## SUNY New Paltz and DEP sponsored NSF REU Summer 2012 Project Description

### Hydrology (Dr. Shafiul Chowdhury):

**Factors Controlling Water Quality:** Surface water samples will be collected using auto sampler before and after major storm events (heavy precipitation) from selected locations from previously delineated sub-watersheds. These samples will be analyzed in the lab to determine water quality parameters (anions, cations, total organic carbon, total suspended solids etc.). Students will also measure pH, conductivity, temperature, turbidity and dissolved oxygen of the stream water in the field. The water quality parameters will be compared with land use, topography, soil type and geologic materials and processes (e.g. high surface runoff, only base flow, glaciated vs. non glaciated areas etc), to determine the controlling factors using GIS.

**Surface Water/ Groundwater Interaction:** During dry periods streams in the Stony Clove sub basin are mostly fed by groundwater (base flow). The above water quality evaluation approach will help us understand the movement of water between groundwater and surface water since this interaction provides a major pathway for chemical transfer between terrestrial and aquatic systems. This transfer of chemicals affects the supply of carbon, oxygen, nutrients such as nitrogen and phosphorus, and other chemical constituents which will be helpful to evaluate the effects of biological and chemical characteristics of aquatic systems.

**Role of Groundwater on Stream Bank Erosion and Slope Failure:** Evaluate the role of groundwater/surface water interaction in a set of rotational hill slope failures along Warner Creek's Reaches 11 and 12 by installing and monitoring piezometers and taking detailed measurements of geotechnical failure features (scarps, activity of slides, longitudinal and lateral migration of failures).

Piezometers will be installed on selected segments of the stream banks and hill slopes longitudinally and laterally to determine hydraulic heads which will give the information about the hydrostatic pressure conditions of the area. Vulnerable areas to potential slope failure will be delineated by combining the collected data of hydraulic head and above mentioned features of slope failure.

### Fluvial Geomorphic Investigations (Mr. Dan Davis)

The SUNY New Paltz REU Program and the New York City Department of Environmental Protection (DEP) have initiated a comprehensive multi-phase investigation of fluvial geomorphic features and processes in the Silver Hollow watershed that hosts Warner Creek, a tributary to Stony Clove Creek located in the Catskill Mountains of Ulster County, NY. Four of the 2010 REU season undergraduate researchers worked with a DEP geologist to

(1) complete a GIS-based watershed-scale assessment using remotely-sensed data (orthorectified photos for 2001 and 2009, georeferenced historical aerial photos dating back to 1959, high resolution digital elevation models, land use/land cover maps) and

(2) a field-based stream feature inventory/assessment (see figure and REU 2010 project description) to record the occurrence of various features in the stream corridor (bed form, channel geology, stream bank and hill slope erosion, headcuts, large woody debris, depositional features, revetment, etc)to establish a baseline condition and to identify subsequent research topics. Students also worked on individual projects (hydrology, headcut mapping, LWD monitoring, and hill slope failure investigation).

**The 2012 REU students can pursue the following potential research topics (these can be combined into team efforts):**

- Repeat stream feature inventory for select reaches (13 total) and compare the results to quantify the geomorphic response to subsequent floods.
- Resurvey a statistically significant set of large woody debris (LWD) features and provide more comprehensive characterization, assessment of geomorphic and ecologic effects, and tag for subsequent monitoring.
- The 2011 REU students attempted to qualitatively characterize the bank erosion hazard potential for individual eroding stream banks, evaluate the characterization based on the stream bank's response to post-assessment high runoff events and develop a photo-based field guide to qualitative and semi-quantitative assessment of bank erosion hazard potential for use in subsequent investigations.
- DEP and Ulster County Soil and Water Conservation District are working with a consultant (Clear Creeks Consulting) to complete a detailed stream corridor restoration assessment for 6,000 feet of stream (Warner Creek reaches 11 and 12) which will yield monumented cross sections installed in fall 2010 and 2011, stream bed sediment characterization using Wolman Pebble counts, a detailed topographic map with 2 ft contour interval resolution, and mapped features such as headcuts, bank erosion, and sediment bars. Restoration projects are planned for late summer 2011 and in 2012, therefore students will have time to resurvey channel, cross-sections, longitudinal profiles, and other features to evaluate geomorphic response in these geomorphically active reaches of Warner Creek.
- Using the 3 meter DEM (very high resolution) attempt to predict the occurrence of stream bank erosion, suspended sediment entrainment sources, deposition, LWD entrainment/storage as a function of stream corridor morphology (slope, valley and

channel cross-sectional geometry), geology, and land cover. Calibrate the model predictions with observed features in Warner Creek and test the model predictions by field checking predicted results in an unassessed tributary to Stony Clove Creek.

