04	•		•	•	•				
Lake Arlington: Western half of upper portion of lake	0828_05	•	•	•	•	•		• chlorophyll-a		• chlorophyll-a
Lake Arlington: Eastern half of upper portion of lake	0828_06	•	•	•	•	•		• chlorophyll-a		• chlorophyll-a
Lake Arlington: Uppermost portion of lake	0828_07	•	•	•	•	•		• nitrate	• bacteria	• nitrate
Lake Arlington: Remainder of lake	0828_08			•	•	•				
Village Creek: From Lake Arlington to the headwaters	0828A_01	•	•	•	•		• bacteria		• bacteria	

**note: blanks in the "Designated Uses" column indicate that no data was available for a specific designated use in the corresponding segment.*

3.4 Data Collection

The majority of data represented in this report was collected at two TCEQ SWQMIS stations existing on Village Creek, generated by TRA's partners within the Clean Rivers Program (CRP). Many of these partners have utilized monitoring programs that have been in place well before the establishment of the Clean Rivers Program, and were used to support such efforts as stormwater permitting or protection of public water supplies. As a result, this report borrows heavily from TRA's Clean Rivers Program 2015 Basin Summary Report (BSR), where the majority of these results were originally presented (TRA 2015).

3.5 Water Quality Trends

Trend analyses were conducted on all datasets determined to be adequately normal. Those datasets that passed significance testing were determined to have trends that warranted further discussion and investigation. The methods used for data preparation and trend analysis are discussed in detail in the 2015 Basin Summary Report (TRA 2015). Please consult the 2015 BSR for additional information regarding normality, significance, and trends.

4.0 Watershed Characteristics

4.1 General Information

The Village Creek-Lake Arlington watershed extends approximately 28 river miles from its headwaters near the city of Joshua in Johnson County to the Lake Arlington dam in Tarrant County. The watershed consists of only two TCEQ-monitored segments, Lake Arlington (0828), a classified segment, and Village Creek (0828A), an unclassified segment.

4.2 Climate

Mean annual daily temperature from the National Weather Service database for the Dallas/Fort Worth Metroplex (https://www.weather.gov/fwd/dfwclimo) is 65.9 °F for the entire period of record (POR) between 1899 and 2015. Temperatures are generally lowest in January and highest in July, with POR daily annual averages of 45.5 °F and 85 °F, respectively.

The watershed generally receives between 32 and 36 inches of precipitation annually, while the mean annual precipitation for the Dallas/Fort Worth Metropolitan area is 33.1 inches for the entire period of record (POR) between 1899 and 2015. The lowest yearly total came in 1921, with only 17.9 inches, with the highest yearly total occurring in 2015, when prolonged storms brought 62.8 inches of rain, along with historic flooding.

4.3 Geology

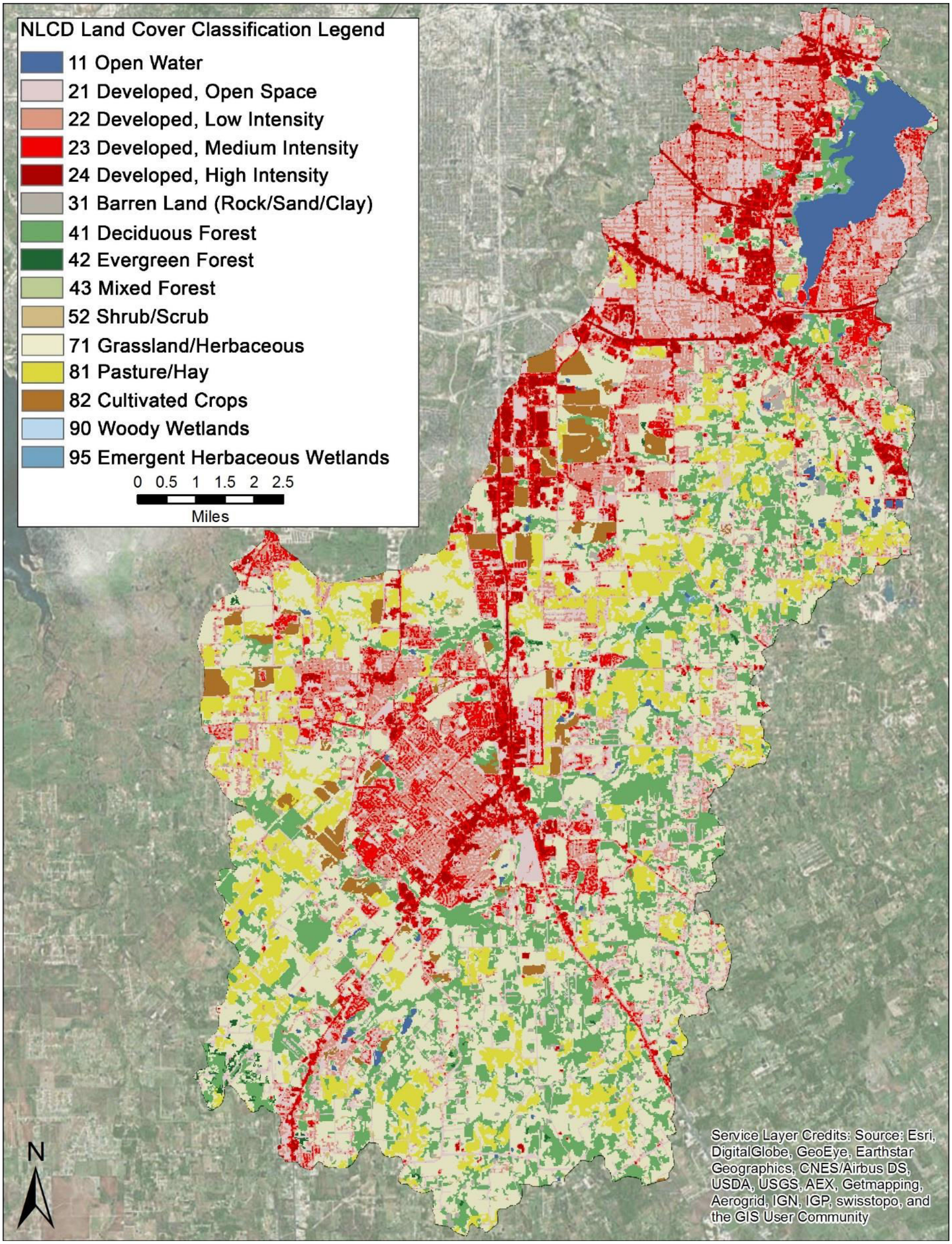
The Village Creek-Lake Arlington watershed is generally located within the Grand Prairie physiographic province according to the Physiographic Map of Texas (Bureau of Economic Geology 1996). The majority of the watershed is underlain by units from the Washita and Woodbine groups, with some fluviatile terrace deposits and alluvial floodplain deposits in areas underlying Lake Arlington and Village Creek.

4.4 Soils

Soils in the vicinity of the lake are composed mainly of fine sandy loams, with silty clays near the transitional zone with Village Creek. Some of the more common upland soil groups in the watershed include Crosstell fine sandy loams, Sanger clays, Crosstell-Urban land complex, and Ponder clay loam. Several hydric soils occupy the bottom land areas of the watershed, with Frio silty clays, Pulexas fine sandy loam, and Hassee fine sandy loam being most common. A complete soils list and map are provided in Appendix A.

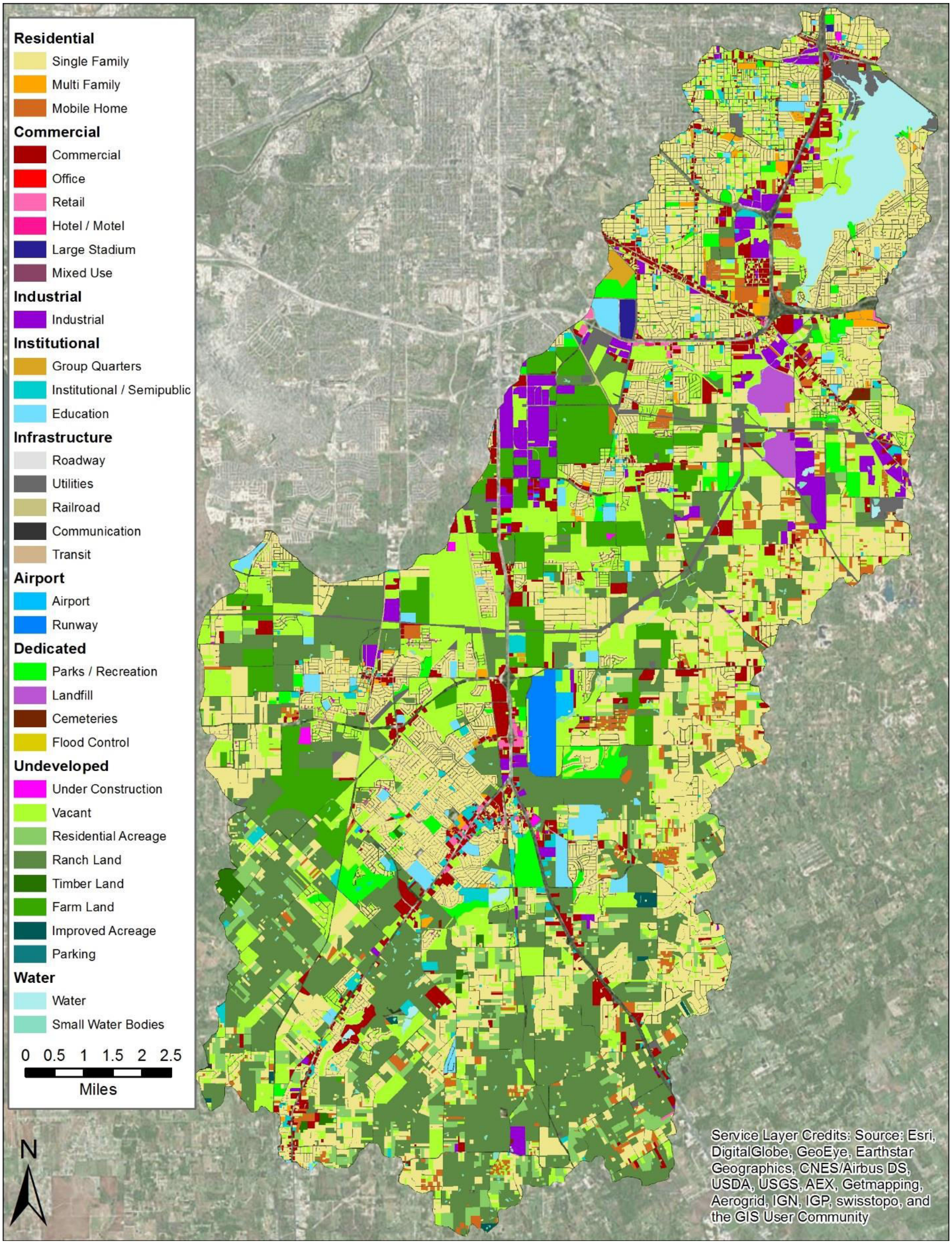
4.5 Land Use and Land Cover

The downstream portions of the subwatershed surrounding the lake are urbanized, while the upstream portions of the subwatershed have remained generally rural with some pastureland and row-crop agriculture. Major population centers include the City of Burleson and the communities of the southwest DFW Metroplex, which includes portions of Fort Worth and Arlington. These population centers compose the majority of the developed land in the area, which is shown at as red areas in Figure 2. Land use within the watershed from 2013 is depicted in Figure 3, which relates a use category (residential, industrial, undeveloped, etc.) to the land cover information. The urban centers previously mentioned are characterized by a high percentage of single family homes, but a significant percentage of industrial complexes are shown to exist immediately south and west of the lake. Outside of these urbanized areas, ranch land is dominant, with pockets of farm land and undeveloped open lots being typical.



Data source: Multi-Resolution Land Characteristics Consortium; Basemap: ESRI World Imagery.

Figure 2. 2012 NLCD land cover classes in the Village Creek-Lake Arlington watershed.



Data source: NCTCOG; Basemap: ESRI World Imagery.

Figure 3. 2013 NCTCOG land use classifications in the Village Creek-Lake Arlington watershed.

4.6 Ecology

The watershed is wholly situated within the Cross Timbers ecoregion. All of segment 0828 is located in the Eastern Cross Timbers ecoregion (29b). Here, post oak (*Quercus stellata*) and blackjack oak (*Q. marilandica*) are common overstory trees, with minor representation from species like black hickory (*Carya texana*), plateau live oak (*Quercus fusiformis*), eastern redcedar (*Juniperus virginiana*), and various sumac species (*Rhus* spp.). with native grasses such as bluestem (*Schizachyrium* spp.), yellow Indiangrass (*Sorghastrum nutans*), and tall dropseed (*Sporobolus asper*) in the understory and within prairie inclusions. In disturbed areas, honey mesquite (*Prosopis glandulosa*) and prickly pear (*Opuntia* spp.) are common.

The majority of segment 0828A also falls within 29b, but the western portion of the watershed, including several Village Creek tributaries, is encompassed within the Grand Prairie ecoregion (29d). The area is dominated by tallgrass prairie species in upland areas. In undisturbed areas, this includes big bluestem (*Andropogon gerardii*), yellow Indiangrass, little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), and Texas cupgrass (*Eriochloa sericea*). However, the occurrence of buffalograss (*Buchloe dactyloides*), Texas wintergrass (*Stipa leucotricha*), and gramas (*Bouteloua* spp.) tends to increase with overgrazing and disturbance. In riparian bands, woody species such as elm (*Ulmus* spp.), pecan (*Carya illinoensis*), and hackberry (*Celtis* spp.) are common. With the onset of European settlement, brush/fire control, and urbanization, invasive species such as Ashe juniper (*Juniperus ashei*) and honey mesquite are now also common (Griffith 2007).

Although no instances of critical habitat occur within the watershed for any federally-listed threatened and endangered species, a U.S. Fish and Wildlife Service (FWS) Information, Planning, and Consultation (IPaC) report indicated the possible presence of several threatened and endangered species that may occur intermittently throughout the watershed. Of note were several endangered avian species, including the Black-capped Vireo (*Vireo atricapilla*), Golden-cheeked Warbler (*Dendroica chrysoparia*), Least Tern (*Sterna antillarum*), and Whooping Crane (*Grus Americana*). The list also included one species of clam, the Texas Fawnsfoot (*Truncilla macrodon*), which is currently listed as a Candidate species. The full IPaC report is provided in Appendix B.

In most cases, state lists of threatened and endangered species are more robust, given the increased specificity for critical populations and habitats afforded by the smaller scope of study inherent to state boundaries. As a result of this refined scope, additional avian and mollusk species appear within the state list produced by the Texas Parks and Wildlife Department (TPWD), shown in Table 5 below. The state list also includes several fish, mammal, reptilian, and plant species, which are not shown in the Federal list. Separate reports for Tarrant and Johnson County are provided in Appendix C.

Table 5. Federal and state status of threatened and endangered species in Tarrant and Johnson Counties.

Scientific Name	Common Name	Fed. Status	State Status	Description
Birds				
Plegadis chihi	White-faced Ibis		T	prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats
Haliaeetus leucocephalus	Bald Eagle	DL	T	found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds
Falco peregrinus	Peregrine Falcon	DL	T	both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.
Falco peregrinus anatum	American Peregrine Falcon	DL	T	year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.
Falco peregrinus tundrius	Arctic Peregrine Falcon	DL		migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.
Grus americana	Whooping Crane	LE	E	potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties
Calidris canutus rufa	Red Knot	T		Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Scientific Name	Common Name	Fed. Status	State Status	Description
		Birds (continued)		
Sterna antillarum athalassos	Interior Least Tern	LE	E	subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony
Athene cunicularia hypugaea	Western Burrowing Owl			open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows
Anthus spragueii	Sprague's Pipit			only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.
Vireo atricapilla	Black-capped Vireo	LE	E	oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer
Setophaga chrysoparia	Golden-cheeked Warbler	LE	E	juniper-oak woodlands; dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer
Ammodramus henslowii	Henslow's Sparrow			wintering individuals (not flocks) found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles; a key component is bare ground for running/walking
		Fishes		
Scaphirhynchus platorynchus	Shovelnose sturgeon		T	open, flowing channels with bottoms of sand or gravel; spawns over gravel or rocks in an area with a fast current; Red River below reservoir and rare occurrence in Rio Grande
Notropis buccula	Smalleye shiner	LE		endemic to upper Brazos River system and its tributaries (Clear Fork and Bosque); apparently introduced into adjacent Colorado River drainage; medium to large prairie streams with sandy substrate and turbid to clear warm water; presumably eats small aquatic invertebrates

Scientific Name	Common Name	Fed. Status	State Status	Description
		Fishes (continued)		
Notropis oxyrhynchus	Sharpnose shiner	LE		endemic to Brazos River drainage; also, apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom a combination of sand, gravel, and clay-mud
		Mammals		
Canis rufus	Red wolf	LE	E	extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies
Canis lupus	Gray wolf	LE	E	extirpated; formerly known throughout the western two-thirds of the state in forests, brushlands, or grasslands
Spilogale putorius interrupta	Plains spotted skunk			catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie
		Reptiles		
Phrynosoma cornutum	Texas horned lizard		T	open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September
Nerodia harteri	Brazos water snake		T	upper Brazos River drainage; riffle specialist, in shallow water with rocky bottom and on rocky portions of banks
Thamnophis sirtalis annectens	Texas garter snake			wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August
Crotalus horridus	Timber rattlesnake		T	swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto
		Mollusks		
Lampsilis satura	Sandbank pocketbook		T	small to large rivers with moderate flows and swift current on gravel, gravel-sand, and sand bottoms; east Texas, Sulfur south through San Jacinto River basins; Neches River
Pleurobema riddellii	Louisiana pigtoe		T	streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments; Sabine, Neches, and Trinity (historic) River basins
Potamilus amphichaenus	Texas heel-splitter		T	quiet waters in mud or sand and also in reservoirs. Sabine, Neches, and Trinity River basins
Truncilla macrodon	Texas fawnsfoot	C	T	little known; possibly rivers and larger streams, and intolerant of impoundment; flowing rice irrigation canals, possibly sand, gravel, and perhaps sandy-mud bottoms in moderate flows; Brazos and Colorado River basins

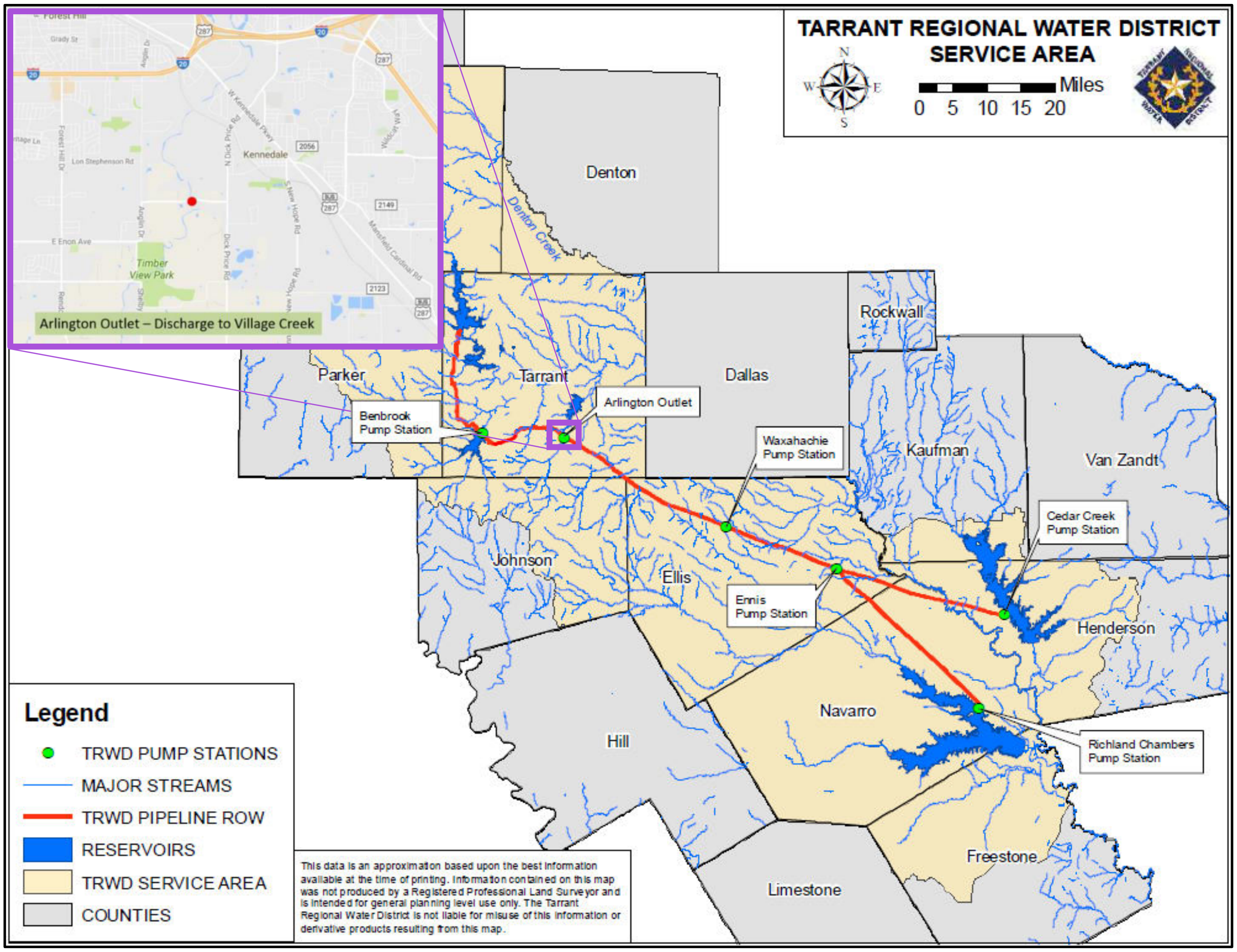
Scientific Name	Common Name	Fed. Status	State Status	Description
Plants				
Echinacea atrorubens	Topeka purple-coneflower			GLOBAL RANK: G3; Occurring mostly in tallgrass prairie of the southern Great Plains, in blackland prairies but also in a variety of other sites like limestone hillsides; Perennial; Flowering Jan-June; Fruiting Jan-May
Cuscuta exaltata	Tree dodder			GLOBAL RANK: G3; Parasitic on various Quercus, Juglans, Rhus, Vitis, Ulmus, and Diospyros species as well as Acacia berlandieri and other woody plants; Annual; Flowering May-Oct; Fruiting July-Oct
Astragalus reflexus	Texas milk vetch			GLOBAL RANK: G3; Grasslands, prairies, and roadsides on calcareous and clay substrates; Annual; Flowering Feb-June; Fruiting April-June
Dalea hallii	Hall's prairie clover			GLOBAL RANK: G3; In grasslands on eroded limestone or chalk and in oak scrub on rocky hillsides; Perennial; Flowering May-Sept; Fruiting June-Sept
Pediomelum reverchonii	Reverchon's curfpea			GLOBAL RANK: G3; Mostly in prairies on shallow rocky calcareous substrates and limestone outcrops; Perennial; Flowering Jun-Sept; Fruiting June-July
Agalinis auriculata	Auriculate false foxglove			Known in Texas from one late nineteenth century specimen record labeled -Benbrook-; in Oklahoma, degraded prairies, floodplains, fallow fields, and borders of upland sterile woods; in Arkansas, blackland prairie; Annual; Flowering August - October
Agalinis densiflora	Osage Plains false foxglove			GLOBAL RANK: G3; Most records are from grasslands on shallow, gravelly, well drained, calcareous soils; Prairies, dry limestone soils; Annual; Flowering Aug-Oct
Yucca necopina	Glen Rose yucca			Texas endemic; grasslands on sandy soils and limestone outcrops; flowering April-June

Source: Texas Parks and Wildlife Department.

