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SEDIMENTS

Newsletter of the North Carolina Sedimentation Control Commission

Monitoring Sediment Export During Construction of the I-40 Bypass in Greensboro

By Dan Line, NCSU Water Quality Group, Department of Biological & Agricultural Engineering, Raleigh, NC

THE SEDGEFIELD LAKES/KINGS MILL project was initiated to document the effects of highway construction on the water quality in the Sedgefield Lakes and King's Mill residential watersheds. Both of these watershed communities encompass small lakes that are highly-valued for aesthetic and recreational purposes. The fact that the I-40 bypass around Greensboro, NC was being constructed within the areas that drained to their lakes was a concern to residents. Their concern focused on the potential increase in sediment and other pollutants to their lakes and the degradation of stream channels in their neighborhoods. Residents of the Sedgefield Lakes community, in conjunction with the NC State University (NCSU) Biological and Agricultural Engineering Department, began a citizen monitoring program of tributaries to their lake at least a year prior to the start of highway construction in their area. This effort and several subsequent meetings led to an agreement with the NC Department of Transportation (NC DOT) to continue and expand the monitoring conducted by NCSU to encompass the period of highway construction. As part of this agreement, the NC DOT also began meeting quarterly with residents on-site to report on monitoring results and hear and address the residents' concerns. Although the NC DOT regularly inspects the highway corridor for sediment control needs, the observations of residents also identified potential pollutant sources that they thought needed to be addressed. These meetings provided an invaluable forum for residents to voice their concerns and for NC DOT personnel to relate their efforts toward alleviating the concerns. The close cooperation between residents and NC DOT resulted in improved sediment control and serves as a model for future projects.

Fig. 1. Sedgefield Lake

The construction contractors, under the supervision of NC DOT, installed many erosion and sediment control measures to reduce sediment export from the highway corridor. These included sediment basins with skimmer (floating pipe to drain the basin from near the top of the water column) outlets and coir baffles, sediment traps, rock dams, accelerated seeding and mulching, slope drains, silt fence, and flocculant applications on selected areas (fig. 2, pg 2). In addition, floating silt or turbidity curtains were installed around the inlets of the two major tributaries to the Sedgefield Lake. These two silt curtains were effective (fig. 3,pg 2) for relatively small storm events occurring shortly after their installation; however, visual observation indicated that the longer they remained in place and the larger the storm, the less effective at containing the sediment/turbidity plume they became.

The water quality monitoring program consisted of installing 6 continuous monitoring stations: 4 in the Sedgefield Lakes watershed and 2 in the King's Mill watershed. In Sedgefield Lakes two stations, Ellery-up (fig. 4, p.3) and Tilly-up were located on tributary streams immediately downstream of the highway corridor and two stations Ellery-down and Tilly-down were located on the same tributaries just upstream of the lake. For the upstream stations the highway corridor comprised at least 26% of the total drainage with the rest of the area being wooded or residential homes with established lawns and landscape. The intent was that sediment loading to the upstream

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State of North Carolina,
Department of Environment & Natural Resources
William G. Ross, Jr., Secretary

Land Quality Section
Division of Land Resources
James D. Simons, Director and State Geologist

Fig. 2. Highway road bank and example sediment control basin.

Fig. 3. Sedgefield Lake with turbidity curtain.

stations would be almost exclusively from the highway corridor as the remainder of the drainage area was stable. In the King's Mill watershed, stations were located on a single tributary upstream and downstream of the highway corridor. The highway corridor comprised 24% of the area between the stations with the rest of the area being wooded or in established residences.

The Sedgefield Lakes stations were installed about 6-8 months before construction of the highway began. In the King's Mill watershed the stations were installed 5 months before major earth disturbing activities began. Ideally, at least 18 months of data would have been collected prior to major construction activities to adequately characterize background or pre-construction conditions; however, this is often not feasible given construction scheduling constraints. For King's Mill, the upstream station serves as a background site since there was no significant construction activity in the drainage area and may be used as background for the Sedgefield Lakes sites also. The stations were installed from February to June, 2004 and are still in place, although the data reported in this article included collection through January 3, 2008. This period of monitoring encompasses the major construction grading and other preparation, which is likely the worst period in terms of sediment export, as well as the start of the post-construction period.

