COMPENDIUM OF ABSTRACTS

September 15–16

2011 Watershed Science and Technical Conference

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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.

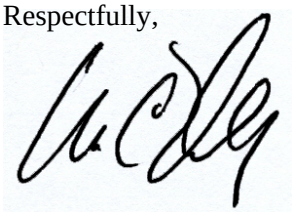
The Watershed Science and Technical Conference was created as an annual opportunity to bring scientists, professionals, and other experts together with watershed stakeholders and the public, to technically inform, exchange ideas, and unveil new information regarding the protection of the nations largest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

It's no secret that our partners at the New York City Department Environmental Protection are always busily engaged in planning and engineering for the future of the nation's largest unfiltered water supply. Staying years ahead of meeting today's drinking water needs for more than 9 million New Yorkers isn't easy on a good day - and it gets even tougher when one of your aqueducts springs a leak. Yes, in addition to the normal array of system infrastructure maintenance, replacement, and upgrade, New York City has been engaged in an unprecedented scientific and engineering initiative to address leaks in a portion of the aqueduct that connects the Rondout Reservoir in Ulster County to the West Branch Reservoir in Putnam County. The leaks release between 15 and 35 million gallons of water a day.

Attendees at this year's conference will hear firsthand about how DEP will build a three-mile bypass tunnel around a portion of the aqueduct that is leaking, and repair other leaks from the inside of the existing tunnel. "The construction of the bypass tunnel and the repair of the lining will ensure that DEP can continue to deliver high quality drinking water every day for decades to come" says DEP. We agree and look forward to hearing the details.

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,



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- The Watershed Agricultural Council
- The United States Geological Survey
- The New York State Environmental Facilities Corporation

Source Tracking *Giardia spp.* in a New York City Watershed Stream: Sampling Considerations

Kerri Alderisio, NYC Department of Environmental Protection

Often the term "source tracking" is used when enhanced analytical methods are applied to select water samples (ribotyping, genotyping, etc…) to determine specific molecular information that will link an organism to a source (*e.g.*, human or animal). However, in the absence of molecular techniques, one can still design a program that may often identify the origin of an undesirable contaminant. A simple and progressive sampling scheme, upstream of the site being investigated, is the first step to identifying areas of concern. Initially a broad assessment of land features and land use must be completed to identify obvious potential sources. Once initial sites have been identified and sampling has occurred, data must be analyzed on an ongoing basis to alter sampling locations and best direct the sampling scheme to identify a final source location. This project describes the evolution of a study to examine a stream site in the New York City watershed that has been identified, through years of sampling, to have a higher than average Giardia spp. concentration compared to other areas sampled in the region. Sampling considerations include: ongoing data analysis, sample volume, stream flow, travel time, sequence of sample collection, precipitation events, and more. Results to date have indicated areas where further analysis is needed, as well as areas not believed to be impacting the site under investigation. This project outlines a progressive and gradual approach to identifying an area of insult, in order to identify best management practices specific to the region. This plan is also a good example of how New York City is monitoring the watershed in areas where Giardia cysts may be elevated, in order to better protect water quality and better understand potential sources of pathogens.

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Phosphorous Loading in the Southern Shelf of Cayuga Lake

Nathaniel Carman, Jose Lazono, Dan Ramer, Ithaca Area Wastewater Treatment Facility

The southern shelf of Cayuga Lake, according to a 2007 DEC Waterbody Inventory study, was listed as having impaired water quality. With a Class A ranking the southern shelf is known to have above average levels of sediments, phosphorous and pathogens that contribute to:

