Northeast Texas Municipal Water District

Cypress Creek Basin Highlights Report

An Overview of Bacteria in Big Cypress Creek below Lake Bob Sandlin and Recreational Use Attainability Analysis

2012

Clean Rivers Program

Water Monitoring Solutions

Texas Commission on Environmental Quality

Texas Clean Rivers Program

The Clean Rivers Program (CRP) is a water quality monitoring, assessment, and public outreach program administered by the Texas Commission on Environmental Quality (TCEQ) and funded by state collected fees. The Northeast Texas Municipal Water District (NETMWD) coordinates the Clean Rivers Program for the Cypress Creek Basin. The CRP was created by the Texas Legislature in 1991 under the Texas Clean Rivers Act.

The Basin Highlights Report is an annual report required under that program. The purpose of the report is to provide a concise overview of water quality conditions and issues throughout the Cypress Creek Basin for the most recent 12-month period beginning September 1 and ending August 31. As a participant in the CRP, NETMWD submits its annual Basin Highlights Report to the TCEQ. The TCEQ and CRP partners use this report and others submitted throughout the State to develop and prioritize programs that will:

- *protect the quality of healthy waterbodies and*
- *improve the quality of impaired waterbodies*

Under the CRP, biologists and field staff collect surface water samples, field parameters and measure flow at sites throughout the Cypress Creek Basin. Other entities participating in the Cypress Creek Basin CRP include the following:

Caddo Lake Institute
Northeast Texas Community College
Pilgrim's Pride Corporation
Titus Co. Fresh Water Supply District #1
Texas Parks and Wildlife Department
United States Geological Survey
East Texas Baptist University
U. S. Steel Tubular Products, Inc.
Luminant
AEP SWEPCO
City of Marshall
City of Longview
Franklin County Water District

NETMWD contracts with Water Monitoring Solutions, Inc. to fulfill specific tasks of the CRP.

Become Involved:

Interested in becoming a stakeholder in your watershed? Stakeholders are anyone interested in the water quality in the Big Cypress Creek Basin, and play an integral role in the decision making process and prioritization of monitoring efforts. You can participate by becoming involved with the Steering Committee. For more information, contact:

Northeast Texas Municipal Water District
PO Box 955
Hughes Springs, TX 75656
903-639-7538
info@netmwd.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

FOREWORD

The *Assessment of Contact Recreation Use Impairments and Watershed Planning for Big Cypress Creek and Tributaries (Hart and Tankersley Creeks)* was a project funded by the Texas State Soil and Water Conservation Board to intensely study these watersheds which are included on the *303(d)* List of Impaired Waters for bacteria. The project commenced in June 2009 and was completed in August 2011. The project tasks included a Survey and Inventory Possible Bacteria Sources, an intensive 22-month bacteria sampling program, a review of all historical data, and a comprehensive recreational use attainability analysis (RUAA). These tasks were performed by the Northeast Texas Municipal Water District and Water Monitoring Solutions, Inc.

Other tasks of the project were performed concurrently by Texas A&M Agrilife Research through the Texas Water Resources Institute (TWRI), Soil and Aquatic Microbiology Lab (SAML), and the Department of Biological and Agricultural Engineering (BAEN). BAEN developed land use maps, calculated load duration curves, and performed Spatially Explicit Load Enrichment Calculation Tool (SELECT) modeling on the study area. SAML conducted Bacterial Source Tracking (BST) analysis to determine the sources of bacteria in the watershed.

Seven public meetings were held to discuss the project scope, design, progress, preliminary findings, and to solicit stakeholder input on activities in the watershed. The purpose of this report is to present a summary and compilation of the tasks performed by all organizations. The data presented in this report are preliminary, currently under review, and are subject to change. All information discussed in the report has been presented to stakeholders at public meetings and is available at the project website: http://bcc.tamu.edu/

The project tasks were performed by:

- Northeast Texas Municipal Water District
- Water Monitoring Solutions, Inc.
- Texas A&M University Agrilife Research:
  - Texas Water Resources Institute
  - Soil and Aquatic Microbiology Lab
  - Department of Biological and Agricultural Engineering

This report was prepared by Water Monitoring Solutions, Inc. on behalf of the Northeast Texas Municipal Water District in cooperation with the Texas Commission on Environmental Quality under the authorization of the Clean Rivers Act.

INTRODUCTION

Every two years, the Texas Commission on Environmental Quality (TCEQ) publishes the Texas Surface Water Quality Inventory, *303(d)* List of Impaired Waters. The Integrated Report, which includes the *303(d)* List, identifies concerns for public health and aquatic life use. One of the uses for surface waters is contact recreation. Contact recreation is assessed by calculating the geometric mean from bacteria sample results. The ranking of concern by TCEQ means that the water body meets state standards, but that some sampling events yielded high enough values to cause a concern or not enough data were available to establish an impairment. A concern may also be applied to water bodies that exhibit elevated values of a parameter for which there is no water quality standard, only a screening level. The *Texas 303(d)* List identifies impaired water bodies that do not meet their designated water quality standard.

Water bodies with concerns or impairments listed in the *2010 Texas Surface Water Quality Inventory* in the Big Cypress Creek Basin were identified and discussed in the *2010 Big Cypress Creek Basin Highlights Report* and the update to 2010 Report which was released in April 2011.

Since the concerns and impairments for the entire Big Cypress Creek Basin have been discussed in detail in the previous reports, the project team decided to use this Basin Highlights Report to provide stakeholders with an overview and summary of the preliminary results for the *Assessment of Contact Recreation Use Impairments and Watershed Planning for Big Cypress Creek and Tributaries (Hart and Tankersley Creeks)*.

The headwaters of Big Cypress Creek originate in southeast Hopkins County. From there, Big Cypress Creek flows east into Lake Cypress Springs and then into Lake Bob Sandlin in Franklin County. After leaving Lake Bob Sandlin, Big

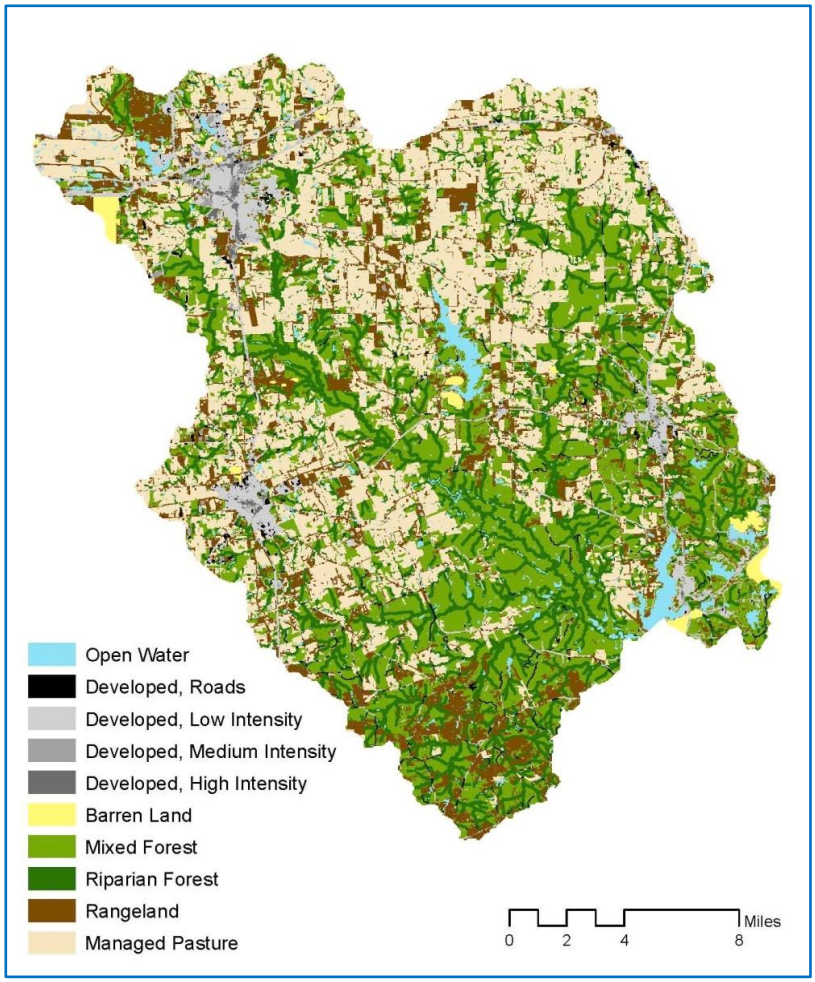


Figure 1: *Land use map of Big Cypress Creek Watershed courtesy of Texas Agrilife Research, Department of Biological and Agricultural Engineering.*

Cypress Creek, which forms the county line between Titus and Camp Counties, flows southeast to Lake O' the Pines and then finally to Caddo Lake before entering Louisiana.

The Big Cypress Creek watershed, between Lake Bob Sandlin and Lake O' the Pines (Segment 0404), encompasses approximately 445 square miles and over 284,000 acres in Camp, Morris, Titus and Upshur Counties. The watershed is characterized by gently rolling wooded hills and broad, frequently flooded, densely vegetated stream bottoms. Post oak savannah is predominant in the western portion of the basin, while piney-woods are common in the eastern portion. Land use in the watershed is predominantly pasture and forest. *(Figure 1)*

Purpose of the Study

In 1996, Segment 0404 of Big Cypress Creek was placed on the *Texas 303(d) List* for having bacteria levels that exceeded water quality standards for contact recreation. In 2000, Tankersley Creek (Segment 0404B) and in 2006, Hart Creek (Segment 0404C) were placed on the *Texas 303(d) List* for not supporting its designated use for contact recreation due to high bacteria levels. Other tributaries to Big Cypress Creek are not currently impaired for bacteria, but they are possibly contributing some degree of loading to the impaired reaches of Big Cypress Creek.

The *Assessment of Contact Recreation Use Impairments and Watershed Planning for Big Cypress Creek and Tributaries (Hart and Tankersley Creeks)* was a project funded by the Texas State Soil and Water Conservation Board to study these watersheds which are listed on the *Texas 303(d)* list for bacteria impairments. The project commenced in June 2009 and was completed in August 2011. The project tasks included a Survey and Inventory Possible Bacteria Sources, an intensive 22-month bacteria sampling program, a review of all historical data, and a comprehensive recreational use attainability analysis (RUAA). These tasks were performed by the Northeast Texas Municipal Water District and Water Monitoring Solutions, Inc.

Other tasks of the project were performed concurrently by Texas A&M Agrilife Research through the Texas Water Resources Institute (TWRI), Soil and Aquatic Microbiology Lab (SAML), and the Department of Biological and Agricultural Engineering (BAEN). BAEN developed land use maps, calculated load duration curves, and performed Spatially Explicit Load Enrichment Calculation Tool (SELECT) modeling on the study area. SAML conducted Bacterial Source Tracking (BST) analysis to determine the sources of bacteria in the watershed. Seven public meetings were held between August 2009 and July 2011 to discuss the project scope, design, progress, preliminary findings, and to solicit stakeholder input on activities in the watershed.

There are currently two recreation use categories in the 2000 Texas Surface Water Quality Standards (TSWQS): contact and noncontact recreation. Contact recreation is presumed a use of all unclassified waters. Contact recreation is defined as recreational activities involving a significant risk of ingestion of water, including wading by children, swimming, water skiing, diving, and surfing. Noncontact recreation is defined as aquatic recreational pursuits not involving a significant risk of water ingestion; including fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity.

In the proposed 2010 TSWQS, TCEQ made major revisions which included additional subcategories of recreational uses. The following recreational use categories are in the proposed document: primary contact, secondary contact 1, secondary contact 2, and noncontact recreation. These use categories are detailed below:

- **Primary contact recreation:**
  Water recreation activities, such as wading by children, swimming, water skiing, diving, tubing, surfing, and whitewater kayaking, canoeing, and rafting, involving a significant risk of ingestion of water.

- **Secondary contact recreation 1:**
  Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion and that commonly occur.

- **Secondary contact recreation 2:**
  Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion but that occur less frequently than for secondary contact recreation 1 due to (1) physical characteristics of the water body and/or (2) limited public access.

- **Noncontact recreation:**
  Activities, such as ship and barge traffic, birding, and using hike and bike trails near a water body, not involving a significant risk of water ingestion, and where primary and secondary contact recreation should not occur because of unsafe conditions.

As part of the proposed TSWQS process, TCEQ has developed procedures for conducting Recreational Use Attainability Analyses (RUAA). In order for a new category of recreational use or a different bacteria water quality standard to be applied to a waterbody, a RUAA must be conducted. There are two types of RUAA: Basic RUAA and Comprehensive RUAA. A Basic RUAA survey is conducted to (1) collect information on a water body, such as the presence or absence of water recreation activities, stream flow, stream depth, (2) establish/verify a presumed use, or (3) provide core information to be included in a Comprehensive RUAA. Basic RUAA surveys can be conducted on a relatively small unclassified water body that is evaluated during conditions amenable for contact recreation and can often be accomplished on a single sampling date. A Comprehensive RUAA, which includes information from a Basic RUAA, is required for classified water bodies or where presumed uses for unclassified water bodies may be inappropriate. A Comprehensive RUAA is an expanded effort requiring two or more field surveys and a historical data review.

In cases where a Basic RUAA Survey indicates that the existing use for recreation might be lower than the presumed primary contact, secondary contact recreation 1, or designated recreational use, then a Comprehensive RUAA is required to fully evaluate the appropriate recreational use of the stream. In

order for a recreational use that is less stringent than a designated or presumed use to apply to a water body, the applicable use must be explicitly assigned to an individual water body in the TSWQS and approved by the Environmental Protection Agency.

Study Area

Segment 0404 of Big Cypress Creek, the main waterway of the study area, begins at Fort Sherman Dam and flows approximately 33 miles southeast into Lake O' the Pines. The landscape near Mount Pleasant is drained by Tankersley and Hart Creeks, tributaries of Big Cypress Creek, which lie on the western and eastern sides of the city, respectively. Tankersley Creek is a perennial stream that extends approximately six miles northwest of Mount Pleasant. The stream flows 2.2 miles southeast into Tankersley Lake north of IH 30 and then travels approximately 6.5 miles south to the confluence with Big Cypress Creek below Lake Bob Sandlin (Fort Sherman Dam). Its main tributary is Dragoo Creek.

Hart Creek rises approximately 4.5 miles north of Mount Pleasant. It flows southeast for about twelve miles to its confluence with Big Cypress Creek southeast of Mount Pleasant. The stream is intermittent in its upper reaches through rolling hills. Near the confluence with Big Cypress Creek the terrain becomes level bottomland in the floodplains of Big Cypress Creek. Tributaries of Hart Creek include Hayes Creek and Evans Creek.