5.0 Reservoir Characteristics

5.1 General Information

In the early 1950s, City of Arlington staff were met with the challenge of providing water to a growing city and expanding industrial area. To meet this need, the construction of a new reservoir was proposed which would dam water from Village Creek and incorporate the already-existing Lake Erie, which provided cooling water to a nearby power generation plant. Construction on the reservoir was completed in 1957. Once completed, the reservoir filled at an unprecedented rate, thanks in part to a 100-year storm event that took place in the spring of 1957. This sudden influx of water filled the lake in a short 30 days, which was a welcome relief for residents considering that most of Texas has just suffered through the worst drought in recorded history, which occurred from 1946 to 1957 (Malcolm Pirnie 2011). Today, yields of the reservoir from Village Creek are supplemented with water piped in from two other reservoirs in East Texas, the Richland-Chambers and Cedar Creek Reservoirs (Figure 4). This allows Lake Arlington to be used as a terminal storage reservoir in the Tarrant Regional Water District's (TRWD) Trinity River Diversion Water Supply Project. The outlet for this pipeline is situated just downstream of the Village Creek bridge on Everman-Kennedale Road (32°38'19.90"N, 97°14'32.30"W), shown on the inset map in (see 'Arlington Outlet') on Figure 4. From the Lake Arlington outlet, the pipeline continues on to Lake Benbrook and from there to Eagle Mountain Reservoir. Occasionally, flow in the pipeline is reversed to deliver water from Lake Benbrook to supply Lake Arlington.



Adapted from: Lake Arlington Master Plan, Malcolm Pirnie 2011.

Figure 4. Pipeline right-of-way (ROW) showing connectivity between reservoirs within the Trinity River Diversion Water Supply Project with area of interest (in purple) showing detail for the location of the Arlington Outlet.

Lake Arlington covers 2,275 acres and impounds Village Creek from the Arlington dam in Tarrant County up to a normal pool elevation of 550 feet. Water rights permits for Lake Arlington are held by the City of Arlington and TXU Electric/Excelon Power. Prior to the construction of the Lake Arlington Dam, Lake Erie inhabited an area in the northwestern corner of the lake. Although it retains some of Lake Erie's former utility as an industrial cooling water source, Lake Arlington water is presently used primarily for municipal purposes, providing drinking water to over half a million residents in the City of Arlington, as well as some surrounding communities in Tarrant County. Drinking water from the lake is treated at two facilities: the Pierce-Burch Water Treatment Plant (WTP), owned and operated by the City of Arlington, and the Tarrant County Water Supply Project (TCWSP) WTP, owned and operated by TRA. Withdrawals for these uses are provided below in Table 6. The lake is also used regularly for public recreation, with several public and privately owned docks allowing for boat entry for fishing and other recreational activities (Malcolm Pirnie 2011).

Table 6. Sources of supply and uses of water in Lake Arlington.

Lake Arlington Supplies and Uses	Average Annual Inflows (acre-ft)	Average Annual Withdrawals (acre-ft)
Natural supply from watershed	50,995(1)	N/A
City of Arlington Pierce-Burch WTP	N/A	32,800(2)
TRA TCWSP WTP	N/A	34,000(2)
Excelon Handley Power Plant	N/A	4,000(3)
TRWD Discharge from Cedar Creek and Richland Chambers Reservoirs to Village Creek	43,500(4)	N/A

N/A - not applicable
(1) Based on rainfall data from 199202009 and PLOAD model projections. Estimated annual inflow includes baseflow from Village Creek (2,735 acre-ft) and estimated surface runoff.
(2) Average annual withdrawal between 2009 and 2010.
(3) Projected 2010 net demand, taking into consideration diversions and return flows. (Source: TRWD, 1998)
(4) Average of monitored discharges between 2005 and 2009.

Adapted from: Lake Arlington Master Plan, Malcolm Pirnie 2011.

Land uses surrounding the lake are classified as urban, mixed with interspersed open greenspaces. The east side of the lake is almost completely urbanized, with the majority of land use being residential. However, two large parks do exist near the lake. On the west side of the lake, some undeveloped land does exist just south of the power generation plant operated by Excelon Handley (Excelon), but land use again turns to residential near the southern end of the lake (Figure 2, Figure 3).

5.2 Hydraulics

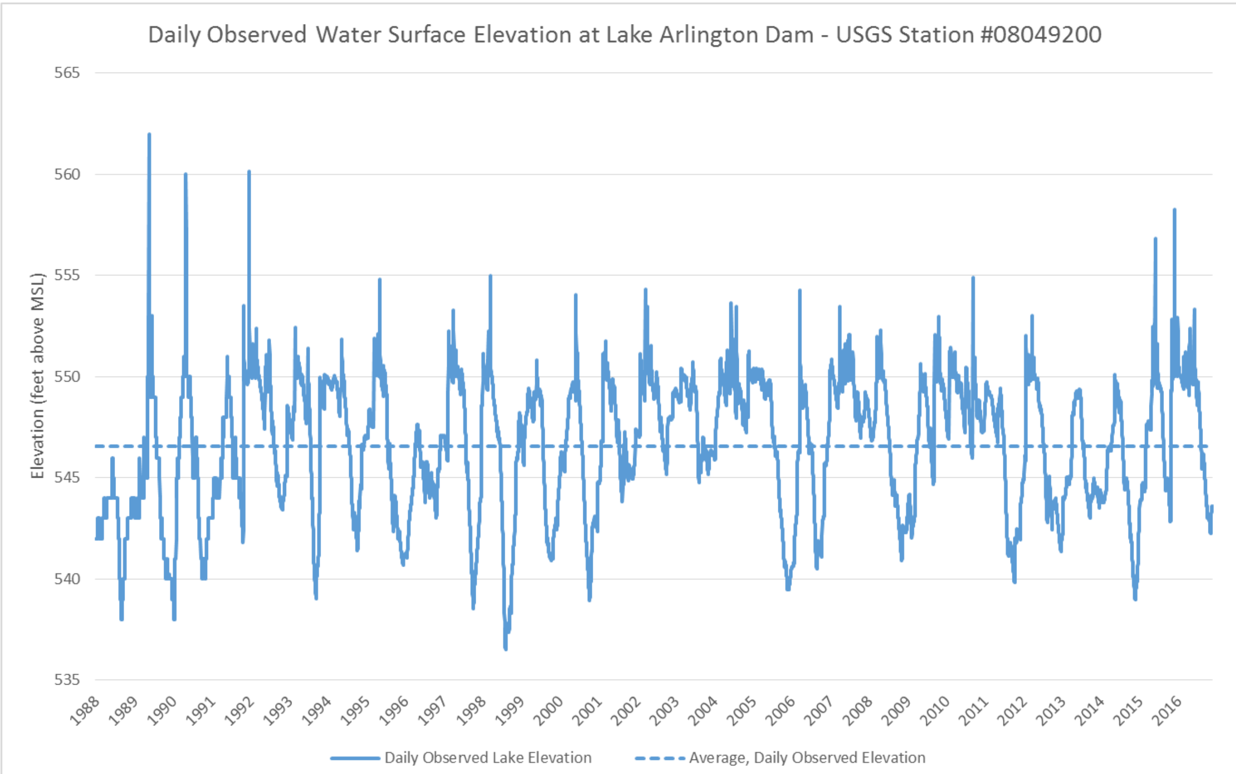
Holders of water rights on Lake Arlington are authorized to impound a total of 45,710 acre-feet of water behind the dam. In contrast, TRA diverts water for their TCWSP plant through contractual agreements with TRWD, utilizing the imported water brought in to Village Creek from TRWD's Trinity River Diversion Water Supply pipeline, instead of the yield from Village Creek itself.

Lake Arlington's operations are based on 4 major factors:

1) Normal inflows from Village Creek;
2) Additional inflows supplied from the TRWD pipeline;
3) Surface evaporation from the lake; and
4) Diversions/withdrawals from the lake by the City, TRA, and Excelon/TXU.

The normal conservation pool elevation for Lake Arlington is 550 ft above mean sea level (MSL), which coincides with the elevation of the drop inlet spillway that drains the lake, located near the east end of the Lake Arlington dam. The dam itself is an earthen structure with a total length of 6,482 ft (1.2 mi) and a height of 83 ft. A flood storage easement held by the City of Arlington allows for additional storage up to 560 ft MSL, and the dam itself reaches a total height of 577.5 ft MSL, which accounts for a parapet wall that was added to the dam after initial construction was complete. During flood events, water may be released from an uncontrolled emergency spillway, which has a crest elevation of 559.7 ft MSL and a width of 882 ft (Malcolm Pirnie 2011). Historical lake elevations from 1988 to 2016 are provided in Figure 5 below.

The management of the lakes' pool elevation relies heavily on the contractual relationships with TRWD, particularly in the summer months. Under a 1971 agreement, TRWD agreed to maintain a minimum lake elevation of 540 ft MSL during the summer months (from June 1 to September 1) and a minimum of 535 ft MSL during the remainder of the year.

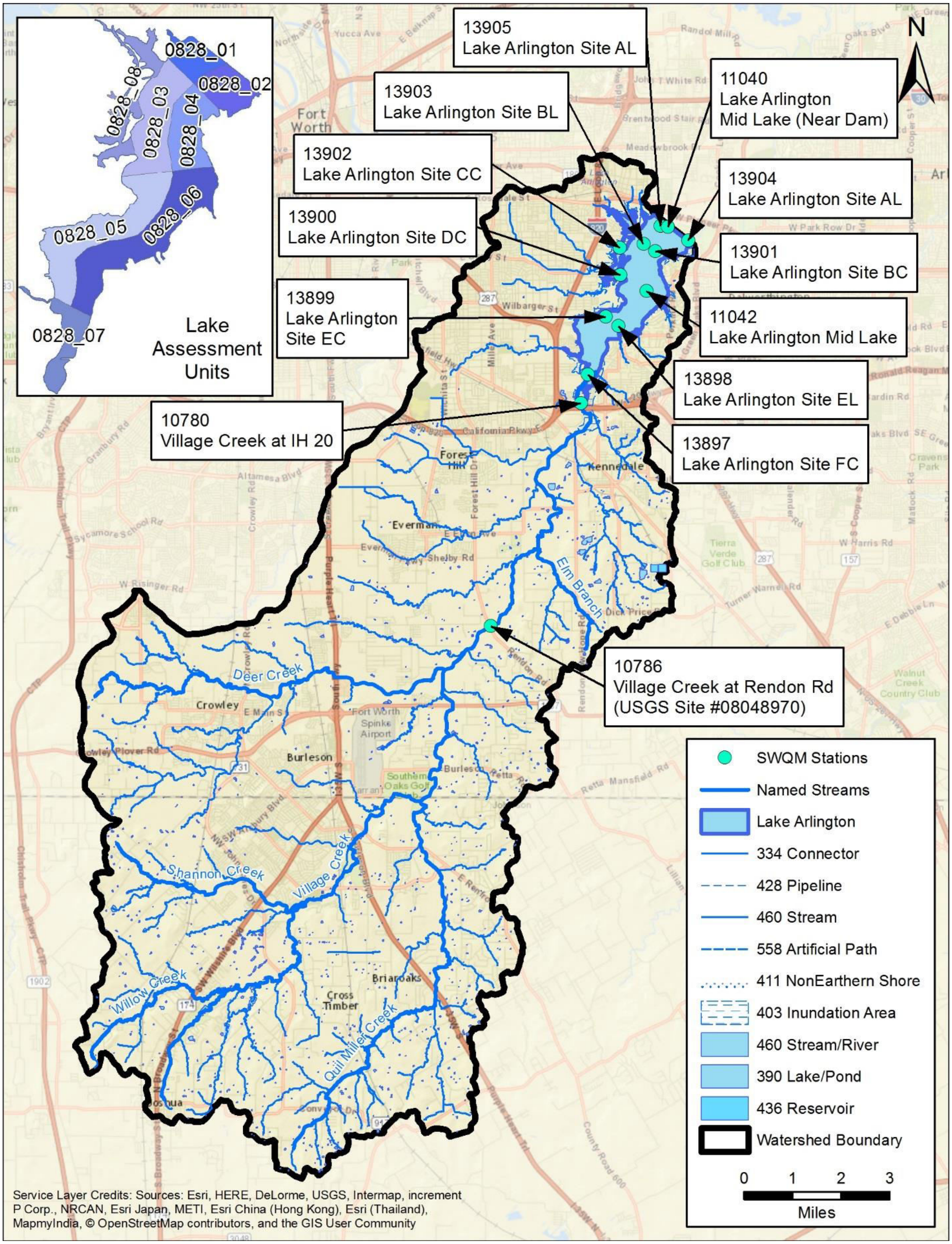


Data source: USGS.

Figure 5. Daily Observed Water Surface Elevation in Lake Arlington, 1988-2016.

5.3 Water Quality Monitoring Data

The lake is composed of 8 assessment units (AUs) that are analyzed for water quality, as part of TCEQ's SWQMIS. These assessment units and their location descriptions are listed in Table 7 below, as well as in all other use assessment results tables that follow. Each assessment unit may contain at least one SWQMIS monitoring station, from which data is analyzed to evaluate the unit's use assessment. The locations of these monitoring stations, as well as the locations of the assessment units, are provided in Figure 6. It is important to note that while information from each unit's station is listed separately in the reporting database, the lake is evaluated as a whole segment, compounding data from all 8 assessment units for analysis. Data in SWQMIS is available from 1971 to present, although data for *E. coli* is only available from 2002 forward, and data for flow is only available from 2007 forward.



Basemap: ESRI World Streetmap.

Figure 6. Water quality monitoring stations, hydrography, and Lake Assessment Units.

5.3.1 Aquatic Life Use Assessments

Adequate aquatic life use data was available for assessment units 0828_02, 0828_05, 0828_06, and 0828_07 (Table 7). The water quality parameter associated with aquatic life assessments is DO. The available data showed that these segments were all fully supporting aquatic life uses.

Table 7. Aquatic life use assessment results for Lake Arlington.

Waterbody	AU	2014 TCEQ Report	5-year TRA In-house Review
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01	Not Assessed (No Data)	Not Assessed (No Data)
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	Fully Supporting	Fully Supporting
Lake Arlington: Western half of lower portion of lake	0828_03	Not Assessed (No Data)	Not Assessed (No Data)
Lake Arlington: Eastern half of lower portion of lake	0828_04	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Western half of upper portion of lake	0828_05	Fully Supporting	Fully Supporting
Lake Arlington: Eastern half of upper portion of lake	0828_06	Fully Supporting	Fully Supporting
Lake Arlington: Uppermost portion of lake	0828_07	Fully Supporting	Fully Supporting
Lake Arlington: Remainder of lake	0828_08	Not Assessed (No Data)	Not Assessed (No Data)

5.3.2 Contact Recreation Use Assessments

Adequate recreational use data was available for assessment units 0828_02, 0828_05, 0828_06, and 0828_07. The water quality parameter associated with this assessment is *E. coli.* This segment was found to be fully supporting based on the TCEQ Draft 2014 Integrated Report (Table 8). However, the in-house 5 year assessment found that 0828_07 was not supporting based on an elevated E. coli geometric mean and appears to be due to a single elevated *E. coli* sample which occurred during an extremely high flow event (Figure 7). Elevated *E. coli* levels typically occur during periods of high flow due to runoff in the watershed which carry in bacteria loads from the surrounding land. Current standards for *E. coli* are 399 most probable number (MPN)/100 mL for a single grab sample and 126 MPN/100 mL for the geometric mean of samples over time.

Table 8. Contact recreation use assessment results for Lake Arlington.

Waterbody	AU	2014 TCEQ Report	5-year TRA In-house Review
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01	Not Assessed (No Data)	Not Assessed (No Data)
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	Fully Supporting	Fully Supporting
Lake Arlington: Western half of lower portion of lake	0828_03	Not Assessed (No Data)	Not Assessed (No Data)
Lake Arlington: Eastern half of lower portion of lake	0828_04	Not Assessed (No Data)	Not Assessed (No Data)
Lake Arlington: Western half of upper portion of lake	0828_05	Fully Supporting	Fully Supporting
Lake Arlington: Eastern half of upper portion of lake	0828_06	Fully Supporting	Fully Supporting
Lake Arlington: Uppermost portion of lake	0828_07	Fully Supporting	Not Supporting
Lake Arlington: Remainder of lake	0828_08	Not Assessed (No Data)	Not Assessed (No Data)

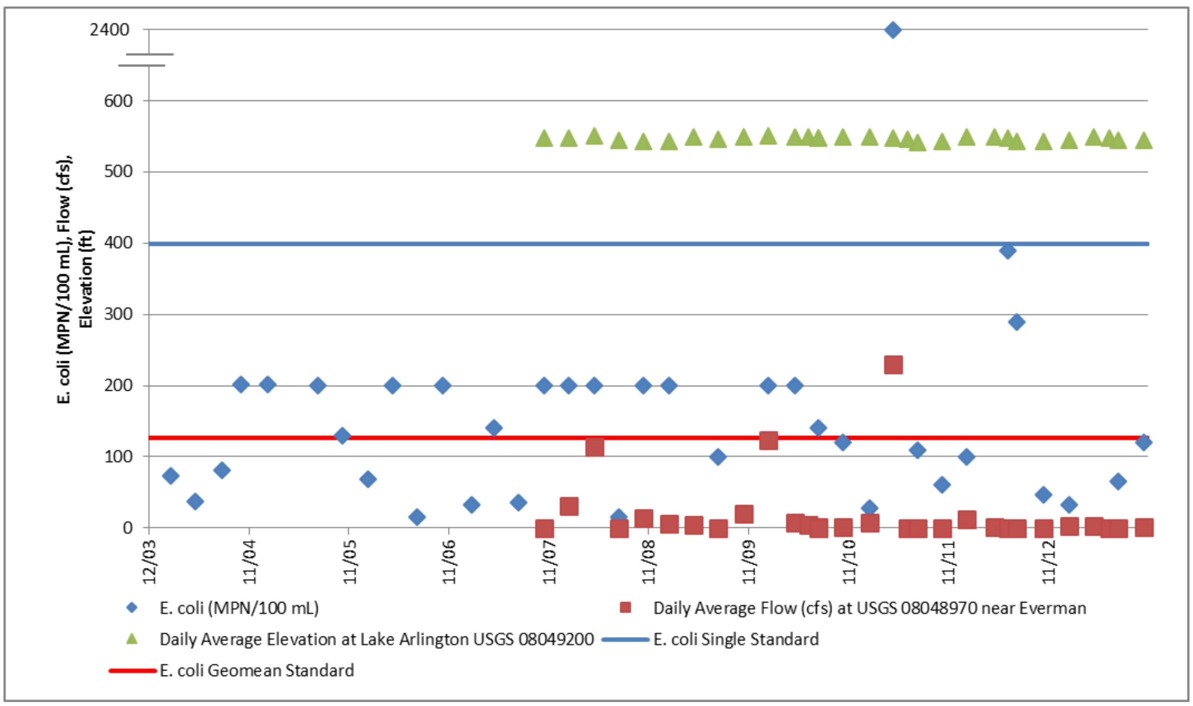


Figure 7. E. coli, Flow, & Lake Elevation in Lake Arlington Assessment Unit 0828_07.

5.3.3 General Use Assessments

Adequate general use data was available for assessment units 0828_01, 0828_02, 0828_05, 0828_06, and 0828_07. The water quality parameters associated with this assessment are temperature, pH, dissolved solids, and several nutrients. Assessment units 0828_02, 0828_05, and 0828_06 were found to have concerns for chlorophyll-a based on the TCEQ 2014 Integrated Report (Table 9). In addition, 0828_07 was found to have concerns for nitrate. The in-house 5 year assessment also found these concerns in the same assessment units.

Table 9. General use assessment results for Lake Arlington.

Waterbody	AU	2014 TCEQ Report	5-year TRA In-house Review
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01	Fully Supporting	Fully Supporting
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	Concern	Concern
Lake Arlington: Western half of lower portion of lake	0828_03	Not Assessed (No Data)	Not Assessed (No Data)
Lake Arlington: Eastern half of lower portion of lake	0828_04	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Western half of upper portion of lake	0828_05	Concern	Concern
Lake Arlington: Eastern half of upper portion of lake	0828_06	Concern	Concern
Lake Arlington: Uppermost portion of lake	0828_07	Concern	Concern
Lake Arlington: Remainder of lake	0828_08	Not Assessed (No Data)	Not Assessed (No Data)

For chlorophyll-a, there does not appear to be any correlation between the measured values and either stream flow or lake elevation. Rather, there is an observed relationship between chlorophyll-a and total phosphorus (TP). This relationship is seen in all three assessment units (0828_02, 0828_06, and 0828_07) and is best seen in Figure 8, which shows that not only is there a relationship between the two parameters and the expected intra-year variation, there also appears to be a pattern in the fluctuation of the values across years. This pattern was also seen in the dataset used for the 2010 TRA Basin Summary Report. Based on that report and this dataset, the pattern appears to have a roughly four year cycle in which values peak and then drop again. This may be due to natural algal population growth and collapse as nutrients are consumed to a point that the algal population can no longer be sustained. However, the water supply and use data provided in Table 6 indicate that the Lake's entire volume is replaced with new water frequently, sometimes more than once within a year. Due to these complexities related to lake storage, which include imports from other reservoirs, more information is needed before conclusions can be drawn regarding the observed pattern.

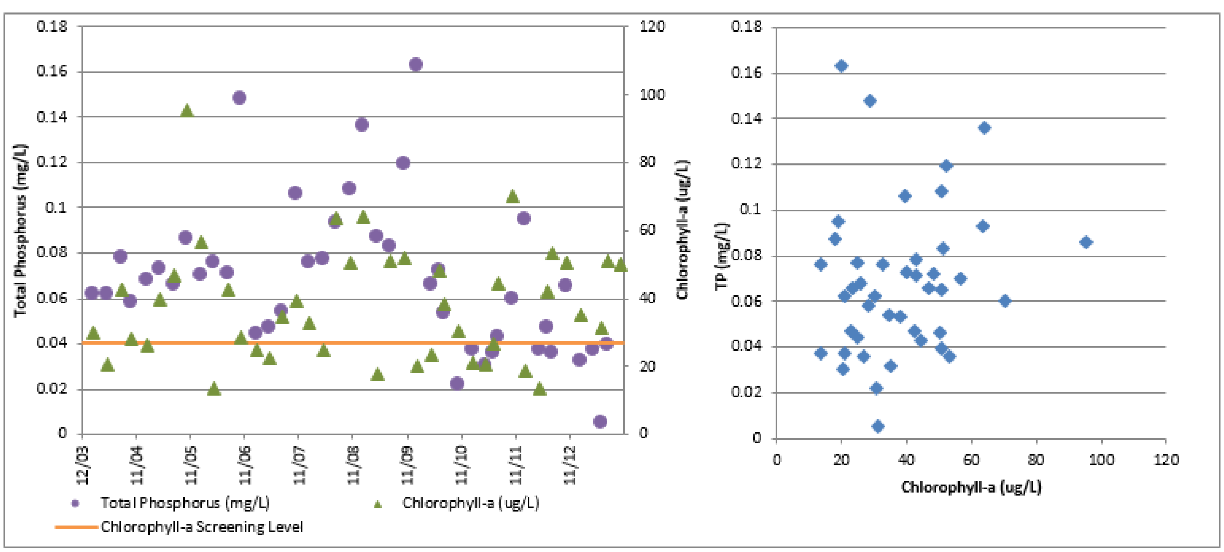


Figure 8. Chlorophyll-a and total phosphorus in Lake Arlington assessment unit 0828_06.

There is a similar pattern for nitrate and chlorophyll-a in 0828_07 as the one seen for chlorophyll-a and total phosphorus in 0828_06 (Figure 9). Again, this may be due to natural algal population growth and collapse. In order to determine a cyclical relationship between chlorophyll-a and nutrients in the lake, a special study would need to be undertaken with a sampling frequency adequate to see if there is a drop in nutrients just prior to the drop in chlorophyll-a.

