

Tarrant Regional Water District

Eagle Mountain Lake Watershed Protection Plan

Draft for Informal Stakeholder Review

DRAFT

June 17, 2026

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Abbreviations

5SUWRP: Five Star and Urban Waters Restoration Program

ACEP: Agricultural Conservation Easement Program

AERI: America's Ecosystem Restoration Initiative

AFA: Alternative Funding Arrangement

ALE: Agricultural Land Easements

AVMA: American Veterinary Medical Association

AWCG: Agricultural Water Conservation Grant

BMPs: Best Management Practices

BOD: biological oxygen demand

CDBG: Community Development Block Grant

CFG: Community Forestry Grants

CFT: Communities Foundation of Texas

CFU: Colony-Forming Units

CGMF: The Cynthia & George Mitchell Foundation

CIG: Conservation Innovation Grants

CIP: capital improvement program

CP: conservation plan

CPP: Conservation Partners Program

CRP: Conservation Reserve Program

CSP: Conservation Stewardship Program

CWA: Clean Water Act

CWSRF: Clean Water State Revolving Fund

DFund: Texas Water Development Fund

DMR: Discharge Monitoring Report

DO: dissolved oxygen

DWSRF: Drinking Water State Revolving Fund

DWTATP: Decentralized Wastewater Technical Assistance and Training Program

ECHO: Enforcement and Compliance History Online

EDAP: Economically Distressed Areas Program

EE: Environmental Education

EFT: Environmental Fund of Texas

EML: Eagle Mountain Lake

EPA: Environmental Protection Agency

EQIP: Environmental Quality Incentives Program

EWP: Emergency Watershed Protection Program

FDC: Flow Duration Curve

FSA: Farm Service Agency

FWP: Farmable Wetlands Program

GLCI: Grazing Lands Conservation Initiative

GRCI: Grassland Resilience and Conservation Initiative

GSI: green stormwater infrastructure

HAWQS: Hydrologic and Water Quality System

HOAs: homeowners associations

I&I: inflow and infiltration

IRSP: Infrastructure Resilience and Sustainability Program

iSWM™: integrated Stormwater Management

LDC: Load Duration Curve

LIP: Landowner Incentive Program

LOADEST: Load Estimation program

LULC: land use and land cover

MCG: Member Collective Grants

mL: Milliliters

MOS: margin of safety

MPN: Most Probable Number

MS4: municipal separate storm sewer system

MSL: Mean Sea Level

NAs: neighborhood association

NASS: National Agricultural Statistics Survey

NCTCOG: North Central Texas Council of Governments

NLCD : National Land Cover Database

NPS: nonpoint source

NRCS: Natural Resources Conservation Service

NRWA: National Rural Water Association

NWQI: National Water Quality Initiative

OSSFs: on-site sewage facilities

PCR1: Primary Contact Recreation 1

QAPP: Quality Assurance Project Plan

RCPP: Regional Conservation Partnership Program

RFPs: requests for proposals

ROI: return on investment

RPP: Regenerative Pilot Program

RRC: Railroad Commission of Texas

RWAF: Rural Water Assistance Fund

SELECT: Spatially Explicit Load Enrichment Calculation Tool

SEP: Supplemental Environmental Projects

SSO: sanitary sewer overflow

SWAT: Soil and Water Assessment Tool

SWCD: soil and water conservation district

SWPCFP: Solid Waste Program Call for Projects

SWPP: "Grassroots" Source Water Protection Program

SWQM: Surface Water Quality Monitoring
SWQMIS: Surface Water Quality Monitoring
Information System
TAC: Texas Administrative Code
TAMFS: Texas A&M Forest Service
TCEQ: Texas Commission on Environmental Quality
TCRP: Texas Clean Rivers Program
TDS: Total dissolved solids
TFRLCP: Texas Farm and Ranch Lands Conservation
Program
TKN: Total Kjeldahl nitrogen
TMDL: Total Maximum Daily Loads
TP: Total phosphorous
TPWD: Texas Parks and Wildlife Department
TRLI: Texas Resilient Landscapes Initiative
TRWD: Tarrant Regional Water District
TSSWCB: Texas State Soil & Water Conservation
Board
TSWQS: Texas Surface Water Quality Standards
TWDB: Texas Water Development Board
TxCDBG: Texas Community Development Block
Grant
USDA: U.S. Department of Agriculture
USFS: United States Forest Service
USGS: U.S. Geological Survey
VPA-HIP: Voluntary Public Access and Habit at
Incentive Program
WFPO: Watershed Protection and Flood Prevention
Operations
WPDG: Wetland Program Development Grant
WPP: Watershed Protection Plan
WPPIG: Watershed Protection Plan Implementation
Grant
WQMP: water quality management plan
WRE: Wetland Reserve Easements
WSEP: Water Supply Enhancement Program
WSIG: Water Supply and Infrastructure Grants
WWTF: wastewater treatment facilities
WWTP: wastewater treatment plant

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1 Watershed Management

1.1 Watersheds and Water Quality

A watershed is the land area that drains water to a common point such as a stream, river, lake, wetland, or ocean. Watersheds can be very small, such as part of a park that drains to the creek in your neighborhood. Many of these small watersheds combine to form much larger watersheds, such as major river basins that drain large portions of states, and in some cases, cover large portions of countries or continents. For example, several subwatersheds make up the Eagle Mountain Lake watershed, which is part of the Trinity River basin (Figure 1-1).

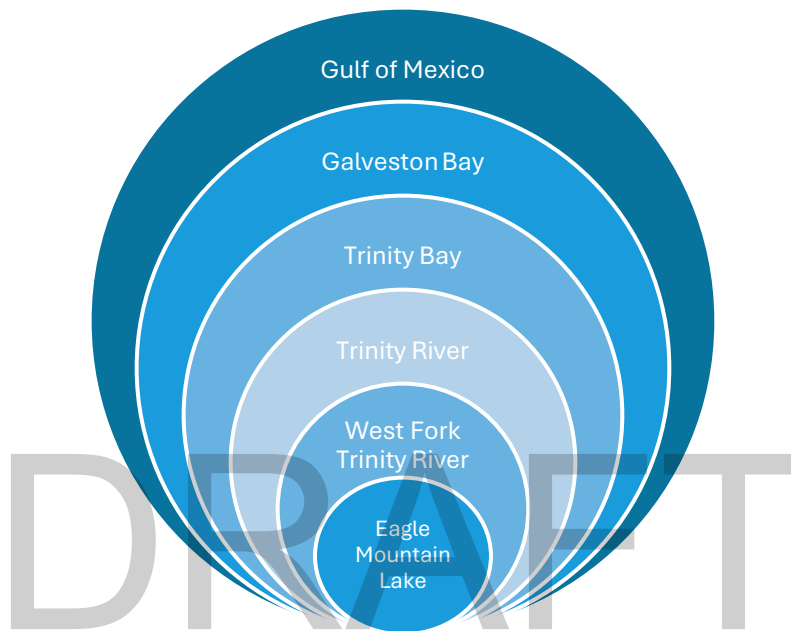


Figure 1-1 Conceptual interpretation of the EML watershed system

No matter where you are on Earth, you're in a watershed. As runoff water from storms flows across the landscape, it picks up and carries sediment and various other substances as it flows to a waterway. This means that everything we do on the land affects both water quality and quantity, and the cumulative effects can impact the function and health of the whole watershed.

An effective watershed management strategy will show a measurable effect on the water quality of the receiving water body. To accomplish this, the strategy must account for and examine the full scope of human activities and natural processes that occur within the watershed's boundary.

1.2 The Watershed Approach

Watersheds usually contain parts of many municipalities and counties and may even cross state lines. This often makes it difficult for any one entity to approach and solve water quality concerns on their own. To address this constraint, state and federal agencies have adopted a *watershed approach* for managing water quality, which involves assessing the sources and impacts of water quality impairments at the watershed level.

A key component of the watershed approach is input from stakeholders, which includes anyone that has an interest in the watershed. These stakeholders may offer unique insights and experiences gained from either working, living, or recreating in the watershed. These insights supplement water quality monitoring data to help

inform management decisions. As users of the watershed, stakeholders have a vested interest in the water quality and will also be affected by the management decisions used to address water quality issues.

1.3 Watershed Protection Planning

A Watershed Protection Plan (WPP) is a watershed-based plan developed by the stakeholders to restore and/or protect water quality and designated uses of a waterbody through a combination of voluntary, non-regulatory water resource management measures. WPPs are an important part of the State’s approach to managing nonpoint source (NPS) pollution. This plan was developed by stakeholders to address growing water quality issues in the Eagle Mountain Lake (EML) watershed and to protect this major drinking water supply from further degradation. The plan provides a comprehensive analysis and planning vehicle for restoring and protecting water quality in EML.

Via the WPP process, stakeholders help select, design, and implement management strategies best suited for the watershed from the standpoints of economic feasibility, social acceptability, and scientific credibility. Public participation is critical throughout plan development and implementation, as ultimate success of any WPP depends on stewardship of the land and water resources by local landowners, businesses, residents, and municipal leaders in the watershed.

To support stakeholders who wish to utilize this watershed approach, the Environmental Protection Agency (EPA) has developed a list of nine key elements (EPA, 2013) necessary for developing a WPP capable of addressing water quality issues. WPPs are reviewed by either Texas Commission on Environmental Quality (TCEQ) or Texas State Soil and Water Conservation Board (TSSWCB) and then EPA to assess a plan's consistency with the nine elements. Acceptance of the WPP by EPA is necessary for implementation and future updates to be considered eligible for Clean Water Act (CWA) §319(h) funding. Details about these elements, as well as the WPP chapters they correspond to, are provided in Appendix A, Key Elements of Successful WPPs.

1.4 The Eagle Mountain Lake Watershed Protection Effort

Effective WPPs utilize local knowledge and expertise to guide the planning process, ensuring that the best management practices (BMPs) selected for implementation are relevant to the watershed’s issues, applicable to the environmental setting of the watershed, and feasible for the watershed residents, given available resources. If this process is followed, local stakeholders are more likely to modify their behaviors and adopt the BMPs identified in the Plan.

The EML watershed protection effort was initiated to address water quality concerns in both EML and its tributaries. Drinking water from EML is part of an integrated regional water system that serves more than 2.4 million customers across 11 counties. Long-term analyses also indicate statistically significant relationships between nutrient and chlorophyll-a concentrations in EML and other lakes in the region. This relationship between “causal” and “response” pollutants allows for the use of both chemical and biological data to establish comprehensive water quality goals for the lake, as well as implementation milestones for the watershed.

1.4.1 Structure

The general EML WPP stakeholder group is open to public participation without formal membership. Anyone with an interest in the watershed and water quality in EML or its contributing streams is welcome to attend and provide input at in-person or virtual stakeholder meetings. Specifically identified partners in Table 1-1 provided technical advice or developed technical materials such as modeling reports. To ensure that watershed interests are well

represented, there is a continued effort by the project team to maintain stakeholder representation that is well distributed, both spatially throughout the watershed, and topically among multiple users with varying needs.

Table 1-1 EML WPP partners

Partner	Contributions
Natural Resources	
Texas A&M AgriLife Research	Modeling/Analytical Products
Texas A&M AgriLife Extension	Workshop support (ongoing)
Texas A&M Forest Service	Technical advice
Texas Parks & Wildlife Department	Technical advice
Texas Water Resources Institute	Technical advice and workshop support
USDA-Natural Resources Conservation Service	Technical advice, data, and document review
Texas State Soil and Water Conservation Board	Technical advice, data, and document review
Groundwater Conservation Districts	Technical advice
Soil and Water Conservation Districts	Data and technical advice
Texas Commission on Environmental Quality	Technical advice, data, and document review
Municipal	
North Central Texas Council of Governments	Data and coordination support
Tarrant County	Technical advice
Wise County	Technical advice
City of Azle	Technical advice
City of Fort Worth	Technical advice
Non-Profit	
Dixon Water Foundation	Technical advice
National Watershed Coalition	Technical advice
Save Eagle Mountain Lake	Community engagement
Individuals and Businesses	
Twenty-seven unique individuals, businesses, and property associations	Document review

1.4.2 Coordinated Development of the Watershed Protection Plan

Partners were instrumental in identifying BMPs and strategies that proved useful from their diverse experiences. Tarrant Regional Water District (TRWD) and its modeling partners at Texas A&M AgriLife used information from technical partners and general stakeholder meetings to recommend which BMPs were the best fit for the EML watershed and its residents.

Ultimately, this information was used to evaluate BMPs that should be implemented to achieve the desired water quality goals. This process involves continuing communication between TRWD, its partners, and stakeholders to identify measurable milestones and prioritize specific BMPs. Partner and stakeholder engagement is described in Appendix E.

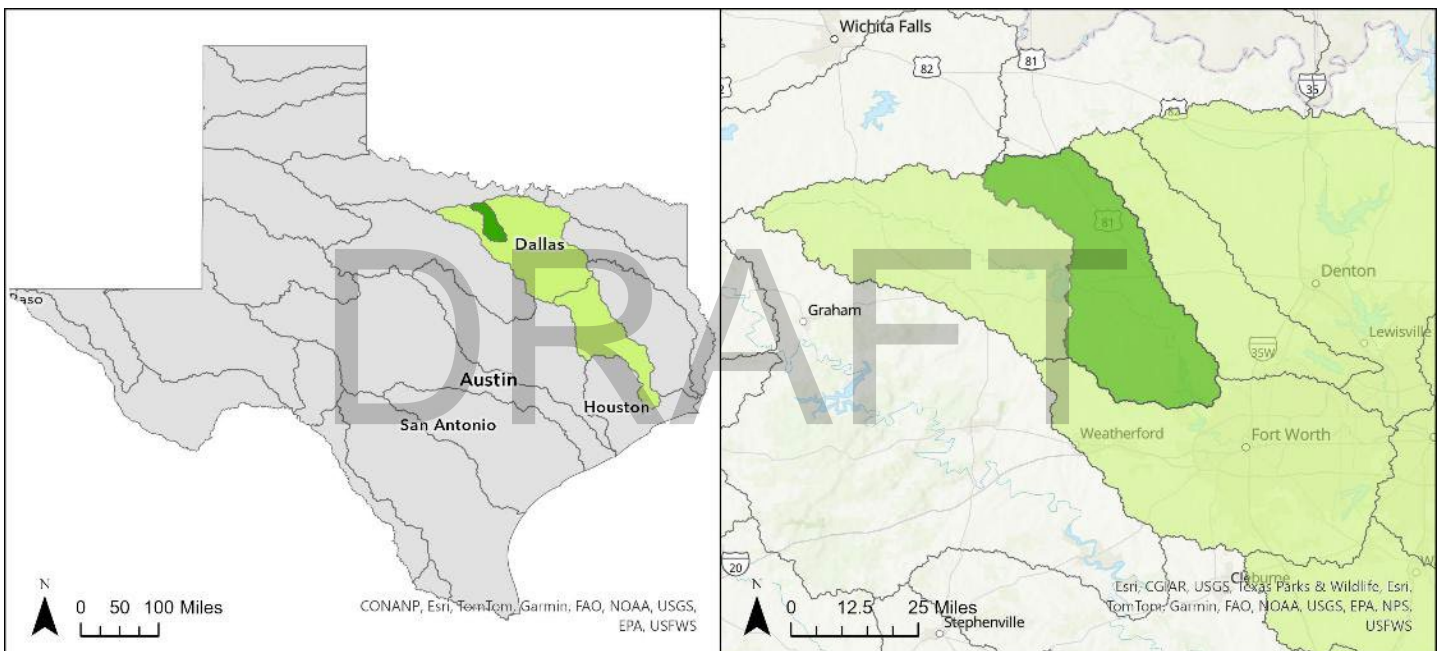
Achieving improvements in water quality will not be a short-term effort and will continue long after the initial planning period is complete. Even after the WPP's water quality goals are achieved, continued preservation of

these goals and long-term protection of the watershed will be necessary. These programs and practices will require ongoing maintenance and periodic evaluation of their results through continued water quality monitoring, which will be targeted to interim and long-term milestones. Through these evaluations, adaptive management techniques will be used to reassess the recommended strategies used in the watershed.

2 Watershed Overview

2.1 Geography

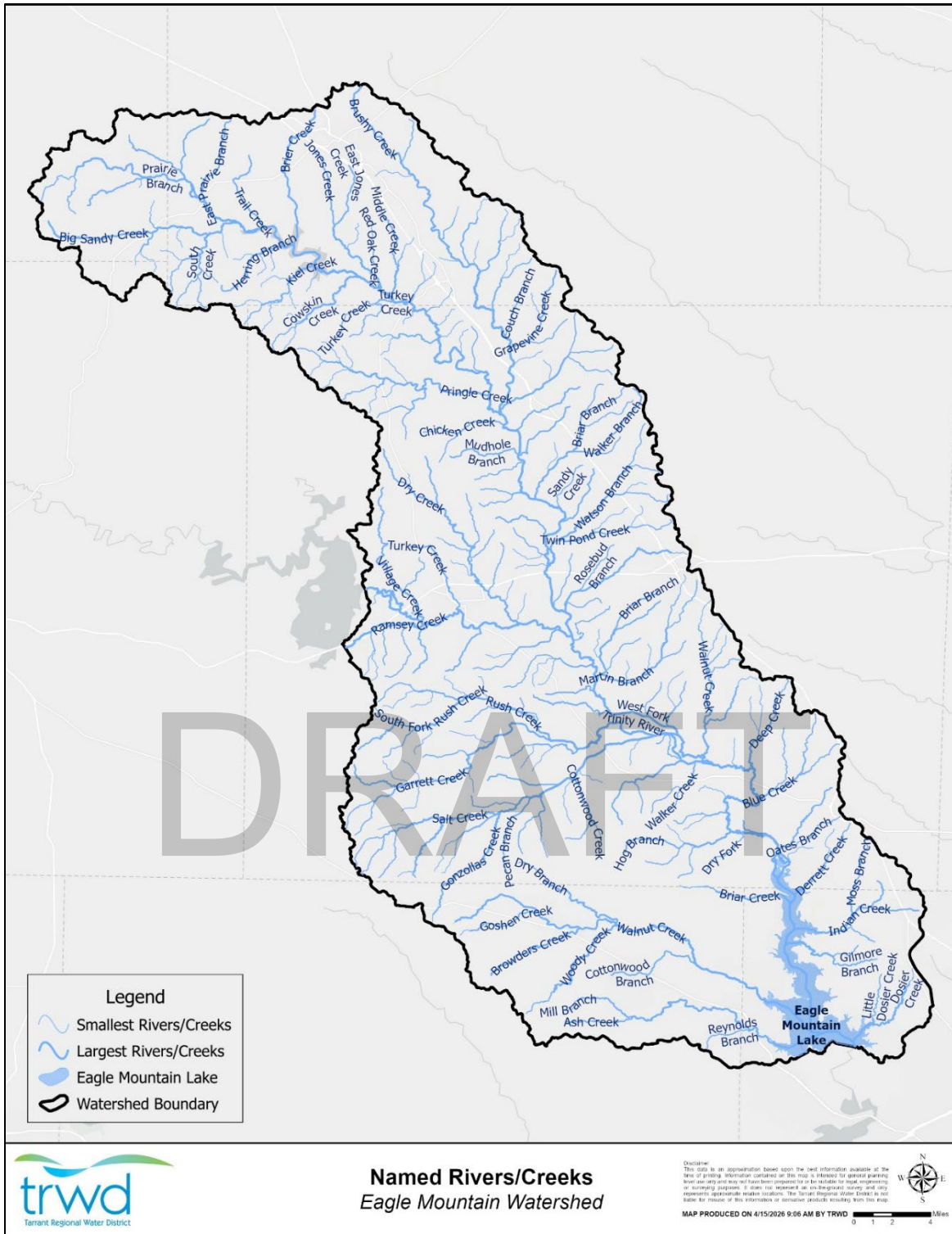
Permitted in 1928 for municipal, industrial, and irrigation use, EML is one of four reservoirs owned by TRWD and operated for raw water supply, irrigation, flood control, and recreational purposes. Construction on the EML dam was completed in 1932, impounding flows from portions of Tarrant, Parker, Wise, Montague, Jack, and Clay counties. EML is part of the Trinity River Basin (Figure 2-1). The planning and implementation described in this WPP applies to this 860 square mile (550,000 acre) EML watershed.



Data source: TWDB and TCEQ.

Figure 2-1 Location of the EML watershed within the Trinity River basin in Texas

EML receives flow from the West Fork of the Trinity River, which is supported by releases from Lake Bridgeport. It also has numerous perennial tributaries, notably Big Sandy Creek, Derrett Creek, Dosier Creek, Martin Branch, and Walnut Creek. The intermittent tributary Ash Creek is also notable due to water quality impairments. These many creeks flow into both the western and eastern sides of the lake, as well into the West Fork above EML (Figure 2-2). These incoming flows are comprised of stormwater runoff, as well as outfalls from 22 permitted municipal and privately owned sources.



Stream data source: NHD
Figure 2-2 Named rivers and creeks of the EML watershed

Databases maintained by TCEQ did not identify any discharges of cooling water, mining effluent, or concentrated animal feeding operation effluent in the watershed. Populations for the 18 municipalities throughout the watershed are shown in Table 2-1 .

Table 2-1 2020 population

City or Town	2020 Population ^a	% of City Limits in Watershed ^b	Population in Watershed ^c
Fort Worth	918,915	3%	27,567
Azle	13,369	99%	13,235
Bridgeport	5,923	98%	5,805
Bowie	5,448	99%	5,394
Decatur	6,538	69%	4,511
Springtown	3,064	100%	3,064
Reno	2,878	100%	2,878
Pelican Bay	2,049	100%	2,049
Boyd	1,416	100%	1,416
Aurora	1,390	100%	1,390
Alvord	1,351	100%	1,351
Rhome	1,630	68%	1,108
Newark	1,096	100%	1,096
Chico	946	100%	946
Paradise	475	100%	475
Sanctuary	337	100%	337
New Fairview	1,386	8%	111
Lake Bridgeport	339	7%	24
(a) U.S. Census Bureau 2020 Decennial Census, Table P1 (U.S. Census Bureau, 2020)			
(b) Calculated using the Texas Department of Transportation 2022 City Transportation boundary dataset (ArcGIS, 2022)			
(c) Assumes uniform population density			

2.2 Geology and Soils

The majority of the watershed is underlain by units from the Trinity and Canyon groups. Soils vary across the watershed but are overall dominated by sandy loams. Areas to the southeast edge of the watershed near EML have higher clay content. Intermittent zones of clay soils also occur in the western reaches of the watershed, and past and present fluvial deposits result in narrow areas of silt-dominated soils, according to a database from the U.S. Geological Survey (USGS) (USGS, n.d.).

2.3 Land Use and Land Cover

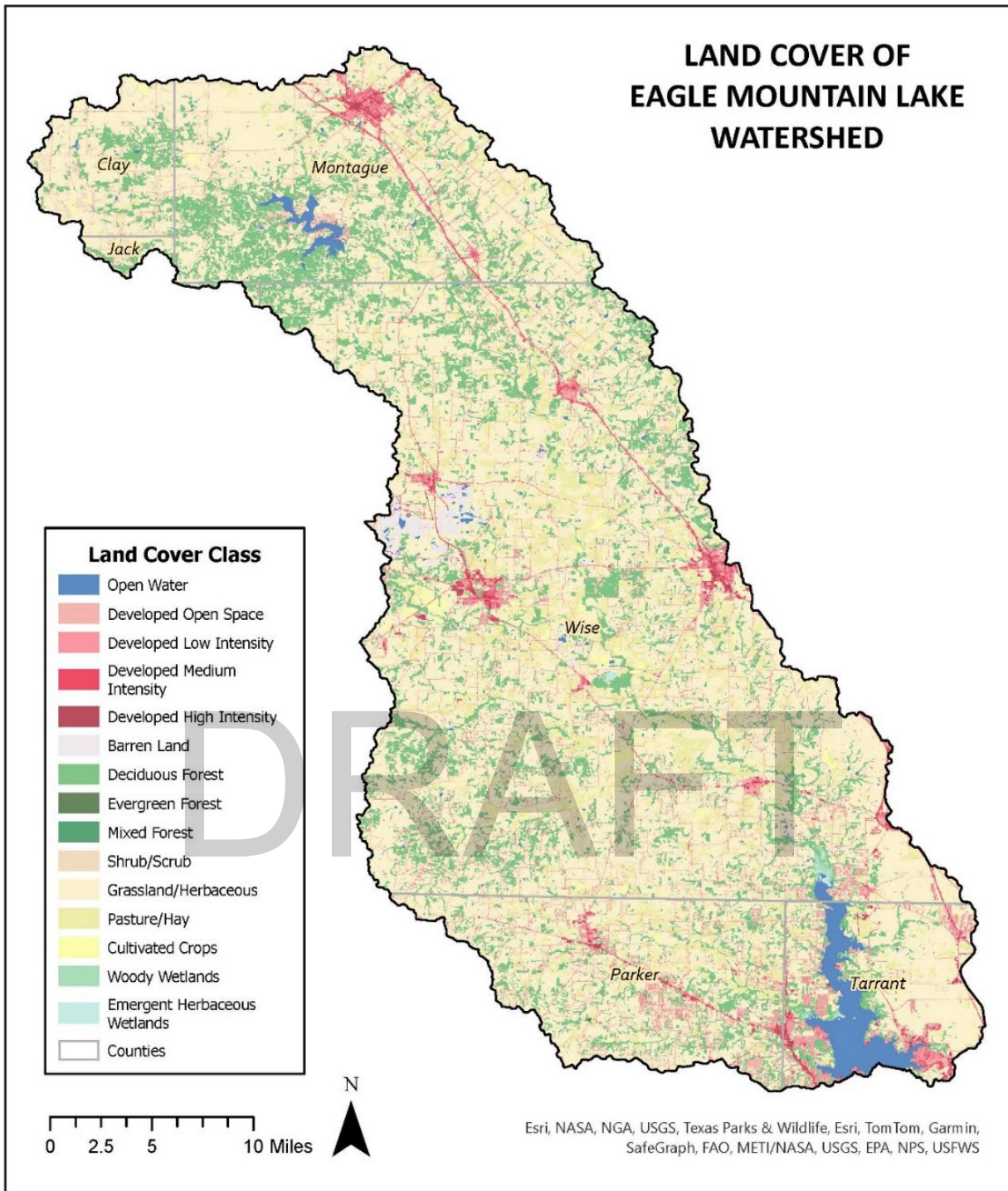
Current land cover maps classify about 57 percent of the total land cover as grassland, 8 percent as pasture and hay, and just 2 percent in cultivated crops (Table 2-2). Agricultural production is the dominant land use in the EML watershed and is a leading driver of water quality in the watershed. Grazeable land is defined by default to include NLCD land cover types of hay/pasture, grassland/herbaceous, and shrub/scrub.

Table 2-2 Land cover types in the EML watershed

LULC Category	Acres	% Total Area
---------------	-------	--------------

	Riparian	Upland		Total
Barren land (Rock/Sand/Clay)	93	3,357	3,450	0.6%
Cultivated Crops	755	10,116	10,871	2.0%
Deciduous Forest	8,087	77,796	85,883	15.6%
Developed, High Density	29	1,863	1,892	0.3%
Developed, Low Density	323	17,834	18,157	3.3%
Developed, Med Density	116	6,335	6,451	1.2%
Developed, Open Space	695	26,039	26,734	4.8%
Emergent Herbaceous Wetlands	558	3,810	4,368	0.8%
Evergreen Forest	8	206	214	0.0%
Grassland/Herbaceous	10,415	304,477	314,892	57.1%
Mixed Forest	10	247	257	0.0%
Open Water	2,598	10,484	13,082	2.4%
Pasture/Hay	3,397	41,370	44,767	8.1%
Shrub/Scrub	785	8,935	9,720	1.8%
Woody Wetlands	4,694	5,857	10,551	1.9%
Total Composite Acreage	32,563	518,728	551,291	100.0%
Source: National Land Cover Database (USGS, 2021)				

Although development is occurring in areas near the lake and around cities and towns, developed land cover (including roadways) makes up less than 10% of the overall watershed area. These population centers compose most of the developed land in the area, which is shown as red areas in Figure 2-3. Population densities are displayed in Figure 2-4. The EML watershed contains multiple parks, trails, and outdoor public spaces operated by various public and private entities including cities, Texas Parks and Wildlife Department (TPWD), United States Forest Service (USFS), TRWD, and land trusts. Parks, trails, and open spaces provide multiple benefits to the watershed, but will also benefit from this WPP as the plan provides BMPs to reduce negative impacts to water quality.



Land data: USGS National Land Cover Database 2021
 Figure 2-3 Land cover across the EML watershed

2.4 Ecology

The watershed is situated almost entirely within the Cross Timbers ecoregion, with a negligible portion in the far northwest portion of the watershed falling into the Central Great Plains (EPA, 1995). The Cross Timbers ecoregion

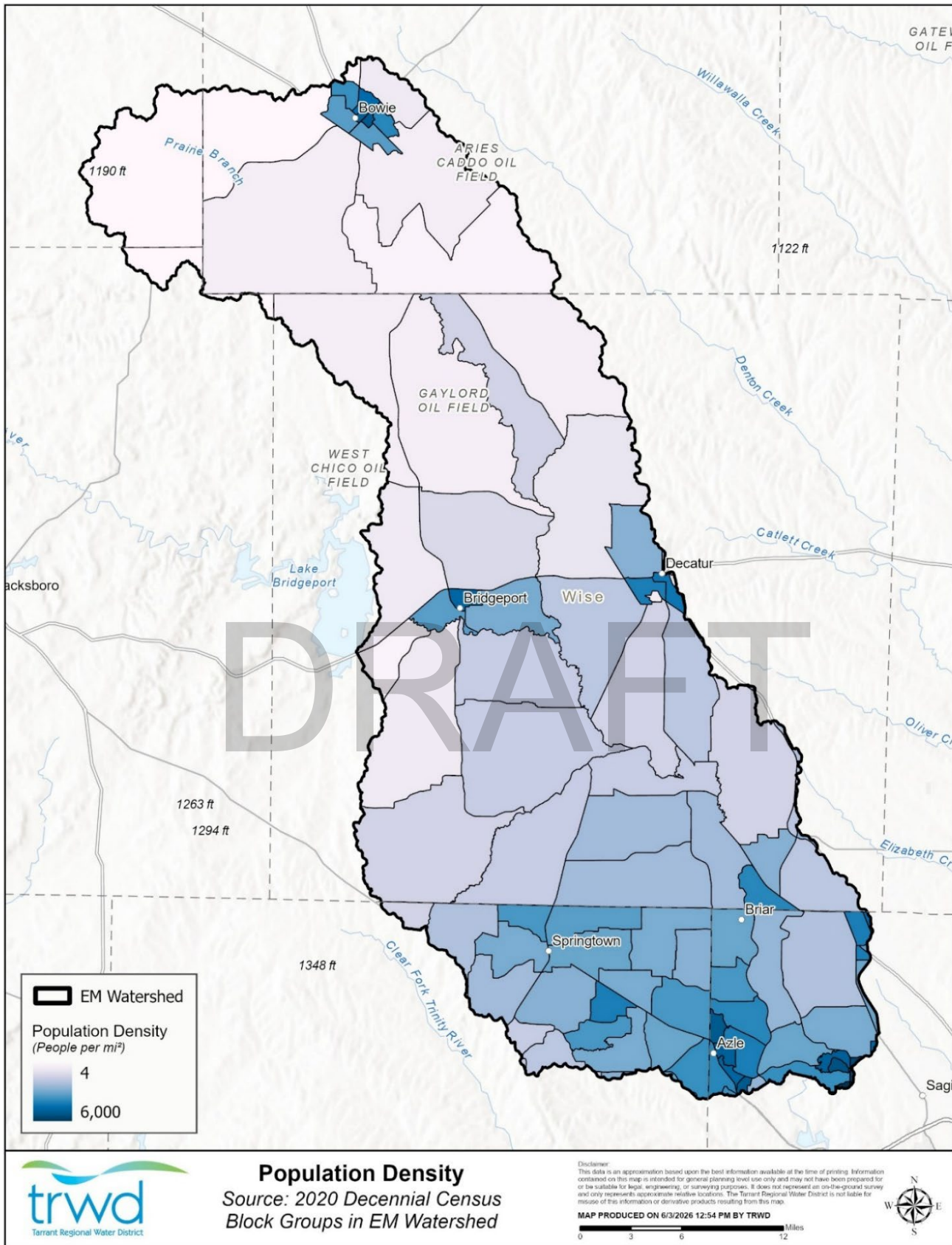


Figure 2-4 2020 Population Density in EML Watershed

includes swaths of prairie habitats with wooded habitat bands. It supports grassland species such as little

bluestem, big bluestem, and Indiangrass. Taller woody species like post oak and American elm occur in forested bands to the east and thin out to isolated trees or clusters of live oaks, Eastern red cedar, and other shrubbier species in the drier west.

The lake itself also has ecological value as habitat for aquatic life and as a food source for animals that feed there. EML has little aquatic vegetation compared to some other lakes in the region. EML is home to several sport-fishing favorites, including white, spotted, and largemouth bass, as well as crappie and catfish.

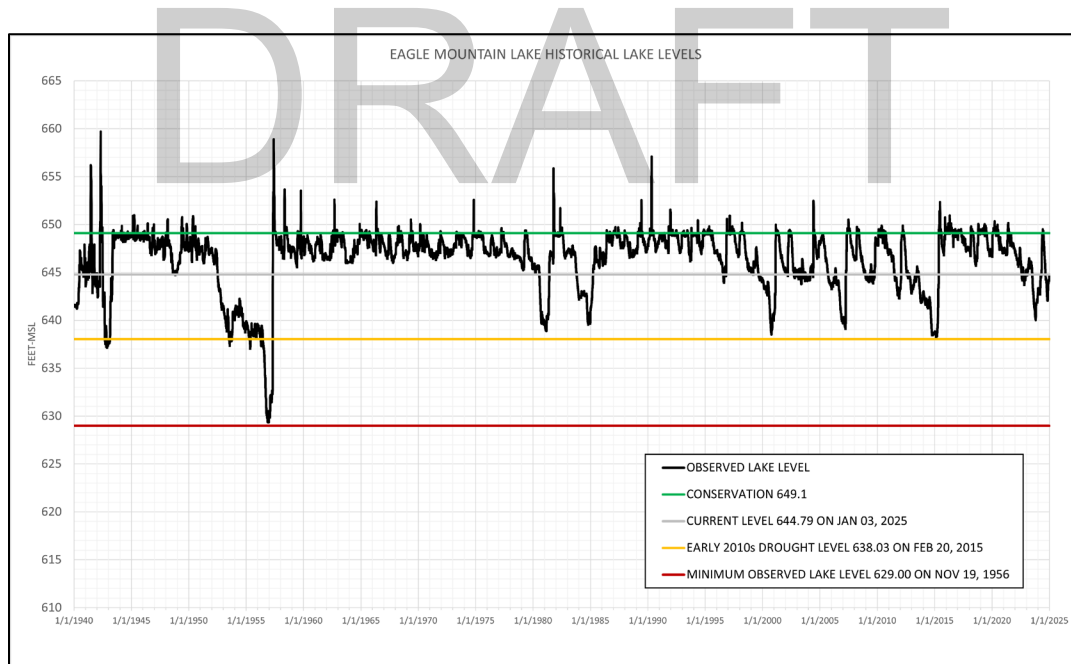
2.5 Climate

The mean annual daily temperature from the National Weather Service’s Dallas-Fort Worth regional database (National Weather Service, 2025) is 66.6° Fahrenheit (F) for the current 30-year period of record. Temperatures are generally lowest in January and highest in August. Annual precipitation is highly variable across North Texas, even within the Cross Timbers ecoregion. Totals range from about 35 inches in the eastern part of the ecoregion, which is where EML is located, to 25 inches in the western parts.

2.6 Surface Water

2.6.1 Eagle Mountain Lake

The normal conservation pool elevation for EML is 649 feet above mean sea level (MSL), and the flood pool elevation is 668 feet MSL. Historical lake elevations from 1940 to 2025 are provided in Figure 2-5. At conservation level, EML holds 179,880 acre-feet of water, according to the Texas Water Development Board (TWDB) (TWDB, 2025).



Data source: TRWD

Figure 2-4 Observed water surface elevation in EML, 1940-2025

As noted in section 2.1, EML receives flows from numerous sources: natural flow from the West Fork Trinity River and other creeks, as well as releases from Lake Bridgeport through the West Fork, and some effluent sources. In addition, EML receives water via pipeline from other reservoirs in the TRWD water supply system to balance supply system-wide and ensure that water is where it needs to be for delivery to customers. Typically, this water comes from TRWD’s larger reservoirs in the wetter eastern part of North Texas.

The lake is also used regularly for aquatic and waterfront recreation, including at two TRWD-owned and -operated parks, Twin Points Park (summer only access with an improved beachfront) and Eagle Mountain Park (year-round access and managed for ecosystem quality).

2.6.2 Lake Tributaries

EML is fed by the West Fork of the Trinity River, its tributaries, and numerous smaller creeks flowing directly into the lake. The West Fork flows into the western side of the watershed out of Lake Bridgeport. To the north, the watershed is drained by Big Sandy Creek and its tributary Brushy Creek across mostly unincorporated land. The creeks that drain directly into the lake, including notable streams like Ash Creek and Walnut Creek flowing into the western side of the reservoir and Dosier and Derrett flowing into the eastern side, drain land areas including communities ranging from small enclaves to the fringes of the Fort Worth metropolitan area.

USGS monitoring stations on Big Sandy Creek above its confluence with the West Fork Trinity River, West Fork Trinity River near Boyd, and Walnut Creek near Reno provide flow data. Other flow data exist at other stations throughout the watershed within the TCEQ Surface Water Quality Monitoring Information System (SWQMIS). This data will be used to supplement the USGS dataset, where appropriate.

3 Water Quality Assessment

The EPA requires states to develop a list, commonly called the 303(d) List, describing water bodies for which effluent limitations are not stringent enough to implement water quality standards (National Archives, 2026). States must include water bodies in or bordering the state. In accordance with the CWA, states may create and apply their own water quality standards, but these must first be approved by the EPA (EPA, 2025). In Texas, these water quality standards and the designated uses they are designed to support are defined in the Texas Water Code, in fulfillment of the requirements laid out by the CWA. Addressing waterways impaired by pollution and hazardous substances is at the heart of the CWA, which requires standards that: 1) maintain and restore biological integrity; 2) ensure that all waterbodies remain “swimmable and fishable” by protecting fish, wildlife, and recreational uses, and 3) assess the many uses of a water of the state (public water supply, agricultural, industrial, wildlife, recreation) from both a use and value standpoint.

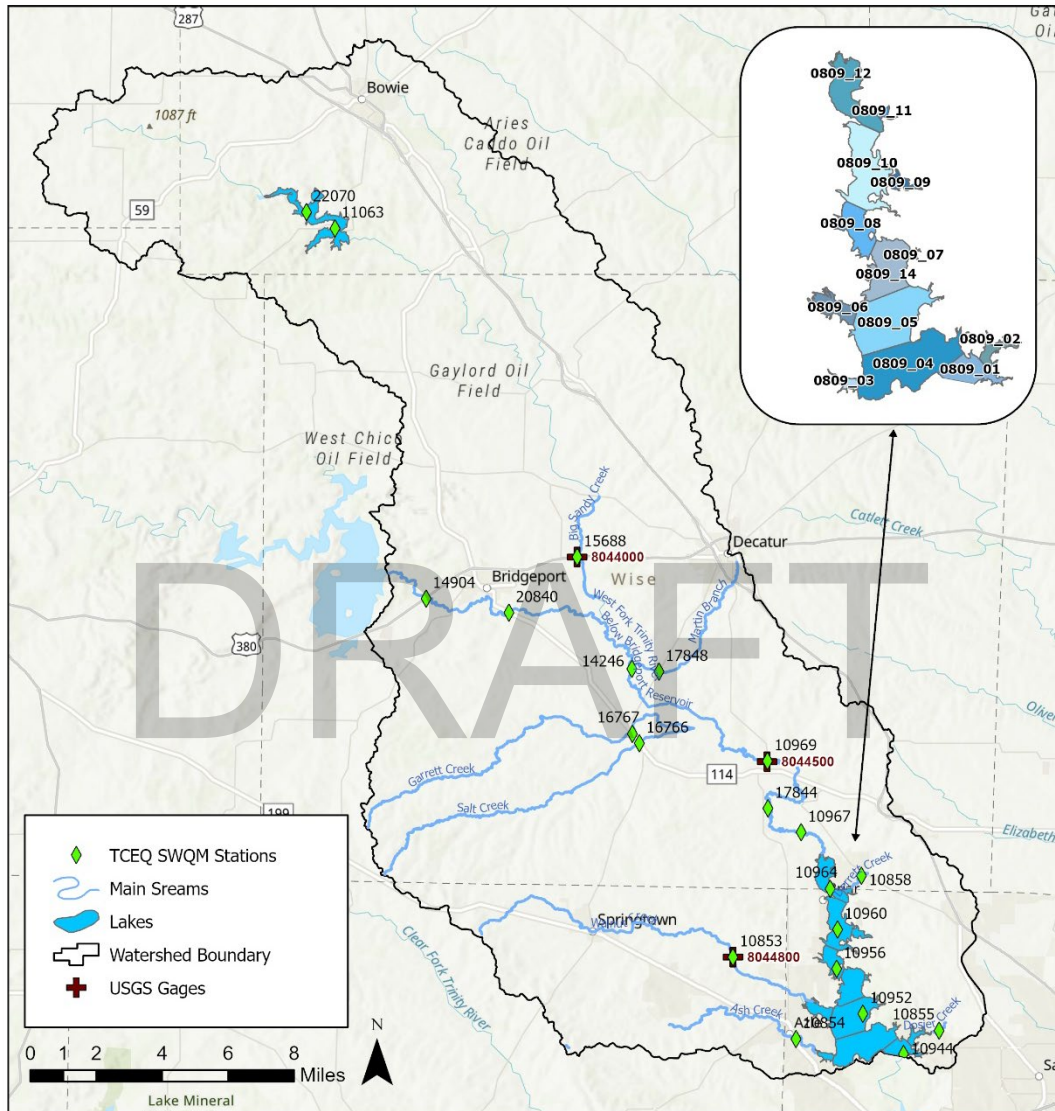
EPA also requires that states develop acceptable strategies for restoring water quality in their impaired waterbodies (National Archives, 2026). One acceptable strategy is the use of a regulatory mechanism for developing total maximum daily loads (TMDLs). TMDLs set budgets for pollutants in a water body. These budgets identify the water body’s maximum pollutant loading capacity and the reduction required to meet standards for applicable uses. TMDLs accomplish this by allocating the pollutant load budget to a variety of pollutant sources and establishing the maximum allowable loads from those sources. An alternative strategy involves the use of non-regulatory methods, such as a WPP. This allows stakeholders to identify and address water quality impairments, along with other water quality concerns in the watershed, with more autonomy in comparison to a TMDL. Due to the wider scope allowed with WPPs, established water quality goals may also include protections for unimpaired waters in addition to the goal of restoring impaired water bodies.

3.1 Water Body Assessments

In compliance with Sections 305(b) and 303(d) of the CWA, TCEQ conducts biennial assessments of Texas waterbodies, with results provided in the Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d) List (TCEQ, 2024a). A range of water quality conditions and assessment status is

expressed by a level of support established in each assessment unit for each use and parameter combination. Support status reflects when (1) data are not sufficient to allow assessment, (2) only a concern can be established from limited data, and (3) the assessment can confidently establish the level of support.

The 2024 Texas Integrated Report for the Trinity River covers a seven- to 10-year assessment period through November 2024 (TCEQ, 2024a). Water quality was evaluated according to the methods described in the 2024 *Guidance for Assessing and Reporting Surface Water Quality in Texas* (TCEQ, 2024b).



Basemap: ESRI World Street Map; Stream data source: NHD; station data: TCEQ

Figure 3-1 Assessment units, segments, and surface water quality monitoring stations in EML watershed

3.1.1 Texas Surface Water Quality Standards

TCEQ is responsible for establishing numeric and narrative criteria for water quality in the state of Texas. These criteria are described in TCEQ’s Texas Surface Water Quality Standards (TSWQS). The standards are codified in the Texas Administrative Code (TAC), Title 30, Chapter 307, hereto referred to as TAC 307 (TCEQ, 2022). The TSWQS are effective for Clean Water Act purposes when they are approved by the EPA.

3.1.1.1 Bacteria

The Primary Contact Recreation 1 (PCR1) use is evaluated using a numeric criterion of 126 colony-forming units (cfu) per 100 milliliters (mL) of water, although newer bacteria enumeration methods use Most Probable Number (MPN)/100 mL metric. The two should be considered equivalent for the purposes of this project. The presumption of a PCR1 use and associated numeric criteria are applied to all freshwater systems in Texas unless site-specific standards have been developed. This numeric criterion is compared to the geometric mean (geomean) of the surface water quality dataset, which must include a minimum of 20 samples over a seven-year period (TCEQ, 2024b). TCEQ is conducting recreational use-attainability analyses for several tributaries to Eagle Mountain Lake and may change their use to PCR2. This WPP will consider all streams as PCR1 for consistency and to manage the waterbodies to the highest possible level.

3.1.1.2 Total Dissolved Solids

Total dissolved solids (TDS) is a rudimentary measurement of all the dissolved ions within a water body, such as chloride, sulfate, and other dissolved salts. While it does provide a rough indicator of general water quality for evaluating aquatic life and public water supply uses, it cannot reveal the specific source or composition of the ions in the sample.

3.1.1.3 Other Measurements

Several additional parameters are often measured routinely to assess general use, support of aquatic life, and for public water supply use. These include dissolved oxygen (DO), water temperature, pH, chloride, and sulfate. Chloride and sulfate are components of TDS, with excessive levels of each posing similar concerns for both aquatic life and public water supply uses.

Water temperature and pH are similarly important for a variety of uses. Healthy aquatic habitats in Texas typically fall within a pH range of 6.5-9.0. The pH values can be heavily dependent on water temperature, with excessively high water temperatures (>95 °F) indicating conditions that are stressful for aquatic organisms. This association is also evident with DO being affected by both temperature and nutrient concentrations. DO is vital to the survival of fish and other aquatic fauna.

Table 3-1 includes criteria for EML and tributaries.

Table 3-1 TCEQ site-specific criteria for EML and tributaries

Parameter		0809 Eagle Mountain Reservoir	0810 West Fork Trinity River Below Bridgeport Reservoir
Chloride (Cl ⁻¹)	mg/L	75	100
Sulfate (SO ₄ ⁻²)	mg/L	75	100
Total Dissolved Solids (TDS)	mg/L	300	500
Dissolved Oxygen (DO)	mg/L	5.0*	5.0*
pH Range	SU	6.5-9.0*	6.5-9.0*
<i>E. coli</i>	#/100 mL	126*	126*
Temperature	Degrees F	94	90

3.2 Nutrient Screening Levels and Reference Criteria

Currently, no numeric criteria have been adopted for nutrients in streams in the state of Texas. Numeric criteria for chlorophyll-*a* have been adopted by TCEQ and approved by EPA for 39 of 75 reservoirs in the state; however, EML is not one of these approved reservoirs. In situations where no numeric criteria have been adopted or are in the process of being developed, controls such as narrative criteria and antidegradation considerations are often used. Despite this lack of numeric criteria, TCEQ continues to screen for parameters such as nitrogen, phosphorus, and chlorophyll-*a* as preliminary indicators for concern. To support this effort, nutrient screening levels and reference conditions are often used to compare a water body to reference values at a local, regional, or national level. Table 3-2 provides screening values from various sources. The Texas Nutrient Screening Levels are based on statistical analyses of Surface Water Quality Monitoring (SWQM) data. They are based on the 85th percentile values for each parameter in freshwater streams, tidal streams and reservoirs without numeric criteria throughout the state of Texas (TCEQ, 2024b).

The EPA Reference Criteria for streams are based on data from streams within specific ecoregion units and those for reservoirs are based upon nutrient criteria models (EPA, 2000a) (EPA, 2000b). While most EPA Reference Criteria are lower than those for state screening levels, surpassing them may not necessarily indicate a concern.

Table 3-2 TCEQ screening levels and EPA reference criteria for nutrients

Parameter		TCEQ Screening Levels		EPA Reference Criteria			
		Lake/Reservoir	Stream	Lake/Reservoir ^a	Stream		
Total Kjeldahl nitrogen (TKN)	mg/L	-	-	0.38 ^b	0.41 ^c	0.3 ^b	0.4 ^c
Nitrate (NO ₃ ⁻)	mg/L	0.37	1.95	-	-	-	-
Nitrite and nitrate, NO _x (NO ₂ ⁻ +NO ₃ ⁻)	mg/L	-	-	0.017 ^b	0.01 ^c	0.125 ^b	0.078 ^c
Total phosphorous (TP)	mg/L	0.2	0.69	0.02 ^b	0.019 ^c	0.037 ^b	0.038 ^c
Ammonia (NH ₃)	mg/L	0.11	0.33	-	-	-	-
Chlorophyll- <i>a</i>	µg/L	26.7	14.1	5.18 ^b	2.875 ^c	0.93 ^b	1.238 ^c
(a) These numeric nutrient criteria from 2000/2001 have been replaced by criterion models to assist states in defining ambient water quality concentrations to protect against adverse effects to aquatic life and human health (EPA, 2021). The 2000/2001 numbers are included for reference.							
(b) Reference conditions for aggregate Ecoregion IX waterbodies, upper 25th percentile of data from all seasons, 1990-1999.							
(c) Reference conditions for level III Ecoregion 29 waterbodies, upper 25th percentile of data from all seasons.							

3.3 Segment Impairments and Concerns

When a sufficient number of elevated surface water quality measurements cause the water body to surpass the water quality criteria (min, max, average, or geomean), the waterbody is considered impaired and may not be supportive of one or more of its designated uses. The most recent assessment period covered by the 2024 Texas Integrated Report identified the impairments and concerns detailed in Table 3-3 and Figure 3-2.

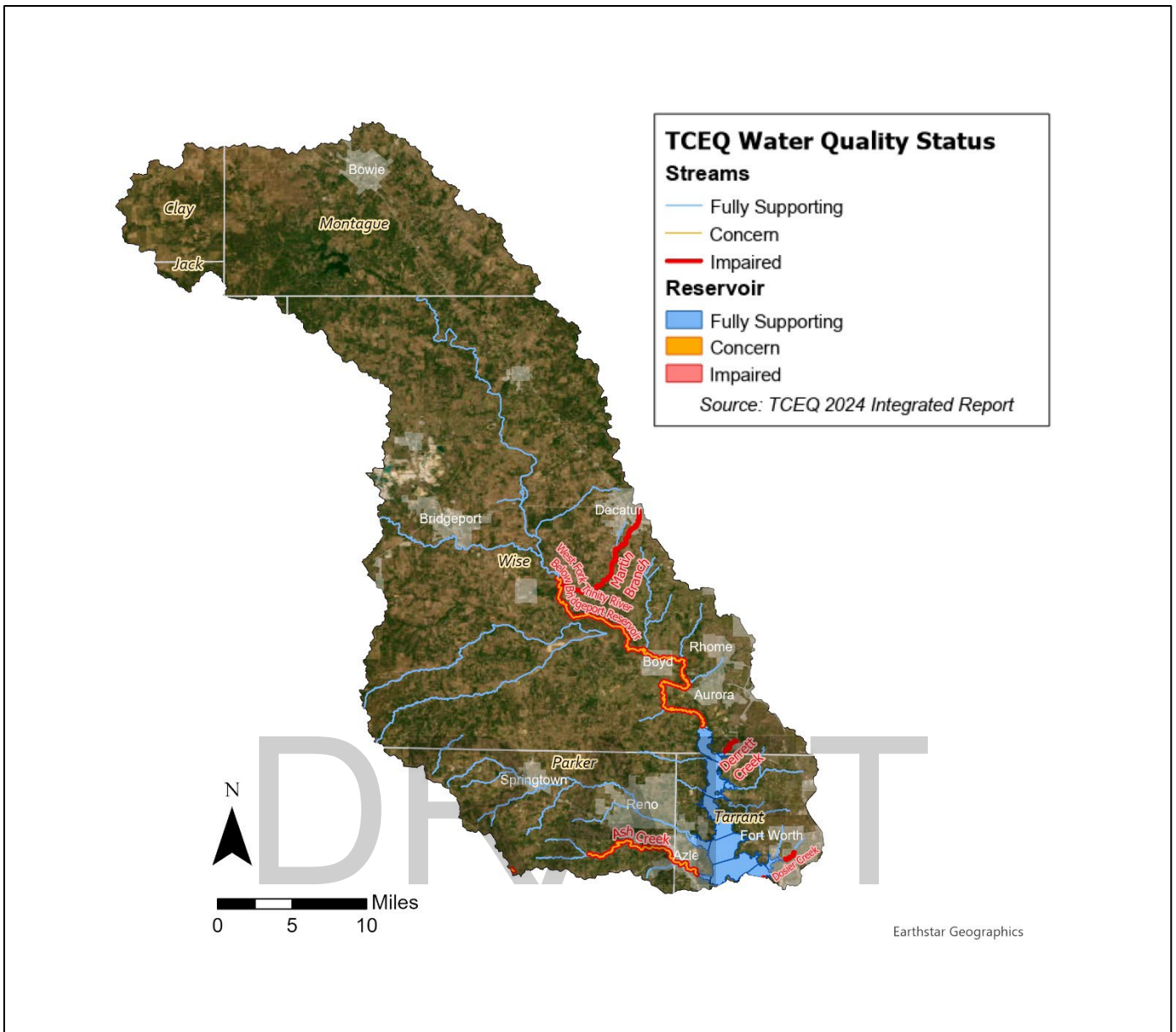
If more than 20 percent of a water body’s samples from the assessment period exceed a screening level, then on average, it will experience higher pollutant concentrations than 85 percent of the streams in Texas and thus is considered to have a concern for elevated nutrients.

Table 3-3 2024 Integrated Report impairments and concerns

Water Body*	Segment(s)	Impairments	Concerns
Eagle Mountain Lake	0809_01 - 0809_14		
Walnut Creek	0809A		
Ash Creek	0809B	Bacteria (<i>E. coli</i>)	Nitrate (NO ₃ ⁻) (screening)
Dosier Creek	0809C	Bacteria (<i>E. coli</i>)	
Derrett Creek	0809D	Bacteria (<i>E. coli</i>)	
West Fork Trinity River Below Lake Bridgeport	0810_01	Bacteria (<i>E. coli</i>)	Chlorophyll- <i>a</i> (screening)
	0810_02		
Big Sandy Creek	0810A		
Garrett Creek	0810B		
Martin Branch	0810C	Bacteria (<i>E. coli</i>)	
Salt Creek	0810D		

* TCEQ is conducting Recreational Use-Attainability Analyses on several tributaries in the EML watershed. The outcome may affect future determinations of impairments.

DRAFT



Basemap: ESRI World Imagery; Stream data source: NHD; AU source: TCEQ
 Figure 3-2 Impaired segments and water quality concerns in the EML watershed

4 Potential Pollutant Sources

Pollutants from human activities and natural processes can be grouped into two categories, based on their origin:

Point source pollution is a discharge that can be traced back to a single point of origin. This can be a pipe, drain, or outfall and is typically discharged directly into a waterway. Because point sources are tied to human activity, they regularly contribute flow to a system regardless of the native flow conditions. In fact, point sources may constitute most or all the baseflow in some systems, particularly in urban watersheds where large or regional wastewater treatment facilities (WWTFs) provide consistent effluent flows.

Point source pollution is regulated through a permitting process; in Texas this is administered through TCEQ. One example of a permitted discharge is effluent from WWTFs. Here, the treated effluent must remain within specific

pollutant limits so that the facility’s impact on the receiving water body is minimized. Other examples of point source include wastewater infrastructure issues, like a break in a wastewater pipeline, or a sanitary sewer overflow (SSO). These sources bypass WWTFs and can have either short-term or long-term effects on water quality depending on when they’re identified and how quickly they’re addressed.

Nonpoint source pollution, by contrast, tends to be more challenging to manage since it cannot be traced back to a single point of origin. Instead, pollutants that are dispersed over the land (either through human activity or natural processes) are carried into waterways with runoff from storm events. Several factors may influence the types and amounts of pollutants that ultimately end up in a waterway, but they are primarily dependent on land use and land cover (LULC). Sources of pollutants may include excess agricultural or residential fertilizers, fluids from leaking vehicles, pet waste from yards or urban public areas, or waste from wildlife, livestock, and feral hogs.

When considering the impacts of pollutant sources, it is important to account for the source’s proximity to waterways. This is accomplished by estimating the percentage of the *E. coli* load that could realistically be transported from source to waterways through surface water or groundwater transport. In the EML WPP, weighted percentages for each source location were applied using the Spatially Explicit Load Enrichment Calculation Tool (SELECT). This approach weights riparian zones more heavily than those in upland zones to account for the increased impacts from sources in riparian zones. For additional information on SELECT and how source loads were calculated for both point and nonpoint sources, see Appendix C.

4.1 Prioritizing Pollutant Sources

Likely pollutant sources in the watershed were identified through historical data review, water quality monitoring, and source identification/load calculation efforts. These results were interpreted and refined with the help of watershed stakeholders (Table 4-1). Further, sedimentation and flooding were also considered a water quality concern due to future growth, expansion, and development in the watershed but could not be included in the modeling; flooding is outside the scope of this WPP. Stakeholders spent substantial time and effort considering these situations as they sorted through their collective priorities. They used a tiered approach to group priorities of similar urgency, based on perceived need, probability of success, and economic advantages.

Table 4-1 Summary of potential pollutant sources and management priorities

Source	Management Practices/Behavior Concerns	Potential Impacts	Rank ¹	Priority ²
Livestock (Cattle, Sheep, Goats)	Increased runoff from overgrazing of upland areas	1. Direct or indirect bacterial loading; 2. Loss of natural pollutant mitigation	1	1 st tier
	Manure transported to water body by runoff			
	Direct manure deposition in water body			
	Riparian buffer degradation/trampling			
OSSFs	Straightpipes" and other illegal wastewater discharges	1. Direct or indirect loading of untreated wastewater (bacteria, nutrients); 2. Groundwater quality degradation	2	1 st tier
	Improperly treated aerobic effluent applied to land			
	Failure due to age, design, or lack of maintenance			
	Improper disposal of pet waste		3	2 nd tier

Pets (Dogs and Cats)	Disease transmission and public safety	1. Indirect bacterial loading from yards, parks, and pet facilities; 2. Spread of disease		
	Lack of education on impacts of proper disposal			
Wildlife	Manure transported to water body by runoff	1. Direct or indirect bacterial loading; 2. Loss of natural pollutant mitigation	4	3 rd tier
	Direct manure deposition in water body			
	Riparian buffer degradation/trampling			
Feral Hogs	Manure transported to water body by runoff	1. Direct or indirect bacterial loading; 2. Loss of natural pollutant mitigation; 3. Loss of biodiversity	*	3 rd tier
	Direct manure deposition in water body			
	Displacement/predation of native species			
	Riparian buffer degradation/trampling			
WWTF	Failure due to age, stormwater inflow and infiltration, or lack of maintenance	1. Direct or indirect loading of untreated wastewater (bacteria, nutrients)	*	1 st tier
	Overloads from population growth or illicit connections			
Yard Waste and Residue	Improper disposal of yard waste/clippings	1. Direct or indirect bacterial, nutrient, and hazardous chemical loading; 2. Impacts to aquatic wildlife	-	2 nd tier
	Excessive fertilizer, herbicide, or pesticide application			
SSOs	Failure due to age, stormwater inflow and infiltration, erosion, or construction damage	1. Direct or indirect bacterial loading; 2. Human health hazards	-	1 st tier
Illegal Dumping	Household/construction waste disposal in/near water body	1. Direct or indirect bacterial, nutrient, and hazardous chemical loading; 2. Human health hazards; 3. Flow obstruction/alteration	-	2 nd tier
	Animal carcass/hunting remains disposal in/near water body			
	Disposal of large items (furniture, appliances, tires, vehicles)			
Sediment and Flooding	Sediment loading and increased flooding in developing areas	1. Impact to aquatic life; 2. Impact to water supply capacity and flood capacity in EML; 3. Direct or indirect bacteria and nutrient loading from runoff/erosion events; 4. Human health and safety hazard; 5. Infrastructure damage	-	2 nd tier
	Loss of natural areas/green spaces			

(1) Relative impact on *E. coli* bacterial load as ranked by SELECT analysis. Sources noted by * were accounted for but represented a negligible load. Sources noted by - are not accounted for in SELECT.

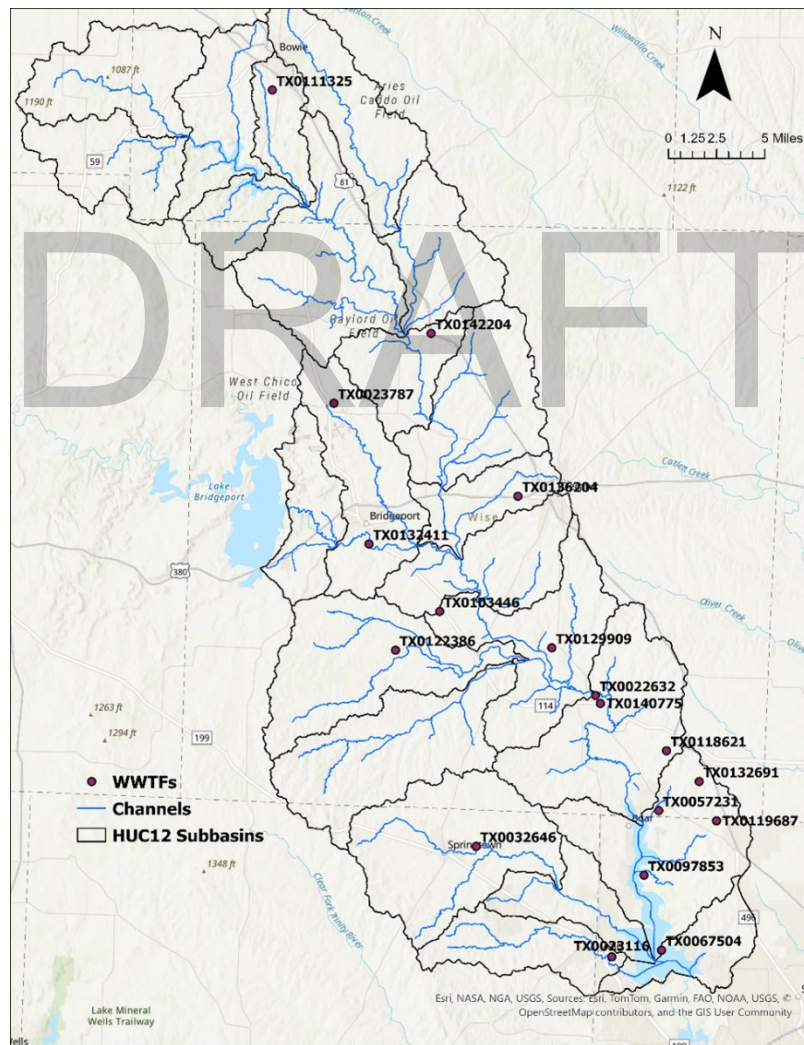
(2) Water quality restoration priorities as identified by the stakeholder group, organized into 1st, 2nd, and 3rd tier priority.

4.2 Point Source Pollution

4.2.1 Permitted Discharges

Wastewater facility outfall data was obtained from the Discharge Monitoring Report (DMR) database via EPA's Enforcement and Compliance History Online (ECHO) website (EPA, n.d.); see Appendix C for additional information. Thirteen total wastewater discharges exist in the EML watershed; four are inactive. Details about the active WWTFs and any associated permit limit exceedances for water quality parameters are provided in Table 4-2.

The significance of the WWTF and wastewater treatment plant (WWTP) locations in this watershed is EML and some of its tributaries contain some portion of wastewater effluent constituting their baseflow throughout the year (Figure 4-1). Stormwater inflow and infiltration (I/I) issues associated with the wastewater infrastructure connected to the WWTF can be the most common cause of elevated *E. coli* concentrations leaving facilities above the permitted effluent limits. This exceedance of treatment capacity can also be caused by unknown illicit connections delivering inconsistent additional flows, or from continued urbanization stressing the WWTF beyond its original design capacity.



Water body data source: TCEQ; outfall data: TCEQ
Figure 4-1 Wastewater discharges to EML watershed

Table 4-2 Compliance history for active WWTFs in the EML watershed

NPDES Permit	Facility Name	Receiving Water body	Flow (daily average, MGD)		<i>E. coli</i> (daily average, MPN/100 mL)		Number of Exceedances ⁽³⁾				Violations in Reporting Period ⁴	
			Permitted	Reported ⁽¹⁾	Permitted	Reported ⁽²⁾	<i>E. coli</i>	NH ₃	BOD	TSS	Violation Identified	Significant/ Noncompliance
TX0023787	City of Chico	DRY CREEK, WEST FORK TRINITY RIVER	0.15	0.056	126	16.541	1	50	2	12	yes	yes
TX0132411	City of Bridgeport WWTP	WEST FORK TRINITY RIVER	0.84	0.525	126	3.811	0	13	16	0	yes	yes
TX0111325	City of Bowie WWTP	UNNAMED TRIB JONES CREEK	1.25	0.651	126	1.004	0	1	0	0	yes	no
TX0142204	City of Alvord WWTP ⁵	UNNAMED DITCH; TRIBUTARY OF ELM CREEK	0.112	0.050	126	2.074	0	0	0	11	yes	yes
TX0136204	City of Decatur Water Plant	UNNAMED BRANCH; WAGGONER BRANCH	0.1	0.088	126	-	-	-	0	0	no	no
TX0122386	Camp Summit	WEST FORK TRINITY RIVER	0.00802	0.002	126	6.538*	0	0	0	0	no	no
TX0103446	Paradise ISD WWTP	WEST FORK TRINITY RIVER	0.03	0.009	126	32.658*	1	-	0	5	yes	yes
TX0129909	Ivy Hills WWTP	WEST FORK TRINITY RIVER	0	-	126	-	-	-	-	-	no	no
TX0022632	City of Boyd WWTP	WEST FORK TRINITY RIVER	0.24	0.089	126	301.547	11	-	6	11	yes	yes
TX0118621	Westside WWTP	WEST FORK TRINITY RIVER	0.15	0.083	126	7.718	0	20	0	7	yes	yes

TX0140775	Fairview Meadows WWTP ⁶	FAIRVIEW MEADOWS WTF	0.2285	0.042	126	7.944	0	1	0	0	yes	no
TX0057231	City of Newark WWTP	DERRETT CREEK	0.15	0.060	126	1.000	0	0	1	0	yes	no
TX0097853	Eagle Mountain Rv Park WWTP	EAGLE MOUNTAIN RESERVIOR	0.006	0.003	126	79.692	1	-	0	0	yes	no
TX0119687	Chisholm Springs WWTP	UNNAMED TRIBUTARY; INDIAN CREEK	0.225	0.119	126	22.428	3	12	5	7	yes	yes
TX0132691	Rvr Water Reclamation & Amp Reuse Facility ⁷	EAGLE MOUNTAIN RESERVOIR	0.15	0.058	126	61.749	3	13	0	6	yes	yes
TX0032646	City of Springtown WWTP	WALNUT CREEK	0.48	0.290	126	70.503	1	0	0	1	yes	no
TX0023116	Ash Creek WWTP ⁸	REYNOLDS BRANCH, ASH CREEK	1.44	1.325	126	1.156	0	0	0	0	yes	no
TX0067504	Fort Worth Boat Club WWTP	EAGLE MOUNTAIN RESERVOIR	0.0158	0.003	126	1.000*	0	-	0	0	no	no

(1) 3-year average based on daily average measurements from EPA data, 04/30/2022 - 04/30/2025.

(2) 3-year geomean based on daily average measurements from EPA data, 04/30/2022 - 04/30/2025.

(3) Exceedances based on daily average from available EPA data 04/01/2022 - 06/01/2025.

(4) Occurrence of Facility Statuses from EPA data, 04/01/2022 - 06/01/2025. Violation Identified is less serious than Significant Violation/Category I Noncompliance.

(5) Data for this facility from EPA data 09/01/2022 - 06/01/2025

(6) Newly permitted facility, data from EPA 10/01/2024 - 06/01/2025

(7) Data begins at 12/31/2023.

(8) Flow data recorded by EPA as "annual average" on monthly basis; flagged for potential coding issue.

*Daily averages reported on quarterly rather than monthly basis.

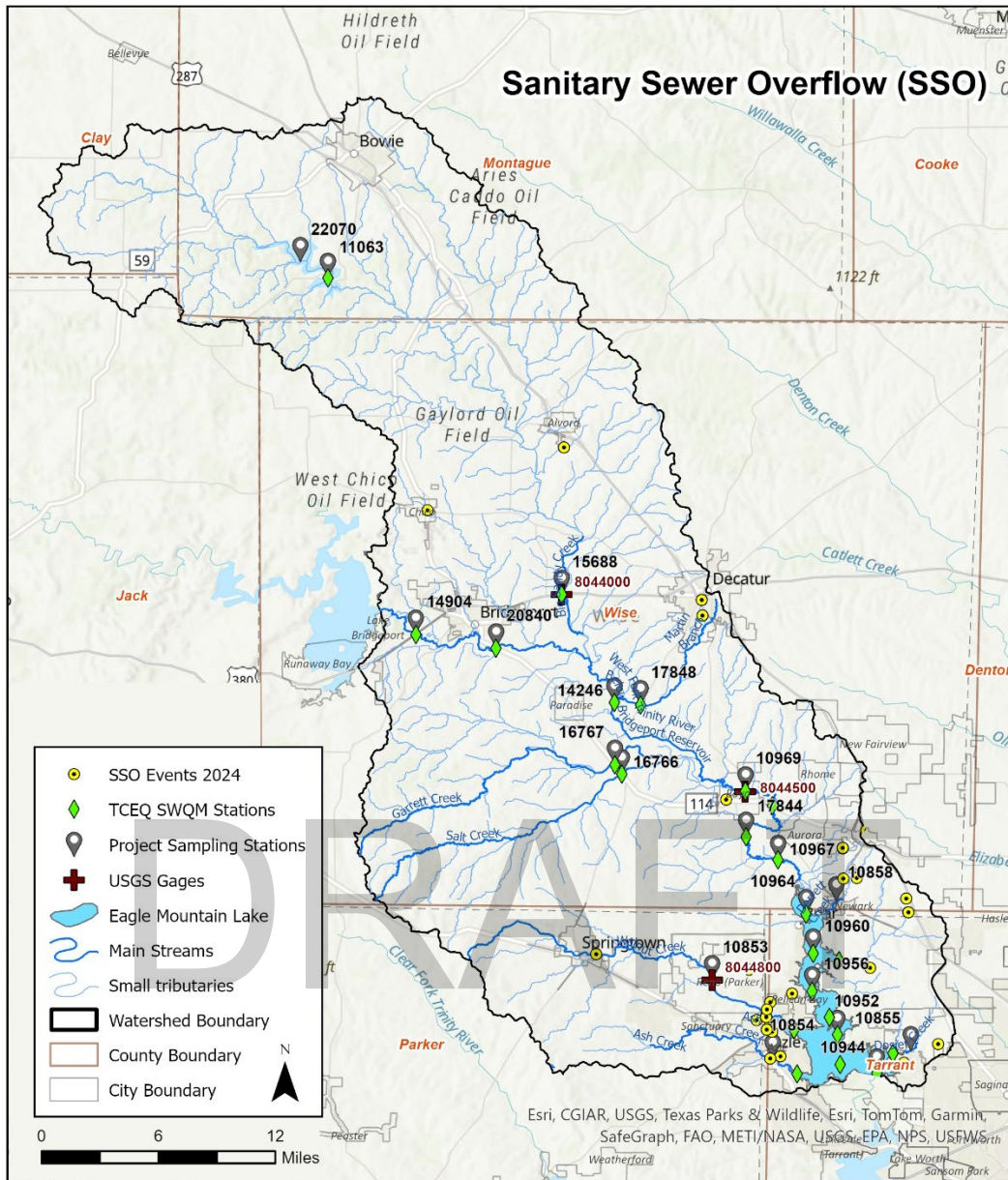
4.2.2 Sanitary Sewer Overflows

Being components of the wastewater conveyance system, many of the same issues encountered at WWTFs are caused by issues with the pipes and other infrastructure carrying wastewater from homes and businesses. SSOs occur when pipes are blocked, broken, or when deteriorating pipes and connections allow stormwater or groundwater infiltration into the wastewater system. These inflow and infiltration (I&I) issues often result in combined stormwater/wastewater volumes that exceed the design capacity of the pipes, causing backups that will eventually find a relief point, often a manhole cover or other surface access. From this relief point, untreated sewage can potentially reach streams and lakes if not contained properly or in a timely manner. For this reason, proximity of the SSO site to a water body must be accounted for when analyzing potential impacts. Older neighborhoods tend to be more prone to SSOs, as they tend to be serviced by older infrastructure that may be subject to the deterioration or design capacity issues mentioned previously. In addition, continued development can overshoot design capacity. In general, SSOs are combined with pet waste nonpoint sources and used as surrogates for urban runoff when calculating pollutant loads from urban sources.

The compendium of past reports of SSO occurrences was used to illustrate locations (Figure 4-2), overflow amount, cause of SSOs, and potentially determine impacts of SSOs on the day of occurrence. BMPs for SSOs require infrastructure assessments and proper maintenance that are usually built into a municipal separate storm sewer system (MS4) program as well as part of operations for any community with infrastructure.

4.2.3 Urban Stormwater Runoff

Impervious surfaces such as rooftops, roadways, driveways, and sidewalks block rainfall from naturally soaking into the ground. Excess water and pollutants, or runoff water, are quickly transported to nearby streams through a system of ditches, channels, and pipes. Increased runoff means that larger amounts of water enter streams more quickly, which can cause stream erosion. Construction for urban development contributes excess sediment, transporting pollutants through stormwater runoff. Stormwater conveyance systems in areas with concentrated populations are regulated by TCEQ under the MS4 program. The goal of the program is to reduce the amount of pollutants washing from urban and developed areas into downstream waterbodies. Some jurisdictions and entities in the EML watershed do fall within these concentrated population areas where MS4 programs must be permitted.



Basemap: ESRI World Street Map; Stream data source: National Hydrography Dataset; station data: TCEQ
 Figure 4-2 Reported SSO events in the EML watershed 2024

4.2.4 Other Point Sources

4.2.4.1 Water Wells

Chemical or pollutant spills that occur in or near any water well can provide a direct route for pollutants to reach aquifers, bypassing the soil and rock substrata that usually provide some measure of remediation in natural systems. Plugged or destroyed wells, along with abandoned or otherwise unmaintained wells, are of particular interest. These wells are usually not closely monitored and potential contamination may go unnoticed for long periods of time. Well construction standards, along with regulation of abandoned or deteriorated water wells, are under the jurisdiction of the Texas Department of Licensing and Regulation. Complaints for such wells can be reported to the Texas Department of Licensing and Regulation through their website.

4.2.4.2 Underground Storage Tanks

Underground storage tanks are often used to store petroleum products and other hazardous liquids, most notably at gas stations. Most underground storage tanks are made of common steel and thus are subject to oxidation and rust over time. Excessive corrosion may lead to cracks or holes in the tank, which can result in groundwater contamination. TCEQ is the regulatory entity and current custodian of records related to leaking underground storage tanks in Texas.

4.2.4.3 Oil & Gas Exploration

Although several traditional oil and gas wells exist in the watershed, continued development of the Barnett Shale natural gas field has resulted in expansion of hydraulic fracturing activities, sometimes near the lake. Along with groundwater concerns, pad site construction may require a clearing of vegetation that can lead to increased runoff. If these pad sites are located near riparian buffer zones, the increased runoff may deliver higher pollutant loads to nearby waterways. The most recent EPA report on hydraulic fracturing (EPA, 2016) recommended that stakeholders focus on activities that are more likely than others to result in water supply impacts, including but not limited to:

- Water withdrawals in areas where groundwater is already scarce;
- Surface spills of chemicals or process water that may reach groundwater sources;
- Fluid injection into inadequately designed wells that allow for leakage into groundwater;
- Discharge of inadequately treated process water into surface water; or
- Disposal or storage of process water in unlined or improperly lined pits, allowing for groundwater contamination.

The Railroad Commission of Texas (RRC) has primary jurisdiction over drilling, exploration, and production activities related to oil and gas in the state of Texas. However, TCEQ does share some of the responsibilities for regulation and operation of oil and gas wells in upstream operations, particularly those that affect air/water quality, surface water management, and waste management (TCEQ, 2023).

4.3 Nonpoint Source Pollution

Unless explicitly stated for each source, the contribution weights for the riparian buffer (90 percent contribution) and upland areas (50 percent contribution) mentioned previously are applied to the nonpoint sources analyzed for this project.

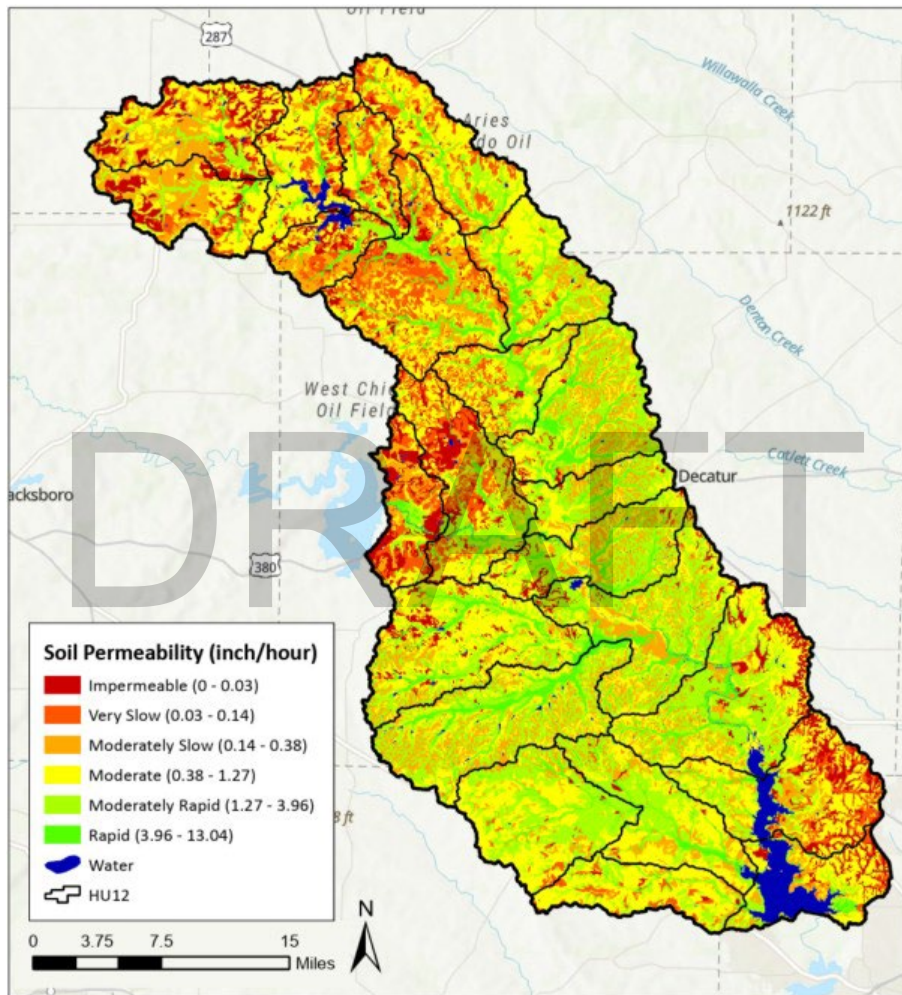
4.3.1 On-Site Sewage Facilities

The EML watershed is large and primarily rural, with widespread use of on-site sewage facilities (OSSFs) for wastewater treatment. When not functioning properly, OSSFs can become sources of pollution for *E. coli*, nutrients, and solids, both in groundwater and surface water bodies. A variety of causes can be to blame for reduced performance or malfunctions, including improper use, design/installation, lack of maintenance, unsuitable soil types, age of the system, and proximity to other systems.

Since 1989, Authorized Agents – including counties, some cities, and TRWD – with agreements with TCEQ are responsible for maintaining records of permitted OSSFs. These must be inspected to ensure compliance with state regulations. Many of the systems in the watershed installed prior to 1989 are not tied to a current permit, indicating that they have not been recently inspected and/or may have been installed improperly or in areas where soils are less suitable for effluent loads (Figure 4-3) and thus have a higher likelihood for failure. Non-permitted systems are considered to contribute severely to OSSF failure rate (Reed, Stowe & Yanke, LLC, 2001).

However, it is expected that even some permitted systems are currently in a state of failure, usually due to neglect or lack of homeowner knowledge regarding OSSF operation. Estimated failure rate in the EML watershed according to septic drainfield limitation class was assumed to be 15 percent (Appendix C). Proximity to a water body and proximity to other systems can negatively affect OSSF performance, particularly in areas where systems are densely spaced. In these situations, multiple failures are possible if one drain field exceeds its capacity and impacts adjacent fields, increasing the likelihood for drain field contaminants reaching waterbodies.

Based on estimates, there are approximately 11,762 permitted OSSFs within the watershed and 15,004 OSSFs constructed before permitting requirements were implemented. See Appendix C for details about how septic numbers were estimated across the EML watershed. Due to limitations in the available geographically explicit data, a 100% modeling contribution was assumed from all OSSFs regardless of riparian buffer.



Basemap: ESRI World Street Map; Soil permeability: USGS SSURGO
Figure 4-3 Soil permeability across EML watershed

4.3.2 Pet Waste

Feces from pets may also be a source of *E. coli* and nutrient loading to waterbodies via stormwater runoff. This may include dogs as well as cats that defecate outdoors, such as feral and barn cats. As with any NPS, the severity of the contamination from an area is heavily influenced by the presence of impermeable soils (Figure 4-3) and increasing amounts of impervious cover (e.g., buildings, parking lots, Figure 2-3) associated with ongoing development in the watershed. These measurements are derived from human population data, so while there will be some contributions from rural areas, it is expected that urban areas will show the largest contributions.

Estimates for pets were made by extrapolating census data from the watershed and applying nationwide estimates for the number of dogs and cats per household. According to an American Veterinary Medical Association (AVMA) survey, in 2025 approximately 42.6 percent of U.S. households owned dogs and 32.6 percent owned cats. The survey estimated 1.6 dogs per household with dogs and 1.8 cats per household with cats (AVMA, 2025).

4.3.3 Agricultural Activities

Free-roaming livestock can also be a contributor to nonpoint source *E. coli* loads, especially if they have direct access to waterbodies where they can defecate into or near them. However, poor land management practices can also affect the amount of manure *E. coli* that reaches waterbodies from upland areas by stormwater flows. If pastures are overgrazed, improperly tilled, or otherwise mismanaged, runoff potential increases, which can deliver larger loads of *E. coli*, nutrients, and pesticides/herbicides to waterbodies.

Initially, stocking rates for cattle, sheep/goats, and horses (Table 4-3), were estimated using data from TPWD, Texas A&M University, or the 2022 Census of Agriculture from US Department of Agriculture’s (USDA’s) National Agricultural Statistics Survey (NASS). Grazing was applied to all grassland and hay/pasture land cover types in both the SELECT tool and the tools Soil and Water Assessment Tool (SWAT) and Hydrologic and Water Quality System (HAWQS) (Appendix C). Cattle population estimates were compared to USDA stocking rate recommendations, alongside technical guidance from local NRCS partners in the watershed. The most common livestock animal in the EML watershed is cattle, with approximately 50,000 head estimated across the watershed based on the 2022 census data (USDA, 2024).

Table 4-3 Estimated animal stocking rates in EML watershed

Animal	Stocking Rate (acre/head)
Cattle	7.4
Sheep	173.2
Goats	110.5
Horses	123.2
Feral Hogs	50
Deer	39.4

In addition to *E. coli* and nutrient inputs from grazing livestock, production agriculture may also contribute other types of nonpoint source pollution to waterways, including nutrients from fertilizers, herbicides, and pesticides.