1. Impaired public bathing
2. Impaired recreation
3. Stressed aesthetics
4. Possibly threatened water supply

Maintaining adequate water quality within the shelf is vital to preserve this ecosystem and the economic benefits associated with it. This can be done largely by formulating a total maximum daily load of phosphorous, TMDL, for the southern shelf. Phosphorous is the limiting nutrient in temperate aquatic ecosystems and in regards to Cayuga Lake is a marker of its health and integrity. Prior research done on phosphorous loading did not yield accurate results because one of the two contributing tributaries, the Cayuga Inlet, did not have an adequate flow model. Preliminary research done by the Ithaca Area Waste Water Treatment Facility has changed that. By using a Doppler Current Profiler (DCP) deployed in the Inlet discharge values were attained with a daily average of 16.4 million gallons per day flowing into Cayuga Lake. The DCP also showed that the Inlet flows both north and south demonstrating characteristics more akin to an estuary than a river. This data, being relatively new to studies of Cayuga Lake, was vital in accurately calculating phosphorous loads. It was found that in the 2010 summer season 33.5 pounds of phosphorous, on average, is discharged per day into the southern shelf of Cayuga Lake. This figure was estimated after monitoring the flows and phosphorous levels of Fall Creek, Cayuga Inlet, Lake Source Cooling, and the Ithaca Waste Water Treatment Facility. The ultimate goal of this research is to create a TMDL for the southern shelf of Cayuga Lake to aid in estimating phosphorous loading which then can be used to create policies to maintain the shelf's health and overall economic value.

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Impacts of Nitrogen Removal on Wastewater Chlorine Disinfection

Sarah Dailey, Robert Sharp, Mike Lynch, Paul Pitt, Hazen and Sawyer, P.C.

Sodium hypochlorite is used for disinfection of secondary effluent at New York City's Wastewater Treatment Plants (WWTPs). The City's traditional approach to disinfection is to utilize chloramines, usually monochloramine, created by the reaction between chlorine and ammonia to provide the target Total Residual Chlorine (TRC) concentrations in the effluent.

However, as the City moves toward biological nitrogen removal at a number of its plants, the traditional approach will need to be amended to ensure adequate disinfection and TRC levels, without excess chemical usage. In order to maintain a consistent and cost effective approach to disinfection, a study is being carried out to better understand the impact of nitrification, diurnal influent loading variations, and lower effluent ammonia concentrations on chlorine demand, efficacy and TRC limits. The study is taking place at 5 NYC WWTPs and includes:

- A Historical Data Analysis involving a survey of all 14 New York City WWTPs using two years of plant data

is being carried out to assess the historical sodium hypochlorite use and correlate that use to seasonal variations in effluent nitrogen species. This would likely show impacts of year long and seasonal nitrification at 3 of the selected plants, while showing typical chloramine disinfection at plants that do not experience significant nitrification.

- A Field Evaluation on all five study plants to determine the impacts of diurnal nitrogen loads on disinfection and sodium hypochlorite use. In addition, specific effluent samples will be collected and analyzed for nitrogen species, then titrated with sodium hypochlorite until the target residual chlorine concentration is achieved. The amount of chlorine added, and the resulting form(s) of chlorine residual (free, combined and total), will be determined to determine the potential impact on plant operations, chemical usage, and receiving water quality.

The paper will present the results on this study and discuss the implications on plant operations and receiving water quality.

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Cyanobacteria Bloom and Nutrient Imbalance Linked to Stocked Sterile Carp in Eutropich Lake

Steve Di Lonardo, John D. Wehr, Ph.D., Alissa A. Perrone, Kam Truhn, Fordham University

A privately owned, shallow eutrophic lake (ca. 20 acres) in Westchester County has been monitored for baseline water quality following the stocking of triploid grass carp (Ctenopharyngodon idella) to control the overgrowth of submerged aquatic vegetation (SAV), which had affected recreational uses by residents (swimming, non-motorized boating). The lake's eutrophic state and SAV overgrowth is attributed to elevated "plant" nutrients (nitrogen and phosphorus) linked to human activity in the watershed. In 2005 and 2006, SAV overgrowth reemerged, presumably due to the decline in carp population since they could not reproduce. Consequently, a permit application was submitted to re-stock the lake with grass carp. Based on a vegetation survey and NYSDEC guidelines (10 carp per vegetated acre for moderately dense SAV stands), 120 carp were added in the spring of 2008. The first two growing seasons (2008, 2009) were characterized by reduced SAV growth, as desired. In 2010, the growth of vegetation was suppressed, presumably due to increased feeding by growing carp. Carp were introduced to address the overgrowth of vegetation and not the root issue, elevated nutrients. As a result, a dense cyanobacteria bloom (not common in prior years) developed in mid-summer of 2010 coincident with the depletion of nitrate in the epilimnion and persisted through the winter under the ice. In addition to the absence of SAV linked to carp, the 2010 growing season was characterized by very warm spring temperatures, resulting in an early growing season. As a precaution, an advisory was sent to lake residents not to swim or drink the water. Further, Microcystin levels were twice tested (summer, winter) and found to be below the WHO guidelines for drinking water (< 1 µg L-1). This study highlights that aquatic ecosystems are a fine balance and that management strategies, even when following guidelines, sometimes have undesirable outcomes.

