AGREEMENT

This AGREEMENT ("Agreement") is made and entered into this _____ day of _____, 2009 between the CITY OF GAINESVILLE, a municipal corporation of the State of Florida ("CITY"), and the UNIVERSITY OF FLORIDA BOARD OF TRUSTEES, a public corporation of the State of Florida, ("CONTRACTOR").

WHEREAS, CITY, as the owner of a Municipal Separate Storm Sewer System (MS4), is charged with the responsibility of reducing its Total Maximum Daily Loads in accordance with load reduction allocations; and

WHEREAS, the CITY wishes to enter into a contractual arrangement with CONTRACTOR for assistance in the development of an MS4 Pollutant Load Reduction tool which will help the CITY to meet its Total Maximum Daily Load requirements; and

WHEREAS, the Florida Stormwater Association Educational Foundation ("FSAEF") was created to assist in expanding and improving education, training, and research for the stormwater management profession; and

WHEREAS, FSAEF wishes to facilitate the development of the MS4 Pollutant Load Reduction tool and by separate agreement has agreed to provide CITY with the funding for this Agreement.

NOW, therefore, CITY and CONTRACTOR hereby agree as follows:

I. SCOPE OF SERVICES

CONTRACTOR shall provide CITY with the services described in its project proposal entitled "Quantifying Pollutant Loads Associated with Particulate Matter and Stormwater Sediment Recovery through Current MS4 Source Control and Maintenance Practices," attached hereto as "Attachment I" and incorporated herein.

II. TERM AND RENEWAL

The effective date of this Agreement shall be the date this Agreement is fully executed. The term of this initial Agreement will continue for two (2) years. Upon satisfactory and faithful performance of this Contract by the CONTRACTOR, the CITY reserves the right, through negotiation with the CONTRACTOR, to extend the term of this Contract for one additional 12-month period.

III. COMPENSATION/PAYMENT

CONTRACTOR shall proceed for a not to exceed amount of $185,331.00. CONTRACTOR shall be paid in equal quarterly installments subject to CITY's receipt of invoices and progress reports submitted in detail sufficient for a proper pre-audit and post-audit and

subject further to CITY'S prior receipt of funding from the FSAEF in an amount sufficient to pay each invoice.

IV.OWNERSHIP AND PUBLICATION OF MATERIALS

All work products, including but not limited to, spreadsheets, formulas, methodologies and reports, whether in electronic or in any other forms that were developed for this project shall become the property of the CITY. CITY recognizes that under CONTRACTOR policy, the results of CONTRACTOR Project must be publishable and agrees that Researchers engaged in Project shall be permitted to present at symposia, national, or regional professional meetings, and to publish in journals, theses or dissertations, or otherwise of their own choosing, methods and results of Project, provided, however, that CITY shall have been furnished copies of any proposed publication or presentation at least two (2) months in advance of the submission of such proposed publication or presentation to a journal, editor, or other third party. CITY shall have one (1) month, after receipt of said copies, to object to such proposed presentation or proposed publication because there is patentable subject matter and/or Confidential/Proprietary information which needs protection. In the event that CITY makes such objection, said Researcher(s) shall refrain from making such publication or presentation for a maximum of three (3) months from date of receipt of such objection in order for CITY to file patent application(s) with the United States Patent and Trademark Office and/or foreign patent office(s) directed to the patentable subject matter contained in the proposed publication or presentation.

V. RECORDS RETENTION

Records of costs incurred under terms of this Agreement shall be maintained and made available to the CITY upon request at all times during the period of this Agreement and for three years after final payment is made. Copies of these documents and records shall be furnished to the CITY upon request. Records of costs incurred include the CONTRACTOR's general accounting records and the project records, together with supporting documents and records of the CONTRACTOR and all subcontractors performing work on the project, and all other records of the CONTRACTOR and subcontractors considered necessary by the CITY for a proper audit of costs. Records which relate to any litigation, appeals or settlements of claims arising from this Agreement shall be kept and made available until a final disposition has been made of such litigation, appeals or claims.

