

Biological and Agricultural Engineering Research Projects 2008-09

The Department of Biological and Agricultural Engineering applies engineering principles to biologically-based systems. Faculty research activities involve the application of engineering principles to achieve efficient utilization of biological and agricultural systems with emphasis on management, preservation and sustainability of natural systems. Scientific and engineering principles are applied to: conserve and manage air, energy, soil and water resources; to manage, protect and restore natural ecosystems; to understand and utilize biological, chemical and physical processes for the production and conversion of biomass to bioenergy; to analyze, understand and utilize mechanical properties of biological materials; to design and develop machinery systems for all phases of agricultural and food production; to design and evaluate structures and environmental control systems for housing animals, plant growth, and biological product storage; to develop improved systems for processing and marketing food and agricultural products; and to design sensor-based instrumentation and control systems for biological and agricultural applications.

Bolin Creek Watershed Restoration

G. Jennings, W. Hunt

\$350,000.

02/01/2009 - 09/30/2011

The Department of Biological and Agricultural Engineering of the North Carolina State University (NCSU) will provide services to the Town of Chapel Hill to implement watershed restoration practices and water quality monitoring as a component of an EPA 319 grant project in the Bolin Creek Watershed. The purpose is to improve ecosystem health and water quality by restoring natural stream functions and managing stormwater runoff in degraded areas in the watershed. The work will be performed by a team of faculty, technicians, and students associated with the Department of Biological and Agricultural Engineering at North Carolina State University.

Stormwater BMPS and LID Measures to Protect Coastal Waters near Eagle Point Golf Club

M. Burchell, K. Bass, W. Hunt

\$24,000

12/01/2008 - 01/31/2010

Eagle Point Golf Club (EPGC) near Wilmington, NC has demonstrated its commitment to preserving the habitat and function of the coastal marshes that surround the site. In 2003, the Eagle Point Golf Course entered ~218 acres of the 231.5 acre site into a conservation easement agreement with the North Carolina Coastal Federation (NCCF), to ensure that the property would be retained in perpetuity in a predominantly natural, scenic and open space condition. As in many other coastal areas in NC, the watershed in which EPGC is located is becoming increasingly developed. Many of these areas currently drain through EPGC following storm events, potentially delivering excess surface water pollutants such as nutrients, sediment, and fecal bacteria. Because of its landscape position, EPGC has become a potential last line of defense for the coastal marshes down gradient. It

currently serves as a buffer for the adjacent Little Creek and Middle Sound estuary. In keeping with the commitment of EPGC and NCCF, the NCSU Department of Biological and Agricultural Engineering proposes to assist the NHC Planning Department in the development of stormwater practices that will help strengthen the ability of this area to protect the surrounding coastal marshes.

Assessment of Bioenergy Crop Production along North Carolina Highway Right-of-ways

Veal, Matthew

\$105,750

03/01/2009 - 05/31/2011

The Bioprocess Extension Program in the Biological and Agricultural Engineering Department at NC State has proposed a project to investigate the feasibility of initiating a Freeways to Fuel project in North Carolina. The following research objectives have been developed to support this activity. 1) Develop assessment criteria to identify right-of-way areas that are suitable for energy crop production and produce a computerized-map (i.e. GIS) project to indicate these areas. 2) Assess the production, economic, and logistical parameters impacting oilseed production in right-of-ways to determine the optimal crop cultivation system. 3) Perform a series of plot trials to assess the yield potential of canola and soybeans in right-of-ways for various cultural practices.

Catawba River Basin Residential Irrigation Water Conservation Study

G. Grabow, R. Huffman, G. Miller

\$142,227

02/10/2009 - 3/31/2012

NC State University is proposing to lead a water use study on Duke Energy lakes in the Catawba River Basin. The study will establish an estimate of water withdrawals by homeowners bordering the lake through installation of water meters at 36 properties during phase I of the study. Additional information about water use practices will be obtained through a survey instrument designed by NC State. Long-term estimates of irrigation water requirements will be generated using existing long-term data from local weather stations, and weather stations will be deployed at project lakes to estimate irrigation water requirements over the course of the study. During Phase II, two groups of cooperating homeowners will receive two types of -smart-irrigation control technologies. One type of technology is weather based and the other is soil-moisture sensor based. A third group of homeowners will receive educational material and guidance on programming their existing irrigation controller and a fourth group will receive no intervention other than water use monitoring. Soil moisture will be recorded in all homes that receive the smart technologies. Weekly and seasonal water use of all groups will be compared between all four groups. Water use of the four groups will all be compared against irrigation requirements as estimated from the weather stations deployed at the Duke Energy lakes. Study results will be used to quantify the potential reduction of water withdrawals from the use of smart irrigation technologies, and an educational campaign aimed at property owners along Duke Energy lakes. Typical water withdrawal patterns (both current patterns and patterns associated with efficient irrigation management) will be used to evaluate the potential water savings.

Genetically Engineered Switchgrass for Ethanol Production

J. Cheng, Qu, R

\$2,000

08/01/2008 - 07/31/2010

The goal of this proposed research is to develop a technology that efficiently converts genetically engineered switchgrass with less lignin and more cellulose to bioethanol. Lower costs will be expected for the technology, compared to the current ones. The specific objectives are to: 1. Clone cDNA of a key lignin biosynthesis gene 4CL (4-coumarate:coenzyme A ligase) from switchgrass (*Panicum virgatum* L.); 2. Genetically transform switchgrass for reduced lignin and increased cellulose; and 3. Improve efficiencies of transgenic switchgrass to ethanol through pretreatment, hydrolysis and fermentation. In this multi-disciplinary research team, we have expertise in grass transformation, lignin/cellulose synthesis biochemistry and molecular biology, and fermentation for ethanol production from cellulose. Collaborative experiments will be conducted to achieve the goal and objectives of this project. This proposed project will have significant economic benefits for renewable energy production. Although at the present there is very little switchgrass grown in the US, many states, e.g. North Carolina, are very suitable for its growth. If the price is right the acreage would rapidly grow. An estimate by NCDA at 2004 indicates that switchgrass could be grown on some 4.4 million acres in the state, involving 11,000 farms, and by our calculation, the switchgrass-to-ethanol industry revenue could reach \$4 billion/year. Moreover, hundreds of jobs will be created by the switchgrass-to-ethanol plants. At this scale, a reduction of each one percentage unit of lignin and conversion of it to cellulose would increase the revenue by \$95 million/year without any more input due to the increased ethanol production.

Riparian Buffer and Stream Channel Enhancements at Smith and Austin Creeks

Jennings, G.

NC DENR

\$73,600

12/12/2008 - 04/30/2009

The Department of Biological and Agricultural Engineering (BAE) of the North Carolina State University will work with the North Carolina Ecosystem Enhancement Program (NCEEP) to implement riparian buffer and stream channel enhancements at the Smith and Austin Creeks EEP project in Wake County, NC. The purpose is to improve ecosystem health by planting native trees and shrubs in designated riparian buffers and by repairing eroding streambanks using natural channel design techniques. The work will be performed by a team of faculty, technicians, and students associated with the Department of Biological and Agricultural Engineering at North Carolina State University.

Town Lake Weed control for Wetland Restoration

K. Hall, K. Bass, J. Spooner

NC DENR

\$40,000

1/1/09 - 11/30/11

Town Lake, located in central Chatham County, NC, is an impoundment of Robeson Creek, a 303(d) listed water body. The lake is impacted by urban and rural nonpoint source pollution resulting in algal blooms stimulated by excessive nutrients. A 2007 feasibility study of Town Lake recom-

mends lowering the upper lake level and creating an emergent wetland to treat pollutants, implement an integrated pest management program for the aquatic, semi-aquatic and terrestrial weeds, and monitor the lake to determine if water quality is improving. Currently, a Clean Water Management Trust Fund proposal has been awarded to NCSU to construct the wetland. The Division of Water Quality will be monitoring the wetland project to determine water quality impacts. This EPA Section 319 proposal aims to address the management program for the aquatic, semi-aquatic and terrestrial weeds that plague the project site. Over three years, an Integrated Pest Management (IPM) plan will be implemented to control the aquatic, semi-aquatic and terrestrial weeds. The IPM will employ appropriate herbicides in the upper lake to control weed growth without adversely impacting aquatic life as well as control semi-aquatic and terrestrial weeds in and around the restoration project. Because of the invasiveness and dominance of the exotic weeds, implementing the IPM to reduce and control weed infestations is necessary to allow native plants to establish in the emergent wetland and the surrounding riparian areas. Initial control and subsequent treatments will allow native vegetation to firmly establish and effectively out-compete residual invasive exotic vegetation at the site. Educational workshops, tours, and interpretive sign installation around the lake will contribute to citizen knowledge and support of this project.

Analysis of the Effects of Biofuel Planting, Growth, and Harvesting on the Hydrology and Water Quality of Pine Plantations

G. Chescheir, W. Skaggs, M. Youssef, F. Birgand

Weyerhaeuser Co.

\$500,000

12/15/2008 - 12/31/2010

This project will investigate the hydrologic and water quality effects of the production of energy crops inter-planted in forest plantations in North Carolina and other southeastern states. The proposed project will expand long-term watershed studies on pine plantations in the Coastal Plain of North Carolina. Growing trees and other crops to produce forest and energy products is a promising method of improving local economies and contributing to energy security, with the added potential of sequestering CO₂, reducing the effects of climate change. However, introduction of energy crops in the traditional plantation forest may have high impact on hydrology and drainage water quality. No information is available on the hydrologic and water quality effects of inter-planting and harvesting biomass crops for energy between rows of pine trees. We propose in this project to use the well documented and calibrated watersheds in Carteret county, NC to study the environmentally related effects of producing both biomass crops and forestry crops for energy. We will also work with researchers in other southeastern states to process and analyze data from similar pine plantation watersheds with inter-planted biomass crops.

New Technologies to Improve the Energy Efficiency in Flue-Cured Tobacco, Phase II

M. Boyette, G. Ellington

Tobacco Education and Research Council

\$107,800

01/01/2009 - 12/31/2009

The fuel and electrical energy required for curing is a major and growing cost in the production of flue-cured tobacco. With the recent increases in the cost of curing fuel and elec-

tricity, energy costs are approaching, and in some cases have exceeded, \$1000 per cure. This situation is clearly untenable and if left unresolved, may shortly result in the wholesale exit of many US flue-cured growers from the industry. We fully understand that the viability of the US flue-cured tobacco industry may hinge on the timely reduction of curing energy costs. Our proposed work is in two parts. First, we will investigate ways to make existing equipment more energy efficient and second, we will investigate the convenient and efficient application of renewable woodchips for curing fuel.

Environmentally Sustainable Swine and Poultry Production Systems for the Future

O. Simmons
US Dept. of Agriculture
 \$205,337
 07/01/2008 - 06/30/2010

This USDA CSREES special research grant to study Swine and Other Waste Management is administered through the NCSU Animal and Poultry Waste Management Center. The work is intended to improve the environmental, economic, public health, and production performance of swine and poultry production systems in North Carolina. The three specific objectives of this grant are to produce a knowledge base of the technologies available to improve emissions as well as economic and production performance of swine and poultry production systems, to conduct a microbiological study of the source, fate and transport of pathogens and indicators associated with animal production, and to conduct an aerosol dispersion modeling study to better predict the dispersion of aerosols from poultry and swine production facilities. Requested funds will be used to support faculty and graduate student time on the project, to provide small equipment, materials and supplies, and to cover travel, publication, and web development services costs of the project.