- Further project ideas can be discussed prior to start of the 2012 season.

## Water Chemistry (Dr. Megan Ferguson)

**Impact of Stony Clove Creek Watershed on Disinfection Byproduct**: Stony Clove Creek, a source of water to Ashokan Reservoir and ultimately New York City, is known to have high sediment loads, and substantial levels of dissolved organic matter may co- occur with that sediment. Since New York City does not filter its drinking water, this imparts a risk of generating disinfection byproducts – harmful halogenated compounds that form when source water that contains dissolved organic matter is treated with chlorine prior to distribution. To examine whether this is a potential problem in this watershed, students will collect water samples in various locations throughout the Stony Clove watershed and downstream toward Ashokan Reservoir. Basic water quality parameters will be collected onsite, and more in-depth information such as ion concentrations, total organic matter, and humic acid fraction will be determined in the lab. Water samples will subsequently be chlorinated in a fashion similar to New York City's drinking water treatment, and students will identify and quantify disinfection byproducts using UV-visible spectroscopy, gas chromatography-mass spectrometry (GC-MS), and other analytical chemistry techniques.

## Application of GIS (Dr. Lawrence McGlinn)

**Modeling Stony Clove, Upper Esopus Basin, New York (GIS based)**: Several projects will utilize GIS to compile and analyze data for Stony Clove sub-basin in the Upper Esopus Creek watershed. Overlaying a range of existing and collected data in our GIS (aerial photography, LIDAR data, DEMs, soils data, hydrologic and geologic data), we will create a three-dimensional model of the Stony Clove basin. This model will aid in analyzing and interpreting the geomorphologic, water quality and slope failure data of Stony Clove. In subsequent years, we will build a robust environmental database on this foundation. Ultimately, our model will represent in detail the reality of Stony Clove as an outdoor laboratory.

## Geologic Mapping (Dr. John Rayburn)

**Surficial Geologic Mapping:** Through both field investigation and analysis of LiDAR data we will investigate the surficial geology (primarily glacial and glacial lacustrine in origin) in the watershed. These are the primary sediment sources for sediment being eroded and transported into the Ashoken Reservoir.

Ecology (Dr. David Richardson)

**Didymo geminata (rock snot) in Esopus Creek:** Abundance of the nuisance stream alga, Didymosphenia geminata, has unexpectedly increased in streams and rivers worldwide in recent decades. D. geminata (Didymo) is informally called "rock snot" because during blooms (i.e., periods of rapid growth), the diatoms produce long stalks which forms a mat on the stream bottom and resembles mucus. Didymo is capable of modifying the physical habitat and biology of the streams due to the large amount of growth on the stream bottom. In New Zealand, Didymo blooms, likely spread by recreational fishermen, have caused recreational and economic damages (>$50 million). The Esopus Creek is one of five known bloom locations in New York State. The students working on this project will work closely with the local United States Geological Survey (USGS) group to investigate the ecology of Didymo, including the chemical and hydrological causes of Didymo blooms in the Esopus Creek using microscopy and water chemistry techniques. In addition to field measurements, the students could also plan and carry out experiments to look at chemical causes of Didymo growth and examine the spatial extent of Didymo blooms within Esopus Creek.