Each monitoring station was equipped with an automated sampler and flowmeter that was programmed to continuously record discharge and collect flow-proportional samples. Samples were recovered from the samplers after roughly a 2-week period, combined into a single composite sample at each station, and analyzed for total suspended solids, total solids, and turbidity. In-situ measurements of temperature, specific conductance, dissolved oxygen (DO), and pH were made occasionally. A recording raingage was also maintained near the Tilly-up monitoring sites in the Sedgefield Lakes watershed.

Table 1 (p. 4) contains a summary of the sediment monitoring data. Despite an array of erosion and sediment control measures installed on the highway corridor, sediment loss at the Tilly-up site increased from 0.01 to 8.1 ton/ac-yr when comparing the pre-construction to during construction periods, while average turbidity of samples went from 25 to 1,570 NTU. About 32% of the total sediment export for the period occurred during two tropical storm systems that hit the Greensboro, NC area in September, 2004 with the majority of the export occurring during the second storm. Although these storms dumped more then 8.5 inches of rain on the area in three weeks, neither event was of a 10-year return period magnitude. This is significant in that most erosion and sediment control practices in North Carolina are designed for the 10-year storm event. However, runoff is computed as if the storms occurred individually and not in relatively close proximity in time.

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Personnel Changes

Tim Garrett, formerly an Environmental Specialist in the Mooresville Regional Office, has transferred and been promoted to Environmental Senior Specialist in the Washington Regional Office.

Trentt James has been promoted to the Environmental Senior Specialist position in the Wilmington Regional Office.

Tim Latham has been promoted to the Environmental Senior Specialist position in the Winston-Salem Regional Office.

Charlie Whaley has been promoted to the Environmental Senior Specialist position in the Mooresville Regional Office.

SEDIMENTS is published quarterly by the NC Sedimentation Control Commission to provide information and assistance to the regulated community and to facilitate communication among personnel of state and local erosion and sedimentation control programs.

Send comments to Ashley Rodgers, NCDENR-Land Quality, 1612 Mail Service Center, Raleigh, NC 27699-1612. Email: Ashley.Rodgers@ncmail.net. Send change of address and subscription information to NCSU Water Quality Group, NCSU Box 7637, Raleigh, NC 27695-7637; (919) 515-3723; cathy_smith@ncsu.edu). To receive *Sediments* electronically, please subscribe at:http://www.dlr.enr.state.nc.us/pages/sedimentationnewsletters.html. Five thousand copies of this newsletter were printed at a cost of $1,490 or 30 cents per copy.

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The North Carolina Sedimentation Control Commission

The Sedimentation Control Commission (SCC) was created to administer the Sedimentation Control Program pursuant to the NC Sedimentation Pollution Control Act of 1973 (SPCA). It is charged with adopting rules, setting standards, and providing guidance for implementation of the Act. The composition of the Commission is set by statute to encompass a broad range of perspectives and expertise in areas related to construction, industry, government, and natural resource conservation and quality. All members are appointed by the Governor and serve three-year terms, except for the Director of the Water Resources Research Institute of the University of North Carolina, who serves as long as he remains Director. The chairman of the SCC is named by the Governor. The following is a list of current members with the organizations they represent:

Chairman:
Kyle Sonnenburg
Fayetteville
NC League of Municipalities

Vice Chairman:
Donnie W. Brewer
Greenville
NC Environmental Management Commission