Environmentally Sustainable Swine and Poultry Production Systems for the Future

L. Wang
US Dept. of Agriculture
 \$68,846
 07/01/2008 - 06/30/2010

This USDA CSREES special research grant to study Swine and Other Waste Management is administered through the NCSU Animal and Poultry Waste Management Center. The work is intended to improve the environmental, economic, public health, and production performance of swine and poultry production systems in North Carolina. The three specific objectives of this grant are to produce a knowledge base of the technologies available to improve emissions as well as economic and production performance of swine and poultry production systems, to conduct a microbiological study of the source, fate and transport of pathogens and indicators associated with animal production, and to conduct an aerosol dispersion modeling study to better predict the dispersion of aerosols from poultry and swine production facilities. Requested funds will be used to support faculty and graduate student time on the project, to provide small equipment, materials and supplies, and to cover travel, publication, and web development services costs of the project.

Evaluating Pathogen Removal in Stormwater BMPs

W. Hunt
NCSU Water Resources Research Institute
 \$35,453
 11/01/2008 - 06/30/2009

Although BMPs have been studied in detail for many pollutants, little peer-reviewed literature is available which documents their ability to remove or inactivate pathogens. The majority of the BMP data associated with pathogen removal is available in a database format through the International Stormwater BMP Database (ISBD). Based primarily on data entered into the ISBD, the USEPA concluded that pathogen removal is less understood than removal of other pollutants in stormwater BMPs. Further, the report highlights the variable performance that initial studies have shown with respect to BMP pathogen removal. Due to the limited amount of literature pertaining to pathogen removal by stormwater BMPs, more research is needed to aid communities throughout the United States in reaching their target pathogen TMDL. Determining which BMPs are capable of efficient pathogen reduction will result in more effective watershed restoration programs. This research is intended to examine and evaluate multiple types of BMPs for pathogenic indicator bacteria removal in Wilmington and Raleigh, NC. The goal of this study is to provide more definitive guidance on BMP selection for watersheds impacted by pathogenic bacteria.

Southern Regional Water Program

G. Jennings
USDA - Texas A & M
 \$176,077
 9/01/2008 - 08/31/2009

Protecting and enhancing abundant safe water supplies are among the highest priority environmental issues in North Carolina and the Southern Region. The North Carolina State University College of Agriculture and Life Sciences (NCSU CALS), including the Cooperative Extension Service, is well-positioned to provide leadership for research and educational programs to meet the needs of homeowners, farmers, businesses, local officials, and government agencies to improve water protection practices. NCSU CALS is committed to working with other Universities, including North Carolina A&T State University and colleagues throughout the Southern Region, to accomplish multi-institutional objectives in water resource protection. The objectives of this project are to: 1. Provide leadership for capacity development and partnerships in North Carolina, the Southern Region, and nation to implement effective integrated water educational and research programs; 2. Provide co-leadership for the Watershed Education and Restoration Program Team in the Southern Region; 3. Provide co-leadership for the Nutrient Management Program Team in the Southern Region; 4. Represent the Southern Region on the CSREES Committee for Shared Leadership at the request of the National Program Leader for Water Resources; and 5. Provide leadership for planning and conducting the annual CSREES National Water Conference for the purpose of sharing water knowledge and strengthening regional and national networks of researchers, educators, and extension professionals.

Town Lake Restoration

K. Hall, K. Bass, D. Line, J. Spooner, J. Blackwell, M. Shaffer
\$476,000
11/1/2008 - 10/30/2011

Town Lake, located in central Chatham County, is part of the upper Cape Fear River Basin and drains into the 331 square mile lower Haw River Watershed (Cape Fear Sub-basin 030604; HUC 03030002050 and 03030002060) in the central Piedmont region of North Carolina. This former water supply lake impounds Robeson Creek and is located within the limits of the Town of Pittsboro. Town Lake is on the NCDENR 303(d) list of impaired waters for aquatic weeds, and is currently not rated for aquatic life according to the 2005 Cape Fear River Basinwide Water Quality Plan. Furthermore, Robeson Creek is also on the 303 (d) list for chlorophyll a violations and biological impairment. Ongoing water quality studies have indicated that Town Lake is impacted by urban and rural nonpoint source pollution. The lake experiences algal blooms stimulated by excessive nutrient input from the watershed. DWQ sampling in 1993 identified significant macrophyte infestation problems in the lake. A restoration feasibility study funded by the Clean Water Management Trust Fund and prepared and completed in 2007 by the NCSU Water Quality Group suggests six restoration alternatives with the preferred alternative being a passive stream and wetland restoration approach. This approach will involve conversion of the lake to a more natural ecosystem with a channel, associated wetland floodplain, and diverse native vegetative community. The wetland area will also have a built-in storage component for water quality improvement purposes. Town Lake is a municipal park owned entirely by the Town of Pittsboro and on August 13th 2007, the Pittsboro Board of Commissioners approved the preferred alternative recommended in the study. With the support of the town as well as the Robeson Creek Watershed Council, a local stakeholder group that is very active in the improvement of water quality throughout the Robeson Creek Watershed, this proposed project will involve implementation of the preferred restoration plan with the goal of improving water quality and removing the lake from the impaired waters list. The passive stream and wetland restoration approach will involve: (1) lowering the water level of the existing upper lake, (2) stabilizing the failed emergency spillway, (3) installation of a water control/storage structure, (4) removing sediment from the mouth of the upper lake, (5) allowing the stream channel to reform on its own, and (6) creating a diverse habitat including upper marsh areas, deep pools, and forested buffers. This approach will improve water quality, improve wildlife habitat, and restore stream and wetland functions to the lake and Robeson Creek.

Effective Strategies for Biogas and Nutrient Management Resulting from Anaerobic Digestion in Covered Swine Lagoons

M. Veal, P. Westerman, J. Cheng, A. Stomp, K. Zering
\$457,433
09/01/2008 through 08/31/2010

Biogas generation and capture using covered lagoons is a promising renewable energy technology that can be utilized by North Carolina swine farmers to increase on-farm income and mitigate rising energy costs. Covering lagoons would also reduce ammonia and greenhouse gas emissions, particularly methane, and have potential to obtain Carbon Credits. Currently, swine producers in the state have reservations about covering lagoons for biogas production as

the economic recovery associated with energy generation equipment is unknown for NC and concerns about nutrient management have lead state officials to exclude covered lagoon projects from state conservation agricultural cost-share programs. An overlooked aspect of anaerobic digestion is the use of the nutrients in the production of crops that can be converted into value-added agricultural products. Algae and duckweed are examples of energy crops that could be grown in a media similar to digested swine wastes and then used in the production of biodiesel or bioethanol. The ultimate goals of this project is to exhibit effective, economically-feasible energy generation technologies utilizing biogas, demonstrate utilization of biogas combustion by-products (i.e. heat and CO₂), and to show a variety of processes that can be implemented to manage swine effluent nutrients. The technologies to be demonstrated in this project include: 1. Anaerobic digestion of swine manure for biogas production and utilization of methane for electricity generation through an internal combustion engine, 2. Utilization of CO₂ from methane combustion to enhance tomato production in greenhouse, 3. Nitrification biofiltration for ammonia emission control, very low cost denitrification in pits for nitrogen removal, and nutrient utilization for greenhouse tomato production, 4. Growing duckweed to recover nutrients from swine wastewater and convert duckweed into bioethanol, and 5. Struvite crystallization for phosphorus removal from swine wastewater. Also, technologies and extension education materials will be transferred to interested stakeholders. Workshops, field days, extension publications, and website spreadsheets and other materials will be developed from the knowledge obtained from this project.

Watershed Retrofit and Management Evaluation for Urban Stormwater Management Systems in North Carolina, Including Projected Costs and Benefits

W. Hunt
WRRRI
\$71,723
09/1/2008 - 06/30/2009

Eight target watersheds will be identified in each of the WRRRI Stormwater Consortium entities (one each). These watersheds' size should range from 1 to 2 mi². A variety of land uses are expected to be evaluated including ultra-urban commercial and institutional, high density, residential, suburban commercial and residential, and urbanizing agricultural/woodland. Additionally, a larger watershed in which the smaller one is nested, 8 to 15 mi² will be examined for potential placement of large off-line stream BMPs. Using provided data, NCSU faculty will estimate pollutant loads from each 1-2 mi² watershed for the pollutant(s) identified on 303(d) lists. This will involve a literature review to establish average loads per given land uses. Composite loads will be determined using GIS. BMP selection will also be based upon a literature review and NCSU-led monitoring projects to determine how various practices improve target pollutant loads. In addition to basic structural solutions, non-structural BMPs will be evaluated, especially street sweeping. BMP types and a tally of each type will be determined for each prospective watershed. A cost estimate for the BMPs used will be made. Additionally, the pollutant removal benefit associated with each BMP type will be determined per prior literature review. If possible, BMPs recommended will be placed in two tiers. The first (or high priority) tier will reflect practices that would deliver the most bang for the buck. The second tier will reflect BMPs which provide a more marginal pollutant removal return on the investment.

Purlear Creek Restoration Phase 3

G. Jennings
 NC-DENR
 \$149,000
 11/1/2008 - 6/1/2009

Faculty, staff, and students associated with the North Carolina State University (NCSU) Department of Biological and Agricultural Engineering will work with the North Carolina Division of Forest Resources (DFR) to complete Phase 3 of a comprehensive stream restoration demonstration/education project on Purlear Creek on the Rendezvous Mountain Educational State Forest (RM-ESF) property in Wilkes County. Funding for this project was obtained by DFR from the North Carolina Division of Water Resources (DWR).

Sustaining the Economic Impact from Tobacco Production in North Carolina

W. Smith, M. Boyette, D. Monks
 NC Tobacco Trust Fund Commission
 \$145,000
 12/11/2008 - 9/30/2010

Sustained tobacco production and the \$1.1 billion in economic impact it provides are solely dependent upon improved profitability at the farm level. Research to develop alternative energy sources, disease management, varieties, pest control, and agronomic management practices followed by extension educational programs to provide outreach into the community is critically necessary for continued production and the survival of this industry which supports 1,800 farm families and employs over 18,000 farm workers. For North Carolina State University to continue its excellent support of tobacco farmers, it must recruit and retain the World's best faculty by providing the World's best infrastructure. Budget limitations at the state level and the unavailability of federal funds have severely restricted investment in research stations, greenhouses, and laboratories. As a result, the university does not have sufficient greenhouse space to support tobacco research; its laboratories lack the analytical capability to fully support variety development and harm reduction research; and research stations need to be modernized to support field research. Therefore, the goal of this project is to sustain the \$1.1 billion economic impact from tobacco production at the farm and community. Specific objectives are: To provide the infrastructure necessary to support research and education programs that increase production efficiency and reduce production costs in tobacco production. Reduce curing costs on tobacco research stations by 90%, thereby providing additional operating funds to support research projects supporting tobacco production. Demonstrate and evaluate alternative fuels in tobacco curing and transplant production. To accomplish these objectives the North Carolina Agricultural Foundation is requesting a grant of \$498,750 from the NC Tobacco Trust Fund Commission to support infrastructure improvements during 2009. Funds will be utilized to convert curing barns on three tobacco research stations for hot water curing fired by wood chips. The same boiler system would also be used to heat the tobacco transplant greenhouse. Engineers estimate a 90% savings with wood fired hot water compared to LP gas. The savings are so substantial that it only takes two years for a return on the conversion cost. In addition, two research stations do not have suitable transplant production greenhouses.

Retrofitting a Pig Nursery with a Transpired Solar Wall To Save Heat Energy and Improve Pig Performance

S. Shah, C. McGuffey
 NC Pork Council
 \$25,000
 07/01/2008 - 06/30/2009

The transpired solar wall consists of an unglazed, dark colored metal sheet with perforations installed on the south side of the house. The transpired solar wall collects most of the solar energy falling on it and when air is drawn through the wall, most of the heat is transferred to the air and thus, air temperature can be raised by up to 63°F. More energy is saved when the transpired wall recovers much of the heat leaking through the wall. The air passing through the transpired wall, being warmer than fresh, cold air will have lower relative humidity, and will hence, help keep the nursery drier. Because high relative humidity can increase disease pressure on piglets, a nursery receiving drier air due to the transpired walls will have a healthier environment than one without a transpired wall. Reduced propane use will also reduce carbon dioxide buildup and emissions, which will be particularly important in houses with unvented heaters. Maintenance of the transpired solar wall is very low because it has no moving or liquid components. While the fan run time (due to greater pressure drop) is likely to be 20% higher, overall, there will be substantial energy savings.

