Texas State Soil and Water Conservation Board
Section 319(h) Nonpoint Source Program
FY 2007 Project 07-06

NONPOINT SOURCE SUMMARY PAGE for the CWA, Section 319(h) Agricultural/Silvicultural Nonpoint Source Program			
Title of Project:	Fate and Transport of *E. coli* in Rural Texas Landscapes and Streams		
Project Goals/Objectives:	The main objectives of this proposal are to identify, characterize, and quantify *E. coli* loads resulting from various sources in an impaired watershed, monitor survival, growth, re-growth, and die-off of *E. coli* under different environmental conditions, monitor re-suspension of *E. coli* in streams, and educate stakeholders by disseminating qualitative and quantitative information acquired in this monitoring and demonstration project. Information gleaned from this project will provide much needed knowledge relevant to modeling bacterial life cycles, their ability to survive and regenerate and their impacts on water quality. A secondary objective of this proposal is to strengthen spatially explicit load allocation tools and validate and improve process-based pathogen transport models used in TMDL development and implementation by providing scientific data collected in this project.		
Project Tasks:	(1) Project coordination and administration, (2) Development of Quality Assurance Project Plan, (3) Conducting sanitary surveys to identify potential *E. coli* contributing sources in the impaired watershed, (4) Conducting demonstration experiments to characterize and quantify *E. coli* loads from identified sources, (5) Monitoring fate of *E. coli* under different environmental conditions, (6) Monitoring concentration of *E. coli* in the instrumented stream, and (7) Education and outreach material production		
Measures of Success:	(1) Identified sources contributing *E. coli* to the selected watershed and stream, (2) Characterization and quantification of *E. coli* loads from identified sources, (3) Elucidation of *E. coli* fate and transport processes in the watershed and (4) Production of outreach materials that will educate stakeholders on bacterial impairments in the State of Texas		
Project Type:	Implementation ( ); Education (x); Watershed Planning ( ); Assessment (x); Groundwater ( )		
Status of Water Body: 2004 Water Quality Inventory and 303(d) List	Segment ID: Unclassified waterbody in 1209 (TBD) 1221 A	Parameter: Bacteria Bacteria	Category: 5c 5c
Project Location: (Statewide or County and Watershed Name)	**Tasks 3, 4 & 5** Brazos, Burleson, Grimes, Milam or Robertson Counties in the Brazos River watershed **Task 6** Erath and Comanche Counties in the Leon River watershed		
Key Project Activities:	Hire Staff ( ); Monitoring (x); Regulatory Assistance ( ); Technical Assistance ( ); Education (x); Implementation ( ); Demonstration (x); Planning ( ); Other ( )		

NPS Management Program Elements:	This project supports the implementation of Goal One – Data Collection and Assessment. Specifically, it addresses the objective of conducting special studies to determine sources of NPS pollution. The project also supports the implementation of Goal Three – Education. The objective addressed under this goal is to administer programs to educate citizens about water quality and their potential role in causing NPS pollution. This project also supports one of TSSWCB FY 2007 priority areas, "clarification of bacteria impairment in category 5c waterbodies through surface water quality monitoring". Additionally, this project also helps to achieve the following milestones: (B) complete the assessment of pollutant problems by reviewing existing water quality data, conduct an inventory of point/nonpoint sources, land use data, and all known stressors influencing water quality; (C) complete water quality monitoring; analyze data, assess loadings, and determine the origin and distribution of pollutants; and (D) develop and apply model(s) to determine numerical load allocations and recommend control strategies for implementation					
Project Costs:	Federal:	$300,000	Non-Federal Match:	$200,142	Total:	$500,142
Project Management:	Texas Water Resources Institute Texas Agricultural Experiment Station Texas Cooperative Extension					
Project Period:	September 1, 2007 – August 31, 2010					

Part I – Applicant Information

Applicant							
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Project Partners	
Names	Roles & Responsibilities
Texas State Soil and Water Conservation Board (TSSWCB)	Project Oversight
Texas Water Resources Institute (TWRI)	Project coordination and management, reporting, and QAPP development
Texas Cooperative Extension (TCE)	Education outreach, site instrumentation, and data collection and analysis
Texas Agricultural Experiment Station (TAES)	Site instrumentation and data collection and analysis
Dr. R. Karthikeyan (TAES)	Project co-lead, investigator
Dr. S. Mukhtar (TCE)	Project co-lead, investigator
Dr. R. Srinivasan (TAES)	Project co-lead, investigator
Dr. R. Lopez, Wildlife and Fisheries Department, Texas A & M University (TAES)	Investigator, Wildlife population surveys
Dr. Daren Harmel, USDA-ARS, Grasslands Soil and Water Research Laboratory	Site instrumentation and data analysis
Tiffany Morgan, Brazos River Authority (BRA)	External advisory and project review, historic data
John Blount, Alisa Max, and Trent Martin, Harris County Public Infrastructure Department	External advisory and project review
Stakeholders	Providing inputs and insights about the impaired watershed