VI. CONTACT PERSONS

The parties hereby designate the following persons to be contacted regarding the performance of this Agreement:

CITY	CONTRACTOR
Stewart Pearson, P.E. Engineering Manager City of Gainesville, Sta. 58 P.O. Box 490 Gainesville, FL 32602	Dr. John J. Sansalone, P.E. University of Florida Environmental Engineering Science Dept. 218 Black Hall Gainesville, FL 32611

VII. TERMINATION FOR CAUSE

If the CONTRACTOR fails to observe or perform or is guilty of a substantial violation of this Agreement, or in the event FSAEF fails to fund this Agreement or terminates its funding agreement with the City, then the CITY, after serving at least ten (10) days written notice to the CONTRACTOR of its intent to terminate, and if the default continues unremedied during the ten (10) day period, may terminate the Agreement without prejudice to any other rights or remedies it may have under this Agreement.

VIII. TERMINATION WITHOUT CAUSE

Either party may terminate this Agreement without cause upon 30 days prior written notice to the other party. In the event of termination, the CONTRACTOR will be compensated for services rendered up to and including the day of termination.

IX. INDEPENDENT CONTRACTOR

CONTRACTOR shall be considered an independent contractor and as such shall not be entitled to any right or benefit to which CITY employees are or may be entitled to by reason of employment. CONTRACTOR shall be solely responsible for the means, method, techniques, sequences, and procedures utilized by the CONTRACTOR in the full performance of this Agreement.

X. NO THIRD PARTY BENEFICIARIES

Nothing contained herein shall create any relationship, contractual or otherwise, with, or any rights in favor of, any third party.

XI. INDEMNIFICATION

CONTRACTOR assumes any and all risks of personal injury and property damage attributable to the negligent or wrongful acts or omissions of CONTRACTOR and the officers, employees, servants, and agents thereof. CONTRACTOR, as a state agency, warrants and represents that it is self-funded for liability insurance, both public and property, with such protection being applicable to CONTRACTOR's officers, employees, servants and agents while acting within the scope of their employment by CONTRACTOR. CONTRACTOR and CITY further agree that nothing contained herein shall be construed or interpreted as (1) denying to either party any remedy or defense available to such party under the laws of the State of Florida; (2) the consent of the State of Florida or its agents and

agencies to be sued; or (3) a waiver of sovereign immunity by either party beyond the waiver provided in Section 768.28, Florida Statutes (2008).

XII. TIMELINESS

The CITY and CONTRACTOR further agree time is of the essence and that work under this Agreement is required to be performed in an expeditious manner and with care reasonably expected of a consultant performing these duties.

XIII. SEVERABILITY AND NON-WAIVER

If any term, provision, covenant or condition of this Agreement, or the application thereof to any person, place or circumstance, shall be held by a court of competent jurisdiction to be invalid, unenforceable or void, the remainder of this Agreement and such term, provision, covenant or condition as applied to other persons, places and circumstances shall remain in full force and effect. Waiver or breach of any provision of this Agreement shall not be deemed to be a waiver of any other provision, and shall not be construed as a modification of the terms of this Agreement.

XIV. VENUE

In the event of any legal proceedings arising from or related to this Agreement, venue for such proceedings shall be in Alachua County, Florida.

XV. ENTIRE AGREEMENT

This Agreement, with Attachment I, constitutes the entire Agreement between the CITY and CONTRACTOR. Any modifications, amendments or alterations shall be in writing and executed by both parties prior to becoming effective.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement the day and year first written above.