Watershed Management in Selected Sub-watersheds of the Falls Lake Reservoir: NCSU Monitoring Component

D. Line, J. Spooner
 NCDENR/ Wake County
 \$43,000
 07/01/2008 - 06/30/2010

The Watershed Management of Selected Subwatersheds of the Falls Lake Reservoir will be a project to plan and commence implementation of measures to improve water quality and habitat conditions in tributaries to Falls Lake that lie within Wake County. The NCSU Water Quality Group's part of the project is to conduct short-term monitoring of the tributaries to assess current water quality conditions and aquatic life in the watershed. This monitoring will include the collection of water samples for chemical analysis and macroinvertebrates for biological assessment of the tributaries. These and other data will be used to recommend immediate management strategies at the subwatershed level and to aid in the development of longer term management strategies.

Evaluate the Toxicity of Forebay Sediment and make recommendations on Ultimate Disposal of Forebay Spoils

W. Hunt
 NC Div. of Water (DENR)
 \$15,384.
 8/1/2008 - 6/30/2009

Hundreds of wet ponds and stormwater wetlands have been installed across the state of North Carolina since the late 1990's. The design of these practices has usually included a forebay, which is designed to initially receive influent runoff and force the settling of its larger particles. Forebays are designed so that they can be accessed for cleaning (or removing of captured sediment and gross solids). The clean-

ing, also known as dredging or dipping, is irregular, but is triggered by accumulation of solids within at least 1 foot of the surface. In the past the collected solids have simply been spread out across nearby open surfaces and subsequently seeded. However, this practice has been somewhat called into question by concerns that the sediment collected by forebays may actually be toxic and need to be safely disposed of in a lined landfill instead. The purpose of this study is to evaluate forebay sediment for toxicity and nutrient content and make a recommendation for ultimate disposal of removed forebay spoils.

High-Value Transportation biofuels from North Carolina Feedstocks

R. Williams, L. Stikeleather
Biofuel Center of NC
 \$32,934
 06/01/2008-7/01/2009

Currently, there is heavy emphasis on ethanol and biodiesel production in the U.S., with ethanol capacity approaching 6.2 billion gallons annually and biodiesel capacity approaching 300 million gallons annually. While these biofuels have enjoyed some commercial success, they do have a number of shortcomings. These “first generation” biofuels are typically tied to a single feedstock, resulting in reliance on a single agricultural commodity. Another problem is that the chemical, physical, and combustion properties ethanol and biodiesel (Fatty Acid Methyl Esters, FAME) differ very significantly from their petroleum-derived counterparts, causing causes many operational difficulties.

Demonstration and Evaluation of Floating Wetland Islands

W. Hunt
NC DENR
 \$95,000
 10/1/2008 - 9/30/2011

Two ponds in Durham, NC, will be retrofitted with floating wetland islands. These ponds currently have no vegetation growing inside them, like most ponds in North Carolina. Due to tremendous retrofitting pressure that is likely to accompany watershed rules associated with the Jordan Lake reservoir, it is imperative for cities like Durham, Burlington and Greensboro to identify cost effective retrofits. Floating wetland islands do not require any earth moving, nor will they detract from the required storage volume required for wet ponds, because they float. The systems are expected to reduce quantities of nitrogen and phosphorus, but the exact amounts will be determined by field monitoring. Inflows and outflows from both ponds will be monitored for one year at the grant’s outset. Following the baseline monitoring period, floating wetland islands will be installed and monitored for an additional year. Inflows and outflows will be collected at the same locations during both stages of the study to verify the impacts of the floating wetland islands. The ponds will be visited via field tours and highlighted at educational events to disseminate knowledge gained to the design community. If successful, ponds with floating wetland islands could become the most commonly retrofitted BMP type in North Carolina.

Genetically Engineered Switchgrass for Ethanol Production

J. Cheng, L. Li, R. Qu
US Dept. of Energy/ Consortium for Plant Biotechnology Research, Inc.
 \$90,000
 08/01/2008-07/31/2010

The goal of this proposed research is to develop a technology that efficiently converts genetically engineered switchgrass with less lignin and more cellulose to bioethanol. Lower costs will be expected for the technology, compared to the current ones. The specific objectives are to: 1. Clone cDNA of a key lignin biosynthesis gene 4CL (4-coumarate:coenzyme A ligase) from switchgrass (*Panicum virgatum* L.); 2. Genetically transform switchgrass for reduced lignin and increased cellulose; and 3. Improve efficiencies of transgenic switchgrass to ethanol through pretreatment, hydrolysis and fermentation. In this multi-disciplinary research team, we have expertise in grass transformation, lignin/cellulose synthesis biochemistry and molecular biology, and fermentation for ethanol production from cellulose. Collaborative experiments will be conducted to achieve the goal and objectives of this project.

Effects of Highway construction on Two Y Streams in Yancey County

D. Line, J. Spooner
NC DOT
 \$16,648
 08/16/2008 - 08/15/2011

Highway construction in close proximity to trout streams is a concern in the mountains of North Carolina. This project is designed to monitor several water quality parameters upstream and downstream of highway construction on 2 mountain streams located in Yancey County. The monitoring will begin prior to the start of construction and continue for about three years until the highway project (NC 19) is complete.

Improved Technology for Enhancing Production Efficiency and Environmental Sustainability of Warmwater Fish Culture

H. Daniels, T. Losordo
USDA
 \$56,296
 8/28/2008 - 07/14/2010

Growth of warmwater fish culture in North Carolina has slowed over the last several years. This is due in part to the relatively high production costs, which limits sale of fish to higher-value white tablecloth restaurants and ethnic markets. Hybrid Striped Bass (HSB) in particular have high production costs, use high volumes of water, and also have notoriously lower feed efficiency relative to other established cultivars. Additionally, effluents from HSB farms are a cause of concern among the citizenry and environmental regulators. Our goal is improve the production efficiency of the North Carolina warmwater fish culture industry through a better understanding of the fundamental mechanisms controlling growth and feed intake, and to establish methods to improve production efficiency and environmental sustainability of HSB and recirculating systems.

Reducing Stormwater Flows and Pollution from Ocean Outfalls at Kure Beach, NC Using Dune Infiltration Systems

M. Burchell, W. Hunt, G. Chescheir
 NC Dept. of Trans.
 \$129,475
 08/16/2008 - 08/15/2009

Based on the initial success of the Dune Infiltration Systems installed at L and M avenue, the Town of Kure Beach, through a continued effort to update its stormwater infrastructure and improve the safety of its beaches, has pledged its support for another system to be installed in the dunes near K avenue. This system will be a somewhat different and more challenging design than the systems installed previously. The design will divert inflow from 3 outfalls near K avenue into a single DIS approximately the size of the system at M avenue. Combining outfalls into one system will require avoidance of subsurface infrastructure (i.e. sewers, water lines, etc.) more so than at the L and M avenue sites. Enhancement of at least one outfall (K avenue) will be required to ensure safety to the new DIS during high rainfall events. NCSU Department of Biological and Agricultural Engineering requests support from NCDOT for the final design, construction costs, and construction oversight for a new DIS near the Kure Beach Fishing Pier at K avenue. This system will serve as a stormwater retrofit for NCDOT in a sensitive environmental area, treating stormwater runoff from US 421, as well as from nearby residential and commercial areas. In addition, support of monitoring and research on this new system and continued support of monitoring the new systems at L and M avenue, which also receive a portion of stormwater from US 421, is requested. Runoff from approximately 1800 ft of US 421 will be addressed with all three of these systems.

Evaluating the Existence of the First Flush Phenomenon for Pathogens

B. Hunt
 EPA (NC DENR)
 \$31,568
 07/15/2008 - 09/30/2010

This research project will involve monitoring 1 urban watershed in either Raleigh or Durham to evaluate the first flush phenomenon for pathogens. These two municipalities have been selected due, in part, to their proximity to N.C. State. This will reduce travel costs and increase quality control. Specifically, E. coli will be evaluated, as it is suggested by the EPA as the best indicator bacteria for pathogenic pollution in fresh waters and is being adopted in many places as such. Multiple flow weighted samples (8 ? 12, depending on storm size) will be taken throughout the course of a storm event and deposited into separate sample bottles. These samples will be analyzed and evaluated to determine if, in fact, the majority of the pathogenic pollution that was generated from the storm occurred within the first flush depth of 1 inch (as established in these municipalities by the State of North Carolina). Ten storm events will be targeted for this study to provide an adequate data set for statistical analysis. Analysis will also be performed to determine if grab samples of each storm event would have resulted in similar results regarding pollutant loadings generated from the target watershed. These data will also be evaluated to determine what portion of the pathogens generated from the watershed would be captured using the first flush as the design criteria for a hypothetical stormwater BMP.

Growing Duckweed on Swine Wastewater for Ethanol Production

A. Stomp, J. Cheng, K. Zering
 Biofuels Center of North Carolina
 \$74,233
 06/25/2008 - 07/01/2009

The Goal of this one-year proposal is to evaluate the feasibility of ethanol production using duckweed biomass as the carbohydrate source. The Objectives are: (1) Create a scaled up version of the duckweed cropping system to finalize cropping management protocols and biomass harvesting; (2) Develop procedure for biomass post-harvest handling to produce dry duckweed with stabilized carbohydrate; (3) Determine ethanol yield from dry duckweed biomass at pilot plant scale; and (4) Perform an economic analysis of the overall process.

Production of Biofuels from Waste Gas Streams using Textiles Coated with Microbial Catalysts

M. Chinn, M. Flickinger, A. Grunden, S. Peretti, K. Zering
 NC Biotechnology Center
 \$243,975
 07/01/2008 - 06/30/2010

Project objectives aim to improve the efficiency of converting synthesis gas into marketable fuels and increase the feasibility of thermochemical fuel production in a biorefinery and focus on: 1) Improving ethanol selectivity of effective autotrophic bacteria using growing and non-growing cultures; 2) Studying the physiology of aceticlastic methanogens for conversion of acetate byproducts to methane; 3) Designing and evaluating combined sequential cultures to enhance conversion process efficiency; 4) Examining the function of coating technology using select microbial catalysts to improve robustness and affect gas diffusion; 5) Developing carbon flux models describing the metabolic behavior of these select biocatalysts for use in future genetic and metabolic manipulation; and 6) Creating models that describe the economic characteristics and efficiency of the proposed conversion processes. It is anticipated that the information gained in this study that focuses on the microbially-catalyzed conversion of synthesis gas streams to biofuels will have broader applicability to the fermentation of other industrially generated waste gas streams and will therefore be of general benefit to the design of many types of gas waste conversion systems.

Calibration and Validation of DRAINMOD-N II as a Tool for Subsurface Drainage System Design in newly reclaimed Land In Egypt

R. Skaggs, M. Youssef
 USDA/US-Egypt Joint Board
 \$24,000
 09/01/2007 - 08/31/2009

The main goal of this joint proposal is to transfer and promote the use of DRAINMOD suite of models as a tool for the design of agricultural drainage systems in Egypt. The models will be calibrated and validated using two years of field measured data from a newly reclaimed, artificially-drained, experimental site located in South El Husseinia Plain. Calibrated models will be applied to design drainage systems for the newly reclaimed areas of South El Husseinia Plain that meet crop production needs, control soil salinity, and minimize the offsite delivery of nitrogen to Lake El-Manzalah. As part of this joint project, a DRAINMOD

workshop will be held to train researchers from the Drainage Research Institute (DRI) and possibly Engineers from the Egyptian Public Authority for Drainage Projects (EPADP) on how to use the model to design and evaluate the performance of drainage systems. The proposed collaboration should benefit EPADP, drainage contractors, and land owners. This is in addition to the overall benefit of conserving the water and land resources of Egypt.”

