Executive Summary
By Andrea Malloy, Coastal Conservation League

The health of the May River is critical to a prosperous community.

A clean and healthy May River is essential to Bluffton's future. Residents, businesses, plants and animals all depend on it. Indeed the May River is the foundation for the high quality of life for which Bluffton and Beaufort County are renowned. In 2009, May River certain shellfish beds were closed to harvesting for the first time in history. In 2010, additional beds were closed. These warning signs indicate that a pollution crisis is facing the May River, and it is escalating in scope with each passing year. If we are to save the May River for enjoyment and use by future generations, quick fixes are not an option. Remedies and long term solutions are a necessity.

The objective of the case study discussed in this report is to use the May River's Stoney Creek and Rose Dhu Creek sub-watersheds to assess the environmental benefit of transferring development rights for some of the 19,000 permitted but unconstructed units from where they are currently planned to already developed areas within the May River watershed.

The case study described herein demonstrates scientifically that a transfer of development rights program could result in large reductions in stormwater runoff volume and pathogen loadings and is one of the many remedies that will be required to save the May River.

Current development patterns are the major contributing factor to May River pollution.

The true culprit of the May River's slow and steady demise is Bluffton's rapid population growth and the accompanying sprawling pattern of development. Bluffton's current development pattern spreads roads, rooftops and any variety of impervious surfaces just about everywhere. Pollutant levels in tidal creeks, including the May River, are directly linked to the increases in stormwater runoff into the headwaters resulting from an increase in the ratio of impervious surface to forested land cover within headwater's sub-watersheds. The porous and varied terrain of natural landscapes, like forests, traps rainwater where it filters slowly into the ground removing many pollutants and recharging groundwater supplies. Only small amounts of the rainfall are discharged into adjacent streams, rivers, and estuaries. In contrast, impervious (nonporous) surfaces, like roads, parking lots rooftops, and the compacted soils associated with sprawling development prevent rain from infiltrating, or soaking, into the ground. In areas containing large amounts of impervious surfaces much of the rainfall becomes stormwater runoff and is released into adjacent water bodies in unnaturally large amounts. This stormwater frequently contains a wide variety and amount of pollutants, including toxic chemicals and pathogens. Abundant research on rivers and estuaries confirms that when impervious surfaces cover more than 10-20% percent of a watershed, the water quality of rivers, creeks, and estuaries they surround become impaired. When the amount of impervious cover in the watershed exceeds 20-30% human uses, such as fishing and swimming , of these ecosystems often become limited and adjacent areas may experience flooding following large storms. As we have seen in the May River, shellfish harvesting is the first use to be lost. Next is seafood harvesting. Finally, recreational uses are threatened.

What will happen to the May River when all of the permitted yet unconstructed units are built? This case study answers this question and poses a viable solution for greatly reducing the pollution that will result.

If development patterns remain unchanged, the May River will succumb to such high pollution levels that practically all human contact uses will be prohibited.

In 1999 the Stoney Creek and Rose Dhu sub-watersheds were covered by 1 to 3% impervious surface. By 2003, impervious had grown to 6% in Stoney Creek and 10% in Rose Dhu sub-watersheds. Currently, there are 19,000 approved and permitted housing units yet to be built in the May River watershed with many, if not most, of these units located in the Stoney and Rose Dhu creek sub-watersheds.

This case study estimates that impervious land cover is likely to reach 14% in Stoney Creek and 20% Rose Dhu Creek sub-watershed if all permitted units are built as approved. The case study further predicts that at build out, *annual runoff volume from these two sub-watersheds to the May River watershed will increase by 579% over 2003 discharge levels. Fecal coliform loadings are also projected to increase by over 1200% from 2003 discharge levels.*

Not surprisingly, given these extraordinary increases in stormwater runoff and pollution loadings, we can expect radical adverse changes in the water quality, seafood production and human uses of the May River. Wide spread closures of shellfishing grounds, water contact swimming advisories, and reduced human uses, including commerce and recreation, will likely occur in the future if large reductions in projected stormwater runoff and pathogen loadings are not rapidly attained.

These are dire projections for sure. But are they foregone conclusions? The case study says no. By transferring the location and pattern of development from an undeveloped are to an area with existing infrastructure and development, via a transfer development rights program, we can change impervious land cover ratios and reduce stormwater runoff and pollution loadings and thereby help mitigate future water quality impairment of the May River.

A transfer of development rights (TDR) program is a planning tool that allows landowners to transfer the right to develop one parcel of land to a different parcel of

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land. In the context of water quality protection, TDR can be used to shift development from a less or undeveloped area to designated growth zones closer to municipal services and existing infrastructure. The parcel of land where the rights originate is generally called the "sending" parcel. The parcel of land to which the rights are transferred is called the "receiving" parcel.
Buying these rights generally allows the owner to build at a higher density than ordinarily permitted by the base zoning or development agreements.

A transfer of development rights program could significantly reduce the future volume of runoff and pollution loading of the May River.

For the case study, a 500 acre site in the Stoney Creek sub-watershed is the "sending area" and a 110 acre site in the Rose Dhu sub-watershed is the "recieving area." The case study analyzes a scenario where 1,300 approved housing units are transferred out of the Stoney Creek sub-watershed and into Rose Dhu sub-watershed. Importantly, there is no net loss in units. At the Rose Dhu receiving site, the additional housing units are accommodated by rearranging development patterns. Streets are narrowed, lots sizes are reduced, and second and third stories are added to commercial and retail buildings as housing. The Stoney Creek sub-watershed loses 1,300 housing units but gains approximately 500 acres of reforested land. This increases the total future forest cover in the Stoney Creek sub-watershed up to about 10%. This is a dramatic improvement over the 0% forest cover projected for Stoney Creek at planned build-out if no transfer occurs.