CITY OF GAINESVILLE	CONTRACTOR
_____	_____
Russ Blackburn City Manager	Roslyn S. Heath Assistant Director of Research
WITNESS:	WITNESS:
_____	_____
Printed name: _____	Printed name: _____

_____
Approved as to Form and Legality

Attachment I

Quantifying Pollutant Loads Associated with Particulate Matter and Stormwater Sediment Recovery through Current MS4 Source Control and Maintenance Practices

Detailed Project Proposal Prepared for the

City of Gainesville, Florida

With Collaboration of Florida Stormwater Association Educational Foundation
Research Advisory Council
719 East Park Avenue
Tallahassee, FL 32301
850/561-0904

Dr. John J. Sansalone, P.E.
University of Florida
Environmental Engineering Science Department
218 Black Hall
Gainesville, Florida 32611
jsansal@ufl.edu

Research Advisory Council

Valerie Harwood, PhD

Robert Pitt, PhD, PE, DEE, DWRE

Ken Reckhow, PhD, PE

John Sansalone, PhD, PE

Martin Wanielista, PhD, PE

Quantifying Pollutant Loads Associated with Particulate Matter and Stormwater Sediment Recovery through Current MS4 Source Control and Maintenance Practices

Background and the 2007 UF-EES Report:

The development of Total Maximum Daily Loads (TMDL) and their associated allocations have been based on the implementation and quantification of large watershed-scale estimations or modeling evaluations of pollutant loads. Providing an accurate and precise assessment of an anticipated load reduction from stormwater program activities and BMPs is a very formidable task for an MS4. Because of the huge financial ramifications of meeting TMDL load reduction allocations, tools are needed to provide more scientifically accurate estimates of pollutant loads and load reductions by various BMPs. Additionally, an MS4 will "inventory" a potentially significant pollutant load within the MS4 drainage system which begins with source area pavement and ends at the point of discharge to the receiving system. Conceptually, a TMDL is easily understood. However, quantification of current stormwater loadings from an MS4 without knowledge of the individual hydrologic functional units (HFU) of the drainage system can either intentionally or otherwise miss important sources of pollutant loading, beginning with impervious pavement, drainage appurtenances such as catch basins, and BMPs resulting in very large uncertainty. While on an individual HFU-basis, for example a unit area of pavement or a single catch basin, the loads are small compared to a watershed-scale load, the number of these HFU of a specific type is very large for an MS4. As a result, most MS4s have potentially significant and non-stationary load inventories within these HFUs that require quantification and management (maintenance, cleaning, recovery). The recovery of these materials is rarely (if ever) defensibly quantified to illustrate the potential load reduction that may be carried out expeditiously by an MS4. Furthermore, in the absence of such management, these load sinks become potential acute and chronic pollutant load sources in which pollutants otherwise associated with a less mobile particulate phase are leached, becoming mobile soluble pollutant loads that most downstream BMPs are incapable of treating and retaining to a significant extent.

The 2007 report submitted to the Florida Stormwater Association (FSA) by the University of Florida's Department of Environmental Engineering Sciences (UF-EES) entitled "Assessing the Environmental Benefits of Selected Source Control and Maintenance Practices for MS4 Permits", demonstrated that pollutant load inventory analysis as a function of pollutant, land use and HFU is potentially viable. The UF-EES report examined over 100 published studies from around the world on pollutant load inventories and provided a statistical evaluation of the results. Since most of these studies were not undertaken for the purpose of quantifying pollutant load inventories (but did allow load inventories to be quantified) the methodologies were highly variable and in most studies there was very limited quality assurance and quality control. While the composite result statistical distributions from these previous studies provide current guidance and proof-of-concept, the distributions exhibited a much wider dispersion than if such studies were specific to Florida MS4s and drainage systems, as well as designed, implemented and analyzed using consistent and defensible methodologies. None the less, results of this ad-hoc study clearly pointed to development of a Florida-specific load assessment tool generating a smaller statistical distribution; with all Florida sites subject to a consistent process methodology that encompassed pollutant load sampling through statistical analysis and reporting.

The Proposal Framework:

The first task proposed is a review of the existing historical stormwater databases for Florida MS4s from the report files available through FDEP and peer-reviewed papers. Such a compilation and analysis will provide add to the foundation of the work that is proposed. As part of this compilation the investigators will work with Mr. Eric Livingston to examine the FDEP database in this topic area. The literature will be synthesized and summarized to provide an evolution of a Florida-based foundation from which this proposal is built. The most relevant and similar study to what is proposed herein for Florida is the 2003 Townsend study. Results from the Townsend study allowed DEP to revise its guidance on how street sweepings and stormwater sediments could be beneficially reused or disposed of in Class 3 landfills, thereby saving millions of dollars for Florida MS4s. However, the Townsend study did not examine nutrients, nutrient leaching, particle size distributions or sampling methodology.