Sediments Newsletter

J. Spooner, R. McLaughlin, M. Markusic, D. Line, C. Smith

NC DENR

\$40,250

07/01/2008 - 05/01/2009

The Sedimentation Control Commission is charged to educate the regulated and design community, as well as the public, on recommended methods, regulations, current events, and instructional topics regarding erosion and sedimentation control. The Sediments newsletter is one aspect of such education and has been published quarterly since 1994. Current print and listserv subscribers number approximately 5400 individuals. This proposal requests funds to continue the publication and distribution of the Sediments newsletter in order to provide information to the regulated community and to facilitate communication among local erosion and sediment control programs.

Simmons Street (New Bern, NC) Stormwater Wetland Design. Construction, Supervision, and Monitoring

W. Hunt, K. Bass, C. Humphrey

NC DENR

\$355,344

05/01/2008 - 12/31/2011

A large stormwater wetland is to be designed and monitored for two years in New Bern, NC. In the submitters combined 20 years of experience, this is an outstanding project that would have a tremendous impact at a relatively low unit construction cost (\$1.7M treating over 700 acres of urbanized New Bern). This wetland, which would be the largest stormwater wetland in North Carolina, would have a surface area of approximately 27 acres. The wetland would be located within 1 mile of the Neuse River and would be expected to have a direct impact on the estuary's health. It is a unique project that NCSU strongly believes should be constructed. One important point is that the construction costs of the wetland would be expected to be much less than the \$28 per lb of N per year per acre removed. Perhaps as low as \$10 per lb less than the \$28 limit.³ It is one of the very few urban projects where this is case. NCSU proposes to design, supervise the construction of and monitor this stormwater wetland.

Water Management Project for Richmond Hill Park

J. Calabria, J. Spooner, K. Carter

Asheville, NC - Soil and Water Environmental Technology Center

\$24,750

04/01/2008 - 9/30/2008

NCSU will assist the City of Asheville with water quality projects, including: design and construction observation, as well as, post-construction monitoring and education. NCSU responsibilities for Richmond Hill Park Water Management

Project include designing a rain garden, preparing bid documents, construction oversight, preparing a planting plan, creation of informational signage, and the facilitation of a workshop potentially during construction or planting. All other work will be contracted out by the City of Asheville, including excavation, rain garden construction, material acquisition, planting, sign printing, and requesting construction bids.

Installation and Demonstration of Rainwater Harvest/Cistern Technology at the Pine Knoll Shores Aquarium

W. Hunt, J. Wright

NC DENR

\$35,000

02/01/2008 - 08/01/2008

Water conservation has grown in importance across North Carolina as much of the state has suffered under drought conditions. In addition to meeting water conservation needs, cisterns and other water harvesting systems have an important application in Low Impact Development as an innovative stormwater management practice. Last year, the North Carolina Aquariums educated over one million visitors. The Pine Knoll Shores Aquarium recently underwent a \$25 million renovation that tripled its size to 93,000 square feet. The remodeling brought nearly 40 new exhibits and many new programs making the aquarium a popular place for people to visit and an excellent opportunity for demonstrating LID practices. A water harvesting system totaling approximately 15,000 gallons will be installed at the Pine Knoll Shores Aquarium in Pine Knoll Shores, N.C. Five cisterns will be designed by NCSU-BAE faculty totaling 3,000 gallons each will be installed to harvest roof top runoff. NCSU-BAE faculty will supervise the cistern installation. The harvested water will then be filtered used to irrigate the landscaped displays in the aquarium. Educational sign will also be installed to describe water harvesting practices to visitors.

Enhancing Competitiveness of NC Biodiesel Producers through Value-Added Enzymatic Processing of Waste Glycerol and Low Value Oils

R. Sharma

UNC - General Administration

\$44,145

12/3/2007 - 6/30/08

NC biodiesel manufacturers face uncertain economic circumstances since the price of their primary raw material, virgin vegetable oil, has risen steadily in recent months. This situation is made worse by the sharp decline in the value of the primary byproduct of biodiesel manufacture, glycerol, driven by increasing worldwide biodiesel production. Researchers at NCSU (NCSU) have recently achieved commercially attractive conversion rates of glycerol into glycerol carbonate from an enzyme system. Glycerol carbonate is a versatile - platform - chemical used in the production of polymers and fine chemicals, and has a market value twenty to thirty times that of crude glycerol. Commercial implementation requires a dramatic reduction in enzyme costs. Researchers from NCSU propose to demonstrate the glycerol conversion technology at the small pilot scale using an inexpensive whole cell immobilization technique that eliminates enzyme purification costs by “displaying” the enzymes on the immobilized cell's surface, much like a porcupine's quills, using the whole porcupine rather than

extracting the individual quills. Field-testing at one NC biodiesel production facility will follow the pilot demonstration. Given NC biodiesel production levels forecast by industry observers for 2008 and beyond, commercial implementation of this process could represent an increase in biodiesel profitability in excess of 60 cents per gallon, or more than \$30 million per year.

Development of Training Materials and Workshops for the Interlocking Concrete Pavement Institute

W. Hunt, M. Jones

Interlocking Concrete Pavement Institute

\$30,000

02/28/08 - 05/28/09

The following is in response to a request from ICPI to develop a comprehensive outreach and training program that demonstrates the effectiveness of permeable interlocking concrete pavement (PICP) at meeting stormwater management water quality regulatory requirements and related resource protection issues. This effort will demonstrate the effectiveness and potential for using PICP to meet community environmental regulations and economic requirements. The end-products will provide the industry with tools and information to facilitate the PICP use in the design, construction and regulatory sectors. This will be supported by providing economic and environmental information in easily understood, readily adaptable and transferable formats. The program is divided into two broad areas: Fact Sheets and Presentations: A series of printed fact sheets and PowerPoint presentations will address the information needs of industry, regulatory, municipal and elected officials, as well as builder/developers. Training Program: On-line, web-cast and seminar presentations that can be used by industry for internal use and to educate the public, stakeholders, regulatory officials, municipal and elected officials about PICP benefits. This effort will include printed training and education materials to accompany these presentations.

Beaverdam Creek Watershed Monitoring

G. Jennings, J. Zink, G. Price

Charlotte-Mecklenburg Storm Water Services

\$236,705

02/27/08 to 12/31/12

Faculty, staff, and students associated with the North Carolina State University (NCSU) Department of Biological and Agricultural Engineering will work with the City of Charlotte Stormwater Services to monitor stream conditions within the Beaverdam Creek watershed in Charlotte, North Carolina. The monitoring will entail annual assessments of stream channel stability and benthic macroinvertebrate communities.

Conservation Reserve Enhancement Program (CREP) Riparian Buffer Monitoring

M. Burchell, D. Osmond, C. Moorman, D. Line, M.

Youssef, O. Duckworth, R. Huffman, J. Spooner, D. Penrose, G. Grabow, K. Hall

NC DENR

\$719,102

01/01/2008 - 12/31/2010

High priority has been placed on protecting riparian buffers based on prior research that indicate that buffers are generally effective in reducing nutrient and sediment inputs to streams from upland sources, such as agriculture. Because

of their effectiveness and sustainability, the N.C. Conservation Reserve Enhancement Program (CREP) intended to provide landowner incentives to establish these buffers to improve water quality and habitat in four targeted watersheds (Chowan, Neuse, and Tar-Pamlico River Basins, and the Jordan Lake watershed). Much is currently known about treatment of pollutants through buffers, and for the most part, we understand how to implement them to achieve some level of water quality benefit. However, with the economic implications of removing lands from agricultural production or from development in the name of water quality protection, it is of utmost importance that we strive to implement these systems properly with an improved understanding of such elements as width, hydrology, and soils.

NCSU Support for the Appalachia/Southeastern Regional Water Quality Assistance Network

G. Jennings, W. Hunt

UNC - UNC Chapel Hill/EPA

\$150,000

10/1/2007 - 9/30/2009

North Carolina State University faculty in the Department of Biological and Agricultural Engineering (BAE) will work with EPA, the Environmental Finance Center for EPA Region 4 (EFC), Southeast Watershed Forum (SEWF), and Auburn University to build a Regional Water Quality Assistance Network to help local watershed organizations and communities protect, maintain and restore water quality.

New Technologies to Improve the Energy Efficiency In Flue-Cured Tobacco)

M. Boyette, G. Ellington

TERC

\$85,000

01/01/2008 -12/31/2008

Two full-size ten-box barns, which are capable of curing up to 30,000 pounds of green tobacco each in a regular 6-7 day curing schedule. The barns employ a common wall design that saves approximately 50% of the pad space as well as reducing the cost of the barn. The barns have approximately 3 times the insulation of the best commercially available barns. Each barn is equipped with a 15 hp Aero-Vent direct-drive bladed fan capable of moving 20,000 cfm at 1.75 inches of water pressure. Heat for the barn is provided by a wood-fired Taylor Water Stove rated at ½ million Btu/hr. The instrumentation designed into these barns allows us to collect the following data on a continuing basis: weight of the tobacco, the electrical power consumed, the heat required, wet and dry bulb temperatures, air pressure over and under the tobacco and air flow through the curing tobacco. We intend to address during the 2008 season: A rapid and accurate tobacco ordering system to re-introduce moisture into the cured leaf at the end of the cure is essential the economic use of barns and the production of a quality product. A reduction of electrical energy by the use of a variable speed fan which has been shown to reduce electrical use during the cure by as much as 30%. This technology is available but needs to be adapted to curing barns. Establishing the correct location for dry and wet bulb sensors has proven problematic for automatic curing systems. We intend to investigate the correct placement of these sensors. As farms expand and the price of equipment falls, wireless communication systems for control and alarm of curing barns are becoming an item desired by many growers. We intend to investigate the systems on the market with an aim of identifying those best suited for different situations.

Robeson Creek Watershed Restoration Project

K. Hall, D. Line, C. Perrin, J. Spooner, G. Jennings, B. Doll, W. Hunt, G. Grabow, K. Bass, D. Jones, G. Putnam, J. Blackwell, D. Penrose
 NC DENR
 \$470,000
 01/01/2008 - 11/30/2010

The Robeson Creek Watershed is impaired for Total Phosphorus, Habitat Degradation, and Aquatic Weeds. Through this project, multiple BMPs are proposed for implementation throughout the watershed at targeted locations to address these impairments. Both urban and agricultural BMPs will be implemented throughout the watershed in critical areas determined by the TMDL Implementation Plan. Because this is a rapidly developing watershed, low impact development and stormwater ordinance education of local government and builders as well as an LID demonstration site is proposed to help stakeholders understand and prevent further degradation and actually work to improve stream health. Using the existing TMDL Implementation Plan, a watershed plan for Robeson Creek will be developed to assist stakeholders in making decisions about water quality measures. Monitoring for water quality and aquatic habitat will determine effectiveness of BMPs. Community involvement as well as technical guidance from the RCWC is paramount in removing this watershed from the 303(d) list. Therefore, the current educational campaign will be continued with quarterly stakeholder meetings, tours, workshops, newsletters, and informational signs at each BMP location.

Characterizations of Particulate Matter Emitted from Egg Production Facilities: Sources versus Public Exposure

L. Wang, D. Beasley
 US Dept of Agriculture
 \$399,080
 01/01/2008 - 12/31/2009

While health effects of PM emitted from AFOs are of increasing interest, PM exposure estimates for most epidemiology studies and risk assessments are currently based upon EPA ambient air quality measurements, of which over 90 percent are taken in urban areas. Lack of information about the linkage of AFO PM emissions and possible public exposure had caused some bias or inaccuracies in studies of health effects or risk assessment associated with AFO PM, which ultimately misled public concept towards AFO industry. The ultimate goal of this project is to establish basic understanding of the relationships between mass and characteristics of particulate matter (PM) including both PM_{2.5} and PM_{10-2.5} at the emission sources and at the property lines of egg production facilities.

