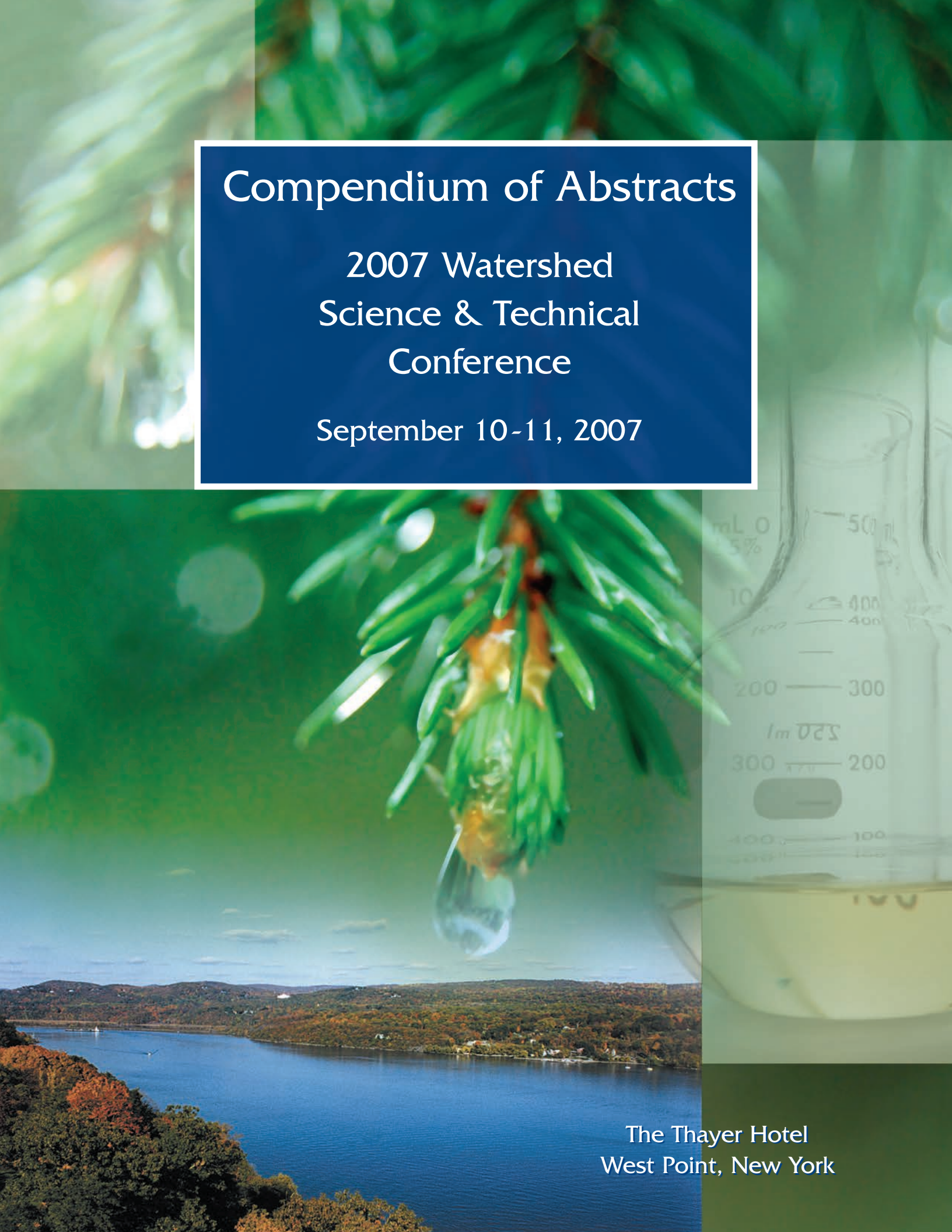

Compendium of Abstracts

2007 Watershed Science & Technical Conference

September 10-11, 2007

The Thayer Hotel
West Point, New York

Compendium of Abstracts

Presented at the

2007 Watershed Science and Technical Conference

September 10 & 11, 2007

Advancing the Science of Watershed Protection

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INTRODUCTION AND ACKNOWLEDGMENTS

Dear Conference Participants,

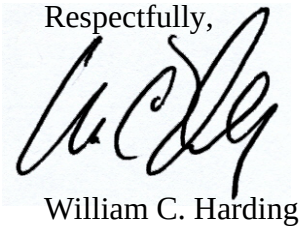
In 1997, the signatories to the historic New York City Watershed Agreement formed an historic partnership to protect and enhance the City's Watershed and the scores of communities living within it. Integral to this complex and ambitious undertaking has been an unprecedented array of Watershed protection and water quality monitoring measures, coupled with unparalleled efforts and resources devoted to understanding the science of watershed protection.

The New York City 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 present information regarding the protection of the nation's largest unfiltered surface water supply. Through the presentation of new research findings and data, the conference serves to enhance information, technology, and coordination among the array of entities working to advance watershed science.

Earlier this year, a Call for Abstracts was made to agencies and stakeholders in and beyond the New York City Watershed. The resulting overwhelming response, coupled with a conference constrained by space and time, necessitated a process of review and selection by the Watershed Protection and Partnership Council's Technical Program Committee. All submitted abstracts were reviewed for technical merit and interdisciplinary utility, as well as temporal and substantive relevance. Those chosen by the Committee for presentation are included in this compendium.

In addition to all 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,



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Executive Director, Watershed Protection and Partnership Council

For the Conference Organizers and Sponsors:

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- The New York City Department of Environmental Protection
- The Catskill Watershed Corporation
- The Watershed Agricultural Council
- The United States Geological Survey

The Effect of Two Different Approved Stains on Pathogen Results for the New York City Water Supply

Kerri Alderisio and Lisa Anne Blancero, NYC Department of Environmental Protection

Protozoan pathogens, namely Giardia cysts and Cryptosporidium oocysts, have realized a prominent role in the water industry due to their potential to cause human disease by transmission through drinking water. National research studies have taken place (Information Collection Rule -ICR) and are currently underway (Long Term 2 Enhanced Surface Water Treatment Rule - LT2) in order to provide insight as to the occurrence of these organisms throughout the country's water supplies. The NYC DEP has been sampling for these protozoa for over 15 years in its watershed, and guidelines for these organisms have been established between the water supply managers and regulators in order to provide guiding principles in the event a course of action is warranted in the interest of public health. Although many water quality factors are considered in the decision tree, the triggers for initial action are based on numbers of organisms discovered in water samples at specific locations. As a result, the number of cysts or oocysts recovered from a sample can have a direct impact on resources and management decisions. In the interest of improving methodology and efficiency NYC DEP evaluated the use of a second US EPA approved stain for use with Method 1623 (EasyStain, BTF Inc.) and compared results with DEP's routine stain (Merifluor, Meridian Bioscience Inc.). Samples were collected at both stream and key point locations and analyzed in duplicate for over one year. Results indicate a significant difference between the recovery of Giardia, and a notable quality difference for Cryptosporidium. These results have implications for the evaluation of any national studies, as well as for utilities and regulators alike, when these different stains are used. Additionally, this work emphasizes the need to advance the science of water quality pathogen assessment to include technologies that provide more detailed information, such as genotyping, in order to more accurately predict potential risk to public health.

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Do fish care about natural-channel-design restoration in Catskill Mountain streams?

Barry Baldigo, U.S. Geological Survey

Fish communities and habitat were surveyed each summer from 1999 to 2006 at six sets of treatment and reference reaches across five Catskill Mountain streams to assess the effects of natural-channel-design (NCD) restoration on fish assemblages. These restorations strive to recreate stable channel geometry and normal hydrologic processes which should improve fish habitat and help promote natural stream ecosystems. Accordingly, the NCD restorations at six reaches were predicted to increase community richness, diversity, equatability, and total biomass and decrease total density via increases in the number and biomass of larger trout species and decreases in the number and biomass of smaller minnow species. The effects of restorations on the health of fish assemblages were assessed through a BACI (before-after-control-impact) study design and analyses of variance (ANOVA) to quantify net changes in fish indices at treatment reaches relative to the same indices at unaltered reference reaches. With some exceptions, community richness increased on average by about 2 species (+29%), Shannon-Weiner diversity increased by 0.7 (+39%), species and biomass equatability increased by 0.05 to 0.17 (+12-34%), total biomass increased by 3.2 grams/m2 (+28%), and total density decreased slightly by almost 1 fish/m2 (-22%) following restorations. As expected, changes in community structure were caused mainly by shifts in dominant species away from dace and sculpin populations common before restoration, toward one or more trout species after restoration. Net biomass of all trout species increased on average by 3.4 g/m2 (+105%) at 5 of 6 streams, whereas dace and sculpin biomass decreased by 3.0 g/m2 (-38%), following restoration. These results demonstrate that the structure and function and, thus, health of local fish communities in perturbed Catskill Mountain streams benefit considerably from NCD restorations. Significant factor interactions, however, indicate that some streams react uniquely to restorations and responses cannot be forecast implicitly. Any comprehensive analysis and interpretation of fish responses to NCD restorations, therefore, needs to be done on a stream-by-stream basis.