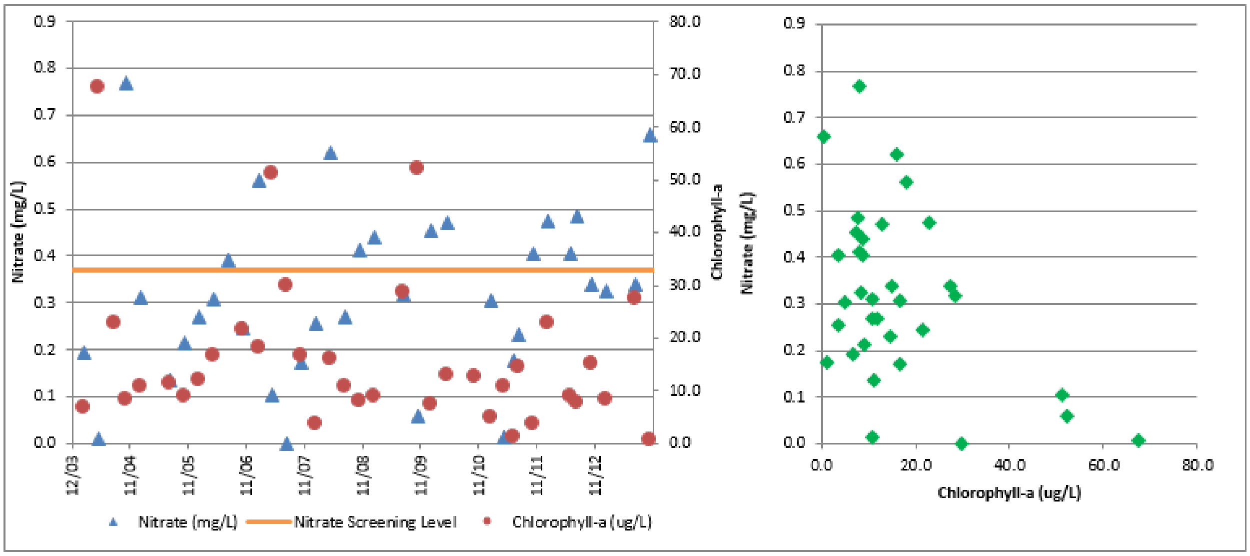


Figure 9. Nitrate and total phosphorus in Lake Arlington assessment unit 0828_07.

5.3.4 Fish Consumption Use Assessments

For the TCEQ Integrated Report, adequate fish consumption use data was unavailable for all assessment units within Lake Arlington (Table 10). As such, no support assessment for the fish consumption use can be made at this time. Fish Consumption uses are not evaluated for the in-house assessment.

Table 10. Fish consumption use assessment results for Lake Arlington.

Waterbody	AU	2014 TCEQ Report	5-year TRA In-house Review
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Western half of lower portion of lake	0828_03	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Eastern half of lower portion of lake	0828_04	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Western half of upper portion of lake	0828_05	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Eastern half of upper portion of lake	0828_06	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Uppermost portion of lake	0828_07	Not Assessed (Inadequate Data)	Not Assessed (No Data)
Lake Arlington: Remainder of lake	0828_08	Not Assessed (Inadequate Data)	Not Assessed (No Data)

5.3.5 Public Water Supply Use Assessments

Adequate public water supply use data was available for all assessment units within Lake Arlington (Table 11). In this particular case of public water supply use, nitrate was the single water quality parameter used for the assessment. This segment was found to be fully supporting of public water supply use based on the TCEQ 2014 Integrated Report. Similarly, the available data used in the in-house 5 year assessment found that these segments presented no concern or were all fully supporting of public water supply uses within Lake Arlington.

Table 11. Public water supply use assessment results for Lake Arlington.

Waterbody	AU	2014 TCEQ Report	5-year TRA In-house Review
Lake Arlington: Lowermost portion of lake along western half of dam	0828_01	Fully Supporting	No Concern
Lake Arlington: Lowermost portion of lake along eastern half of dam	0828_02	Fully Supporting	Fully Supporting
Lake Arlington: Western half of lower portion of lake	0828_03	Fully Supporting	No Concern
Lake Arlington: Eastern half of lower portion of lake	0828_04	Fully Supporting	No Concern
Lake Arlington: Western half of upper portion of lake	0828_05	Fully Supporting	Fully Supporting
Lake Arlington: Eastern half of upper portion of lake	0828_06	Fully Supporting	Fully Supporting
Lake Arlington: Uppermost portion of lake	0828_07	Fully Supporting	Fully Supporting
Lake Arlington: Remainder of lake	0828_08	Fully Supporting	No Concern

6.0 Stream Characteristics

6.1 Flow

Flow data for Village Creek is tracked continuously by a U.S. Geological Survey (USGS) gaging station at the Village Creek bridge on Rendon Road (USGS Gage #08048970). However, this dataset only dates back to July 2007. Other flow data exist at other stations throughout the watershed within SWQMIS that will be used to supplement the USGS dataset.

6.2 Water Quality Monitoring Data

The Village Creek segment contains only one assessment unit that is analyzed for water quality under SWQM procedures. This assessment unit and its location description is listed in Table 13. Within this unit, there are two stations (TCEQ Station IDs 10780 and 10786) that were used in the use analysis. It is important to note that data taken at 10786 is sampled where the previously-mentioned USGS gage is located. It is also worth noting that while information from each station is listed separately in the SWQMIS database, the segment is evaluated as a whole, combining data from both stations for analysis. Data in SWQMIS is available from 1977 to present, although data for *E. coli* is only available from 2002 forward.

6.2.1 Aquatic Life Use Assessments

Adequate aquatic life use data was available for assessment unit 0828A (Table 12). As with Lake Arlington, DO was the water quality parameter used in the assessment. The available data showed that these segments were all fully supporting aquatic life uses.

Table 12. Use assessment results for Village Creek.

Waterbody/ AU	Use Assessment	2014 TCEQ Report	5-year TRA In-house Review
From Lake Arlington to the headwaters - 0828A_01	Aquatic Life	Fully Supporting	Fully Supporting
	Contact Recreation	Not Supporting	Not Supporting
	General	Fully Supporting	Not Supporting
	Fish Consumption	Fully Supporting	Not Assessed (No Data)
	Public Water Supply	Not Assessed (No Data)	Fully Supporting

6.2.2 Contact Recreation Use Assessments

This segment was found to be not supporting based on both the TCEQ 2014 Integrated Report and the in-house 5 year assessment due to elevated *E. coli* geometric means. In addition, the in-house 5 year assessment found this segment to be not supporting based on the single grab sample standard. Current standards for *E. coli* are 399 MPN/100 mL for a single grab sample and 126 MPN/100 mL for the geometric mean of samples over time. As seen in Figure 10, there are several elevated *E. coli* values throughout the dataset. These values are associated with higher flow values in the stream. As discussed above, elevated *E. coli* and stream flow values typically occur in tandem due to nonpoint source inputs of incoming stormwater runoff from the surrounding watershed.

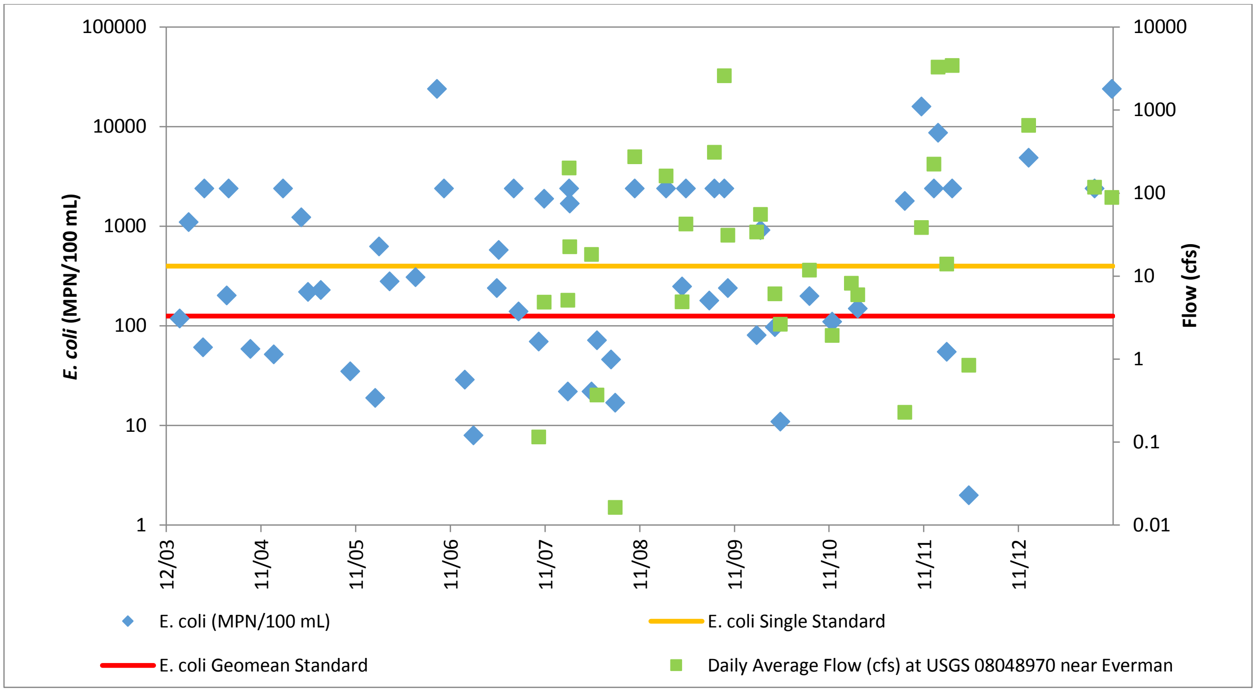


Figure 10. E. coli and flow in Village Creek, segment 0828A.

There are two sites used in the dataset for this unclassified segment; one is at the headwaters of the lake in an urbanized area (Station 10780) and the other is further upstream in a more rural area of the watershed (Station 10786). Although there are a few elevated *E. coli* values at the headwater site, a majority of the elevated values originate at the upstream rural site. This indicates that the source of the impairment in 0828A may be due to factors such as wildlife, livestock, or faulty septic tanks.

6.2.3 General Use Assessments

The in-house 5 year assessment found that this unclassified segment was not supporting due to total dissolved solids (TDS). This may be due to drought conditions in the area. As less rainfall occurs, more lawn and agricultural irrigation takes place. The runoff from irrigation is generally high in dissolved solids. In addition, as evaporation takes place in the streams and reservoirs, dissolved solids in the water become concentrated. This relationship is shown in Figure 11 for Village Creek and Lake Arlington. It is also worth noting that drought conditions may also be a factor where prolonged periods of reduced rainfall result in baseflow being dominated by effluent from wastewater treatment facilities (WWTFs), of which there are several known in the watershed. This effluent may also be a source of TDS. Inputs from other reservoirs can be eliminated as a source, since the water quality monitoring data for which these assessments are based on come from a sampling station that is situated upstream of the Arlington Outlet (Figure 4 and Figure 6).

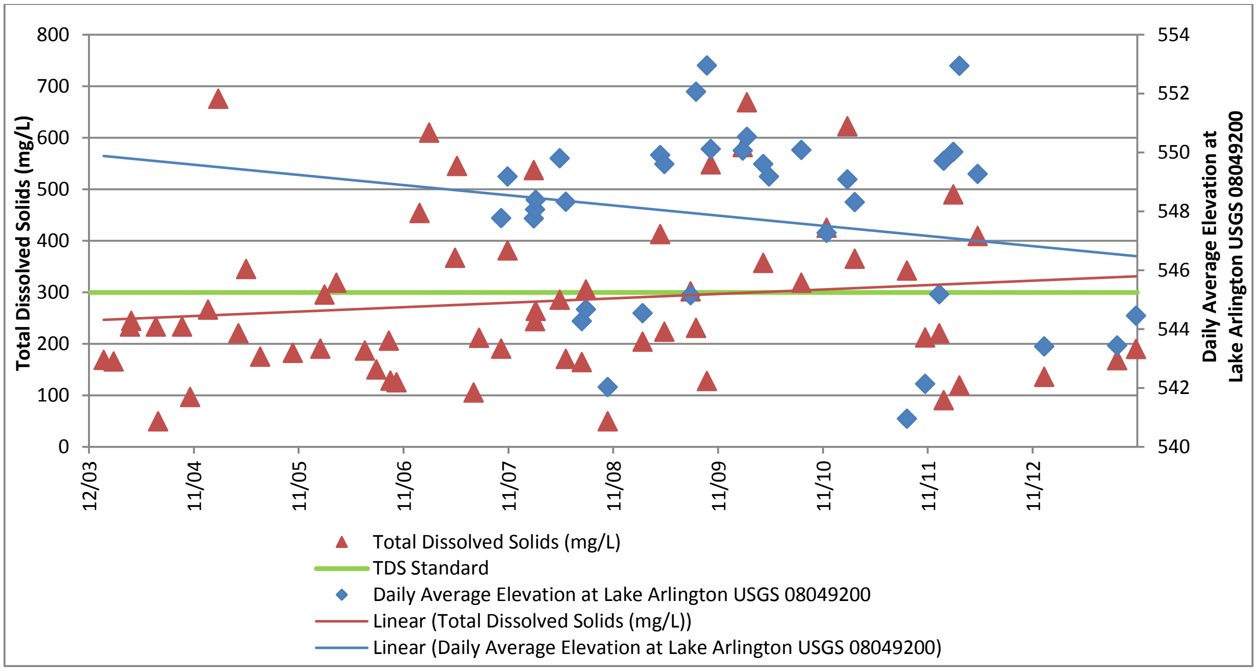


Figure 11. Relationship between TDS in Village Creek (0828A) and elevation in Lake Arlington (0828).

6.2.4 Fish Consumption Use Assessments

For the TCEQ Integrated Report, Adequate fish consumption data was available for the assessment unit 0828A, as reviewed under the TCEQ Integrated Report (Table 12). The available data showed that these segments were all fully supporting aquatic life uses. Fish Consumption uses are not evaluated for the in-house assessment.

6.2.5 Public Water Supply Use Assessments

Typically, streams are not used for public water supplies. However, since this segment is a tributary to a water supply reservoir, the in-house assessment is conducted using parameters related to water supply uses to determine if there may be future drinking water supply concerns found by TCEQ's Integrated Report. The data reviewed in the in-house assessment indicated that this use was fully supported (Table 12).

7.0 Trend Analysis

There were 42 significant trends identified for this segment as summarized in Table 13. For additional detail on trend methods, please see the Data Review Methodology section in the 2015 Basin Summary Report (TRA 2015).

Table 13. Trend analysis results summary for Village Creek (0828A) and Lake Arlington (0828).

Assessment Unit		Flow Severity			Secchi Depth			Water Temp			DO			pH			Sp Cond			Chlorophyll-a			TSS			VSS		
Seg_AU	Site	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W
0828_02	13904						DN						DN												UP			
0828_05	13899																											
0828_06	11042																											
0828_07	13897																				DN							
0828A_01	10780	UP		UP										DN	DN	DN	UP		UP									
0828A_01	10786									DN																DN		

Assessment Unit		TDS			SO4			NH3			NO3			TKN			OP			TP			Hardness		
Seg_AU	Site	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A	S	W
0828_02	13904	DN					DN								DN	DN				DN	DN			DN	
0828_05	13899													DN		DN									
0828_06	11042	DN						DN						DN	DN	DN		DN			DN				
0828_07	13897								UP							DN			DN			DN			
0828A_01	10780	UP		UP																					
0828A_01	10786							DN	DN	DN		DN		DN	DN	DN									

Trends Key

A-All Months

S-Summer/Growing Season (May-October)

W-Winter/Dormant Season (November-April)

UP Increasing Trends

DN Decreasing Trends

7.1 Trends in Lake Arlington

Table 14 provides a detailed analysis of the significant trends within Lake Arlington. Contrary to data analyzed in past BSRs, chlorophyll-a and total phosphorus trends are now decreasing. As discussed above in the General Use section, this may be due to natural algal population cycles in the lake. Overall, trends in this segment have R^2 values less than 0.33. There are 5 trends with R^2's greater than 0.4; however, these are all decreasing trends with very shallow slopes.

Table 14. Detailed trend analysis results for Lake Arlington (0828).

Segment	Station	Parameter	Season	R^2	Slope	P	Std Dev	T	Skewness /SES	Kurtosis/ SEK	N	Mean	Max	Q75	Median	Q25	Min	IQR	Min Date	Max Date
0828_02	13904	Secchi Depth	Winter	0.48	-0.04	0	0.01	-4.04	0.32	-0.57	20	0.7	1	0.79	0.7	0.61	0.46	0.18	2/18/2004	11/13/2013
0828_02	13904	DO	Winter	0.16	-0.22	0.08	0.12	-1.83	-0.56	-0.45	20	9.99	12.5	11.25	10.02	9	6.7	2.25	2/18/2004	11/13/2013
0828_02	13904	TSS	Winter	0.17	0.42	0.07	0.22	1.89	-0.14	-0.91	20	11.55	17.1	13.9	11.9	8.57	6.8	5.33	2/18/2004	11/13/2013
0828_02	13904	TKN	Summer	0.47	-0.06	0	0.01	-4.32	-1	2.46	23	0.89	1.53	1.06	0.85	0.78	0.1	0.28	5/17/2004	8/14/2013
0828_02	13904	TKN	Winter	0.19	-0.03	0.06	0.01	-1.99	-1.11	0.6	19	0.96	1.27	1.12	0.98	0.86	0.51	0.26	2/18/2004	11/13/2013
0828_02	13904	TP	POR	0.16	-0.07	0.01	0.02	-2.81	-0.97	0.71	43	0.07	0.19	0.08	0.06	0.05	0.02	0.03	2/18/2004	11/13/2013
0828_02	13904	TP	Summer	0.41	-0.01	0	0	-3.91	0.41	-0.56	24	0.06	0.11	0.07	0.06	0.04	0.02	0.04	5/17/2004	8/14/2013
0828_02	13904	Hardness	Summer	0.27	-2.5	0.01	0.87	-2.88	-1.55	-0.85	24	26.66	43.65	36.68	30.38	13.96	3.79	22.72	5/17/2004	8/14/2013
0828_02	13904	SO4	Winter	0.15	-0.58	0.1	0.33	-1.74	0.57	-0.22	19	30.53	39.3	33.5	29.7	27.3	21.9	6.2	2/18/2004	11/13/2013
0828_02	13904	TDS	POR	0.11	-0.02	0.03	0.01	-2.27	0.62	1.16	44	180.84	258	192.69	181	165	129	27.69	2/18/2004	11/13/2013
0828_05	13899	TKN	POR	0.33	-0.04	0.01	0.01	-3.09	-0.99	-0.29	21	0.92	1.26	1.05	0.98	0.82	0.51	0.23	2/18/2004	11/13/2013
0828_05	13899	TKN	Winter	0.33	-0.04	0.01	0.01	-2.96	-0.81	-0.38	20	0.92	1.26	1.08	0.95	0.8	0.51	0.28	2/18/2004	11/13/2013
0828_06	11042	NH3	POR	0.16	-0.18	0.01	0.07	-2.66	1.26	-2.01	39	0.02	0.1	0.04	0	0	0	0.04	2/18/2004	11/13/2013
0828_06	11042	TKN	POR	0.33	-0.05	0	0.01	-4.57	-0.59	1.87	44	0.89	1.64	1.06	0.94	0.72	0.1	0.35	2/18/2004	11/13/2013
0828_06	11042	TKN	Summer	0.47	-0.07	0	0.02	-4.44	-0.11	1.46	24	0.88	1.64	1.06	0.93	0.66	0.1	0.4	5/17/2004	8/14/2013
0828_06	11042	TKN	Winter	0.16	-0.03	0.08	0.02	-1.87	-1.06	-0.37	20	0.91	1.22	1.1	0.95	0.74	0.42	0.36	2/18/2004	11/13/2013
0828_06	11042	TP	Summer	0.44	0	0	0	-4.14	-0.73	-0.28	24	0.06	0.09	0.07	0.06	0.04	0.01	0.04	5/17/2004	8/14/2013
0828_06	11042	OP	Summer	0.25	-0.18	0.02	0.07	-2.57	0.64	-1.46	22	0	0.02	0.01	0	0	0	0.01	5/17/2004	8/14/2013
0828_06	11042	TDS	POR	0.11	-3.15	0.03	1.39	-2.27	0.75	2.93	44	182.52	258	196.71	182	161.5	98	35.21	2/18/2004	11/13/2013
0828_07	13897	NH3	Summer	0.24	0.01	0.06	0	2.02	1.01	-0.54	15	0.07	0.16	0.1	0.05	0.03	0	0.07	5/17/2004	8/14/2013
0828_07	13897	TKN	Winter	0.17	-0.04	0.07	0.02	-1.93	0.41	2.48	20	0.8	1.5	0.89	0.73	0.68	0.1	0.22	2/18/2004	11/13/2013
0828_07	13897	TP	Winter	0.22	-0.14	0.04	0.06	-2.27	0.22	-0.66	20	0.14	0.5	0.18	0.09	0.05	0.02	0.13	2/18/2004	11/13/2013
0828_07	13897	OP	Winter	0.24	-0.22	0.04	0.1	-2.2	-1.8	1.36	17	0.04	0.21	0.05	0.02	0.02	0	0.04	2/18/2004	11/13/2013
0828_07	13897	Chlorophyll-a	Summer	0.23	-0.15	0.06	0.07	-2.07	-1.72	2.5	16	21.12	67.4	27.95	15.25	10.75	1.3	17.2	5/17/2004	8/14/2013

Table 15. Detailed trend analysis results for Village Creek (0828A).

