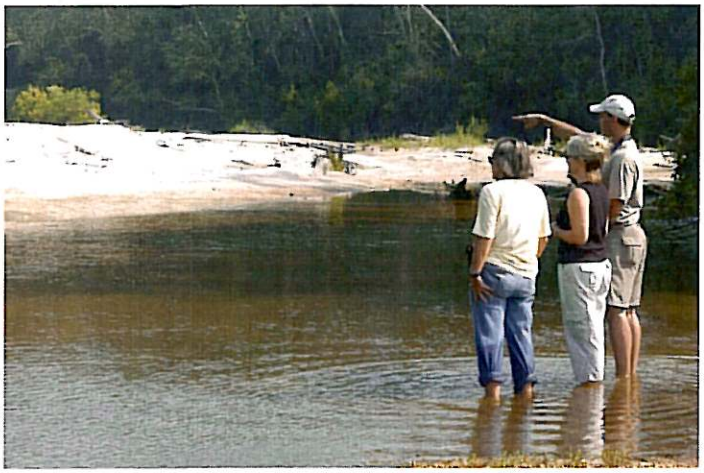
Friends of Red Creek

Watershed Action Plan



Stone County, Mississippi

Spring 2007

Red Creek Action Plan sponsored by Land Trust for the Mississippi Coastal Plain
in collaboration with Friends of Red Creek

Funding assistance from EPA, Region IV

Technical Assistance from MDEQ
Pascagoula River Basin Team

Mississippi Department of Environmental Quality
Office of Pollution Control

Prepared by Eco-Logic Restoration Services, LLC
Submitted to Land Trust for Mississippi Coastal Plain
Spring 2007

www.ecologic-restoration.com

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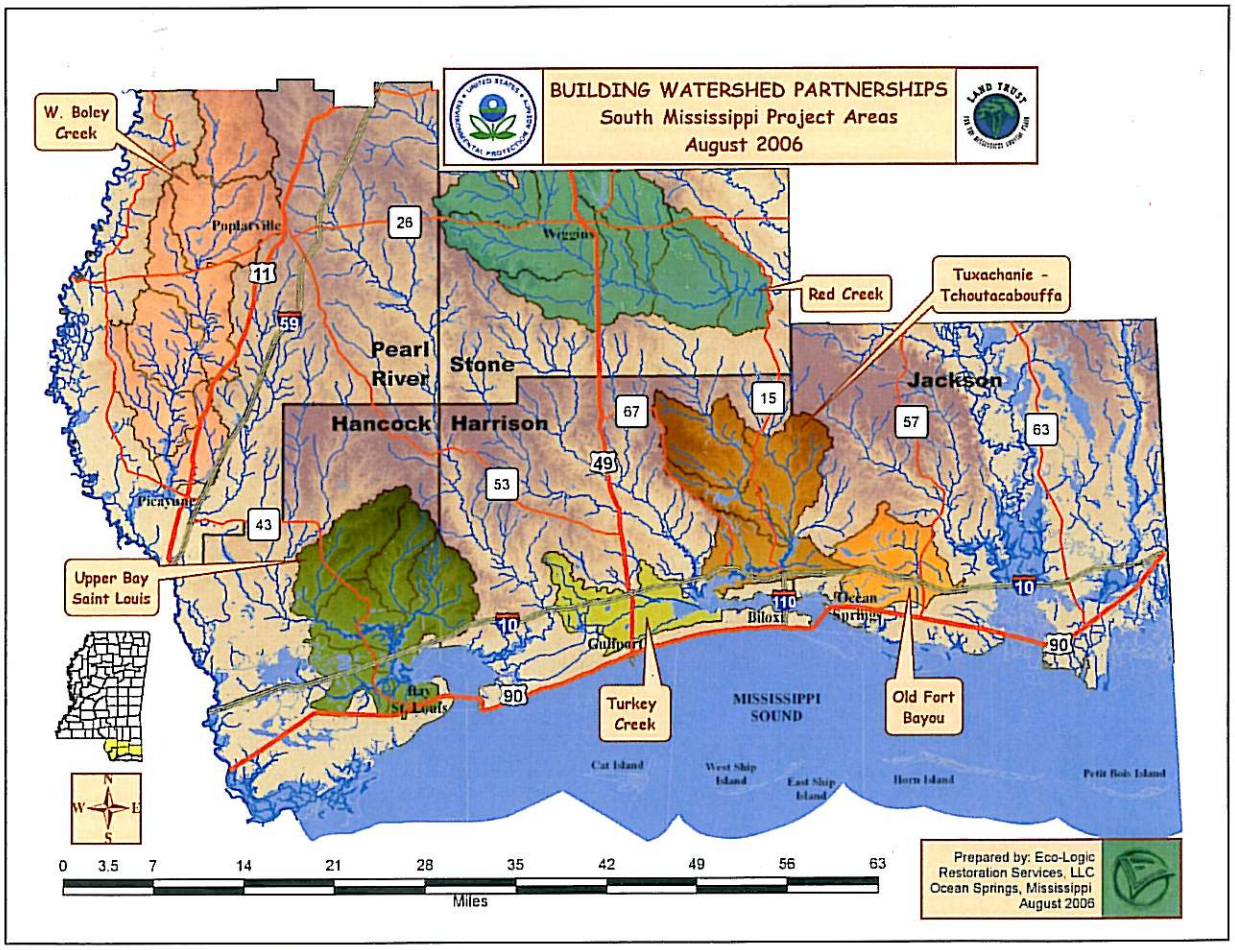
EXECUTIVE SUMMARY

Before Hurricane Katrina, the Land Trust for the Mississippi Coastal Plain (Land Trust) was awarded a grant from EPA Region IV to build watershed partnerships in six watersheds in south Mississippi. Criteria for selecting watershed partnership areas included: (1) watersheds that represented south Mississippi both geographically and ecologically; (2) watersheds where the Land Trust owned and managed lands; and (3) watersheds where there was a demonstrated need for restoration and protection. The six watersheds that were chosen included Turkey Creek in Harrison County, Red Creek (stream sections flowing through Stone County), Old Fort Bayou in Jackson County, West Hobolochitto Creek in Pearl River County, Tchoutacabouffa River (stream sections flowing through Harrison County) and Upper Bay of St. Louis (identified streams in Hancock County).



The Land Trust's efforts to build a partnership for Red Creek began in October 2005. These efforts were strengthened by an opportunity to submit a 319 grant proposal to the Mississippi Department of Environmental Quality in February 2006. Since that time, the Land Trust formed a steering committee to guide planning efforts and to host community watershed forums. We are grateful to those individuals for their time, effort and passion.

We have learned and gained much from their participation and leadership: Jon Bond, Julia O'Neal, Liz Cox, Nell Murray, Sam LaRosa, Dorlean Spiers and Robin Lott.

This Red Creek Action Plan is written to provide context and brief overview of the ecological, cultural and scenic significance of Red Creek as it flows through Stone County. It is a record of our planning efforts and the actions that were identified and prioritized by the steering committee. The hope of those involved in this planning is to foster better stewardship of the natural resources of the Red Creek watershed.

When forum participants were asked, "What would you like to see for your watershed in the future?", they identified several major areas of concern: water quality, sand bars, wildlife and fish protection, forested riparian corridors, watershed education, public access and absentee landowners. Most participants agreed that the current state of the watershed is good to fair, indicating a need to restore and protect the watershed and its resources. To accomplish this, non-point source pollution must be addressed at every level. Failing septic tanks, headcutting, downcutting, deforestation and contaminated runoff are sources of stress that contribute to increased sedimentation, nutrient and bacteria loading.

Forum participants also identified the need for increased understanding about the impact of motorized vehicles on stream banks, stream beds and sandbars and for increased enforcement of public waterway laws. Residents discussed the need to keep regular prescribed fire as a primary tool for natural lands management; limit development and create setback requirements in the floodplain through local zoning action; reforest stream banks and protect headwater streams and tributaries. There is a great need to educate the local citizenry and to develop pride in place so that littering and dumping can be minimized, streamside management can be better understood and implemented, and appropriate public policy can be implemented as the population grows.

According to the Southeast Watershed Forum, excess sedimentation is the single greatest contributor to poor water quality. After a general investigation and site visit on July 19th, 2006, Dr. Michael Hanley, Sustainable Watershed Technologies reported that the "*...newly reforming channel of Red Creek will erode its banks and riparian vegetation in order to rebuild a stream channel planform; ... during this channel adjustment process the regional sedimentation will most likely increase and remain elevated on trend ...*". In order to reduce sedimentation and improve water quality, the Land Trust submitted a 319 grant proposal that includes a model passive stream restoration project.

The Land Trust established a standing committee, the Friends of Red Creek (FORC), to lead the implementation of the Watershed Action Plan including supporting the 319 grant project: *Red Creek Watershed Education and Restoration Initiative – City Bridge to Ramsey Springs.* The Friends of Red Creek can be reached by contacting the Land Trust office:

Land Trust for Mississippi Coastal Plain
P.O. Box 245
Biloxi, MS 39533
228.435.9191
judysteckler@aol.com
www.LTMCP.org

VISION STATEMENT

The Friends of Red Creek envision a legacy for future generations that includes clear, clean, red-tinted running water; abundant fish and wildlife; pristine sandbars; forested stream corridors; safe, clean and well-interpreted public access and recreational opportunities.

MISSION STATEMENT

The mission of the Friends of Red Creek is to form community partnerships that will work with the Land Trust and the Mississippi Department of Environmental Quality (DEQ) to implement the Watershed Action Plan for Red Creek, thus protecting and restoring the natural and cultural heritage of the Red Creek Watershed.

WATERSHED ACTION TEAM

The Friends of Red Creek (FORC) is a group of community leaders and stakeholders that live and work in that portion of Red Creek watershed that flows through Stone County. They are organized as a standing committee of the Land Trust. FORC welcomes the participation of all interested individuals and/or stakeholder groups who share a love for Red Creek and support the stated mission.

FORC steering committee hosted two forums and helped write and prioritize the Red Creek Watershed Action Plan. They will be instrumental in working with the Land Trust and DEQ to complete the 319 project, entitled: *Red Creek Watershed Education and Restoration Initiative – City Bridge to Ramsey Springs.* They will work to develop new friends for Red Creek, help secure local match funding for grants awarded, track milestones and monitor results, seek additional funding sources as needed and support the Action Plan's private-public partnerships.

The following lists of partners and collaborators were developed to gather those individuals already involved in various initiatives surrounding the watershed and additional individuals with technical expertise into a cohesive planning group that speaks with a singular authoritative voice for the protection and restoration of the natural resources of the Red Creek Watershed.