Part II – Project Information

Project Type							
Surface Water	x	Groundwater					
Does the project implement recommendations made in a Watershed Protection Plan or TMDL Report or Implementation Plan?				Yes		No	x
If yes, identify the document. (Approved or Draft)							
If yes, identify the agency/group that developed and/or approved the document.				Year Developed			

Watershed Information					
Task(s)	Watershed Name(s)	Hydrologic Unit Code (8 Digit)	Segment ID	305 (b) Category	Size (Acres)
3, 4 & 5	Wickson Creek	12070103	1209E	5c	TBD
3, 4 & 5	Cedar Creek	12070103	1209G	5c	TBD
3, 4 & 5	Duck Creek	12070103	1209H	5c	TBD
3, 4 & 5	Gibbons Creek	12070103	1209I	5c	TBD
3, 4 & 5	Shepherd Creek	12070103	1209J	5c	TBD
3, 4 & 5	Steele Creek	12070103	1209K	5c	TBD
6	Resley Creek	12070201	1221A	5c	TBD

Project Narrative

Problem/Need Statement

As of January 2006, 197 water bodies in Texas were impaired because they did not meet bacteria criteria established by the state to protect contact recreation use (freshwater and saltwater) and/or oyster water use. The freshwater contact recreation use criterion used to determine impairment includes both a geometric mean for indicator bacteria, *Escherichia coli* (*E. coli*), of 126 colonies per 100 mL and a single sample maximum of 394 colonies per 100 mL.

A bacteria TMDL task-force was formed in the State of Texas to evaluate the current TMDLL development process, address current weaknesses in the process and to develop a roadmap for further scientific research needed to reduce uncertainty in watershed modeling. There are several recommendations provided in the task-force document (Draft Four, 06/04/2007) to "scientifically" address the current "uncertainties" in bacteria TMDL development and implementation. (http://twri.tamu.edu/bacteriatmdl/). The objectives of this proposal are formulated based on several key recommendations compiled by task force experts. The key recommendations include identifying and characterizing *E. coli* sources and monitoring fate and transport of *E. coli* in impaired watersheds and streams. This project proposes a "holistic plan" for TMDL development that includes identification, characterization, and quantification of *E. coli* sources in impaired watersheds and monitoring the fate and transport of *E. coli* in these impaired watersheds. The outputs of this project will help to decrease uncertainties in *E. coli* load estimation from various sources and simulation of fate and transport processes of *E. coli* in watersheds and streams. The overall outcome of this project will help in developing scientifically sound TMDLs.

The first bacteria TMDL task-force recommendation that this project will focus on is conducting a sanitary survey of the watershed. Inventory sanitary surveys identify various potential *E. coli* sources in an impaired watershed are indispensable in TMDL development. In the majority of rural and agricultural stream-impairments due to bacteria, specifically *E. coli*, the specific sources and accurate quantities from each source have not been accurately determined. This lack of information makes managing the impaired waterway difficult and expensive. Currently, the most widely used approach to determine the source of *E. coli* is Bacteria Source Tracking (BST). This approach is good in determining the source of the impairment, but not in determining the load produced by specific sources. Moreover, BST methods are very labor intensive and expensive. Contrarily, inventory sanitary surveys identify various potential *E. coli* sources in impaired watersheds, are simpler and less expensive. *E. coli* load estimation tools such as Spatially Explicit Load Enrichment Calculation Tool (SELECT) estimates *E. coli* loads from various sources using literature values. *E. coli* content of feces has been reported in literature for certain domestic and wildlife species and has been summarized in some reports used in TMDL development. However, this information has not been the focus of the reported research and therefore has not undergone extensive peer review. Consequently, there is a high level of uncertainty in identifying *E. coli* loads and sources for use in watershed modeling and *E. coli* load estimation tools. This project will conduct inventory sanitary surveys to identify potential *E. coli* sources in the chosen watershed. Then, *E. coli* in various identified animal sources in the inventory survey will be characterized and quantified. Accurate identification, characterization, and quantification of *E. coli* sources in the impaired watershed will improve the predictions of SELECT, which is currently developed and successfully applied in TMDL development for an impaired watershed in the State of Texas.