4.3.4 Wildlife

Wild animals tend to spend much of their life moving through riparian areas, so it is important to account for them as a pollutant source. Deer density data were sourced from TPWD’s 2006 ecoregion-based estimates and applied to shrub/scrub, grasslands/herbaceous, hay/pasture, cultivated crops, forest, and wetland areas within the watershed. Feral hog density was based on planning-level estimates from Texas A&M AgriLife Extension and distributed across the same land use categories (Table 4-3). Feral hogs are classified as exotic livestock by Texas Agriculture Code (State of Texas, 2003). However, they are treated as wildlife in the WPP because feral hog management strategies for water quality have more similarities to wildlife management strategies than livestock management strategies.

4.3.5 Other Nonpoint Source Pollutants

Sediment is a pollutant source concern as well as an impact to the water supply and flood control capacity of EML. Land management practices that decrease root biomass or leave more soil surface exposed increase erosion potential and thus, sedimentation of EML. Future development will lead to increased impervious surfaces and shallow-rooted turfgrasses, in turn speeding up runoff velocities that will increase erosion. Sedimentation in the streams and the lake will impact aquatic life, harbor bacteria, affect recreational lake users, and impact the water supply capacity in EML. A sedimentation study conducted in 2018 by TWDB (Figure 4-4) showed that the lake had lost 25,913 acre-feet of storage capacity since its impoundment in 1934 (TWDB, 2019). Anecdotal evidence from stakeholders indicates that this is an ongoing issue in many areas of the lake.

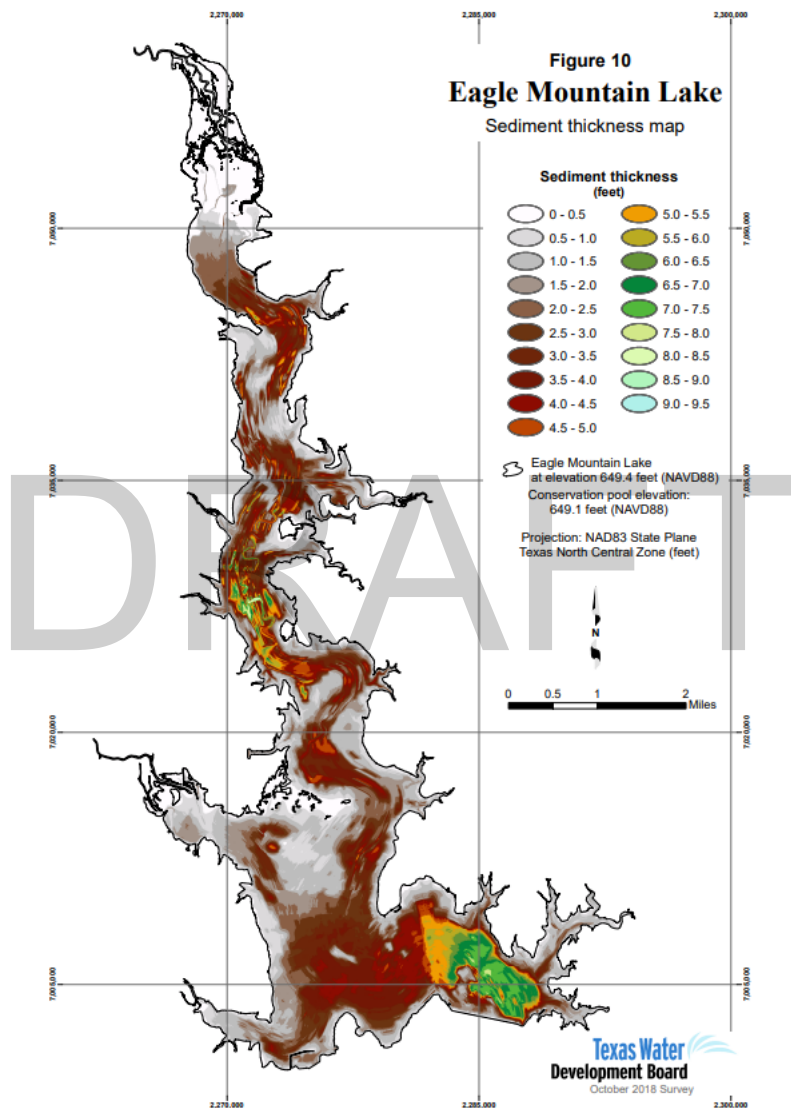


Figure 4-4 EML sediment thickness map 2018

5 Pollutant Source Assessment

No one method of analysis is sufficiently accurate to provide a clear picture of the water quality impacts in a watershed. To ensure that a thorough characterization of the watershed's status was achieved, pollutant loadings were assessed using a variety of methods utilizing both empirical data and estimations based on literature values from multiple sources. The methods used in this study included routine and flow-biased water quality data analysis, the Load Estimation program (LOADEST) Load Duration Curve (LDC) analysis based on collected data for multiple pollutants, Flow Duration Curves (FDCs), spatial analysis of potential *E. coli* sources using the SELECT analysis, and hydrological modeling using SWAT.

SWAT has been the most widely used watershed-scale hydrology/water quality model in the world for over 20 years. The standard version of SWAT requires detailed inputs related to weather, climate, topography, soils, land use, water infrastructure, and point-sources of pollution. As a result, it can be difficult to build and calibrate SWAT models for specific watersheds and river basins. To overcome this problem, the Texas A&M University Spatial Sciences Laboratory has worked closely with the EPA to develop the HAWQS.

HAWQS is a free, open-source, online platform using a point-and-click interface and powerful output visualization tools. HAWQS provides all input data (soils, weather, land use, topography, water bodies, point-sources of pollution, etc.) and graphical input/output interfaces for the contiguous 48 states. It requires no specialized software, hardware, or training in statistics or geographic information systems (GIS). The HAWQS platform allows users to customize SWAT inputs to create scenarios based on BMPs by modifying agricultural management, operations management, and conservation practices. Additional information about this analysis is provided in Appendix B.

Teague et al. developed SELECT to identify and estimate potential pathogen loads resulting from various fecal sources in watersheds (Teague et al, 2009). For EML, Texas specific databases were used based on stakeholder input. While the methodology used was from SELECT, this is now referred to as SELECT-TX. This tool can simulate potential pathogen loading in a watershed for various management scenarios based on user defined inputs. Inputs that can be modified based on BMPs include pet density, livestock and wildlife stocking rates, sources of OSSF numbers and amount of wastewater, daily *E. coli* and discharge values for WWTFs, and fecal coliform production rates and conversion to *E. coli* factors. Additional information about this analysis is provided in Appendix C. It should be noted that SELECT was designed specifically for calculating loads from *E. coli* sources and thus cannot be used to calculate loads from other pollutants of interest to stakeholders, despite their relative importance.

5.1 Water Quality Monitoring

TRWD conducts routine water quality monitoring in EML and its tributaries (refer to Figure 3-1 for station locations). Water quality monitoring includes sample collection for pollutants that require laboratory testing and field-measured data (Table 5-1). This monitoring data is reported to TCEQ for inclusion in the SWQMIS database. The monitoring complies with the Quality Assurance Project Plan (QAPP) for the Trinity River, included as Appendix D.

5.1.1 Lake Monitoring Regime

TRWD water quality monitoring teams take field measurements and collect samples for lab analysis at five sites in EML on a quarterly basis, plus one additional sample during the critical period of July 1 through September 29 annually. SWQM site numbers for TRWD monitoring are 10964, 10960, 10956, 10952, and 10944. Additional measurements are taken at the water supply intake (10944) during quarterly testing. All sites are sampled near the surface and at multiple depths during the index period, March 15 through October 15 annually. From October 15 through the following March 15 annually, TRWD collects samples near the surface of the lake and at the water

supply intake. Water quality parameters sampled can be found in Table 5-1. In addition, weekly profiles are taken in the field with a sonde device at the EML intake from surface to bottom. This profile provides measurements across the depth profile of temperature, dissolved oxygen, oxidative reduction potential, pH, and conductivity.

5.1.2 Tributaries Monitoring Regime

TRWD water quality monitoring teams perform monthly testing at five SWQM sites on EML tributaries including the West Fork Trinity River: 10854 on Ash Creek, 10853 on Walnut Creek, 10858 on Derrett Creek, 10855 on Dosier Creek, and 10969 on the West Fork Trinity River. Additional sites on the West Fork Trinity River are tested quarterly as part of an *E. coli* program. Site 10969 is tested both monthly and quarterly as part of the tributary and West Fork testing, respectively. Water quality parameters sampled can be found in Table 5-1.

5.1.3 WWTFs Monitoring Regime

TRWD performs quarterly monitoring at 10 WWTFs near the lake on a rotating basis wherein each site ends up being sampled once or twice annually. Priority is given to sampling large WWTFs. Samples are collected upstream and downstream from the WWTFs and from facilities' effluent discharge. The following locations are sampled: Eagle Mountain RV Park, Fort Worth Boat Club, City of Newark, City of Boyd, City of Rhome, City of Decatur, City of Bowie, City of Springtown, City of Bridgeport, City of Azle.

Table 5-1 TRWD water quality monitoring summary

Sites	Total sites	Parameters tested	Frequency
All EML Sites	5	<i>Chlorophyll-a</i> , TSS, TDS, VSS, NH ₃ , No _x , TKN, TP, DOPO ₄ , TOC, DOC, Alkalinity, Chlorides, <i>E. coli</i>	Quarterly, with one extra during critical period
EML Intake additional	1	Calcium, Magnesium, Sodium, Potassium, Sulfate, Total Arsenic, Total Iron, Total Manganese, Total Silica, Dissolved Silica, Total Copper, Dissolved Copper	Quarterly, with one extra during critical period
EML Intake field profile	1	Temperature, DO, Oxidative Reduction Potential, pH, Conductivity	Weekly from April - October
EML Tributaries	5	TSS, VSS, NH ₃ , No _x , TKN, Dissolved TKN, TP, Dissolved TP, DOPO ₄ , TOC, DOC, <i>E. coli</i> , Chlorides	Monthly
West Fork Trinity River	10	<i>E. coli</i>	Quarterly
WWTFs	10	CBOD ₅ , TSS, VSS, NH ₃ , No _x , TKN, TP, DOPO ₄ , TOC, <i>E. coli</i> , Chlorides	Quarterly on rotating basis

5.2 Load Duration Curve Analysis

In watersheds where NPS are likely the primary source of pollutant loading, LDCs are useful tools for illustrating the relationship between stream flow, pollutant concentration, and the resulting pollutant loads. The pollutant loads during each monitoring event can be compared to the maximum allowable load at that particular flow rate; this data can then be used to calculate the reduction needed to meet the water quality goal for each pollutant.

Although LDCs cannot be used to differentiate between specific sources (e.g., livestock, pets, OSSFs), they can be used to determine whether point sources or nonpoint sources are the primary concern by identifying whether exceedances occur within a specific flow regime. If exceedances are only observed during high flow or moist conditions associated with storm events, then nonpoint sources are the likely contributor. However, if exceedances are also present during dry conditions or low flow, then it is likely that point sources are also contributing to the overall load, becoming more prominent as flows decrease (Figure 5-1) (EPA, 2007). Exceedances at high flows are usually attributed to flooding, and thus inherently unmanageable. Therefore, reductions demonstrated in the mid-range conditions flow regime are most appropriate for representing the water quality reduction goal at each site. A 10 percent margin of safety (MOS) was included for each water quality standard criterion. This means that 10 percent of the allowable pollutant load is intentionally set aside as a buffer to account for uncertainties in future stressors or modeling, data, or natural variability (EPA, 2024a). This helps ensure that water quality standards are met even if there are unforeseen variations or errors in the analysis. Additional information regarding LDC development is provided in Appendix B.

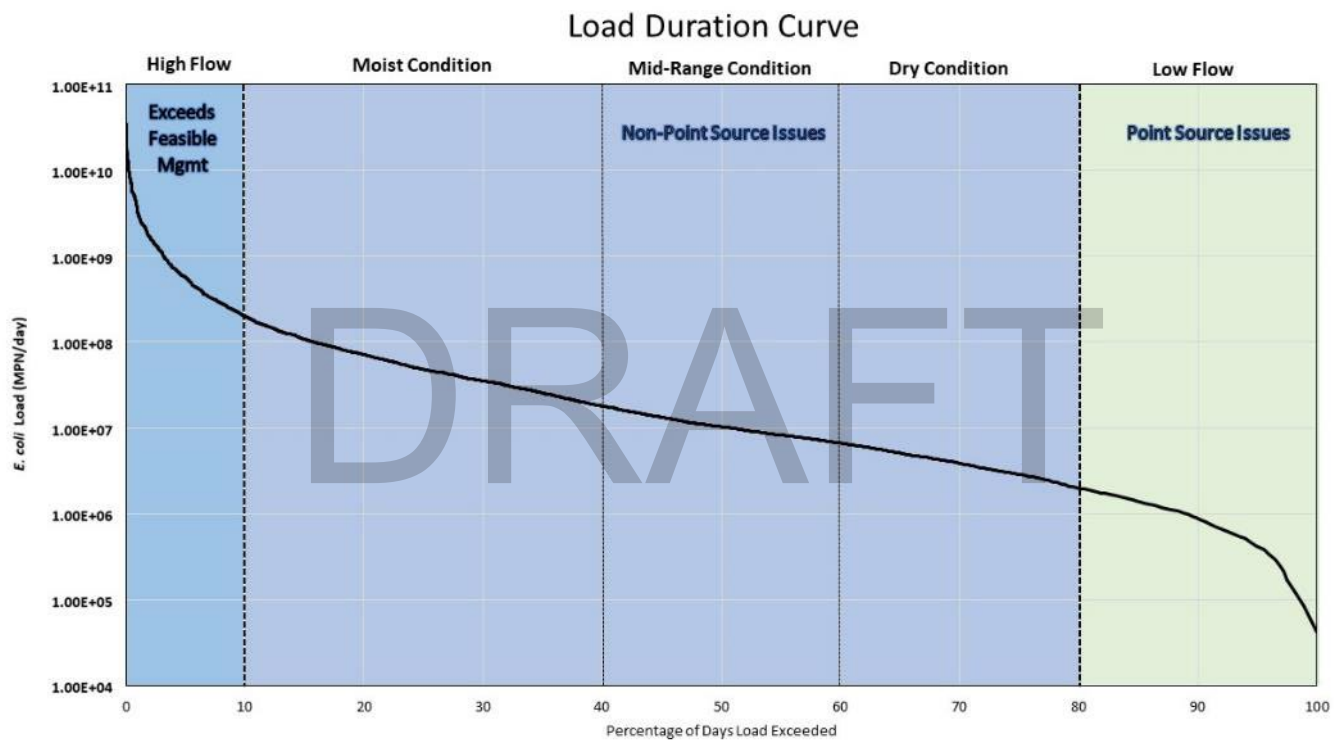


Figure 5-1 Flow categories and regions of likely pollutant sources in an example LDC

A minimum of 12 paired stream flow-pollutant concentration data points is required to properly execute the LDC analysis tool. LDCs were developed at three surface water quality monitoring stations with paired USGS flow gages for three key constituents: *E. coli*, total phosphorous (TP), and nitrogen oxides (NO_x), which account for nitrate and nitrite (NO₃⁻ + NO₂⁻). Stations are referred to by their SWQM station number. LDCs for 10969 (West Fork Trinity River NE of Boyd near FM730), 10853 (Walnut Creek west of Reno near FM 1542), and 10854 (Ash Creek in Azle near SH199) had sufficient recent data to include in this plan. It is important to note that station 10854 does not have a paired USGS station but was instead paired with modeled flow from a calibrated model. Station 17844 (West Fork Trinity River S of Boyd, below station 10969) was also assessed as part of SWAT calibration, but data concerns excluded station 17844 from use for load reductions (Appendix B).

For planning purposes, surface water quality monitoring station 10969 was selected for establishing pollutant load reductions. This station represents the most comprehensive available paired water quality and flow data with significant loading to EML. 10969 is also assumed to be far enough upstream from the lake to exemplify flowing conditions, not subject to lake backwater influence for the majority of the year. Its location near the lake on the West Fork means that it captures a majority of the watershed area, with exception of the numerous small tributaries that discharge directly into EML.

5.2.1 *E. coli*

The LDC analysis indicates that elevated *E. coli* concentrations are associated with all flow conditions. At site 10969, exceedance decreases as flow decreases, indicating that *E. coli* loading is primarily due to nonpoint source inputs from runoff and/or resuspension of existing sediment bacterial colonies (Figure 5-2 and Table 5-2). At site 10853, exceedances also decrease as flow decreases, but overall, exceedances at site 10853 are less than at site 10969 (Figure 5-3 and Table 5-3). However, at site 10854, loading exceedances are steady across all flow conditions, indicating that there may be a point source loading issue (Figure 5-4 and Table 5-4).

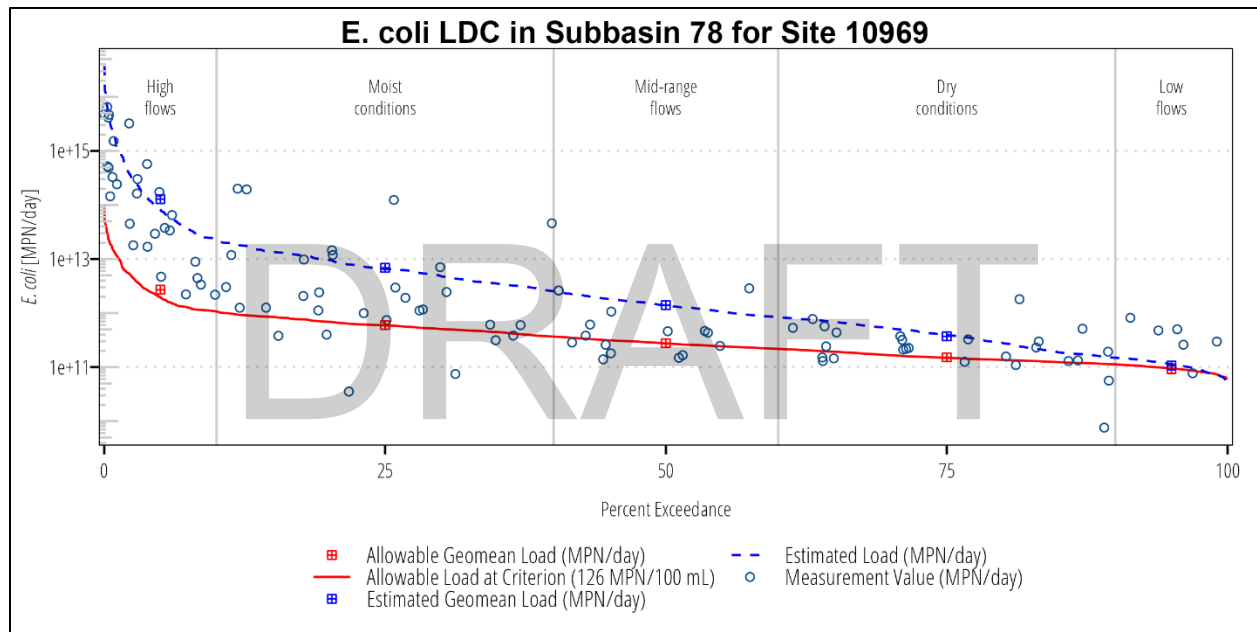


Figure 5-2 *E. coli* LDC and allowable load at site 10969

Table 5-2 *E. coli* reduction needed to meet allowable loading for each flow condition at site 10969

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	1,723,680	0-10	2.71E+12	1.28E+14	1.26E+14	97.9
Moist Conditions	522,374	10-40	6E+11	6.88E+12	6.28E+12	91.3
Mid-range Conditions	241,402	40-60	2.77E+11	1.4E+12	1.12E+12	80.2
Dry Conditions	131,242	60-90	1.52E+11	3.71E+11	2.19E+11	59.0
Lowest Flows	84,033	90-100	9.17E+10	1.07E+11	1.53E+10	14.3

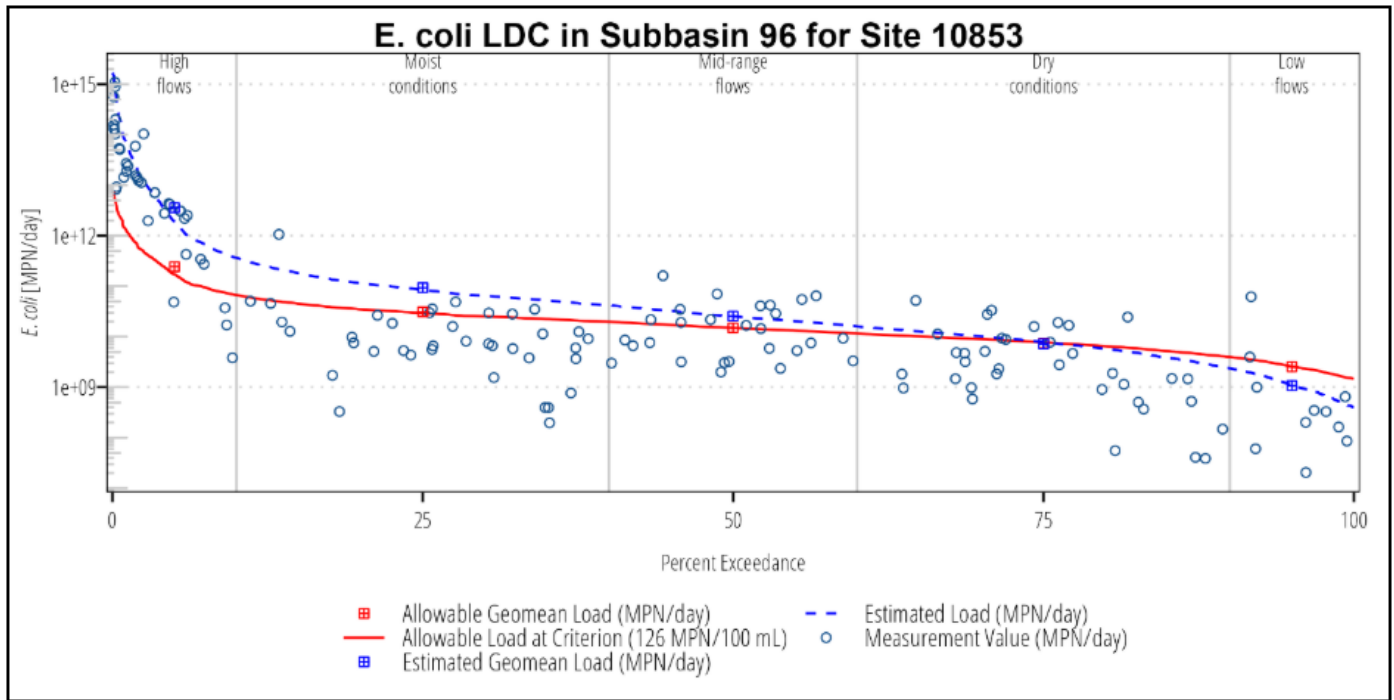


Figure 5-3 *E. coli* LDC and allowable load at site 10853

Table 5-3 *E. coli* reduction needed to meet allowable loading for each flow condition at site 10853

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	149,904	0-10	2.44E+11	3.59E+12	3.35E+12	93.2
Moist Conditions	25,937	10-40	3.11E+10	9.37E+10	6.25E+10	66.8
Mid-range Conditions	13,167	40-60	1.50E+10	2.56E+10	1.06E+10	41.3
Dry Conditions	6,780	60-90	7.38E+09	7.21E+09	0	0
Lowest Flows	2,282	90-100	2.55E+09	1.08E+09	0	0

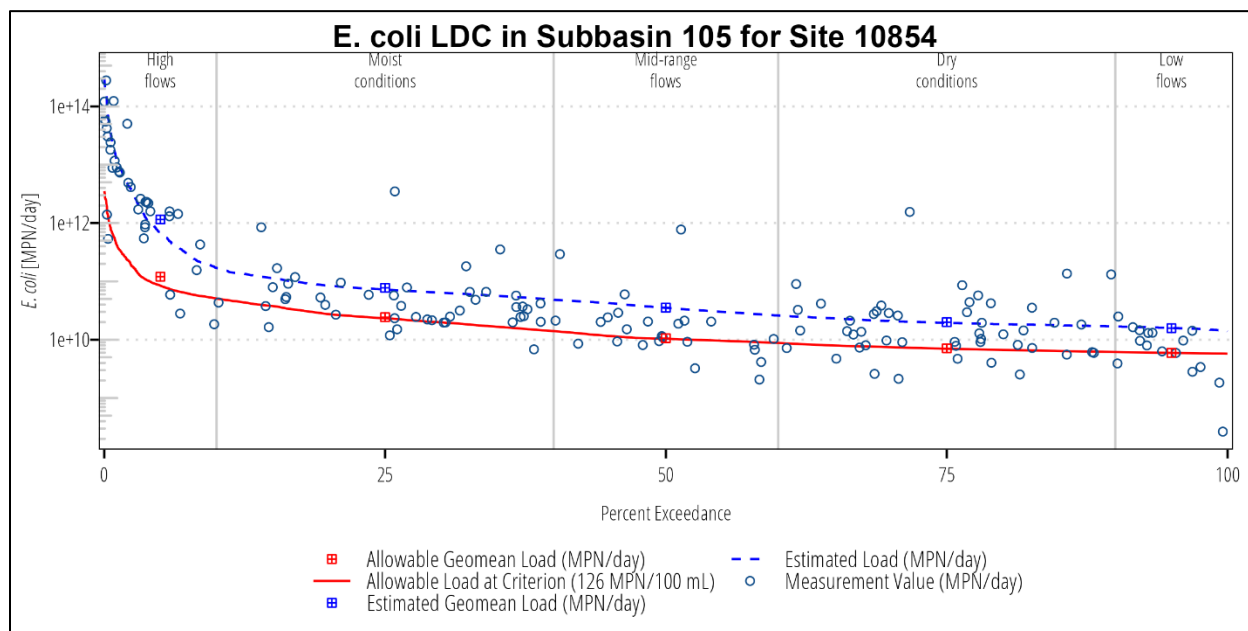


Figure 5-4 *E. coli* LDC and allowable load at site 10854

Table 5-4 *E. coli* reduction needed to meet allowable loading for each flow condition at site 10854

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	1.2E+11	1.15E+12	1.03E+12	89.5
Moist Conditions	20,485	10-40	2.43E+10	7.75E+10	5.31E+10	68.6
Mid-range Conditions	9,150	40-60	1.06E+10	3.54E+10	2.48E+10	70.1
Dry Conditions	6,178	60-90	7.12E+09	2E+10	1.29E+10	64.4
Lowest Flows	5,238	90-100	5.94E+09	1.58E+10	9.82E+09	62.3

5.2.2 Nutrients

Nutrients are transient in flowing water bodies, but once they are delivered to a lake or reservoir, flow rates decrease significantly. This increased residence time leads to accumulation of nutrients, sediment, and other solids. Accumulation will continue in both the water column and lakebed sediments until they are used by organisms, removed by human means (typically through dredging), or resuspended and flushed downstream via the dam. Excessive accumulation in a lake can lead to algal blooms because nutrients are no longer a limiting factor on populations of photosynthetic organisms. This phenomenon is commonly referred to as lake eutrophication. Eutrophication does occur naturally, but it can be intensified by human activities, for example certain farm or ranch management practices and the proliferation of urban environments. In addition to the potentially harmful environmental effects, algal blooms may also cause taste and odor problems in municipal water taken from the lake and may impact recreational opportunities.

For this plan, nutrient reductions focus on nitrogen and phosphorous. Nitrogen enters water bodies in various forms from many potential sources throughout a watershed. NO₃⁻ is a common component of chemical fertilizers, which are used in both agricultural and urban settings. Ammonia (NH₃) is a component of human and animal waste, entering water bodies via wastewater effluent, SSOs, OSSFs, or animal waste carried by runoff. NO₃⁻ can

also be formed within the water body through oxidation of various nitrogen compounds. NO_3^- is highly soluble and moves readily through soil and water bodies. Phosphorous comes from many of the same sources, but it is more likely to bind to soil particles; therefore, mitigating erosion is a major component of controlling phosphorous loads. Typically, phosphorus is the limiting nutrient for algal growth in a water body.

LDCs were created based on monitoring data for total TP and NO_x . These pollutants do not have CWA-based impairment thresholds, so the LDCs were created using TCEQ screening level criteria for TP and using criteria for NO_3^- as a proxy for nitrogen oxides because NO_2^- typically exists in water bodies in trace amounts due to its tendency to oxidize to NO_3^- . There were mildly elevated nutrient values for NO_x at 10854 (Figure 5-5 and Table 5-5), which corresponds with a screening concern for nitrate on that assessment unit. There were no reductions needed for NO_x or TP at 10969.

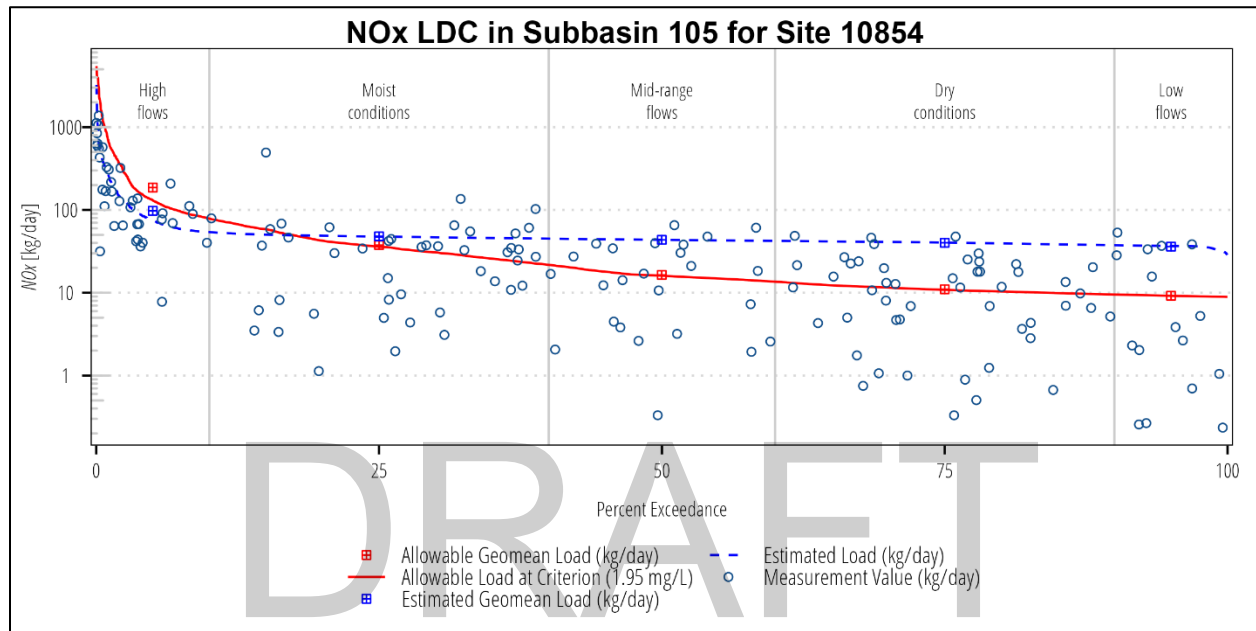


Figure 5-5 NO_x LDC and allowable load at site 10854

Table 5-5 NO_x reduction needed to meet allowable loading for each flow condition at site 10854

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	186.4	97.6	0.0	0.0
Moist Conditions	20,485	10-40	37.7	48.0	10.4	21.6
Mid-range Conditions	9,150	40-60	16.4	43.6	27.2	62.3
Dry Conditions	6,178	60-90	11.0	40.1	29.1	72.5
Lowest Flows	5,238	90-100	9.2	36.1	26.9	74.5

5.3 Spatial Analysis of *E. coli* using SELECT

Watershed prioritization and BMP recommendations were further refined with the use of the SELECT analysis, which distributes potential *E. coli* loads into 23 HUC 12 subwatersheds (Figure 5-6), based on likely *E. coli* sources as identified by watershed stakeholders. Potential point sources of *E. coli* were entered using their spatially explicit locations and permitted discharges (Appendix C). Using a combination of GIS and spreadsheet tools,

estimated populations of various warm-blooded animal species (humans, pets, livestock, wildlife) were distributed spatially throughout the watershed based on each population’s applicability to different LULC characteristics and estimated stocking rates by county (Appendix C).

Once distributed, species-specific *E. coli* load production values published in scientific literature were applied to each population (Appendix C), producing the *E. coli* loads that may eventually find their way to waterways (Figure 5-7). To account for the variety in the sizes of the subwatersheds, these loads were then normalized to a per-acre basis to ensure that contributions from larger subwatersheds did not overshadow those from several smaller ones. Finally, the separate, normalized sources were then aggregated to produce an overall normalized *E. coli* load for each subwatershed (Figure 5-8).

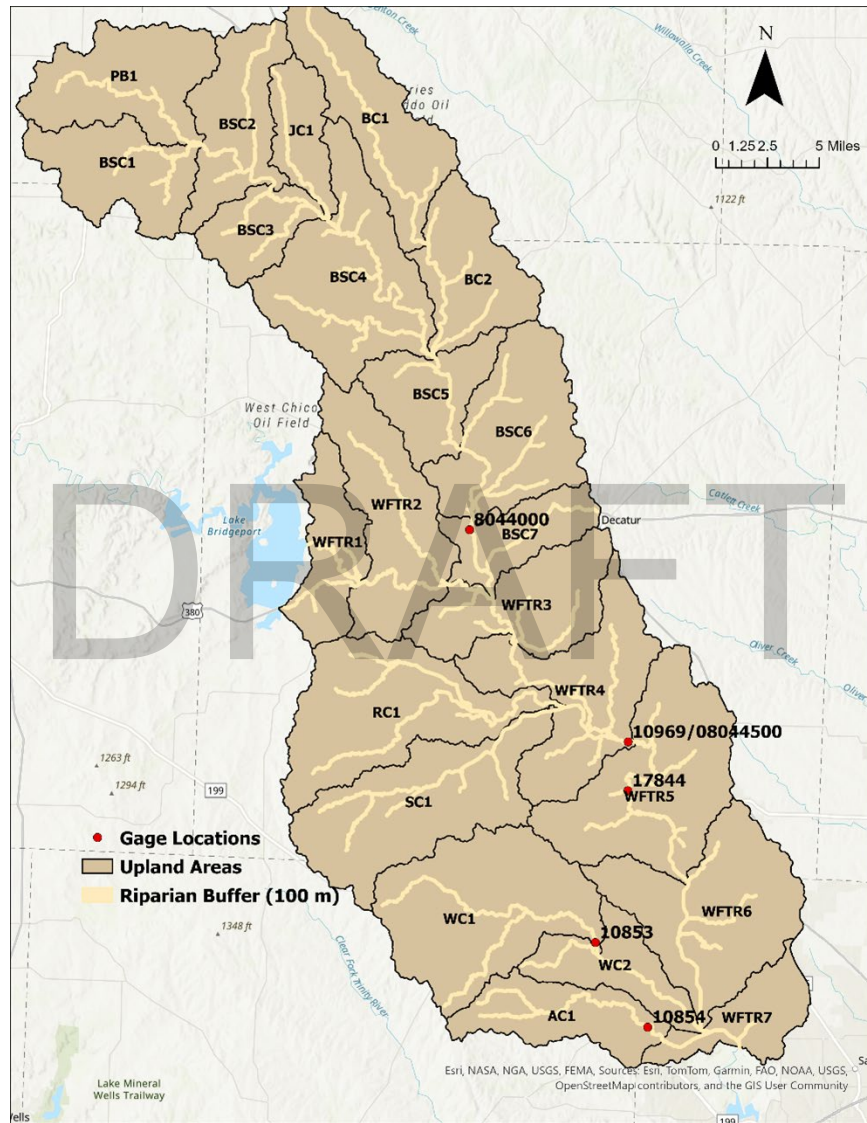


Figure 5-6 EML subwatersheds and riparian buffers used in SELECT analysis

Raw SELECT output is often seen as a “worst case scenario” for estimating *E. coli* loads, as the tool does not contain any built-in functionality that automatically adjusts for *E. coli* die-off, predation, soil entrainment, or other forms of mitigation between the time of deposition up to its introduction to a waterway. However, these processes can be partially accounted for by applying weights to the loads based on their distance to a waterway. For example, manure deposition within riparian buffer areas (< 100-m (330-ft) from a stream), carry more weight than deposition

in an upland area (Figure 5-7). Use of this tactic will allow for further refinement of critical areas for BMP implementation. Details about weights used for each source can be found in Appendix C.

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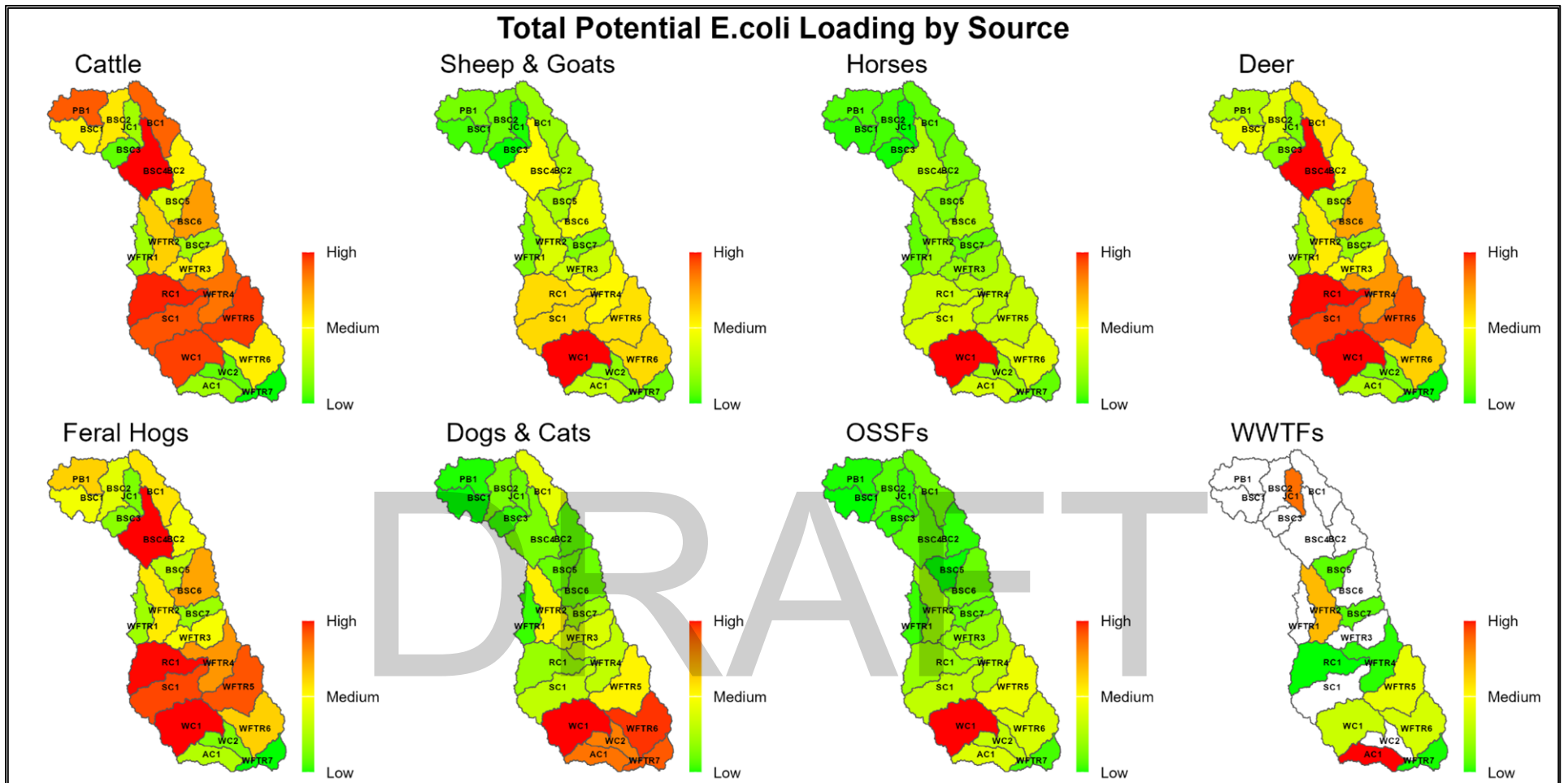


Figure 5-7 Potential *E. coli* loading by source from SELECT

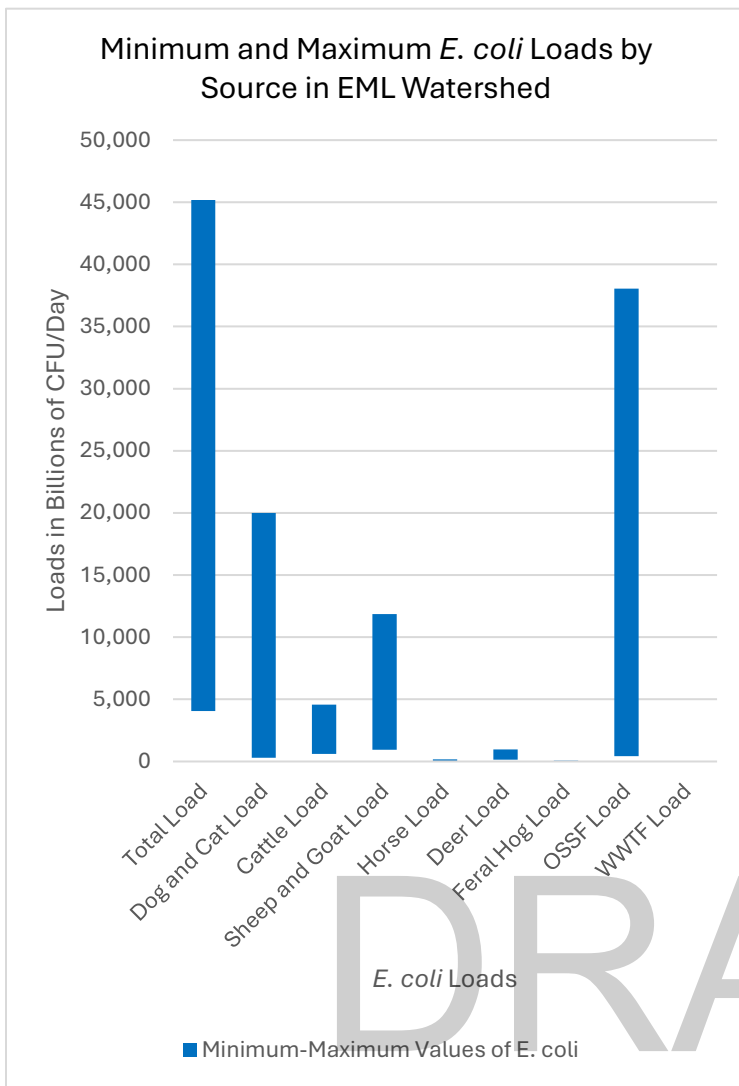
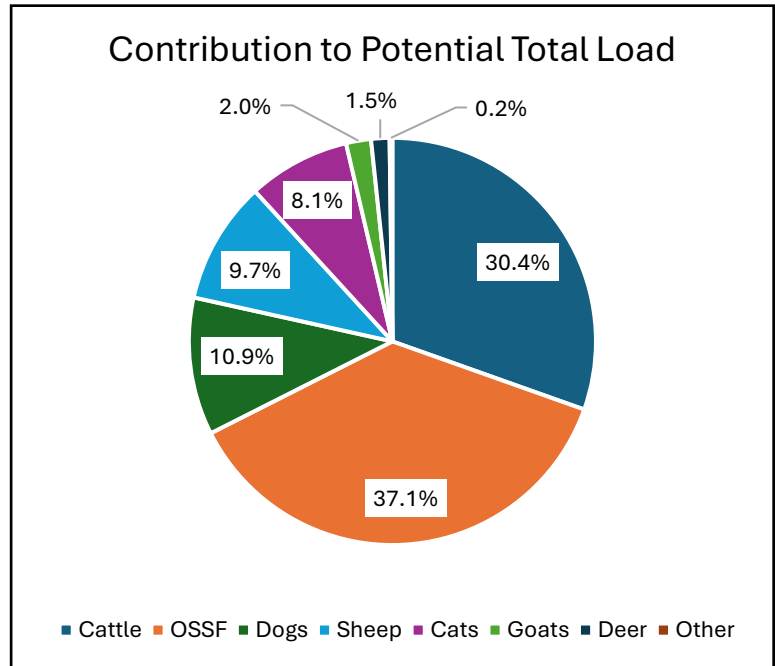
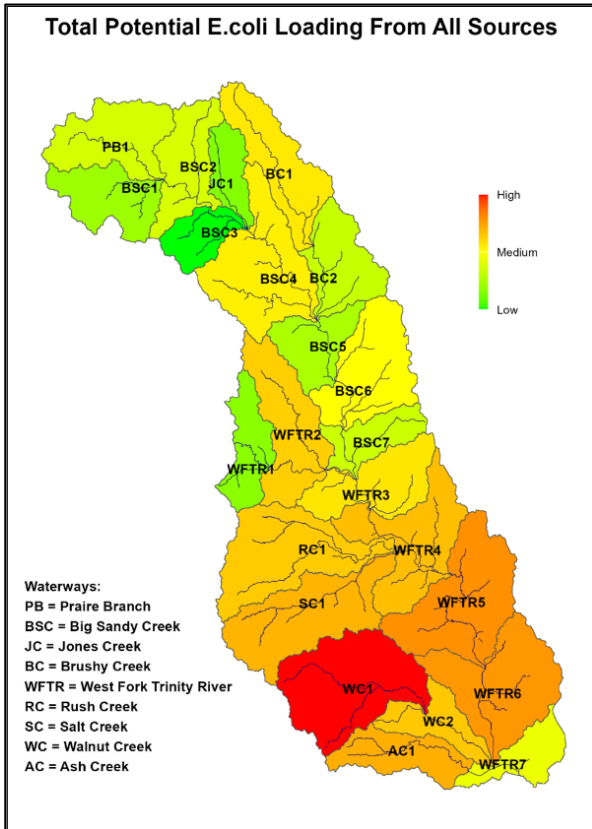


Figure 5-8 Comparison of potential *E. coli* loading by source from SELECT

Contribution to potential livestock *E. coli* loads were highest and most widespread throughout the watershed for cattle, compared to sheep and goats. Loading from smaller livestock and hobby livestock like sheep, goats, and horses is higher around the exurban fringes; this is especially true of horses. Similarly, OSSF loading is highest around the exurban fringes of Fort Worth’s outer suburbs, especially in the Upper Walnut Creek subwatershed. This makes sense as many far-flung, lower-density suburbs are built without service to their most proximate city’s utilities, but there is a higher load than the more truly rural areas in the northern parts of the watershed. Deer and feral hog loads follow a similar pattern wherein relative loads are high across much of the watershed except in more heavily urbanized areas. Dogs and cats are predictably producing the highest relative *E. coli* loads where human populations and therefore household pet populations are higher. Lastly, WWTF loads correspond directly to the size and number of treatment plants present in each subwatershed.

It is important to keep in mind that the maps in Figure 5-7 are relative within each source described. Figure 5-8 compares the minimum and maximum *E. coli* loads by source. In Figure 5-9, the spatial distribution of potential *E. coli* loads from all sources across the watershed are illustrated. Figure 5-10 shows a more

comprehensive picture of the total loads that each source contributes to the overall *E. coli* load within the EML watershed. Livestock (cattle, sheep, and goats) together account for 42.1 percent of the total potential load; OSSFs contribute 37.1 percent; household pets (dogs and cats) contribute 19.0 percent; deer contribute 1.5 percent; all other sources (horses, feral hogs, and WWTFs) contribute the remaining 0.2 percent.



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Figure 5-9 Total potential *E. coli* Loading by subwatershed (left)

Figure 5-10 Contributions to potential total *E. coli* load by source (right)

5.4 Conclusions

Based on these analyses, nonpoint source pollution is the main driver of water quality impairments in the EML tributaries, with the potential exception of small urban subwatersheds like Ash Creek, which may sustain consistently high *E. coli* loads from WWTFs. There are several significant sources of *E. coli*, nutrients, and other contaminants distributed throughout the watershed; therefore, focusing on one particular land use or location will not provide a viable solution to overall load issues.

Livestock, OSSFs, and household pets are likely the major contributors to *E. coli* issues and potentially also major contributors to nutrient issues in the EML watershed. Household pets are potentially heavy contributors in more urbanized areas. Several well-known and proven management strategies exist for all three source categories: grazing management practices implementation, OSSF maintenance education and funding programs, and pet waste management education and infrastructure can all help reduce both *E. coli* and nutrient loads. Additional BMPs put in place for several of the other source categories will provide additional flexibility for achieving the needed loading reduction of 4.09×10^{14} MPN/yr *E. coli* to meet water quality standards.

6 Management Strategies and Associated Load Reductions

6.1 Meeting Water Quality Goals

The primary water quality reduction goals for the watershed, as defined in Section 5.2, are specifically for *E. coli* loads. To meet this challenge, load reduction goals will refer to the Primary Contact Recreation 1 water quality

standard for *E. coli* of 126 MPN/100 mL, which is measured as a concentration rather than a load. With a 10 percent MOS, the water quality target for the waterbodies of interest will effectively be 113 MPN/100 mL for calculating the *E. coli* loads.

Also of interest is nutrient loads, as some nitrate and chlorophyll-*a* concerns exist in the watershed. This is not a focal point for this WPP, but it is a parameter to keep an eye on for future updates to the WPP. Sediment loads are also a strong consideration for TRWD's water supply goals, but are not used as a load reduction metric for the purposes of this WPP. Loads of all pollutants of concern are expected to fluctuate throughout the life of the WPP, with BMP implementation at times offset by LULC changes.

Typically, one index site is chosen for establishing water quality goals in a WPP. The index site for this WPP is station 10969 because it accounts for a majority of the watershed area flowing into the lake via the West Fork Trinity River and Big Sandy Creek. Stakeholders agreed with the suggestion to utilize the mid-range conditions flow regime as the basis for calculating the load reductions needed to reach the water quality goal. An annual reduction for this portion of the watershed during mid-range flow conditions of *E. coli* is 4.09×10^{14} MPN/yr is needed to achieve water quality goals. A five-year interim goal is 1.64×10^{14} MPN/yr. This number is less than half of the overall goal to accommodate administrative activities to seek implementation funding during the first years of the implementation timeline.

Nutrient and sediment reductions are inherently tied to management recommendations for *E. coli*, since many bacteria BMPs, specifically those for water retention/detention and treatment, are also expected to curb both nutrient and sediment loads.

6.2 The Watershed Approach to Water Quality Goals

Stakeholders understand that focusing efforts on a single source will likely result in diminishing returns in the form of load reductions with successive incremental funding increases. Instead, it is prudent to offset these diminishing returns by selecting appropriate BMPs for a variety of pollutant source categories. While the overall loads from each source are an important consideration, the stakeholder BMP recommendation process also incorporated feasibility, cost-effectiveness, and community visibility. It is for this reason that some unmodeled pollutant sources received a higher stakeholder priority rating than did more significant *E. coli* sources, as illustrated in Table 4-1. Due to the difficulty of addressing *E. coli* loads from native wildlife and the fact that they represent a small portion of the overall load, wildlife BMPs receive minimal consideration in this WPP.

Prioritization by source was then followed by spatial prioritization. Placement of physical/environmental BMPs should follow the results of the SELECT analysis for maximum targeting of sources. Similarly, education-based BMPs should be targeted in areas where the educational goal matches the relevant land uses or populations – for example, OSSF maintenance workshops should be ideally held in areas with higher OSSF concentration, while grazing management workshops should be held in locales with higher livestock numbers. Priority areas will likely fluctuate in size, shape, and location as needs arise or are resolved. These adjustments will rely heavily on stakeholder input, and only those BMP recommendations approved by stakeholders (at present or in the future) will be considered. Stakeholders, with technical and financial assistance outlined in Chapter 7, are responsible for implementing these voluntary recommendations, and their willingness to do so will ultimately define the speed and efficacy with which water quality goals are achieved.

6.3 Education and Outreach

Education and outreach are key components of WPP implementation. Any BMP implemented on private land will require education and outreach regarding maintenance of the BMP and the goal of meeting water quality

standards. This information will be provided in any printed materials associated with BMPs on private land and during discussions with or presentations by TRWD and implementation partners. Education and outreach will include discussions and training on how to properly maintain BMPs.

6.4 Critical Areas for Implementation

Critical areas for implementation are listed for BMP recommendations in Tables 6-1 through 6-7. These areas were identified in some cases through SELECT modeling of *E. coli* load sources. In other cases, critical areas are identified by their proximity to riparian areas or the reservoir. In addition to these areas, any West Fork Trinity River subwatershed is a critical area because this tributary collects 83 percent of the inflow to EML.

6.5 Data Gaps

SELECT estimates the locations of *E. coli* loading sources based on LULC and per-county stocking rate estimates from NASS. Stakeholders provided additional input on stocking rates. However, more specific locations of production agriculture must be determined so BMPs can be targeted to those locations. Once this information is available, the number of BMPs per subwatershed can be determined to meet water quality goals.

6.6 Animal Sources

6.6.1 Livestock

Livestock species (cattle, horses, sheep, and goats) ranked 1st with respect to daily potential *E. coli* loading according to the SELECT analysis (Figure 5-7). As a source, waste from livestock may sometimes be deposited directly into a water body if the animals are allowed access for drinking or wading to cool off during hotter seasons. However, livestock waste is typically deposited in upland areas and washed into waterways via stormwater runoff. As such, a significant amount of the *E. coli* deposited by livestock as waste dies before it can reach a stream or lake (Wagner et al, 2012). In addition to direct water quality impacts from *E. coli*, direct access may significantly impact bank stability and increase sedimentation near the access area. Based on the high overall potential load and availability of effective BMPs, stakeholders ranked this a 1st-tier management priority.

In production agriculture, BMPs for water quality improvement typically involve managing population density and distribution. Using exclusionary fencing is a simple method for reducing or eliminating livestock access to streams but requires the construction of alternative watering facilities and shade to accommodate livestock needs. Even if fencing is not used, alternate watering facilities placed closer to animal grazing areas can effectively reduce traffic to streams. These additional water sources are usually supplied by wells but can be fed by municipal supply in some cases.

To reduce stormwater runoff of *E. coli* in upland areas, BMPs focused on improving soil infiltration and reducing runoff velocity are most effective. Prescribed grazing, when combined with herbaceous weed control, brush management, and strategic plantings of forage species will improve the vegetative cover quality of grazing areas. Increased surface coverage, combined with increased root depth and density, slow runoff and increase infiltration, reducing erosion and flows of *E. coli* into water bodies. Responsible pest and nutrient management will further improve forage health and reduce the potential for excess additives being washed into waterbodies.

These practices are most effective when applied simultaneously across an entire property using a comprehensive management plan. To assist producers, technical and financial assistance is available through Natural Resources Conservation Service (NRCS) as conservation plans (CPs) and the Texas State Soil & Water Conservation Board

(TSSWCB) as water quality management plans (WQMPs). These plans, usually administered through local soil and water conservation districts (SWCDs), are developed with input from district-level technicians familiar with the management methods best suited for the local area. A summary of critical areas for implementation, stakeholder recommendations and the associated load reductions for livestock are provided in Table 6-1.

Table 6-1 Recommended BMPs for livestock

Pollutant Source: Livestock	
Concerns	Overstocking results in overgrazing or overbrowsing, degradation of riparian buffers and terrestrial habitat, stream bank destabilization and erosion, nutrient transport to surface water.
Potential Impacts	(1) Indirect <i>E. coli</i> loading to waterbody from pasture and range land, (2) Direct <i>E. coli</i> loading from defecation in water body, (3) Sedimentation due to increased erosion both upland and on streambank, (4) Property damage from streambank failures
Critical Areas for Implementation	(1) Production agriculture operations, especially along riparian areas, (2) All WFTR subwatersheds, (3) Based on SELECT estimates for <i>E. coli</i> , the following subwatersheds should be prioritized for BMP implementation: WC1, WFTR5, RC1, SC1, BSC6, BSC4, WFTR5, WFTR6, BC1, PB1. These subwatershed estimates will be refined with more specific information prior to implementation. Riparian areas of subwatersheds will be prioritized over upland areas.
Goal	Reduce <i>E. coli</i> loading and sediment yield by encouraging participation in WQMP/CP programs, with focus on reducing animal time spent in riparian areas and land/grazing management methods that improve vegetative cover and soil structure.
Objectives	(1) Promote use of WQMPs/CPs in the watershed, with emphasis on operations near riparian zones, (2) Provide educational opportunities for ag producers to improve management of their property
Recommendations	
Focal Groups	Management Practices
Producers	Develop and implement WQMPs and CPs for 180 properties in the EML watershed, using land management strategies to reduce the annual <i>E. coli</i> load by an amount equivalent to reducing the stocking rate by 25%
Producers, hobby farmers	Provide educational programs and resources about grazing management practices and exclusionary fencing
Estimated Load Reductions	
Adherence to prescribed whole-farm management plans like WQMPs and CPs is expected to reduce <i>E. coli</i> loading to streams through indirect and direct inputs. Improving landcover management and limiting the time spent by animals in riparian zones are expected to provide a total annual <i>E. coli</i> load reduction of 9.8×10^{15} MPN/yr, in addition to reductions to both nutrient and sediment loads. For simplicity, this calculation was made using only the cattle population, as they had the greatest presence in the watershed. Additional detail regarding this estimate is provided in Appendix C.	
Effectiveness	Reducing the time spent by livestock within riparian zones, coupled with proper management of vegetative cover in upland areas, are expected to provide significant direct and indirect reductions to <i>E. coli</i> loads reaching waterbodies, with those used directly within riparian zones being the most effective.
Certainty	Locating willing landowners will be heavily dependent on local natural resource representatives, and there is no guarantee that future owners will continue to utilize the BMPs identified in the site plans if the property changes ownership
Commitment	Agricultural landowners are typically willing to engage in land conservation practices once they're made aware of the benefits, especially if those practices relate to cost savings in the form of reduced erosion and more efficient use of pesticides, herbicides, and fertilizers. However, initial costs may limit adoption of such practices.
Needs	Significant financial support, as directed through the WQMP and CP programs, is essential for the success of this component, which is capable of providing significant load reductions if utilized across all ag species. Therefore, education pertaining to participation and benefits of these

	programs is also imperative, as is funding for education targeted to new small-acreage landowners.
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6.6.2 Pet Waste

Pet waste issues in the EML watershed stem from the southern end of the watershed, where there is a greater percentage of urban and suburban land use. As the Fort Worth metropolitan area continues to expand northward, numbers of dogs and cats in the watershed will continue to rise. BMPs selected for reduction of *E. coli* loads from pet waste will primarily focus on dogs, as it is assumed that most domestic cats use litter boxes and have their waste deposited in the landfill. However, it is expected that some portions of domestic felines are indoor/outdoor cats, barn cats, or other feral cats that do defecate outdoors. It is also likely that some cat owners dump soiled cat litter into the environment.

Management practices recommended to reduce pet waste *E. coli* loads seek to remove pet waste from stormwater runoff primarily by confining the waste to a landfill. This includes capitalizing on several educational opportunities that are already being promoted through various entities in the Dallas-Fort Worth metropolitan area. This includes relevant print media (utility bill inserts, info pamphlets, public signage) as well as mass media campaigns (websites, videos). This also includes promotion of proven waste management strategies, such as providing supplementary pet waste stations for public areas. Runoff avoidance can also be achieved through infiltration via in-ground pet waste digesters, which are a less common but potentially effective pet waste solution. Stakeholder ranked this a 2nd-tier management priority. A summary of recommendations and the associated load reductions for pet waste are provided in Table 6-2.

Table 6-2 Recommended BMPs for pet waste

Pollutant Source: Pet Waste	
Concerns	(1) Improper disposal of pet waste, (2) Lack of education on impacts and proper disposal, (3) Disease transmission and public safety
Potential Impacts	(1) Indirect <i>E. coli</i> loading to waterbody from yards, public greenspaces, kennels, and shelters, (2) Spread of disease among/between species
Critical Areas for Implementation	(1) Subwatersheds adjacent to the lake, (2) Urbanized areas, (3) All WFTR subwatersheds, (4) Based on SELECT estimates for <i>E. coli</i> , the following subwatersheds should be prioritized for BMP implementation: WC1, SFTR6, WFTR7, AC1, WC2. These subwatershed estimates will be refined with more specific information prior to implementation. Riparian areas of subwatersheds will be prioritized over upland areas.
Goal	Reduce the <i>E. coli</i> load from pet waste delivered to waterbodies through management of <i>E. coli</i> loads representing 50% of the present pet population.
Objectives	(1) Increase education and outreach efforts pertaining to proper disposal of pet waste, (2) Provide opportunities for proper waste disposal/abatement
Recommendations	
Focal Groups	Management Practices
Cities, counties, North Central Texas Council of Governments (NCTCOG), regional entities	Expand delivery of existing pet waste education resources, develop/implement new educational resources (e.g., utility bill inserts, websites, info pamphlets, videos, signage in public greenspaces/trails)

Cities, counties, HOAs, neighborhood associations (NAs)	(1) Development and adoption of model pet waste pickup/disposal ordinances for municipalities and bylaws for HOAs/NAs (2) Reconnaissance of critical areas for pet waste station placement in municipal or community greenspaces (3) Phased installation of 34 new pet waste stations and funds for supplies (collection bags, wastebin bags) for the duration of the 10-year implementation timeline (4) Phased installation of 8 bioswales/rain gardens in parks for onsite treatment of pet waste in stormwater/irrigation runoff
Estimated Load Reductions	
BMPs recommended for pet waste seek to a) confine the waste to a landfill, or b) treat waste on-site in the ground. In doing so, the amount of <i>E. coli</i> from pet waste sources entering waterways via runoff from rainfall or irrigation will be reduced. It is reasonable to assume that some pet waste management is already occurring in the watershed, as many people do pick up after their pets. Therefore, an overall reduction goal of 50% of the potential load from a baseline with no management is reasonable. Similarly, it is expected that the recommendations will likely capture loads from only 50% of the present pet population. This results in a reasonable estimate of the total annual pet waste reduction of 6.13×10^{15} MPN/yr for the managed pet population.	
Effectiveness	With denser population centers in the southern areas of the watershed, pet populations are estimated to be similarly dense. Treatment in this case is by direct removal of the pollutant source and internment elsewhere, exhibiting a high removal efficiency. Therefore, noticeable reductions are likely even by managing a limited population.
Certainty	Improving opportunities for proper pet waste disposal for those aware of the contamination concern will provide most of the reductions. It is assumed that those who have other reasons for not properly disposing of waste will be difficult to convince to modify their behavior.
Commitment	Many green spaces already have some level of pet waste stations on-site. Signage for ordinances/by-laws are less visible, and enforcement thereof is limited or non-existent.
Needs	Funds for increasing the number and continued maintenance of pet waste stations, enactment of pet waste disposal ordinances/by-laws or enforcement of those existing.

6.6.3 Wildlife

Deer constituted about 1.5 percent of the potential *E. coli* load in the EML watershed. Management of *E. coli* loading from deer and other native wildlife is difficult to achieve because some level of natural bacterial load from these sources is inevitable. If population numbers are healthy, there are not many management actions to be taken. In areas of overpopulation of deer or other wildlife species, reducing human feeding activities (deer feeders, bird feeders, water bird feeding) or introducing deterrents (nesting deterrents, dummy predators) can abate the issues. However, due to its relatively low estimated load and absence of major overpopulation issues, stakeholders ranked this a 3rd-tier management priority. Stakeholders did note that some residents are feeding deer, potentially increasing the animals' presence in urban areas. A summary of recommendations and the associated load reductions for pet waste are provided in Table 6-3.

Table 6-3 Recommended BMPs for wildlife

Pollutant Source: Wildlife	
Concerns	(1) Human feeding activities increase deer populations in urban areas, (2) Increased deer populations in urban areas leading to economic losses and public safety threats from consumed landscaped or deer-vehicle collisions, (3) Lack of education or ordinances to discourage human feeding activities
Potential Impacts	(1) Indirect <i>E. coli</i> loading to waterbody, (2) Spread of disease among/between species
Critical Areas for Implementation	(1) Subwatersheds adjacent to the lake, (2) Urbanized areas, (3) All WFTR subwatersheds, (4) Based on SELECT estimates for <i>E. coli</i> , the following subwatersheds should be prioritized for BMP implementation: WC1, RC1, BSC4, SC1, WFTR5. These subwatershed estimates will be

	refined with more specific information prior to implementation. Riparian areas of subwatersheds will be prioritized over upland areas.
Goal	Reduce the <i>E. coli</i> load from wildlife delivered to waterbodies through management of <i>E. coli</i> loads.
Objectives	(1) Increase education and outreach efforts pertaining to negative impacts of human feeding activities, (2) Encourage city ordinances related to human feeding activities
Recommendations	
Focal Groups	Management Practices
Cities	(1) Create Deer Management Action Committees, (2) Develop an urban deer management plan, (3) Develop and adopt ordinances banning human feeding activities
TPWD, cities, HOAs, neighborhood associations (NAs)	Conduct education and outreach about the concerns and potential impacts related to human feeding of deer populations in urban areas.
Estimated Load Reductions	
An average stocking rate of 39.4 acre/head was estimated for deer in the watershed. However, while white-tailed deer populations adapt to urban environments, the number of deer in urban areas where human feeding activities take place is not estimated. The number of outreach and education activities and ordinances adopted is the recommended measure of effectiveness of this BMP. The incidence of <i>E. coli</i> could be expected to be reduced if human feeding activities are reduced in urban areas.	
Effectiveness	Prohibiting human feeding activities is essential and effective to reducing an overabundance of urban deer. Education, city ordinances, and enforcement are essential.
Certainty	Urbanization is reducing habitat for deer, increasing deer-human interactions. The animals can adapt well to urban environments. Improving awareness of problems associated with urban deer population can aid in reducing human feeding activities.
Commitment	Some residents may view deer as innocent and natural parts of an urban setting abutting a lake. Education may be sufficient to encourage some residents who view deer positively to reduce human feeding activities; however, regulation and enforcement may be required to ensure all residents eliminate human feeding activities.
Needs	Funding opportunities exist for outreach and education activities. Smaller cities may face challenges with funding to develop and enforce ordinances.

6.6.4 Feral Hogs

The potential *E. coli* load from feral hogs was not significant enough to warrant its own ranking according to SELECT analysis, and feral hog control as a means of load reduction was accordingly given a 3rd-tier ranking by stakeholders. In addition to its low capacity to meaningfully reduce *E. coli* loads, population management with feral hogs is difficult, due in no small part to the species' prolific reproductive capacity. Feral hogs also prefer dense habitat, are opportunistic feeders, and can quickly adapt to trapping tactics.

Despite these obstacles, feral hogs' preference for riparian habitat and propensity for property damage means that they will continue to be a target for educational opportunities and structural controls by several partner agencies. TRWD will continue to support these efforts as requested, but feral hogs will not be a major focus for technical and financial assistance for the purposes of this WPP.

6.7 Wastewater

6.7.1 On-Site Sewer Facilities

OSSFs, which are extremely prevalent in the EML watershed, use onsite treatment of human waste into a soil drain field as opposed to routing waste to a centralized WWTF. With sound construction and normal maintenance, these systems are an effective method of sequestering and mitigating various pollutants within the soil, away from human and animal contact that could result in disease transmission. Systems can fail due to poor design and construction, neglected maintenance, or use beyond their capacity. Failures result in excess releases of pathogens, nutrients, and other biological oxygen demand (BOD)-related substances, endangering human health and contaminating local surface water sources.

Though spatially explicit lists could not be obtained from all Authorized Agents in the watershed, supplemental estimation methods suggest that the highest concentrations of OSSFs exist in the southern end of the watershed. The most affected subwatersheds seem to align with areas with low density suburban/exurban developments; areas that either formerly or currently are outside the reach of city sewage services, but not as low density as truly rural areas in the northern half of the watershed.

Stakeholders ranked OSSFs as a 1st-tier priority pollutant source due to their high potential load ranking in the SELECT analysis and their relatively high concentration in subwatersheds adjacent to the lake. However, addressing OSSF issues is costly, so emphasis should be strategically placed on OSSFs that exist within the riparian buffer or along the lake, as these are the most likely to be pollutant sources.

Repair or replacement of failing OSSFs is the most straightforward method of contaminant reduction, but funding these activities directly is cost-prohibitive, especially given the sheer number of OSSFs in the EML watershed. It is likely more cost effective to provide OSSF maintenance education, paired with incentives offsetting the costs of both inspection and/or pump out. Along with the requisite homeowner-focused OSSF maintenance training, training for real estate professionals would also be beneficial. Inexperienced homeowners moving from more urban areas may be unaware that they even have an OSSF on their property, a scenario that can quickly lead to system failure. Providing support to counties and municipalities to draft and enforce ordinances requiring OSSFs to be inspected (and potentially even pumped out) before properties change hands could also be effective. Support for municipal “septic to sewer” programs, designed to bring older properties within municipal jurisdictions that still use OSSFs onto the centralized WWTF, will also be considered, along with encouraging homeowners associations (HOAs)/neighborhood associations (NAs) to coordinate with private OSSF contractors to develop neighborhood-wide inspection/pump out events in an attempt to reduce costs for residents. A summary of priority project areas, stakeholder recommendations and the associated load reductions for OSSFs are provided in Table 6-4.

Table 6-4 Recommended BMPs for OSSFs

Pollutant Source: OSSFs	
Concerns	(1) Direct/indirect pollutant loading from failing OSSFs, (2) Disease transmission/public safety
Potential Impacts	(1) Indirect <i>E. coli</i> loading to waterbody from failing OSSFs, (2) Spread of disease among/between species
Critical Areas for Implementation	(1) Riparian buffer zones in unincorporated areas, (2) Subwatersheds adjacent to the lake, (3) Urbanized areas, (4) All WFTR subwatersheds, (5) Based on SELECT estimates for <i>E. coli</i> , the following subwatersheds should be prioritized for BMP implementation: WC1, WFTR5, AC1, WFTR6, WC2, SC2. These subwatershed estimates will be refined with more specific information prior to implementation. Riparian areas of subwatersheds will be prioritized over upland areas.

Goal	Reduce the <i>E. coli</i> load from OSSFs delivered to waterbodies directly or indirectly through education, outreach, and incentivized inspections to yield reduction in estimated failure rates from 15% to 5%. This goal may lead to an unrealistic number of repairs or replacements. For this reason, OSSFs in riparian areas will be prioritized, and the WPP recommends incentivizing 50 repairs annually and 5 replacements annually upon receiving implementation funding.
Objectives	(1) Increase education and outreach efforts pertaining to proper maintenance of OSSFs, (2) Provide access to affordable inspections/pump outs for at-risk OSSFs in the watershed
Recommendations	
Focal Groups	Management Practices
Residents, HOAs, NAs, NCTCOG, AgriLife	Provide homeowner-focused OSSF care/maintenance training
Residents, HOAs, NAs	(1) Incentivize OSSF inspections and/or pump outs for property owners with at-risk systems that have not been recently inspected (\$350 incentive toward 450 inspections and/or pump outs over the implementation timeline) with priority for OSSFs within riparian buffer zones (2) Where HOAs/NAs exist, encourage coordination of neighborhood-wide inspection/pump out days to reduce costs (3) Replace failing systems within lake or riparian buffer zones (\$8,000 incentive toward 40 replacements over the implementation timeline)
Real estate agents, OSSF professionals, NCTCOG	Provide practice-focused OSSF training for awareness of pollution potential, local ordinances, and importance of routine maintenance/cleanouts
Cities, Counties	(1) Work with municipalities to create/expand “septic to sewer” programs to transition eligible properties with OSSFs over to the centralized wastewater collection system (2) Conduct spatially explicit OSSF inventories (3) Draft and enforce ordinances that require OSSFs to be inspected before property changes hands
Estimated Load Reductions	
Efforts involve BMPs focused on OSSF owner education and incentivized inspections targeting at-risk OSSFs, with priority given to those located in riparian buffer zones. By applying these recommended BMPs, a decrease in the estimated failure rate of 15% to 5% is expected, resulting in an <i>E. coli</i> load reduction 17.0×10^{15} MPN/yr.	
Effectiveness	Lack of awareness and proper maintenance are inferred to be the main causes of malfunction. Repair or replacement of faulty OSSFs will provide direct reductions to <i>E. coli</i> loading to nearby waterways.
Certainty	Workshops targeted to residents/homeowners are subject to wide ranges of variance in attendance, but those targeted to trade professionals are usually well-attended, especially for those with education requirements. If a malfunction is identified during an inspection, most authorized agencies require reporting and remedy to the OSSF. This may motivate some owners to not be proactive and eschew the inspection incentives.
Commitment	It is unclear if homeowners will put what they learn into practice, but professionals are likely to adopt curriculum into their long-term business practices. It is also unclear whether OSSF owners will continue with proactive inspections after receiving the initial incentive.
Needs	Significant funding is required for the incentivized inspection/pump out program, along with identification of several local private contractors willing to conduct the work in cooperation.

6.7.2 Centralized Wastewater

For incorporated areas where onsite wastewater treatment is infeasible, centralized systems are the most common method of wastewater treatment. These systems use a network of pipelines connecting homes and businesses to a centralized processing facility where it is treated before being released into a nearby waterway. The data shows that most WWTFs within the EML watershed generally function as intended, with effluent averages well

below limits. However, several facilities in the watershed have a handful of daily average *E. coli* exceedances, and a good deal more ammonia exceedances (Table 4-2).

Vulnerabilities within the sewage conveyance system, including above ground and underground pipelines, pump stations, and manholes, can also release bacteria and nutrients. These include both I&I issues that cause the majority of wet-weather SSOs, as well as blockages and physical damage that can result in dry-weather SSOs. Of these, I&I issues tend to cause the majority of large-volume SSOs that are most likely to reach waterbodies before being contained. Dry-weather SSOs tend to be the result of system misuse, especially improper disposal of non-flushable items in toilets. While SSOs were not assessed for potential volume as an *E. coli* loading source in the watershed, stakeholders placed SSOs and WWTFs in the 1st-tier priority pollutants list.

Education and outreach efforts will focus on preventing blockages and damage by educating citizens about the consequences of indiscriminately using toilets as means of waste disposal. Addressing SSOs from I&I issues is primarily reliant on training for wastewater infrastructure operators, with emphasis on establishing and/or improving interdepartmental and inter-entity communication to ensure that I&I issues are quickly identified and addressed. The majority of construction for SSO-related water quality improvement rests with municipal capital improvement program (CIP) funding, as infrastructure projects are typically outside of the purview of CWA 319(h) funding mechanisms. A summary of priority project areas, recommendations, and the associated load reductions for centralized wastewater are provided in Table 6-5.

Table 6-5 Recommended BMPs for WWTFs and SSOs

Pollutant Source: WWTFs and SSOs	
Concerns	(1) Overloaded wastewater infrastructure from I&I, illicit discharges, or conveyance blockages from improperly disposed waste items, (2) Failure of deteriorated, aging, or undersized wastewater infrastructure
Potential Impacts	Direct/indirect loading to waterbodies from failing infrastructure/overloaded systems, (2) Localized human health hazards
Critical Areas for Implementation	(1) Subwatersheds adjacent to the lake, (2) Older neighborhoods with aging infrastructure, (3) Areas applying for new WWTF permits and WWTFs with significant enforcement actions, (4) All applicable WFTR subwatersheds, (5) Based on SELECT estimates for <i>E. coli</i> , the following subwatersheds should be prioritized for BMP implementation: AC1, WFTR2, JC1. These subwatershed estimates will be refined with more specific information prior to implementation.
Goal	Reduce the <i>E. coli</i> load from human sewage delivered to waterbodies through failing or overloaded wastewater conveyance infrastructure by reducing the instance of SSOs by 10%
Objectives	(1) Identify high-priority SSOs, their causes, and available remedies, (2) Increase public education and outreach efforts pertaining to protection of wastewater infrastructure
Recommendations	
Focal Groups	Management Practices
Wastewater infrastructure operators	(1) Use interdepartmental communication mechanisms to identify recurring/high-volume SSOs to target for rehab/replacement through capital improvement programs, (2) Proactively address effluent violations, (3) Encourage new facilities to tie into established, reliable wastewater networks
Cities, counties	Conduct stormwater infrastructure assessments for identification of illegal wastewater connections, proper placement and abundance of storm drains, other opportunities to improve conveyance/reduce pollution
Cities, commercial properties, developers	Incentivize installation of green stormwater infrastructure (GSI)-like permeable pavers and detention/retention facilities like rain gardens to reduce stormwater runoff and decrease likelihood of I&I-related SSOs

Residents	Coordinate with other entities on established public outreach campaigns related to wastewater infrastructure protection/SSO prevention
Estimated Load Reductions	
Effects from SSOs are highly localized and acute in nature, and in many cases, discharges are contained before reaching a waterway. Therefore, making accurate predictions for load reductions based on these BMPs may be difficult. Much of the wastewater produced within the watershed is conveyed to WWTFs elsewhere, and <i>E. coli</i> violations at WWTFs in the watershed are rare. Therefore, reducing the instance of SSOs on a numeric basis was deemed as the appropriate metric for tracking progress.	
Effectiveness	Identification and correction of SSOs will provide a direct reduction to <i>E. coli</i> loads reaching waterbodies. Reductions in the amount of improperly flushed items will significantly reduce the instance of pipeline blockages that lead to many of the smaller, dry-weather SSOs.
Certainty	SSOs can usually be identified easily by both trained staff and concerned citizens, but an entity's ability to address SSO issues is often limited by available funding, with many entities opting for 5- 10-year CIPs. Improving awareness of what is safe to flush among uninformed individuals may produce some benefit, but it is assumed that those who do so out of convenience will be difficult to convince to modify their behavior.
Commitment	Most cities already employ some level of interdepartmental communication for alerts about stormwater/sewer issues. Regular messaging through education/outreach may be necessary to ensure that the public remains aware of how their actions affect wastewater infrastructure.
Needs	Significant funding is needed to correct even the smallest SSO issue, and many municipalities lack sufficient funding to address them all in a timely fashion. Identifying supplemental funds for CIP projects will be of utmost importance. Existing NCTCOG outreach campaigns like "Defend Your Drains" and "Cease the Grease" are well-known and are low-cost message delivery mechanisms.

6.8 Sediment and Flooding

Due to increased flooding from development and long-term lake capacity and water quality threats posed by excess sediment, this was given 2nd-tier management priority.

6.8.1 Sediment

In addition to addressing flow and nutrient sources, the SWAT modeling effort also addressed potential sediment yield reductions associated with various BMPs (Appendix C). Excess and suspended sediment in waterbodies can harbor bacteria and nutrients, decrease die-off of bacteria, impact DO levels, alter flow regimes, and decrease water supply and flood control capacity in EML. The primary sources of sediment in the EML watershed are agricultural activities associated with grazing on pasture or rangeland. Increasing vegetation quality and soil health are key to reducing runoff and therefore, erosion. According to NRCS suggestions, most grazed areas in the EML watershed are overstocked. However, it is not palatable to many agricultural stakeholders to make sharp reductions to livestock numbers. Alternate measures, such as range planting, rotational grazing, and cover cropping pastures, can achieve some sediment yield reductions in lieu of reduction in actual animal numbers.

Stakeholders raised concern about urban development and construction and these practices' contribution to sediment load. The watershed experienced a 9.7 percent change (53,223 acres) in developed land use across the Eagle Mountain watershed when comparing the 2016 National Land Cover Database (NLCD) land use dataset to the 2020 NLCD land use dataset (Appendix B). Growth is expected to continue with construction of new developments contributing to the sediment load. While no grant funding for WPP implementation may be used to

conduct activities already required by an entity’s MS4 permit, the WPP will promote existing programs to cities and counties to reduce sedimentation.

It is important to note that many of the management measures for bacteria and nutrients also function to provide erosion control and sediment capture, and thus some recommendations, management measures, and load reductions are included in other tables throughout Chapter 6.

6.8.2 Flooding

Increased development can lead to a decrease in riparian buffers, a decrease in filtration capacity, and an increase in erosion due to runoff velocities. Hydrologically functional open space, both within urban areas and across the urban landscape, acts as a sponge that absorbs rainfall and decreases floods. On a small scale, GSI, parks, and riparian greenbelts can reduce localized flooding. Protection and sound ecological management of large open tracts throughout the watershed allow for greater infiltration on a landscape scale.

Management measures are identified based on feasibility. Coordination with partner efforts and programs that overlap with these concerns is recommended as part of the BMPs. A summary of priority project areas and recommendations for sediment and flooding are provided in Table 6-6.

Table 6-6 Recommended BMPs for sediment and flooding

Pollutant Source: Sediment and Flooding	
Concerns	(1) Sediment loading to EML, reducing capacity for water supply and flood mitigation, (2) Increased risk of flooding in developing areas, (3) Loss of natural areas/green spaces, (4) Loss of fertile soil in managed pasture areas, (5) High speed and volume of stormwater runoff in urban and developing areas and construction, (6) Limited adoption of voluntary programs to improve stormwater management
Potential Impacts	(1) Impact to aquatic life, (2) Impact to water supply and flood supply capacity in EML, (3) Direct/indirect nutrient and bacteria loading to waterbodies from runoff and erosion events, (4) Public health and safety, (5) Erosion, (6) Infrastructure damage
Critical Areas for Implementation	(1) All WFTR subwatersheds, (2) Pasture areas watershed wide that are adjacent to riparian areas, (3) Urban areas that are experiencing development; urban areas that do not currently utilize suggested practices or whose previously applied practices have exceeded their approved lifespan. These estimates will be refined with more specific information prior to implementation.
Goal	Mitigate sediment loading and flooding
Objectives	(1) Work with partners and agencies tasked with flood assessment to incorporate water quality concerns in future development and planned flood mitigation projects, (2) Identify and install green infrastructure in coordination with cities, counties, and property owners (list not exhaustive), (3) Protect high-functioning open spaces to provide regulating ecosystem services, including erosion mitigation and infiltration (park spaces, conservation easements/agreements, rewilding), (4) Encourage use of cover crops in managed pasture areas
Recommendations	
Focal Groups	Management Practices
Cities, property owners, contractors, agencies, partners, developers	(1) Identify and install GSI as funding becomes available, (2) Adopt <i>integrated</i> Stormwater Management (<i>i</i> SWM™) Program for Construction and Development, a voluntary program created by NCTCOG
Cities, counties	Conduct stormwater infrastructure assessments for identification of illicit discharges, proper placement and abundance of storm drains, other opportunities to improve conveyance/reduce pollution, and identify erosion and prevent erosion

USACE, cities, counties, State partners, nonprofits, volunteer groups	Riparian, Wetland, and/or Stream Restoration Projects
Landowners, land trusts, agencies, cities, counties	Protect and preserve large tracts of land for increased rainfall infiltration and erosion mitigation. Permanently protected landscapes provide the highest long-term return on investment (ROI) – fee simple purchases of parkland or open space, voluntary conservation easements, and mitigation banks are proven vehicles for this work.
Cities, counties, NCTCOG, regional entities	(1) Expand delivery of existing sediment, flooding, and BMP education resources, including <i>i</i> SWM™, (2) Develop/implement new educational resources (e.g., utility bill inserts, websites, info pamphlets, videos, signage in public greenspaces/trails)
Estimated Load Reductions	
BMPs recommended for mitigation of sediment loading and flooding are not tied to a specific <i>E.coli</i> or nutrient reduction, but it is likely that reductions in the incidence of <i>E.coli</i> and nutrients will occur to some degree as nutrients can be bound to soil and sediments, which can harbor <i>E.coli</i> and reduce die-off. Potential load reductions were not calculated because the location, type, and size of projects installed will dictate the potential load reductions; however, specific projects have not been identified yet. Sediment yield, however, can be calculated for different adoption rates of cover crops for managed pasture areas. A 25 percent increase in adoption of cover crops can generate a 71.10% reduction in sediment yield.	
Effectiveness	The effectiveness of BMPs at reducing sediment loadings and mitigating flooding is dependent on the design, site selection and maintenance of the BMP. Permanent land protection practices come with stipulations about future management of the property, so these, if implemented, provide effective long-term ecosystem service benefits.
Certainty	Design and installation of BMPs can require high up-front costs, which may turn away many municipalities and businesses/developers despite long-term ROI. Similarly, large-scale restoration or land protection projects have a high cost barrier. Conservation easements and mitigation banking are not yet common in the watershed, but there is a growing presence of organizations that do this work.
Commitment	Municipalities and businesses have to engage in long-term maintenance of GSI and <i>i</i> SWM™ BMPs. Conservation easements or open space acquisitions require perpetual stewardship and monitoring.
Needs	Significant funding is needed to identify, install, maintain and monitor GSI and <i>i</i> SWM™ BMPs. Significant funding is needed to design and implement restoration projects and identify and implement land protection via purchase or conservation easement.