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The Kensico Action Plan A Hybrid Approach to Modeling in the Kensico Reservoir Watershed

Francisco Brilhante, Sumant Mallavaram, Guy Apicella, HDR | LMS and Dale Borchert, NYC Department of Environmental Protection

Significant changes to the Kensico watershed have occurred in the past ten years. Approximately 45 stormwater management practices (BMPs) have been installed and are operating within the watershed. Stormwater facilities, including extended detention basins, outlet stilling basins and a turbidity curtain, are effective in reducing the TSS, fecal coliform bacteria (FCB) and associated pollutant loadings conveyed to the Kensico Reservoir (NYCDEP 2004).

The Kensico Action Plan seeks to develop a model for use in evaluating stormwater flows and discharges of pollutants to the Kensico Reservoir. The model selected for the KAP must be capable of simulating the stormwater runoff and pollutant loading characteristics as a function of the land use in sub-basins of the watershed. The model must also be capable of simulating management practices as well as other remedial measures to manage non-point source pollution loads. Accordingly, the model must be able to perform continuous simulations of stormwater runoff and discharges of these constituents:

" Total and dissolved phosphorus (TP/DP)" Total suspended solids (TSS)" Fecal coliform bacteria (FCB)" Biochemical oxygen demand (BOD)

Several models including SWMM, WinSLAMM, and HSPF were considered for this study. A hybrid approach for modeling the Kensico watershed was selected. Both SWMM and WinSLAMM were compatible with the application of GIS tools to delineate sub-basins, extract land use, impervious cover, soils, storm sewer, stream, and other data that provide the input to these models. A diagram of the model linkage is shown.

WinSLAMM was used to simulate the runoff quantity, quality and any landside BMPs. Flows and pollutant concentrations were then passed to SWMM and routed through a network of streams, conduits or channels as needed. The model generated flows and concentrations for runoff input into the Kensico Reservoir. The model was used to identify sources of stormwater contamination and quantify reductions in pollutant loads due to BMPs.

The first task of the Kensico Action Plan (KAP) was the development of a comprehensive database to provide inputs to the models. Relevant information and data concerning the Kensico Reservoir watershed was essential to the successful development and implementation of the watershed protection program. The database development provided the foundation for the delineation of the sub-basins in the Kensico watershed and the application of the stormwater runoff and stream flow routing models (WinSLAMM and SWMM)..

GIS played a major role in the development of the KAP. In addition to the development of the comprehensive database, GIS was used to delineate sub-basins using ArcHydro and to determine impervious cover and landuse type which was used by the model to estimate pollutant loadings.

The use of GIS along with the hybrid modeling approach allowed the modeling team to rank the sub-basins according to these criteria:

" TSS Load" FC Load" Impervious surface area" Existing Extended Detention Basin (EDB)

This ranking targeted areas in the watershed where additional BMPs were recommended to protect the Kensico watershed and ensure the water quality of New York City’s water supply.

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Linking Water Supply Protection and Recreation: Management of Boat Fishing on New York City Water Supply Reservoirs and Lakes

Jennifer Cairo, NYC Department of Environmental Protection

The New York City Water Supply features 21 reservoirs and controlled lakes that are popular fishing destinations for anglers, nearly 11,000 of whom keep rowboats on site in concentrated storage areas for their use. DEP is committed to providing for boat fishing by law and requires on-site storage to prevent water supply contamination from substances and organisms, including zebra mussels. DEP's strategy for boat fishing is to maintain a plan and supporting policies that will minimize negative water supply protection issues related to fishing by boat while providing safe, managed, high-quality public deep water fishing opportunities. This strategy includes 1) boat storage area clean up, 2) outreach and feedback, including user surveys, 3) creation and application of a Boat Area Rapid Assessment (BARA) procedure incorporating GIS mapping, inventory, natural resources assessment (e.g., soil compaction, vegetation loss, erosion), aesthetics, and evaluation, 4) improvement of existing boat areas, and 5) creation and implementation of a long-term approach and policies within the context of DEP's water supply land management plans.

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Sources, Characterization, Transformation and Transport of Disinfection Byproducts through Wachusett Reservoir Watersheds, Central Massachusetts

Cynthia Castellon, Erich Fielder, David Reckhow and Paula Rees, University of Massachusetts, Amherst

Nutrient, pathogen, and sediment inputs to drinking water reservoirs from point and nonpoint sources are a major concern for watershed managers working to protect public drinking water supplies. Knowledge of the input loads and transport pathways can lead to better watershed management. Accurate quantification of the effects of hydrologic variability and land use change on watershed, river, and reservoir water quantity and quality is of particular importance for long-term management, source water protection, microbial risk assessment, and for the prediction of the effects of climate change on water quality. Focused data collection efforts, in combination with modeling, have the potential to extend our understanding of these dynamics.

Drinking water disinfection byproducts (DBPs) are compounds produced inadvertently during the use of chlorine for inactivating pathogens. These compounds have been associated with various human cancers and reproductive problems. Early attempts by engineers to reduce DBP concentrations focused on end-of-the-pipe solutions such as adsorption or gas stripping of the DBPs. Currently the preferred control technology is organic precursor removal by coagulation and filtration prior to addition of chlorine. While partly effective, it ignores the potential benefits of upstream precursor control. The alternative approach that is the focus of this research is to control natural organic matter (the precursor compounds) at their source. To implement this will require that water engineers and scientists substantially improve their understanding of the nature of DBP precursor material, its origin, and factors that affect its concentration. While, ecologists and hydrologists have explored the origin, transport and fate of organic carbon in surface waters, little has been done to understand the origin and behavior of DBP precursor organic compounds

To develop a greater understanding of the origin and behavior of DBP precursor organic compounds, a series of field and laboratory investigations was conducted aimed at characterizing disinfection byproduct (DBP) precursor levels in the Wachusett Reservoir watershed. Stream water samples were collected from spatial based sampling campaigns, storm event sampling campaigns, and laboratory leaching experiments. In addition, soil-, ground- and rainwater were sampled. These samples were analyzed for DOC, TOC and DBP precursors (trihalomethanes, haloacetic acids and others) in an effort to characterize the changes in precursor levels and natural organic matter (NOM) character in this watershed. These data were used to (1) calibrate an export coefficient model and 2) calibrate a daily TOC model for the watersheds, enabling evaluation of the affect of hydrologic variability and land use on TOC load. With additional data collection, the potential exists to extend the modeling effort to include many types of DBP precursors.

The results of the monitoring and modeling effort will be presented.

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Indian Brook-Croton Gorge Watershed Conservation Action Plan

Tracey Corbitt and Susan Darling, Westchester County

The Indian Brook-Croton Gorge Watershed Conservation Action Plan is the first comprehensive watershed program developed along the Hudson River in Westchester County. Prior to the Indian Brook - Croton Gorge Watershed Conservation Action Plan, environmental initiatives along the Hudson River were limited or fragmented and were based on individual community/project needs and resources. In order to develop a comprehensive watershed program for the Croton Bay Watershed, each municipality, municipal representative and Westchester County had to agree to the same goals and objectives for the watershed. At the beginning of the planning process, six major goals for the plan were established relating to protecting and restoring the natural resources, developing and implementing stormwater management practices, promoting sustainable development, preserving and protecting significant wildlife habitats, public outreach and education, and inter-municipal cooperation.

The Westchester County Department of Planning received funding from the NYSDEC Hudson River Estuary Program (HREP) to work with the communities in the Croton Bay Watershed, which consists of the Croton Gorge and Indian Brook subwatersheds, to prepare a Watershed Conservation Action Plan. The Croton Bay Watershed Steering Committee, an inter-municipal committee consisting of representatives from the Towns of Cortlandt, Ossining, and New Castle, the Villages of Ossining and Croton-on-Hudson and Westchester County was created. The Westchester County Department of Planning provided technical and administrative assistance to the Croton Bay Steering Committee in carrying out its goals related to the creation of the plan.

The plan details the existing conditions, or the state of the watershed, which includes information on the physical and natural resources, wildlife and significant wildlife habitats and land uses of the Croton Bay Watershed. Through analysis of the state of the watershed, recommendations were developed based on the above goals to improve the current water quality conditions found throughout the watershed. Implementation of the recommendations will require inter-municipal cooperation and coordination among the municipalities.

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The Croton Plan For Westchester

Gina D'Agrosa, Ed Buroughs and Tracey Corbitt, Westchester County

The Croton Plan for Westchester, released for public comment June 2007, is the product of a detailed and comprehensive intermunicipal water quality planning effort. Ten municipalities worked with Westchester County and the NYCDEP to assess watershed conditions, identify water quality impacts and develop strategies to reduce those impacts and prevent water quality degradation while enhancing community character.

The Croton Watershed is a major source of drinking water supply. The watershed is home to a series of interconnected reservoirs and lakes in northern Westchester and Putnam Counties and is one of three major components of the NYC drinking water supply system. The Croton network, put into service in 1842, provides 10% of the City's water under normal conditions and up to 30% of in-City consumption in times of drought. The combined New York City water supply system provides drinking water to 85% of Westchester County residents.