The Bacteria TMDL task-force also emphasized the need for additional studies that focus on developing a better understanding of fecal bacteria fate and transport processes. Currently, knowledge of these processes is limited at best and contributes to significant uncertainties in the modeling of these processes. Fate and transport of *E. coli* in rural and agricultural landscapes is largely dependent on various environmental factors and management practices. Dominant environmental factors that affect *E. coli* transport in landscapes (e.g., waste source, soil type, temperature, rainfall, moisture content, nutrient status, etc) and persistence, re-growth, and survival in landscapes need to be identified. Re-growth of *E. coli* in landscapes due to favorable environmental conditions (e.g., rainfall after dry weather conditions) is one of the major fate processes that influence *E. coli* concentrations in streams. The influence of different environmental variables on growth kinetics of *E. coli* and re-growth also need to be thoroughly studied and demonstrated to strengthen watershed models that simulate *E. coli* fate and transport in landscapes. The kinetic parameters obtained from this monitoring task will be used to validate and improve fate and transport models used in TMDL development and implementation plans. Growth kinetics, survival rates, and re-growth are critical factors to accurately model the fate and transport of bacteria in watersheds and, as identified by the Task Force, current understanding of these processes is limited.

Project Narrative

Problem/Need Statement (continued)

Re-suspension of *E. coli* in streams (e.g. scouring of stream bed sediments due to high flows) is one of the major fate processes that influence stream impairment. Unfortunately this process is not well studied or understood. The effect of rainfall and runoff on survival and growth of *E. coli* in streams and stream-bed sediments and subsequent re-suspension of *E. coli* in streams need to be quantified to properly assess the impairment of a stream. Parameters obtained from the stream-monitoring study will be used to improve in-stream hydrodynamic processes modeled by fate and transport models. Information gleaned from this evaluation can and most likely will have a significant impact on the types of BMPs recommended to alleviate bacterial contamination issues in agricultural watersheds.

Identifying, characterizing, and quantifying *E. coli* loads resulting from various sources are critical tasks in TMDL development for any impaired watershed. Monitoring and assessing the fate and transport processes of *E. coli* in landscapes and streams and monitoring the effects of environmental factors on fate and transport processes are required to develop and validate watershed models that utilize process-based fate and transport subroutines. Effective communication of findings is a crucial task that will not be overlooked in this project. Concise, easy to read publications and brochures will be developed that will inform readers about the findings of the study. This project will combine these vital aspects of TMDL development and demonstrate that they are effective tools for enhancing the understanding of these complicated processes.

Project Narrative

General Project Description (Include Project Location Map)

The first portion of this monitoring and assessment project (Tasks 3, 4, & 5) will involve conducting sanitary surveys in the selected creek twice a year (winter and summer) to identify various dominant and relevant *E. coli* sources (cattle, poultry, deer, feral hogs, etc). The developed sanitary surveys will be updated with inputs from local experts (e.g. wildlife experts and enthusiasts, stakeholders, county agents, farmers, citizens). Waste streams will be quantified for identified sources in the watershed by utilizing collected fecal production numbers (Task 4) and assumed population densities from sanitary surveys (Task 3) (for example if “dairy cows” are a source, excreted manure, flushed manure, separated solids, lagoon wastewater, composted dairy manure, etc will be waste streams). *E. coli* numbers resulting from characterized waste streams (*five maximum*) for all *dominant* identified sources (*five maximum*) will be quantified. Random and representative samples of identified waste streams and fecal material of identified species will be collected. Four sub-samples will be collected for each waste stream/fecal material and a composite sample will be made on-site. Each composite sample will be transferred to a 1 L bottle. All sample bottles will be stored in a cooler at 5°C and transported to the laboratory for *E. coli* analysis. Each composite sample collected will be extracted with de-ionized water and filtered through a filter paper for *E.coli* incubation and enumeration. Samples of each identified waste stream and fecal material will be collected separately in 1 gallon containers and brought back to the laboratory for conducting the Phase II study.