Therefore, the proposed focus of this project builds upon and extends the existing Townsend study through a focus on nutrients (total nitrogen, TN and total phosphorus, TP), and leaching of nutrients associated with particulate matter (PM) or stormwater sediments that accumulate in BMPs such as catch basin inserts, street sweepers, and other source controls. This proposed project generates information for Florida MS4s that is currently not available and is needed since MS4s are faced with quantifying load reductions in Basin Management Action Plans to achieve TMDLs. In addition to a consistent sampling/analysis methodology proposed, the statistical (or probabilistic) analysis of results from Florida MS4 studies is the key component to any potential quantitative analysis of pollutant load reductions resulting from MS4 management/maintenance practices. However, the methods must be robust, representative and defensible. In order to obtain representative values of pollutant loading or reduction in this tabular loading framework (for example, phosphorus loadings in street sweepings from residential land use pavements) it is necessary for an MS4 to collect comparable results that will provide statistically significant numbers of samples. For example, samples obtained by the MS4s in a particular category (for example, total phosphorus loading in street sweepings from residential land use pavements) will be sufficient in number so that statistics such as the mean, median, standard deviation, quartiles and range levels such as a 95th or 5th percentile level with statistical significance using a non-parametric analysis. Results will be summarized as quantitative distributions in the form of box and whisker plots so that percentile levels of pollutant concentration could be determined by visual inspection, and also reported as a table of statistics as illustrated in Table 1 and Figure 1.

Statistic	COD	TP	Cu	Zn	Pb	Cr
Mean [mg/kg]	312.3	1.0E+05	72.3	1258.9	89.7	27.1
Median [mg/kg]	383.4	7.0E+04	25.6	1294.7	38.7	16.7
Std. Dev. [mg/kg]	170.9	1.0E+05	99.2	1025.3	164.1	50.3
CL (95%) [mg/kg]	212.1	3.5E+04	32.6	857.2	41.7	12.8
Minimum [mg/kg]	28.1	708.0	4.9	39.7	6.0	6.2
Maximum [mg/kg]	436.9	4.4E+05	398.4	2488.9	1060.0	398.4
# Samples	5	34	38	8	62	63

Table 1. Table 1 is a tabular summary of catch basin particulate matter constituent concentrations (across all land uses on a *dry weight* basis) for available datasets from across North America along with several European datasets. CL = Confidence Level