## Sample project abstracts of SUNY New Paltz 2011 REU Program

## ABSTRACTS

### Reconnaissance Mapping of Surficial Geology in the Catskill Mountains of New York

**R.M. Sandstrom, Vassar College**

The surficial geology of the Upper Esopus drainage basin was investigated during the summer of 2011 by students from the SUNY New Paltz REU program in collaboration with the New York City Department of Environmental Protection (DEP). Esopus Creek empties into the Ashokan Reservoir, a water supply for New York City. Fine sediment sources derived from varved glacio-lacustrine clay and clay-rich tills are causing excessive turbidity. Mapping glacial deposits helps determine the extent and location of fine sediment sources for future DEP remediation work.

LiDAR was used to identify landforms for field observation and determination of origin. Morphostratigraphic units were mapped using GIS software. Overburden stratigraphy was compiled from available well logs and field measurements of exposures. The resulting surficial geologic map of the Upper Esopus refines recent STATEMAP efforts in the Phoenicia quadrangle (De Simone, 2009) and surrounding quadrangles (NY Survey, in progress).

Mapping and stratigraphic interpretation reveals deposits from multiple glacial events. Generalized basin-wide stratigraphy includes a lowermost unit of grey compact till at least locally underlain by gravel. Lacustrine varved clays and sand overlie this grey till. The upper lacustrine contact exhibits shear deformation with faults and folds and grades into a red clay-rich diamicton. This is evidence of ice advance of undetermined age. The clay-rich diamicton with small pebbles represents the basal facies of a compact red clay-rich valley till. A thin sandy brown upland till occurs on most valley walls and mountain ridges. Ice-contact sand & gravel deposits are locally present within the field area. Post-glacial erosion truncates the valley units and caps them with multiple alluvial terraces that step down to modern stream level.

**Modeling the Glacial History of the Ashokan Watershed in the Catskill Mountains of New York Using GIS**

**Karen E. Kiser, Macalester College**

New York City drinking water is partially supplied through the Ashokan Reservoir located in the Upper Esopus drainage basin of the Catskill Mountains. Fine sediment sources such as varved lacustrine clays and clay-rich tills are contributing to the suspended sediment load of the watershed and degrading water quality. Students of the 2011 SUNY New Paltz REU program in collaboration with the New York City Department of Environmental Protection modeled glacial lakes and ice margins as a means of finding the extent of the fine sediment sources. Two hypotheses were posed as to the nature and extent of glacial lakes. The first hypothesis envisions large regional lakes with at least two stages comparable to Rich's (1935) interpretation. A second hypothesis predicts the formation of small local valley lakes during deglaciation with dead ice filling portions of narrow valleys in the high relief terrain.

A raster GIS digital elevation model of possible lakes modified to correct for post-glacial isostatic rebound was created using potential thresholds at Wagon Wheel Gap, Peekamoose Gorge, Deep Notch, and the Hudson-Delaware drainage divide pass. Variations of modeled glacial lacustrine extents were field checked to accept or reject model hypotheses. Thick packages of varved lacustrine sediments of fine silt and clay were found throughout these valleys. Well logs indicate a widespread occurrence of fine grained lacustrine sediments. This supports the former existence of a large regional lake in the area.

A red diamicton facies consisting of compact clay-rich matrix and small pebbles overlies the lacustrines. Where observed, the contact shows extensive deformation that includes folded lacustrines with thrust faults. This facies was previously considered a slump or debris flow deposit but is here interpreted as the basal facies of the overlying red till on valley floors. The red till records an ice advance across valley floors covered with lacustrines. Varved sediments of coarser silt and sand found only in some valleys supports the hypothesis that local lakes also existed at some time. These lakes were distinct from regional lakes in the Esopus drainage basin.

**Dynamic Stream Adjustment: A Study of Warner Creek's Erosive Response to Large Hydrological Events**

**Christopher J. Callinan, SUNY New Paltz**

The New York City Department of Environmental Protection (DEP) must maintain delivery of a high quality of water to 9 million people. Turbidity from suspended sediment in the unfiltered water supply can interfere with the efficiency of disinfection mechanisms. Warner Creek is a tributary to Stony Clove Creek in the Esopus Creek and Ashokan Reservoir watershed and is identified as a significant source of turbidity due to its interaction with legacy glacial deposits. Bank erosion can entrain glacial silts and clays, causing acute and chronic suspended sediment loading. This study aims to understand the fluvial processes in a glaciated mountainous terrain and evaluate assessment methods used to diagnose conditions to characterize this watershed.