The City of Mount Pleasant in Titus County is the largest urban center within the study area with a population of about 15,250. Other population centers in the Big Cypress Creek watershed are Pittsburg with approximately 4,700 residents; Daingerfield with 2,400; and Lone Star with 1,550. There are eight permitted discharges within the study area, but none discharge directly into Big Cypress Creek. Five of the wastewater treatment plants (WWTP) are permitted to discharge less than 1 million gallons per day (MGD) of treated domestic sewage. The City of Pittsburg is permitted for a maximum of 1.17 MGD, while the City of Mount Pleasant is 2.91 MGD, and the Pilgrims Pride WWTP is 3 MGD. Tankersley Creek is the receiving water for the Pilgrims Pride plant and Hart Creek receives treated effluent from the City of Mount Pleasant plant. There are no municipal separate storm water sewer system (MS4) permits in the project area.

Much of the watershed is located in rural areas and most homes use on-site septic systems for sewage treatment. Potential non-point sources include bacteria originating from aquatic birds, wildlife, cattle, inadequately treated sewage, and/or failing septic systems. The results of SELECT modeling conducted by Texas A & M University Department of Biological and Agricultural Engineering (BAEN) showed that the highest potential *E. coli* loads are from septic systems, cattle, poultry litter, and feral hogs. *(McKee, et al., 2011)*

The Texas Parks and Wildlife Department (TPWD) publication, *An Analysis of Texas Waterways,* states that water conditions in Big Cypress Creek are not normally adequate for recreational activities: however, during periods of run-off, it is possible to float portions of the upper reaches. Often, many hazardous log and brush jams are found which impair navigation. *(Texas Parks and Wildlife Department website)*

Land Use

Land use in the basin in dominated (approximately 87%) by rangeland, managed pasture, mixed forest, and riparian forest. *(Gregory, et al., 2010) (Appendix A)* Impervious cover is represented in the watershed by areas of development within the city limits of Mount Pleasant west of Hart Creek and east of Tankersley Creek. Development is predominantly low intensity mainly from residential areas with increased development toward the center of the city in commercial and industrial locations. High intensity development exists in the form of roads, parking lots, and concrete slabs.

Hart Creek (0404C), an unclassified water body, rises 4.5 miles north of Mount Pleasant in central Titus County and runs southeast for twelve miles to its confluence with Big Cypress Creek, six miles southeast of Mount Pleasant in central Titus County. The stream is intermittent in its upper reaches and flows in a generally southeast direction. It receives surface drainage from Hayes Creek and Evans Creek, small tributaries near the eastern city limits of Mount Pleasant and south of New Mount Pleasant Lake (Town Lake). Downstream from this point, Hart Creek carries overland flow for a distance of approximately 6.5 miles before discharging into Big Cypress Creek at the Titus-Camp county line. The western border of the watershed transects through the western central area of Mount Pleasant where impervious cover is common with various intensities of development. Near its confluence the terrain changes to a more level bottomland in the floodplains of Big Cypress Creek. The soils are sandy along the creek's upper reaches and loamy along its middle and lower reaches. The area was originally heavily wooded, with pines and various hardwoods predominating. Throughout the upper and eastern portion of the Hart Creek watershed, the predominant land use was categorized as managed pasture often adjacent to mixed forest along the riparian corridor.

Tankersley Creek (0404B) arises in Titus County northwest of the City of Mount Pleasant. The upper reach of the creek above IH 30 is predominately managed pasture in the northwest of the watershed with mixed forest and rangeland to the north. The stream flows through relatively flat terrain passing through more managed pasture and heavily wooded forest before its confluence. The creek flows in a southeasterly direction for approximately two miles before it enters Tankersley Lake, which impounds Tankersley Creek about two miles northwest of Mount Pleasant. Downstream of the spillway of the 150-acre impoundment, stream flow is to the south for a distance of about eight miles to the confluence of Tankersley Creek with Big Cypress Creek at the Titus-Camp county line. Tankersley Creek is an unclassified water body.

The riparian corridor of Big Cypress Creek is heavily wooded and the creek drains much of the western Cypress Creek Basin, a predominantly rural watershed of rolling wooded hills with regional elevations of 200 to 800 feet MSL, but with limited local relief, gentle slopes, and broad, frequently flooded, densely vegetated stream bottoms. Post oak and blackjack oak constitute the dominant climax canopy vegetation, but loblolly and shortleaf pine are also common. The bottomland forest is the most mesic habitat in eastern Texas; the dense vegetation is generally comprised of water oak, willow oak, sweet gum, black gum, and birch primarily vegetated by a mixture of oak woodland and prairie. Stream flow is influenced by releases from Lake Bob Sandlin upstream.

The watershed is primarily located in the South Central Plains Ecoregion with the westernmost reaches located in the East Central Texas Plains Ecoregion. Natural vegetation in the watershed is typified by oaks, hickory and pines. The vegetation of the watershed is marked by a transition from the extensive agricultural clearing of the western portion of the Basin to the more densely forested eastern portion. The riparian woodland surrounding the middle portion of Big Cypress Creek is extensive and undisturbed relative to the adjacent uplands. Large areas above the upper portion of Lake O' the Pines are swamp-like. Soils of the nearly level Big Cypress Creek floodplain are typically of the somewhat poorly drained Estes clay loam soil unit. Upland soils of the watershed are typically moderately well drained and well drained sandy and loamy soils.

Climate

The climate is hot during the summer when daily average temperatures are in the upper 80's and cold during winter with daily average temperatures in the 40's ^{o}F. The warmest month is August with an average maximum temperature of 95.6^{o}F, while the coldest month is January with an average minimum temperature of 31.1^{o}F. Temperature variations between night and day tend to be moderate during both summer and winter months with an average difference of 24^{o}F. The average annual rainfall is approximately 47 inches. The rainy season ranges from October to June with monthly rainfall amounts between 3.7 inches and 5.6 inches.

Review of Prior Studies

There are 22 publications in the Texas State Library pertaining to Big Cypress Creek. These reports involve cultural resources, intensive water quality surveys, waste load evaluations, land use, dam studies, water supply and soil types. None of the reports involve recreational uses of the streams. *(Library Catalog of Texas State Agencies)* No historical photographic evidence, local newspaper accounts, museum collections, published reports, historical society records or long-term landowners/residents accounts concerning recreation could be found. *(Texas Historical Commission, The Daily Tribune)* No additional information on the historical use the stream was found.

Much of the available historic data were collected during two Clean Rivers Program special studies: the *Tankersley Creek Indicator Bacteria Special Study* in 2003 *(Price, 2003)* and the *Tankersley Bacterial Source Tracking Special Study* in 2005. *(Price, 2005)*

Tankersley Creek Indicator Bacteria Special Study Upper Big Cypress Creek Watershed (FY 2003)

To supplement existing data and further characterize basin conditions, bacteriological samples were collected from six locations. Stations were situated upstream (station 10264) and downstream (station 10261) of the Pilgrim's Pride WWTP outfall on Tankersley Creek, which drains the western side of Mount Pleasant. Stations were positioned upstream (station 10272) and downstream (station 10266) of the City of Mount Pleasant WWTP outfall on Hart Creek, which drains the eastern side of Mount Pleasant. Big Cypress Creek was sampled at locations downstream of Lake Bob Sandlin and upstream of the confluence with Tankersley Creek and the confluence with Hart Creek, and at the State Highway 11 crossing (station 10308). The study included quarterly sampling at the stations on Tankersley Creek for both Fecal coliform bacteria and *E. coli*, and quarterly sampling for *E. coli* only at the Big Cypress Creek and Hart Creek stations.

A wet weather sampling program was also initiated at all six stations to document the levels of *E. coli* during and after rainfall/runoff events. Fecal coliform samples were also sampled at the two Tankersley Creek locations during rainfall/runoff events.

Tankersley Creek Bacterial Source Tracking Special Study (FY 2004 – 2005)

This study was initiated in order to determine the extent of bacterial abundance and evaluate potential impairment throughout the Tankersley Creek Watershed, including Tankersley Lake and Dragoo Creek; identify the hydrologic conditions associated with events of elevated levels of bacteria; determine the relation between land use and *E. coli* concentration; and continue the examination of the relationship of Fecal coliform and *E. coli* results. *E. coli* samples were collected monthly at twelve stations, of which six were historical TCEQ monitoring stations. Fecal coliform bacteria were also collected monthly at these same six sites given that historical data was available for use in comparison and evaluation.

Station locations were based on criteria which included sites with road accessibility, sites near industrial or domestic discharges and areas that may potentially receive high non-point source loads. Water quality monitoring, storm runoff studies, and modeling results which were part of the Lake O' the Pines TMDL program showed that poultry production, processing, and waste disposal were a significant source of the nutrient loading entering Big Cypress Creek. *(Texas Commission on Environmental Quality, 2006)*

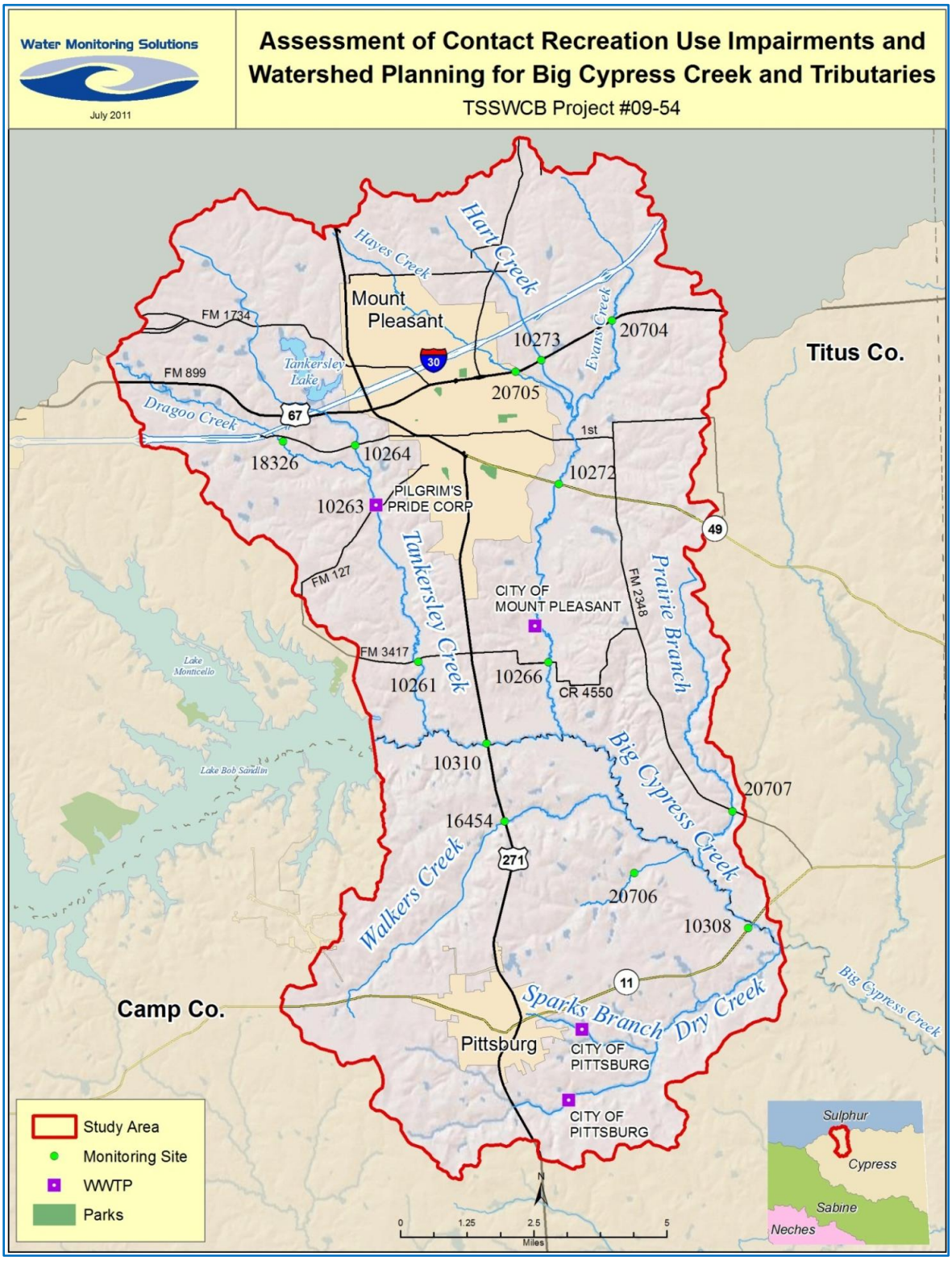


Figure 2: *Project Monitoring Stations*

PRELIMINARY FINDINGS

The following section discusses the preliminary findings of the project. All information discussed has been presented at public meetings; however, none of the data reports have been finalized at the time of this writing.

Historical Data Review

In order to include Fecal coliform results in the historical data analysis, they were converted to *E. coli* equivalent values using a factor of 0.63. This factor has been commonly used for Fecal coliform to *E. coli* conversion throughout the country and its use was approved by the project stakeholders in February 2010.

The following table shows that the geometric mean and percent of single sample results did not support the water quality criteria at any station in the watershed. *(Table 1)* In order to evaluate base-flow conditions, qualifying information such as days since last rainfall, flow severity and field comments were used to sort through the data sets. Samples collected within two days of the last rainfall, reported with high to flood flow severity, or had comments including “event sample” or “raining” were removed. Qualifying information was not available for approximately 35% of the samples. These data were assumed to have been collected during low to normal flow conditions and were included in the analysis. Removal of the event-influenced data yielded substantial reductions in the geometric mean and the percent of single sample exceedances at most stations. Once event-based sample results were removed from the data set, the *E. coli* criterion was met at all but two stations.

Table 1: *Historical bacteria data. Values in red exceed the state bacteria geometric mean standard of 126 MPN/100mL. Geometric mean calculated using combined E. coli and Fecal coliform equivalent values.*

Description	Station ID	Data Range	All Data		Adjusted Data **	
			Geomean*	# of Samples	Adjusted Geomean*	# of Samples
Dragoo Creek at CR 2400	18326	12/2004 to 8/2004	280	11	311	4
Tankersley Creek at FM 899	10264	5/1992 to 4/2005	219	39	**113**	18
Tankersley Creek at FM 127	10263	9/1997 to 4/2005	265	13	**74**	7
Tankersley Creek at FM 3417	10261	9/1987 to 4/2005	312	55	157	33
Hart Creek at SH 49	10272	10/2002 to 8/2003	390	13	**106**	5
Hart Creek at CR SE-12	10266	9/1997 to 8/2007	222	24	**92**	14
Big Cypress Creek at SH 11	10308	9/1972 to 8/2007	181	136	**104**	77
Big Cypress Creek at US 271	10310	9/1987 to 8/2007	251	5	308	3

** Geometric mean in MPN/100mL*

***Event influenced data removed*

Bacterial Source Survey

A survey of point and non-point sources of bacteria was conducted in the Hart Creek, Tankersley Creek, and Big Cypress Creek watersheds in 2010. Potential non-point sources included pets, livestock, wildlife, and improperly functioning septic systems.