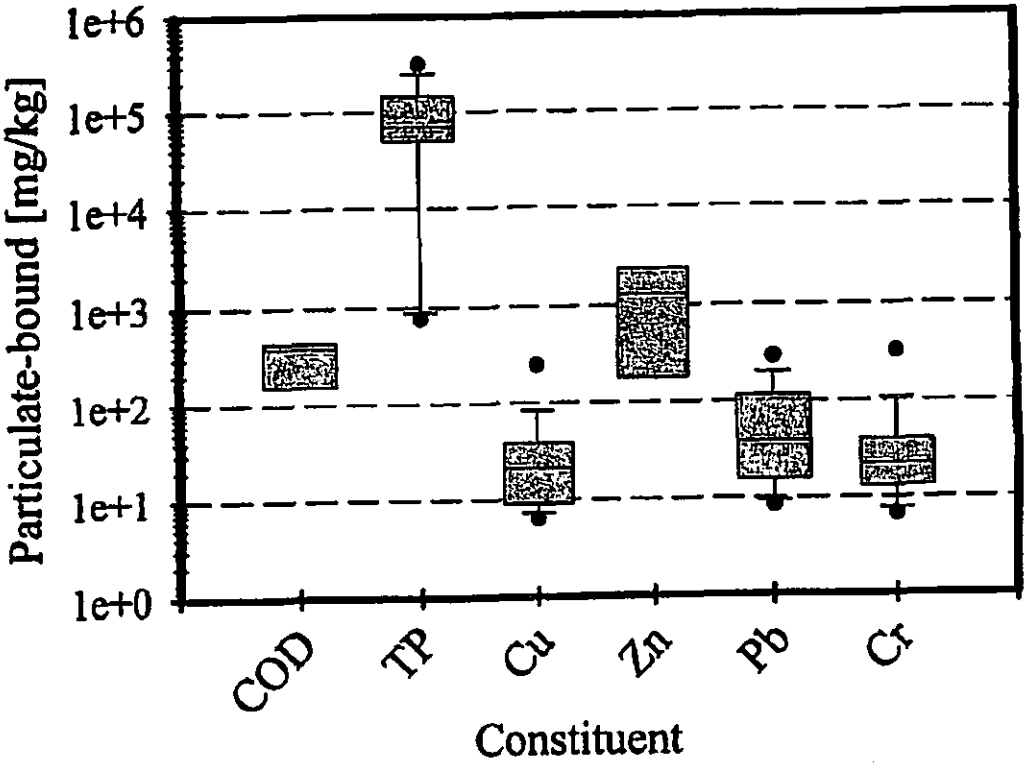

Figure 1. Figure 2 is a tabular summary of catch basin particulate matter constituent concentrations (across all land uses on a *dry weight* basis) for available datasets from across North America along with several European datasets.

This proposed study will require 13 to 14 representative Florida MS4 locations for a particular pollutant and HFU that provide, at least, pollutant concentration on a dry weight basis [mg/kg], total PM dry load in mg, and particle size distribution (PSD) of particulate matter (PM). Ideally, a probability distribution could be utilized with sufficient results for an MS4 to describe the distribution of resulting load values collected by the MS4 (for example, providing the ability to non-parametrically describe the phosphorus loading in street sweepings from residential land use pavements that may be described by a log-normal probability distribution if a much larger dataset were proposed). However, description through a probability distribution would require at least 30 representative values, a scope that is beyond the financial constraints and timely need of the proposed deliverables for Florida MS4s. It should be clearly recognized that success will entail multiple representative samples for the particular pollutant, land uses and MS4 drainage

system component so that sampling, analytical and statistical validity can be demonstrated. The ability for MS4s and FDEP to utilize non-parametric results from the proposed experimental matrix provides a tool and yardstick from which FDEP and MS4s can agree on the quantitative value of load reduction through common and existing MS4 maintenance practices.

This project will evaluate MS4 components including street sweeping, catch basins, and other BMPs. Other BMPs could include catch basin inserts, baffle boxes, filters or separation systems installed downstream of a catch basin or pavement drainage system. Sampling locations in MS4s will be selected based on the combination of pavement drainage, catch basins and existing BMPs in a specific MS4 drainage system. BMP load capture with the resulting pollutant enrichment or release from the BMP (possibly as a result of PM scour or leaching) are variable quantities and must be described on a statistical (non-parametric or distribution-free) or probabilistic basis. Given the uncontrolled variability of BMP loadings and BMP performance (in some cases negative) a single value of BMP performance or load capture does not represent reality; a statistical non-parametric or probabilistic approach is required. Such an approach represents realization by the MS4 that while much of their management of load recovery are reasonably deterministic (for example, phosphorus loading in street sweepings from residential land use pavements would include information on previous dry hours, equipment utilized, area cleaned, duration of cleaning, type of pavement, location, biogenic sources, pavement drainage, annual average daily traffic, dry weight of recovered material, etc.) that there will be variability even for the same BMP or land use location. However, a consistent, defensible and viable methodology will allow an accurate a-priori examination of this variability for a Florida MS4 to a much greater degree than an ad-hoc examination of load recovery variability without the benefit of such a methodology. Results can be quantified using simple mathematical relationships as a function of land use, MS4 drainage component or BMP (HFU), and specific solid-phase pollutant.

