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INTRODUCTION AND ACKNOWLEDGMENTS

Dear Conference Participants,

In 1997, the signatories to the historic New York City Watershed Agreement formed an enduring partnership to protect and enhance the City’s Watershed and the scores of communities living within it. Underlying this complex social and political undertaking has been an unprecedented technical initiative among scores of local, State and federal agencies with one common goal: to advance the science of watershed protection.

The Watershed Science and Technical Conference was created as an annual opportunity to bring scientists, professionals, and other experts together with watershed stakeholders and the public, to technically inform, exchange ideas, and unveil new information regarding the protection of the nation’s largest unfiltered surface water supply.

The Conference Call for Abstracts was made to agencies and stakeholders in and beyond the New York City Watershed. The resulting responses were reviewed by the Technical Program Committee for technical merit and interdisciplinary utility, as well as temporal and substantive relevance. Those chosen by the Committee for presentation at this year’s Conference are included in the compendium.

In addition to our esteemed presenters and all those who submitted their scientific endeavors, we wish to thank the many agencies, professional organizations, and individuals who contributed to the success of this conference. It is our hope that all who attend will be edified by the scientific data presented, and inspired by the dedication and hard work of those who, each day, advance our insight into the science of protecting the drinking water for 9 million New Yorkers.

Respectfully,

William C. Harding
Executive Director, Watershed Protection and Partnership Council

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The Catskill Watershed Corporation
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Future Climate Projections of NYC Watershed: Gcm Selection and Downscaling

Anandhi Aavudai, Ph.D. and Allan Frei, CUNY Institute for Sustainable Cities, Donald Pierson, Ph.D. and David Lounsbury, NYC Department of Environmental Protection

Global circulation models (GCMs) are mathematical models developed to simulate the climate conditions on earth, for hundreds of years, using the fundamental laws of physics and observations. Hence GCMs are important tools for simulating and understanding climate. Nevertheless, the use of GCM data is difficult at relatively finer spatial scales (e.g., watershed, small river basin) due to the relatively coarse spatial resolution of the GCM data. For example a typical GCM grid cell ranges between 40,000 - 90,000 km2 while New York City (NYC) model simulations are typically run on watershed areas of 25-1200 km2. Hence, techniques, such as the regional climate models, or statistical downscaling methods, are developed specifically for the study of climate change in watersheds of the scale found in the NYC water supply. A suite of watershed and reservoir models are required to understand the affects of potential climate changes on the water quantity and quality in the NYC supply. Selection of GCMs to provide input data for these models becomes important and valuable, as the number of model runs for impact studies increases exponentially with every GCM selected. GCM selection starts with the evaluation of GCM projections with respect to model performance (how well a GCM simulates the observed climate record). The GCMs are then ranked in terms of its performance. The highly ranked GCMs are selected for further downscaling to obtain scenarios of climate change at watershed scale for further climate change impact studies. This objective of this study is to evaluate the performance of GCMs in simulating the temperature and precipitation for NYC watersheds, to select the GCMs and to describe the method used to downscale the chosen GCM models to the local watershed scale. GCMs from Intergovernmental Panel on Climate Change’s (IPCC) fourth assessment report are evaluated in this study.

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Assessment of Protozoa in New York City’s Hillview Reservoir

Kerri Ann Alderisio and Steve DiLonardo, NYC Department of Environmental Protection

Hillview Reservoir, located in Yonkers, New York, is the terminal reservoir for New York City’s (NYC) Catskill and Delaware water supplies. It is an elevated, uncovered reservoir with a capacity of 0.9 billion gallons, through which approximately 500 million gallons pass every day. As an uncovered finished water reservoir, Hillview is governed by the requirements of the Environmental Protection Agency’s Long Term 2 Enhanced Surface Water Treatment Rule (LT2) which requires utilities with uncovered finished water storage facilities to take steps to address contamination risks. These steps include either covering the reservoir, or treating the discharge to achieve inactivation and/or removal of 4-log virus, 3-log Giardia lamblia and 2-log Cryptosporidium. The NYC Department of Environmental Protection performed a study between September 2006 and August 2008 to determine if there was a significant contribution of protozoa after the inlet to Hillview Reservoir, but prior to the outlet. A total of 300 field samples were collected, including 98 paired samples entering and leaving the reservoir, in addition to over 90 duplicates and nearly 150 matrix spike samples. As with many protozoan studies, the statistical tool selected and the quality control data were critical to the data interpretation. In all, 82% of the data resulted in the same value at the effluent as at the paired influent of the reservoir making statistical analysis a challenge. Data analysis using the appropriate modified sign test indicated no evidence that either Giardia or Cryptosporidium were significantly greater at the effluent of the reservoir compared to the influent (p = 0.5). Analysis of both matrix spike and duplicate data support this conclusion. In summary, data from this study do not indicate that there is a significant contribution of Giardia cysts or Cryptosporidium oocysts within the negligible Hillview Reservoir watershed.

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Do Fish Care about Restoration in Streams of the New York City Watershed?

Barry Baldigo, US Geological Survey

The effects of stream restoration on fish assemblages and habitat are seldom monitored, evaluated, nor published. Thus, ecological impacts are poorly described and subsequent projects cannot build upon prior successes or failures. Fish assemblages at six pairs of treatment and control reaches in five Catskill Mountain streams were sampled 3 to 6 times from 1999 to 2007 to assess their response to natural-channel-design (NCD) restoration. A Before-After Control-Impact (BACI) study design was used to quantify net changes in fish indices at treatment reaches relative to those at nearby control reaches. In general, restorations produced significant increases in community richness (+29%), diversity (+39%), species and biomass equitability (+12 to 34%), and total biomass (+28%), and a decrease in total density (-22%). Although net biomass of trout increased on average by 105% and dace and sculpin biomass decreased by 38%, analyses show that stream habitat and fish assemblages did not improve at two of six restored reaches. Differences in fishery indices at stable and unstable reaches identify several thresholds that may be indicative of poor habitat quality, and which may help gauge the prospects for improvements following restoration. Although fish responses were sometimes inconsistent among streams, our findings demonstrate that health of fish communities and trout populations at unstable reaches can benefit from NCD restorations. Fish, therefore, do appear to care about stream stability and restoration. The universal lack of monitoring programs and published findings, however, continues to impair our understanding of the relations among stream stability, fish assemblages, habitat quality, and restoration.

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Watershed Protection through Local Leadership in the Schoharie Basin

David Burns, NYC Department of Environmental Protection and Michelle Yost, Greene County Soil and Water Conservation District

An effective watershed management approach recognizes that local communities, officials and decision-makers are integral to water quality protection. Now that Stream Management Plans have been completed for all major tributaries in the Schoharie Basin, implementing the plans—recommendations through local participation and decision-making—is the task before the Schoharie Watershed Advisory Committee (SWAC). Charged with taking stream management plans to the next level of implementation, the SWAC consists of appointed representatives from each Schoharie Basin municipality, representatives from three subcommittees (Highway Superintendents, Education & Outreach, and Recreation and Habitat), and a Greene County Legislator. Technical and advisory support is provided by local, state and federal regulatory and non-profit agencies. The local communities are taking their responsibilities seriously as evidenced by most adopting the relevant stream management plan, signing Memorandums of Understanding with the GCSWCD or Schoharie SWCD and appointing representatives to the SWAC. The goal of the Stream Management Implementation Program (SMIP) is to foster a holistic, science-based, cooperative approach to watershed management with the SWAC being the conduit to building local awareness and capacity. By capitalizing on the knowledge and diversity each committee member brings to the process, the SWAC and technical advisors continue to learn from and support one another as the SMIP unfolds. Two million dollars has been allocated by NYCDEP specifically for the SMIP, with additional funding provided to the GCSWCD for technical expertise to ensure an integrated, comprehensive watershed program approach. SMIP funding categories include: creative stormwater practices and critical area seeding, landowner stream assistance, planning/assessment, highway/infrastructure improvement, education on watershed protection, and recreation and stream habitat improvements. An application process launched in March 2009 is an exciting step for the watershed committee. Basin activities by the SWAC, GCSWCD, SCSWCD and NYCDEP are tracked through annual action plans, which are available at www.catskillstreams.org/SWAC.html.