SUNY New Paltz REU and DEP evaluated a 10,500 ft. section of Warner Creek through a diagnostic stream assessment to determine reach scale response to two geomorphically significant high flow events (Q>25 year recurrence interval), occurring in the past 9 months. Baseline geomorphic data was collected by the SUNY New Paltz REU program and DEP in the summer of 2010 before these flow events in the form of a comprehensive stream feature inventory for >90% of the 9 mile stream length. Stream features including eroding banks and fine sediment sources were remapped in 2011 to put the spatial data from 2010 REU into a temporal context. The features were collected using a GeoXT Trimble GPS unit and processed using ARCGIS software. A reach stability study was conducted by Clear Creeks Consulting in between the two large flow events. Bank cross sections and BEHI scores were calculated. Five cross sections in an actively adjusting reach were resurveyed and overlain with the existing data to determine bank retreat. We find that the floods of late 2010 cause extensive erosion, entrainment of large woody debris, and deposition. This resulted in an increasing eroding bankline in some reaches and caused extensive bank retreat from fluvial and consequent geotechnical processes. Values calculated for bank retreat in this study were used to conclude that BEHI is an adequate predictor of erosional hazard. The limitations of this study include error associated with collected GPS data, differences in methodology in surveying techniques and only one year of spatial data being available as baseline information.

**Response of Transport in Warner Creek to High Magnitude Flood Events**

**Greg P. Shaheen, Wesleyan University**

One of the primary goals of NYCDEP is to provide high quality, unfiltered, surface-based drinking water to millions of NYC residents. A Catskill mountain stream in the Ashokan watershed that presents an especially difficult challenge to this goal through excessive suspended sediment loading is Warner Creek. The fine sediment introduced by Warner Creek is attributable to erosion into Pleistocene glacial deposits. This study is a diagnostic assessment attempting to gain insight into the factors influencing stability and thus the processes producing turbidity.

Although it is hard to define stability in a dynamic mountain stream, one clear indicator is the stream's ability to transport wood and sediment, particularly when overcome with such material by extreme hydrologic activity.

This study is confined to the broader, wider, and more developed lower 10,500 feet of Warner Creek. These reaches were predicted by a 2010 assessment of the entire 41,000 feet of stream to be most sensitive to channel response. To evaluate these findings, a GPS-based Stream Feature Inventory (SFI) was compared with baseline SFI information from the 2010 assessment, with knowledge that Warner Creek experienced two 25-year recurrence interval floods in between. ArcGIS and orthorectified aerial photos allowed analysis of the spatial distribution of Large Woody Debris (LWD) and depositional features from both years. Further investigation included historical channel alignment analysis, topographic survey, and bar sampling.

Most LWD was found in sections of the stream with a riffle-pool bedform and almost all transported pieces of LWD longer than the average bankfull channel width were found at meander bends. Most LWD jams were found caught on islands where the channel splits, at forest avulsions, in overflow channels, or in the channel margin in a steeper, boulder-dominated reach. Overall, the floods have introduced more wood. Similarly, the majority of depositional features, mostly cobble bars, have grown since 2009. Areas of aggradation and the disappearance of a number of headcuts also suggest that an increased supply of coarse sediment has helped arrest an apparent systemic degrading condition. Continued monitoring will help determine if this flux is part of an ongoing trend toward aggradation and decreased transport capacity.

## *Didymosphenia Geminata* (Rock Snot) in the New York City Watershed – A Spatial Analysis

**Isabella A. Oleksy, University of New Hampshire**

*Didymosphenia geminata* (didymo) is a nuisance stream species of algae that has unexpectedly and unpredictably increased in streams and rivers worldwide in recent years. Didymo is native to cool temperate regions of the Northern Hemisphere including northern Europe, Asia, and North America. Also nicknamed "rock snot," didymo biofilms have a cotton-like texture and brown/tan color. During rapid periods of growth known as blooms, the diatoms produce long polysaccharide stalks and mats on the stream bottom, which modify the physical habitat and biology of streams through extensive growth on stream bottoms. Didymo is currently found in seven known bloom locations across New York State and spreads by transportation on recreational equipment such as fishing waders. We investigated the spaitial distribution of didymo in Esopus Creek (Catskill Mountains) and the chemical and hydrological causes of blooms by using water chemistry and microscopy techniques. On a weekly basis in June and July 2011, we sampled at 7 sites, ranging from the headwaters to just above the Ashokan Reservoir. Geographic Information Systems (GIS) were used to analyze spatial patterns of didymo distribution and cell densities within the Esopus Creek and in four tributaries above the