Most importantly, the 500 acres of reforested land in the Stoney Creek and 25 acres in the Rose Dhu sub-watersheds are projected to result in a 15% annual decrease in stormwater volume and 50% decrease in fecal coliform loadings into the headwaters of the May River.

The case study goes on to extrapolate the benefits to the May River if additional development rights transfers were to occur within these two sub-watersheds. A total 2,175 acres are approved for development and not-yet-built within these sub-watersheds. According to the case study, 1,725 acres could reasonably be included in a transfer of development rights program. This study predicts various scenarios depending upon what percentage of those 1,725 acres are preserved and reforested through a transfer of development rights. The study finds as follows:

- If 50% of the 1725 acres is preserved and reforested, there will be a 33% reduction in stormwater runoff volume and 47% reduction in fecal coliform loadings from what is projected to occur at build-out.

- If 75% of the 1725 acres is preserved and reforested, there will be a 44% reduction in stormwater runoff volume and 62% reduction in fecal coliform loadings over what is projected to occur at build-out.

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- If 100% of acreage of the 1725 acres is preserved and reforested, there will be a 56% reduction in stormwater runoff volume and 68% reduction in fecal coliform loadings from what is projected to occur at build-out.

These are significant reductions that cannot be ignored if indeed our goal is to protect the health of the May River.

If protecting the May River is a priority, so too must be a transfer of development rights program.

This study demonstrates that transfer of development rights is a viable and readily available tool that produces dramatic results with respect to runoff volume and fecal coliform load. As such, transfer of development rights should be the priority in any approach to restoring water quality in the May River.

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Case study evaluating the reductions in stormwater runoff volume and fecal coliform loadings projected to result from a transfer of development rights program in the May River watershed.

Prepared by:

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Introduction

Tidal creeks and their associated wetlands are the interface between the landscape and estuaries where freshwater from the land mixes with saltwater from the oceans. These shallow creeks are dynamic environments that are renowned for their natural beauty, ecological complexity, seafood production and role as nursery habitat for shrimp and finfish (Kneib 1997, Holland et al. 2004, Mallin et al. 2000, Lerberg et al. 2000, Sanger et al. 1999a, b). In the Southeast, tidal creek watersheds are rapidly being developed because of their natural beauty and the high quality of life associated with living in their watersheds. Changes in land use associated with coastal development invariably result in increased amounts of stormwater runoff being discharged into tidal creek ecosystems impairing their ecological integrity and human uses (Holland et al. 2004, Sanger et al. 2008, Holland and Sanger 2008). Major categories of development-related impairment include degraded water quality, increased chemical and pathogen loads, reduced nursery activity, increased risk to public health and reduced human use, such as fishing and shellfishing. Development related impairment to tidal creek water quality, occurs years to decades in advance of impairment of deeper estuarine waters. Tidal creek water quality and ecological health therefore provide early warning of ensuing harm making them valuable sentinels of ecosystem and public health threats.

Coastal development creates two types of pollution: point source (originating from a regulated discharge pipe) and non-point source (everything else). In general, state and federal laws effectively control the amount and quality of pollution originating from point source discharges. Non-point source pollution, also called stormwater runoff, originates from many different sources including runoff from roads, parking lots, lawns, parks and golf courses. Because non-point source pollution originates from diffuse sources, it is difficult to control and is currently the priority pollution issue for most regulatory agencies.

Headwater tidal creeks are the primary aquatic link between coastal development and estuaries. Changes in the volume and rate (or flashiness) of stormwater runoff is the major means through which coastal development impairs water quality, public health, and the quality of coastal living (Holland et al. 2004, Holland and Sanger 2008). A major contributor to development related increases in stormwater runoff is the increase in the proportion of the landscape used for roads, sidewalks, parking lots and roofs (i.e., impervious surfaces). Impervious surfaces impede rain from penetrating the soil and returning to groundwater systems. Coastal development also removes natural forests decreasing the amount of rain that is returned to the atmosphere through vegetation-based evapotranspiration (Figure 1). In forested settings, only about 10 to 20 percent of the rain that falls on a watershed enters tidal creeks. In suburban and urban areas, 15 to 75 percent of rain that falls on the watershed is discharged to the creek. When the amount of impervious cover in a tidal creek watershed exceeds 10 to 20 percent of a watershed or sub-watershed, measurable increases in the volume and rate of stormwater runoff generally occur.