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State Revolving Funds Update

Matthew J. Driscoll, NYS Environmental Facilities Corporation

The New York State Environmental Facilities Corporation (EFC) administers the largest State Revolving Fund Programs (SRF) in the Nation. Since 1970, EFC has provided almost $15.5 billion in low-cost financing and grants for over 2,100 drinking water and sewer infrastructure projects spanning New York. Recently, both the New York Clean Water State Revolving Fund and Drinking Water State Revolving Fund have expanded their efforts to incorporate sustainable, "green" components into clean and drinking water projects. Furthermore, in conjunction with traditional SRF financings, EFC is providing $112 million and $16 million in grants for clean and drinking water projects, respectively; allowing disadvantaged communities to affordably proceed with their infrastructure investments in a 'greener' manner. Audiences may also be interested to learn more about the Corporation's award-winning Green Innovation Grant Program and new initiatives for 2011.

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Utilizing Sorbtive Media to Enhance Green Infrastructure Practices

Robert Gallucci, Imbrium Systems

Low Impact Development (LID) is a design approach which supports the overall health and wellness of people, and the environment that surrounds us. Green Infrastructure, under the scope of LID, has the potential to restore, recycle and extend natural and man-made infrastructure. Furthermore, it can effectively reduce runoff, remove pollutants, and deliver multiple community benefits at less cost than conventional building practices. This is where Stormwater Management

comes into play, as a central component of LID. When applied to stormwater, Green Infrastructural methods can promote infiltration to reduce peak discharge rates, to provide volume reduction by groundwater recharge and evapotranspiration, to filter and pre-treat runoff through soil matrices, and to serve as wildlife habitat by incorporating native plants and vegetation. The overall effectiveness of these green practices, however, can vary on a seasonal basis. Antecedent rainfall patterns can also yield variations in results.

This paper will serve to demonstrate the enhancement of green practices through the use of Sorbtive Media, a phosphorus-absorbing material, as applied to three case studies. Analyzed systems include a green roof project, permeable concrete pavers, and a biofiltration ecoswale:

1. TRCA and the University of Waterloo constructed the "green" Archetype Houseat the Kortright Center. The discharged effluent from the green roof leached phosphorus on a cyclical basis. Imbrium Systems provided a collection and treatment system incorporating Sorbtive Media to remove the dissolved phosphorus. Initial results from 2010 indicate 80 to 90% removal of soluble reactive phosphorus and total phosphorus.
2. North Carolina State and the Casey Law firm in Boone, NC installed three equal sections of permeable concrete pavers to compare the water quality of infiltrated runoff. Sixteen storms will be sampled once the study is completed. The treatment provided by conventional stone bedding (10 inches of #2 stone) will be compared with a 22 inch stone bedding section and a 10-inch stone bedding section amended with a 1- inch layer of Sorbtive Media.

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Water Quality Highlights of the NYC Watershed Protection Program for the Catskill/Delaware Systems

Lorraine Janus, Ph.D., NYC Department of Environmental Protection

The New York City Department of Environmental Protection (DEP) is responsible for operating, maintaining, and protecting the City's water supply and it is among the few large systems in the nation that maintain "Filtration Avoidance" (*i.e.*, a waiver from filtration). One requirement of the waiver is a comprehensive watershed protection program. An evaluation of the effectiveness of the City's watershed protection program was conducted recently (see New York City's 2011 Watershed Protection Summary and Assessment at www.nyc.dep.gov). This analysis presents the most important water quality changes observed over the past 17 years and discusses these changes in the context of the protection programs.
As outlined in the SWTR, potential issues of concern for unfiltered water supplies fall into several categories: coliform bacteria, enteric viruses, Giardia sp., Cryptosporidium sp., turbidity, disinfection by-products, and watershed control. DEP collects nearly 16 thousand samples each year from approximately 475 sites throughout the watershed to provide water quality data that guide operations, protection programs, and policies. Water quality changes are responsive to many factors, including natural forcings (such as precipitation), land-based sources of contaminants, and physical, chemical, and biological processes. Watershed protection programs work in conjunction with these factors and since several programs may operate simultaneously on the same analyte, direct cause and effect relationships are not always clear. Observations show that there are several long-term improvements in water quality that have taken place coincident with protection programs. The most notable changes that have occurred are decreases in phosphorus concentrations, reductions in coliform bacteria, and a general increase in conductivity. Various sampling designs and diagnostic modeling are some of the approaches used to provide insight into the effects of specific programs. The primary focus will be on explanation of the major water quality changes observed and how they relate to programs.