Land use in the study area was reviewed to determine possible sources of bacterial loading. A large percentage of land in each watershed is managed pasture, rangeland, and mixed/riparian forest. Livestock access to most waterways is unrestricted, therefore the potential exists that significant bacteria loading occurs from animals depositing fecal material directly into or adjacent to the creeks and their tributaries. No concentrated animal feeding operations (CAFOs) were permitted in the project area. Cattle and horse populations were estimated at 12,510 animals in the watershed and accounted for 40% of the *E. coli* loading in the study area based upon preliminary BST findings. *(Martin and Gentry, 2011) (Figure 3)*

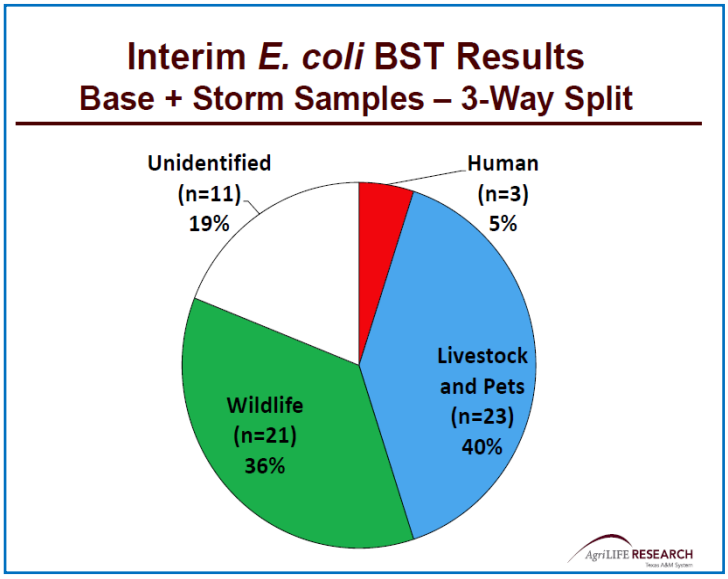


Figure 3: *Preliminary BST Sample Results*

Preliminary BST data showed about 36% of the *E. coli* loading in the study area came from wildlife with feral hogs being a major contributor. *(Martin and Gentry, 2011)* There were an estimated 4,923 feral hogs in the study area assuming one animal per 7.5 acres of riparian land *(McKee, et al., 2011)*. Bacteria from feral hogs produced positive BST results at several sites in the study area. *(Appendix B)*

Numerous poultry houses are located throughout the study area and land applied litter was a bacteria loading concern. Preliminary BST results showed that land applied poultry litter was not a major contributing source of bacteria loading. (*McKee, et al., 2011*) Stakeholders estimated that as much as 95% of the litter produced in the study area was land applied outside of the watershed.

On-site septic facilities are a common method of wastewater treatment, and it was estimated that 6,182 households were on septic systems in the study area. (*McKee, et al., 2011*) They can offer a decentralized, lower cost, long-term solution to wastewater treatment as opposed to conventional gravity sewers for large centralized wastewater systems. *(Figure 4)* However, they require regular maintenance and management to prevent contamination to ground and surface waters. Septic systems that are not installed or maintained properly can fail or leak, and over time, pretreated waste can leach underground and potentially increase bacteria levels in streams. Preliminary BST data showed about 5% of the *E. coli* loading came from human sources. *(Martin and Gentry, 2011)*

No municipality in the study area maintains a permit for a municipal separate storm sewer system (MS4) which would identify specific discharge points of storm water directly into a waterway.

There are two main point sources in the study area. The Pilgrim's Pride Corporation Southwest Waste Water Plant, located on FM 127, is permitted to discharge 3.0 MGD into Tankersley Creek. The treatment process includes chlorination and de-chlorination to less than 0.1 mg/l chlorine residual. The facility also discharges storm water from three designated outfall locations. Storm water from all three outfalls drains to a roadside ditch which discharges into Tankersley Creek.

Figure 4: *Septic system installation*

The City of Mount Pleasant Waste Water Treatment Plant is located southeast of the city and discharges into an unnamed tributary of Hart Creek north of County Road 4550 and is permitted to discharge up to 2.91 MGD. The primary source of wastewater is domestic, but some industrial waste is also treated at the facility.

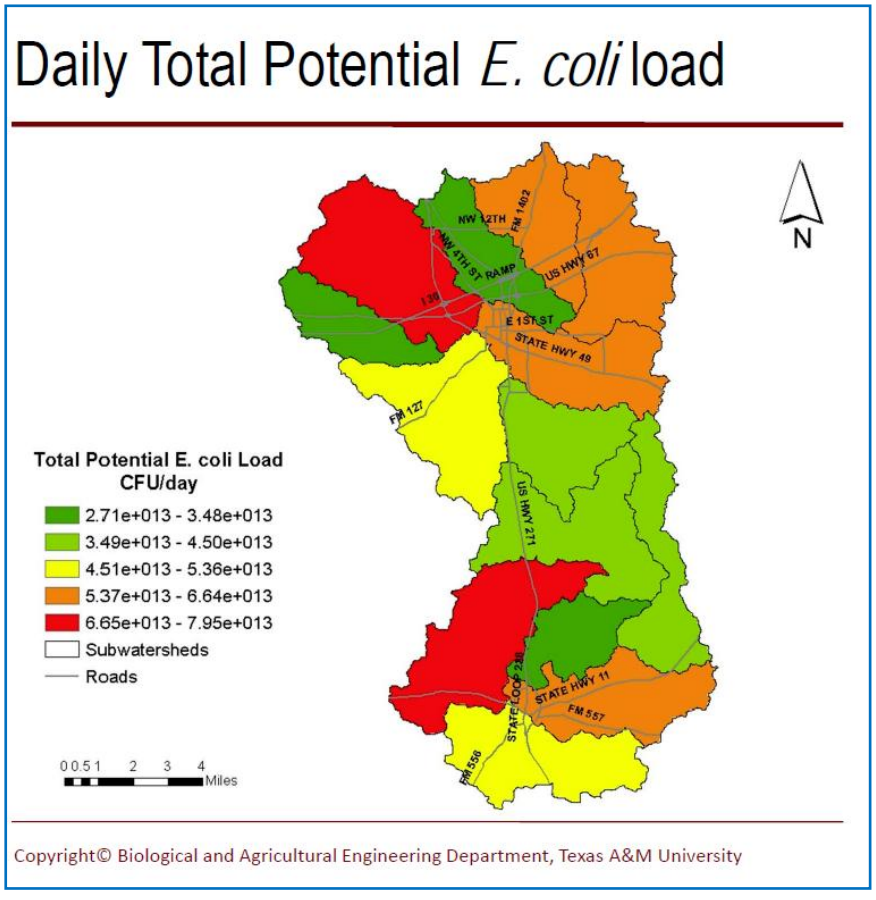


Figure 5: *Daily Total Potential E. coli load*

Bacteria loading from both WWTPs were minimal based upon preliminary SELECT modeling results. *(McKee, et al., 2011)*

Water Quality Monitoring

NETMWD collected routine ambient samples at fourteen stream sites and at two WWTP outfalls every two weeks from August 2009 through May 2011. *(Figure 7)* Routine sampling was conducted on a schedule determined by NETMWD and approved in the Quality Assurance Project Plan. Sampling occurred on a temporal basis regardless of conditions and rainfall. Routine monitoring was sometimes interrupted in order to collect storm event samples.

NETMWD also collected seven storm event samples at all sixteen stations during the study period. The intent of storm sampling was to identify and monitor the impact of non-point sources on water quality. Threshold limits were identified in the project Quality Assurance Project Plan to define a storm event.

Field parameters and bacteria samples were collected following procedures detailed in the TCEQ *Surface Water Quality Monitoring Procedures Manual, Volume 1: Physical and Chemical Monitoring Methods, 2008* (RG-415). Field parameters including water temperature, specific conductance, pH, and dissolved oxygen were obtained using a YSI Model 600XLMv2 multi-parameter sonde. All stream samples were collected mid-channel and upstream of the bridge at road crossings. The samples were collected at 0.3 meter depth or at mid-depth if the stream or WWTP outfall was less than 0.3 meter deep. At most stations, bacteria samples were collected from the bridge or stream bank directly into the sample bottle attached to the end of a telescoping rod. At sites where samples were collected by the technician entering the stream, the sample was collected upstream of the technician and away from disturbed sediments. All samples were collected directly into pre-cleaned bottles and labeled accordingly.

The average annual rainfall for the watershed, based upon data recorded by a USGS gage on Lake Bob Sandlin, is approximately 53 inches. The rainy season normally ranges from October to June with monthly average rainfall amounts between 3.7 inches and 5.6 inches. With little exception, rainfall is sporadic with dry periods in between. The combination of sporadic, heavy rainfall and the land use of managed pasture and rangeland along with an abundant wildlife population provide the opportunity to influence bacteria levels in the basin during runoff events.

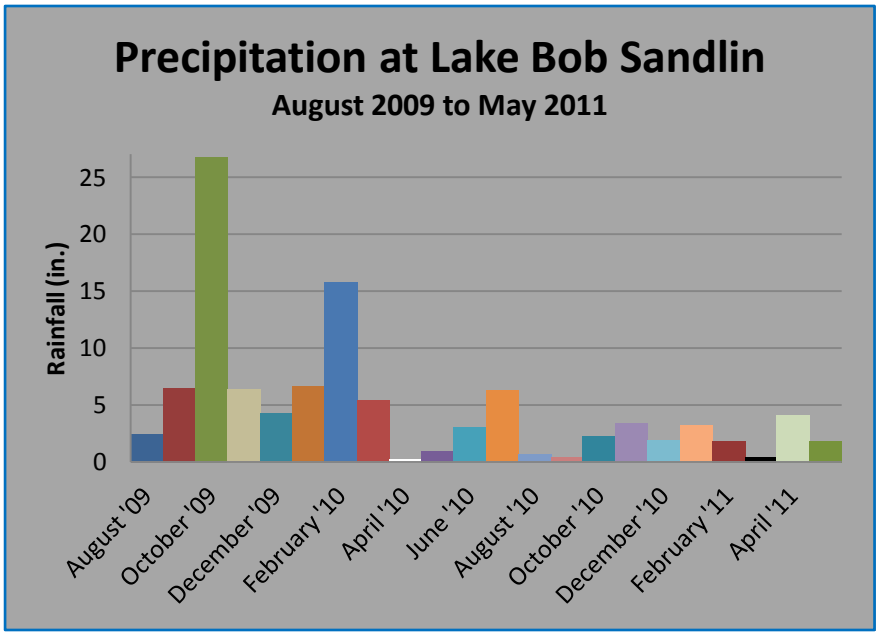


Figure 6: *Precipitation at Lake Bob Sandlin from August 2009 through May 2011*

During the data analysis, it became apparent that the bacteria results varied greatly due to heavy rainfall (wet period) from August 2009 to May 2010 as compared to a

period of drought from June 2010 to May 2011 (dry period). Approximately 75 inches of rain was measured at the USGS gage located on Lake Bob Sandlin during the ten-month wet period. Less than 30 inches of rain fell during the following twelve-month dry period. *(Figure 6)*

Exceptionally heavy rainfall was recorded in the study area shortly after the project commenced. From August to November 2009, 35.7 inches of rainfall was recorded by the Lake Bob Sandlin gauge. After the first qualifying storm event samples were collected on September 14, 2009, frequent rainfall events prevented the collection of storm samples that met the event-based criteria during the remainder of the first and much of the second quarters.

Routine sample and storm sample geometric means exceeded the state standard of 126 MPN/100mL at all stations except at the City of Mount Pleasant WWTP outfall. *(Table 2)* The lowest routine sample geometric means were at the Pilgrim's Pride WWTP outfall (180 MPN/100mL), Dragoo Creek (191 MPN/100mL), and Big Cypress Creek at SH 11 (198 MPN/100mL), which is the most downstream station.

Table 2: *Geometric means for routine and storm sampling*

Station Name	Station ID	Routine Sample Geometric mean	Storm Sample Geometric mean
Dragoo Creek	18326	191	260
Tankersley Creek at FM 899	10264	215	1575
Pilgrim's Pride Processing WWTP	16468	180	15
Tankersley Creek at FM 127	10263	370	1267
Tankersley Creek at FM 3417	10261	366	1592
Evans Creek at US 67	20704	385	1316
Hart Creek at US 67	10273	431	2074
Hayes Creek at US 67	20705	234	1502
Hart Creek at SH 49	10272	338	1519
City of Mount Pleasant WWTP	16467	3	1
Hart Creek at CR 4550	10266	424	1519
Big Cypress Creek at US 271	10310	256	1132
Walkers Creek at US 271	16454	236	767
Unnamed tributary Dukes Chapel Road	20706	440	1665
Prairie Branch at FM 2348	20707	225	1767
Big Cypress Creek at SH 11	10308	198	1086

Geometric means were calculated for both the wet and dry periods and were analyzed for trends and variability. *(Table 3)* The most downstream station in the study area, Big Cypress Creek at SH 11, had the second lowest geometric mean of all stream stations. Only Dragoo Creek had a lower geometric mean for routine samples. This station had the third lowest storm sample geometric mean and had the lowest geometric mean for samples collected within two days of rainfall. The site was also the second lowest geometric mean for samples collected after more than seven days after rainfall.

Figure 7: *Sample collection by NETMWD staff*

The geometric means of routine samples collected during the wet period were lower than results of the samples collected during the dry period at many stations. This was the case for all stations and tributaries in Tankersley Creek and in Big Cypress Creek except in Prairie Branch. These results are likely due to dilution during the wet period and possibly due to mammals concentrating near water sources during the dry period.

The preliminary results of SELECT modeling conducted by Texas Agrilife Research support these findings. The results showed high potential loadings from livestock and feral hogs. (*McKee, et al., 2011*) Preliminary BST analysis conducted by Texas Agrilife Research confirmed that a significant bacteria contribution from feral hogs and other wildlife was found in areas where land use is classified as forest, managed pasture, or rangeland. *(Martin and Gentry, 2011)*

Given the criteria for defining a storm event, the exceptional rainfall that occurred between August 2009 to May 2010, and the dry conditions from June 2010 to May 2011, NETMWD was only able to collect six storm samples. Despite a disproportionate amount of rain early in the project, the rainfall events between September 2009 and May 2010 were too frequent for samples to meet event-based criteria.