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An Examination of Chlorine Demand in the Catskill and Delaware Supplies During 2005-2006

Charles Cutietta-Olson, NYC Department of Environmental Protection

The physical property of chlorine demand of the Catskill and Delaware Systems’ waters is assumed to be influenced by temperature, pH and occasionally turbidity. Electronic and paper records were combined to create a data set for the period 2005-2006 which included source water turbidity and treated water chlorine residual in 5 minute intervals and pH, temperature and other parameters measured less frequently. Chlorine demand for each system was calculated as the initial chlorine concentration derived from the target dosage minus the chlorine concentration at the first treated site. Examinations of chlorine demand graphically and statistically found fairly stable values over the two year period that were not substantially influenced by any of the three parameters, although statistical significance was observed probably due in part due to the high number of data points. The effort required to assemble and prepare the data for this project illuminate requirements for data content and structure if this type of analysis is considered useful to pursue in the future.

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Japanese Knotweed Composting Feasibility Study, Delaware County, NY

Laurence Day and Jessica Rall, Delaware County Soil and Water Conservation District, Susan McIntyre, Delaware County Department of Public Works and Charles Terrance, SUNY Delhi

This project investigated the possibility of using a municipal solid waste co-composting facility in Delaware County, NY as a means to safely dispose of “Japanese knotweed” (Fallopia japonica). Live portions of mature knotweed stems, leaves, roots and crowns were subjected to conditions within the composting process by using sentinels to contain and allow retrieval of samples from active piles of compost. Samples were subsequently removed from sentinels, planted in pots containing a peat-based growing medium and placed in growth chambers for 30 days. Treatment of three days or more at sustained temperatures >55° C was adequate to kill all samples in the sentinels; moist heat treatment alone for three days between 52° and 55° C seemed equally effective. Results suggest that introducing minor amounts of Japanese knotweed into the present composting process or similar bio-solids composting operations may be a practical disposal option.

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An Interactive Water Information System for the Consolidation of Inter-Divisional Data: A Case Study

Steven DiLonardo and James C. Alair, NYC Department Environmental Protection

The New York City Department of Environmental Protection (DEP) is a large organization which generates vast amounts of data in many forms from many different divisions, and these are stored in several locations. Continuously monitored data, such as meteorological and stream discharge data, is especially subject to access limitations since it is not all in a centralized database. In response to this, DEP has made efforts to consolidate the various data sources through an interactive data information system which permits data access to all DEP employees, and more importantly, offers a central location for data to be stored and checked by data managers. Currently, the data information system is set up to automatically import data via data scraping import tools at 288 sites, including USGS and DEP stream discharge gauges, meteorological stations, keypoints, and reservoir capacities. The data end-user interfaces with the dataset using an interactive map and can generate tables and charts. While in development, the utility of this system was highlighted following a sewage spill, which occurred as a result of a power failure at a sewage treatment facility. The municipality estimated that 200 gallons of sewage entered the reservoir. Using the information system, which stores stream discharge data, DEP was able to retrospectively determine that over 20,000 gallons entered the reservoir shortly after it was notified of the spill. Consequently, proper measures were taken in response to this spill. Once complete, this system will have the capabilities of notifying data managers that data has exceeded specified limits, which would lead to a more proactive response to emerging events. Also, this data information system can be used for operational decision-making (aqueduct shutdowns), data analysis (annual reports), and quality control (data comments), which would ultimately streamline the use and access of data.

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A Probabilistic Model for Turbidity and Temperature in the Schoharie Reservoir Withdrawal

Steven Effler, Ph.D. and Rakesh Gelda, Ph.D., Upstate Freshwater Institute and Donald C. Pierson, Ph.D., NYC Department of Environmental Protection

Mathematical models of water quality are invaluable tools to support management decisions for impacted aquatic ecosystems that are the focus of rehabilitation initiatives. Robust representations of the effects of variability in natural and operational drivers in application of validated models to evaluate management options are widely sought. Long-term model simulations, driven by long-term records of environmental forcing conditions, such as meteorology and hydrology, meet this goal and support probabilistic presentations of predictions. This approach and its utility is demonstrated for the water quality issues of turbidity and temperature of the withdrawal of Schoharie Reservoir, NY. The development and application of a probabilistic modeling framework to conduct a priori simulations (forecasts) of temperature (Tw) and turbidity (Tn,w) in the withdrawal is described. The model framework incorporates previously tested transport/hydrothermal and turbidity submodels, long-term (57 years) records of meteorology, hydrology, and operations, and empirical models to specify other drivers, including tributary temperature and turbidity inputs, over the same period. The probabilistic framework simulates the observed wide variations in Tw and Tn,w for an eighteen year period very well. The major sources of variability for both Tw and Tn,w are demonstrated to be variations in hydrologic and linked operating conditions. Application of the probabilistic framework indicates the water quality goal for Tw (21.1 °C) could be met continuously with a multi-level intake (MLI) facility, instead of the existing single fixed depth intake. However, this management alternative would provide only modest benefits for Tn,w levels. Probabilistic forecasts with the model predicts that moving the MLI facility to a deeper portion of the reservoir will not improve the water quality of the withdrawal within the context of management goals.

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Habitat Responses to NCD Restoration: The Good, the Bad, and the Ugly

Anne Ernst, Barry Baldigo and Christiane Mulvihill, US Geological Survey and Mark Vian, NYC Department of Environmental Protection

Stream restorations based on natural-channel-design (NCD) concepts attempt to mimic stable reference-reach geomorphology and thereby allow recovery of the original stream processes and habitat. Six reaches on five disturbed Catskill Mountain streams were restored during 2000-03 through NCD techniques to decrease bed- and bank-erosion rates, decrease sediment loads, and increase water quality. Habitat surveys were conducted during summer baseflow. A BACI (before-after-control-impact) study design and ANOVA tests were used to evaluate the effects of NCD restorations on net changes in stream-channel and bank variables in the study reaches relative to those in upstream control reaches. Three measures of bank stability indicate that stability increased significantly overall during the first 2 to 5 years after restoration, although stability was unchanged in 2 streams when analyzed individually. Mean channel depth, thalweg depth, and pool-to-riffle ratio generally increased, whereas mean channel width, percentage of streambank area covered by trees, and measures of shade generally decreased. Channel dimensions after restoration were generally characteristic of a more stable stream form. Washed out vanes and displaced boulders caused by high flows in some streams still served to increase habitat quality via improved heterogeneity. Habitat suitability index (HSI) scores for several trout species increased in streams where stability increased, but were unchanged in streams where stability was unchanged. Although habitat responses were sometimes inconsistent among streams, these findings demonstrate that NCD restorations can improve habitat conditions in disturbed mountain streams.