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Engineering, Operational, and Environmental Considerations as the Long Island Sound 2014 TMDL Nitrogen Limits Approach

Fred Kincheloe, Savin Engineers, P.C.

Water quality in the Long Island Sound has been impacted by discharge of pollutants directly to the Sound as well as to tributaries that discharge to the Sound. Primary among these water quality issues is low dissolved oxygen (or Hypoxia) and its effect on the living resources of the Sound. Nitrogen has been identified as the primary nutrient contributing to hypoxia. To address hypoxia, wastewater treatment plants have been implementing nitrogen reduction technologies. The most stringent nitrogen targets are culminating in 2014 and as we near those limits, significant engineering, operations, and environmental challenges have been identified. This presentation will review those challenges and present approaches to meeting those challenges.

A summary of nitrogen removal technologies will be presented. The summary will include a description of the biological and chemical reactions that occur during each treatment process. It will outline the technologies used to meet the stringent limits. It will present major design requirements

for each treatment system and will provide the necessary conditions to allow chemical and biological reactions to occur. Critical operating concerns will be identified and techniques to resolve those concerns will be provided. Key features of the technologies and ways these technologies have been implemented will be provided.

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On-Site Wastewater Treatment Options

Mark Koester, Koester Associates, Inc.

This paper will outline several methods to achieve secondary and tertiary treatment standards for domestic and commercial/industrial wastewater. Technologies that are applicable to biological nutrient removal will be addressed including conventional activated sludge, fixed film processes, and membrane-based systems. Filtration and other tertiary treatment processes will be discussed. Subtopics include design criteria, loadings, effluent quality, operations and maintenance. Pre-treatment, including clarification and septic treatment will be addressed as related to subsequent biological processes.

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Challenges to Wetland Mapping and Delineation in the Ashokan Basin of the NYC Water Supply Watershed

Laurie Machung, Frank Parisio, NYC Department of Environmental Protection; Ralph Tiner, US Fish and Wildlife Service

DEP has numerous wetland projects in place which are identifying and addressing challenges to wetland mapping and delineation in the Ashokan Reservoir Basin that can likely be extrapolated throughout the Catskills. DEP partnered with the USFWS in 2005 to update the National Wetlands Inventory using 2003 and 2004 photography. This mapping effort identified approximately 1300 acres of palustrine wetlands within the Ashokan Reservoir Basin. However, field delineations conducted for DEP forest and stream management projects indicate that the NWI underestimates the extent of wetlands in forested headwaters, while overestimating their extent along mainstem tributaries such as the Esopus Creek. These field-scale projects have also identified challenges to wetland delineation in the Ashokan Basin, such as red parent materials, and cobbly to sandy fluventic substrates along higher order streams. To this end, DEP has partnered with the USFWS to install IRIS tubes in sandy to gravelly soils along streams throughout the Ashokan Reservoir Basin, and is also assessing the applicability of the Regional Supplement to the Corps of Engineers Wetland delineation Manual for addressing these circumstances. DEP will continue to apply these findings and advances in remote sensing to improve wetland detection in the New York City Watershed.

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Pharmaceutical and Personal Care Products in NYC's Watersheds: Results from DEP's 2010 Study

Timothy Martin, David Lipsky, Ph.D., Calder Orr, Ian Hurley, NYC Department of Environmental Protection

In 2009, New York City Department of Environmental Protection (DEP) conducted a one-year occurrence study to document the presence or absence of a target group of emerging contaminants in drinking water, including those classified as pharmaceuticals and personal care products (PPCPs), in New York City's watersheds. DEP continued this program of quarterly PPCP sampling in 2010. One additional chlorinated site, DEL19, was added to the list of sampling locations which included DEP's three source water keypoints: CATLEFF, DEL18, and CRO1T (CROGH alternate site). All locations were sampled using the "clean hands" method as a guidance to reduce potential cross-contamination from exogenous sources.