Storm event sampling was included in the project design to identify the bacteria loading from non-point sources in the project area. Results of the event based sampling produced *E. coli* quantities greater than the analytical capabilities of the laboratory. The laboratory dilution was scaled to yield a maximum of 2,400 MPN/100mL. As a result, 52 of 95 storm sample results were reported as values greater than this limit. The actual value of these samples was unknown. Routine samples collected within two days of a significant rainfall event paralleled these results.

The geometric mean for storm samples highly exceeded the state standard compared to routine monitoring geometric means. The WWTP storm event geometric means were lower than the routine sampling events for the project. Overall, a comparison of routine sample results to stormwater sampling indicated that the majority of bacteria loading took place in the upper reaches of Big Cypress Creek as a result of non-point sources in the watershed.

Table 3: *Geometric means for routine sampling dry period versus wet period*

Station Name	Station ID	Wet Period 8/2009 - 5/2010	Dry Period 6/2010 - 5/2011
Dragoo Creek	18326	109	355
Tankersley Creek at FM 899	10264	192	241
Pilgrim's Pride Processing WWTP	16468	146	224
Tankersley Creek at FM 127	10263	289	479
Tankersley Creek at FM 3417	10261	302	447
Evans Creek at US 67	20704	387	383
Hart Creek at US 67	10273	436	426
Hayes Creek at US 67	20705	271	204
Hart Creek at SH 49	10272	387	297
City of Mount Pleasant WWTP	16467	2	4
Hart Creek at CR 4550	10266	297	595
Big Cypress Creek at US 271	10310	145	465
Walkers Creek at US 271	16454	218	258
Unnamed tributary at Dukes Chapel Road	20706	402	484
Prairie Branch at FM 2348	20707	277	184
Big Cypress Creek at SH 11	10308	165	237

The storm sample geometric means were dramatically higher at all stream stations except in Dragoo Creek where the storm sample geometric mean was less than 25% higher than the routine sample geometric mean. Interestingly at the Pilgrim's Pride WWTP, the storm sample geometric mean (15 MPN/100mL) was much lower than the routine sample geometric mean (180 MPN/100mL).

Trend analysis was performed to determine statistical significance between *E. coli* and discharge using a 95% confidence interval. The relationship was determined to be statistically significant when meeting two criteria: the T-stat value was greater than the absolute value of two, and the p-value was less than 0.05. A statistically significant relationship existed between *E. coli* and discharge at all stream sites except at Tankersley Creek at FM 3417. Dirt work along the stream banks on the private property upstream of the station began in July 2010. The erosional and destabilized banks may have influenced the bacteria results due to high sediment transport. However, these findings confirm the standard assumption that the amount of bacteria in the water increases as discharge increases.

Comprehensive Recreational Use Attainability Analysis

A total of 91.2 kilometers in Tankersley Creek, Hart Creek, and Big Cypress Creek were evaluated with a total of 18 full surveys during each round of RUAA surveys. *(Appendix A)* The RUAA surveys were completed in order to evaluate whether the existing and/or attainable recreational uses of these streams might be different than the presumed contact recreation use. Important data collected in the RUAA included general stream characteristics, observations and evidence of recreational use, surrounding conditions that promote recreation, and surrounding conditions that impede recreation including channel obstructions.

Figure 8: *WMS staff measuring thalweg depth*

A 300 meter reach was surveyed at each station. The stream width and thalweg depth was measured at 30 meter intervals. Depth was measured using a metric leveling rod and the location of each 30 meter transect was determined using a laser range finder. *(Figure 8)* A kayak was used to travel and survey the reach at non-wadeable stations.

Field observations included measuring the air and water temperature, and the length and width of all pools within the reach. Pools were defined as being at least one meter deep by ten meters long. A stream flow measurement was made at all wadeable stations where there was not an existing USGS gage. Flow was measured using a SonTek FlowTracker Acoustic Doppler Velocimeter.

Other observations included noting channel obstructions such as dams, log jams, pipelines, fencing and trash; human presence including litter, walkways, fire pits and fishing tackle; animal presence including tracks, trails, nests, scat, and beaver dams *(Figure 9)* Physical characteristics of the reach such as bank steepness, bank stability, sediment material, water clarity, and vegetation were noted. The ease of access, fencing and/or no trespassing signs, and the number of people present were also recorded on field forms.

Figure 9: *Fallen trees and surface scum in Big Cypress Creek at US 271*

The first round of field surveys was conducted on Memorial Day (May

30) through June 1, 2011 and the second round was conducted on July 1 through 3, 2011. Sites where people were most likely to be present were surveyed on Memorial Day and during the July 4th weekend. Three sites on Big Cypress Creek were selected where there was public access and where the stream was presumed to be the deepest. These sites were at the bridge crossings on US 271, SH 11 and Sand Crossing. No one was present at these stations during either round of surveys; however, many people were observed at Lake Bob Sandlin Park on Memorial Day and at Town Lake on Saturday, July 2nd. No one was observed at any of the eight stations where bacteria sampling and flow measurements were made from August 2009 through May 2011.

Forest was the dominant riparian zone recorded for all the streams combined (58%), followed by shrub dominated corridors (17%), and pastures (16%). Field observations indicated that Big Cypress Creek had a significant amount of water at the time of the surveys despite extreme drought conditions. Only Segment 0404 had substantial pools of over one meter in depth at the majority of its stations; however, the results of the RUAA summary analysis indicated that no primary contact recreation activities occurred at any station in the study area. The results of land owner interviews and discussions with public officials and stakeholders at seven public meetings over the course of two years corroborated these findings.

Figure 10: *No trespassing (purple paint on tree)*

There were two sites in the study area identified during the RUAA field surveys where public access was readily available: FM 1734 in the headwaters of Tankersley Lake and in Big Cypress Creek at Sand Crossing located above Lake O' the Pines. There were no houses, parks, playgrounds, or schools located adjacent to or near any of the stations in the study area. Access to the other stations was limited to the public right of way at stations with a bridge crossing. With the exception of litter near the bridge crossings, no evidence of human activity was recorded at any site in Hart Creek or Tankersley Creek.

RUAA summary analysis indicated that all of the stations had very limited public access due to the large amount of privately owned land surrounding these streams. *(Figure 10)* All of the streams combined had an average of less than three conditions that promote recreation, while they had an average of 8.5 conditions that impede recreational uses. Conditions that impeded recreational use of the streams included private property with fences (84%), no parking area (95%), and thick riparian vegetation such as briars and poison ivy (89%). Other conditions that impeded the recreational use of the stream

included deep mud/silt (79%) and the presence of wildlife, especially snakes (79%). *(Figure 11)* In addition to limited access to the stream, channel obstructions were also common with an average of four types of obstructions per stream. These channel obstructions included log jams (78%), followed by thick vegetation (78%), along with garbage and other large debris (44%).

RUAA summary analysis further indicated that no secondary contact recreation activities occurred at any station in Hart Creek or in Tankersley Creek except at FM 1734 located in the headwaters of Tankersley Lake. There were indications of secondary contact recreation in Big Cypress Creek below the Fort Sherman Dam, US271, SH11, and at Sand Crossing. Three men fishing from a boat were observed immediately below the Fort Sherman Dam. Access to this station is limited to Titus County Freshwater Supply District staff only, and one must pass through a security controlled gate to enter the stream.

The Sand Crossing site had the most evidence of human activity. Fishing tackle, a fire pit, walking trails, and a chair were noted during the field surveys. A small amount of fishing line and a bobber were noted in Big Cypress Creek at US271 and SH11 as well at the Tankersley Creek station located in the headwaters of Tankersley Lake.

No noncontact recreation activities were noted at any station in the study area.

Figure 11: *Snake in Big Cypress Creek*

SUMMARY

The results presented in this report are preliminary and are under review by the Texas State Soil and Water Conservation Board. All data discussed in this report have been presented at public meetings and those presentations are available to the public on the project website: http://bcc.tamu.edu/

A review of the historical data showed that much of the bacteria data for Big Cypress Creek, Tankersley Creek, and Hart Creek were collected during a storm event or within a couple of days of an event. Removal of the event-based data yielded substantial reductions in the geometric mean and the percent of single sample exceedances at most stations. The bacteria source survey identified many contributors of possible sources of bacteria. Non-point sources included livestock, pets, wildlife, sludge application fields, and on-site septic systems. There are two point sources in the study area: the City of Mount Pleasant WWTP located in Hart Creek and the Pilgrim's Pride Corporation Southwest WWTP in Tankersley Creek.

Preliminary monitoring data showed that bacteria geometric means exceeded the state standard at all stream stations in the study area. The geometric mean also exceeded the state standard with the data separated into wet and dry periods. Monitoring data showed that the treatment plants were not significant sources of *E. coli* loading and that storm event results showed that the majority of the loading came from non-point sources.

The preliminary results of BST analysis and SELECT modeling supported these findings. Both BST analysis and SELECT modeling showed that the highest levels of bacterial contributions came from wildlife and livestock, and that loading from humans and poultry were not significant sources. The results of BST analysis showed that feral hogs and ruminants (cattle and deer) were major contributors of *E. coli* in the basin. Preliminary BST analysis also showed that the levels of *E. coli* from human, ruminant and feral hogs were almost equal during normal flows, but the ruminant and feral hog indicators escalated during storm events, with feral hog levels more than doubling.

Preliminary results of the Comprehensive RUAA found no evidence of primary contact recreation occurring within the study area. Interviews with landowners, public officials, game wardens and stakeholders at public meetings supported these findings. Conditions that impeded the recreational use of the streams included private property, fences, no parking area, thick riparian vegetation such as briars and poison ivy, channel obstructions, deep mud/silt and the presence of wildlife.

There was no evidence of secondary contact recreation occurring at any station in Hart Creek or Tankersley Creek except at FM 1734 which is at the headwaters of Tankersley Lake. The preliminary RUAA results showed that fishing is the most common recreational use of Big Cypress Creek. There was evidence of fishing below the Fort Sherman Dam, and crossings at US 271, SH 11, and Sand Crossing located immediately above Lake O' the Pines.

REFERENCES

Gregory, Lucas, Texas Water Resources Institute; Jasjeet Kaur, Kyna McKee, R. Karthikeyan, Texas Agrilife Research, Texas A&M University, Biological and Agricultural Engineering. *GIS and Land Use/Land Cover Development.* February 4, 2010 public meeting; Mount Pleasant, Texas.

Library Catalog of Texas State Agencies website: *http://tsla.sirsi.net/uhtbin/cgisirsi/x/x/0/49/* Accessed May 18, 2011

Martin, Emily and Gentry, Terry. *Bacterial Source Tracking Big Cypress Creek Bacteria Assessment Project.* Texas Agrilife Research, Texas A&M University, Soil and Aquatic Microbiology Laboratory. July 18, 2011 public meeting; Mount Pleasant, Texas.

McKee, Kyna; Jasjeet Kaur; R. Karthikeyan. *Modeling Support for Big Cypress Creek Watershed – SELECT.* Texas Agrilife Research, Texas A&M University, Biological and Agricultural Engineering. July 18, 2011 public meeting; Mount Pleasant, Texas.

Paul Price Associates, Inc. 2003. *Tankersley Creek Indicator Bacteria Special Study, Upper Cypress Creek Watershed*. Prepared for the Northeast Texas Municipal Water District.

Paul Price Associates, Inc. 2005. *Tankersley Creek Bacterial Source Tracking Special Study, Cypress Creek Basin FY 2004 – 2005*. Prepared for the Northeast Texas Municipal Water District.

Texas Commission on Environmental Quality. 2006. *Lake O' the Pines: A TMDL Project for Dissolved Oxygen*. http://www.tceq.state.tx.us/implementation/water/tmdl/19-lakeopines.html#tmdls

Texas Commission on Environmental Quality. 2008. *Texas Water Quality Inventory and 303(d) List.* http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/2008_303d.pdf

Texas Commission on Environmental Quality. 2010. *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*. http://www.tceq.texas.gov/waterquality/assessment/305_303.html

Texas Historical Commission website: *www.thc.state.tx.us* Accessed May 20, 2011

Texas Parks and Wildlife Department. 1974. *An Analysis of Texas Waterways, A Report on the Physical Characteristics of Rivers, Streams and Bayous in Texas.* Published by The Texas Agricultural Extension Service.

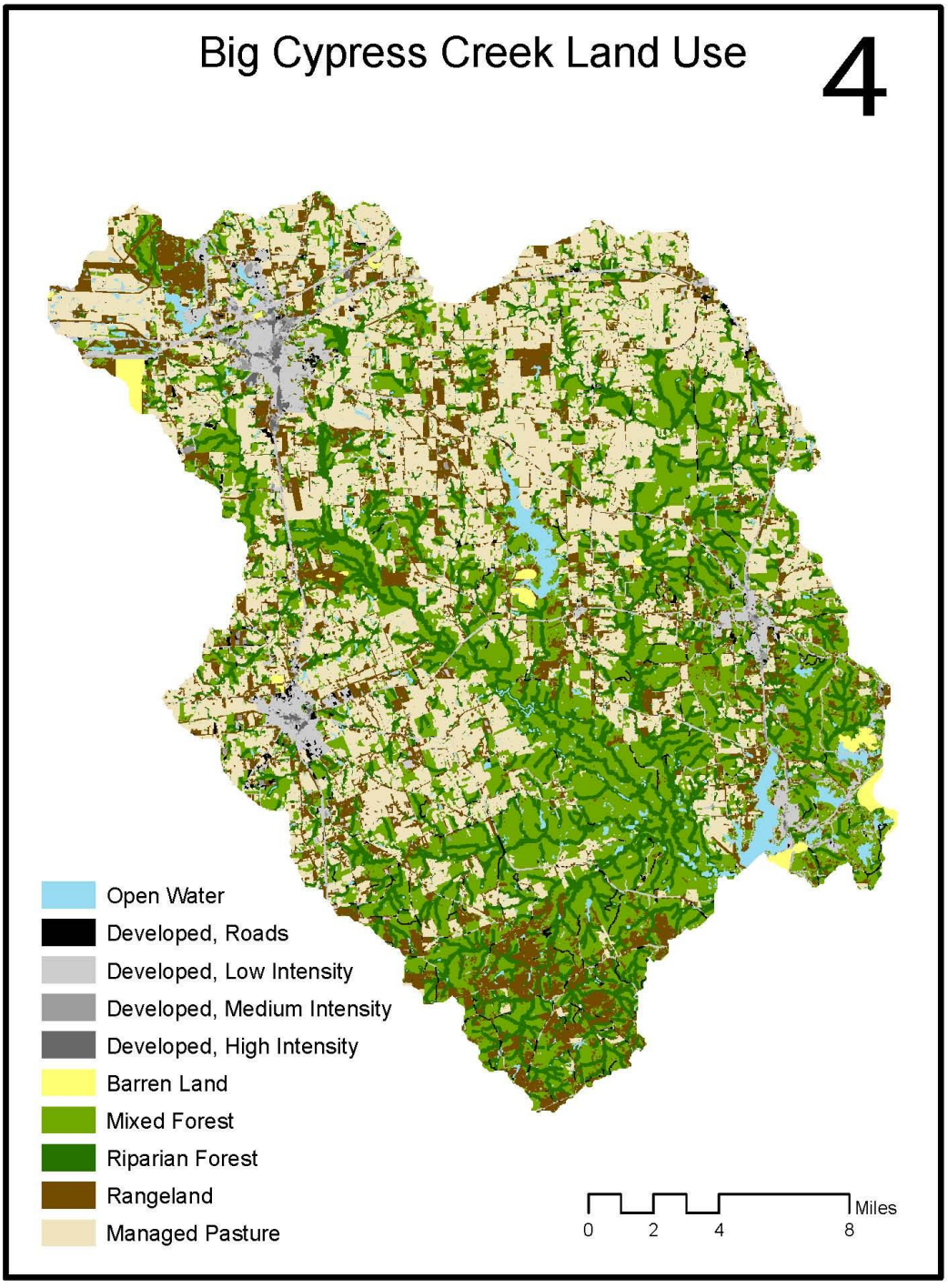
Texas State Historical Association. *Handbook of Texas Online. Big Cypress Creek.* http://207.200.58.4/handbook/online/articles/BB/rbbch.html Accessed July 30, 2010