6.9 Human Activities

6.9.1 Illegal Dumping and Litter Accumulation

E. coli loads represent only a fraction of the potentially hazardous substances that may arise from illegal dumpsites, which commonly occur in easily accessible areas, constituting a public health hazard. For these reasons, stakeholders consider illegal dumping to be a 2nd-tier priority for water quality improvement.

Several regional campaigns for littering currently exist and can be administered in the watershed. TRWD hosts an annual lakeshore Trash Bash at EML and Save Eagle Mountain Lake runs additional stewardship and clean-up events. TRWD runs a robust Adopt-a-Trail program along the Fort Worth Floodway – this programming could feasibly be expanded to TRWD-owned recreation facilities on EML. Stakeholders also had an interest in the expansion of home hazardous waste pickup/drop off events into rural/unincorporated areas, as those efforts are currently only available to residents of participating cities. A summary of priority project areas, stakeholder

recommendations and associated load reductions for illegal dumping and litter accumulation are provided in Table 6-7.

Table 6-7 Recommended BMPs for illegal dumping and litter accumulation

Pollutant Source: Illegal Dumping and Litter Accumulation	
Concerns	(1) Multiple pollutants from illegally dumped materials leaching into local water resources, (2) Large dumped items restricting/redirecting flow in waterways
Potential Impacts	(1) Direct/indirect contamination of waterbodies from <i>E. coli</i> , nutrients, and hazardous materials, (2) Localized human health hazards, (3) Flow obstruction/alteration resulting in impoundment or erosion
Critical Areas for Implementation	(1) Riparian buffers. These estimates will be refined with more specific information prior to implementation, (2) All WFTR subwatersheds
Goal	(1) Reduce trash and litter in watershed, including hazardous waste, (2) Educate the public about watershed-related threats of illegal dumping
Objectives	(1) Continue hosting TRWD Trash Bashes at EML (2) Support other stakeholder entities engaging in cleanup events, (3) Increase education and outreach efforts pertaining to litter and illegal dumping through existing mass media campaigns
Recommendations	
Focal Groups	Management Practices
TRWD, residents	Continuation of annual TRWD Trash Bash cleanup; track participation and litter removed by year
Cities, counties, CDPs, NCTCOG	Work with county representatives and local leaders in unincorporated areas to institute hazardous waste pickup days or landfill drop-off days
Cities, counties, NCTCOG, HOAs, NAs, nonprofits, resource agencies	Coordinate with other watershed entities on public outreach/education opportunities via existing litter/illegal dumping mass media campaigns, educational resources, and illegal dumping hotlines or other monitoring efforts
Estimated Load Reductions	
BMPs recommended for illegal dumping and litter accumulation are not tied to a specific <i>E. coli</i> reduction, but it is likely that reductions in the incidence of <i>E. coli</i> will occur to some degree. Although this group of BMPs may not necessarily be tied to a load reduction, their visual nature garners community support and participation.	
Effectiveness	The "patchwork" urban/rural landscape of the watershed provides prime opportunities for illegal dumping activity. Treatment in this case is by direct removal of the pollutant source, exhibiting a high removal efficiency. Due to the highly visible nature of the pollutant source, identification takes minimal effort.
Certainty	Improving opportunities for proper waste disposal for those aware of the contamination concern is expected to yield little, if any, improvement, as illegal dumping typically takes place as a matter of convenience for perpetrators, and thus it will be difficult to convince them to modify their behavior. Therefore, it is assumed that the bulk of illegal dumping concerns will be addressed through enforcement of city ordinances and criminal investigations.
Commitment	Several municipalities have code enforcement staff currently available to handle illegal dumping activities but lack the staff to actively patrol for violations. Community engagement to provide these staff with the evidence they need via a regional hotline or each municipality's code violation submission process will improve their efficiency and response time.
Needs	Fund support of household hazardous waste pickup/drop-off and cleanup events; enforcement of existing illegal dumping codes once evidence has been provided.

6.9.2 Lawn Residue and Waste

Stakeholders evaluated concerns related to residue and waste from managed green spaces stemming from ignorance of the environmental impacts, lack of proper education/training, or potentially willful disregard of existing laws and ordinances. There is a lack of solid information required to make pollutant load estimates, meaning that lawn residue and waste could not be quantitatively compared to other pollutant sources. Despite this lack of information, stakeholders saw the benefits of including BMPs for this water quality concern, identifying it as a 2nd-tier priority to be addressed. As urbanization continues to spread, especially in the southern areas of the watershed closer to the lake, this will likely become an increasingly important component of nutrient abatement.

As is the case with many other pollutant sources, education and outreach initiatives are a vital first step. In this case, that entails ensuring that both staff and citizens have the knowledge to recognize behaviors that produce nutrient and DO concerns, which can consequently lead to fish kills, taste/odor problems in drinking water, or other impacts from eutrophication. Existing programs from TRWD, AgriLife Extension, NCTCOG, and others address low-input, low-waste landscaping solutions that are accessible and affordable for homeowners.

Impervious surfaces in developed and urbanized areas increase the amount of rainfall that becomes runoff. This increased overland flow can carry urban/suburban pollutants to nearby water bodies, even during small rainfall events. The variables are too numerous to model with certainty (urban fertilizer and pesticide use, construction sites, urban avian and terrestrial wildlife, trash and other waste, and many other nonpoint sources); however, any reduction in runoff will result in a reduction of pollutants reaching surface waterbodies. There are various stormwater/green infrastructure BMPs available to reduce the volume of stormwater that runs off developed sites, potentially decreasing the amount of pollutants entering the stream. Based on one study in Texas, implementing rainwater harvesting, permeable pavers and rain gardens in 20 percent-34 percent of properties with roofs and 31 percent to 47 percent of properties with parking lots, an estimated reduction in surface runoff varies from 14 percent to 29 percent and reduction in nitrate runoff varies between 24 percent and 30 percent (Seo et al, 2017). In another study, stormwater quality improvements were seen through installation of pervious pavement, raingardens, bioswales, and bioretention ponds that reduced pollutant loads by 25 percent-100 percent (Clary et al, 2017).

The TRWD RainScapes provides a model for GSI implementation. Education programs utilizing this resource are available to homeowners, municipal staff, and private landscaping and engineering firms in the Dallas-Fort Worth metropolitan area. A summary of priority project areas, stakeholder recommendations, and associated load reductions for lawn residue/waste are provided in Table 6-8.

Table 6-8 Recommended BMPs for lawn residue and waste

Pollutant Source: Lawn Residue and Waste	
Concerns	(1) Improper disposal of organic lawn waste, (2) Excessive fertilizer, herbicide, pesticide, or other chemical application on lawns and other open areas
Potential Impacts	(1) Direct/indirect contamination of waterbody from <i>E. coli</i> , nutrients, and hazardous materials; (2) Impacts to aquatic wildlife
Critical Areas for Implementation	(1) All WFTR subwatersheds, (2) Lake-adjacent urban subwatersheds, including WFTR5, WFTR6, WFTR7, WC2, (3) Managed open spaces (sports fields, golf courses, oil/gas pad sites). These estimates will be refined with more specific information prior to implementation.
Goal	Prevention of new nutrient-related concerns from developing as subwatersheds near the lake and the Fort Worth metropolitan area continue to densify.
Objectives	(1) Increase education and outreach efforts pertaining to proper handling of organic yard waste, (2) Promote use of residential/commercial lawn management

Recommendations	
Focal Groups	Management Practices
TRWD, Cities, counties, NCTCOG, regional entities, resource agencies	(1) Expand delivery of existing lawn waste education resources, develop/implement new educational resources (utility bill inserts, websites, pamphlets, videos, signage in public greenspaces/trails) (2) Deliver education programs (WaterWise, Healthy Lawns and Healthy Waters, TRWD programs) to residents/landscapers for proper lawn care, landscaping, and stormwater management, with soil nutrient testing opportunity
Residents, businesses, cities, counties	Incentivize use of GSI practices through demonstration projects (rainwater harvesting, permeable pavers, native and adapted plant gardens, etc.)
Estimated Load Reductions	
BMPs recommended for lawn residue/waste seek to reduce the amount of organic matter, nutrients, and chemicals reaching waterbodies via stormwater runoff and irrigation. Although the LDC analysis revealed that load reductions were only needed in two monitored tributaries, urban/suburban landscaping byproducts are expected to increase as the watershed urbanizes. It is expected that several of the BMPs recommended for <i>E. coli</i> reductions will also reduce nutrient loading, by either a) confining the organic matter to a landfill, b) on-site retention and composting, or c) more efficient applications of lawn additives. In doing so, the amount of organic matter, nutrients, and other chemicals from lawn waste and residue entering waterways via runoff from rainfall or irrigation will be reduced at values proportional to those of <i>E. coli</i> .	
Effectiveness	Effectiveness varies depending on the BMP of interest, with direct removal/reductions possible with respect to proper lawn waste management, but less direct benefits from lawn chemical application training/management.
Certainty	Education on properly managing lawn waste is a low-cost solution that most individuals can adopt easily. Adoption of structural GSI that mitigates inputs and therefore waste at municipal, commercial, and residential spaces is a higher burden that may require further incentives.
Commitment	Homeowner adherence to lawn waste management protocols can be fleeting, dependent on perceptions of convenience, aesthetics, and understanding of negative impacts. Most homeowners understand the impacts of over-application of lawn additives but may be uncomfortable with customizing their lawn care regimens even after receiving training to do so. Use of appropriate GSI BMPs that reduce waste can require higher upfront costs or retrofits that deter entities from utilization.
Needs	Funding for development and delivery of educational resources, funding of demonstration projects in the watershed.

6.10 Summary of Expected Load Reductions

While reductions to watershed-wide *E. coli* loads are the primary goal of this WPP, stakeholders chose to incorporate other water quality-related goals for the watershed. In many recent WPPs, education and outreach have become prominent components. While these can be effective means of achieving pollutant reductions, they are difficult to quantitatively measure due to the lengthy response time inherent to many BMPs that rely on behavioral change. The use of before/after surveys for these activities can be used to test knowledge gained but cannot predict what knowledge attendees will put into practice. Furthermore, any water quality improvements from education/outreach initiatives often run parallel to other recommended BMPs, particularly those targeted at reducing animal waste volumes. These BMPs provide direct, and often the most significant, reductions to *E. coli* loads. Activities targeted at correction/removal of SSOs, as well as malfunctioning OSSFs, will provide some additional relief for systems stressed by excessive *E. coli* loads. The total annual anticipated load reduction provided by the management measures is 3.29×10^{16} MPN/yr. This exceeds the reduction of 4.09×10^{14} MPN/yr

needed to remove the watershed from impaired status. Therefore, management measures that have co-benefits for reducing nutrients and sediment may take priority.

There is an expectation that steps taken to physically reduce *E. coli* loads would inherently reduce both nutrient and sediment loads as well. Additionally, measures related to illegal dumping and lawn waste and residues can reduce water quality concerns for nitrate and other pollutants. As indicated earlier, reductions of these nature are dependent on the level of participation, which cannot always be predicted.

WPP recommendations associated with cover cropping and cattle stocking rate have been modeled for their potential to reduce nutrients and sediment yield (Appendix C). The anticipated nutrient load reduction of these recommendations is 3.68 percent for nitrate and 48.66 percent for total phosphorus. The anticipated sediment yield reduction of these practices is 72.86 percent.

7 Plan Implementation

The management recommendations of the EML WPP will require technical and financial assistance. Technical assistance from partner agencies, non-profit groups, and stakeholders will promote implementation of the broad scope of projects recommended by stakeholders. The level of assistance required will vary by management recommendation, as will the need for financial assistance. Financial assistance must be matched with eligible management recommendations. Because implementation will require many moving parts in terms of personnel and financing, the schedule must be flexible. Interim milestones may be needed to track progress and adjust implementation as necessary.

7.1 Technical Assistance

Possible sources of technical assistance include federal, state, and local government entities; nonprofit organizations; wastewater infrastructure operators; and HOAs and NAs. Staff or members of some of these entities have already participated in the WPP as stakeholders.

Sources of technical assistance will vary depending on pollutant source and management recommendations. Possible providers of technical assistance are listed for categories of pollutant sources:

Livestock: NRCS and Farm Service Agency (FSA); AgriLife; soil and water conservation districts, nonprofit organizations

Pet Waste: Cities and counties; councils of governments; HOAs and NAs

Wastewater Infrastructure: cities and counties; wastewater infrastructure operators; HOAs and NAs

Sediment and Flooding: U.S. Army Corps of Engineers; cities and counties; AgriLife; councils of governments; nonprofit organizations

Illegal Dumping and Litter Accumulation: TRWD; cities and counties; councils of governments; nonprofit organizations; HOAs and NAs

Lawn Residue and Waste: TRWD; cities and counties; councils of governments; HOAs and NAs

The kinds of WPP-relevant technical assistance provided by these sources are described in Tables 6-1 through 6-8.

Technical assistance will be tied to financial assistance in some cases. For example, some NRCS programs provide both technical and financial assistance. These programs enable farmers and ranchers to implement conservation practices to improve water quality and reduce soil erosion and sedimentation.

7.2 Financial Assistance

Financial assistance is available as grants, loans, and in-kind contributions. TRWD will use in-kind contributions to fund staffing for as many EML WPP recommendations as possible. But additional financial assistance will be essential given the scope of the WPP recommendations. TRWD will seek funding from federal, state, and non-profit organizations. The following funding sources were available at the time the WPP was submitted for review. Potential applicants should confirm funding availability and funding cycles, because they could be impacted by federal and state decision making. Useful websites to review available programs include:

NRCS Programs & Initiatives: <https://www.nrcs.usda.gov/programs-initiatives>,
<https://www.nrcs.usda.gov/state-offices/texas#programs>

FSA Fund a Program: <https://www.fsa.usda.gov/resources/programs>

EPA Grants: <https://www.epa.gov/grants>

National Fish and Wildlife Foundation: <https://www.nfwf.org/programs>

National Rural Water Association: <https://nrwa.org/>

TCEQ: https://www.tceq.texas.gov/agency/water_main.html

TWDB Financial Assistance Programs: <https://www.twdb.texas.gov/financial/programs/index.asp>

TSSWCB: <https://tsswcb.texas.gov/programs>

TPWD: <https://tpwd.texas.gov/landwater/land/private/>

Texas A&M Forest Service (TAMFS): <https://tfsweb.tamu.edu/grants-financial-assistance/>

TAMFS also hosts a Funding Connector web tool that identifies federal, state, and other financial assistance for land stewardship in Texas, <https://texasforestinfo.tamu.edu/fundingconnector/>.

The following list of financial assistance sources includes descriptions of practices funded under each program. The practices described are limited to Texas and practices relevant to implementing the WPP; most programs support a broader range of practices than described here.

7.2.1 U.S. Department of Agriculture Financial Assistance

Agricultural Conservation Easement Program (ACEP) — Agricultural Land Easements (ALE)

Funder: USDA/NRCS

Eligibility: Agricultural land owners, land trusts, state and local governments, and nongovernmental organizations

Description: Provides financial assistance to partners for purchasing Agricultural Land Easements that protect the agricultural use and conservation values of land.

Funding Cycle: Applications accepted year-round but see <https://www.nrcs.usda.gov/ranking-dates> for state-specific ranking dates. Competitive process.

Source: <https://www.nrcs.usda.gov/programs-initiatives/ale-agricultural-land-easements>

Agricultural Conservation Easement Program (ACEP) — Wetland Reserve Easements (WRE)

Funder: USDA/NRCS

Eligibility: American Indian tribes and agricultural land owners with farmed or converted wetlands

Description: Provides technical and financial assistance directly to private landowners and American Indian tribes to restore, enhance, and protect wetlands through the purchase of a wetland reserve easement.

Funding Cycle: Applications accepted year-round but see <https://www.nrcs.usda.gov/ranking-dates> for state-specific ranking dates. Competitive process.

Source: <https://www.nrcs.usda.gov/programs-initiatives/wetland-reserve-easements>

Conservation Innovation Grants (CIG)

Funder: USDA/NRCS

Eligibility: State or local governments, federally recognized American Indian tribes, non-governmental organizations, and individuals

Description: Drives public- and private-sector innovation in resource conservation by developing tools, technologies, and strategies to support next-generation conservation efforts on working lands and supporting on-farm trials of innovative practices.

Funding Cycle: Competitive grants with variable timing for funding announcement; natural resource focus may vary from year to year

Source: <https://www.nrcs.usda.gov/programs-initiatives/conservation-innovation-grants>

Conservation Reserve Program (CRP)

Funder: USDA/FSA

Eligibility: Agricultural producers and landowners with environmentally sensitive land that meets criteria related to cropping history and environmental characteristics

Description: Provides rental payments and cost-share assistance to convert highly erodible and other environmentally sensitive acreage to vegetative cover, such as native grasses, trees, and riparian buffers.

Funding Cycle: Varies based on the type of signup; contact local FSA office

Source: <https://www.fsa.usda.gov/resources/programs/conservation-reserve-program>

Conservation Stewardship Program (CSP)

Funder: USDA/NRCS

Eligibility: Farmers, ranchers, and forest landowners who own or rent agricultural land and have already been doing conservation work

Description: Compensates agricultural and forest producers who increase their level of conservation activities while maintaining their baseline level of conservation.

Funding Cycle: Applications accepted year-round but see <https://www.nrcs.usda.gov/ranking-dates> for state-specific ranking dates.

Source: <https://www.nrcs.usda.gov/programs-initiatives/conservation-stewardship-program>

Emergency Watershed Protection (EWP) Program

Funder: USDA/NRCS

Eligibility: Public and private landowners working through a sponsor such as a city, county, town, or conservation district and located in a watershed where the NRCS State Conservationist has declared a local watershed emergency.

Description: Offers financial and technical assistance to relieve imminent threats to life and property caused by natural disasters that impair a watershed. Activities can include removing debris from stream channels, reshaping and protecting eroded streambanks, establishing vegetative cover on critically eroding lands, repairing levees, and repairing certain conservation practices.

Funding Cycle: Following declaration of a local watershed emergency

Source: <https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection/texas/emergency-watershed-protection-texas>

Environmental Quality Incentives Program (EQIP)

Funder: USDA/NRCS

Eligibility: Farmers, ranchers, and forest landowners who own or rent agricultural land

Description: Provides technical and financial assistance to implement conservation practices that improve water and air quality; conserve ground and surface water; increase soil health and reduce soil erosion and sedimentation; improve or create wildlife habitat; and mitigate against drought and increasing weather volatility.

Funding Cycle: Applications accepted year-round but see <https://www.nrcs.usda.gov/ranking-dates> for state-specific ranking dates.

Source: <https://www.nrcs.usda.gov/programs-initiatives/environmental-quality-incentives-program>

Farmable Wetlands Program (FWP)

Funder: USDA/FSA

Eligibility: Farmers and landowners with previously cropped land suitable for wetland restoration

Description: Provides payments for restoration of farmable wetlands, including establishing vegetative cover and installing conservation structures to control water flow and improve habitat.

Funding cycle: Contact FSA

Source: <https://www.fsa.usda.gov/resources/programs/farmable-wetlands-program>

"Grassroots" Source Water Protection Program (SWPP)

Funder: USDA/FSA/NRWA

Eligibility: Small water utilities, local businesses, agriculture, government, and others

Description: Identifies areas with need for pollution prevention and identifies voluntary actions farmers and ranchers can install to prevent source water pollution.

Funding Cycle: Contact local FSA office

Source: <https://nrwa.org/sourcewater-protection-program/>, <https://www.fsa.usda.gov/programs-and-services/conservation-programs/source-water-protection>

Grazing Lands Conservation Initiative (GLCI)

Funder: USDA/NRCS

Eligibility: Contact the National Grazing Lands Coordinator for information

Description: Leverages partner capacity, expertise, and technical assistance for livestock producers to increase the use of conservation practices on grazing lands.

Funding Cycle: Contact NRCS

Source: <https://www.nrcs.usda.gov/programs-initiatives/grazing-lands-conservation-initiative>

National Water Quality Initiative (NWQI)

Funder: USDA/NRCS in partnership with state water quality agencies, local conservation districts, and EPA

Eligibility: Farmers, ranchers, and forest landowners in watersheds identified as impaired, threatened, or critical

Description: Identifies and address impaired water bodies through voluntary, on-farm conservation investments and focused water quality monitoring and assessment resources. Includes source water protection for surface and ground water public water systems.

Funding Cycle: Contact local NRCS office

Source: <https://www.nrcs.usda.gov/programs-initiatives/national-water-quality-initiative>

Regenerative Pilot Program (RPP)

Funder: USDA/NRCS

Eligibility: Farmers and ranchers

Description: Addresses whole-farm resource concerns through support for voluntary regenerative agriculture conservation plans by bundling regenerative practices into a single application. Associated with the EQIP and CSP programs.

Funding Cycle: Applications should be submitted by January 15, 2026. It's not clear if this program will be annual or is a one-time thing. Well, because it is a pilot program.

Source: <https://www.nrcs.usda.gov/programs-initiatives/regenerative-pilot-program>

Regional Conservation Partnership Program (RCPP) Alternative Funding Arrangements (AFAs)

Funder: USDA/NRCS

Eligibility: Agricultural or silvicultural producer associations, state or local governments, Indian tribes, farmer cooperatives, water districts or organizations that deliver water to agricultural producers, municipal water or wastewater treatment entities, institutes of higher education, organizations that have previously worked with NRCS, entities that have a farmland or grassland protection program that purchases land easements, conservation districts

Description: Reimburses partners for conservation activities done for or on behalf of producers, landowners, or other entities.

Funding Cycle: Contact local NRCS office

Source: <https://www.nrcs.usda.gov/programs-initiatives/regional-conservation-partnership-program>

Regional Conservation Partnership Program (RCPP) Classic

Funder: USDA/NRCS

Eligibility: Agricultural or silvicultural producer associations, state or local governments, Indian tribes, farmer cooperatives, water districts or organizations that deliver water to agricultural producers, municipal water or wastewater treatment entities, institutes of higher education, organizations that have previously worked with NRCS, entities that have a farmland or grassland protection program that purchases land easements, conservation districts

Description: Promotes public/private partnerships using NRCS contracts and easements with producers, landowners and communities, in collaboration with project partners.

Funding Cycle: Contact local NRCS office

Source: <https://www.nrcs.usda.gov/programs-initiatives/regional-conservation-partnership-program>

Voluntary Public Access and Habitat Incentive Program (VPA-HIP)

Funder: USDA/NRCS

Eligibility: State and tribal governments

Description: Helps state and tribal governments encourage landowners to allow public access to their land for hunting, fishing, and other wildlife-dependent recreation. Provides incentives to improve wildlife habitat on enrolled public access program lands.

Funding Cycle: Competitive grants program; contact USDA

Source: <https://www.nrcs.usda.gov/programs-initiatives/voluntary-public-access-and-habitat-incentive-program>

Watershed Protection and Flood Prevention Operations (WFPO) Program

Funder: USDA/NRCS

Eligibility: Units of federal, state, local, and federally recognized tribal governments

Description: Plans and implements watershed programs related to watershed protection, flood prevention, municipal water supply, water quality management, public fish and wildlife, and other benefits. Agricultural benefits, including rural communities, must be $\geq 20\%$ of the total benefits for the project. Includes conservation easements for wetlands or floodplains.

Funding Cycle: Contact local NRCS office

Source: <https://www.nrcs.usda.gov/programs-initiatives/watershed-protection-and-flood-prevention-operations-program>

7.2.2 Environmental Protection Agency Financial Assistance

Clean Water Act Section 319(h) (CWA §319)

Funder: EPA/TCEQ

Eligibility: Designated state and tribal agencies

Description: Supports nonpoint source management programs, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

Funding Cycle: Annual formula funds

Source: <https://www.epa.gov/nps/cwa-ss319-grant-current-guidance>

Environmental Education (EE) Grants

Funder: EPA

Eligibility: Local education agencies, state education or environmental agencies, colleges or universities, non-profit organizations, non-commercial educational broadcasting entities, tribal education agencies

Description: Promotes environmental awareness and stewardship and helps provide people with the skills to take responsible actions to protect the environment. Environmental priorities can vary from year to year.

Funding Cycle: Notice of funding opportunity issued annually

Source: <https://www.epa.gov/education/grants>

Midsize and Large Drinking Water System Infrastructure Resilience and Sustainability Program (IRSP)

Funder: EPA

Eligibility: Medium and large size public water systems

Description: Funds programs or projects that increase the resilience of public water systems to natural hazards, including drinking water infrastructure resiliency measures against natural hazards.

Funding Cycle: Contact EPA

Source: <https://www.epa.gov/dwcapacity/midsize-and-large-drinking-water-system-infrastructure-resilience-and-sustainability#Eligible%20Applicants>

Water Pollution Control (Section 106) Grant Program

Funder: EPA

Eligibility: States, interstate agencies, and eligible tribes

Description: Supports water pollution prevention and control programs and activities, including monitoring and assessing water quality, developing water quality standards, identifying impaired waters and TMDLs, protecting source water, and managing outreach and education programs.

Funding Cycle: Formula funds provided annually to states and interstate agencies

Source: <https://www.epa.gov/water-pollution-control-section-106-grants>

Wetland Program Development Grants (WPDGs)

Funder: EPA

Eligibility: States, tribes, local governments, interstate associations, and intertribal consortia are eligible to apply for the Regional WPDG requests for proposals (RFPs); nonprofits, interstate associations, and intertribal consortia are eligible to apply for the National WPDG RFPs

Description: Promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys and studies relating to the causes, effects, extent, prevention, reduction and elimination of water pollution

Funding Cycle: RFPs typically issued in the spring time

Source: <https://www.epa.gov/wetlands/wetland-program-development-grants-and-epa-wetlands-grant-coordinators>

7.2.3 National Fish and Wildlife Foundation

America's Ecosystem Restoration Initiative (AERI)/Private Forests, Rangeland and Farmland Grants

Funder: NFWF and public and private partners

Eligibility: Nonprofit organizations, states, tribal nations, territories, local and municipal governments, and educational institutions

Description: Supports outreach and engagement with private landowners for voluntary conservation efforts on working lands

Funding Cycle: Contact National Fish and Wildlife Foundation

Source: <https://www.nfwf.org/programs/americas-ecosystem-restoration-initiative?activeTab=tab-3>

Conservation Partners Program (CPP)

Funder: National Fish and Wildlife Foundation and public and private partners

Eligibility: Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, tribal governments and organizations, and educational institutions serving geographic focus areas, including the Great Plains in Texas

Description: Accelerates the adoption of regenerative agriculture principles and conservation practices on private lands at a landscape scale; provides technical assistance to landowners and operators, including assistance to enroll in Farm Bill conservation programs.

Funding Cycle: Contact National Fish and Wildlife Foundation

Source: <https://www.nfwf.org/programs/conservation-partners-program>

Five Star and Urban Waters Restoration Program (5SUWRP)

Funder: National Fish and Wildlife Foundation (NFWF) and public and private partners

Eligibility: Local governments, universities, school districts, nonprofit organizations, and others

Description: Funds on-the-ground restoration or green infrastructure activities that integrate education, outreach, and training; community partnerships for ecological and educational outcomes; and measurable benefits.

Funding Cycle: Contact National Fish and Wildlife Foundation

Source: <https://www.nfwf.org/programs/five-star-program?activeTab=tab-3>

Grassland Resilience and Conservation Initiative (GRCI)

Funder: NFWF and public and private partners

Eligibility: NFWF partner organizations (may expand in future years) serving grasslands including the Great Plains

Description: Funds projects that provide technical and financial assistance to ranchers seeking to adopt voluntary conservation and grazing management practices. Grantees will hire or support field conservation professionals to help ranchers develop and implement economically sound management plans and practices.

Funding Cycle: Contact National Fish and Wildlife Foundation

Source: <https://www.nfwf.org/programs/grassland-resilience-and-conservation-initiative?activeTab=tab-3>

7.2.4 U.S. Department of Housing and Urban Development

Community Development Block Grant (CDBG) Program

Funder: U.S. Department of Housing and Urban Development

Eligibility: Qualified cities, qualified urban counties, states

Description: Supports acquisition of real property and construction of water and sewer facilities.

Funding Cycle: Annual grants

Source: <https://www.hud.gov/hud-partners/community-cdbg#top>

7.2.5 National Rural Water Association

Decentralized Wastewater Technical Assistance and Training Program (DWTATP)

Funder: National Rural Water Association (NRWA)

Eligibility: Small and rural communities

Description: Identifies solutions to community water and wastewater problems and assists with improving management and operations of wastewater systems

Funding Cycle: Contact NRWA

Source: <https://nrwa.org/decentralized-wastewater-technical-assistance-and-training-program/>

7.2.6 Texas A&M Forest Service

Community Forestry Grants (CFG)

Funder: TAMFS

Eligibility: Public or non-profit entities

Description: Helps communities develop sustainable programs that provide Texans with healthy trees and forests.

Funding Cycle: Contact TAMFS

Source: <https://tfsweb.tamu.edu/grants-financial-assistance/community-grants-and-programs/community-forestry-grants/>

Texas Resilient Landscapes Initiative (TRLI)

Funder: TAMFS

Eligibility: Properties with tree loss from natural disasters within the last 10 years with a minimum project area of 10 acres and maximum of 150 acres for the replanting efforts. Non-federal, non-industrial forest/woodland landowners in good standing with the State of Texas. Must have a written stewardship plan prior to reimbursement.

Description: Builds resilience in Texas forests and woodland ecosystems by leveraging funding to support reforestation efforts in areas that have experienced tree damage due to natural disasters within the last 10 years. This includes tree loss from fire, flood, wind/ice storms, tornadoes, hurricanes, drought, insect, and disease issues.

Funding Cycle: Contact TAMFS

Source: <https://tfsweb.tamu.edu/grants-financial-assistance/landowner-grants/texas-resilient-landscapes-initiative/>

Watershed Protection Plan Implementation Grant (WPPIG)

Funder: TAMFS

Eligibility: Municipalities, public utility districts, state agencies, non-profit organizations, non-governmental organizations, tribal entities, and community-based organizations

Description: Supports up to 15 \$50,000 grants over five years to implement tree and forestry components of approved WPPs.

Funding Cycle: Contact TAMFS

Source: <https://tfsweb.tamu.edu/grants-financial-assistance/community-grants-and-programs/watershed-protection-plan-implementation-grants/>

7.2.7 Texas Commission on Environmental Quality

Supplemental Environmental Projects (SEP) Program

Funder: Respondent or eligible and financially qualified local governments

Eligibility: Businesses or individuals who have failed to comply with environmental laws and are facing an enforcement settlement

Description: Funds TCEQ-approved environmental projects to offset assessed penalties in enforcement actions. Respondent can contribute to a pre-approved SEP performed by a third party; respondent can perform the project with their own resources; or an eligible local government may correct alleged violations or remediate environmental harm caused by alleged violations.

Funding Cycle: Contact TCEQ

Source: <https://www.tceq.texas.gov/compliance/enforcement/sep>

Texas Clean Rivers Program (TCRP)

Funder: TCEQ

Eligibility: River authorities

Description: Identifies and evaluates water quality issues, establishes priorities for corrective action, works to implement those actions, and adapts to changing priorities.

Funding Cycle: Contact TCEQ

Source: <https://www.tceq.texas.gov/waterquality/clean-rivers/index.html#Fund>

7.2.8 Texas Water Development Board

Agricultural Water Conservation Grant and Loan Programs (AWCG)

Funder: TWDB

Eligibility: State agencies and political subdivisions

Description: Funds agricultural water conservation programs and projects, including technical assistance, technology transfer, demonstrations, education and preparation of dry land for more efficient use of natural precipitation.

Funding Cycle: Closes in March

Source: <https://www.twdb.texas.gov/financial/programs/AWCG/index.asp>

Clean Water State Revolving Fund (CWSRF)

Funder: EPA/TWDB

Eligibility: Political subdivisions, federally authorized tribal organizations, private entities (for nonpoint source or estuary projects only)

Description: Provides low-cost financing for wastewater, stormwater, reuse, and other pollution control projects, including stormwater control, nonpoint source pollution control projects such as failing on-site systems, wetlands restoration, conservation easements, and agricultural BMPs.

Funding Cycle: Opens in December of every year and closes in March of the following year

Source: <https://www.twdb.texas.gov/financial/programs/CWSRF/>, <https://www.epa.gov/cwsrf/clean-water-state-revolving-fund-cwsrf-agricultural-best-management-practices>

Drinking Water State Revolving Fund (DWSRF) Loan Program

Funder: EPA/TWDB

Eligibility: Publicly and privately owned community water systems; nonprofit water supply corporations; nonprofit, noncommunity public water systems; state agencies

Description: Provides low-cost financing for water projects that facilitate compliance with drinking water standards, including implementing green projects (pursuant to EPA guidance) and source water protection projects. Projects must be consistent with the State Water Plan.

Funding Cycle: Opens in December of every year and closes in March of the following year

Source: <https://www.twdb.texas.gov/financial/programs/DWSRF/index.asp>

Economically Distressed Areas Program (EDAP)

Funder: TWDB

Eligibility: Cities, counties, water districts, nonprofit water supply corporations, and all other political subdivisions; projects must be located in an economically distressed area as defined by TWDB

Description: Provides loans to address failing on-site sewage systems or wells or for existing water or wastewater systems that do not meet minimum state standards.

Funding Cycle: Contact TWDB

Source: <https://www.twdb.texas.gov/financial/programs/EDAP/index.asp>

Rural Water Assistance Fund (RWF)

Funder: TWDB

Eligibility: Rural political subdivisions

Description: Assists small rural utilities to obtain low-cost financing for water and wastewater projects, including water quality enhancements such as wetland wastewater treatment facilities and nonpoint source pollution abatement.

Funding Cycle: Not currently accepting applications; contact TWDB

Source: <https://www.twdb.texas.gov/financial/programs/RWF/index.asp>

Texas Water Development Fund (DFund)

Funder: TWDB

Eligibility: Political subdivisions of the state, including cities, counties, districts, and river authorities

Description: Funds planning, design, and construction for water supply and wastewater projects and for structural and nonstructural flood protection improvements. Wastewater projects include nonpoint source pollution abatement.

Funding Cycle: Closes in December

Source: <https://www.twdb.texas.gov/financial/programs/TWDF/index.asp>

Water Supply and Infrastructure Grants (WSIG)

Funder: TWDB

Eligibility: Cities, districts, counties, river authorities, and other political subdivisions

Description: Funds projects that address water loss, a TCEQ violation, or provide additional water supply, including source water protection through land acquisition and conservation (the latter for population sizes no larger than 150,000). Projects must be consistent with the 2027 State Water Plan.

Funding Cycle: One-time opportunity with applications due July 2026

Source: <https://www.twdb.texas.gov/financial/programs/WSIG/index.asp>

7.2.9 Texas State Soil and Water Conservation Board

Water Quality Management Plan Program (WQMP)

Funder: TSSWCB

Eligibility: Owners of agricultural or silvicultural lands

Description: Assists with developing a WQMP for a landowner; provides cost-shares for implementing strategies from WQMPs.

Funding Cycle: Contact TSSWCB

Source: <https://tsswcb.texas.gov/programs/water-quality-management-plan>

Water Supply Enhancement Program (WSEP)

Funder: TSSWCB

Eligibility: Contact TSSWCB

Description: Uses a competitive grant process to implement targeted brush control of species that are detrimental to water conservation.

Funding Cycle: Contact TSSWCB

Source: <https://tsswcb.texas.gov/programs/water-supply-enhancement-program>

7.2.10 Texas Parks and Wildlife Department

Landowner Incentive Program (LIP)

Funder: TPWD

Eligibility: Private, non-federal landowners

Description: Funds projects that enhance and protect wildlife habitat and/or enhance target watersheds. Common practices include native plant restoration, control of exotic vegetation, prescribed burning, selective brush management, wetland enhancement, riparian restoration, and forest stand improvement.

Funding Cycle: Contact TPWD

Source: <https://tpwd.texas.gov/landwater/land/private/lip/>

Texas Farm and Ranch Lands Conservation Program (TFRLCP)

Funder: TPWD

Eligibility: Agricultural land owners

Description: Maintains and enhances the ecological and agricultural productivity of working lands through Agricultural Conservation Easements.

Funding Cycle: The next funding cycle will open in July 2027

Source: <https://tpwd.texas.gov/landwater/land/private/farm-and-ranch/>

7.2.11 Texas Department of Agriculture

Texas Community Development Block Grant (TxCDBG)

Funder: U.S. Department of Housing and Urban Development

Eligibility: Non-entitlement cities under 50,000 in population and non-entitlement counties with a non-metropolitan population under 200,000 in the non-entitlement cities and unincorporated areas of the county

Description: Supports public improvement projects including water/sewer improvements.

Funding Cycle: Two-year application cycle

Source: <https://texasagriculture.gov/Grants-Services/Rural-Economic-Development/-TxCDBG-Rural-Community-Development-Block-Grant>

7.2.12 Councils of Governments

Solid Waste Program Call for Projects (SWPCFP)

Funder: Nortex Regional Planning Commission/Texas Commission on Environmental Quality

Eligibility: Cities, counties, public schools and school districts, general and special law districts with authority and responsibility for water quality protection or municipal solid waste management; must be within Nortex's 11-county region

Description: Funds local and regional implementation of solid waste projects, plans, studies, enforcement, cleanups, and education and training.

Funding Cycle: Call for projects every two years

Source: <https://nortexrpc.org/>

SWPCFP

Funder: NCTCOG/TCEQ

Eligibility: Cities, counties, public schools and school districts, general and special law districts with authority and responsibility for water quality protection or municipal solid waste management; must be within NCTCOG's 16-county region

Description: Funds local and regional implementation of solid waste projects, plans, studies, enforcement, cleanups, and education and training.

Funding Cycle: Call for projects every two years

Source: <https://www.nctcog.org/envir/Materials-Management/Grants>

7.2.13 Private Funding Sources

Member Collective Grants (MCG)

Funder: The Conservation Alliance

Eligibility: Local and national nonprofit organizations, Tribes, and groups with fiscal sponsorship

Description: Funds projects that establish long-term protection for land and/or water or that support management processes and planning that promote the climate resiliency and biodiversity of protected areas.

Funding Cycle: Annual

Source: <https://conservationalliance.com/member-collective-grants/>

The Cynthia & George Mitchell Foundation (CGMF) Grant

Funder: The Cynthia & George Mitchell Foundation

Eligibility: 501(c)(3) public charities

Description: Funds projects related to conservation including capacity building and finance and stewardship incentives; sustainability education; and water, including water quality.

Funding Cycle: Submit a Letter of Inquiry

Source: <https://cgmf.org/p/home.html>

Environmental Fund of Texas (EFT) Grant

Funder: EFT

Eligibility: 501(c)(3) charities; public, tax-exempt schools for teacher projects

Description: Supports projects that engage volunteers and local communities in on-the-ground conservation action related to protecting natural water sources and their watersheds; protecting, restoring, and providing stewardship of ecologically functional natural areas; protecting and sustaining native, at-risk wildlife; and engaging local classrooms, teachers, and students in conservation action.

Funding Cycle: Year-round

Source: <https://www.efundtexas.org/grant-guidelines>

Communities Foundation of Texas (CFT) Community Grants

Funder: CFT

Eligibility: 501(c)(3) tax-exempt designation from the Internal Revenue Service that has been active for at least two years; serves population in the broader North Texas area

Description: Provides resources to nonprofits to help them achieve their missions.

Funding Cycle: Contact CFT

Source: <https://www.cftexas.org/nonprofits/>

Carbon Sequestration (CS)

Funder: Multiple organizations

Eligibility: Ability to meet requirements of organizations that pay agricultural producers for implementing practices that sequester carbon in soil

Description: Organizations are emerging that pay ag producers to implement practices that sequester carbon in soil. These organizations in turn sell credits to companies to offset those companies' carbon impacts.

Funding Cycle: Contact carbon sequestration organizations

7.3 Schedule, Interim Schedule Milestones, and Estimated Costs

Implementation is planned to occur over 10 years. Implementation will begin upon approval of the plan by state and federal agencies. The implementation schedule should end 10 years following the start of implementation. The implementation schedule, however, is subject to funding availability. The schedule also is subject to factors such as staff turnover and delayed project initiation. Modifications to the planned 10-year implementation schedule and list of feasible BMPs may be necessary.

Early emphasis for implementation will be on projects that have lower management needs, favorable cost-to-benefit ratios, and the ability to significantly reduce loadings for *E. coli* and other contaminants. These “low-hanging fruits” are often projects that have been widely utilized across the state or nation with documented and significant positive influence on water quality. If further reductions are required after implementation of these projects, stakeholders may choose to proceed with incrementally less favorable, more cumbersome, or more costly methods of load reduction.

Table 7-1 identifies an implementation schedule and estimated costs for each management measure recommended in Tables 6-1 through 6-8. Potential funding sources are identified by the acronyms provided in Section 7.2. Estimated costs are just that – planning-level estimates. Costs for time and materials are subject to change over time. Management measures that are considered an existing part of staff responsibilities do not include costs for staff hours. TRWD will develop detailed implementation budgets for management measures closer to implementation; in some cases, these budgets will be necessary to apply for funding.

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Table 7-1 WPP implementation schedule

Management Measure	Responsible Party	Unit Cost (\$) ^{1,2}	Units Implemented by Years					Total Cost (\$) ³	Potential Funding Sources
			1-2	3-4	5-6	7-8	9-10		
Livestock									
WQMPs and CPs	Producers, NRCS, SWCDs	Variable based on resources to be addressed in plan	20	40	40	40	40	Variable based on resources to be addressed in plan	WQMP, CRP, CSP, EQIP, SWPP, GLCI, NWQI, RPP, RCPP/AFA, RCPP, VPA-HIP, WFPO, CWA §319, IRSP, AERI, CPP, 5SUWRP, GRCl, TCRP, AWCG, WQMP, WSEP, LIP, TFRLCP, MCG, CGMF, EFT, TRLI, WPPIG, CS
Education and outreach programs	Producers, hobby farmers, NRCS, SWCDs, nonprofits	\$10,000	2	2	2	2	2	\$100,000	ACEP, WRE, CIG, EQIP, SWPP, GLCI, NWQI, RCPP/AFA, RCPP, VPA-HIP, WFPO, CWA §319, EE, Section 106, WPDG, AERI, CPP, 5SUWRP, GRCl, AWCG, WQMP, CGMF, EFT, CFT, CS
Pet Waste									
Education and outreach general	Cities, counties, NCTCOG, regional entities, residents	\$10,000	2	2	2	2	2	\$100,000	CWA §319, EE, Section 106, 5SUWRP, CGMF, EFT, CFT
Pet waste ordinance/regulation adoption	Cities, counties	N/A	As early as feasible					N/A	N/A
Materials for pet waste station installation	Cities, counties, HOAs, NAs	\$450	8	12	12	12	12	\$25,200	CWA §319
Pet waste station bags/replacements 4x year through implementation timeline		\$85	8	12	12	12	12	\$74,800	CWA §319
Install bioswales at parks and dog parks		\$40/square foot	0	2	2	2	2	Variable by square footage installed	CWA §319, 5SUWRP, CWSRF, DWSRF
Wildlife									
Education and outreach	TPWD, cities	\$10,000	2	2	2	2	2	\$100,000	CWA §319, EE, Section 106, 5SUWRP, CGMF, EFT, CFT
OSSFs									
Incentives for inspection and/or pump out	Residents, HOAs, NAs	\$350 ⁴	50	100	100	100	100	\$157,500	CWA §319, DWTATP, CWSRF, EDAP, RWAf

Coordination of neighborhood-wide inspection/pump out days		N/A	Assistance/input as needed					N/A	CWA §319, DWTATP, CWSRF, EDAP, RWAF
Incentives to replace failing OSSFs		\$8,000 ⁴	0	10	10	10	10	\$320,000	CWA §319, CDBG, DWTATP, CWSRF, EDAP, RWAF, DFund, TxCDBG
Education and outreach for homeowners	Residents, HOAs, NAs, cities, counties, AgriLife	\$10,000	2	2	2	2	2	\$100,000	CWA §319, Section 106, CWSRF, DWSRF, EDAP
Education and outreach for real estate professionals	Real estate agents, OSSF professionals	\$10,000	0	1	1	1	1	\$40,000	CWA §319, Section 106, CWSRF, DWSRF, EDAP
Septic to sewer programs	Cities, counties	\$750,000	0	1	1	1	1	\$3,000,000	CDBG, TxCDBG
Adoption of ordinances/laws/regulations to require inspection before ownership transitions	Cities, counties	N/A	As early as feasible					N/A	N/A
WWTFs and SSOs									
ID recurring/high volume SSOs for rehab	Wastewater infrastructure operators	Variable based on size of project, but can run from tens of thousands of dollars to millions of dollars	0	1	1	1	1	N/A	CWA §319, Section 106, CDBG, WPDG, DWTATP, TCRP, CWSRF, DWSRF, EDAP, RWAF, DFund, TxCDBG, water and wastewater impact fees, bonds
Address effluent violations			As identified/needed/funding available					N/A	CWA §319, Section 106, CDBG, WPDG, DWTATP, TCRP, CWSRF, DWSRF, EDAP, RWAF, DFund, TxCDBG, water and wastewater impact fees, bonds
Tie new facilities to existing wastewater networks			As identified/needed/funding available					N/A	CWA §319, Section 106, CDBG, WPDG, DWTATP, TCRP, CWSRF, DWSRF, EDAP, RWAF, DFund, TxCDBG, water and wastewater impact fees, bonds
Stormwater infrastructure assessments	Cities, Counties	N/A	Ongoing responsibility of local jurisdictions					N/A	CWA §319, Section 106, CDBG, WPDG, DWTATP, TCRP, CWSRF, DWSRF, EDAP, RWAF, DFund, TxCDBG, stormwater fees
Incentivize installation of GSI	Cities, commercial properties, developers	\$5,000-\$10,000	2	4	4	4	4	\$90,000-\$180,000	CWA §319, CWSRF, DWSRF, EDAP, stormwater fees

Education and outreach about protection of wastewater infrastructure	Cities, counties, NCTCOG	\$10,000	2	2	2	2	2	\$100,000	EE, Stormwater fees, MCG, CGMF, EFT, CFT	
Sediment and Flooding										
Riparian, wetland, or stream restoration projects	USACE, cities, counties, State partners, nonprofits/volunteer groups	Estimates range from \$3,000-\$46,000 per acre for riparian; \$10,000-\$20,000 per acre for wetland; \$64,000-\$2.6 million/river mile for stream restoration	As identified/needed/funding available				N/A	ACEP-WRE, CRP, CSP, EQIP, EWP, FWP, SWPP, GLCI, NWQI, RPP, RCPP/AFA, VPA-HIP, WFPO, CWA §319, AERI, CPP, 5SUWRP, GRCl, TCRP, AWCG, CWSRF, WQMP, LIP, MCG, EFT, CFG, TRLI, WPPIG		
Conservation easements	Landowners, land trusts, State and Federal agencies	\$50,000-\$75,000 in landowner costs, depending on easement size	0	1	1	1	1	\$200,000-\$300,000	ACEP/ALE, ACEP/WRE, RCPP/AFA, RCPP Classic, WFPO, CPP, TFR LCP	
Mitigation banks	Mitigation banking companies	N/A	Driven by demand for mitigation credits, which is typically spurred by development				N/A	Investors, speculators, landowners, purchases of mitigation credits		
Open space or parkland purchases	Landowners, cities and counties, partner companies	Varies from tens of thousands of dollars to more than \$1 million, depending on parcel size	0	1	1	1	1	N/A	Bond programs, public-private partnerships, DFund	
Education and outreach, including promotion of iSWM™	Producers, SWCDs, NRCS, cities, counties, NCTCOG, developers, land trusts	\$10,000	2	2	2	2	2	\$100,000	CIG, EQIP, FWP, SWPP, GLCI, RPP, RCPP/AFA, WFPO, CWA §319, EE, WPDG, AERI, CPP, 5SUWRP, GRCl, AWCG, CWSRF, MCG, CGMF, EFT, CFT	
Illegal Dumping and Litter Accumulation										
Trash Bashes and other TRWD litter-related public engagement programs	TRWD, residents	\$1,000-\$20,000	3	3	3	3	3	\$205,000-\$275,000	5SUWRP, TRWD, NCTCOG, NRPC, local sponsors	

Litter trap installation	TRWD, cities and counties	\$490,000	As needed/identified/funding available					N/A	TRWD
Hazardous and other waste pickups and landfill drop-off days (chemicals, electronics, and tires)	Cities and counties, trash and recycling companies, RC&Ds	\$100,000-\$150,000 first year with reduced costs for subsequent years	9	18	18	18	18	\$7,350,000	5SUWRP, NCTCOG, NRPC
Education and outreach	Cities and counties, NCTCOG, HOAs, nonprofits	\$10,000	2	2	2	2	2	\$100,000	CWA §319, EE, 5SUWRP, NCTCOG, CGMF, EFT
Lawn Residue and Waste									
Education and outreach general	TRWD, cities and counties, NCTCOG,	\$10,000	2	2	2	2	2	\$100,000	CWA §319, EE, 5SUWRP, CGMF, EFT
Public programming (workshops)	State agencies, nonprofits	\$5,000	1	2	2	2	2	\$45,000	CWA §319, EE
Demonstration projects	Residents, businesses, cities and counties	\$15,000	1	2	2	2	2	\$135,000	CWA §319, EE
Curbside collection, drop-off centers, seasonal collection events	Landowners, cities	N/A	Ongoing responsibility of local jurisdictions or of landowners in areas without service				N/A	Fees	
Data Gaps									
Efforts to identify locations of production agriculture in critical areas	Producers, NRCS, SWCDs	Variable	2	2	2	1	0	Variable	CWA §319
Installation and sponsorship of additional USGS gage	TRWD, USGS	\$100,000	0	1	0	0	0	\$100,000	CWA §319, Section 106
Methods developed for measuring stream flow on tributaries without USGS gages	TRWD, consultants	Variable	2	1	0	0	0	Variable	CWA §319, Section 106
Methods for measuring sedimentation	TRWD, consultants	Variable	2	1	0	0	0		CWA §319, Section 106
Upstream/downstream or before-and-after monitoring	TRWD, consultants	Variable	0	V ⁵	V ⁵	V ⁵	V ⁵	Variable	CWA §319, Section 106

¹ Unit cost does not include staff hours when work is a typical responsibility for the responsible party or an effort already underway by the responsible party.

² Unit cost may include ranges to cover multiple strategies per row or to account for variability in costs

- ³ Total cost may vary from simple multiplication of unit cost by units implemented per year. This can reflect size variations, multiple strategies per row, or variation in the length of time costs may continue.
- ⁴ Unit cost provided is for the cost of incentives, not the total cost of inspections and/or pump outs or replacements of OSSFs.
- ⁵ Variable depending on location and number of BMPs implemented.

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7.4 Synergies with Existing and Ongoing Water Quality Initiatives

EML implementation efforts may overlap ongoing water quality and environmental initiatives led by other entities within the watershed. Participants in the EML WPP will do their best to identify these other initiatives to reduce duplication of efforts, avoid division of resources, and uncover opportunities for collaboration. Stakeholders should also be aware of the MS4-related activities currently being required of all the Phase I and Phase II entities in the watershed. This should be done to ensure that no grant funding is being used to conduct activities already required by an entity's MS4 permit. Section 319 funds cannot be used to fund any measures in the MS4 permits but can potentially be used to fund stormwater management activities that go above and beyond permit requirements (EPA, 2024b).

8 Measuring Success

The EML WPP recommends water quality targets and interim milestones to measure the success of WPP implementation. These targets include quantified reductions in *E. coli*, quantified implementation of BMPs, and more qualitative outputs. Stakeholders will receive annual updates and an opportunity to revise BMPs based on demonstrated feasibility and success.

8.1 Water Quality Targets and Interim Water Quality Milestones

Modeling and stakeholder input was used to identify and prioritize potential pollutant sources and management practices in Table 4-1. Stakeholder decision-making was influenced by feasibility in addition to model outputs. This led to stakeholders creating three tiers to prioritize implementation.

First-tier prioritizations for pollutant sources include livestock/cattle, OSSFs, WWTFs, and SSOs. Second-tier pollutant sources include pet waste, yard waste, illegal dumping, and sediment and flooding. Third-tier pollutant sources include wildlife and feral hogs, which generated negligible pollutant loads according to SELECT modeling; these pollutant sources will not be addressed in the EML WPP except for human/deer interactions.

Feasibility again influenced stakeholder recommendations for water quality targets and milestones for *E. coli*. Modeling to estimate MPN/year reductions is documented in Appendix C.

8.1.1 Animal Sources

Stakeholders identified animal sources of *E. coli* as a first-tier priority (livestock) and second-tier priority (pet waste). Wildlife and feral hogs were considered third-tier priorities; targets and milestones have not been developed for these pollutant sources.

8.1.1.1 Livestock

Stakeholders provided input on cattle stocking rate changes and grazing management, a first-tier priority. Table 4-3 demonstrates stocking rates in the EML watershed; these rates generally exceed those recommended by NRCS. Stakeholders were hesitant to recommend reduced stocking rates because of the impact this would have on agricultural producers' incomes. Instead, they recommended alternative

strategies that could provide an *E. coli* reduction equivalent to reducing stocking rates by 25 percent. Strategies recommended included:

- Promoting the wildlife tax valuation (Section 1-d-1 of the Texas Constitution) to landowners to allow lower stocking rates than those required to meet agricultural tax valuations
- Educating ranchers and assisting construction of lagoons and restoration of agricultural riparian buffers
- Improving land management practices, including adopting rotational grazing and reducing the duration livestock spend in water sources

The EML WPP recommends livestock management practices that will accomplish the water quality benefit equivalent to reducing stocking rates by 25 percent. This strategy would provide an *E. coli* reduction of 9.8×10^{15} MPN/yr in the watershed.

A Year Five interim milestone is 4.36×10^{15} MPN/yr, based on the implementation timeline in Table 7-1.

8.1.1.2 *Pet Waste*

Stakeholders initially were split between recommending a 50 percent or 80 percent reduction in pet waste, a second-tier priority. Educational programs already exist, such as NCTCOG's "Doo the Right Thing" campaign. This program engages dog owners via a social media campaign and annual photo contest.

The EML WPP recommends a 50 percent reduction in pet waste after stakeholders were surveyed a second time. The EML WPP notes the individual compliance required to reduce pet waste and selects a 50 percent reduction as feasible. This reduction would provide an *E. coli* reduction of 6.13×10^{15} MPN/yr in the watershed.

A Year Five interim milestone is 2.85×10^{15} MPN/yr, based on the implementation timeline in Table 7-1.

8.1.2 Wastewater

All wastewater-related pollutant loads are a first-tier priority for stakeholders, who identified partners and strategies for addressing failings of this infrastructure.

8.1.2.1 *On-Site Sewer Facilities*

The estimated failure rate in the EML watershed according to septic drainfield limitation class was assumed to be 15 percent (Appendix C). Non-permitted systems are considered to contribute severely to OSSF failure rate (Reed, Stowe & Yanke, LLC, 2001). Stakeholders provided input on improvements to these failure rates. They recommended the WPP seek reduction to a 5 percent failure rate. However, they noted the challenge of identifying failing OSSFs because non-permitted OSSFs in the watershed are not on record. The development of regulations, such as state laws, also was noted as a potential option for creating mechanisms to identify non-compliant sites. HOAs and local pumping services were identified as potential partners in identifying failing OSSFs. Stakeholders also noted that financial incentives to repair or replace failing systems could encourage residents to self-report. Stakeholders believed reducing the OSSF failure rate would be a cost-effective strategy.

The EML WPP recommends a reduction of the OSSF failure rate from 15 percent to 5 percent. This would require repairs or replacements of 2,700 failing OSSFs to provide an *E. coli* reduction of 17.0×10^{15} MPN/yr in the watershed. For feasibility's sake, Table 7-1 identifies 50 inspections and pump outs annually and five replacements annually.

A Year Five interim milestone was selected by stakeholders. This goal is 7.56×10^{15} MPN/yr. Over the course of implementation, stakeholders and TRWD will work together to determine whether the implementation schedule can be increased to reach this goal.

8.1.2.2 Centralized Wastewater

Stakeholders provided qualitative input on WWTF violations. Stakeholders noted that the focus should be on preventing I&I violations during storms.

The EML WPP recommends practices such as stormwater infrastructure assessments, proactive efforts to address effluent violations, and use of green stormwater infrastructure to reduce stormwater runoff and the risk of I&I violations. *E. coli* reductions for WWTFs and SSOs are qualitative because these violations are sporadic, but the number of actions taken can be quantified, including education and outreach and the installation of GSI. The EML WPP recommends annual education and outreach efforts and the installation of 18 GSI locations.

A Year Five interim milestone per Table 7-1 includes five completed annual education and outreach efforts and eight installed GSI locations.

8.1.3 Sediment and Flooding

The EML WPP focuses on reducing *E. coli*. However, the format of WPPs allows them to address additional concerns in the watershed.

8.1.3.1 Sediment

While *E. coli* transport is associated with sediment, sediment is also of interest to stakeholders and TRWD because increasing sediment in reservoirs reduces their capacity to store raw water.

One strategy to reduce the runoff of sediment into EML is to increase the use of cover crops by agricultural producers. Stakeholders recommended a 25 percent increase in row crop acreage utilizing cover crops. Stakeholders noted the benefits cover crops provide to producers and suggested these benefits could improve adoption rates. Stakeholders suggested partnering with NRCS, SWCDs, extension agents, and non-profit organizations. They suggested creating demonstration projects to illustrate benefits.

The EML WPP recommends a 25 percent increase in pasture land acreage using cover crops. This increase is modeled in SELECT to yield a 71.10 percent decrease in sediment yield, a 27.95 percent decrease in TP, but a 5.23 percent increase in NO_3 . Any corresponding impact on *E. coli* is not modeled in SWAT.

A Year Five interim milestone is a 31.6 percent reduction in sediment yield resulting from the increase in use of cover crops, based on the implementation timeline in Table 7-1.

The recommended 25 percent reduction in stocking rates, or alternate strategies that produce equivalent results in sediment runoff as discussed in 8.1.2.1, is modeled to yield a 1.76 percent reduction sediment yield, a 20.71 percent reduction in TP, and an 8.91 percent reduction in NO₃.

A Year Five interim milestone is a 0.78 percent reduction in sediment yield resulting from reduction in stocking rates, or alternative strategies that produce equivalent results, based the implementation timeline in Table 7-1.

8.1.3.2 Flooding

Flooding can result in exceedances at high flows. These exceedances are considered inherently unmanageable, and flood control is generally outside the scope of the WPP. However, portions of the EML watershed are within the study area of a flood study led by NCTCOG. The Upper Trinity River Transportation and Stormwater Infrastructure Project is expected to be completed in December 2026. The study will recommend flood-prevention strategies. The EML WPP recommends adoption of these strategies as feasible to reduce flooding and support water quality benefits.

8.1.4 Human Activities

Human activities related to trash and yard waste were both second-tier priorities for stakeholders.

8.1.4.1 Illegal Dumping and Litter Accumulation

To address illegal dumping and litter accumulation, stakeholders recommended two strategies:

- Creating a hotline to report illegal dumping sites coupled with signs in locations where dumping occurs
- Increasing public awareness of Trash Bash events to improve public participation and support for watershed protection

Illegal dumping reductions on *E. coli* are qualitative because they are challenging to quantify and are not accounted for in SELECT. However, implementation actions can be quantified.

The WPP recommends implementing annual Trash Bashes and other TRWD litter-related public engagement programs for a total of 15 events/programs; 81 hazardous/electrical/tire waste pickups; and 10 education and outreach programs.

A Year Five interim milestone per Table 7-1 includes 7-8 Trash Bashes and other TRWD litter-related public engagement programs; 36 hazardous/electrical/tire waste pickups; and 5 education and outreach programs.

8.1.4.2 Yard Waste and Residue

Stakeholders also identified yard waste and residue as second-tier priorities. They identified education and outreach as key strategies to reduce pollution from yard waste and residue. Like illegal dumping, yard waste and residue reductions are not accounted for in SELECT. Therefore, the yard waste and residue reductions on *E. coli* are qualitative, but their implementation actions can be quantified.

The EML WPP recommends actions such as education and outreach, public programming, and demonstration projects.

A Year Five interim milestone per Table 7-1 includes five education and outreach programs, four workshops, and four demonstration projects.

8.2 Water Quality Monitoring

TRWD conducts quarterly water quality monitoring of five sites in EML and 10 sites on the West Fork of the Trinity River as indicated in Table 5-1. Quarterly monitoring also occurs on a rotating basis at 10 WWTFs. TRWD conducts monthly testing on five sites in EML tributaries, one of which duplicates a West Fork site. All sites monitor *E. coli*.

This quarterly and monthly monitoring regime will continue throughout the EML WPP implementation period. Where USGS gages or alternatives are available, flow data during mid-range flows will enable the use of LDCs to verify whether nonpoint sources are the likely contributor to pollutant loads. These sites are identified in Table 8-1. The use of LDCs will allow TRWD to measure progress toward load-reduction goals.

Table 8-1 SWQM stations and USGS gages for load duration curves

Location	SWQM Station	USGS Gage
West Fork Trinity River NE of Boyd near 730	10969	8044500
Walnut Creek west of Reno near FM 1542	10853	8044800
Big Sandy Creek at US380	15688	8044000

Monitoring results are reported to TCEQ and incorporated into the Texas IR. Assuming implementation is launched in the EML watershed in 2027, results of BMPs could be reflected in the Texas IR in the mid- to late-2030s.

For the purposes of the WPP, site 10969 on the West Fork Trinity River will be used to monitor progress. This is the most important tributary site for understanding pollutant loading in EML because of the drainage it collects.

Monitoring will comply with the QAPP for the Trinity River, included as Appendix D.

8.3 Data Gaps

Tributaries with significant urban land uses are not well represented by USGS gages in the EML watershed. This poses challenges when monitoring the success of urban BMPs such as those that address pet waste and sedimentation. Alternative methods for measuring flow have been used on Ash Creek. Similar strategies may need to be adopted on additional tributaries to provide data to model estimated loads, or the USGS could be petitioned to add gages.

An additional challenge exists in monitoring changes in sedimentation. The WPP currently cites a TWDB survey on sedimentation (TWDB, 2019), but this survey is conducted only periodically. Additional strategies for monitoring changes in sedimentation should be developed.

To address both urban BMPs and sedimentation, additional sampling could be conducted upon implementing BMPs. This sampling could include up-stream/downstream or before-and-after monitoring.

8.4 BMP Implementation

Several pollutant sources identified by stakeholders may indirectly reduce *E. coli* in ways that cannot be monitored, or their benefits may otherwise not be modeled using SELECT. These pollutant sources include:

- WWTFs
- SSOs
- Sediment and flooding
- Illegal dumping and litter accumulation
- Lawn residue and waste

The success of strategies to address these pollutant sources will be monitored qualitatively or will be monitored quantitatively by identifying the number of implementation actions taken. TRWD's watershed coordinator will coordinate with implementing partners to track reductions of these pollutant sources.

8.5 Progress Updates

TRWD's watershed coordinator will communicate progress and methods to stakeholders on an annual basis via email updates and/or stakeholder meetings. Meetings will take place in Year 5 and any year monitoring results indicate change may be necessary in the implementation plan. Progress updates will outline strategies that have been implemented, water quality monitoring results, and any modeling work to quantify potential load reductions that have occurred.

The goal of the EML WPP is to attain *E. coli* load reductions of 3.29×10^{16} MPN/yr over a 10-year implementation timeline. The implementation timeline identifies an interim, Year Five goal of *E. coli* load reductions of 1.48×10^{16} MPN/yr.

However, progress can be hampered by factors beyond TRWD and stakeholder control. Funding limitations or delays in acquiring funding, staff turnover, and landowner or pet owner resistance to implementing change could all delay the recommended improvements in water quality. It is understood that the commitment to reducing *E. coli* is a long-term one, and strategies may need to evolve over time.

Annual progress updates will be an opportunity for stakeholders to identify whether progress is being made toward goals and when strategies must be revised to attain goals.

8.6 Adaptive Management

Adaptive management allows the WPP to set goals, take initial actions, monitor the watershed's response to those actions, evaluate progress toward the goals and, if necessary, identify additional actions that will be taken until the final goal is accomplished. This process requires the input of watershed stakeholders.

Annual communications with stakeholders will be an opportunity to review and modify the WPP's recommended strategies, both for feasibility and success. Feasibility can be evaluated by success in acquiring funding and the number of implementation actions taken. Success can be evaluated by the number of implementation actions taken as well, but analyzing water quality data will be another important means to evaluate success of the WPP.

LULC changes must be monitored. Tarrant County is forecast to grow by 27 percent between 2026 and 2050; Wise County is forecast to grow by 95 percent during the same period (NCTCOG, 2025). WPP implementation may need to focus increasingly on urban BMPs as growth occurs in the EML watershed, particularly if that growth has a geographic nexus to impaired waterbodies and/or the lake.

Challenges exist. Water quality data and modeling may be unable to identify cause and effect between specific BMPs and results. Time lags between actions and results can further obscure these connections. For these reasons, watershed planning requires long-term commitment and cooperation between partners and jurisdictions.

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Appendix A EML WPP

Element	Report Section(s)
Element A: Identification of Causes and Sources	
1. Sources identified, described, and mapped	Sections 3.4, 4.1, 4.3, 5.1, 5.2, 5.3 Figures 3-2, 4-1, 4-2, 4-3, 4-4, 5-2, 5-3, 5-4, 5-5, 5-7, 5-8, 5-9 Tables 4-3, 5-2, 5-3, 5-4, 5-5 Appendix C
2. Loads quantified	Sections 5.2, 5.3 Figures 5-2, 5-3, 5-4, 5-5, 5-7, 5-8 Table 5-2, 5-3, 5-4, 5-5 Appendix C
3. Subwatershed sources identified	Section 5.3 Figures 5-7, 5-8
4. Data sources are accurate and verifiable	Sections 4 and 5 Appendix B and C
5. Data gaps identified	Section 5.2 Appendix B and C
Element B: Expected Load Reductions	
1. Load reductions achieve environmental goal	Sections 5.2, 5.4, 6.1, 6.3, 6.4, 6.5, 6.6, 6.7 Figure 5-2, 5-3, 5-4, 5-5 Tables 5-2, 5-3, 5-4, 5-5, 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8
2. Load reductions linked to source	Section 6.3, 6.4, 6.5, 6.6 Figures 5-7, 5-8, 5-9 Tables 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8
3. Model complexity appropriate	Sections 5.0, 5.2, 5.3 Figures 5-2, 5-3, 5-4, 5-5 Tables 5-2, 5-3, 5-4, 5-5 Appendix B, Appendix C
4. Basis of effectiveness estimates explained	Sections 5.0, 5.2, 5.3, 5.4, 6.2, 6.3 Figures 5-2, 5-3, 5-4, 5-5 Tables 5-2, 5-3, 5-4, 5-5, 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8 Appendix B, Appendix C
5. Methods and data cited and verifiable	Sections 5.0, 5.1, 5.2, 5.3, 9.0 Appendix B, Appendix C
Element C: Management Measures Identified	
1. Specific management measures are identified	Sections 4.1, 6.2, 6.3, 6.4, 6.5, 6.6 Tables 4-1, 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8

2. Expected BMPs and priority areas mapped	Sections 4.1, 5.2, 5.3, 5.4 Figures 5-7, 5-8, 5-9 Table 4-1
3. Measure selection rationale documented	Sections 4.1, 6.0, 6.1, 6.2, 6.3, 6.4, 6.5, 6.5, 6.6, 6.7 Tables 4-1, 6-1, 6-2, 6-3, 6-4, 7-5, 6-6, 6-7, 6-8 Appendix C
4. Technically sound	Section 5.0, 5.1, 5.2, 5.3, 6.0, Figures 5-2, 5-3, 5-4, 5-5 Tables 5-2, 5-3, 5-4, 5-5 Appendix B, Appendix C
Element D: Technical and Financial Assistance	
1. Estimate of technical assistance	Sections 7.0, 7.1 Table 7-1
2. Estimate of financial assistance	Sections 7.0, 7.2 Table 7-1
Element E: Education/Outreach	
1. All relevant stakeholders are identified	Section 1.4.1 Table 1-1
2. Public education/information	Appendix E
3. Stakeholder engagement	Sections 1.2, 1.3, 1.4, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 8.4 Tables 1-1, 4-1, 6-1, 6-2, 6-3, 6-4, 7-5, 6-6, 6-7, 6-8 Appendix D
4. Public participation in plan development	Sections 1.2, 1.3, 1.4, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 8.4 Tables 1-1, 4-1, 6-1, 6-2, 6-3, 6-4, 7-5, 6-6, 6-7, 6-8 Appendix D
5. Emphasis on achieving water quality standards	Sections 1.3, 3.0, 3.1, 3.2, 3.3, 3.4, 5.1, 5.2, 5.4, 6.1, 8.1, 8.5 Figures 5-2, 5-3, 5-4, 5-5 Tables 5-2, 5-3, 5-4, 5-5 Appendix C
6. Operation and maintenance of BMPs	Sections 6.3, 6.4, 6.5, 6.6, 7.1, 7.2, 8.3, 8.5 Tables 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8, 7-1
Element F: Implementation Schedule	
1. Includes completion dates	Section 7.3 Table 7-1
2. Schedule is appropriate	Sections 7.3, 8.1, 8.5

	Table 7-1
Element G: Milestones	
1. Milestones are measurable and attainable	Sections 8.1, 8.2 Tables 7-1, 8-1
2. Milestones include completion dates	Sections 7.1, 8.1, 8.2 Tables 7-1
3. Progress evaluation and course correction	Sections 7.1, 8.2, 8.4, 8.5
4. Milestones linked to schedule	Section 7.1 Table 7-1
Element H: Load Reduction Criteria	
1. Criteria are measurable and quantifiable	Sections 3.1, 3.2, 3.3, 6.6, 6.4, 6.5, 6.7 Tables 3-1, 3-2, 6-1, 6-2, 6-4, 6-6
2. Criteria measure progress toward load reduction goal	Sections 8.1, 8.2
3. Data and models identified	Sections 4.3, 5.0, 5.1, 5.2 Figures 5-2, 5-3, 5-4, 5-5 Table 5-1, 5-2, 5-3, 5-4, 5-5 Appendix C
4. Target achievement dates for reduction	Sections 8.1, 8.4 Table 7-1
5. Review of progress toward goals	Sections 8.4, 8.5
6. Criteria for revision	Sections 8.4, 8.5
7. Adaptive management	Section 8.5
Element I: Monitoring	
1. Description of how monitoring is used to evaluate implementation	Sections 5.1, 8.2 Tables 5-1, 8-1
2. Monitoring measures evaluation criteria	Sections 8.1, 8.2
3. Routine reporting of progress and methods	Section 8.4
4. Parameters are appropriate	Sections 3.2, 3.3 Tables 3-1, 3-2
5. Number of sites is adequate	Sections 5.2, 8.2 Table 8-1
6. Frequency of sampling is adequate	Sections 5.1, 8.2 Tables 5-1, 8-1
7. Monitoring tied to QAPP	Sections 5.1, 8.2 Appendix D
8. Can link implementation to improved water quality	Sections 5.1, 8.1, 8.2, 8.4 Tables 5-1, 8-1



APPENDIX B SWAT model setup and calibration for the Eagle Mountain watershed

Model Setup: HAWQS v2.0

Calibration: SWAT-CUP

[Abstract](#)

This report includes the information on SWAT model setup and calibration process for the Eagle Mountain Watershed.

SWAT

The United States Department of Agriculture (USDA) and Texas A&M University jointly developed the Soil & Water Assessment Tool (SWAT) and have actively supported the model for more than 30 years. SWAT is a small watershed to river basin-scale modeling software used to simulate the quality and quantity of surface and groundwater and predict the environmental impact of land use, land management practices, and climate change. SWAT is widely used in assessing soil erosion prevention and control, non-point source pollution control, and regional management in watersheds and cited in over 6,800 peer-reviewed journal articles (Center for Agriculture and Rural Development, 2023).

SWAT is physically based, requiring input about weather, soil properties, topography, vegetation, and land management practices occurring in the watershed. These data are available from various government agencies. SWAT uses these inputs to model physical processes associated with water movement, sediment movement, crop growth, nutrient cycling, etc. SWAT is a continuous time model which simulates long-term yields enabling users to study long-term impacts (*e.g.*, over several decades).

SWAT theoretical documentation and information on SWAT input and output files can be found on the documentation section of the TAMU SWAT website¹.

HAWQS

The Hydrologic and Water Quality System (HAWQS)² is a web-based interface that streamlines the development of SWAT watershed models by providing pre-loaded input data and modeling support capabilities for setting up models, running simulations, and processing outputs. SWAT is a commonly used public domain semi-distributed mechanistic watershed model that is used to evaluate the effects of land management and agricultural practices on water, sediment, and chemical fluxes across a wide range of watershed sizes, land uses, and physiographic provinces (Neitsch, et al., 2011). HAWQS provides pre-loaded national input data necessary to develop SWAT watershed models at resolutions that range from the 14-digit HUC (HUC14) to the 8-digit HUC (HUC8). The HAWQS platform was used to create the Eagle Mountain watershed SWAT model. Table 1 summarizes the input datasets used from HAWQS for the watershed.

Table 1. HAWQS v2.0 input data.

Input Dataset	Source	Specifications
Watershed Boundaries	National Hydrography Dataset Plus 2.0 (NHDPlus)	Scale: HUC14
Elevation	USGS National Elevation Dataset (NED)-Digital Elevation Model (DEM)	Resolution: 10-meter Year: 2019
Stream Network	NHDPlus 2.0	Year: 2019
Climate	Parameter-elevation Regressions on Independent Slopes Model (PRISM) 2.0	Period: 1981-2020 (Gridded) Resolution: ~4km Scale: Monthly

¹ <https://swat.tamu.edu/docs/>

² <https://hawqs.tamu.edu/#/>

Land Use (agricultural)	United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL)	Years: 2016 - 2018
Land Use (non-agricultural)	National Land Cover Database (NLCD)	Year: 2016
Soil	USDA Natural Resources Conservation Service (NRCS) Soil Survey Geographic Data (SSURGO)	Scale: County level Year: 2019
Point Sources	Water Quality eXchange (WQX) and National Pollutant Discharge Elimination System (NPDES)	Year: 2020
Ponds, Dams, and Reservoirs	National Inventory of Dams (NID) and NHDPlus 2.0	Year: 2018 and 2019
Management Data	USDA- NRCS crop management zone data	Year: 2010

TRWD HAWQS

A HAWQS platform was created for the Tarrant River Watershed District (TRWD)³ to provide calibrated watershed to be used for watershed protection plans and analysis of various best management practices in the watersheds across the TRWD. The resulting calibrated Eagle Mountain watershed from this project will be available on the TRWD HAWQS platform for users to create and analyze.

Eagle Mountain Watershed

The SWAT model for the Eagle Mountain watershed was developed with the outlet at the Eagle Mountain Dam (32°52'27.3" N, 97°27'39.2" W) near Fort Worth, Texas. The hydrologic unit code (HUC14) boundaries within the delineated watershed area were considered as subbasin boundaries (Figure 1). The contributing area to Lake Bridgeport was not included in the delineated watershed due to the high regulated flow in the watershed from Bridgeport Dam. However, Lake Bridgeport Dam discharge was considered as a point source to the Eagle Mountain watershed along with the HAWQS point source databases (Table 1). As a result, the delineated watershed had a total area of 551,312 acres (2231.08 km²) with 108 HUC14 subbasins. There was no land use threshold adopted when creating hydrologic response units (HRUs) which resulted in 10,239 HRUs across the watershed. Table 2 shows the distribution of land use in the Eagle Mountain watershed. The model outputs were simulated at monthly time-step from 2003 to 2020 with a 2-year warm-up period.

³ <https://trwd.hawqs.tamu.edu/>

Table 2. Land use distribution within the Eagle Mountain Watershed.

Land use	Area (acres)	Percentage (%) of watershed area
Range-Grasses	327,427	60.47
Forest Deciduous	91,232	16.85
Pasture	47,352	8.74
Residential- Low density	19,182	3.54
Riparian Wetlands- Forested	11,278	2.08
Range- Brushes	9,501	1.75
Winter Wheat	7,672	1.42
Tall Fescue	6,659	1.23
Residential- Medium density	6,402	1.18
Others (under 1% each)	14,782	2.73

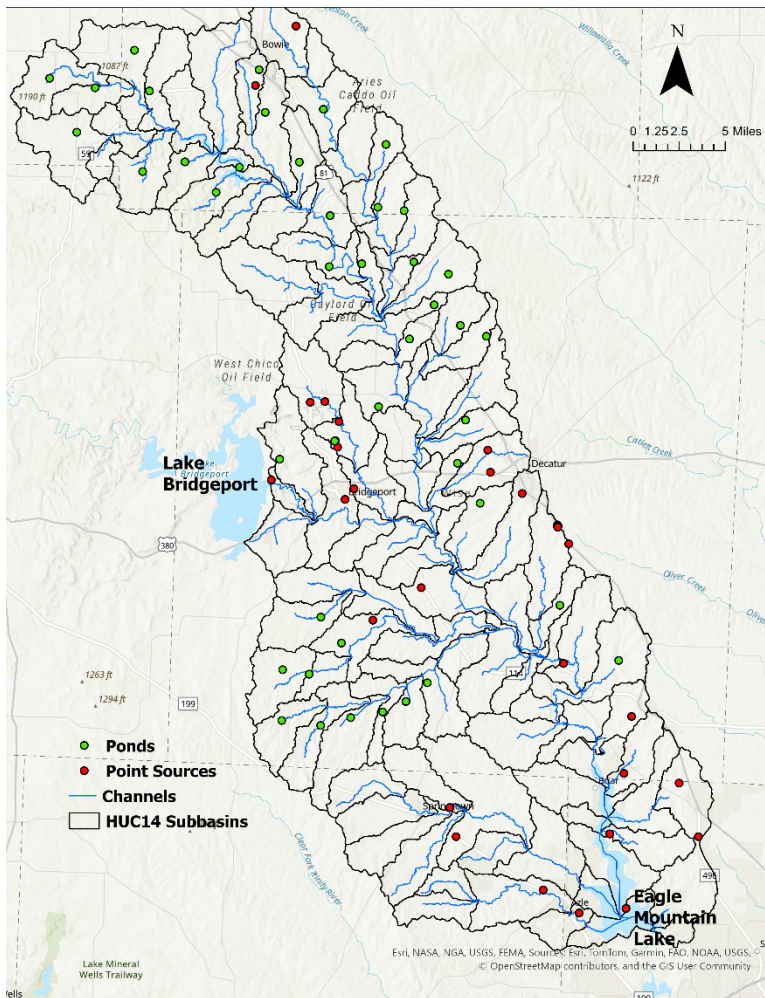


Figure 1. Eagle Mountain watershed at the HUC14 subbasin scale with Bridgeport Lake Dam as a point source.

Eagle Mountain Watershed Updates

Once the HUC14 model was created from the HAWQS platform, additional data was used to update the model to better represent current land development and management practices within the watershed.

Land Use

The HAWQS platform uses 2016 NLCD land use data as the default dataset. Since 2016, there has been extensive urbanization across the Eagle Mountain watershed. To account for this urbanization, the 2020 NLCD land use dataset was compared to the 2016 dataset to see if the urbanization increase was indeed evident in the land use dataset.

Overall, there was a 9.7% change (53,223 acres/215.4 km²) in developed land use across the Eagle Mountain watershed when comparing the 2016 NLCD land use dataset to the 2020 NLCD land use dataset. This change was significant enough to update the land use data layer in the Eagle Mountain watershed to 2020. Figure 2 shows where the change in Developed land occurred in the watershed from 2016 to 2020.

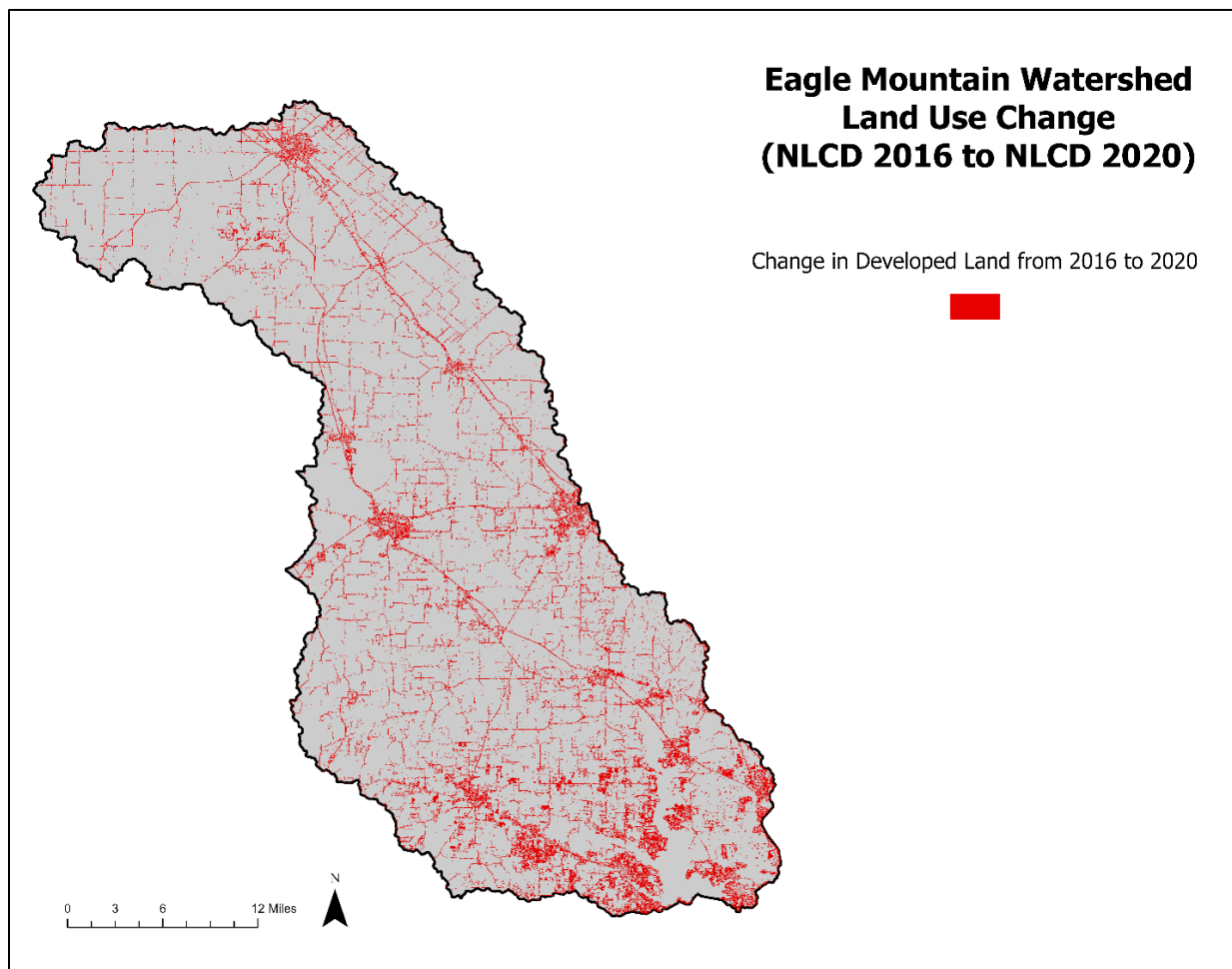


Figure 2. Developed land change in Eagle Mountain from 2016 to 2020 using NLDC Land Use layers.

Management Practices

To verify the model simulates current management practices across the watershed, historical Natural Resources Conservation Service (NRCS) data of best management practices (BMPs) implemented in the Eagle Mountain from 2008-2023 was analyzed. From the NRCS data, six management practices implemented within the watershed were chosen to simulate in the Eagle Mountain watershed model. Table 3 shows the management practices simulated in the watershed, and the area (or number of structures) of implementation.

Table 3. NRCS BMPs simulated in the Eagle Mountain watershed. The amount of land available, the amount of land receiving management, and the percentage of land applied.

