RESTORING HORSEPEN CREEK:
Recommendations for Camden County, Georgia Management of Onsite Wastewater Systems

2013 Final Project Report

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Background and Introduction

The St. Marys River[1] rises from the Okefenokee Swamp before travelling 126 miles to the east and emptying into the Atlantic Ocean. Its watershed covers approximately 1500 square miles in both Georgia and Florida, and for much of its length it forms the southeastern boundary between these two states.

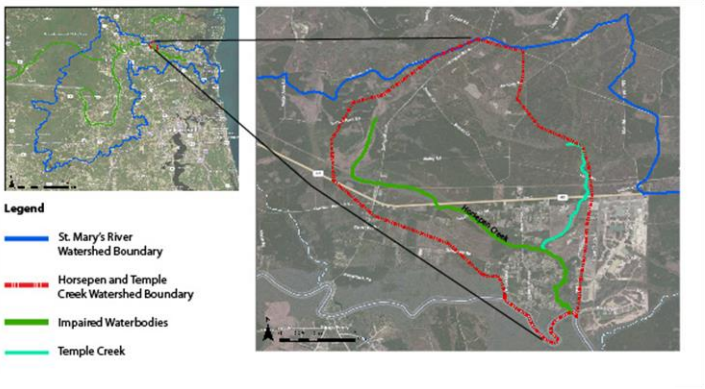

Figure 1: Map showing watershed boundaries and impaired waterbodies

The St. Marys River is an important economic, environmental and community resource in southeast Georgia and northeast Florida.[2] Despite its long held reputation as a pristine black-water river, water quality in the St. Marys River is deteriorating. In 2010, 14 stream segments comprising 53 miles of creeks and streams in Georgia's portion of the St. Marys watershed were listed as impaired by the State of Georgia.[3] Most of these impairments are due to low dissolved oxygen levels and high concentrations of fecal coliform.[4] Protecting the water quality and ecological integrity of the river is critical to the future of these surrounding communities. This includes protecting the water quality in its constituent tributaries.

The St. Marys River Management Committee (SMRMC) was established as an intergovernmental group by Camden and Charlton Counties in Georgia and by Nassau and Baker Counties in Florida to provide these localities with guidance on issues affecting the St. Marys River. The SMRMC advises the member governments on river issues and works to coordinate their policies to "promote the long-term viability of both the environmental and economic resources of the St. Marys River in a way that retains local control, protects property rights, and fosters cooperation among individuals, governments, and agencies of all levels."[5] In 2011, the SMRMC partnered with the University of Georgia's River Basin Center (RBC) to examine the extent to which septic systems contribute to high fecal coliform levels on a direct tributary to the St. Marys River in Camden County known as Horsepen Creek and propose steps to address this source of pollution.

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[1] USGS Hydrologic Unit Code (HUC) 03070204.

[2] *See* St Marys River Management Committee, St Marys River Management Plan. 2003. *Available at*: http://www.sjrwmd.com/stmarysriver/pdfs/stmarys_mgmt_plan.pdf.

[3] Georgia's 2012 Integrated 305(b)/303(d) Report (also referred to as Water Quality in Georgia 2008-2009) GIS Data Sets. *Available at*: http://www.gaepd.org/Documents/gismenu.html.

[4] Id. A number of these lists also identified high mercury levels.

[5] St. Marys River Management Plan at pg. *a*.

Four miles of Horsepen Creek are included in Georgia's 2012 305(b)/303(d) Listing Documents. The Horsepen Creek watershed is approximately 8 square miles of predominantly evergreen forest and timber farms (approximately 63%) and woody wetlands (approximately 27%), though most of the timber land is located on hydrologically altered wetlands. The remaining 10% is mostly residential development served by septic systems.

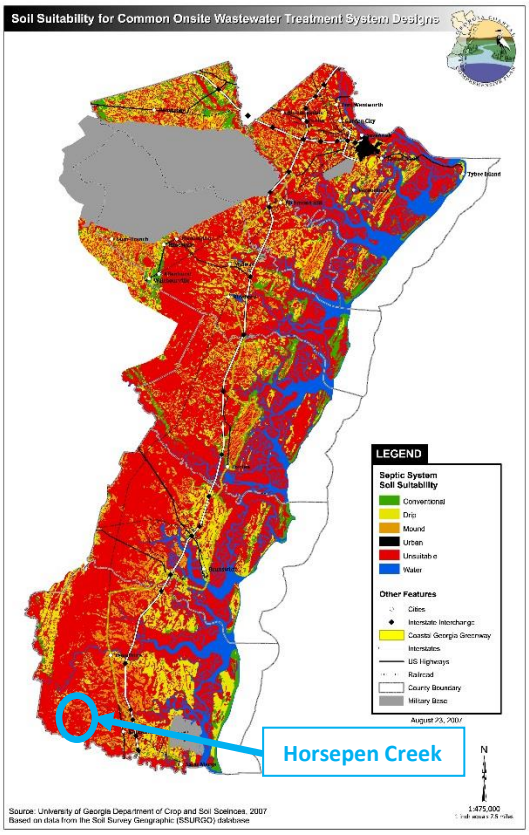

Figure 2: Soil Suitability for Septic Systems from the Coastal Comprehensive Plan.

Camden County, like most of the Georgia coast, is a difficult place to operate a traditional onsite wastewater disposal system. This is primarily due to poorly percolating soils, and a high water table. These factors make it difficult for wastewater to infiltrate through the ground, which is where wastewater leaving the septic tank is treated.

Studies have shown that on average a single failing system can contribute more than 77,000 gallons of untreated waste into groundwater and surface water every year.[6] The EPA estimates that between 1% and 5% of septic systems fail each year, though this number varies widely as many areas are poorly suited for septic systems. In some areas failure rates as high as 70% have been reported.[7] Even a moderate failure rate can impair water quality, especially in coastal areas. Wastewater from failing septic tanks contribute bacteria, viruses and parasites to the local waterbodies. Contact with these contaminated waters can cause headaches, abdominal cramps, vomiting, and diarrhea in people as well as a number of severe illnesses including typhoid, paratyphoid, dysentery, cholera, and gastroenteritis. In addition to polluting the environment, wastewater can also damage fisheries, and from time to time shellfish harvesting areas in coastal Georgia are closed due to fecal bacteria contamination from nonpoint source pollution.[8] Septic system also contribute excess nutrients and organic matter to water bodies that can have significant negative impacts to aquatic systems.

[6] "Septic System Failure", Purdue Extension, Home & Environment HENV-1-W. *Available at:* http://www.extension.purdue.edu/extmedia/henv/henv-1-w.pdf.

[7] USEPA, 1997 Response to Congress on Use of Decentralized Wastewater Treatment Systems. *Available at*: http://water.epa.gov/infrastructure/septic/upload/septic_rtc_all.pdf.

[8] Water Quality in Georgia 1996-1997. Georgia Department of Natural Resources/Environmental Protection Division. Atlanta, Georgia. 1998.

The Georgia Environmental Protection Division of the Department of Natural Resources (EPD) listed Horsepen Creek for bacterial contamination based on water quality samples taken in 1998 and 2003. Water quality samples were taken from Horsepen Creek just south of Greenville Road near Kingsland, Georgia (GAEPD site 08010491). Because over 10 percent of the samples exceeded 400 colony counts/100 ml, a four-mile segment of Horsepen Creek was added to the State's 303(d) list,[9] and a TMDL was prepared to address the cause of this bacterial contamination.