FORC Steering Committee
Jon Bond
Liz Cox
Robin Lott
Nell Murray
Julia O'Neal
Dorlean Spiers
Judy Steckler, LTMCP Director
Sam LaRosa, LTMCP Board Member

Technical Advisory Team
DEQ, Pascagoula River Basin Coordinator
South MS RC&D Council
MS Dept of Wildlife Fisheries and Parks, Scenic Streams Program
Red Creek Wildlife Management Area
MS Dept of Marine Resources: Coastal Resources Management Program and MS
Gulf Coast Heritage Program
MS State Department of Health
DeSoto National Forest
Stone County Soil and Water Conservation District
Natural Resource Conservation Service
MS State University, Extension Service, Stone County
MS Forestry Commission
Pat Harrison Waterway District
Stone County Utility Authority

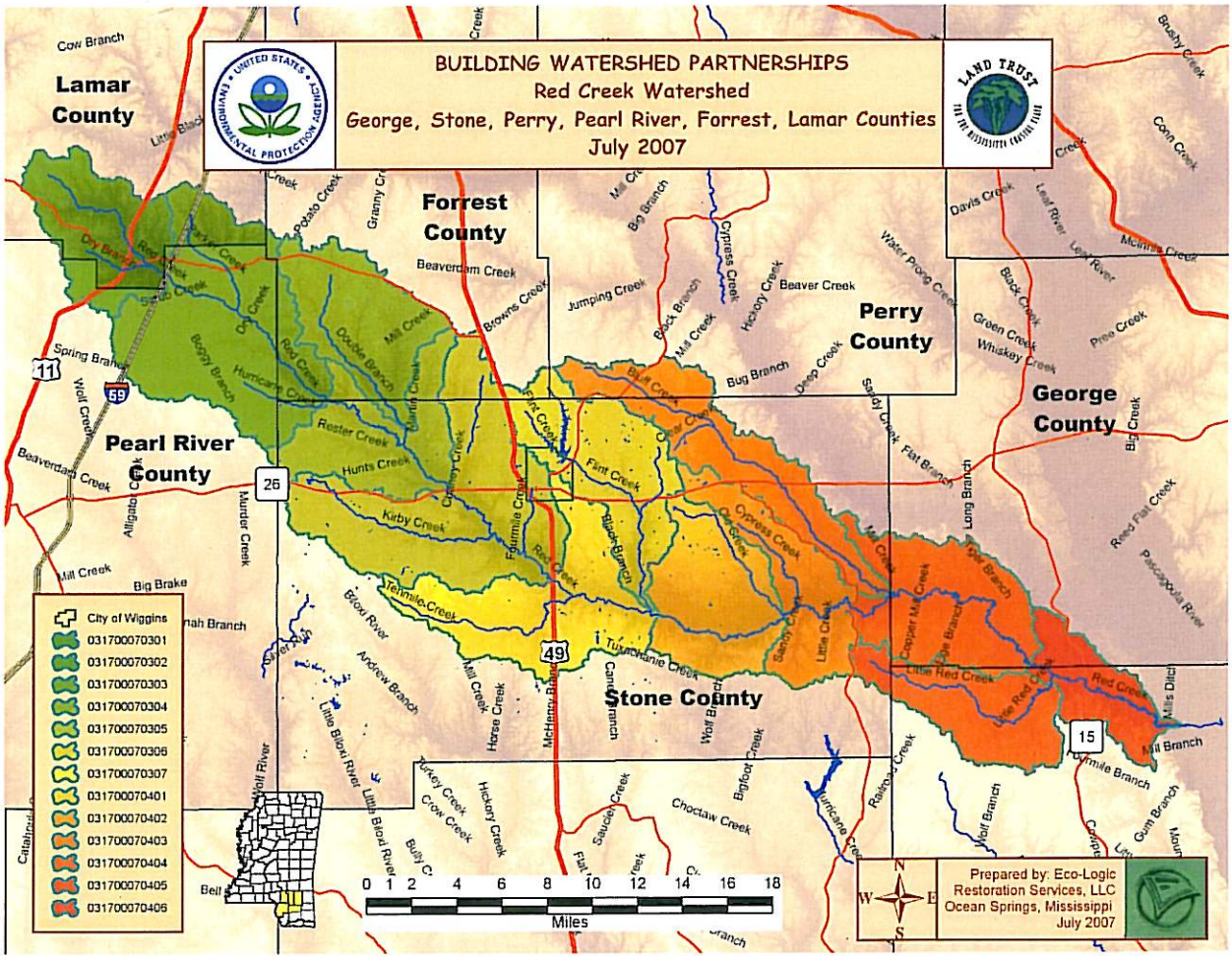
Education and Recreation Resources Team
Land Trust for the Mississippi Coastal Plain
MS Gulf Coast Community College, Perkinston campus
Mississippi Wildlife Federation
Pascagoula River Basin Alliance
Pascagoula River Audubon Center
Local Canoe Rental Companies
South MS Environment and Agricultural Coordination Organization (SMEACO)
MSU, MS Agricultural and Forestry Experiment Station
MS Canoe and Kayak Club
Pat Harrison Waterway District
The Nature Conservancy

RED CREEK: WATERSHED DESCRIPTION

Geographic Location

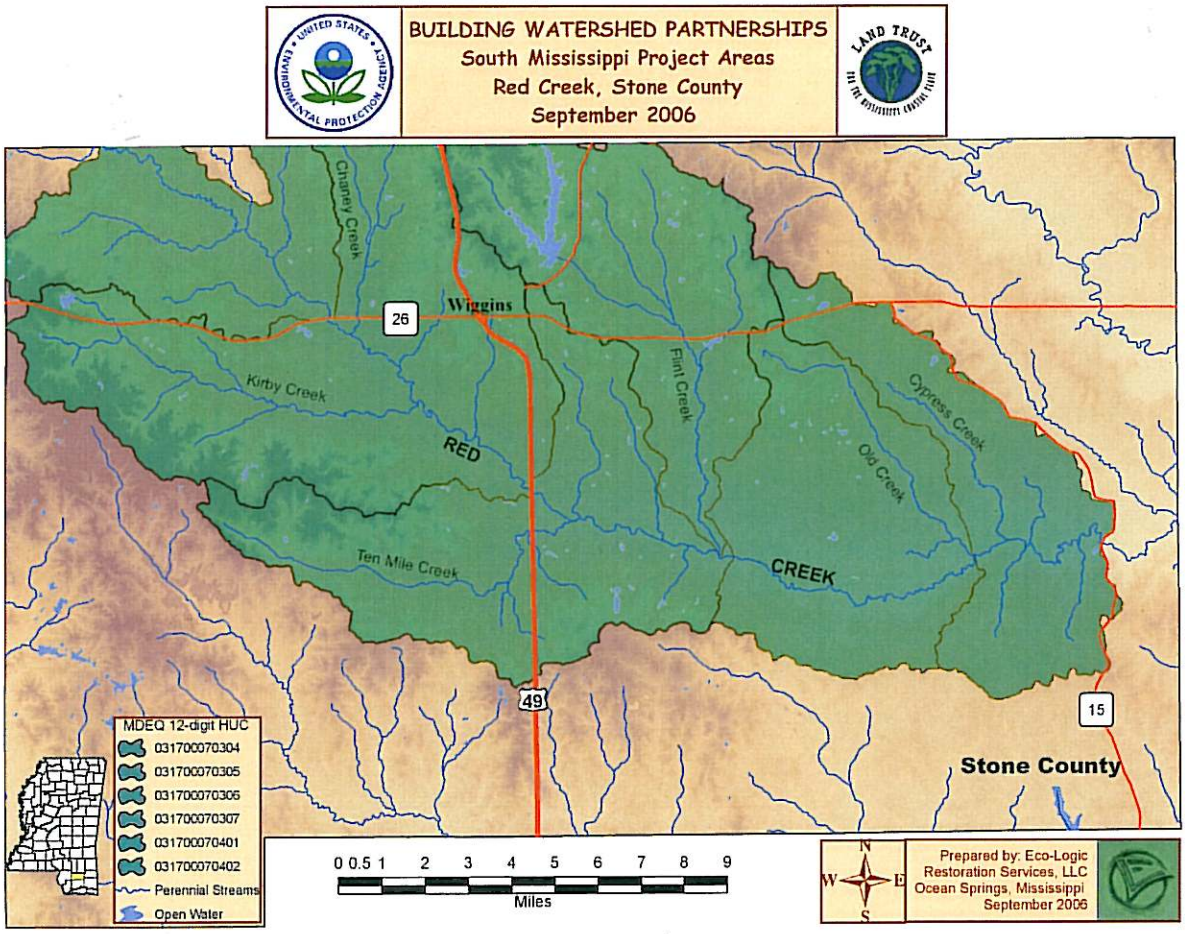
The entire drainage area of Red Creek is over 400 square miles. Red Creek flows through Lamar, Stone, George, and Jackson Counties. It also touches Pearl River, Lamar, and Forrest Counties. It is an important sub-basin of the Pascagoula River Watershed, a nationally significant eco-system with the largest unimpeded river in the continental United States. Red Creek is in the Pascagoula River Basin in southeastern Mississippi.

figure 1. Red Creek Watershed



The Friends of Red Creek partnership area includes all of Red Creek as it flows through Stone County. The area under consideration for specific action through a MDEQ 319 project includes stream sections located between City Bridge Road and Highway 15 (Ramsey Springs) in Stone County.

figure 2. FORC partnership area
includes six of thirteen sub-basins of Red Creek Watershed



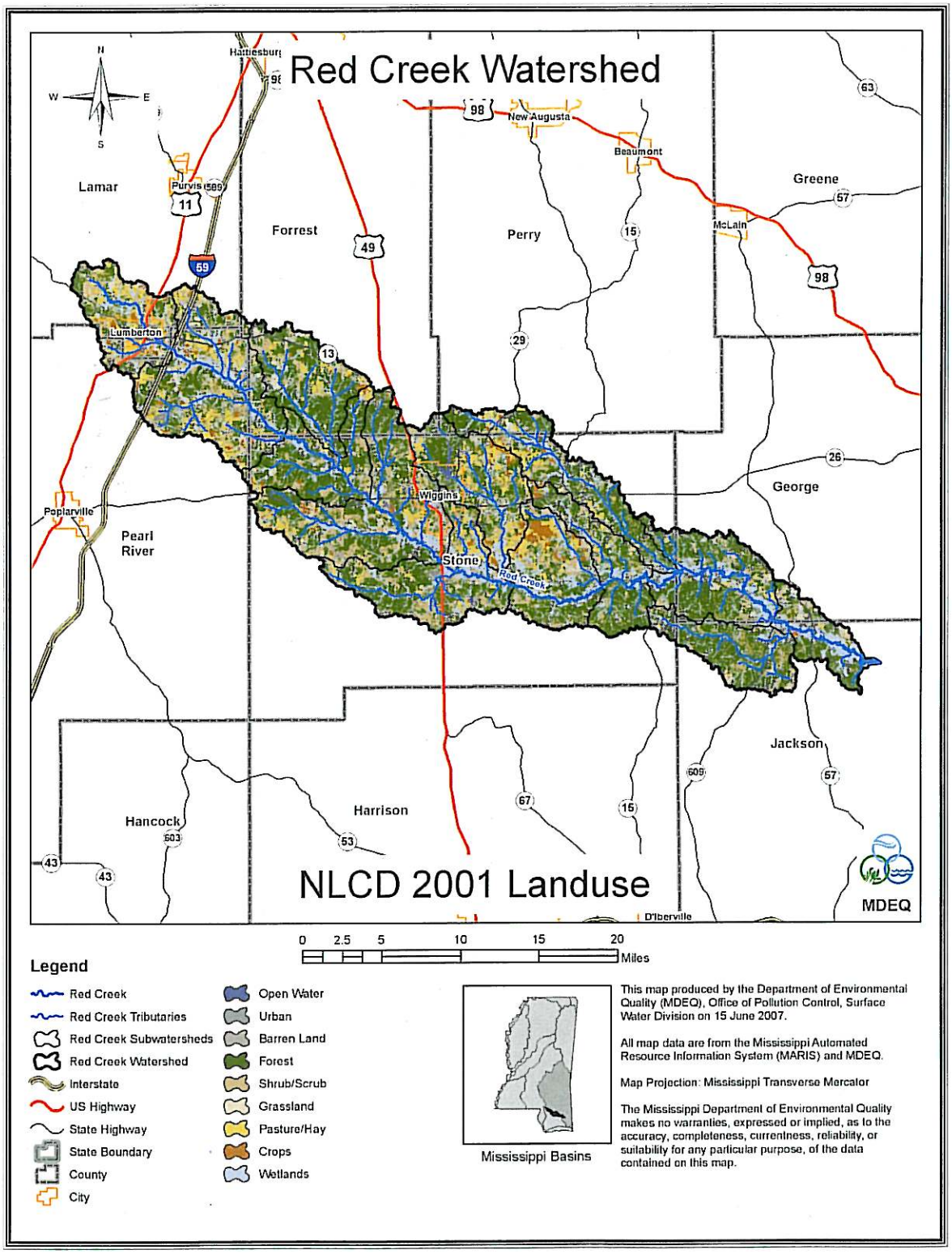


figure 3. Land Use (MDEQ)