Watershed Impact of Stormwater Bioretention and Bioinfiltration BMPs: Field Testing In North Carolina

W. Hunt
 Cooperative Institute for Coastal and Estuarine Environmental Technology - Villanova Univ.
 \$150,660
 09/01/2007 - 08/31/2010

The proposed research focuses on making science based recommendations for the design and performance of LID Bioretention and Bioinfiltration best management practices (BMPs) to both understand and optimize their use as a stormwater control measure at the watershed scale. The

NCSU project investigator (Dr. William F. Hunt) is part of a research team headed by Villanova University Professor Dr. Robert G. Traver Stormwater Best Management Practice (BMP) concepts of Bioretention and Bioinfiltration concentrate on the removal of volume from the runoff to reduce negative stormwater impacts from development and changing land use. These control measures directly address recharge, water quality, increased volume, peak delay and peak flow issues. These control measures are unique in that they are most effective when spread over the landscape in an LID setting, contrasting to past practices of larger control technologies at the bottom of the watershed. Specifically, this proposal is to: “ review current and past research, to both better understand the science and to select preferred design criteria’s ; establish a standard monitoring protocol for the three universities to facilitate performance comparison (QA/QC) .;perform field and laboratory experiments to confirm the hypothesis. @ NC State ; Select and monitor four existing bioretention BMPs for water quality, quantity, and peak flow performance. Measure post-construction in-situ soil infiltration rates. & examine the performance from a LID perspective. Specifically, how close does a site properly fitted with bioretention facilities approach that of an undeveloped site from a hydrologic and water quality perspective?

Design, Construction Supervision, and Preparation for Monitoring of a Stormwater Wetland at the old NC Armory on 18 Bypass City of Lenoir, NC

W. Hunt, J. Hathaway, K. Bass
 Clean Water Management Trust Fund
 \$62,500
 11/15/2007-10/31/2009

The North Carolina Clean Water Management Trust Fund (CWMTF) has allocated money to construct 3- to 4-acre stormwater wetland at the former NC Armory Site on NC 18 Bypass in the City of Lenoir. NCSU- BAE has agreed to provide design, permitting and construction oversight services to the City for this project, with the ultimate intent of NCSU monitoring this large stormwater wetland as part of the CWMTF’s requirements for this project.

Demonstration & Evaluation of Effective Level Spreader Designs

W. Hunt, D. Osmond, J. Hathaway
 EPA
 \$99,974
 08/2007 - 4/2010

Since 1998, level spreaders have been installed throughout the Neuse River watershed. Since then, their use has spread to adjoining basins (Tar-Pamlico, Jordan Lake) and to other parts of the state (Catawba). A conservative estimate of the number of level spreaders in Wake County alone is 200. The goal of this project is to demonstrate and evaluate four level spreaders at two locations in either Wake or Franklin County. This would be the first field monitoring project of level spreaders in urban areas in NC. Both surface water and ground water samples will be collected. During the grant, level spreader design guidance fact sheet will be produced and 3 level spreader design workshops/field tours will be conducted. With 100’s of level spreaders being installed in NC and so many of these level spreaders failing, it is critically important that effective design, construction, and maintenance standards be developed.

Effects of Minor Drainage on Hydrology of Forested Wetlands

W. Skaggs
USDA Forest Service
 \$50,000
 09/2007 - 02/2009

Drainage for silvicultural production is a common practice in the poorly drained soils of the south and southeast. In many cases the lands affected by the practice are jurisdictional wetlands. In such cases “minor drainage” sufficient to provide access to the lands for forest operations without damaging the soil and water resources is an accepted practice. Drainage is normally provided by a system of relatively shallow (2 to 4 feet deep) field ditches which empty into collector and main canals. It is assumed that such minor drainage can be accomplished without changing the wetland hydrologic status of the forested lands. The purpose of this study is to evaluate the effects of minor drainage on wetland hydrology and to establish guidelines for reducing impacts on jurisdictional wetlands. The water management model DRAINMOD will be used to analyze effects of various intensities of subsurface drainage on wetland hydrologic status in forested lands.

Innovative Drainage Water Management In North Carolina

W. Skaggs, M. Youssef, C. Crozier, D. Osmond
USDA
 \$190,887
 09/2007-9/2010

This project will develop and implement a web-based system for encouraging and assisting users in the proper application of drainage water management in the North Carolina Coastal Plain. A web-based system will be developed and implemented on a pilot scale with 12 farmers in at 6 Coastal Plain counties. The system will provide crop, soil and location sensitive advice and reminders on management of the control structures. DRAINMOD simulations to evaluate soil water status and provide guidance on managing the structures based on weather conditions will be conducted and updated monthly through the year and more frequently during the growing season. Three sites will be developed to demonstrate the proper application of drainage water management and to assess its effectiveness in terms of crop yield, water conservation and nitrogen and phosphorus loads to surface waters.

Demonstration & Monitoring of Rainwater Harvesting/Cistern Technology in North Carolina

W. Hunt, J. Wright
EPA (NCDENR)
 \$109,914
 9/2007 - 5/2010

In addition to meeting water conservation needs, cisterns and other water harvesting systems have an important application in Low Impact Development as an innovative stormwater management practice. Rainwater Harvesting systems (cisterns) will be installed throughout the state of NC in the following counties: Craven, Cumberland, Guilford, and Watauga. Various applications will be demonstrated including above ground and in-ground systems and a small water-harvesting pond. Planned uses for the captured stormwater include washing emergency vehicles at a firehouse, irrigating landscapes, irrigating gardens, and washing farm equipment. Both urban (primarily) and agricultural examples will be demonstrated. A high and low irrigation schedule

will be examined to evaluate the amount of stormwater harvested under traditional water conservation compared to a more aggressive irrigation schedule. Five water harvesting workshops will be conducted state-wide to teach stormwater officials, developers, engineers, and other design professionals how to site, design, and install water harvesting systems. System evaluation will lead to the design recommendations to be incorporated into the State of NC’s new Stormwater BMP Design Manual.

LID Feasibility, Design and Implementation at Cape Lookout National Seashore

W. Hunt, J. Wright, R. Smith
NC Coastal Federation
 \$45,484
 8/2007 - 11/2008

The grounds surrounding the Core Sound Waterfowl Museum and the Visitors’ Center of the Cape Lookout National Seashore provide little stormwater runoff treatment as they are currently configured. As both facilities are immediately adjacent to Core Sound and Back Sound, any pollutants that fall on the grounds, particularly on impermeable surfaces, can easily migrate to sensitive waters. Also, as thousands of visitors pass through the National Park Service property each year, there is a tremendous opportunity to demonstrate practices to reduce the amount of runoff, and its associated pollutants, entering the sounds. One new “set of” techniques are those associated with Low Impact Development, or LID. LID uses small scale, on-site controls to replicate pre-development hydrology. These controls include bioretention areas (aka rain gardens), permeable pavement, wetland gardens, cisterns, and infiltration swales.

The New American House: A Low Impact Development Demonstration & Evaluation Project for Raleigh, NC

D. Line, J. Spooner, J. Blackwell, L. Szpir (Inactive)
NCDENR
 \$99,117
 10/2007 -9/2010

This project partners with the developer, New Southern Land Company, LLC / Szostak Design Inc., to build a 12 unit residential housing subdivision on Trailwood Drive, Raleigh, NC, using Low Impact Development (LID) principles and practices, and green building methods as outlined in The New American House Green Builder Program. The project will serve as a research and demonstration site for designing, constructing, building, maintaining, and evaluating LID. A paired watershed design will be employed to monitor stormwater runoff from the LID subdivision and from a nearby traditionally-built subdivision for comparison of runoff quantity (peak flow and volume) and quality (nutrients and sediment). Cost information will be collected from the LID subdivision. As part of The New American House Green Builder Program, the project will be one of the first private developments in the Triangle to adopt rigorous sustainable building guidelines. The houses will be resource and energy efficient, healthy to live in, and have lower maintenance requirements. Also, the houses will be built in a manner that protects the natural habitat, streams and other environmental features, and ensures proper disposal or recycling of waste during and after construction. Site tours will be given during the construction and post-construction phase of the project to educate building professionals, government staff and the general public on the research results of implementing and evaluating LID.

Barnes and Noble (Cary, NC) Innovative Wetpond Design and Construction Oversight

W. Hunt, R. Smith
 NCDENR
 \$75,648
 08/2007-08/2009

NCSU BAE designers would greatly increase the size of an existing pond and add wetland treatment to a large watershed in Cary (31 acres), containing a section of Walnut Street, part of the Cary Town Center complex and the adjacent Barnes and Noble Plaza. NCSU would subcontract the design of a dam required for the pond to Jewell Engineering Consultants. The innovative wetpond site is currently owned by the Town of Cary. There are 2 sanitary sewer lines on-site that must be protected from ponded water. Maintenance access roads will be constructed over the lines and will be bordered in some locations by wetland shelves. Other wetland zones will be incorporated around the perimeter of the wetpond. A large portion of the BMP surface area would be wetland along with portions of pond, making the BMP more of an extended detention wetland/wetpond hybrid.

A Rapid Assessment Tool for Determining Uniformity of Irrigation-Type Animal Waste Land Application Systems

G. Grabow, K. Shaffer
 NC Pork Council
 \$50,454
 07/2007-09/2009

The objective of this proposal is to develop a rapid uniformity assessment tool for irrigation-type land application equipment used in land application of swine waste. In order to accomplish this, several easily obtainable hydraulic measurements will be correlated to application uniformity. These measurements will include sprinkler or big gun operating pressure, sprinkler wetted diameter and lane (or sprinkler) spacing. Information will be gathered from three sources: previously done work that evaluated application uniformity in traveling guns and solid set sprinkler systems, controlled field trials at the Lake Wheeler Land Application and Demonstration Facility, and field trials at cooperating animal facilities. Several combinations of the factors measured will be correlated against uniformity as measured by the traditional catch can method. The measurements will be taken on traveling gun systems and stationary systems. The North Carolina Swine industry will benefit from the development of this tool through savings of time and human resources associated with measuring system uniformity by the catch can method. The catch can method is currently required as part of the 1217 guidance document, and is to be performed once every three years. If an alternate method, such as the one proposed, proves to be a good predictor of uniformity there is a strong possibility that the guidance may be changed to allow the easier method. The proposed method will also help determine if a system is operating correctly or is in need of maintenance or operational changes. An easily performed measurement of application uniformity will ensure that crops receiving animal waste receive nutrients uniformly, and that the environment is protected.

QAPP Review Assistance

J. Spooner, D. Line
 NCDENR
 \$25,000
 08/2007-09/2008

Federal 319 guidance requires that a Quality Assurance Project Plan (QAPP) be prepared for all projects that include collection of monitoring data. A QAPP is done to help assure that the procedures used in collecting, transporting and analyzing samples are of suitable quality for a variety of purposes. A total of over 40 projects have, or will be, contracted between FY 2003 and 2007 requiring QAPPs. The scope and purpose of these projects vary. Examples include, but are not limited to: “assessing the effectiveness of an innovative BMP” “assessing a watershed to determine sources and stressors of impairment” “determining whether to add or subtract a water body to the state’s 303(d) list” “collecting data for use in development of a watershed model and/or TMDL. The Division of Water Quality has insufficient staff to perform the reviews other than checking for completeness. While this is adequate for some projects, a much more thorough review is needed for others, particularly those where the data affects 303(d) listing. The purpose of this contract is for NCSU to provide assistance needed by the Division of Water Quality in reviewing QAPPs per federal guidance.

