

Stream chemical interactions within the urban environment: assessing the fate of nitrogen and mercury in a stream impacted by combined sewer overflows

Basic Information

Title:	Stream chemical interactions within the urban environment: assessing the fate of nitrogen and mercury in a stream impacted by combined sewer overflows
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Descriptors:	None
Principal Investigators:	Joseph T Bushey

Publications

There are no publications.

CONNECTICUT INSTITUTE OF WATER RESOURCES

Project Title: Dynamics of nitrogen loading and speciation in urban combined sewer catchments: An assessment of the effects of flow conditions

QUARTERLY REPORT

Period: April 2009 – May 2010

Submitted: May 28, 2010

PRINCIPAL INVESTIGATOR

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ADDITIONAL PROJECT PARTICIPANTS

Graduate Student, Mykel Mendes, MS

OVERVIEW:

Efforts during the first year of the project (April 2009 – May 2010) have focused on establishing field sampling sites, purchasing equipment hiring and training a graduate student and collecting samples. Because of budgetary delays, the project support was not finalized until April 2009, in line with the proposed start date. As such, a graduate student was not able to be hired until August 2009 rather than April 2009 as proposed. Dr. Bushey and Ms. Mendes have toured the sampling sites in April 2009 and October 2010. Following field site selection, equipment was purchased and arrived in August 2009. Summer 2009 also involved the development of a conceptual design for the pore water samplers. Site access to the proposed sites was obtained in October 2009. Stream water collection began in November 2009 with installation of pore water samples in early December 2009. Pore water samplers were purged in April 2010 and sediment samples were collected in May 2010.

Accomplishments to date:

- Finalized sampling site selection and instrumentation plan
- Obtained site access
- Designed a pore water sampler and ordered necessary equipment to conduct sampling/analyses
- Hired and trained a graduate student to execute sampling and chemical analysis
- Conducted literature review of relevant chemical analyses (DOC characterization and fractionation; sulfide). Ordered supplies for analytical methods of DOC and S^{2-} .
- Began collection of monthly stream water samples (November 2009)
- Installed porewater samplers (December 2009)
- Purged porewater samplers (April 2010)
- Collected sediment samples (May 2010)

RESEARCH AND EDUCATIONAL ACTIVITIES:

Field Deployment:

Dr. Bushey and Mr. Perkins from the University of Connecticut Center for Environmental Sciences and Engineering made an initial evaluation of perspective field sites in April 2009 in association with a related project for The Metropolitan District Commission. This was followed by two additional site visits by Dr. Bushey during Summer 2009 and by Dr. Bushey and Ms. Mendes in November 2009. Based on these initial discussions regarding The MDC study, a stream reach was selected to bracket the influence of combined sewer overflows (CSOs) and untreated wastewater on water quality in the North Park River (NPR), in Northwestern Hartford (CT). Concerns remained regarding the suitability of the field sampling sites relative to (1) the CT IWR study objectives, (2) the physical potential to install and maintain porewater samplers, and (3) site access approval. Based on preliminary site visits, four sites were selected within the initial stream reach for stream water sampling: UConn Law School, Albany Avenue, University of Hartford and Portage Road moving upstream, respectively (Figure 1). These four sites were approximately equally-distributed along the reach with two each above and below the uppermost CSO. Site access for the respective sites was obtained in Fall 2009 during discussions with homeowners (Portage Rd), the University of Hartford, the University of Connecticut Law School and Hartford and MDC personnel (Albany Ave).

Equipment

Following site selection, the samplers and flow monitoring devices were ordered. Equipment was ordered and porewater samplers were designed based on an installation approach. The installation approach was selected over composite sampling using a temporary pumping probe due to the consistent potential for the permanent devices. A sediment sampler, flow-meter and two water chemistry probes were ordered and prepared for use. Sufficient 1-ft and 2-ft plastic sediment core sleeves were ordered to collect the proposed number of sediment cores from the sites.

For porewater sampling, 30 mL Teflon vials were ordered with one transfer port on the tip. Holes were drilled into the sides of the vials to allow for uniform water flow into the vials during sampling. The smallest possible drill bit was used to minimize the entrainment of solids

during sampling. Additionally, the sediment corer was retrofitted to enable easy installation of the porewater samples at the appropriate depth (Figure 2). A prototype temporary porewater sampling device also was explored and constructed due to potential issues with the permanent installations and site channel sediment composition as discussed below.