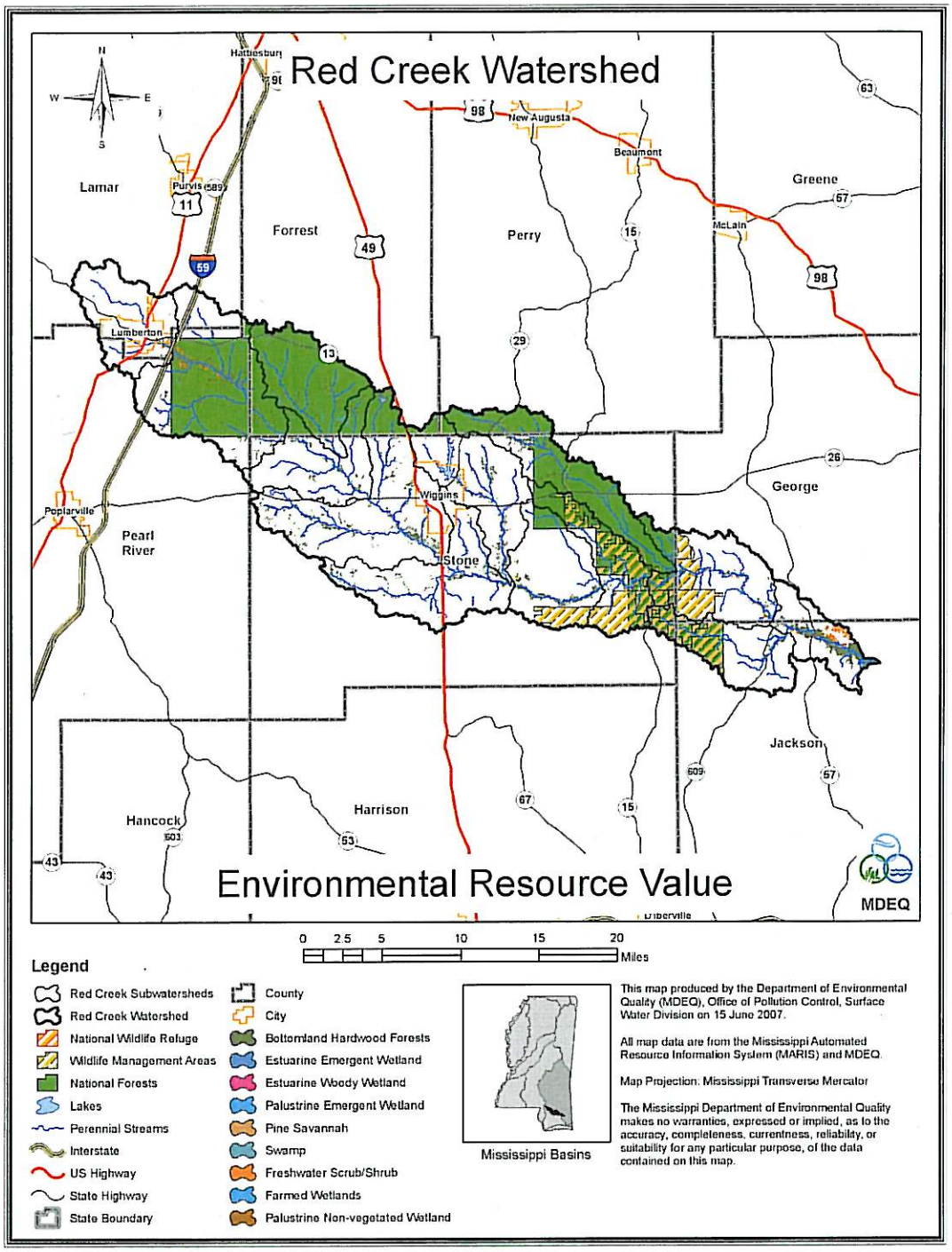


figure 4. Environmental Resource Value (MDEQ)

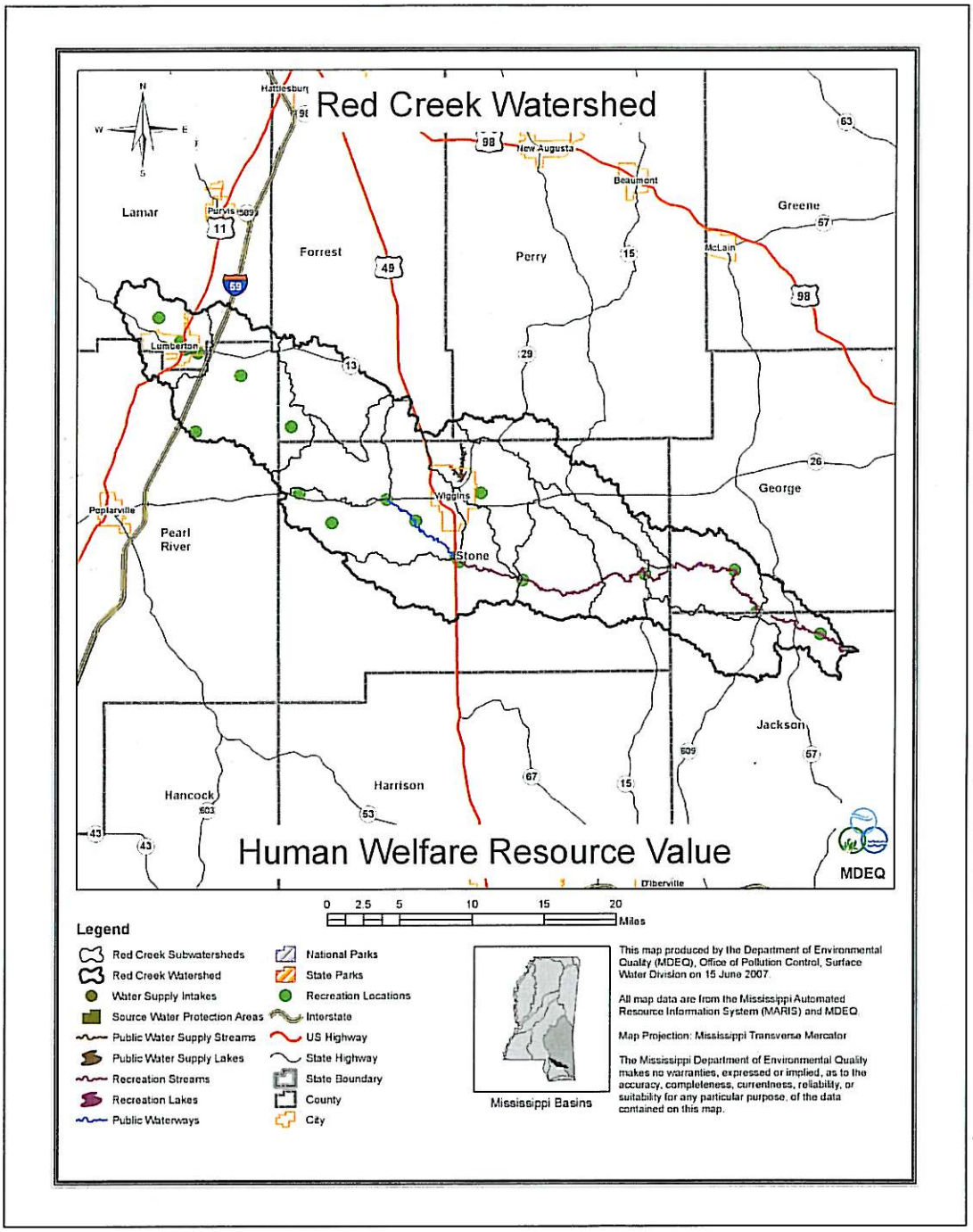


figure 5. Human Welfare Resource Value (MDEQ)

NATURAL RESOURCES OF RED CREEK

Red Creek is a coastal blackwater stream that forms near Lumberton in Lamar County and ends when it meets Black Creek near the Pascagoula River in Jackson County. It gets its name from the reddish stain that naturally-occurring tannins impart to the water. In 2004, the watershed was documented as 66% forested with a 100 foot, well-forested riparian zone extending from Highway 26 (west of Wiggins) to its confluence with Black Creek. This section of Red Creek is a public waterway and, according to Ernest Herndon's Canoeing Mississippi, is a beautiful float trip. The Mississippi Museum of Natural Science has documented 61 species of freshwater and diadromous fishes with a recreational fishery for at least 5 species.

Red Creek is in the East Gulf Coastal Plain Ecoregion and is a major tributary in the Pascagoula River watershed. For list of Natural Heritage flora and fauna for Stone County, see Appendix A.

Soils and Geology

The soil association within the creek is smithton-harleston-bibb while the area south of the creek within the area under consideration is susquehanna-benndale-dorovan.

Area of Stone County	
- Total	1,160 km² (448 mi²)
- Land	1,154 km² (445 mi²)
- Water	7 km² (3 mi²), 0.60%

Wetlands and Waterbodies

Red Creek is a second or third order stream (depending on the stream section) that drains to the Pascagoula River. Within the watershed, there are thirteen (13) sub-basins. Wetland habitat types include the coastal blackwater stream, bottomland hardwood with cypress-tupelo swamp and bayhead swamp.

RED CREEK TOTAL LENGTH = 80 miles (approximate). Source MDEQ 2005.
RED CREEK STREAM LENGTHS (approximate) Stone County, Mississippi

	Meters	Miles
County line to Hwy 26	13,860	8.612
Hwy 26 to Hwy 49	13,260	8.239
Hwy 49 City Bridge Rd.	9,439	5.865
City Bridge Rd. to Hwy 15	20,587	12.792
Hwy 15 to County line	4,348	2.702
Total length in Stone Cty:	61,494	38.210

Land Use

Current land uses within the watershed include:

- urban developed land;
- cropland, pasture, grassland;
- upland cutover and scrub/shrub and sand/barren land;
- upland forest;
- wetlands forest;
- wetland cutover and scrub/shrub land.