Effects of Highway Construction In Sedgefield Lakes and Kings Mill

D. Line, J. Spooner
 NCDOT
 \$34,400
 07/2007 - 12/31/08

The need to document, through water quality monitoring, water quality conditions before, during, and after highway construction is critical to assessing the long-term implications of highway construction. This is especially true where highway construction is occurring in close proximity to high quality water resources such as in the Sedgefield Lakes and King’s Mill communities. The objectives of this study are to 1) document the changes in the water quality of unnamed tributaries in the Sedgefield Lakes and Kings Mill watersheds as the construction is completed and the highway corridor is stabilized and to 2) evaluate, through statistical and other means, the monitoring data to determine if changes in water quality parameters are significant.

Putting LID on the “Big Box”: Integrating LID Technology on a Commercial Site

W. Hunt, D. Line
 EPA
 \$137,655
 06/2007-11/2009

Three Big Box developments will be monitored to determine the impact of LID stormwater practice integration on commercial sites. All three sites are proposed to be at Wal-Mart locations. Wal-Mart Stores, Inc. has agreed to host the study. The first site will be an old Wal-Mart property that had no stormwater measures installed. The second property will be a newer store that includes traditional stormwater treatment such as a wet pond or dry pond; the third property will integrate LID stormwater practices throughout (bioretention, water reuse, and a small green roof). The locations for all three properties will need to be determined at a later time, but Wal-Mart has assured NCSU that approximately 5 stores

are opened in North Carolina each year. NCSU will assist Wal-Mart engineering design consultants in the design and integration of the LID practices. In addition to comparing the overall function of the LID site to more traditional treatment and non-treatment, the effectiveness of individual stormwater BMPs will be tested. At least 4 bioretention areas will be installed, two of which will be monitored to determine either the impact fill soil selection or vegetative cover type on water quality improvement. Also, the water reuse system will be evaluated.

Synthesizing and Extending Lessons Learned from the 13 CREES-CEAP Watersheds

D. Osmond, G. Jennings, D. Line, J. Spooner
 USDA
 \$600,000
 09/01/2007- 8/31/2011

The project, to evaluate and assess 13 CSREES Conservation Effects Assessment Projects (CEAP), will be conducted by a diverse, interdisciplinary, and experienced team of investigators with a proven record of assessment of the effects of conservation practices on water quality. Project personnel for this proposal were carefully selected to include geographic distribution, diverse subject matter expertise, watershed assessment capability and experience, and impartiality, with over 150 years of combined experience. The methodology developed for this assessment relies on a series of nested, science-based strategies to evaluate the effects of the conservation practices used in the 13 CREES-CEAP projects.

Research of Hydrologic and Water Quality Performance of 4 Linear Wetlands In Eastern NC and House Creek Watershed Interchange Retrofits

W. Hunt, J. Hathaway, J. Wright
 \$189,384
 03/2007-06/2009

The project is comprised of 4 objectives: (1) evaluating four roadside linear stormwater treatment wetlands in eastern NC, (2) evaluating highway interchange retrofits located in the House Creek watershed in Raleigh, NC, (3) conducting a BMP design training, and (4) conveying information gained from the first two objectives at two national/international conferences. The North Carolina Department of Transportation (NC DOT) is charged by an agreement with the North Carolina Department of Environment and Natural Resources (NC DENR) to treat stormwater runoff from NC DOT facilities across North Carolina. One heretofore unaccounted treatment is hundreds of miles of right-of-way linear wetlands in eastern North Carolina. It is possible that these serendipitous practices are improving runoff quality along these highways. If so, an assessment of their performance is needed. As part of the larger House Creek study in Raleigh, NC, part of which is sponsored by the NC Ecosystem Enhancement Program (EEP), NC DOT has agreed to provide treatment within quadrants of the I-440/Wade Avenue interchange. These treatments include (1) amending the soil in one quadrant to make it more permeable and provide for more water storage and (2) incorporating detention within a series of quadrants. NCSU-BAE will conduct a two-phase research project. The first stage will be an analysis of pre-BMP installation hydrology and water quality. The first stage of the analysis is the portion of the project for which North Carolina State University's Department of Biological and Agricultural Engineering (NCSU-BAE) is requesting funding.

National Air Emissions Monitoring Study - Layer Operation in North Carolina

L. Wang
 Purdue University
 \$205,256
 02/2007-12/2009

This project is part of the National Air Emission Study (NAEMS) under EPA Air Complican Agreement for animal feeding operations. NAEMS is sponsored by the Agricultural Air Research Council (AARC). Purdue University is the lead institution or Independent Monitoring Contractor (IMC) as referred to by the Air Consent Agreement, and is subcontracting with principal investigators from several different universities across the United States. Dr. Lingjuan Wang is one of the identified principal investigators who will oversee a study site for layer operation in NC. Emissions from this layer site represent southeast layer operations.

Poultry and Livestock Air Quality Research Initiative

S. Shah
 USDA CSRS
 \$72,326
 07/2006 -06/2009

The Poultry and Livestock Air Quality Research and Education Initiative at NC State University, will foster growth of research programs in agricultural air quality that provide the basis for effective outreach programs and the development of educational programs for technology transfer. The initiative will emphasize research, teaching, and extension functions and is designed to accomplish several general goals in relation to agricultural air quality: 1. Foster scientific excellence in air quality research and education on an industry-wide basis 2. Enhance scientific understanding of urgent agricultural air quality problems affecting all sectors of the industries 3. Promote collaboration in air quality science and engineering among researchers and scientists from industries, governmental agencies and academia throughout the United States 4. Provide educational opportunities for students to acquire fundamental knowledge for developing careers in environmental air quality associated with poultry and livestock production 5. Increase competitiveness for other funding to solve the agricultural air quality problems in North Carolina and in the United States.

Flounder Farming in North Carolina: Developing Improved Strains and Enhancing Marketability For Economic Success

H. Daniels, T. Losordo, G. Wossink
 NCSU Sea Grant Program
 \$73,000
 04/2007 - 03/2009

Hybrid striped bass (HSB) production in ponds is a highly water-intensive operation. Current production practices require annual pond draining to harvest and move fish and avoid infestations by the parasitic yellow grub (Daniels 2005). These practices create large volumes of effluent at certain times of the year and have led to complaints by local residents about stream eutrophication and habitat degradation. Effluents released from the North Carolina HSB farms are slow-moving and drain into wide and shallow estuarine coastal creeks that empty into the Pamlico Sound' part of the nutrient sensitive Tar-Pamlico River Basin (sub basin No. 7).

Pilot Project for Value-added Product Development from Solid Waste Generated on Swine Farms

C. Williams, J. Rice, K. Creamer

USDA

\$376,988

8/4/2006 - 02/04/2009

The project includes five components: 1. Construction of Value-Added Processing Infrastructure. In the case of Super Soils, grinders and processors will be constructed on site; in the case of vermiculture, sheds and worm rows will be installed on the Little Creek Hog Farms. 2. Transfer of solids; produce value-added products. 3. Technical evaluation of the solids and process (in the case of vermiculture). 4. Delivery of products to buyers/users; collect feedback on market reception. 5. Economic assessment and delivery of results to producers, technology providers, and decision-makers.

NCTRC the Design Construction, Testing and Demonstration of Advanced Flue-Cured Barns

M. Boyette

Ag Foundation

\$107,000

NCTRC Mechanization and Curing with Wood

M. Boyette

Ag Foundation

\$130,000

Research on the enhanced energy efficiency of crop drying.

Post-harvest handling of Flu Cured Tobacco

M. Boyette

Ag Foundation

\$102,821

Research efforts for post-harvest handling of flu cured tobacco.

Reducing Bacterial Loads from Ocean Outfalls Using Dune Infiltration Systems

M. Burchell, W. Hunt

NCSU Water Resources Research Institute

\$42,322

03/01/2007-08/31/2009

Many coastal communities face the challenge of handling stormwater runoff with limited land area. Stormwater outfalls, common in many coastal towns, empty stormwater containing bacteria, nutrients, and other pollutants into the ocean, sounds, or estuaries. Pollutants discharged into these areas increase the potential for human contact, with bacteria and other pathogens being the primary concern. Local officials are contemplating larger scale implementation of this system. However, even though bacterial concentrations in the groundwater beneath the dunes have been well below state standards, the concentration at one of the two sites has begun an upward trend. The complex nature of the groundwater hydrology (as influenced by tides, a large permeable unsaturated zone (the dune system), and periodic stormwater dosing from this system) must be further investigated before these systems can be recommended for wider use. This pre-proposal seeks to address these concerns and WRRRI priority research area E2 (Urbanization Impacts on Water Quality / Coastal Stormwater Management) by continued monitoring of stormwater treatment volumes and bacterial

levels in the groundwater, with a more in-depth investigation of water table gradients, treatment flow paths and bacterial fate beneath the infiltration system.

French Broad Training Center

J. Calabri, K. Carter, J. Spoone, E. Caldwell

NC Division of Water Quality

\$93,962

01/01/2007- 12/31/2009

NCSU proposes the continuation of the Western North Carolina French Broad Training Center as a resource center for the French Broad Basin and other areas of Western North Carolina to continue to provide expertise and technical assistance for Low Impact Development and Sediment and Erosion Control strategies. In addition to serving as a regional resource, the project deliverables will include three educational workshops, four field tours, and two projects. The projects will be completed using external funding, including federal, local and state funding outside of EPA 319 for implementation and administration funding.

Conversion of Coastal Bermuda Grass into Bioethanol

J. Cheng, H. Jameel, R. Venditti

NC Biotechnology Center

\$249,988

01/01/2007- 04/30/2010

The ultimate goal of this proposed project is to develop an economically competitive ethanol production system based on the utilization of coastal Bermuda grass (CBG) (scientific name: *Cynodon dactylon*). The basic idea is to use genetically engineered cellulase enzymes to convert cellulose in CBG to fermentable sugars and to further ferment the sugars to ethanol. The project will lead to the development of a cost-effective technology for biofuel production from a lignocellulosic material. A multi-disciplinary research team with expertise in biological & agricultural engineering, wood & paper science, and enzyme biochemistry & fermentation from North Carolina State University (NCSU) and Novozymes North America, Inc. (Novozymes) will collaborate in the proposed research project.

Opportunities for Biofuel Feedstock at the Neuse River Wastewater Treatment Plant

J. Classen, R. Sharma, M. Chinn, K. Zering

WRRRI

\$22,407

04/01/2006-12/2008

Bio-fuels production is a growing part of the larger bioprocessing sector of the economy and there exists the potential in North Carolina to contribute to the national supply of these fuels and / or to the production of appropriate feedstocks. Two main feedstocks for bioethanol production are corn and lignocellulosic biomass, both of which can be produced in large quantities in North Carolina. The Neuse River Wastewater Treatment Plant in Raleigh, North Carolina operates a large agricultural production enterprise for the disposal of biosolids and use of nutrients. The overall goal of this work is to provide information including pros and cons and recommendations to the Reuse Division Superintendent regarding how best to integrate the City of Raleigh's Neuse River Wastewater Treatment facility into bio-fuel production systems.

Microbial Characterization of the Treatment Zone in Swine Waste Lagoons

J. Classen, A. Grunden, L. Bull
NC Pork Council
 \$25,000
 07/01/2006- 12/31/2008

Simulated lagoon columns will be used to define the active lagoon treatment zone on top of the inactive sludge layer based upon microbial counts and identifications which will be correlated to measurement of various components of solids in the lagoon. In-field verification will include the same microbial and solids analyses to assure laboratory results define the active lagoon treatment zone and top of the inactive sludge layer in the field.