Student Training

In addition to the set up of instrumentation, a graduate student, Mykel Mendes, has been hired and trained. Due to the timing of the grant, the student did not begin until August 2009. However, in this short time frame, the student has been trained by Dr. Bushey and CESE personnel on laboratory protocol as well as the analysis of dissolved organic carbon (DOC), anions and mercury (Hg). Ms. Mendes has also investigated DOC characterization techniques and is setting up the capabilities to sample for and fractionate DOC in the UConn laboratory. Additionally, Ms. Mendes (MS) has become familiar with sampling and field work as well as obtained knowledge of the relevant research in the field.

Sampling and piezometers installation

Stream water sampling was initiated in November 2009 following the granting of site access. Samples were collected at each of the four sampling sites for Hg speciation, DOC characterization, anions and metals. Monthly stream samples have been collected through May 2010 with subsequent trips planned through January 2011.

Bed type and suitability were examined for porewater samplers during the initial stream water sampling at the four sites in November 2009 (Figure 1). The Portage Road site was eliminated for porewater samplers due to the bedrock stream bed characteristics. At the UConn Law School site, the stream channel is composed of a thick clay layer. However, a sandy layer exists near rip-rap installed to protect a recently modified MDC sewer pipe crossing beneath the channel. Three samplers were installed in this sandy layer as these relatively exchangeable sites are Denitrification and methylation hotspots. The transect of three porewater samplers at the Albany Avenue site was installed perpendicular to the channel (Figure 3) at an approximate depth of 4 in to the top of the sampler. This depth was deeper than initially intended but necessary to prevent the sampler from washing downstream during high flow. The two transects at the University of Hartford site included two samplers in the stream channel at 4 in depth with

four samplers installed in sand/gravel bar on a bend in the river (Figure 4). Two samplers were installed at different depths of the bar, one shallow (8 in below surface) and one deep (22 in below surface). The transects at the UConn Law School stream channel site were installed similarly to those at Albany Ave.

At the UConn Law School, a small side channel which floods during elevated discharge conditions was instrumented with porewater samplers as a thick littoral layer existed over the clay layer. However, two of the lysimeter tubes were vandalized in the month following installation while the others filled with clay making pumping difficult. The stream bank samplers at the University of Hartford location were also vandalized. Finally, a decision was made not to install porewater samplers in the small pond on the University of Hartford campus in lieu of sediment core collection. Due to vandalism we are re-exploring the temporary porewater collection device as described by the USGS. Permanent samplers are difficult and costly to install particularly given the lack of protection from vandalism afforded at the urbanized sites.

Initial discharge readings were to be calculated from readings across the channel, with channel morphology noted. However, this has proved difficult and inconsistent. A set of water level loggers has been ordered and will be installed in June 2010 at the Portage Rd and the UConn Law School sites. These will be calibrated during multiple events to discharge using ISCO® discharge recorders.

Dissolved Organic Carbon Characterization

A column set up is being set up to separate the humic acid, fulvic acid, hydrophobic acid and hydrophilic acid fractions. Additionally, DOC will be characterized for aromaticity via SUVA₂₅₄. Organic characteristics have been documented to reflect source contributions to the watershed and also to influence contaminant, particularly trace metal, mobilization.

Future Work

- Collect stream water samples monthly through January 2011
 - Analyze for Hg speciation, N speciation, metals, DOC characterization and ancillary parameters
- Collect porewater samples quarterly
 - Analyze for Hg speciation, N speciation, metals and ancillary parameters

- Analyze sediment samples for Hg speciation, metals, POC characterization, organic content and ancillary parameters
- Collect stream water samples across precipitation events, during which CSOs are likely to occur. Assess pore water chemical changes with following precipitation events.
- Begin manuscript preparation regarding Hg-DOC relationships, shifts in N speciation during events and with CSO inputs

Figure Captions

Figure 1 Location of stream water sampling sites (⊕) and porewater sampling sites (■) in the North Park River.