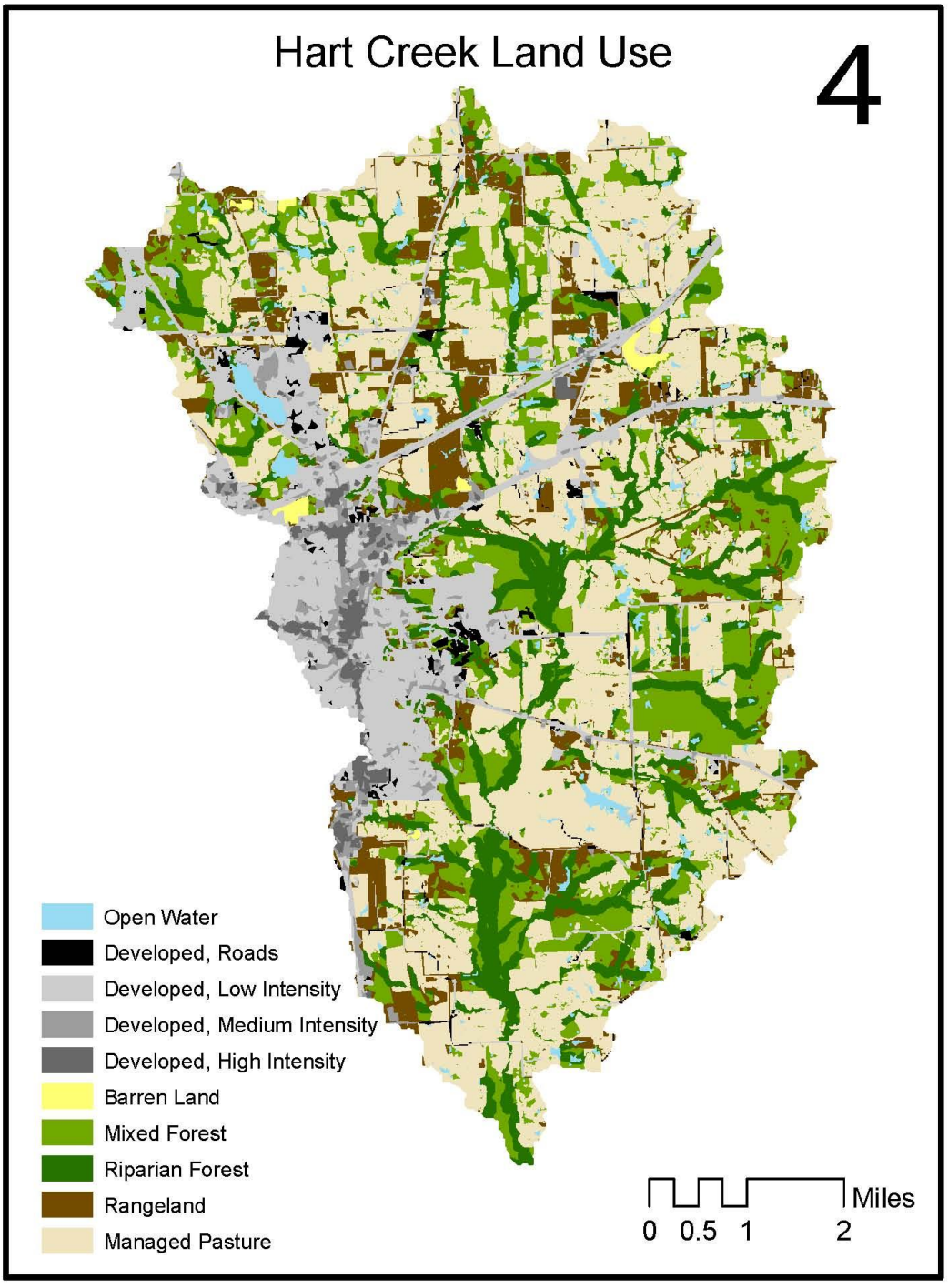
The Daily Tribune (Mount Pleasant newspaper) website: *www.dailytribune.net* Accessed May 20, 2011