Management Practices	Available Acres	Applied Acres	Percent of Land Applied
Grade Stabilization Structure		14*	
Brush Management	8,376	609	7.3%
Cover Crop	25,045	2,584	10.3%
Pasture Hay Planting	250,209	733	0.3%
Range Planting	159,429	381	0.2%
Prescribed Grazing	350,329	267,766	76.4%

* For grade stabilization structure, there were 14 different structures applied in the watershed.

SWAT can simulate various BMPs across a watershed. Some BMPs can only be simulated for the entire model run, while others can be simulated on the date of implementation. The grade stabilization structures were added to the SWAT model on the date and were implemented from the NRCS dataset. All locations prior to 2020 were included in the Eagle Mountain watershed resulting in 14 grade stabilization structures (Figure 3). In the SWAT model, these were simulated by creating a grass waterway in each HRU using the parameter values provided in Table 4. Each location and the corresponding HRU selected to simulate the structure are found in Table 5.

Table 4. List of variables adjusted to simulate Grade Stabilization Structures (grassed waterways) in the Eagle Mountain watershed.

Variable	Description	Value
GWATI	Flag to simulate grass waterways	1
GWATN	Manning's N value for overland flow	0.14
GWATL	Length of grassed waterway (km)	1
GWATW	Average width of grassed waterway (m)	15
GWATD	Depth of grass waterway channel from top of bank to bottom (m)	0.5
GWATS	Average slope of grassed waterway channel (m)	0.005
GWATSPCON	Linear parameter for calculating sediment in grassed waterways	0.005

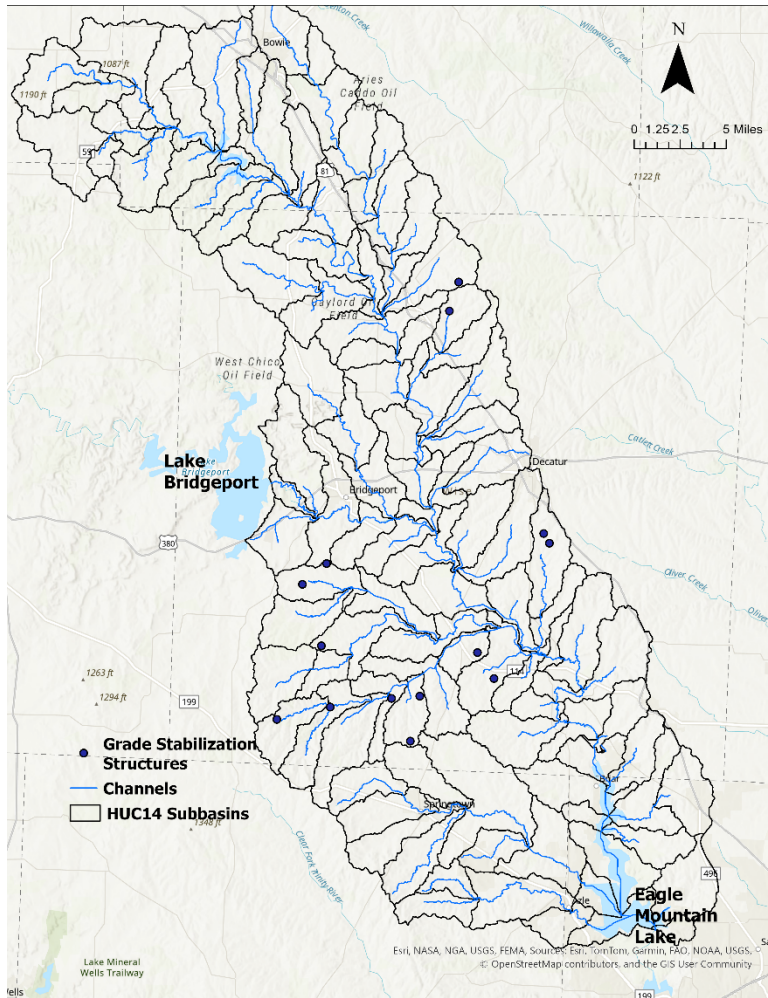


Figure 3. Grade Stabilization Structures added in the Eagle Mountain SWAT model. Implementation dates ranging from 2009-2018.

Table 5. Locations of Grade Stabilization Structures from NRCS and the corresponding HRU selected in the Eagle Mountain SWAT model.

NRCS Details				SWAT Location Used			
HUC12 Subbasin	Date	Area (acres)	Land Use	HUC14	Land Use	Soil Num	HRU
(120301010603) Salt Creek	11/9/2009	94	Pasture	12030101060307	RNGE	373644	000710021
(120301010604) Walnut Creek-West Fork Trinity River	5/7/2010	63.2	Pasture	12030101060402	FESC	373649	000730126
(120301010604) Walnut Creek-West Fork Trinity River	4/3/2012	13	Range	12030101060406	RNGE	373702	000770022
(120301010603) Salt Creek	4/12/2012	32.2	Pasture	12030101060303	RNGE	373667	000670010
(120301010603) Salt Creek	5/22/2012	26.5	Range	12030101060303	RNGE	373666	000670006

(120301010507) Lower Brushy Creek	7/6/2012	87	Range	12030101050704	UTRN (URLD)	373667	000330052
(120301010603) Salt Creek	7/16/2012	17.31	Pasture	12030101060304	RNGE	373678	000680016
(120301010604) Walnut Creek-West Fork Trinity River	5/17/2013	53	Pasture	12030101060402	PAST	373663	000730113
(120301010603) Salt Creek	6/26/2015	140	Range	12030101060301	RNGE	373666	000650014
(120301010510) Briar Branch-Big Sandy Creek	7/21/2015	14	Range	12030101051001	UTRN (URLD)	373702	000440041
(120301010602) Garrett Creek	5/2/2017	146	Range	12030101060206	FRSD (RNGE)	373679	000630019
(120301010602) Garrett Creek	5/2/2017	16	Range	12030101060206	RNGE	373642	000630003
(120301010602) Garrett Creek	6/11/2018	13	Range	12030101060202	FRSD (RNGB)	373704	000590025
(120301010603) Salt Creek	10/16/2018	8.2	Range	12030101060306	RNGE	373666	000700003

When simulating the other five management practices in SWAT, the same annual management was added within the selected HRUs for the entire simulation period (2005-2020). Since the amount of land receiving each management practice changed slightly over the period of the simulation, the annual average area within each HUC12 from the NRCS data was used. The annual average area for the watershed receiving each BMP is shown in Table 3.

The brush management BMP was simulated in the Eagle Mountain watershed by selecting RNGB (Range Brush) land use HRUs and converting them into RNGE (Range Grass) HRUs. This was done in the SWAT model by changing the initial land cover status to growing and defining RNGE as the plant type.

For the cover crop BMP, PAST (Pasture) HRUs were selected and either WWHT (Winter Wheat) or OATS (Oats) were planted as a cover crop. The Eagle Mountain watershed has more land with WWHT than OATS, so the HRUs selected for the cover crop BMPs were split with 75% simulating WWHT as the cover crop and 25% simulating OATS as the cover crop. The cover crop BMP was simulated in the SWAT model by changing the initial land cover status to growing and defining either WWHT or OATS as the initial plant type. Then, the management operations were set to harvest and kill at the end of March (03/31), plant BERM (bermudagrass) at the start of April (04/01), fertilize with 89 lbs/acre of nitrogen on 04/02, harvest only on 09/30, then plant the initial plant type again on 10/02.

To simulate pasture hay planting in the Eagle Mountain watershed, PAST HRUs were selected and updated with planting operations. This was done by adding in a heat unit operation where PAST was planted at heat units of 0.15, then auto fertilization of 89 lbs/acre of nitrogen was simulated with a trigger for application when the nitrogen stress factor falls to 0.75. Finally, a harvest and kill operation was set when the heat units reach 1.2.

The range planting BMP simulated in model was done like pasture hay planting. For the range planting, however, RNGE (Range Grass) HRUs were selected and the plant defined during the planting at the 0.15 heat unit was RNGE. The same auto fertilization of 89 lbs/acre of nitrogen with the 0.75 nitrogen stress factor was used as well as the harvest and kill operation at 1.2 heat units.

The last management practice added into the Eagle Mountain SWAT model was prescribed grazing. Using the NRCS data, and input from the NRCS Decatur Office, ~75% of the available PAST and RNGE land were used to simulate prescribed grazing. Additionally, the NASS Census data was used to determine the number of cattle, including cows within the watershed. The average number of animals from the Census data was 60,379. The NRCS Decatur office recommended using a factor of 1.2 animals to determine the animal units (AU) within the watershed. This resulted in 72,455 AU in Eagle Mountain and a stocking rate of 4.1 acres/AU (~5 acres/head), which was in line with the 2-4 acres/AU they recommended. NRCS Decatur also recommended simulating grazing from mid-April (04/15) through mid-November (~220 days). Modelers from the Blackland Research Extension Center (BREC) recommend that 1 AU typically eats 20 lbs/acre, tramples 10 lb/acre, and produces 5 lbs/acre of manure a day. These values were added into the selected PAST and RNGE HRUs selected along with a minimum biomass for grazing value of 1070.6 lbs/acre and harvest operation with a harvest efficiency of 0.8 on 12/01 (both recommended by BREC modelers).

After all the management practices were added into the Eagle Mountain SWAT model, the model was then calibrated against available flow and water quality data to ensure accurate simulation across the watershed.

Calibration Process

SWAT-CUP⁴ is a program that performs calibration, validation, and sensitivity and uncertainty analysis for SWAT models. The program links the Sequential Uncertainty Fitting v2 (SUF12) routine, the Particle Swarm Optimization (PSO), the Generalized Likelihood Uncertainty Estimation (GLUE), the Parameter Solution (ParaSol), and the Markov Chain Monte Carlo (MCMC) to SWAT models. For the Eagle Mountain watershed calibration, the SUF12 algorithm was used since it is the most flexible algorithm and the only algorithm that can be run with parallel processing within the SWAT-CUP program. This algorithm measures two values: the p-factor and r-factor. The p-factor is the percentage of observed data enveloped by the 95 percent prediction uncertainty (95PPU). The r-factor is the thickness of the 95PPU. The objective of the SUF12 algorithm is to have most observed values fall within a relatively small 95PPU. A comprehensive description of the SUF12 algorithm can be found in Abbaspour et al. (2007). Within SWAT-CUP, there are 11 statistical tests that can be used to evaluate model performance. Model performance is evaluated against three basic statistical tests: Percent bias (PBIAS); Nash-Sutcliffe efficiency (NSE); and Kling–Gupta efficiency (KGE), which are described below.

Percent bias (PBIAS)

PBIAS measures the average tendency of the simulated data to be larger or smaller than their observed counterparts (Gupta, et al., 1999; Moriasi, et al., 2015). The optimal value of PBIAS is 0.0, with low-magnitude values indicating accurate model simulation. Positive values indicate model underestimation bias, and negative values indicate model overestimation bias (Gupta, et al., 1999; Moriasi, et al., 2015).

⁴ <https://swat.tamu.edu/software/swat-cup/>

PBIAS is calculated with the equation below where PBIAS is the deviation of data being evaluated, expressed as a percentage.

$$PBIAS = \frac{[\sum_{i=1}^n (Y_i^{obs} - Y_i^{sim}) * (100)]}{\sum_{i=1}^n (Y_i^{obs})}$$

Where Y_i^{obs} is the i th observation for the constituent being evaluated, Y_i^{sim} is the i th simulated value for the constituent being evaluated, and n is the total number of observations. Table 6 provides the range of acceptable values for PBIAS for flow, sediment, and nutrients consistent with current best modeling practices.

Table 6. General percent error calibration targets, applicable to monthly calibration (Donigian, 2002; Moriasi et al., 2007).

SWAT Output	Very Good	Good	Fair
Hydrology/Flow	<10	10-15	15-25
Sediment	< ± 15	± 15 to ± 30	± 30 to ± 55
Nutrients (TN & TP)	< ± 25	± 25 to ± 40	± 40 to ± 70

Nash-Sutcliffe efficiency (NSE)

NSE is a normalized statistic that determines the relative magnitude of the residual variance (“noise”) compared to the measured data variance (“information”) (Nash & Sutcliffe, 1970). NSE indicates how well the plot of observed versus simulated data fits the 1:1 line. NSE is calculated as:

$$NSE = 1 - \left[\frac{\sum_{i=1}^n (Y_i^{obs} - Y_i^{sim})^2}{\sum_{i=1}^n (Y_i^{obs} - Y^{mean})^2} \right]$$

Where Y_i^{obs} is the i th observation for the constituent being evaluated, Y_i^{sim} is the i th simulated value for the constituent being evaluated, Y^{mean} is the mean of observed data for the constituent being evaluated, and n is the total number of observations.

NSE ranges between negative infinity and 1.0, with 1.0 being the optimal value (a perfect model fit) and values <0.0 indicating that the mean observed value is a better predictor than the simulated value, thereby demonstrating unacceptable model performance. Good performance is indicated by values >0.5 and acceptable performance by values between 0.0 and 0.5 (Moriasi, et al., 2007).

Kling–Gupta efficiency (KGE)

KGE (Gupta, et al., 2009) is a performance indicator based on the equal weighting of linear correlation (r), bias ratio (β), and variability (γ), between simulated and observed data:

$$KGE = 1 - \sqrt{(r - 1)^2 + (\gamma - 1)^2 + (\beta - 1)^2}$$

Where γ is the standard deviation of simulated/standard deviation of observed, β is the mean of simulated/mean of observed, and r is the linear regression coefficient between simulated and measured data. The calibration results range between negative infinity and 1.0, with 1.0 being a perfect model fit. KGE values larger than 0.5 are considered satisfactory (Moriasi et al., 2007).

KGE captures three additional statistics: mean, standard deviation, and r^2 (coefficient of determination). In most cases, evaluation of KGE encompasses the conclusions that can be made from evaluating PBIAS and, to a lesser extent, NSE. Therefore, KGE was used as the primary calibration metric to evaluate model performance in the Eagle Mountain watershed calibration.

Flow Calibration

The Eagle Mountain model was calibrated using monthly observed streamflow from two USGS gage stations- 08044000 located on Big Sandy Creek near Bridgeport, Texas and 08044500 located on the West Fork Trinity River near Boyd, TX (Figure 4). The available observed monthly streamflow data for the 2005-2020 period (190 observations) was used to calibrate the model.

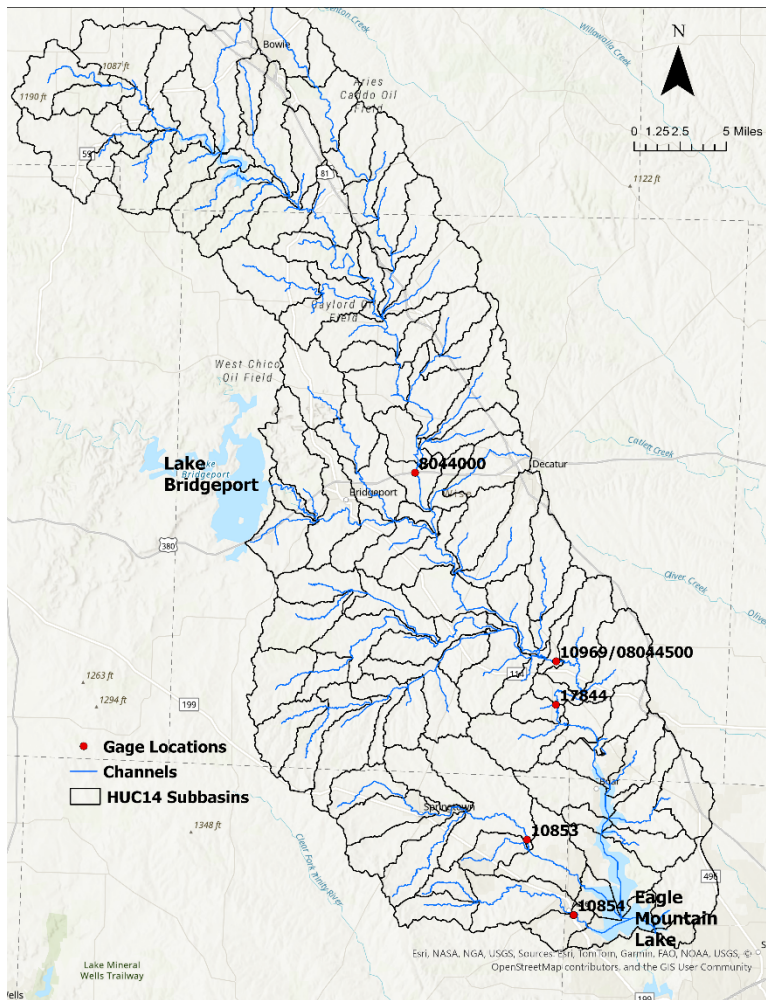


Figure 4. Flow and water quality gages used for calibration of the Eagle Mountain watershed.

Table 7 shows the best fitted parameter values for the calibrated Eagle Mountain SWAT model from SWAT-CUP. The resulting hydrographs for observed and simulated streamflow for the calibration period are shown in Figure 5 and Figure 6 and the flow calibration summary statistics are presented in Table 8. The USGS 08044000 gage on Big Sandy Creek is downstream of a large reservoir, the Soil Conservation Service Site 8 Reservoir. The observed flow at that gage is very low, 2.12 cms, and there was no release data available from the upstream reservoir, therefore the calibration at this gage was able to simulate

the variability at the site, but the magnitude of the flow was larger than the acceptable range (PBIAS > +/-25%). The USGS 0804450 gage on the West Fork of the Trinity River is located on the main stem of the river, therefore the watershed calibration was prioritized at this gage. This gage is downstream of Lake Bridgeport Dam, which was used as a point source boundary condition in the model. As shown in Table 8 and Figure 6, SWAT-CUP was able to simulate both the variability (NS and KGE statistics) and the magnitude of the flow (PBIAS) very well.

Table 7. Flow calibration parameters used in the Eagle Mountain watershed and their range of acceptable values.

Value Type	Input File	SWAT Parameter	Description	Fitted Value	Range
Multiply	mgt	CN2	Initial SCS runoff curve number for moisture condition II	-0.074453	-0.1 to 0.1
Multiply	sol	SOL_AWC()	Available water capacity of all soil layer	0.000391	-0.05 to 0.05
Replace	HRU	CANMX	Maximum canopy storage	1.40625	0 to 20
Replace	HRU	ESCO	Soil evaporation compensation factor	0.372656	0.5 to 0.75
Replace	gw	ALPHA_BF	Baseflow alpha factor	0.134609	0.005 to 0.1
Replace	gw	ALPHA_BF_D	Alpha factor for ground recession curve of the deep aquifer	0.433594	0 to 1
Add	gw	GW_DELAY	Ground water delay time	21.171875	-30 to 90
Add	gw	GWQMN	Threshold depth of water in shallow aquifer required for return flow to occur	72.65625	-1000 to 1000
Add	gw	RCHRG_DP	Deep aquifer percolation fraction	0.005078	-0.05 to 0.05
Add	gw	REVAPMN	Threshold depth of water in shallow aquifer for “revap” or percolation to deep aquifer to occur	-378.906	-750 to 750
Replace	HRU	SLSOIL	Slope length of lateral subsurface flow	110.9375	0 to 200
Replace	HRU	LAT_TTIME	Lateral flow travel time	1.148438	0 to 14
Replace	gw	GW_REVAP	Groundwater “revap” coefficient	0.096172	0.02 to 0.1
Replace	rte	CH_K2	Effective hydraulic conductivity in main channel alluvium	4.453125	0 to 20
Replace	sub	CH_K1	Effective hydraulic conductivity in tributary channel alluvium	1.757813	0 to 20
Replace	HRU	EPCO	Plant uptake compensation factor	0.149219	0.1 to 1

**CANMX parameter was adjusted for Rangeland- brush, Forest- deciduous, Forest- evergreen, Forest- mixed.

Table 8. Flow calibration summary statistics from SWAT-CUP for the Eagle Mountain watershed.

Gage ID	NS	PBIAS	KGE	Simulation Mean (cms)	Observation Mean (cms)
USGS 08044000	0.8	-68.4	0.31	3.56	2.12
USGS 08044500	0.56	3.1	0.56	8.19	8.46

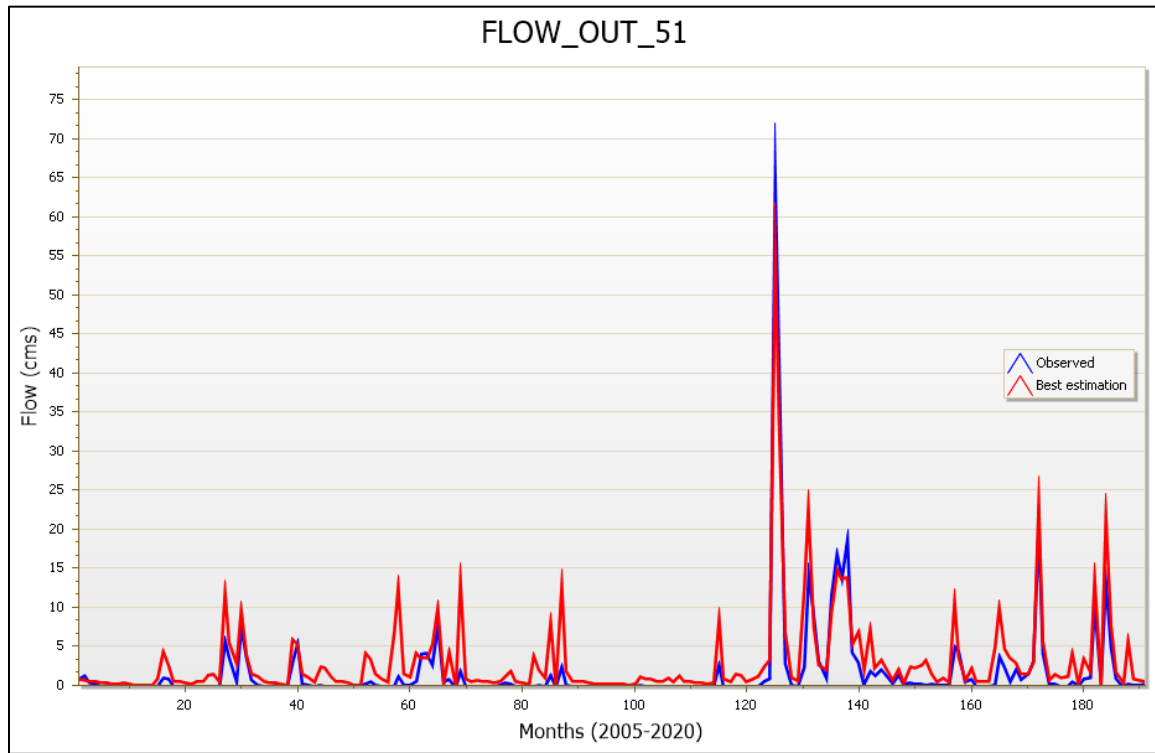


Figure 5. SWAT-CUP flow calibration results at USGS 08044000.

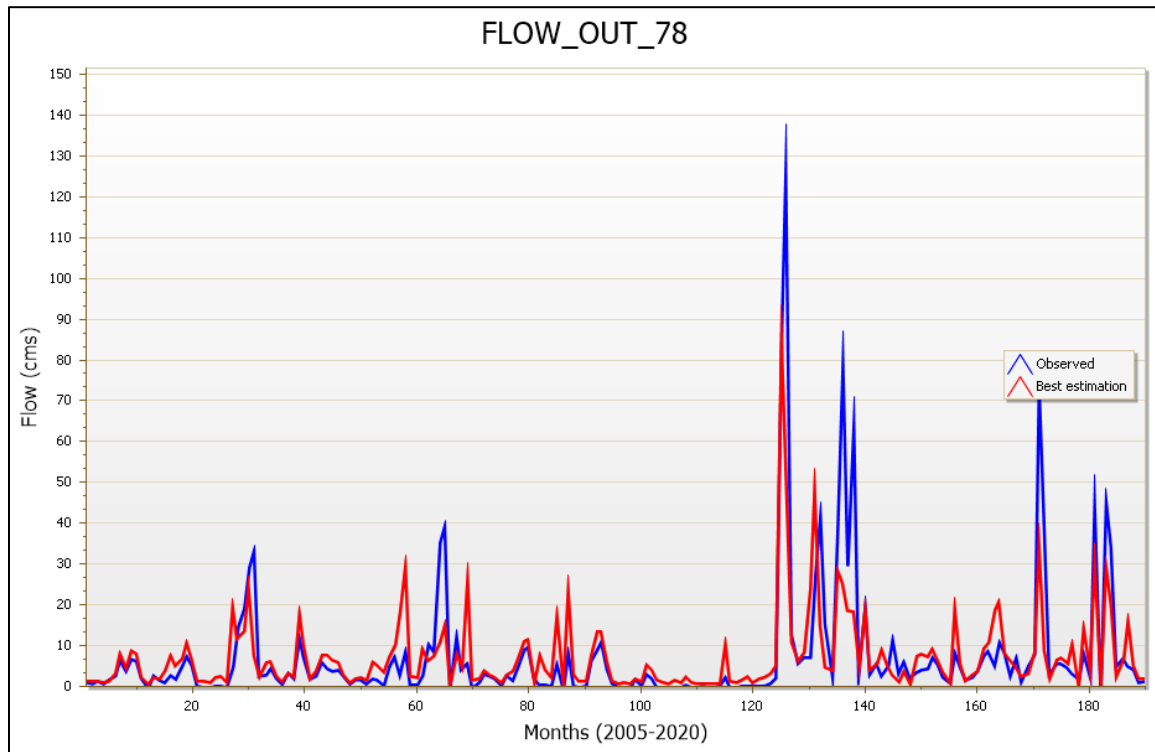


Figure 6. SWAT-CUP flow calibration results at USGS 08044500.

A flow duration curve for the USGS 08044500 gage on the West Fork Trinity River is shown in Figure 7. This illustrates that the high flow conditions happen less than 10% of the time, with dry to low flow conditions accounting for 40% of time. The remaining 50% of the flow is where BMPs can be successful in helping to reduce the amount of loading reaching the waterways.

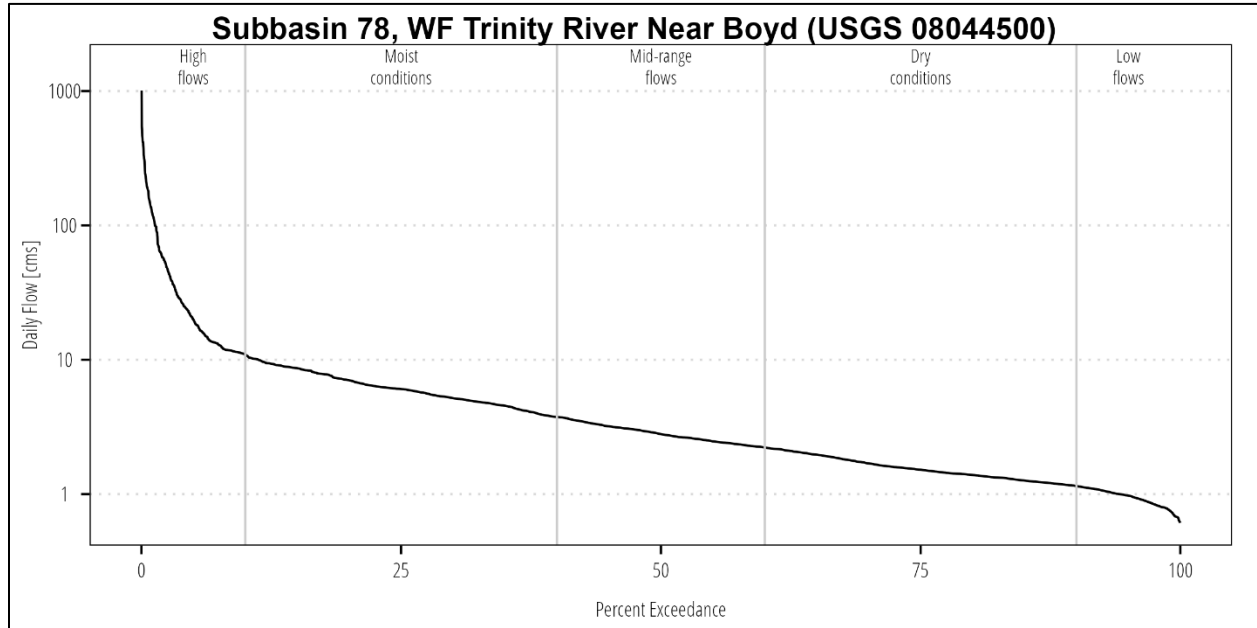


Figure 7. Flow duration curve for the West Fork Trinity River near Boyd.

Water Quality Calibration

Water quality (WQ) observations used in the calibration of the Eagle Mountain watershed, provided by the TRWD, are shown in Table 9. Site locations are shown in Figure 4.

Table 9. Monitoring sites used for calibration of the Eagle Mountain watershed.

Site Name	Site Number	Time Period	Data Available
Ash Creek	10854	2005-2020	TSS, NO2+NO3, NH3, TN, PO4, TP
Walnut Creek	10853	2005-2020	NO2+NO3, NH3, TN, PO4, TP
WF @ FM730	10969	2011-2020	TSS, NO2+NO3, NH3, TN, PO4, TP
WF @ Bobo/4668	17844	2005-2010	TSS, NO2+NO3, NH3, TN, PO4, TP

LOADEST

The USGS LOADEST (Load Estimator) tool is a powerful and widely used software developed by the United States Geological Survey (USGS) to estimate the transport of sediment and nutrients in rivers and streams. LOADEST utilizes three statistical models to estimate the loads of sediment, nutrients, and other contaminants based on available WQ data. The Adjusted Maximum Likelihood Estimation (AMLE) and Maximum Likelihood Estimation (MLE) are appropriate when the calibration model errors (residuals) are normally distributed, and the Absolute Deviation (LAD) is an alternative when the residuals are not normally distributed.

For the Eagle Mountain watershed, the AMLE statistical model was used in LOADEST to estimate constituent loads for calibration. The model was developed using the dates and times of observations,

observed flow, and observed constituent concentrations. Because LOADEST requires a continuous flow time series to estimate loads, the calibrated SWAT-simulated flow was used as this input. The resulting estimation of constituent load was generated including the mean load estimates, standard errors, and 95 percent confidence intervals on a monthly timestep.

The summary statistics used to determine if the estimated load should be used for calibration were the Load Bias in Percent (B_p), where positive (negative) values indicate over (under) estimation. The model should not be used when the + or - bias exceeds 25%. The Partial Concentration Ratio (PCR) is another measure to show the amount of over or under estimation and is calculated using B_p .

$$PCR = (B_p + 100) / 100$$

PCR values > 1 indicate overestimation; values < 1 indicate underestimation. Finally, the Nash Sutcliffe Efficiency Index (E) (Nash and Sutcliffe, 1970). values range from -infinity to 1.0 with E = 1 a perfect fit to observed data, E = 0 the model estimates are as accurate as the mean of observed data, and E < 0; the observed mean is a better estimate than the model estimates. Table 10 shows the resulting LOADEST summary statistics for total phosphorus for each location across the Eagle Mountain watershed. All locations and constituents had acceptable LOADEST results except for NH₃ at site 10854.

Table 10. LOADEST results for each station and WQ constituent. Red entries indicate poor LOADEST performance.

Station	Variable	B_p [%]	PCR	E
10969	Sediment (TSS)	-12.565	0.874	0.095
10969	NOx (NO ₂ +NO ₃)	-2.899	0.971	0.096
10969	Ammonium-N (NH ₃)	-4.883	0.951	0.062
10969	Orthophosphate-P (OP ₄)	2.242	1.022	0.008
10969	Total Nitrogen (TN)	-1.128	0.989	0.215
10969	Total Phosphorous (TP)	-0.585	0.994	0.152
17844	Sediment (TSS)	1.457	1.015	0.155
17844	NOx (NO ₂ +NO ₃)	5.922	1.059	0.071
17844	Ammonium-N (NH ₃)	-8.751	0.912	0.05
17844	Orthophosphate-P (OP ₄)	-0.424	0.996	0.085
17844	Total Nitrogen (TN)	-19.675	0.803	0.027
17844	Total Phosphorous (TP)	-0.739	0.993	0.406
10853	Nitrate-N (NO ₃)	20.774	1.208	-0.035
10853	Ammonium-N (NH ₃)	0.045	1	0.336
10853	Orthophosphate-P (OP ₄)	11.572	1.116	-0.05
10853	Total Nitrogen (TN)	1.792	1.018	0.391
10853	Total Phosphorous (TP)	7.54	1.075	0.296
10854	Sediment (TSS)	21.291	1.213	0.272
10854	NOx (NO ₂ +NO ₃)	10.582	1.106	0.204
10854	Ammonium-N (NH ₃)	-13.911	0.861	-0.004
10854	Orthophosphate-P (OP ₄)	7.826	1.078	0.388

10854	Total Nitrogen (TN)	-6.434	0.936	0.093
10854	Total Phosphorous (TP)	11.082	1.111	0.171

Additionally, LOADEST was used to simulate continuous time series over the same time period for *E. coli* from the observations at each site. The summary statistics from LOADEST for *E. coli* are similar, but slightly different from the other WQ variables. The *E. coli* LOADEST tool provides R^2 , Prob. Plot. Corr. Coeff. (PPCC), and serial correlation of residuals. The R^2 value indicates the percentage of variability in the observed *E. coli* loads that is explained by the model. Larger values indicate stronger fit, suggesting the model does a good job of predicting *E. coli* loads based on the input data. The PPCC assesses how well the residuals (differences between observed and predicted values) follow a normal distribution. A value close to 1 indicates that the residuals are normally distributed, which supports the validity of statistical assumptions in the model. The serial correlation of residuals measures how correlated the residuals are over time. A value of 0 would indicate no correlation over time, while values closer to ± 1 indicate strong serial correlation. Table 11 provides the statistical results from the *E. coli* LOADEST for each station. All locations have strong fitted models (R^2 values), nearly normal distribution (PPCC) and mild positive autocorrelation (Corr. Residuals).

Table 11. LOADEST results for *E. coli* at each station.

Station	R^2	PPCC	Corr. Residuals
10969	82.12	0.984	0.2287
17844	77.35	0.989	0.0355
10853	82.74	0.994	0.1776
10854	81.3	0.967	0.1351

Results

For WQ calibration, SWAT-CUP was also used. First, SWAT-CUP was run to calibrate sediment. The best fitted value for each parameter used in the flow calibration (Table 7) was set as fixed values, and the parameters that calibrate sediment from Table 12 were used across their respective ranges to find the best fitted value. Next, the nitrogen was calibrated using a similar method of setting the previous calibration (flow and sediment) parameters as fixed and finding the best fitted value for the nitrogen parameter in Table 12. Finally, this process was completed for phosphorus resulting in a final calibrated model for all WQ constituents.

Table 12. Water quality calibration parameters used in the Eagle Mountain watershed and their range of acceptable values.

Value Type	SWAT Parameter	Input File	Description	Fitted Value	Range
Replace	SPCON	bsn	Maximum amount of sediment that can be reentrained	0.000417	0.0001 to 0.01
Replace	SPEXP	bsn	Sediment reentrained in channel sediment routing	1.380469	1 to 2

Replace	ADJ_PKR	bsn	Peak rate adjustment factor for sediment routing in the subbasin	1.858203	0.5 to 2
Replace	PRF_BSN	bsn	Peak rate adjustment factor for sediment routing in the main channel	0.417188	0 to 2
Replace	PPERCO	bsn	Phosphorus percolation coefficient	10.52734	10 to 17.5
Replace	PHOSKD	bsn	Phosphorus soil partitioning coefficient	199.2188	120 to 200
Replace	PSP	bsn	Phosphorus sorption coefficient	0.576016	0.01 to 0.7
Replace	SOL_P_MODEL	bsn	Soil phosphorus model	1	0 to 1
Replace	P_UPDIS	bsn	Phosphorus uptake distribution parameter	83.59375	20 to 100
Replace	CMN	bsn	Rate factor for humus mineralization of active organic nitrogen	0.001516	0.001 to 0.003
Replace	N_UPDIS	bsn	Nitrogen uptake distribution parameter	2.34375	0 to 100
Replace	NPERCO	bsn	Nitrogen percolation coefficient	0.242188	0 to 1
Replace	RSDCO	bsn	Residue decomposition coefficient	0.080625	0.02 to 0.1
Replace	CDN	bsn	Denitrification exponential rate coefficient	1.120313	1 to 1.2
Replace	SDNCO	bsn	Denitrification threshold water content	0.840625	0.6 to 1
Replace	AI2	wwq	Fraction of algal biomass that is phosphorus	0.013828	0.01 to 0.02
Replace	AI1	wwq	Fraction of algal biomass that is nitrogen	0.073594	0.07 to 0.09
Replace	AI0	wwq	Ratio of chlorophyll-a to algal biomass	86.640625	10 to 100
Replace	RS2	swq	Benthic (sediment) source rate for dissolved phosphorus in the reach at 20°C	0.076023	0.001 to 0.1
Replace	RS3	swq	Benthic source rate for NH ₄ -N in the reach at 20°C	0.742188	0 to 1
Replace	RS4	swq	Rate coefficient for organic N settling in the reach at 20°C	0.089945	0.001 to 0.1
Replace	RS5	swq	Oranic phosphorus settling rate in the reach at 20°C	0.017242	0.001 to 0.1

Table 13 presents the water quality calibration results from SWAT-CUP. Calibrating the Eagle Mountain watershed as a whole provides a consistent representation of hydrologic processes and accounts for the interconnectedness between upstream and downstream areas. In contrast, adjusting channel processes at individual gage sites can result in localized fixes that overlook broader watershed dynamics and may introduce inconsistencies across the model. Among the sites, calibration at site 10969 yielded the most consistent and reliable results, possibly due to its more recent data availability (2011–2020). Site 17844, located slightly downstream on the West Fork Trinity River, had data only from 2005–2010 and showed the least favorable calibration. Site 10969, which overlaps with USGS gage 08044500 used for flow calibration, was prioritized during calibration. Sites 10853 and 10854, located on Walnut Creek and Ash Creek, respectively, contribute relatively low loading to Eagle Mountain Lake; thus, despite mixed LOADEST and calibration results, their impact on overall watershed loading is minimal. The SWAT model output separates NO₂ and NO₃, and during calibration, only one can be selected for calibration. The average annual loading of NO₂ is 5% of NO_x (NO₂+NO₃) at sites 10969 and 17844, and 6.7% at site 10854, and 4.2% at site 10853 therefore NO₃ was used for the calibration of the NO_x observations.

Table 13. Water quality calibration summary statistics from SWAT-CUP for the Eagle Mountain watershed. Bold values indicate acceptable calibration. TSS = metric tonnes, NO₃, NH₃, PO₄, TN, TP = kilograms (kg).

Gage ID	Constituent	NS	PBIAS	KGE	Simulation Mean	Observation Mean
10969	TSS (tonnes)	0.63	2.9	0.7	10,095.86	10,394.62
10969	NO ₃ (kg)	0.36	-9.1	0.65	13,425.61	12,311.01
10969	NH ₃ (kg)	0.5	37.6	0.35	3,273.16	5,243.13
10969	PO ₄ (kg)	0.64	-4.8	0.66	5,727.16	5,464.76
10969	TN (kg)	0.52	31.5	0.44	42,854.48	62,547.68
10969	TP (kg)	0.54	-19.7	0.7	13,308.03	11,116.98
17844	TSS (tonnes)	0.75	9.6	0.83	6,125.54	6,773.68
17844	NO ₃ (kg)	-1.08	-98.4	-0.15	12,100.86	6,100.37
17844	NH ₃ (kg)	-5.47	-133.3	-1.21	3,323.82	1,424.43
17844	PO ₄ (kg)	-5.8	-184.5	-1.61	4,499.02	1,581.26
17844	TN (kg)	-0.28	-21.7	0.3	37,132.2	30,509.19
17844	TP (kg)	0.46	-26.4	0.6	9,134.45	7,226.91
10853	NO ₃ (kg)	0.54	-28.8	0.46	1,474.75	1,144.7
10853	NH ₃ (kg)	0.38	36.0	0.18	229.02	358.0
10853	PO ₄ (kg)	0.83	-10.7	0.69	516.4	466.55
10853	TN (kg)	0.81	-41.4	0.53	5,634.83	3,985.22
10853	TP (kg)	0.57	-70.4	0.2	1,563.78	917.73
10854	TSS (tonnes)	0.28	52.1	0.04	407.52	851.42
10854	NO ₃ (kg)	0.37	-52	0.23	1,508.92	992.53
10854	NH ₃ (kg)	-2.52	-305.6	-2.15	382.12	94.22
10854	PO ₄ (kg)	0.26	-13.8	0.63	153.21	134.65
10854	TN (kg)	0.5	-105.7	-0.06	3,945.85	1,918.03
10854	TP (kg)	0.16	-70.3	0.19	526.17	308.88

The resulting simulated WQ constituent time series at site 10969 on the West Fork Trinity River are shown in Figure 8 for sediment (TSS), Figure 9 for Nitrate (NO3), Figure 10 for Ammonium (NH3), Figure 11 for Orthophosphate (PO4), Figure 12 for Total Nitrogen (TN), and Figure 13 for Total Phosphorus (TP). As shown, both the variability over the time period (2011-2020) and the magnitude of each constituent is well simulated when compared to the observed data.

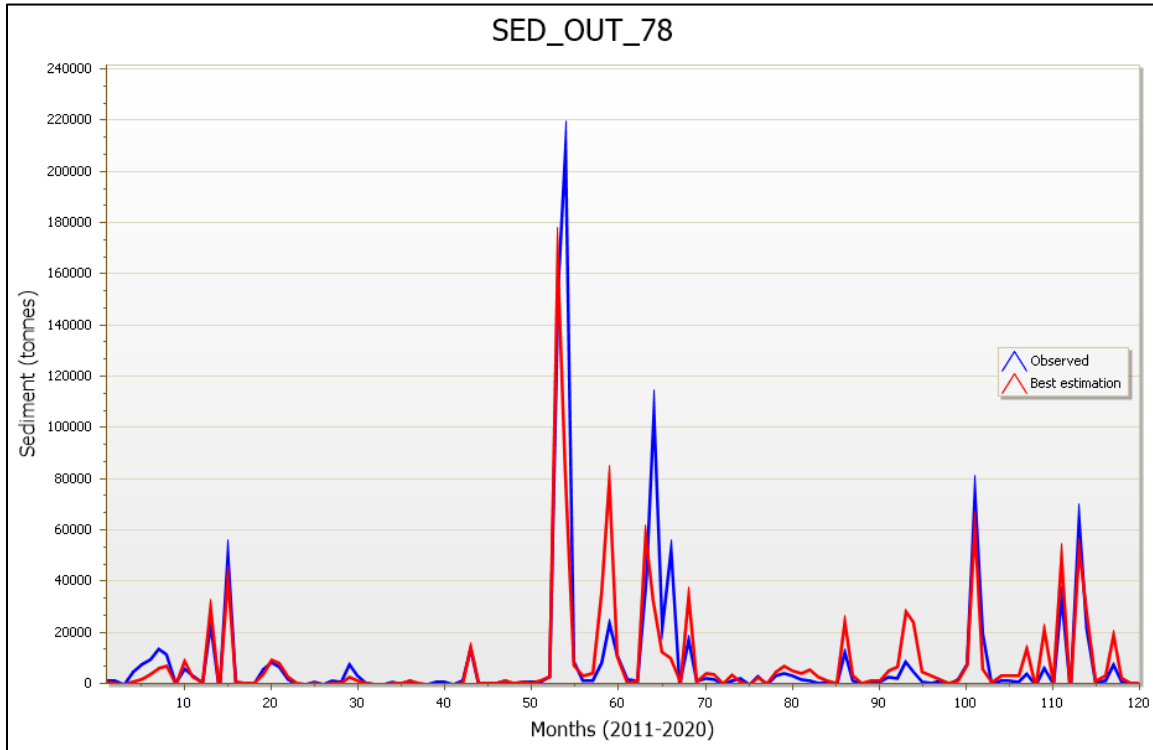


Figure 8. SWAT-CUP sediment calibration results for site 10969 on the West Fork Trinity River.

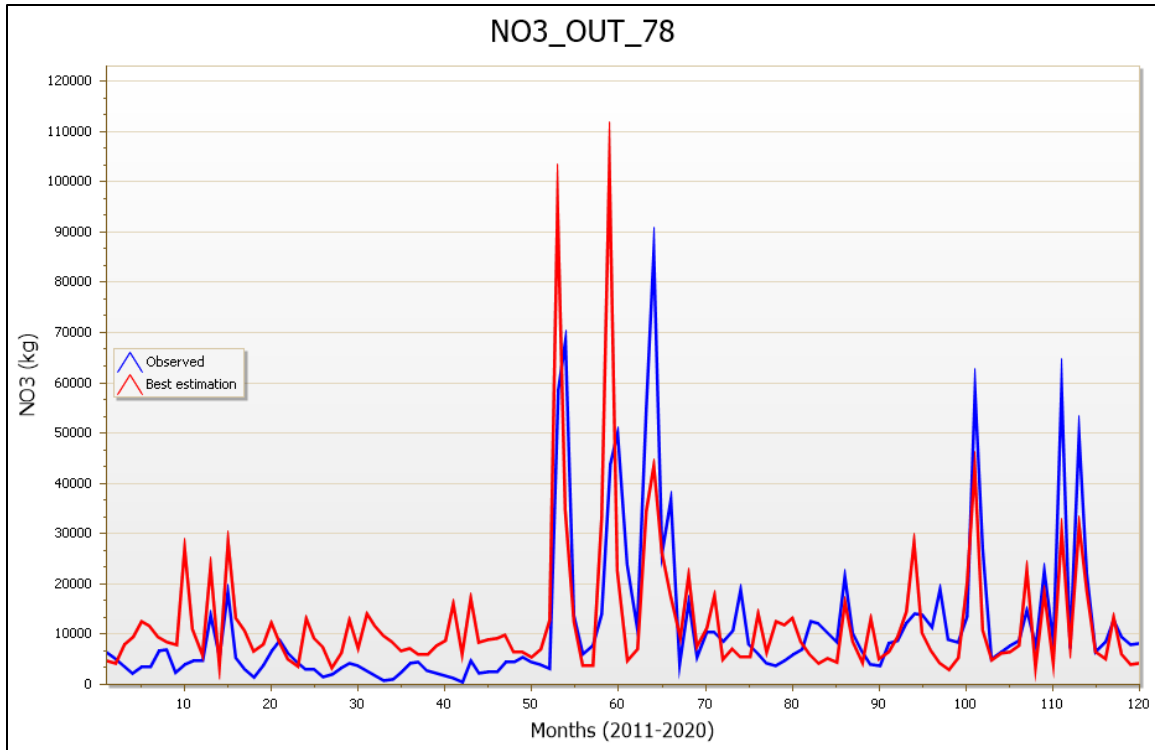


Figure 9. SWAT-CUP NO3 calibration results for site 10969 on the West Fork Trinity River.

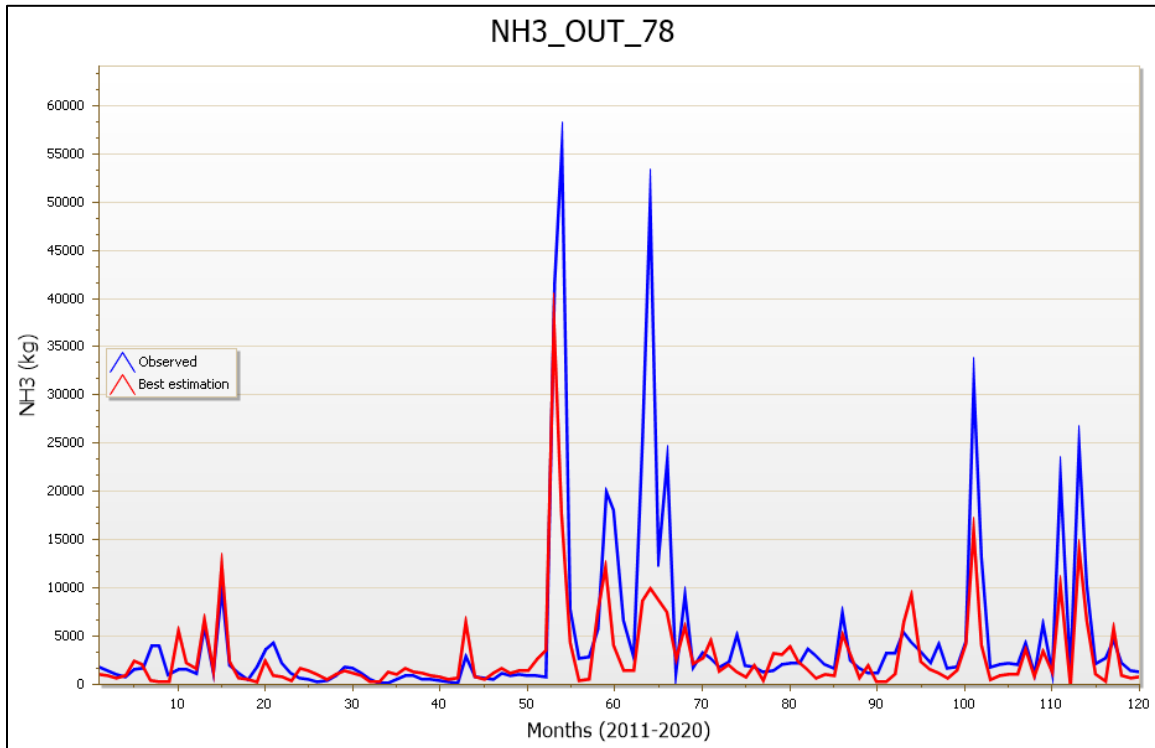


Figure 10. SWAT-CUP NH3 calibration results for site 10969 on the West Fork Trinity River.

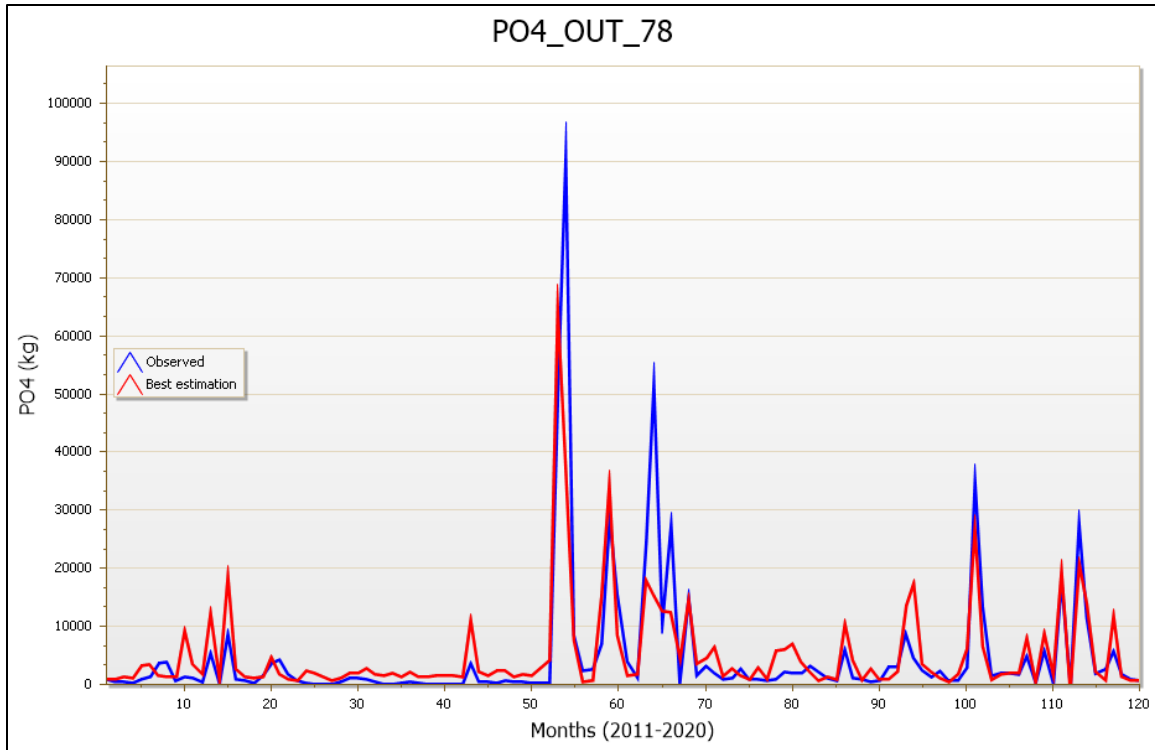


Figure 11. SWAT-CUP PO4 calibration results for site 10969 on the West Fork Trinity River.

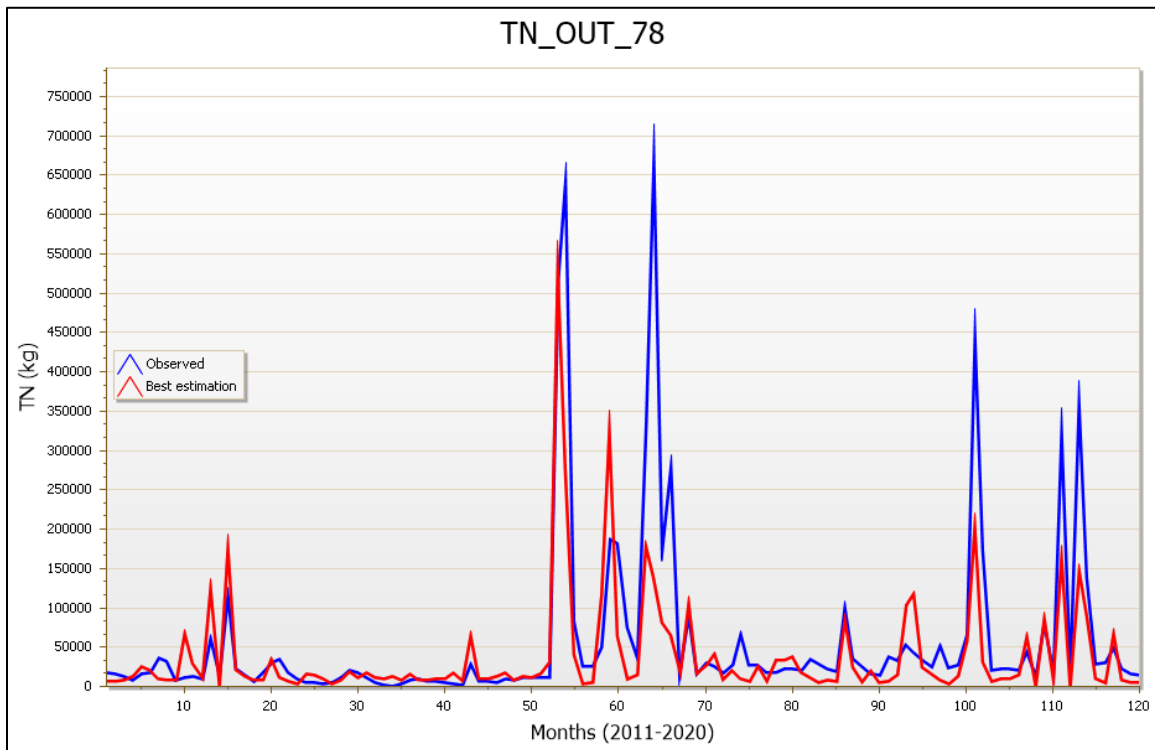


Figure 12. SWAT-CUP TN calibration results for site 10969 on the West Fork Trinity River.

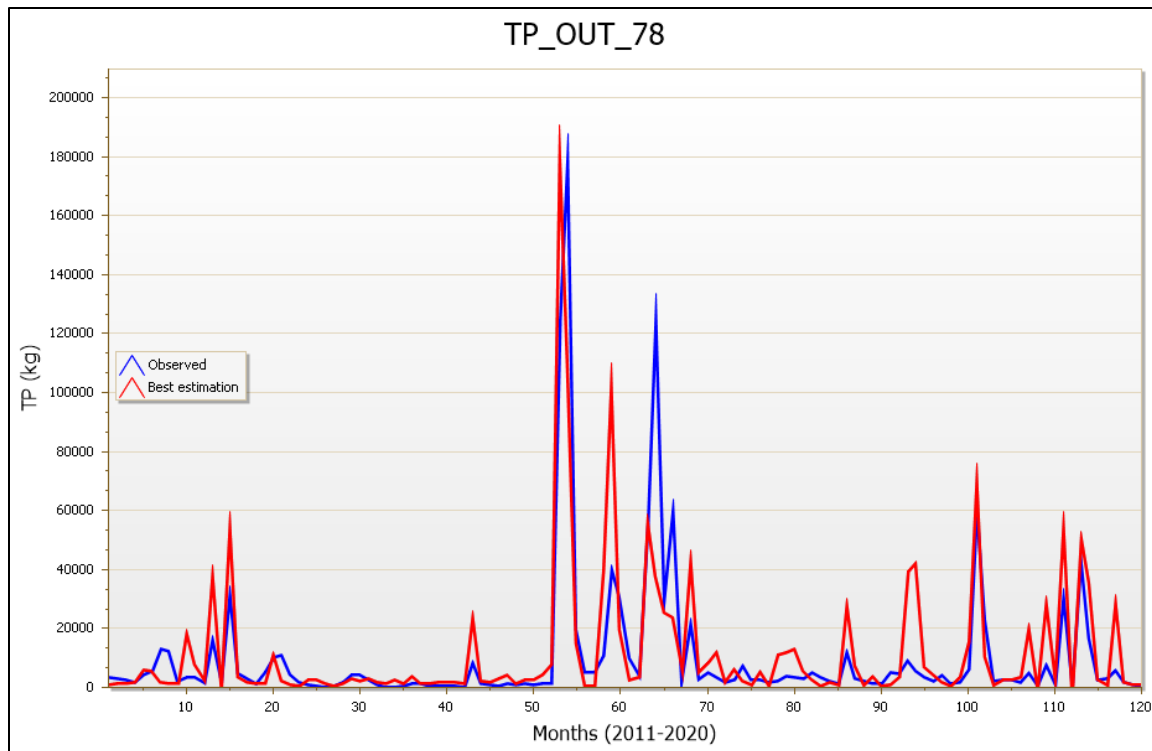


Figure 13. SWAT-CUP TP calibration results for site 10969 on the West Fork Trinity River.

Load Reduction

Texas Surface Water Quality Standards

The Texas Commission on Environmental Quality (TCEQ), set specific criteria for E. coli concentrations to protect recreational uses of surface waters. For contact recreation (e.g., swimming), the geometric mean criterion for E. coli is 126 CFU/100 mL. This standard helps assess water quality and guide watershed management efforts to reduce bacterial contamination.

TCEQ Screening Level

Currently, no numeric standards exist for nutrients in streams in the state of Texas. However, the TCEQ continues to screen for parameters such as nitrogen, phosphorus, and chlorophyll-a (chl-a) as preliminary indicators for waterbodies of possible concern for 303(d) impairments. To support this effort, nutrient screening levels are often used to compare a waterbody to screening levels that are set at the 85th percentile for those parameters of interest seen in similar waterbodies (Table 14). The Texas Nutrient Screening Levels are based on statistical analyses of Surface Water Quality Monitoring (SWQM) data (TCEQ, 2019).

Table 14. TCEQ water quality screening criteria for different constituents.

TCEQ Screening Levels	TKN (mg/L)	NH3 (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NO2+NO3 (mg/L)	TP (mg/L)	OP ^d (mg/L)	Chlorophyll-a ^e (µg/L)
Lake/Reservoir	-	0.11	-	0.37	-	0.2	0.05	26.7
Stream	-	0.33	-	1.95	-	0.69	0.37	14.1

(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.

Load Reduction Curves

Using the calibrated Eagle Mountain SWAT model and the TCEQ screening criteria, load reduction curves (LDCs) were created for WQ constituents of interest in the Eagle Mountain watershed. A 10% Margin of Safety (MOS; USEPA 1999) was included for each water quality standard criterion. This means that 10% of the allowable pollutant load is intentionally set aside as a buffer to account for uncertainties in the modeling, data, or natural variability. This helps ensure that water quality standards are met even if there are unforeseen variations or errors in the analysis.

NO_x

The observational data was available for NO_x (NO₂+NO₃) at each site. The TCEQ only had a screening criterion for NO₃, therefore that criterion was used as a proxy for the NO_x LDCs. Figure 14 and Figure 15 show the LDCs for the two gages on the West Fork Trinity River. The corresponding geomean values from the figures are found in Table 15 and Table 16 respectively. There is no reduction needed at these two gages to meet the screening criteria.

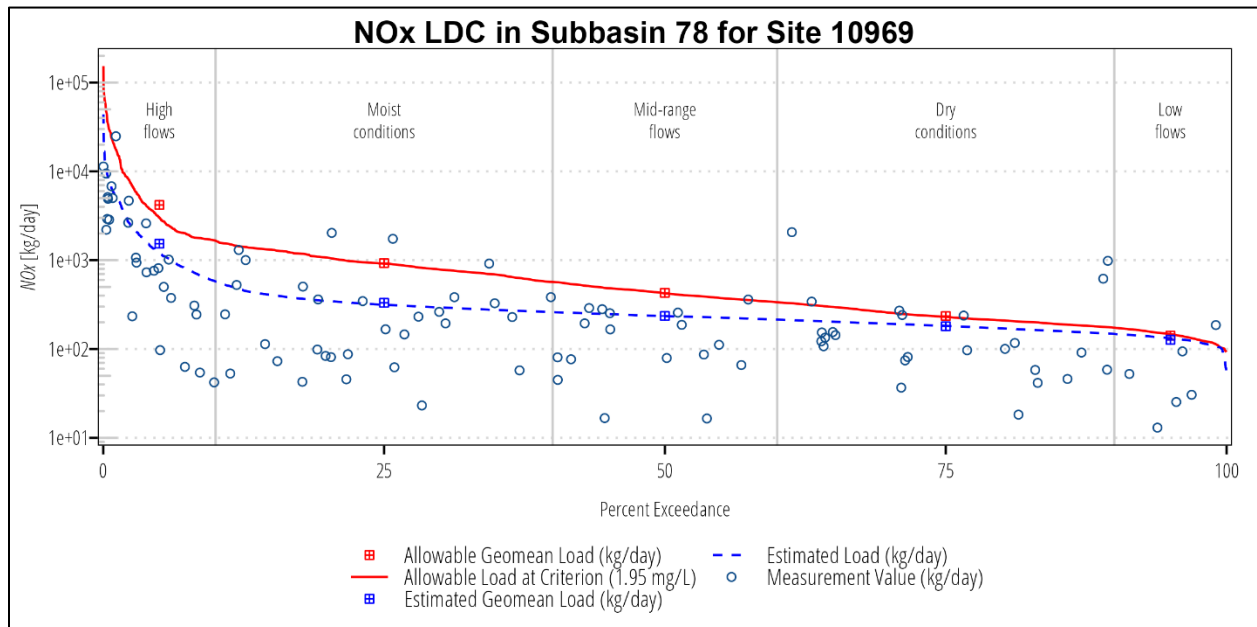


Figure 14. Nitrate (NO_x) load duration curve and allowable load at site 10969.

Table 15. Nitrate (NO_x) reduction needed to meet allowable loading at site 10969 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	1,723,680	0-10	4192.6	1535.8	0.00	0.0
Moist Conditions	522,374	10-40	927.8	331.7	0.00	0.0
Mid-range Conditions	241,402	40-60	429.2	235.9	0.00	0.0
Dry Conditions	131,242	60-90	235.5	180.5	0.00	0.0
Lowest Flows	84,033	90-100	141.9	127.2	0.00	0.0

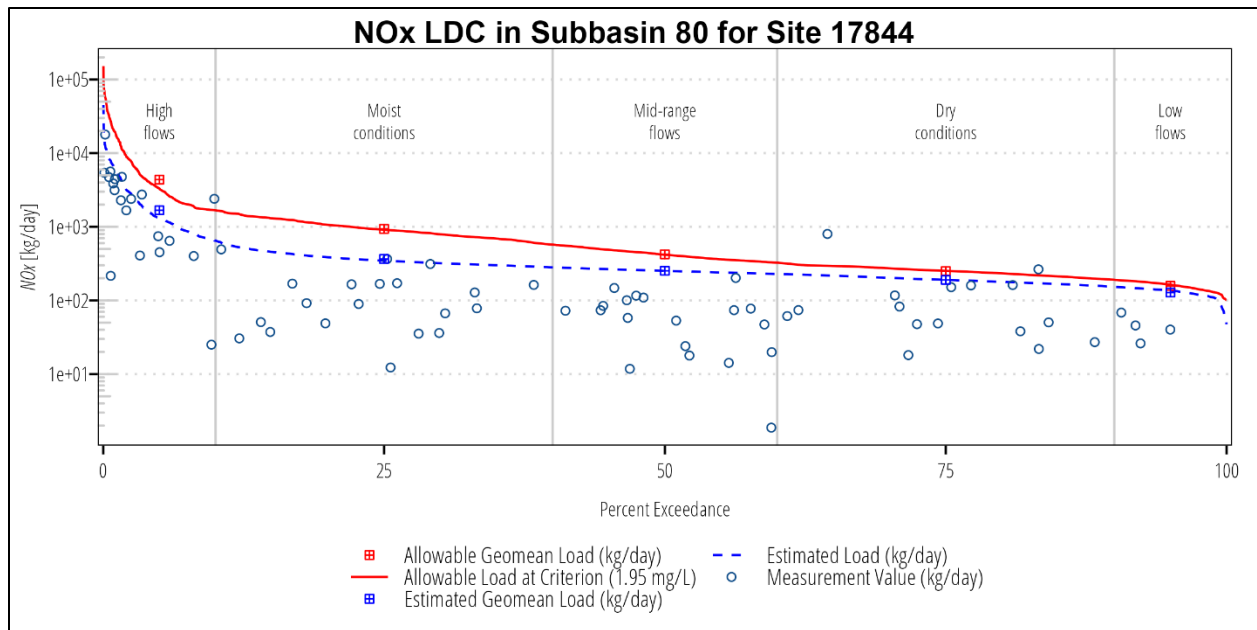


Figure 15. Nitrate (NOx) load duration curve and allowable load at site 17844.

Table 16. Nitrate (NOx) reduction needed to meet allowable loading at site 17844 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	1,882,656	0-10	4364.7	1678.2	0.00	0.0
Moist Conditions	518,400	10-40	936.0	365.6	0.00	0.0
Mid-range Conditions	237,082	40-60	422.6	252.7	0.00	0.0
Dry Conditions	143,770	60-90	250.4	190.0	0.00	0.0
Lowest Flows	93,442	90-100	157.8	128.1	0.00	0.0

The NOx LDC was also created for Ash Creek (site 10854) and shown in Figure 16. The only flow condition that did not exceed the screening criteria was high flows. All other flow regimes exceed the criteria. Table 17 provides the amount of reduction needed during each flow regime to return loading below the screening criteria. However, the simulated loading at the site did over simulate, therefore the amount of reduction needed could be lower.

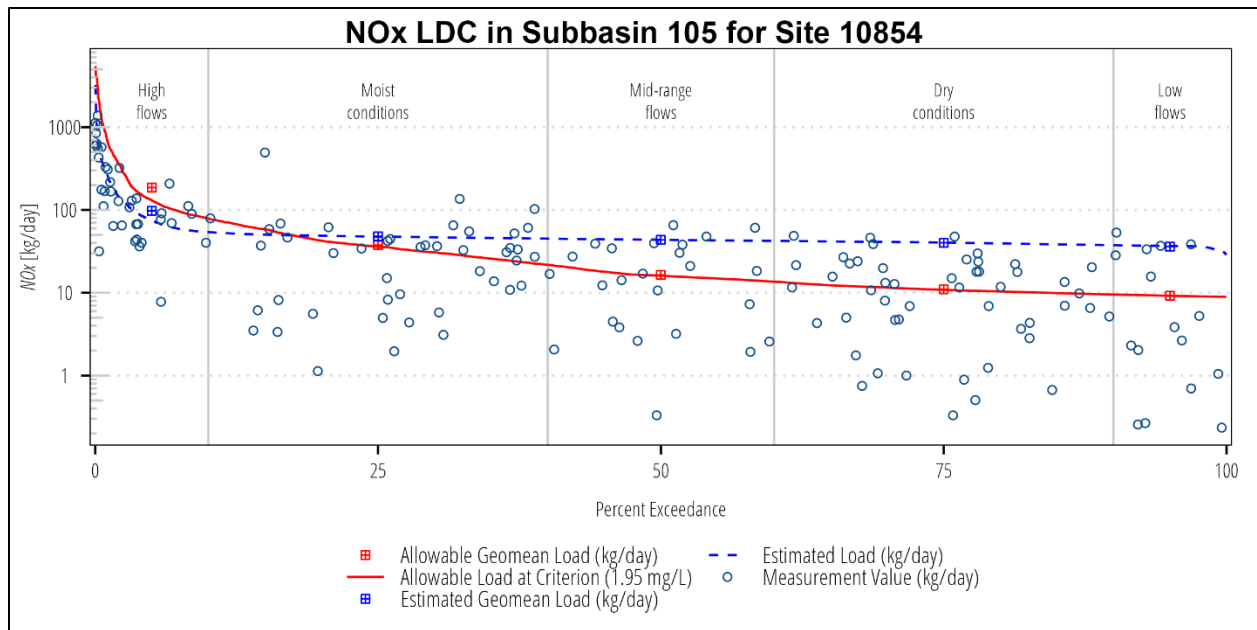


Figure 16. Nitrate (NOx) load duration curve and allowable load at site 10854.

Table 17. Nitrate (NOx) reduction needed to meet allowable loading at site 10854 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	186.4	97.6	0.0	0.0
Moist Conditions	20,485	10-40	37.7	48.0	10.4	21.6
Mid-range Conditions	9,150	40-60	16.4	43.6	27.2	62.3
Dry Conditions	6,178	60-90	11.0	40.1	29.1	72.5
Lowest Flows	5,238	90-100	9.2	36.1	26.9	74.5

The NOx LDC was also created for Walnut Creek (site 10853) and shown in Figure 17. Mid-range to low flows exceeded the screening criteria. Table 18 provides the amount of reduction needed during each flow regime to return loading below the screening criteria. During baseflow or lower flow periods nitrate from agricultural leaching can continue to enter the streams through groundwaters discharge. During high flow conditions the amount of nitrate can be diluted or masked with excessive surface runoff.

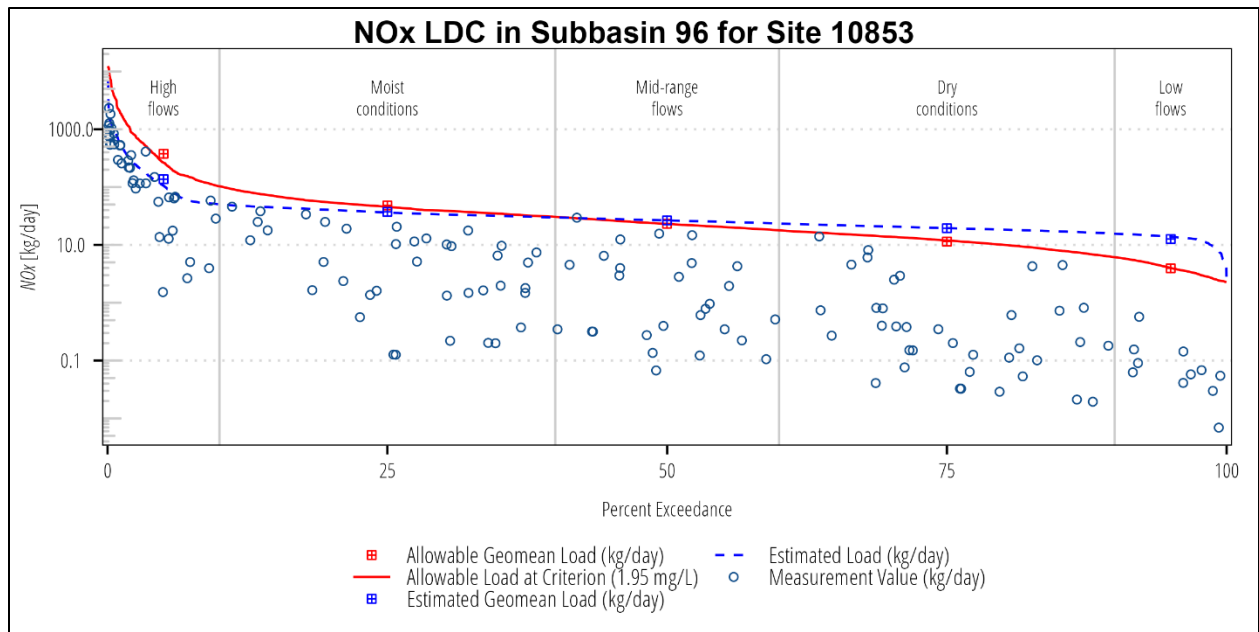


Figure 17. Nitrate (NOx) load duration curve and allowable load at site 10853.

Table 18. Nitrate (NOx) reduction needed to meet allowable loading at site 10853 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	149,904	0-10	376.9	137.3	0.0	0.0
Moist Conditions	25,937	10-40	48.2	37.3	0.0	0.0
Mid-range Conditions	13,167	40-60	23.2	26.5	3.3	12.3
Dry Conditions	6,780	60-90	11.4	19.4	8.0	41.2
Lowest Flows	2,282	90-100	3.9	12.6	8.7	68.8

TP

LDCs for TP were created using the TCEQ screening criteria. For three of the four sites, the loading did not exceed the screening criteria for any of the flow regimes (see Figure 18, Figure 19, and Figure 20; and Table 19, Table 20, and Table 21). For Walnut Creek, however, TP exceeded the screening criteria for both dry and low flow conditions (Figure 21 and Table 22). This could be a result of legacy phosphorus in streambeds or slow-release sources like septic seepage.

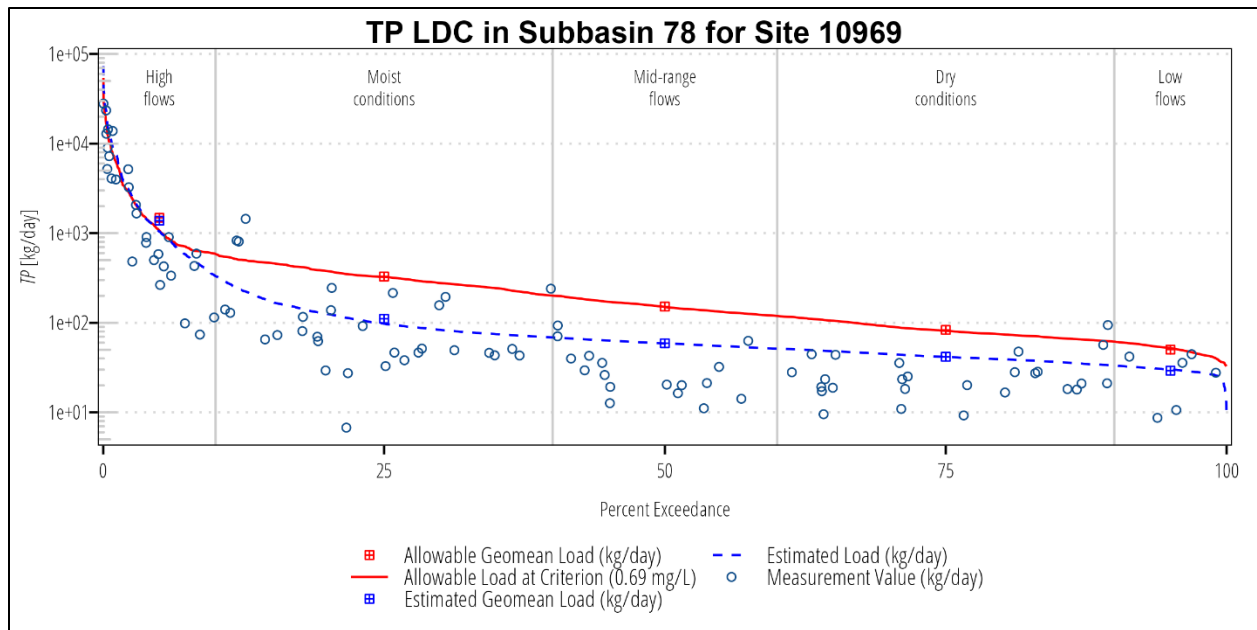


Figure 18. Total phosphorus (TP) load duration curve and allowable load at site 10969.

Table 19. Total phosphorus (TP) reduction needed to meet allowable loading at site 10969 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	1,723,680	0-10	1483.5	1378.3	0.00	0.0
Moist Conditions	522,374	10-40	328.3	110.9	0.00	0.0
Mid-range Conditions	241,402	40-60	151.9	59.1	0.00	0.0
Dry Conditions	131,242	60-90	83.3	41.8	0.00	0.0
Lowest Flows	84,033	90-100	50.2	29.2	0.00	0.0

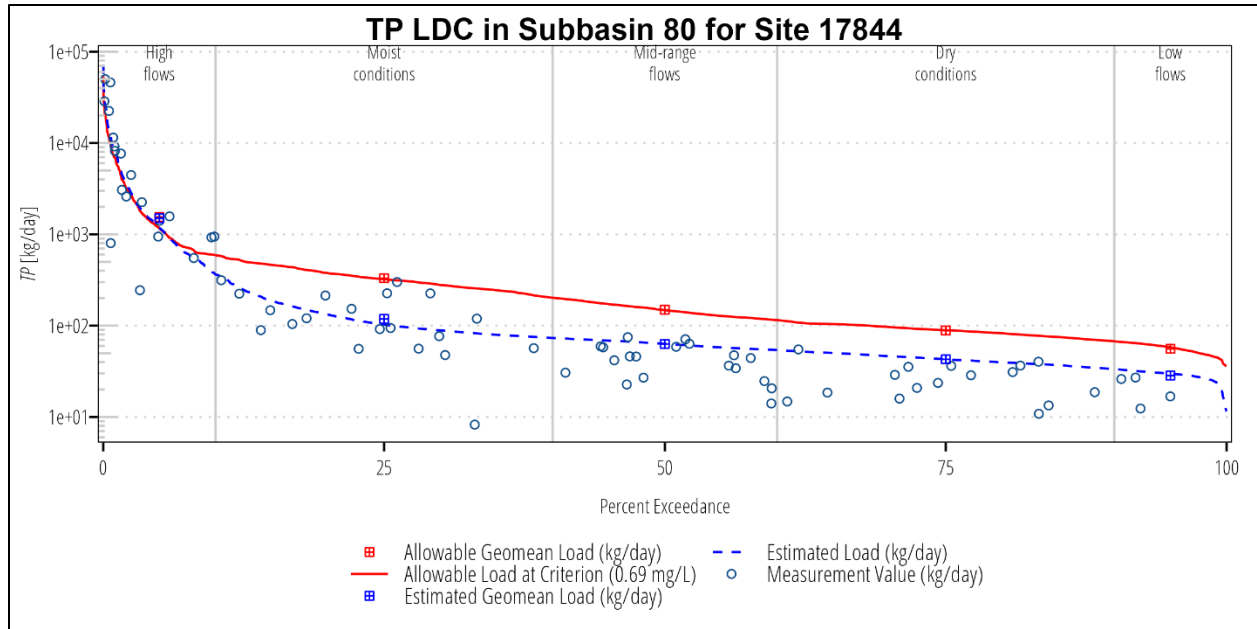


Figure 19. Total phosphorus (TP) load duration curve and allowable load at site 17844.

Table 20. Total phosphorus (TP) reduction needed to meet allowable loading at site 17844 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	1,882,656	0-10	1544.4	1500.6	0.00	0.0
Moist Conditions	518,400	10-40	331.2	118.6	0.00	0.0
Mid-range Conditions	237,082	40-60	149.5	63.0	0.00	0.0
Dry Conditions	143,770	60-90	88.6	42.9	0.00	0.0
Lowest Flows	93,442	90-100	55.8	28.5	0.00	0.0

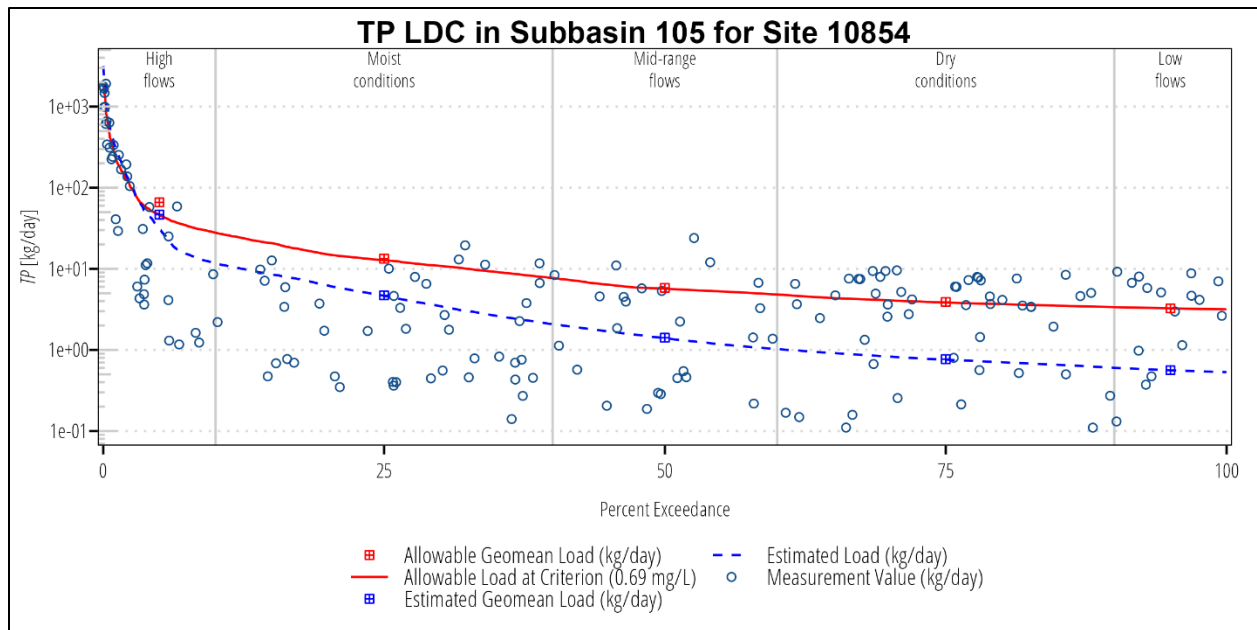


Figure 20. Total phosphorus (TP) load duration curve and allowable load at site 10854.

Table 21. Total phosphorus (TP) reduction needed to meet allowable loading at site 10854 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	65.9	46.5	0.0	0.0
Moist Conditions	20,485	10-40	13.3	4.7	0.0	0.0
Mid-range Conditions	9,150	40-60	5.8	1.4	0.0	0.0
Dry Conditions	6,178	60-90	3.9	0.8	0.0	0.0
Lowest Flows	5,238	90-100	3.3	0.6	0.0	0.0

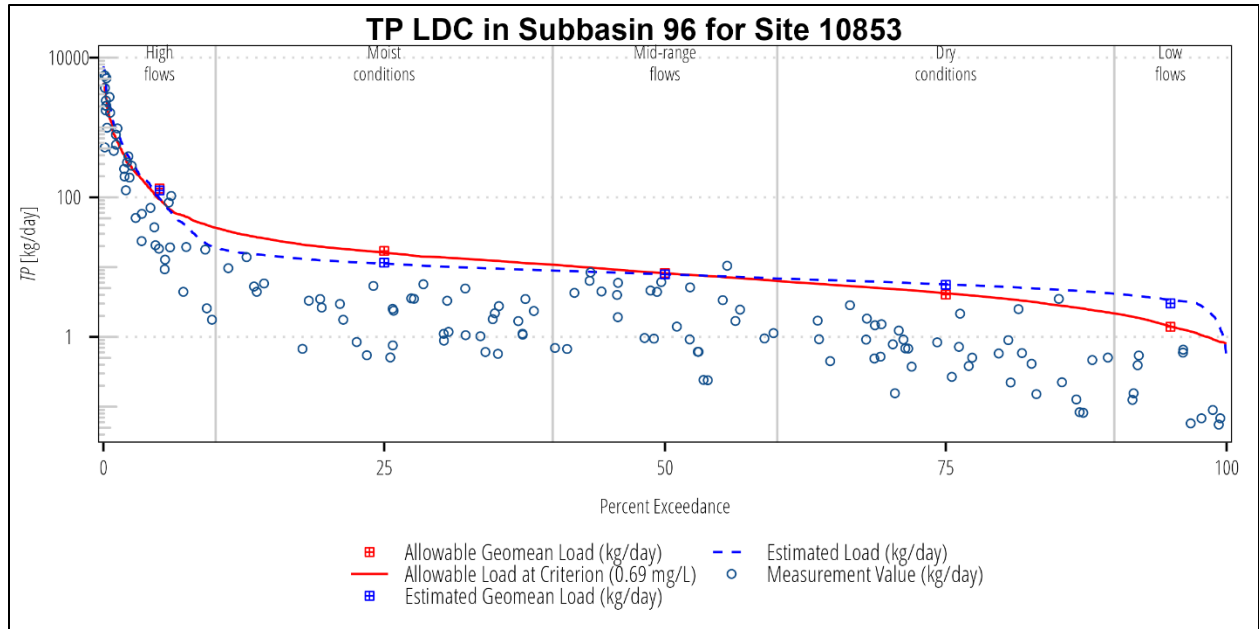


Figure 21. Total phosphorus (TP) load duration curve and allowable load at site 10853.