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Bio-Stability of New York’s Distribution Water Evaluated by HPC and Bioreactor Biofilm

Salome Freud, Xiaoping Wang, Ph.D. and Guo Baiying, Ph.D., NYC Department Environmental Protection

The ability to limit regrowth in drinking water is referred to as biological stability (bio-stability) and is dependent on the concentration of the substrates required for the growth of microorganisms. The bio-stability of New York City’s distribution system water was assessed by evaluating HPC levels in distribution water and biofilms from a laboratory bioreactor. The HPC levels in the drinking water were compared in 5 year increments with data from 1990 to 2008. HPC levels were measured in drinking water from the distribution system and in prefinished water samples. The HPC levels were categorized by concentrations: <1, 1-100, 101-200, 201-500, >500 cfu/mL. HPC levels in distribution declined with time between 1994 and 2008. The greatest decrease was observed in samples with the highest levels of HPC, >500 cfu/mL, but the proportion of samples in the other categories >1 cfu/mL also declined significantly. All HPC samples >50 cfu/ml were speciated by an automatic bacterial ID system (Vitek). These analyses showed that the most frequently isolated HPC bacteria were Acinetobacter spp, Aeromonas spp, Enterobacter spp, and Pseudomonas spp, in the years between 2000 and 2004. Aeromonas spp and Enterobacter spp decreased tremendously between 2005 to 2008. The HPC levels of biofilm grown on cast iron slides in a laboratory bioreactor supplied with NYC distribution water were used to evaluate the regrowth capacity supported by BDOC (biodegradable organic carbon) in New York City’s distribution system over time. These biofilm samples were collected and analyzed in 2006 to 2008. Biomass analysis showed that BDOC can support only 105 to 106 log cfu/cm2 of HPC bacteria growth in a two week period. HPC levels from the biofilm samples were consistent over the 3 years of monitoring. These studies show that HPC levels have declined and New York City’s distribution system is a bio-stable system.

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A Turbidity Model for Ashokan Reservoir, NY

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Inorganic suspended particles are important to the ecology and water quality of aquatic ecosystems. These particles delivered during runoff events cause problems of high turbidity in many lakes and reservoirs. Mathematical models of turbidity are desired that couple the patterns of the terrigenous driver with those of the receiving waters associated with runoff events, to quantify cause and effect relationships and to provide a framework to evaluate management alternatives to abate the problem. In this study, a turbidity model, composed of a two-dimensional hydrothermal/transport submodel and a turbidity submodel, is developed and tested for Ashokan Reservoir, NY, that experiences elevated turbidity levels following runoff events. A robotic monitoring network, rapid profiling instrumentation, and individual particle analyses are used to support the modeling, by specifying turbidity loads and in-reservoir patterns and features of the particles that guided representation of settling. The turbidity-causing particles are clay minerals, 1 to 10 µm in diameter. The hydrothermal/transport submodel that serves as the physical framework for the overall model, was separately validated for a 13 year period. The turbidity submodel considered three particle size/settling velocity classes of turbidity, consistent with the independent individual particle characterizations. Robust performance is demonstrated for the overall turbidity model, as it simulates well the wide range of patterns observed in the reservoir and withdrawal, associated with a number of major runoff events from the same 13 year period. The model will be used to support forecasting in the evaluation of management alternatives intended to abate the problem.

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Post Flood Tools and Techniques for Working in and Near Streams

Scotty Gladstone and Rick Weidenbach Delaware County Soil & Water Conservation District and Philip Eskeli, NYC Department of Environmental Protection

Following floods, the need to reopen transportation networks and ensure public protection along waterways that have become choked with debris and sediment requires local government to commit its fiscal and manpower resources to stream work. Emergency stream work or “stream intervention” must occur within hours and days of the event, leaving little time for assessment and design. Deciding where to work and how much to address are critical to effective response. Over excavating stream channels or extending operations into less impacted stream reaches can have negative implications for stream function, stream stability, aquatic habitat, and water quality, not to mention fiscal consequences to the community. This year, Delaware County Soil and Water Conservation District, working from their experience following floods in 2006-2008, is providing local highway departments and private construction contractors with a series hands on training sessions to enable them to make decisions on where and how to work in streams following flood events. Using information developed by Catskill stream managers about the proper sizing of streams in the Catskills and strategies for restoring the stream’s access to its floodplain, preserving sinuosity, and minimizing disturbance, the training is demonstrating these concepts at sites across the Catskills. This session will review the training program progress, highlight issues that have been the focus of the training and describe on how this type of training works within a framework of coordinated flood response and recovery. The training is sponsored by NYS Environmental Protection Fund and NYC DEP Stream Management Program.

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Riparian Restoration Plan for Agricultural Lands in the Raritan Basin

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In 2006, North Jersey Resource Conservation & Development Council, the New Jersey Water Supply Authority (NJWSA) and the New Jersey Institute of Technology (NJIT) received a Cooperative Conservation Partnership Initiative (CCPI) grant from the Natural Resources Conservation Service (NRCS) to develop a riparian restoration plan for agricultural lands in the Raritan Basin. The Basin, which provides water supply for approximately 1.5 million people, comprises approximately 1,100 square miles. Agricultural use comprises approximately 19% of the Basin. Riparian area analyses show a conversion of approximately 30% of the Basin’s historical riparian areas to urban and agricultural land uses. This indicates a need for better protection of stream corridors to prevent future degradation of the Basin’s surface waters and continued loss of habitat. As part of the Raritan Basin Watershed Management Plan, NJWSA delineated riparian areas. Through the CCPI project, NJIT mapped Critical Source Areas (CSA), the intersection of hydrologically sensitive areas (those that actively contribute to runoff) and pollutant source areas. Restoring buffers within CSAs is both environmentally effective and cost-effective. Utilizing the baseline riparian area and CSA mapping with GIS layers for wildlife habitat, impervious surface, and an erodibility index, the project team developed a multi-criteria decision making framework to identify priority restoration areas. The project team analyzed the funding needed to implement the restoration plan. The team worked closely with agricultural producers to gain a better understanding of why these programs are not being fully utilized. An interview protocol was developed for use with agricultural producers and landowners. Interview results identified perceptions about riparian buffers and educational, financial and institutional barriers to buffer adoption. High priority areas for riparian restoration were identified during the planning process. The plan will provide a clear road map to achieve restoration of these critical areas, thus maximizing the environmental benefit of conservation funding.

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River-Friendly Certification Programs
Kathy Hale, New Jersey Water Supply Authority and Abigail Jones North Jersey Resource Conservation & Development Council

The New Jersey Water Supply Authority (NJWSA, www.njwsa.org) implements a suite of River-Friendly programs, including those for Golf Courses, Businesses and Residents. Through these programs, NJWSA works with landowners to improve water quality by implementing actions in 4 categories:

- Water Quality Management & Nonpoint Source Pollution Management,
- Water Conservation
- Native Habitat & Wildlife Enhancement, and
- Education & Outreach.

The voluntary River-Friendly Golf Course and Business programs are a cooperative effort between the participants and NJWSA. They provide an opportunity for landowners to become local stewards, to showcase positive environmental actions they have already taken and to work with NJWSA to implement new practices. Participating landowners receive ongoing technical information, support and guidance for implementing environmental actions tailored to their unique location, resources and needs.

The voluntary River-Friendly Resident program is a resident’s pledge to manage their property in a responsible manner to help protect our drinking water resources and the environment. The questionnaire includes questions about lawn management practices, water conservation and septic system management. Technical assistance is available to residents who wish to implement River Friendly actions on their property.

The River-Friendly Farm program, administered by North Jersey Resource Conservation and Development Council (www.njriverfriendlyfarm.org) and the Raritan Watershed Agricultural Committee, uses a set of five criteria, including nutrient management, pest management, riparian buffers, soil loss and irrigation water management. Approximately 30 farms are participating in the program.