The Croton Watershed in Westchester County is also the home of 100,000 people and the work place for 43,000 employees. The watershed extends over all or parts of nine towns and one village/town, encompassing 177 square miles - 40% of the county's land area. Most of the Westchester residents who live in the Croton Watershed are served by groundwater supplies. These groundwater supplies, including private, community and municipal wells, are recharged by water passing through the watershed and infiltrating into the ground. Many threats to surface water supplies also impact groundwater. Many measures designed to protect surface water will also protect groundwater supplies.

The Croton Plan was developed using teams with specific technical expertise in the areas of land management, water management and outreach and education. Several technical reports were prepared to provide the foundation for the plan. Each subject was analyzed on a municipal or drainage basin basis, or both. For example, community character was analyzed by municipality, pollution sources and sewage diversion were analyzed by drainage basin and land use was examined by both municipality and drainage basin.

The Plan consists of several elements - the body of the Plan, four technical reports and three special studies the Croton Watershed Westchester Wastewater Diversion Study, the Westchester County Groundwater Study and the Stormwater Management Study and Manual. The comprehensive plans of the towns that were partners with Westchester County in developing the Plan were relied upon, as was the County's land use planning policy document, Patterns for Westchester: The Land and the People. The Plan presents the results of study, research and analysis in seven chapters: setting, water quality conditions and impacts, development and redevelopment potential, findings and approaches, strategies to protect water quality and implementation.

The Croton Plan discusses physical and regulatory settings, describes the existing land use patterns and water quality conditions, estimates the future development potential and offers 53 recommendations to ensure future actions will improve water quality protection, and prevent degradation of, in the Croton Watershed in Westchester. A methodology was also provided which considers the existing governmental, regulatory and financial conditions, to achieve timely and effective implementation of the plan.

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The Development of the New York City Nitrogen Program

Sarah Dailey and Norman Bradley, Hazen and Sawyer and Keith Mahoney and Elio Paradis, New York City Department of Environmental Protection

The Long Island Sound Study (LISS), a partnership between the United States Environmental Protection Agency, New York, and Connecticut, was formed by Congress to address water quality concerns related to eutrophication and hypoxia. Nitrogen was identified as the causal agent for the observed water quality problems, and a set of phased Nitrogen removal targets were implemented to reduce discharges to the Sound by more than 50% over a 15-year period of time. Over the course of those 15 years, the nitrogen reductions will step-down so that a phased adaptive management approach is taken to achieve the long-term nitrogen removal goals. The New York City Department of Environmental Protection (NYCDEP) has four WPCPs that discharge to the Upper East River: Hunts Point, Tallman Island, Bowery Bay, and Wards Island. Step-Feed Biological Nitrogen Removal (BNR) was identified as the most feasible technology for implementation to achieve the necessary Nitrogen removal. To assist in the development of BNR designs and the management of these simultaneous upgrades, the Department formed the AWT Team to provide design and program management expertise. The Team has assisted NYCDEP in meeting Consent Order milestones, development of BNR facility plans, production of site specific BNR design guidelines, review of BNR design drawings and specifications, and the development of programmatic guidance for design engineers at each of the four WPCPs.BNR guidance was developed to ensure that a common approach was followed by the large number of consulting firms, as well as the Department itself, over the duration of the project. Major elements of the BNR upgrades detailed in the guidance include:" Aeration System Upgrades Provides new blowers and an enhanced process air distribution system to ensure better nitrification occurs" Upgrades to Aeration Tanks Uses baffle walls to separate oxic and anoxic zones to allow nitrification/denitrification to occur and " Froth Control Systems Reduces the population of foam-producing bacteria" Alkalinity Addition Systems Provides alkalinity required for nitrification and pH maintenance" Return Activated Sludge Upgrades Allows WPCPs to operate at a higher mixed liquor" Separate Centrate Treatment Provides a dedicated aeration volume to nitrify ammonia-rich centrate" Improved Flow Splitting and Control Equalizes the Food-to-Microorganism ratio, thus lowering the peak oxygen demand" Carbon Addition Provides additional carbon in the form of methanol to assist in denitrification The NYCDEP faced challenges in scheduling and coordinating multiple major capital construction projects, meeting Consent Order construction completion mandates, and simultaneously meeting interim Nitrogen discharge limits. As a tool to assist NYCDEP, the flow and load projections were developed for each WPCP and treatment performance was modeled before, during, and after construction using the BioWin process model. The BioWin modeling included treatment limitations, such as reactors taken offline for construction, as well as treatment enhancement as the Nitrogen upgrades were placed online. The DEP has used the "Nitrogen Bulge" to track actual East River performance versus predictions over the same timeframe. The Bulge is within 1.1% of actual plant performance between October 2003 and April 2006.

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Settling Characteristics of Giardia cysts and Cryptosporidium (oo)cysts in Storm Water flow to a New York City Drinking Water Reservoir

Steve Di Lonardo and Kerri Alderisio, NYC Department of Environmental Protection, Greg Characklis, Ph.D.,University of North Carolina - Chapel Hill

Giardia and Cryptosporidium are significant causes of water-borne enteric disease throughout the world. We identified whether Giardia cysts and Cryptosporidium oocysts (the resistant stages found in the environment) attached to suspended particulate matter and further, whether this particle association was based on particle size class. In the first phase of our study, we synchronously sampled five tributaries of Kensico Reservoir (Westchester County, New York), just prior to the stream-reservoir interface, for Giardia cysts and Cryptosporidium oocysts during storm events (using auto-samplers), and base flow conditions (grab samples) over one year. The streams were selected based on the flow weight, and sub-basin physical characteristics (i.e. flowing from a wetland or man-made retention pond, spatial location around Kensico Reservoir). For the second phase of the study, we selected three of the five streams for resolved storm sampling (based on pathogen loading and attachment to suspended particulate matter), which involved sampling dissected phases of a storm, based on the storm's hydrological characteristics (e.g. rising limb, peak, descending limb). The samples were analyzed in laboratory for Giardia cyst and Cryptosporidium oocyst abundance as well as particle size and density attachment. Our results suggest differences in pathogen settling and loading between base flow and storm conditions, as well as within the different phases of a storm. Similarly, we analyzed differences in pathogen loading and loading rates as well as differences in suspended particulate matter concentrations between streams, for base flow and storm conditions and within the different phases of a storm. This study will ultimately aid in the modeling of transport across the reservoir and into aqueducts supplying water to New York City residents and eventually be useful in attempts to reduce transport of pathogens into drinking water supplies.

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Molecular tracer signatures of end-member sources of potential contamination to NY streams

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The use of organic molecular tracers is an emerging technique for identifying the sources behind water quality degradation. A critical step in using these molecular tracers is that tracer signatures of all potentially important sources are well characterized. As part of a large-scale water-quality monitoring project in New York City's drinking water-supply watersheds, we collected and analyzed 34 samples from different end-member sources. These sources included: waste water treatment plant influent and effluent; septic field influent and leachate; and animal feces from cows, horses, deer, beaver, opossum, raccoon, geese and gulls, all of which were analyzed for 10 fecal steroids and caffeine. The fecal steroids concentrations can be expressed as various ratios between two or more steroids to aid in the process of source separation. We used seven such ratios in a Principal Component Analysis (PCA) that was very successful in separating human from non-human sources as well as separating among the various animal sources. Total explained variance in the steroid ratios of the fecal sources was 87% using the first 2 PCA axes. The first axis separated human (+) from non-human sources (-) (67% explained variance) while the second axis (20% explained variance) primarily separated larger herbivores (+) from birds (-).We took the first 2 PCA axis scores (eigenvalues) and created separate predictive equations, one for each PCA axis. We used these equations to predict a source "signature" score for stream samples collected at 62 sites under summer baseflow conditions in 2003 through 2005. The average (nd3) predicted human source score for stream samples, based on the first PCA axis, were significantly (a=0.05) and positively correlated with watershed characteristics including: %agriculture, %residential, 2000 population density, road density and WWTP effluent volume and negatively correlated with %Forest. Average predicted large herbivore source scores for streams, based on the second PCA axis, were significantly (a=0.05) and negatively correlated with 2000 population density and WWTP effluent volume. We collected fecal coliform samples at a subset of the summer baseflow-monitored sites for the 2003-2005 period. The mean (nd3) fecal coliform counts in streams were significantly (a=0.05) and positively correlated with the predicted human source score based on the first PCA axis. Our ultimate goal with this work is to evaluate the relative importance of the end-member sources we examined as potential contamination sources in the streams and rivers we sampled across NY City's drinking water-supply watershed.

The Stroud Water Research Center (www.stroudcenter.org) is an independent, non-profit institution devoted to basic and applied research on streams and rivers in North America and beyond.