Segment	Station	Parameter	Season	R^2	Slope	P	Std Dev	T	Skewness /SES	Kurtosis/ SEK	N	Mean	Max	Q75	Median	Q25	Min	IQR	Min Date	Max Date
0828A_01	10780	Sp Cond	POR	0.32	0.1	0	0.03	3.46	1.28	-0.78	27	459.56	1030	562	360	294	254	268	1/21/2004	9/19/2011
0828A_01	10780	Sp Cond	Winter	0.48	66.88	0.01	21.1	3.16	1.48	0.18	13	506.62	1030	655	410	294	260	361	1/21/2004	3/21/2011
0828A_01	10780	pH	POR	0.34	-0.09	0	0.03	-3.53	-1.25	2.12	26	7.86	8.6	8	7.8	7.8	7	0.2	1/21/2004	3/21/2011
0828A_01	10780	pH	Summer	0.41	-0.11	0.02	0.04	-2.74	-0.3	2.32	13	7.85	8.6	7.9	7.8	7.8	7	0.1	7/21/2004	9/16/2010
0828A_01	10780	pH	Winter	0.3	-0.08	0.05	0.04	-2.18	-1.66	2.01	13	7.88	8.4	8.1	7.9	7.8	7	0.3	1/21/2004	3/21/2011
0828A_01	10780	Flow Severity	POR	0.15	0.03	0.05	0.02	2.04	-0.16	1.64	26	2.92	5	3	3	3	2	0	1/21/2004	9/19/2011
0828A_01	10780	Flow Severity	Winter	0.26	0.1	0.07	0.05	1.97	-0.39	1.89	13	2.92	4	3	3	3	2	0	1/21/2004	3/21/2011
0828A_01	10780	TDS	POR	0.32	0.1	0	0.03	3.46	1.28	-0.78	27	298.71	669.5	365.3	234	191.1	165	174.2	1/21/2004	9/19/2011
0828A_01	10780	TDS	Winter	0.48	43.47	0.01	13.7	3.16	1.48	0.18	13	329.3	669.5	425.75	266.5	191.1	169	234.7	1/21/2004	3/21/2011
0828A_01	10786	Water Temp	Winter	0.21	-0.61	0.04	0.28	-2.22	-0.1	-0.75	21	12.56	20.6	15.9	12.5	9.8	5.3	6.1	2/25/2004	11/25/2013
0828A_01	10786	VSS	POR	0.15	-0.37	0.05	0.18	-2.04	-0.69	-1.58	25	15.38	57.7	26.7	9.8	0.5	0.5	26.2	2/25/2004	5/26/2010
0828A_01	10786	NH3	POR	0.49	-0.4	0	0.07	-5.58	-0.4	-2.17	35	0.05	0.19	0.09	0.03	0	0	0.09	2/25/2004	11/25/2013
0828A_01	10786	NH3	Summer	0.56	-0.44	0	0.11	-4.08	-0.56	-1.23	15	0.04	0.14	0.06	0.03	0	0	0.06	7/29/2004	9/20/2013
0828A_01	10786	NH3	Winter	0.33	-0.01	0.01	0	-2.95	1.33	-0.33	20	0.06	0.19	0.1	0.05	0	0	0.1	2/25/2004	11/25/2013
0828A_01	10786	NO3	Summer	0.28	-0.08	0.04	0.03	-2.27	1.53	0.02	15	0.37	1.1	0.59	0.26	0.04	0.01	0.55	7/29/2004	9/20/2013
0828A_01	10786	TKN	POR	0.3	-0.14	0	0.04	-3.81	1.28	-1.03	36	1.19	2.85	1.75	0.94	0.58	0.1	1.17	2/25/2004	11/25/2013
0828A_01	10786	TKN	Summer	0.46	-0.2	0.01	0.06	-3.36	1.02	-0.71	15	1.11	2.38	1.95	0.81	0.53	0.1	1.42	7/29/2004	9/20/2013
0828A_01	10786	TKN	Winter	0.24	-0.12	0.02	0.05	-2.47	0.88	-0.7	21	1.24	2.85	1.6	1.27	0.67	0.1	0.93	2/25/2004	11/25/2013

7.2 Trends in Village Creek

Table 15 provides a detailed analysis of the significant trends within Village Creek. There are increasing trends for both TDS and specific conductivity in the winter. As discussed in the General Use section above, this may be due to ongoing drought conditions in the area. The trends for the period of record have an R^2 of 0.32 with shallow slopes. The average of all the TDS data in this assessment unit is 283 mg/L which is close to the standard of 300 mg/L. For this reason, it is advisable to continue monitoring TDS in the stream and determine if the high TDS levels are natural or anthropogenic. Of the remaining trends with R^2 values greater than 0.4, three are decreasing trends for nutrients (ammonia and TKN) and one is a decreasing trend for pH. The decreasing nutrient trends are of no concern as they are desirable. The decreasing pH trend has a shallow slope so it is not of immediate concern as shown in Figure 12.

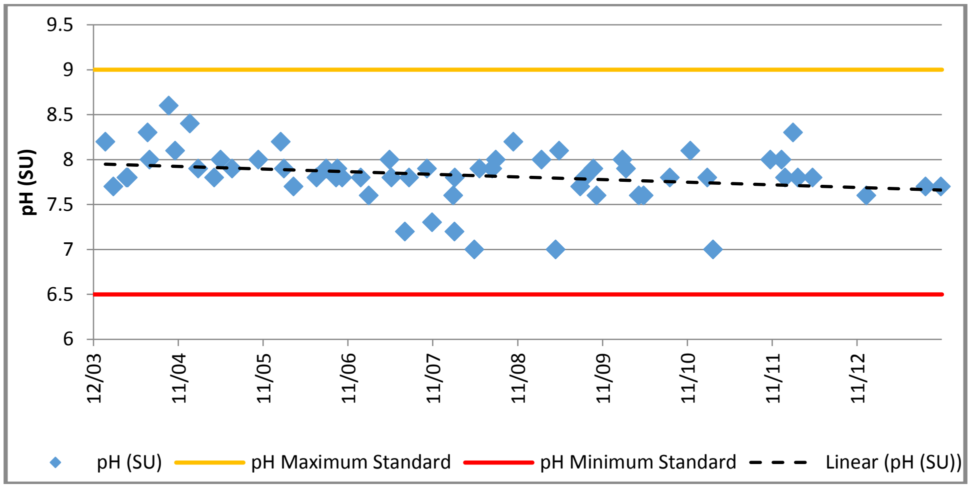


Figure 12. pH trend in Village Creek (0828A).

8.0 Source Identification Analysis

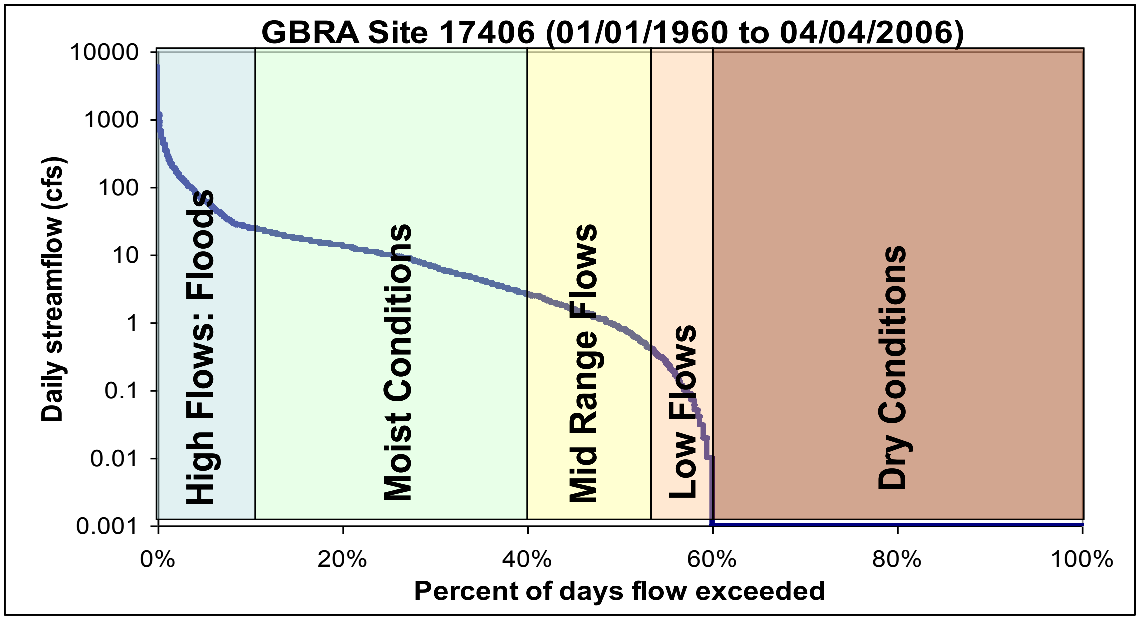
Segment 0828A is currently listed on the 2014 Texas 303(d) list for a recreation use impairment due to bacteria, i.e., elevated concentrations of *E. coli*. The objective of this section is to describe the planned modeling approach for identifying the sources of pollution that contribute to this impairment, and developing pollutant load reduction targets required to gain attainment for the recreation use. The following subsections will describe the suite of source identification strategies that will be used in the watershed.

8.1 Baseline Watershed Monitoring

Source identification will involve 11 sampling locations spatially representative of the Village Creek-Lake Arlington watershed. Sites will be positioned to identify contributions from major tributaries and suspected areas of pollutant loading. Sampling will include 12 total events at all eleven stations including six bi-monthly routine events and six flow-biased events. One flow-biased event is expected to occur in the two-month period between each routine event. Once complete, this monitoring effort is expected to provide spatial specificity to potential areas of high influence, providing a “bracketing” effect with which we can discern whether one particular type of land use, tributary, or geographic area is contributing a greater pollutant load than others.

8.2 Flow and Load Duration Curves

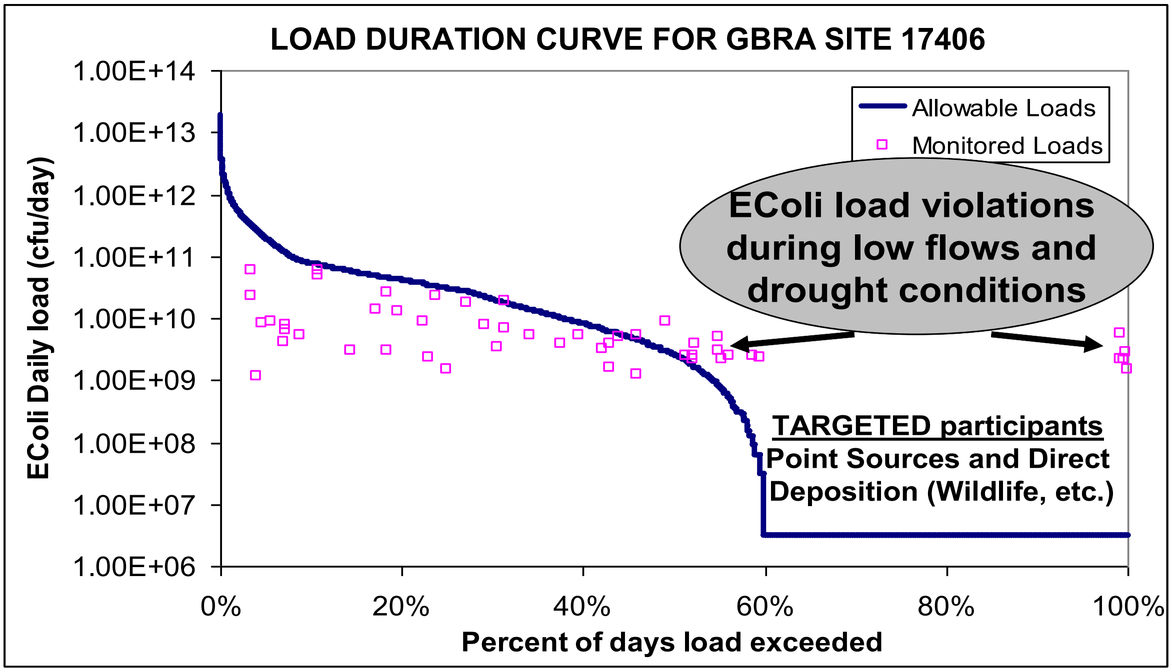
Once completed, the flow and *E. coli* datasets can then be used to build flow duration curves and load duration curves to further evaluate the contaminant sources. First, all flow values are aggregated and ranked from lowest to highest. This data is then graphically depicted to show the general flow regime, complete with the percentage of time that the water body is expected to be dry, as well as its response to storm flows (Figure 13).



Source: Flow Duration Curve (FDC) for streamflow conditions at GBRA monitoring station 17406 on Plum Creek, near Uhland, TX.

Figure 13. Flow duration curve example from Plum Creek watershed (log scale Y-axis).

The flow duration curve can then be used to develop a load duration curve (LDC) for a specific pollutant of interest, given that there is pollutant concentration data that complements the flow data. Figure 14 depicts an example LDC based on the FDC shown in Figure 13. The first step in the process is to apply the pollutant's allowable limit concentration to all available flow values to produce the allowable load limit curve. In the case of bacteria, this value is 126 MPN/100 mL (blue line in Figure 14). Then, the baseline monitoring data values for *E. coli* (also in MPN/100 mL) are also multiplied by their associated flow values to get loads for each data point (pink squares in Figure 14). This can be developed further by performing regression analysis on the monitored data points, as depicted in Figure 15. Here, the allowable load limit is depicted in red, while the regression line for the data points is depicted in blue. For each of the different flow regimes (High Flows, Moist Conditions, Mid-range Flows, etc.), a load reduction estimate can be calculated. Achieving these reductions will become the primary targets for success once the WPP moves into the implementation stage.



Source: Load Duration Curve for E. coli at GBRA monitoring station 17406 on Plum Creek, near Uhland, TX.

Figure 14. Load duration curve example from Plum Creek watershed (log scale Y-axis).

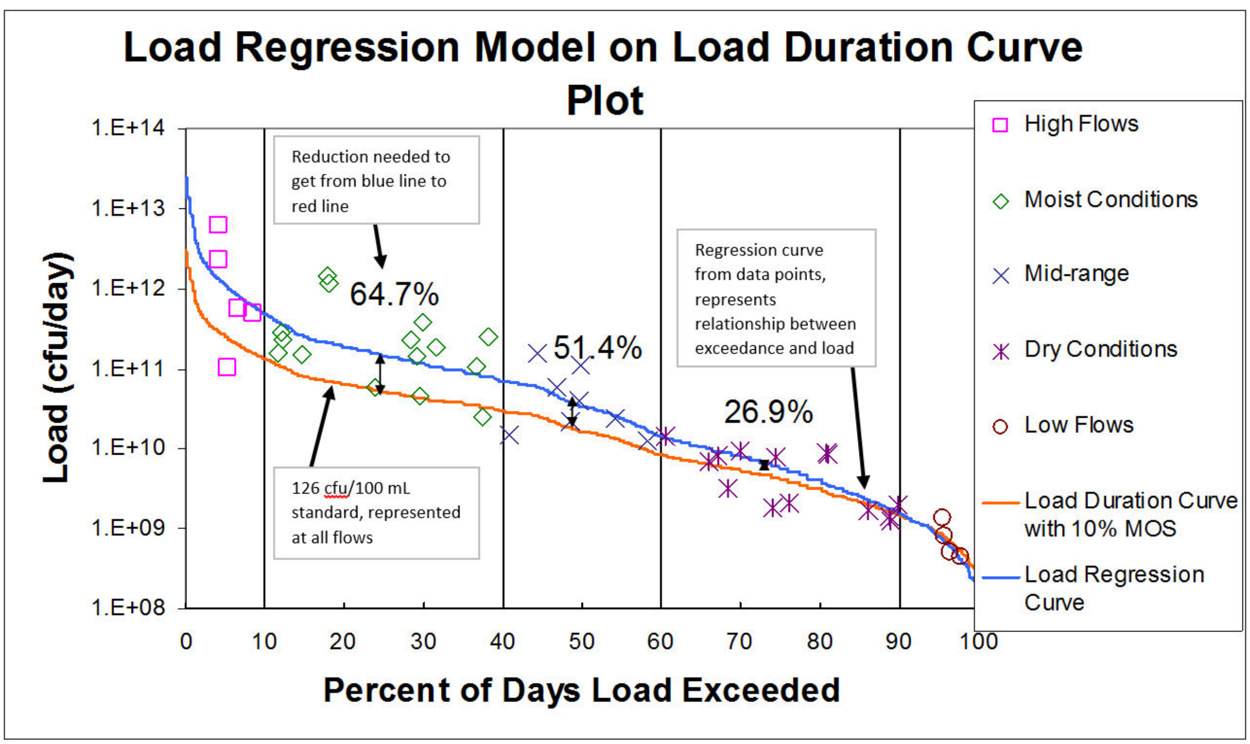


Figure 15. Load duration curve example for E. coli, with flow condition breakdowns and load reduction estimates (log scale Y-axis).

However, it is worth noting that some of these reductions, specifically those within the "High Flows" range, may not be achievable due to feasibility of applying management measures to storm flows that fall within the extreme range. It is therefore customary to focus efforts on the load reductions identified at the lower flow conditions, where it becomes easier to separate potential point source contributors from nonpoint source contributors. In most cases, if a water body exhibits high pollutant loads on the extreme right of the graph where low flows are represented (Figure 16), it is highly likely that this may be attributable to a point source, such as a malfunctioning WWTF or leaking/failing wastewater infrastructure somewhere in the watershed. These types of contributions can typically be easily addressed, and are worth investigating early on in the process. Conversely, if pollutant loads tend towards the middle of the graph, it is likely that they are attributed to stormwater runoff during periods of normal or moderate rainfall. While typically not as easily addressed as point sources, load reductions in these areas may also be targeted for watershed pollutant load reductions through BMP recommendations.

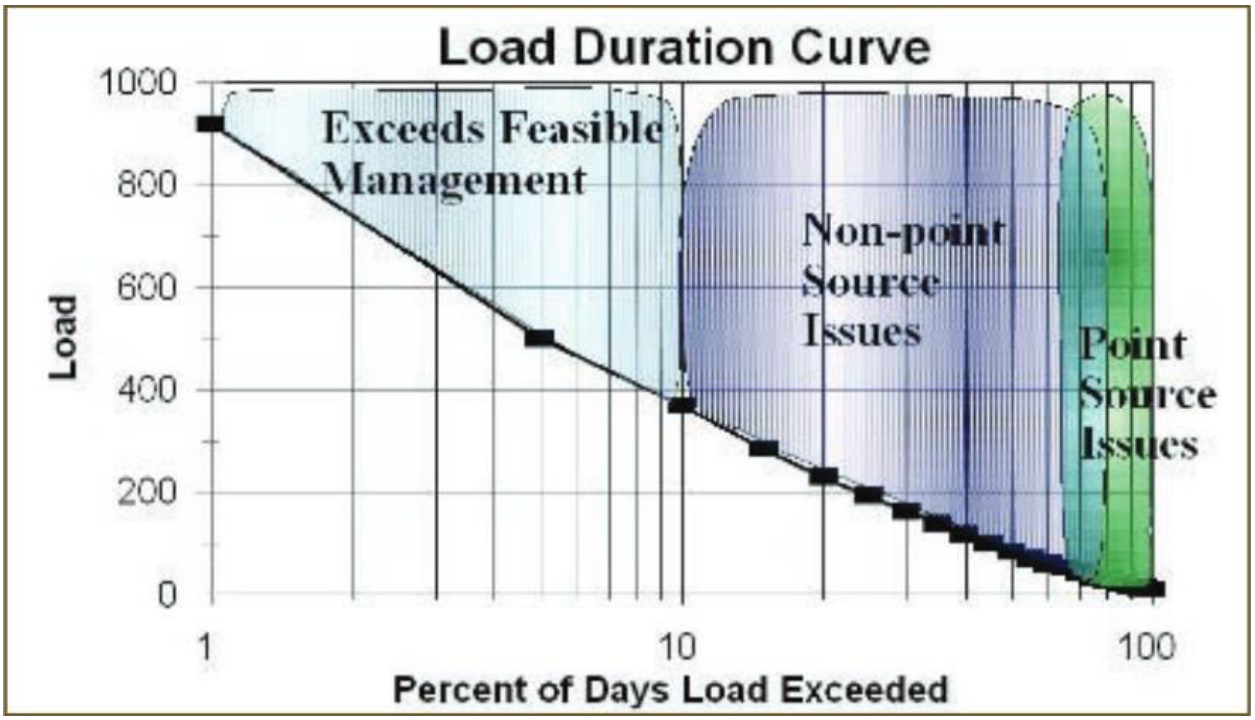


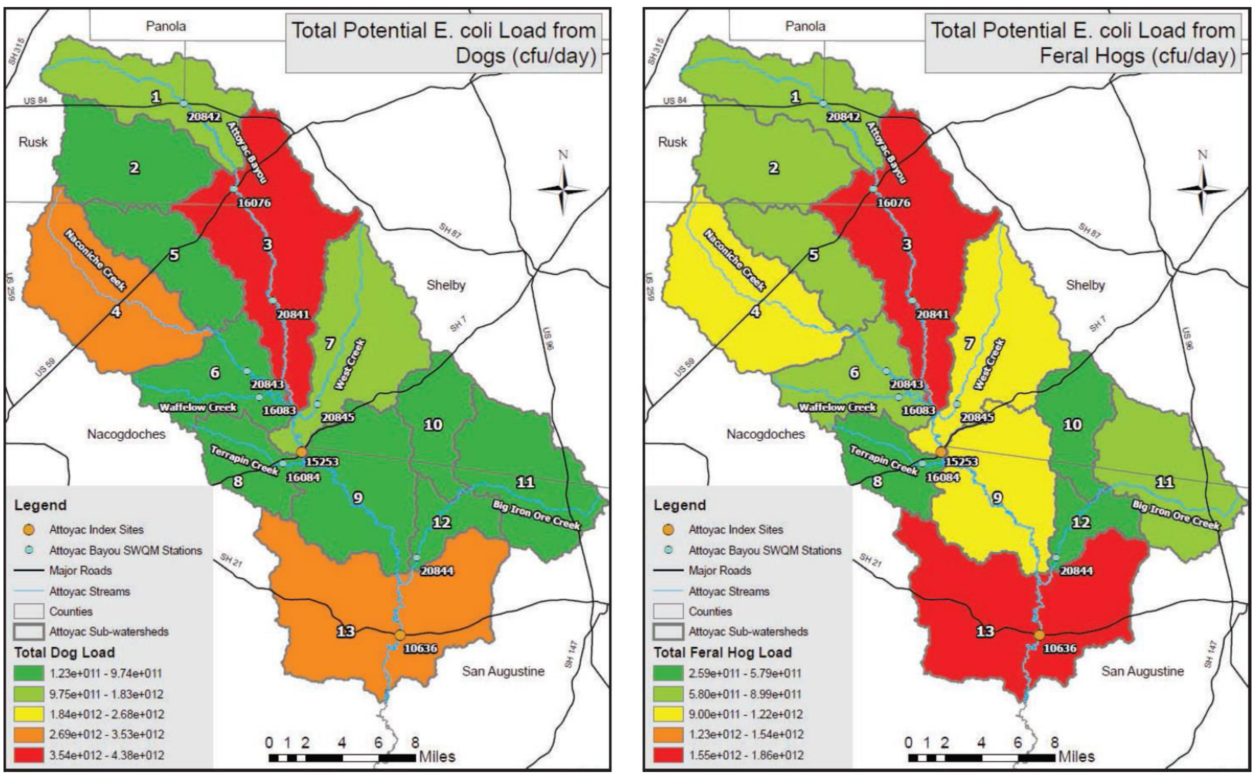
Figure 16. Regions of likely pollutant sources along load duration curve (normal scale Y-axis, log scale X-axis).

8.3 SELECT Analysis

Through baseline monitoring and the associated LDC analysis, it is possible to begin forming an understanding of where areas contributing high pollutant loads may be situated in the watershed, as well as whether those contributions may be from point or nonpoint sources. However, this only provides a basic spatial location of the potential sources and a general understanding of their origin. To further identify the extent of a certain source type's likely contribution to the bacteria load in a specific subwatershed, the SELECT analysis can be conducted for any number of potential bacteria source types, including urban/municipal runoff, agricultural runoff, failing septic systems, wildlife, and even invasive species.

SELECT first uses spatial data for land use and/or land cover data to determine where representatives from a particular contributing source might be located, and then uses watershed boundaries, soils data, topography, and stream network information to further determine suitability and range. In the example provided in Figure 17, it was expected that the majority of dogs would be found in close proximity to human populations, while it was expected that feral hogs would stay within suitable habitat found within riparian bands near rivers, on cropland, or within the vicinity of other water sources, so the spatial analysis incorporated these limitations.

Then, an estimated population density is applied to these suitable areas. Population density data can come in the form of census estimates for humans, literature values from published resource agency materials, or in some cases, anecdotal evidence from watershed stakeholders. In the example provided in Figure 17, statewide estimates for feral hog population were first applied to the watershed, then anecdotal evidence from watershed stakeholders was used to verify and adjust the statewide estimates. For dogs, an average value of dogs per household was applied to local human population estimates, and that estimated population was then concentrated around areas with higher human population densities to simulate the expected loading conditions.



Source: Attoyac Bayou Watershed Protection Plan.

Figure 17. Visual output examples from SELECT analysis for separate estimated populations of dogs (left) and feral hogs (right).

Finally, literature values for *E. coli* production from these sources are applied to the estimated population so that a potential *E. coli* load can be calculated for each subwatershed in the analysis. This yields visual output that can be color-coded to show the severity of the load's potential contribution to the watershed, which can be used to pinpoint areas where management measures would provide the most cost-to-benefit ratio. In the case of the feral hog analysis in Figure 17, funding used for hog control

BMPs would be best utilized in subwatersheds 3 and 13, where contributions are expected to be significant. Conversely, potential *E. coli* contributions from feral hogs are low in 8, 10, and 12 so it would be best to focus control efforts elsewhere.