The River-Friendly programs offer an incentive-based approach to best management practice implementation. For farms, golf courses and businesses, this recognition incentive, when properly marketed, can translate to financial incentives through increased business from educated consumers.

We will discuss the challenges and successes we have experienced during the implementation of these programs, as well as the modifications made in response to those challenges.

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Prediction of Land Use Change and Nutrient Loading Consequences in the West of Hudson Watersheds to 2022

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To estimate potential future changes in nutrient loading from land use change in the West of Hudson watershed we have applied the land use change model GEOMOD to test which of over 30 independent landscape factors explain the historical transition from undeveloped to developed and from agriculture to forest in the WOH watersheds. Patterns based on the calibration period of 1975 to 1987 were projected to 2002 and validated against the actual 2002 landscape using the receiver operating characteristic (ROC) statistical measure of “goodness of fit.” Once the best combined set of drivers and their relative weights were determined we created post-2002 “transition potential” maps for both types of change. We then applied rate projections derived from satellite imagery analysis and parcelization history at the town level to project land cover change to year 2022, and applied the results of our statistical analysis of 2001-2003 median nutrient export coefficients to project 2022 water quality impacts. The landscape factors with the highest individual ROC explaining transition to development, stratified by town, were 1) distance from developed areas, 2) seasonal housing unit density, and 3) median home value. For abandonment of agriculture the most important factors were slope, elevation and distance from other farmland. Projections to 2022 resulted in between 2,934 and 6,538 acres of new development. Reforestation occurs at a rate of 2% in keeping with the 1987-2002 trend resulting in 17,735 acres of agricultural land returning to forest. Water quality predictions vary according to the development rate employed. At the watershed level, under the higher development rate, TN loading would be reduced in the Cannonsville and Pepacton drainages due to reforestation, but is offset by higher loadings in all other basins. All six basins would experience enhanced TP loading. TDP, SRP and NO3NO2 increase in all basins except the Pepacton.

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Use of a Saturated/unsaturated Zone Groundwater Model to Investigate Soil-Water Dynamics in Onsite Wastewater Treatment Systems

James Hassett, Ph.D. and Ouro Koumai, SUNY Environmental Science and Forestry

Water quality in the New York City water supply system depends in part on the integrity of on-site individual wastewater treatment systems. We investigated wastewater flow dynamics in subsurface wastewater disposal systems (SWISs) using the VS2DTI, graphical two dimensional software package. First, two generic models (one raised trench and one conventional system) were used to study the effect of flow rate, soil textural class, soil layers and site slope on the systems water table response to wastewater disposal. Second, unsaturated/variably saturated wastewater flow in three SWISs in the New York City’s Catskill/ Delaware watershed was simulated to understand breakout, seepage, unusual grass growth patterns and soil saturation within these systems. Engineering design data from the Catskill Watershed Corporation were used as basis of model inputs. Water table mounding was found to be linearly correlated to the wastewater application rate. The soil texture class and layer stratification play important roles in pressure head changes and can determine whether a system succeeds or suffers hydraulic failure. The occurrence of breakout on one raised bed system was found to be related to flow patterns between the native soil and the fill material in sloped sites. Grass growth patterns observed on S2 was due to increased moisture content around the perforated discharge pipes. The consistent saturation at C2 was attributed to the lack of provision of a minimum of 4 feet of usable soil at time of installation. The VS2DT modeling results typically justified requirements set in appendix 75-A by the NYS DOH. Model application to the three actual systems more or less replicated the observations made in the field. These results suggest the use of such models to predict SWIS design success thus ensuring adequate system performance over the life of the system.

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The Impacts of Reservoir Drawdown on Water Quality in NYC’s Catskill and Delaware Reservoirs

Lorraine Janus, Ph.D., G. Marzec, R. Van Dreason and D. Pierson, Ph.D., NYC Department of Environmental Protection

The water levels of NYCDEP’s water supply reservoirs influence water quality. Water levels (i.e., elevations) are influenced primarily by runoff, consumer demand, and releases to streams. When significant water level reductions occur, due to drought or drawdown, water quality is usually affected in a negative way. The objective of this study was to quantify the impacts of reservoir drawdown on water quality parameters in several reservoirs. A basic tenet of limnology is that water quality is influenced by hydrology. Hydraulic loads determine both nutrient loading and water residence times. Together, loading and water residence times determine biological productivity. Elevation histories and water residence times of headwater and terminal reservoirs were used to characterize reservoirs. An analysis of 20 years of data on several reservoirs was conducted to demonstrate how water quality has responded to drought or drawdown in the past. Time series plots, scatter plots, and correlations were used to identify the strongest relationships between water quality and reservoir elevation. An interesting feature of these data was that in many cases, the relationship between drawdown and water quality parameters became stronger once water levels fell below a critical elevation. Case studies of specific periods of drawdown, such as those in 2008 for Ashokan and West Branch were also examined. Model simulations show that measured turbidity levels in the West Basin of Ashokan were affected by sediment resuspension during drawdown. Similar effects would be expected to occur in the East Basin and this could impact use of Ashokan Water. High frequency monitoring of West Branch turbidity during a 2008 Delaware Aqueduct shutdown also demonstrated increased turbidity during drawdown. In this case, increases in turbidity were relatively small, but these could impact Kensico Reservoir which is subject to the most stringent regulatory criteria.

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Results of the Continued Catskill Forest Nutrient Imbalance Experiment

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Atmospheric deposition has altered Catskill soils by decreasing the availability of calcium and increasing the availability of nitrogen. In other parts of the Northeast, this type of nutrient imbalance has been shown to slow growth and lower the resistance of trees to stresses such as climate and pest infestations. With over 95% of the NYC watersheds forested, changes in the growth and health of the Catskill forest could have significant effects on the quality of the NYC water supply. To evaluate a possible imbalance in the availability of nitrogen and calcium (and possibly magnesium), a long-term study was initiated in the fall of 2003, in which forest plots in the Neversink River valley were fertilized with dolomite (limestone that contains both calcium and magnesium) and/or nitrogen. Fertilization effects on soil and soil water chemistry are being monitored in conjunction with the response of canopy trees and understory. The goal of this experiment is to determine the degree to which soil conditions are controlling tree growth and health, which plays an important role in protecting water quality. Five years of treatment data indicate that the experiment has been successful in causing measurable changes in soil chemistry that are reflected by the vegetation. The response of nitrate concentrations in soil water is consistent with the vegetation effects associated with the treatment. Concentrations of exchangeable calcium have increased by a factor of 3 in the rooting zone of the treatment plots, but the concentrations measured in 2007 remain low relative to those found in healthy sugar maple stands. Tree diameter growth of all trees in the plots also showed preliminary responses to treatment effects. More time is required for the dolomite to be dissolved in the soil. The slow response of mature trees to environmental changes contributes to the need for more time.

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Natural Resource Issues and Property Management Responsibilities of a Large Water-Supply Landowner

Paul Lenz, NYC Department of Environmental Protection

Being a large landowner of water-supply lands carries with it a very large responsibility. The City now owns over 110,000 acres of land including miles of aqueduct, almost 34,000 acres of reservoirs, and over 13,000 acres of conservation easements. With the 2007 FAD, an additional $300 million dollars was committed by the City to acquire more lands and conservation easements through 2017. Long term land and natural resource management responsibilities and commitments will only continue to grow over time as demands to use City lands increase as private lands become less accessible and usable. In addition, the City recognizes the important role its land can play in contributing to the well-being of local economies and communities. This presentation will provide a general overview of how the City is managing its water supply lands including natural resources, public access and use of City land. Examples of topics covered include the development of a comprehensive forest management plan, managing invasive species, property management, agricultural use, and recreation.