Opportunities For Biofuel Feedstock at the Neuse River Wastewater Treatment Plant

J. Classen/R. Sharma/M.Chinn/K. Zering
WRRRI
 \$147,407
 01/01/2007- 12/31/2008

The Neuse River Wastewater Treatment Plant (NRWWTP) is an advanced treatment facility with a capacity to treat and discharge 60 million gallons per day (MGD) of municipal wastewater. Biosolids that contain significant plant nutrients are a byproduct of the plant that must be handled according to regulations designed to protect environmental resources. Application of this material as fertilizer on the 1,000 acres of farmland is one option for biosolids disposal but must be carefully monitored to avoid over-application of nutrients and metals. In the past, this farming operation has produced corn, soybeans and wheat for sale in local commodity markets

Design and Evaluation of Channelized Stream Restoration Alternatives in the Crisp Creek Watershed

Robert O Evans/ Garry L Grabow/ Michael R Burchell/ Kristopher L Bass/ Christy A Perrin
NC Department of Environment & Natural Resources
 \$266,724
 06/01/2006- 12/31/2008

The Departments of Biological and Agricultural Engineering (BAE) and Watershed Education for Communities and Local Officials (WECO) of North Carolina State University (NCSU) will work with the North Carolina Ecosystem Enhancement Program (NCEEP), to identify, design, construct, monitor and evaluate alternative restoration methodology for approximately 3,000 feet of channelized stream in the Crisp Creek Watershed. Crisp Creek is one of four sub-watersheds identified for stream, riparian buffer and wetlands restoration through the Local Watershed Planning (LWP) for Cataloging Unit 03020103 of the Tar Pamlico River Basin. Crisp Creek watershed is located in Edgecombe and Martin counties within the Mid-Tar River Sub-basin 03-03-03 and the USGS Cataloging Unit 03020103. It is a major tributary to the 303(d) listed Conetoe Creek and was determined by DWQ staff to be impaired in 2003.

North River Wetlands Restoration

G. Grabow, R. Evans, Shear
NC DENR
 \$804,232
 8/02-3/31/09

Approximately 200 acres of prior converted wetlands in Carteret County, NC were re-converted to wetlands in this project (Phase 1). In addition, the design for a subsequent restoration project of about 500 acres has been completed and construction is underway for Phase II of this wetlands project. In phase I, three restoration techniques were implemented and water quality and hydrologic modeling performed to assess differences in the techniques in their ability to restore the land to wetlands (jurisdictional criteria and other criteria).

Comparing Environmental Impacts and Agronomic Performance of a Subsurface Drip Irrigation System and a Traditional Spray System used for Land Application of Animal Waste

G. Grabow/R. Huffman/R. Maguire
NCSU Animal & Poultry Waste Management Center
 \$32,749
 07/01/2006-06/30/2009

New methods that reduce ammonia emissions and odor, and enhance agronomic value of treated wastewater need to be evaluated. One such method is application through a subsurface drip irrigation (SDI) system. The objectives of this study are 1) to evaluate the technical feasibility of applying animal (swine) wastewater through an SDI system, including operational requirements of an appropriate filtration system and comparison to traditional spray irrigation, and 2) to assess the beneficial environmental impact of an SDI system compared to the traditional method. In order to meet these objectives, a subsurface drip irrigation (SDI) system will be installed in North Carolina in a small field adjacent to a swine lagoon. Wastewater from the lagoon will be land applied through the SDI system. Wastewater will also be applied through a solid set sprinkler system (aluminum pipe with sprinklers on risers) to contrast with SDI impacts, and to contrast yields. Soil sampling will be performed prior to land application and at the end of the study period. Soil samples will be analyzed to infer movement of phosphorus (P). The analytes will be soluble P, Mehlich-3 P, and percent soil saturation with P. Soil water samplers will be installed and used to sample for total P and chloride. Ammonia volatilization will be characterized by surface sampling. Soil moisture sensors will be used to monitor wastewater movement from the drip lines.

National Center for Livestock and Poultry Environmental Stewardship

L. Bull, M. Williams and F. Humenik
US Department of Agriculture
 \$435,214
 July 1, 2005 – June 30, 2008

Build on the successes of the USDA Fund for Rural America supported National Center for Manure and Animal Waste Management and the membership-supported North Carolina State University Animal and Poultry Waste Management Center to provide for more effective national coordination for science-based research and education programs, to assure economically and environmentally sustainable animal agriculture. The achievement of this Objective will assist and support efforts by USDA (CSREES and ARS) both in research and extension/educational roles.

CAFO Permit Writer and Inspector Training

Rice, J.M., Grabow G.,
US Department of Agriculture
\$140,741
May 1, 2005 – Oct. 31, 2008

The National Center for Manure and Animal Waste Management at NCSU will assist EPA in delivering 10 training sessions for the course on “Technical Fundamentals of Concentrated Animal Feeding Operations for Permit Writers and Inspectors.” The National Center is to coordinate with individual state extension service programs to obtain the requisite leadership and participation. In each EPA region, two land-grant university specialists will be designated for training, to locate tour sites for on-farm visits by workshop participants, promote the project with individual state land-grant university specialists and to deliver follow-up training to state regulatory staff. Programming and travel funds will be provided to individual state regulatory agencies and staff to ensure participation in the training.

A National Learning Center for Animal Agricultural Water Quality Issues

F. Humenik
University of Nebraska-Lincoln
\$12,500
September 30, 2005 – August 31, 2009

The proposal will utilize proven approaches from recent successful national and regional initiatives in outreach education. This proposal directly targets the stated National Integrated Water Quality Program priorities of “disseminating the knowledge base available to agricultural, rural, communities” and “leading to science-based decision making ... that improves water quality”. It specifically addresses the NIWQP priority themes of (1) Animal Waste Management, (4) Nutrient Management, and (8) Water Policy. Specific to National Facilitation projects this grant will address the 2005 special emphasis of “explore and test compelling or persuasive communication techniques to enhance the effectiveness of science-base resource communication...”

Monitoring BMPs for Temperature Impacts in State Designated “Tr” Waters (524797)

W. Hunt, R. Smith
NC DENR
\$68,149
2/05-10/08

Stormwater Management Practices (SMPs) potentially increase temperature of stormwater which is detrimental to trout and other sensitive aquatic species. N.C. State campus faculty, field agents and grad students selected six BMPs (wetlands, wet ponds, and bioretention) to be evaluated during the field reconnaissance portion of the project. During the installation stage, temperature, rainfall, and stage/flow measurement and logging equipment at the 6 selected sites were installed. Data will be collected for 2 periods - late spring through mid fall 2005 and the again for the same period in 2006. Project cooperators include NC DENR and local governments.

Selection, Design and Installation, Monitoring, and Technical workshops of Innovative Stormwater Treatment Practices in the Neuse and Tar-Pamlico Basins

W. Hunt
NC DENR
\$128,938
01/07- 07/09

This proposal is a continuation of a project (FAS # 5-24544) funded by NC DENR’s Ecosystem Enhancement Program. The project focuses on stormwater treatment in the Neuse and Tar-Pamlico Basins. The Proposal is broken into 4 objectives: (1) Site Selection of Innovative Practices, (2) NCSU-led Design & Construction Supervision of Innovative Practices & Workshop Delivery, (3) Monitoring of 1 Practice and 500-acre watershed, with nested sub-watersheds, and (4) Biological Monitoring in the House Creek watershed.

Pathogenic Bacteria in Coastal Waters, BMP Model Development, and Grassed Bioretention Research

W. Hunt/J. Hathaway/J. Wright
NC DENR
\$69,029
02/01/2007- 09/30/2008

This proposal consists of 3 pieces:

(1) A study of pathogenic bacteria (enterococcus and fecal coliform) removal from 6 stormwater practices in New Hanover County. The data are expected to be used to assign pathogenic bacteria removal rates for stormwater wetlands, wet ponds, and bioretention. (2) Model development for green roofs, permeable pavement, and bioretention. All three models will be spreadsheet based and be made available to the general public (3) Evaluation of a turf covered bioretention cell in Alamance County. This will focus on TN, TP, and fecal coliform removal. It will be used to establish design criteria for grassed covered bioretention cells and assign removal TN and TP removal credit for them.

Community Conservation Manual Development and Training for NCDENR Division of Soil and Water Conservation Personnel

W. Hunt/J. Hathaway
NC DENR
\$67,088
02/01/2007- 01/31/09

With recent grant support for the Community Conservation Program, the NC DENR Division of Soil and Water Conservation (DSWC) is charged with installing 100’s of stormwater practices across the state of North Carolina. There is an important need to develop a stormwater management practice design manual and other training materials and to deliver the design, construction, and maintenance guidance to DSWC technicians. Biological and Agricultural Engineering (BAE) faculty propose to develop a design manual, other training guidance, and to deliver workshops for NC DENR DSWC. Additionally, inspection and maintenance guidance will be delivered (via workshops) by NC Cooperative Extension and BAE faculty.

Phase II: the Effect of Urban Stormwater BMPs on Runoff Temperature Impacts in Trout Sensitive Waters

W. Hunt
 NC DENR
 \$38,325
 12/01/2006- 10/31/2008

This proposal is an amendment to the currently funded NCDENR proposal # EW 05050 (NCSU ID # is 5-24797). Research conducted during the summer of 2005 and 2006 by BAE has provided some interesting results and also raised some new questions with regards to the ability of stormwater BMPs to reduce runoff temperatures. Monitoring results have indicated a wide variability in runoff temperatures depending upon time of year, time of day, storm characteristics, and other weather patterns. This variability makes it difficult to determine the thermal impact of a stormwater system with short term monitoring and encourages the use of a computer modeling approach for engineers and planners interested in the thermal impact of their development. Preliminary results indicate the possibility of modifying outlet structure design to reduce effluent temperatures from stormwater wetlands, wet ponds, and bioretention areas. With the continuation of monitoring studies and the development of a computer model, optimum outlet configurations could be prescribed for a variety of BMP designs.

Restoring the Burnt Mill Creek Watershed through Storm Water Management and Community Involvement

W. Hunt, M. Burchell
 NC DENR
 \$465,554
 11/04-10/08

BAE faculty are to design and construct six stormwater BMPs in the Burnt Mill Creek Watershed, to involve the community in identifying and constructing low-impact development retrofits (BMPs) on their own property, and to monitor the effectiveness of the constructed BMPs in ameliorating the impacts of urbanization in the watershed. The objectives of the project, as defined by local participants in the New Hanover Watershed Plan, are to improve in-stream habitat, reduce pollutant loads, reduce severity of residential flooding, and protect the safety of people who come into contact with Burnt Mill Creek. Cooperators include the Dept. of Agricultural and Resource Economics, the City of Wilmington, and Cape Fear River Watch.

The Southern Region Water Quality Coordination Project

G. Jennings, D.L. Osmond
 Texas A & M
 \$425,318
 09/15/04- 09/30/09

The North Carolina project leader will participate in regional coordination meetings and conferences in support of the Southern Region water quality program. The North Carolina project leader will also serve as the representative of the eight states in EPA Region 4 to the USDA CSREES Committee for Shared Leadership / Water Quality (CSL-WQ). In this role, the project leader will communicate local, regional, and national priorities and opportunities for enhanced water quality extension, research, and education. The North Carolina project leader will also provide leadership for planning the

annual USDA CSREES National Water Quality Conference. This responsibility provides national citizenship support for the CSL-WQ to facilitate water quality program information sharing and coordination efforts.

Monitoring of Stream, Wetland, and Buffer Restoration Projects

G. Jennings, D. Clinton, L. Rozzell, D. Penrose, D. Bidel-spach, B. Doll, K. Bass, J. Zink, K. Hall, J. Patterson, J. Spooner
 NC Department of Environment & Natural Resources
 \$554,685
 04/01/2006-03/31/2009

The Biological and Agricultural Engineering Department (BAE) of the North Carolina State University will work with the North Carolina Ecosystem Enhancement Program (NCEEP), to conduct a comprehensive monitoring program for stream, wetland, and buffer restoration projects designated by NCEEP. The purpose of the monitoring program is to evaluate the long-term success of restoration projects and to recommend maintenance actions to improve success.