Although SELECT can provide users with valuable information for pollutant source location and quantification, there are some caveats which must be publicized to stakeholders about its use. The load calculations that are output from the model, even if based on the best available science and information, are still predicted *E. coli* loadings that are effectively "worst-case scenarios." This is because SELECT is not currently capable of taking into account the natural processes that occur in the watershed, such as natural bacterial decay, breakdown by sunlight, permeation to groundwater, etc. that influence bacteria die-off as the load makes its way to a water body. As such, the total load predicted from a subwatershed by SELECT is not expected to reach the creek, and thus, represents a potential loading. SELECT is currently incapable of making adjustments needed to provide a real-world, delivered loading to the creek. Despite this shortcoming, both stakeholders and technical advisory staff agree that this analysis method, coupled with the LDC analysis covered in Section 8.2, is the most cost-effective means of source identification and analysis available for the watershed.

9.0 Conclusions

In addition to the impairments and nutrient concerns listed for Segments 0828 and 0828A in the *2014 Texas Integrated Report of Surface Water Quality for the Clean Water Act Sections 305(b) and 303(d)* (TCEQ 2015d), the WPP effort will also endeavor to address other stakeholder concerns with respect to water quality as identified during public meetings and other outreach campaigns. As these concerns are identified and investigated through continued contact with stakeholders and studied in the watershed, additional historical data analysis may be needed, which will continue past the submission of this report. Application of and adherence to this adaptive approach will result in a more thorough and applicable set of solutions for managing water quality issues and concerns within the Village Creek-Lake Arlington watershed.

9.1 Lake Arlington (Segment 0828)

While there are no immediate needs for addressing water quality impairments in Lake Arlington, there are two persistent water quality concerns related to nutrients that stakeholders would like to see addressed in the WPP. These concerns are related to nitrate inputs and algal growth and decay (as indicated by chlorophyll-a). Overall trends for both parameters are currently decreasing in the lake, and the management measures recommended in the WPP will hopefully continue to add to these decreases, or at the very least, stall any future increases. These management measures may be targeted to areas with direct drainage to the lake, or by extension within larger tributaries such as Village Creek, which may be contributing a significant portion of the nutrient load itself.

While certainly important, lake protection strategies for the listed water quality concerns are two of many outcomes identified thus far in the stakeholder process. The LAMP (Malcolm Pirnie 2011) also identified several aesthetic and community wellness-based outcomes that are expected to be incorporated into the Village Creek-Lake Arlington WPP. These include trash and litter control efforts, lakefront property renovations, and other efforts that are expected to also provide some level of bacteria and/or nutrient load reductions as well. As stakeholder outcomes develop around the lake, further historical data analysis will be conducted to adapt to and address stakeholder needs.

9.2 Village Creek (Segment 0828A)

The primary focus within Village Creek, and for the Village Creek-Lake Arlington WPP effort as a whole, is the bacteria impairment, where the dataset indicates that *E. coli* trends are on the rise. Along with the data collected through this effort, stakeholder input and expert technical advice will be used to provide the base on which management efforts to address the impairment will be built. The end goal will be improving water quality in Village Creek, and by extension, protecting the water quality downstream in Lake Arlington.

As with Lake Arlington, there are several additional stakeholder concerns that are expected to be addressed in the WPP. These include similar concerns for floatable and deposited trash and debris, along with erosion control measures and nutrient controls. As with Lake Arlington, the BMPs identified to address these additional concerns are expected to provide some level of bacteria and/or nutrient load reductions in addition to their primary purposes.

10.0 References

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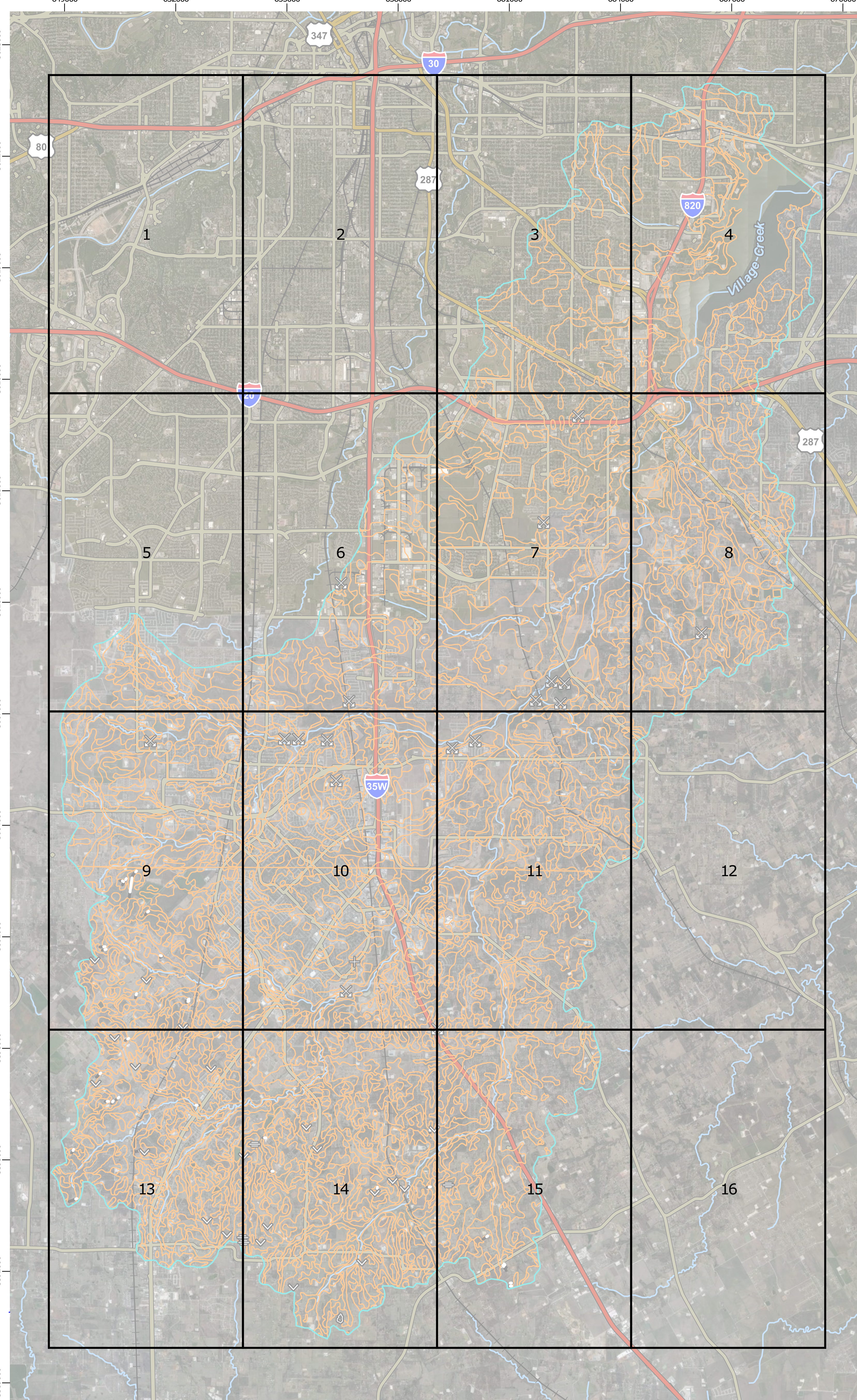
Appendix A

NRCS Soils Survey for Tarrant and Johnson Counties

Appendix A

NRCS Soils Survey for Tarrant and Johnson Counties

Soil Map—Johnson County, Texas, and Tarrant County, Texas
(VCLA Watershed Soil Survey)
Index Sheet



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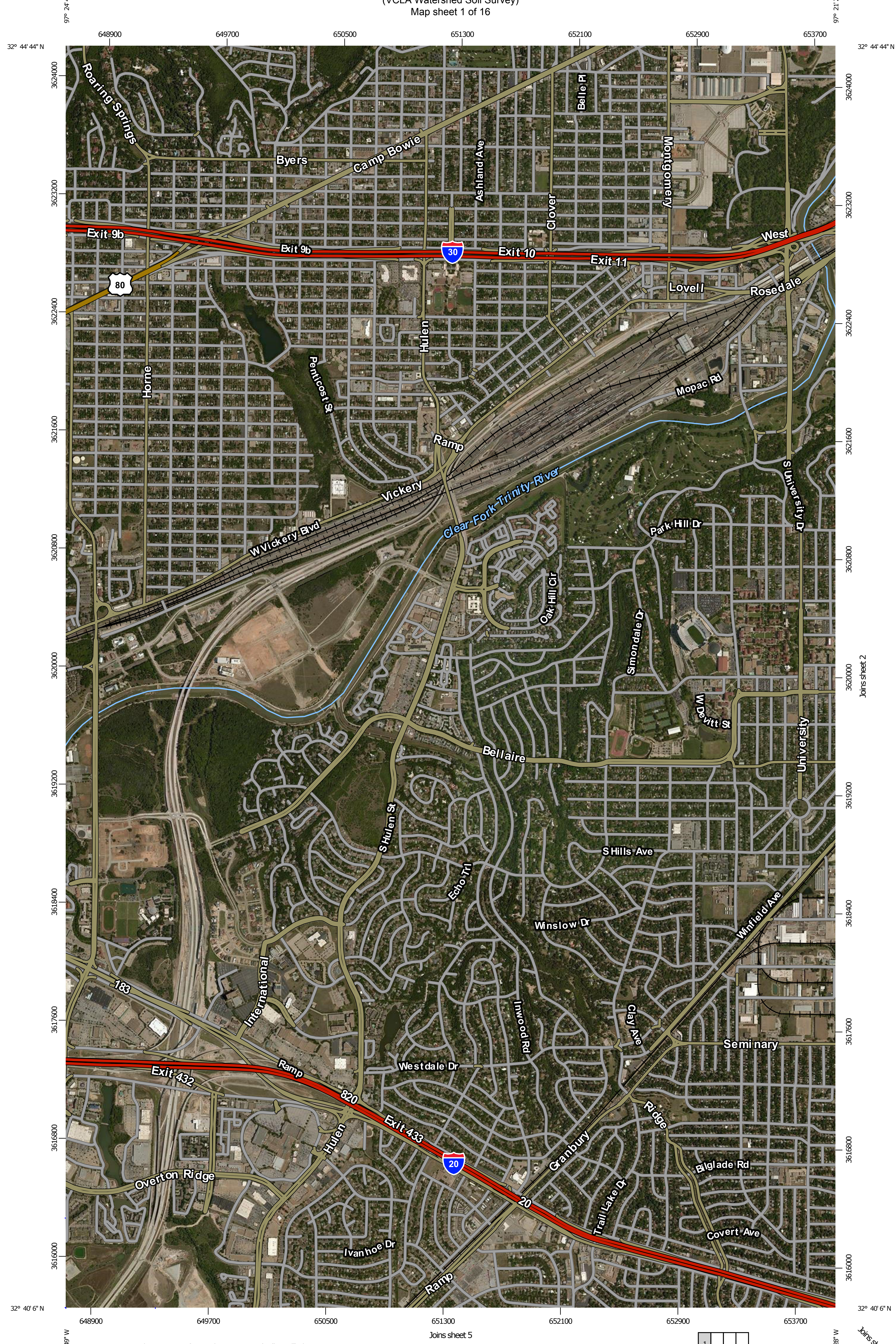
N

0 1500 3000 6000 9000 Meters

0 5000 10000 20000 30000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

Soil Map—Johnson County, Texas, and Tarrant County, Texas
(VCLA Watershed Soil Survey)
Map sheet 1 of 16



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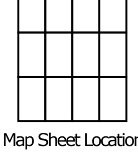
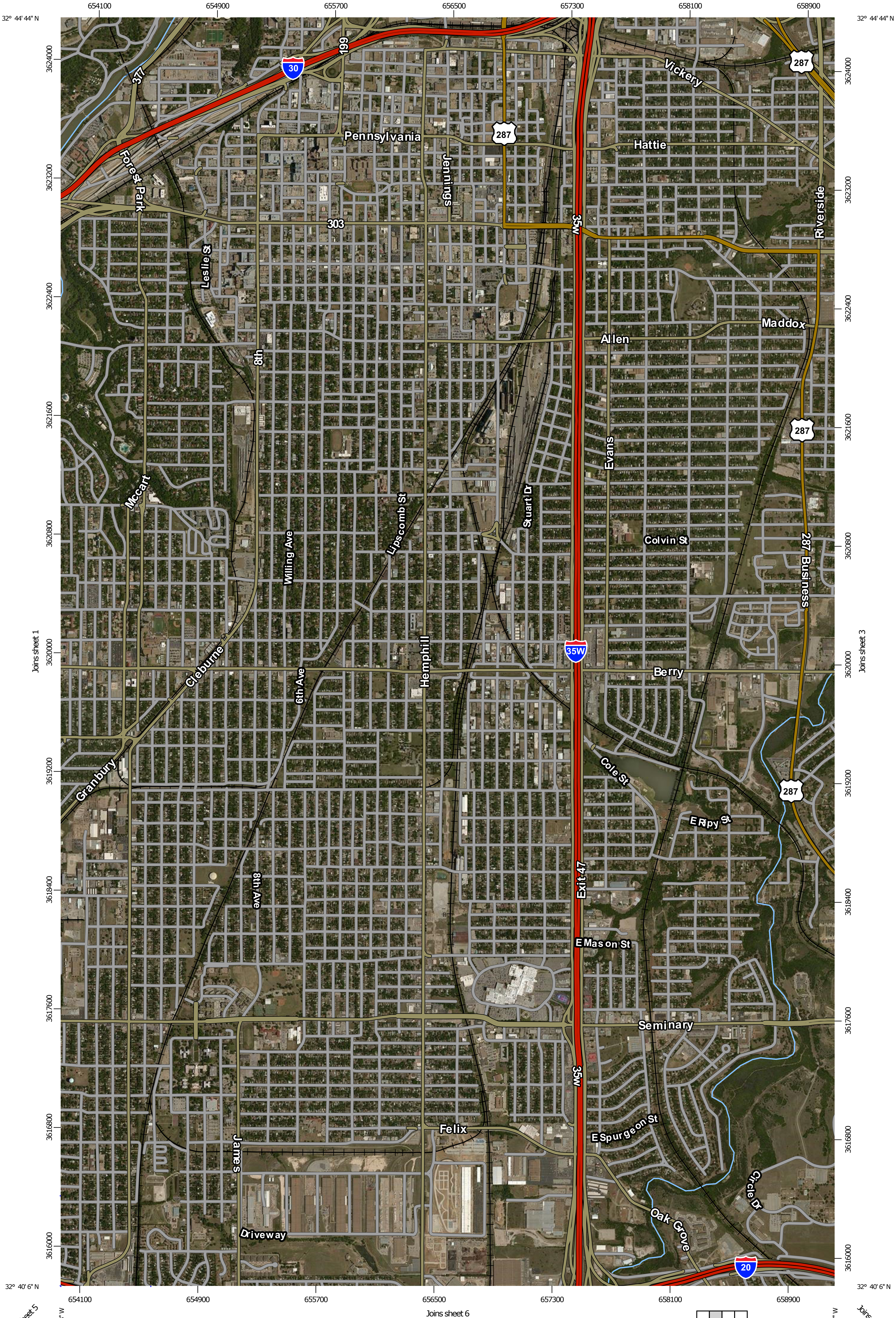


Map Sheet Location

Soil Map—Johnson County, Texas, and Tarrant County, Texas
(VCLA Watershed Soil Survey)
Map sheet 2 of 16



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Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

Map Sheet Location

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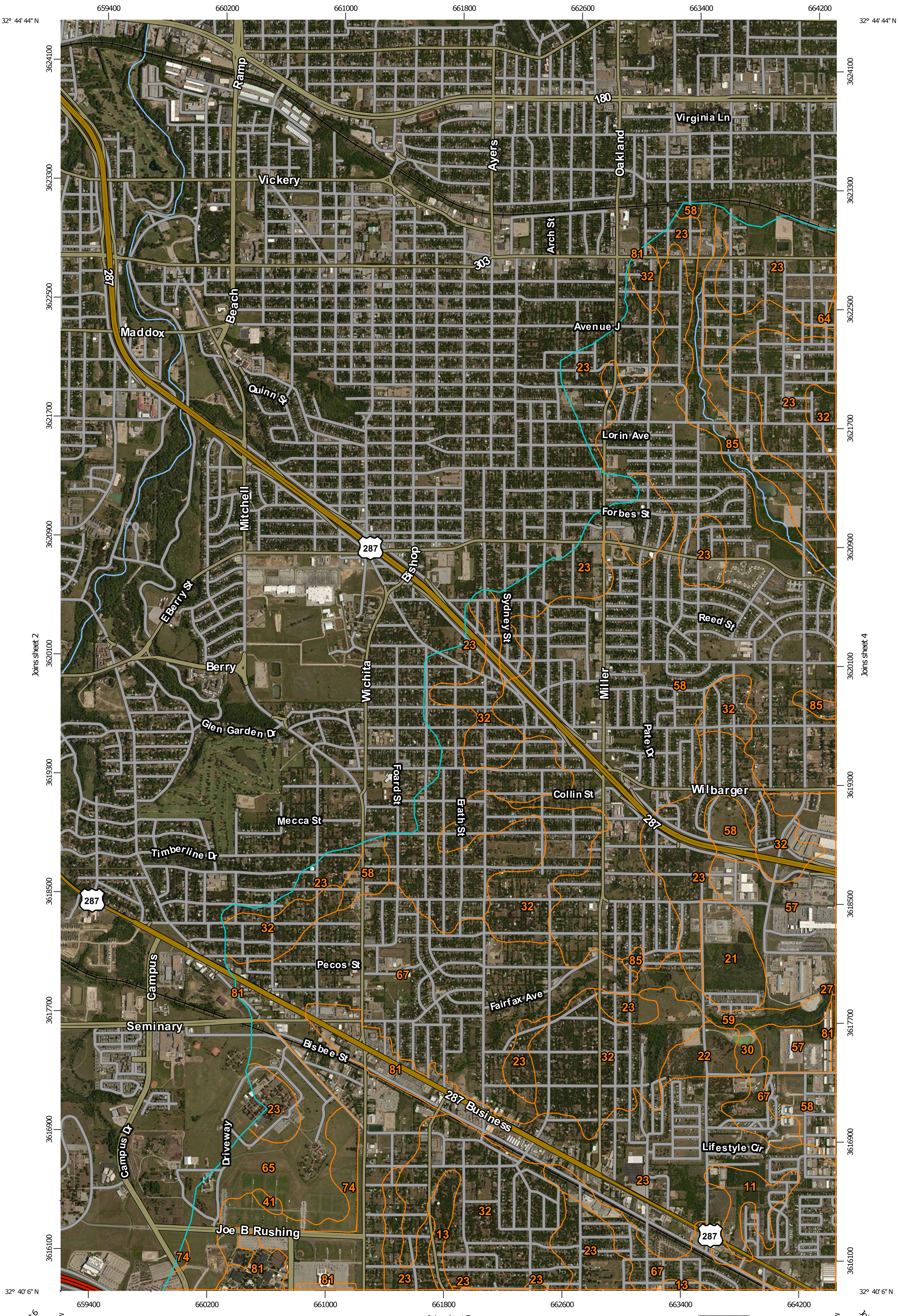
(VCLA Watershed Soil Survey)
Map sheet 3 of 16



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Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

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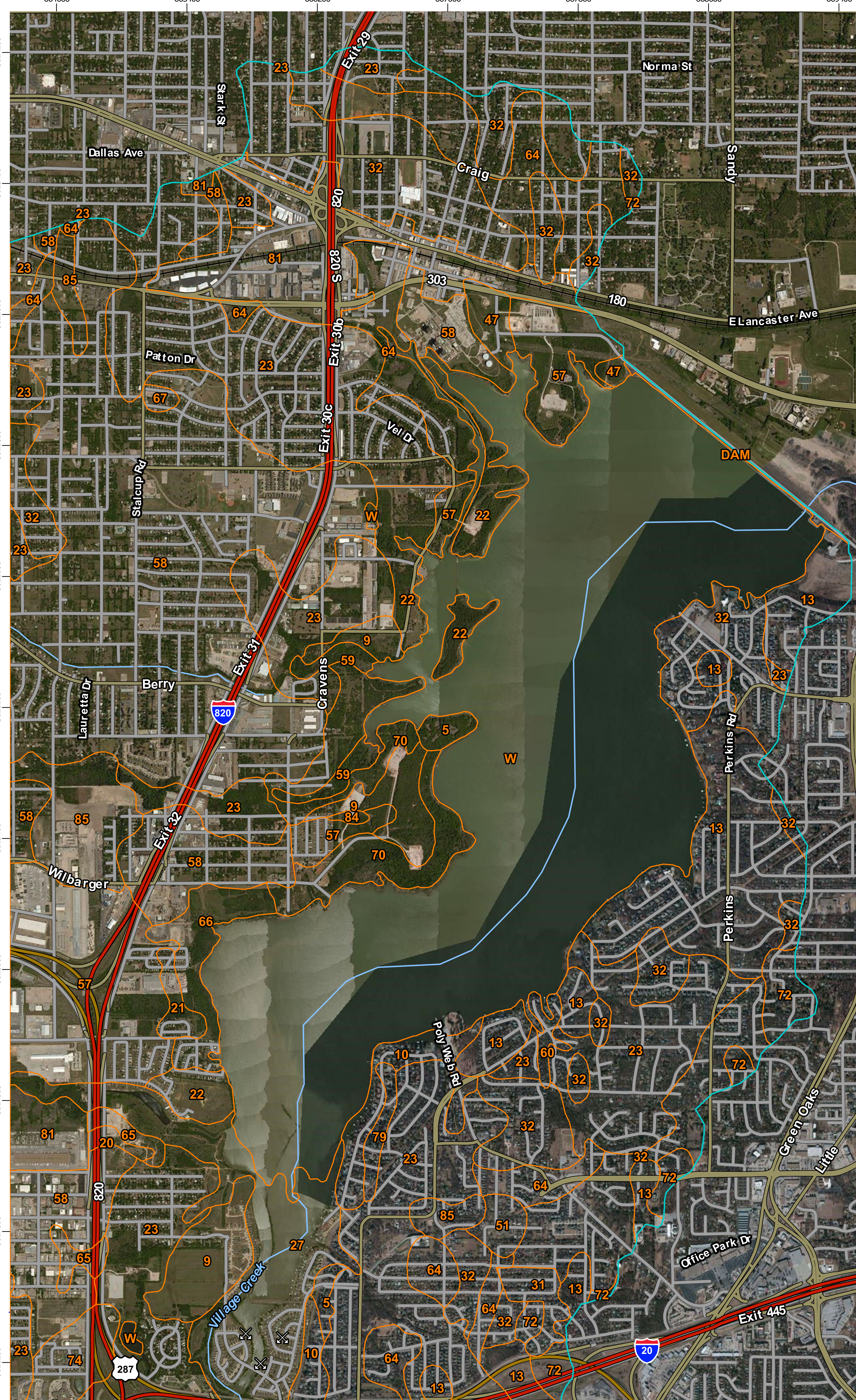

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Joins sheet 3

32° 40' 6" N 32° 40' 6" N

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Joins sheet 8

Joins sheet 7

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Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

N

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0 1000 2000 4000 6000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