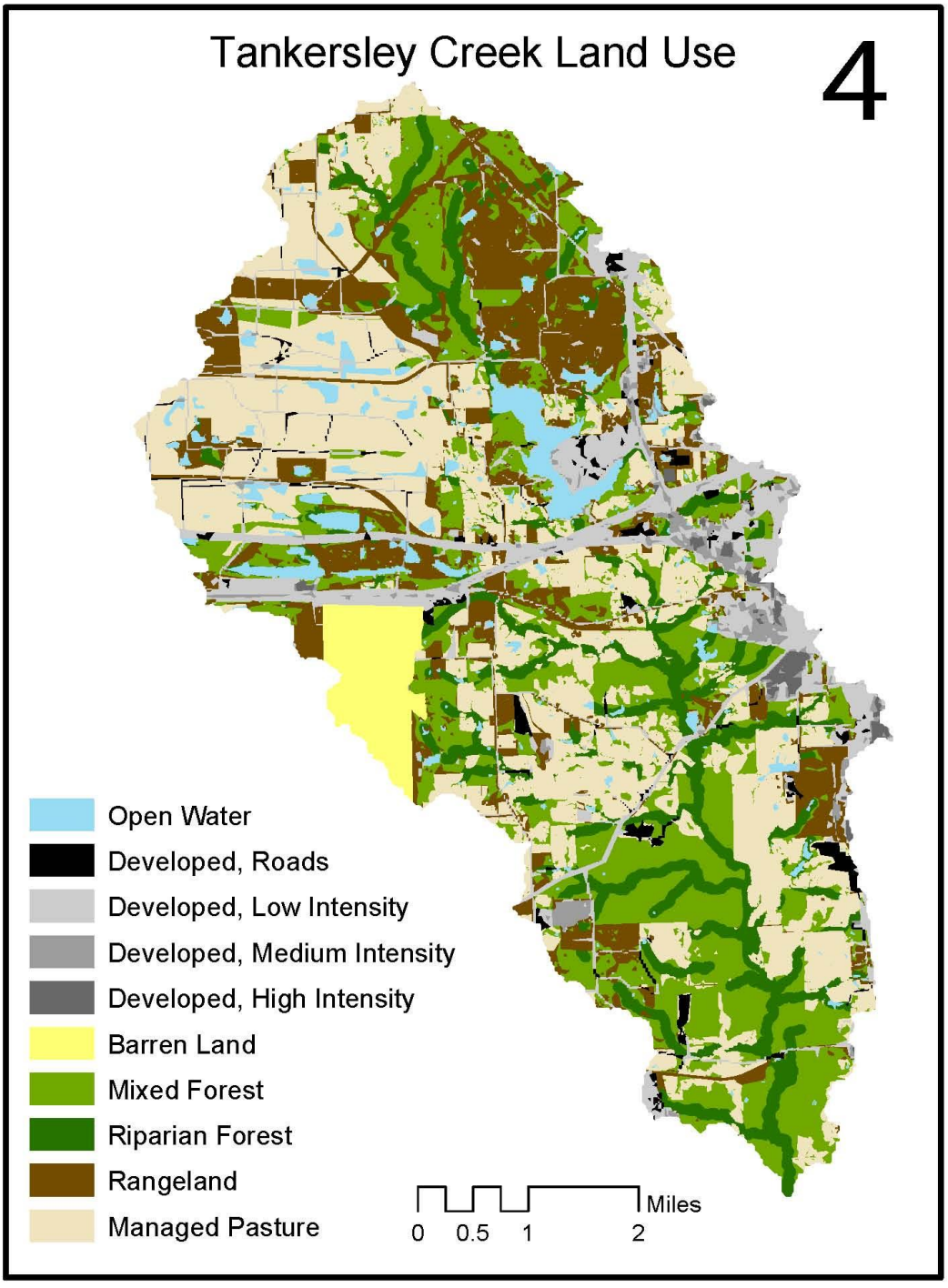
APPENDIX A

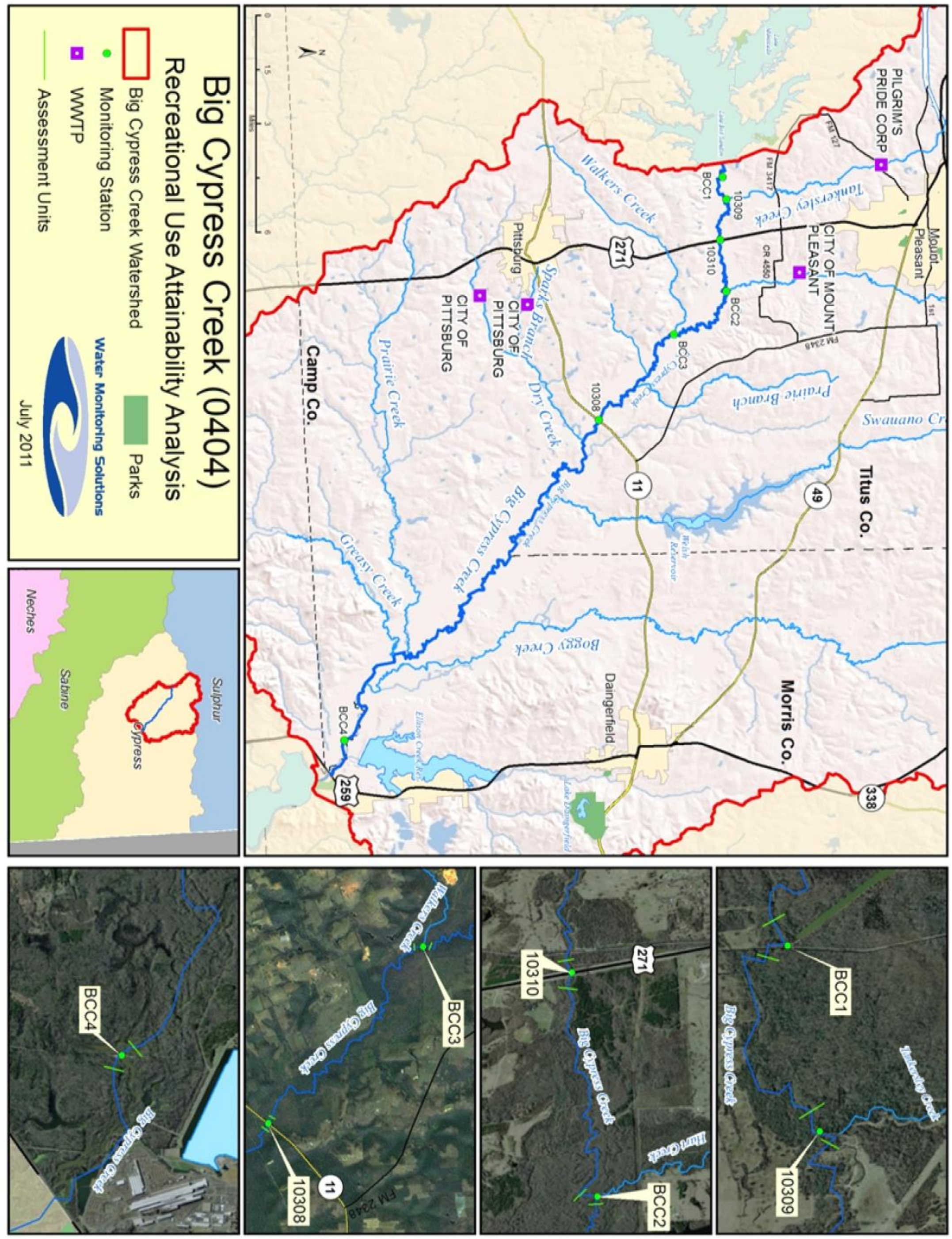
LAND USE MAPS

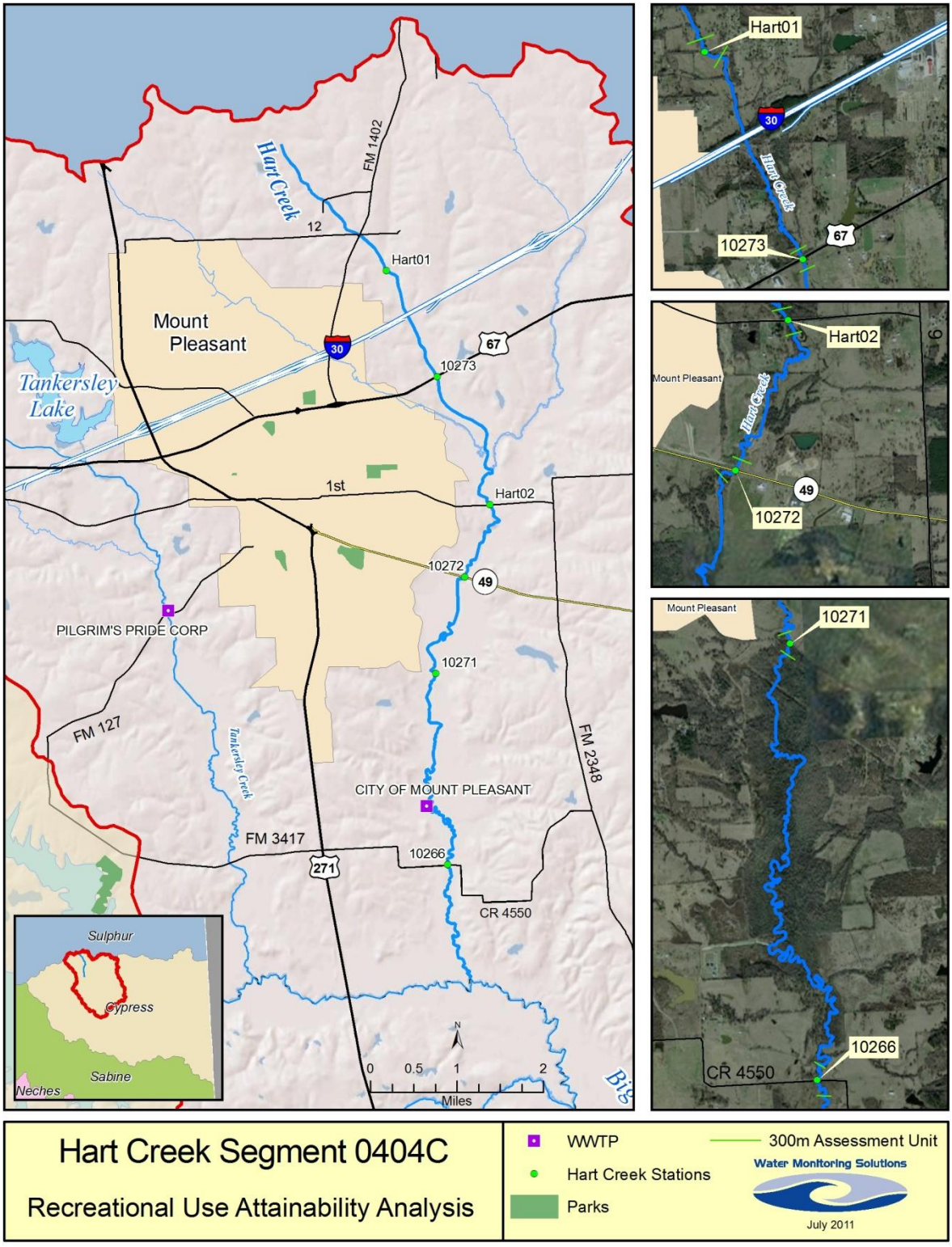
RUAA STATION MAPS

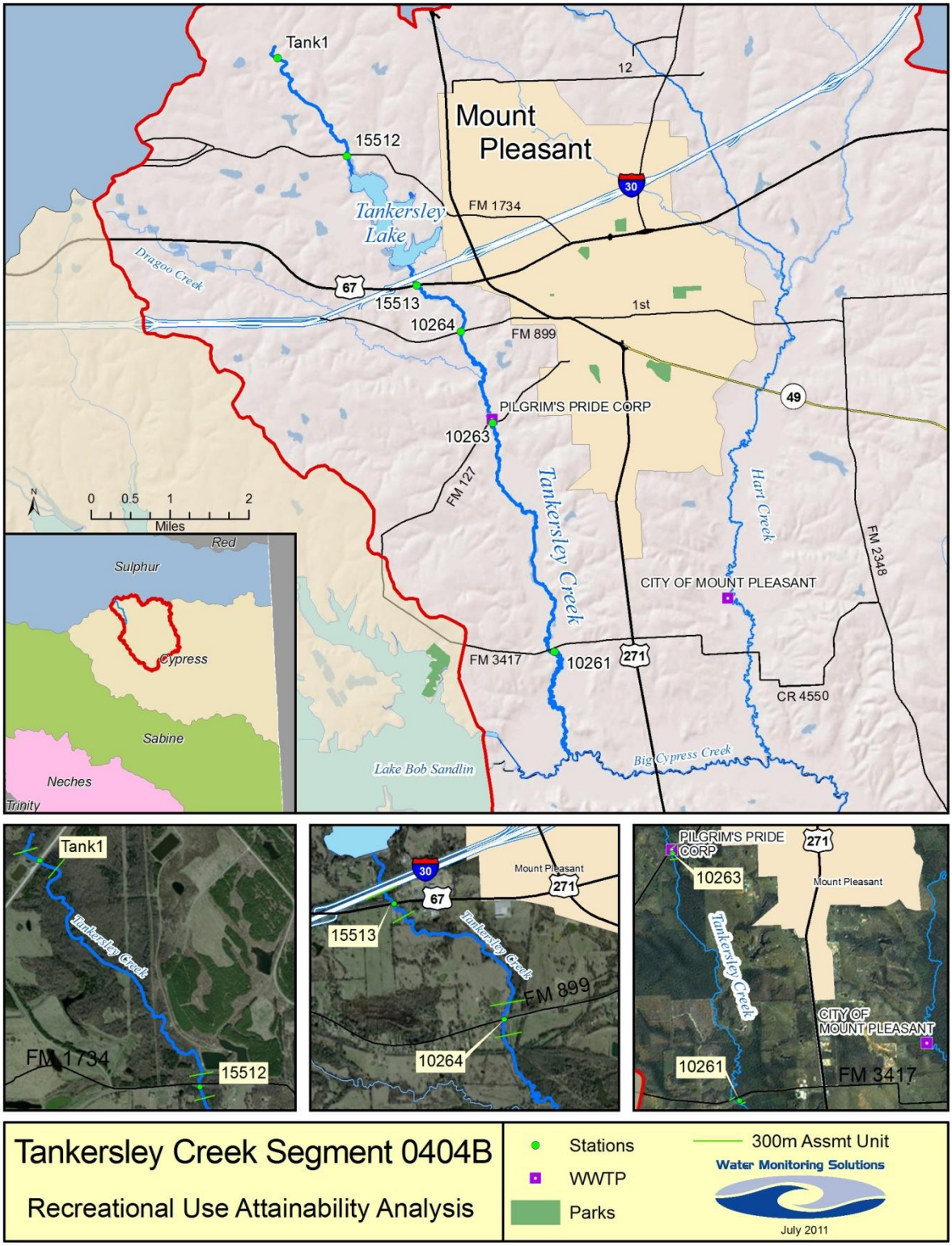

Big Cypress Creek Land Use
4
Open Water
Developed, Roads
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land
Mixed Forest
Riparian Forest
Rangeland
Managed Pasture
0
2
4
8
Miles


Hart Creek Land Use
4
Open Water
Developed, Roads
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land
Mixed Forest
Riparian Forest
Rangeland
Managed Pasture
Miles
0 0.5 1 2


Tankersley Creek Land Use
4
Open Water
Developed, Roads
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land
Mixed Forest
Riparian Forest
Rangeland
Managed Pasture
0 0.5 1 2
Miles


Big Cypress Creek (0404)
Recreational Use Attainability Analysis
Big Cypress Creek Watershed
Monitoring Station
WWTP
Assessment Units
Parks
Water Monitoring Solutions
July 2011
Miles
PILGRIM'S PRIDE CORP
Mount Pleasant
CITY OF MOUNT PLEASANT
Pittsburg
CITY OF PITTSBURG
CITY OF PITTSBURG
Daingerfield
Titus Co.
Morris Co.
Camp Co.
Tankersley Creek
Walkers Creek
Sparks Branch
Dry Creek
Prairie Branch
Swauano Cr
Prairie Creek
Greasy Creek
Boggy Creek
Big Cypress Creek
BCC1
BCC2
BCC3
BCC4
10309
10310
10308
271
11
49
259
338
Sulphur
Cypress
Sabine
Neches


Hart Creek Segment 0404C
Recreational Use Attainability Analysis
WWTP
Hart Creek Stations
Parks
300m Assessment Unit
Water Monitoring Solutions
July 2011
Hart01
Hart02
10273
10272
10271
10266
Mount Pleasant
Tankersley Lake
PILGRIM'S PRIDE CORP
CITY OF MOUNT PLEASANT
FM 1402
FM 127
FM 3417
FM 2348
CR 4550
1st
12
67
49
271
30
Tankersley Creek
Hart Creek
Sulphur
Cypress
Sabine
Neches
0 0.5 1 2
Miles

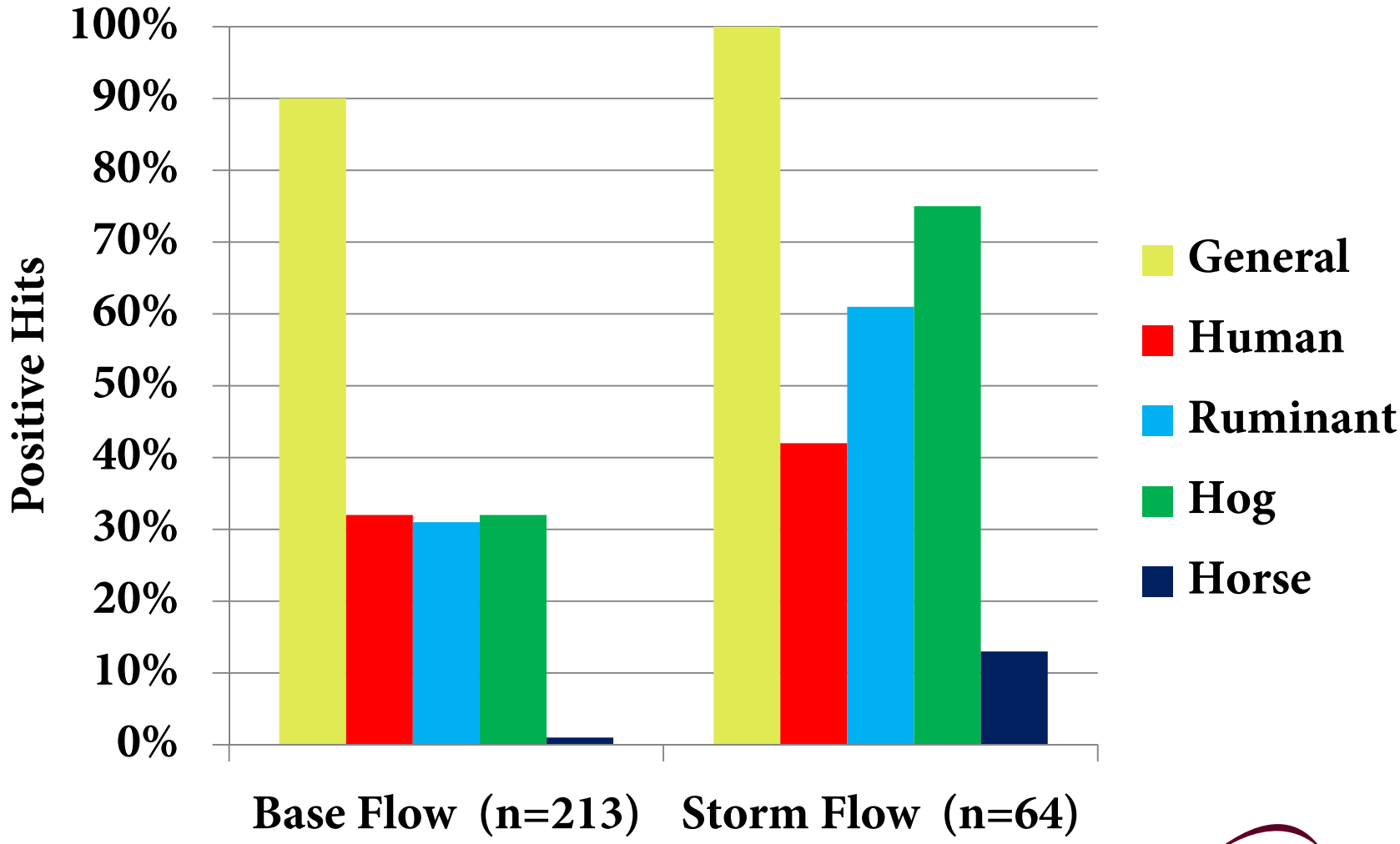

Tank1
15512
Mount Pleasant
12
30
FM 1734
Tankersley Lake
Dragoo Creek
67
15513
10264
1st
FM 899
49
PILGRIM'S PRIDE CORP
10263
FM 127
Tankersley Creek
Hart Creek
FM 2348
CITY OF MOUNT PLEASANT
FM 3417
10261
271
CR 4550
Big Cypress Creek
Lake Bob Sandlin
N
0 0.5 1 2
Miles
Red
Sulphur
Cypress
Sabine
Neches
Trinity
Tank1
Tankersley Creek
FM 1734
15512
30
67
Mount Pleasant
271
15513
Tankersley Creek
FM 899
10264
PILGRIM'S PRIDE CORP
271
10263
Mount Pleasant
Tankersley Creek
CITY OF MOUNT PLEASANT
10261
FM 3417
Tankersley Creek Segment 0404B
Recreational Use Attainability Analysis
Stations
WWTP
Parks
300m Assmt Unit
Water Monitoring Solutions
July 2011