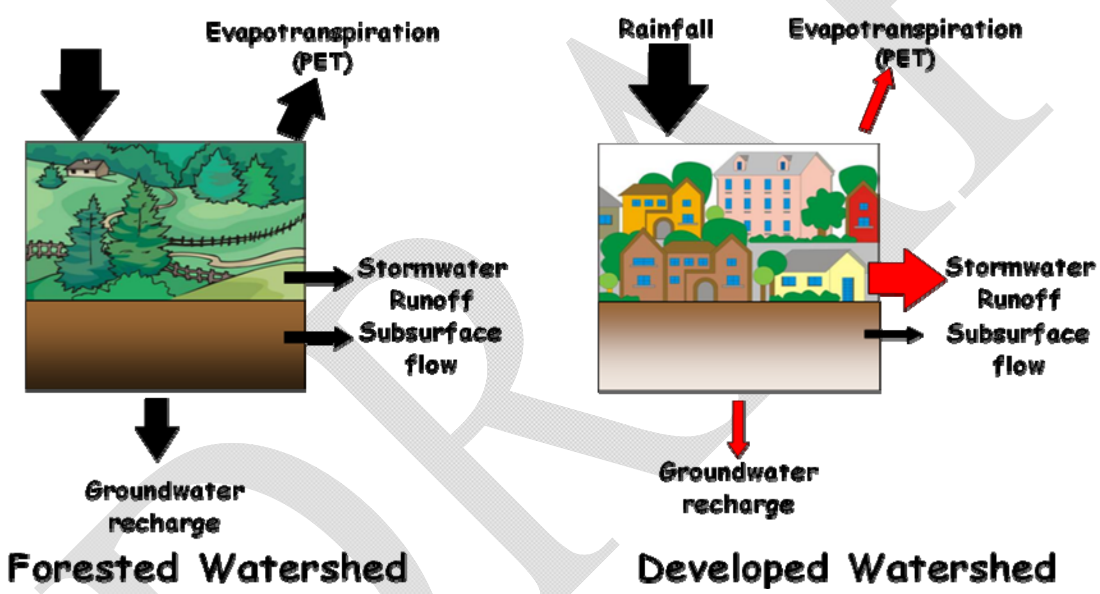

Figure 1. Visual representation contrasting water budgets for a forested coastal ecosystem and an urban coastal environment. The magnitude of the differences is represented by the size of the arrows in the schematics.

Episodic runoff from suburban and urban watersheds causes large fluctuations in water quality creating poor nursery habitat for juvenile fish, shrimp, and crabs. Nutrients, such as nitrogen, which are abundant in runoff from lawns and golf courses, are much more abundant in suburban and urban creeks in comparison to forested creeks. Excessive levels of nutrients can result in noxious and harmful algae blooms and decreased dissolved oxygen levels. Stormwater runoff also transports pathogens into tidal creeks. Humans are typically exposed to water-borne pathogens by ingesting shellfish, such as oysters, that concentrate pathogens in their tissues or by water contact recreation.

Human pathogens in the water and shellfish tissues are not generally measured because they are difficult and expensive to sample and the count. Instead, fecal coliform bacteria are frequently used as indicators of the presence of human pathogens in aquatic environments. These indicator bacteria are abundant, inexpensive and easy to sample and count, and have a long track record of protecting public health. Most states close shellfish grounds to harvesting when the number of fecal coliform bacteria exceeds about 50 colony forming units (CFU) per 100 ml of water. Water contact recreation is generally prohibited when fecal coliform levels exceed about 400 CFU per 100 ml of water.

The level of pathogen contamination (as indicated by fecal coliform bacteria) increases when the amount of impervious cover in tidal creek watersheds increases (Figure 2). The sources of high fecal coliform levels in suburban areas include pets and other domestic animals, urban wildlife and faulty septic tanks. Extremely high fecal coliform levels in urban creeks are from many sources, including domestic and feral animals, urban wildlife and humans. Most undeveloped, forested headwater creeks, do not meet the fecal coliform standard for shellfish harvesting or swimming. The source of most of the fecal coliform contamination in undeveloped, forested tidal creeks is wildlife and the repository of bacteria that exists in sediments and wetlands. Many human diseases originate from pathogens associated with domestic animals and wildlife. Therefore, consumption of seafood or swimming in water containing large numbers of fecal bacteria is a human health risk, even if the bacteria are from pets and wildlife. Human immune systems are not adapted to combating pathogens from non-human sources.

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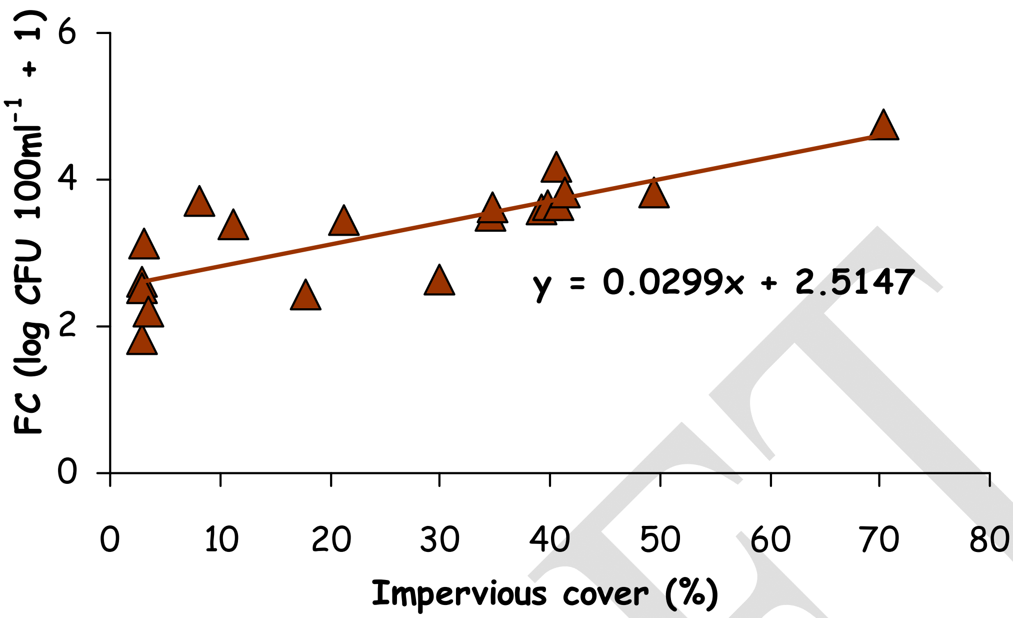

Figure 2. Linear regression of fecal coliform concentrations [log10 (x+1)] in headwater tidal creeks versus % impervious cover (r^2 = 0.63, $p < 0.05$) for southeastern U.S. from Sanger et al. (2008).