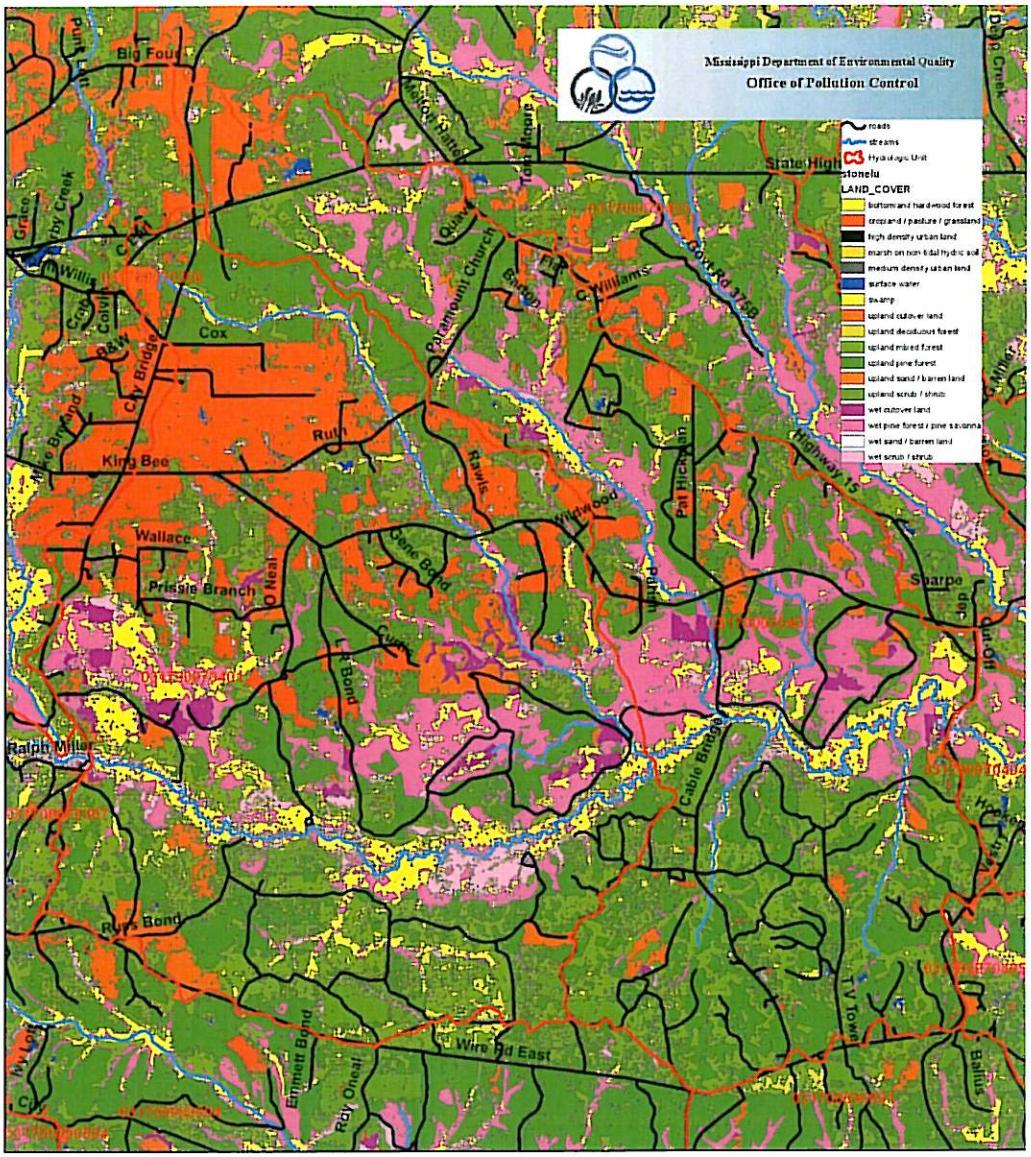


figure 6. Land use map, FORC partnership area

Stone County has a rich history of manufacturing and agriculture related to timber resources. Wood products manufacturing is still the dominant industry within the county as of the 2000 U.S. census. International Paper, a primary landowner within the county, recently sold approximately 50,000 acres of timberland. Part of this land is slated for development of new housing. More than 5,000 new homes are scheduled to be built within the watershed in the next 5 years.

Within the project area, the majority of the property is privately held. Single family homes, timber farms, and livestock farms are noted. Recreational activities along the creek include a privately owned off-road vehicle trail, RV park and campground, and canoe and kayak outfitter. Public lands, including Red Creek Wildlife Management Area (WMA) and DeSoto National Forest are open for non-consumptive recreation as well as hunting and fishing.

Significant environmental management areas within the watershed include federally owned and managed DeSoto National Forest and the state Red Creek WMA.

Demographics

The estimated population of Stone County in 2005 was 14,862, an increase of over 6% from the 2000 census. Stone County is among the fastest growing counties in the state of Mississippi (U.S. Census Bureau, 2000). It has 445.4 sq. miles in land area and a population density of 33.4 per square mile as of 2005. In the last three decades of the 1900s its population grew by 68.2%. About 80% of the population is white Caucasian, with about 19% African American and 1% Hispanic. The average household size is 2.72 persons compared to an average family size of 3.13 persons.

The county seat of Wiggins, population 3,849, lies within the watershed to the north of the project area, and the city of Perkinston lies to the west of Red Creek. Many residents are concerned about the rate of growth and development within the county in the past five years. New residents and developers are attracted to the quality of life within the area, and with the sale of the International Paper land, more housing developments are planned for the future.

Since Hurricane Katrina in the summer of 2005, more people have moved into the county from coastal areas. New subdivisions are springing up, including one such area that will host over 5,000 new homes. New infrastructure will be built or added to accommodate this new "town" including roads and sewer, police and fire stations, and new schools.

WATER RESOURCES

History of Activity in the Watershed

In April, 2006, the Land Trust began the process of organizing a steering committee from local stakeholders to provide local leadership for watershed planning and to assist in planning the watershed forums for the community. Key members of the community were asked to provide names of local residents who would be interested in participating and leading a watershed action team. Team members are nominated informally by the steering committee to participate in the process.

Red Creek watershed was chosen as worthy of the watershed planning effort because of the aesthetic qualities of the watershed, the character of the community, and because the land use is rapidly changing through increased development and development pressures.

Water Quantity – Surface and Groundwater

Mississippi is blessed with an abundance of both surface and groundwater. However, we must use these water resources wisely today if we want to ensure that these resources are available for future generations. In 2006, the Mississippi legislature formed the Gulf Regional Utility Board. Future efforts to protect and manage waste water, potable water and storm water will include the Stone County Utility Board as well as DEQ.

Water Conservation

The amount of water used in drinking water supply systems, treated in septic systems, retained for recreation in lakes and ponds and used for irrigating fields affects the watershed in many ways. Because water conservation is one of the best ways to minimize problems, where possible, conservation practices should be encouraged.

Wildlife & Fisheries

The important recreational species in the watershed are game species such as white tail deer, bobwhite quail, rabbit, squirrel, and frogs. Within the watershed, hunting is allowed within DeSoto National Forest land, Red Creek WMA and on privately owned lands. Sportfishing occurs along Red Creek and its tributaries.

Threatened or endangered aquatic or terrestrial species found within the watershed as listed by the Natural Heritage Program includes gopher tortoise (*Gopherus polyphemus*), red-cockaded woodpecker (*Picoides borealis*), Louisiana black bear (*Ursus Americanus luteolus*), and Louisiana quillwort (*Isoetes louisianensis*). Species of concern related to Stone County are listed in Appendix C along with state and federally listed species.

Designated Use Classifications and Water Quality Standards

Red Creek has been listed as a Priority Watershed for Restoration and Protection by the Land Trust for the MS Coastal Plain and The Nature Conservancy. Its designated use by the State of Mississippi in the Water Quality Criteria for Intrastate, Interstate, and Coastal Waters regulation is for recreation and fish and wildlife support.

Waters in this classification are intended for fishing and for propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Criteria shall also be suitable for secondary contact recreation. Secondary contact recreation is defined as incidental contact with the water during activities such as wading, fishing and boating, that are not likely to result in full body immersion.

Parameter	Criteria
Fecal Coliform	Fecal coliform shall not exceed a geometric mean of 200 per 100 ml based on a minimum of five (5) samples taken over a 30-day period with no less than twelve (12) hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100 ml more than ten percent (10%) of the time.
Specific Conductance	There shall be no substances added to increase the conductivity above 1000 micromhos/cm for freshwater streams.
Dissolved Solids	There shall be no substances added to the water to cause the dissolved solids to exceed 750 mg/L as a monthly average value, nor exceed 1500 mg/L at any time for freshwater streams.

Table 1. Numeric Water Quality Standards Table for Recreation and Fish and Wildlife

Current Status of Water Bodies in the Watershed

The state's 303(d) List of Impaired Water Bodies lists the water bodies that do not meet one or more applicable water quality standards. These impaired waters require a 'pollution budget' or Total Maximum Daily Load (TMDL) analysis.

Red Creek is a designated State Scenic Stream. However, DEQ has identified several water quality issues for Red Creek:

> *There have been two TMDLS completed for Red Creek. The pathogen TMDL was approved in 2000, and the nutrient TMDL was approved June 30, 2005. The pathogen*
> *TMDL called for no reductions. The nutrient TMDL recomended a 50 to 68% reduction in the Total Phosphorus load, but the state will primarily focus on attaining this goal through the nonpoint portion of the TMDL (85% of the load is nonpoint source). Also, quarterly nutrient monitoring is recommended for Hunt Southland Refining Company and Lumberton POTW. (source: MDEQ, December 2005)*

In HUCS 031700070401 and 031700070402, the designated primary action area for Friends of Red Creek, the primary issues are bank erosion and sedimentation. Obviously these issues of concern are a problem for scenic stream status as well as recreational fishing and canoeing. Southeast watershed forum has noted that sedimentation is the single greatest contributor to poor water quality, particularly in warm climates.

Rural streams, such as Red Creek, face various impairments to their health *"from road construction projects, pipeline crossings, and excessive sediment and polluted runoff from farming and forestry activities. All of this is collectively called 'non-point source pollution.'"* Mississippi has developed soil conservation measures and water quality improvement practices to *"reduce the impacts of non-point source pollution on streams. These Best Management practices (BMPs) are designed to maintain good water quality in streams that may be affected by construction, farming and forestry activities. Any stream impacted by channel or bank disturbance, coupled with increased nonpoint source runoff eventually can show the effects of accelerated erosion...BMPs reduce adverse impacts to a stream's water quality, and their use will help fight the effects of accelerated erosion."*[1]

MARIS land use and land classification data reveal a watershed that has been degraded, primarily by the removal of bottomland hardwood forests especially in wetland areas of headwater streams. Cutovers have often been followed by pine plantations in vital wetland areas. Certain timbering operations in headwater wetland areas may alter the hydrology and reduce wetland flood storage that is critical to a healthy watershed.

A site inspection by Eco-Logic Restoration Services on February 15, 2006 revealed that the section of Red Creek between City Bridge Road and Highway 15 is experiencing accelerated erosion and bank destabilization as the stream incises and changes from an E to an F Channel. This process results in increased sedimentation and decreased water quality. To stabilize the channel, we recommend the installation of passive restoration structures for grade control and bankfull bench building.

In the summer of 2006, the Red Creek Watershed Field Team conducted a general investigation of the physical conditions of Red Creek in the vicinity of the City Bridge Road

[1] Whitehurst, Andrew. 2003. Mississippi Streamside Landowner's Handbook, Page 12.

Crossing. The purpose of the Red Creek investigation was to determine the geomorphic trend of the Red Creek and then to explore the relevant issues and concerns as identified by the Field Team (*from Red Creek Trip Report, Sustainable Watershed Technologies, 2006*). See Appendix D for full report.

TMDLs.

The TMDL will determine the acceptable amount of a specific pollutant a stream can handle without a violation of water quality standards. The following table is a summary of the TMDLs completed for water bodies in the watershed.

• **Red Creek, Stone County, HUCS 031700070401 and 031700070402**
• Impaired use = fecal coliform
• The source(s) of impairment = septic systems and cattle
• Recommended load reduction for TMDL = 50% load reduction in fecal contribution from septic tanks and 60% reduction in cattle access
• Recommended management actions for load reduction = The recommendations were to fence in streams and educate landowners about BMPs (Best Management Practices)

Table 2. Numeric Water Quality Standards Table for Recreation and Fish and Wildlife

First forum, June 2006, Red Creek Camp

Second forum, September 2006, Fairgrounds

STAKEHOLDER INTERESTS

In June, 2006, the Land Trust together with the Red Creek Steering Committee hosted a facilitated forum for invited residents and landowners of the Red Creek Watershed. Participants were encouraged to discuss the following questions within the group as well as by filling out survey forms (21 survey forms were collected, 63 attended the first forum):

- What would you like to see for your watershed in the future?
- How would you describe the current state of your watershed?
- Is there anything in the watershed in its present state that you want to protect?
- What are the challenges/concerns that we face in order to see the watershed become what we envision for the future?

Responses to these questions were grouped into main categories as follows:

- What would you like to see for your watershed in the future?
    - Water Quality monitoring and protection
    - Sand Bars protection
    - Wildlife and Fish protection
    - Conservation corridors defined and protected
    - Public Education

- Public access

- How would you describe the current state of your watershed?

  - Fair 6
  - Good 13
  - Perfect as is 1

- Is there anything in the watershed in its present state that you want to protect?

  - Sand Bars
  - Water Quality
  - Wildlife and Fish
  - Public Access
  - Conservation corridors

- What are the challenges/concerns that we face in order to see the watershed become what we envision for the future?