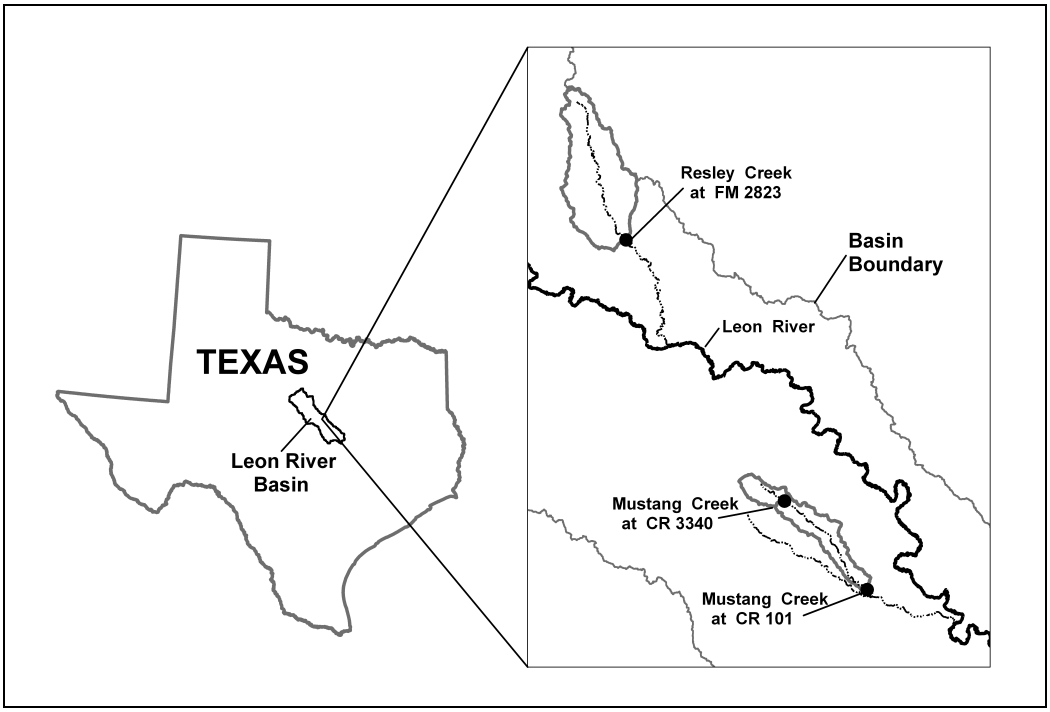
This demonstration project also addresses another major concern stated by the Bacteria TMDL task force. This involves monitoring the survival, growth, re-growth, and die-off of *E. coli* in water under different environmental conditions. Currently, there is a significant knowledge gap about the fate of *E. coli* from various sources under different environmental conditions. Composite samples from each waste stream and species will be subjected to different temperatures (0°C, 10° C, 25° C, and 50°C), moisture conditions (0%, 5%, 25%, 50%, and 75% dry-basis), and pH (acidic, neutral, and alkaline). Growth and die-off at above mentioned environmental conditions will be monitored. Once optimum conditions are identified, re-growth will be monitored by bringing back the environmental conditions for the above mentioned scenarios to optimum conditions.

Project Narrative

General Project Description (Include Project Location Map)

E. coli survival, growth, re-growth, and die-off in stream sediments (Task 6) and re-suspension of *E. coli* in streams are also poorly understood. In many cases, the re-suspension of *E. coli* has been suspected as a significant source of *E. coli* measured in the stream. Physical disturbances from humans, animals, waterfowl, fish, and large rainfall events etc. can significantly increase the amount of suspended sediments in the stream and thus may have a significant impact on the amount of *E. coli* suspended in the water column. Automatic water sample collection systems will be installed at two locations along the impaired stream in the impaired watershed. Data will be collected under baseflow, highflow, rainfall events and while sediment has been mechanical agitated. Analysis will result in information about survival, growth, re-growth and die off under all conditions. Sediment samples will be collected from 24 random locations along the instrumented stream and three sub-samples will be used to make one composite sample. Sediment samples will be brought to the laboratory to monitor survival, growth, re-growth, and die-off of *E. coli* under different temperatures (0°C, 10°C, 25°C, and 35°C), nutrient conditions (three different concentrations of organic carbon), pH (acidic, neutral, and alkaline), light intensity (three different light intensities), and chlorination (three residual chlorine concentration levels). Re-suspension of *E. coli* in streams will be monitored during four rainfall events two each during winter and summer and will be reconciled with runoff samples using re-suspension data collected from mechanical sediment disturbance. Water samples will be collected for those rainfall events using the automatic sample collection systems. Mechanical re-suspension will be made by disturbing the stream bed-sediments four times; two each during winter and summer; and grab samples of water will be taken at six different locations along the stream. All water samples will be stored in coolers at 5°C and transported to the laboratory for *E. coli* analysis.