Commissioners:
W.T. "Buzz" Bryson
Raleigh
NC Public Utilities

Elaine C. Chiosso
Bynum
Non-governmental Conservation

John William Miller, Jr.
Burnsville
NC Mining Commission

Joseph H. Kleiss
Raleigh
NC State University, Dept. of Soil Science

Grover McPherson
Winston-Salem
NC Soil and Water Conservation Commission

David H. Moreau
Raleigh
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Joseph Rudek
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Non-governmental Conservation

Mark A. Taylor
Greensboro
Professional Engineers of NC

Richard Vick
Wilson
Carolinas Associated General Contractors

Rob Weintraub
Wake Forest
NC Home Builders Association

The close proximity created a very wet antecedent condition which resulted in increased runoff and more than twice as much sediment export during the second event. Following these events, additional sediment basins with skimmer outlets and coir fiber baffles, flocculation logs, and sediment traps

Fig. 4. Ellery-up monitoring station.

were installed in the drainage area.

Sediment loss rate in the much larger Tilly-down watershed increased from 0.07 ton/ac-yr prior to construction to 3.0 ton/ac-yr during the construction period. The much smaller increase was likely due to the fact that the highway corridor encompassed only 15.8% of the Tilly-down watershed and that a greater section of the highway was near grade thereby requiring less fill which made the section less susceptible to erosion. The section of the highway corridor draining to Tilly-up was comprised mostly of a fill section (fig. 5) where the roadbed was raised at least 25 ft thereby creating steep fill slopes that were more vulnerable to erosion. Mean turbidity levels in samples increased from 54 NTU pre-construction to 927 NTU during construction, which resulted in a corresponding increase in the turbidity of the

Fig. 5. Road section showing bank created by fill.

downstream lake.

Sediment loss rate at the Ellery-up site increased from 0.04 ton/ac-yr before construction to 4.7 ton/ac-yr during construction. This increase was about half that of Tilly-up even though the highway corridor encompassed more than 25% of both drainage areas and the section of highway contained considerable fill slopes. The main difference was that construction in the Ellery-up area was at an earlier phase with fewer fill slopes at the time of the tropical storms of September, 2004; thus, the highway corridor was less vulnerable to erosion at the time of the tropical storm. The little more than a month of post-construction data has been collected at this site has documented a sediment yield rate of 0.8 ton/ac-yr and mean turbidity of 176 NTU.

At Ellery-down, the sediment loss rate increased from 0.20 ton/ac-yr before to 1.2 ton/ac-yr during the construction period. Mean turbidity levels in samples increased from 140 NTU before to 466 NTU. These increases can be attributed to a combination of the I40 bypass highway construction, the widening of a city road just upstream of the station, and residential housing construction in the watershed. The post highway construction (since November, 2007) sediment export rate, which is also post city road widening and residential housing construction, was 0.12 ton/ac-yr with a mean turbidity of 62 NTU.

At King's Mill, sediment loss upstream of the highway corridor was 0.08 ton/ac-yr, while downstream it was 1.5 ton/ac-yr. Much of this increase could be attributed to the highway construction. In fact, assuming that sediment export from the nonhighway land between the stations was 0.08 ton/ac-yr, then the estimated sediment export from the highway corridor was 12.8 ton/ac-yr during construction. This export rate has essentially dropped to 0.0 ton/ac-yr since the completion of highway construction in November, 2007. During construction average turbidity of upstream samples was 42 NTU, while downstream it was 580 NTU, post construction upstream was 28 NTU and downstream 35 NTU.

This project highlights the difficulty in controlling sediment export resulting from large storm events that occur at time of high erosion vulnerability as was the case for the Tilly-up drainage area. Further, the Tilly-up drainage area included a large fill section of highway, which is particularly susceptible to erosion given the steep roadbanks. The project also documents the rapid drop in sediment export associated with the completion of highway construction. In addition, the continued cooperation and coordination with local residents helped identify and mitigate erosion and sediment control