  - Water Quality
  - Public Access
  - Conservation corridors and development
  - Education

The Land Trust hosted a second forum to share these findings with the community. During that forum, participants had an opportunity to evaluate and confirm the findings and to prioritize their interests. Questions from the first forum were also addressed including discussion topics for conservation options for private landowners, streamside management, and citizen water quality monitoring programs. A slide show presentation of images from Red Creek was shown throughout the forum. See Watershed Management Activities below for Watershed Action Plan items.

WATERSHED ACTION PLAN

WATERSHED EDUCATION STRATEGIES

1. Improve public access: work with county and stakeholders to help establish new public access and improve existing access at (1) Stone County land, City Bridge Road, and (2) DeSoto National Forest land, Hwy 15.
    - Establish a working group to support project design and funding for construction and maintenance phases
    - Identify partners and collaborators and their potential roles in successful "blueway" development
    - Utilize *Leave no trace* principles as applicable

2. Create an overall blueway development plan for public access points: The blueway plan should include amenities such as picnic tables and garbage cans, as well as safety, law enforcement and garbage collection. In addition to attractive, informative signage at public access points, the blueway plan could include:
    - Red Creek canoe trail map with distance between points
    - Canoe trail markers
    - Ecological and historical markers
    - Watchable wildlife notes
    - Safety tips
    - Visitor behavior expectations, private land rights and applicable laws
    - *Leave no trace* principles

3. Create an educational film about Red Creek: Establish a working group to identify target audience and primary messages, determine length of film, develop a budget and scope of work, identify potential funding sources and serve in advisory capacity throughout project development.

4. Work in public/private partnerships to design and distribute educational programs, materials and signage. Some of the identified primary issues of concern are:
    - Littering
    - Dumping on roadways and streambanks
    - Dumping into storm drains
    - Off-road vehicles in streamside management zones

5. Establish adopt-a-stream program for Red Creek. Schedule and host adopt-a-stream workshops led by Mississippi Wildlife Foundation with groups willing to commit to three year programs. Encourage Adopt-a-stream programs at Perkinston Community College and Stone County High School in both science classes and environmental clubs (see #14). Encourage Adopt-a-stream programs by individual creekside landowners or groups of owners. Water quality reports from the Adopt-a-Stream program would be released in Friends of Red Creek communications (see #9).

6. Establish Red Creek Clean-up. Work with Desoto National Forest and Friends of Red Creek to host a spring "Creek Sweep" in conjunction with Forest Service annual clean-up in May.

7. Develop a watershed signage program for Red Creek: You are entering the Red Creek Watershed. Primary partners: MDOT, EPA, DEQ, PHWD, PRBA.

8. Host Watershed Harmony Puppet Show for 4th and 5th grades. This has already been funded and approved by DEQ for the 2006-2007 school year.

9. Establish regular communications about Red Creek. Include regular water quality reports in this communication. Some of the preferred methods for disseminating information include:
    - E newsletter
    - Web-page (thru Land Trust: www.ltmcp.org)
    - Speakers bureau (approved powerpoint presentation designed for civic groups)

10. Conduct field trips for local decision-makers led by watershed experts.

11. Establish an annual Red Creek watershed rally. Develop and host an annual watershed celebration day to include fun, games, food, education and an annual review of accomplishments/next steps.

12. Formalize a watershed partnership group. At this point in time, this will best be accomplished as a working group under the Land Trust's organizational umbrella. Design a logo and start developing an identity for the Friends group.

13. Design and install storm-drain signage. It was suggested to establish a storm drain education program in Wiggins with signage keyed to Friends of Red Creek logo or to Watershed education signage.

14. Support the establishment of a Student Environmental Club at the high school. This step could be in conjunction with the Adopt-a-Stream Program (see #5). Suggested name for the Club: Junior Friends of Red Creek.

15. Develop an outreach program for out-of-town landowners. This would include:
    - identifying out of town landowners in the Stone County portion of Red Creek Watershed
    - developing effective communication tools
    - providing information to those landowners about natural resource management issues and technical or funding assistance available to them

PROTECTION AND RESTORATION STRATEGIES

Planning phase

1. Identify restoration sites:
    - areas affected by stream channel degradation and bank destabilization and landowners associated with these areas
    - potential headwater streamside and/or old oxbow sites in need of restoration and landowners associated with these areas

2. Identify -landowners of the above sites and contact them to assess their interest in restoration activities, conservation easements or selling for conservation purposes

3. Prioritize restoration demonstration sites (based on landowner interests, ecological function and public visibility)

4. Negotiate easements or acqulsitions for these sites

5. Develop the restoration and management plans. Include baseline conditions and monitoring for success

Implementation phase

6. Identify and remove impediments to canoe and recreational fishing (selective removal of woody debris in stream – do no harm!)

7. Install passive stream restoration structures as identified

8. Implement designated streamside bottomland reforestation

9. Identify and remove rotated trees to prevent further bank rotation and bank failure

ORGANIZATIONAL STRATEGIES TO SUPPORT THE RED CREEK WATERSHED ACTION PLAN

Land Trust for Mississippi Coastal Plain has established Friends of Red Creek as an action committee under their umbrella.

1. Establish Friends of Red Creek Steering Committee for 2007: write a mission statement, define the role of the steering committee and how it interfaces with LT board.
2. Develop a timeline, estimated budget and measures of success for each education, restoration and protection goal above. Amend Action Plan accordingly.
3. Establish a technical advisory committee that will provide information and assistance as needed to the Friends of Red Creek: such as RC&D Council, NRCS, PHWD, Soil & Water Conservation District, Southeast Watershed Forum.

4. Establish small working groups as needed to accomplish action plan: such as blueway working group; communications working group, events working group.

EVALUATION OF PROGRESS

Measures of Success:

The overall partnership area will be monitored through the FORC Adopt-a-Stream program. The program will monitor at five sites: (1) near hwy 49, (2) near City Bridge Road and (3) near Ramsey Springs, Hwy15, (4) Red Creek Road (the bridge across the creek at Vestry), (5) and Cable Bridge. A citizen-driven "Adopt-Red Creek" blog will post regular summaries of the monitoring reports on FORC's webpage: www.ltmcp.org/Red Creek. The official Adopt-a-Stream reports can be found on Mississippi Wildlife Federation's website: www.mswildlife.org. FORC's citizen monitoring program will watch for changes in water quality, particularly turbidity.

The Friends of Red Creek will rely on MDEQ to monitor fecal coliform and recommend private action(s) that will help reduce this particular water quality concern. In general, the most appropriate action that FORC can take regarding fecal coliform is to provide education for homeowners, developers and local policy-makers. Improvement in water quality will primarily rest on an increase in the local "political will" to require better landuse planning and ordinance enforcement, particularly in the flood plan.

During the next triennial review (not until 2009-2010), FORC may wish to request that Red Creek be re-designated for primary contact recreational use, rather than for fish and wildlife with secondary contact recreational use

Other measures of success:

1. Success of streamside BMPs will be noted in linear feet of stream bank (riparian corridor) reforested with native species by the partnership
2. Success of passive restoration installed through the 319 grant will be assessed by number of linear feet restored, included photo documentation
3. Number of acres placed under conservation easement or purchased fee-simple for the purpose of watershed protection
4. Education activities can be measured by numbers of participants and through use of evaluation forms for activities
5. Education/outreach materials can be measured by quality and quantity of materials distributed

PLAN REVISION

Regular evaluation of the watershed action plan should be performed to ensure the plan remains a vital tool to guide future management efforts in the watershed. FORC shall appoint a small working group to review the Plan annually and bring back findings and recommendations. The annual review shall include consideration of tasks completed as well as changes in the watershed, in stakeholder interests, in watershed issues, in science, and in understanding of the watershed system.

Watershed plans are living documents that must be adapted to changing conditions within the watershed.

RESOURCES

Watershed Description:
MARIS on-line mapping for Mississippi at www.maris.state.ms.us/HTM/maps.htm

Wildlife Resources:
Mississippi Natural Heritage Inventory on-line at www.mdwfp.com/museum/html/research/general_info.asp, NatureServe Explorer database of species information on-line at www.natureserve.org/explorer/

Water Quality Standards:
Through MDEQ Basin Management water quality standards website at www.deq.state.ms.us/MDEQ.nsf/page/WMB_Water_Quality_Standards?OpenDocument

Designated Beneficial Uses: through the MDEQ Basin Management website at www.deq.state.ms.us/MDEQ.nsf/page/WMB_Basin_Management_Approach?OpenDocument

Biological Ratings: Contact MDEQ.

303(d) List and 305(b) report: MDEQ on-line at www.deq.state.ms.us/MDEQ.nsf/page/TWB_Total_Maximum_Daily_Load_Section?OpenDocument

Approved TMDLS: MDEQ TMDL website at www.deq.state.ms.us/MDEQ.nsf/page/TWB_Total_Maximum_Daily_Load_Section?OpenDocument
or through Basin Management website at www.deq.state.ms.us/MDEQ.nsf/page/WMB_Basin_Management_Approach?OpenDocument

Potential management actions:
Mississippi NRCS program website at www.ms.nrcs.usda.gov/programs/, particularly the EQIP program conservation practice, sign up, and ranking documents

Mississippi Streamside Landowner's Handbook. By Andrew Whitehurst, Scenic Streams Stewardship Program, Mississippi Museum of Natural Science, Mississippi Dept of Wildlife, Fisheries and Parks

Handbook for Developing Watershed Plans to Restore and Protect Our Waters, U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch, Oct. 2005

Economic values (Natural Capital):
From Open Spaces to Wild Places, The Economic Value of Habitat protection to Your Community, a publication of the Southeast Watershed Forum.
www.southeastwaterforum.org

APPENDIX A

MISSISSIPPI NATURAL HERITAGE DATA

PLANTS AND ANIMALS FOUND IN STONE COUNTY

Source: Mississippi Naturage Heritage Program, located in the Mississippi Museum of Natural Science, Mississippi Department of Wildlife Fisheries and Parks:
www.mdwfp.com/museum/html/research/

The Mississippi Natural Heritage Program identifies the state's most significant natural areas through a comprehensive inventory of rare plant and animal species, exemplary natural communities, special geological features, and significant natural areas. From the inventory, the Natural Heritage Database compiles information on the distribution, biology, status, and preservation needs of these species and communities. The database is updated continuously and is used to set state, national and global priorities for the preservation of natural diversity.

The Natural Heritage Database

The Natural Heritage Database is a continuously updated inventory of rare plant and animal species and representative natural communities in Mississippi. Today current information on the statewide status and locations of special animals, plants, and natural communities is available in a central location. By utilizing the Heritage Program, resource planners are able to save time and money. The information contained within the Program's database was compiled from a broad range of sources, including museum and herbarium collection records, publications, unpublished reports, and experts throughout the southeast.

Specific Information Available:

- Tracks the status of more than 700 species of plants and animals that are rare or imperiled at the state or global level.
- Contains more than 9,400 records of locations for rare plants, animals, and natural communities.
- State and Federal protection status of select species.
- State and global ranking of species and communities.
- Protection and management priorities and urgency.

PLANTS – Stone County

Scientific Name	Common Name	Global Rank	State Rank
AGALINIS APHYLLA	COASTAL PLAIN FALSE-FOXGLOVE	G3G4	S2S3
AGALINIS FILICAULIS	THIN STEMMED FALSE-FOXGLOVE	G3G4	S2?