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Response of Habitat Conditions to Natural-Channel-Design Restoration in Streams of the Catskill Mountains

Anne Ernst, Barry P. Baldigo and Christiane Mulvihill, U.S. Geological Survey

Many streams and rivers throughout North America have been extensively modified (straightened, widened, and hardened) since the middle 1800s, but the effects of these modifications on aquatic ecosystems have rarely been monitored or reported. Beginning in the early 1990 s, stream restoration using natural-channel-design (NCD) concepts have become increasingly popular. NCD is designed to mimic stable reference-reach geomorphology and, thus, promote natural stream processes and habitat. Six reaches on five Catskill Mountain streams were restored during 2000-03 using NCD techniques to decrease bed- and bank-erosion rates, decrease sediment loads, and increase the quality of stream waters. Goals of the restorations were to improve both short-term-response parameters (e.g., decrease channel width and increase depth) and long-term-response parameters (e.g., increase bank stability, riparian vegetation, and shading). The effects of NCD restorations on stream condition were assessed using a BACI (before-after-control-impact) study design to quantify the net changes in stream and bank habitat parameters at treatment reaches relative to changes in corresponding parameters at unaltered reference reaches. Surveys were conducted during summer low flow between 2001 and 2006. Results from two-factor analysis of variance (ANOVA) tests show that mean channel depth, thalweg depth, pool-to-riffle ratio, and visual estimates of stable streambank vegetation generally increased, whereas mean channel width, percent streambank coverage by trees, and several measures of shade generally decreased overall following restoration. The response of different measures of bank stability varied, with some metrics indicating an increase in bank stability and others showing a decrease. Many short-term-response parameters showed immediate improvements, whereas long-term-response parameters tended to show either no effect or a decrease in habitat condition in the 2-4 years follow restoration. Overall, these findings demonstrate that habitat conditions may be improved in perturbed Catskill Mountain streams through NCD restorations, though the effectiveness of several habitat changes may take years to develop.

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Is a Little Crypto OK? Results of Very High Volume Sampling

Stephen Estes-Smargiassi, Massachusetts Water Resources Authority

As part of a long term research effort to examine links between drinking and recreational waters and infection rates among children, MWRA and Tufts University have collaborated on high volume sampling of finished water for Cryptosporidium and Giardia. Weekly samples of 1000 liters have been taken since 2001, using automated samplers which composite water over the course of the week. With approximately 300,000 liters of water analyzed, the long term average is about 0.0003 oocysts/L. Comparisons with less sensitive raw water samples and published results for infectious oocysts in finished water from well run filtered water systems are presented.

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Modeling of the Wachusett Reservoir Watersheds, Central Massachusetts, for Improved Watershed Management

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Nutrient, pathogen, and sediment inputs to drinking water reservoirs from point and nonpoint sources are a major concern for watershed managers working to protect public drinking water supplies. Knowledge of the input loads and transport pathways can lead to better watershed management. Accurate quantification of the effects of hydrologic variability and land use change on watershed, river, and reservoir water quantity and quality is of particular importance for long-term management, source water protection, microbial risk assessment, and for the prediction of the effects of climate change on water quality. Watershed modeling, in combination with focused data collection efforts, has the potential to extend our understanding of these dynamics.

During the past five years, UMass has worked on the development of empirical and physically based watershed models of the Wachusett Reservoir watersheds, central Massachusetts. These models are designed for load and hydrologic estimation, and are thus useful for management purposes. The current models simulate daily runoff and load for nine basins and four constituents (nitrate, total phosphorus, total organic carbon, and fecal coliform) based on a daily rainfall trace. Land use effects are accounted for in terms of a curve number, for hydrologic routing, and in terms of calibrated export coefficients, for water quality. Development of basin average rainfall time series based on radar data is planned to further improve subbasin hydrologic estimation capabilities by better accounting for spatial variability.

Results will be presented describing usefulness of the models for setting watershed monitoring schemes. The development and evaluation of monitoring schemes focuses on combining modeling and monitoring to address the following priority questions:-What is the most appropriate hydrologic data to collect for adequate water quantity characterization?-Is characterization of water quality in additional hydrologic components (e.g., in ground and soil water in addition to stream water) important for making sound watershed management decisions?-What range of hydrologic conditions should be sampled for water quality to ensure accurate characterization of seasonal and monthly loads?-What is the most critical part of a storm event to monitor and what is the most efficient means of capturing this information?

In addition, the models may be used to estimate the effect of global change, including urbanization and changing climate. While vulnerability of the reservoir system to climate and land use change has been studied by other researchers, this study is based on the published results of current Global Climate Models (GCMs), which use more complex scenarios of greenhouse gas emissions than previous studies. In addition, this study seeks to expand prior work by looking at the potential impacts of a changing climate on water quality in the reservoir system, rather than just water quantity.

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A Diamond in the Rough: Seattle's Cedar River Watershed

Suzanne Flagor and Darian Davis, Seattle Public Utilities

Largely unseen and unknown to many residents of the greater Seattle area, the Cedar River Municipal Watershed encompasses over 91,000 acres of protected land in the Cascade Mountains east of Seattle. Providing over 100 million gallons/day to 850,000 customers, this watershed is also the focus of innovative efforts in ecological restoration, road abandonment, education, and cultural resource management.

Ecology: The Cedar River Watershed Habitat Conservation Plan, adopted in 2000, was created to protect the City from potential impacts to water supply under the endangered species act. By creating a comprehensive, multi-species Habitat Conservation Plan, the City not only mitigated risks associated with the recent listing of Chinook salmon, but also created a blue-print for large-scale watershed restoration with an eye towards ecological values. A long-term plan to decommission 30% of the roads in the watershed, and replace culverts with bridges is also reducing the potential for long lasting sediment producing events, and reducing long-term maintenance and water treatment costs.

Education: In striving to reach a balance between public access and education, in 1992 the City embarked on an ambitious plan to provide high-quality education programming within the closed boundaries of the Watershed, while creating an Education Center that would encourage a connection to the drinking water without actually entering the closed boundaries. Together with the a non-profit, the Friends of the Cedar River Watershed, the Education Center was built at the edge of the hydrographic Today, the Cedar River Watershed Education Center is the hub for education programs reaching over 30,000 visitors annually.

Cultural Resources: The Cedar River Municipal Watershed is a microcosm of Pacific Northwest cultural history, with continuous human habitation documented for over 9,400 years. Native American archaeological sites and historic railroad, homestead, municipal towns, mining, manufacturing and logging are all preserved within the closed boundaries of the Watershed. The challenge of protecting cultural sites during construction, forest restoration and water supply activities precipitated the creation of a comprehensive Cultural Resource Management Plan, which has become a regional model for landscape level cultural resource management.

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Using Public Outreach and Education on the Dangers of Pet Waste as a Tool for Lowering Bacterial Loading in Tributaries to Drinking Water Supplies

Kelly Freda, Commonwealth of Massachusetts Department of Conservation and Recreation-Water Supply Protection

The Wachusett Reservoir, an unfiltered water supply with a watershed that encompasses five different towns in central Massachusetts, provides drinking water for over 2.5 million people in the Boston metropolitan area. Thirty tributaries to this reservoir are tested weekly for fecal coliform bacteria. Periodically there have been unexplained bacteria spikes seemingly unrelated to storm events, septic tank failures, or sewer malfunctions in several of these tributaries located in residential areas. While investigating possible causes for elevated fecal coliform levels in one stream it was noted that many of the homes had dogs that could directly access the water. There are a total of 5374 licensed dogs within the five watershed towns (in the 108 square mile drainage basin). Using the assumption that each dog produces approximately ¾ pounds of solid waste per day it was estimated that 4,024 pounds of solid waste per day is produced by dogs within the watershed. Assuming that half of the dog owners pick up after their pets, 2,012 pounds and a tremendous number of bacteria are still left on the ground to be washed into the streams and rivers. In an attempt to reduce or eliminate the potential drinking water contamination from dog waste, the Department of Conservation and Recreation Division of Water Supply Protection began a public outreach and education campaign targeting adult owners of dogs. The initial campaign targeted three neighborhoods and subsequently has been extended watershed wide. Bacterial loading numbers have declined in the initial targeted neighborhoods, but it is unclear if the results can be directly attributed to this outreach.