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National reconnaissance studies as well as studies within the NYC Watershed conducted by USGS and NYSDEC have detected the presence of ng/L (part per trillion) levels of certain pharmaceutical and personal care products in the nation’s waterbodies including groundwater. In response to concerns about the prevalence and potential impacts of these and other emerging contaminants, DEP initiated a program of quarterly monitoring of its source waters for the presence of pharmaceutical compounds. The program began in January, 2009 and will continue until at least four quarters of sampling have been completed. Samples are being collected by DEP staff at the three key points (Del 18, CatLeff, and CroGH) in order to assess differences between the West-of-Hudson and more urbanized East-of-Hudson watersheds. Because of the very low detection limits utilized for the study, the sampling program involves the collection of a number of QC samples as well as the use of “clean hands” sampling techniques. Samples are being analyzed by two separate contract laboratories using different analytical methods. The sampling and analytical approach used in the study will be discussed. The current regulatory and research framework at the State and National levels that is being used to help further assess the public health significance of PPCPs in drinking water will also be presented.
Status, Trends, Distribution, and Functions of Wetlands in the New York City Water Supply Watershed

Laurie Machung, New York City Department of Environmental Protection

The New York City Department of Environmental Protection has a mapping and research program in place to characterize and assess wetlands located throughout the New York City Water Supply Watershed. Mapping projects have been completed through cooperative agreements with the USFWS and include the National Wetlands Inventory, Wetland Status and Trends, and a Wetland Characterization and Functional Assessment. These projects have enabled DEP to estimate the current extent, recent trends, and distribution of wetlands in the East and West of Hudson systems. DEP also conducts a monitoring program to characterize the baseline vegetation, soils, hydrology, and water quality conditions and functions of reference wetlands throughout the watershed. This presentation will summarize key findings of DEP’s wetland mapping and monitoring programs to describe the overall extent, recent trends, landscape settings, characteristics and functions of wetlands located throughout the New York City Watershed. Comparisons will be drawn between the East of Hudson and West of Hudson systems, with particular emphasis on the functions and regulatory vulnerability of headwater wetlands. Results of these programs have provided DEP with information regarding baseline conditions and water quality functions of a number of wetland types to benefit the development of both regulatory and non-regulatory wetland protection and non-point source programs.

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Climate Change Effects on Phytoplankton Composition in Cannonsville Reservoir

Hampus Markensten, Ph.D. and Emmett Owens, P.E., Upstate Freshwater Institute, Donald Pierson, Ph.D., NYC Department of Environmental Protection and Aavudai Anandhi, Ph.D., Hunter College of CUNY

Future climate change is expected to impact the New York City (NYC) water supply by affecting river discharge, nutrient loading, reservoir thermal structure and hydrodynamics, and finally the composition of phytoplankton in the reservoirs. This presentation focuses on the effects of climate change on phytoplankton composition in Cannonsville Reservoir (the third largest reservoir in the NYC water supply) which, prior to recent point source remediation and watershed management programs, had chlorophyll and phosphorus concentrations suggesting eutrophic conditions. [--]To estimate the effects of climate change on the Cannonsville reservoir phytoplankton composition we adopted a modeling approach where a 1-Dimensional (vertical resolution) hydrothermal water quality model (UFI 1-D) created by Upstate Freshwater Institute (UFI) was driven using the output from a watershed model (GWLF). Meteorological input for both watershed and reservoir models was created using historical climate data that was perturbed based on change factors derived from General Circulation Model (GCM) predictions. The phytoplankton model is focused on the biology of multiple phytoplankton functional groups, where each group has a set of characteristics allowing them to express complex behaviors similar to what is found in nature. Light, temperature and nutrient availability determines whether the different phytoplankton groups will settle, float, swim, or fix molecular nitrogen. Growth rates for each functional phytoplankton group are derived from phytoplankton size and volume characteristics together with light, temperature and nutrient availability in the reservoir. Climate change influences both watershed inputs (streamflow, nutrient loads) and reservoir behavior (thermal structure, hydrodynamics). The relative importance of these impacts are investigated through a series of model scenarios.

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Climate Change Impacts on Water Availability in NYC Water Supply

Adao Matonse, Ph.D., Hunter College of CUNY, Allan Frei, CUNY Institute for Sustainable Cities and Donald Pierson, Ph.D. and Mark Zion, NYC Department of Environmental Protection

For the NYC water supply system different components including watershed hydrology, climatology, reservoir capacities, reservoir operating rules, and system demands are accounted for in the OASIS model framework. The hydrology and climatology of the reservoir watersheds connected to OASIS determines the water availability in the system. Projections based on simulations from diverse General Circulation Models (GCMs) have suggested changes in magnitude and variability of climate variables that may have an impact on the hydrology of the NYC water supply. Preliminary results are presented that link future climate hydrologic model simulations to the NYC OASIS model framework while assuming water supply operation rules and water demands remain the same as under current conditions. These results suggest that future climate change will impact regional hydrology and ultimately, affect water availability on a seasonal basis. Projected increases in winter air temperatures, increased winter rain, and earlier snowmelt resulted in more runoff during winter and earlier reservoir refill in the spring. This presentation will illustrate how system indicators calculated using the OASIS model can be used to evaluate potential effects of future climate change. System indicators used in this study include the amounts of inflow, reservoir storage and probability of future refill and spills. These indicators can be analyzed on a daily, weekly, monthly, seasonal and yearly basis to support system operation or evaluate system long-term performance.

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Water Quality Trends in NYC Watershed Streams

James Mayfield, NYC Department of Environmental Protection

As stated in DEP’s Long-Term Watershed Protection Program, one of the goals of DEP’s Watershed Monitoring Program is to provide a comprehensive evaluation of watershed water quality status and trends and other research activities to support assessment of the effectiveness of watershed protection programs. One of the specific objectives of the monitoring program is to be able to detect monotonic trends in the detrended water quality data (i.e., the data record after removal of seasonality and dependence on flow) with reasonable confidence and power. The protocol for trend analysis in streams is to use nonparametric statistics because in ordinary linear regression over time, the assumption of normally distributed data is often violated. The analytes were selected on the basis of what is most likely to be of practical consequence to the City with an emphasis on nutrients and turbidity. These techniques were applied in an appraisal of long-term water quality trends to demonstrate the effectiveness of ongoing watershed protection efforts. Results will be presented with an emphasis on the major inflows to the NYC reservoirs. In addition to the FAD watersheds, data from East of Hudson streams will be presented as well. The challenges of examining data for trends due to unforeseen events, both natural and human-induced, e.g. flood events, laboratory method changes, etc., will be considered. Results will be discussed in conjunction with the implementation of DEP watershed programs and natural events.

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The Chesapeake Bay: An Evolving Framework for Watershed Collaboration

Jane McDonough, AECOM Water and Andrea Sweigart, EDAW

The Chesapeake Bay is the largest US estuary, with a watershed that spans six states. Excessive nutrients are the primary source of Bay degradation, and cooperative efforts to restore the Bay have been ongoing since 1983, coordinated by the Chesapeake Bay Program, a multi-state partnership including USEPA and scientists. Despite significant voluntary cooperation, the Bay Program goals are not going to be met. This spring the signatory states committed to two-year measurable milestones, an unprecedented action that’s part of an effort to increase the rate of nutrient reduction in preparation for a 2010 Bay-wide TMDL. In addition, President Obama declared the Bay a National Treasure in his May 2009 Executive Order, and established a new Federal Leadership Committee to oversee the coordination of programs and activities. Ongoing discussion about how to implement the TMDL revolves around refinement into smaller geographical WLA’s; TMDLs for MS4 permit holders; new roles and programs for federal agencies; and the potential for a new watershed-based regulatory and enforcement framework. It’s clear that a new structure for management of lands within the watershed is evolving which will affect stakeholders including multiple federal agencies, state agencies, local governments, the development community, agriculture and other industries, and private land owners. Watershed-based planning allows stakeholders to collaborate to solve difficult issues such as those that will affect the communities within the Bay states in coming years. This paper will illustrate a number of case studies, including the Big Darby Creek initiative in Ohio, where successful watershed-based planning and policy development have provided communities with principles and tools for sustainable growth. The case studies presented will serve as examples for the numerous communities, government and industry representatives who will be called on to collaborate to meet the goals for restoration of the Bay to a fishable and swimmable condition.