The TMDL pointed to nonpoint pollution sources as the source of this contamination, specifically failing septic systems. The TMDL also considered the impacts of other nonpoint sources such as wildlife since the St. Marys River basin has a significant deer population, and agricultural livestock as the area does contain some pasture land. This project specifically sought to target the septic contributions by trying to assess the relative impacts these sources have on bacterial levels in Horsepen Creek and beginning to develop a strategy to reduce this load.

Project Description

The overarching purpose of this project was to assess the extent to which failing septic systems are contributing to fecal coliform levels in Horsepen Creek and to devise a strategy to reduce septic system failure in this area. To that end, this project had four objectives: 1) Investigate the extent that failing septic systems contribute to the fecal coliform levels in Horsepen Creek; 2) Install one new septic system as a demonstration project in the challenging conditions found in much of Camden County; 3) Develop a comprehensive septic maintenance strategy for the local community, and 4) Conduct a public outreach campaign to support the septic management strategy.

1. Investigate the extent that failing septic systems contribute to the fecal coliform levels in Horsepen Creek

This project began as an effort to identify "hotspots" of septic contamination where individual failing systems were contributing significant loads of bacterial pollution to Horsepen Creek. The UGA investigators planned to use targeted water quality sampling at various points along Horsepen Creek to identify the problem systems. Once these sources were identified, the failing systems would be replaced by septic systems that were better suited to the difficult conditions in the watershed.

UGA personnel conducted visual surveys of the Horsepen Creek watershed on three occasions in June and September of 2012. Water quality samples were taken during both the June and September trips. Additional samples were taken by a representative of the SMRMC in July of 2012. Many of these samples revealed high bacterial content. A summary of these sampling results are attached in the

[9] TMDL Implementation Plan, Horsepen Creek (Fecal Coliform). Prepared by the Coastal Regional Development Center for the Georgia Department of Natural Resources. 2001.

Appendix. The highest concentrations of bacteria were confirmed to involve human sources.[10] However, the physical condition of the creek, primarily due to the intermittent flow, made definitively identifying sources of the human bacteria impossible.

Much of the Horsepen and Temple Creek watershed has been channelized to drain local silviculture operations and residential areas. This artificial drainage pattern appears to reduce the base flow of water in Horsepen Creek, and when coupled with generally dry conditions there was virtually no water flowing in the creek. Also, a portion of the Temple Creek watershed is siphoned off by a man-made channel connecting the Temple Creek watershed to Catfish Creek, which drains to the Satilla River, as documented by the revised Tier 2 TMDL Implementation Plan for Horsepen Creek dated March 30, 2009. These flow conditions made sampling difficult, and it made identifying the sources of the bacterial contamination impossible.[11] These flow conditions were present during all three visits to the creek.

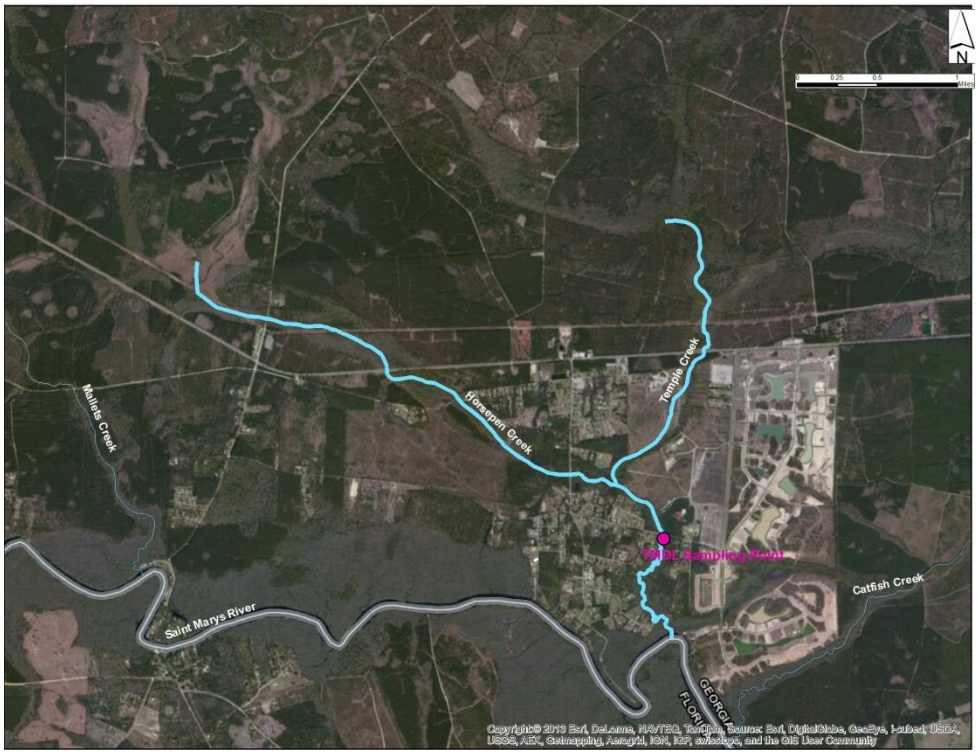

Figure 3: Map showing TMDL sampling point on Horsepen Creek.

[10] The samples with high bacteria counts were examined using DNA based bacteria source tracking techniques, which confirmed the presence of human originated bacteria in these samples, though the proportion of the bacteria that came from human sources is not known.

[11] One suspected failing septic system was identified. Due to the impaired flow in the main body of the creek, a number of sampling points were chosen along the man-made drainages in the residential areas of the watershed. These samples showed the presence of human specific bacteria, but they provided little information regarding identifiable septic hotspots, though one sample collected in July 2012 from a drainage ditch was thought to be linked to a residence as that property appeared to be the only source of water runoff to the sampled portion of the ditch. That owner was not responsive to our attempts to contact him, which included letters, phone calls and two in-person visits to his home.

Due to the inability of the targeted water quality sampling to yield actionable data, this project was modified to focus on decreasing septic contribution to fecal coliform pollution through an assessment of the condition of septic systems in the Horsepen Creek watershed and by increasing public outreach and education about septic system use and maintenance. This effort had four primary components: 1) direct public outreach to residents in the Horsepen Creek watershed; 2) conducting septic system inspections to determine a failure rate for this area, and 3) reviewing County records to assess the state of septic systems in the watershed.

1.1 Public Outreach

We began the public outreach phase of this project by hosting a public meeting for residents in the Horsepen Creek area at the Temple Landing Park on November 15, 2012. Invitations to the event were mailed to more than 300 residents; signs were posted along roadsides in the neighborhood, and SMRMC members promoted the event through personal communications with people in the area. Turn-out for the event far exceeded expectations as well over 100 people attended the event. SMRMC members presented information about the history, ecology and social importance of the St. Marys River and its tributaries. Scott Pippin and Katie Sheehan with the UGA RBC then discussed how proper maintenance and operation of septic systems are necessary to protect these qualities and how failing septic systems and high bacteria levels are linked to serious public health concerns. At the close of the presentations, we invited residents to sign up for free septic system inspections and pump-outs. Fourteen households signed up for this offer.

Two additional public presentations were held at the Camden County Board of Commissioners meetings in October 2012 and June 2013. We hosted a final public outreach event at the Kingsland Catfish Festival on August 31, 2013 to which we specifically invited all of the Horsepen Creek residents. On two occasions residents were mailed information regarding the relationship of septic systems to environmental quality and public health and discussing the importance of proper septic maintenance. Finally SMRMC members and RBC staff had numerous meetings and conversations with individual residents in the Horsepen Creek watershed explaining the purpose of this project, why septic maintenance is important, and soliciting information about local water quality and local septic systems.