Table 1. Sediment Export and Mean Turbidity at Monitoring Sites through 1/3/08						
Monitoring Site	Before Construction		During Construction		Post-Construction	
	Ton/ac-yr	NTU	Ton/ac-yr	NTU	Ton/ac-yr	NTU
Tilly - Upstream	0.01	25	8.1	1570	*(a)*	*(a)*
Tilly - Downstream	0.07	54	3.0	927	*(a)*	*(a)*
Ellery - Upstream	0.04	29	4.7	1607	0.8	176
Ellery - Downstream	0.20	140	1.2	466	0.12	62
King's Mill - Upstream	n/a	n/a	0.08	42	*(a)*	28
King's Mill - Downstream	n/a	n/a	1.5	580	*(a)*	35
NOTE: (a) = data pending						

and other issues.

IECA International Conference Report

Richard McLaughlin, NC State University

A number of papers presented focused on stormwater runoff treatment. One paper described a system (Bacterra) which consisted of a curbside storm drain insert in which a small tree is planted.[1] The storm water is routed through the growing medium, which provides treatment for bacteria, nutrients, grease and oil, and heavy metals. The authors claimed that the system is self-sustaining and requires no maintenance, two features which, if true, would make this a very unique system. Laboratory column data showed bacteria removal rates of 57% for high flow to 99% for low flow tests. A field test in California only had two storms at the time of the paper, with removal rates of 20-70%, the higher rates occurring early in the storm event.

A N.C. State graduate, Dr. Johnny Grace, described his work with the U. S. Forest Service to determine forest road erosion rates and to validate a model (WEPP) of that process. [2] They used field measurements of sediment deposition in adjacent areas to determine erosion rates over time for sections of roads with different slopes and traffic patterns. The model and field measurements generally agreed in erosion rates, which averaged 50 kg/m/year, most of which deposited in the buffer.

Seattle, Washington is adding a third runway to their airport, which involves a fill of tens of millions of cubic yards adjacent to a salmon stream. Discharges from the construction site are limited in turbidity to 5 NTU, so they had to build a large runoff storage capacity and a chemical treatment system in order to meet this requirement. [3] They chose to use chitosan, a cationic polymer derived from crab and shrimp shells. The treatment system is quite elaborate, with automated polymer injection and sand filtration which is controlled by in-line turbidity and pH sensors. The storage capacity was designed to handle two times the 10 year storm volume. The operational costs for treating the more than 4 million gallons of water was close to $0.02/gallon, but the author suggested costs up to $0.05/gallon might be typical. Costs associated with installing the storage and diversions were not included, although much of this capacity will remain as part of the stormwater treatment system planned.

The use of turf reinforced matting (TRM) as a replacement for rock lining was presented in a case study from Illinois. [4] The TRM was installed in a very wide channel (80 feet or so) below a box culvert, but unfortunately they did not get the channel lined above the culvert prior to when work ceased for the winter. As a result, considerable sediment was deposited on the lined portion of the channel. They also had a major event which brought logs and large debris into the channel, tearing the fabric in places. The damaged sections were replaced, and, in spite of these setbacks, the vegetation came through vigorously over the summer. One problem area discussed was the interface between the TRM and the culvert, which failed initially. The fabric was buried and large rock was placed on it for several feet after the culvert. One good suggestion was to have a section of fabric installed under the culvert bottom with a length left to overlap with the TRM when it is installed. This could be specified in the plans so the culvert installers would know to lay down the TRM material prior to pouring concrete.

An alternative approach to designing and implementing erosion and sediment control plans was presented by Leo Holm, an engineer from Minnesota. His approach is use risk analysis to determine where the most effort and money should be spent. His system takes a full day for training, but he briefly went through it in the hour and a half he had for his presentation. The key part is to do some risk estimating for various systems. For instance, he calculated the risk of a silt fence failing is about 50%. His main point was that you should concentrate your efforts at places on the construction site where the risk is greatest, considering both the device failure potential and the consequences of that failure. A silt fence adjacent to a stream has a much higher risk than one adjacent to a farm field, so perhaps a double row or some other device would be worth installing adjacent to a stream. (no paper provided)