Figure 2 Porewater sampler.

Figure 3 Sampler layout at the side channel near the UConn Law School.

Figure 4 Sampler installation at the University of Hartford site.

The Metropolitan District Sanitary and Storm Sewers North Branch of the Park River - Hartford

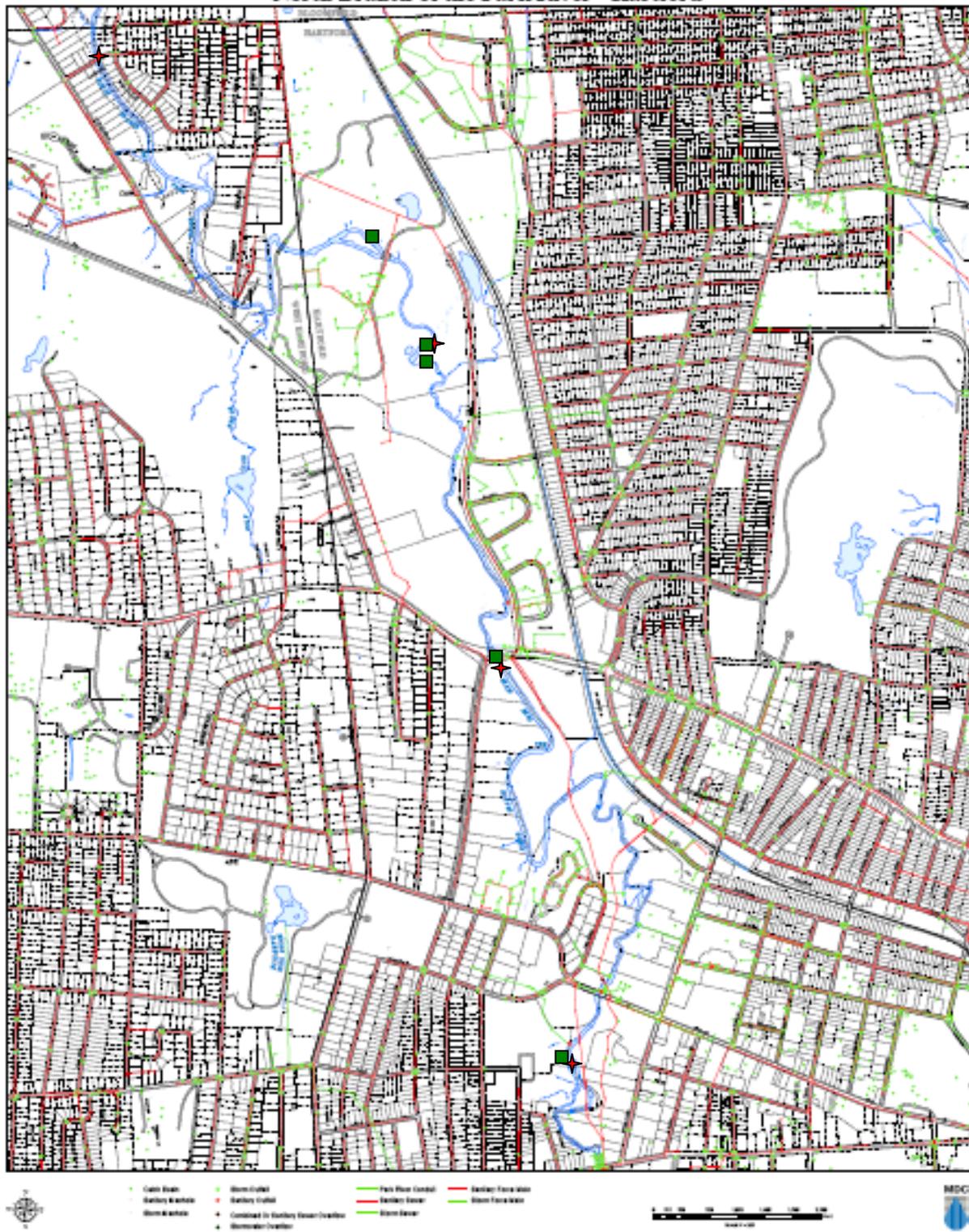


Figure 1



Figure 2



Figure 3



Figure 4