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Community Based Biodiversity Assessment Training
Andrew Meyer and Gretchen Stevens, Hudsonia Ltd.

Most land development decisions are made without knowledge of the potential impacts on biological resources. Hudsonia’s Biodiversity Assessment Training program teaches land use decision makers on planning boards, conservation commissions, and on the staffs of conservation NGOs to interpret maps and other existing information for predicting the occurrence of ecologically significant habitats, to identify and assess those habitats in the field, and to develop biodiversity conservation strategies for land use policy and planning. Since the program’s inception in 2001, Hudsonia has engaged over 50 communities in the program and helped participants create habitat maps for over 60,000 acres of the Hudson River Estuary watershed. The program emphasizes the importance of whole landscapes for supporting plants, animals, and habitats of conservation concern, and helps trainees bring an independent body of knowledge to landscape-wide and site-specific decisions on development and conservation. After completion of the program, trainees have incorporated biodiversity concerns into municipal comprehensive plans, zoning ordinances, open space plans, and routine environmental reviews of land development projects, and have worked to educate other agencies and the general public about biodiversity conservation.

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Resuspension as a Source of Turbidity in a Water Supply Reservoir

Emmet Owens, P.E., Rakesh Felda, Ph.D. and Steven Effler, Ph.D., Upstate Freshwater Institute and Donald C. Pierson, Ph.D., NYC Department of Environmental Protection

Sources of turbidity to drinking water reservoirs that are commonly encountered include tributary streams and algae growth. In some reservoirs, resuspension of sediment from the reservoir bottom is also a significant source. One such water body is Schoharie Reservoir, one of 19 reservoirs that supply drinking water to the City of New York. As a part of a program to evaluate turbidity control alternatives, a mechanistic two-dimensional turbidity model (W2Tn) of Schoharie Reservoir has been developed. Enhancements to this model to simulate sediment resuspension and its effect on turbidity in the reservoir water column and drinking water withdrawal are described. Bed stress that drives bottom resuspension in the reservoir is computed from currents and surface waves, which are simulated by hydrodynamic components of the model. Resuspension flux is computed from bed stress and is included as a source of turbidity in the water column. Three size classes of turbidity-causing particles, with differing settling velocities, are represented. The model is tested through application to Schoharie Reservoir using a variety of field observations. Predictions of bed stress due to currents are validated using measurements from acoustic Doppler instruments. Predictions of wind-driven surface waves are shown to compare well to near-shore wave observations. Testing of the turbidity model was completed for a 3.5-year period of historical observations, which included a number of runoff events and variations in reservoir drawdown. The enhanced model performed well in simulating observed turbidity in the water column and drinking water withdrawal. The resuspension mechanism was found to make a significant contribution to turbidity during periods of reservoir drawdown and during a severe runoff event. Reservoir currents largely drove resuspension of particles contributing to turbidity, with surface waves playing a smaller role.
Calculation of a Protozoan Pathogen Budget for Kensico Reservoir

Christian Pace and Kerri A. Alderisio, NYC Department of Environmental Protection

As the terminal reservoir prior to water entering the distribution system, Kensico Reservoir is a vital component of New York City’s water supply. The New York City Department of Environmental Protection (DEP) has maintained a weekly monitoring program for protozoan pathogens (Cryptosporidium and Giardia) at source water sites for 17 years. By comparison, this is more frequent than the monthly sampling requirements of the relatively recent Environmental Protection Agency’s Long Term 2 Enhanced Surface Water Treatment Rule (LT2). Aqueduct influent volume, transferring water quality from upstate reservoirs to Kensico Reservoir, accounts for approximately 99% of the annual flow through this critical reservoir. The Kensico watershed is an additional potential source of protozoa; however, the fixed frequency sampling program does not yield high enough mean concentrations at the eight perennial streams to make them significant contributors. Consequently, the amount of loading necessary to proportionately affect the much larger aqueduct influents could not be attributed to the tributaries. However, with the addition of targeted storm event sampling, DEP was able to collect samples with much higher means during elevated flows, likely due to the higher transport potential. All eight tributaries were sampled during various types of rainfall during the study period. Analysis of this data, coupled with 10-minute flow at each sample site, yielded stream loading estimates far above those found with fixed frequency sampling. This information has proven to be valuable in demonstrating the difference between the movement of protozoa during base flow compared to periods of higher transport. Local stream contributions with regard to protozoa are believed to be significant when storm flow is considered. This presentation will outline the methods used for calculating influent and effluent loading of Giardia and Cryptosporidium from aqueducts and streams around Kensico Reservoir.

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Light-Scattering Features of Turbidity-Causing Particles in Interconnected Reservoir Basins and a Connecting Stream

Feng Peng, Ph.D. and Steven Effler, Ph.D., Upstate Freshwater Institute and Donald C. Pierson, Ph.D. and David G. Smith, NYC Department of Environmental Protection

Optical attributes are important features of water quality and the functioning of aquatic ecosystems. Cloudy or turbid water associated with elevated levels of light scattering is a general concern for aesthetic impairments, and more specifically for water supply lakes and reservoirs because of regulatory requirements for low turbidity (Tn). Inorganic (or mineral) particles dominate turbidity in the Catskill watershed of New York City’s water supply system. This study documents the light-scattering (i.e., turbidity-causing) features of mineral particles in interconnected water bodies of this system (Schoharie, Ashokan and Kensico Reservoirs, Esopus Creek), as characterized by scanning electron microscopy interfaced with automated X-ray microanalysis and image analysis (SAX). SAX provided information on composition, size distribution, and projected area concentration (PAVm) of these particle populations. Mie theory calculations based on SAX results were used to estimate the scattering coefficient at a wavelength of 660 nm [bm(660)]. Both PAVm and bm(660) were strong predictors of Tn. Throughout the study system, nonspherical clay mineral particles in the 1-10 micrometer size range dominated PAVm, light scattering, and its surrogate, Tn. Patterns of particle size contributions to bm(660) (and Tn) remained relatively invariant over a wide range of Tn (more than 200-fold difference). Upstream sources of turbidity-causing particles within the study system were demonstrated to have highly similar light scattering features. This indicates similar potencies for the particle populations from these sources for turbidity impacts in downstream waters and supports the direct incorporation of Tn measurements into loading calculations to evaluate relative contributions of these inputs with respect to such impacts. Moreover, the presented results, indicating relatively uniform particle characteristics amongst the sampled locations, have guided the parameterization of mechanistic turbidity models for these reservoirs. Specifically, these results have guided the specification of Stokes (settling) equivalent particle sizes in mathematical models of Tn for the Catskill System.