Findings from this study will be presented in a series of publications. Results from each component of the project will be published in the form of easy to read brochures or fact sheets that will clearly present information in a way that the reader can easily understand what is being presented. A technical report will be developed at the conclusion of the project and will present complete findings from the monitoring and assessment phases of the project. Additionally, all materials related to the project will be posted on a website that will be developed specifically for the website. The website will also contain a brief description of the project, the need for the project, provide contact information for all parties involved, goals and objectives and any project updates that may occur. Findings from all Tasks and specifically, Task 6, will support the development and implementation of a WPP (TSSWCB 319 project 06-12) and TMDLs in the Leon River watershed.



Resley Creek Site Map (Task 6 Demonstration Site)

Water Quality Impairment

Describe all known causes (pollutants of concern) of water quality impairments from any of the following sources: 2004 Water Quality Inventory and 303(d) List, 2004 Summary of Waterbodies with Water Quality Concerns (Secondary Concerns List) or Other Documented Sources (ex. Clean Rivers Program Basin Summary or Basin Highlights Reports).

Tasks 3, 4 & 5: Possible Streams

Segment	Name	Basin	Use	Parameter	Category
1209 E	Wickson Creek	Brazos River	Contact Recreation	Bacteria	5c
1209 G	Cedar Creek	Brazos River	Contact Recreation	Bacteria	5c
1209 H	Duck Creek	Brazos River	Contact Recreation	Bacteria	5c
1209 I	Gibbons Creek	Brazos River	Contact Recreation	Bacteria	5c
1209 J	Shepherd Creek	Brazos River	Contact Recreation	Bacteria	5c
1209 K	Steele Creek	Brazos River	Contact Recreation	Bacteria	5c

Source: Draft 2006 Texas 303(d) List

Task 6 Stream

Resley Creek (unclassified water body)
Segment: 1221A

Standards not met in 2004:
Assessment area: entire water body
Use: contact recreation
Support status: not supporting
Parameter: bacteria
Category: 5c

Source: 2004 Texas Water Quality Inventory
(based on data from 3/1/1998 to 2/28/2003)

Project Goals

The main goals of this proposed project are to

(1) Identify, characterize, and quantify *E. coli* loads resulting from various sources in an impaired watershed,

(2) Monitor survival, growth, re-growth, and die-off of *E. coli* under different environmental conditions,

(3) Monitor re-suspension of *E. coli* in streams, and

(4) Develop and disseminate clear and concise educational materials that can be used to educated the public on bacterial issues in the state

(5) Strengthen spatially explicit load allocation tools and validate and improve process-based pathogen transport model used in TMDL development by providing scientific data collected in this project

Tasks, Objectives and Schedules (Replicate or modify table as needed)						
Task 1:	Project Coordination and Administration					
Costs:	Federal:	$31,815	State:	$6,404	Total:	$38,219
Objective:	To effectively coordinate and monitor all work performed under this project including technical and financial supervision, preparation of status reports, and maintenance of project files and data. TWRI will perform accounting functions for project funds and be responsible for developing timely and accurate reports. Progress reports shall document all activities performed within a quarter and shall be submitted not later than thirty (30) days after the close of the quarter.					
Subtask 1.1:	TWRI will prepare electronic quarterly reports for submission to the TSSWCB. All progress reports will be provided to all Project Participants.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.2:	TWRI will coordinate quarterly meetings (in person or TTVN) as appropriate with project participants to discuss project activities, project schedule, lines of responsibility, communication needs, and other requirements.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.3:	TWRI will attend meetings with the TSSWCB project manager and other meetings, as needed, to review project status, deliverables, etc.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.4:	TWRI will submit appropriate Reimbursement Forms.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.5:	TWRI will develop (Months 1-3), host and maintain (Months 3-36) an internet website for the dissemination of information.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.6:	TWRI and TCE will work together to develop the Final report.					
	Start Date:	Month 30	Completion Date:	Month 36		
Subtask 1.7:	TWRI and TCE will work together to develop publications, brochures and reports that can will be disseminated for educational purposes.					
	Start Date:	Month 1	Completion Date:	Month 36		
Deliverables	• Quarterly Reports • Project Website • Reimbursement Forms • Final Report • Publications, brochures and report for educational purposes					