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Determining the Effects of Road Salting on Groundwater Quality at Select Public Supply Well Fields Using BR/Cl Molar Ratio Analysis, Suffolk County, New York

Tyrand Fuller, Suffolk County Water Authority

Fresh ground water on the North Fork of Long Island is contained within a series of hydraulically isolated lenses that decline in thickness eastward. In the recent past, several Suffolk County Water Authority (SCWA) public supply wells on the North Fork and parts of the South Fork have been impacted by elevated chloride concentrations. In an effort to determine the source of the high chlorides, a 3 year study was conducted to evaluate the impacts of stormwater and agricultural runoff at select public supply Well fields. Two well fields in Peconic experiencing significant chloride impacts- Mill Lane and Ackerly Pond Road- were analyzed using samples obtained from vertical profile wells and focused electromagnetic induction logs. Since the relative concentration of chloride is quite high in road salt, the bromide-chloride (Br/Cl) molar ratio in groundwater affected by road salting is much lower than the Br/Cl molar ratio in groundwater impacted by lateral or vertical saltwater intrusion. The Br/Cl molar ratios of selected well samples were analyzed to determine if the chloride increases observed in the public supply wells were due to upconing from over pumping, or from road salting. An aquifer test was conducted at Ackerly Pond to determine site-specific parameters. Contributing Point source contaminants to all Well fields were identified using the Long Island Source Water Assessment Reports.Results indicate that on the North Fork the water quality at several sites have been significantly impacted by road runoff and agricultural land use. In the case of Mill Lane and Ackerly Pond Road, road salting has impacted both well fields. This is especially true at the Ackerly Pond Road well field, since the site is located in close proximity to a recharge basin, which retains stormwater from a section of a major highway. Vertical profiles at Mill lane detected similarly abnormal Br/Cl molar ratios opposite the screen setting of the public supply wells, also indicating impacts from road salting. While the South Fork experiences seasonal fluctuations in chloride levels, attributed to saltwater upconing, the Br/Cl molar ratios are relatively unaffected. It is hoped that future changes in the operation of well fields, as well as closer monitoring of water quality trends, will allow the SCWA to continue to use the well fields, despite these water quality impacts.

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Environmental and Economic Impacts of Increasing Corn Land and Incorporating No-till Management to NY Dairy Farms

Lula Ghebremichael, Ph.D. and Tamie Veith,USDA-ARS, Paul Cerosaletti, NYC Department of Environmental Protection and Dale Dewing, Delaware County Cooperative Extension

Increasing demand for corn by ethanol producers is driving up corn grain prices. This is introducing a major shift into the NY dairy farm system by prompting farmers to place more land into corn production. Increasing corn grain production may allow farmers to produce their feed grain needs on-farm and, thus, avoid tight marginal profits caused by purchasing higher-priced grain. However, erosion and associated phosphorus (P) loadings of corn land is of particular environmental concern. P loss from agricultural lands continues to be a major pollutant for NY city water supply reservoirs. To reconcile the farmers' economic needs for increasing on-farm corn grain production with the risk of increased erosion and P loss threats from expanded corn fields, farm planners and other agencies are initiating a no-till management option to the corn production system. This study quantitatively assesses the potential environmental and economical effects of implementing no-till management in conjunction with the increased need to grow corn grain. This study applies a whole-farm model to a large and small farm in Cannonsville Reservoir Watershed to evaluate different management scenarios. Farm factors evaluated include farm profits, feed imports, farm P balance, and P losses. Study findings will enable relative comparisons between the risks of increasing downstream water quality pollution with that of decreasing on-farm economic viability.

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Whitetail Deer Browsing Effects on Watershed Forests and DEP's Assessments and Management Strategies

Fred Gliesing, NYC Department of Environmental Protection

Watershed forests require structural and species diversity in order to effectively control nutrient releases and respond to major disturbances to minimize impacts to water quality. Browsing by whitetail deer can have a detrimental effect on forest structure and diversity. DEP has initiated several assessment methods to evaluate deer impacts and densities, including the use forward looking infrared radar (FLIR). Through the data derived from FLIR and other methods, we have implemented forest and deer management strategies and supported regional deer management initiatives to promote watershed forest regeneration. This presentation will focus on the efforts the DEP Natural Resources Management group has taken to address deer impacts on City watershed lands. This includes the deer impact management strategy (DIMS), forest management project strategies, implementation of deer herd management strategies on selected sites, technical support for regional deer task forces, and cooperative management initiatives programs with the NYSDEC and local sporting organizations.

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Upgrading Wastewater Facilities with Membrane Microfilters to comply with NYC Watershed Rules and Regulations, A Case Study: Hobart, NY

Joe Habib, Pall Corporation and Richard Reightmyer, Lamont Engineers

In 2002, the Hobart Wastewater Treatment Plant (WWTP) selected hollow fiber microfiltration as the primary component of its tertiary treatment upgrade. The purpose of the upgrade was to ensure plant compliance with New York City Department of Environmental Protection (DEP) Watershed Rules and Regulations. The 180,000 gpd WWTP discharges effluent directly into the West Branch Delaware River, which ultimately feeds the Cannonsville Reservoir, one of six NYC reservoirs in the Watershed. The Village of Hobart was required and funded under provisions in the DEP 1997 Memorandum of Agreement (MOA) to further treat its extended aeration activated sludge effluent to meet monthly average State Pollution Discharge Elimination System (SPDES) permit limits for CBOD5 (25 mg/l), SS (10 mg/l), P (0.5 mg/l), N (8.2 mg/l as NH3), and fecal coliform (200 coliforms/100 ml). The plant was subsequently upgraded with tertiary treatment, which included coagulation/flocculation, multi-media filtration, hollow fiber microfiltration (MF), and low-pressure UV disinfection. The microfiltration system (Pall AriaTM AP-Series) is comprised of two primary 20-module membrane skids each designed conservatively at a flux rate of less than 23.3 gal/ft2/day per DEP specifications. Each skid can independently accommodate maximum plant flow for full redundancy. A third auxiliary 7-module membrane skid processes backwash from the media filters for greater overall recovery. The membrane system provides an absolute barrier for cryptosporidium and coliforms that could potentially pass through the multimedia filters. Downstream, the UV system further ensures the elimination of microbial contamination and the discharge of high quality effluent into the receiving body. After nearly 5 years online, the plant has consistently met its SPDES permit requirements.

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The Role of Impervious Surfaces in Future Nutrient Loading in the New York City West of Hudson Watersheds

Myrna Hall, Prajjwal K. Panday and Charles A. S. Hall, SUNY Environmental Science and Forestry and Mary Tyrrell, Yale School of Forestry and Environmental Studies

It is a basic assumption of most non-point source pollution models that impervious surfaces in the built environment enhance runoff and delivery of nutrients to receiving waters. However, historically, in the New York City West of Hudson (WOH) Watersheds, a region that was still 78% forested in 2002, most of the degradation in water quality has been attributed to agricultural land use and practices. We have shown, using satellite image analysis, that agriculture is waning and forests recovering in the WOH catchments. This should be good news for the future quality of New York City's drinking water. However, the increased construction of rural residences and roadways that we have documented coupled with our analysis of the empirical water quality data may indicate otherwise. Using USGS flow records and NY City Department of Environmental Protection water quality data (2001-2003) we have calculated loads for seven chemical analytes in 35 West of Hudson sub-watersheds using nine different loading models summarized by Endreny (2004). We analyzed the mean model export coefficient value (ECV) statistically against a suite of spatially-varying watershed characteristics using step-wise regression. Contrary to our expectations, five of the seven resultant models include mean percent impervious surface as a significant explanatory factor. We then compared our empirically-based nutrient loads (P and N) to those derived using ECVs developed by e.g. Reckhow, Beaulac and Simpson (1980) and Brown and Rafferty (1980) whose ECVs for urban land use range from 33% to 100% those for agriculture. By adjusting their land use-specific ECVs to reproduce the empirically-based loads we were then able to calculate future loads based on land use projections to 2022. It appears that even as the proportion of agriculture in the watershed decreases, growing development and its associated increases in impervious surfaces may offset the benefits derived from increasing forest cover.

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Catskill Watershed Corporation Septic Monitoring Program

James Hassett, SUNY Environmental Science and Forestry and Thomas DeJohn, Catskill Watershed Corporation

The Catskill Watershed Corporation (CWC) is a not-for-profit corporation that implements and administers various environmental protection, economic development, and community improvement programs throughout the portion of the New York City (NYC) watershed located west of the Hudson River (WOH watershed). This watershed and its six reservoirs are the primary source of drinking water for NYC as well as numerous other municipalities that adjoin the NYC aqueducts.The goal of this research project is to provide information about the effectiveness of alternative onsite wastewater treatment technologies under local conditions to help designers and regulators select appropriate, cost-effective systems in the WOH watershed. CWC staff works with many septic systems that are on lots insufficient for NYS Department of Health 75-A conventional onsite systems standards due to poor soils, small size, proximity to watercourses, high groundwater, or steep slopes. The CWC Septic Monitoring Program will help promote use of the best available technology for long term control of sewage from on-site systems. This research project is designed to provide information to help answer the following questions:

"Can alternative technologies remediate substandard absorption areas to an acceptable level (i.e., to dispose of wastewater to the subsurface)?" What is the performance (i.e., carbon, nutrient and pathogen removal) of such systems in real world conditions? "What is the cost of installation, operation and maintenance of various technologies?" Can these systems be provided proper maintenance, through septic maintenance districts or other mechanisms?

The National Research Council confirmed the need for such research in a draft report released in 1999 entitled "Watershed Management for Potable Water Supply: Assessing New York City's Approach." The report recommended greater use in the watershed of aerobic systems. The report states that other alternative technology such as peat filters, re-circulating sand filters, constructed wetlands and waterless systems may be as effective as aerobic units, but research is needed to verify this. The report further states that performance monitoring of septic systems can be difficult and has not been done in the NYC watershed on a regular basis.