Table 22. Total phosphorus (TP) reduction needed to meet allowable loading at site 10853 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	149,904	0-10	133.4	125.2	0.0	0.0
Moist Conditions	25,937	10-40	17.0	11.6	0.0	0.0
Mid-range Conditions	13,167	40-60	8.2	7.9	0.0	0.0
Dry Conditions	6,780	60-90	4.0	5.6	1.5	27.4
Lowest Flows	2,282	90-100	1.4	3.0	1.6	53.9

E.coli

The SWAT model does not directly model *E.coli*. Therefore, the LDCs were created using the LOADEST generated time series from the provided observations. The two sites located on the West Fork Trinity River and the site located on Ash Creek all needed load reductions for every flow regime. The site located on Walnut Creek only exceeded the allowable load for mid-range to high flow conditions.

Figure 22 and Table 23 provide the amount of reduction needed to reach the allowable load for site 10969. The allowable load is almost doubled during high flow conditions, and a smaller reduction during low flow conditions of ~14% is necessary.

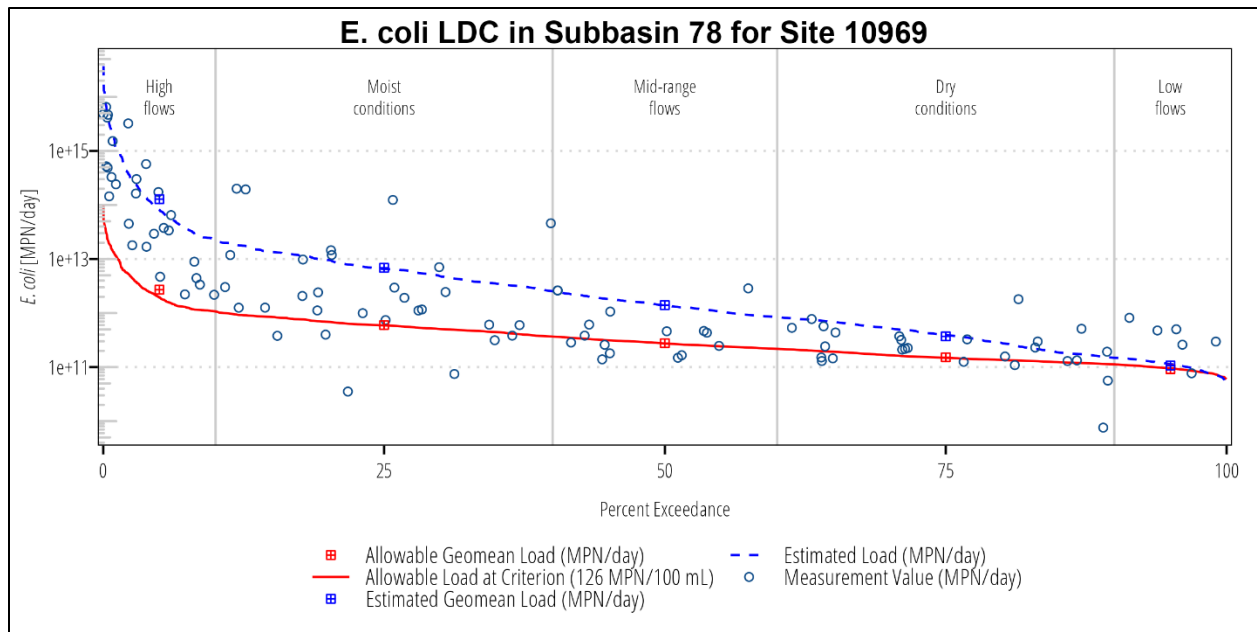


Figure 22. *E.coli* load duration curve and allowable load at site 10969.

Table 23. *E.coli* reduction needed to meet allowable loading at site 10969 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	1,723,680	0-10	2.71E+12	1.28E+14	1.26E+14	97.9
Moist Conditions	522,374	10-40	6E+11	6.88E+12	6.28E+12	91.3
Mid-range Conditions	241,402	40-60	2.77E+11	1.4E+12	1.12E+12	80.2
Dry Conditions	131,242	60-90	1.52E+11	3.71E+11	2.19E+11	59.0
Lowest Flows	84,033	90-100	9.17E+10	1.07E+11	1.53E+10	14.3

For site 17844 (Figure 23 and Table 24) the reduction needed is smaller in all flow regimes. However, the observations used for this LDC were only available from 2005-2010, therefore when looking at BMPs to reduce the loading, it would be advisable to reach the load reductions of the upstream site 10969 which uses more recent observational data (2011-2020).

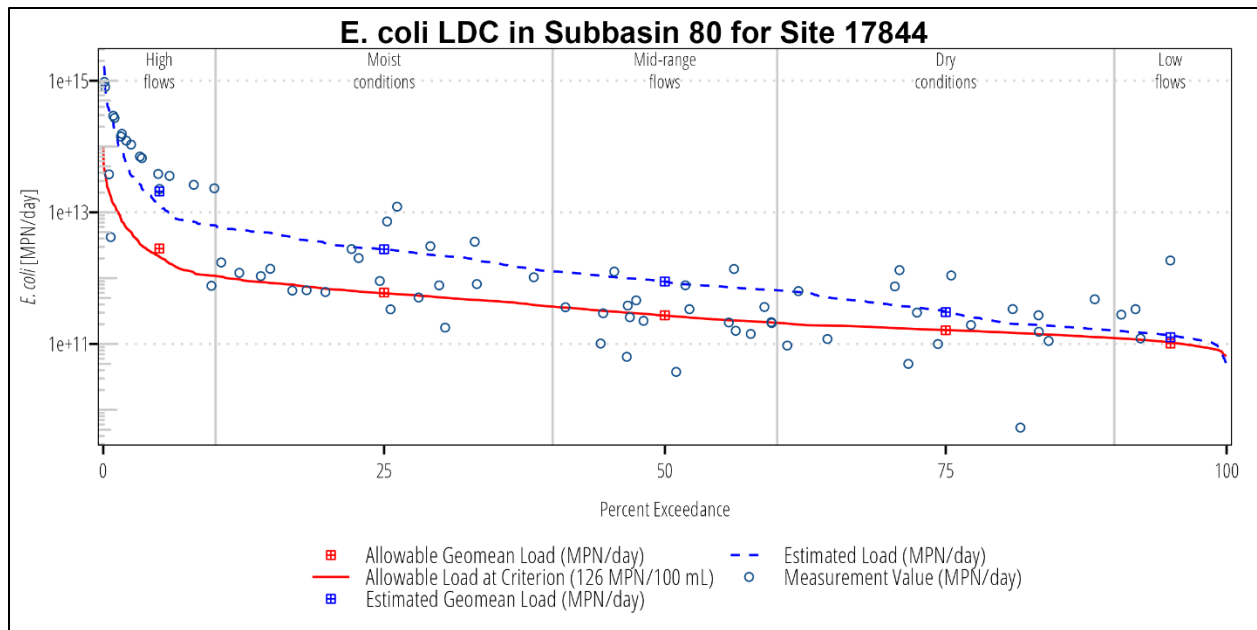


Figure 23. *E.coli* load duration curve and allowable load at site 17844.

Table 24. *E.coli* reduction needed to meet allowable loading at site 17844 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	1,882,656	0-10	2.82E+12	2.08E+13	1.8E+13	86.5
Moist Conditions	518,400	10-40	6.05E+11	2.75E+12	2.15E+12	78.0
Mid-range Conditions	237,082	40-60	2.73E+11	8.91E+11	6.18E+11	69.4
Dry Conditions	143,770	60-90	1.62E+11	3.05E+11	1.43E+11	47.0
Lowest Flows	93,442	90-100	1.02E+11	1.27E+11	2.48E+10	19.6

For site 10854 again, reduction is needed for all flow regimes. Since there is a consistent amount of reduction needed (Figure 24 and Table 25) for all flow regimes, this could indicate that the *E.coli* loading in the Ash Creek may be from a point source instead of non-point source land processes which could be addressed with land management BMPs. To reduce the loading of *E.coli* at this site, point source information may be required.

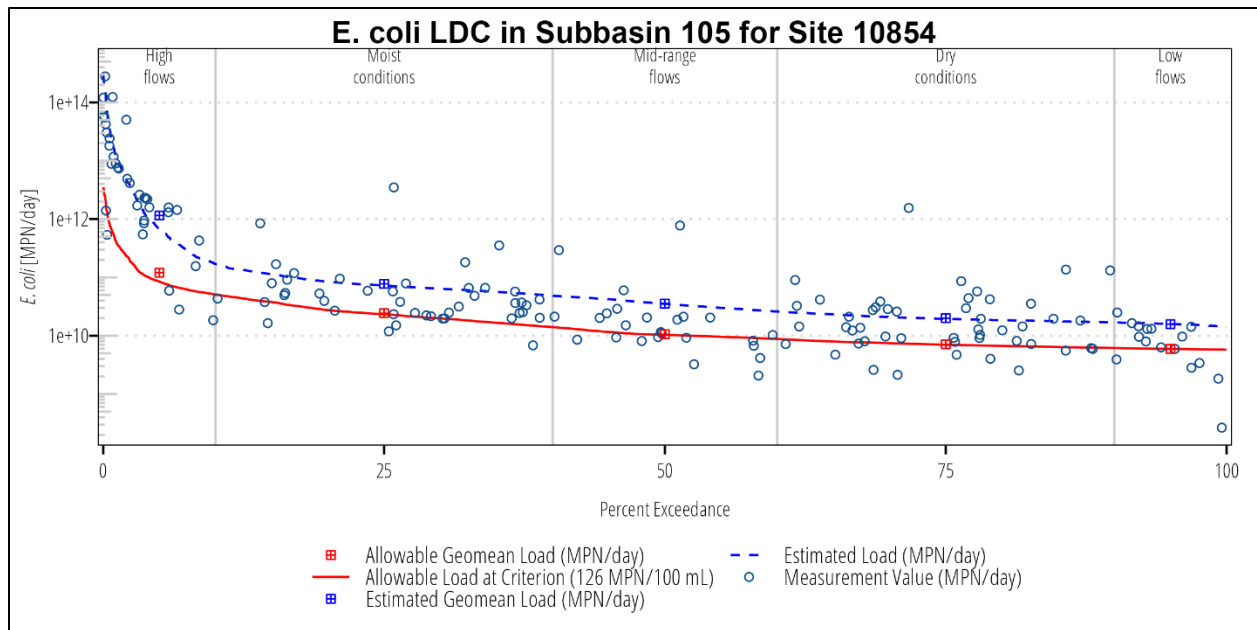


Figure 24. *E. coli* load duration curve and allowable load at site 10854.

Table 25. *E. coli* reduction needed to meet allowable loading at site 10854 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	1.2E+11	1.15E+12	1.03E+12	89.5
Moist Conditions	20,485	10-40	2.43E+10	7.75E+10	5.31E+10	68.6
Mid-range Conditions	9,150	40-60	1.06E+10	3.54E+10	2.48E+10	70.1
Dry Conditions	6,178	60-90	7.12E+09	2E+10	1.29E+10	64.4
Lowest Flows	5,238	90-100	5.94E+09	1.58E+10	9.82E+09	62.3

For site 10853, the loading exceeded the allowable criteria for high flows through mid-range flows. Figure 25 shows the LDC for Walnut Creek and Table 26 provides the amount of reduction needed to meet the allowable criteria. Exceedances are common during and right after high flow events. This is often associated with stormwater runoff which includes livestock waste, urban surfaces, and resuspension of bacteria in sediments into the streams.

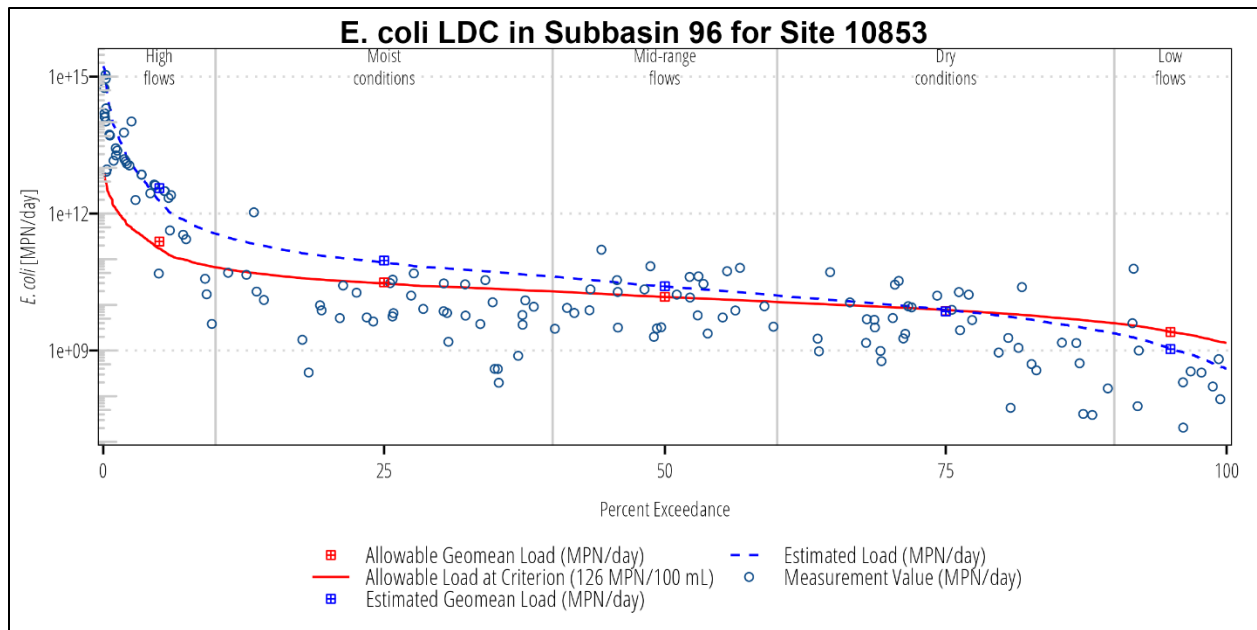


Figure 25. *E.coli* load duration curve and allowable load at site 10853.

Table 26. *E.coli* reduction needed to meet allowable loading at site 10853 for each flow condition.

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	149,904	0-10	2.44E+11	3.59E+12	3.35E+12	93.2
Moist Conditions	25,937	10-40	3.11E+10	9.37E+10	6.25E+10	66.8
Mid-range Conditions	13,167	40-60	1.50E+10	2.56E+10	1.06E+10	41.3
Dry Conditions	6,780	60-90	7.38E+09	7.21E+09	0	0
Lowest Flows	2,282	90-100	2.55E+09	1.08E+09	0	0

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APPENDIX C Load Reduction Strategies for the Eagle Mountain Watershed

Nutrients: SWAT

E.coli: TX-SELECT

Abstract

This report includes the information on the Best Management Scenarios simulated to reduce loading in Eagle Mountain watershed.

SWAT

The Soil and Water Assessment Tool (SWAT) was utilized to evaluate the potential effectiveness of various best management practices (BMPs) in reducing nutrient and sediment loads across the Eagle Mountain watershed. SWAT is a widely recognized, process-based watershed model capable of simulating the impact of land use, management practices, and climate on water, sediment, and agricultural yields in large and complex watersheds. In this study, SWAT was calibrated using observed streamflow and water quality data, as described in detail in the companion calibration document. The resulting model provided a reliable baseline representation of current watershed conditions and pollutant loads, serving as the foundation for evaluating the effectiveness of proposed BMPs.

Once the baseline model was established, a suite of BMP scenarios was simulated to assess their impact on reducing total nitrogen, total phosphorus, and sediment delivery throughout the watershed. These scenarios included management-based practices, such as cover cropping, nutrient management, and cattle stocking rate improvements. Each BMP was evaluated individually to understand its potential contribution to improving water quality. The simulation results allowed for watershed scale assessment to identify the potential for improvement of each BMP. This approach supports data-driven decision-making and helps stakeholders target resources efficiently to meet watershed conservation goals.

Load Reduction Strategies

Implementing nutrient and sediment load reduction strategies offers significant environmental benefits by improving water quality in streams, rivers, and downstream ecosystems. Excess nitrogen and phosphorus from agricultural runoff, wastewater, and urban sources can lead to harmful algal blooms, oxygen depletion, and loss of aquatic biodiversity. By adopting practices such as cover cropping, precision nutrient management, and improving cattle stocking rates, these pollutants can be significantly reduced at the source. This not only enhances aquatic habitat health but also helps maintain the integrity of drinking water supplies and supports recreational uses of water bodies.

Beyond environmental gains, nutrient and sediment reduction strategies contribute to long-term economic and social resilience. Healthier watersheds require fewer costly interventions for water treatment and infrastructure maintenance caused by sediment accumulation. Additionally, improved soil conservation supports agricultural productivity by preventing topsoil loss and enhancing soil fertility. These practices also demonstrate compliance with regulatory frameworks and help communities meet Total Maximum Daily Load (TMDL) goals, positioning them for future funding opportunities and partnerships. Overall, integrated load reduction strategies support sustainable land and water resource management while promoting community well-being.

The BMPs selected for modeling in the Eagle Mountain watershed were designed as enhancements to existing land management activities. Rather than introducing entirely new practices, the simulations focused on improving the effectiveness or increasing the extent of current practices already in use across the watershed.

Four distinct BMP types were evaluated; each applied at varying levels of implementation relative to the baseline scenario. These varying levels represent incremental changes in the adoption or intensity of the BMPs, allowing for an assessment of their potential impact on nutrient and sediment reduction under

different management scenarios. Further details on each BMP and the modeled implementation levels are provided below.

Cover Crops

To assess the potential impact of increased cover crop adoption, additional land within the Eagle Mountain watershed was simulated to receive cover cropping treatments. Specifically, three levels of increased adoption were modeled—15%, 25%, and 40% above the current extent of cover crops in the watershed. These increases were applied to managed pasture areas using either oats (OATS) or winter wheat (WWHT) as the cover crop species using the same 25%/75% split, respectively, as the baseline model. Table 1 presents the total area under cover crops for each scenario, along with the corresponding average changes in nitrate (NO₃), total phosphorus (TP), and sediment yield (SYLD) across the watershed.

Cover crops offer numerous environmental and agronomic benefits, particularly when implemented on pasture land. Species such as oats and winter wheat provide soil cover during periods when fields would otherwise be bare, reducing erosion, improving soil structure, and enhancing infiltration. They also scavenge residual nutrients from the soil, particularly phosphorus, preventing leaching into nearby waterways. Over time, cover crops contribute to improved soil health through increased organic matter and microbial activity. In the Eagle Mountain watershed, expanding the use of cover crops on managed pastures not only helps reduce phosphorus and sediment loads but also supports long-term land productivity and resilience. Increasing the area of land receiving cover crops resulted in a slight increase in average NO₃ levels across the watershed. This outcome is attributed to the simulated application of nitrogen fertilizer on managed pasture land as part of the cover crop management. In the baseline scenario, pasture land did not receive nitrogen fertilizer, so the introduction of fertilization with the cover crop simulation represents a new source of nitrogen in the system.

While this fertilizer application supports cover crop establishment and productivity, it also introduces additional nitrogen that can contribute to leaching and runoff if not effectively taken up by the crops. This highlights the importance of carefully managing nutrient inputs when implementing cover cropping practices, particularly on land where fertilizer was not previously applied. Despite the increase in NO₃, the use of cover crops still provided measurable reductions in sediment and total phosphorus, underscoring their value as a conservation practice when integrated thoughtfully.

Table 1. Increase in cover crop area and corresponding average reductions in NO₃, TP, and sediment yield (SYLD) across the Eagle Mountain watershed.

Increase	Area (acres)	NO ₃ % Change	TP % Change	SYLD % Change
15%	2,996	3.63%	-20.64%	-55.39%
25%	3,281	5.23%	-27.95%	-71.10%
40%	3,680	7.29%	-35.57%	-74.49%

Nutrient Management of Hay Planting

Nutrient management was also simulated as a best management practice (BMP) on pasture lands that received nitrogen fertilizer but did not include cover crops. This approach aimed to reduce excess nutrient application and improve the efficiency of fertilizer use. Specifically, the second BMP scenario

focused on pasture land where bermudagrass (BERM) was planted and received nitrogen fertilizer. In these fields, the nitrogen fertilizer application rates were reduced by 15%, 25%, and 40% from the baseline application of 89 lbs/acre. These reductions were applied to approximately 733 acres of land distributed across the Eagle Mountain watershed. Table 2 presents the average changes in NO₃, TP, and SYLD resulting from each level of fertilizer reduction. Implementing nutrient management practices on hay fields helps align fertilizer inputs more closely with BERM nutrient requirements, minimizing losses to surface and groundwater. Reducing nitrogen application lowered the risk of NO₃ leaching however, there were slight increases in TP and SYLD.

This highlights the importance of implementing nutrient management as part of an integrated approach. While the reduction in NO₃ reflects improved nutrient efficiency and reduced leaching risk, the observed increases in TP and SYLD could be due to indirect effects, such as reduced plant biomass or ground cover, potentially increasing vulnerability to erosion. Combining nutrient management with complementary practices—such as cover crops or buffer strips—can help mitigate these unintended impacts. In this context, nutrient management remains a valuable BMP, especially when tailored to site-specific conditions and integrated within a broader conservation strategy to address multiple water quality concerns.

Table 2. Reduced nitrogen fertilizer application on hay fields and corresponding average reductions in NO₃, TP, and sediment yield (SYLD) across the Eagle Mountain watershed.

N Reduction	NO ₃ % Change	TP % Change	SYLD % Change
15%	-10.68%	1.73%	5.64%
25%	-17.20%	2.53%	9.40%
40%	-26.77%	3.62%	15.30%

Nutrient Management of Range Planting

The third set of BMPs simulated nutrient management on range-planted areas where nitrogen fertilizer was applied in the baseline scenario. This involved reducing nitrogen application rates by 15%, 25%, and 40% from baseline levels on approximately 381 acres throughout the Eagle Mountain watershed. These scenarios aimed to evaluate the impact of more efficient fertilizer use on rangeland productivity and watershed nutrient dynamics. Table 3 summarizes the resulting changes in NO₃, TP, and SYLD across the watershed for each level of fertilizer reduction.

The results in Table 3 show a consistent reduction in NO₃ loading as nitrogen application decreased, demonstrating the effectiveness of nutrient management in minimizing nitrogen loss on rangeland. However, similar to the hay planting scenarios, there were slight increases in TP and SYLD. These increases were smaller in magnitude compared to the hay planting results, likely due to the smaller treatment area and differences in land cover or management intensity. Overall, these findings suggest that nutrient management on range-planted land can contribute to reduced nitrate levels but may require additional conservation practices to address potential increases in phosphorus and sediment transport.

Table 3. Reduced nitrogen fertilizer application on range fields and corresponding average reductions in NO₃, TP, and sediment yield (SYLD) across the Eagle Mountain watershed.

N reduction	NO ₃ % Change	TP % Change	SYLD % Change
15%	-4.37%	1.69%	2.92%
25%	-10.06%	3.13%	5.67%
40%	-17.80%	5.12%	9.82%

Cattle Stocking Rate Modification

The final BMP simulated was the only practice that resulted in reductions across all three pollutants: NO₃, TP, and SYLD. This fourth BMP involved modifying the cattle stocking rate, which in this context means increasing the number of acres allocated per head of cattle—effectively reducing grazing pressure. The simulation modeled stocking rate increases by 15%, 25%, and 40% across approximately 267,901 acres of rangeland and pasture within the Eagle Mountain watershed. Table 4 presents the potential reductions in nutrient and sediment loads associated with each level of increased stocking rate. The stocking rate increase was calculated individually within each of the 23 subbasins across the Eagle Mountain watershed, allowing for spatially distributed adjustments based on local conditions. The watershed average is provided in Table 4.

Modifying the acreage per head of cattle can have significant positive impacts on watershed health. By reducing animal density, the land experiences less compaction, overgrazing, and vegetation loss, all of which contribute to erosion and nutrient runoff. Improved ground cover and root structure help stabilize soils and increase nutrient uptake, thereby reducing both sediment transport and nutrient leaching. In the Eagle Mountain watershed, these effects translated into measurable decreases in NO₃, TP, and SYLD. This BMP highlights the value of sustainable grazing management as a low-impact, landscape-scale strategy to enhance water quality and support long-term land productivity.

Table 4. Modification in cattle stocking rate and corresponding average reductions in NO₃, TP, and sediment yield (SYLD) across the Eagle Mountain watershed.

% Modification	Stocking Rate (acres/head)	NO ₃ % Change	TP % Change	SYLD % Change
15%	8.7	-5.54%	-12.49%	-0.84%
25%	9.9	-8.91%	-20.71%	-1.76%
40%	12.4	-13.56%	-32.98%	-4.04%

TX-SELECT

TX-SELECT (Texas - Spatially Explicit Load Enrichment and Calibration Tool; Jain et. al. 2025) is an interactive web-based platform developed to support watershed management and planning efforts across Texas. This site uses an updated version of SELECT originally created by Teague et. al. 2009. The datasets used in the TX-SELECT are outlined in Table 5. The site was created to streamline access to spatially detailed information on nutrient and sediment loads, leveraging outputs from the HAWQS (Hydrologic and Water Quality System, HAWQS 2.0, 2023) model. TX-SELECT allows users to explore watershed-specific model results, visualize pollutant load estimates, and compare baseline and scenario

conditions across the state. It is designed to assist stakeholders—including researchers, planners, and decision-makers—in identifying priority areas, evaluating best management practices (BMPs), and supporting data-driven water quality initiatives with a user-friendly interface and downloadable outputs.

Table 5. Description of datasets used in TX-SELECT.

Type	Data	Description	Source
GIS boundaries	Watershed	2-digit, 4-digit, and 12-digit Hydrologic Unit Code (HUC) boundaries	HAWQS 2023; Simley and Carswell Jr 2009
	Counties	County boundaries	USCB 2023
	Urban Area	2020 Census urbanized area polygons	USCB 2023
	CCN	Wastewater Certificate of Convenience and Necessity (CCN) digital mapping data	PUC 2023
Livestock	Livestock counts	NASS 2022 Census of Agriculture - county livestock counts	USDA NASS 2022
Wildlife	Deer density	TPWD ecoregions average deer densities	Lockwood 2006
	Ecoregions	EPA level IV ecoregions	Omernik and Griffith 2014
Demographic data	1990 Census	1990 Census block group level data on sewage disposal	Manson et al. 2023
	2020 Census blocks	2020 Census block polygons	USCB 2023
	2020 Census demographics	2020 Census block population and housing units	USCB 2023
	Address points	911 address points	Arctur 2018; USDOT
Watershed attributes	2021 NLCD	30-meter land cover raster from the 2021 national land cover database	Dewitz 2023
	SSURGO	30-meter SSURGO soil data	Soil Survey Staff 2023
	PRISM	4-km mean annual precipitation normals raster	Daly et al. 2008
Permitted discharges	WWTFs	Permitted discharges from the EPA Echo database	USEPA 2023

Water quality in a watershed is affected by two main categories of pollutant sources: **point sources** and **nonpoint sources**. Point sources are identifiable and localized, such as wastewater treatment facilities (WWTFs) and overflows from on-site sewage facilities (OSSFs). Nonpoint sources are diffuse and harder to trace, including urban and agricultural runoff containing nutrients from fertilizers, pesticides, crop residues, pathogens, and waste from livestock, pets, and households. In the Eagle Mountain watershed, potential sources of *E. coli* assessed in this report include waste from pets, livestock, OSSFs, wildlife, and WWTFs.

Pathogen load estimations are derived by multiplying the population counts of each source by their corresponding production rates (see Table 6). The OSSFs and household pets production rates were set to the highest fecal coliform production rates reported in the EPA guidelines (USEPA, 2001) Additionally,

to estimate *E. coli* levels from fecal coliform figures, a conversion factor was applied. Based on the 2010 Texas surface water quality criteria for recreational uses, default conversion factors of 0.63 for *E. coli* was used.

Table 6. Fecal coliform production rates used to estimate daily potential bacteria load in TX-SELECT.

Source	Fecal coliform production rate	Reference
Cattle	8.55×10^9 cfu/head/day	Wagner and Moench 2009
Sheep	5.8×10^{10} cfu/head/day	
Goats	4.32×10^9 cfu/head/day	
Horses	3.64×10^8 cfu/head/day	
Deer	1.68×10^9 cfu/head/day	
Feral Hogs	1.51×10^8 cfu/head/day	
Dogs and Cats	5.0×10^9 cfu/head/day	USEPA 2001
OSSFs	10×10^6 /100 ml	

Raw SELECT output is often considered a “worst-case scenario” for estimating *E. coli* loads, as the tool lacks built-in functionality to account for natural mitigation processes such as *E. coli* die-off, predation, soil entrainment, or other reductions that occur between the point of deposition and entry into a waterway.

However, these limitations can be partially addressed by applying distance-based weighting to the estimated loads. For instance, manure deposited within riparian buffer zones (i.e., within 100 meters or 330 feet of a stream) is typically assigned a higher weight than manure deposited in upland areas farther from the waterway (see Figure 1).

Incorporating this approach allows for more refined identification of critical areas, thereby enhancing the effectiveness of Best Management Practice (BMP) implementation. Table 7 provide the amount of land across the Eagle Mountain watershed that falls within the riparian buffer zone, and the amount of land located in the uplands by land use category.

TX-SELECT was used to create a model for the Eagle Mountain watershed at the HUC12 scale resulting in a 23 subbasin watershed. There are nine waterways across the watershed, Prairie Branch (PB), Big Sandy Creek (BSC), Jones Creek (JC), Brushy Creek (BC), West Fork Trinity River (WFTR), Rush Creek (RC), Salt Creek (SC), Walnut Creek (WC), and Ash Creek (AC). The land cover distribution is equivalent to the HAWQS generated Eagle Mountain watershed at the HUC14 scale, which is outlined in the calibration document.

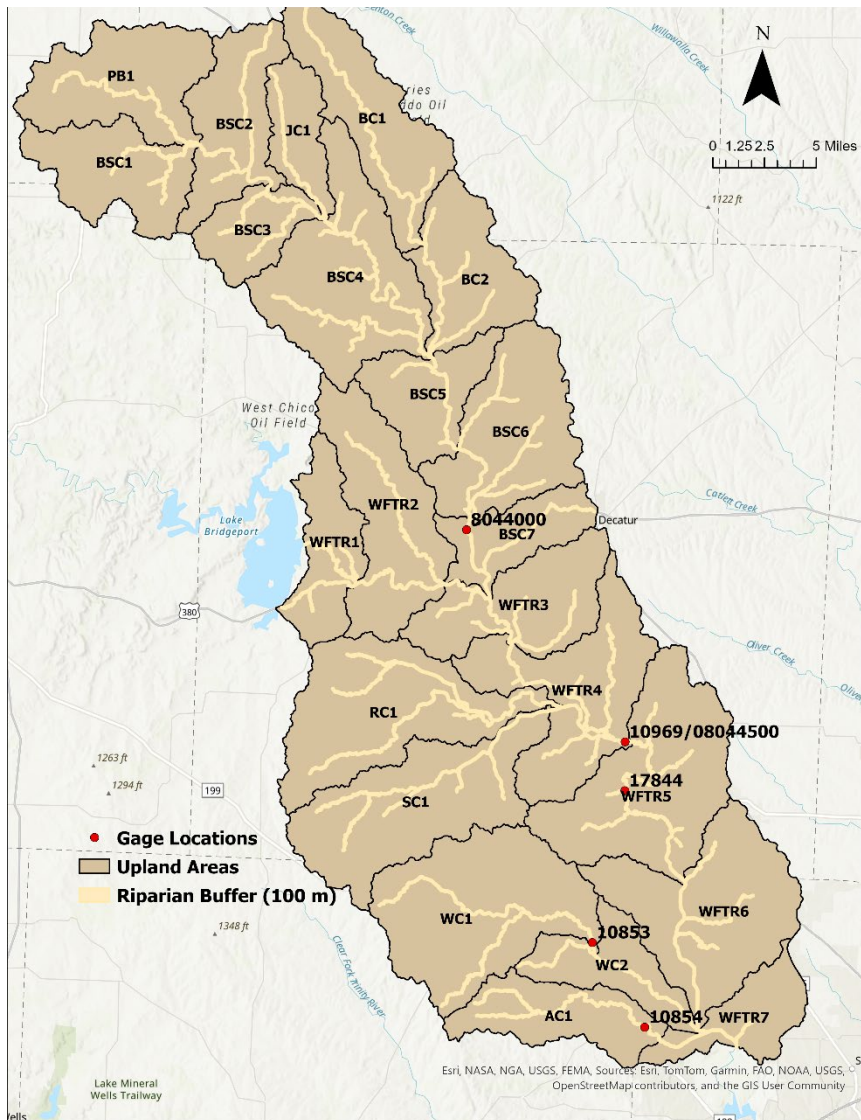


Figure 1. Upland area and 330 ft riparian buffer around the stream network in the HUC12 Eagle Mountain watershed.

Table 7. Acreage of riparian and upland area by land use type across the Eagle Mountain watershed.

LULC Category	Acres	
	Riparian	Upland
Barren land (Rock/Sand/Clay)	93	3,357
Cultivated Crops	755	10,116
Deciduous Forest	8,087	77,796
Developed, High Density	29	1,863
Developed, Low Density	323	17,834
Developed, Med Density	116	6,335
Developed, Open Space	695	26,039
Emergent Herbaceous Wetlands	558	3,810
Evergreen Forest	8	206

Grassland/Herbaceous	10,415	304,477
Mixed Forest	10	247
Open Water	2,598	10,484
Pasture/Hay	3,397	41,370
Shrub/Scrub	785	8,935
Woody Wetlands	4,694	5,857
Total Composite Acreage	32,563	518,728

Pets

The domestic pet population (dogs and cats) is estimated by multiplying a user-defined pet density per household by the total number of households in each subbasin. Household counts used in TX-SELECT are based on 2020 census block-level data. Default densities—0.614 dogs and 0.457 cats per household—from the 2017 U.S. pet ownership statistics from the American Veterinary Medical Association (AVMA) were used across the Eagle Mountain watershed. A 90% contribution was assumed to reach waterways within the 330-ft (100-m) riparian buffers, with a presumed 50% contribution from upland areas.

Wildlife

TX-SELECT includes both deer and feral hogs as potential sources of *E. coli* loading. Deer density data were sourced from Texas Parks and Wildlife’s 2006 ecoregion-based estimates and applied to shrub/scrub, grasslands/herbaceous, hay/pasture, cultivated crops, forest, and wetland areas within the watershed. Feral hog density was based on planning-level estimates from Texas A&M AgriLife Extension and distributed across the same land use categories. Table 8 presents the average subbasin stocking rates for each species modeled in the watershed. To account for proximity to waterways a 90% contribution was assumed to reach waterways within the 330-ft (100-m) riparian buffers, with a presumed 50% contribution from upland areas.

Livestock

TX-SELECT accounts for livestock populations including cattle, sheep, goats, and horses. Livestock numbers are estimated by applying species-specific stocking rates (acres per head) to the total area of grazeable land within each subbasin. Grazeable land is defined by default to include NLCD land cover types of hay/pasture, grassland/herbaceous, and shrub/scrub. Stocking rates for each livestock type are derived from county-level headcounts reported in the 2022 Census of Agriculture by the USDA National Agricultural Statistics Service (NASS) for all counties overlapping the watershed, as detailed below.

$$\text{Stocking Rate} \left(\frac{\text{acres}}{\text{head}} \right) = \sum_{i=1}^N \text{SR County}_i \times \text{Proportion of watershed grazing area in County}_i$$

Where N is the total number of counties intersecting the subbasin and SR County is the grazeable land divided by the number of heads in the county.

The suggested stocking rates in TX-SELECT for cattle using 2022 USDA census values resulted in slightly lower rates than the average used in the SWAT model. The number of cattle in the watershed according

to the 2022 Census was ~50,000 head of cattle whereas the average head of cattle from 2007-2017 was closer to 60,000. Additionally, the SWAT model only simulated cattle on hay/pasture and grassland, so only those land use types were selected for the Eagle Mountain watershed. Therefore, the results from TX-SELECT may be conservative but still consistent with the current management practices across the watershed. The stocking rate for cattle used in the Eagle Mountain watershed is also found in Table 8. Additionally, 90% of contribution was assumed to reach waterways within the 330-ft (100-m) riparian buffers, with a presumed 50% contribution from upland areas.

Table 8. Average stocking rate used in TX-SELECT for the Eagle Mountain watershed.

Animal	Stocking Rate (acre/head)
Cattle	7.4
Sheep	173.2
Goats	110.5
Horses	123.2
Feral Hogs	50
Deer	39.4

Wastewater treatment facilities (WWTFs)

Permitted wastewater treatment facilities within the Eagle Mountain watershed were identified using data from the U.S. EPA's ECHO database (2023). The geographic locations of these facilities are illustrated in Figure 2. To estimate daily pathogen loads (expressed in MPN/day), the most recent values for fully permitted discharge volumes and the corresponding allowable average daily pathogen concentrations (MPN/100 mL) were used, as calculated using the equation provided below.

$$Load = Discharge(MGD) \times \frac{Daily\ E.\ coli\ limit\ (MPN)}{100\ mL} \times \frac{10^6\ gal}{MGD} \times 3758.2\ \frac{mL}{gal}$$

Table 9 provides a list of the WWTP facilities in Eagle Mountain along with the daily limit of *E.coli* and the discharge used to calculate the potential load for each facility. Since discharge from WWTPs typically flow directly into waterways, 100% contribution of loading from WWTPs was assumed across the Eagle Mountain watershed.

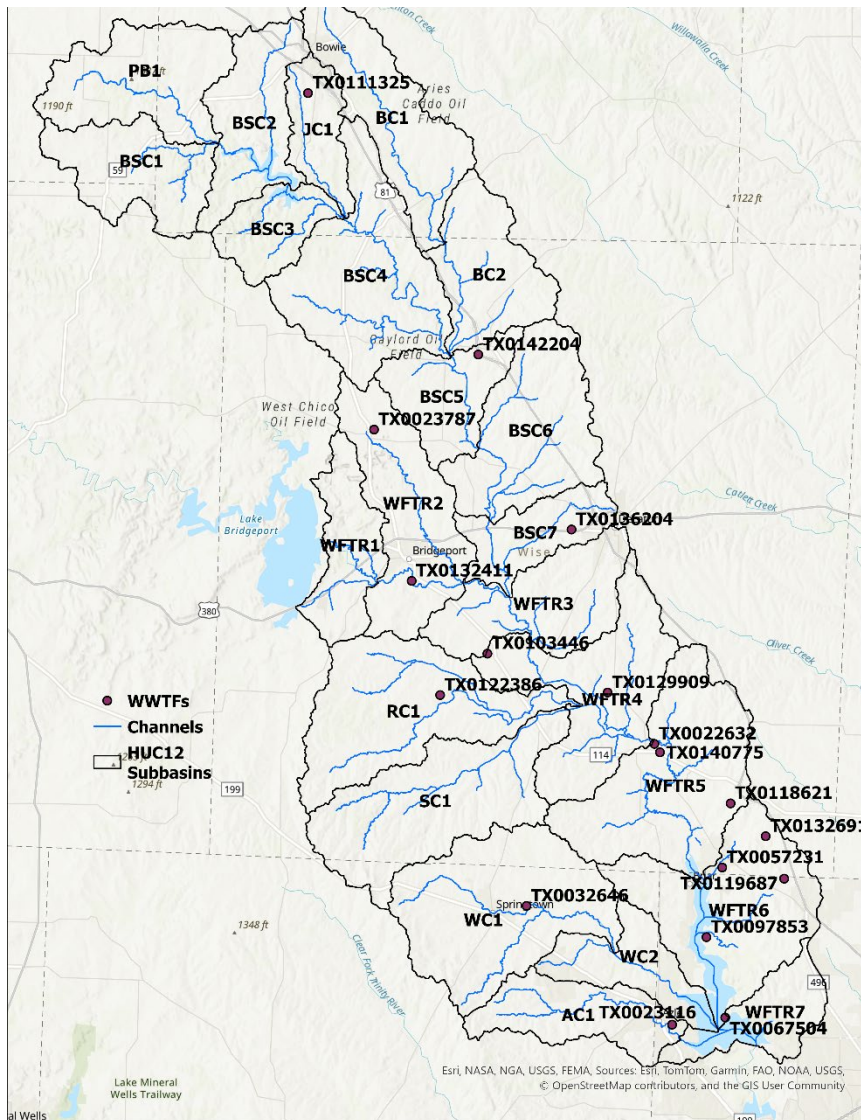


Figure 2. NPDES permitted WWTFs in the Eagle Mountain watershed.

Table 9. NPDES permitted WWTP facilities in the Eagle Mountain watershed along with the permitted daily average E.coli and flow.

NPDES Permit	Facility Name	City	E.coli Daily Limit, MPN/100 mL	Discharge Daily Average, MGD
TX0023787	City of Chico	Chico	126	0.15
TX0132411	City of Bridgeport WWTP	Bridge City	126	0.84
TX0111325	City of Bowie WWTP	Bowie	126	1.25
TX0142204	City of Alvord WWTP	Alvord	126	0.112
TX0136204	City of Decatur Water Plant	Decatur	126	0.1
TX0122386	Camp Summit	Paradise	126	0.00802
TX0103446	Paradise ISD WWTP	Paradise	126	0.03

TX0129909	Ivy Hills WWTP	Wise County	126	0
TX0022632	City of Boyd WWTP	Boyd	126	0.24
TX0118621	Westside WWTP	Rhome	126	0.15
TX0140775	Fairview Meadows WWTP	New Fairview	126	0.2285
TX0057231	City of Newark WWTP	Newark	126	0.15
TX0097853	Eagle Mountain Rv Park WWTP	Fort Worth	126	0.006
TX0119687	Chisholm Springs WWTP	Tarrant County	126	0.225
TX0132691	Rvr Water Reclamation & Amp Reuse Facility	Rhome	126	0.15
TX0032646	City of Springtown WWTP	Springtown	126	0.48
TX0023116	Ash Creek WWTP	Azle	126	1.44
TX0067504	Fort Worth Boat Club WWTP	Fort Worth	126	0.0158

On-site sewage facilities (OSSFs)

TX-SELECT offers three methods to estimate the number of on-site sewage facilities (OSSFs) in the Eagle Mountain watershed. One approach relied on 1990 Census records, which provided an estimate of approximately 15,004 OSSFs. Since permitting requirements did not begin until after 1989, this method was useful in identifying the likely number of non-permitted systems present before regulations took effect. Another estimation method used 911 address point data. While comprehensive, this approach tends to overestimate the number of OSSFs, as it includes a wide variety of address types beyond residential housing units—such as barns, electric poles, and other non-residential structures. This method produced an estimate of 38,222 OSSFs within the watershed. The third method utilized 2020 Census housing unit data to estimate the number of OSSFs by identifying housing units not connected to centralized wastewater treatment systems. This approach provided a more current and refined estimate, yielding approximately 26,958 OSSFs across the watershed.

To validate the estimates generated from these different methods, permitting data from the Texas Commission on Environmental Quality (TCEQ) was reviewed for the period 1992 through 2020. This data includes annual records of OSSFs permitted by county and TCEQ region. Using an area-weighted average from the county-level data, approximately 11,762 permitted OSSFs were identified within the watershed over this timeframe. When combined with the 15,004 estimated systems in place prior to the start of permitting, the total number of OSSFs in the watershed is estimated to be 26,766. This value is consistent with the estimate generated using the 2020 Census housing unit method, which identified 26,958 systems. Given this alignment and the relative reliability of the housing unit data, the 2020 Census Housing Units method was selected as the preferred basis for estimating the number of OSSFs in the Eagle Mountain watershed model.

OSSF failure rates for each subbasin are derived based on the predominant septic drainfield limitation class from the SSURGO Soil Surface Geographic database (2023). For the Eagle Mountain watershed, a default failure rate of 15%—corresponding to areas classified as "very limited"—was applied. These failure rates are then used to estimate the total number of malfunctioning OSSFs within each subbasin. The average number of individuals per household with a failing OSSF is determined by dividing the total

population of the subbasin by the number of housing units. The resulting OSSF pathogen load (in MPN/day) is computed using the formula provided below.

$$Load = Failing\ OSSFs \times PR \times CF \times \frac{70\ gal}{person.\ day} \times \frac{Person}{Household} \times 3758.2 \frac{mL}{gal}$$

Where PR is the production rate of fecal coliform for OSSFs (Table 6) and CF is the conversion factor for *E.coli* (0.63).

Table 10 lists the estimated number of OSSFs and the average persons per household for each subbasin in the Eagle Mountain watershed, used to calculate potential daily *E.coli* loads.

Table 10. Number of OSSFs and potential daily loading per huc12 subbasin in the Eagle Mountain watershed.

HUC12 Subbasin	OSSFs	Failure Rate	Person/Household	Load (MPN/day)
WFTR1	242	0.15	2.42	1.455 x10 ¹²
WFTR2	1,168	0.15	2.81	8.148 x10 ¹²
PB1	142	0.15	2.02	7.135 x10 ¹¹
BSC1	88	0.15	1.94	4.251 x10 ¹¹
BSC2	609	0.15	1.76	2.666 x10 ¹²
JC1	213	0.15	2.27	1.203 x10 ¹²
BSC3	230	0.15	1.98	1.131 x10 ¹²
BC1	794	0.15	2.12	4.193 x10 ¹²
BC2	196	0.15	2.34	1.139 x10 ¹²
BSC4	626	0.15	2.15	3.353 x10 ¹²
BSC5	76	0.15	2.48	4.685 x10 ¹¹
BSC6	639	0.15	2.51	3.981 x10 ¹²
BSC7	540	0.15	2.54	3.411 x10 ¹²
WFTR3	1,165	0.15	2.47	7.165 x10 ¹²
RC1	1,205	0.15	2.66	7.968 x10 ¹²
SC1	1,835	0.15	2.57	1.173 x10 ¹³
WFTR4	1,706	0.15	2.53	1.074 x10 ¹³
WFTR5	2,654	0.15	2.59	1.712 x10 ¹³
WFTR6	2,276	0.15	2.58	1.458 x10 ¹³
WC1	5,930	0.15	2.58	3.804 x10 ¹³
WC2	1,938	0.15	2.55	1.230 x10 ¹³
AC1	2,358	0.15	2.56	1.503 x10 ¹³
WFTR7	328	0.15	2.43	1.978 x10 ¹²

There was no information available for the actual number of “non-permitted” OSSFs across the Eagle Mountain watershed, therefore these potential sources of loading are not explicit in the TX-SELECT model. Non-permitted OSSFs tend to have a large failure rate, 50% (Reed et al., 2001) and not accounting for these could result in a lower representation of potential loading across the watershed

from OSSFs. However, since exact OSSF locations across the watershed are undefined, a 100% contribution was assumed for modeling purposes.

Baseline Loading

Using all the criteria outlined above TX-SELECT was run to show locations of potential loading. For the Eagle Mountain watershed, the percentage of total contribution for each of the main categories are shown in Figure 3. The “Other” category includes horses, feral hogs, and WWTFs and account for only 0.2% of the potential total loading.

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Figure 3. Potential sources of E.coli loading in Eagle Mountain watershed.

The combined loading from all sources across the watershed are shown in Figure 4. The headwaters of Walnut Creek (WC1) show the largest potential source of loading within the watershed. This subbasin has the largest number of estimated OSSFs out of all subbasins (5,930) and ranks among the highest contributors for most of the potential sources across the watershed (see Figure 5).

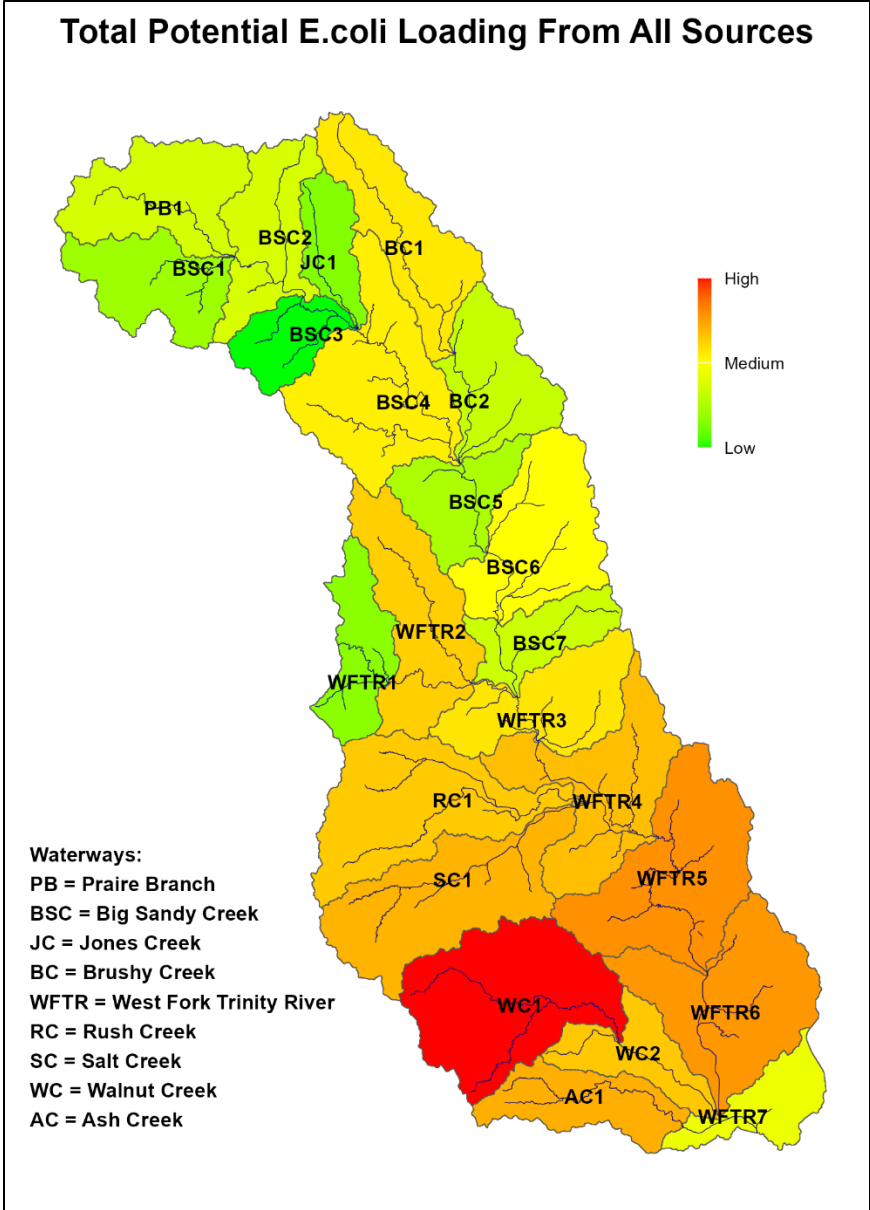


Figure 4. Total potential E.coli Loading from all sources within the Eagle Mountain watershed.

To see where in the watershed each potential source is contributing the most, each source was plotted in Figure 5. The color scale indicates the areas of low, medium, and high contributions for each source separately, and are not equivalent between categories.

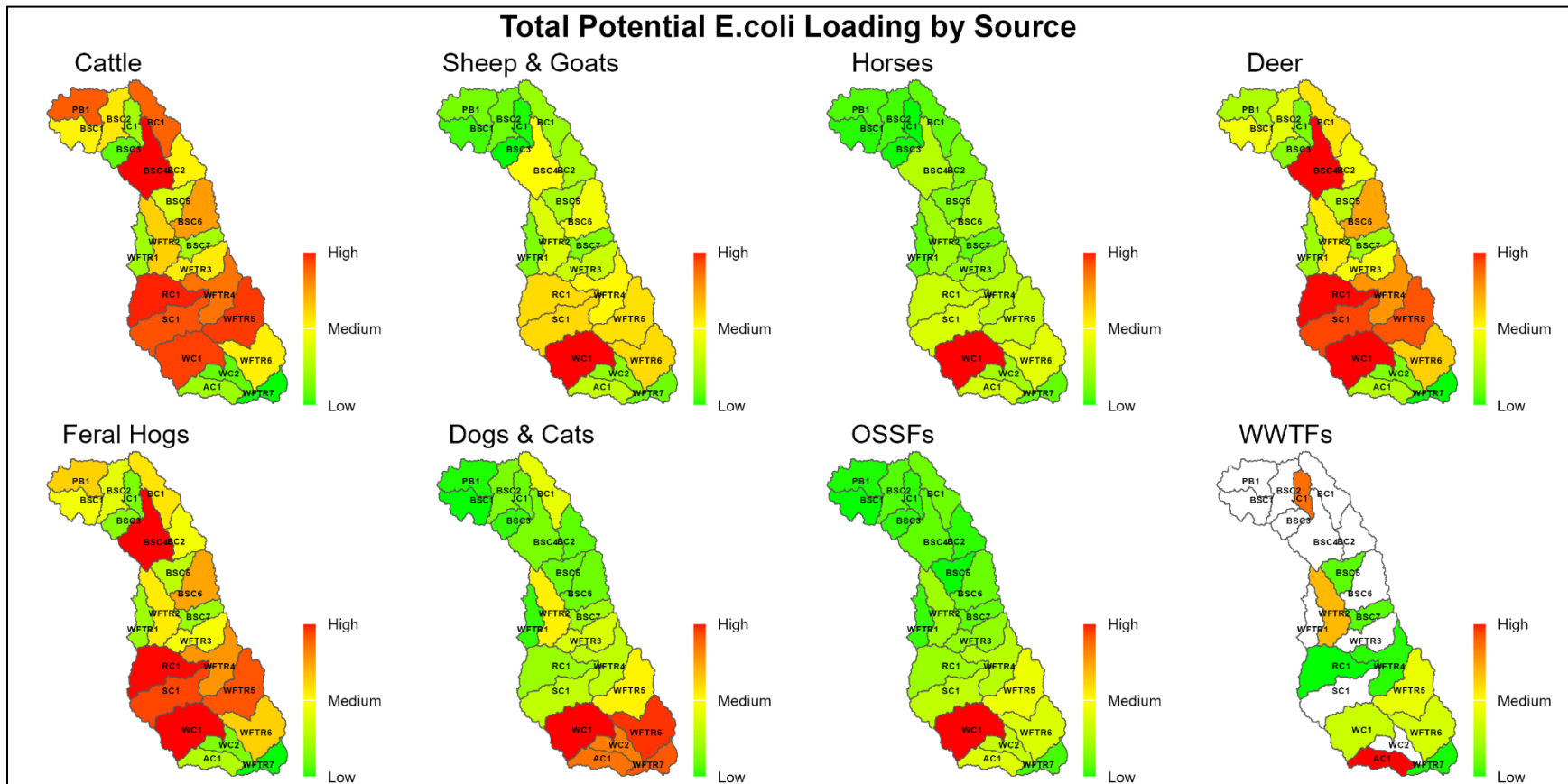


Figure 5. Potential E.coli loading by source from SELECT.

Reduction Strategies

The TX-SELECT tool can simulate potential reductions in loadings to get an idea of how impactful various BMPs would be at *E.coli* load reduction within the watershed. This is done by adjusting the input values in TX-SELECT and comparison the resulting output to the baseline loading scenario.

Cattle Stocking Rate

Cattle is the second largest source of potential loading in the Eagle Mountain watershed with a potential contribution of 30.4% of the total load. To see how much reduction is possible, the stocking rate of the cattle was modified (increasing the amount of land per animal) within the watershed. These values were used to simulate potential load reductions, not necessarily a realistic BMP for the watershed. First a 25% increase in the stocking rate was simulated, then a 50% increase, and finally a 75% increase. The stocking rate increase was calculated within each of the 23 subbasins across the watershed. The resulting subbasin average stocking rates (acre/head) are show in Table 11 along with the percentage of potential *E.coli* reduction at each monitored subbasin and for the entire watershed. Table 12 provides the estimated loading reduction in MPN/yr.

Average Stocking Rate		<i>E.coli</i> Reduction				
	Acre/Head	WF Trinity River Near Boyd (WFTR4)	WF Trinity River at Bobo Bridge (WFTR5)	Walnut Creek (WC1)	Ash Creek (AC1)	Watershed
Baseline	7.4					
25%	9.9	10.7%	10.2%	3.6%	2.6%	7.6%
50%	14.9	21.4%	20.3%	7.2%	5.1%	15.2%
75%	29.7	32.1%	30.5%	10.8%	7.7%	22.8%

Table 11. The amount of potential reduction in loading for changes in cattle stocking rates in the Eagle Mountain watershed.

Table 12. The amount of potential reduction in loading for changes in cattle stocking rates (MPN/yr*10¹⁵).

Stock Rate Reductions	<i>E.coli</i> Reduction (MPN/yr*10 ¹⁵)				
	WF Trinity River Near Boyd (WFTR4)	WF Trinity River at Bobo Bridge (WFTR5)	Walnut Creek (WC1)	Ash Creek (AC1)	Watershed
25%	9.8	10.7	0.8	0.3	12.6
50%	19.7	21.4	1.7	0.6	25.3
75%	29.5	32.1	2.5	0.8	37.9

The largest increase in stocking rate (75%) results in an overall *E.coli* loading reduction of ~31% along West Fork of the Trinity River. This shows that modifying the stocking rate of cattle across the watershed alone, even beyond a reasonable amount, still will not reduce the amount of *E.coli* loading in the watershed to the amount necessary to meet the EPA requirements.

OSSF Failure Rate Improvement

The largest category of potential *E.coli* loading (37.1%) in the Eagle Mountain watershed is from OSSFs. To show the potential reduction of *E.coli* loading from OSSFs, the failure rate was deducted to 10% and 5%. The results of potential reduction for each monitored subbasin and the entire watershed are shown in Table 13. Table 14 provides the estimated loading reduction in MPN/yr.

Table 13. The amount of potential reduction in *E.coli* loading for reduced OSSF fail rates in the Eagle Mountain watershed.

OSSF Failure Rate Reduction	<i>E.coli</i> Reduction				
	WF Trinity River Near Boyd (WFTR4)	WF Trinity River Near Bobo (WFTR5)	Walnut Creek (WC1)	Ash Creek (AC1)	Watershed
10%	9.3%	10.1%	19.7%	17.0%	12.4%
5%	18.5%	20.2%	39.3%	34.0%	24.8%

Table 14. The amount of potential reduction in *E.coli* loading for reduced OSSF fail rates MPN/yr*10e15.

OSSF Failure Rate Reduction	<i>E.coli</i> Reduction (MPN/yr*10 ¹⁵)				
	WF Trinity River Near Boyd (WFTR4)	WF Trinity River at Bobo Bridge (WFTR5)	Walnut Creek (WC1)	Ash Creek (AC1)	Watershed
10%	8.5	10.6	4.6	1.8	20.6
5%	17.0	21.2	9.3	3.7	41.1

Pet Reduction

The potential loading from pets (Dogs and Cats) in the Eagle Mountain watershed is the third largest source of loading contributing ~19% (10.9% for dogs, and 8.1% for cats). To simulate the amount of potential reduction of *E.coli* loading in the Eagle Mountain watershed, the density rate of dogs and cats were reduced. The baseline density of dogs was 0.614 and cats was 0.457. Two scenarios were simulated, one with a density reduction of 50%, and one with a density reduction of 80%. The densities used for dogs and cats for each reduction scenario, along with the resulting percentage of reduction at each monitored subbasin and the entire watershed are shown in Table 15. Table 16 provides the estimated loading reduction in MPN/yr.

Table 15. The amount of potential reduction in E.coli loading for various amounts of pet reduction in the Eagle Mountain watershed.

Pet Reduction			E.coli Reduction				
	Dog	Cat	WF Trinity River Near Boyd (WFTR4)	WF Trinity River Near Bobo(WFTR5)	Walnut Creek (WC1)	Ash Creek (AC1)	Watershed
50%	0.307	0.1228	6.7%	6.8%	8.0%	15.2%	9.5%
80%	0.2285	0.0914	10.7%	10.9%	12.9%	24.2%	15.2%

Table 16. The amount of potential reduction in E.coli loading for various amounts of pet reduction in MPN/yr*10e15.

Pet Reduction	E.coli Reduction (MPN/yr*10 ¹⁵)				
	WF Trinity River Near Boyd (WFTR4)	WF Trinity River at Bobo Bridge (WFTR5)	Walnut Creek (WC1)	Ash Creek (AC1)	Watershed
50%	6.13	7.14	1.89	1.63	15.81
80%	9.80	11.43	3.03	2.61	25.30

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Eagle Mountain Lake Watershed Protection Plan Stakeholder Meeting

Katie Myers, Rural Programs Coordinator
Aaron Hoff, Watershed Programs Manager



Water Quality: Designated Uses



Aquatic Life

Protect aquatic species

Dissolved Oxygen, Toxic Chemicals, Total Dissolved Solids



Recreation

Estimates the relative risk of swimming and other water recreation activities

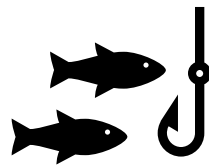
Bacteria



Drinking Water

Indicates if water is suitable as a source of drinking water

Metals, Pesticides, Toxic Chemicals, Total Dissolved Solids, Nitrates



Fish Consumption

Protect public from consuming fish that may be contaminated

Metals, Pesticides, Other Toxic Chemicals

What is a WPP?

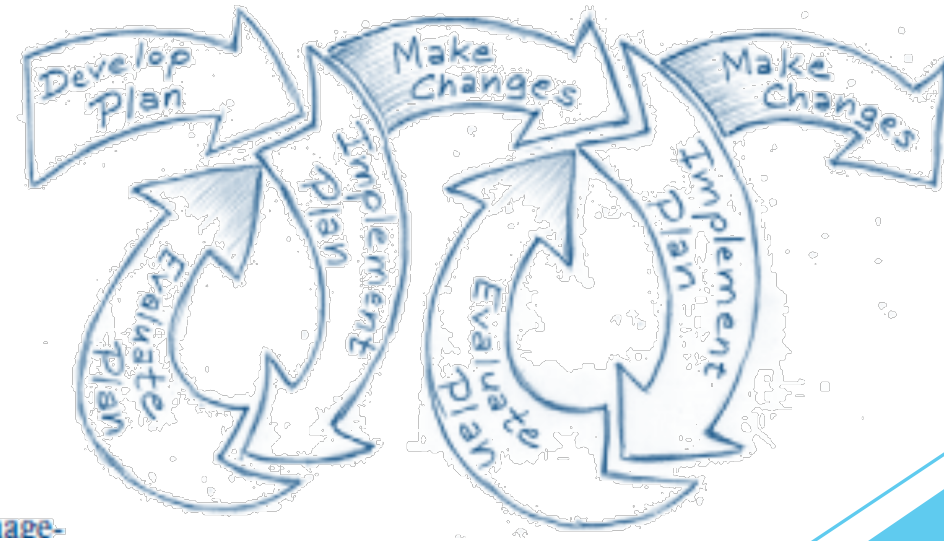
Watershed Protection Plan: A strategy that provides assessment and management information for a defined watershed.

- ▶ Clean Water Act §319 → EPA Framework
 - ▶ TCEQ Integrated Report (303(d) List)
- ▶ Stakeholder involvement
- ▶ Actions supported by sound science
- ▶ Technical expertise from diverse sources
- ▶ Diverse skills & knowledge
- ▶ Focus on water quality goal



Six Steps to Effective Watershed Management

1. Build partnerships
2. Characterize your watershed
3. Establish goals & identify solutions
4. Develop an implementation program
5. Implement your plan
6. Measure progress & make adjustments





EPA Nine Elements of a Successful Watershed Plan

- a. Identify causes and sources of pollution
- b. Estimate pollutant loading into the watershed and the expected load reductions
- c. Describe management measures that will achieve load reductions and targeted critical areas
- d. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan
- e. Develop an information/education component
- f. Develop a project schedule
- g. Describe the interim, measurable milestones
- h. Identify indicators to measure progress
- i. Develop a monitoring component

Six Steps in Watershed Planning and Implementation Process

1. Build partnerships

- Identify key stakeholders
- Identify issues of concern to be included in the watershed plan
- Set preliminary goals
- Conduct public outreach

2. Characterize the Watershed

- Collect existing data and create a watershed inventory
- Analyze data
- Identify causes and sources of pollution that need to be controlled
- Identify data gaps and collect additional data if needed
- Quantify pollutant loads

3. Finalize Goals and Identify Solutions

- Set overall goals and management objectives
- Develop indicators/targets
- Determine load reductions needed
- Identify critical areas
- Develop management measures to achieve goals

4. Design an Implementation Program

- Develop implementation schedule
- Develop interim milestones to track implementation of management measures
- Develop criteria to measure progress towards meeting watershed goals
- Develop monitoring component
- Develop information/education component
- Develop evaluation process
- Identify technical and financial assistance needed to implement plan
- Assign responsibility for reviewing and revising the plan

5. Implement Watershed Plan

- Implement management strategies
- Conduct monitoring
- Conduct information/education activities

6. Measure Progress and Make Adjustments

- Review, evaluate information
- Prepare annual workplans
- Report back to stakeholders and others
- Make adjustments to program

Element d

Characterization and Analysis Tools

- GIS
- Statistical packages
- Monitoring
- Load calculations
- Model selection tools
- Models
- Databases (environmental and social tools)

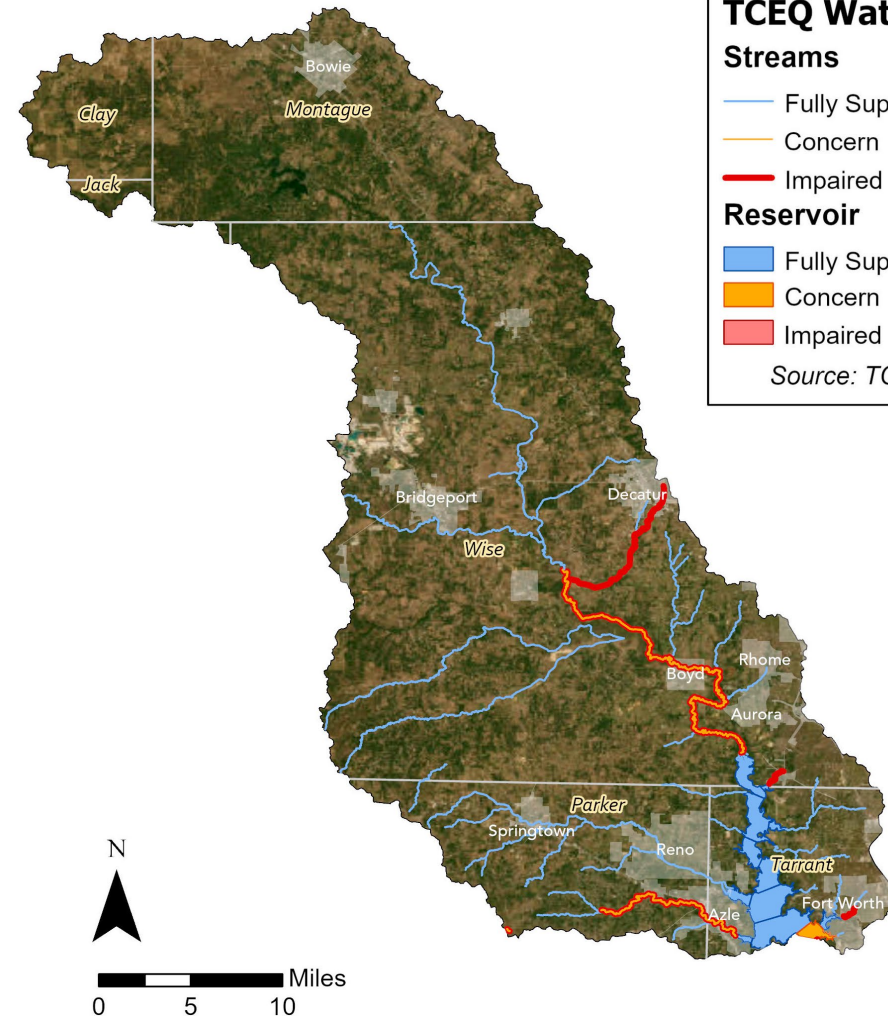
Watershed Plan Document

Element e

Cross-reference between Six Steps and Nine Elements

Eagle Mountain Watershed

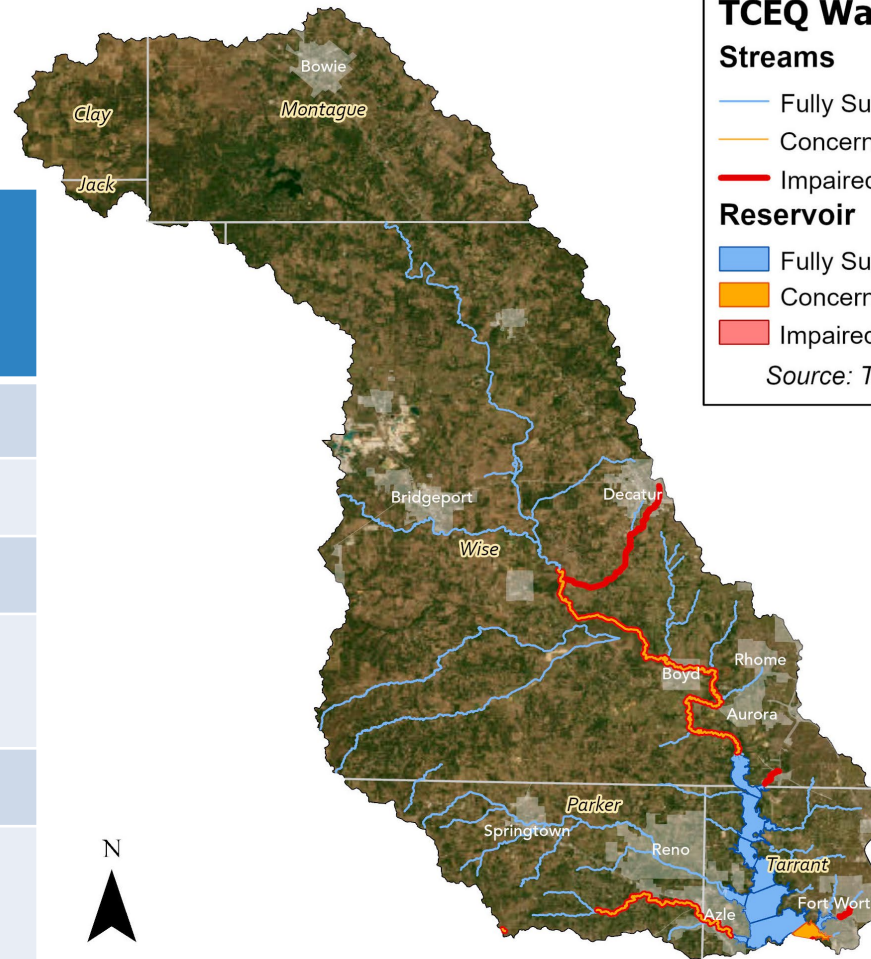
- ▶ Part of a TRWD's raw water supply system serving 2.4 million people
- ▶ Recreational and habitat values
- ▶ TRWD Concerns
 - ▶ Sedimentation
 - ▶ Eutrophication
 - ▶ Clean Water Act standards





Water Quality Issues

Segment	Impairment(s)	Concern(s)
Ash Creek	Bacteria	Nitrate
Dosier Creek	Bacteria	
Derrett Creek	Bacteria	
West Fork TR below BP	Bacteria	Chlorophyll-a
Martin Branch	Bacteria	
West Fork TR below EM	Dioxin in edible tissue	
Eagle Mountain Reservoir		Dissolved Oxygen



TCEQ Water Quality Status

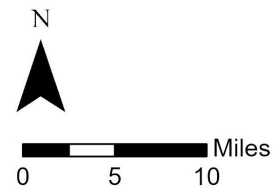
Streams

- Fully Supporting (light blue line)
- Concern (orange line)
- Impaired (red line)

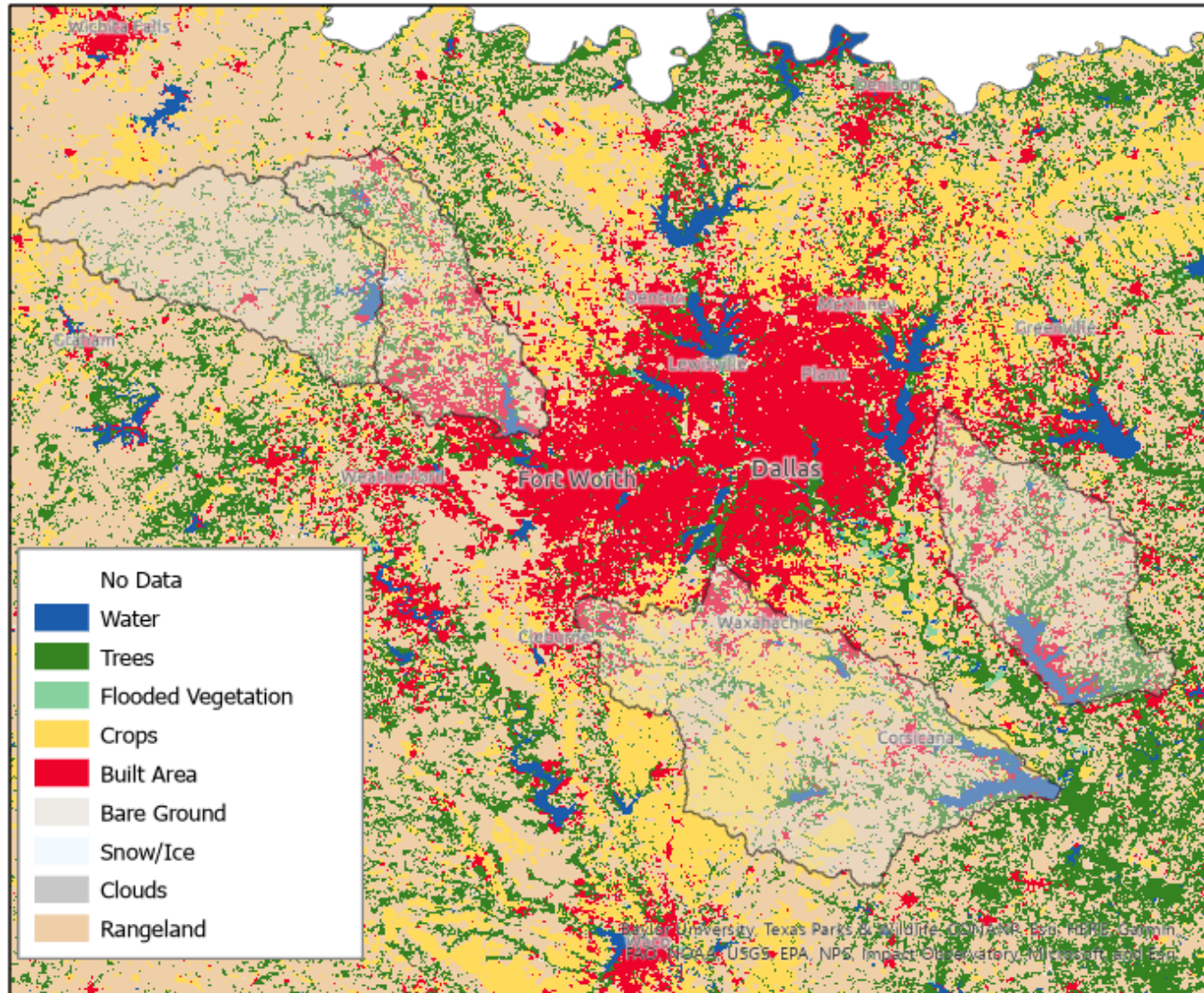
Reservoir

- Fully Supporting (light blue square)
- Concern (orange square)
- Impaired (red square)

Source: TCEQ 2022 Integrated Report

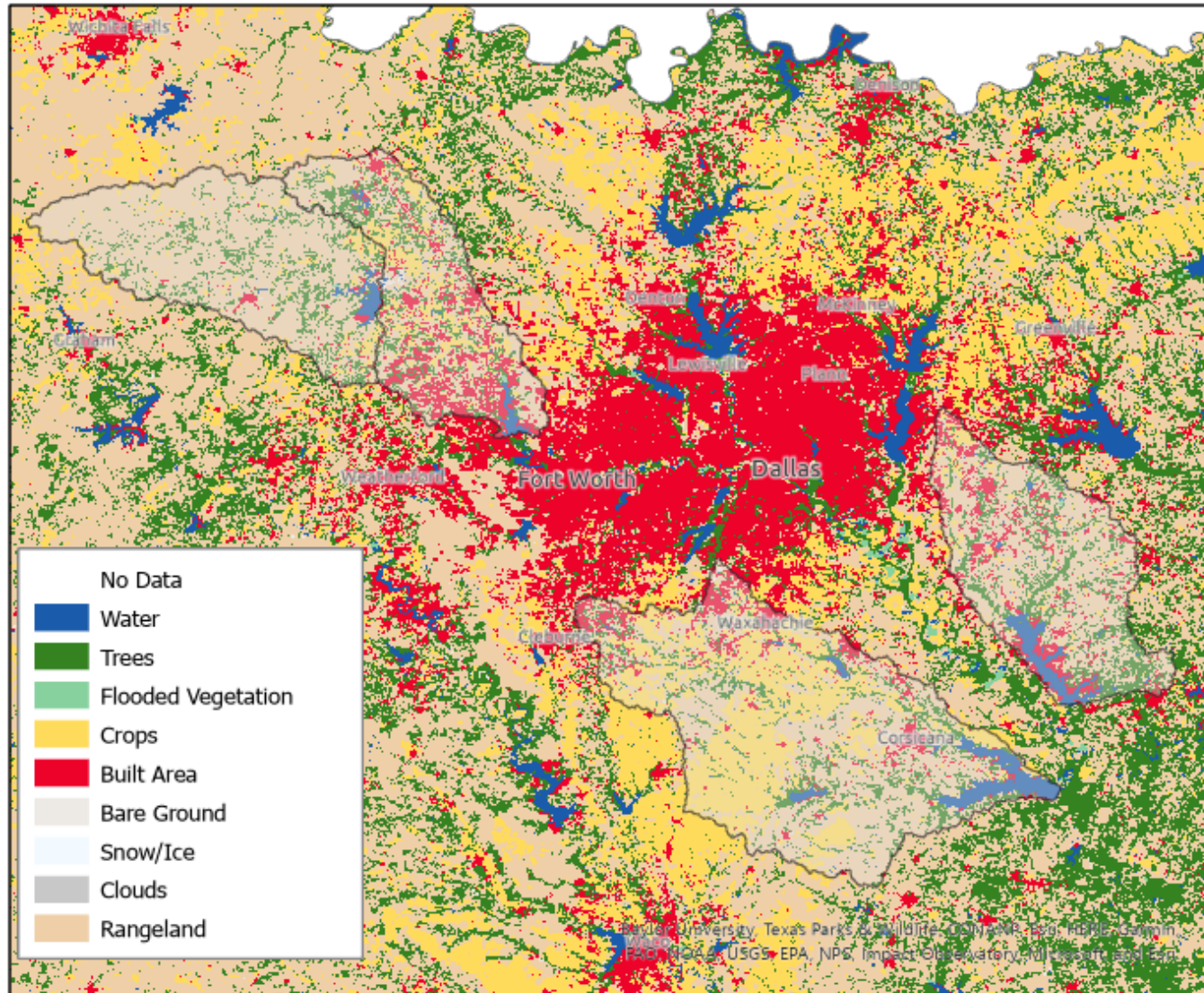


Water Quality Issues



- ▶ Rapidly urbanizing NW fringe of DFW metroplex
 - ▶ Higher runoff volume due to impervious surface
 - ▶ Higher volume of pollutants associated with wastewater treatment, landscaping, construction, pets
- ▶ Advocate for appropriate development standards and pollution abatement ordinances/regulations

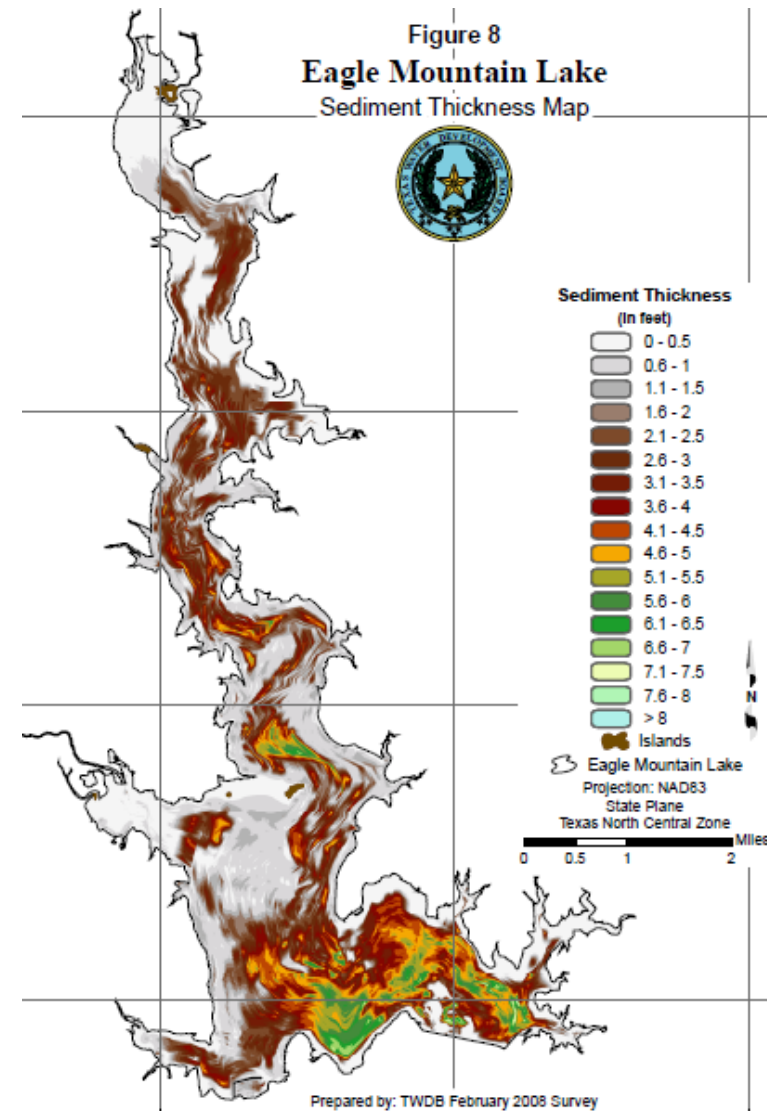
Water Quality Issues



- ▶ Still a large amount of rural and agricultural land
 - ▶ Not a lot of row crops in this area
 - ▶ Mostly pasture/range
- ▶ Grazing methods, stocking rates, upland vegetation management, and riparian buffer quality affect erosion/sediment and nutrient and bacteria loading

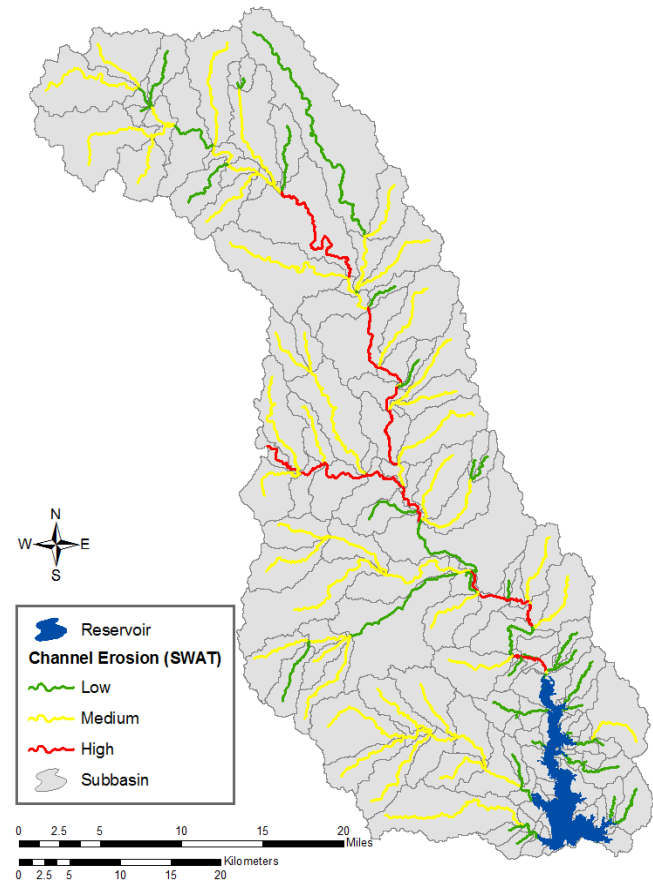
Water Quality Issues

- ▶ Sediment: Quality and Supply issue
- ▶ State Volumetric Survey 2008
 - ▶ >15,000 ac-ft of sedimentation since 1934

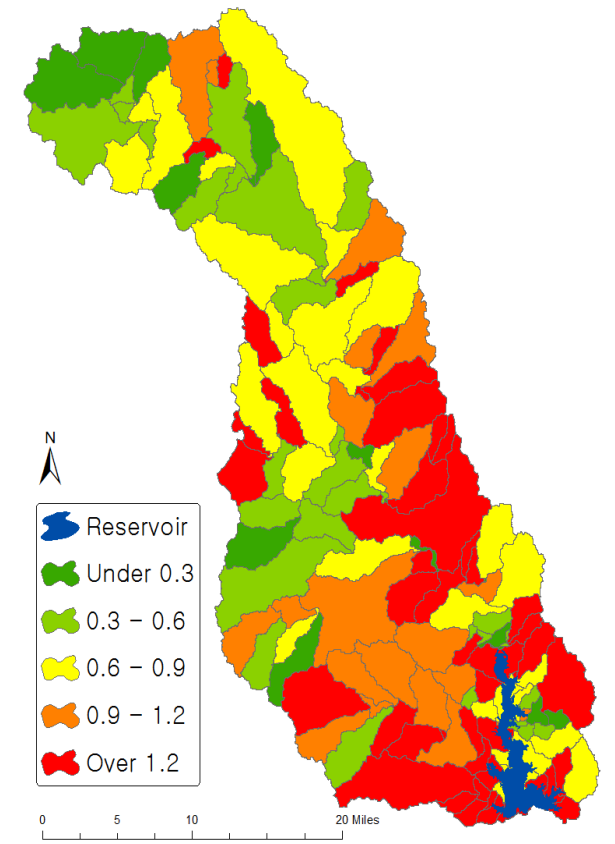


EM WPP - Where We've Been

- ▶ Then: wrote WPP in 2010s
 - ▶ Agency review flagged for spatial distribution of data
 - ▶ Eagle Mountain Lake Conservation Initiative



Channel erosion estimation



TP loading (kg/ha) by overland flow



EM WPP - Where We Are

- ▶ **Now: rewriting WPP**
 - ▶ Reusing old pieces where appropriate
 - ▶ Integrating new data and refreshing modeling
 - ▶ Fitting all information and formatting to EPA Nine Elements guidance

- A. Identify problem & sources
- B. Reductions needed to reach goals
- C. Identify measures needed to achieve reductions
- D. Assistance needed
- E. Education & outreach plan
- F. Schedule
- G. Milestones
- H. Criteria for measuring progress
- I. Monitoring Plan



EM WPP - Where We're Going

We are here



▶ Next: so, so many things

Phase I: Watershed Characterization & Planning			Phase II: Implementation	
Public Education	Writing WPP Document	Informal Review	Agency Approval Process	Federal Grant Funds Available for Project Submittals
Data Collection	Review Watershed Modeling	<ul style="list-style-type: none"> • NRCS/ SWCD • Partners (you!) 		
Data Analysis and Modeling		Formal Agency Review 1) Send draft to state agencies 2) Respond to agency comments 3) 45-day Public Comment Period 4) Respond to comments 5) Re-submit to state agencies		
Stakeholder Meetings				
<ul style="list-style-type: none"> • Priority Selection • Recommendations for WPP 				

EM WPP - Where We're Going

- ▶ Periodic meetings as new chapters are ready to review
- ▶ Next up:
 - ▶ Chapter 3: Water Quality Assessment
 - ▶ Initial modeling from Texas A&M, hopefully with modeling team as guest speaker
 - ▶ Chapter 4: Potential Pollutant Sources
 - ▶ This is a great place for people with boots on the ground to provide some ground-truthing to better inform or adjust the models
- ▶ Planning to do the next couple virtually
 - ▶ Open to other suggestions: continue holding at the library, move venues around the watershed?