Results from the 2010 study were similar to 2009, with relatively few PPCPs detected at very low concentrations (low parts per trillion range). Most of the compounds were detected very close to or just above the minimum reporting limits for the method. Croton source water exhibited a greater frequency of detections compared to the Catskill/Delaware source waters. A total of 15 individual compounds were detected in at least one sampling event. Similar to the 2009 results, caffeine, acetaminophen, cotinine, and ibuprofen, were consistently detected at multiple sampling sites. PFOS, a fluorosurfactant, was detected at low concentrations at all locations. Butalbital was also detected in each quarterly sampling event at CRO1T. Four new compounds were detected in 2010 including diltiazem, primidone, meprobamate, and iopromide. These detections were partially attributed to modifications made to the PPCP analytical methods employed in 2009.

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An Evaluation of the Conversion of Septic Systems to Sewer Systems on Stream Water Quality in NYC's West of Hudson Watershed

Gerard Marzec, NYC Department of Environmental Protection

As part of the Filtration Avoidance Determination, NYC has a program to replace septic systems in high density areas to prevent degradation of water quality. The objective of this study is to determine the water quality effects of providing new or improved WWTP service to areas that were previously on septic systems. The following sites were selected for septic conversion given the high density and proximity of the septic systems to streams: Wright Brook near Bloomville, NY (Cannonsville watershed); Sawmill Creek in Tannersville, NY(Schoharie watershed); and Bull Run near Margaretville, NY (Pepacton watershed). The facility in the Wright Brook watershed was completed in August 2009, and provides an early comparison. Data were compared for each pair of sample sites above and below the septic conversion. Analytes of interest include conductivity, chloride, total phosphorus, total nitrogen, nitrate, ammonia, dissolved organic carbon, dissolved oxygen, and fecal coliform. Preliminary results suggest that chloride and specific conductivity values are generally higher at sampling sites below the proposed septic conversion locations. Similarly, downstream sites yielded higher fecal coliform counts in the majority of the samples, and the same was also true for TP, TN and NO3-NO2. DO and DOC did not differ greatly. The preliminary results at Wright Brook suggest a significant difference between the upstream and downstream sites persisted before and after the conversion to a sewered system, suggesting that this monitoring scheme may not be sensitive enough to detect differences. Additional data from the other sites should help provide a more definitive answer.

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Simulated Effects Versus Historical Trends of Climate Change on the NYC Reservoir System: What Can We Learn?

Adao Matonse, Ph.D., Allan Frei, City University of New York Institute for Sustainable Cities; Elliot Schneiderman, Ph.D., Don Pierson, NYC Deparetment of Environmental Protection

A recent study of the possible effects of climate change on New York City water supply indicates that projected future changes in air temperature and precipitation are likely to have an impact on the streamflow regime in the Catskill region of New York and on NYC reservoir system operations (Matonse et al. 2011; Burns et al. 2006). Scenarios that use current system operation rules and water demands together with future simulated Catskill reservoir inflows, suggest that in the future, greater runoff will occur earlier in the winter period, causing the reservoirs to refill earlier in the year. Since reservoirs may fill up earlier, the total volume and timing of water releases and spills may also change with the total volume of storage and spill increasing during the winter. Despite increased evapotranspiration during non-winter periods, future simulations suggest that increased precipitation will lead to a reduction in the number of days the system is under drought conditions. Based on these results the NYC water supply will continue to show high resilience, high annual reliability, and relatively low vulnerability. This presentation focuses on analyzing the future simulated results in conjunction with statistics and trends developed from local historical data. The central question is how much indication (if any) of the simulated future states of the system can be detected from trends in current observations and if other insights can be obtained from this analysis to improve our modeling methodology to better address the effects of climate change on the NYC water supply.

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Stream Management Plans and Their Impact on Turbidity in Schoharie Streams

James Mayfield, NYC Department of Environmental Protection

The Schoharie Reservoir is the northernmost reservoir in the NYC Water Supply System. Greene County Soil & Water Conservation District has been working in partnership with DEP on the development of comprehensive Stream Management Plans (SMP). These plans have multiple objectives, including addressing water quality issues, and in particular trying to mitigate transport of turbidity and easily eroded glacial clay sediments as found in the Schoharie basin.