Tasks, Objectives and Schedules (Replicate or modify table as needed)						
Task 2:	Development of Quality Assurance Project Plan					
Costs:	Federal:	$5,000	State:	$3,500	Total:	$8,500
Objective:	Develop Data Quality Objectives (DQO), a Quality Assurance Project Plan (QAPP) and provide amendments and annual revisions to the QAPP, as needed. The QAPP will be developed using guidelines in EPA QA/G-5, "Guidance for Quality Assurance Project Plan".					
Subtask 2.1:	TWRI will develop a QAPP that will detail project goals and objectives relating to water quality monitoring activities; identify the data needed to fulfill those objectives; list field and laboratory methods; describe procedures and schedules to be followed; and specify a data management structure and the quality assurance protocols.					
	Start Date:	Month 1	Completion Date:	Month 6		
Subtask 2.2:	Provide annual revisions to the QAPP and amendments, as necessary, to the TSSWCB and EPA.					
	Start Date:	Month 6	Completion Date:	Month 36		
Deliverables	• Approved QAPP • Approved annual revisions and amendments to QAPP					

Tasks, Objectives and Schedules (Replicate or modify table as needed)						
Task 3:	Conducting sanitary surveys to identify potential *E. coli* contributing sources in the impaired watershed					
Costs:	Federal:	$30,481	State:	$20,272	Total:	$50,753
Objective:	Conduct a comprehensive sanitary survey to identify potential *E. coli* sources that might cause the impairment in the watershed.					
Subtask 3.1:	Choose a suitable watershed from the provided list of bacteria impaired stream segments					
	Start Date:	Month 1		Completion Date:	Month 2	
Subtask 3.2:	Travel to the selected watershed and conduct a renaissance survey of the watershed and sources					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 3.3:	Conduct a thorough sanitary survey to identify various wildlife sources that contribute *E. coli* loads during winter. This survey will be conducted by a wildlife expert.					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 3.4:	Conduct a through sanitary survey to identify various domestic livestock and poultry sources and waste streams that contribute *E. coli* loads during winter. This survey will be conducted by an extension county agent and/or an animal-production agriculture expert.					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 3.5:	Verify and update wildlife survey with inputs from stakeholders and Texas Parks and Wildlife personnel and domestic animal survey with inputs from stakeholders, ranchers, and extension county agents.					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 3.6:	Conduct a thorough sanitary survey to identify various wildlife sources that contribute *E. coli* loads during summer. This survey will be conducted by a wildlife expert.					
	Start Date:	Month 8		Start Date:	Month 12	
Subtask 3.7:	Conduct a through sanitary survey to identify various domestic livestock and poultry sources and waste streams that contribute *E. coli* loads during summer. This survey will be conducted by an extension county agent and/or an animal-production agriculture expert.					
	Start Date:	Month 8		Completion Date:	Month 12	
Subtask 3.8:	Verify and update wildlife survey with inputs from stakeholders and Texas Parks and Wildlife personnel and domestic animal survey with inputs from stakeholders, ranchers, and extension county agents.					
	Start Date:	Month 12		Completion Date:	Month 14	
Deliverables	• Final selection of watershed for Tasks 3, 4 and 5 • Potential wildlife sources of *E. coli* in the watershed identified • Potential domestic animal sources and waste streams of *E. coli* in the watershed identified • Comprehensive and thorough sanitary surveys for two different seasons					

Tasks, Objectives and Schedules (Replicate or modify table as needed)						
Task 4:	Conducting demonstration experiments to characterize and quantify *E. coli* loads from identified sources					
Costs:	Federal:	$80,751	State:	$63,122	Total:	$143,873
Objective:	To characterize and quantify *E. coli* loads resulting from various identified sources.					
Subtask 4.1:	Collect feces samples of relevant and dominant identified sources (five maximum) and samples of waste streams (five maximum) identified in Task 4 during winter.					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 4.2:	Extract feces samples and waste streams for *E. coli* collected during winter.					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 4.3:	Analyze samples collected during winter for *E. coli* using EPA's approved enumeration technique					
	Start Date:	Month 6		Completion Date:	Month 8	
Subtask 4.4:	Calculate the *E. coli* load resulting from all identified sources collected during winter					
	Start Date:	Month 8		Completion Date:	Month 10	
Subtask 4.5:	Collect feces samples of relevant and dominant identified sources (five maximum) and samples of waste streams (five maximum) identified in Task 3 during summer.					
	Start Date:	Month 10		Completion Date:	Month 12	
Subtask 4.6:	Extract feces samples and waste streams for *E. coli* collected during summer.					
	Start Date:	Month 10		Completion Date:	Month 12	
Subtask 4.7:	Analyze samples collected during summer for *E. coli* using EPA's approved enumeration technique					
	Start Date:	Month 10		Completion Date:	Month 12	
Subtask 4.8:	Calculate the *E. coli* load resulting from all identified sources collected during summer					
	Start Date:	Month 12		Completion Date:	Month 14	
Deliverables	A database of potential *E. coli* load resulting from identified sources in the impaired watershed • during winter • during summer					