For this research project, CWC and their consultant Project Team will monitor alternative technologies to replace or repair existing septic systems in difficult sites typical to the WOH area. In Phase I of this project the CWC will oversee installation of several alternative technologies including aerobic treatment, peat filters, sand filters, raised systems as well as conventional 75-A systems at up to 38 sites. In Phase II the Project Team will sample subsurface soil water and pretreated effluent at twenty select sites over a one year period to observe the level of treatment provided. This presentation will conclude this research project by summarizing Phase I and Phase II including aspects of equipment design and system installation, site selection criteria as well as provide a draft of the final report and analysis of Phase II. The importance of this research lay not only in the system types and sites tested but also the significant number of systems of each type in a single coordinated research project.

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Storm Event Monitoring for Pathogens on the Esopus Creek in 2006

Paul LaFiandra, NYC Department of Environmental Protection

As part of a Water Resources Development Act (WRDA) grant awarded to NYCDEP by the United States Army Corps of Engineers, monitoring for pathogens Giardia spp. and Cryptosporidium spp during storm events was performed on the Esopus Creek in from April to December 2006. Monitoring was performed at a mid-upper headwaters site, a tail-waters site of the Esopus Creek and at a third site representing a major input between the two other stream sites. A total of ten events were monitored with two pathogen samples collected per event at the stream sites and one per event at the third stream input site. All of the equipment met and exceeded design expectations and a great deal of experience was realized in terms of the equipment programming and storm monitoring logistics.

Mean storm event pathogen concentrations at the headwaters site (E5) were found to exceed mean baseline Giardia and mean baseline Cryptosporidium concentrations in 2006. Mean storm event pathogen concentrations at the tail waters site (E16I) were found to exceed the mean baseline Giardia concentrations and Cryptosporidium concentrations for 2006. Mean pathogen concentrations at the Schoharie Reservoir diversion site (SRR2CM) exceeded expected concentrations given the fact that this water source was not under storm influence at the time of sampling. Seasonal trends in pathogen concentration and loading were not observed.

Pathogen loading calculations were also performed which indicated that pathogen loadings were the highest at the tail waters monitoring site. This type of result was expected given the significant increases in flow at the two stream sites during storm events.

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Utilizing the Watershed Lands Information System to Manage City-owned Water Supply Lands and Conservation Easements

Paul Lenz, NYC Department of Environmental Protection

A Watershed Land Information System (WaLIS) is being used by the Natural Resource Management group within the Bureau of Water Supply to manage land and conservation easements owned by the City. WaLIS continues to be developed with the help and support of the New York State Department of Environmental Conservation's Division of Water, the US Environmental Protection Agency, and PAR Government Systems Corporation.

WaLIS is a cutting-edge database that incorporates mapping capabilities similar to Geographic Information Systems and empowers ÿnon-technical usersto access data, prepare maps and reports, track conversations, record and view documents and pictures, and communicate among internal staff. The primary goals for the WaLIS application includes: the ability to collect, manage, and store vast amounts and types of data that is available to ÿdesk-topusers, improving the consistency and equity of decisions regarding management of City water supply lands, improving the accuracy, consistency, and security of land information assets, improving employee satisfaction with the work environment and ability to effectively schedule tasks, increasing productivity and reducing cycle time for completion of business processes related to land management, eliminating redundant data and processes, and improving the accountability and ability to report the status of land management activities both internally and externally.

At the time of this presentation, WaLIS 4 will be presented which is the latest version and incorporates a new look and many updated features and functionalities. This presentation will take the audience through the many features of WaLIS using real-world scenarios and illustrate how land managers at DEP use this system for the effective management of City land and easements.

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Storm Water Loading of Giardia spp. and Cryptosporidium spp. in Perennial Streams of a New York City Reservoir

Christian Pace, Kerri Ann Alderisio, James C. Alair and Steve Serge Di Lonardo, NYC Department of Environmental Protection

The loading of waterborne pathogens and particulate matter increases significantly during the elevated stream flow of storm events. Recognizing its potential implications for water quality, the New York City Department of Environmental Protection constructed several storm water attenuation basins (BMP's) around Kensico Reservoir to help minimize the effects of storm water on reservoir water quality. We previously reported the development of integrated monitoring stations for event-based sampling. In the second phase of this project, we sampled nine perennial tributary streams to Kensico Reservoir (Westchester, New York), to estimate Cryptosporidium oocyst and Giardia cyst loading of each stream over the course of 10 storms (0.36 - 2.76 in) in 2006. Sampling was performed with automated samplers at 13 stations with continuous flow monitoring. Two composite samples representing the hydrologic phases of a storm (rising and descending limbs), were obtained by sampling 24 aliquots at 30 min intervals from the nine streams. Five streams contained BMPs, two of which were monitored upstream and downstream to examine whether a reduction in pathogen loading was realized. Loading was calculated for each sampling period using the composite sample concentration and sum of the flow over the course of the sampling period. Each stream was ranked according to storm flow, and compared against a ranking for pathogen loading. We found that BMPs delayed pathogen loading into the reservoir; however, loading was not significantly reduced. This study suggests that the efficacy of existing BMPs, initially designed for the reduction of turbidity and fecal coliform bacteria, may not be as effective in reducing pathogens as previously assumed, and this information should ultimately be considered in future BMP designs.

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Incidence of Enteric Viruses in Surface Water from New York City's Catskill and Delaware Watersheds

Gerald Pratt and Kerri Alderisio, New York City Department of Environmental Protection

Surface water samples from aqueduct monitoring locations representing New York City's Catskill and Delaware Watersheds as well as effluent samples from 10 waste water treatment plants (WWTP) located within these watersheds, were collected for Human Enteric Viruses (HEV) over a five year period, 2002 through 2006. The weekly surface water samples and quarterly plant samples were collected and analyzed using the Total Culturable Virus Assay (TCVA) according to USEPA Information Collection Rule (ICR). The aqueduct monitoring occurred at influent and effluent locations of a surface water reservoir in Westchester County New York. Surface water samples ranged from 66% to 80% non-detect of HEV at influent locations and 87% to 84% at effluent locations. Average HEV concentrations from aqueduct influent locations ranged from 0.61 to 1.8 MPN/100L, while average virus concentrations of water samples from aqueduct effluent locations were 0.28 to 0.48 MPN/100L. These results suggest a reduction of virus occurrence during transport through the reservoir, and that any local input of viruses is similarly reduced by the reservoir. The WWTPs monitored were located in Delaware, Ulster, Sullivan, and Green Counties and were upgraded just prior to sampling. WWTP effluent samples had a 99% non-detection rate. Of the 170 samples collected, only 2 tested positive for viruses, each about 1MPN/100L, suggesting that plant upgrades were adequate to mitigate virus loads to either minimal concentrations, or to eliminate them from final effluent.

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Challenges of the NYCDEP Wastewater Treatment Plant Regulatory and SPDES Upgrade Program

Robert Ravallo, NYC Department of Environmental Protection

Challenges of the NYCDEP Wastewater Treatment Plant Upgrade Program: As part of the New York City Memorandum of Agreement, 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 NYC watershed. For the purposes of this program, "Regulatory Upgrades" mean equipment and methods of operation that are required solely by the NYC Watershed Regulations, and not by federal or State law. "SPDES Upgrades" refers to equipment that is necessary to the treatment process , where such measures are not required solely by the NYC Watershed Regulations and where such upgrades will allow the WWTPs to reliably meet the conditions of their respective SPDES permit. The City further agreed to pay the annual costs of operation and maintenance of the upgraded facilities. The task of coordinating these complex projects with the 106 different owners in the watershed is enormous. Virtually all of the WWTP owners are restaurateurs, hoteliers, camp operators, homeowners' associations, school administrators, managers of recreational facilities and the like not professional WWTP operators and construction specialists. DEP has proceeded diligently with this vast undertaking and provided step-by-step guidance on a host of legal, engineering, contracting and regulatory issues.

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Monitoring and Control of Nuisance Algae in a Drinking Water Reservoir

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The Massachusetts Water Resources Authority (MWRA) is an unfiltered surface water supply, providing drinking water to over 2 million customers in eastern Massachusetts including Boston. Wachusett Reservoir is the primary source of water, although approximately 50% of the water in Wachusett is transferred from the Quabbin Reservoir in the western part of the state. Wachusett Reservoir is an oligotrophic, low nutrient water body (Worden and Pistrang, 2003).

Many different algae, or phytoplankton, are present in Wachusett Reservoir, but only some of these are of concern. Among the major taxa, algae are classified as chrysophytes (golden brown algae), cyanophytes (blue-green algae), chlorophytes (green algae), and bacillariophytes (diatoms). Only certain taxa within these families are of concern in Wachusett Reservoir, and these are enumerated specifically. The primary nuisance algae causing taste and odor in the MWRA water supply are Anabaena and Synura. Other potential nuisance algae include Dinobryon, Chrysosphaerella and Uroglenopsis.