4

Map Sheet Location

Joins sheet 1

Joins sheet 2

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97° 21' 28" W

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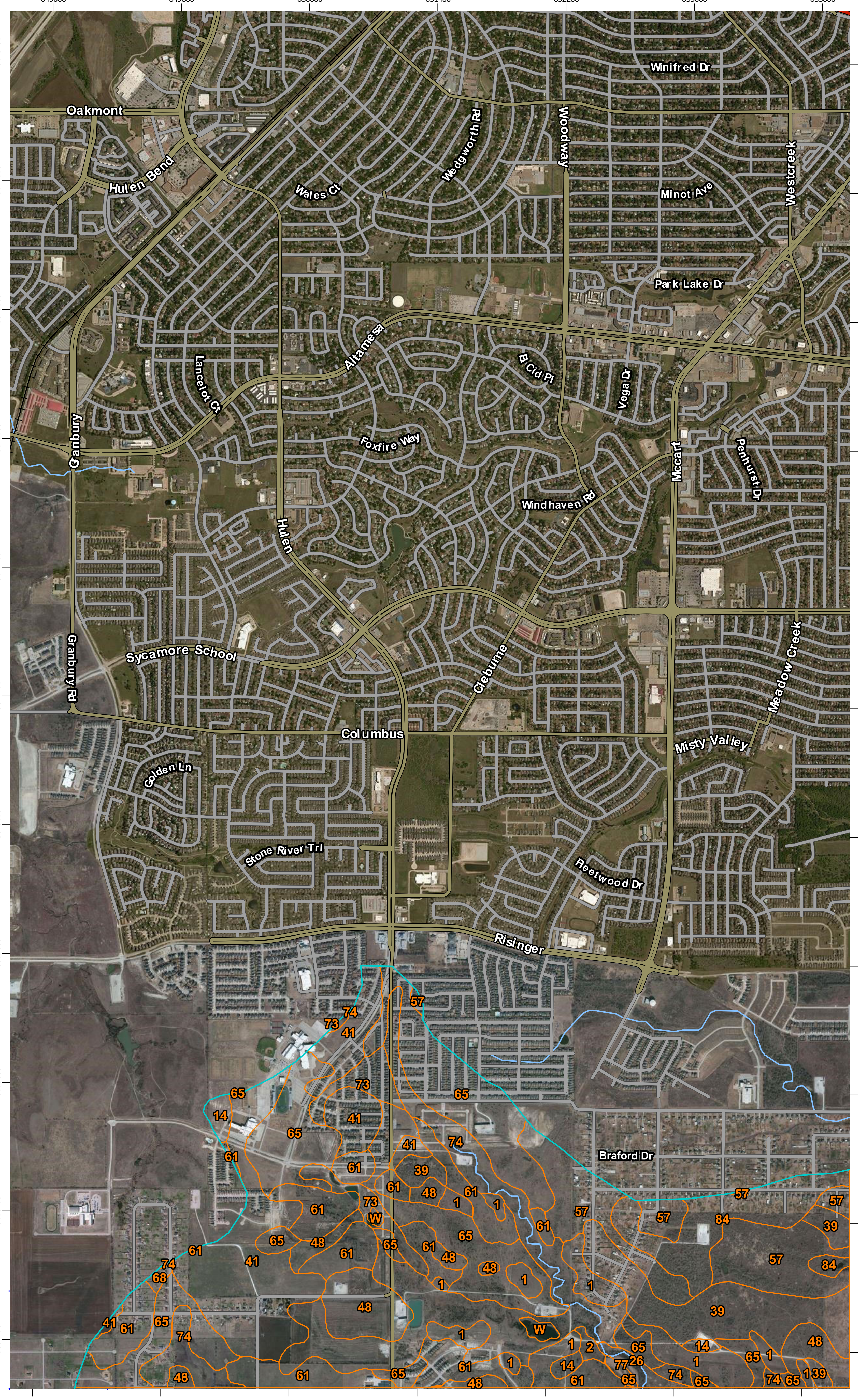
32° 40' 6" N



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Joins sheet 6

32° 35' 28" N

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Joins sheet 9

Joins sheet 10

97° 24' 49" W

97° 21' 28" W

Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

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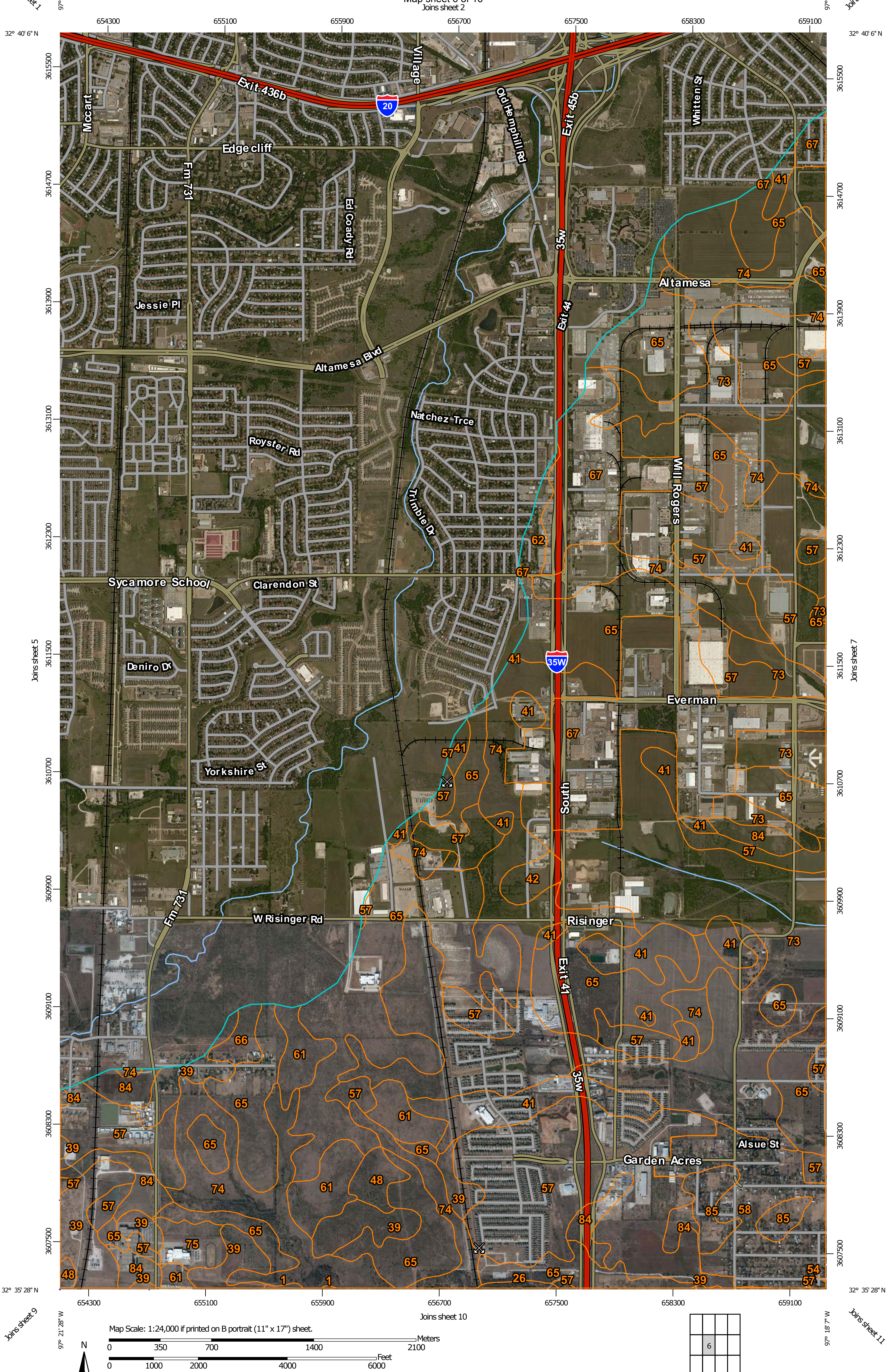
Feet: 0 1000 2000 4000 6000

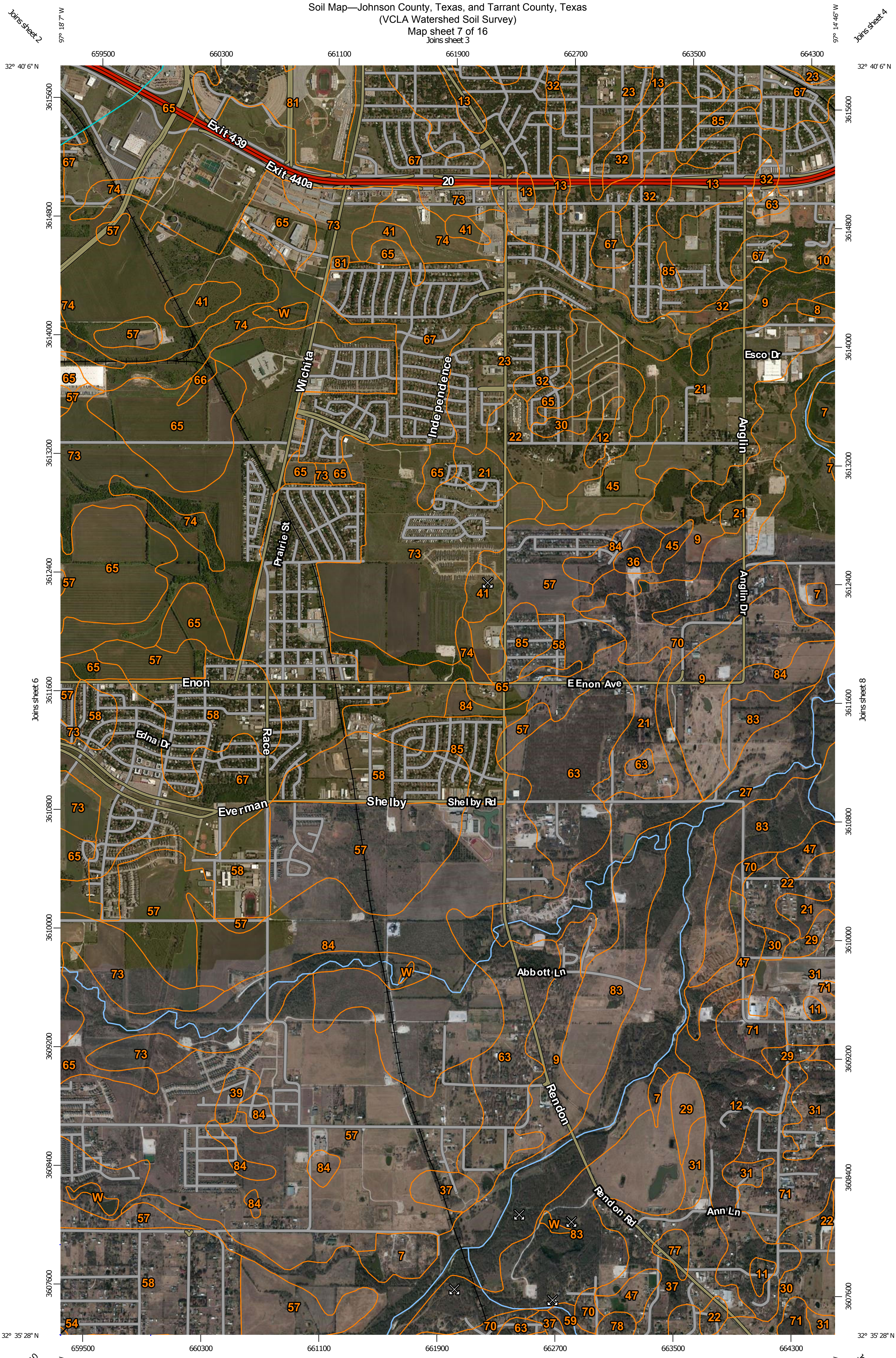
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

5

Map Sheet Location

Soil Map—Johnson County, Texas, and Tarrant County, Texas
(VCLA Watershed Soil Survey)
Map sheet 6 of 16





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Soil Map—Johnson County, Texas, and Tarrant County, Texas
(VCLA Watershed Soil Survey)
Map sheet 8 of 16

Joins sheet 3

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Joins sheet 4

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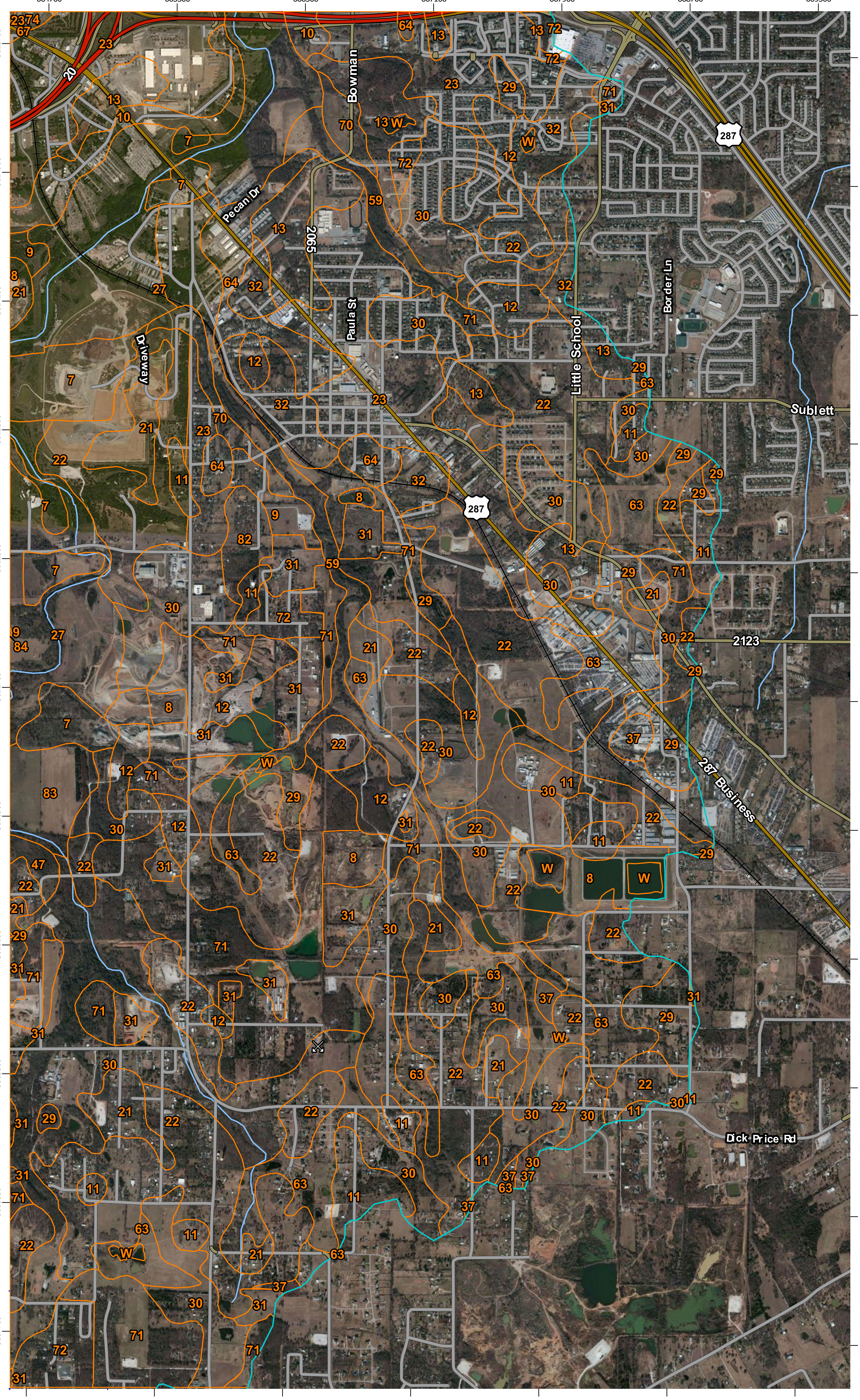

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Joins sheet 12

Joins sheet 11

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0 1000 2000 4000 6000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

8

Map Sheet Location

Joins sheet 5

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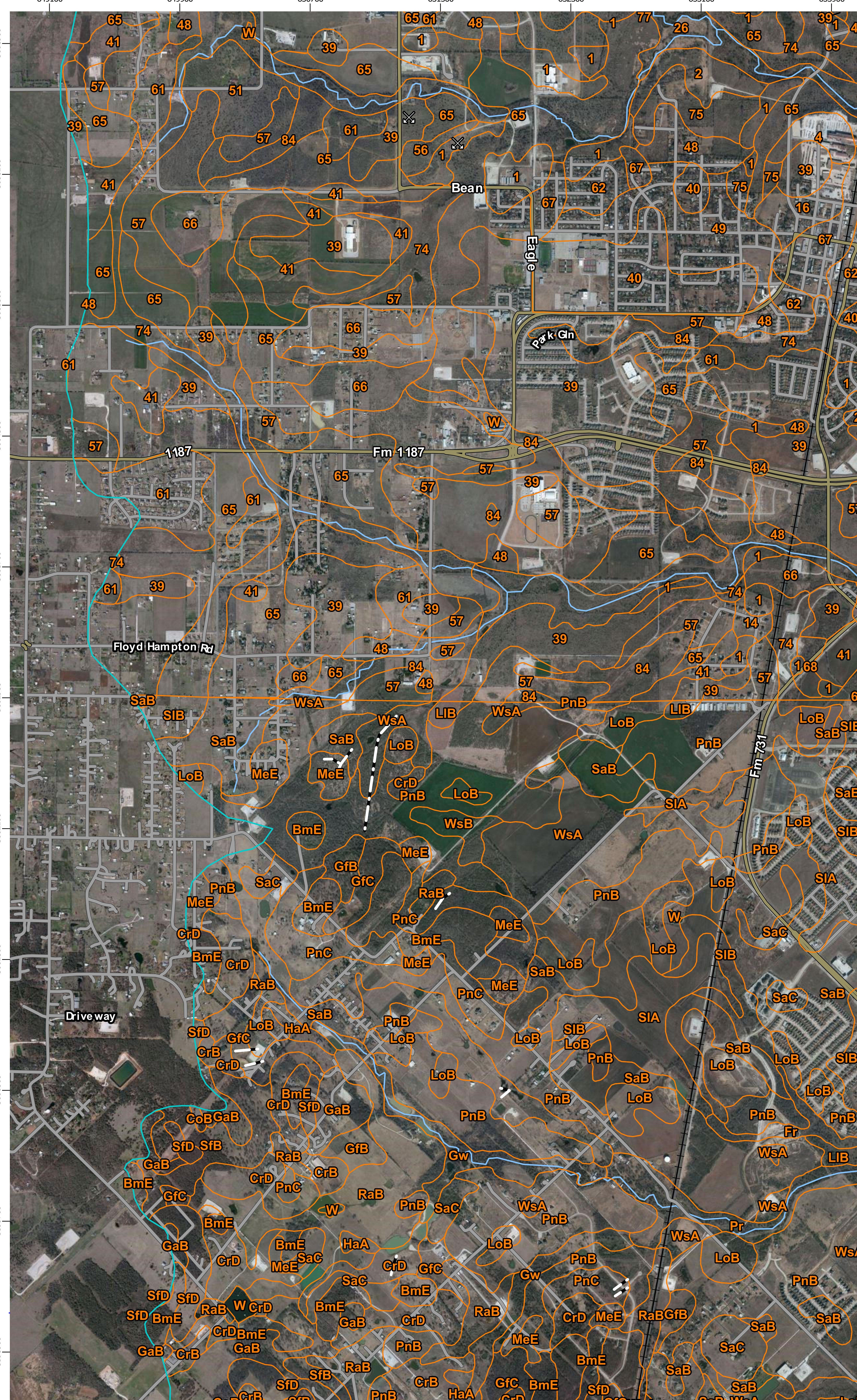

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Joins sheet 13

Joins sheet 14

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Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

9

Map Sheet Location

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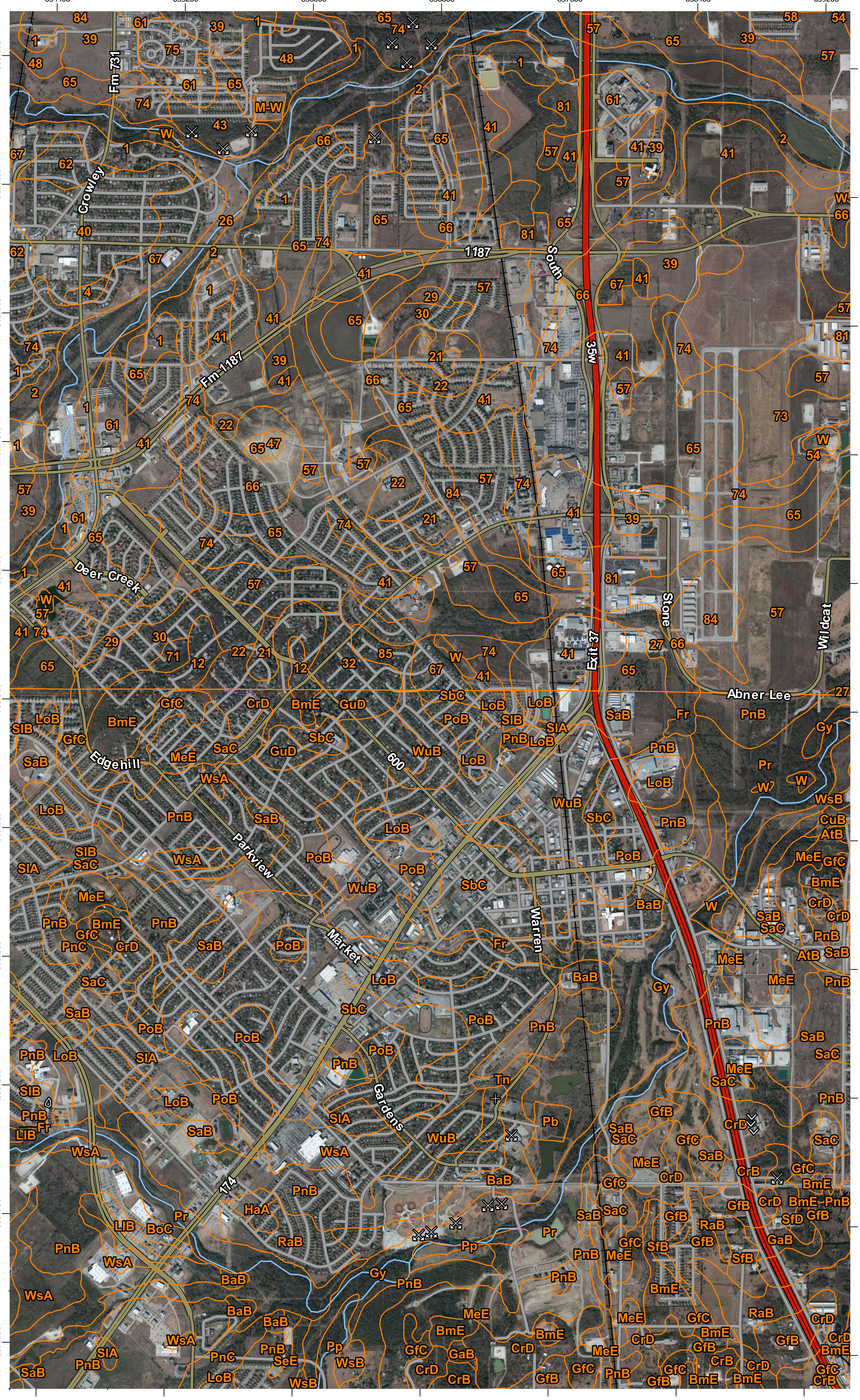
32° 35' 28" N



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Joins sheet 9 | Joins sheet 11

32° 30' 50" N

654400 | 655200 | 656000 | 656800 | 657600 | 658400 | 659200

Joins sheet 13 | 97° 21' 28" W | Joins sheet 14 | 97° 18' 7" W | Joins sheet 15

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Feet: 0 | 1000 | 2000 | 4000 | 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

10

Map Sheet Location

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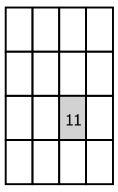