As impervious cover levels and coastal development increase, human use of tidal creeks decreases. Impaired tidal creek water quality ultimately impacts the values society associates with our coasts. For example, degradation of tidal creek water quality decreases seafood harvesting opportunities and recreational use. Few, if any, tidal creeks located in developed watersheds support shellfish harvesting, and many suburban and urban creeks do not meet the water quality criteria for swimming. High levels of impervious cover also increase the vulnerability of adjacent land to flooding. Persistent flooding increases insurance costs and decreases property values. Remediation of flooding damage is expensive because it requires modifications to drainage infrastructure.

Coastal communities in Beaufort County, South Carolina, have developed rapidly over the past decade. Since 2000, the population of the Bluffton planning area has increased from 19,044 to nearly 40,000. The Stoney Creek and Rose Dhu Creek sub-watersheds drain particularly rapidly developed portions of the Town of Bluffton and unincorporated Beaufort County. These watersheds are located in the headwaters of the May River estuary and both contain an extensive tidal creek network. In 1999, these sub-watersheds were 76% and 85% forested and only contained ~3% and <1% impervious surfaces, respectively (Filipowicz 2004). By 2003, forested lands had decreased in both sub-watersheds to about 45% and impervious levels in Stoney Creek and Rose Dhu Creek sub-watersheds had increased to ~6% and ~10%, respectively.

Over 19,000 permitted but unconstructed units currently exist in the May River watershed. Many of these units are programmed to be located in the Stoney Creek and Rose Dhu Creek sub-watersheds. When these units are constructed less than 1% of the Stoney Creek and Rose Dhu Creek sub-watersheds will be forested and impervious cover levels will have increased to 14% for the Stoney Creek sub-watershed and 20% for the Rose Dhu Creek sub-watershed (adapted from the May River Chapter, Beaufort County Stormwater Management Plan). Some of the impervious cover levels cited above may be underestimates. Other South Carolina and Southeastern watersheds with similar levels of development generally are characterized by higher levels of impervious cover levels.

The objective of this effort is to conduct a case study for the Stoney Creek and Rose Dhu Creek sub-watersheds to assess the environmental benefit of transferring development rights for some of the 19,000 permitted but unconstructed units to other locations within the May River watershed. We hypothesized that these transfers would reduce stormwater runoff and fecal coliform loadings as effectively, faster and less costly than modifications to infrastructure. An additional goal study was to demonstrate that a shift in the development pattern from a sprawling suburban pattern to a compact and environmentally friendly development pattern would also result in reductions in stormwater runoff and fecal coliform loadings and still maintain a high quality of life.

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Methods

Identification and Characterization of Sending and Receiving Areas

Two sites which have construction approvals and permits but have not initiated infrastructure development were identified for the case study. Site 1 is referred to as the sending area and is located in the unconstructed portion of the Sand Hill Tract. This site is 500 ac and is located in the Stoney Creek sub-watershed. Site 2 is referred to as the receiving area and is a 110 ac portion of Buckwalter Commons at the intersection of Buckwalter and Bluffton Parkways. The receiving area is located in the Rose Dhu Creek sub-watershed.

The Stoney Creek sub-watershed consists of 4,933 ac and in 2003 was estimated to consist of ~6% impervious cover including 45% forested habitat, 3% commercial use, 21% residential use, 5% open space, and 27% wetlands (Table 1). The Rose Dhu Creek sub-watershed is composed of 3,755 ac and in 2003 was estimated to consist of ~10% impervious cover including 44% forested habitat, 8% commercial use, 25% residential use, 15% open space including a golf course, and 0% wetlands (Table 1). The estuarine wetlands at the location where Rose Dhu Creek joins the May River Estuary were not included in the Rose Dhu Creek sub-watershed.

The future land use data in Table 1 were adapted from Table 4-8 of the May River Chapter, Beaufort County Stormwater Management Plan. An approximately 1000 ac parcel of May River Region 4 as defined in Table 4-8 is associated with the Palmetto Bluff area. Land cover for this parcel was determined to be ~95% forested (952 ac) and ~5% low density residential (52 ac) land cover based on Google Earth satellite images. These data were subtracted from the data for May River Region 4 in Table 4-8. In addition, the open water (622 ac) and wetlands (321 ac) portions which are not within the Rose Dhu Creek sub-watershed were also removed. The Rose Dhu Creek sub-watershed boundary used for the case study are shown in Figure 3. A similar process was followed for Stoney Creek sub-watershed with 825 ac of forested land cover and 427 ac of open water land cover being removed from values in Table 4-8 in the May River Chapter, Beaufort County Stormwater Management Plan. The Stoney Creek sub-watershed boundaries used for the case study are shown in Figure 3. Although the process used to define future land use in the Stoney Creek and Rose Dhu Creek sub-watersheds was not exact, we considered it to be sufficiently accurate to address our objectives which mainly involved comparing runoff volumes and fecal coliform loadings for a range of alternative rainfall amounts and development build-out.

For this study, the development rights for a 500 ac undeveloped portion of the Sand Hill Tract (Site 1 or sending area) that is programmed to consist of 1,316 dwelling units at a density of 2.6 dwelling units per acre would be transferred to the receiving area. The 500 ac would then be

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placed in a conservation easement and reforested. Four different lot sizes were assumed for the 500 ac: 0.25 and 0.17 ac individual homes, 0.05 ac townhome sites and 0.5 ac 6-unit apartments. If developed under the existing development standards for the Sand Hill Tract, the estimated impervious coverage for the 500 ac is projected to be 18-20%. For the purposes of estimating stormwater runoff volume, we assumed the sending area represented medium and low density residential development. The Sand Hill Tract originally consisted of 3,123 ac of residential development and was assigned 4,655 dwelling units by the Buckwalter Development Agreement. Subsequent assignments to the Sand Hill Tract included the communities of Hampton Hall (950 units permitted, 504 constructed), Hampton Lake (955 units permitted, 200 constructed), and Lawton Station (500 units permitted, 150 constructed) consisting of about 2,666 ac of residential properties.