AGRIMONIA INCISA	INCISED GROOVEBUR	G3	S3S4
ANDROPOGON CAPILLIPES	CHALKY BLUESTEM	G4Q	S1?
ANDROPOGON PERANGUSTATUS	ELLIOTT'S BLUESTEM (VAR.2)	G5T3T4	S1?
ARISTIDA CONDENSATA	SANDHILLS THREE AWN	G4?	S3S4
ARISTIDA SIMPLICIFLORA	SOUTHERN THREE-AWNED GRASS	G3	S1
CALOPOGON BARBATUS	BEARDED GRASS-PINK	G4?	S2S3
CAREX EXILIS	COAST SEDGE	G5	S2
CHRYSOGONUM VIRGINIANUM	GREEN-AND-GOLD	G5	S3
CLEISTES DIVARICATA	SPREADING POGONIA	G4	S3
COREOPSIS HELIANTHOIDES	SOUTHEASTERN TICKSEED	G3G4Q	S1?
GORDONIA LASIANTHUS	LOBLOLLY BAY	G5	S3S4
HEXALECTRIS SPICATA	CRESTED CORALROOT	G5	S2
ILEX AMELANCHIER	JUNEBERRY HOLLY	G4	S3
ILEX MYRTIFOLIA	MYRTLE HOLLY	G5?	S3S4
ISOETES LOUISIANENSIS	LOUISIANA QUILLWORT	G3	S2
JUNCUS GYMNOCARPUS	NAKED-FRUITED RUSH	G4	S3
LACHNOCAULON DIGYNUM	PINELAND BOGBUTTON	G3	S2
LINDERA SUBCORIACEA	BOG SPICE BUSH	G2	S2
LINUM MACROCARPUM	LARGE FRUITED FLAX	G2?	S2
MACRANTHERA FLAMMEA	FLAME FLOWER	G3	S3?
MARSHALLIA TRINERVIA	BROAD-LEAF BARBARA'S BUTTON	G3	S3

MELANTHIUM VIRGINICUM	VIRGINIA BUNCHFLOWER	G5	S2S3
PANICUM NUDICAULE	NAKED-STEMMED PANIC GRASS	G3Q	S2
PARNASSIA GRANDIFOLIA	LARGE-LEAVED GRASS-OF-PARNASSUS	G3	S2
PELTANDRA SAGITTIFOLIA	WHITE ARUM	G3G4	S2S3
PETALOSTEMON GRACILIS	PINE BARRENS PRAIRIE CLOVER	G5T3T4	S2S3
PINGUICULA PLANIFOLIA	CHAPMAN'S BUTTERWORT	G3?	S2
PINGUICULA PRIMULIFLORA	SOUTHERN BUTTERWORT	G3G4	S3
PLATANTHERA CRISTATA	CRESTED FRINGED ORCHID	G5	S3
PLATANTHERA INTEGRA	YELLOW FRINGELESS ORCHID	G3G4	S3S4
POLYGALA HOOKERI	HOOKER'S MILKWORT	G3	S1S2
POLYGALA LEPTOSTACHYS	GEORGIA MILKWORT	G3G4	S1
PYCNANTHEMUM MUTICUM	BLUNT MOUNTAINMINT	G5	S2S3
QUERCUS MINIMA	DWARF LIVE OAK	G5	S1
RHODODENDRON AUSTRINUM	FLORIDA FLAME AZALEA	G3	S2S3
RHYNCHOSPORA DECURRENS	SWAMP-FOREST BEAKRUSH	G3G4	S1
RHYNCHOSPORA MACRA	LARGE BEAKRUSH	G3	S3
RHYNCHOSPORA STENOPHYLLA	CHAPMAN BEAKRUSH	G4	S1?
RUELLIA NOCTIFLORA	NIGHT-FLOWERING RUELLIA	G2	S2
SCHIZACHYRIUM STOLONIFERUM	CREEPING BLUESTEM	G3G4Q	S1?
SCLERIA RETICULARIS	RETICULATED NUTRUSH	G3G4	S1
SORGHASTRUM	OPEN INDIAN GRASS	G3Q	S3

APALACHICOLENSE			
SPIRANTHES BREVILABRIS VAR FLORIDANA	FLORIDA LADIES'-TRESSES	G3G4T?	S1
STEWARTIA MALACODENDRON	SILKY CAMELLIA	G4	S3S4
TRIDENS CAROLINIANUS	CAROLINA FLUFF GRASS	G3	S3S4
XYRIS CHAPMANII	CHAPMAN'S YELLOW-EYED GRASS	G3	S2?
XYRIS DRUMMONDII	DRUMMOND'S YELLOW-EYED GRASS	G3	S2
XYRIS FLABELLIFORMIS	FAN-SHAPED YELLOW-EYED GRASS	G4	SU
XYRIS SCABRIFOLIA	HARPER'S YELLOW-EYED GRASS	G3	S1S2

ANIMALS – Stone County

Scientific Name	Common Name	Global Rank	State Rank
AIMOPHILA AESTIVALIS	BACHMAN'S SPARROW	G3	S3?B,SZN
CROTALUS ADAMANTEUS	EASTERN DIAMONDBACK RATTLESNAKE	G4	S3S4
ELANOIDES FORFICATUS	SWALLOW-TAILED KITE	G5	S2B
FALLICAMBARUS BYERSI	LAVENDER BURROWING CRAYFISH	G4	S3
FALLICAMBARUS DANIELAE	SPECKLED BURROWING CRAYFISH	G2	S2
GOPHERUS POLYPHEMUS	GOPHER TORTOISE	G3	S2
HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE	G2	SH
ONTHOPHAGUS POLYPHEMI	ONTHOPHAGUS TORTOISE COMMENSAL SCARAB BEETL	G?	S?
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S1

PITUOPHIS MELANOLEUCUS LODINGI	BLACK PINE SNAKE	G4T3	S2
PROCAMBARUS FITZPATRICKI	SPINY-TAILED CRAYFISH	G2	S2
PROCAMBARUS LECONTEI	MOBILE CRAYFISH	G3G4	S2
PSEUDOTRITON RUBER	RED SALAMANDER	G5	S3
RHADINAEA FLAVILATA	PINE WOODS SNAKE	G4	S3?
URSUS AMERICANUS LUTEOLUS	LOUISIANA BLACK BEAR	G5T2	S1

APPENDIX B

Red Creek Trip Report
July 19, 2006

Red Creek, Stone County, MS

City Bridge Road to Highway 15

Respectfully Submitted to
The Land Trust for the Mississippi Coastal Plain

Prepared by
Sustainable Watershed Technologies

On Wednesday July 19th, 2006 the Red Creek Watershed Field-Team conducted a general investigation of the physical conditions of Red Creek in vicinity of the City Bridge Road crossing. The Field-Team as seen in Figure 1. was aptly staffed by (from left to right) Mrs. Robin Lott; Mr. Jon Bond; Mrs. Cynthia Ramseur; Mr. Jim Kelly; and the invisible Mike Hanley (taking the picture).

Figure 1.

1. PURPOSE OF INVESTIGATION:

The purpose of the Red Creek investigation was to determine the geomorphic trend of the Red Creek and then to explore the relevant issues and concerns as identified by the Field Team. The topics of concern are as follows:

a.) Where is the Red Creek channel heading in geomorphic trend?
b.) What were the potential water quality threats (increased fluvial sediment supply/ alluvium) that might result from channel instability? (*Source Water Protection*)
c.) What were the potential water quantity threats that might result from channel instability due to Red Creek historical incision and the degree of entrenchment from it's floodplain. (Source Water Protection)?
d.) What are some possible solutions that might ameliorate the threats to the channel instability, water quality, and water quantity?

***Section 2 is a five page brief overview of geomorphic concepts and graphics that are referenced in Section 3.

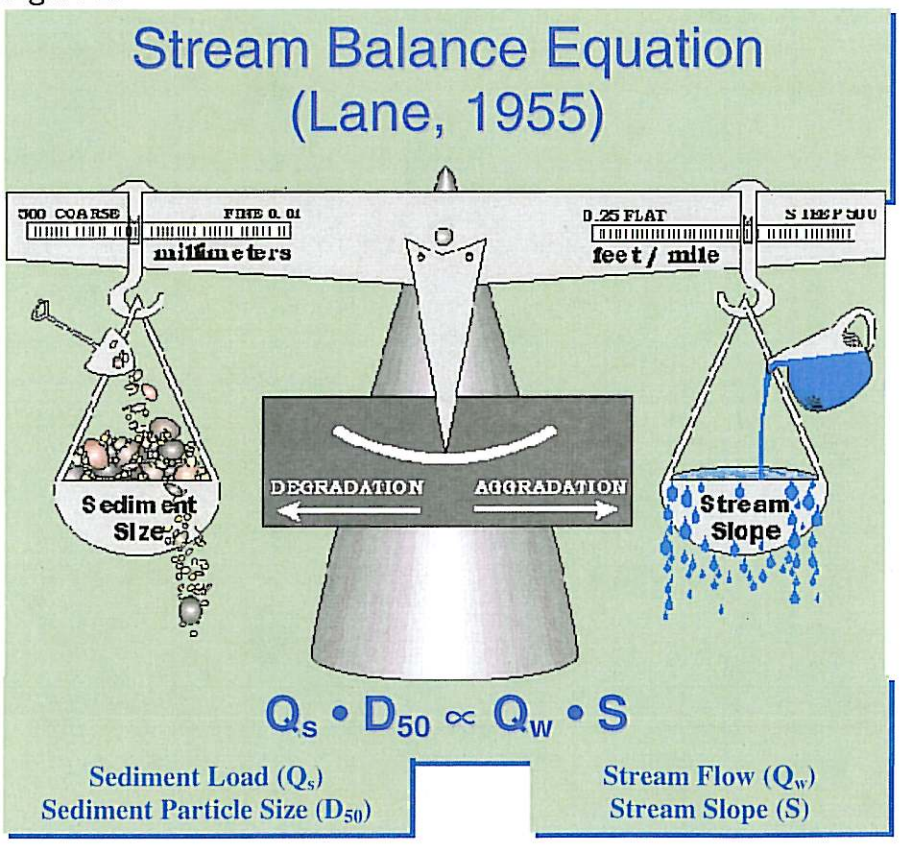
***Section .3 on page 7. begins the Red Creek field report information.

2. BRIEF OVERVIEW OF FLUVIAL GEOMORPHIC CONCEPTS:

a.) The Master Scale (Watershed Scale) Fluvial Geomorphic Considerations

The Definition of River Stability: *the ability to maintain, over time, its dimension, pattern, and profile in such as manner that it is neither aggrading nor degrading and its ability to transport the flows and sediment generated by its watershed without adverse consequences*. Also termed as dynamic equilibrium

The Concept of Lanes Balance to River Stability and Adjustment:
Figure 2.

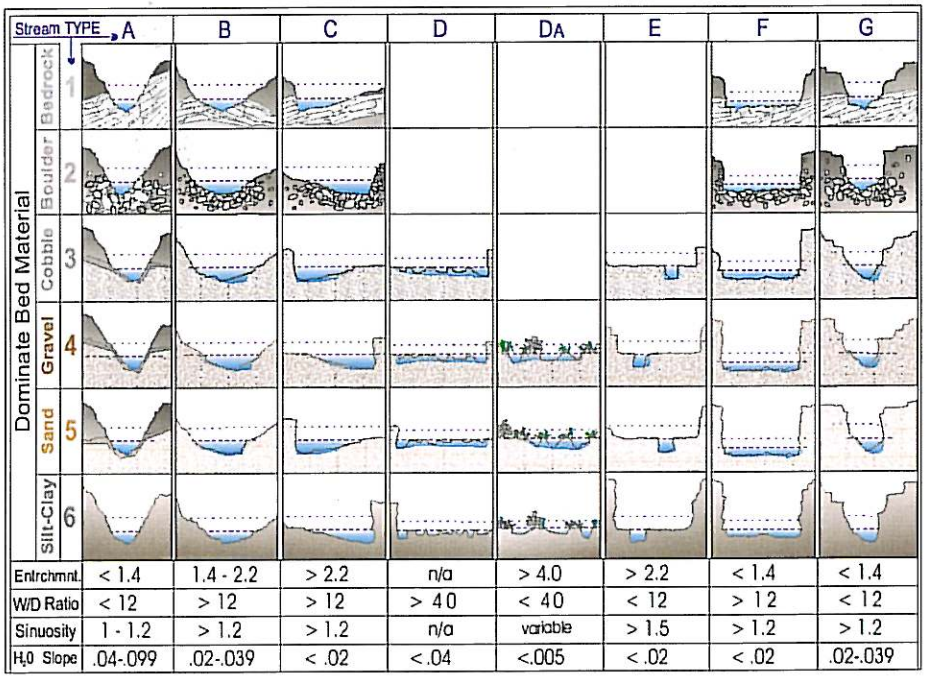


A river's sediment budget (both particle size, particle geology, and load of particles) are delicately balanced with a river's water budget (water power) in such a manor that the river's geomorphic characteristics (hydraulic slope, channel cross-sectional area, and channel

shape) have evolved collectively to form a stable relationship called dynamic equilibrium. If one of the master parameters (sediment size, sediment type, sediment load, water flows, riparian vegetation, channel slope, channel shape, channel area) are changed then the result is a corresponding change from one or more (usually more than one) of the other master geomorphic variables that will serve as the input to null out the original change. This is best described as being a natural auto-catalytic feedback mechanism.