Many taste and odor causing algae contain geosmin and 2-methyl-isoborneal (MIB) (Knappe et al, 2004; Cotsaris et al, 1995). These compounds may be released continuously from the living algal cells, and others may be released when the algae cells are lysed or killed (Parker, 1996). In either situation, it is important to control the growth of these algae. This report describes how MWRA controls levels of particular nuisance algae. Since 1997, MWRA targets the addition of copper sulfate (CuSO4) at the early stages of exponential growth - when levels are just starting to increase and a bloom is considered to be imminent. Control of algae blooms early in log growth is most successful in limiting taste and odor impacts. Application once an algae bloom has occurred is less effective, and also results in taste and odor issues associated with dead algae (Taylor, et al., 2006, AwwaRF #91102).

A monitoring program to enumerate and determine when nuisance algae have reached the trigger level is described. Results using manual microscopic counts and examination of samples using Fluid Imaging Technologies, Inc., Flow-Cam are compared.

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UV Disinfection for the Protection of the NYC Watershed

Cathy Robson, Trojan Technologies

Water scarcity has become a growing issue globally. Many cities in the world are experiencing water stress (i.e., deterioration in water quality and growing shortage in water quantity). Reuse of treated municipal wastewater offers an attractive solution to the water stress problem. The treated wastewater can be reused for the purpose of irrigation, landscaping, toilet flushing, car washing, industrial use, etc. Since people are in direct or indirect contact with reuse wastewater, proper disinfection is critical for protecting public health. Chlorine has been used for disinfecting wastewater for reuse purposes, but there are two (2) issues associated with chlorine disinfection. First, it has been well established in the literature that chlorine disinfection forms disinfection byproducts. Byproducts can cause both acute and long-term health effects. This is of specific concern if the wastewater is being discharged upstream of a drinking water intake. Second, chlorine is ineffective in disinfecting Cryptosporidium. In North America, Cryptosporidium is commonly found in municipal wastewater even after conventional treatment. A Cryptosporidium outbreak in Milwaukee in 1993 affected 403,000 people.

Ultraviolet (UV) disinfection is effective in controlling a broad spectrum of pathogens including chlorine-resistant Cryptosporidium. It is also environmentally friendly in that no harmful byproducts are formed. UV disinfection of wastewater for reuse purposes has been successfully applied for decades in large scale treatment plants in North America. This presentation will provide an overview of UV technology for reuse applications, related regulations, experience in North America, and the associated costs and benefits. Practical considerations for successfully implementing UV technology for reuse applications will be presented.

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Detection and Elimination of Illicit Discharges to Storm Sewers

Andrew Sansone, Monroe County Department of Environmental Services

The Monroe County Department of Environmental Services operates and maintains the sewer collection system in the City of Rochester, NY. The County began an outfall inspection program in 2002 with the goal of meeting Stormwater Phase IIIDDE requirements by December 2007.Five years into the program and there have been great successes in identifying illicit discharges, primarily cross connections to storm sewers.GIS mapping has proven to be essential in tracking and isolating these cross connections. In addition, a variety of tools have been employed including sampling, optical brighteners, televising, dye testing and smoke testing.

This presentation will focus on the how these various detection tools have been utilized and will look at increased efforts to address generating sites. In addition, there will be a discussion of the nature and impacts of the new illicit discharge ordinance.

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The AAI and ASTM Standards for Environmental Site Assessments: A Tool in Watershed Protection

Stuart J. Spiegel, O'Brien & Gere

An important element in any watershed protection program is effective control of the inputs to the watershed. Often, property is acquired so that land uses can be monitored and potential impacts to the resource can be controlled. As a step in the property acquisition process, a Phase I Environmental site assessment (ESA) is recommended for each property to ascertain potential recognized environmental conditions(issues of actual or potential environmental contamination) at a site. Using this process, the environmental quality status of a property can be defined early in the decision-making process, and the planning entity can refrain from taking title to properties requiring significant remediation. The same process can be used to research and demonstrate which properties may require further evaluation to protect the integrity of the watershed.

On November 1, 2006 (40 CFR Part 312), the U.S. Environmental Protection Agency's (USEPA's) All Appropriate Inquiries (AAI) ("Innocent Landowners, Standards for Conducting All Appropriate Inquiries") regulations became effective. These regulations set the standard for conducting Phase I ESAs to meet the test of the so-called innocent purchaser defenseunder the federal Superfund program. The AAI regulations reference ASTM's E1527-05 standard of practice ("Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process") for Phase I ESAs as equivalentto the AAI. However, these procedures have significant differences, among them: (1) the AAI regulations include only contaminants that are CERCLA hazardous substances included in the federal Superfund program, so petroleum compounds are explicitly excluded from consideration, although the potential for liability remains in other federal and state petroleum contamination laws and regulations; (2) the historical periods that need to be reviewed differ between AAI and ASTM 1527-05; and (3) AAI does not recommend a report format, while ASTM 1527-05 does (as did the previous versions of the standard);

It also is important to understand the purpose of performing an ESA, which is intended to allow the user to assert liability protections under Superfund. Also, it is required for many USEPA Brownfields Grant recipients, having been promulgated pursuant to the Small Business Liability Relief and Revitalization Act (also known as the (Brownfields Act). Lastly, independent of these drivers, AAI and ASTM 1527-05 establish a standard, minimum baseline that is considered reasonable to provide a user with information about the environmental quality of a property.

This presentation will summarize the key elements of the AAI regulations and ASTM standard, and highlight the significant differences between the two practices.

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Hydrologic Modeling for the Prediction of Microbial Contaminant Dynamics

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Pathogens from point and nonpoint sources are a major concern for public drinking water providers and public health departments responsible for recreational water quality monitoring. Knowledge of the input loads and transport pathways of pathogens can lead to better watershed management. Accurate quantification of the effects of hydrologic variability and land use change on watershed, river, and reservoir water quantity and quality is of particular importance for long-term management, source water protection, quantitative microbial risk assessment, and for the prediction of the effects of climate change on water quality. Watershed modeling, in combination with focused data collection efforts, has the potential to extend our understanding of these dynamics. However, pathogen monitoring efforts needed for model development at the watershed scale are too often prohibitively expensive or have too many non-detects. As such, we continue to rely heavily on indicator organisms for the calibration and validation of these models.

This paper compares two modeling and monitoring approaches for the prediction of microbial contaminant dynamics for two systems in Massachusetts, U.S.A. The first system involved the development of empirical and physically based watershed models of the Wachusett Reservoir watersheds, a source of drinking water for Boston, MA and surrounding area. These models were designed for load and hydrologic estimation, and are thus useful for management purposes. The current model will simulate daily runoff and bacterial load for nine basins based on a daily rainfall trace. Land use effects are accounted for in terms of a curve number, for hydrologic routing, and in terms of calibrated export coefficients, for bacterial indicators. For the Wachusett system, 7 years of fecal coliform data were available for model calibration and validation. Development of basin average rainfall time series based on radar data is planned to further improve subbasin hydrologic estimation capabilities by better accounting for spatial variability.

The second system involved the development of a distributed, process based model of the Blackstone River Watershed. The WATFLOOD hydrologic modeling system will be used to estimate the temporal and spatial variation of Escherichia coli in the Blackstone River. The data requirements are greater for the Blackstone River model. To support this effort, E. coli data were collected on a sub daily basis at 29 sites for multiple precipitation events beginning in the fall of 2005. In addition, samples were collected from stream sediments at 3 of the 29 locations and analyzed for E. coli densities over the course of the hydrograph. Ribotypes of E. coli were obtained to determine the hydrological connection among sites and between the sediments and the water column, since previous modeling and monitoring have identified resuspension from sediments as one of the processes of greatest importance for predicting peak indicator densities.

Results will be presented describing the usefulness of the models for predicting the dynamics of microbial contamination for watershed management.

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Hydrodynamic and Water Quality Modeling for Watershed & Reservoir Management

John Tobiason, Ph.D. and David Ahlfeld, Ph.D., University of Massachusetts, Amherst

The purpose of this paper is to present applications of long-term and multi-faceted reservoir modeling approaches undertaken for the Division of Water Supply Protection of the Massachusetts Department of Conservation and Recreation (DCR) in fulfilling their responsibilities for watershed and reservoir management. The modeling work is part of a larger effort focused on a two reservoir source of currently unfiltered drinking water for the Boston metropolitan area, with the long term research goal of providing a rational basis for watershed and reservoir management decisions through measurements of water quality and modeling of significant transport and transformation processes. Modeling of reservoir hydrodynamics and water quality has included extensive use of CEQUAL W2, a two dimensional (longitudinal segments, depth layers, lateral homogeneity) finite difference model available in the public domain. Assessment and calibration of annual water budgets have highlighted strengths and weaknesses of available data in properly characterizing water quantity. The terminal supply reservoir (Wachusett) can be significantly affected by transfers from a larger, more pristine, supply reservoir (Quabbin) such that modeling of hydrodynamic and water quality impacts of this transfer is important. Project work has illuminated key aspects of this transfer. Another aspect of the project has been to assess inputs and transformations of natural organic matter (NOM) due to its influence on subsequent oxidant/disinfectant demands and by-product formation. A more recent emphasis of using reservoir models has been to assess potential impacts of contaminant spills (sewage, hydrocarbons) into the reservoir on water quality in the overall reservoir and at the water supply intake. In order to properly characterize one basin of the reservoir a three dimensional computational fluid dynamics (CFD) model was developed which has revealed the importance of jet and eddy effects and the location of potential spills. This paper will summarize and highlight key findings from the several of the modeling applications undertaken to date.