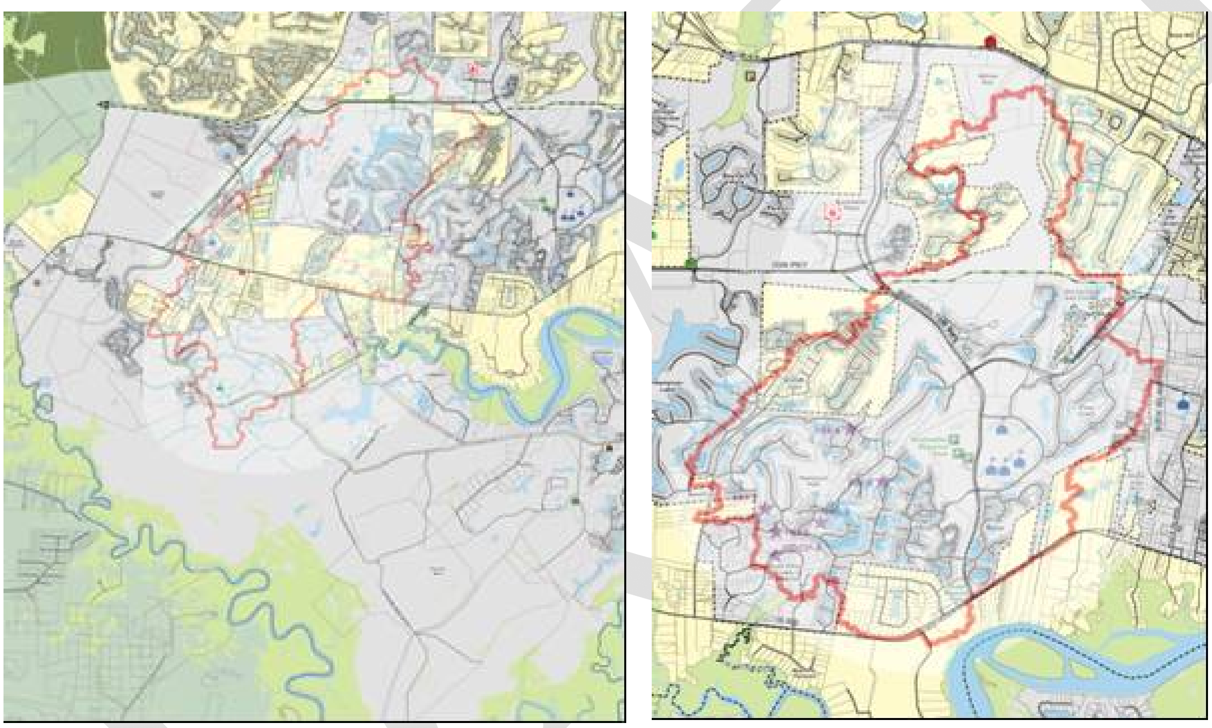

Figure 3. Stoney Creek (left) and Rose Dhu Creek (right) sub-watersheds.

(source information to be added)

The receiving area (Site 2) is located within the Buckwalter PUD at the intersection of the Bluffton and Buckwalter Parkways. This 110 ac site is designated for general commercial development and only permits non-residential uses (not mixed use). For this study, we assumed because of the location of the receiving area along critical road infrastructure, it would be used for 700,000 SF of commercial space including 2,800 parking spaces, including a Walmart (176,000 SF), a Lowes (116,000 SF), a Best Buy (50,000 SF), an unidentified grocery store

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(40,000 SF), and other commercial entities (318,000 SF) including chain restaurants. This type of development typically has an impervious cover level of ~90%. The development rights for the 1,316 dwelling units from Sand Hill Tract (the sending area) would be transferred to the upper floors of the 700,000 SF of commercial space, and the parking requirements would be reduced to 2,600 using a shared parking model. About 30 ac of the 110 ac would be left undeveloped and placed in conservation easement and reforested. We assumed three stories for all buildings, with commercial uses on the ground floor and residential uses above. Residential units were assumed to be ~1000 SF in size. The type of development we proposed for the sending area is generally referred to as environmentally friendly or smart growth.

Stormwater Modeling Methods

The modeling system used to simulate stormwater runoff volume was a modified version of the curve number method and algorithms developed by the U.S. Department of Agriculture, Natural Resources Conservation Services (USDA-NRCS). The general modeling approach is described in Part 630 of the National Engineering Handbook and in Technical Release 55 (USDA 1986, 2004a, 2004b, 2007). Curve numbers are simple indices used by hydrologists to determine how much rainfall enters the drainage network as stormwater runoff. These indices are influenced by soil characteristics, antecedent moisture conditions, slope/topography, amount and type of vegetation and meteorology conditions. The larger the curve numbers the greater the potential for runoff. For example, runoff from a paved urban parking lot with almost no infiltration has a curve number of 98. Forested habitats have a range of curve numbers ranging from 30-79 depending upon soil type, forest condition and coverage. Residential suburban settings are represented by intermediate curve numbers. As a part of the curve number modeling effort, a weighted curve number is calculated based on the proportional land use and soil characteristics in the drainage area. Curve numbers used for the stormwater runoff modeling conducted for this case study are provided in Table 2.