Lick Creek Watershed Restoration Plan: NCSU Monitoring Component

D. Line/J. Spooner/D. Penrose/B. Culberson
 Upper Neuse River Basin Association
 \$43,000
 11/01/2006- 10/31/2008

The Lick Creek Watershed Restoration Plan will be a 3-year project to develop and commence implementation of a watershed restoration plan to address biological impairment in Lick Creek by improving water quality and habitat conditions. The NCSU Water Quality Group's part of the project is to conduct short-term (pre-intervention) and long-term (post-intervention) monitoring to assess changes in water quality and aquatic life in the watershed. This monitoring will include the collection of water samples for chemical analysis and macroinvertebrates for biological assessment of Lick Creek and its tributaries. These and other data will be used to recommend management strategies at the subwatershed level and to produce a Watershed Restoration Plan that identifies and prioritizes potential restoration projects

Monitoring Two Threatened Creeks in Chatham County

D. Line/ J. Blackwell/K. Hall/J. Spooner
 Haw River Assembly
 \$50,000
 12/15/2006- 03/31/2009

The Haw River Assembly seeks to address some of the water quality problems in its own backyard by targeting two threatened creeks, Dry Creek and Pokeberry Creek in Chatham County. These streams are part of the watershed of the Haw River arm of Jordan Lake, and will be included in the nutrient load reduction targets proposed by the NC Division of Water Quality under the Draft Jordan Lake Nutrient Management Strategy and TMDL. The purpose of this project is to conduct stormwater monitoring of sites on these two creeks to complement the visual stream assessments and macroinvertebrate counts of landowners along both creeks. The monitoring will involve measuring discharge as well as collecting flow-proportional samples during storm events to characterize pollutant loading in the streams.

Village Neighborhoods at Bray Park in Siler City LID Proposal

D. Line/J. Spooner

NC DENR

\$19,496

10/01/2005- 05/31/2009

A low impact development (LID) subdivision called Village Neighborhoods at Bray Park is being planned for a 22-acre tract of land in Siler City. Runoff from the site drains to Loves Creek which is an impaired stream and on the 303D list. The magnitude and quality of runoff from a portion of the site will be monitored and sampled using automated sampling equipment. Samples will be analyzed for nitrogen, phosphorus, and sediment. Storm event and annual export of nitrogen, phosphorus and sediment will be computed from the site and compared to export from conventionally developed sites and other LID sites to document the effectiveness of the developers in minimizing pollutant export.

Demonstrating and Evaluating Low Impact Development Techniques (Pacifica)

Daniel Line/Jean Spooner

NC DENR

\$63,800

10/1/2005-09/30/08

Urban runoff accentuated by rapid development has been identified as a contributor to the impairment of Bolin Creek and Little Creek, tributaries to Jordan Lake, impaired due to excess nutrients. This project measures the runoff and pollutant export from a small LID residential development. Bioretention areas, pervious pavement, grass swales, level spreaders, a riparian buffer, and a retention pond are integrated into the development to retain, slow, and treat stormwater from the site. Runoff and pollutant export are compared to pre-development monitoring data and from a comparable area that was developed conventionally.

Commercialization of Black Sea Bass (*Centropristis striata*) aquaculture: nursery, growout, and marketing

T. Losordo

UNC - UNC Wilmington

\$96,245

09/01/2006-07/31/2009

As part of a multi-institutional research proposal, UNC Wilmington will serve as the lead institution to NOAA Marine Aquaculture Program on a comprehensive study in the commercialization of the aquaculture of black sea bass (*Centropristis striata*). This proposal is being developed as part of the larger proposal to NOAA Sea Grant and will be conducted as a subcontract. The objectives of the studies to be conducted by NC State University are as follows: Objective 1. Demonstrate growout of hatchery-reared BSB in pilot commercial scale RAS in brackish water at an inland site. Objective 2. Reduce operational costs of RAS by demonstrating and evaluating new and innovative technology for RAS waste treatment and salt recovery.

Monitoring Restoration, Urban Stormwater and Best Management Practice (BMP) Projects

David Penrose/Karen Hall/Daniel Clinton/William Hunt

Clean Water Management Trust Fund

\$517,000

3/10/06-12/31/2009

A monitoring program is established on a subset of the NC Clean Water Management Trust Fund's stream restoration, stormwater and agricultural best management practices (BMP) projects. The program includes field evaluation, as well as more comprehensive monitoring on a subset of recently funded projects.

Taxonomy and Water Pollution Ecology of Aquatic Insects

D. Penrose/ J. Spooner/G. Jennings/Karen Hall

NC Department of Environment & Natural Resources

\$64,020

01/01/2006- 12/31/2008

The objective of this project is to illustrate the effectiveness of 319 watershed projects and various land-use practices on the aquatic ecology of stream systems. Concurrent with this effort, a workshop series will be developed that instructs individuals on the pollution ecology of aquatic insect larvae. These workshops also will instruct individuals on taxonomic identification and recognition of these organisms (EPT families primarily). Collection locations will be selected to correspond with 319 project sites or other watershed studies when possible.

Covered Lagoons for The Reduction of Odor and Ammonia Volatilization and Conservation and Processing of Nitrogen to A Value-added Product

J. Mark Rice/John J. Classen/David B Beasley/Lingjuan

Wang/Diana C. Rashash/Kelly D. Zering/Lynn Worley-Davis

NC Pork Council

\$25,000

07/06-06/08

A permeable cover that has been in place for five years on a one-acre swine waste lagoon will be evaluated to confirm that odor emissions are still low and ammonia volatilization has continued to decrease beyond the 80 percent measured about 8 months after cover installation. DEKKER Vacuum Technologies, Inc. is providing a unit to process lagoon liquid to a value-added ammonia solution. The economics of this covered lagoon system and value-added products obtained will be compared with the traditional uncovered lagoon-sprayfield system.

Litter Amendment and Improved Diet Impacts on Broiler Ammonia Emissions and Productivity

S. Shah, Grimes, P. Westerman

USDA CRS

\$499,754

01/06-12/08

High ammonia levels inside broiler houses can adversely affect broiler health while its release into the atmosphere through ventilation degrades air quality. This study will quantify the impact of litter treatment and improved diet on ammonia concentrations inside broiler houses, ammonia emissions as well as bird performance in a 2-year study. Ammonia emissions from broiler litter stockpiles as affected by the in-house treatment, type of storage (e.g., open vs. covered), and weather will also be quantified.

Switchgrass varieties as feedstock for bioethanol

R. Sharma
Ag Foundation
 \$39,940

This account is funded by the Ag Foundation to support a PhD student to conduct research on the potential of switchgrass for ethanol production. Various pretreatment methods are being investigated to degrade lignin and release sugars from three switchgrass germplasms developed by Dr. Joe Burns in Crop Science. Sample preparation and pretreatment conditions will be optimized to enhance subsequent enzyme hydrolysis and fermentation. It is expected that future funding from extramural sources will help study the impact of scale up on the results of this project.

Impacts of Fertilization on Water Quality in a Coastal Pine Plantation

R. Skaggs
Natl. Council for Air & Stream Improvement, Inc.
 \$67,900
 07/01/2006- 06/30/2009

The objective of this research is to evaluate the impacts of fertilization of a young regenerated and a mature recently thinned coastal pine plantation on downstream water quality and deliver the results to forest industries, land owners, researchers and regulators through various media including presentations and publications

DRAINMOD-NII Soils Correlations

R. Skaggs
USDA
 \$27,300
 08/01/2006-09/30/2008

This project will provide DRAINMOD-NII correlation necessary for temperature and soil dependent variables for specific temperature zones and soil types. Additional correlations will be accomplished as funds become available.

DRAINMOD-NII simulates the performance of agricultural drainage systems on soils with shallow water tables. Outputs include water table depth, drainage rates, surface runoff, ET, etc. on a continuous basis. A recent enhancement evaluates the loss of applied nitrogen fertilizers from drained lands. The DRAINMOD-NII technology will enable NRCS to develop alternative drainage design and management practices to reduce nutrient losses from artificially drained agricultural lands.

Nitrogen Fate and Transport Model Development and Application

M. Youssef, R. Skaggs
USDA Forest Service
 \$67,500
 09/08/2006-12/31/2010

To develop, field-test and apply a comprehensive hydrology and water quality model for simulating nitrogen dynamics in managed forested land in Southeastern USDA.

Enhancement and Application of DRAINMOD-NII for Predicting Nitrogen Losses from Drained Lands in Midwest U.S.

R. Skaggs/M. Youssef/G. Chescheir
EPA
 \$70,000
 10/01/2006-06/30/2009

This project will develop and enhance the application of a tool to predict effects of drainage design and management on nitrogen losses to surface waters in Midwest U.S. In a cooperative effort with researchers in Illinois, Indiana, Iowa, Minnesota, and Ohio, DRAINMOD-NII will be calibrated and tested using data sets from previous research on drained soils in each state. Other project outputs include documented input data sets and a trained group of DRAINMOD-NII users who will be able to analyze impacts of alternative drainage design and management scenarios on N losses from drained lands.

Low Impact Development for Stormwater Management Guidance for North Carolina

C. Perrin /Daniel Line/William Hunt/Jean Spooner/L. Steve Smutko/ Laura Szpir
NC DENR
 \$178,493
 1/1/06-12/31/08

The purpose of this project is to evaluate and incorporate results from current research on stormwater management into guidelines for implementing LID in North Carolina. These guidelines will be in the form of a manual which will help municipalities control stormwater through LID site planning and stormwater practices while meeting State stormwater regulations. Based upon research results, the guidelines will contain information on special design considerations for implementation of LID in the coastal, piedmont and mountain regions of the state.

Low Impact Development & Green Building Training Curriculum for North Carolina

K. Cone/J. Spooner/C. Perrin/W. Hunt/L. Rozzell, L. Szpir
(Inactive)
NC DENR
 \$99,908
 01/01/2007- 12/31/2009

As a follow-up to this manual, this project will develop LID training curriculum for three target audiences: 1) the building community (landscape architects, homebuilders, and developers); 2) local government staff (engineers, planners and code enforcers); and 3) homeowners associations. The curriculum will also incorporate guidelines developed under the NC HealthyBuilt Homes Program, which focus on energy and water efficiency, indoor air quality, and sustainable building materials and processes. The curriculum will be pilot tested via three coastal workshops organized by the UNC Coastal Studies Institute, and the final material will be made available as PowerPoint presentations for delivery by professional organizations, government agencies, or through web-based learning programs.

Phosphorus Recovery From Concentrated Wastewater With a Continuous-Flow Struvite Crystallizer

P. Westerman/ D. Rashash/ K. Zering
National Pork Board
 \$38,148
 05/01/2007- 04/30/2009

Environmental concern with phosphorus (P) transport in runoff or drainage is equally important as the concern with nitrogen regarding eutrophication or degradation of receiving waters. Numerous fields that have been receiving animal wastes have a high P index in soil-test samples, meaning the soil already has enough P to provide crop nutrients for several years; in some cases for the next 20 or more years. Removal of P from lagoons will have the most overall benefit for swine farms in North Carolina because of the large number of swine lagoons compared to dairy or poultry. Demonstration, evaluation and further development of the crystallizer on a commercial farm is important to help show the value of this process to farmers in North Carolina and other states, and help them be proactive in managing P. A cost analysis will also be conducted to include installation costs, operating costs, operating returns, and operating performance of the crystallizer, and potential avoided costs or benefits elsewhere on the farm.

Harvesting and Curing Mechanization for Modified Leaf Flue-Cured Tobacco

J. Young
Ag Foundation
 \$67,367

Not listed In 2008/2009 -17 proposals less than \$20,000 each which total \$189,304.

BIOLOGICAL AND AGRICULTURAL ENGINEERING FACULTY

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