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Joins sheet 8

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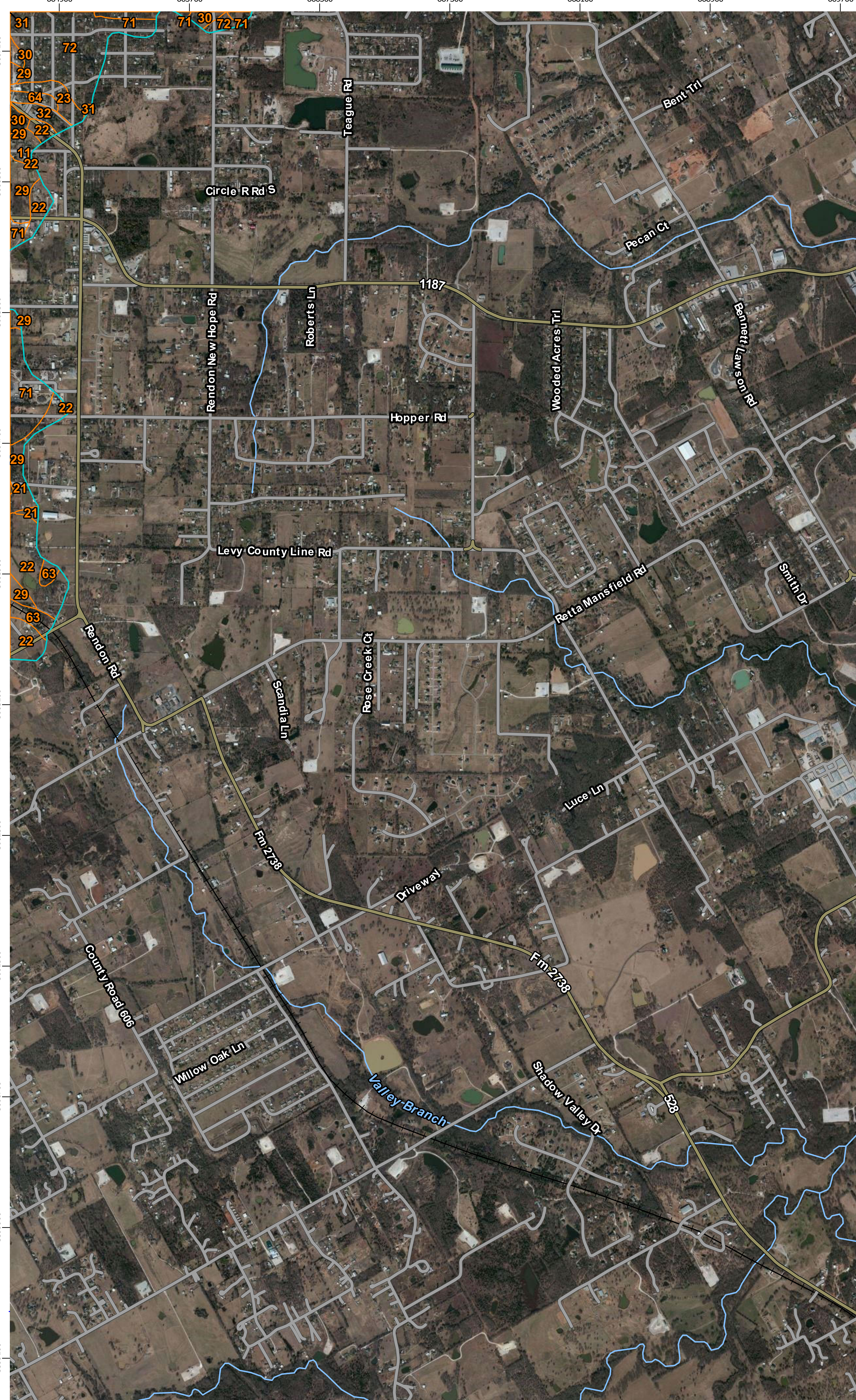
97° 11' 24" W

32° 35' 28" N

32° 30' 50" N



Joins sheet 11

Joins sheet 16

Joins sheet 15

Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

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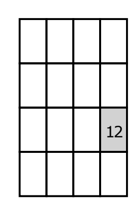
Feet: 0, 1000, 2000, 4000, 6000

Map projection: Web Mercator   Corner coordinates: WGS84   Edge tics: UTM Zone 14N WGS84



Map Sheet Location

Joins sheet 9

Joins sheet 10

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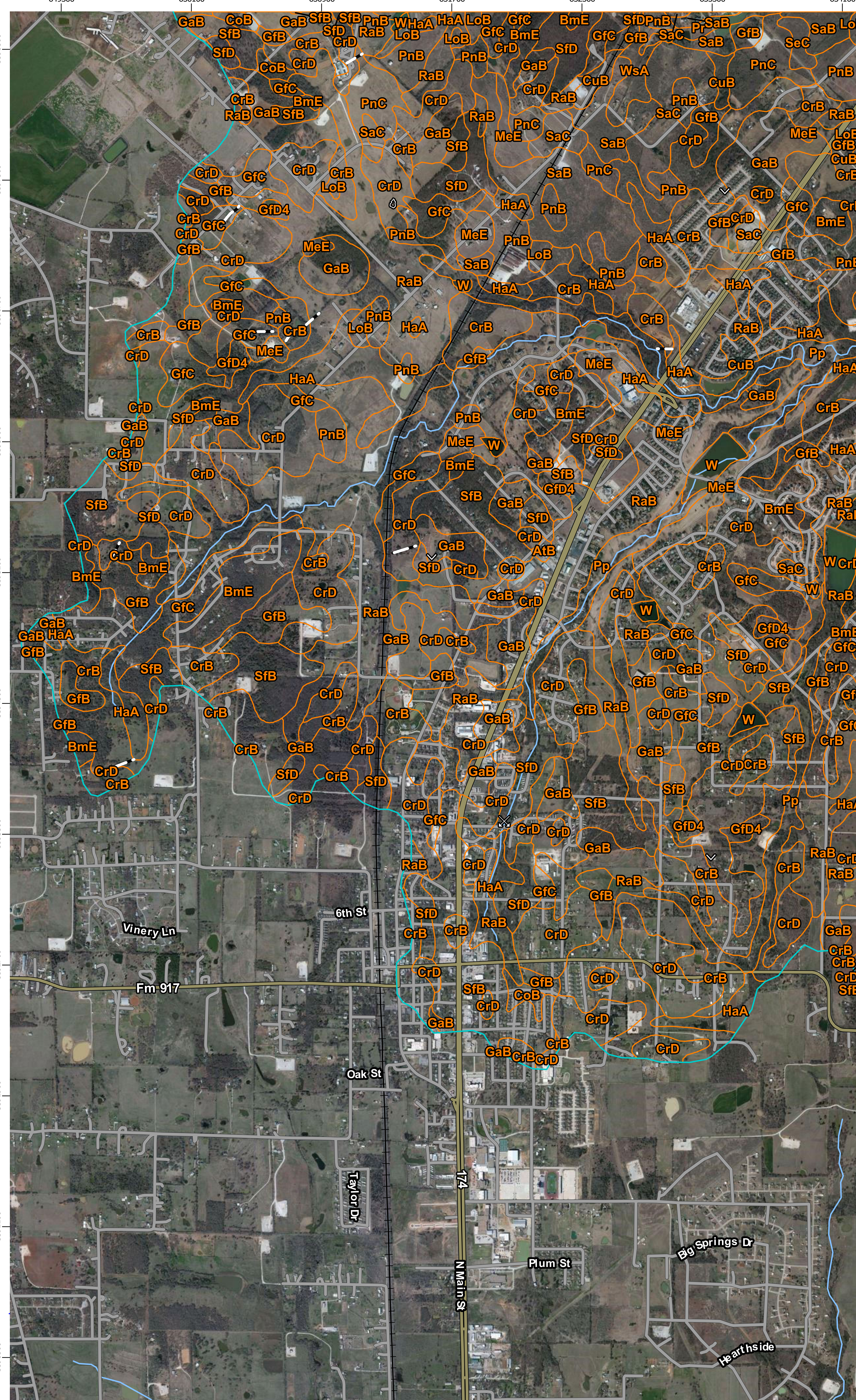
32° 30' 50" N   32° 30' 50" N



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97° 24' 49" W   97° 21' 28" W

Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

N

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0 1000 2000 4000 6000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

13

Map Sheet Location

Joins sheet 10

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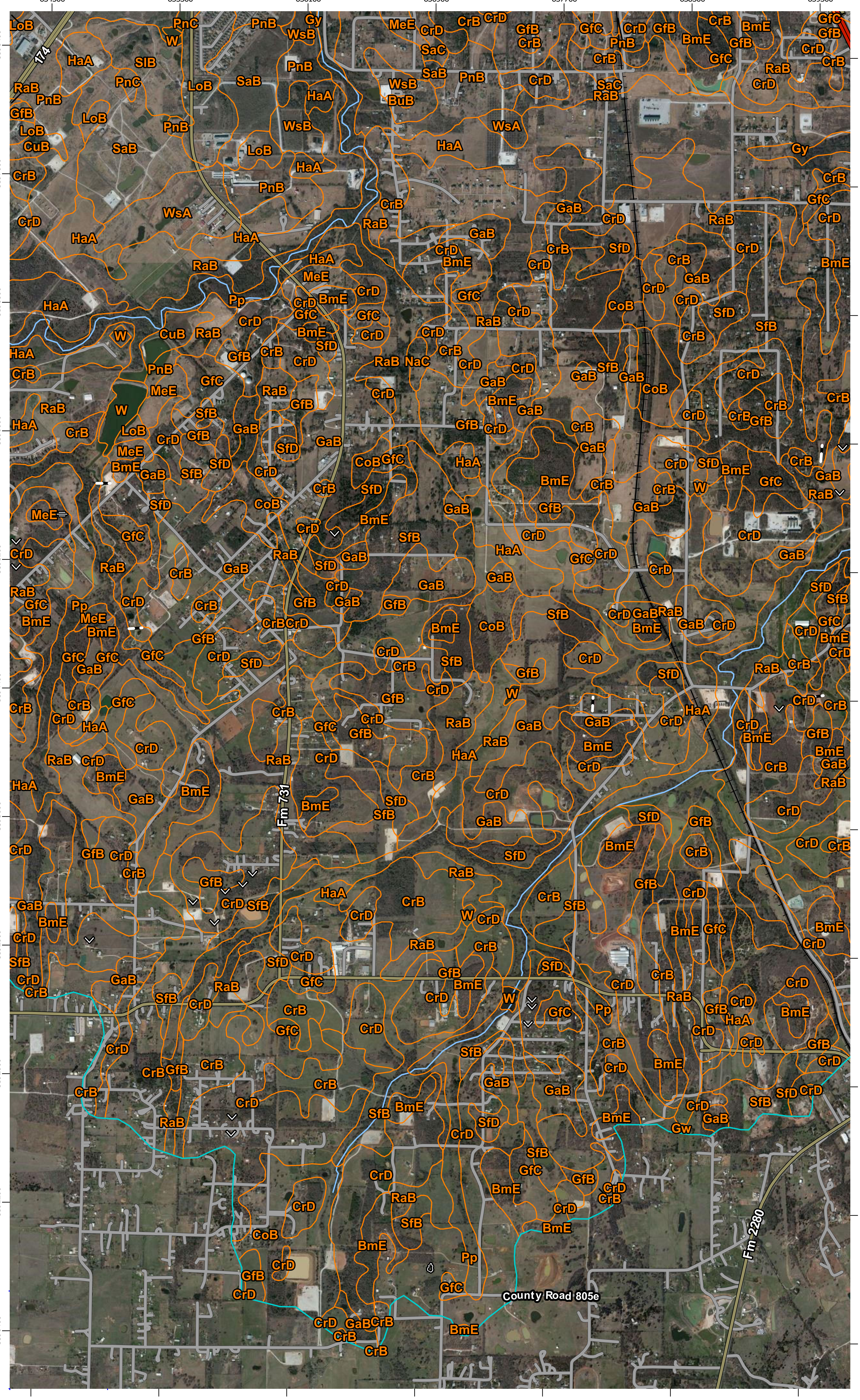

97° 21' 28" W | 97° 18' 7" W

Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

Meters: 0 350 700 1400 2100

Feet: 0 1000 2000 4000 6000

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Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

Map Sheet Location (14)

Joins sheet 11

Joins sheet 10 | Joins sheet 12 | Joins sheet 14 | Joins sheet 16

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659800 | 660600 | 661400 | 662200 | 663000 | 663800 | 664600

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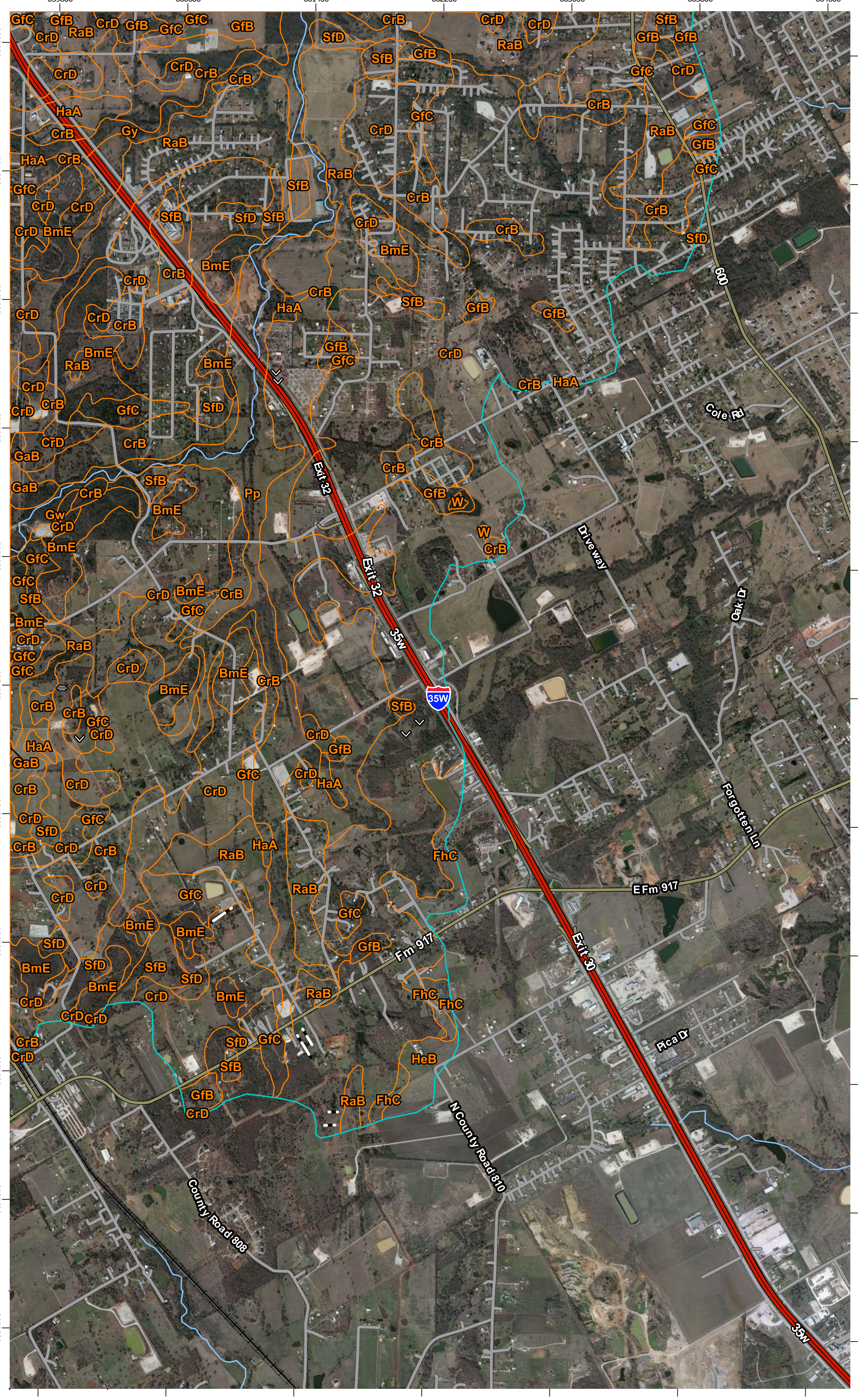

Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

N

Meters: 0 | 350 | 700 | 1400 | 2100

Feet: 0 | 1000 | 2000 | 4000 | 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

Map Sheet Location: 15

Joins sheet 11

Joins sheet 12

97° 14' 46" W | 97° 11' 24" W

32° 30' 50" N

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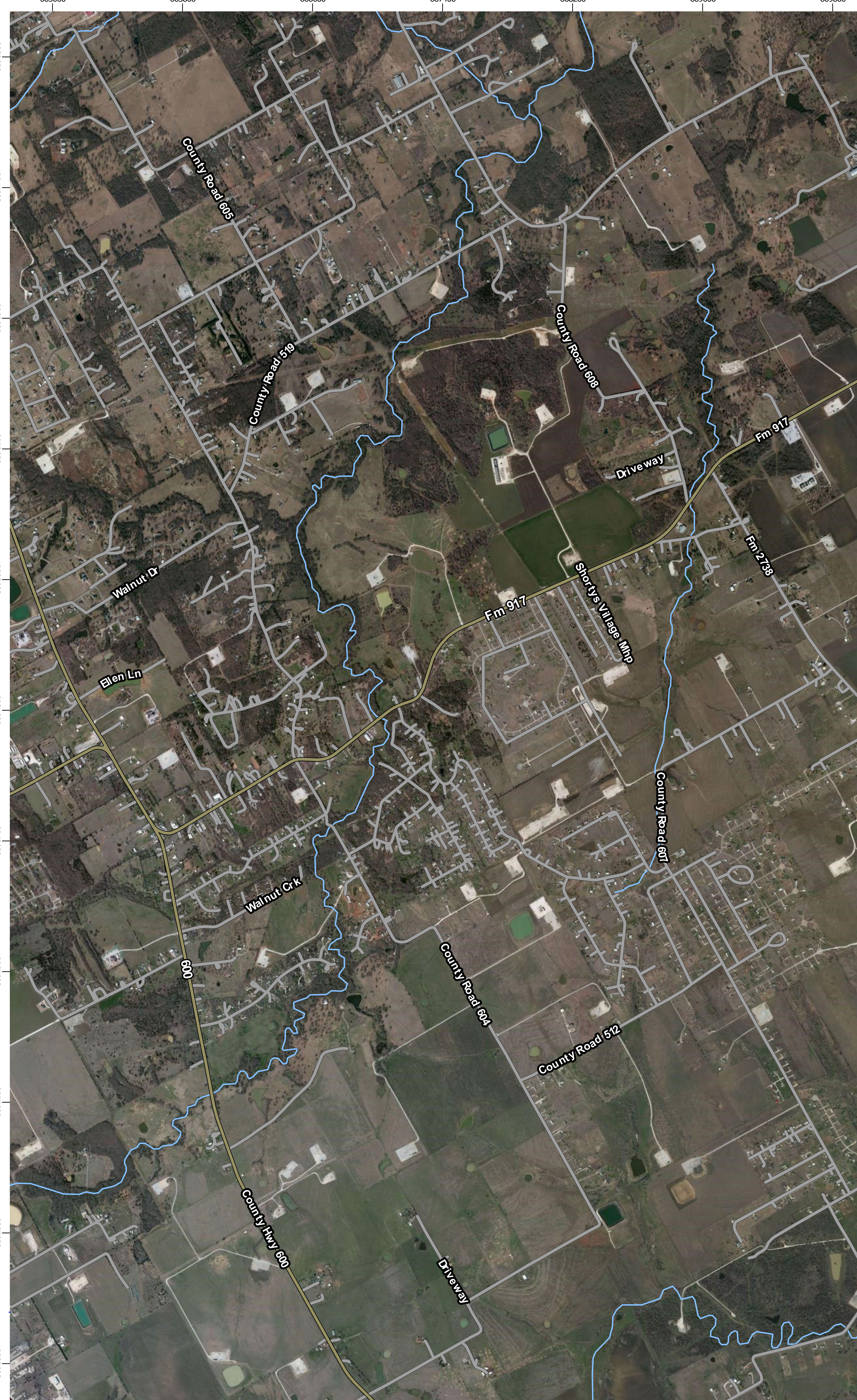

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32° 26' 12" N

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97° 14' 46" W | 97° 11' 24" W

Map Scale: 1:24,000 if printed on B portrait (11" x 17") sheet.

N

0 350 700 1400 2100 Meters

0 1000 2000 4000 6000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

16

Map Sheet Location

MAP LEGEND

Area of Interest (AOI)
Area of Interest (AOI)

Soils
Soil Map Unit Polygons
Soil Map Unit Lines
Soil Map Unit Points

Special Point Features
Blowout
Borrow Pit
Clay Spot
Closed Depression
Gravel Pit
Gravelly Spot
Landfill
Lava Flow
Marsh or swamp
Mine or Quarry
Miscellaneous Water
Perennial Water
Rock Outcrop
Saline Spot
Sandy Spot
Severely Eroded Spot
Sinkhole
Slide or Slip
Sodic Spot
Spoil Area
Stony Spot
Very Stony Spot
Wet Spot
Other
Special Line Features

Water Features
Streams and Canals

Transportation
Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background
Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Johnson County, Texas
Survey Area Data: Version 11, Sep 23, 2015

Soil Survey Area: Tarrant County, Texas
Survey Area Data: Version 12, Sep 28, 2015

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 13, 2010—Jul 13, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Johnson County, Texas (TX251)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AtB	Altoga silty clay, 2 to 5 percent slopes	96.2	0.1%
BaB	Bastrop fine sandy loam, 0 to 3 percent slopes	164.8	0.2%
BmE	Birome-Rayex complex, 5 to 20 percent slopes	1,275.9	1.4%
BoC	Bolar clay loam, 3 to 8 percent slopes	11.0	0.0%
BuB	Burleson clay, 1 to 3 percent slopes	7.3	0.0%
CoB	Coving loamy fine sand, 0 to 3 percent slopes	234.8	0.3%
CrB	Crosstell fine sandy loam, 1 to 3 percent slopes	3,286.9	3.6%
CrD	Crosstell fine sandy loam, 3 to 8 percent slopes	8,163.1	8.9%
CuB	Culp clay loam, 0 to 3 percent slopes	90.1	0.1%
FhC	Ferris-Heiden complex, 2 to 5 percent slopes	64.5	0.1%
Fr	Frio silty clay, 0 to 1 percent slopes, occasionally flooded	69.7	0.1%
GaB	Gasil loamy fine sand, 0 to 5 percent slopes	1,464.1	1.6%
GfB	Gasil fine sandy loam, 1 to 3 percent slopes	1,387.0	1.5%
GfC	Gasil fine sandy loam, 3 to 5 percent slopes	1,237.6	1.4%
GfD4	Gasil fine sandy loam, 1 to 8 percent slopes, gullied	32.4	0.0%
GuD	Gasil-Urban land complex, 1 to 8 percent slopes	37.2	0.0%
Gw	Gowen clay loam, occasionally flooded	114.2	0.1%
Gy	Gowen clay loam, frequently flooded	483.3	0.5%
HaA	Hassee fine sandy loam, 0 to 1 percent slopes	959.9	1.1%
HeB	Heiden clay, 1 to 3 percent slopes	36.7	0.0%
LlB	Lindale clay loam, 1 to 3 percent slopes	34.8	0.0%
LoB	Lott silty clay, 1 to 3 percent slopes	570.2	0.6%

Johnson County, Texas (TX251)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
MeE	Medlin clay, 5 to 15 percent slopes	503.1	0.6%
NaC	Navo clay loam, 2 to 5 percent slopes	7.6	0.0%
Pb	Pits	11.6	0.0%
PnB	Ponder clay loam, 1 to 3 percent slopes	2,723.5	3.0%
PnC	Ponder clay loam, 3 to 5 percent slopes	271.8	0.3%
PoB	Ponder-Urban land complex, 1 to 3 percent slopes	480.9	0.5%
Pp	Pulexas fine sandy loam, frequently flooded	1,457.7	1.6%
Pr	Pursley clay loam, frequently flooded	507.4	0.6%
RaB	Rader fine sandy loam, 0 to 3 percent slopes	3,760.1	4.1%
SaB	Sanger clay, 1 to 3 percent slopes	1,399.2	1.5%
SaC	Sanger clay, 3 to 5 percent slopes	510.3	0.6%
SbC	Sanger-Urban land complex, 1 to 5 percent slopes	527.4	0.6%
SeC	Seawillow clay loam, 1 to 5 percent slopes	10.1	0.0%
SeE	Seawillow clay loam, 5 to 12 percent slopes	6.8	0.0%
SfB	Silstid loamy fine sand, 1 to 3 percent slopes	1,361.7	1.5%
SfD	Silstid loamy fine sand, 3 to 8 percent slopes	756.7	0.8%
SlA	Slidell clay, 0 to 1 percent slopes	278.6	0.3%
SlB	Slidell clay, 1 to 3 percent slopes	224.4	0.2%
Tn	Tinn clay, 0 to 1 percent slopes, frequently flooded	7.6	0.0%
W	Water	109.0	0.1%
WsA	Wilson silty clay loam, 0 to 1 percent slopes	528.7	0.6%
WsB	Wilson silty clay loam, 1 to 3 percent slopes	90.8	0.1%
WuB	Wilson-Urban land complex, 0 to 2 percent slopes	266.9	0.3%
Subtotals for Soil Survey Area		**35,623.8**	**39.0%**
Totals for Area of Interest		**91,419.8**	**100.0%**