The specific modifications to Technical Release 55 method are described in Blair et al. (2011) and Blair et al. (prepared manuscript) and were designed to adapt the curve number method to the environmental conditions characteristic (e.g., low slopes) of the Southeast. The modified modeling system output was calibrated and validated using USGS precipitation and discharge measurements from August 2002 through September 2003 for three South Carolina tidal creeks that have watershed and land cover similar to the Stoney Creek and Rose Dhu Creek sub-watersheds and for which extensive stream flow measurements were available (Smith 2005).

We used the watershed boundaries in Figure 3 and the proportional land use data modified from the May River Chapter, Beaufort County Stormwater Management Plan, Table 4-8. We assumed

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the soils in the two watersheds were 95% Type A (sands) and 5% Type D (muddy, hydric soils). Group A soils are most pervious to rainfall and Group D soils most impervious. We are aware that soils types in the Stoney Creek and Rose Dhu Creek sub-watersheds are complex and that hydric soils occur in a patchy and unequal distributional pattern throughout these sub-watersheds. Our soils assumption will result in an underestimate of runoff volume but will have little effect on relative comparisons between watersheds or temporal comparisons within watersheds. We also assumed average antecedent soil moisture conditions. Higher runoff would have been estimated had the soils been saturated and lower runoff would have been simulated had dry conditions been assumed. Stormwater runoff volumes were calculated for rainfall events representing 0.25, 0.5, 1.0, 2.0, 3.0, and 4.0 in. Annual estimates of stormwater runoff volume and fecal coliform loadings were calculated using the rainfall data summarized in Table 3. These data represent conditions observed on Wadmalaw Island, SC, in 2003 and represent the rainfall pattern for a "typical" year in coastal South Carolina.

Stormwater runoff volume and fecal coliform loadings were simulated for: (1) the sending area at projected build-out; (2) the sending area after proposed development rights trading was completed; (3) the receiving area at projected build-out; (4) the receiving area after proposed development rights trading was completed; (5) changes in stormwater runoff and fecal coliform loadings for sending and receiving areas combined; (6) the Stoney Creek sub-watershed in 2003; (7) the Rose Dhu Creek sub-watershed in 2003; (8) the Stoney Creek and Rose Dhu Creek sub-watersheds combined in 2003; (9) the Stoney Creek sub-watershed at projected build-out; (10) the Stoney Creek sub-watershed after proposed development rights trading was completed; (11) the Rose Dhu Creek sub-watershed at projected build-out; (12) the Rose Dhu Creek sub-watershed after proposed development rights trading was completed; and (13) changes in stormwater runoff volume and fecal coliform loadings for Stoney Creek and Rose Dhu Creek sub-watersheds combined after the proposed development rights trading were completed.

Fecal coliform loadings were estimated using impervious cover information provided in Table 1 and the fecal coliform concentration predicted for Southeastern headwater tidal creeks using the equation in Figure 2. Fecal coliform loadings (as colonies) were estimated by multiplying calculated stormwater runoff volume by estimated fecal coliform concentration in the headwaters of Stoney Creek and Rose Dhu Creek. Using fecal coliform concentrations from headwaters will result in an underestimate of the "actual" fecal concentration released into headwater creeks. Considerable dilution and mortality have undoubtedly occurred before the bacteria reach the headwaters. The fecal coliform information in Figure 2 was, however, the most reliable estimates available and the only one available that had a strong relationship with impervious cover.

Results

Projected increases in Stormwater Runoff between Build-out and 2003

Estimates of the absolute and proportional changes in stormwater runoff and fecal coliform loadings for the Stoney Creek and Rose Dhu Creek sub-watersheds between 2003 and projected build-out are provided in Table 4. **When all permitted development projects are completed annual runoff volume will be increased by 505% for the Stoney Creek sub-watershed, 745% for the Rose Dhu Creek sub-watershed, and 579% for the two sub-watersheds combined. Fecal coliform loadings in the Stoney Creek sub-watershed will increase by >1000%, by >1500% in the Rose Dhu Creek sub-watershed, and by 1229 for the two sub-watersheds combined.** In summary, at projected build-out 5 to 7 times more stormwater runoff and 10 to 15 times more fecal coliform bacteria will be introduced into the headwaters of the May River than occurred in 2003. These projected changes are huge and provide a perspective for the analyses and data presented later in this document. If these increases in stormwater runoff and associated pollution loadings are allowed to occur, we project that radical, adverse changes in the water quality, seafood production, and human uses of the May River will occur including wide spread closures of shellfishing grounds, posting of water contact swimming advisories at known swimming locations, and reduced human uses including commerce and recreation.

Case Study: Site Scale Findings

Projected stormwater runoff, fecal coliform loadings and changes in stormwater runoff and fecal coliform loadings at the site scale associated with the proposed transfer of development rights case study are provided in Table 5. The transfers resulted in substantial decreases in stormwater runoff volume and fecal coliform loadings at the site scale for all rainfall events and over a typical annual cycle for both the sending and receiving areas. The largest proportional decreases occurred for the smaller rainfall events and the largest absolute decreases occurred for the largest rainfall events. During larger rain events (>1-2 in) soils become saturated and surface runoff increases substantially as rain can no longer penetrated the soils as fast as it is reaching the land surface. **Percent decreases in the volume of stormwater runoff for the simulated annual cycle were 100% and 69% for the sending and receiving areas, respectively. Percent decreases in fecal coliform loadings for sending and receiving area for the simulated annual cycle were 100% and 95%, respectively. Cumulatively (sending + receiving area) the decrease in stormwater runoff volume and fecal coliform loadings for the simulated annual cycle were 92% and 95%, respectively.** The site scale decreases in runoff volume and fecal coliform loadings that are projected to be gained from implementing the development rights trading case study are substantial and are about 15% of the estimated increases in runoff volume and 28% of the fecal coliform loadings projected to occur between 2003 and build-out. In summary, site scale reductions in runoff and fecal coliform loading are large.