1.2 Conduct Septic Inspections

Fourteen households volunteered to have their home septic systems pumped-out and inspected at the first public information meeting held on November 15, 2012. Three of these volunteers later decided not to participate so 10 inspections were conducted. To bolster public support for this project, we wanted to use local companies as much as possible. Local septic professionals can also often provide insight into local conditions and practices that contribute to septic system failure. There are two licensed septic haulers located in Camden County. After discussions with both haulers, we reached an agreement with Superior Septic Tank Service Corp. to conduct these inspections.

These inspections identified seven systems as failing.[12] Two of these residences have structural problems with their septic tanks and drainfields and thus require completely new systems. Three

[12] While "failing" is often interpreted to mean the systems is backing up into the residence or surfacing in the yard, this project took a broader view and considered any system that did not appear to be adequately treating

systems have problems necessitating a complete replacement of the drainfield primarily due to damage caused by root intrusion and biomat growth. The remaining two systems required only minor repairs. We had funding to repair three systems, the two with minor problems and one with a damaged drainfield.

1.3 Review County Septic Records

There is no centralized sewer system in the unincorporated portion of Camden County. Virtually all of the residences outside of the incorporated cities dispose of their wastewater through traditional septic systems, though a small number of homes are served by community wastewater systems. The 2010 U.S. Census indicates that there are approximately 7,500 housing units in unincorporated Camden County.[13] As there is no sewer service and few community systems, this is probably a fairly accurate estimate of the number of active septic systems in Camden County.

The TMDL reports estimate that there are 90 septic systems in the Horsepen Creek watershed.[14] However, preliminary analysis of GIS data indicates that this number is actually much higher. Looking at topographic data for the St. Marys watershed, we manually crafted the watershed boundary for Horsepen Creek. Overlaying this boundary on Camden County's parcel data, we determined that there are 240 individual parcels with residential structures in the watershed. Given that there are no sewer connections, it is assumed that all of these residences are on onsite septic systems.

Comparing these parcel numbers to the Camden County Environmental Health Department's digital septic records shows that only 140 (58%) of these parcels have a recorded septic system. Of the fourteen systems that residents requested to be inspected, only nine were recorded in the county records, which is a comparable recorded rate of 64%. Even among the systems that are recorded, the quality and value of the records varies widely, depending largely on the age of the records. Some of the older records are incomplete, contain confusing information, or are illegible in parts. More recent records are much more standardized and thorough, which provides a much clearer picture of the status of septic systems.

This record review also sought to determine the average age of septic systems in the Horsepen Creek area. Of the nine recorded systems that requested inspections, the average age was 18.6 years, though only two were less than 20 years old.[15] A random sample of 10 parcels in the Horsepen Creek watershed

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wastewater as failing even if there were no obvious external signs of it such as water backing up into the residence or surfacing in the yard at the time of the inspection.

[13] U.S. Census Bureau; State and County Quickfacts, Camden County. *Available at*: http://quickfacts.census.gov/qfd/states/13/13039.html. The 2010 census data show 21, 616 housing units in Camden County. Of these 7,443 are in the City of St. Marys, and 6,506 are in the City of Kingsland. A small number are in the City of Woodbine.

[14] "Total Maximum Daily Load Evaluation for Three Stream Segments in the St. Marys River Basin for Fecal Coliform." The Georgia Department of Natural Resources Environmental Protection Division. January 2006. pg. 9-12.

[15] Some of these records only contained documentation of system inspections or well tests, and they did not include specific system installation dates. If the systems' age could not be directly determined from the records, the ages were assumed to be the same as the structure on the parcel as stated in the Camden County parcel records.

with septic records had an average system age of 15.9 years, though this average resulted from four parcels with systems 4-9 years old and five parcels with systems 22-27 years old. While this is a relatively small sample size, between these two samples, 12 of 19 systems are over 20 years old. This seems to indicate that many systems are approximately 10 years old or less, and the majority of the rest are 20 years old or older.

Also, given that more than 40% of all of the septic systems in the Horsepen Creek watershed are not recorded, it is very possible that there are many systems that are 25 or 30 years old or older. The age of the systems does not necessarily indicate widespread failures, but in this situation it is likely that these older systems are failing at a higher than expected rate. Septic systems can be expected to last 20 to 30 years if well maintained.[16] However, a 20 year old system was installed early 1990's when septic records were first being kept and regulatory requirements for their siting and construction were much more lax. A 30 year old system was installed without any regulation. Also, many of these systems may have been illegally constructed outside of the current permitting process. Another issue is the level of usage. Some of the older septic systems were designed and installed for single families or seasonal use, and they are now used by larger families, multiple households, or year round usage.

Given that these systems were installed to meet lower performance expectations, it is more likely that they do not provide adequate treatment in the challenging conditions in the Horsepen Creek watershed due to its poorly percolating soils and high water table. Without more complete and detailed records it is impossible to determine a reliable failure rate for septic systems in the Horsepen Creek watershed, but given the age of the systems, the challenging hydrologic conditions, and the lack of regular maintenance, the failure rate is almost certainly well above what is generally expected or what is anticipated in new development.[17]

2. Install a Demonstration Septic System

Installing a demonstration septic system was intended to promote proper septic location, design, and construction. To that end, we sought to identify a site with particularly challenging physical properties characteristic of the difficulties of installing septic systems in this area. We also wanted a site that would have significant public visibility in order to demonstrate the importance of proper septic system design and installation.

In our conversations with local residents, we repeatedly heard that the septic system at the Temple Landing Boat Ramp was not functioning properly. Temple Landing is a public park on the St Marys River, and though it does not immediately abut Horsepen Creek, it is a prominent location that many residents

[16] A Suitability Code of F means the site is "normally considered unsatisfactory for use for conventional absorption fields."

[17] In 2000, the U.S. EPA estimated a failure rate between 10% and 20%; *see* Onsite Wastewater Treatment Systems Manual, EPA/625/R-00/008. February 2002. The Metropolitan North Georgia Water Planning District (MNGWPD) sites the top reasons for septic system failures as: unsuitable soils/poor location, age of the system, and poor maintenance. *See*: Septic System Status and Issues Working Paper, Metropolitan North Georgia Water Planning District. January 19, 2006 Draft.

use on a regular basis. To these residents, this failing septic system was symbolic of the regulatory officials' indifference to septic maintenance, and it contributed to their belief that septic system management was unimportant.

Figure 4: Map showing location of Temple Landing and its relationship to Horsepen Creek and the St. Marys River.

Camden County Environmental Health inspected the system and determined that it was not functioning and there were signs of a recent wastewater overflow from the septic tank. Due to the public visibility of this site, and its proximity to the river, we determined that this would be the location for the project's demonstration site.

A soil test of the site confirmed that it presented challenging conditions for onsite wastewater treatment. Only one portion of the park was determined to be at all suitable for a septic system. Even in this area, the seasonal high water table was 15 inches below the surface and the percolation rate was 70 minutes/inch, which combined to give the site a suitability code of "F".[18] To address these issues we designed a mounded system using an aerobic sand filter system.

[18] Suitability Code F = Normally considered unsatisfactory for use for conventional absorption fields.

Figure 5: Map showing location of septic system at the Temple Landing Park.