reservoir. Higher didymo areal densities were found near public fishing access points, as well as in parts of the creek that experienced lower flow velocities. We have identified the bloom extents and this project will provide valuable information for educational material that can be posted at stream access points along the Esopus Creek. This will inform fishermen and other recreational stream-users about how to clean gear and avoid transport of didymo cells from stream to stream.

**Physiochemical Growth Controls of the Freshwater Diatom *Didymosphenia Geminata* in the Rondout Creek, New York**

**Amalia M. Handler, Franklin and Marshall College**

The freshwater diatom, *Didymosphenia geminata* (didymo), is native to nutrient poor (oligotrophic) northern temperate regions. In recent years, didymo has become a nuisance species by producing a dense mat, covering benthic stream systems. The mat is composed of an extracellular polysaccharide stalk, thought to be used for absorption of limiting macro- and micronutrients in oligotrophic systems. In summer of 2011, we prepared and deployed a number of nutrient combinations into the Rondout Creek (Catskills, NY), where didymo was first detected in March 2011. The experimental unit releases nutrients to the biofilm colonizing a glass frit substrata. Seven treatments (acetate (Ace), iron (Fe), sulfate (S), phosphate (P), acetate + sulfate (AS), iron + sulfate (FeS), and acetate + sulfate + iron (ASF)) were placed in the Rondout Creek for two weeks. The colonized substrata were analyzed for didymo cell densities, chlorophyll concentrations, primary production, and respiration. The Ace, AS, and ASF treatments had higher mean cell densities and lowest negative values for net ecosystem metabolism (NEM), with $O_2$ consumption by respiration exceeding $O_2$ released by photosynthesis. Given high cell densities in the treatments with acetate and the low NEM, we believe that bacteria are creating an oxygen poor environment, which enables didymo to more easily remove nutrients from the water column, grow stalk material, and reproduce. Chlorophyll *a* concentrations were not correlated with didymo cell densities; however, the mean chlorophyll a concentrations were higher in the phosphate treatment than all other treatments. A comparison of chlorophyll *b*, which is associated with green algae, and chlorophyll *c*, which is associated more with diatoms, through chlorophyll *b*/*c* ratios were similar between all treatments and lower than the phosphate treatment ratio. The phosphate treatment with low didymo cell densities, high chlorophyll *a*, and high chlorophyll *b*/*c* ratio suggests that other algae are outcompeting didymo for resources. This research indicates that didymo mats have a complex role in nutrient sequestration, possibly closely tied to bacteria living in the mats and that interspecific competition between didymo and other algae effects bloom size.

**Factors Controlling Water Quality of the Esopus Creek Watershed, New York**

**Casey R. Halton, SUNY New Paltz**

The Ashokan Reservoir watershed is one of the main drinking water sources for New York City. Monitoring the temporal changes of water quality parameters upstream and downstream of this reservoir is very important due to the significantly large population that is dependent upon this resource. The aim of this study is to develop a dataset of current water quality parameters and identify factors that control these parameters for comparison to future research. Fifteen sites were selected upstream of the reservoir in the Stony Clove Creek, a tributary of the Esopus Creek, and its tributaries. Seven sites were selected downstream of the reservoir in the lower Esopus Creek. Lab and field parameters including temperature, pH, dissolved oxygen (DO), conductivity, total dissolved solids (TDS), turbidity, alkalinity, and major cation (Sodium, Potassium, Lithium, Ammonium, and Magnesium) and anion (Nitrate, Phosphate, Nitrite, Chloride, Sulfate, Fluoride, and Bromide) concentrations were measured for each site. Ion concentrations were determined using an Ion Chromatograph. Water temperature was found to be higher and the concentration of dissolved oxygen was found to be lower downstream of the reservoir. Alkalinity was found to be higher in the lower Esopus Creek where it flows over Paleozoic carbonate rocks. The upper Esopus basin is generally dominated by silica-rich sandstones with little or no buffering capacity; however one sampling point in the Stony Clove Creek displayed abnormally high alkalinity values due to the installation of imported rip rap of calcareous rock for stream bank stabilization. Nitrate concentrations were found to be significantly higher at sites in the Esopus Creek below the reservoir. Turbidity was found to be higher at sites upstream of the reservoir, especially in the lower Stony Clove Creek and Warner Creek, one of its tributaries. These water quality parameters are most likely controlled by differences in land use practices and heterogeneous glacially-derived surficial geology.