Cooperation and Guidance

Given the nature of this project, a formal "technical advisory committee" will not be used. However, the project's principal investigator, FSAEF staff and FSAEF leadership will remain in

close communication with staff of the FDEP Division of Environmental Assessment and Restoration, and all project participants throughout the duration of the project, especially at its initiation and other key milestones.

TASKS, DELIVERABLES and BUDGET

1. Sampling Methodology

A detailed sampling plan will be prepared that includes all required elements of a QAPP and which sets forth the specific procedures by which representative samples will be collected, preserved (if necessary) and TN and TP analyzed in accordance with DEP Standard Operating Procedures.

2. Schedule

Project start date: Upon Award approval

24-month project duration

3. Site Selection

13 to 14 Florida MS4s distributed around the state will participate in the project and carry out sampling/recovery and delivery of samples. At least three land uses and sediment capture BMPs will be included within each MS4.

1. Distribution of the MS4s to be sampled using a consistent methodology will include:
    a. Pensacola/Escambia County
    b. Tallahassee
    c. Jacksonville
    d. Gainesville (outside and inside residential reclaimed irrigation water areas)
    e. Orange County
    f. Orlando
    g. Tampa (outside and inside residential reclaimed irrigation STAR I areas)
    h. Sarasota County (outside and inside reclaimed irrigation water areas)
    i. Stuart
    j. Lee County
    k. Seminole County
    l. Miami-Dade County
    m. St. Petersburg/Pinellas County
    n. Hillsborough County

2. Three land uses per MS4:
    a. Highway (major or minor arterial)
    b. Residential
    c. Commercial/Retail

3. Three HFU or practices (with three representative locations of each HFU or practice):
    a. Pavement sweepings
    b. Residuals collected in catch basins downstream of swept/sampled (where possible) pavement areas
    c. A common MS4 BMP downstream of sampled catch basins or pavement drainage, which could include catch basin inserts, baffle boxes, filters, hydrodynamic separators. This BMP may vary depending on the common BMP in the MS4, but all BMPs will be solids-capturing BMPs with access to representative sampling.

4. **Samples**

All samples will be analyzed in accordance with the approved monitoring plan. Analytes will include:

1. Pollutants and indices:
    a. Total (associated with PM) and Leachable phosphorus [mg/kg] (associated with PM)
    b. Total (associated with PM) and Leachable nitrogen [mg/kg] (associated with PM)
    c. PM (a mass-based PSD; and solids mass as suspended sediment load for each sample)
    d. Inorganic/organic fractions by ignition (inferences for anthropogenic and biogenic)
    e. Water content and drainable water content
2. QA/QC replicate (10) sampling for one land use and HFU/practice at each MS4
3. Statistical analysis of datasets for all HFUs, land uses and MS4s
4. Granulometric-based analysis for all samples from one MS4 (17 PM sizes per sample)
5. Modeling of PM-based analysis (to provide a spreadsheet 2-parameter model)

5. **Deliverables:**

1. Draft and Final Project Reports to FSA, all Project participants, and FDEP
2. Two peer-reviewed archival manuscripts and a peer-reviewed manuscript to FWRJ
3. Two one-half day education seminars for stakeholders at FSA conference venue
4. One-day education seminar for operators on sampling/recovery at UF
5. Spreadsheet tools relating MS4 PM load and pollutant load recovery in FL MS4s.

6. Summary:

14 MS4s @ 3 land uses per MS4 @ 3 HFUs @ 3 representative locations = 378 separate samples (+ reclaimed area samples (3 x 3 x 9 = 81); and replicate samples (11 x 10 = 110), minimum representative dry mass of 4000 g/sample. Sampling and sample delivery carried out by each MS4 with location agreement by MS4 and PI. One MS4s will generate additional PSD sub-samples per sample to characterize TN and TP as a function of PSD.

7. Budget

$185,331 for 24 months.

- ✓ UF - $185,331 for Principal Investigator, post-doctoral researcher, PhD and undergraduate students; sampling oversight for MS4s; analytical and lab work; and, presentations, manuscripts, final report, seminars, travel, etc.