There are a number of elements of the proposed system we want to promote. The first is the use of mounded system. Mounded systems are generally used when it would otherwise be difficult or impossible to achieve sufficient separation from the water table or where the soils would not allow sufficient infiltration of wastewater. Discussions with local residents revealed a strong antipathy towards septic system mounds, and a belief that they are an eyesore and an unnecessary expense. We hope that the presence of a mounded system in highly visible community gathering place will raise awareness of the reasons mounds are beneficial, and perhaps it will normalize the practice in the community and help residents overcome their resistance to installing them.[19]

[19] One resident we spoke to specifically referred to the lack of a mound at Temple Landing as evidence that the County did not believe them to be necessary and were just a way for septic installers to drive up the costs. We hope this will dispel such ideas.

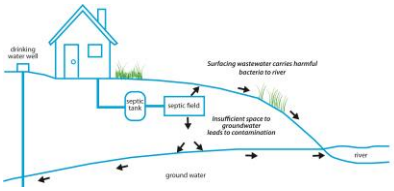

Figure 6: Gravity Drainfield – in areas with a high water table or poor percolation, gravity fed systems may not provide sufficient treatment.

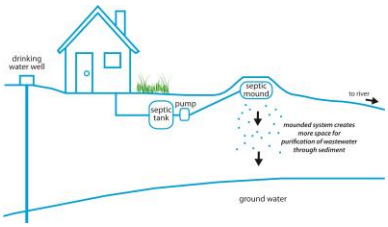

Figure 7: Mounded System – mounded systems can provide additional space for percolation and effluent treatment

The second feature we intend to promote with this system is its dosing pump. A pump is required in a mound system to move the effluent from the septic tank to the drainfield due to the higher elevation of the drainfield. We would have likely installed a dosing pump even if we were not using a mound system. One of the most frequent causes for system failure is the accumulation of bacteria in the drainfield to the extent that it prevents the infiltration of wastewater into the ground. This layer of bacteria is frequently referred to as a "biomat". A biomat is often formed when the drainfield does not have sufficient time to dry out before being re-inundated with water from the septic tank often because the system is undersized, overused or due to water leaks in the house. A dosing pump prevents the growth of a biomat by dispersing the wastewater in intervals sufficient to allow the drainfield to dry out before more water is added, thus inhibiting excessive bacterial growth. The widespread use of dosing pumps alone would reduce the failure rate for septic systems significantly.

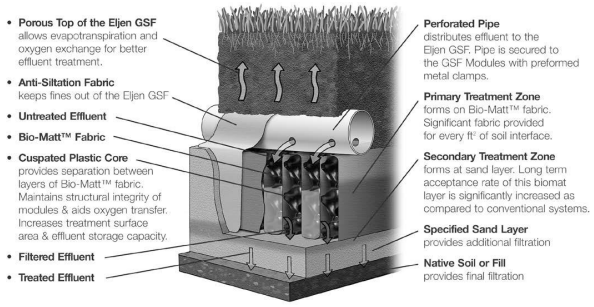

Figure 8: GSF Systems

Finally, we highlight the use of an aerobic sand filter treatment system. Specifically we are using the Eljen Geotextile Sand Filter System (GSF).[20] The GSF uses a plastic core instead of gravel for the drainfield bed. The plastic allows for additional contact area with the wastewater and additional oxygen transfer. This allows for the same level of wastewater treatment in a smaller area. For a conventional system, Georgia Environmental Health regulations mandate a 24 inch separation between the bottom of the system's drain field and the seasonal high water table.[21] If the system provides more aerobic treatment of the effluent, such as with the Eljen GSF system, the distance can be reduced to 12 inches

[20] For more information about the Eljen system and design specifications or download the Georgia design manual see: http://www.eljen.com/Pages/GSF/GSFoverview.html. There are numerous other similar technologies, and while we determined the Eljen system offered the most cost effective means to showcase more advance onsite wastewater treatment technologies, this is not meant in any way to be specific endorsement of the Eljen GSF system or any other product.

[21] Georgia Department of Human Resources Division of Public Health Environmental Health Division, Manual for Onsite Sewage Management Systems, revised April 2007, p.25.

resulting in a significantly shorter mound. In addition, the GSF modules allow for a wider area calculation for each line in the drainfield. This allows for a more efficient use of space and an overall smaller drainfield.

The installation of this system will directly impact water quality by replacing a failing system that is in close proximity to the St. Marys River. However, the larger impact is anticipated to come from public exposure to the system. Because this is such a visible site that is popular with local residents, this demonstration project is well suited to improve local understanding of septic issues. Discussion of the issues that went into selecting the system and the limitations of the installation site will provide another opportunity to present information about proper system design and installation and the connection between septic systems and environmental and human health.

3. Comprehensive Septic Management Strategy

One of the principal goals of this project was to develop recommendations for a comprehensive septic management strategy that Camden County could implement to improve septic functionality in Horsepen Creek and across the county. There are two conclusions that are supported by the findings in Horsepen Creek. First, there are a number of unrecorded systems that are currently not directly considered part of the County's wastewater infrastructure. Second, there are a large number of older systems that do not function properly due to a lack of maintenance and poor design and installation, many of which are likely the unrecorded systems previously mentioned.

An effective long-term septic management strategy begins with active data collection. This includes a thorough inventory of the existing septic systems and an assessment of the general condition of onsite wastewater systems in the county. This inventory and assessment should be coordinated with a broad effort to assess water quality in order to see if there are obvious links between septic systems and water quality issues. While this data collection is underway, the County should focus on replacing and upgrading as many of the poorly designed, badly placed, and antiquated systems still in use. Once these systems are brought up to modern standards, there should be a marked decrease in septic contribution water quality impairments. This will also reduce the disproportionate burden new septic regulations could place on the owners of older homes in Camden County. Once these issues are being addressed, the County can begin the legal and political process of choosing an ongoing regulatory strategy that meets its needs based on this new data. Designing this regulatory solution should include examining how other planning and development activities can coordinate with this effort to improve water quality.

From that general outline, we identified five activities that the County can undertake immediately or in the near future to address pollution from septic systems and provide specific a specific recommendation for how to execute each of them. These activities are 1) Septic System Inventory and Mapping; 2) Septic System Assessments, Repairs, and Upgrades; 3) Local Water Quality Monitoring; 4) Planning and Site Design, and 5) Long-Term Regulation.[22]

[22] The UGA River Basin's Center book Decentralized Wastewater Management: A Guidebook for Georgia Communities ("Septic System Guidebook") provides a variety of regulatory and non-regulatory actions local governments can undertake to promote ongoing septic maintenance and management, and it describes a process

4. Public Outreach

Due to the inadequacy of the water sampling data collected as part of this project, the public outreach campaign became an integral part of the septic system investigation component of this project discussed in Section 1. A more detailed discussion of this effort is described in Section 1.1 on page 6 above. However, in short, our public outreach efforts consisted of a public meeting for residents in the Horsepen Creek area at the Temple Landing Park on November 15, 2012. Two additional public presentations were held at the Camden County Board of Commissioners meetings in October 2012 and June 2013. We also hosted a final public outreach event at the Kingsland Catfish Festival on August 31, 2013 to which we specifically invited all of the Horsepen Creek residents. The Georgia Department of Community Affairs contributed funding to pay for three septic inspections and pump-outs for volunteers in the Horsepen Creek watershed that we met at the Catfish Festival.

On two occasions residents were mailed information regarding the relationship of septic systems to environmental quality and public health and discussing the importance of proper septic maintenance. Finally SMRMC members and RBC staff had numerous meetings and conversations with individual residents in the Horsepen Creek watershed explaining the purpose of this project, why septic maintenance is important, and soliciting information about local water quality and local septic systems.