FYI: *I calculated the bankfull discharge at around 5,800 cubic feet per second from the 45 year period of hydrologic record taken from the USGS gage data at Vestry.*

b.) Stream Channel Classification Systems – The stream channel classification system that we used during this field visit was the Rosgen classification system.
Figure 3.

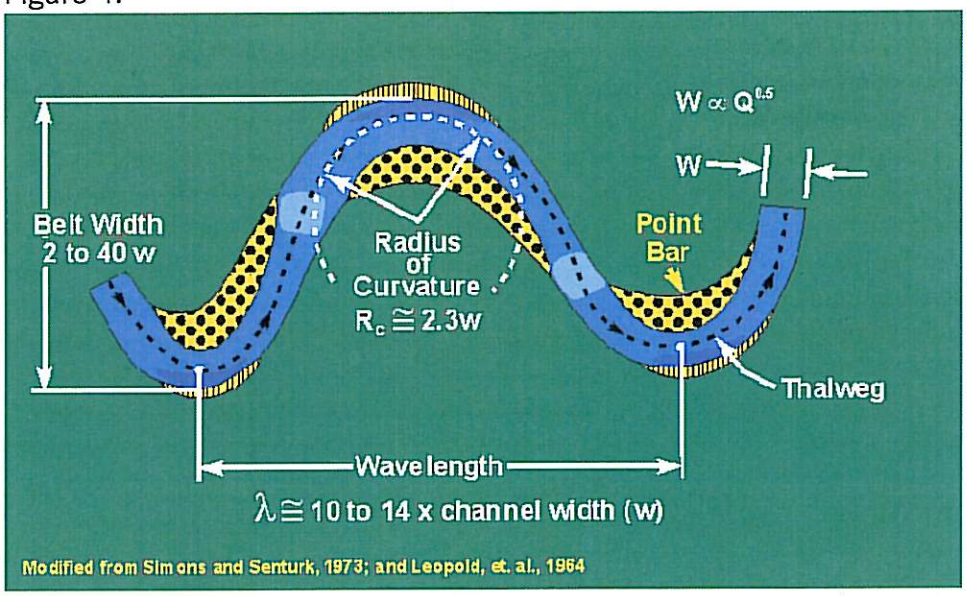


Stream TYPE	A	B	C	D	DA	E	F	G
Entrchmnt.	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	> 1.5	> 1.2	> 1.2
H_2O Slope	.04-.099	.02-.039	< .02	< .04	<.005	< .02	< .02	.02-.039

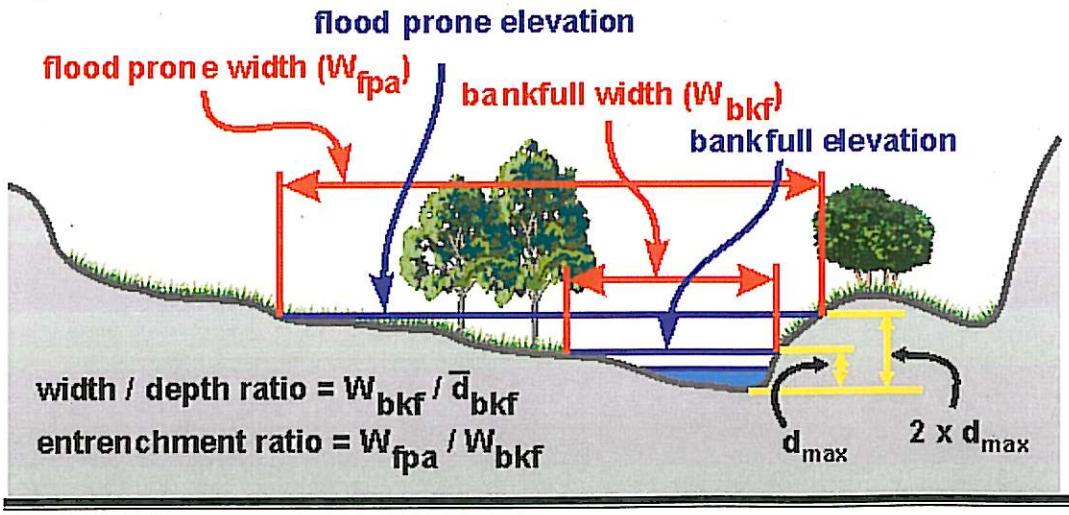
This is one of the most easily understood stream channel classification systems that I have found and I use it often when communicating with watershed groups and municipalities. It is as easy as 1-2-3 and A-B-C. For instance, consider Red Creek as an example: Our Red Creek started out as a E-5 channel (E channel with sand sized bed material dominant) type about 150 years ago now. But then the E-Channel (our Red Creek) under went episodes of head-cutting and degraded into a G-5 channel that resulted from channel incision due to dramatic increases in water runoff that was caused most likely from the landscape level deforestation within the Pascagoula Basin. Then the G-5 channel cut down to the heavily bedded/ very cohesive blue-grey clay of Miocene age that underlies the surficial deposits of sands and gravels. That tough old grey clay was very heavily bedded and the Red Creek could not cut-down any further. This left the Red Creek trapped in an incised channel that kept more of the flood waters (and their erosive hydraulic power) within the sandy & more easily erodible channel banks. This condition then transitioned into an F-5 channel type that was keeping even more of the flood flows and stream power within the active channel banks. The land began to heal in again. Trees were planted and they grew tall on the floodplains. The forests

that grew back were now managed in smaller timber harvest operations and were owned by different landowners such that the watershed was not completely deforested at any time period since the original disturbances. The F-5 channel kept on eroding its banks and also reworked & deposited the valuable sediments supplied from the healing landscape. The F-5 channel began to build proto-pointbars (little alternating sand & gravel bars) that were low in elevation. And the F-5 channel began to cut/erode its outside banks such as to add length to it's self and thusly reduce its hydraulic gradient (channel slope). The sick old F-5 channel began to increase its belt-width and was then trending to becoming a poor example of a C-5 channel. Enter the Red Creek Watershed Partnership and their field team. Here we are today with an F-5 channel type that is transitioning into a C-5 channel type.

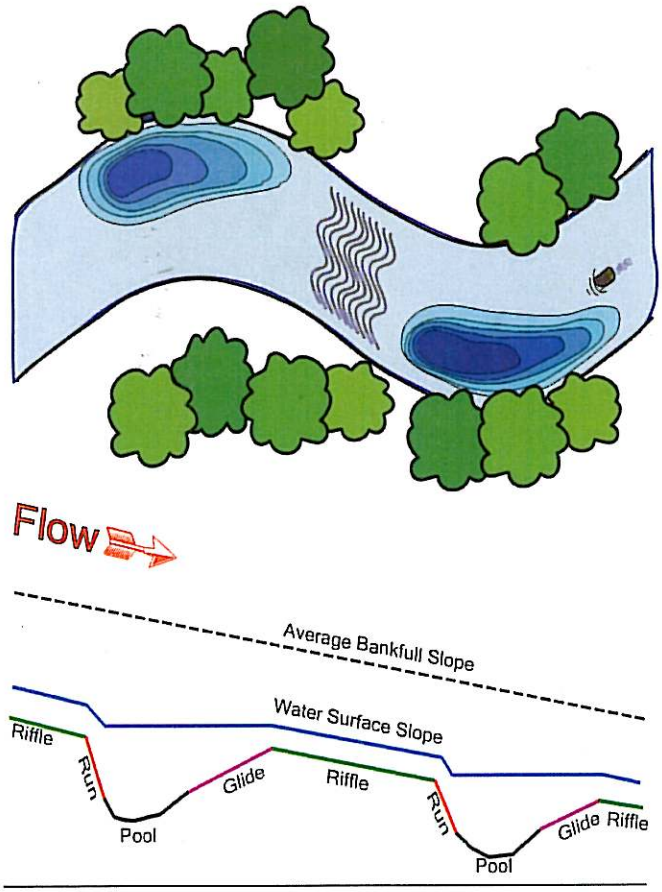
c.) Stream Channel Planform Descriptions
Figure 4.



d.) Stream Channel Cross-Section and Geomorphic Descriptions
Figure 5.

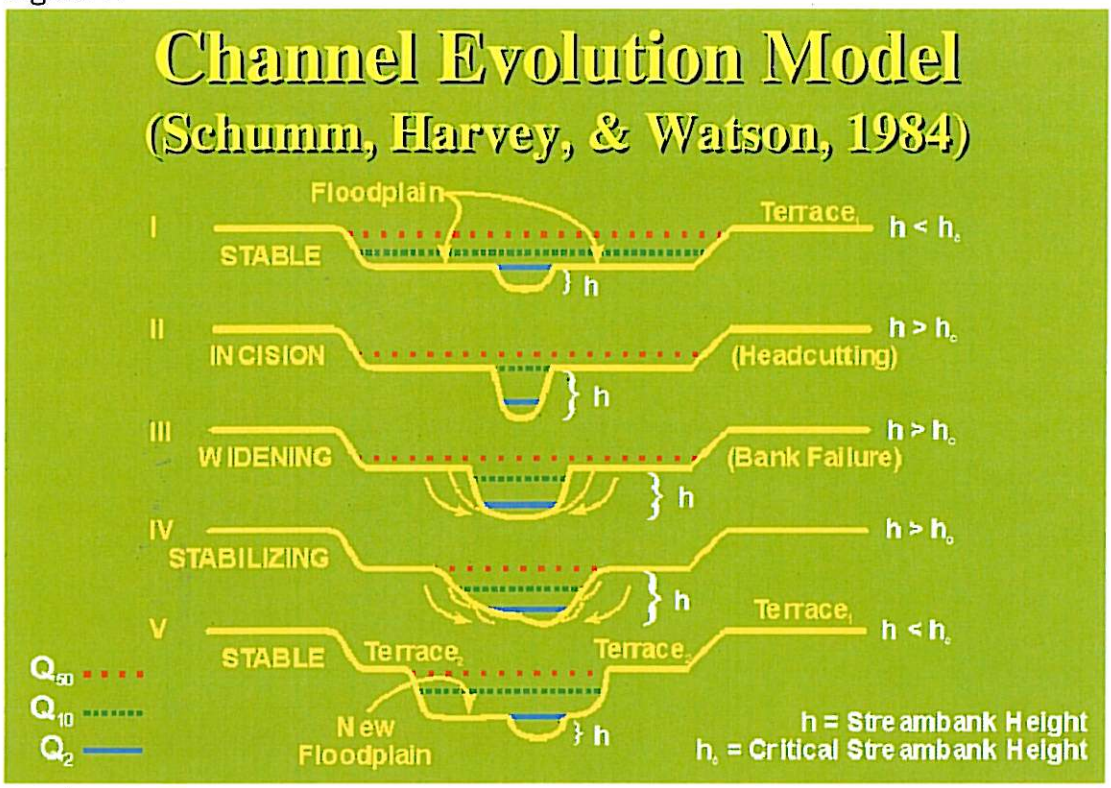


e.) The Stream Channel Geometry in Planform and Longitudinal Profile View
Figure 6.