Attorney Kim Maree Johannessen provided a short workshop to prepare professionals interested in being an expert witness in lawsuits. This was a very comprehensive review of all of the aspects one needed to consider both before and during trial. She strongly advised anyone receiving a call from a lawyer inquiring about their availability as an expert witness to ask about the nature of the lawsuit, who was involved, and what the timeline was going to be. She also indicated that no opinions should be provided until you are under contract. (no paper provided)

[1] Coffman, L. S., and M. Ruby. 2008. Bacterra™ by Filterra® Ad vanced Bioretention SystemDiscussion of the Benefits, Mechanisms and Efficiencies for Bacteria Removal. Int'l Eros. Ctrl. Assoc. Environmental Connection 2008, Conference Proceedings.

[2] Grace, J. M., and W. J. Elliot. 2008. Determining Soil Erosion from Roads in the Coastal Plain of Alabama. Int'l Eros. Ctrl. Assoc. Environmental Connection 2008, Conference Proceedings.

[3] Ziemer, J. J. 2008. Air Port Water Quality Soars to New Heights. Int'l Eros. Ctrl. Assoc. Environmental Connection 2008, Conference Proceedings.

[4] Pack, J. 2008. High Performing Turf Reinforcement Mats Provide Stormwater Control in Large Drainage Channel. Int'l Eros. Ctrl. Assoc. Environmental Connection 2008, Conference Proceedings.

Environmental Connection '08

Melanie Markusic, NC State University

The International Erosion Control Association (IECA) held its annual Environmental Connection meeting this year in Orlando, Fl… home to Disney World.

So….What could I expect to find at **Environmental Connection 08?**

According to the website (http://www.ieca.org**)**

- **22 Full-day training courses** addressing hot topics such as wind erosion, construction site management and NPDES regulations and compliance.
- **Over 50 case studies and technical paper presentations** providing original research and proven techniques to help you stay ahead in a competitive market.
- **2000+ attendees** to network with for increased exposure, business opportunities and resources.

And this is exactly what I found and MORE!

There were so many things to see and do, including social events almost every night. Monday, I was involved in an all day workshop put on by the EPA's own Nikkos Singelis, Lisa Nisenson (TetraTech), John Kosco (TetraTech) and Mike Novotney (Center for Watershed Protection). The workshop was entitled "Planning and Design 101: Post –Construction, LID, and Smart Growth as Stormwater BMPs". This hands-on workshop focused on the post-construction phase of land disturbing activities and how to maximize the performance of BMPs. Monday night hosted a night for first time attendees. This enabled everyone to meet and greet those who had never attended before. Great for everyone involved.

Tuesday, I was also involved in an all day workshop taught by Jarred Fifield Ph.D. This workshop was entitled "Designing for Effective Sediment and Erosion Control on Construction Sites". This class gave a little more of a hydrodynamics perspective to the installation and maintenance of BMPs as well as the insight to hydrodynamic characteristics of a given watershed. Tuesday evening was the grand opening of the exhibit hall. **More than 160 vendors** showed the latest products and technology available in the largest expo dedicated to erosion and sediment control.

Wednesday morning started off with a spectacular presentation from the keynote speaker, Chad Pregracke. Please visit his website to learn more about him and his successful mission to clean up the waterways of the United States, starting with the Mississippi River. http://www.livinglandsandwaters.org/

Wednesday continued with multiple technical sessions throughout the day. I gave a talk on Sediment Basin design and different BMP's that help to improve their overall efficiencies. Dr. Rich McLaughlin gave a talk on Polyacrylamides and their ability to reduce construction site effluent turbidity levels. Wednesday night arrived with more networking during the "Hydrodeo"…Chapter Challenge. This event gave the different chapters across the world to show their true competitive side while having a great time getting to know one another. All individual chapters then had their annual chapter meetings.