**Biological Stream Survey of Lower Esopus Creek, Catskill Mountains, New York**

**Elizabeth K. Johnson, CSU Monterey Bay**

Spillovers and releases from the Ashokan Reservoir into the Lower Esopus Creek have been observed to increase discharge, water level, and turbidity. Concerns about these effects on drinking water quality and stream ecology have spurred debate between the New York City Department of Environmental Protection (NYC DEP) and citizens living within the Esopus Creek watershed. This study was designed to assess Lower Esopus Creek health, compare current conditions to those in 2007, and identify controlling factors in benthic macroinvertebrate (BMI) distribution. Samples were collected, twice in July, at seven sites below the reservoir, six sites along Lower Esopus Creek and one on Sawkill creek (a tributary to Esopus Creek). Data was collected under both normal flow conditions and after a storm event. BMI and water samples were collected at each site. The BMI samples were collected, stored, and evaluated according to the 2009 New York State Department of Environmental Conservation (NYS DEC)

protocol for Biological Monitoring of Surface Waters in New York State. Physical habitat and water chemistry parameters were also measured in the field. During this sampling period, the same methods were used at seven sites in the Stony Clove Creek and its tributaries. Non-parametric tests were used for analysis due to the small sample size and non-random nature of the sampling. The results showed no significant differences in BMI populations between normal and high flow conditions, or between 2007 and 2011. BMI population, total dissolved solids (TDS), turbidity, current, and dissolved oxygen (DO) were not significantly correlated to distance downstream from the reservoir. BMI population was significantly correlated to TDS and DO, but was not significantly correlated to turbidity. There are no significant longitudinal trends in Lower Esopus Creek; therefore stream ecology is probably more affected by local conditions than by impoundment effects from the Ashokan Reservoir.

**Biological Assessment of Water Quality and Turbidity in the Stony Clove Creek, Catskill Mountains, New York**

**Natalie J. Hughes, Binghamton University**

This study was conducted to characterize the water quality of the Stony Clove Creek, a tributary of the Esopus Creek, in the Ashokan Watershed of the Catskill region of New York State. The stream is of particular interest to the New York City Department of Environmental Protection (DEP) because it has been identified as a significant contributor of suspended sediment in the Ashokan Reservoir, one of the largest drinking water sources for New York City. The main cause of turbidity is bank erosion of abundant clay-rich tills and glacial lacustrine layers as well as several complicated riparian slope failure systems. Benthic Macro-Invertebrates (BMI) sampling, field parameters such as dissolved oxygen (DO), pH, total dissolved solids (TDS), temperature, and major cation/anion concentrations were analyzed to characterize the water quality. BMI indexing at the family level indicated that the benthic community of Stony Clove is slightly impacted near the confluence with the Esopus Creek and decreases in impaction towards the headwaters. Despite the turbid baseline flows (values ranging from approximately 1-25 NTU) in the lower reaches of the Stony Clove Creek, turbidity is probably not the primary factor controlling the ecological health of the BMI habitat. It is most likely a combination of natural and anthropogenic alterations to the habitat, chemical constituents, and physical properties which inhibit the water quality. This study also provides baseline data to be utilized when determining future stream management and water quality monitoring programs in the Stony Clove Creek.