Tasks, Objectives and Schedules (Replicate or modify table as needed)						
Task 5:	Monitoring fate (survival, growth, re-growth, and die-off) of *E. coli* under different environmental conditions					
Costs:	Federal:	$80,825	State:	$60,232	Total:	$141,057
Objective:	Monitor *E. coli* (resulting from identified sources, maximum ten) growth and survival under different environmental conditions in the watershed. Only samples collected during summer will be utilized for this monitoring study.					
Subtask 5.1:	Prepare collected samples in Task 4.5 for this monitoring study.					
	Start Date:	Month 12	Completion Date:	Month 12		
Subtask 5.2:	Measure growth kinetics of *E. coli* in different sources under varying environmental conditions					
	Start Date:	Month 12	Completion Date:	Month 20		
Subtask 5.3:	Measure survival of *E. coli* in different sources under varying environmental conditions					
	Start Date:	Month 12	Completion Date:	Month 20		
Subtask 5.4:	Measure re-growth of *E. coli* in different sources under optimum conditions					
	Start Date:	Month 20	Completion Date:	Month 26		
Deliverables	A database consisting of • Growth kinetics • Survival rates • Re-growth pertaining to *E. coli* resulting from various species (identified sources in the watershed) and waste streams.					

Tasks, Objectives and Schedules (Replicate or modify table as needed)						
Task 6:	Monitoring concentration of *E. coli* in the instrumented stream as a result of rainfall and runoff events					
Costs:	Federal:	$71,128	State:	$46,612	Total:	$117,740
Objective:	To study the effect of rainfall and runoff and survival and growth of *E. coli* in stream-bed sediments on re-suspension of *E. coli* in Resley Creek.					
Subtask 6.1:	Collect water samples during summer for two rainfall-runoff events.					
	Start Date:	Month 8	Completion Date:	Month 32		
Subtask 6.2:	Collect water samples during winter for two rainfall-runoff events.					
	Start Date:	Month 8	Completion Date:	Month 32		
Subtask 6.3:	Collect stream bed sediments after each water sample collection periods.					
	Start Date:	Month 8	Completion Date:	Month 32		
Subtask 6.4:	Analyze water and sediment for *E. coli* concentrations					
	Start Date:	Month 8	Completion Date:	Month 34		
Subtask 6.5:	Measure growth kinetics, survival, and re-growth *E. coli* in stream bed sediments under different environment conditions					
	Start Date:	Month 9	Completion Date:	Month 32		
Subtask 6.6:	Mechanically disturb stream bed sediments four times; twice each during summer and winter, collect grab water samples, and analyze the samples for *E. coli*					
	Start Date:	Month 9	Completion Date:	Month 32		
Deliverables	A database consisting of • Growth kinetics • Survival rates • Re-growth pertaining to *E. coli* resulting in stream bed sediments and information on the re-suspension of *E. coli* in streams due to rainfall-runoff and mechanical disturbance of stream bed sediments					

Measures of Success
(1) Identification of sources contributing *E. coli* to the impaired watershed (2) Quantifying *E. coli* loads from identified sources (3) Monitoring fate and transport of *E.coli* under different environmental conditions (4) Development of educational materials that can be used to educate the public on bacterial impairments

2005 Texas Nonpoint Source Management Program Document Reference
Goals &/or Milestone(s)
This project will help the state to meet the Long-term goal to protect and restore water quality from nonpoint source pollution through assessment, implementation, and education is addressed; specifically, the objective to increase overall public awareness of NPS issues and prevention activities is supported by the project.
It also supports the implementation of Short-term Goal One – Data Collection and Assessment. Specifically, it addresses the objective of conducting special studies to determine sources of NPS pollution.
Short-term Goal Three – Education is also addressed. The objective addressed under this goal is to administer programs to educate citizens about water quality and their potential role in causing NPS pollution.
The project will also help the state in achieving milestones; (B) complete the assessment of pollutant problems by reviewing existing water quality data, conducting an inventory of point/nonpoint sources, land use data, and all know stressors influencing water quality, (C) complete water quality monitoring; analyze data, assess loadings, and determine the origin and distribution of pollutants, and (D) develop and apply model(s) to determine numerical load allocations; recommend control strategies for implementation