Watershed Protection Programming

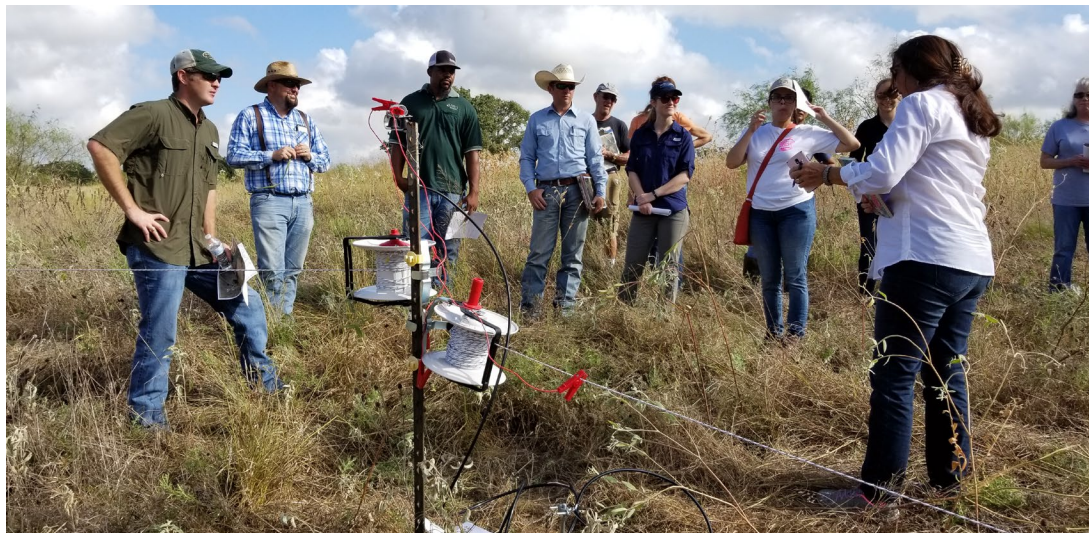
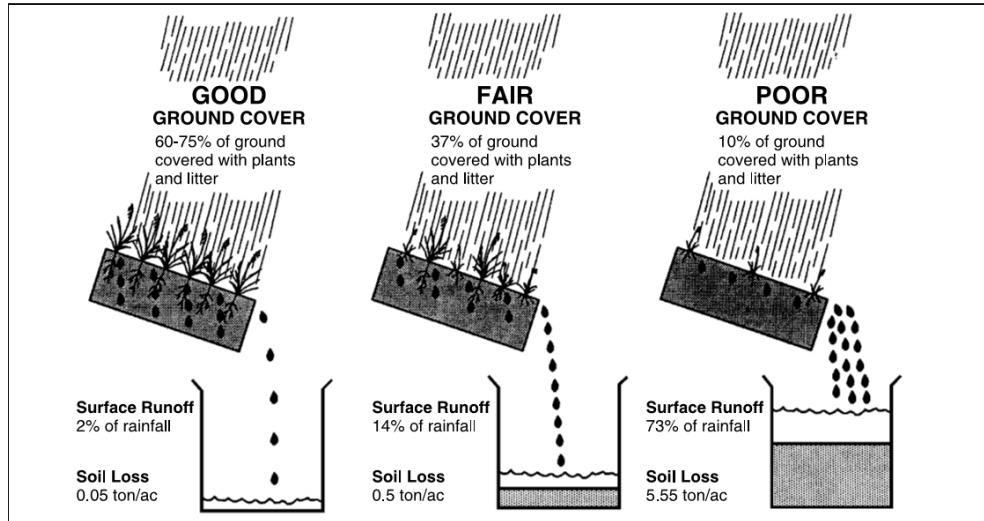
- ▶ Support for partners:
 - ▶ Natural resource agencies
 - ▶ Nonprofits
 - ▶ Municipal governments



- ▶ In the form of:
 - ▶ Workshop/event funding and co-programming
 - ▶ Speaking/teaching opportunities
 - ▶ Demonstration projects

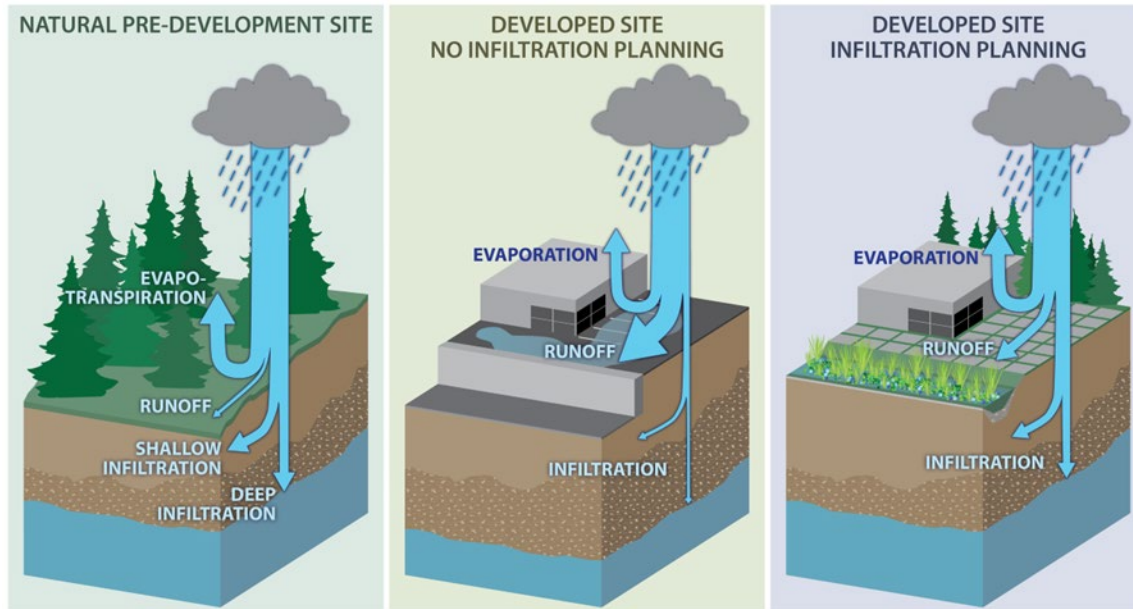


Watershed Protection Programming: Rural



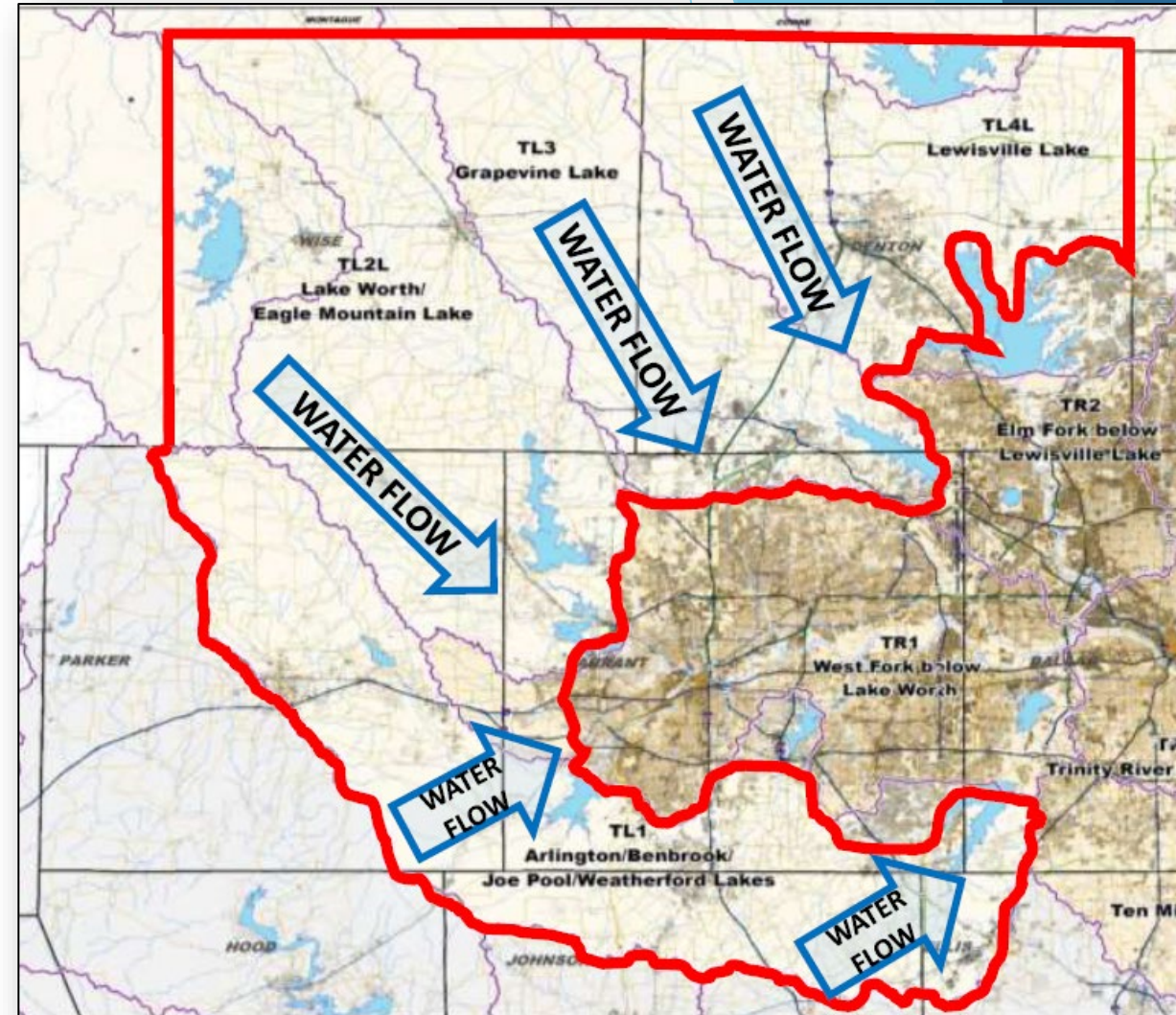
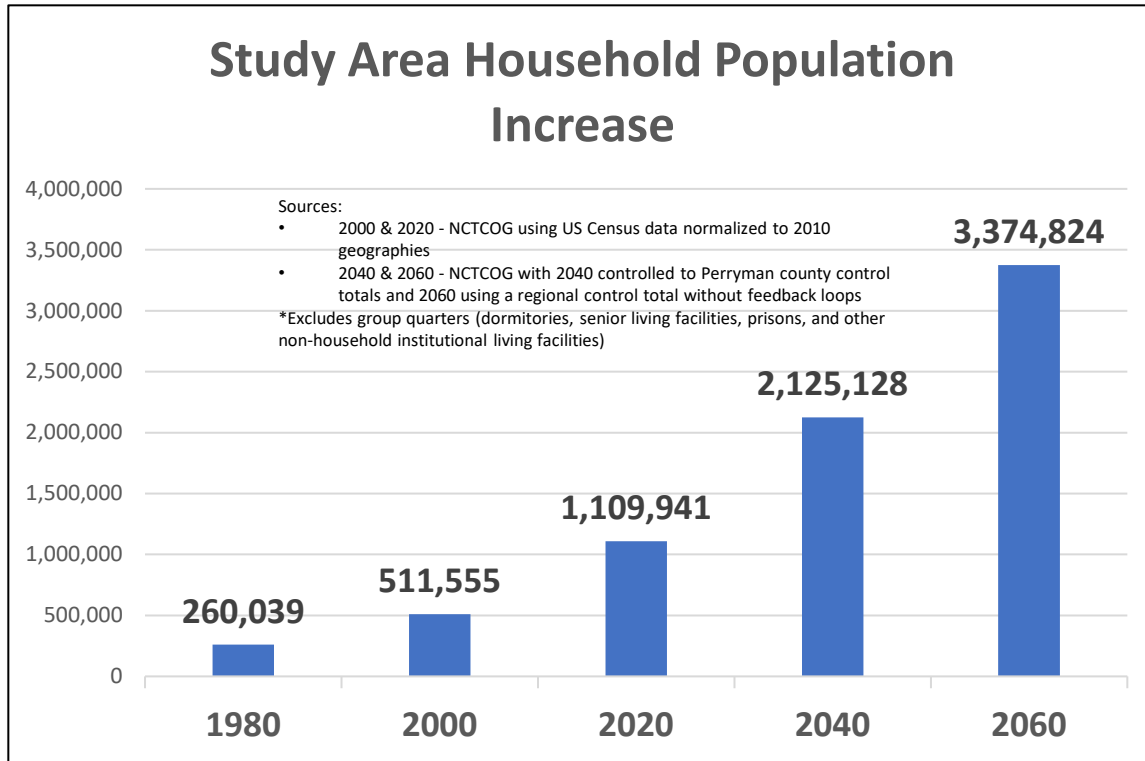
Watershed Protection Programming: Urban

- ▶ Building more sustainably with:
 - ▶ Green Stormwater Infrastructure (GSI)
 - ▶ Nature-Based Solutions (NBS)
 - ▶ Blue-Green Infrastructure (BGI)
 - ▶ Low-Impact Development (LID)





Watershed Protection Programming: Urban



Reviewing goals with stakeholders



Proactive Planning

- Reimagine transportation design to integrate stormwater, environmental, and flood reduction benefits
- Protect current and future infrastructure
- Develop model for replication

Reduce Flooding

- Reduce flooding downstream of rapidly growing upstream communities
- Increase resiliency to flooding disasters
- Inform decision-making
- Implement stormwater infrastructure with transportation infrastructure

Tools/ Resources

- Empower communities to adopt higher floodplain management standards
- Develop GIS based tools and resources

Local-Scale Innovation

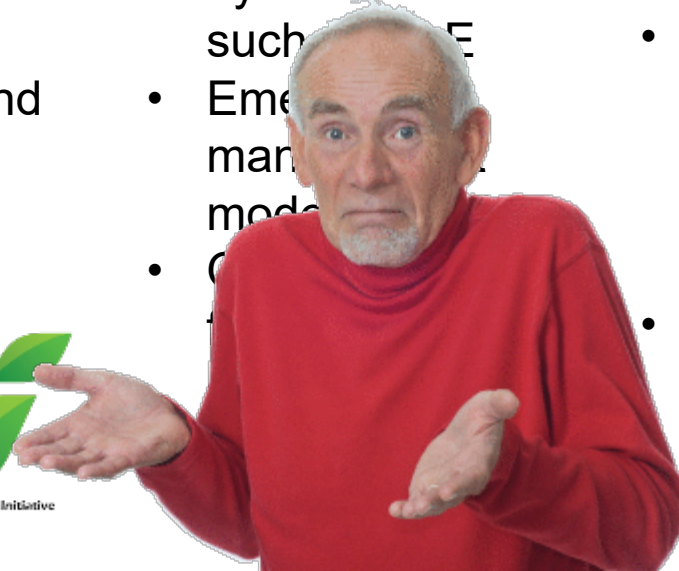
- Enhance Trinity River Watershed Hydrology Assessment
- Enhance existing hydraulic models such as HEC
- Emergency management models
- Community

Community Roadmap

- Produce planning-level designs for transportation, stormwater detention, and environmental
- Integrate these layers to identify what needs to be built and achieved benefits
- Establish ways to fund planned infrastructure



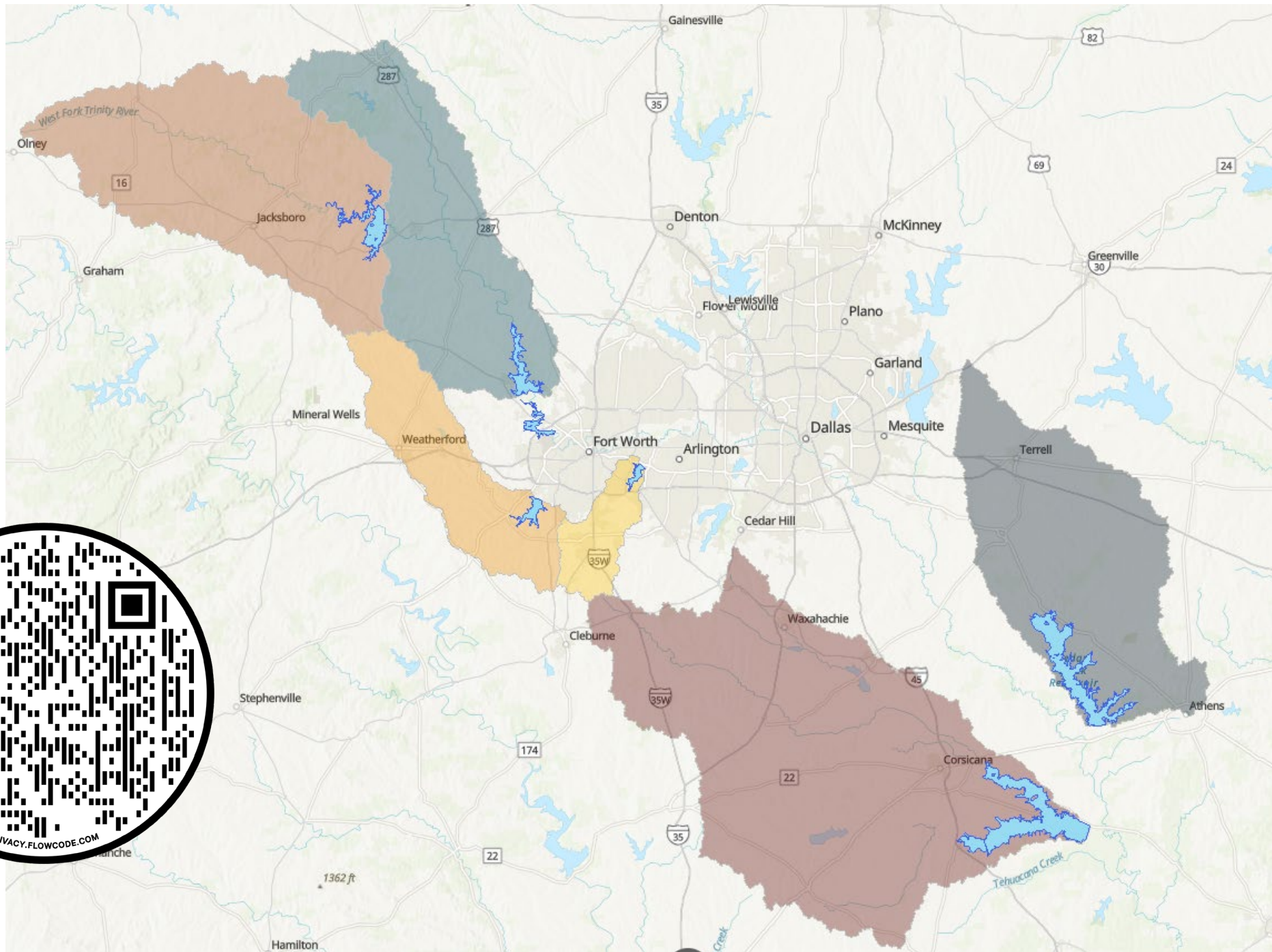
Integrated Transportation and Stormwater Management Initiative





Guided Review: Chapters 1 & 2

- ▶ **General readability**
 - ▶ Clarity (weird wording, technical information not explained well)
 - ▶ Grammar (hopefully not, but I'm not perfect)
- ▶ **Content**
 - ▶ Anything questionable or that might be incorrect
 - ▶ Anything potentially useful that's missing
- ▶ **Visuals**
 - ▶ Size, colors, legibility
 - ▶ Additional maps you'd like to see



Contact Info

- ▶ Katie Myers, Rural Programs Coordinator
 - ▶ Katie.myers@trwd.com
- ▶ General watershed inquiries: watersheds@trwd.com
- ▶ Our website: <https://www.trwd.com/watersheds/>

Eagle Mountain Lake Watershed Protection Plan Stakeholder Meeting #1

January 27, 2025

10:15 a.m. – 12 p.m.

Azle Memorial Library, 333 W. Main Street, Azle, TX 76020

Introductions

TRWD staff and stakeholders introduced themselves and identified their connection to the lake or watershed.

Tarrant Regional Water District (TRWD) and Watershed Protection Planning Overview

Katie Myers from TRWD described the process for watershed protection planning, including a definition of a watershed protection plan (WPP), the six steps to effective watershed management, and the nine elements that make a successful watershed plan.

Stakeholders asked whether Texas Commission on Environmental Quality (TCEQ) is involved in WPPs. Katie said that TCEQ and the Texas State Soil and Water Conservation Board are both involved. She said TCEQ also approves permits associated with municipal stormwater.

Stakeholders asked about Element A, Identify Causes and Sources of Pollution. They asked whether this element covered current causes and sources or also included future sources. Katie said this element covers current causes and sources. She said modeling of future land use change and urbanization can be used to project future causes and sources, but stakeholder feedback is needed to ensure what's being modeled reflects realistic expectations for what is going to be built.

Eagle Mountain Lake Watershed Protection Plan (WPP) Overview

Katie provided an overview of the Eagle Mountain watershed. She said TRWD's pollution concerns for the reservoir include sedimentation, eutrophication, and Clean Water Act standards. She identified impairments for bacteria in five tributaries to Eagle Mountain Lake. She noted that downstream from the reservoir, the West Fork of the Trinity River has an impairment for dioxin in edible tissues; however, this portion of the West Fork is not part of the Eagle Mountain watershed or the reservoir. She noted that concerns for nitrate or chlorophyll-a occur in two tributaries. Katie identified urbanization and agricultural sources of water quality issues. She identified how sediment can affect both water quality and water supply, the latter by reducing the storage capacity of the reservoir.

Katie provided background on the WPP process for Eagle Mountain, noting that a WPP was written in the 2010s. Agency review flagged concerns about the spatial distribution of data in the WPP, leading TRWD to go back to the drawing board for the WPP. In the meantime, the Eagle Mountain Lake Conservation Initiative was formed to address water pollution issues before acceptance of a revised WPP.

Stakeholders asked about the impact rural land uses have had on water quality. Katie said these land uses have a big impact. She said TRWD partners with soil and water conservation districts (SWCDs) in the watershed to promote conservation; TRWD recently expanded those partnerships to include SWCDs in Jack and Archer counties. Katie noted that developers who build and then remove themselves from responsibility for developments are subject to relatively basic Stormwater Pollution Prevention Plan requirements.

Darrel Andrews with TRWD said that success is defined differently for everyone. He said TRWD has been working with Wise County landowners since 1968 to protect the 100-year-old reservoir. Darrel said confounding variables could be responsible for affecting nutrient and algae increases. He said it could be rainfall practices, fertilizer practices, and/or implementation of best management practices.

Katie asked stakeholders about their preference for holding future meetings virtually or in person. Most agreed they could attend virtual meetings. Darrel also suggested holding in-person meetings in a variety of locations in the watershed to engage new audiences. However, he said this could make it hard for the same individual to attend multiple meetings.

Chapter 1-2 Guided Review

Katie sought feedback on the chapters' readability, content, and visuals. Stakeholders asked about the list of partners in Table 1-1. They wanted to know whether any organization could be a partner or whether a funding contribution was required. Katie said anyone could be a partner, and she said private landowners could let TRWD know if they wanted their information included; TRWD does not automatically include individuals to ensure their privacy is protected.

Stakeholders said the land cover map in Figure 2-3 would be better if like-vegetation types were collapsed, so fewer colors were displayed on the map. They asked about GIS color ramps that met accessibility needs, including the possibility of providing a vision-accessible version elsewhere in the document. TRWD noted that the map needed to meet the requirements of reviewing agencies. Stakeholders also asked about the distinction between cultivated crops vs. hay/pasture vs. grassland/herbaceous. These designations

may determine how resources are allocated. The group also discussed the difference between Cross Timbers and the Cross Timbers Ecoregion.

Stakeholders expressed interest in a map that labels creeks and tributaries. They also discussed a map showing TRWD pipeline networks; TRWD said a map of pipelines must exclude some details due to Homeland Security risks. The group discussed dilution and where and when releases of water occur in Eagle Mountain Lake and the influence of other reservoirs' water quality on Eagle Mountain Lake. Darrel said modeling simulates how the water transfers impact water quality and quantity.

Stakeholders asked whether TRWD staff were using artificial intelligence to develop the WPP. Katie said no, TRWD staff are following a strict rubric to seek state and federal acceptance of the WPP.

Wrap Up

Katie Myers adjourned the meeting after discussing next steps and a general timeline for the next stakeholder meeting.



Eagle Mountain Lake Watershed Protection Plan Stakeholder Meeting



Katie Myers, TRWD, Rural Programs Supervisor
Aaron Hoff, TRWD, Watershed Programs Manager
Katie Mendoza, Texas A&M AgriLife Research,
Research Specialist III

What is a WPP?

Watershed Protection Plan: A strategy that provides assessment and management information for a defined watershed.

- ▶ Clean Water Act §319 → EPA Framework
 - ▶ TCEQ Integrated Report (303(d) List)
- ▶ Stakeholder involvement
- ▶ Actions supported by sound science
- ▶ Technical expertise from diverse sources
- ▶ Diverse skills & knowledge
- ▶ Focus on water quality goal



Water Quality: Designated Uses



Aquatic Life

Protect aquatic species

Dissolved Oxygen, Toxic Chemicals, Total Dissolved Solids



Recreation

Estimates the relative risk of swimming and other water recreation activities

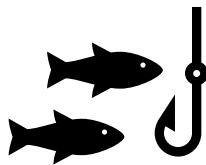
Bacteria



Drinking Water

Indicates if water is suitable as a source of drinking water

Metals, Pesticides, Toxic Chemicals, Total Dissolved Solids, Nitrates



Fish Consumption

Protect public from consuming fish that may be contaminated

Metals, Pesticides, Other Toxic Chemicals



EPA Nine Elements of a Successful Watershed Plan

- a. Identify causes and sources of pollution
- b. Estimate pollutant loading into the watershed and the expected load reductions
- c. Describe management measures that will achieve load reductions and targeted critical areas
- d. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan
- e. Develop an information/education component
- f. Develop a project schedule
- g. Describe the interim, measurable milestones
- h. Identify indicators to measure progress
- i. Develop a monitoring component



WPP Process Overview

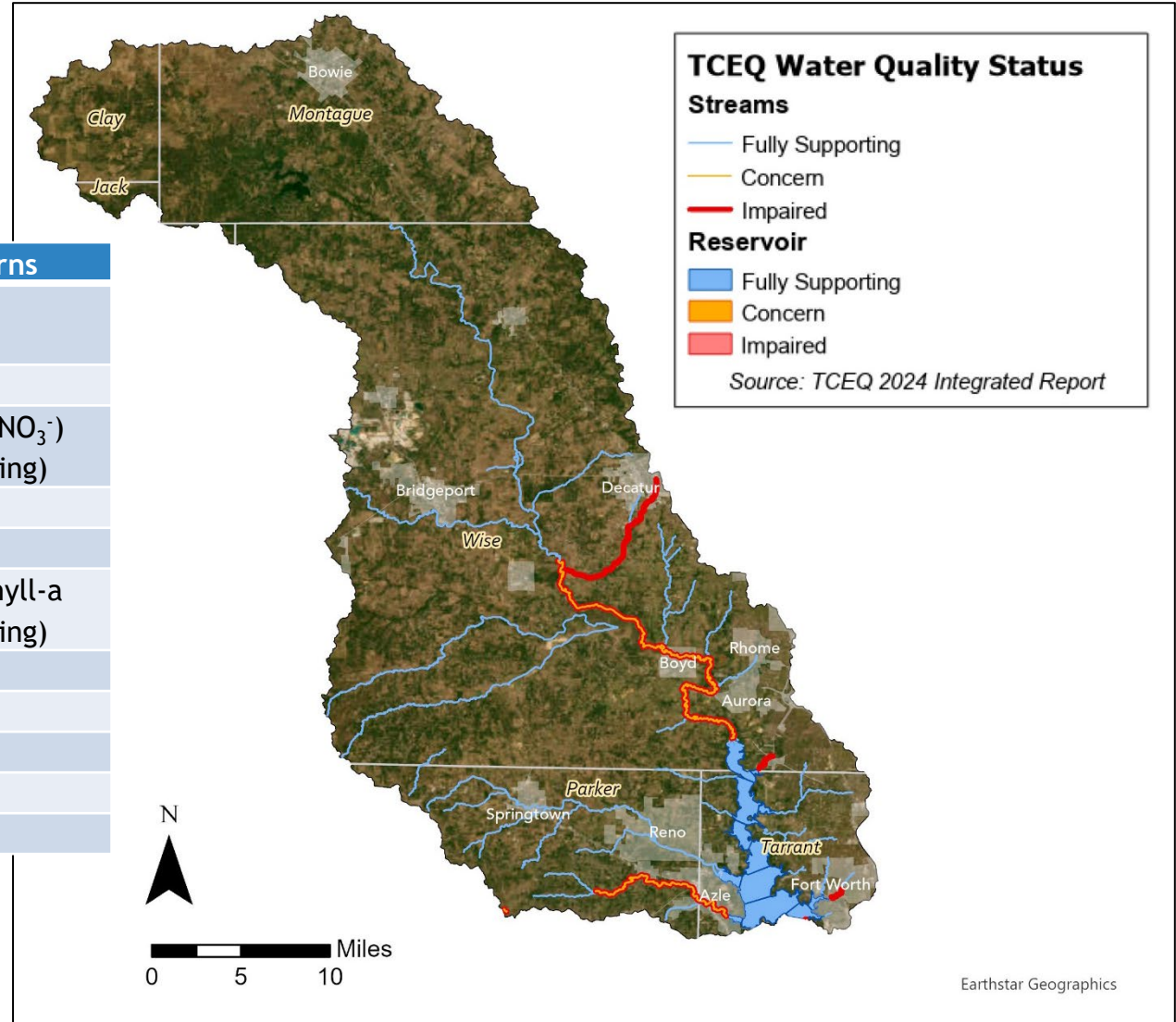
We are here



Phase I: Watershed Characterization & Planning			Phase II: Implementation
Public Education Data Collection Data Analysis and Modeling Stakeholder Meetings <ul style="list-style-type: none"> • Priority Selection • Recommendations for WPP 	Writing WPP Document Review Watershed Modeling	Informal Review <ul style="list-style-type: none"> • NRCS/ SWCD • Partners (you!) Formal Agency Review <ol style="list-style-type: none"> 1) Send draft to state agencies 2) Respond to agency comments 3) 45-day Public Comment Period 4) Respond to comments 5) Re-submit to state agencies 	Agency Approval Process Federal Grant Funds Available for Project Submittals



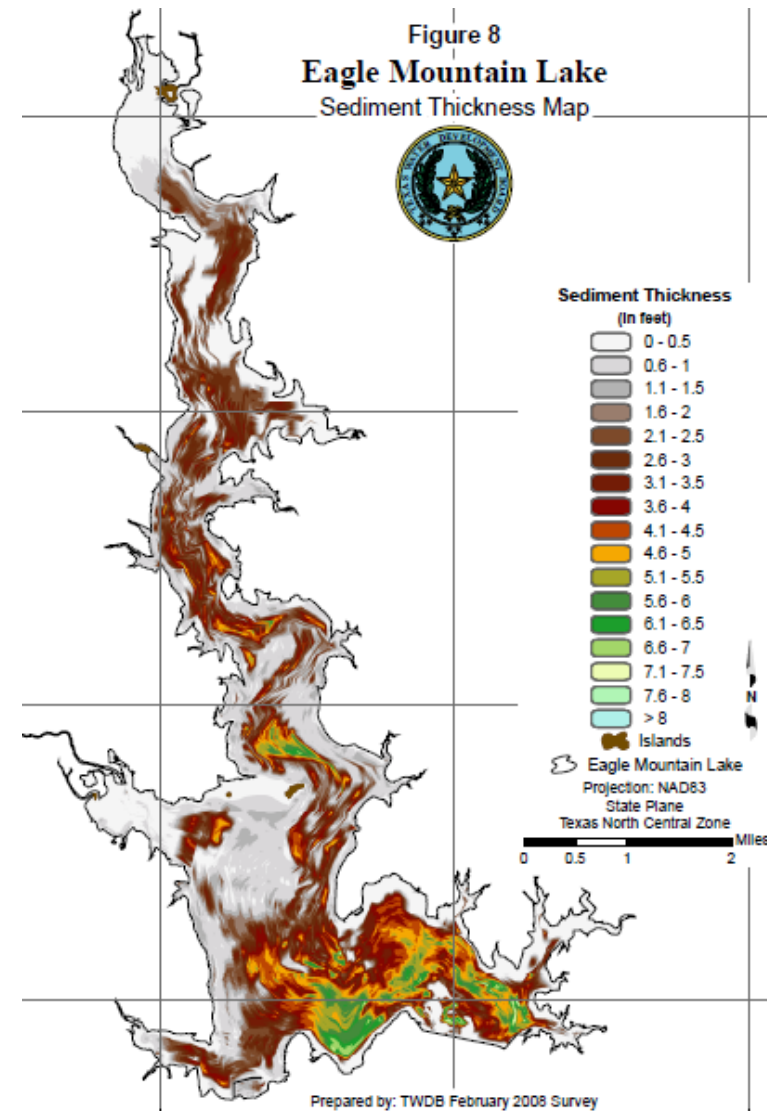
Water Quality Issues



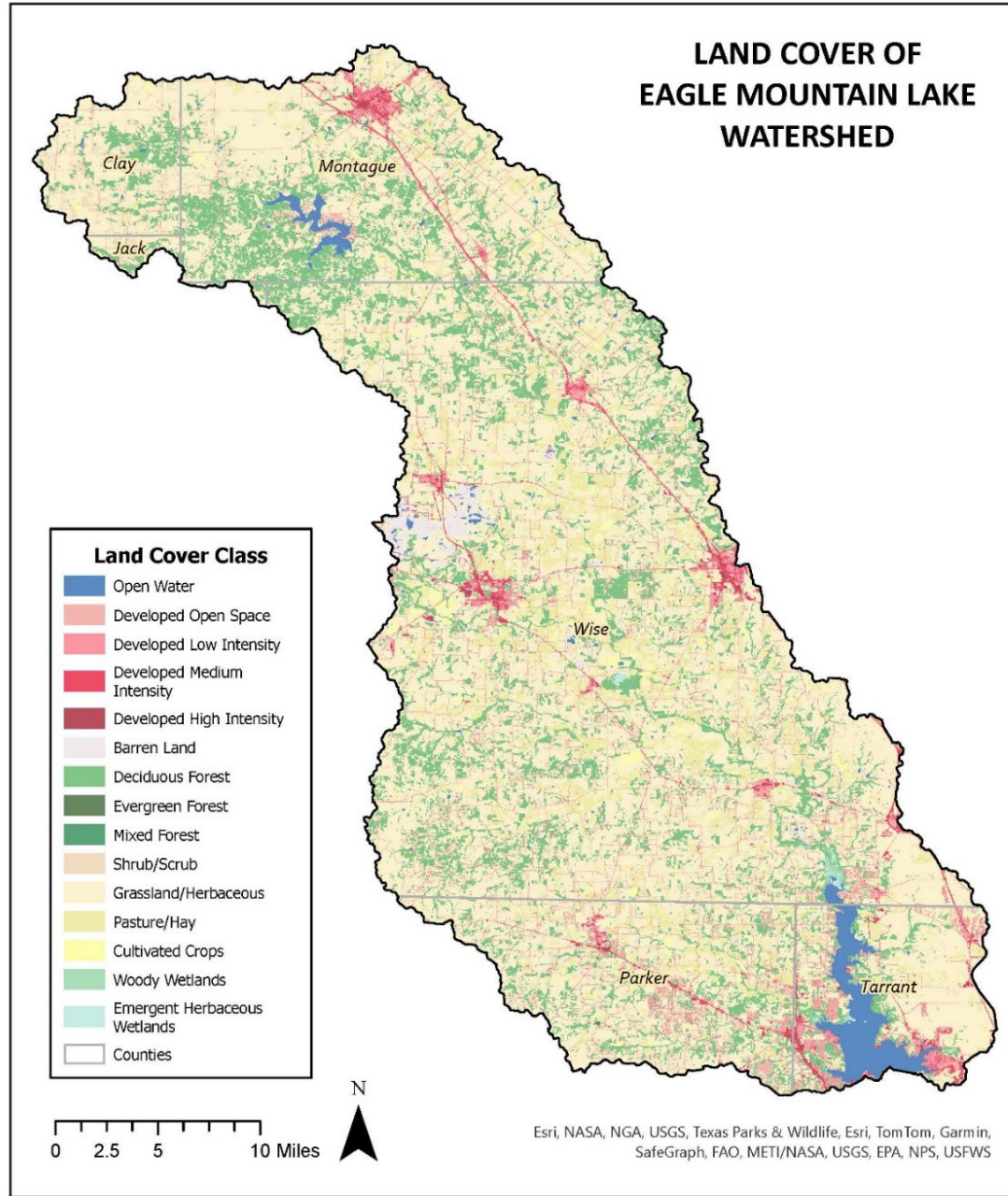
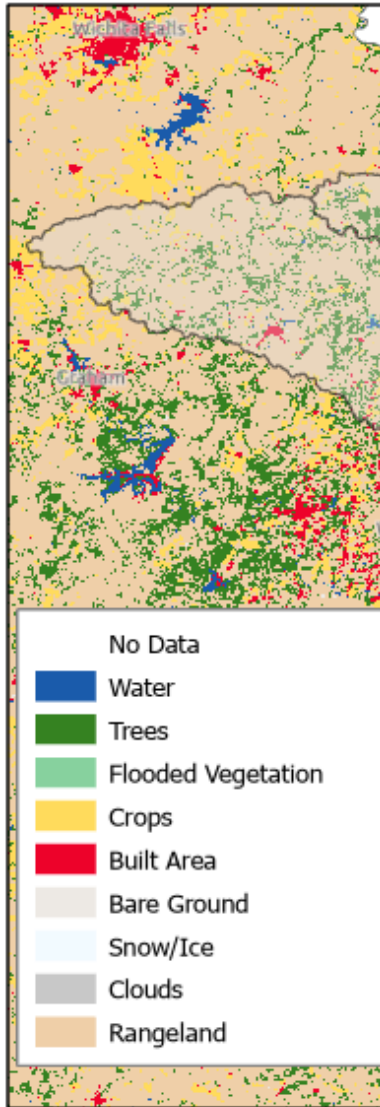
Name	Segment(s)	Impairments	Concerns
Eagle Mountain Lake	0809_01 - 0809_14		
Walnut Creek	0809A		
Ash Creek	0809B	Bacteria (E. coli)	Nitrate (NO ₃ ⁻) (screening)
Dosier Creek	0809C	Bacteria (E. coli)	
Derrett Creek	0809D	Bacteria (E. coli)	
West Fork Trinity River Below Lake Bridgeport	0810_01	Bacteria (E. coli)	Chlorophyll-a (screening)
Big Sandy Creek	0810_02		
Garrett Creek	0810A		
Martin Branch	0810B		
	0810C	Bacteria (E. coli)	
Salt Creek	0810D		

Water Quality Issues

- ▶ Sediment: Quality and Supply issue
- ▶ State Volumetric Survey 2008
 - ▶ >15,000 ac-ft of sedimentation since 1934



Water C



- ▶ Rapidly urbanizing NW fringe of DFW metroplex
- ▶ Still a large amount of rural and agricultural land



Watershed Modeling Overview

Aaron Hoff

Eagle Mountain Lake WPP Meeting

July 9, 2025





Watershed Data Models & Tools used by TRWD

- ▶ Why do we use watershed models?
- ▶ LDCs/LOADEST
- ▶ SWAT/HAWQS
- ▶ WASP
- ▶ SELECT

Watershed Modeling basics

Targeted Implementation



30% TP Reduction Target

Cropland

- Grassed Waterways
- Cropland Conversion
- Terracing
- Nutrient Management
- Filter Strips

Pasture

- Prescribed Grazing
- Pasture Planting
- Critical Area Planting
- Grade Stabilization
- Prescribed Burning
- Brush Management

Watershed

- Flood Protection Structures

Urban

- Phase II Storm Water Control Measures
- Urban Nutrient Management
- Wastewater Treatment Plant Upgrade

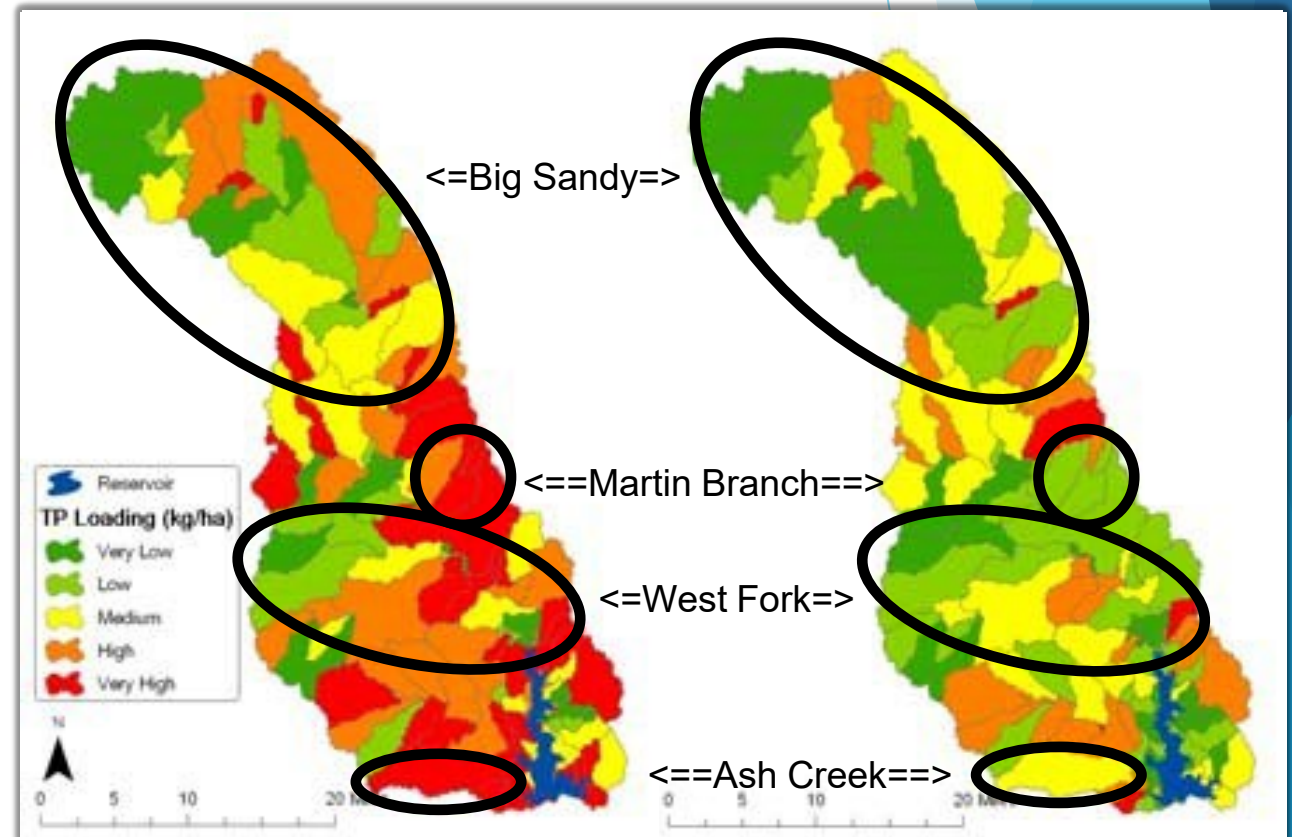
Riparian

- Brush Management
- Wetland Development
- Buffer Strips

In-Lake

- Hypolimnetic Aeration
- P-Inactivation

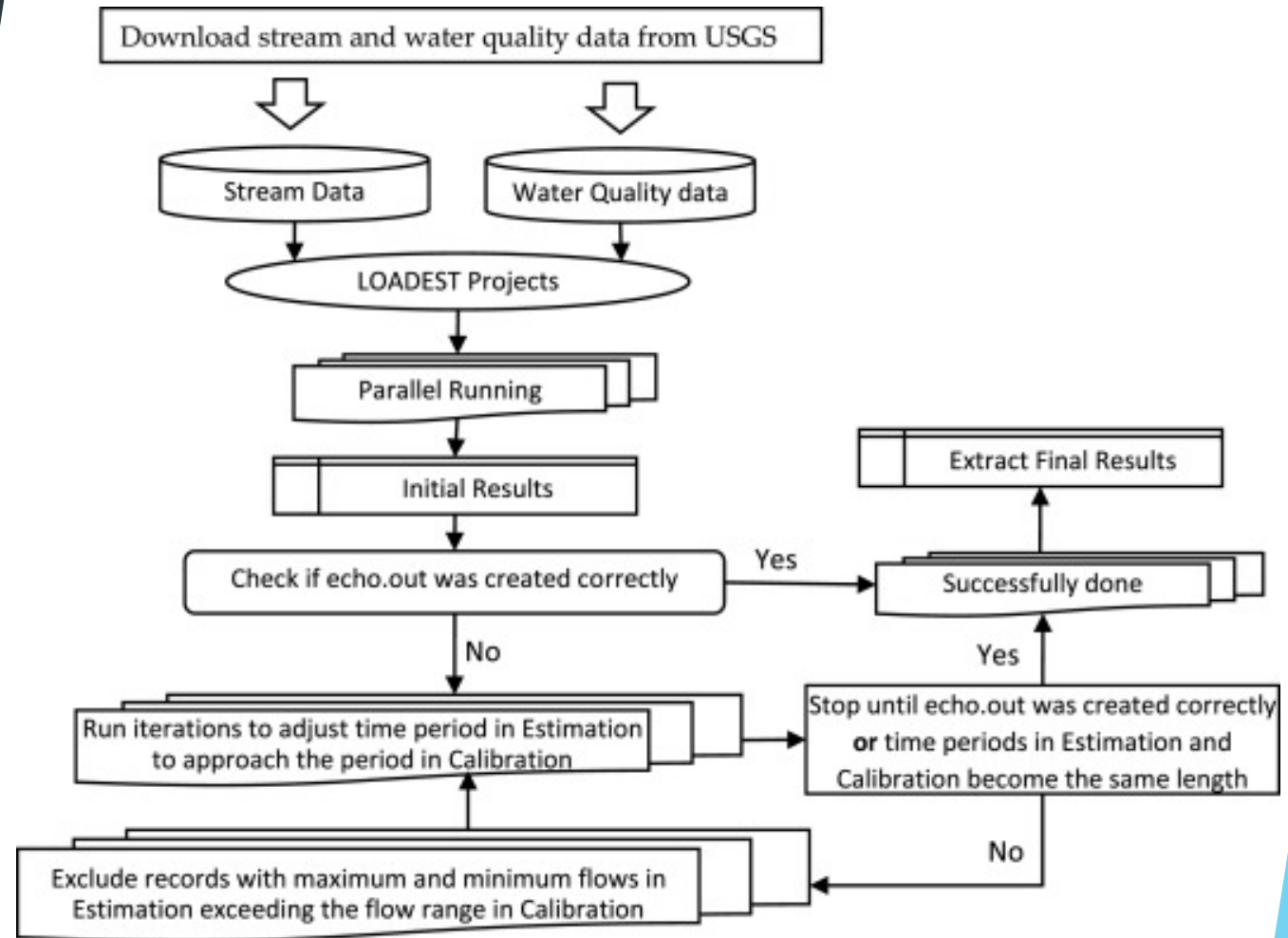
TP Reductions by Subwatersheds Pre- and Post-Implementation



Load Duration Curve (LDC) Analysis

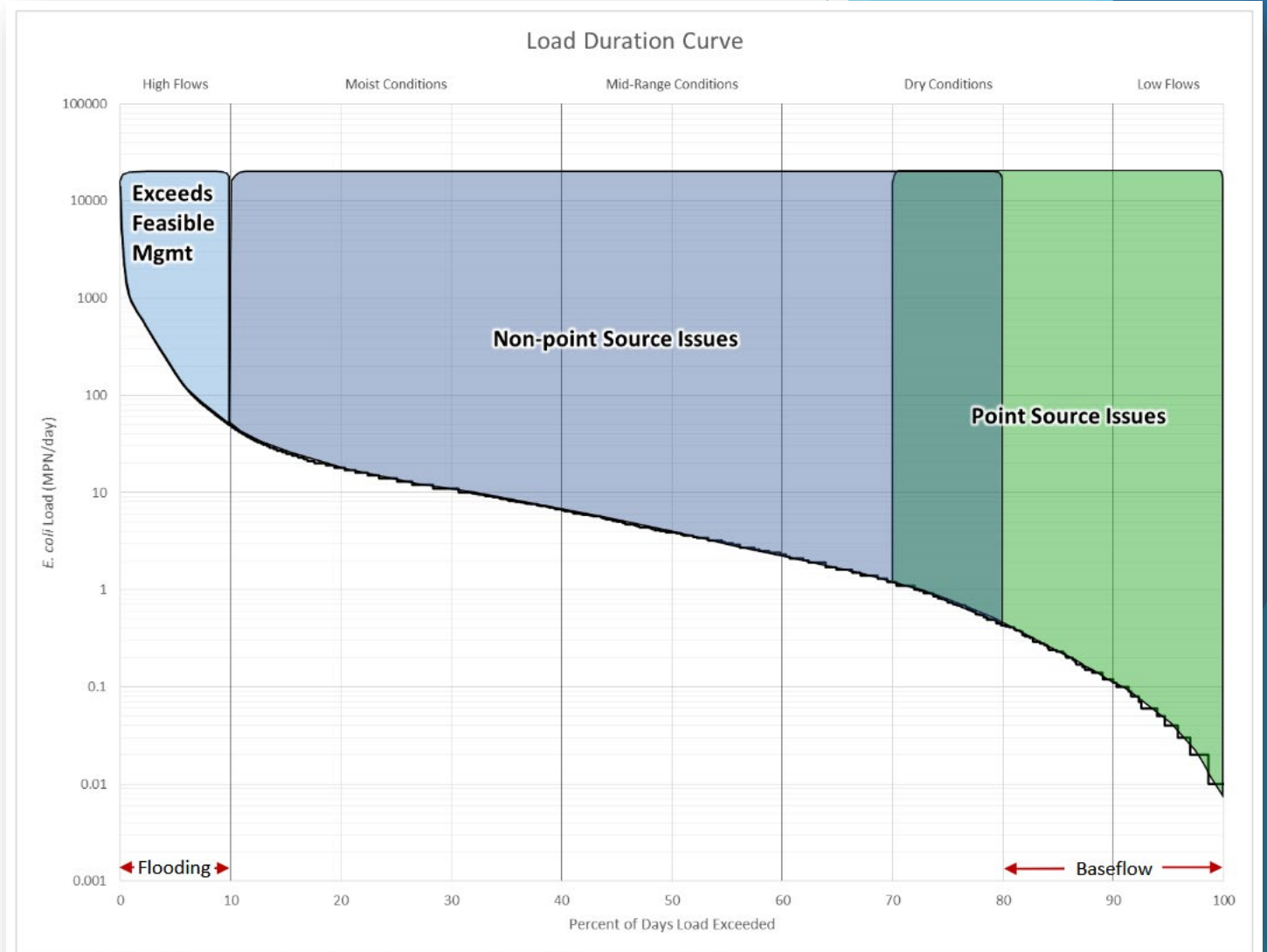
LOADEST - working behind the scenes

- ▶ No acronym here - literally just stands for “LOAD ESTimator”
 - ▶ Height of USGS creativity
- ▶ Requires paired data points
 - ▶ Measured pollutant concentration
 - ▶ Observed streamflow at same time
- ▶ Generally need at least 12 paired points for a reliable data set
 - ▶ LOADEST won't run if it doesn't have enough data



Visualizing loads with LDCs

- ▶ Comparing data within a station
 - ▶ How do points compare to the max allowable load?
 - ▶ Problems at high flow or low flow?
- ▶ Comparing different stations
 - ▶ Worth our time to focus on subwatersheds that correspond to specific stations?
 - ▶ Substantial increases between two stations?



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

Characterizing Watershed Pollutant Sources with SWAT/HAWQS

Reviewing Pollutant Source Inputs

Human Impacts

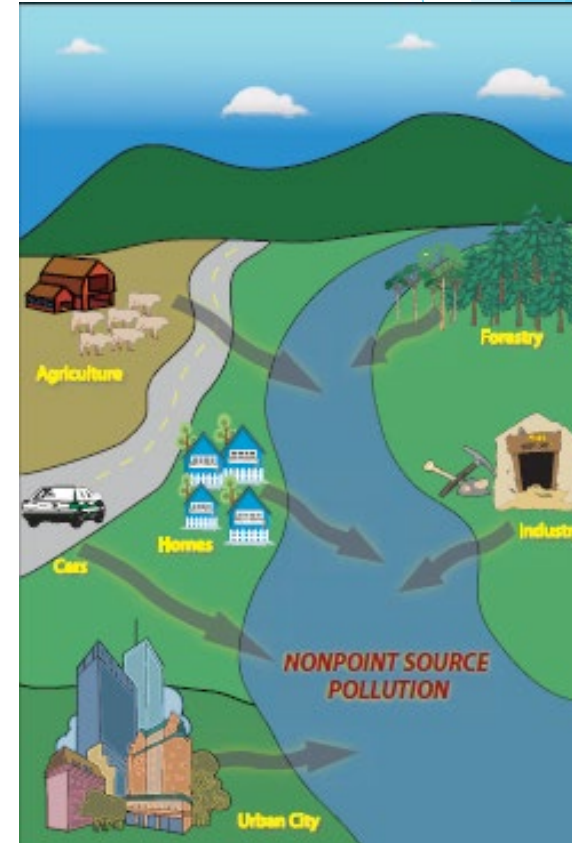


Point Source Pollution

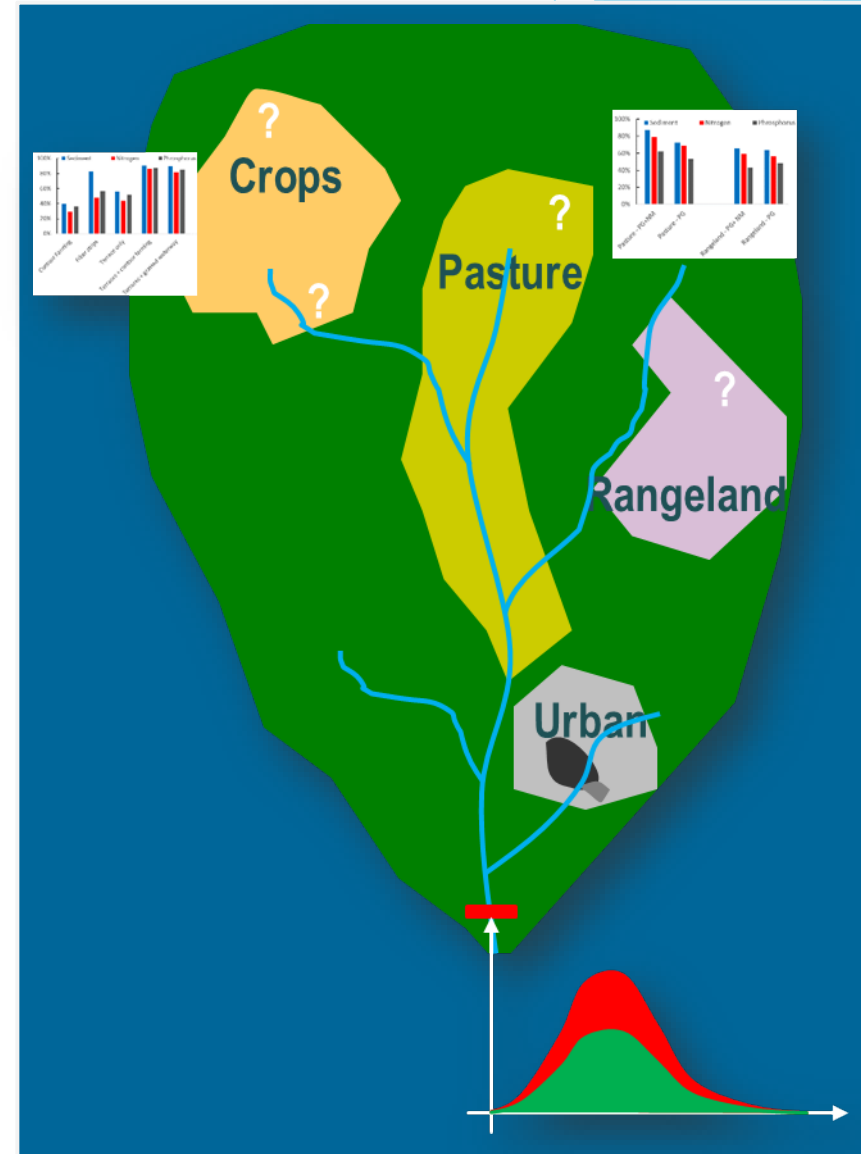
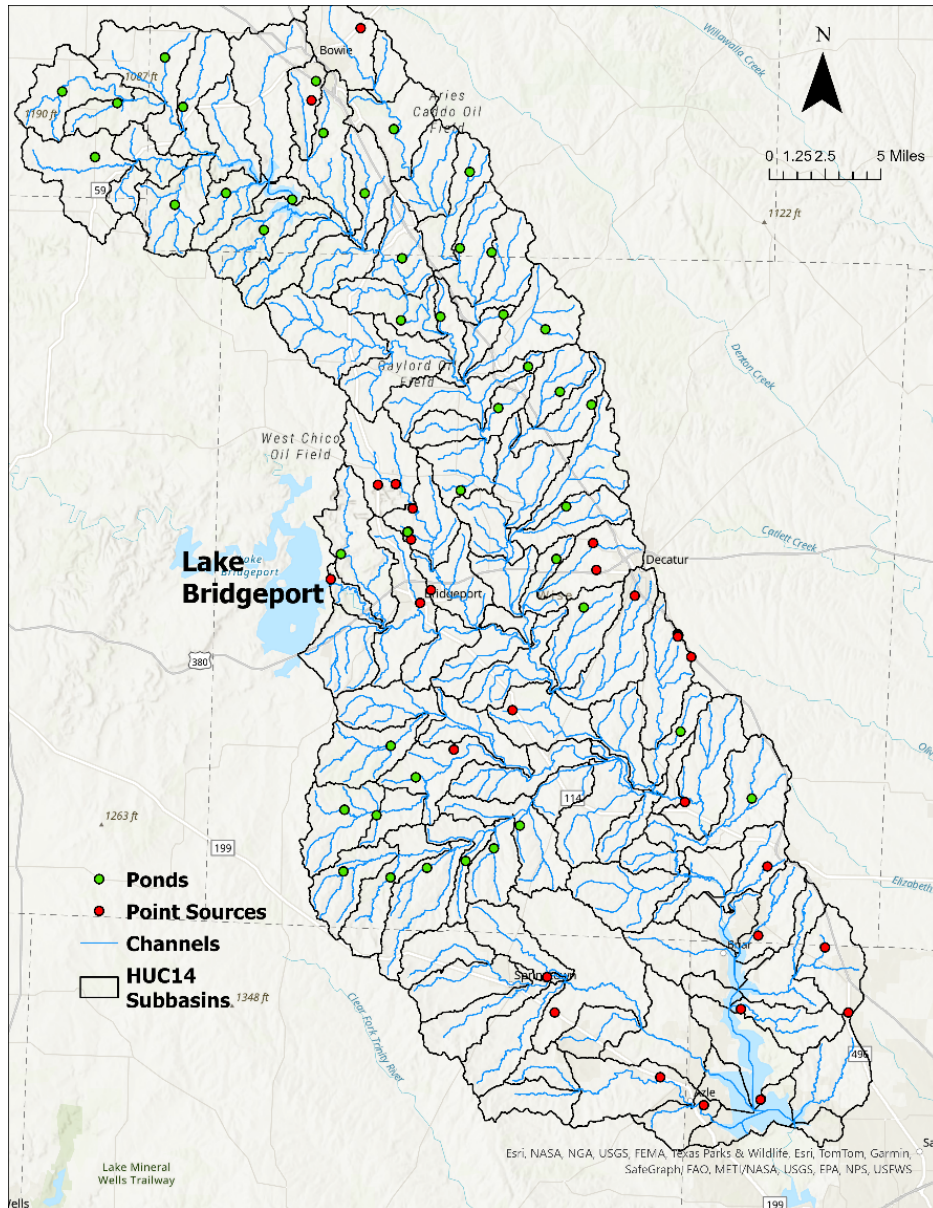
discharged from a clearly defined, fixed point such as a pipe, ditch, channel, sewer or tunnel

Non-Point Source Pollution

originates from many different places across the landscape, most of which cannot be readily identified.

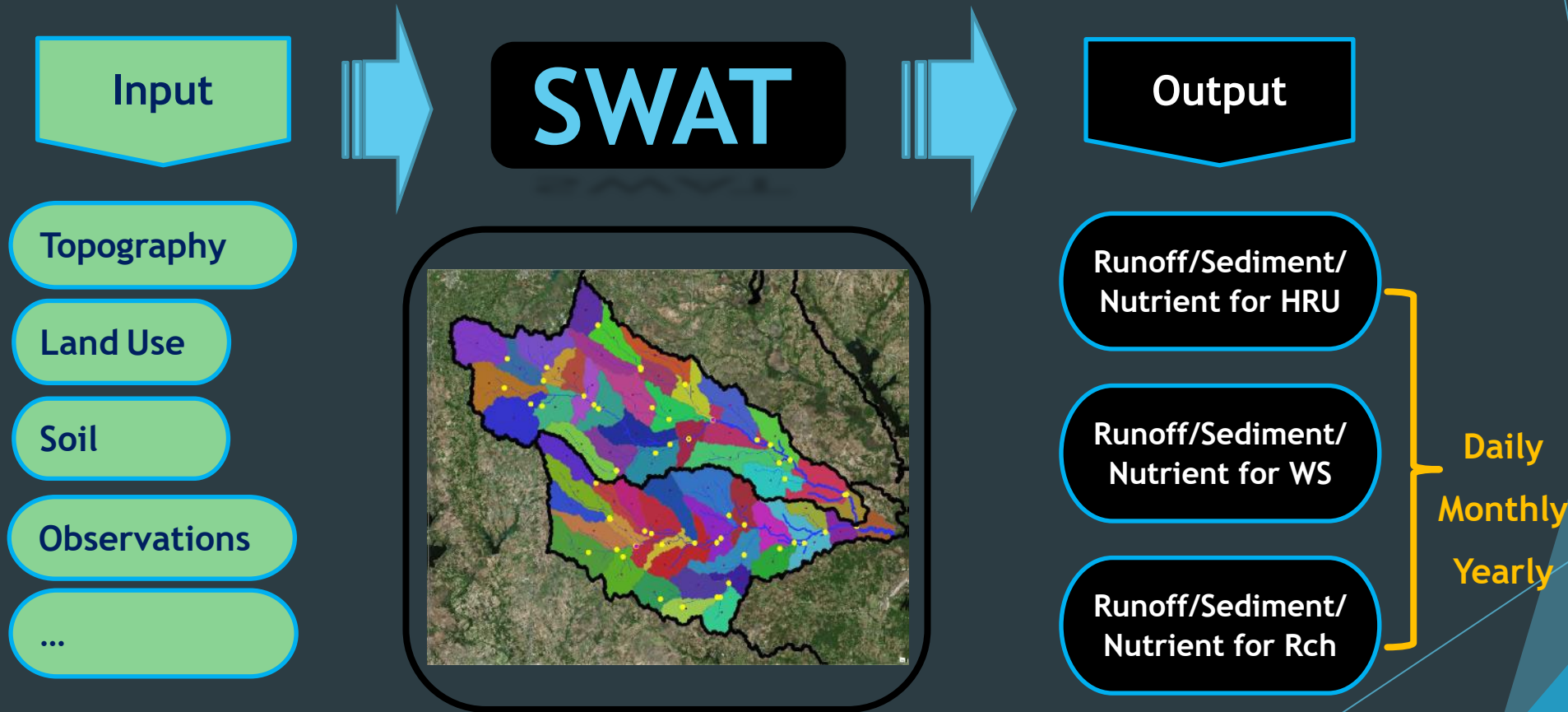


Let's talk inputs



Characterizing Sources

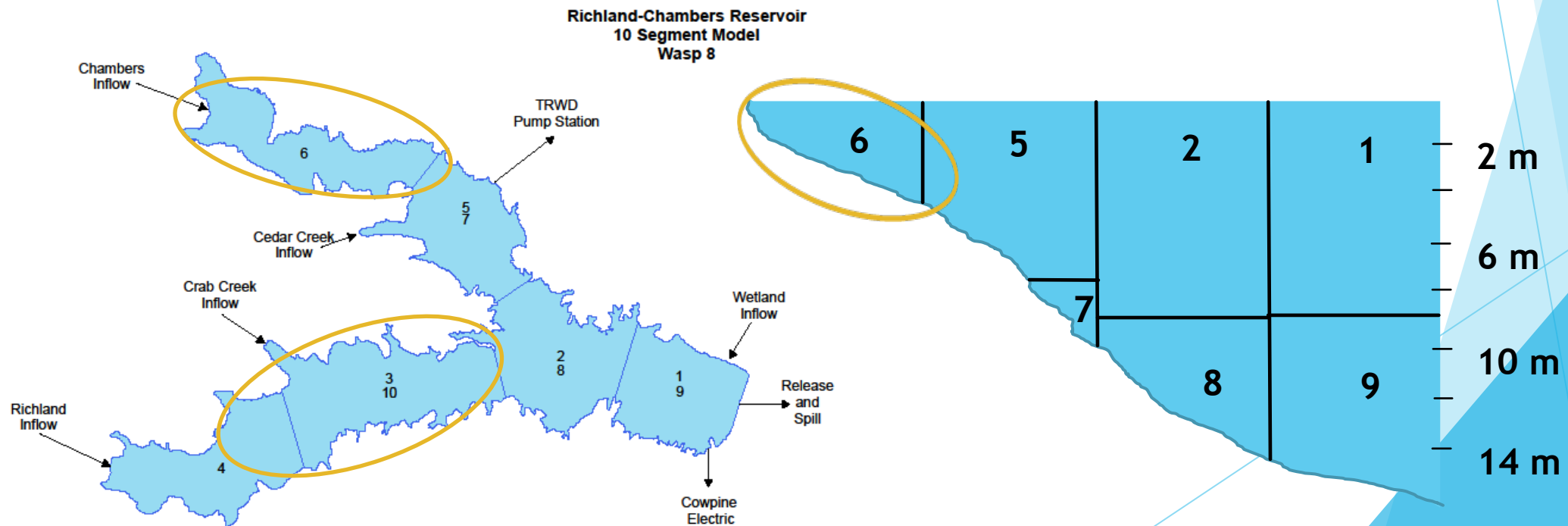
Soil & Water Assessment Tool (SWAT)



Lake Analysis with the Water Quality Analysis Simulation Program (WASP)

WASP Lake Modeling

- Simulates the processing and cycling of nutrients (N, P) in a lake.
- Estimates water quality response, in all or part of the lake, to nutrient inputs from the watershed.



Calculating *E. coli* loads with the
Spatially Explicit Load Enrichment
Calculation Tool (SELECT)

SELECT basics

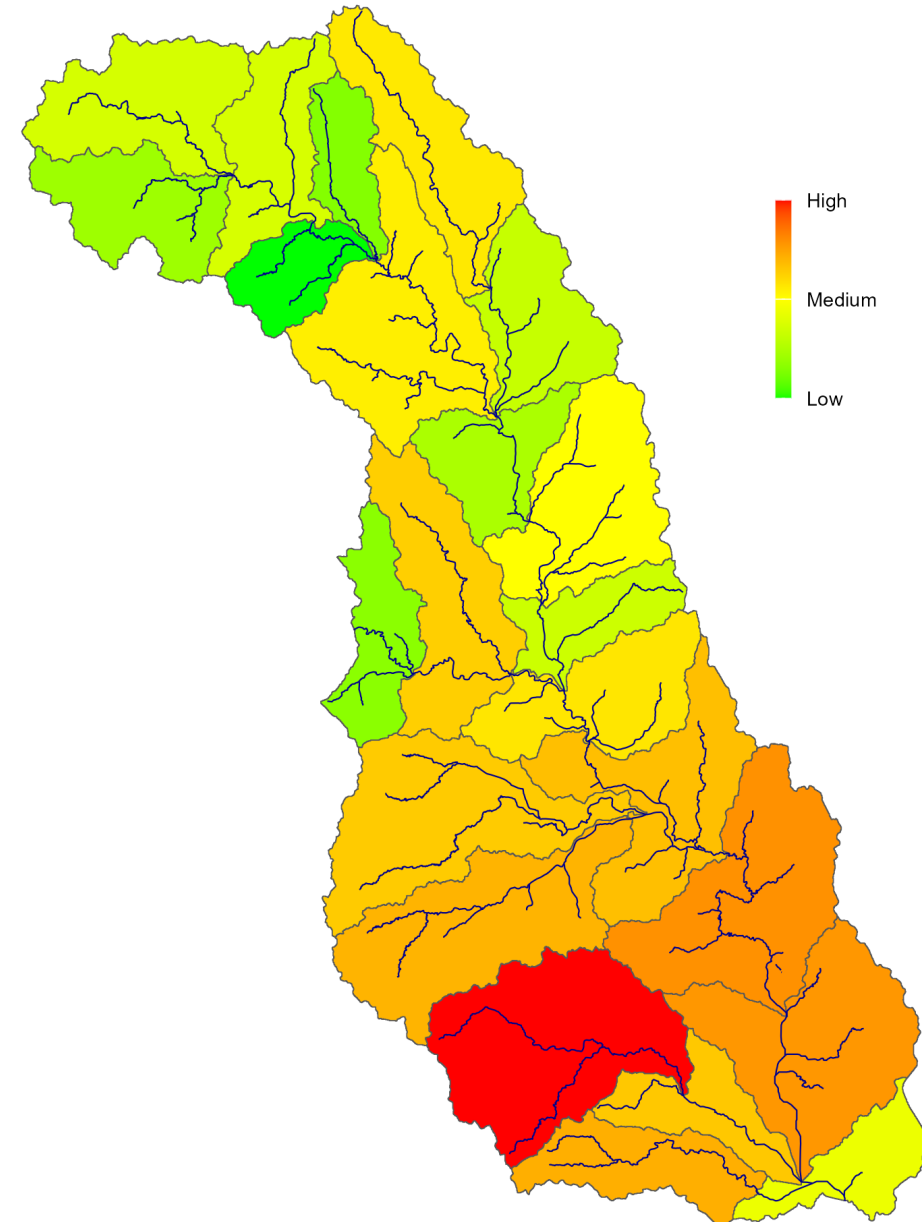
- ▶ Analytical approach for determining potential bacterial loads in specific areas of a watershed
- ▶ Spatial data inputs
 - ▶ Land use data
 - ▶ Population data (human and animal)
- ▶ Literature values for fecal production rates
- ▶ SELECT does **not** account for any natural or anthropogenic mitigation processes
 - ▶ Results in an overestimation of potential sources
 - ▶ Provides a “worst-case scenario”



Visualizing loads in SELECT

- ▶ Determines which “catchments” have the greatest contribution to the overall pollutant load
- ▶ Targets areas for potential management practices

Total Potential E.coli Loading From All Sources



Bringing “Worst Case Scenario” into focus

- ▶ Logic follows - sources further from stream will have less influence on load
- ▶ Distance from E. coli source (the “poop point”) to stream isn’t taken into account automatically
- ▶ Artificially account for this to a small degree by using a stream buffer
 - ▶ Within buffer zone = more influence (90% reaches stream)
 - ▶ Outside buffer zone = less influence (50% reaches stream)



Contact Us

- ▶ Watersheds@TRWD.com
- ▶ Aaron.Hoff@TRWD.com

Eagle Mountain Watershed

Modeling of Nutrient and *E.coli* Loading

Commissioned by Tarrant Regional Water District

Provided by Texas A&M AgriLife Research

SWAT



- Model Set-up
- Calibration
- Load Duration Curves
- Nutrient Load Reduction Strategies

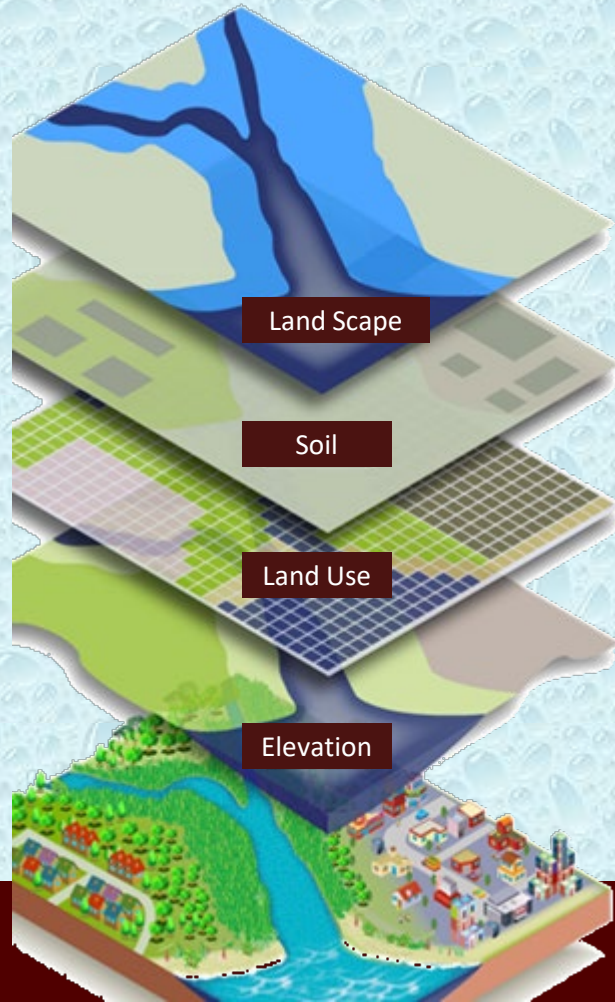
SELECT



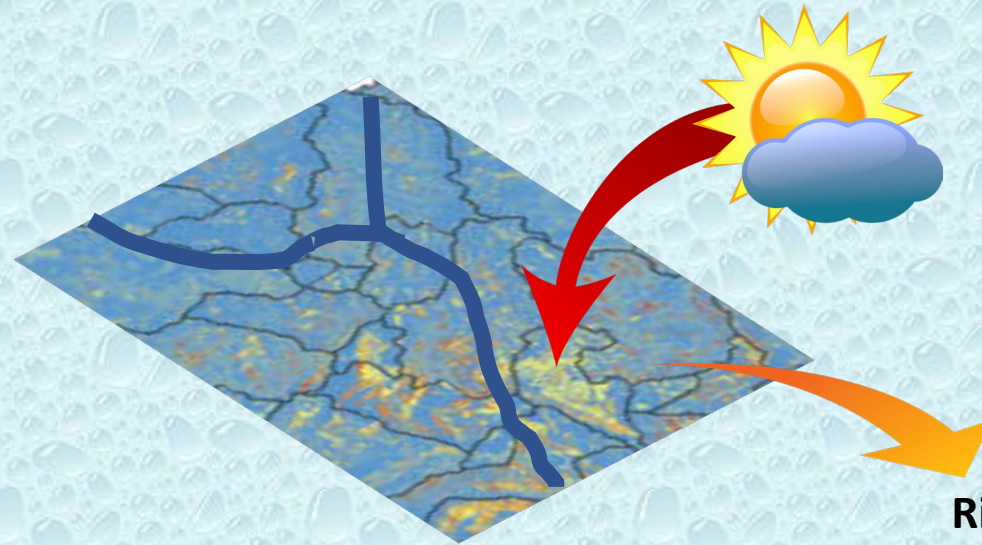
- Model Set-up
- Potential Loading
- E.coli Load Reduction Strategies

SWAT- Soil and Water Analysis Tool

Semi-distributed watershed scale ecosystem model



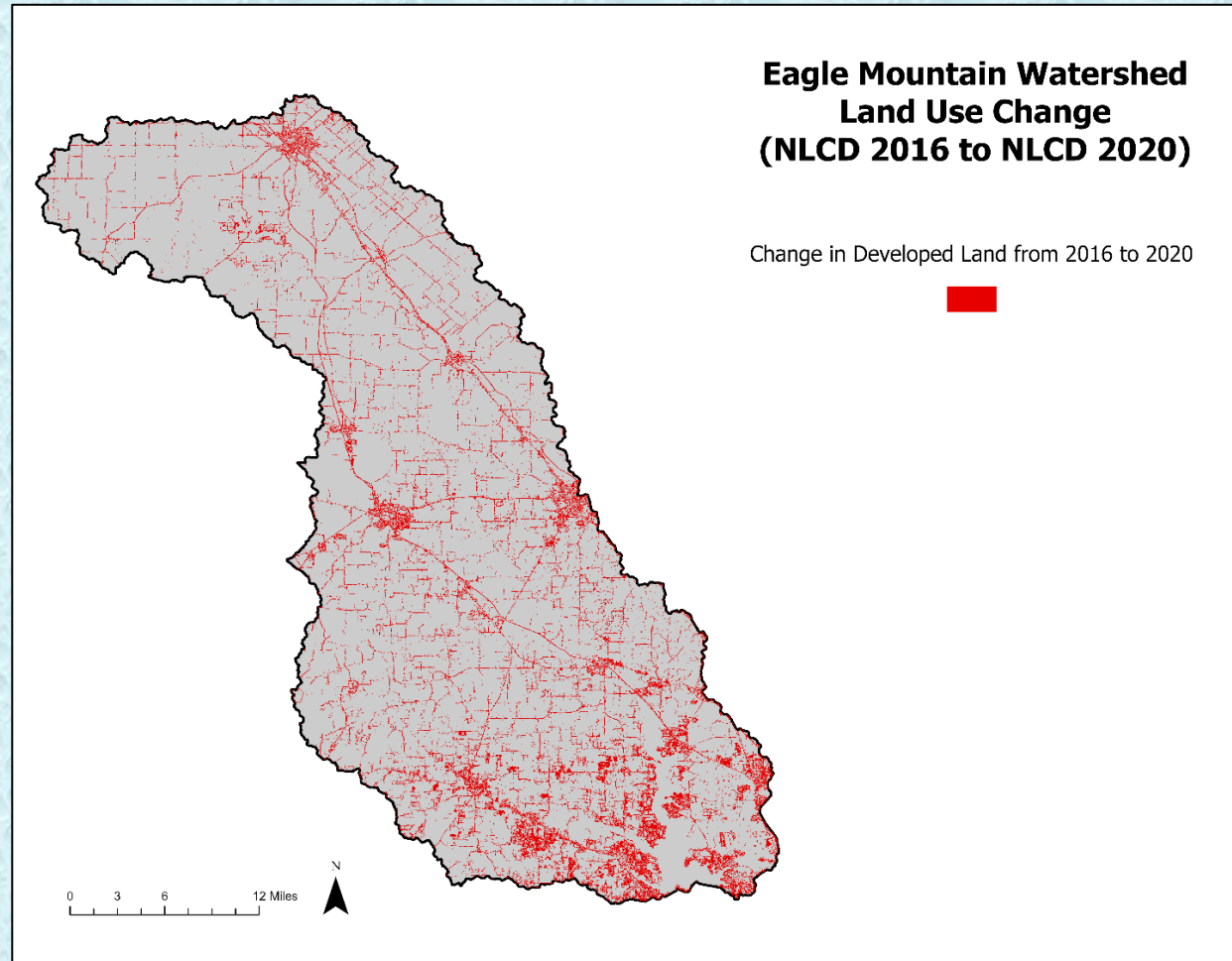
Watershed → Subbasins → HRUs
Areas of unique properties



River flow
Sediments
Evapotranspiration

SWAT Model Set-up

**9.7% (53,223 acres)
increase in developed
area since 2016**



SWAT Model Set-up

Management Practices implemented between 2008-2023 from Natural Resources Conservation Service (NRCS)

Management Practices	Available Acres	Applied Acres	Percent of Land Applied
Grade Stabilization Structure		14*	
Brush Management	8,376	609	7.3%
Cover Crop	25,045	2,584	10.3%
Pasture Hay Planting	250,209	733	0.3%
Range Planting	159,429	381	0.2%
Prescribed Grazing	350,329	267,766	76.4%

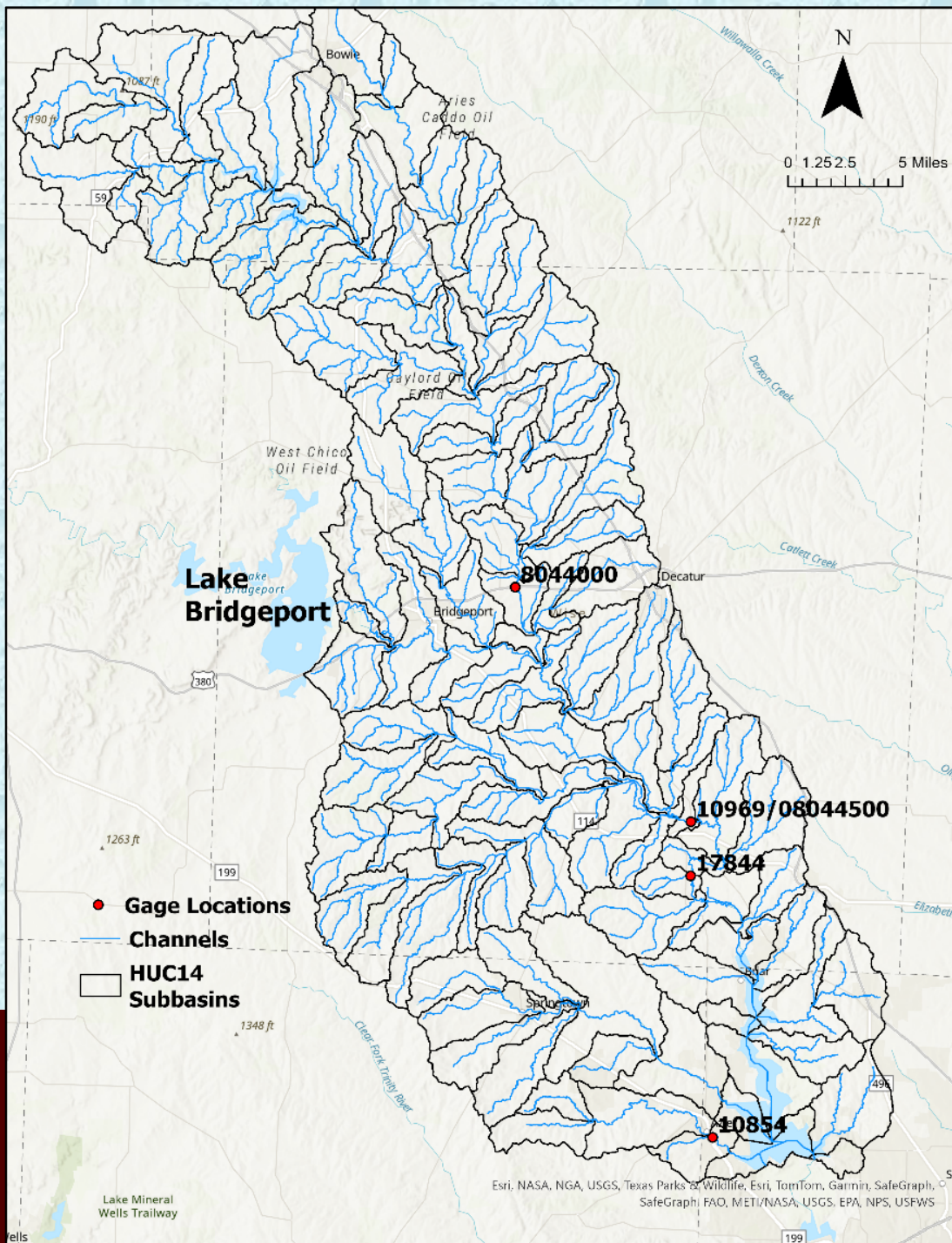
* For grade stabilization structure, there were 14 different structures applied in the watershed.