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Utilization of the Biolance System for the InSituProduction of Hydrogen for Bioremediation of Chlorinated Solvents

David B. Tompkins, The Chazen Companies and Hugh H. Russell, AR Environmental Services, Inc.

The "BioLance" System installs electrodes in an aquifer system for the generation of hydrogen. The hydrogen stimulates microbial mediated reductive dechlorination of chlorinated solvents, such as Perchloroethene (PCE) and Trichloroethene (TCE). The System was installed and tested over the past four years at a site in New Jersey, which was impacted with PCE.

In 2003, a Field Pilot Test System was installed as a proof of concept and field validation study. The System was monitored by sampling five groundwater monitoring wells on a monthly basis for about one year. Data analysis showed loss of PCE attributable to the production of hydrogen and microbial activity. Residual hydrogen concentrations as high as 16 nanomoles per liter were detected in the monitoring wells. As a result, the technology was field validated.

Following activation of the first injection area, a second system (System 2) was installed upgradient of System 1. System 2 incorporated design and installation changes from evaluation of System 1. Data from the System 2 monitoring wells indicated it was more efficient at removal of PCE than System 1. With hydrogen concentrations as high as 160 nanomoles per liter detected in monitoring wells.

To fully remediate the Site, a third system (System 3) was installed at the up gradient edge of the plume. Approximately six months after System 3 was installed, there was a sustained observable loss of PCE, which coincided with a transient increase in Dichloroethene (DCE), a known daughter product.

The required clean up goals for the Site are 1 ppb for PCE and TCE and 70 ppb for DCE. As of January 17, 2007, groundwater in three wells remain above clean up goals for PCE and TCE. All three of the wells are associated with System 1. Two are within an order of magnitude of the required clean up goals (approx. 9 ppb) and the third is within two orders (110 ppb). The well with the highest current concentration of chlorinated solvents is the furthermost down gradient monitoring location. The wells monitoring both System 2 and System 3 are currently below 1 ppb for PCE, TCE, and DCE and treatment in these areas may soon be discontinued since the area is devoid of chlorinated solvents, both progenitor and daughter products. Except for two small areas in the vicinity of System l, the aquifer appears to have been remediated. The wells monitoring System 2 have been below required clean up goals for the past seven months. Based on 4 years of monitoring.

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New Aquifer Recharge Rate Estimates and Septic Density Guidance

Russell Urban-Mead, The Chazen Companies and Scott Chase, Dutchess County Water and Wastewater Authority

A report recently commissioned by the Dutchess County Water & Wastewater Authority provides updated understandings of aquifer recharge rates for Dutchess County and could be expanded to other surrounding areas. The report also provides new guidance for sustainable densities of septic systems. The approaches outlined in this report can help municipalities, developers and planners better understand groundwater availability for various applications.

The updated aquifer recharge rate estimates have been calibrated to reflect precipitation and stream flow data, and are correlated with Hydrologic Soil Groups A, B, C and D, mapped by the Soil Conservation Service. The aquifer recharge rates for each Hydrologic Soil Group are judged to be accurate to approximately 0.2 inches per year, and allow calculation of site or regional aquifer recharge budgets, estimated recharge areas supporting particular wells, or evaluations of stream baseflows.

For areas intended for continued use of individual wells and conventional septic systems, the report includes guidance for minimum sustainable parcel sizes able to support individual wells and septic systems. The septic system density calculations can be adjusted to reflect occupancy rates and impervious surfaces on parcels, as well as local precipitation and streamflow conditions.

Municipalities, developers and planners may use the principles found in the recently-released report without cost. The report has benefitted by pre-release review by the DCDOH, the DC Planning Department and a USGS hydrogeologist. The study was completed by The Chazen Companies. The report is available for download on the Water and Wastewater page under the Dutchess County home page.

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Conservation efforts in Cannonsville: Are they working?

Tamie Veith, Ray Bryant and Bil Gburek,USDA-ARS,

The Cannonsville Reservoir is a major component of the unfiltered New York City water supply system. This year, the voluntary, incentive-based Watershed Agricultural Program marks a 15-year history of collaboration among producers, the Natural Resources Conservation Service (NRCS), the Delaware County (NY) Soil and Water Conservation District, and Cornell Cooperative Extension to address the problem of phosphorus (P) loading effects on water quality through implementation of whole farm plans for watershed farms. As a result of the efforts of these and other scientists, a wide range of conservation practices have been tested and implemented in the watershed. For the past 5 years, Cannonsville has been a benchmark watershed for the USDA Conservation Effects Assessment Project (CEAP), which is collaboratively funded by Agricultural Research Service (ARS) and Cooperative State Research, Education, and Extension Service (CSREES). As a result, the watershed and its farms have been a focus of numerous studies documenting the effectiveness of implemented or potential conservation practices. For example, an NRCS-developed system for simultaneous seeding of cover crops with silage corn reduced total P loads in runoff by 72%. In-stream deposits by pastured cattle equates to approximately 10% of watershed-level P loadings attributed to agriculture, and efforts to exclude pastured cattle from streams as part of the Conservation Reserve Enhancement Program are estimated to have already reduced in-stream deposition of fecal phosphorus by 32%. The Integrated Farm System Model, modified to include a process-level soil P model, was used to assess precision feed management, which more precisely balances dairy cattle diets and improves production and utilization of homegrown forage. More accurate feeding of P, integrated with increased productivity of grass-forage and the proportion of forage in the diet, resulted in a farm P balance reduction of 75% and a soluble P loss reduction of 17%. Predicted soluble P loss reduction at the watershed outlet was 10%. By developing a better understanding of the effectiveness of applied conservation practices and using in-depth watershed knowledge to design and predict the effectiveness of novel management practices, we can continue to improve and maintain an environmentally healthy watershed and a clean, unfiltered water supply for New York City.

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Three years of Studies in Harbor Island Park, Mamaroneck, the big filter works!

Anna Yeung-Cheung, Ph.D., Manhattanville College

Gunderboom® BPS (Beach Protection System) (Gunderboom Inc., AK) was reinstalled in 2002 in Harbor Island Park, Mamaroneck, NY, to try to lower the bacterial levels in the water. The Gunderboom® is an 800 foot curtain made of a treated polypropylene/polyester fabric. In summer of 2004, preliminary study was first done in the Harbor Island Park and in 2005 summer, water from inside and outside the Gunderboom® was tested from June to November. Coliscan® Membrane Filtration plates (Micrology Lab., IN) were used to estimate the relative amounts of E. coli and coliform bacteria. Soft-shelled clams (Mya arenaria) living in both these areas were also tested for E. coli and coliform bacteria using 3M Petrifilm" Plates (3M company, MN). Our studies found significant differences ($p<0.05$) in the amount of E. coli and coliform bacteria recovered from water and soft-shelled clams inside the Gunderboom® as compared to the outside. In 2006 summer, water and sediments were collected and tested weekly from inside and outside the Gunderboom® along with other watersheds within the Mamaroneck Harbor (Mamaroneck River, Guion Creek and Shore Acres Beach). 1/3 of samples were collected after rainfall. The results showed the amount of bacteria recovered from water and sediments were significantly lower inside the Gunderboom® as compared to outside and the other 3 watersheds even in the presence of rainfall. There was a 78% reduction in E. coli and 70% reduction in coliform bacteria inside the Gunderboom® as compared to the outside. This further indicates the effectiveness of the Gunderboom® in reducing bacteria in the beach.

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HSRS, a Spatial Decision Support System Optimizing Forest Harvest to Reduce its Hydrologic Impact

Yanli Zhang, Ph.D. and Ramanathan Sugumaran, University of Northern Iowa and Paul K. Barten, University of Massachusetts, Amherst

Forest harvest will generally reduce evapotraspiration and thus increase water yield of the forested watershed. However, water yield increase may cause many kinds of environmental and ecological problems, such as wetter soils, soil erosion, nutrient mobilization, decreased water quality, increased channel erosion, and degraded aquatic habitat. Especially when the increased stream flow occurs as augmentation of peak flows, it can exacerbate erosion, transport of sediment and nutrients, and damage to roads and structures. This research explores studies dealing with the relationship between timber harvesting and corresponding hydrologic effect, especially long term water yield increase. In order to minimize the hydrologic effect of forest harvest and to limit the related negative environmental influences, disturbance threshold theory is raised and a spatial decision support system, the Harvest Schedule Review System (HSRS), is developed with ArcObjects and Visual Basic as an ArcGIS extension with user friendly interface. It is designed to review forest harvest schedules and to find plans that will cause the accumulated effect to exceed the disturbance threshold.

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