Recommendations and Action Items

1. System Inventory and Mapping

Recommendation #1: Build upon past mapping efforts and the development of the Welstrom database to develop a full inventory of septic systems in Camden County.

This project highlighted a significant lack of tangible data about septic systems in Camden County. This project gathered some data about the condition of systems in this area, which provides an indication of the quality of these systems, though it primarily emphasizes the need for a more thorough investigation. A comprehensive inventory can provide valuable information about concentrations of septic systems, proximity to surface waters and other environmentally sensitive areas, as well as allow tracking the systems' age, performance, repairs, and failures.

The Coastal Health District's Environmental Health Office in Camden County began keeping records of septic systems in the early 1990's though at that time there were no general standards regulating system installation. Many systems that were installed long before this time are still in use. Also, many of the records created before the Environmental Health office's current digital records keeping program are of marginal utility due to illegible hand writing and incomprehensible drawings.[23] Therefore a

through which localities can implement these measures. This book provides the basis for some of the recommendations that follow and should be consulted for additional information about ongoing onsite wastewater management. It can be downloaded at: http://www.rivercenter.uga.edu/research/onsite.htm.

[23] This should not be construed as a criticism of the Environmental Health Office, which is diligently working to correct these issues. The point here is that additional outside resources should be directed to addressing these problems.

concerted effort should be made to collect the needed data, expand the system inventory, and improve the existing records.

The University of Georgia's Marine Extension Service (MAREX) undertook a project to map septic systems and well sites in Bryan, Effingham, Liberty, and Long Counties.[24] As part of this project, MAREX also facilitated the transfer of Camden County's paper septic records to the state-wide Welstrom database,[25] and Phase II of the project provided Camden County Environmental Health inspectors with training and equipment to continue mapping local septic systems. The Welstrom database promises to be an extremely valuable tool in managing septic systems, and MAREX's work has greatly facilitated its development on the Georgia coast and throughout the state. As of January 2013, Camden County has mapped 2,639 septic systems.[26] This is a significant improvement, but as the records review discussed above made clear, there are many more systems to be inventoried.

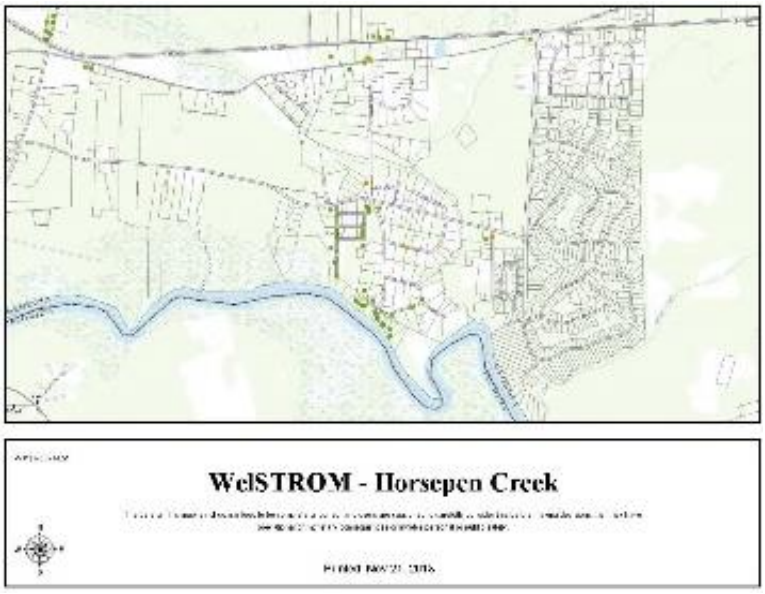

Figure 9: Welstrom Map for the Horsepen Creek Watershed

Based on the 2010 census numbers, there may be as many as 7,500 septic systems in the unincorporated county. This means that there are thousands of septic systems that are not yet included in the Welstrom database. Some of these are documented in the paper records that Camden County Environmental Health is in the process of digitizing, but many more are simply undocumented. The County should make a concerted effort to locate these unrecorded systems, prioritizing those that are most prone to failure, i.e. those that are the oldest, those that are in the most challenging conditions, and those that are the most likely to cause environmental damage. To target these areas, this inventory should examine the existing County parcel data, use the improvements fields in that data to locate residential structures, compare that to the list of recorded septic systems, and identify those parcels with unrecorded septic systems. This will provide a relatively comprehensive list of systems that should be targeted for recording and geolocation. The parcels on this list can be prioritized based on the age of the system, based on the parcel improvement data, and on Welstrom's Pollution Susceptibility Index Score. Incentives and outreach efforts can then be directed to the highest priority areas and systems in order to build upon the County's existing septic inventory.

[24] *See* "Final Project Report, Phase II Coastal OSDS Inspection, Compliance, Geolocation and Analysis." EPD Grant Number: 751-110016. January 2013.
[25] *See*: http://www.sgwebmaps.com/welstrom/.
[26] "Final Project Report, Phase II Coastal OSDS Inspection, Compliance, Geolocation and Analysis," p.20.

2. Septic System Assessments, Repairs, and Upgrades.

Recommendation #2: Leverage State and Federal Funding to Conduct a Broad Septic Assessment, Repair, and Upgrade Program.

The septic system inspections conducted as part of this project indicate that there are likely a significant number of failing septic systems in the Horsepen Creek area, and throughout Camden County. The sample size was far too small to draw any particular conclusions, however, when coupled with ages of the systems determined by the records review and the large number of systems that are unrecorded, the number of failures seen here indicates that it is likely that there is a significant number of failing or poorly functioning systems that need attention. Therefore, in conjunction with the mapping and inventory program, the County should assess the functionality of septic systems and implement a program to provide financial assistance to facilitate repair, upgrade or replace the worst systems. Once most of the oldest and poorly functioning systems are repaired, upgraded, or replaced with systems that meet current standards of functionality it will be more cost effective to implement a stronger regulatory program, and this will also be less onerous to property owners.

Two successful programs that have leveraged Clean Water Act Sec. 319 funding to conduct ongoing septic replacement programs have been carried out by two of Georgia's Resource Conservation and Development Offices (RC&D).

Limestone Valley Resource Conservation and Development (LV RC&D) Authority Cost-Share project operates in the South Chickamauga River headwaters area in Murray and Whitfield Counties. It provides between 25% and 60% of septic system repair costs based on the severity of the problem and the proximity of the system to an impaired stream. There are no income restrictions, and while the system focuses on repairing systems located near streams, other residents are encouraged to apply as well. Funding for LV RC&D's program is provided by annual Sec. 319 grants.[27]

Limestone Valley RC&D Rubes Creek 319 Project operated in the Rubes Creek watershed, which is a tributary to the Coosa River running through Cherokee and Cobb Counties. A seven mile segment of Rubes Creek was listed as impaired on Georgia's 303(d) list for fecal coliform in 2003. Using Sec. 319 grant funds, supplemented with other third party funding and support from the City of Canton, Cherokee County, The Nature Conservancy, the Wildlife Fund, and other local stakeholders, LV RC&D implemented various BMPs to reduce pathogen levels in Rubes Creek. These BMPs included replacing failing septic systems and installing 250 feet of grassed swales that slowed and treated contaminated stormwater before it enters the creek. After the completion of this project in 2009, Georgia EPD removed Rubes Creek from the 303(d) list in 2010.[28]

[27] http://limestonevalley.org/cost-shares-on-septic-system-repairs-available-in-the-south-chickamauga-headwaters-project-area/

[28] EPA Water: Nonpoint Success Stories: http://water.epa.gov/polwaste/nps/success319/ga_rubes.cfm

The Rolling Hills RC&D Authority[29] (RH RC&D) manages water quality projects in the Big Cedar Creek watershed in Polk and Floyd Counties and the Lower Little Tallapoosa watershed in Carroll, Heard, and Haralson Counties. Part of the RH RC&D's water quality efforts includes providing financial assistance for septic system owners. Landowners in the project regions can receive a 50% cost share to repair an existing septic system. Some landowners also receive a $200 voucher for pumping as part of regular maintenance. To date, RH RC&D has repaired or replaced over 200 failing septic systems at an average cost of $2,000 per system. This includes the use of a number of Advanced Treatment Units (ATU) for sites with soils that are unsuitable for conventional drainfields or on undersized lots.