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Case Study: Sub-watershed Scale Findings

Projected stormwater runoff, fecal coliform loadings and changes in stormwater runoff and fecal coliform loadings associated with the proposed transfer of development rights case study at the sub-watershed scale are provided in Table 6. **The Stoney Creek sub-watershed had the largest simulated decreases in runoff and fecal coliform loadings. Over a simulated annual cycle, the 500 acres of reforested land and ~2% reduction in impervious cover resulted in a 22% decrease in stormwater volume and a 62% reduction in fecal coliform loadings. Projected annual reductions in stormwater runoff and fecal coliform loadings for the Rose Dhu Creek sub-watershed was only 4% and 9%, respectively. Simulated reductions in stormwater runoff and fecal coliform loadings into the headwaters of the May River were 15% and 50%, respectively.** As expected, the projected reductions in runoff volume and fecal coliform loadings at the sub-watershed scale for the development rights trading case study were not as large proportionally as the site scale reductions discussed above. These reductions were, however, roughly equal to the projected runoff volumes for the combined watersheds in 2003 and exceeded the fecal coliform loadings in 2003. Thus, they are also substantial.

Case Study: Summary of Findings

Transferring the development rights for 1,316 dwelling units located on 500 ac in the Sand Hill Tract to the second and third floors of a 110 ac commercial development to be located at the junctions of Buckwalter Parkway and Bluffton Parkway was projected to result in substantial reductions in the volume of stormwater runoff and fecal coliform loadings at the site and watershed scales. *Potential Benefit of Additional Transfers of Development Rights*

The case study represents about 7% (1,316) of the more than 19,000 housing units and 28% of (610 acres) the undeveloped land in the Stoney Creek and Rose Dhu Creek sub-watersheds that are currently permitted for development. In the section below we: (1) evaluate the current status of development in the Stoney Creek and Rose Dhu Creek sub-watersheds and identify the amount of land that is programmed for development that could reasonably be incorporated into a transfer of development rights program; and (2) estimate the reductions in stormwater runoff and fecal coliform loading that are projected to result if **50%, 75%, and 100%** of the undeveloped but permitted land were included in transfer of development rights program. The purpose of these "what if" simulations is to assess the magnitude of the reductions in stormwater runoff and fecal coliform loadings that may be possible to gain from a transfer of development rights program. We did not include the specific development details for the transfers. These details are beyond the scope of this effort. Rather, we assumed the development at receiving sites and sub-watersheds would have no effect on runoff volume and fecal coliform loadings.

Current Status of Stoney Creek Sub-watershed

The Stoney Creek sub-watershed consists of approximately 4,933 acres, most of which contains existing homes and homesites for the following communities: Baynard Park, Hampton Lake, Grande Oaks PUD, the Willows, Kenzie Park, Pritchard Farms, The Townes at Palmetto Point, Cedar Lake, Palmetto Pointe, Swan Lake, Lawton Station, Southern Oaks, New Riverside, and lands in unincorporated Beaufort County. This sub-watershed also contains an elementary school campus. We strongly believe that the built-out, conventional suburban and golf-course communities including Hampton Lake, Lawton Station, Southern Oaks, Kenzie Park, Swan Lake, Palmetto Pointe, Verdier View, Pritchard Farms would prove difficult to retrofit or "absorb" any transfer of density of a meaningful amount. The Townes at Palmetto Pointe and the areas near the intersection of Hampton Parkway and Bluffton Parkway may, however, be appropriate receiving areas in a transfer of development rights.

In summary, the Stoney Creek sub-watershed consists of ***1,575 acres permitted but not yet built*** composed of New Riverside Tracts 7A, 8A & 8B (675 acres), Sandhill Tract of Buckwalter PUD (600 acres), unincorporated Beaufort County lands (permitted via zoning—225 acres), Jones Tract PUD (25 acres), and Grande Oaks PUD (50 acres). Approximately **1,275 acres that are permitted but not yet built could reasonably be included into a transfer of development rights program** including New Riverside Tracts 7A, 8A & 8B (675 acres) and the Sandhill Tract of Buckwalter PUD (600 acres).

Current Status of Rose Dhu Creek Sub-watershed

The Rose Dhu Creek sub-watershed consists of approximately 3,755 acres, most of which contains existing homes and homesites for the following communities: Hampton Hall, Rose Dhu Creek Plantation, Barton's Run, the Farm, Pine Ridge and Pine Crest, Shell Hall, Old Carolina, Grande Oaks, Sandy Pointe, and Edgefield. The Rose Dhu Creek sub-watershed also contains the 142-acre Buckwalter Regional Park (between the Farm and Pine Ridge) and the Bluffton School Campus/Boys & Girls Club. We strongly feel that the built-out, conventional suburban and golf-course communities including Hampton Hall, Pine Crest, Pine Ridge, the Farm, Rose Dhu Creek Plantation, Barton's Run, Old Carolina, Grande Oaks, Edgefield, Sandy Pointe would prove very difficult to retrofit or "absorb" any transfer of density of a meaningful amount. We believe a Shell Hall retrofit could absorb approximately 300 dwelling units (above and beyond the base residential assignment) for a retrofitted, resultant density of 6.96 dwelling units/acre. This is highlighted in the Bluffton watershed plan excel workbook. Aside from the Shell Hall possibility, the primary transfer opportunities are within the Buckwalter Commons including FKA Northern Tract and Willow Run Tract. The FKA Northern Tract totals 298 acres and has been assigned 145 dwelling units (0.7 dwelling units) and commercial acreage. The FKA Willow Run Tract totals 163 acres and has been assigned 260 dwelling units (1.6 dwelling units) and commercial acreage. The Rose Dhu Creek sub-watershed only covers approximately 50% of the Willow Run Tract or approximately 80 acres. The portion of the Willow Run tract that is outside of the Rose Dhu Creek sub-watershed could easily absord all of the residential and commercial assignments of the Northern and the Willow Run Tracts. The remainder of the Willow Run Tract and entire Northern Tract could then be reforested and placed in conservation easement. Aside from these transfer opportunities, there may be small remnants elsewhere in the Rose Dhu Creek sub-watershed including but not limited to a portion of the Grande Oaks PUD and a couple of parcels along SC 46 that are located in Beaufort County that total ~75 acres.