Part III – Financial Information

Budget Summary			
Federal 319(h)	$300,000	% of total project	60%
Non-Federal Match	$200,142	% of total project (at least 40%)	40%
Total $ Cost	$500,142	Total project %	100%

Category	Federal	Non-Federal Match	Total
Personnel	$114,575	$72,152	$186,727
Fringe Benefits	$22,075	$16,169	$38,244
Subtotal Personnel & Fringe	$136,650	$88,321	$224,971
Travel	$12,244	$0	$12,244
Equipment	$0	$0	$0
Supplies	$71,500	$0	$71,500
Contractual	$26,000	$0	$26,000
Construction	$0	$0	$0
Other	$14,476	$0	$12,976
Subtotal	$124,220	$0	$124,220
Total Direct Costs	$260,870	$88,321	$349,191
Indirect Costs (15%)	$39,130	$40,186	$79,316
Unrecovered IDC		$71,635	$71,635
Total Project Costs	$300,000	$200,142	$500,142

The §319(h) Nonpoint Source Program has a 60/40% match requirement. Your entity will be reimbursed 60% from federal funds and must contribute a minimum of 40% of the costs to conduct your project. The 40% match must be from non-federal sources and should be described in your budget detail. Indirect costs are limited to 15%. The project budget generally covers a three year period.

Budget Justification (Federal)		
Category	Total Amount	Justification
Personnel & Fringe Benefits	$136,650	Graduate Student at PhD level Hourly student worker (20 hr/wk @ $8/hr for 10 wk/yr1, 40wkyr2&3) Hourly student worker (20 hr/wk @ $8/hr for 10 wk/yr1, 40wkyr2&3) Dr. Karthikeyan' Salary (1.5 mo/yr in yrs 1 & 2) TWRI Project Manager (20% in yr 1 & 10% in yr 2 & 3) TWRI IT Associate (5% in yr 1 and 2.5% in yrs 2 & 3)
Travel	$12,244	Travel to impaired watersheds (Resley Creek 300 miles) (TBD Creek ≤100 miles) back and forth to College Station @ 0.45c/mile rate. Fifty trips to each site for conducting sanitary surveys, collecting fecal samples, collecting water and sediment samples, and occasional maintenance of instrumentation. Total of 12 overnight stays project personnel @ $150 per night TWRI travel: 7 trips to watershed and back (300 miles) @0.45c/mile and 3 overnight trips at $150 per trip
Equipment	$0	
Supplies	$71,500	Weighing balance, vacuum pump, pH meter, and fluorescence light for conducting high-quality dedicated *E.coli* analysis. Freezer, coolers, and blue-ice for storing collected samples and transporting collected samples for *E.coli* analysis. Sampling probes, mixing bowls, and shovels to collect sediment and fecal samples in the impaired watershed. Chemical reagents include high-quality growth media, agar solution, nutrients, salts, etc. for *E.coli* plating and enumeration. Disposable supplies include agar plates, sterile loops, disposable pipettes, serum bottles, weighing paper, filter paper, gloves, sterile bottles, autoclavable containers, etc. for 60 fecal samples, 480 samples resulting from monitoring and assessment study, and 140 sediment samples. Sanitary survey supplies include infrared cameras, sampling nets, etc.
Contractual	$26,000	Instrumentation and maintenance of auto-samplers for three years, collection and analysis of water samples
Construction	$0	
Other	$14,476	Publication costs for bulletins, field-day handouts, semi-technical publications, and promotional materials. Graduate student PhD level tuition.
Indirect	$39,130	15% of Total Direct Federal
Budget Justification (Non-Federal)		
Category	Total Amount	Justification
Personnel & Fringe Benefits	$88,321	Dr. Karthikeyan' Salary (2.55 month/year 1,2&3) Graduate student, Dr. Lopez (fellowship from state funds)
Travel	$0	
Equipment	$0	
Supplies	$0	
Contractual	$0	
Construction	$0	
Other	$0	
Indirect	$40,186	45.5% of Total Direct Non-Federal Match
Unrecoverd IDC	$71,635	30.5% of Total Direct Federal