3. Local Water Quality Monitoring

Recommendation #3: Develop a Local Water Quality Monitoring Program to Improve Understanding of the Sources of Contamination and Local Hydrology.

The most recent water quality tests that caused Horsepen Creek to be listed on the state 303(d) list were conducted in 2003 at the site shown in Figure 3 on page 4 above. Approximately half of the development in the Horsepen Creek watershed is located upstream of this sampling site, and most of the remaining area is forest and managed pine plantation. The TMDL documents indicate wildlife, livestock, and residential septic systems are all likely contributors to this creek's elevated fecal levels. A long term water quality monitoring project with multiple sites upstream and downstream along Horsepen Creek would provide a much more thorough picture of the sources of contamination.

The hydrology of the Horsepen Creek watershed has been severely impacted by agricultural and silviculture practices along with residential development. The impacts are primarily from drainage ditches and the clearing of forests and wetlands. This ditching and clearing reduces the landscape's capacity to retain and treat stormwater runoff, which is the primary method fecal bacteria and other pollutants are transported to the streams. The 2009 TMDL Implementation Plan specifically cites the ditching, channelization, and wetland loss as a contributing factor to Horsepen Creek's impaired water quality by impacting the creek's natural flow volume and rate.[30] A broader study of local hydrology could identify various non-regulatory opportunities to address water quality issues.

Georgia EPD's Adopt-a-Stream program could be used to implement this sort of monitoring. It provides a low cost mechanism to harness community support and allow volunteers to lead monitoring efforts. Thousands of sites are monitored by Adopt-a-Stream programs around the state, but there is only one current Adopt-A-Stream site in Camden County. A small amount of funding and public support could help local groups such as the Satilla Riverkeeper and the SMRMC develop the capacity for ongoing water quality monitoring through this program.

This effort needs to be coordinated with other water quality monitoring in Camden County, and throughout the St. Marys River watershed. For example, currently the Georgia Coastal Regional Commission, with the assistance of the Ecological Planning Group, LLC, is preparing a monitoring plan

[29] For more information about the RH RC&D's watershed activities see their website: http://www.rollinghillsrcd.org/watershed_projects1.htm.
[30] 2009 TMDL IP p.70.

for the St. Marys River between Catfish Creek and Millers Branch. A broad monitoring program for the St. Marys River or for Camden County should be coordinated with this effort. Also, there are other TMDLs in the St. Marys basin and in the Satilla River basin, which makes up the majority of Camden County that could benefit from additional monitoring. A coordinated plan could provide important data to inform a variety of planning decisions in the area.

4. Planning and Site Design

Recommendation #4: Consider Land Use and Green Infrastructure Policies to Reduce the Impacts of Failing Septic Systems.

Horsepen Creek's hydrology has been severely impacted by silviculture practices, residential development, and infrastructure construction. These impacts have reduced infiltration rates, increased run-off speed and volume, and thereby decreased base-flows in surface waters. Amending land use or subdivision regulations and development standards to promote the restoration of ecological systems, encourage the use of low impact development strategies, incentivize the use of green infrastructure, and otherwise promote natural environmental services will lessen the impacts of development and decrease pollution loads from nonpoint sources such as septic system failures. Preserving and restoring ecosystem function can reduce pollutant loads by increasing baseflow levels, increasing runoff times from stormwater, and generally increasing the assimilative capacity of the creek. Even if bacteria loads cannot be reduced enough by better managing septic systems to achieve the desired water quality, these types of measures can bolster the creek's natural ability to treat bacteria allowing it to achieve the desired bacteria levels. Furthermore, restoring the ecosystem functions of the watershed can provide additional benefits in improving aquatic habitat, increased flood control, and increased downstream flow.

Many coastal communities are beginning to implement these type of regulations through the adoption of the Coastal Stormwater Supplement to the Georgia Stormwater Management Manual (GSMM).[31] The GSMM Coastal Supplement provides "comprehensive guidance on an integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design" to protect coastal Georgia's natural resources to reduce the impacts of land development and nonpoint source pollution.[32] Green infrastructure practices and stormwater BMPs such as those suggested in the GSMM Coastal Supplement should be incorporated into county planning efforts, subdivision regulations, and development guidelines so that they can be strategically implemented to reduce the amount of bacteria and other pollution entering Horsepen Creek and the St. Marys River through these drainage structures.

5. Long-Term Regulation

Recommendation #5: Create an Advisory Committee to Consider a Long-Term Septic Management Policy.

[31] Local governments in Georgia's 11 county coastal region operating a regulated Municipal Separate Storm Sewer System (MS4) are currently required to adopt the Coastal Supplement or an equivalent design program as a condition of their MS4 NPDES discharge permit. See General NPDES Stormwater Permit GAG610000, Sec. 4.2.5.1. December 12, 2012.

[32] Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, first edition. April 2009. P. 1-3.

Finally, to the extent that septic systems are an integral part of the wastewater infrastructure in Camden County it is essential that the County implement a program ensuring ongoing septic maintenance.[33] The first step towards implementing a long-term management program is to establish an advisory committee made up of local leaders and stakeholders who understand the issues associated with proper onsite wastewater disposal. Specific steps for forming such a committee are in the RBC's Septic System Guidebook.[34]

Designing a long-term management program requires a solid understanding of the condition of onsite wastewater disposal systems in the County. Therefore, the recommendations proposed above will inform the development of a long-term solution, but forming the Advisory Committee is an important first step that can be taken immediately. The Committee can then participate in the development of the data necessary to inform this design process, and the Committee can evaluate the information developed by the investigations recommended above and decide how best to improve the maintenance and management of local septic systems. The Committee could also determine the best mechanisms to finance such a program whether through permit fees, leveraging state and federal funding, or establishing an independent utility.

Some options for long-term septic management programs include directly requiring mandatory inspections, requiring proof in an inspection for the provision of some public service such as public water or electricity, and providing financial incentives for septic maintenance.

Mandatory Inspections

The most direct approach to promoting regular septic system inspections and maintenance is to require all system owners to have their systems inspected according to an established schedule. The City of Berkely Lake, Georgia mandates septic inspections in this way. The city requires that septic system owners have their systems inspected and pumped at least once every five years and provide documentation of that activity to the city for its records.[35] The city mails reminder notices to septic system owners 90 days prior to the compliance deadline. Once the inspection is completed, the contractor completes a section on the notice, which is then returned to the city clerk. System owner may also file a form recording any unrequired maintenance on their septic system, and service will not be required again until five years from the last service on record with the city.