Tarrant County, Texas (TX439)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Aledo gravelly clay loam, 1 to 8 percent slopes	522.6	0.6%
2	Bolar-Aledo complex, 3 to 20 percent slopes	182.7	0.2%
4	Aledo-Urban land complex, 1 to 8 percent slopes	30.9	0.0%
5	Altoga silty clay loam, 5 to 12 percent slopes	56.2	0.1%
7	Arents, frequently flooded	248.3	0.3%
8	Arents, loamy	110.8	0.1%
9	Bastsil fine sandy loam, 0 to 3 percent slopes	706.4	0.8%
10	Bastsil-Urban land complex, 0 to 5 percent slopes	210.2	0.2%
11	Birome fine sandy loam, 1 to 5 percent slopes	319.5	0.3%
12	Birome-Aubrey-Rayex complex, 5 to 15 percent slopes	588.7	0.6%
13	Birome-Aubrey-Urban land complex, 5 to 15 percent slopes	874.0	1.0%
14	Bolar clay loam, 1 to 3 percent slopes	27.0	0.0%
16	Bolar-Urban land complex, 1 to 5 percent slopes	33.1	0.0%
20	Chatt silty clay, 1 to 3 percent slopes	8.7	0.0%
21	Crosstell fine sandy loam, 1 to 3 percent slopes	1,011.3	1.1%
22	Crosstell fine sandy loam, 3 to 6 percent slopes	2,522.6	2.8%
23	Crosstell-Urban land complex, 1 to 6 percent slopes	4,427.7	4.8%
26	Frio silty clay, 0 to 1 percent slopes, occasionally flooded	678.9	0.7%
27	Frio silty clay, frequently flooded	1,922.0	2.1%
29	Gasil fine sandy loam, 1 to 3 percent slopes	1,147.6	1.3%
30	Gasil fine sandy loam, 3 to 8 percent slopes	1,713.0	1.9%
31	Gasil sandy clay loam, graded, 1 to 5 percent slopes	443.4	0.5%
32	Gasil-Urban land complex, 1 to 8 percent slopes	1,880.7	2.1%
36	Justin loam, 1 to 3 percent slopes	8.5	0.0%

Tarrant County, Texas (TX439)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
37	Konsil fine sandy loam, 1 to 5 percent slopes	215.5	0.2%
38	Leson clay, 1 to 3 percent slopes	41.4	0.0%
39	Lindale clay loam, 1 to 3 percent slopes	1,649.0	1.8%
40	Lindale-Urban land complex, 1 to 3 percent slopes	302.0	0.3%
41	Lott silty clay, 1 to 3 percent slopes	1,404.1	1.5%
42	Lott-Urban land complex, 1 to 5 percent slopes	23.8	0.0%
43	Luckenbach clay loam, 1 to 3 percent slopes	39.8	0.0%
45	Mabank fine sandy loam, 0 to 1 percent slopes	71.2	0.1%
47	Medlin clay, 5 to 15 percent slopes	164.6	0.2%
48	Mingo clay loam, 1 to 3 percent slopes	321.9	0.4%
49	Mingo-Urban land complex, 1 to 3 percent slopes	112.3	0.1%
51	Navo-Urban land complex, 1 to 3 percent slopes	79.9	0.1%
54	Ovan clay, frequently flooded	62.2	0.1%
56	Pits, quarries	13.0	0.0%
57	Ponder clay loam, 1 to 3 percent slopes	4,583.6	5.0%
58	Ponder-Urban land complex, 0 to 3 percent slopes	3,599.2	3.9%
59	Pulexas fine sandy loam, frequently flooded	454.5	0.5%
60	Pulexas-Urban land complex, occasionally flooded	14.5	0.0%
61	Purves clay, 1 to 3 percent slopes	693.8	0.8%
62	Purves-Urban land complex, 0 to 5 percent slopes	116.2	0.1%
63	Rader fine sandy loam, 0 to 3 percent slopes	1,226.6	1.3%
64	Rader-Urban land complex, 0 to 3 percent slopes	514.4	0.6%
65	Sanger clay, 1 to 3 percent slopes	5,449.6	6.0%
66	Sanger clay, 3 to 5 percent slopes	586.1	0.6%

Tarrant County, Texas (TX439)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
67	Sanger-Urban land complex, 1 to 5 percent slopes	2,631.7	2.9%
68	San Saba clay, 0 to 2 percent slopes	14.6	0.0%
70	Silawa fine sandy loam, 3 to 8 percent slopes	836.9	0.9%
71	Silstid loamy fine sand, 1 to 5 percent slopes	1,074.3	1.2%
72	Silstid-Urban land complex, 1 to 5 percent slopes	295.8	0.3%
73	Slidell clay, 0 to 1 percent slopes	1,980.9	2.2%
74	Slidell clay, 1 to 3 percent slopes	2,282.5	2.5%
75	Speck clay loam, 0 to 3 percent slopes	117.1	0.1%
77	Sunev clay loam, cool, 1 to 3 percent slopes	34.3	0.0%
78	Sunev clay loam, 3 to 8 percent slopes	13.4	0.0%
79	Sunev-Urban land complex, 2 to 8 percent slopes	18.0	0.0%
81	Urban land	649.9	0.7%
82	Weatherford-Duffau complex, 3 to 8 percent slopes	36.7	0.0%
83	Whitesboro loam, frequently flooded	793.9	0.9%
84	Wilson clay loam, 0 to 2 percent slopes	1,204.3	1.3%
85	Wilson-Urban land complex, 0 to 2 percent slopes	454.2	0.5%
DAM	Dams	7.4	0.0%
M-W	Miscellaneous water	7.2	0.0%
W	Water	1,928.6	2.1%
Subtotals for Soil Survey Area		**55,795.9**	**61.0%**
Totals for Area of Interest		**91,419.8**	**100.0%**

Appendix B

USFWS IPaC Report for the Village Creek-Lake Arlington Watershed

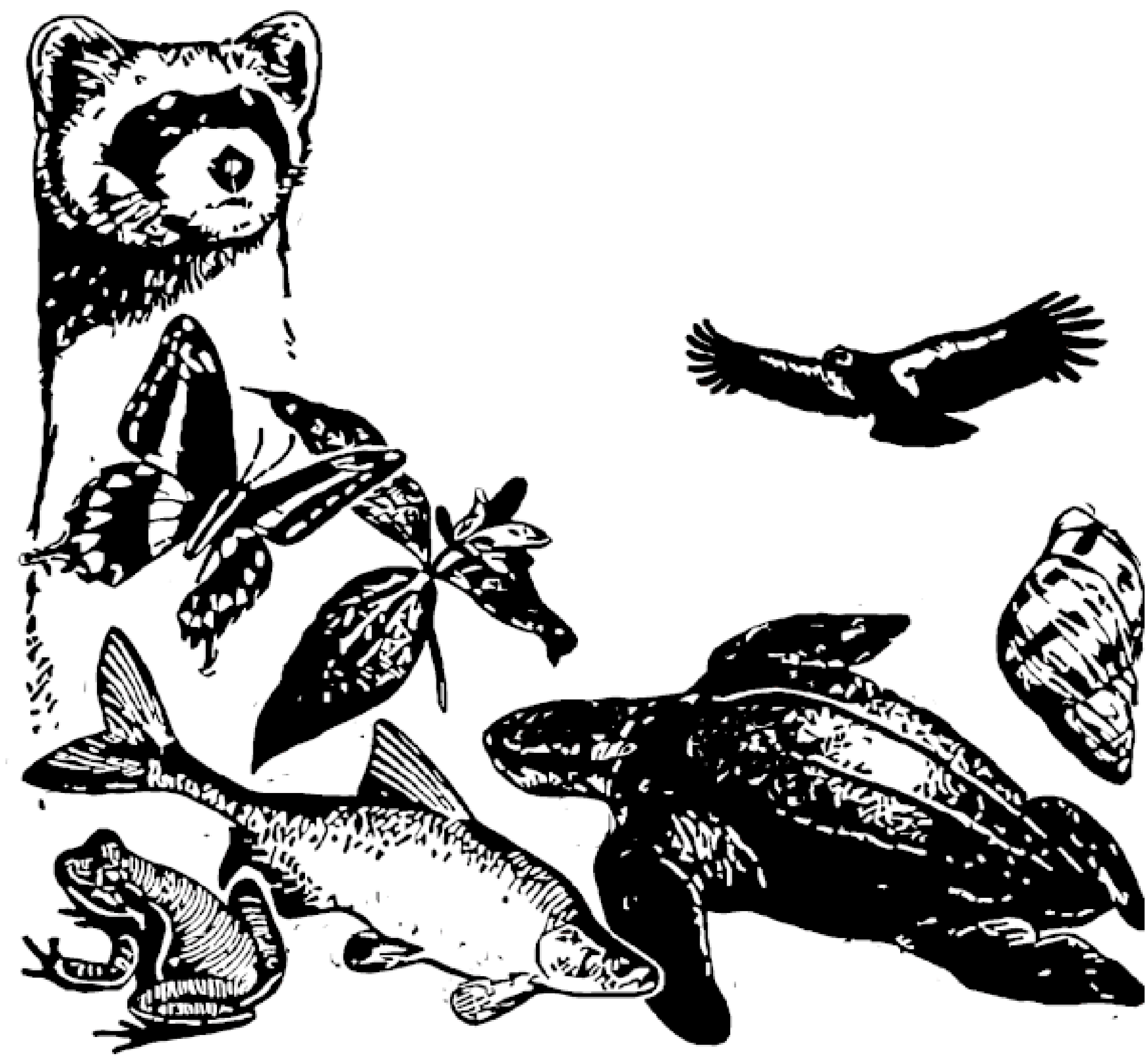
U.S. Fish & Wildlife Service

Village Creek-Lake Arlington

IPaC Trust Resource Report

Generated January 14, 2016 11:55 AM MST, IPaC v2.3.2

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (http://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

US Fish & Wildlife Service

IPaC Trust Resource Report

NAME

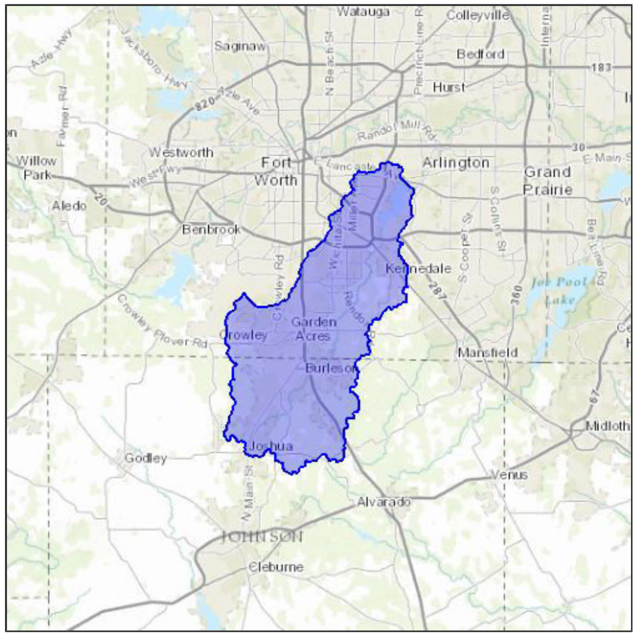
Village Creek-Lake Arlington

LOCATION

Johnson and Tarrant counties, Texas

IPAC LINK

http://ecos.fws.gov/ipac/project/DRYCU-Y4D5V-H2BHE-7B42J-ZOIALQ



U.S. Fish & Wildlife Contact Information

Trust resources in this location are managed by:

Arlington Ecological Services Field Office
2005 Ne Green Oaks Blvd
Suite 140
Arlington, TX 76006-6247
(817) 277-1100

Endangered Species

Proposed, candidate, threatened, and endangered species are managed by the Endangered Species Program of the U.S. Fish & Wildlife Service.

This USFWS trust resource report is for informational purposes only and should not be used for planning or analyzing project level impacts.

For project evaluations that require FWS concurrence/review, please return to the IPaC website and request an official species list from the Regulatory Documents section.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list from the Regulatory Documents section in IPaC.

The list of species below are those that may occur or could potentially be affected by activities in this location:

Birds

Black-capped Vireo Vireo atricapilla — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B07T

Golden-cheeked Warbler (=wood) Dendroica chrysoparia — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B07W

Least Tern Sterna antillarum — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B07N

Piping Plover Charadrius melodus — Threatened

THIS SPECIES ONLY NEEDS TO BE CONSIDERED IF THE FOLLOWING CONDITION APPLIES
Wind Energy Projects

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B079

Red Knot Calidris canutus rufa — Threatened

THIS SPECIES ONLY NEEDS TO BE CONSIDERED IF THE FOLLOWING CONDITION APPLIES
Wind Energy Projects

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0DM

Whooping Crane Grus americana — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B003

Clams

Texas Fawnsfoot Truncilla macrodon — Candidate

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=F04E

Critical Habitats

There are no critical habitats in this location

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity which results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service (1). There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

Additional information can be found using the following links:

- Birds of Conservation Concern
  http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/akn-histogram-tools.php

The following species of migratory birds could potentially be affected by activities in this location:

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B008

Bell's Vireo Vireo bellii — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JX

Burrowing Owl Athene cunicularia — Bird of conservation concern
Seasons: Breeding, Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0NC

Chestnut-collared Longspur Calcarius ornatus — Bird of conservation concern
Season: Wintering

Dickcissel Spiza americana — Bird of conservation concern
Season: Breeding

Fox Sparrow Passerella iliaca — Bird of conservation concern
Season: Wintering

Harris's Sparrow Zonotrichia querula — Bird of conservation concern
Season: Wintering

Hudsonian Godwit Limosa haemastica — Bird of conservation concern
Season: Migrating

Lark Bunting Calamospiza melanocorys — Bird of conservation concern
Season: Wintering

Le Conte's Sparrow Ammodramus leconteii — Bird of conservation concern
Season: Wintering

Least Bittern Ixobrychus exilis — Bird of conservation concern
Season: Breeding

Little Blue Heron Egretta caerulea — Bird of conservation concern
Season: Breeding

Loggerhead Shrike Lanius ludovicianus — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FY

Mccown's Longspur Calcarius mccownii — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HB

Mississippi Kite Ictinia mississippiensis — Bird of conservation concern
Season: Breeding

Orchard Oriole Icterus spurius — Bird of conservation concern
Season: Breeding

Painted Bunting Passerina ciris — Bird of conservation concern
Season: Breeding

Prothonotary Warbler Protonotaria citrea — Bird of conservation concern
Season: Breeding

Red-headed Woodpecker Melanerpes erythrocephalus — Bird of conservation concern
Year-round

Rufous-crowned Sparrow Aimophila ruficeps — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MX

Rusty Blackbird Euphagus carolinus — Bird of conservation concern
Season: Wintering

Scissor-tailed Flycatcher Tyrannus forficatus — Bird of conservation concern
Season: Breeding

Short-eared Owl Asio flammeus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HD

Sprague's Pipit Anthus spragueii — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0GD

Refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuges in this location

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Wetland data is unavailable at this time.

Appendix C

TPWD Threatened & Endangered Resources Reports for Tarrant and Johnson Counties

Last Revision: 5/16/2016 5:47:00 PM

JOHNSON COUNTY

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Bald Eagle	*Haliaeetus leucocephalus*	DL	T

found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Black-capped Vireo	*Vireo atricapilla*	LE	E

oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer

Golden-cheeked Warbler	*Setophaga chrysoparia*	LE	E

juniper-oak woodlands; dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer

Henslow's Sparrow	*Ammodramus henslowii*		

wintering individuals (not flocks) found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles; a key component is bare ground for running/walking

Interior Least Tern	*Sterna antillarum athalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

JOHNSON COUNTY

BIRDS — Federal Status — State Status

Common Name	Scientific Name	Federal Status	State Status
Red Knot	*Calidris canutus rufa*	T	

Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. A small plump-bodied, short-necked shorebird that in breeding plumage, typically held from May through August, is a distinctive and unique pottery orange color. Its bill is dark, straight and, relative to other shorebirds, short-to-medium in length. After molting in late summer, this species is in a drab gray-and-white non-breeding plumage, typically held from September through April. In the non-breeding plumage, the knot might be confused with the omnipresent Sanderling. During this plumage, look for the knot's prominent pale eyebrow and whitish flanks with dark barring. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Common Name	Scientific Name	Federal Status	State Status
Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Common Name	Scientific Name	Federal Status	State Status
Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Common Name	Scientific Name	Federal Status	State Status
White-faced Ibis	*Plegadis chihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

Common Name	Scientific Name	Federal Status	State Status
Whooping Crane	*Grus americana*	LE	E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

FISHES — Federal Status — State Status

Common Name	Scientific Name	Federal Status	State Status
Sharpnose shiner	*Notropis oxyrhynchus*	LE	

endemic to Brazos River drainage; also, apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom a combination of sand, gravel, and clay-mud

Common Name	Scientific Name	Federal Status	State Status
Smalleye shiner	*Notropis buccula*	LE	

endemic to upper Brazos River system and its tributaries (Clear Fork and Bosque); apparently introduced into adjacent Colorado River drainage; medium to large prairie streams with sandy substrate and turbid to clear warm water; presumably eats small aquatic invertebrates

JOHNSON COUNTY

MAMMALS		Federal Status	State Status
Gray wolf	*Canis lupus*	LE	E

extirpated; formerly known throughout the western two-thirds of the state in forests, brushlands, or grasslands

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Red wolf	*Canis rufus*	LE	E

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

MOLLUSKS		Federal Status	State Status
Texas fawnsfoot	*Truncilla macrodon*	C	T

little known; possibly rivers and larger streams, and intolerant of impoundment; flowing rice irrigation canals, possibly sand, gravel, and perhaps sandy-mud bottoms in moderate flows; Brazos and Colorado River basins

REPTILES		Federal Status	State Status
Brazos water snake	*Nerodia harteri*		T

upper Brazos River drainage; riffle specialist, in shallow water with rocky bottom and on rocky portions of banks

Texas garter snake	*Thamnophis sirtalis annectens*		

wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Timber rattlesnake	*Crotalus horridus*		T

swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

PLANTS		Federal Status	State Status
Hall's prairie clover	*Dalea hallii*		

GLOBAL RANK: G3; In grasslands on eroded limestone or chalk and in oak scrub on rocky hillsides; Perennial; Flowering May-Sept; Fruiting June-Sept

JOHNSON COUNTY

PLANTS

Federal Status State Status

Reverchon's curfpea *Pediomelum reverchonii*

GLOBAL RANK: G3; Mostly in prairies on shallow rocky calcareous substrates and limestone outcrops; Perennial; Flowering Jun-Sept; Fruiting June-July

Texas milk vetch *Astragalus reflexus*

GLOBAL RANK: G3; Grasslands, prairies, and roadsides on calcareous and clay substrates; Annual; Flowering Feb-June; Fruiting April-June

Tree dodder *Cuscuta exaltata*

GLOBAL RANK: G3; Parasitic on various Quercus, Juglans, Rhus, Vitis, Ulmus, and Diospyros species as well as Acacia berlandieri and other woody plants; Annual; Flowering May-Oct; Fruiting July-Oct

TARRANT COUNTY

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies’ far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Bald Eagle	*Haliaeetus leucocephalus*	DL	T

found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Henslow's Sparrow	*Ammodramus henslowii*		

wintering individuals (not flocks) found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles; a key component is bare ground for running/walking

Interior Least Tern	*Sterna antillarum athalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies’ listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

TARRANT COUNTY

	BIRDS	Federal Status	State Status
Red Knot	*Calidris canutus rufa*	T	

Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. A small plump-bodied, short-necked shorebird that in breeding plumage, typically held from May through August, is a distinctive and unique pottery orange color. Its bill is dark, straight and, relative to other shorebirds, short-to-medium in length. After molting in late summer, this species is in a drab gray-and-white non-breeding plumage, typically held from September through April. In the non-breeding plumage, the knot might be confused with the omnipresent Sanderling. During this plumage, look for the knot's prominent pale eyebrow and whitish flanks with dark barring. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Whooping Crane	*Grus americana*	LE	E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

	FISHES	Federal Status	State Status
Shovelnose sturgeon	*Scaphirhynchus platorynchus*		T

open, flowing channels with bottoms of sand or gravel; spawns over gravel or rocks in an area with a fast current; Red River below reservoir and rare occurrence in Rio Grande

	MAMMALS	Federal Status	State Status
Gray wolf	*Canis lupus*	LE	E

extirpated; formerly known throughout the western two-thirds of the state in forests, brushlands, or grasslands

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

TARRANT COUNTY

MAMMALS — Federal Status — State Status

Red wolf *Canis rufus* LE E

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

MOLLUSKS — Federal Status — State Status

Louisiana pigtoe *Pleurobema riddellii* T

streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments; Sabine, Neches, and Trinity (historic) River basins

Sandbank pocketbook *Lampsilis satura* T

small to large rivers with moderate flows and swift current on gravel, gravel-sand, and sand bottoms; east Texas, Sulfur south through San Jacinto River basins; Neches River

Texas heelsplitter *Potamilus amphichaenus* T

quiet waters in mud or sand and also in reservoirs. Sabine, Neches, and Trinity River basins

REPTILES — Federal Status — State Status

Texas garter snake *Thamnophis sirtalis annectens*

wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August

Texas horned lizard *Phrynosoma cornutum* T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Timber rattlesnake *Crotalus horridus* T

swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

PLANTS — Federal Status — State Status

Auriculate false foxglove *Agalinis auriculata*

Known in Texas from one late nineteenth century specimen record labeled -Benbrook-; in Oklahoma, degraded prairies, floodplains, fallow fields, and borders of upland sterile woods; in Arkansas, blackland prairie; Annual; Flowering August - October

Glen Rose yucca *Yucca necopina*

Texas endemic; grasslands on sandy soils and limestone outcrops; flowering April-June

Hall's prairie clover *Dalea hallii*

GLOBAL RANK: G3; In grasslands on eroded limestone or chalk and in oak scrub on rocky hillsides; Perennial; Flowering May-Sept; Fruiting June-Sept

TARRANT COUNTY

PLANTS

Federal Status State Status

Osage Plains false foxglove *Agalinis densiflora*

GLOBAL RANK: G3; Most records are from grasslands on shallow, gravelly, well drained, calcareous soils; Prairies, dry limestone soils; Annual; Flowering Aug-Oct

Reverchon's curfpea *Pediomelum reverchonii*

GLOBAL RANK: G3; Mostly in prairies on shallow rocky calcareous substrates and limestone outcrops; Perennial; Flowering Jun-Sept; Fruiting June-July

Texas milk vetch *Astragalus reflexus*

GLOBAL RANK: G3; Grasslands, prairies, and roadsides on calcareous and clay substrates; Annual; Flowering Feb-June; Fruiting April-June

Topeka purple-coneflower *Echinacea atrorubens*

GLOBAL RANK: G3; Occurring mostly in tallgrass prairie of the southern Great Plains, in blackland prairies but also in a variety of other sites like limestone hillsides; Perennial; Flowering Jan-June; Fruiting Jan-May