In summary, the Rose Dhu Creek sub-watershed consists of **600 total acres that have been permitted but not yet built** including 50% of the Willow Run Tract (82 acres), Northern Tract (298 acres), Grande Oaks PUD (20 acres), Eastern Tract of Buckwalter (50 acres), unincorporated Beaufort County lands (permitted via zoning—75 acres), and Shell Hall Phase II and III (75 acres). Approximately **450 acres that are permitted but not yet built could reasonably be included into a transfer of development rights program** including 50% of the Willow Run Tract (82 acres), Northern Tract (298 acres), Grande Oaks PUD (20 acres), and the Eastern Tract of Buckwalter (50 acres).

"What if" Scenarios Evaluating the Potential for a Broad Scale Transfer of Development Rights Program to Reduce Stormwater Runoff and Fecal Coliform Loadings

Tables 7, 8, and 9 provide projected land use estimates for the Stoney Creek and Rose Dhu Creek sub-watersheds if a transfer of development rights program was implemented for 50%, 75%, and 100% of land identified above as being reasonable to include in such a program. Estimates for stormwater runoff, fecal coliform loadings and decreases in stormwater runoff and fecal coliform loadings associated with implementing a transfer of development rights program for the land identified as being reasonable to include at the 50%, 75% and 100% level are provided in Tables 10, 11 and 12. **If 50% of the potentially available land for both sub-watersheds were included in a transfer of development rights program stormwater volume and fecal coliform loading would be reduced by 33% and 47%, respectively. If 100% of the potentially available land for both sub-watersheds were included in a transfer of development rights program stormwater volume and fecal coliform loading would be reduced by 56% and 68%, respectively.** The 100% level represents a "best case" scenario and is about 3.6 times the runoff and 1.3 times the fecal coliform loadings projected for the case study. This "best case" scenario is 3 times greater than runoff levels and 4 times greater than fecal coliform loadings projected for 2003 land use conditions. It is, however, unlikely that this "best case" transfer of development rights scenario would restore water quality in the headwaters of the May River to levels that would support shellfish harvesting. This standard is just too stringent. A transfer of development rights program would likely assist in sustaining other human uses.

Conclusions & Implications

The simulations we conducted indicate that a transfer of development rights program has great potential for reducing stormwater runoff and fecal coliform in the headwaters of the May River. However, even if 100% of the potentially available land were included in a program to reduce stormwater runoff and fecal coliform loading into the headwaters of the May River, there would still be is 3 times greater than runoff levels and 4 times greater than fecal coliform loadings projected for 2003 land use conditions.

There is no easy, simple solution for restoring May River water quality. Successful restoration will require a broad range of engineering projects (e.g., regional ponds, modifications to existing ponds and ditches, retrofitting using low impact development technology into exiting developments), a transfer of development rights program, installation of runoff reducing technologies by significant numbers of homeowners (e.g., cisterns for capturing and reusing rainwater) and extensive public education.

A transfer of development rights program is not a "one stop shopping" solution for restoring May River water quality. It is, however, a low cost and easy to implement alternative (e.g., implementing ordinance exists) that is an essential part of the "tool box" of approaches and technologies required to restore May River water quality. Implementing a transfer of development rights program is therefore an easy way to take a "giant step" toward improving May River water quality. We were unable to estimate the economic costs of implementing a transfer of development rights program in the time available to conduct these analyses; however, we hypothesize that is less costly and more effective than construction of stormwater ponds. A detailed economic analysis of a transfer of development rights program should be conducted to validate or refute our hypothesis.

The most appropriate scale for identifying and selecting among alternative technologies for restoring May River water quality is the sub-watershed (i.e., drainage basin) scale. A watershed or drainage basin is an easy to define geographical unit that supports a range of ecosystem goods and services (seafood production, waste processing) and a broad range of human uses (fishing, recreation). Substantial differences in land use and related differences in stormwater runoff volume and fecal coliform loadings between the Stoney Creek and Rose Dhu Creek sub-watersheds suggest that approaches that mitigate stormwater runoff in one watershed may not be as effective in the other.

The simulated stormwater runoff volumes and fecal coliform loadings reported in this document are in the ranges reported in the May River Chapter of the Beaufort County Stormwater Management Plan for the Stoney Creek and Rose Dhu Creek sub-watersheds and generally agree with previous stormwater runoff volume and fecal coliform loadings estimates for tidal creek watersheds in similar size ranges and levels of development.

The estimates of stormwater runoff volume and fecal coliform loadings in this report are underestimates. Including recent soils information, fecal coliform data, and improved land use information would likely result in less uncertainty in the estimates of runoff and loadings. These improvements would not, however, likely change the conclusions or the spatial and temporal contrasts presented in this document.

The estimates of impervious cover used for our simulations came from a range of sources and were obtained using different methods with vastly different levels of uncertainty. If reliable estimates of impervious cover were obtained it is likely that similar results would have been obtained. We, however, suggest that uniform and standard methods for estimating impervious cover be applied. Such consistent estimates would greatly improve the planning process.

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