If an inspection is not necessary, a system owner can get an extension. Owners who believe they should be eligible for an extension complete an extension application and submit it to city hall at least 30 days before the compliance deadline. Extensions are granted when the system owner can show that the system can satisfactorily function with a longer service interval such as when a system's usage is

[33] While the Board of Health oversees septic system regulation, they are statutorily prohibited from requiring ongoing maintenance of non-mechanical septic systems, which includes the majority of traditional septic systems. Therefore any comprehensive program must be implemented by government body with general police powers such as the Camden County Board of Commissioners.

[34] *See* Decentralized Wastewater Management: A Guidebook for Georgia Communities *supra* at note 22. P.19.

[35] Berkely Lake, Georgia Code of Ordinances; Pt. II, Sec. 58.

significantly less than its capacity; the residence is only partially occupied, or the system is an approved advanced technology septic system. Violations of this ordinance are punishable by fines up to $1,000.

A mandatory inspection program should increase the number of systems that are inspected and pumped on a regular basis if it is administered properly and vigorously enforced. However, many residents may see such a program as imposing significant new burdens on them as the majority of septic system owners would have to have their systems inspected soon after such a program went into effect. Also this type of program would create new administrative and enforcement burdens for the County that would likely not be fully covered by any revenue generated from fines or penalties. However, despite the possible political and administrative costs, directly mandating inspections is the simplest way to improve the rate of septic inspections.

Inspection as a Requirement of Service Delivery

Douglasville-Douglas County Water and Sewer Authority protects its Dog River Reservoir by requiring that anyone with an onsite septic system who receives services from the authority have their system pumped every five years. Residents and businesses in the Dog River drainage with systems constructed prior to 1991 must provide proof that their systems were pumped within the past five years before they can establish an account for water service.[36] Residents and businesses with systems constructed after 1991 must be able to produce proof that their systems have been pumped within the past five years upon request.[37] Similarly, in Charlton County, Georgia, in order to establish electric service at an address that is served by a septic system, an applicant must present evidence that the system has been pumped and inspected in the past five years.

Programs that tie proof of septic system maintenance to the provision of a service such as water or electricity are effective at increasing the rate of septic maintenance. However, these programs do not cover all septic systems, and it is likely that they miss some of the most problematic systems. For instance, connecting a septic maintenance requirement to the provision of drinking water does not reach those homes served by private well, which are common in rural areas like Camden County and are the houses most likely to have their drinking water contaminated from septic system effluent. Also, requiring septic maintenance as a condition of water service increases the cost of connecting a residence to public water and may discourage some residents from doing so. Tying the maintenance requirement to electrical services covers more rural homes, but it is only effective when residents move and therefore is not as effective for homes occupied for long periods of time.

On the other hand, these systems do not pose any immediate burdens on property owners, and therefore they may be more politically feasible to implement. Also, since these requirements are added to an existing application process, the cost of implementation and administration is significantly less than a direct mandatory inspection program. Therefore, this type of program may be more feasible to implement in Camden County.

[36] Douglasville-Douglas County WSA Rules and Regulations, Sec.2-20 (A)1.
[37] Douglasville-Douglas County WSA Rules and Regulations, Sec. 2-20 (B)2.

Financial Assistance

An alternative to mandating inspections and pump-outs is to rely on public education and financial incentives to promote proper septic maintenance. This type of program can provide loans, grants, or simply education and technical assistance to reduce the cost to residents for upgrading and maintaining their septic systems. There are a number of state and federal programs that can be used to leverage local funds to improve septic management. These and many other opportunities exist to implement the recommendations presented here and can make it possible for Camden County to leverage local resources to achieve its goal of protecting the community's health along with its important natural resources.

United States Department of Agriculture (USDA):

Rural Repair and Rehabilitation Loans and Grants provides loans and grants to very low-income homeowners 62 years-old or older to repair, improve, or modernize their dwellings or to make repairs and improvements to make the dwelling more safe and sanitary. Loans of up to $20,000 and grants of up to $7,500 are available. Loans are for up to 20 years at 1 percent interest.[38]

Housing Preservation Grants (HPG) program provides grants for the repair or rehabilitation of low- and very low-income housing defined as below 80 percent of the area median income (AMI). HPG funds received by the sponsors are combined with other programs or funds and used as loans, grants, or subsidies for recipient households based on a plan contained in the sponsor's application. Funds must be used within a two-year period.[39]

Water and Waste Disposal Direct Loans and Grants can be used to develop water and waste disposal systems in rural areas and towns with a population not in excess of 10,000. Funds can be used for construction, land acquisition, legal fees, engineering fees, capitalized interest, equipment, initial operation and maintenance costs, project contingencies, and any other cost that is determined by the Rural Development to be necessary for the completion of the project. Projects must be primarily for the benefit of rural users.[40]

Water and Waste Revolving Fund Grants assist communities establish a lending program to finance water and wastewater systems. The loans are made to eligible entities to finance pre-development costs of water and wastewater projects or short-term small capital improvement projects not part of the regular operations and maintenance of current water and wastewater systems. The amount of financing to an eligible entity shall not exceed $100,000 and shall be repaid in a term not to exceed 10 years. The rate shall be determined in the approved grant work plan.[41]

United States Environmental Protection Agency (EPA):

[38] http://www.rurdev.usda.gov/HAD-RR_Loans_Grants.html
[39] http://www.rurdev.usda.gov/HAD-HPG_Grants.html.
[40] http://www.rurdev.usda.gov/UWP-dispdirectloansgrants.htm.
[41] http://www.rurdev.usda.gov/UWP-revolvingfund.html.

EPA Clean Water State Revolving Fund funds water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management through low interest loans to a variety of borrowers and partnerships with other funding sources.[42]

EPA Nonpoint Source Section 319 Grant Program provides grants administered by the states for controlling nonpoint sources of pollution, such as that from onsite septic systems. In states where onsite systems have been identified as a significant source of such pollution, the section 319 funds may be used to construct, upgrade or repair onsite systems.[43]

United States Department of Housing and Urban Development (HUD):

Community Development Block Grants (CDBG) are intended to develop viable communities by providing decent housing and a suitable living environment and by expanding economic opportunities, principally for persons of low- and moderate-income. This includes installing or repairing septic and other wastewater systems.[44]

Georgia Environmental Finance Authority (GEFA):

Georgia Fund is a state-funded loan program for water, wastewater improvements. Eligible projects include wastewater system improvement that include septage treatment and storage.

Clean Water State Revolving Fund (CWSRF) is a federal loan program administered by GEFA that provides funding for a variety of wastewater infrastructure and pollution prevention projects. Eligible projects include water quality, water conservation and wastewater treatment projects, such as constructing new wastewater treatment plants, repairing and replacing sewer, stormwater control projects and implementing water conservation projects and programs.[45]

Septage Discussion

"Septage" is the liquid and accumulated solid material that collects in a septic tank over time. A septic tank can retain 60% to 70% of the solids, oils, and grease that pass through the system.[46] This concentrated waste, which also contains higher concentrations of other pollutants and considerable amounts of grit, hair, and debris, must be pumped out of the septic tank periodically or these materials will enter the drainfield and prevent infiltration of the wastewater. Generally, septage is discharged into the same wastewater treatment system that treats wastewater from the sewer system, though this

[42] http://water.epa.gov/infrastructure/septic/funding.cfm.
[43] http://water.epa.gov/infrastructure/septic/funding.cfm.
[44].http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/stateadmin.
[45]http://gefa.georgia.gov/clean-water-state-revolving-fundl; and http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm.
For information about CWSRF funding of septic system improvements see: http://water.epa.gov/grants_funding/cwsrf/upload/2003_03_21_cwfinance_cwsrf_septic.pdf.
[46] Clement Solomon, et al. "Septage Management," National Small Flows Clearinghouse, 1998.

requires some level of additional management to ensure that this concentrated waste does not cause the facility to exceed its treatment capacity.