APPENDIX B

PRELIMINARY BST RESULTS

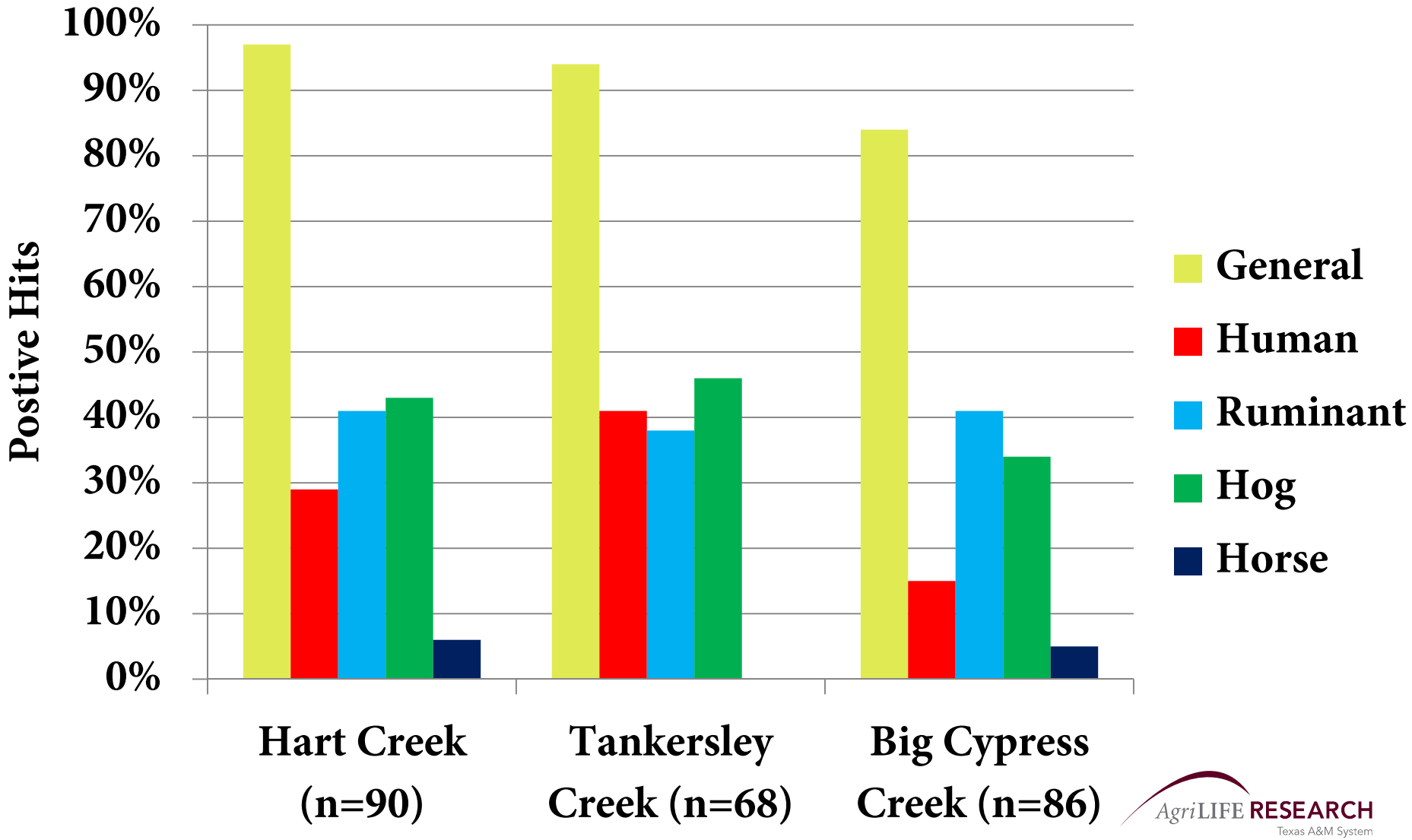
PRELIMINARY SELECT MODEL RESULTS

Bacteroidales BST Results
Base v. Storm Samples



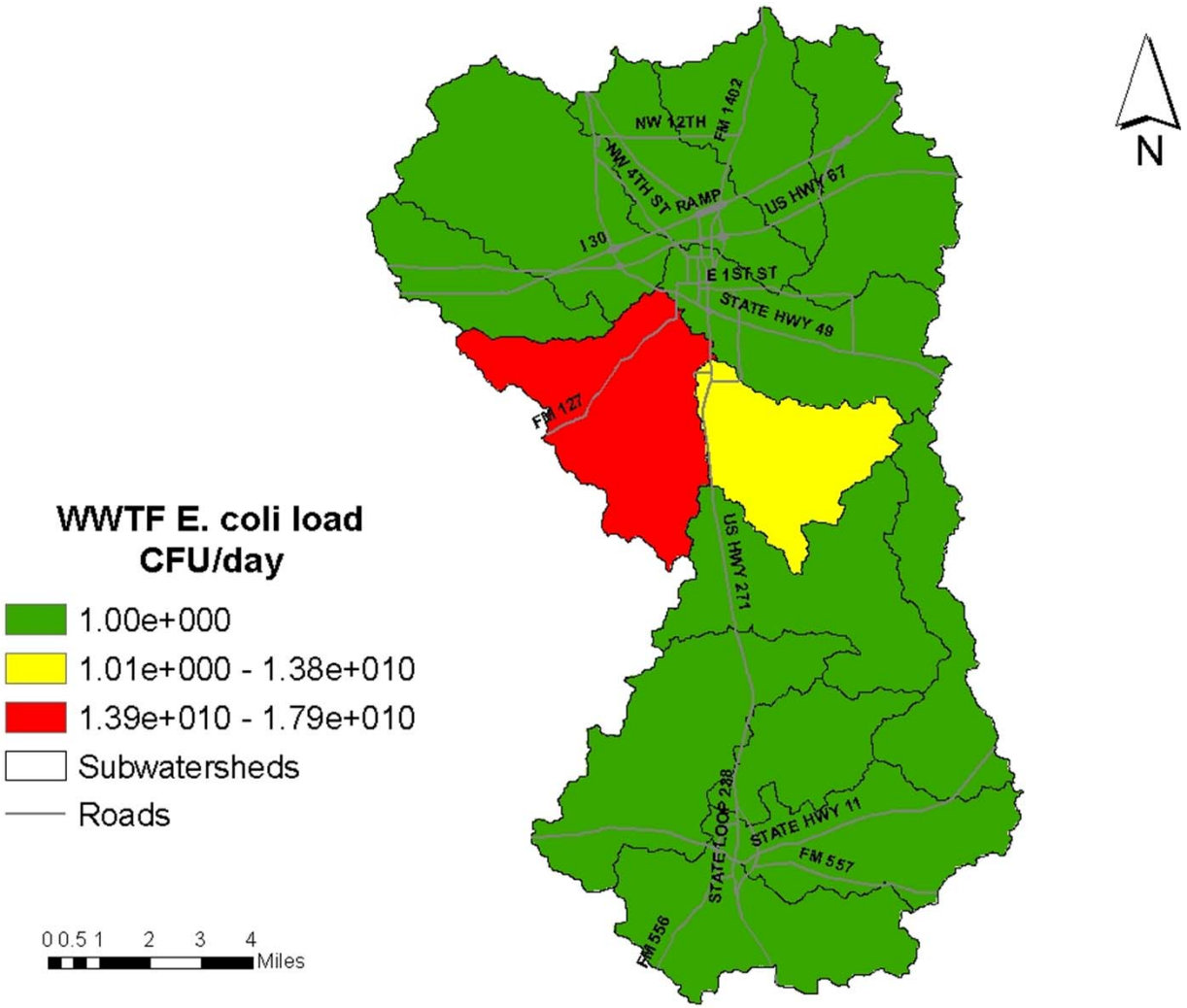
AgriLIFE RESEARCH
Texas A&M System

Bacteroidales BST Results
Sub-Watershed Stream Samples

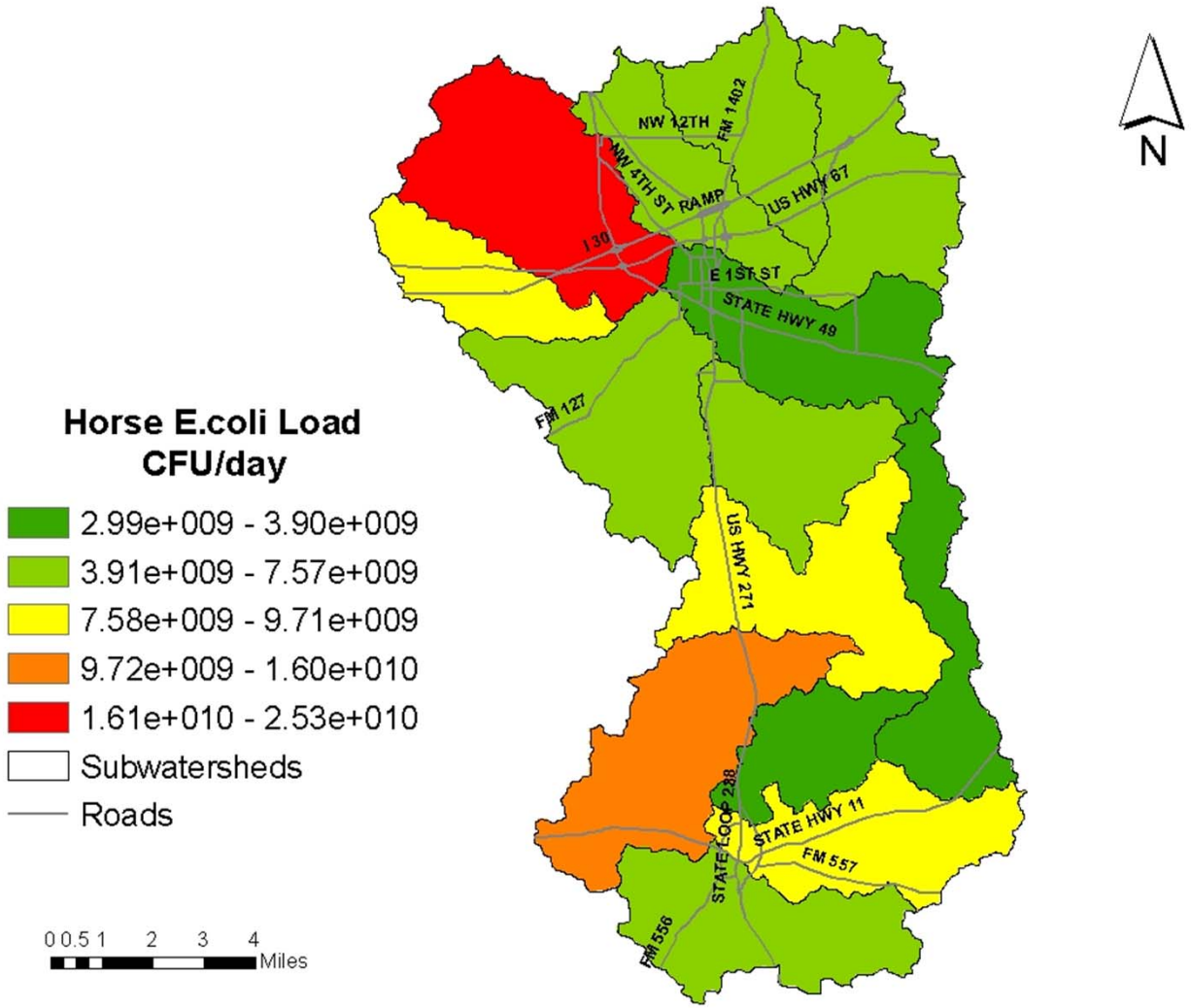


AgriLIFE RESEARCH
Texas A&M System

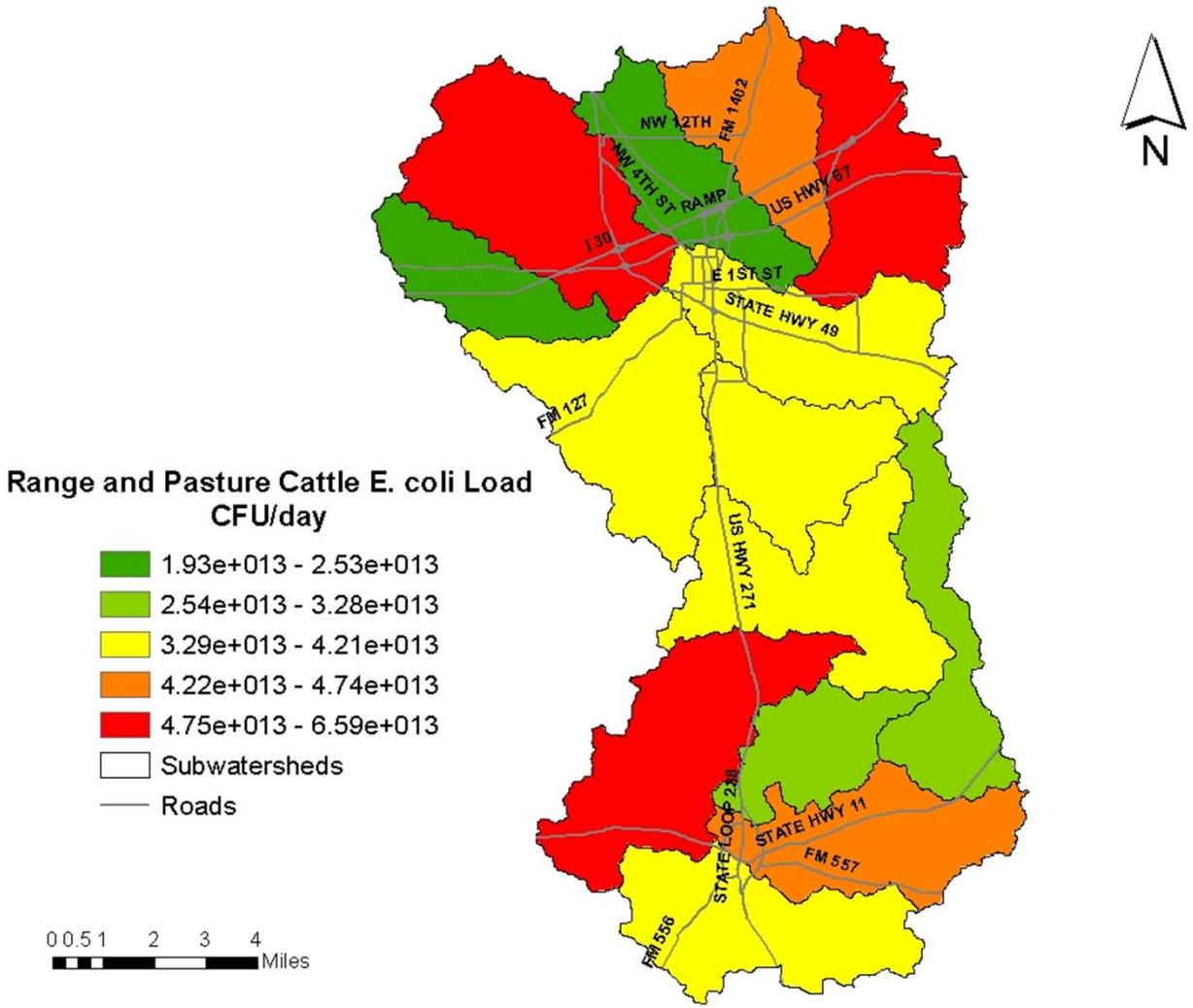
Potential *E. coli* loads resulting from Wastewater Treatment Facilities