**The Hydrogeology of a Highly Unstable Streambank Affecting New York City's Drinking Water Supply**

**Shane M. Putnam, SUNY Oneonta**

In an effort to reduce chronic turbid conditions, the New York City Department of Environmental Protection (NYC DEP) has an ongoing plan to implement a stream restoration project on an actively failing bank of the Stony Clove Creek in the Catskill Mountains of upstate New York. The Stony Clove is a tributary of Esopus creek, which feeds the Ashokan Reservoir; one of New York City's largest drinking water supplies. It is also the largest source of suspended sediments in the watershed. Monitoring wells were installed upslope of a large landslide during the planning stages of the bank stabilization project; however, the groundwater-surface-water interactions were neither explored nor taken into account in the design.

Water samples from each well, surface channel, and the Stony Clove were analyzed using an ion chromatography system, while slug and pump tests were performed on the wells to quantify aquifer properties. The Hvorslev Slug-Test Method was used to determine the hydraulic conductivity and transmissvity of the waterbearing units. The depth to water was higher than the depth to the well screen in all wells, demonstrating the confining effects of the clays which increase pore pressure and the potential for slope failure. Hydrogeochemical signatures indicate that the surface channels are not directly connected to the deeper groundwater system which seeps from the sandy layers of interbedded massive clays and sands and enters the Stony Clove Creek as baseflow. Hydraulic conductivity values as low as 0.0031 m/day and as high as 0.029 m/day were observed between the wells, as is typical for aquifers dominated by glacial clays. The lack of connectivity between the channels and the seeps located within the failure zone suggests that armoring the bank and diverting surface-waters, as is intended, will only offer a temporary fix.

**Disinfection Byproduct Formation Potential of the Esopus Creek Watershed**

**Andrew J. Jacobs , Alfred University**

Disinfection byproducts (DBPs) are halogenated organic compounds formed when water containing dissolved organic matter is chlorinated during the drinking water treatment process. The specific compounds formed as DBPs are dependent on the source material, and while many DBPs have yet to be characterized, previous research has established that trichloromethane (chloroform) and trichloroacetic acid are often formed. These compounds are toxic, and maximum allowable limits in municipal drinking water are regulated. The goal of this project was a spatial analysis of source contribution to DBP formation in the Catskill Watershed. Gas Chromatography-Mass Spectrometry and UV-Vis data suggests filtered water has a greater capacity to form DBPs than water containing suspended clay particles. This is believed to be in part due to the adsorptive properties of clay particulates. Chloroform was detected in chlorinated samples from the Stony Clove Creek and Esopus Creek at concentrations up to 0.067 mg/L.

Results suggest a complex relationship between sediment load, dissolved organic matter, and DBP formation.

**The Disinfection Byproduct Formation Potential of the Esopus Watershed**

**Michelle Weber, University of the Cumberlands**

When water containing dissolved organic carbon (DOC) is chlorinated during water treatment processes there is the potential to form harmful halogenated organic byproducts or disinfection byproducts (DBP). The Esopus Watershed's potential for making these DBPs was studied as it is the water supply for New York City. High sediment load was of particular interest in this watershed because New York City has obtained a waiver to treat its water without filtration. Samples that were both unfiltered and filtered through a 0.45µm filter were collected at twelve sites along streams feeding the Ashokan Reservoir. Studies have shown a strong linear correlation between the decrease in UV absorption at 272 nm after chlorination due to the breakdown of the organic molecules aromatic rings and the formation of total organic halogen (TOX). Additional tests were run on chlorinated samples quenched with N, N-diethyl-p-phenylenediamine (DPD) in order to measure free chlorine and thus show how much chorine had been incorporated into the organic structures. Chloroform and haloacetic acids, specific kinds of disinfection byproducts, were measured separately using gas chromatography joined to a mass spectrometer (GS/MS). Trends confirmed by both DPD quenched samples and samples run through the GC/MS show a tendency for unfiltered samples to produce less byproduct after chlorination for water collected from Esopus Creek. This is believed to be a result of DOC adhering to clay particles while in sample bottles and not being available later to produce byproduct. Assuming these bench scaled test are representative of the water being treated for consumption in New York City, failure to filter the drinking water may not pose as large of a threat as originally hypothesized.