Camden County does not currently have any septage disposal capacity. Septic pumpers currently drive to Brunswick, Georgia to discharge every truck load of septage, which can be approximately 40 to 45 miles one-way depending on the location of the septic system in Camden County. Typically an empty truck can pump out two full septic systems before reaching capacity. Currently, this situation functions, if not efficiently, at least tolerably well, though it does lead to higher septic maintenance costs for Camden County residents. There are also suggestions that the expense of hauling septage that distance has led to illegal dumping as a cost saving measure.

Illegal dumping aside, there are two reasons for concern over the lack of septage disposal in Camden County. The first is that if the Brunswick wastewater water treatment plant stops accepting septage, there is no good alternative disposal option. The second reason is that if Camden County or the state implements a successful long term septage management program, the septic systems will be pumped far more frequently resulting in significantly more septage. A lack of capacity to handle this septage could result in environmental degradation if the septage is not handled properly, and it impose economic hardships on homeowners who have to pay even higher fees for septic tank maintenance.

There are no reliable numbers on the amount of septage currently generated in Camden County. A very rough estimate based on the records of one hauler since 2005 suggests that currently 300,000 gallons of septage are hauled to the Brunswick WWTP annually. This is a relatively small amount, but that is misleading. This figure represents only a fraction of the volume of septage the County's septic systems produce as relatively few systems are maintained regularly. No attempt was made to estimate the volume of septage that would be generated if a septage management strategy were implemented, but it would likely be a dramatic increase.

There are three options for addressing this lack of septage disposal capacity: 1) Develop a county septage disposal facility; 2) Promote the development of a private septage disposal facility, or 3) Work in conjunction with wastewater officials in Woodbine and St. Marys to develop capacity at existing WWTPs. Which of these options to pursue should be addressed by the Advisory Council discussed above as this is in an essential element of a long-term septic system management program.

Camden County does not have sufficient demand for septage disposal to justify building its own independent septage disposal facility. A county-owned facility would provide the greatest assurance that sufficient septage disposal capacity would be available, but given the volume of septage pumped in the county such a facility would have to rates too high to compete with the Brunswick facility and defeating the purpose of promoting lower septic maintenance costs.

The county could promote a private septage disposal facility. If one or more septic haulers developed their own septage disposal facilities they could integrate the hauling and disposal components of septic maintenance thereby driving down costs and increasing disposal capacity. This increased capacity would be dependent on the operations of these private enterprises, but it would create an alternative disposal mechanism and the Brunswick WWTP would remain an option if these facilities shut down. The county

could promote such an operation policy actions such as designating certain areas where this use would be allowed by right in the zoning code, or through financial incentives and technical support.

The most cost effective short-term strategy is to access the treatment capacity of the existing wastewater treatment plants. Camden County should consider partnering with the City of St. Marys or one of the other local wastewater treatment providers to develop better septage management facilities at an existing wastewater treatment plant. A county investment in improving a WWTP to better manage septage would provide a long term solution to its septage management problem. Such an investment would give the county an equity stake in the facility guaranteeing access to some capacity at the treatment facility. This arrangement would benefit the facility by proving a financial partner to finance improvements to the facility that would generate additional revenues from septage dumping fees.

Appendix: HPC Sampling Report

UGA personnel conducted visual surveys of the Horsepen Creek and Temple Creek watershed on three occasions in February, June and September of 2012. Water quality samples were taken during both the June and September trips. Additional samples were taken by a representative of the SMRMC in July of 2012. These samples revealed high bacterial content, and the highest concentrations of bacteria were confirmed to involve human sources as indicated on the tables below. However, the physical conditions of the creek at sampling sites, primarily due to the intermittent flow, made definitively identifying sources of the human bacterial impossible.[47] These flow conditions were present during all three visits to the creek.

Much of the Horsepen and Temple Creek watershed has been channelized to drain local silviculture operations and residential areas. This artificial drainage pattern reduces the base flow of water in Horsepen Creek. Also, a portion of the Temple Creek watershed is siphoned off by a man-made channel connecting the Temple Creek watershed to Catfish Creek to the east as documented by the revised Tier 2 TMDL Implementation Plan for Horsepen Creek dated March 30, 2009. Because of the impaired flow caused in part by these drainage ditches, a number of sampling points were chosen along the man-made drainages in the residential areas of the watershed. It was hoped that sampling water from these ditches would provide better information about potential septic failures that contribute to bacteria loads in the creek.

This channelization of this watershed affects bacterial loads in two ways that impair the ability of the UGA researchers to draw meaningful conclusions from the data. First, channelization reduces the time to peak concentration of water flow, which leads to higher peak flows and lower base flows. Therefore the concentrations of bacteria in the creek during base flow periods will be higher than under natural conditions. Secondly, the ditches receive the runoff from residential areas. When a septic is failing, untreated wastewater will tend to flow towards the ditches and accumulate therein both during rain evens and in dry weather. When a water sample is taken in or near one of these ditches and there is not sufficient flow in the stream channel, the results of bacteria counts only tell you the concentration of bacteria in the one spot of a small volume of often still water. This cannot be interpreted as showing the concentration of bacteria in the stream when it is flowing. It does indicate that there are sources of bacterial contamination in the area, and that much of the bacteria is of human origin, but it does not give you enough information to determine the specific source of the contamination or its overall impact to the water quality downstream where more consistent flows are present.

Therefore, this project was modified to remove its reliance on targeted water quality sampling and focus on lessening septic contribution to fecal coliform pollution through an assessment of the condition of septic systems in the Horsepen Creek and Temple Creek watershed and by increasing public outreach and education about septic system use and maintenance.

[47] There is one exception where a high sample collected in July 2012 from a drainage ditch could the linked to a residence that appeared to be the only contributor of water flow to the sampled portion of the ditch.

Table 1:
TABLES OF SAMPLING RESULTS

June 2012 Sample	Coliform MPN/100 mL	*E. coli* CFU's/100mL	HuBac (human)
1 TC		380	+
2 TC		60	+
3 TC		85	+
4 TC		35	+
5 TC		90	-
6 TC		55	-
7 HP		285	-
8 TC		50	-
11 HP		65	-
12 TC		230	-
July 2012 Sample	**Coliform MPN/100mL**	***E. coli* MPN/100mL**	***Human***
TC Ditch 1053*	<1	NA	-
TC Granger Dock	TNTC	160.7	-
TC Ditch Corner Creek	TNTC	1299.7	+
Northside Temple at Green...	TNTC	50.4	-
TC Ditch 264/362	TNTC	26.2	-

September 2012 Sample	Coliform MPN/100 mL	*E. coli* MPN/100 mL	Positive for HuBac
1	TNTC	21.1	N/A
2	TNTC	7.3	N/A
3	TNTC	66.3	N/A
4	TNTC	98.8	N/A
5	TNTC	119.8	N/A
6	TNTC	1732.9	+
7	TNTC	344.8	-
8	TNTC	TNTC	+
9	TNTC	344.8	-
10	TNTC	686.7	-
11	TNTC	1046.2	+
12	TNTC	40.4	N/A
13	TNTC	48.7	N/A
14	TNTC	98.4	N/A
15	TNTC	224.7	N/A

HORSEPEN CREEK WATERSHED