SWAT Model Calibration

Monthly Flow Calibration

- USGS Gages from 2005-2020
 - USGS 08044000 on Big Sandy Creek
 - USGS 08044500 on West Fork Near Boyd

Gage ID	NS	PBIAS	KGE	Simulation Mean (cms)	Observation Mean (cms)
USGS 08044000	0.8	-68.4	0.31	3.56	2.12
USGS 08044500	0.56	3.1	0.56	8.19	8.46



SWAT Model Calibration

Gage ID	Constituent	NS	PBIAS	KGE	Simulation Mean	Observation Mean
10969	TSS (tonnes)	0.63	2.9	0.7	10,095.86	10,394.62
10969	NO3 (kg)	0.36	-9.1	0.65	13,425.61	12,311.01
10969	NH3 (kg)	0.5	37.6	0.35	3,273.16	5,243.13
10969	PO4 (kg)	0.64	-4.8	0.66	5,727.16	5,464.76
10969	TN (kg)	0.52	31.5	0.44	42,854.48	62,547.68
10969	TP (kg)	0.54	-19.7	0.7	13,308.03	11,116.98
17844	TSS (tonnes)	0.75	9.6	0.83	6,125.54	6,773.68
17844	NO3 (kg)	-1.08	-98.4	-0.15	12,100.86	6,100.37
17844	NH3 (kg)	-5.47	-133.3	-1.21	3,323.82	1,424.43
17844	PO4 (kg)	-5.8	-184.5	-1.61	4,499.02	1,581.26
17844	TN (kg)	-0.28	-21.7	0.3	37,132.2	30,509.19
17844	TP (kg)	0.46	-26.4	0.6	9,134.45	7,226.91
10854	TSS (tonnes)	0.28	52.1	0.04	407.52	851.42
10854	NO3 (kg)	0.37	-52	0.23	1,508.92	992.53
10854	NH3 (kg)	-2.52	-305.6	-2.15	382.12	94.22
10854	PO4 (kg)	0.26	-13.8	0.63	153.21	134.65
10854	TN (kg)	0.5	-105.7	-0.06	3,945.85	1,918.03
10854	TP (kg)	0.16	-70.3	0.19	526.17	308.88

Monthly Water Quality Calibration

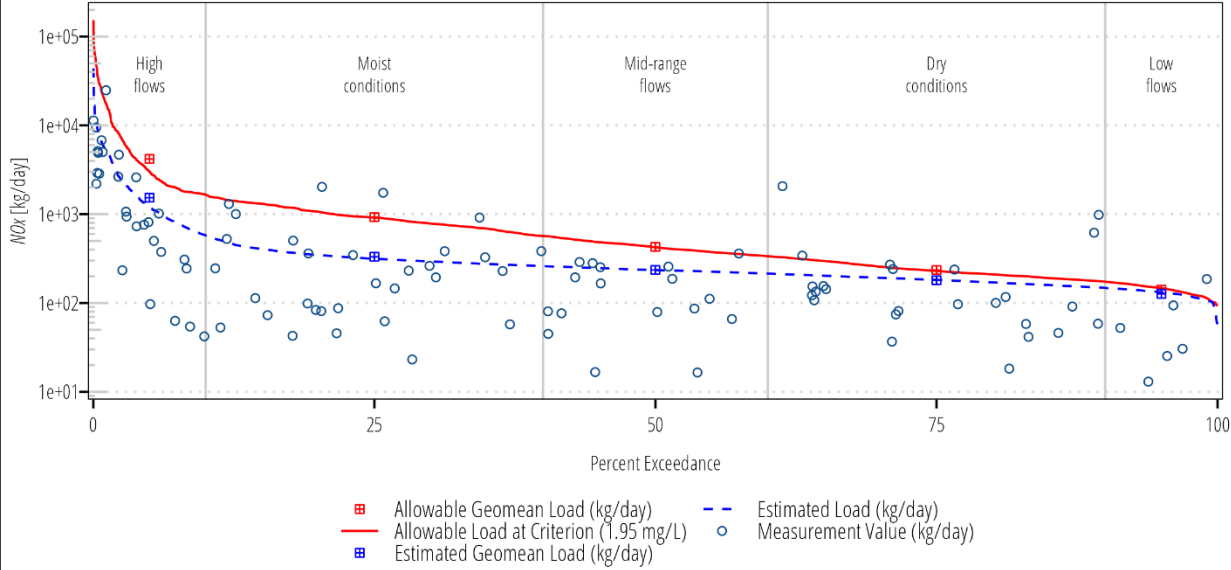
- TRWD Gages
 - 10969 West Fork @ FM730
 - 2011-2020
 - 17844 West Fork @ Bobo/4668
 - 2005-2020
 - 10854 Ash Creek
 - 2005-2020

Grab sample data and calibrated flow data was processed using LOADEST to create monthly time series

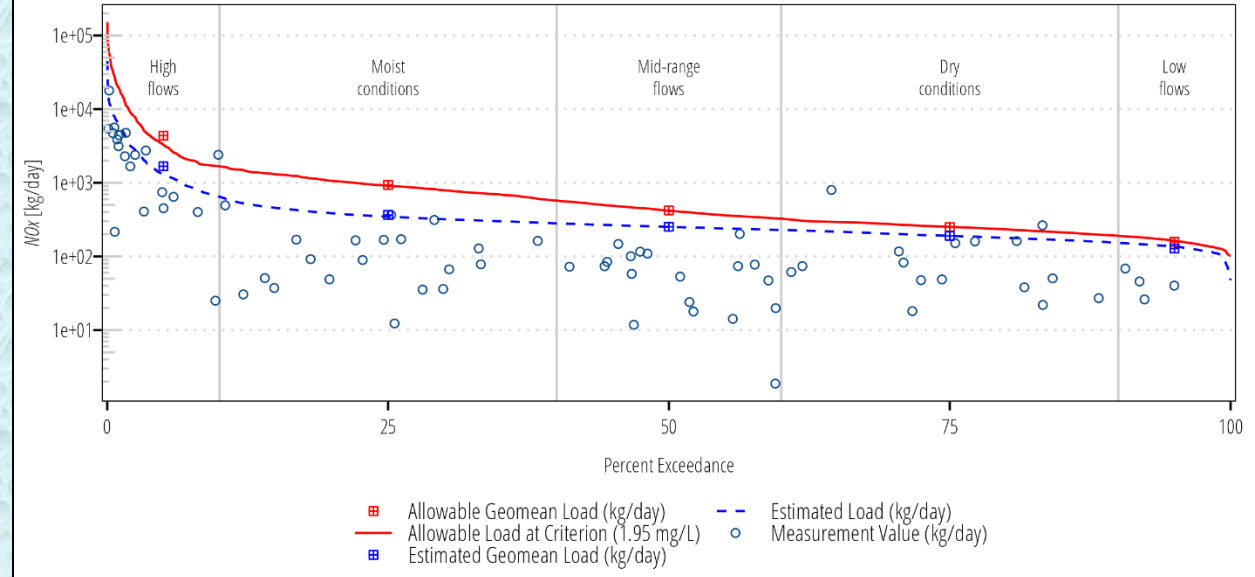
Load Duration Curves: Nutrients

Gages on WF did not Exceed Allowable Load for NOx and TP

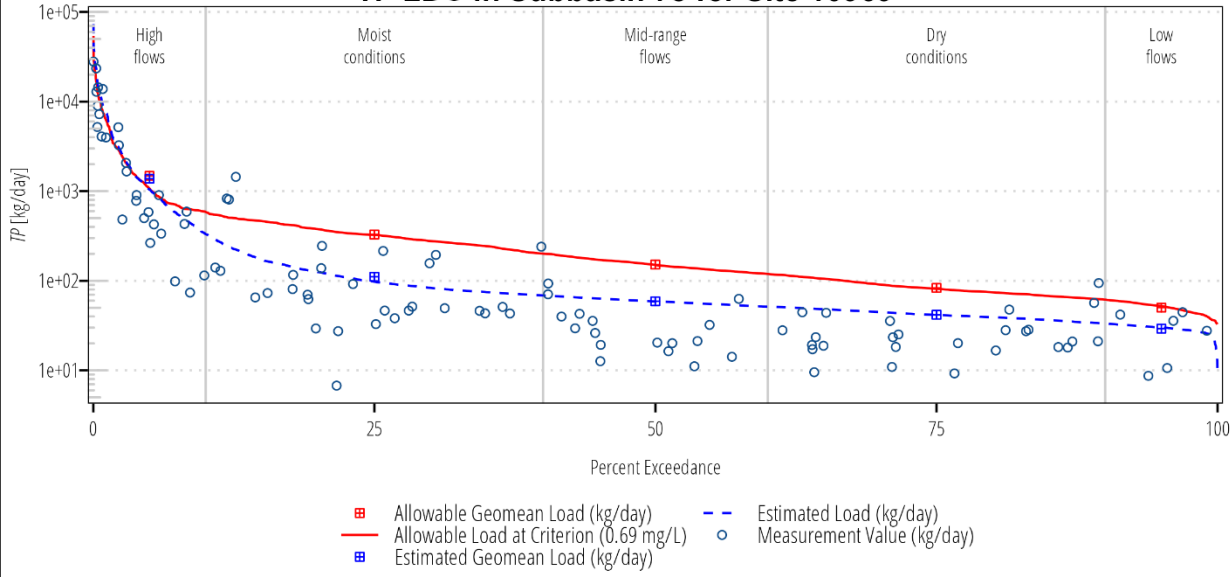
NOx LDC in Subbasin 78 for Site 10969



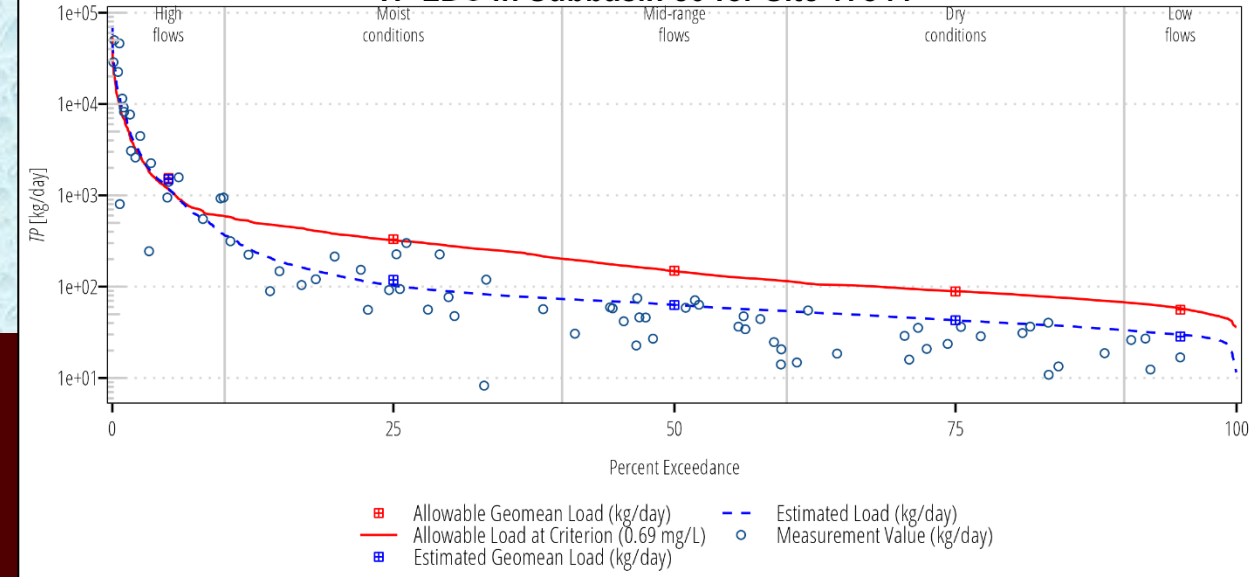
NOx LDC in Subbasin 80 for Site 17844



TP LDC in Subbasin 78 for Site 10969



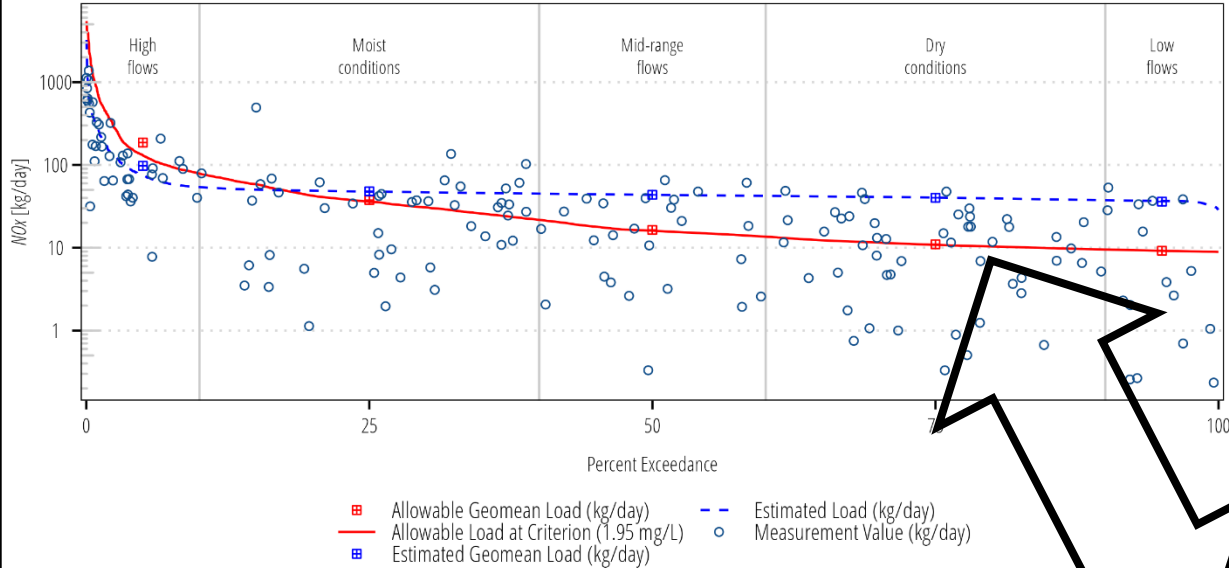
TP LDC in Subbasin 80 for Site 17844



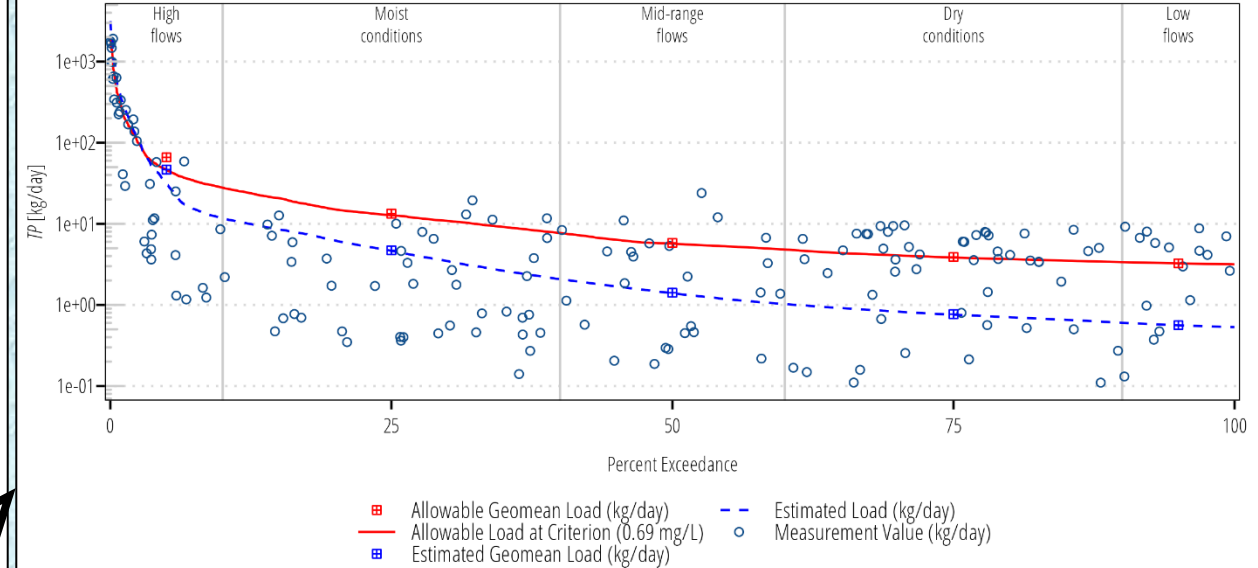
Load Duration Curves: Nutrients

NOx exceeded allowable loading in Ash Creek during Moist to Lowest Flow conditions

NOx LDC in Subbasin 105 for Site 10854



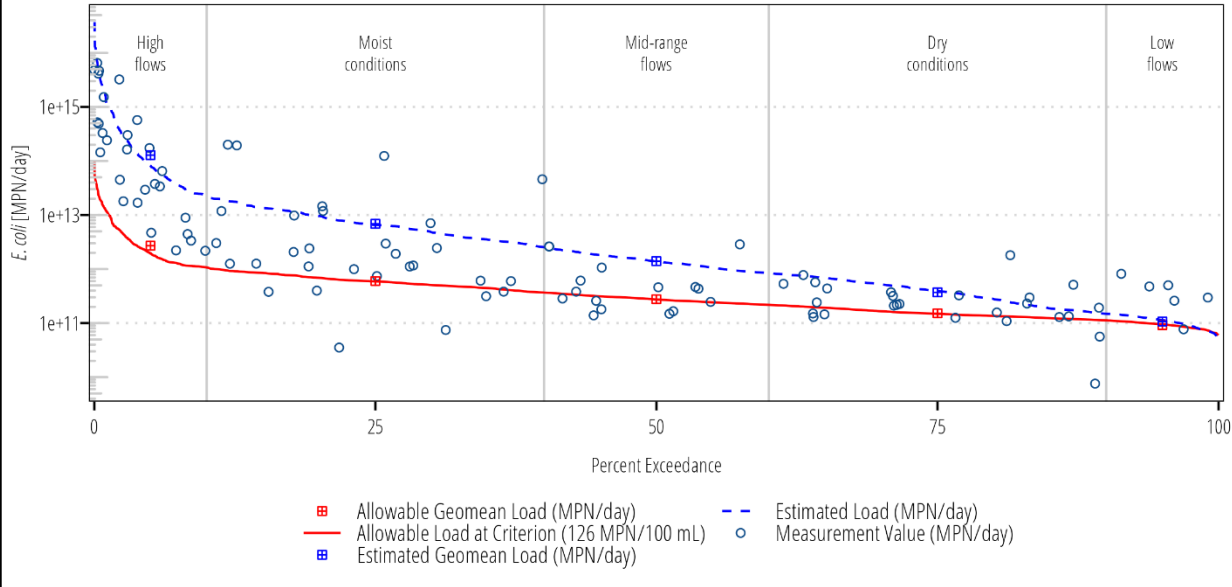
TP LDC in Subbasin 105 for Site 10854



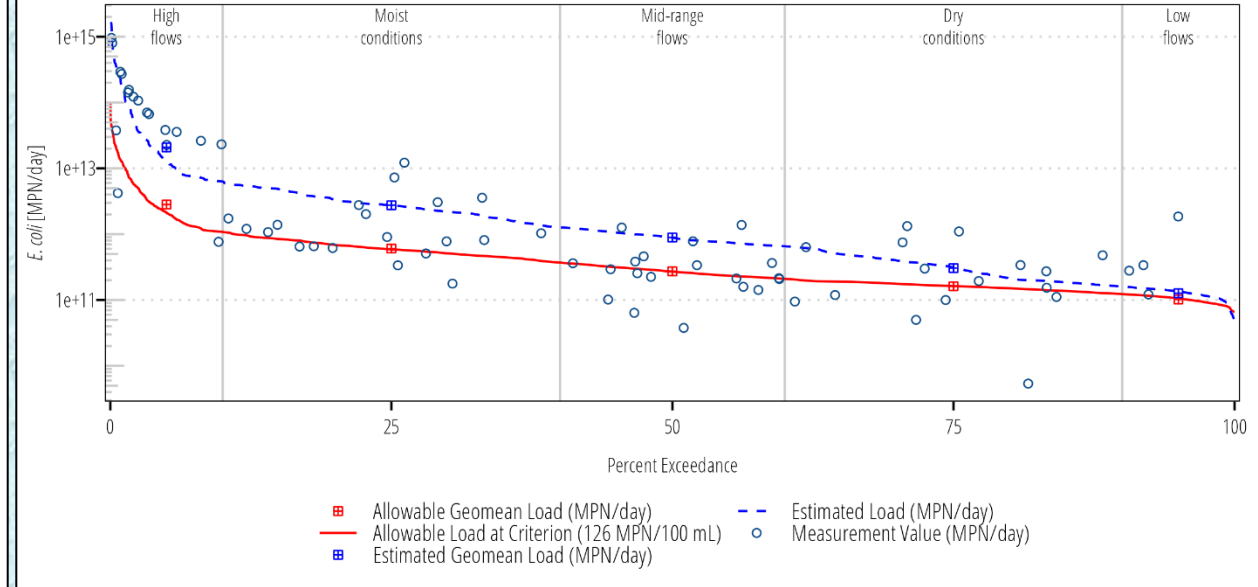
Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	186.4	97.6	0.0	0.0
Moist Conditions	20,485	10-40	37.7	48.0	10.4	21.6
Mid-range Conditions	9,150	40-60	16.4	43.6	27.2	62.3
Dry Conditions	6,178	60-90	11.0	40.1	29.1	72.5
Lowest Flows	5,238	90-100	9.2	36.1	26.9	74.5

Load Duration Curves: *E.coli*

E. coli LDC in Subbasin 78 for Site 10969

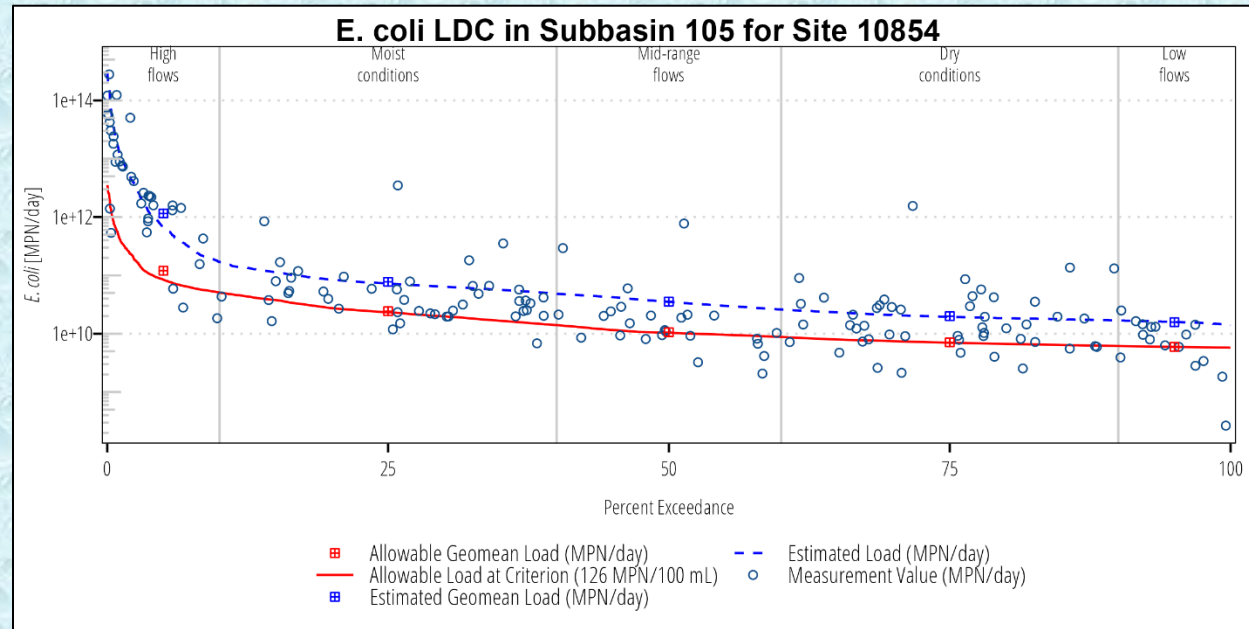


E. coli LDC in Subbasin 80 for Site 17844



Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed	Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	1,723,680	0-10	2.71E+12	1.28E+14	1.26E+14	97.9	Highest Flows	1,882,656	0-10	2.82E+12	2.08E+13	1.8E+13	86.5
Moist Conditions	522,374	10-40	6E+11	6.88E+12	6.28E+12	91.3	Moist Conditions	518,400	10-40	6.05E+11	2.75E+12	2.15E+12	78.0
Mid-range Conditions	241,402	40-60	2.77E+11	1.4E+12	1.12E+12	80.2	Mid-range Conditions	237,082	40-60	2.73E+11	8.91E+11	6.18E+11	69.4
Dry Conditions	131,242	60-90	1.52E+11	3.71E+11	2.19E+11	59.0	Dry Conditions	143,770	60-90	1.62E+11	3.05E+11	1.43E+11	47.0
Lowest Flows	84,033	90-100	9.17E+10	1.07E+11	1.53E+10	14.3	Lowest Flows	93,442	90-100	1.02E+11	1.27E+11	2.48E+10	19.6

Load Duration Curves: *E.coli*



Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	1.2E+11	1.15E+12	1.03E+12	89.5
Moist Conditions	20,485	10-40	2.43E+10	7.75E+10	5.31E+10	68.6
Mid-range Conditions	9,150	40-60	1.06E+10	3.54E+10	2.48E+10	70.1
Dry Conditions	6,178	60-90	7.12E+09	2E+10	1.29E+10	64.4
Lowest Flows	5,238	90-100	5.94E+09	1.58E+10	9.82E+09	62.3

Load Reduction Strategies: Nutrients

1) Cover Crops

Increase	Area (acres)	NO ₃ % Change	TP % Change	SYLD % Change
15%	2,996	3.63%	-20.64%	-55.39%
25%	3,281	5.23%	-27.95%	-71.10%
40%	3,680	7.29%	-35.57%	-74.49%

Nutrient Management

2) Hay Planting

N Reduction	NO ₃ % Change	TP % Change	SYLD % Change
15%	-10.68%	1.73%	5.64%
25%	-17.20%	2.53%	9.40%
40%	-26.77%	3.62%	15.30%

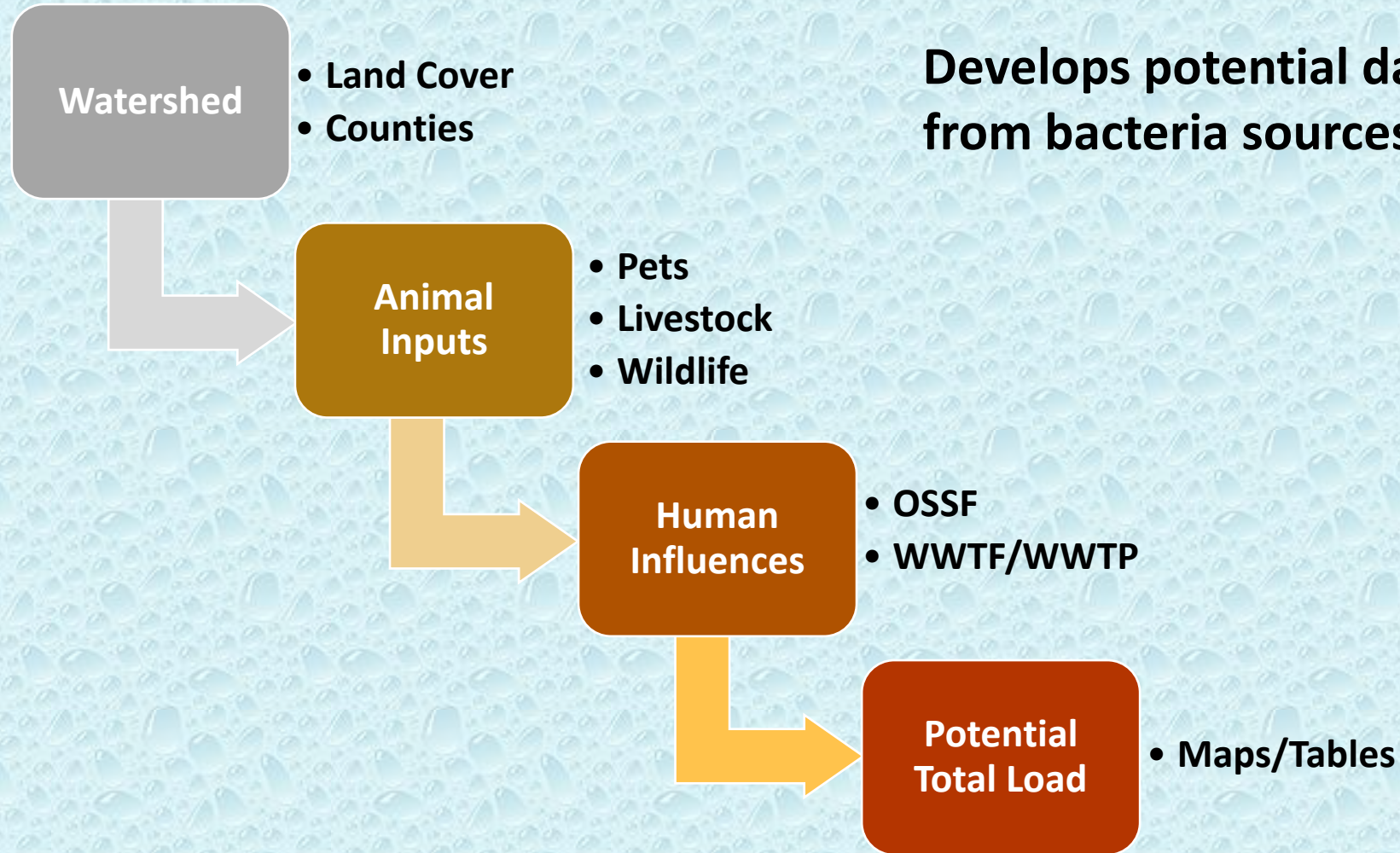
3) Range Planting

N reduction	NO ₃ % Change	TP % Change	SYLD % Change
15%	-4.37%	1.69%	2.92%
25%	-10.06%	3.13%	5.67%
40%	-17.80%	5.12%	9.82%

4) Cattle Stocking Rate Modification

% Modification	Stocking Rate (acres/head)	NO ₃ % Change	TP % Change	SYLD % Change
15%	8.7	-5.54%	-12.49%	-0.84%
25%	9.9	-8.91%	-20.71%	-1.76%
40%	12.4	-13.56%	-32.98%	-4.04%

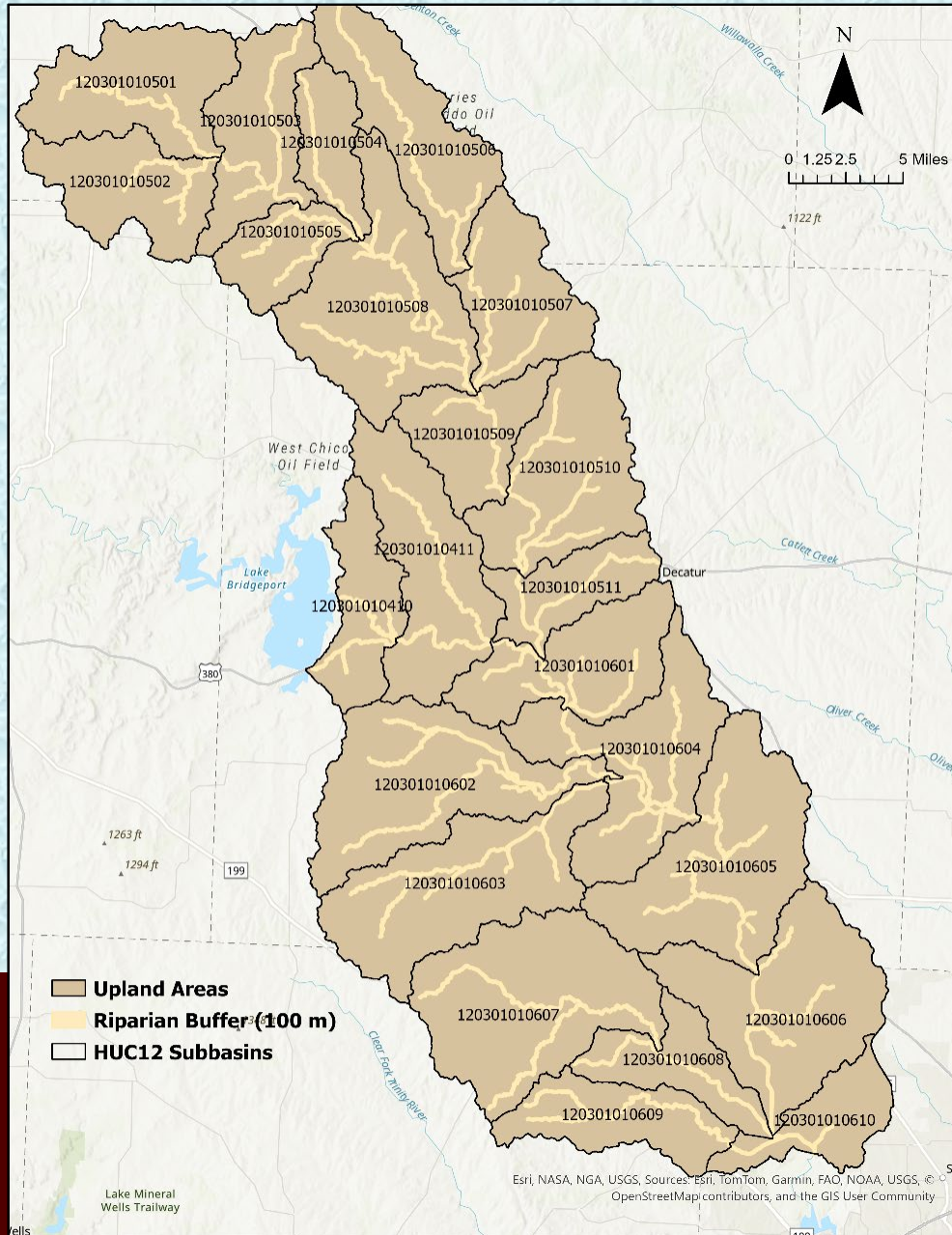
SELECT- Spatially Explicit Load Enrichment Calculation Tool



Develops potential daily *E. coli* loads from bacteria sources for a watershed

SELECT Model Set-up

Defined a 100m (330ft) riparian buffer around each stream



LULC Category	Acres	
	Riparian	Upland
Barren land (Rock/Sand/Clay)	93	3,357
Cultivated Crops	755	10,116
Deciduous Forest	8,087	77,796
Developed, High Density	29	1,863
Developed, Low Density	323	17,834
Developed, Med Density	116	6,335
Developed, Open Space	695	26,039
Emergent Herbaceous Wetlands	558	3,810
Evergreen Forest	8	206
Grassland/Herbaceous	10,415	304,477
Mixed Forest	10	247
Open Water	2,598	10,484
Pasture/Hay	3,397	41,370
Shrub/Scrub	785	8,935
Woody Wetlands	4,694	5,857
Total Composite Acreage	32,563	518,728

SELECT Model Set-up

Pets, Wildlife, and Livestock

- 90% contribution from riparian
- 50% contribution from uplands

WWTFs (18 facilities)

- 100% contribution

OSSFs (~27,000 facilities)

- Failure rate of 15%
- 100% contribution

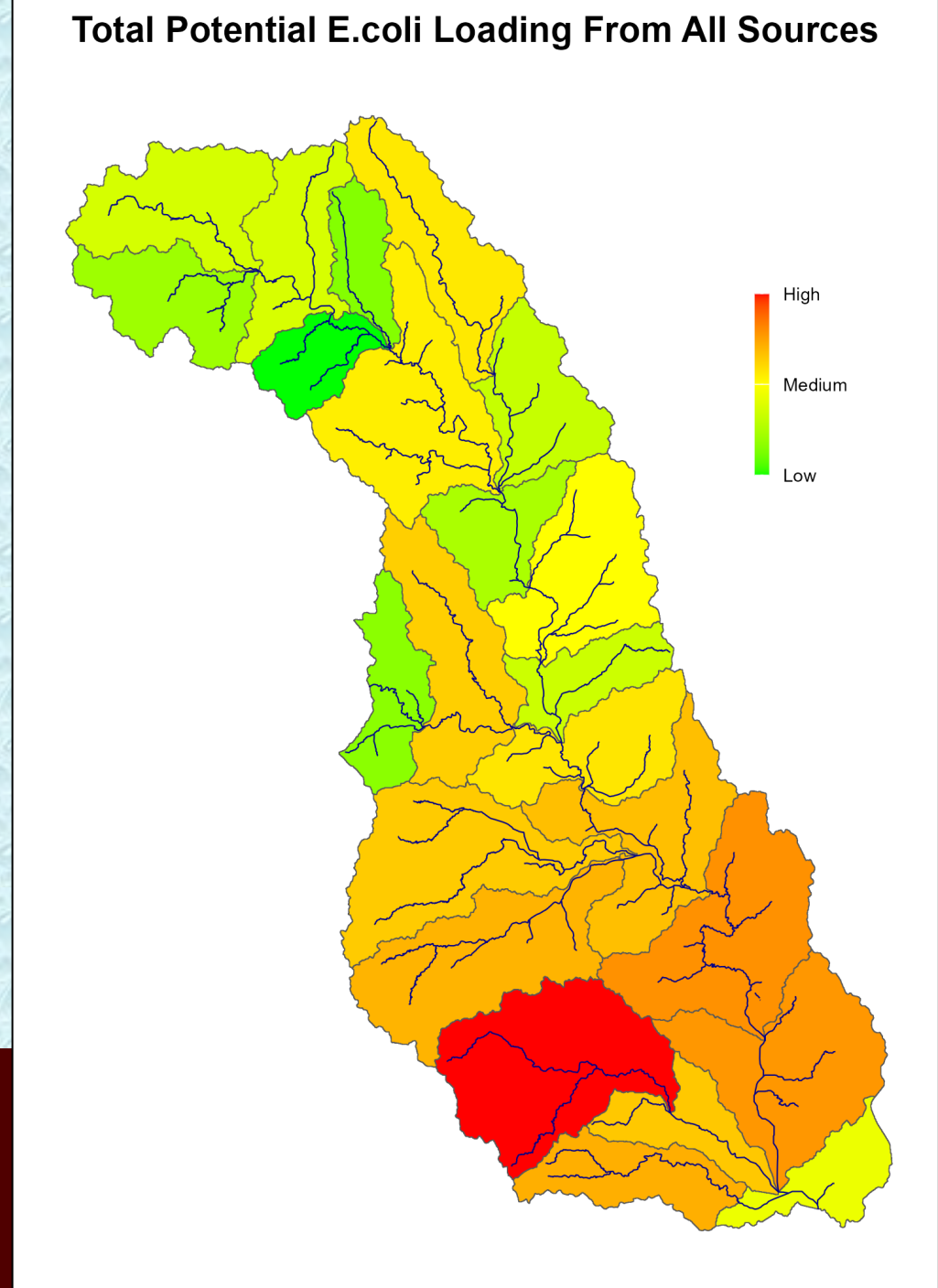
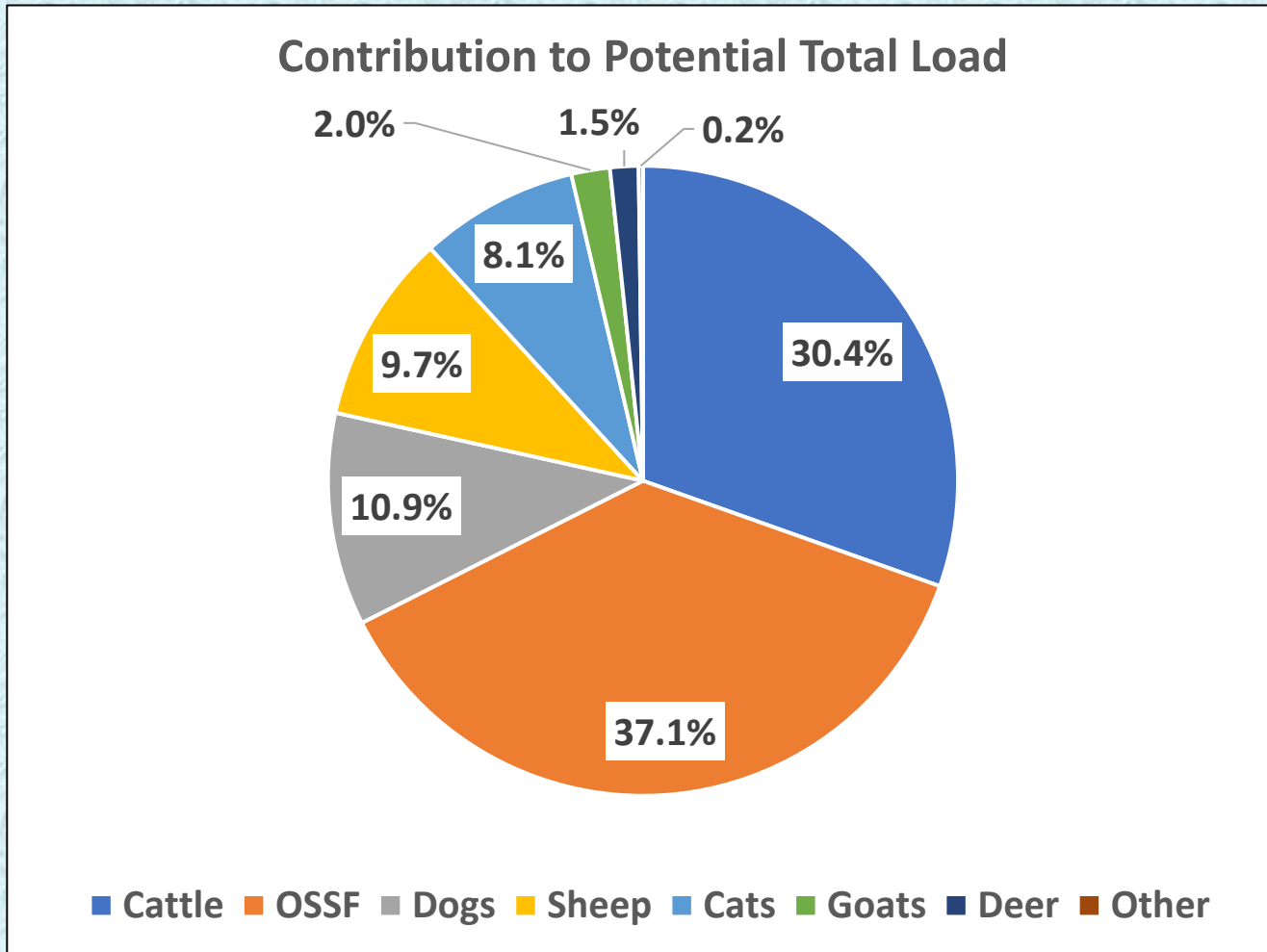
Average Watershed Stocking Rates

Animal	Stocking Rate (acre/head)
Cattle	7.4
Sheep	173.2
Goats	110.5
Horses	123.2
Feral Hogs	50
Deer	39.4

Fecal Coliform Production Rates

Source	Fecal coliform production rate	Reference
Cattle	8.55×10^9 cfu/head/day	Wagner and Moench 2009
Sheep	5.8×10^{10} cfu/head/day	
Goats	4.32×10^9 cfu/head/day	
Horses	3.64×10^8 cfu/head/day	
Deer	1.68×10^9 cfu/head/day	
Feral Hogs	1.51×10^8 cfu/head/day	
Dogs and Cats	5.0×10^9 cfu/head/day	USEPA 2001
OSSFs	10×10^6 /100 ml	

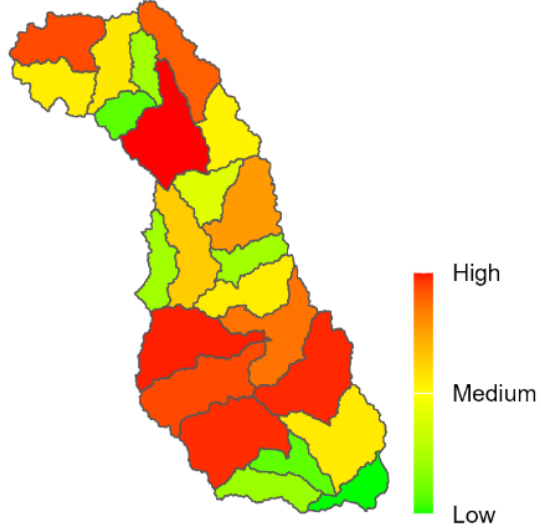
SELECT Potential Loading



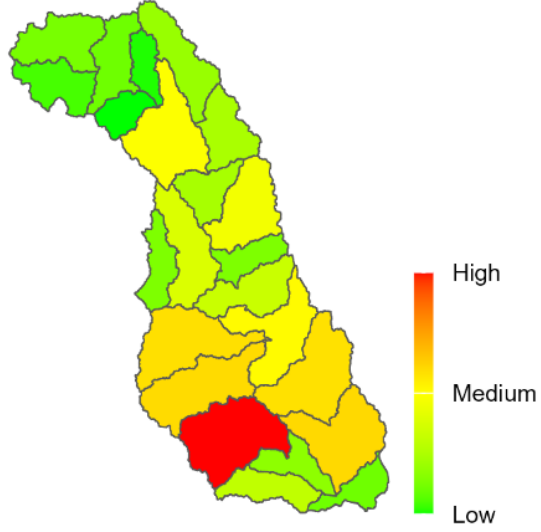
SELECT Potential Loading

Total Potential E.coli Loading by Source

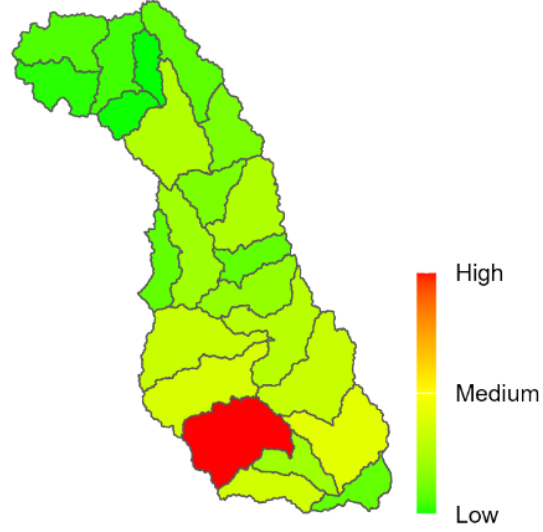
Cattle



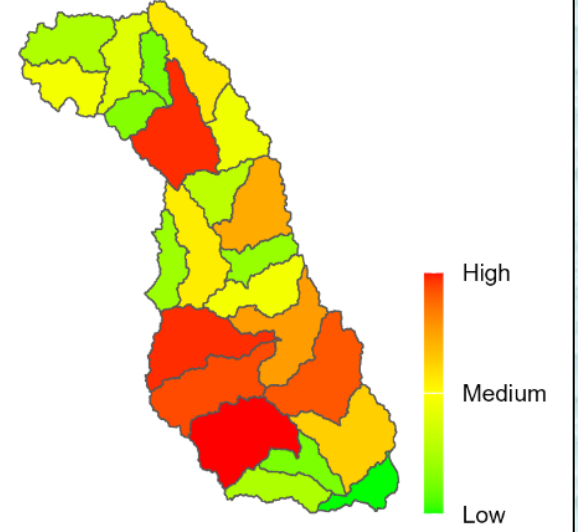
Sheep & Goats



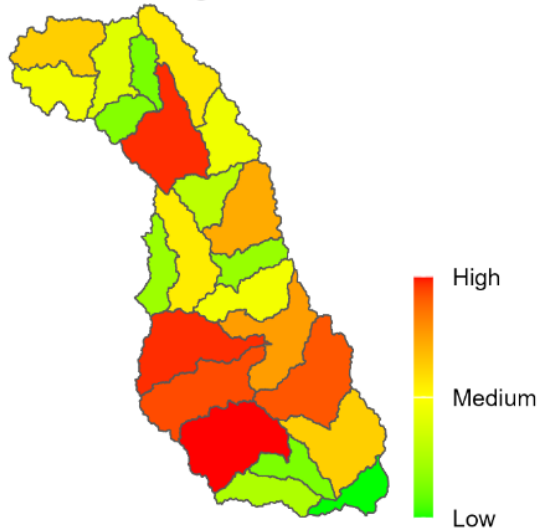
Horses



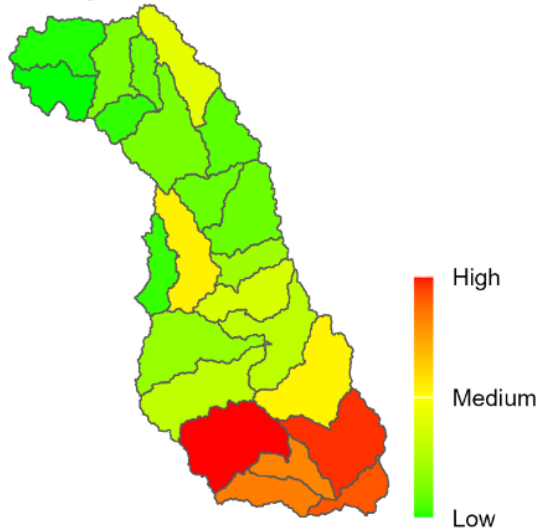
Deer



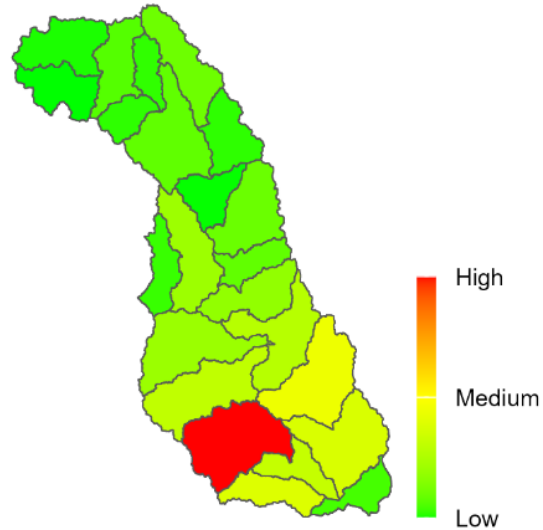
Feral Hogs



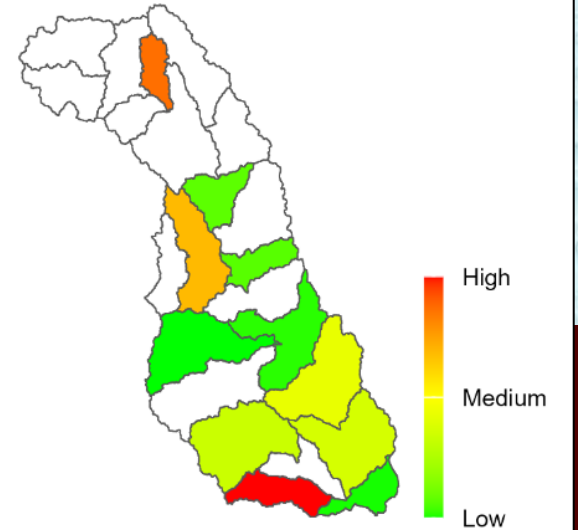
Dogs & Cats



OSSFs



WWTFs



Load Reduction Strategies: *E.coli*

Average Stocking Rate		E.coli Reduction			
	Acre/Head	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
Baseline	7.4				
25%	9.9	10.7%	10.2%	2.6%	7.6%
50%	14.9	21.4%	20.3%	5.1%	15.2%
75%	29.7	32.1%	30.5%	7.7%	22.8%

1) Cattle Stocking Rate Modification

OSSF Failure Rate Reduction		E.coli Reduction			
		WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
10%		9.3%	10.1%	17.0%	12.4%
5%		18.5%	20.2%	34.0%	24.8%

2) OSSF Failure Rate Improvement

Pet Reduction			E.coli Reduction			
	Dog	Cat	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
50%	0.307	0.1228	6.7%	6.8%	15.2%	9.5%
80%	0.2285	0.0914	10.7%	10.9%	24.2%	15.2%

3) Pet Reduction

Comments or Questions?



Guided Review: Chapters 3-5

- ▶ **General readability**
 - ▶ Clarity (weird wording, technical information not explained well)
 - ▶ Grammar (hopefully not, but I'm not perfect)
- ▶ **Content**
 - ▶ Anything questionable or that might be incorrect
 - ▶ Anything potentially useful that's missing
- ▶ **Visuals**
 - ▶ Size, colors, legibility
 - ▶ Additional maps you'd like to see

Source	Management Practices/Behavior Concerns	Potential Impacts	Rank ¹	Priority ²
Livestock (Cattle, Sheep, Goats)	Increased runoff from overgrazing of upland areas	1. Direct or indirect bacterial loading; 2. Loss of natural pollutant mitigation	1	
	Manure transported to water body by runoff			
	Direct manure deposition in water body			
	Riparian buffer degradation/trampling			
OSSFs	Straightpipes" and other illegal wastewater discharges	1. Direct or indirect loading of untreated wastewater (bacteria, nutrients); 2. Groundwater quality degradation	2	
	Improperly treated aerobic effluent applied to land			
	Failure due to age, design, or lack of maintenance			
Pets (Dogs and Cats)	Improper disposal of pet waste	1. Indirect bacterial loading from yards, parks, and pet facilities; 2. Spread of disease	3	
	Disease transmission and public safety			
	Lack of education on impacts of proper disposal			
Wildlife	Manure transported to water body by runoff	1. Direct or indirect bacterial loading; 2. Loss of natural pollutant mitigation	4	
	Direct manure deposition in water body			
	Riparian buffer degradation/trampling			
Feral Hogs	Manure transported to water body by runoff	1. Direct or indirect bacterial loading; 2. Loss of natural pollutant mitigation; 3. Loss of biodiversity	*	
	Direct manure deposition in water body			
	Displacement/predation of native species			
	Riparian buffer degradation/trampling			
WWTF	Failure due to age, stormwater inflow and infiltration, or lack of maintenance	1. Direct or indirect loading of untreated wastewater (bacteria, nutrients)	*	
	Overloads from population growth or illicit connections			
Yard Waste and Residue	Improper disposal of yard waste/clippings	1. Direct or indirect bacterial, nutrient, and hazardous chemical loading; 2. Impacts to aquatic wildlife	-	
	Excessive fertilizer, herbicide, or pesticide application			
SSOs	Failure due to age, stormwater inflow and infiltration, erosion, or construction damage	1. Direct or indirect bacterial loading; 2. Human health hazards	-	
Illegal Dumping	Household/construction waste disposal in/near water body	1. Direct or indirect bacterial, nutrient, and hazardous chemical loading; 2. Human health hazards; 3. Flow obstruction/alteration	-	
	Animal carcass/hunting remains disposal in/near water body			
	Disposal of large items (furniture, appliances, tires, vehicles)			
Sediment and Flooding	Sediment loading and increased flooding in developing areas	1. Impact to aquatic life; 2. Impact to water supply capacity and flood capacity in EML; 3. Direct or indirect bacteria and nutrient loading from runoff/erosion events; 4. Human health and safety hazard; 5. Infrastructure damage	-	
	Loss of natural areas/green spaces			

Poll: Pollutant Source Prioritization

- ▶ Link is in the chat or scan the QR code
- ▶ Take about 3-5 minutes to rank pollutant sources to focus on
 - ▶ Feel free to ask questions
 - ▶ We will discuss afterward
- ▶ Link will be sent out in a meeting recap for all EM MailChimp subscribers (that includes you if you're here) to garner more input
 - ▶ Final ranking from all voters will be discussed and finalized at the next meeting

EML WPP Pollutant Sources Stakeholder Rankings



EM WPP - What's up next

- ▶ Next up:
 - ▶ Chapter 6: Management Strategies for Load Reductions
 - ▶ BMPs by pollutant source
 - ▶ Chapter 7: Plan Implementation
 - ▶ Schedule, estimated costs, financial and technical assistance, education and outreach
 - ▶ Chapter 8: Measuring Success
 - ▶ Monitoring, progress indicators
- ▶ Hoping to hold another meeting in August
 - ▶ Will frame out 6-8, but these will need some substantive stakeholder input on priorities and feasibility - will likely take multiple meetings to flesh this out and continue to refine WPP

Land Use Type: Agricultural and Rural		
Problem:	Overgrazing, invasive species, and soil amendments that result in landscape and riparian erosion which increases sediment and	
Goal:	Management Measure	Responsible Party
Objectives:	Strategically apply practices in nutrient runoff across landscape	
Objectives:	AVOID soil and nutrient loss and amendments, and increase	
Location:	Management Measure	
Critical Areas:	General Watershed Awareness	
Priority Rang	Multimedia information campaign	
Practice	Texas Watershed Stewards Program	
Prescribed Gra (Avoid)	Texas Riparian Workshop	
Nutrient Mana (Avoid)	Public School Education Program	
Brush Manager (Avoid & Cont)	Nonpoint Source Pollution Educational Program	
Critical Area Planting (Control & Tra)	Community Outreach Events – Display/handouts	
Upland Wildlif Habitat Manag (Control & Tra)	Community Stream Cleanups	
Range Planting (Trap)	Installation of BMPs for educational purposes	
Application P	Watershed Signage	
Effectiveness:	Education Coordinator/Watershed Coordinator	
Certainty:	Agricultural Programs	
Needs:	Producer educational workshops – Nutrient Management, Crop Management, Grazing Management, Riparian Management	
	Soil Testing Campaign	
	Producer Education – Ag BMPs and SWCD/NRCS Technical Assistance	
	BMP demonstration sites	
	Urban Programs	
	Workshops and information for municipalities on storm water management, urban landscape management, soil testing, low impact development	
	Program to promote neighborhood association recognition for environmentally friendly landscaping	
	Water Wise™ lawn care training	Residents, landscapers
	Education & outreach - direct marketing	Cities, counties, regional
	Education & outreach - general	entities

Management Measures ⁽¹⁾		Anticipated E. coli Load Reduction	Other Management Goals
Pet Waste			
Pet waste disposal ordinances	Units Implemented (by year)	Total Cost	Funding Source
Supplemental pet waste stations	1 2 3 4 5 6 7 8 9 10		
Bioswale/rain garden projects	N/A	N/A	L, F3
Backyard pet waste digesters	As early as feasible		
Lawn Residue and Waste			
Illicit discharge surveys	Responsible Party	Total Cost	1-3 4-6 7-9 10-12 13-15
Lawn waste management ordinances			1.86E+01 Ton/yr
Permeable paver sidewalks/driveways, rain barrels, low-water plantings, bioswale/rain garden projects, bio retention ponds	TRWD/Texas A&M AgriLife	\$1,756,250	3 3 3 3 3
Livestock			
Wetlands and CPs	Texas A&M AgriLife Extension	N/A ¹	1 1 1.08E+15 MPN/yr 1
OSSFs			
Incentivized OSSF inspections/pumpouts	Texas A&M AgriLife	\$150,000	3 3 3 3 3
HOA/NA-coordinated OSSF cleanup events	TRWD/Texas A&M AgriLife	\$ 3,000	3 3 3 3 3
Practice-focused OSSF training	TRWD	\$ 75,000	3 3 3 3 3
Septic-to-sewer initiatives	TRWD/Texas A&M AgriLife	\$ 25,000	1 1 1 1 1
OSSF inspection ordinances for property transfers			
Illegal Dumping and Litter Accumulation			
Illegal dumping surveys	TRWD/Texas A&M AgriLife	\$1,425,000 ²	3 3 3 3 3
Rural home hazardous waste pickup/dropoff days			-
JPL cleanup events	Texas A&M AgriLife	\$ 2,500	4 4 4 4 4
SSOs			
Support for interdepartmental reporting network for SSO locations	Texas A&M AgriLife	\$ 67,000	3 3 3 3 3
Stormwater infrastructure assessments	Texas A&M AgriLife	\$ 3,500	1 1 1 1 1
Permeable paver parking lots			
Sediment and Flooding			
Riparian, wetland and/or stream restoration projects	Texas A&M AgriLife	\$ 90,000	4 4 4 -4 4
Stormwater infrastructure assessments			
Identify and install green infrastructure			
Feral Hogs			
Trap and release program	TRWD/Texas A&M AgriLife	\$ 12,000	3 3 3 3 3
Establish regional feral hog resource and support network			
Feral hog removal and/or exclusion from attractive nuisances		\$3,500	1 1 1 1 1
Riparian buffer assessment/extension		\$153,000	1 1 1 1 1
		\$17,000	1 1 1 1 1
Total Anticipated E. coli Load Reductions			3.40E+15 MPN/yr
Anticipated Nutrient Load Reductions			1.86E+01 Ton/yr

USDA. NRCS. (2015) Field Office Technical Guide: Conservation Practices
 USDA. NRCS. (2017) Conservation Practice Physical Effects on Soil, Water, Air, Plants, Animals, Energy, People; National Summary Tool

(1) Note that all management measures categories include education and outreach components.

Contact Info

- ▶ Katie Myers, Rural Programs Coordinator
 - ▶ Katie.myers@trwd.com
- ▶ General watershed inquiries: watersheds@trwd.com
- ▶ Our website: <https://www.trwd.com/watersheds/>

Eagle Mountain Lake Watershed Protection Plan Stakeholder Meeting #2

July 9, 2025

10 a.m. – 12 p.m.

Virtual via Microsoft Teams

Tarrant Regional Water District (TRWD) and Watershed Protection Planning Overview

Katie Myers with TRWD described TRWD’s role in watershed protection planning and the planning process. She noted that water quality is managed based on different designed uses for water bodies. Katie Myers said the Eagle Mountain Lake Watershed Protection Plan (WPP) is in Phase I: Watershed Characterization and Planning. This includes public education, data collection, data analysis and modeling, and stakeholder meetings. She described water quality issues in the reservoir and its tributaries, and the roles different land uses play in water quality.

Watershed Modeling Overview

Aaron Hoff with TRWD described how models are used in WPPs to identify pollutant loads both pre- and post-implementation. He said the US Geological Survey developed its LOADEST tool to estimate pollutant loads. The tool requires paired data points measuring pollutant concentration and observed streamflow at the same time pollutant concentration was measured. He said this data is then visualized with Load Duration Curves (LDCs). LDCs allow TRWD to compare data from different stations or within one station – such as whether pollutant loads are above or below allowable levels or whether the loads vary based on streamflow.

Aaron described the difference between point source and non-point source pollution. He explained the data inputs used by the Soil and Water Assessment Tool (SWAT) and the outputs from the tool that characterize pollutant sources.

Aaron described the Spatially Explicit Load Enrichment Calculation Tool (SELECT), which determines potential bacterial loads in subwatersheds based on spatial land use data and population data. He explained that SELECT provides a “worst-case scenario” that typically overestimates potential bacterial loads.

Eagle Mountain Lake Watershed Modeling for Loads and Load Reductions

Katie Mendoza with Texas A&M AgriLife Research described the modeling work AgriLife completed for nutrients and *E. coli*. She provided more detail on the SWAT and SELECT

tools. She stepped stakeholders through LDCs, showing how gages on the West Fork of the Trinity River demonstrate that the allowable loads for nitrogen oxides and total phosphorus were not exceeded. She showed how LDCs demonstrate that nitrogen oxides allowable loads were exceeded in Ash Creek during moist to low flow conditions.

Stakeholders asked about numbers used that were associated with prescribed grazing. Katie Mendoza responded that numbers of cattle/acre were determined with input from Natural Resources Conservation Service staff.

Michelle Wood-Ramirez with TRWD asked whether development could have caused elevated levels of *E. coli* in Ash Creek. Katie Mendoza said *E. coli* is elevated throughout the LDC, suggesting that a point source may contribute much of the *E. coli* loading. Aaron suggested other urbanization impacts could affect *E. coli*, such as sanitary sewer overflows, effluent from air conditioning systems, etc.

Katie Mendoza described the results for modeling of strategies to reduce nutrient loads in the Eagle Mountain Lake watershed. She also discussed how the SELECT tool develops potential daily *E. coli* loads from different bacteria sources, such as pets, livestock, and on-site sewage facilities (OSSFs) or septic systems. She noted that modeling can also estimate the success of different management strategies in reducing *E. coli*.

Katie Mendoza said the management strategy of reducing stocking rates was a stand-in for other management practices, such as prescribed grazing, that would provide a benefit equivalent to reducing the stocking rate. Similarly, the pet waste management strategy does not call for a reduction in the number of pets, but instead an increase in removal of pet waste leading to a reduction of pet waste that could affect water quality.

Stakeholders noted that pasture has been converted to development with streets and lawns, affecting stormwater runoff. They noted that thousands of homes have been built, and asked what TRWD can do to enforce that cities and developers utilize the *integrated* Stormwater Management (*iSWM*[™]) program developed by the North Central Texas Council of Governments. Katie Myers said *iSWM*[™] is a voluntary program, and TRWD has no regulatory teeth to require cities or developers to adopt the program.

Stakeholders circled back to the stocking rate management strategy, pointing out that stocking rate is not equal to grazing practices. Katie Mendoza said models cannot describe every grazing practice, so the stocking rate is used as a proxy.

Guided Review of Eagle Mountain Lake Watershed Protection Plan (WPP) Chapters

Katie Myers sought input on Chapters 3-5, which stakeholders had been provided ahead of time. She asked stakeholders about readability, content, and visuals. Content included

pollutant sources, associated management practices, and potential impacts of the pollutant sources (such as groundwater quality degradation caused by OSSFs). The different sources were ranked by the SELECT results based on the sources' impact on the watershed. Livestock were ranked first, OSSFs second, pets third, and wildlife fourth.

Stakeholders were asked to provide input on their own priorities for addressing the pollutant sources. A QR code was provided for stakeholders, and 10 stakeholders responded. Results are provided in Attachment 1. Stakeholders provided additional comments via the online survey:

“Based on the ECHO results for WWTF in EML and incoming package plants in the DFW region WWTF should definitely be ranked higher than how we ranked it in JPL/VCLA - we can talk more about it later.”

“Urbanization and over applying lawn fertilizer is a big problem with continued land development. Concrete and large parking lots with oil and other pollutants is also an issue which ties back to urbanization.”

“Management practices in livestock management requires education and most people try do their best.”

“Depends if we're looking at urban, suburban, exurban, rural acreage/not subdivided excessively.”

Wrap Up and Adjourn

Katie Myers adjourned the meeting.

Survey Results from Eagle Mountain Lake WPP Stakeholder Meeting #2

Number of Respondents who Ranked Source as:	Livestock	OSSFs	Pets	Wildlife	Feral Hogs	Wastewater Treatment Facilities	Yard Waste and Residue	Sanitary Sewer Overflows	Illegal Waste Dumping	Sediment and Flooding
Low	0	0	3	7	5	1	2	1	1	0
Medium	4	2	6	3	3	3	4	0	1	5
High	6	8	1	0	2	6	4	9	8	5



Eagle Mountain Lake Watershed Protection Plan Stakeholder Meeting



Katie Myers, TRWD, Rural Programs Supervisor
Aaron Hoff, TRWD, Watershed Programs Manager
Katie Mendoza, Texas A&M AgriLife Research,
Research Specialist III

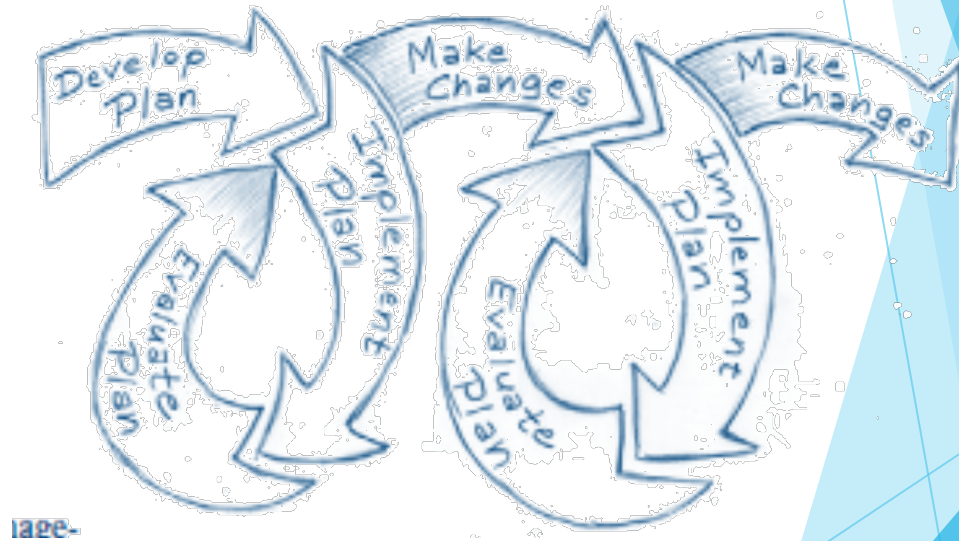
What is a WPP?

Watershed Protection Plan: A strategy that provides assessment and management information for a defined watershed.

- ▶ Clean Water Act §319 → EPA Framework
 - ▶ TCEQ Integrated Report (303(d) List)
- ▶ Stakeholder involvement
- ▶ Actions supported by sound science
- ▶ Technical expertise from diverse sources
- ▶ Diverse skills & knowledge
- ▶ Focus on water quality goal



1. Build partnerships
2. Characterize your watershed
3. Establish goals & identify solutions
4. Develop an implementation program
5. Implement your plan
6. Measure progress & make adjustments





WPP Process Overview

We are here



Phase I: Watershed Characterization & Planning			Phase II: Implementation	
Public Education	Writing WPP Document	Informal Review <ul style="list-style-type: none">• NRCS/ SWCD• Partners (you!)	Agency Approval Process	Federal Grant Funds Available for Project Submittals
Data Collection	Review Watershed Modeling	Formal Agency Review <ol style="list-style-type: none">1) Send draft to state agencies2) Respond to agency comments3) 45-day Public Comment Period4) Respond to comments5) Re-submit to state agencies		
Data Analysis and Modeling				
Stakeholder Meetings <ul style="list-style-type: none">• Priority Selection• Recommendations for WPP				



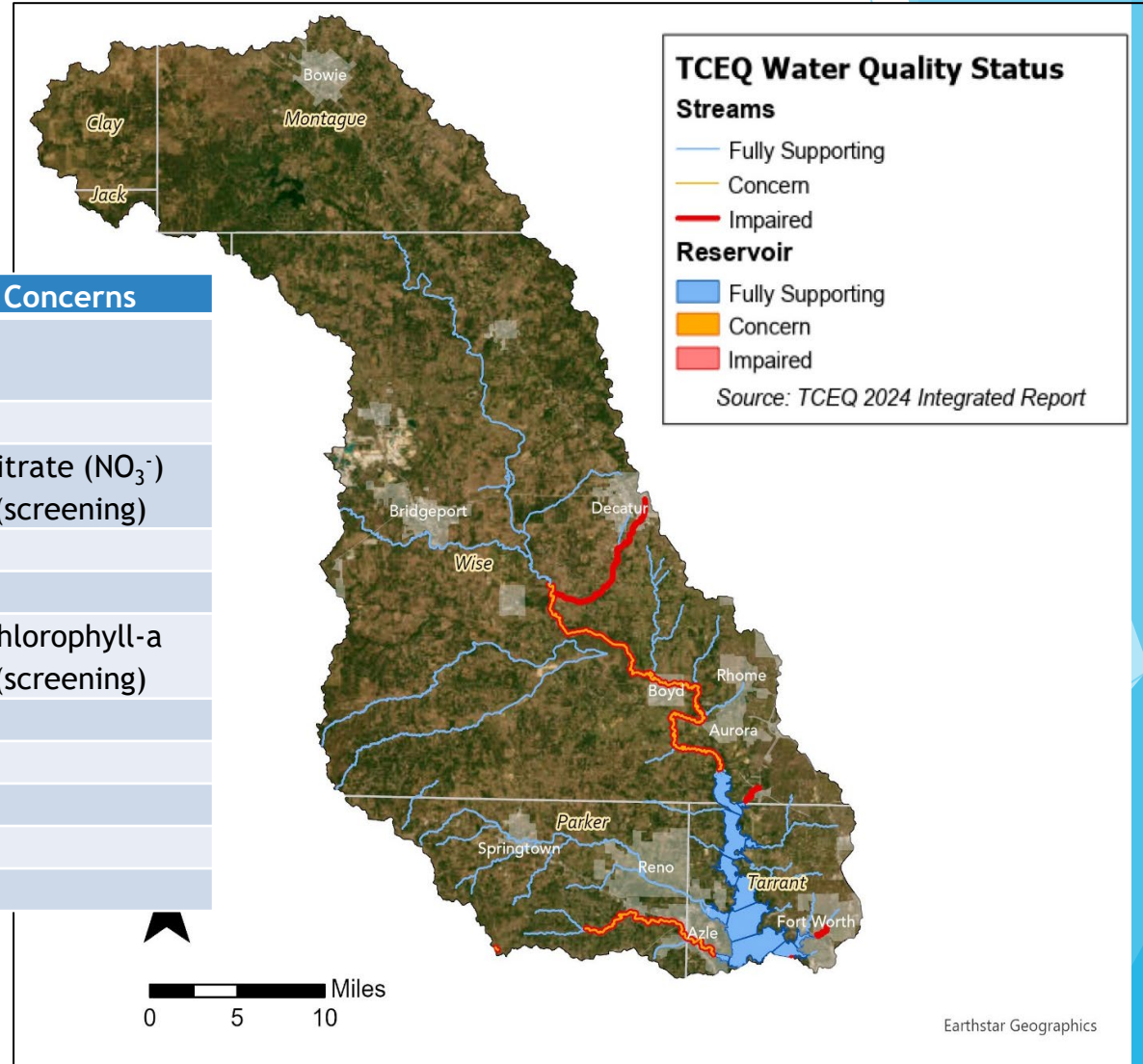
EML WPP Updates

- ▶ Table 4-1 filled in with stakeholder input
- ▶ Minor narrative changes
- ▶ SELECT map updates in Ch 4 and 5
- ▶ Additional paired USGS gauge and SWQM station evaluated (included in Appendix B)
- ▶ Additional charts/graphics created to communicate load reductions
- ▶ Chapter 6 written



Water Quality Issues

Name	Segment(s)	Impairments	Concerns
Eagle Mountain Lake	0809_01 - 0809_14		
Walnut Creek	0809A		
Ash Creek	0809B	Bacteria (E. coli)	Nitrate (NO ₃ ⁻) (screening)
Dosier Creek	0809C	Bacteria (E. coli)	
Derrett Creek	0809D	Bacteria (E. coli)	
West Fork Trinity River Below Lake	0810_01	Bacteria (E. coli)	Chlorophyll-a (screening)
Bridgeport	0810_02		
Big Sandy Creek	0810A		
Garrett Creek	0810B		
Martin Branch	0810C	Bacteria (E. coli)	
Salt Creek	0810D		



Chapter 6 Overview and Goals



- ▶ Sets overarching load reduction goals and provides a menu of practical actions that could be combined to achieve those goals
- ▶ “Fact sheets” by pollutant format is a trick that has been useful to agency reviewers
- ▶ Input you give today will help us fill in the missing load reduction numbers
- ▶ Specifics in menu of suggested management actions are also up for discussion
- ▶ Implementation plans - timeline and financial/technical assistance needs will be fleshed out in Ch 7-8
- ▶ **Suggestion: have document and survey open during the meeting**

Pollutant Source: Pet Waste	
Concerns	(1) Improper disposal of pet waste, (2) lack of education on impacts and proper disposal, (3) disease transmission and public safety
Potential Impacts	(1) Indirect <i>E. coli</i> loading to waterbody from yards, public greenspaces, kennels, and shelters, (2) spread of disease amongst/between species
Critical Areas	(1) Subwatersheds adjacent to the lake, (2) urbanized areas
Goal	Reduce the <i>E. coli</i> load from pet waste delivered to waterbodies through management of <i>E. coli</i> loads representing 50% of the present pet population.
Objectives	(1) Increase education and outreach efforts pertaining to proper disposal of pet waste, (2) Provide opportunities for proper waste disposal/abatement
Recommendations	
Focal Groups	Management Practices
Cities, counties, NCTCOG, regional entities	Expand delivery of existing pet waste education resources, develop/implement new educational resources (e.g., utility bill inserts, websites, info pamphlets, videos, signage in public greenspaces/trails)
Cities, counties, HOAs, NAs	(1) Development and adoption of model pet waste pickup/disposal ordinances for municipalities and bylaws for HOAs/NAs (2) Reconnaissance of critical areas for pet waste station placement in municipal or community greenspaces (3) Install ### new pet waste stations and fund supplies (collection bags, wastebin bags) for ## years (4) Install bioswales/rain gardens in parks for onsite treatment of pet waste in stormwater/irrigation runoff can add in target # sites if it's a stakeholder priority
Estimated Load Reductions	
BMPs recommended for pet waste seek to a) confine the waste to a landfill, or b) treat waste on-site in the ground. In doing so, the amount of <i>E. coli</i> from pet waste sources entering waterways via runoff from rainfall or irrigation will be reduced. It is reasonable to assume that some pet waste management is already occurring in the watershed, as many people do pick up after their pets. Therefore, and overall reduction goal of 50% of the potential load from a baseline with no management is reasonable. Similarly, it is expected that the recommendations will likely only capture loads from only 50% of the present pet population. This results in a reasonable estimate of the total annual pet waste reduction of ### MPN/yr for the managed pet population.	
Effectiveness	With denser population centers in the southern areas of the watershed, pet populations are estimated to be similarly dense. Treatment in this case is by direct removal of the pollutant source and internment elsewhere, exhibiting a high removal efficiency. Therefore, noticeable reductions are likely even by managing a limited population.
Certainty	Improving opportunities for proper pet waste disposal for those aware of the contamination concern will provide most of the reductions. It is assumed that those who have other reasons for not properly disposing of waste will be difficult to convince to modify their behavior.
Commitment	Many green spaces already have some level of pet waste stations on-site. Signage for ordinances/by-laws are less visible, and enforcement thereof is limited or non-existent.
Needs	Funds for increasing the number and continued maintenance of pet waste stations, enactment of pet waste disposal ordinances/by-laws or enforcement of those existing.

Chapter 6 Overview and Goals



▶ Meeting Documents

▶ Input form



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 - 6.1 Meeting Water Quality Goals
 - 6.2 The Watershed Approach to Water Quality Goals
 - 6.3 Animal Sources
 - 6.3.1 Livestock
 - 6.3.2 Pet Waste
 - 6.3.3 Wildlife
 - 6.3.4 Feral Hogs
 - 6.4 Wastewater
 - 6.4.1 On-Site

6.0 Management Strategies and Associated Load Reductions

6.1 Meeting Water Quality Goals

The primary water quality reduction goals for the watershed, as defined in Section 5.2, are specifically for *E. coli* loads. To meet this challenge, load reduction goals will refer to the Primary Contact Recreation 1 water quality standard for *E. coli* of 126 MPN/100 mL, which is measured as a concentration rather than a load. With a 10% MOS, the water quality target for the waterbodies of interest will effectively be 113 MPN/100 mL for calculating the *E. coli* loads.

Also of interest is nutrient loads, as some nitrate and chlorophyll-*a* concerns exist in the watershed. This is not a focal point for this WPP, but it is a parameter to keep an eye on for future updates to the WPP. Sediment loads are also a strong consideration for TRWD's water supply goals, but are not used as a load reduction metric for the regulatory purposes of this WPP. Loads of all pollutants of concern are expected to fluctuate throughout the life of the WPP, with BMP implementation at times offset by LULC changes.