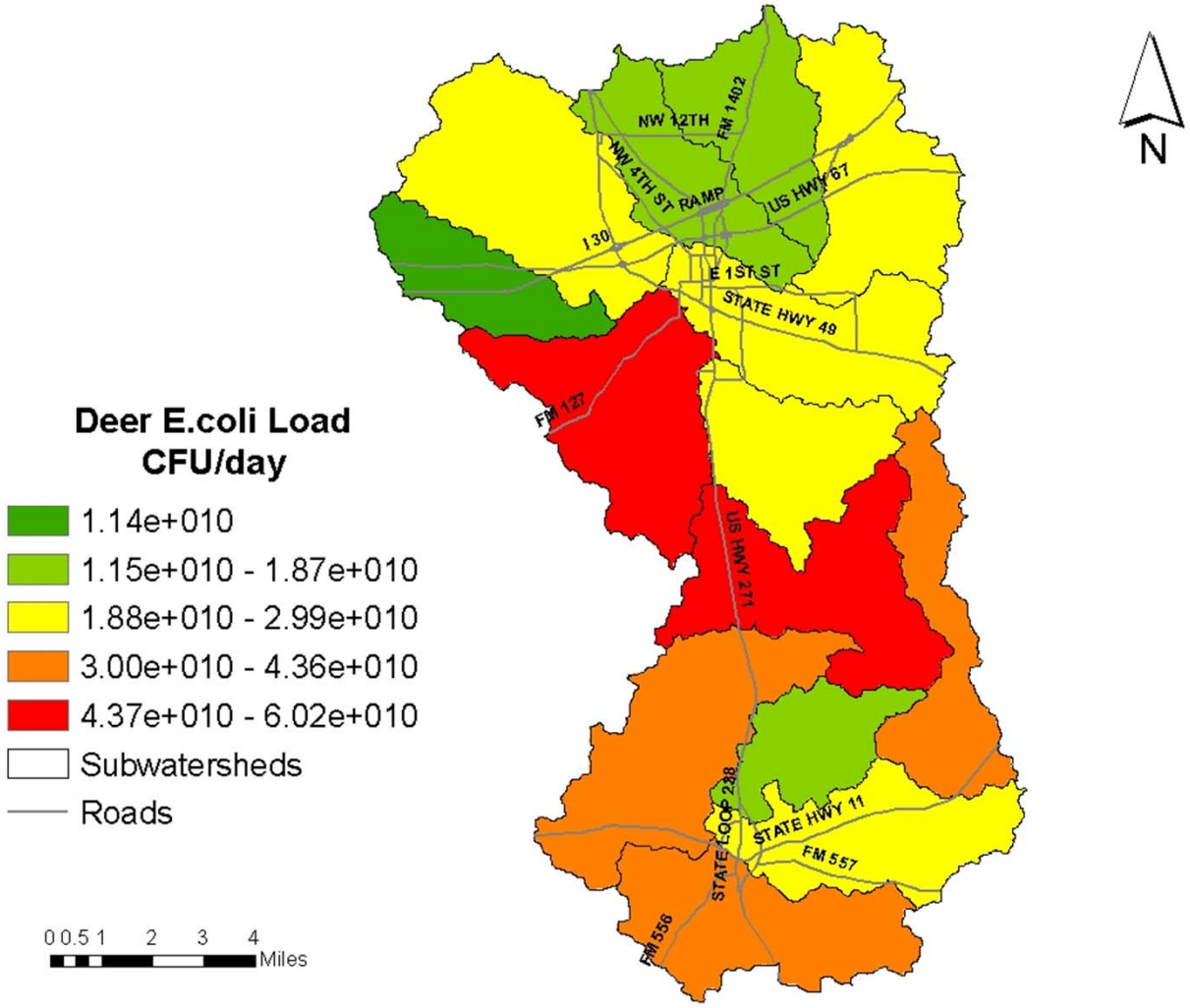
Potential *E. coli* loads resulting from Horses



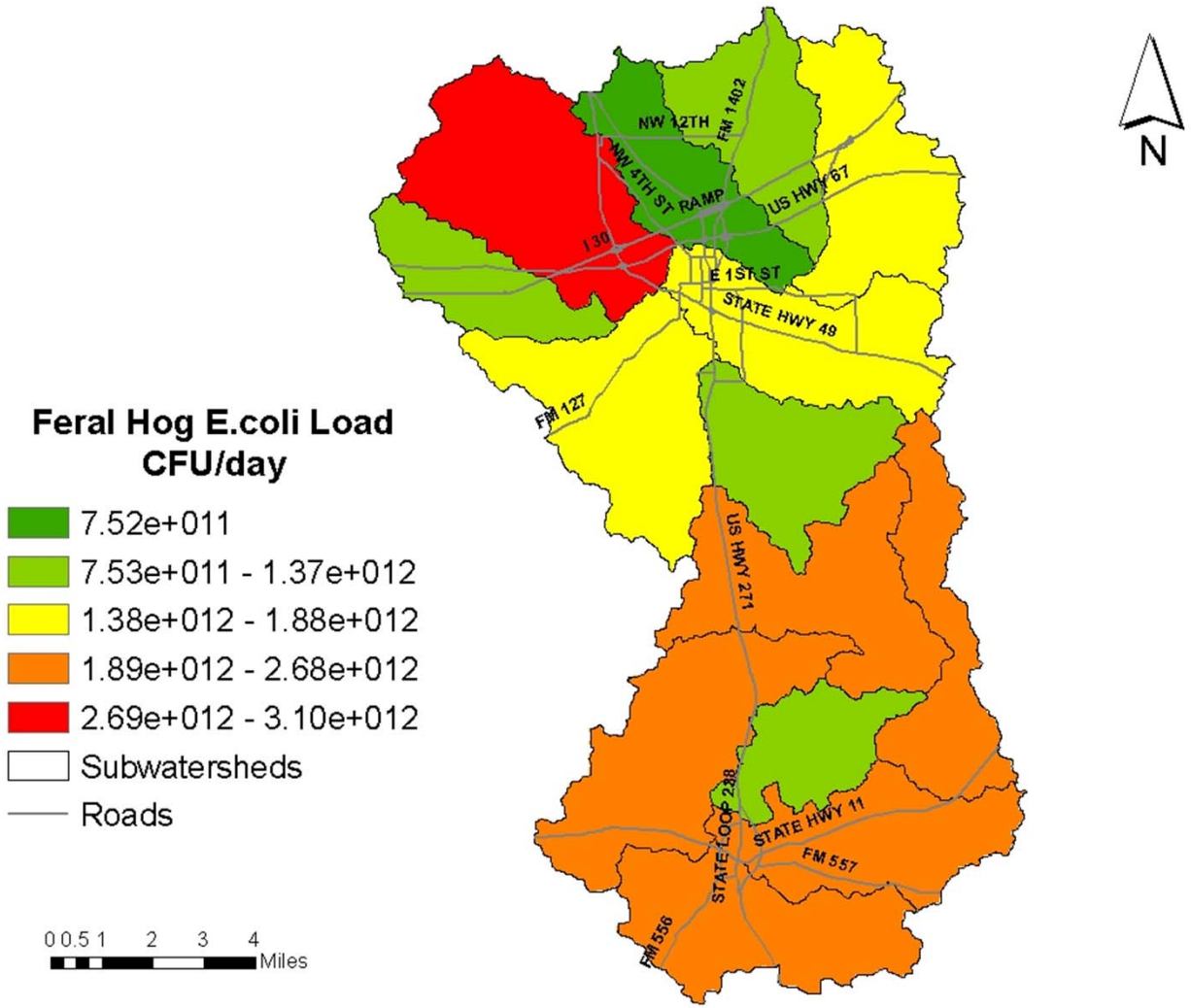
Potential *E. coli* loads resulting from Cattle



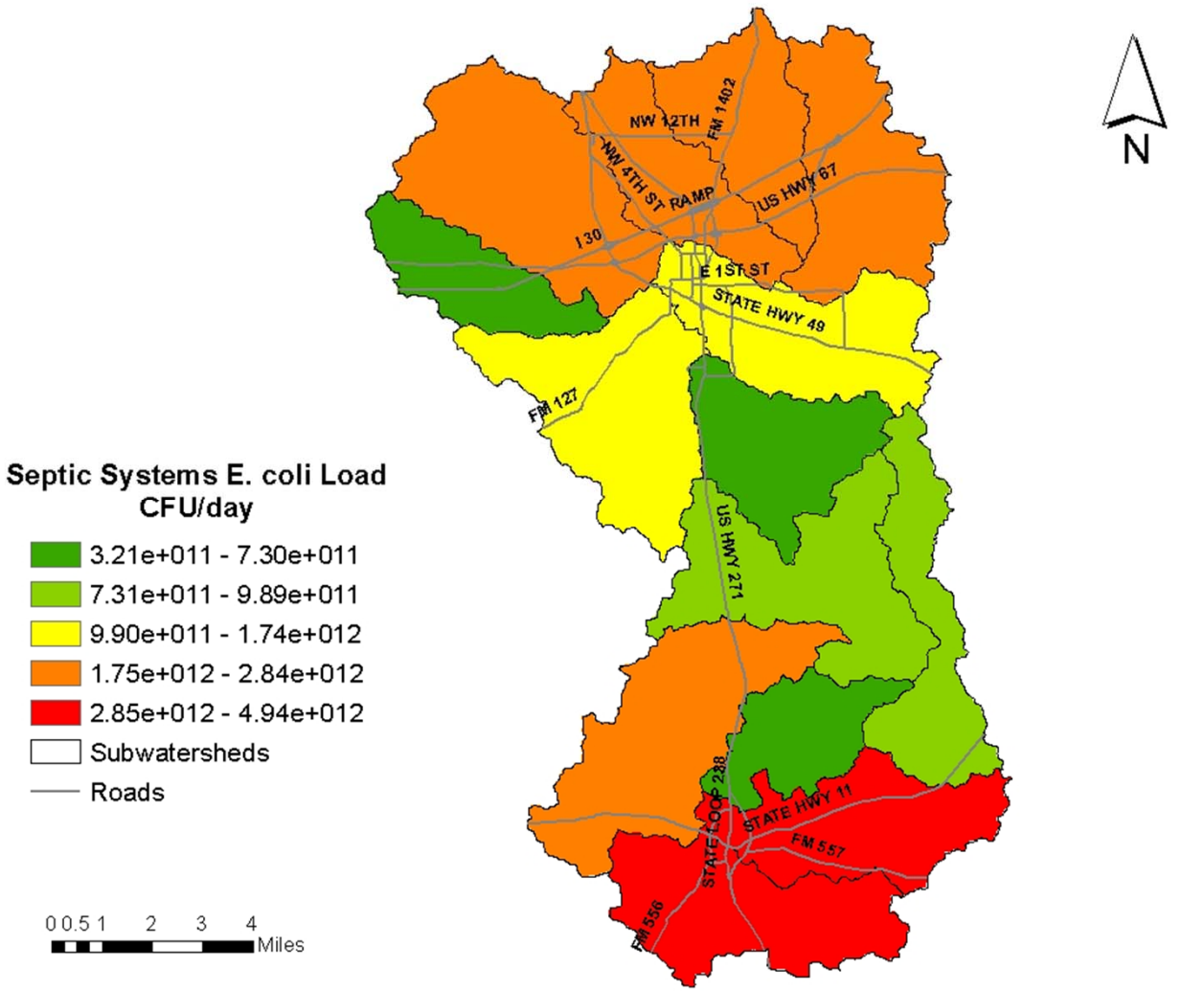
Potential *E. coli* loads resulting from Deer



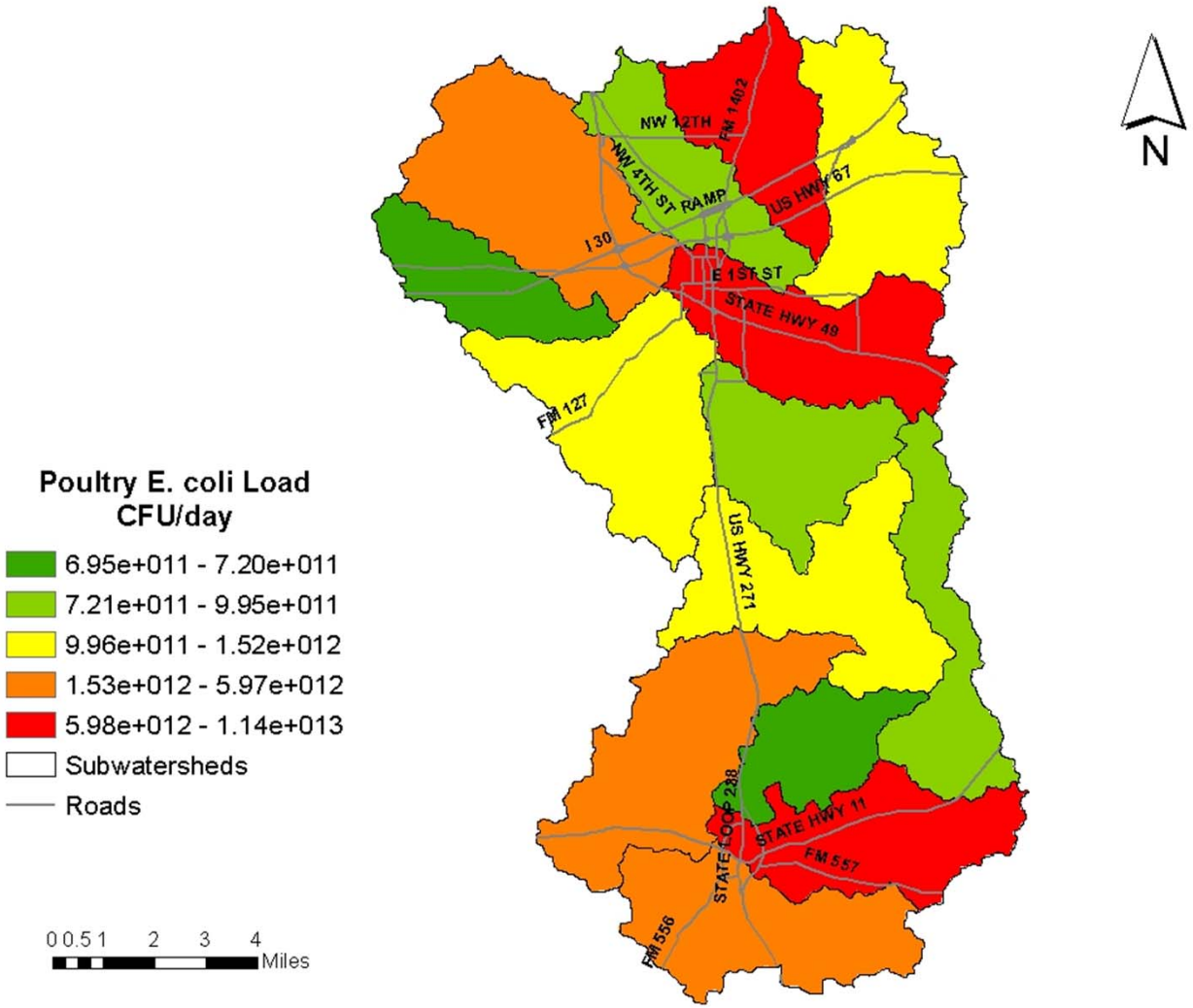
Potential *E. coli* loads resulting from Feral Hogs



Potential *E. coli* Load Resulting From Septic Systems



Potential *E. coli* loads resulting from Poultry



Daily Total Potential *E. coli* load