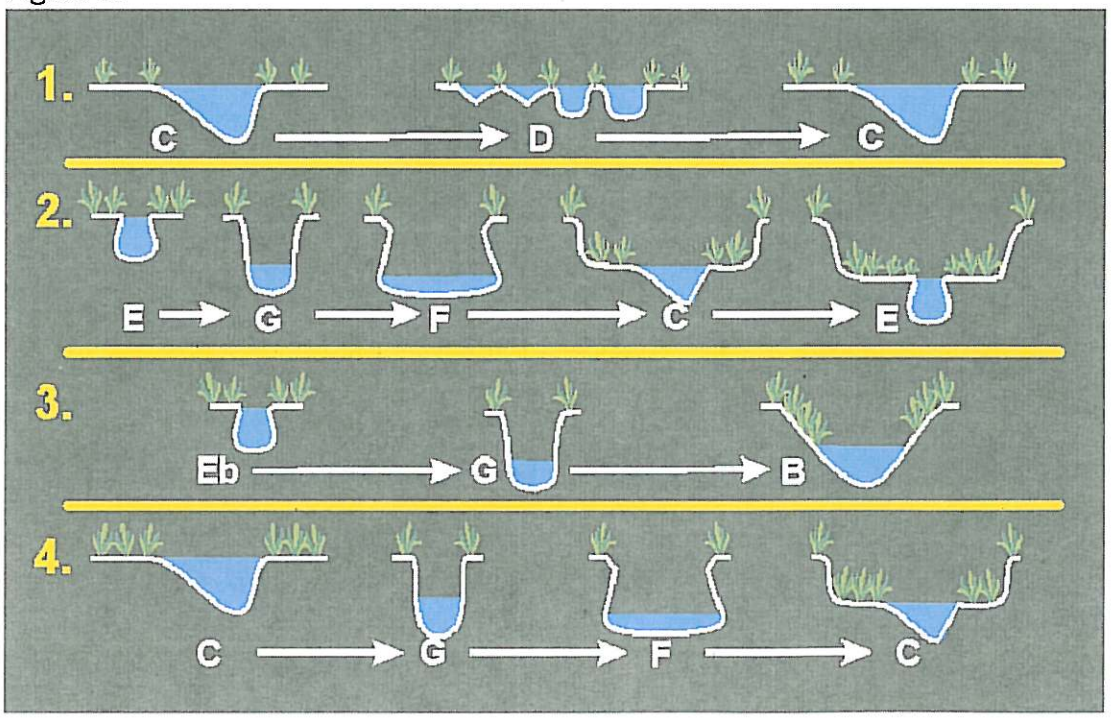


The dark blue colored areas in Figure 6. are the deeper pools that the river needs for energy dissipation during flood events. The pools are also deep water refugia for aquatic species. The waters of the pool are cool, shaded, well oxygenated and that's why the best fishing is usually in the pools. The pool area is where a river mixes surface waters with cooler spring/ground water that discharges into the depths of the pool. The Glide surface (the purple line) is the most stable part of the river. This is where most fishes choose to spawn due to the relative quality of the sediments and the high oxygen coming up from the pool. Glides and Riffles are important because they set a rivers channel slope or to the Engineer, they set the rivers hydraulic gradient (this is important for the streams power). You will notice how the water surface slopes of the pool are more flat than the average bankfull water surface slope. But notice how the Riffle slope is approximately the same as the average bankfull water surface slope. These differences in slopes are extremely important to the river for stability and sediment transport competence.

f.) The Five Phases of Gross Scale Channel Evolution
Figure 7.



g.) The Fine Scale Stream Channel Type Evolution Scenarios
Figure 8.



3.) RED CREEK FIELD REPORT:

As luck would have it on the morning of our investigation the Red Creek was still very low in stage at the time of the field visit and the field team was limited to walking a couple of sections/ stream-reaches of Red Creek within the project area where Mr. Jon Bond had vehicular access.

The Field Team started their investigation of the subject Red Creek reach just down stream of the City Bridge Road crossing. The photo in Figure 9. is the Red Creek as viewed when looking upstream at the City Bridge Road crossing. One should notice the over-widened stream channel (relict of historical down cutting and excessive bank instability) and the low elevation proto-point bars (rebuilding sand/gravel bars) and as evidenced in Figure 9. The presence of these afore mentioned physical attributes suggest that the stream channel is beginning to construct (via erosion, reworking, and deposition of alluvium) the necessary fluvial geomorphic facets required to reach dynamic equilibrium in the distant future. Refer to Figure 7. in Section 2.f. for a description of the gross scale channel evolutional adjustments. The present day Red Creek channel is a type F-5 channel form trending to a type C-5 channel form. One can determine this by the presence of alternating low elevation proto-bars as evidenced in figure 9. Refer to Figure 3. in Section 2.b. for a detailed description of the channel classification system used during the field visit. The Red Creek was historically a very stable E-5 channel type that supported an extensive bottomland hardwood floodplain wetland system. Refer to Figure 8. in Section 2.g. for Red Creek's most provable stream channel evolution scenario. Scenario # 2 in Figure 8. depicts how a stream channel would evolve from a stable E channel type then to a degraded and incising G channel type then to a very unstable F channel type (that lowers the water table and increases sediment supply) and then begin to evolve/ stabilize slightly to an over widened C channel type and possible in the distant future back to a quasi-stable E channel with a lowered water table and a decreased connection with the floodplain wetland system. The gross scale channel adjustment phase is between Phases three and four as depicted in Figure 7. in Section 2.f.

Figure 9.

Figure 10.

The photo in Figure 10. is of the right descending stream bank of the Red Creek just down stream of the City Bridge Road crossing. The unstable/ eroding stream bank in Figure 10. is an outside cut-bank of a meander bend. The critical bank height of the sandy material has

been exceeded due to the channel incision (down-cutting) and this symptom of watershed instability can lead to substantial increases in the regional sediment supply. In connection to the stream channel's need to lower it's critical bank heights is the channel's need to increase its belt width and thusly reduce the degree of slope for the stream's hydraulic gradient/ channel slope by lateral extension of the meander bends. The lateral extension is accomplished by the stream channel actively eroding its outside cut-banks such as to increase the channel's planform & beltwidth as described in Figure 4. of Section 2.c.

Figure 11.

Figure 12.

We next visited a reach of the Red Creek flowing through an undeveloped area that Jon Bond has permission to access by vehicle. Our team wanted to evaluate the stream stability in another location away from the influence of the City Bridge Road crossing. The prognoses of Red Creek's condition was the same as at our second location as had been at the City Bridge Road crossing. The stream channel is a type F-5 trending to a C-5 channel type. One should notice in Figure 11. that the channel is depositing logs, gravels, and course sands in the Riffle position such as to rebuild the longitudinal geometric facets (and increasing its hydraulic roughness). The stream channel needs to increase its riffle heights in order to reduce inchannel velocities and near boundary shear stress. This is an important step in the channel evolution process.

One should notice in Figure 12. that the stream's point bars are rebuilding in and decreasing the width to depth ratio of the active hydraulic channel. This process is an important aggradational phase as the channel is trending from an F-5 channel type to an C-5 channel type. The channel needs to narrow its width, deepen its pools, and raise the elevations of its riffles in such a way that it will have developed the longitudinal facets (geomorphic facets such as: riffle, run, pool, and glide/tail-out sequences) depicted in Figure 6. in Section 2.e..

At this stage of channel evolution/adjustment, if the correct passive restoration actions are taken carefully then it could serve the river to greatly hasten the channel evolution process and lead to a more stable and functionally interactive river, riparian, and floodplain ecosystem.

Our Original Questions Revisited:

a.) Where is the Red Creek channel heading in geomorphic trend?

The overall geomorphic trend of the Red Creek within the area of study is an F-5 channel type trending/ aggrading into a proto C-5 channel type as depicted in Scenario # 2 of Figure 8. The gross geomorphic evolutionary adjustment phase is currently between Phases three and four as depicted in Figure 7. Red Creek's condition is trending towards a more stable form.

b.) What are the potential water quality threats (increased fluvial sediment supply/ alluvium) that might result from channel instability? (*Source Water Protection Issues*)

The newly reforming channel of Red Creek will erode its banks and riparian vegetation in order to rebuild a stream channel planform; longitudinal profile (hydraulic slope/gradient); and channel cross-sectional area & shape that will allow it to process the water-budget and sediment-budget that its watershed provides to it as depicted in Figure 2.(Lane's Balance). However, during this channel adjustment process the regional sedimentation will most likely increase and remain elevated on trend for as much a two to four decades if left to evolve/ heal in alone under its own hydraulic power.

c.) What are the potential water quantity threats that might result from channel instability due to Red Creek historical incision and the degree of entrenchment from it's floodplain. (Source Water Protection)?

The present day condition of the Red Creek is moderately incised but it still attains interaction with its historical floodplain during higher flows. This condition leads to a more flashy discharge character. This exhibits frequent pulses in hydraulic discharge record with a hasty return to near base-flow/ low-flow conditions for much of the year. This is commonly thought to be natural by local residents but it is a symptom of basin scale impairments to the water budget and stream. The more frequent but lower floods do not attain the floodplain elevation and are not allowed to be absorbed into the floodplain wetland systems. The flows are not hydraulically attenuated by the wetlands on the floodplains and thusly the rainfall/ stream discharge contributions are more quickly processed through the riverine system and then on to the Gulf of Mexico. Some major results of this impairment are lowed watershed hydraulic storage (storativity); degraded water quality, severely lower aquifer levels during annual drought seasons (water quantify losses).

d.) What are some possible solutions that might ameliorate the threats to the channel instability, water quality, and water quantity?

The time is right to take passive restoration actions and work with the reforming stream channel to seed the sediment deposition in the correct locations and form such as to nudge the channel ahead in the evolutionary process. The passive restoration actions would most likely involving using some of the damaged logs from Katrina. Logs are a natural material and have always been part of the riverine ecosystems healing mechanisms. The logs would need to be interlocked so they would stay in place during flood events. Also I would suggest establishing native vegetation on destabilized banks in order to reduce near boundary shear

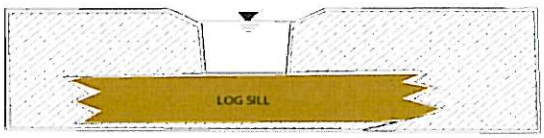
and velocity. We would also suggest establishing native vegetation on newly forming bars to induce further deposition of sediments during higher flows. These processes are called Bioengineering and have been used in the field of river engineering/ restoration for over 200 years. These practices could provide the Red Creek watershed with even greater water-quality benefits when used in combinations with other conservation practices like stream-side management zones (SMZs), riparian buffer creation, wetland restoration/ preservation, and floodplain management planning.

4. **Concept typicals for the passive restoration actions using natural log materials to construct bankfull benches with logs and native earth materials.** Post construction these areas would be reestablished with native vegetation using native trees, shrubs, and grasses (bioengineering materials) to hold the sediments in place and to reduce the boundary velocities.

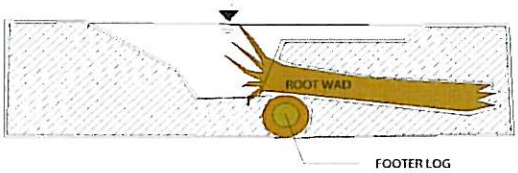
Typical log sizes would be 16-20 feet long and a minimum of 10 inches on the small end.

Design Typicals by R. Michael Hanley
Sustainable Watershed Technologies

CROSS SECTION TYPICAL FOR LOG SILL



CROSS SECTION VIEW OF ROOT WAD WITH FOOTER LOG



PLAN VIEW OF RESTORATION STRUCTURES