Thursday morning started bright and early for many attendees with a 5K walk/run. This event was designed as a fundraiser for the new SOIL fund. "Save our International Land" fund provides a permanent funding source for programs and projects that improve environmental quality through ***education, research, and applied technology***. The rest of Thursday was again full of technical sessions and exhibitor hall trips, discussing with vendors the array of BMPs available today.

Friday finished with a field trip to the Greenwood Urban Wetland. The Greenwood Urban Wetland was built to alleviate flooding and to treat stormwater runoff prior to discharge to drainage wells which flow to the Floridian Aquifer.

The system is designed to detain the runoff from 2.5 inches of rainfall. Approximately 300,000 cubic yards of material was removed to create the system which enlarged the surface area of the "lake" from four to thirteen acres. Weirs were constructed to control water levels and establish three ponds to maximize stormwater detention. The average water depth is 5.1 feet, the storage volume is 66 acre feet, and the hydraulic residence time is 22.7 days. The lakes have a 25 to 30-foot-wide littoral shelf which was planted with over 82,000 plants of ten species of native macrophytes.

The lakes are connected by marsh flowways and the system also includes a "riverine floodway" that allows large storms to bypass the lake system. The floodway is planted with seven species of hardwood swamp trees. An upstream sediment/debris basin, pond aeration, and an irrigation system reusing stormwater are incorporated into the design to increase pollutant removal effectiveness. The reuse system allows the City to irrigate the park and the adjacent city-owned cemetery with stormwater instead of potable water, saving the city $25,000 per year. In addition to providing flood protection and stormwater treatment, the 26 acre Lake Greenwood Urban Wetland park includes sidewalks, bridges, and green space passive recreation which is widely used by nearby residents.

NC WRRI Workshops

Information on the Fall Erosion and Sedimentation Control Planning and Design Workshops will be available on the WRRI web site in mid-August: *http://www.ncsu.edu/wrri/erosionworkshops.html*

These workshops are sponsored by the NC Sedimentation Control Commission, NCDENR Division of Land Resources Land Quality Section and the Water Resources Research Institute (WRRI) of The University of North Carolina.

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5/7/08	**NCSU Hands-On Course on Installation of Constructon Site Erosion and Sediment Control Devices,** Raleigh, http://www.soil.ncsu.edu/swetc/sediment2/2008/sedinstal.htm
5/14/08	**Assessment and Identification of Riparian Vegetation,** Pittsboro, NC http://www.ncsu.edu/ srp/veg_workshop.html/
5/28/08	**Level II: Erosion & Sediment Control/Stormwater Certification,** Raleigh, NC http://www.bae.ncsu.edu/workshops/dot/
5/29/08	**Level I: Erosion & Sediment Control/Stormwater Certification,** Raleigh, NC http://www.bae.ncsu.edu/workshops/dot/
6/4/08	**Level III-A: Design of Erosion & Sediment Control Plans,** Raleigh, NC http://www.bae.ncsu.edu/workshops/dot/
6/5/08	**Level III-B: Design of Erosion & Sediment Control for Reclamation Plans,** Raleigh, NC http://www.bae.ncsu.edu/workshops/dot/
6/23-24/08	**Low Impact Development Summit**, NC http://www.bae.ncsu.edu/workshops/lid_summit/
6/24/08	**Level II: Erosion & Sediment Control/Stormwater Certification,** Hickory, NC http://www.bae.ncsu.edu/workshops/dot/
6/25/08	**Level I: Erosion & Sediment Control/Stormwater Certification,** Hickory, NC http://www.bae.ncsu.edu/workshops/dot/
6/26/08	**Level II - Recertification: Erosion & Sediment Control/Stormwater Certification,** Hickory, NC http://www.bae.ncsu.edu/workshops/dot/
7/26-30/08	**2008 Soil and Water Conservation Society's Annual Conference,** Tucson, AZ http://www.swcs.org/08ac
11/3-6/08	**2008 Southeast Regional Stream Restoration Conference**, Asheville, NC http://www.ncsu.edu/srp/2008conference/