8. Deliverables

- ✓ 1 Project QAPP Document
- ✓ Approximately 400 to 500 samples
- ✓ 1 report
- ✓ 3 manuscripts
- ✓ 2 education seminars to FSA stakeholders
- ✓ 1 sampling seminar to operators
- ✓ 1 spreadsheet tool

FSA Educational Foundation
Research Advisory Council

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JOHN J. SANSALONE, Ph.D., P.E.

PROFESSIONAL PREPARATION

Christian Brothers University (Memphis, TN)	B.S.	Civil Engineering	1983
North Carolina State University	M.S.	Civil (Geotechnical) Engineering	1992
University of Cincinnati	Ph.D.	Environmental Engineering	1996

APPOINTMENTS

Aug. 2008 -	Professor	Environmental Engineering Sciences, University of Florida
Aug. 2002 – Aug. 2005	Associate Professor	Civil and Environmental Engineering, Louisiana State University
July 1998 – Aug. 2002	Assistant Professor	Civil and Environmental Engineering, Louisiana State University
June 1998, 2004, 2005	Visiting Professor	College of Engineering, University of Calabria, Cozensa, Italy
Jan. 1997 – July 1998	Research Asst. Prof.	Civil and Environmental Engineering, University of Cincinnati

PUBLICATIONS

1. Liu, D., Sansalone, J.J., and Cartledge, F.C., "Overall Rate Kinetics for Adsorption of Rainfall-Runoff Heavy Metals by Composite Oxide-Coated Polymeric Media", *J. of Environmental Engineering*, August 2005.
2. Liu, D., Sansalone, J.J., and Cartledge, F.C., "Bench-Scale Comparison of Storm Water Filter Media for Heavy Metal Capacity", *J. of Environmental Engineering*, August 2005.
3. Sansalone, J.J., Hird, J. P., Cartledge, F.C., and Tittlebaum, M.E., "Event-based Rainfall-Runoff Water Quality and Quantity Loadings from Elevated Urban Infrastructure Impacted by Transportation", *J. of Water Environment Research*, August, 2005.
4. Dean, C.M., Sansalone, J.J., Cartledge, F.K., and Pardue, J.H., "Influence of Hydrology on Storm Water Metal Element Speciation at the Upper End of the Urban Watershed", *ASCE J. of Environmental Engineering*, Vol. 131, No. 4, April 2005.
5. Sansalone, J.J and Cristina, C.M., "Gradation-Based Heavy Metal Mass Prediction Utilizing Granulometry of Urban Land Use Snowmelt Particulate Residuals", *ASCE J. of Environmental Engineering*, Vol. 130, No. 12, December 2004.
6. Mishra, S.K., Sansalone, J.J., and Singh, V.P., "A Partitioning Analog for Metal Elements in Urban Overland Flow Using the SCS-CN Concept", *ASCE J. of Environmental Engineering*, Vol. 130, No. 2, pp. 145-154, 2004.
7. Mishra, S.K., Sansalone, J.J., Glenn, D.W. and Singh, V.P., "PCN-Based Metal Partitioning in Urban Snowmelt, Rainfall-Runoff and River Flow Systems", *J. of American Water Resources Association*, Vol. 40, No. 5, October, 2004.
8. Sansalone, J.J. and Glenn, D.W., "Physical and Chemical Characteristics of Urban Roadway Snow Residuals Generated from Traffic Activities", *J. of Water, Air and Soil Pollution*, Vol. 148, (1-4), pp. 46-61, August 2003.
9. Mishra, S.K., Sansalone, J.J. and Singh, V.P., "Hysteresis-Based Analysis of Overland Metal Transport", *J. of Hydrologic Processes*, 17(8), pp. 1579-1606, 2003.
10. Glenn, D.W. and Sansalone J.J., "Accretion and partitioning of heavy metals associated with urban traffic activities in roadway snow – Part II", *ASCE J. of Environmental Engineering*, Vol. 128, No. 2, pp. 167-185, February 2002.