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Urban Stormwater Runoff Phosphorus Loading and BMP Treatment Capabilities

Scott Perry, CPSWQ, Brian Lee and Joel Garbon, Imbrium Systems

Continued land development through urbanization is deteriorating surface water quality. A significant concern with our limited global fresh water resources is the onset of toxic algae blooms and reduced dissolved oxygen due to continued, uncontrolled phosphorus loading from an ever increasing source, urban development. This is leading to negative ecologic, economic, and human health impacts. As a result, regulators are beginning to acknowledge the impairment of fresh water bodies, and have begun implementation of Total Maximum Daily Loads (TMDLs). However, applying phosphorus related TMDLs specifically to urban stormwater runoff may not be effective without first understanding the available mechanisms and limitations involved in phosphorus treatment for stormwater applications. To achieve high levels of permanent phosphorus removal, review of the fate and transport of Phosphorus, including both particulate-bound and dissolved phosphorus, in urban stormwater runoff is necessary. Significant field monitoring data of various stormwater Best Management Practices (BMPs) exists which illustrates advantages and disadvantages of removal mechanisms, and ranges of performance variance in both conventional Best Management Practices (BMPs) as well as newer Low Impact Development (LID) applications. Advances in phosphorus treatment technologies have recently become available and better understood, providing the ability to capture high levels of both particulate-bound and dissolved phosphorus. Amending both conventional BMPs and LID applications with engineered solutions offers increased ability to achieve existing and future phosphorus based TMDLs. These concepts, performance data and design amendments are discussed as a potential means to protect our fresh water resources from remaining eutrophication.

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Overview of DEP Climate Change Integrated Modeling project: Present Activity and Future Goals

Donald Pierson, Ph.D., Mark Zion and Elliot M. Schneiderman, NYC Department of Environmental Protection and Allan Frei, CUNY Institute for Sustainable Cities

Projected affects of climate change on the NYC water supply include increases in air temperature and precipitation, changes in the timing and intensity of storm events, and changes in the accumulation and melting of snow. These changes in climate will in turn impact hydrological, biogeochemical, limnological, and terrestrial ecosystem processes. The complexity of these many processes and the interactions between them makes direct prediction of the affects of climate change on the quantity and quality of water in the NYC supply difficult. Modeling provides a quantitative framework that can aid in evaluating the potential impact of climate change on the NYC water supply. NYC DEP is undertaking a modeling based evaluation of climate change by adapting its present suite of watershed hydrology and water quality models, reservoir water quality models and water supply system models to make predictions of watershed and water supply conditions under future climate scenarios. This climate change integrated modeling project (CCIMP) was designed to specifically examine the affects of climate change on: turbidity in the Catskill reservoir system; eutrophication in the Delaware reservoir system; and water quantity and operations of the entire water supply. CCIMP modeling and analysis is being carried out by DEP modeling staff, CUNY post doctoral researchers, and CUNY faculty. In this presentation an overview of the project is given which includes a description of the major modeling components and the strategy chosen for evaluating climate change. Present progress and future plans are discussed.

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Impact Assessment of Natural Gas Production in the NYC Water Supply Watershed

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In response to increased interest in natural gas development activity in New York State and its potential for occurrence in the New York City West-of-Hudson watershed, the New York City Department of Environmental Protection (DEP) is conducting an assessment of the risks natural gas development may pose to the NYC water supply. The overall goal of the project is to identify potential threats to the continued reliability and high quality of New York City’s water supply by providing an objective assessment of the impacts of future natural gas development activities within the NYC watershed (or in proximity to critical infrastructure) on water quality, water quantity, and water supply infrastructure. This presentation reviews the assessment framework and provides a summary of the major issues that have been identified specific to the West-of-Hudson watersheds and related NYC infrastructure.

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Benefits of the NYCDEP Wastewater Treatment Plant Upgrade Program

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Benefits of the NYCDEP Wastewater Treatment Plant Upgrade Program. As part of the MOA, the City agreed to fund the eligible costs of designing, permitting and constructing upgrades of all non-City-owned wastewater treatment plants (WWTPs) in the watershed. For the purposes of this program, “Upgrades” mean equipment and methods of operation that are required solely by the WR&R, and not by federal or State law. The City further agreed to pay the annual costs of operation and maintenance of the upgraded facilities. The goal of the Program is water quality improvement through implementation of the NYC WR&R. The City facilitated the achievement of this goal by providing planning, funding and technical assistance which lead to improvements to infrastructure and operations. The Upgrade Program has produced many benefits both environmental, economical and the introduction of state of the art technology for WWTPs. The presentation will talk to these benefits. The presentation will also cover lessons learned.

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Progress, Opportunities and Challenges for Stream Management in the Catskill and Delaware Watersheds

Elizabeth Reichheld, NYC Department of Environmental Protection

Some fifteen years ago a new partnership emerged among the County Soil and Water Conservation Districts serving the Catskills region and the NYC DEP Stream Management Program. This partnership arose in response to the challenge of improving water quality in streams throughout the West of Hudson Watershed, taken together with the lessons of the January 1996 flood and the opportunities created by the 1997 Memorandum of Agreement. This fledging partnership has solidified over the years around a foundational mission, to protect and/or restore achievable levels of stream system stability and ecological integrity by providing for the long-term stewardship of streams and floodplains. With the 2007 FAD, the SMP partnership program moves from a planning and demonstration phase to an implementation phase. Setting the stage for the following presentations, the Program’s core goals will be reviewed with a focus on its most challenging hurdles and most important achievements, answering the following questions: What did we learn during the development of stream management plans? What are their most important recommendations? What role have the restoration projects served, as the most visible aspect of the program? What have we learned from these projects (broadly) and what are we seeking to learn from them next? What does sustainable stream management in the Catskills look like?

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Biomonitoring Demonstrates the Success of Wastewater Treatment Plant Upgrade

Martin Rosenfeld, NYC Department of Environmental Protection

Using biomonitoring protocols based on the collection of benthic macroinvertebrates, Hallocks Mill Brook in Westchester County, NY, has been repeatedly assessed as moderately to severely impaired since the New York City Department of Environmental Protection began sampling it in 1994. A major source of impairment is the Yorktown Heights wastewater treatment plant, which discharges into the stream. Following completion of the plant’s upgrade in 2008, sampling revealed the presence of 10 ephemerellid mayflies (Ephemera spp.) at a site 1.2 miles downstream of the plant’s outfall. This represents approximately 9% of the sample. Ephemerae mayflies are very sensitive organisms, rarely found in New York City’s East of Hudson watershed, and never before in Hallocks Mill Brook. Another mayfly genus, Baetis spp., accounted for approximately 20% of the sample. Baetis mayflies are more tolerant than Ephemerella, but have previously been seen in the stream only in very low numbers, and in some years not at all. All mayflies are considered sensitive to pollution. The site’s assessment score was twice as high as it had ever been before, resulting in an assessment of slightly impaired; this contrasts to previous ratings, all of which had been moderately impaired. Together, these data provide strong evidence that the Yorktown Heights wastewater treatment plant upgrade has produced substantial improvements to the stream’s benthic community.

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Habitat Mapping: Biodiversity Assessment for Resource Conservation

Nava Tabak and Gretchen Stevens, Hudsonia Ltd.