Typically, one index site is chosen for establishing water quality goals in a WPP. The index site for this WPP is station 10969 because it accounts for a majority of the watershed area flowing into the lake via the West Fork Trinity River and Big Sandy Creek. Stakeholders agreed with the suggestion to utilize the mid-range conditions flow regime as the basis for calculating the load reductions needed to reach the water quality goal. An annual watershed wide reduction during mid-range flow conditions of *E. coli* is 1.12E+12 MPN/yr is needed to achieve water quality goals. **With a reduction of around 80% needed to achieve this goal, stakeholders may opt to set an interim goal for the purposes of this WPP.**

Nutrient and sediment reductions are inherently tied to management recommendations for *E. coli*, since many bacteria BMPs, (specifically those for water retention/detention and treatment) are also expected to curb both nutrient and sediment loads as well.

6.2 The Watershed Approach to Water Quality Goals

Stakeholders understand that focusing efforts on a single source will likely result in diminishing returns in the form of

EML Chapter 6 Load Reductions Feedback Form

Section 1

Load Reduction Charts Review

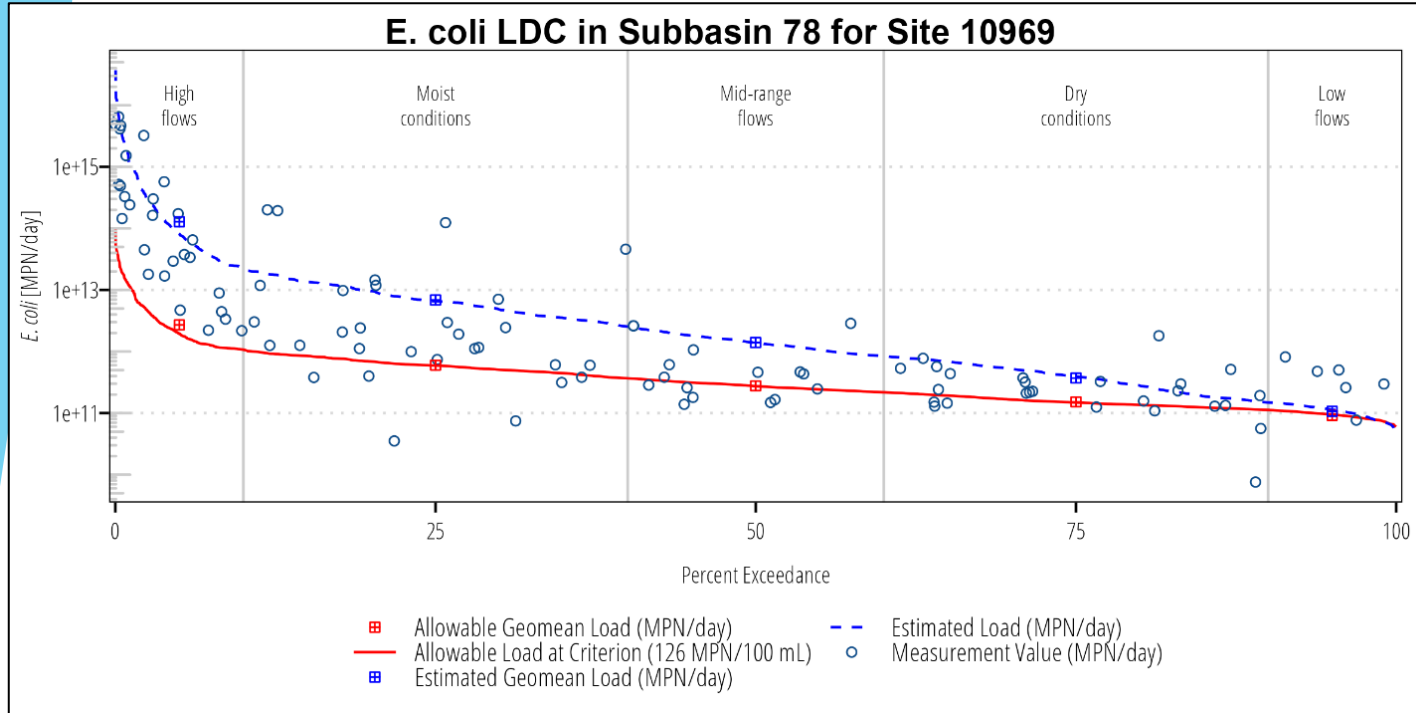
We'll go through this section together with the powerpoint to set some numerical load reduction goals.

1. Cattle stocking rate changes and grazing management (6.3.1)

- 25%
- 50%



Pollutant Loads: *E. coli*

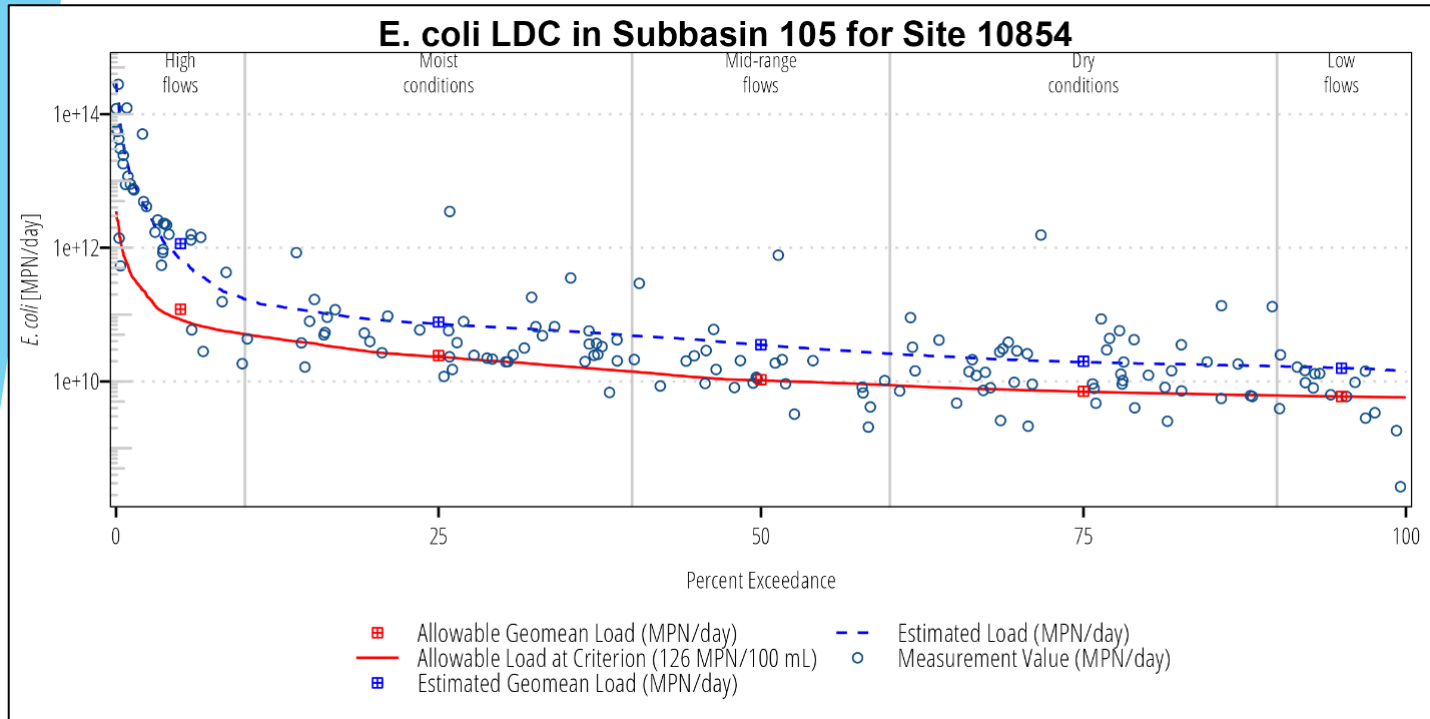


- ▶ LDCs were created for 4 sites in the watershed (two on West Fork, Walnut Creek, and Ash Creek)
- ▶ Due to its position in the watershed and data quality, 10969 will be the index site for achieving water quality goals
- ▶ It is customary to target reductions to the mid-range flows

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	1,723,680	0-10	2.71E+12	1.28E+14	1.26E+14	97.9
Moist Conditions	522,374	10-40	6E+11	6.88E+12	6.28E+12	91.3
Mid-range Conditions	241,402	40-60	2.77E+11	1.4E+12	1.12E+12	80.2
Dry Conditions	131,242	60-90	1.52E+11	3.71E+11	2.19E+11	59.0
Lowest Flows	84,033	90-100	9.17E+10	1.07E+11	1.53E+10	14.3



Pollutant Loads: *E. coli*



▶ 10854 (Ash Creek) will not be used for load reduction measurement purposes, but does present an interesting scenario that suggests a point source loading problem

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (MPN/day)	Estimated Geomean Loading (MPN/day)	Reduction Needed (MPN/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	1.2E+11	1.15E+12	1.03E+12	89.5
Moist Conditions	20,485	10-40	2.43E+10	7.75E+10	5.31E+10	68.6
Mid-range Conditions	9,150	40-60	1.06E+10	3.54E+10	2.48E+10	70.1
Dry Conditions	6,178	60-90	7.12E+09	2E+10	1.29E+10	64.4
Lowest Flows	5,238	90-100	5.94E+09	1.58E+10	9.82E+09	62.3

Setting Load Reduction Goals



Pet Reduction			E.coli Reduction			
	Dog	Cat	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
50%	0.307	0.1228	16786.8E+9	19572.7E+9	4467.469E+9	43321.49E+9
80%	0.2285	0.0914	26858.9E+9	31316.4E+9	7147.951E+9	69314.39E+9

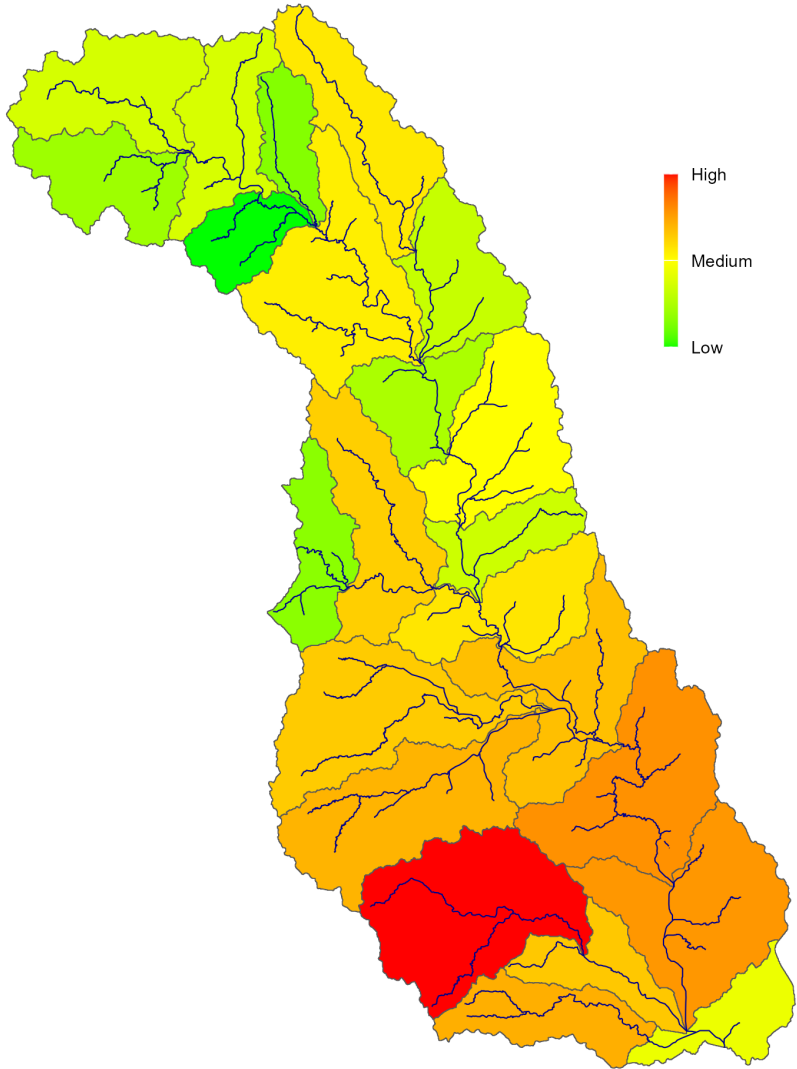
Pet Reduction			E.coli Reduction			
	Dog	Cat	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
50%	0.307	0.1228	6.7%	6.8%	15.2%	9.5%
80%	0.2285	0.0914	10.7%	10.9%	24.2%	15.2%

- ▶ NOTE: We can set an interim goal based on *realistic options*
 - ▶ Hint: realistic options are not going to achieve the absolute nor the relative reduction goals
- ▶ NOTE #2: Other successful area WPPs have used absolute numbers when setting reduction goals and potential BMP reductions, so I plan to include these in the WPP
 - ▶ (but for the presentation, we are looking at %s because they are much easier to understand)

Pollutant Loads: *E. Coli*

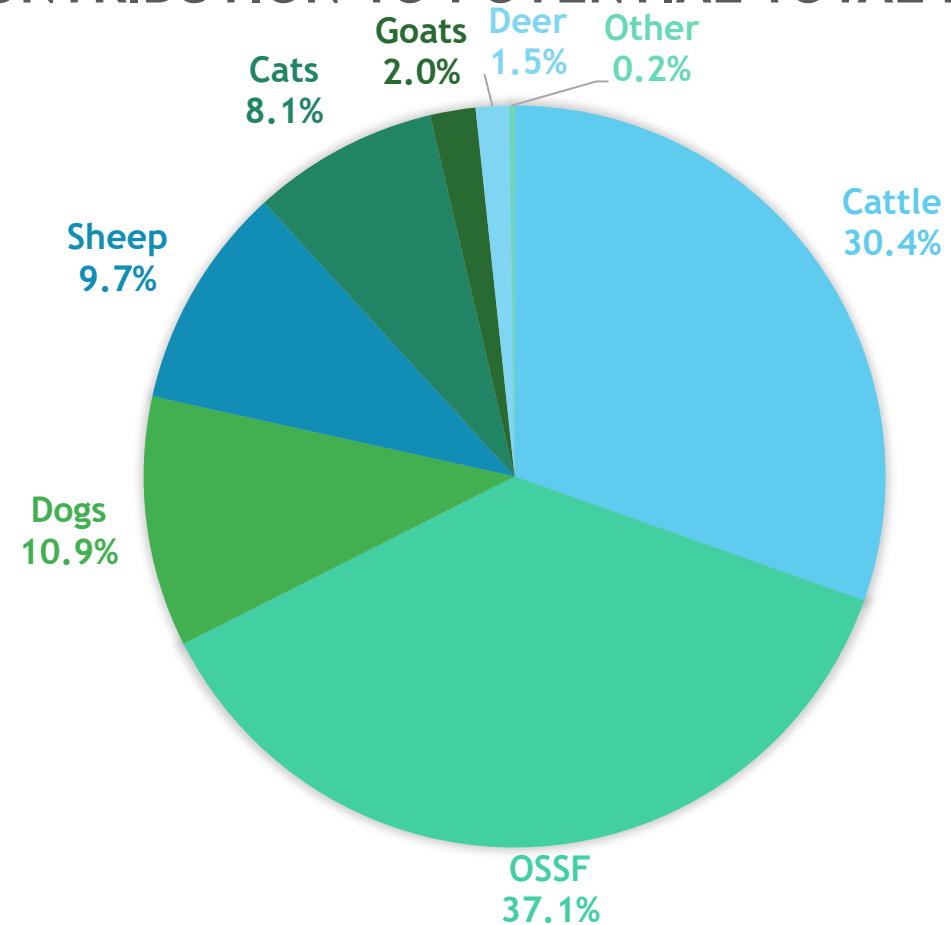


Total Potential E.coli Loading From All Sources



- ▶ According to SELECT analysis, highest probable E. coli loads are combined livestock and OSSFs

CONTRIBUTION TO POTENTIAL TOTAL LOAD



E. Coli Load Reductions: Cattle



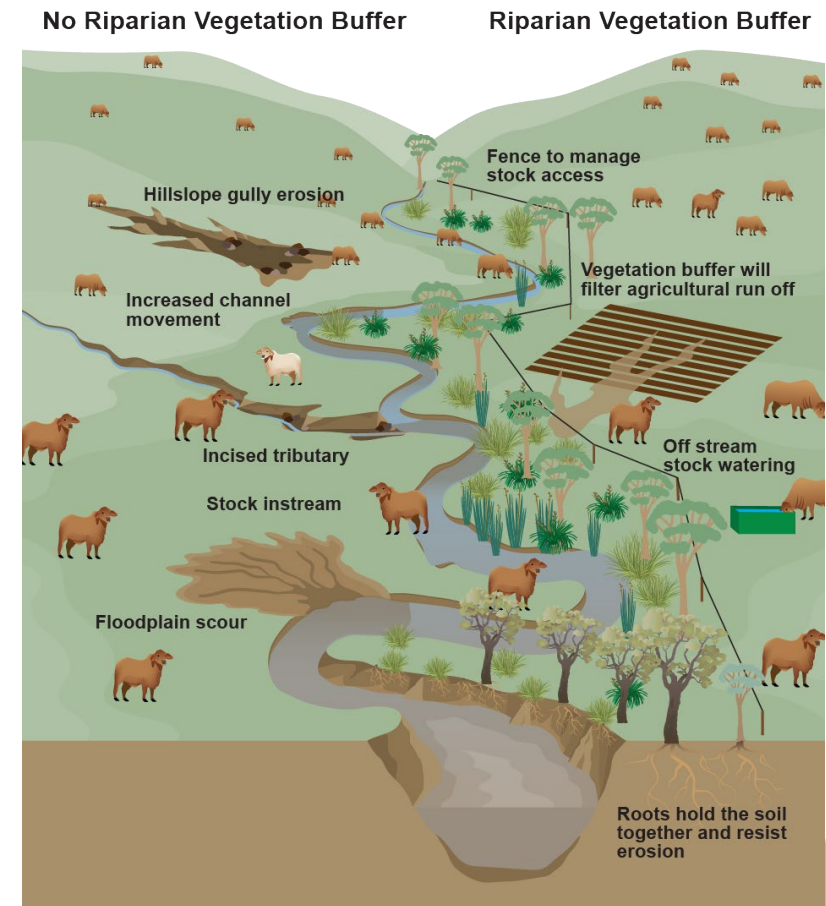
Average Stocking Rate		E.coli Reduction			
	Acre/Head	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
Baseline	7.4				
25%	9.9	10.7%	10.2%	2.6%	7.6%
50%	14.9	21.4%	20.3%	5.1%	15.2%
75%	29.7	32.1%	30.5%	7.7%	22.8%

Current stocking rate - estimated with NRCS data and advice - is significantly higher than NRCS suggests for the area

Some reduction can be achieved by keeping cattle outside of riparian areas (90% contribution of deposited *E. coli* reaching water body vs. 50% for upland)

- ▶ Exclusionary fencing, alternate watering and cover areas can substitute for some stocking reduction
- ▶ Other range and riparian buffer health practices can also help arrest *E. coli* before it reaches waterways

▶ Discussion (Q1-2, 6.3.1)



[Riparian fencing to control stock/feral animal access \(Department of the Environment, Tourism, Science and Innovation\)](#)

E. Coli Load Reductions: Pets



Pet Reduction			E.coli Reduction			
	Dog	Cat	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
50%	0.307	0.1228	6.7%	6.8%	15.2%	9.5%
80%	0.2285	0.0914	10.7%	10.9%	24.2%	15.2%

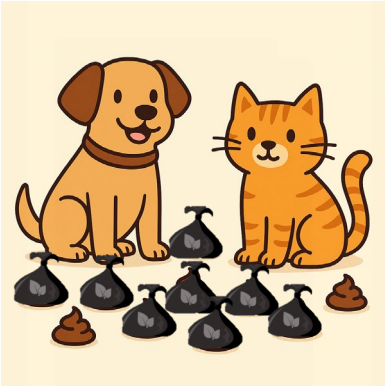
Base line



50% Reduction



80% Reduction



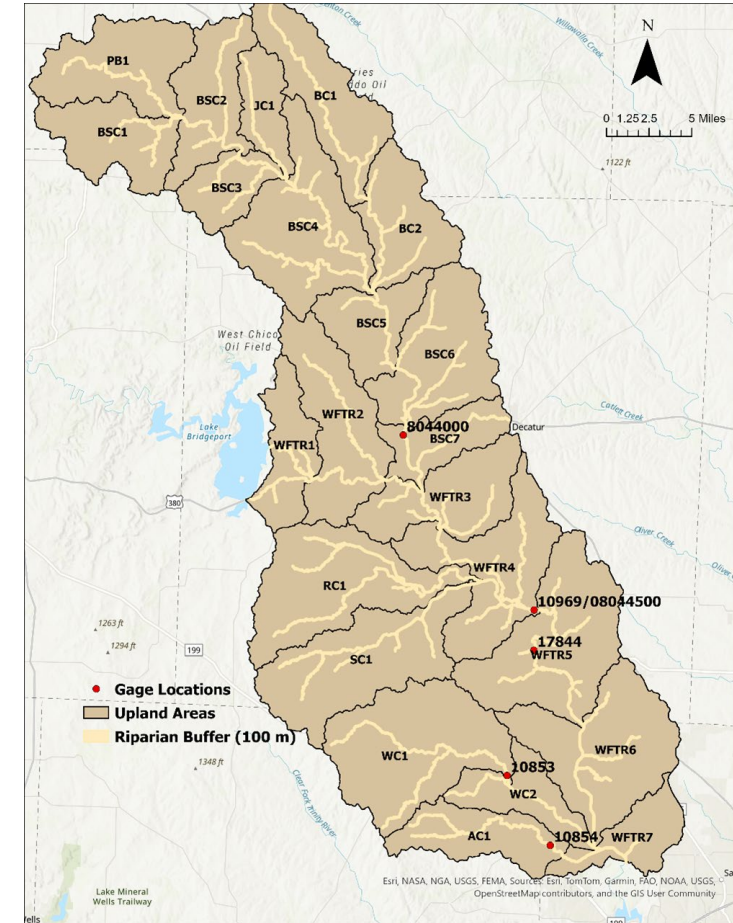
- ▶ SELECT is based on fecal coliform production per animal - this is not assuming any existing management
 - ▶ Many people likely already pick up after pets, so we can aim for a higher % reduction from baseline here
- ▶ “Pet reduction” = unmanaged pet waste reduction
- ▶ Achieved in public spaces through signage and waste station - relatively low cost for high yield
- ▶ Achieved at home through social marketing - low cost, but potentially less effective
- ▶ Discussion (Q3-4, 6.3.2)

E. Coli Load Reductions: OSSF

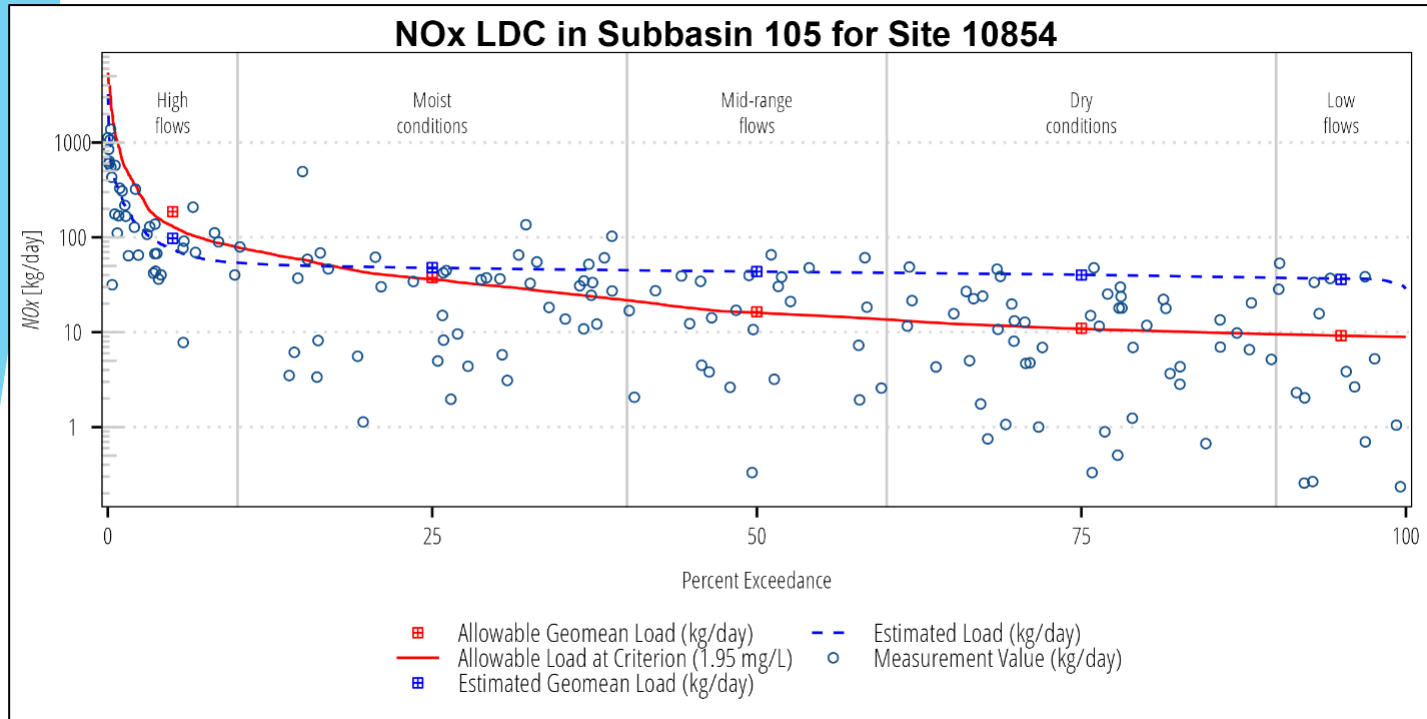


OSSF Failure Rate Reduction	E.coli Reduction			
	WF Trinity River Near Boyd	WF Trinity River Near Bobo	Ash Creek	Watershed
5%	9.3%	10.1%	17.0%	12.4%
10%	18.5%	20.2%	34.0%	24.8%

- ▶ Recall that SELECT is a “worst-case scenario”
- ▶ Most available OSSF data was not geographically explicit → all OSSFs assumed in tool to contribute the same whether upland or riparian
- ▶ Based on multiple datasets and estimation methods, this watershed could have ballpark 27,000 OSSFs with an assumed failure rate of 15% (4,050 failing units)
 - ▶ Eliminate failure in 10% (405) or 5% (203), preferably targeted at riparian areas
- ▶ Failure rate reduced through education (resources, workshops) and subsidized inspection and pumpout
- ▶ Discussion (Q5-6, 6.4.1)



Pollutant Loads: Nutrients



- ▶ Nutrients will not be considered for regulatory purposes, but TRWD and stakeholders have expressed concern with nutrient-related issues
- ▶ Ash Creek does have nitrate concern listed in the Integrated Report

Flow Condition	Median Flow (m ³ /day)	% of Time Flow Exceeds	Allowable Geomean Loading (kg/day)	Estimated Geomean Loading (kg/day)	Reduction Needed (kg/day)	% Daily Load Reduction Needed
Highest Flows	74,451	0-10	186.4	97.6	0.0	0.0
Moist Conditions	20,485	10-40	37.7	48.0	10.4	21.6
Mid-range Conditions	9,150	40-60	16.4	43.6	27.2	62.3
Dry Conditions	6,178	60-90	11.0	40.1	29.1	72.5
Lowest Flows	5,238	90-100	9.2	36.1	26.9	74.5

Nutrient and Sediment Load Reductions

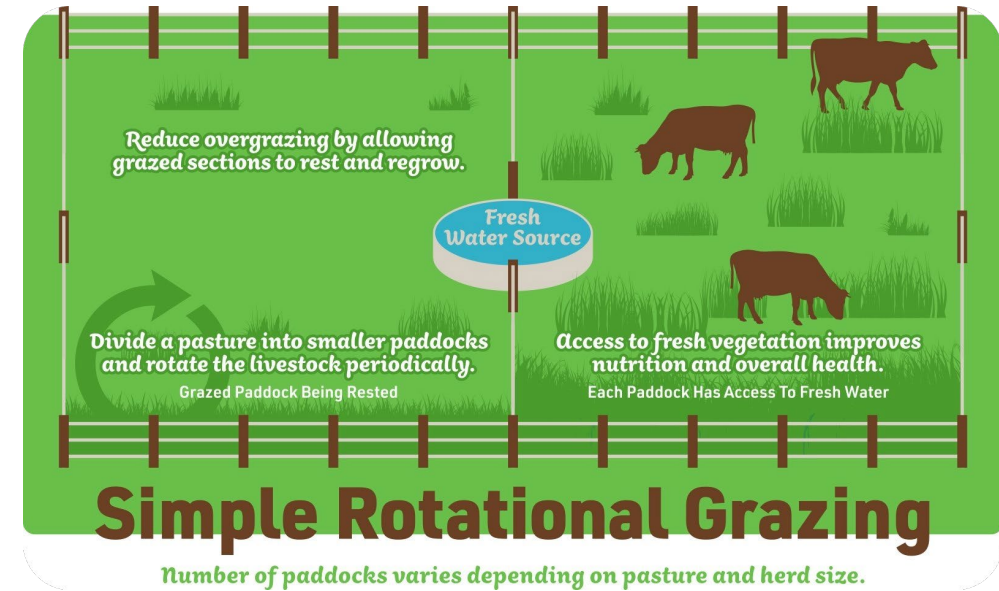


Cattle Stocking Rate

% Modification	Stocking Rate (acres/head)	NO ₃ % Change	TP % Change	SYLD % Change
15%	8.7	-5.54%	-12.49%	-0.84%
25%	9.9	-8.91%	-20.71%	-1.76%
40%	12.4	-13.56%	-32.98%	-4.04%

Cover Crops

Increase	Area (acres)	NO ₃ % Change	TP % Change	SYLD % Change
15%	2,996	3.63%	-20.64%	-55.39%
25%	3,281	5.23%	-27.95%	-71.10%
40%	3,680	7.29%	-35.57%	-74.49%



- ▶ As with *E. coli* reductions, effective stocking rate reductions can be achieved partly through grazing management measures (again, the tool will only manipulate raw #s)
- ▶ Important note on cover crops is saturation level - the more we implement, the fewer producers are left to achieve the next level on increased practice
- ▶ Discussion (Q7-8, 6.5)

Chapter 6 Document Review



▶ Meeting Documents

▶ Input form



Section 2

Load Reduction Fact Sheets/WPP Document Review

This focuses on the "fact sheets" within Chapter 6. You can provide feedback in the meeting or in this form. Suggestions regarding practices, parties of interest, or needs are all welcome. Feedback regarding highlighted text is especially needed.

9. 6.3.1 Livestock

10. 6.3.2 Pet Waste



Thank you!!

- ▶ Watershed Programs watersheds@trwd.com
- ▶ Reminder: Katie Myers is moving to Colorado (in 11 days!!) - she may continue to work on this WPP, but details are TBD

Eagle Mountain Lake Watershed Protection Plan

Stakeholder Meeting #3

August 20, 2025

10:30 a.m. – 12 p.m.

Virtual via Microsoft Teams

Tarrant Regional Water District (TRWD) and Watershed Protection Planning Overview

Katie Myers, TRWD, defined watershed protection plans (WPPs), six steps of effective watershed management, and where the Eagle Mountain Lake WPP is within the watershed planning process. She described changes TRWD has made to chapters 1-5 of the WPP based on feedback at previous stakeholder meetings. She recapped the water quality issues in the watershed, including impairments for bacteria (*E. coli*) in five tributaries to the reservoir and concerns for nitrate and chlorophyll-a in one tributary each.

Chapter 6 Guided Review

Katie told stakeholders that Chapter 6 identifies a menu of actions that can be taken to reduce pollutants in the watershed. She said actions include pollutant load reduction goals for each action, when those goals can be modeled. This information is displayed in fact sheets in Chapter 6.

She described the *E. coli* load duration curves (LDCs) that display data for four sites in the watershed. This data compares existing loads to allowable loads to identify whether exceedances are occurring. Katie explained that target reductions are typically identified for mid-range flows, because high flows (floods) are unmanageable and exceedances at these flows may indicate that point sources are the source of pollutants. WPPs are designed to manage non-point source pollution. She identified site 10969 as the index site for achieving water quality goals during WPP implementation.

Katie showed a pie chart that demonstrated that livestock and on-site sewer facilities (OSSFs) or septic systems created the greatest *E. coli* loads, based on modeling analysis.

Stakeholders were provided a QR code to access an online survey. The survey included questions about topics to be covered during the remainder of the meeting.

Katie reviewed management strategies for cattle, including reducing the stocking rate; using fences, alternate watering sources, and covered areas to reduce the presence of cattle in streams; and other range and riparian buffer practices to reduce the amount of *E. coli* that reaches waterways.

Katie then reviewed management strategies for pet waste, which could be achieved through signage, waste stations, and social marketing.

OSSFs were addressed next. Katie reviewed management strategies to reduce the failure rate of these systems, including education and subsidized inspections and pump outs.

While *E. coli* is the water quality standard addressed by the WPP, TRWD and stakeholders also seek to reduce nutrient and sediment loads. Management strategies discussed included the cattle stocking rate, cover crops, and rotational grazing.

Seven stakeholders provided feedback on reduction goals for the management strategies. The results are provided in Attachment 1.

Stakeholders provided additional feedback including:

“It might be helpful to promote the wildlife tax valuation (1-d-1w) to landowners in the area. If they have an existing ag valuation for at least 5 years, they are eligible to transfer to the wildlife valuation. Landowners can still have cattle on their property, but they don't have to meet the same acre/head intensity requirements.”

“For reduction of high stocking rate cattle operations, information on lagoons and restored agricultural riparian buffers might be beneficial for ranchers who would prefer higher stocking rates.”

"I think the biggest opportunity is to improve land management practices and not by reducing numbers. Please only use this as a rotational practice vote. Especially since sedimentation is also a big problem, and grazing practices can also address this problem as well. I do not support removal of animals from riparian areas through exclusionary areas given sound management practices (short duration in that water source). With funding provided to non-profits for this education is a solution if NRCS does not have capacity."

“A 25% reduction in livestock also means roughly a 25% reduction in producer income, which creates a significant compliance challenge. How would stocking rate reductions be verified in practice? And what happens during drought years, when pastures may not support even the reduced numbers? A constructive alternative could be for TRWD, maybe in partnership with Texas A&M AgriLife, to sponsor one or two pilot ranches or farms in the watershed to test innovative grazing strategies, such as riparian fencing or regenerative grazing, and use those sites as peer-to-peer education hubs. Demonstration projects like these could showcase both water-quality improvements and forage benefits, helping build landowner confidence and participation. Plus, if there are programs to help them off-set costs, that could be more effective.”

“Are you partnering with NCTCOG's annual "Doo the Right Thing" campaign?”

“I agree that this is a big possibility if infrastructure (pet waste station) is present to encourage change in practice.”

“A 50% reduction goal [for pet waste] seems more achievable than 80% given the reliance on voluntary compliance. Significant reductions will require a combination of education campaigns, pet waste stations, HOA/community enforcement, and potentially local ordinances. It may be a 2nd-tier source, but disproportionately more important in places like Eagle Mountain Lake with lakefront, and recreational zones and nonpermutable surfaces.”

“If you can deduct where these [OSSF] sources are it could be managed by regulation. This will mean influencing regulators. There is a good option with half costs assistance if there are non-compliant sites that can be identified. HOA's can be a source of assistance for efficiency.”

“A 10% reduction [for OSSFs] is achievable, but it represents a significant number of failing septic systems around EML. The real challenge is identifying them, since many older systems were installed before permitting and aren't even on record. One option would be to involve local pumping services in reporting cleanout locations so cities and counties can build a more accurate database of septic systems. Residents may also be more willing to self-report failing systems if they know there are services and financial assistance available to help with repairs or replacements. Another issue worth noting, while not a dominant watershed-wide source, it happens more often than people realize; some lake users relieve themselves directly in the water. In crowded recreation areas like Party Cove, even a small number of incidents can create localized health risks for swimmers and negatively impact public perception of the lake. Addressing this doesn't require heavy enforcement (since it's not the least bit practical) but rather better facilities (e.g., floating restrooms, portable units on the Island, or shoreline facilities near Eagle Mountain Park) and clear messaging to encourage responsible behavior. Given that EML is a high-traffic recreational destination, investing in these solutions would both improve water quality and strengthen public confidence. It seems there would be some funding available through the Recreation Master Plan.”

“This [increased acreage of cover crops] is absolutely possible with education of agricultural producers. It also has financial benefit if adopted so an easy to sell move. This in conjunction with presence of animals to ‘fertilize these crops’ adds the extra bump in success. Again, non-profits are well positioned to do this work if provided with funding to do these workshops if NRCS is not able to.”

“Partnering with NRCS, local soil & water conservation districts, and extension agents to offer cost-share programs and demonstrations will help build confidence. A phased approach, starting with a 25% target, may be more realistic and provide proof-of-concept before pushing higher adoption rates. Maybe create a ‘Clean Water Farm’ recognition program to publicly highlight conservation-minded landowners. Establish demonstration plots near the watershed to show visible sediment and nutrient reduction benefits. Might be able to help overcome barriers to adoption. SEML [Save Eagle Mountain Lake] would be happy to play a supporting role in education and outreach.”

“Seems reasonable to target 15-20% *E. coli* reduction from livestock BMPs but need to know how many producers will actually participate to make this realistic. How do you measure compliance?”

“The big effort should be close to where there is a high density of pet walkers near water bodies or wetlands.”

“With 50% participation, could maybe achieve 10% watershed *E. coli* reduction but this assumes people actually use the waste stations and follow thought. Might be too optimistic. The challenge again is compliance.”

“Liked HOA engagement [with OSSFs] and possible legislation if possible.”

“Even 10% improvement in failing [OSSF] systems should give us 12-15% watershed *E. coli* reduction. This seems like one of the most cost-effective approaches IF we can get homeowners to participate. The key is finding ways to get homeowners to participate and self-report. Offering service options and financial assistance could help.”

“Focus [on wastewater treatment facilities (WWTFs)] should be on preventing I&I overflows during storms. Hard to quantify load reduction since violations are sporadic.”

“The preservation of current greenways and riparian buffers especially ones with significant tree canopy or native grasses [to reduce sediment].”

“Education by non-profits rather than NRCS is a good solution given funding for these activities. Co benefit with livestock management on this topic is a huge opportunity. Keeping roots in the soil! Healthy plants in that soil due to provision of ‘natural’ fertilization is a big area of discussion in the regenerative ag space. The result is also less synthetic fertilizer in the watershed. These are all interrelated and there are good non-profit programs to educate rural communities effectively for good outcomes.”

“More emphasis should be put on sediment removal during periods of drought. At SEML we're inundated by concerns and questions about sediment removal and control. We're looking into ways to assist lakefront property owners to dredge around their docks and to

find grant funds to help offset costs. I also believe it's worth installing floating treatment wetlands (FTWs) at the Walnut Creek mouth and Ash Creek mouth to reduce sedimentation. SEMML would be happy to help with the construction and maintenance of these if we can obtain the grant funding for it.”

“[Illegal dumping] hotline that results in signage.”

“This [illegal dumping] is more about community engagement than load reduction. Hard to quantify *E. coli* impact but good for building public support for watershed protection. The Trash Bash event is visible and a great way to get people involved but needs to be revamped to increase participation. Most residents aren't even aware when it happens. We (SEMML) continue to expand our Lake Bottom Clean Up to remove trash from ‘party cove.’ More emphasis for resident participation in these types of events could help.”

“Greatest issue here [with yard waste] is overcoming ignorance and lack of concern - two of the greatest challenges in life! Educate, educate, educate. Work with HOAs to encourage residents and push compliance.”

“Plan needs realistic interim milestones - 25% reduction by Year 3, 50% by Year 7... Also, plan should address construction site controls for new development - this is a growing sediment and bacteria source. Also need regional funding mechanism since watershed crosses multiple jurisdictions, and backup regulatory options if voluntary approaches don't achieve targets (which is highly likely). Focus should be on riparian areas first since they have 90% pollution impact.”

Wrap Up

Katie adjourned the meeting.

Stakeholder Votes for Recommended Reductions/Increases by BMP to Address E. coli, Nutrients, and Sediments

Modeled Options Provided to Stakeholders	Reduced Cattle Stocking Rate	Reduced Pet Waste	Reduced OSSF Failure Rate	Increased Acreage Cover Crops
5%	*		5	
10%			1	
15%				0
25%	5			5
40%				0
50%	1	3		
80%		3		

* Grayed-out cells were not options modeled or voted on by stakeholders for each BMP



Eagle Mountain Lake Watershed Protection Plan Stakeholder Meeting

March 6, 2026



Kate Zielke, TRWD, Rural Programs Supervisor
Aaron Hoff, TRWD, Watershed Programs Manager



What is a Watershed Protection Plan?

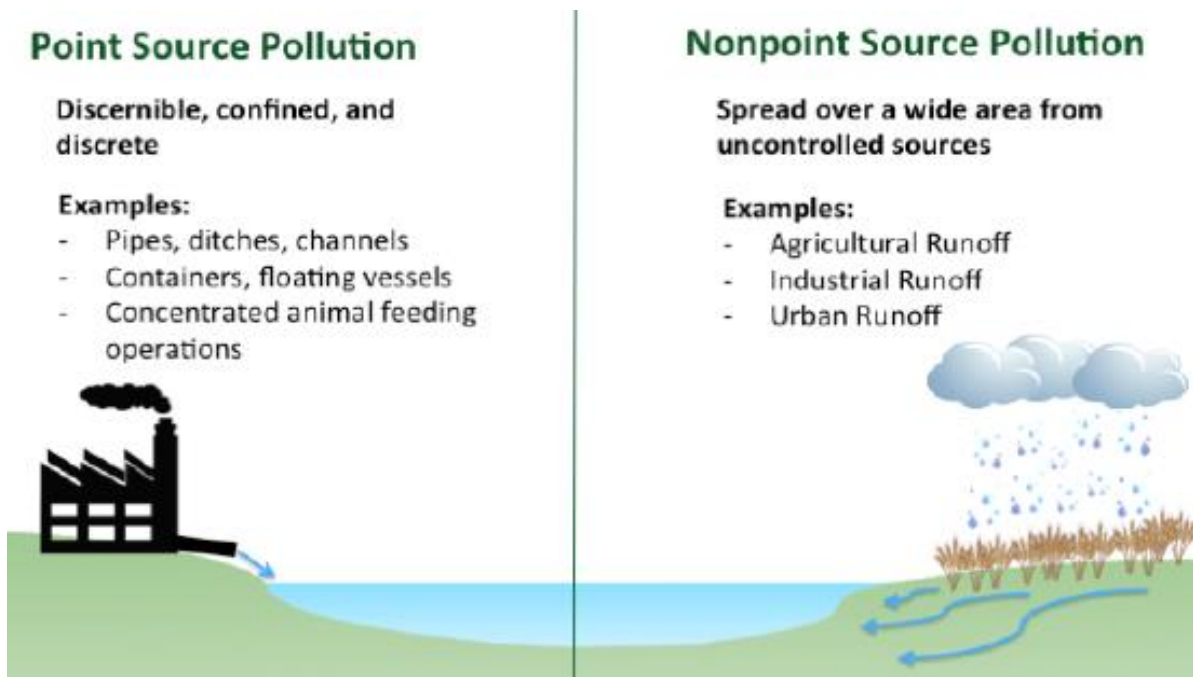
“A strategy that provides assessment and management information for a defined watershed”



- ▶ Clean Water Act §319 → EPA Framework
 - ▶ TCEQ Integrated Report (303(d) List)
- ▶ Address non-point source pollution
- ▶ Additional focus on water quality goals - sediment, nutrients
- ▶ Stakeholder involvement
- ▶ Actions supported by sound science
- ▶ Non-regulatory

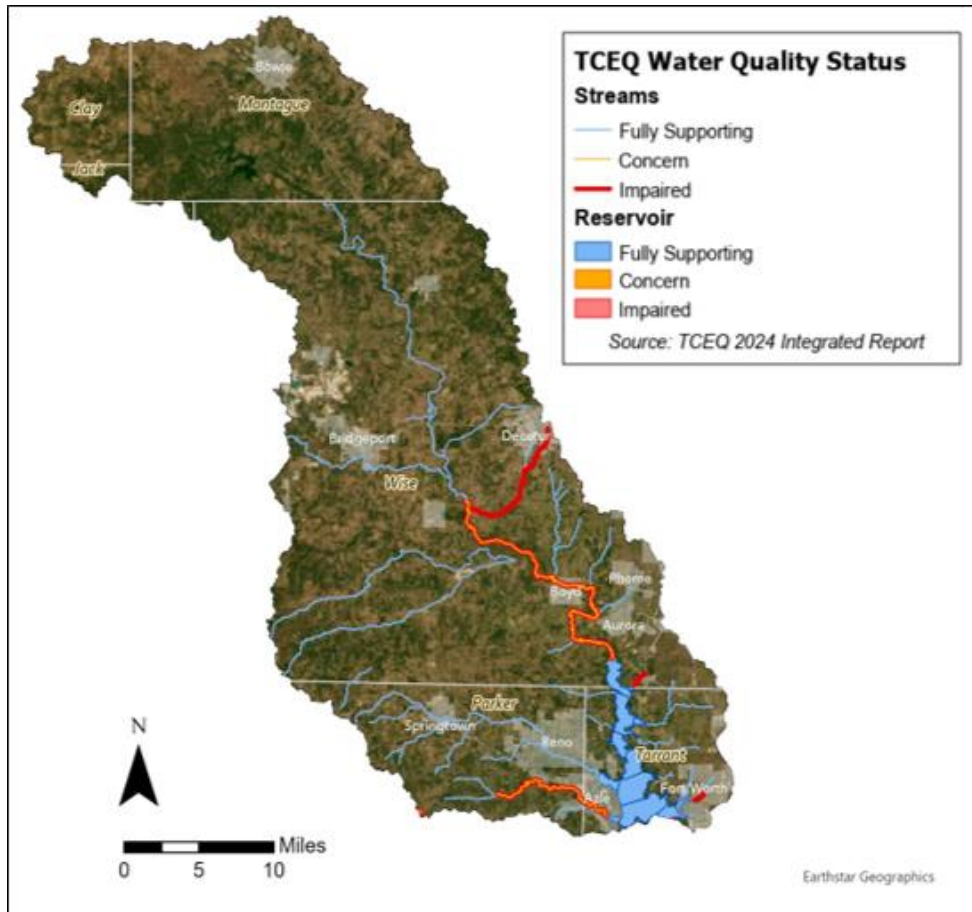
What is Non-Point Source Pollution?

- ▶ Stormwater
- ▶ Sediment
- ▶ Toxic chemicals
- ▶ Agricultural runoff
- ▶ Nutrients



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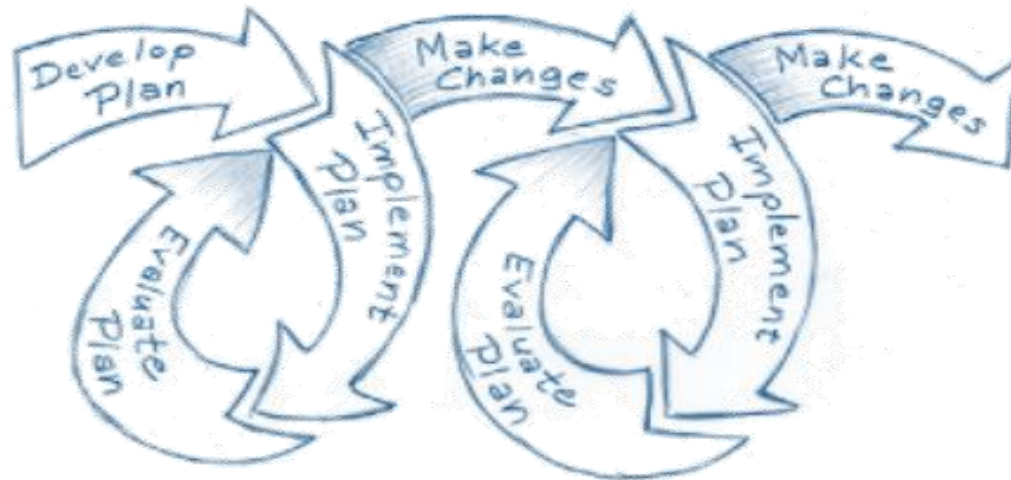
Water Quality Issues in Eagle Mountain Lake Watershed



Impaired Segments		
Name	Impairments	Concerns
Ash Creek	Bacteria (<i>E. coli</i>)	Nitrate (NO ₃ ⁻) (screening)
Dosier Creek	Bacteria (<i>E. coli</i>)	
Derrett Creek	Bacteria (<i>E. coli</i>)	
West Fork Trinity River Below Lake Bridgeport	Bacteria (<i>E. coli</i>)	Chlorophyll-a (screening)
Martin Branch	Bacteria (<i>E. coli</i>)	

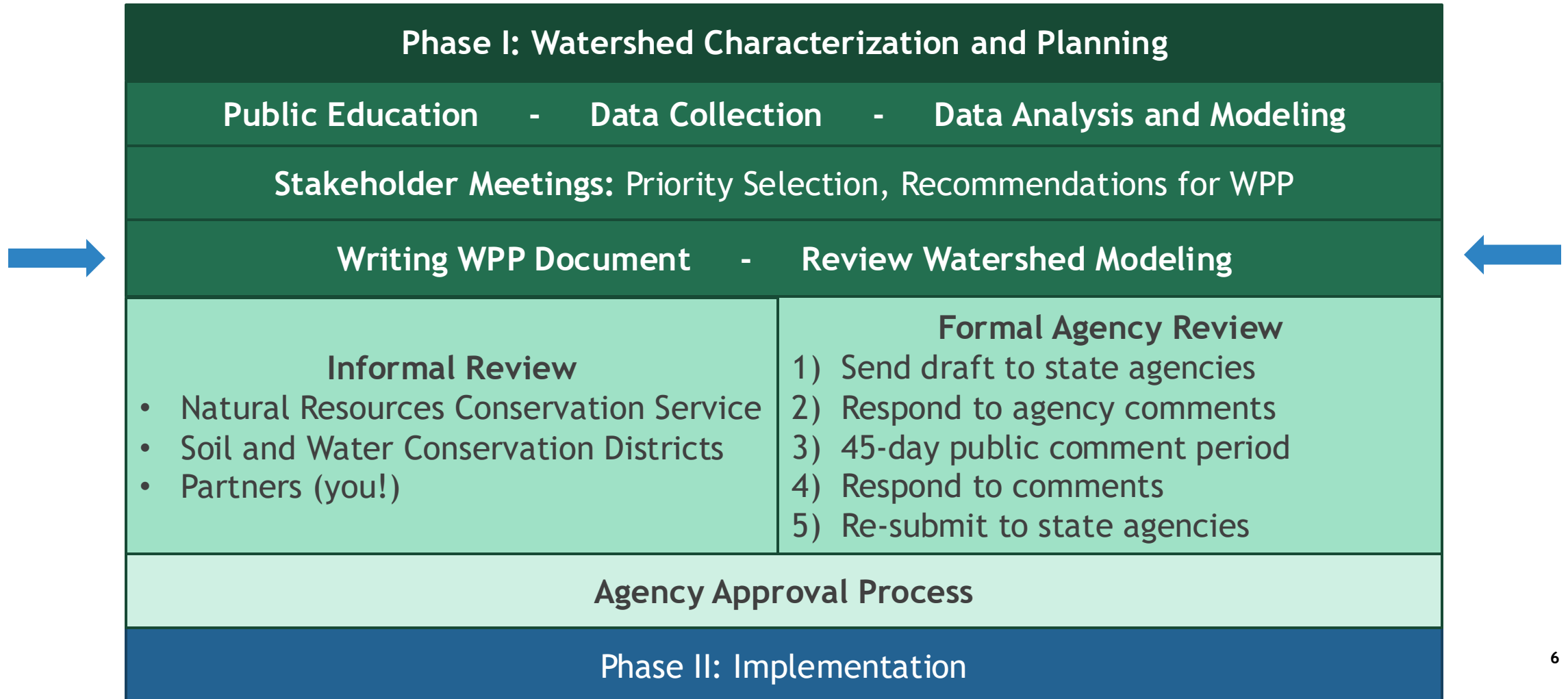
Six Steps to Effective Watershed Management

1. Build partnerships
2. Characterize your watershed
3. Establish goals and identify solutions
4. Develop an implementation program
5. Implement your plan
6. Measure progress and make adjustments





Watershed Protection Plan Process





Previous Stakeholder Meetings for EML WPP

2019 November

- ▶ EPA and TCEQ comments on submitted WPP

2025 January

- ▶ Review of Chapters 1 and 2
 - ▶ Background on watershed management
 - ▶ Overview of EML watershed characteristics

<https://www.trwd.com/watersheds/>

Eagle Mountain Lake

Eagle Mountain Lake is located northwest of Fort Worth, and is a major water supply reservoir for Fort Worth and surrounding cities. The Eagle Mountain Lake watershed is 869 square miles in size and includes parts of Tarrant, Parker, Wise, Jack, Montague, and Clay Counties. This largely rural watershed is dominated by range and grassland as well as a growing suburban population.

The goal of the Eagle Mountain Lake WPP is to slow algae growth in the lake by reducing phosphorus contributions to the lake. The WPP reflects input from many partners and stakeholders to address agricultural and urban sources throughout the watershed, and is based on scientific and economic studies presented in the WPP Modeling Report. TRWD is currently updating this plan. Click the newsletter button to receive updates about ongoing watershed initiatives and opportunities to participate.

The Eagle Mountain Lake Conservation Initiative, which ran from 2011 to 2022, was a partnership between the NRCS, Wise SWCD, Wise County WCID1, Wise County Commissioners Court, and TRWD to address agricultural sources of sediment and nutrients to the lake. The purpose of the initiative was to enhance technical assistance and conservation planning in the Eagle Mountain Lake Watershed and encourage implementation of agricultural conservation systems to address water quality concerns.

WATERSHED PROTECTION PLAN

FACT SHEET & MAP

Stakeholder Meetings

2025 August
2025 July
2025 July Presentations
2025 January
2019 November

Reports

Eagle Mountain Lake WPP
Modeling Report 2016



Previous Stakeholder Meetings for EML WPP

2025 July

- ▶ Overview of modeling methods
- ▶ Review of Chapters 3, 4, and 5
 - ▶ Assessment of current water quality in EML and tributaries
 - ▶ Identification of potential pollutant sources
 - ▶ Modeling of potential pollutant sources

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Eagle Mountain Lake WPP
Modeling Report 2016



Previous Stakeholder Meetings for EML WPP

2025 August

- ▶ Review of Chapter 6
 - ▶ Identification of management strategies and associated load reductions

<https://www.trwd.com/watersheds/>

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[2025 July](#)
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[2025 January](#)
[2019 November](#)

Reports

[Eagle Mountain Lake WPP Modeling Report 2016](#)



Today's EML WPP Updates

Chapter 6

- ▶ Factsheets updated with *E. coli* reduction goals

Chapter 7

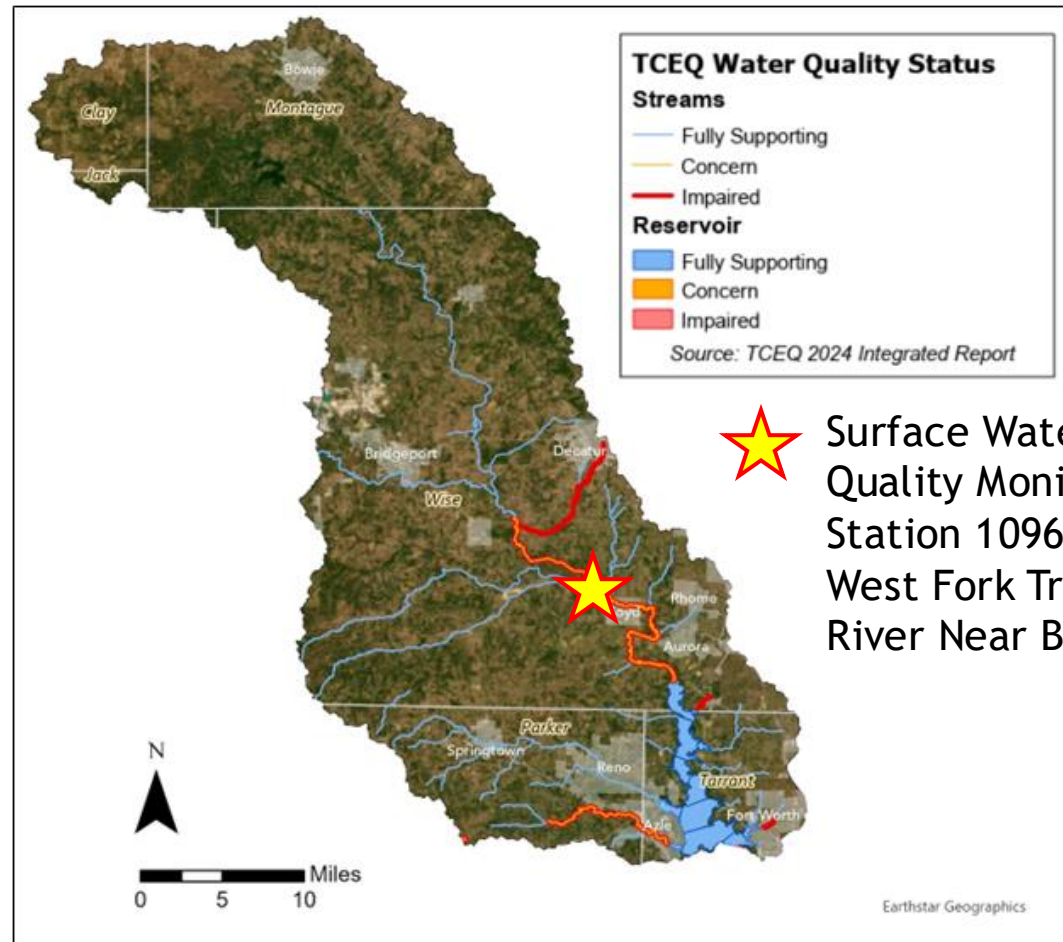
- ▶ Technical assistance content drafted
- ▶ Financial assistance content drafted
- ▶ Implementation schedule and cost estimate drafted

Chapter 8

- ▶ 10-year and 5-year milestones drafted
- ▶ Plans for water quality monitoring, best management practice (BMP) implementation, progress updates, and adaptive management

E. Coli Monitoring Location

- ▶ Site 10969 will be used to monitor progress
- ▶ Collects drainage that is most important to understanding pollutant load in EML
- ▶ Referred to as WF Trinity River Near Boyd (WFTR4) in Appendix C Tables



Here's Where We Need Stakeholder Input



- ▶ Chapters sent via email
- ▶ Chapters also available on table



Chapter 6: Review

Management Strategies and Associated Load Reductions

- ▶ Provides management measures to reduce pollutant load created by:
 - ▶ Livestock * **
 - ▶ Pet Waste *
 - ▶ On-Site Sewer Facilities (OSSFs) *
 - ▶ Wastewater Treatment Facilities (WWTFs) and Sanitary Sewer Overflows (SSOs)
 - ▶ Sediment
 - ▶ Illegal Dumping and Litter Accumulation
 - ▶ Lawn Residue and Waste

* Modeling results available on measures' ability to reduce *E. coli*

** Modeling results available on measures' ability to reduce sediment and nutrients

Chapter 6: Pet Waste

- ▶ Responses received at August 2025 meeting were evenly split between reducing pet waste by 50% or 80%
- ▶ SELECT modeling is worst-case scenario
 - ▶ Assumes 0% pet waste is currently picked up
 - ▶ 50% pet waste picked up
 - 6.13 MPN/yr*10¹⁵ *E. coli* reduction
 - ▶ 80% pet waste picked up
 - 9.80 MPN/yr*10¹⁵ *E. coli* reduction

Survey Questions 1 and 2



Chapter 6: OSSFs

- ▶ Revising question asked of stakeholders in August 2025 to match available modeling
- ▶ Assumption: 27,000 OSSFs exist in EML watershed
- ▶ Assumption: 15% failure rate currently
- ▶ SELECT modeling demonstrates reduction in failure rate to:
 - ▶ 10% failure rate
 - 1,350 OSSFs repaired or replaced
 - 8.5 MPN/yr*10¹⁵ *E. coli* reduction
 - ▶ 5% failure rate
 - 2,700 OSSFs repaired or replaced
 - 17.0 MPN/yr*10¹⁵ *E. coli* reduction

Survey Questions 3 and 4



Chapter 7: Review

Plan Implementation

Technical Assistance

- ▶ Federal, state, and local government entities
- ▶ Nonprofit organizations
- ▶ Wastewater infrastructure operators
- ▶ Homeowners associations and neighborhood associations
- ▶ Vary by strategy



Chapter 7: Review

Plan Implementation

Financial Assistance

- ▶ Grants, loans, in-kind contributions
- ▶ TRWD funding
- ▶ Federal, state, and local funding
- ▶ Private funding



Chapter 7: Implementation Plan

Table 7-1

- ▶ Management measures included in WPP are eligible for Clean Water Act §319 funding
- ▶ Summarizes measures and estimates frequency, costs, and potential funding sources
- ▶ Organized by pollutant source
- ▶ Handout available

Management Measure	Responsible Party	Unit Cost (\$) ^{1,2}	Units Implemented by Years					Total Cost (\$) ³	Potential Funding Sources
			1-2	3-4	5-6	7-8	9-10		
Livestock									
WQMPs and CPs	Producers, NRCS, SWCDs	\$17,000	3	6	6	6	6	\$459,000	WQMP, CRP, CSP, EQIP, SWPP, GLCI, NWQI, RPP, RCPP/AFA, RCPP, VPA-HIP, WFPO, CWA §319, IRSP, AERI, CPP, SSUWRP, GRCI, TCRP, AWCG, WQMP, WSEP, LIP, TFRLLP, MCG, CGMF, EFT
Education and outreach programs	Producers, hobby farmers, NRCS, SWCDs, nonprofits	\$2,000	2	2	2	2	2	\$20,000	ACEP, WRE, CIG, EQIP, SWPP, GLCI, NWQI, RCPP/AFA, RCPP, VPA-HIP, WFPO, CWA §319, EE, Section 106, WPDG, AERI, CPP, SSUWRP, GRCI, AWCG, WQMP, CGMF, EFT, CFT
Pet Waste									
Education and outreach general	Cities, counties, NCTCOG, regional entities, residents	\$2,000	2	2	2	2	2	\$20,000	CWA §319, EE, Section 106, SSUWRP, CGMF, EFT, CFT
Pet waste ordinance/regulation adoption	Cities, counties	N/A	As early as feasible					N/A	N/A
Materials for pet waste station installation	Cities, counties, HOAs, NAs	\$450	8	12	12	12	12	\$25,200	CWA §319
Pet waste station bags/replacements 4x year through implementation timeline		\$85	8	12	12	12	12	\$74,800	CWA §319
Install bioswales at parks and dog parks		\$40/square foot	0	2	2	2	2	Variable by square footage installed	CWA §319, SSUWRP, CWSRF, DWSRF
OSSFs									
Incentives for inspection	Residents, HOAs,	\$350 ⁴	50	100	100	100	100	\$157,500	CWA §319, DWTATP, CWSRF, EDAP,

Chapter 7: Implementation Plan

Table 7-1

- ▶ What number of Water Quality Management Plans or Conservation Plans is reasonable annually?
- ▶ Should funding for OSSF inspections and/or pump outs and OSSF replacements cover an incentive or the full cost?

Survey Questions 5 and 6



Chapter 7: Implementation Plan

Table 7-1

- ▶ Any additional questions/comments on the implementation plan?

Management Measure	Responsible Party	Unit Cost (\$) ^{1,2}	Units Implemented by Years					Total Cost (\$) ³	Potential Funding Sources
			1-2	3-4	5-6	7-8	9-10		
Livestock									
WQMPs and CPs	Producers, NRCS, SWCDs	\$17,000	3	6	6	6	6	\$459,000	WQMP, CRP, CSP, EQIP, SWPP, GLCI, NWQI, RPP, RCPP/AFA, RCPP, VPA-HIP, WFPD, CWA §319, IRSP, AERI, CPP, SSUWRP, GRCI, TCRP, AWCG, WQMP, WSEP, LIP, TFRLCP, MCG, CGMF, EFT
Education and outreach programs	Producers, hobby farmers, NRCS, SWCDs, nonprofits	\$2,000	2	2	2	2	2	\$20,000	ACEP, WRE, CIG, EQIP, SWPP, GLCI, NWQI, RCPP/AFA, RCPP, VPA-HIP, WFPD, CWA §319, EE, Section 106, WPDG, AERI, CPP, SSUWRP, GRCI, AWCG, WQMP, CGMF, EFT, CFT
Pet Waste									
Education and outreach general	Cities, counties, NCTCOG, regional entities, residents	\$2,000	2	2	2	2	2	\$20,000	CWA §319, EE, Section 106, SSUWRP, CGMF, EFT, CFT
Pet waste ordinance/regulation adoption	Cities, counties	N/A	As early as feasible					N/A	N/A
Materials for pet waste station installation	Cities, counties, HOAs, NAs	\$450	8	12	12	12	12	\$25,200	CWA §319
Pet waste station bags/replacements 4x year through implementation timeline		\$85	8	12	12	12	12	\$74,800	CWA §319
Install bioswales at parks and dog parks		\$40/square foot	0	2	2	2	2	Variable by square footage installed	CWA §319, SSUWRP, CWSRF, DWSRF
OSSFs									
Incentives for inspection	Residents, HOAs,	\$350 ⁴	50	100	100	100	100	\$157,500	CWA §319, DWTATP, CWSRF, EDAP,



Chapter 8: Measuring Success

E. coli Water Quality Targets - Year Ten

Pollutant Source	Management Measures	Target <i>E. coli</i> reduction as modeled
Livestock	Reduce stocking rate by 25% (using alternative measures that provide same benefit)	9.8 MPN/yr*10 ¹⁵
Pet Waste	Reduce presence of pet waste by:	
	50%	6.13 MPN/yr*10 ¹⁵
	80%	9.80 MPN/yr*10 ¹⁵
OSSFs	Reduce failure rate to:	
	10%	8.5 MPN/yr*10 ¹⁵
	5%	17.0 MPN/yr*10 ¹⁵
TOTAL		Depends on today's choices

Survey Question 7



▶ Input on targets



Chapter 8: Measuring Success

E. coli Water Quality Interim Milestones - Year Five

Pollutant Source	Management Measures	Target <i>E. coli</i> reduction for Year Five
Livestock	Reduce stocking rate by 25% (using alternative measures that provide same benefit)	4.36 MPN/yr*10 ¹⁵
Pet Waste	Reduce presence of pet waste by:	
	50%	2.85 MPN/yr*10 ¹⁵
	80%	4.90 4.55 MPN/yr*10 ¹⁵
OSSFs	Reduce failure rate to:	
	10%	3.78 MPN/yr*10 ¹⁵
	5%	7.56 MPN/yr*10 ¹⁵
TOTAL		Depends on today's choices

Based on Table 7-1 timeline

Survey Question 8



▶ Input on targets



Chapter 8: Measuring Success

Sediment Water Quality Targets

Pollutant Source	Management Measures	Change in Sediment Yield as Modeled
Livestock	Increase cover crop use in pastureland by 25%	-71.10%
Livestock	Equivalent to reducing stocking rate 25%	-1.76%

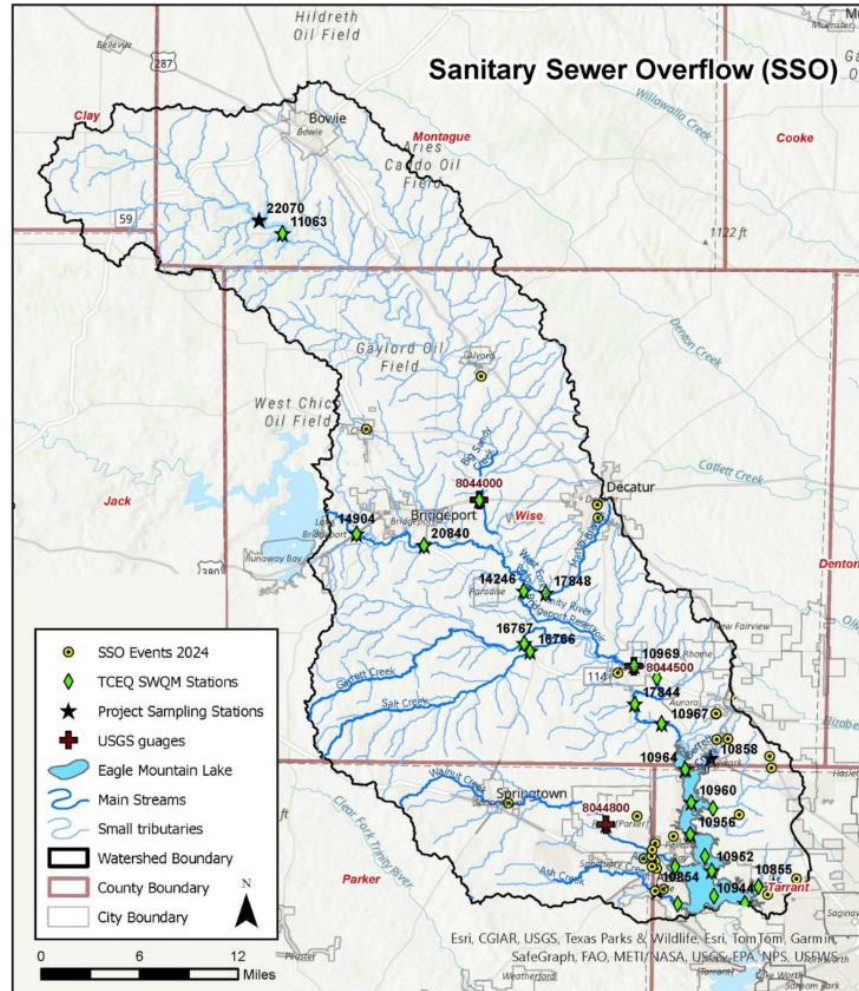


Chapter 8: Measuring Success

Nutrient Water Quality Targets

Pollutant Source	Management Measures	Nutrient	Change in Nutrient Yield as Modeled
Livestock	Increase cover crop use in pastureland by 25%	Nitrate	+5.23%
		Total Phosphorus	-27.95%
Livestock	Equivalent to reducing stocking rate 25%	Nitrate	-8.91%
		Total Phosphorus	-20.71%

Chapter 8: Measuring Success



Water Quality Monitoring

- ▶ TRWD existing monitoring schedule will continue
- ▶ Three monitoring sites can provide data for modeling
 - ▶ Paired with USGS gages that provide flow data
- ▶ Site 10969 will be site of record for EML WPP

Chapter 8: Measuring Success

BMP Implementation

- ▶ *E. coli* benefits of some BMPs cannot be quantified by modeling:
 - ▶ Wastewater treatment facilities
 - ▶ Sanitary sewer overflows
 - ▶ Sediment and flooding
 - ▶ Illegal dumping and litter accumulation
 - ▶ Lawn residue and waste
- ▶ Success measured:
 - ▶ Qualitatively
 - ▶ Quantitatively by the number of implementation actions taken

Chapter 8: Measuring Success

Progress Updates

- ▶ Annual progress updates will be provided to stakeholders
 - ▶ Via email
 - ▶ Via meeting if significant changes are sought
 - ▶ Via meeting in Year Five
- ▶ To receive updates, provide contact information



Survey Questions 9-11



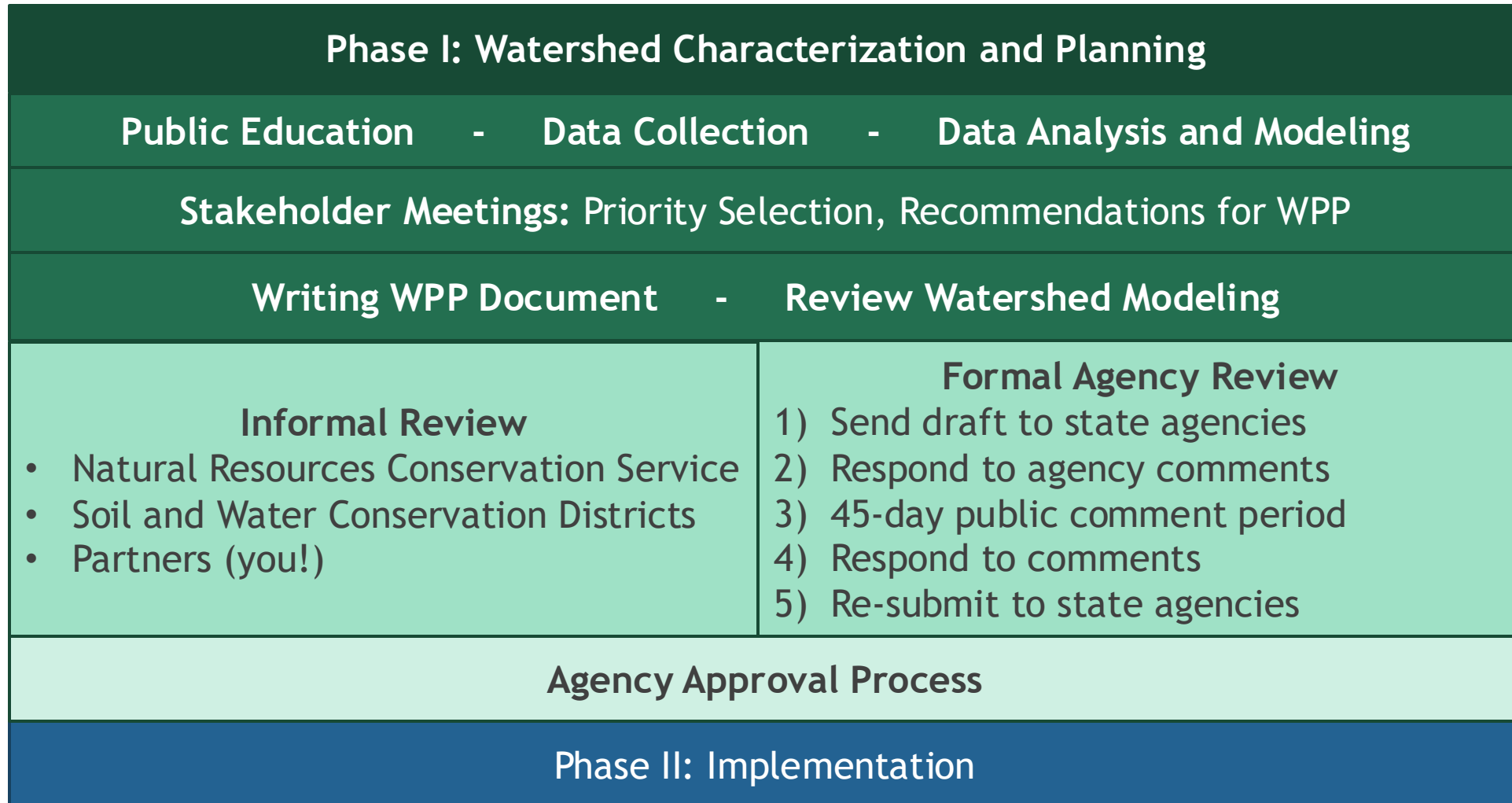
Chapter 8: Measuring Success

Adaptive Management

- ▶ Annual progress updates are an opportunity to identify need for course correction
 - ▶ Feasibility
 - ▶ Success
- ▶ Challenges
 - ▶ Cause and effect
 - ▶ Time lag



Next Steps



Questions or Comments?





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Watershed protection website:

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Eagle Mountain Lake Watershed Protection Plan

Stakeholder Meeting #4

March 6, 2026

1 p.m. – 3 p.m.

Azle Memorial Library, 333 W. Main Street, 76020

Tarrant Regional Water District (TRWD) and Watershed Protection Planning Updates

Kate Zielke with TRWD defined watershed protection plan (WPP), non-point source pollution, and point source pollution for stakeholders. She identified *E. coli* impairments and nitrate and chlorophyll-a concerns in the Eagle Mountain Lake watershed. She also described the planning process and where TRWD was in the process for Eagle Mountain Lake. Kate provided a recap of previous stakeholder meetings.

Chapter 6 Review of Stakeholder Feedback

A QR code was provided to stakeholders so they could provide feedback on chapters 6, 7, and 8 via an online survey. These are the final chapters of the WPP. Kate said stakeholders at the August 2025 meeting were evenly split between choosing a reduction target for pet waste. She said stakeholders should consider what was feasible. Stakeholders discussed the importance of reducing pet waste vs. reducing wildlife waste. They questioned whether reducing pet waste would provide much of a benefit. They noted that residents in one city are feeding deer, but the city did not adopt an ordinance to prevent this feeding. Other stakeholders said pet owners are throwing pet waste into the lake. They said it was an opportunity to distribute fliers to educate pet owners. Stakeholders asked whether horses fell into the pet category or the livestock category. Kate responded that horses fell into the livestock category. Stakeholders discussed the benefits of rotational grazing, noting that this strategy was not applicable to all ag producers, such as those who grow hay.

Kate asked stakeholders to address targets for reducing the failure rate of on-site sewer systems (OSSFs), or septic systems. She said TRWD needed to modify the question it asked stakeholders at the August 2025 meeting, because the modeling addressed a target failure rate, not the percent reduction in failures that was discussed at the previous meeting. Stakeholders discussed who would pay for repairs or replacements of failing septic systems. One stakeholder thought inspections were skewed toward finding that repairs were not needed, when in fact septic systems were failing. Some stakeholders noted that this was a homeowner responsibility, and incentives should not be provided. Stakeholders also discussed solutions to waste from un-housed people that did not enter OSSFs. One stakeholder noted that Lake Lavon in Collin County, Texas, successfully implemented a 10-year OSSF plan.

Chapter 7-8 Guided Review

Kate reviewed the content of Chapter 7 with stakeholders. This chapter focuses on technical assistance, which could be provided by federal, state, or local government entities; nonprofit organizations; wastewater infrastructure operators; and homeowners associations and neighborhood associations. Kate also discussed opportunities for financial assistance to implement the WPP recommendations. This assistance could come in the form of grants, loans, in-kind contributions, and private funding. She said TRWD salaries will fund some implementation work. A stakeholder noted that Texas A&M Forest Service provides a website on grant funding appropriate for WPPs. Another stakeholder asked about the source of TRWD's funding. Kate responded that these funds come from the sale of raw water and from taxes.

Kate guided stakeholders through Table 7-1. The table identifies the management strategies chosen by stakeholders and estimates costs and a timeline for each strategy. Stakeholders brought up illegal dumping that is occurring near the lake. One stakeholder responded that if a homeowner is allowing others to dump items on their property, it is not illegal. Stakeholders noted they would rather funds go to addressing lake levels and human waste dumping than to reducing pet waste. Others discussed urban development that is replacing ranch lands. They believed the WPP needs to plan for future conditions and create more depth in the lake to improve storage capacity of drinking water. They asked that TRWD add urban development strategies to the WPP and questioned whether construction generated more sediment than pastures. They noted that development around the lake will increase over time and livestock will decrease. One stakeholder said counties do not have enforcement abilities when it comes to stormwater management. A stakeholder called for the WPP to build relationships and work on a few big strategies rather than many small strategies. Kate explained that the WPP includes all possible options, because Section 319 funds from the Environmental Protection Agency can only be used for strategies included in an approved WPP. Including all strategies gives TRWD flexibility to implement those strategies for which it can receive funds and that are most feasible.

Jennifer Owens with TRWD said the District is being proactive regarding many of the concerns stakeholder discussed regarding lake levels. She said one employee's job was to address these specific concerns. A stakeholder asked if the reservoir could be dredged, while another stakeholder asked whether the sediment may be contaminated with pollution. Aaron Hoff with TRWD confirmed that sediment could be contaminated with legacy pollutants. A stakeholder asked what percentage of the watershed had native buffer zones. Another stakeholder said another reservoir needs to be built.

Regarding proposed OSSF incentives for replacement, a stakeholder asked whether the funds would go directly to the homeowner, noting they would prefer funds went to the installer. Others asked about education opportunities for homeowners. Another noted that the \$8,000 incentive proposed for replacement was very fair because it was almost half the cost of total replacement. Other stakeholders believed replacing OSSFs was the personal responsibility of property owners and TRWD should not incentivize replacements. Jonathan Killebrew, a TRWD board member, described incentives as a carrot vs. stick scenario to improve lake quality for everyone. Stakeholders expressed interest in being added to city sewer systems.

A stakeholder asked if *E. coli* goals were achievable. Kate said the reduction needed to remove impairments was indeed achievable by implementing only some of the strategies included in the WPP. A stakeholder asked if cities using water from the reservoir had trouble treating the pollution in the water. Jennifer responded that cities had not communicated about such a problem.

Multiple stakeholders championed the benefits of education and outreach regarding the WPP strategies.

Kate discussed multiple options for continuing to seek stakeholder input after the WPP is approved and implementation is launched. These options included email notifications, virtual meetings, and in-person meetings.

Aaron described next steps for the WPP. He said a draft will be provided to the Natural Resources Conservation Service; soil and water conservation districts in the watershed; and partners, including the stakeholders who provided feedback over the course of WPP development. After TRWD incorporates feedback from that informal review, the District will submit the WPP for formal state agency review. Aaron said this review will be followed by a 45-day public comment period. After responding to comments, TRWD will re-submit the WPP to state agencies.

Survey results are available in Attachment 1.

Wrap Up

Kate adjourned the meeting.

Stakeholder Votes for Recommended Reductions in Pet Waste and Target OSSF Failure Rates

Modeled Options Provided to Stakeholders	Reduction in Pet Waste	OSSF Target Failure Rate
5%	*	12
10%		5
50%	11	
80%	6	

* Grayed-out cells were not options modeled or voted on by stakeholders for each BMP.

Stakeholder Votes for Funding OSSF Inspections and Replacements

	OSSF Incentives for Inspections and Replacements	OSSF Full Price for Inspections and Replacements	OSSF Incentives for Inspections and Full Price for Replacements	OSSF Full Price for Inspections and Incentives for Replacements
Number of Stakeholder Votes	8	2	4	2

Votes for the annual number of Water Quality Management Plans or Conservation Plans to implement varied widely. TRWD will consult with the Natural Resources Conservation Service and soil and water conservation districts to finalize this number in Table 7-1.

Stakeholder Votes on 10-Year Target for *E. coli* Reduction

	10-Year Target Based on Table 7-1
Much Too High	0
Too High	1
Just Right	9
Too Low	6
Much Too Low	0

Stakeholder Votes on 5-Year Interim Target for *E. coli* Reduction

	5-Year Target Based on Table 7-1
Too Ambitious	1
Just Right	11
Not Ambitious Enough	3



Eagle Mountain Lake

Eagle Mountain Lake is located northwest of Fort Worth, and is a major water supply reservoir for Fort Worth and surrounding cities. The Eagle Mountain Lake watershed is 869 square miles in size and includes parts of Tarrant, Parker, Wise, Jack, Montague, and Clay Counties. This largely rural watershed is dominated by range and grassland as well as a growing suburban population.

The goal of the Eagle Mountain Lake WPP is to slow algae growth in the lake by reducing phosphorus contributions to the lake. The WPP reflects input from many partners and stakeholders to address agricultural and urban sources throughout the watershed, and is based on scientific and economic studies presented in the WPP Modeling Report. TRWD is currently updating this plan. Click the newsletter button to receive updates about ongoing watershed initiatives and opportunities to participate.

The Eagle Mountain Lake Conservation Initiative, which ran from 2011 to 2022, was a partnership between the NRCS, Wise SWCD, Wise County WCID1, Wise County Commissioners Court, and TRWD to address agricultural sources of sediment and nutrients to the lake. The purpose of the Initiative was to enhance technical assistance and conservation planning in the Eagle Mountain Lake Watershed and encourage implementation of agricultural conservation systems to address water quality concerns.

[WATERSHED PROTECTION PLAN](#)

[FACT SHEET & MAP](#)

Stakeholder Meetings

- [2025 March](#)
- [2025 August](#)
- [2025 July](#)
- [2025 July Presentations](#)
- [2025 January](#)
- [2019 November](#)

Reports

- [Eagle Mountain Lake WPP Modeling Report 2016](#)