SYNERGISTIC ACTIVITIES

New Curricular Development

1. **Control and Treatment of Urban Storm Water:** (Graduate-Undergraduate) This course develops the knowledge of urban hydrologic processes, water quality aspects of urban storm water, unit operations and processes for storm water treatment and evaluation of treatment alternatives. A primary objective is the understanding of pollutant species and loads in rainfall runoff and snow melt and how this understanding can be used to design unit operations and processes for storm water.
2. **Experimental Methodology in Environmental and Hydrologic Engineering:** (Undergraduate) The course provides students the opportunity to participate, contribute and learn through direct involvement with research involving specific environmental and hydrologic engineering topics, typically as part of current research of particular interest to the student. Students participate in laboratory and field research experience with faculty, students and research associates. Participation includes experimental design, testing, operation, measurements and field methodology.

3. **Unit Operations Laboratory:** (Undergraduate) Course provided students with lab experience that develops understanding of physical, chemical and biological operations and processes commonly utilized in environmental engineering and science. A new laboratory was designed and built. New unit operations and process experiments were designed and fabricated as part of course development.
4. **Geo-Environmental Engineering:** (Undergraduate) Introduction to properties and engineering behavior of soil as a native earth material, an engineering material and an environmental medium subject to flux and transport of liquids and contaminants. Provide an understanding of elementary physical, chemical, biological and hydraulic phenomena as such phenomena influence the engineering behavior of soils. A companion lab was modified to address geo-environmental topics.

B. Committee Service

International

1. Scientific Organizing Committee for the Tenth International Conference of Urban Drainage, (10ICUD) Copenhagen, Denmark (2005).
2. Scientific Organizing Committee for the Third International Conference on New Trends in Water and Environmental Engineering for Safety and Life, Capri, Italy (2005).
3. Secretary, Working Group on Cold Climates, International Association on Water Quality (2003 – present).
4. Storm Water Source Control Management SOCOMA Committee on Urban Water Quality of International Association on Water Quality (1993-present).

International Conference or Symposia Session Chair

1. Session Chair and Session Organizer, "The Nature of Storm Water Particulate Matter", Session at the 9th International IWA/IAHR/ASCE Conference on Urban Drainage (ICUD-2002) in Portland, Oregon, Sept. 2002.
2. Session Chair, "Storm Water Databases and Applications", Session at the 4th International Conference on Innovative Technologies in Urban Storm Drainage in Lyon, France, June 2001.
3. Water Resources and Eco-Systems Management Session, "New Trends in Water and Environmental Engineering for Safety and Life – Eco-Compatible Solutions for Aquatic Environments", International Association for Hydraulic Research Conference, Capri, Italy, July 2000.
4. Underground Water Vulnerability Session, "New Trends in Water and Environmental Engineering for Safety and Life – Eco-Compatible Solutions for Aquatic Environments", International Association for Hydraulic Research Conference, Capri, Italy, July 2000.
5. "Hydraulic and Biological Processing of Infiltration Devices" Session at the 3rd International Conference on Innovative Technologies in Urban Storm Drainage in Lyon, France, 1998.

National

1. Associate Editor for Journal of Environmental Engineering (October 2004 -)
2. University of New Hampshire National Storm Water Center Board (2005 -)
3. Scientific Expert Service to US EPA's Brake Pad Partnership (2004).
4. Member, American Society of Civil Engineering Gross Solids Committee (2004 -).
5. Expert Service to California Storm Water Quality Task Force (2001).
6. Expert Service to Southern California Regional Water Quality Control Board (2001).
7. Expert Service to University of California at Irvine/Davis for Research Project Review and Scientific Report Reviews. (Aug. 2001 – Present)

COLLABORATORS

F. Cartledge, V.J. Singh, R. Malone, K. Rusch, D. Fratta, R. Seals, L. Wang (Louisiana State University)
S. Buchberger, Y. Li (University of Cincinnati)
D. Griffin (Louisiana Tech University)
J. Heaney (University of Florida)

GRADUATE AND THESIS ADVISORS

R. Borden (North Carolina State University), S. Buchberger (University of Cincinnati)