In response to increasing development pressure and limited public resources for conservation, the Biodiversity Resources Center of Hudsonia Ltd., a non-profit institute for environmental research and education, has developed a program to create townwide habitat maps for use in planning and environmental reviews. These biodiversity assessments are intended to fill a current gap in the information that local decision-makers need in order to protect both biological diversity and ecological services such as groundwater filtration and recharge. Using remote sensing and extensive field verification we identify and map all of the ecologically significant habitats, including occurrences of regionally rare habitat types (such as kettle pools, fens, circumneutral bog lakes, and oak-heath barrens), habitats that are often overlooked in environmental reviews (such as intermittent woodland pools, wet meadows, and intermittent streams), and other common but important habitats that constitute the landscape matrix (such as upland forests and meadows). Our accompanying reports describe the habitats, the kinds of rare plants and animals they may support, and our recommendations for effective conservation. The maps are a unique resource, providing habitat and biodiversity information heretofore unavailable. They present an overall biodiversity picture of large study areas sweeping enough for comprehensive planning, but with enough detail for use in reviewing site-specific development proposals. Wetlands are mapped more thoroughly and with much greater accuracy than the state or federal wetland maps available to the public. The upland habitat information is unduplicated by any other resource, and provides essential information for watershed management. The townwide perspective helps users understand the landscape connections that are essential for species, biological communities, and functioning ecosystems. To date we have completed eight townwide habitat maps in Dutchess County. Towns have incorporated the maps into their comprehensive plans, zoning ordinances, and open space plans, and into routine reviews of development projects.

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Land Acquisition: Quality and Quantity Considerations
Dave Tobias, NYC Department of Environmental Protection

Since 1997, the City’s Land Acquisition Program (LAP) has secured almost 100,000 acres scattered throughout a 2,000-square-mile watershed. This acquisition effort has increased the City’s ownership of real property in the Catskill/Delaware watershed from 3.5% to 12.3%. But the connection between these significant numbers and the protection of water quality may not be immediately apparent. This presentation will explore the basis of the City’s design of Priority Areas, how LAP has focused its efforts using a mix of landscape analysis and water quality science, as well as the acquisition patterns that have evolved with respect to water quality considerations.

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Recent Water Quality Trends in Cannonsville Reservoir (2002 - 2008)

Richard Van Dreason and Gerard Marzec, NYC Department of Environmental Protection

Trend analysis was performed on a multitude of indicator analytes (e.g. fecal coliform, turbidity, chlorophyll a, phosphorus) for Cannonsville Reservoir, an impoundment having the largest watershed in the NYC Water Supply system. The Seasonal Kendall trend test (Hirsch et al. 1982) was used to indicate statistical significance and the seasonal Kendall Sen slope estimator to estimate annual change. To evaluate intermediate as well long-term trends a visual trend assessment will be accomplished using LOcally WEighted regression Scatterplot Smoothing (LOWESS) (Cleveland, 1979) Results from the analysis of the time period 2002-2008, indicate either stable or decreasing long-term trends for all analytes tested. These results and probable causes will be discussed in the presentation. Cleveland, W.S. 1979. Robust Locally Weighted Regression and Smoothing Scatterplots. J. A. Stat. Assoc. 74, 829-836. Hirsch, R.M., J.R. Slack, and R.A. Smith 1982. Techniques for trend analysis for monthly water quality data. Water Resources Research 18, 107-121.

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Evaluation of Turbidity Control Alternatives at Schoharie Reservoir

William Weiss, Ph.D., P.E., Maryland, Hazen and Sawyer, P.C., Steven Effler, Ph.D., Upstate Freshwater Institute and David Warne, NYC Department of Environmental Protection

In order to protect and improve the quality of its unfiltered drinking water supply, NYCDEP has undertaken the Catskill Turbidity Control Study. Though the Catskill watershed generally provides very high quality water, peak runoff events mobilize natural clay deposits in stream banks and channels, and contribute to periodically elevated turbidity levels in Schoharie Creek, Esopus Creek, and Schoharie and Ashokan Reservoirs. Elevated turbidity is of concern with respect to the overall quality of NYC’s unfiltered drinking water supply as well as its effects on aquatic habitat and recreation in Esopus Creek. Earlier study phases have evaluated the water quality performance and costs of a wide array of turbidity control alternatives at both Schoharie and Ashokan Reservoirs. A key component of earlier study phases has been the development of modeling tools capable of characterizing the water quality performance of both operational and structural turbidity control alternatives. The need for realistic evaluation of alternatives within the context of the constraints and capabilities of NYC’s complex reservoir system, coupled with the need for robust simulation of fate and transport of turbidity within the Catskill reservoirs, has led to the development of linked water supply, water quality model (OASIS-W2). OASIS-W2 accounts for the dynamic interaction between reservoir water quality and system operations, and allows for long-term simulations that characterize performance potential under a wide range of environmental forcing conditions. This presentation will describe existing and/or planned infrastructure improvements at Schoharie Reservoir, review Schoharie turbidity and temperature control alternatives (including operational measures and selective withdrawal capacity), and summarize findings from an updated analysis of these alternatives.

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A GIS-Based Model to Identify Sensitive Water Resource Properties in Need of Protection

Jen Zhang, NJ Water Supply Authority

Source Water Protection (SWP) has long been recognized as one of the most effective means for ensuring long-term viability of water supply and maintenance of water quality. The New Jersey Water Supply Authority (Authority) has used GIS technology to identify potential properties through open space acquisition program to ensure the sensitive water resources areas are properly protected. The Authority developed a GIS model to identify, acquire, and manage critical watershed parcels to improve the protection of water resources. The GIS model incorporated about 20 different data layers based on the criteria selected by the Authority acquisition workgroup, which included riparian areas, core/dense forested areas, critical habitats/threatened & endangered species, highly erodible soils, primary ground water recharge areas, primary aquifer recharge areas, and so on. The model ranked each property relatively based on their sensitive water resources values (percentage in water resource areas) and the property size (acreage of each property); this will help to determine which properties provide the highest value for preservation. The model will also help to control land development by clustering away from sensitive water resource areas to ensure those areas would not be developed, damaged or destroyed, and assist open space acquisition entities to avoid open space isolation and create continuous green corridors. The GIS model will also give interested organizations the flexibility to customize their own criteria based on their conservation priorities. The whole process involves intensive GIS data manipulation and analysis using readily available GIS information, remote sensing, Digital Elevation Model (DEM), and aerial photography.

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Potential Impacts of Climate Change on Water Quality in the New York City Water Supply System

Mark Zion, Donald C. Pierson, Ph.D. and Elliot M. Schneiderman, NYC Department of Environmental Protection and Hampus Markensten, Ph.D., Upstate Freshwater Institute

New York City Department of Environmental Protection (DEP) is developing an integrated modeling system to further understand the implications of potential future climate changes on the quantity and quality of the New York City (NYC) Water Supply. This modeling project utilizes climate change projections as input to an integrated suite of models including watershed hydrology and water quality models, a water system operations model, and reservoir hydrothermal and water quality models. This presentation focuses on water quality results of the most recent applications of the integrated modeling system. In particular, the modeling applications focus on turbidity in Schoharie Reservoir and on trophic status in the Cannonsville and Pepacton Reservoirs. The integrated modeling system is used to better understand how potential changes in climatic forcings affect reservoir inputs and characteristics critical to water quality. Specifically, the amount and timing of reservoir inputs of water, sediment and nutrients from the watershed are impacted by changes in watershed precipitation and evapotranspiration Changes in temperature, surface solar radiation and wind speed affect the hydrodynamics of the reservoir including timing and intensity of thermal stratification and potential depth of vertical mixing. These issues are critical to the internal dynamics of critical water quality constituents including the transport and settling of turbidity causing particles and phytoplankton growth. Furthermore, the modeling system also allows the differences in reservoir water quality due to climate change to be placed in the context of other possible water quality improvements due to watershed management activities. Scenarios of potential future climate and watershed characteristics are developed for implementation within the modeling system. Comparison of the results of the various combinations of these scenarios allows further understanding of the importance of future climate change combined with potential changes in watershed characteristics.

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