Two major tributaries to Schoharie Creek, Batavia Kill and West Kill, have had several full channel restoration projects installed on them between 1999 and 2009. In an effort to determine the impact these projects may have on water quality, turbidity data from routine samples collected monthly from 1997-2010 were examined. It is very important to note that most of the sampling for this analysis occurred near baseflow conditions. The data were analyzed for trends using the non-parametric Seasonal Kendall Test. Trend analysis was performed on the flow-adjusted data as well as the raw data. These results indicate a statistically significant decrease in turbidity at both the Batavia Kill and West Kill downstream sites. The results for Batavia Kill indicated a decrease of about 0.2 NTU/year (about 4%/year) and a decrease of about 0.35 NTU/year (8%/year) on the West Kill.

More importantly, data collected at a higher frequency and sampling targeted at high flow events will be used to develop flow-concentration relationships. DEP has been monitoring storm events upstream and downstream of the Conine Restoration Project on the Batavia Kill, before and after restoration, to help determine whether the project has an impact on turbidity. The data collected to date will be examined to quantify the effects of stream restoration projects on turbidity at higher flows. These higher flows with elevated turbidities are the types of storm events that can create water quality issues, so an understanding of stream response and the role of the SMPs under high flow conditions is critical to water quality management.

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Stormwater Retrofit Source Controls to Address Combined Sewer Overflows in New York City

Sandeep Mehrotra, Hazen and Sawyer, P.C.; Julie Stein, NYC Department of Environmental Protection; William Leo, HDR/Hydroqual; Tim Burkett, Biohabitats

With approximately 44 inches of annual precipitation and predominantly impervious surfaces, New York City faces significant challenges in managing its wet weather flows. Specifically, large or intense rainfall events can lead to combined sewer overflows, exacerbating surface water quality problems in New York Harbor. As part of the Mayor's PlaNYC 2030 initiatives, New York City (NYC) Environmental Protection (DEP) is leading the development of innovative and long-term sustainable measures to treat stormwater runoff and reduce sewer overflow discharges through incremental investments in green infrastructure over the next 20 years.

Because many stormwater source controls have not been extensively implemented throughout NYC, a series of stormwater pilot projects are being designed and constructed at locations throughout various boroughs to evaluate their functionality and indentify any unique challenges in the ultra-urban environment. Stormwater pilots include tree pits enhanced for infiltration, stormwater infiltration swales, bioretention, pervious pavement, blue roofs, and underground infiltration systems retrofits are being implemented within highway medians, park-and-ride lots, public parks, street-side sidewalks, and public housing facilities.

A variety of potential retrofit sites were considered before final site selection, accounting for available open space, contributing drainage area, site access, utility conflicts, and relative costs. The primary objective of these pilots is to reduce the rate and volume of stormwater runoff entering the combined sewer, while also improving water quality directly. Design of alternate conveyance mechanisms to divert stormwater runoff to the stormwater source controls without affecting the existing drainage infrastructure proved to be a major element of the pilot designs. In many cases, utility conflicts and configuration of the existing drainage infrastructure had substantial impacts on the pilot designs and controlled the extent of the drainage area that could be treated. Wherever possible, educational elements and landscape amenities were incorporated into the stormwater pilot designs in order to engage the public.

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Hydrologic and Hydraulic Modeling for Green Stormwater Practices

Sandeep Mehrotra, Matthew Jones, Hazen and Sawyer, P.C.; James Garin, Dana Gumb, NYC Department of Environmental Protection

Effective stormwater management design requires a comprehensive analysis of natural and anthropogenic conveyance, detention, and treatment mechanisms. One approach to address these elements is through the use of the U.S. Army Corps of Engineers Hydrologic Engineering Center's hydrologic (HEC-HMS) and hydraulic (HEC-RAS) models, which can provide a flexible and robust framework for conceptualizing an urbanized, tidally-influenced watershed, as well as simulate the impact of Best Management Practices (BMPs), aiding in their design.

This approach was utilized as part of the New York City (NYC) Environmental Protection's (DEP) Staten Island Bluebelt Program, linking storm sewer systems to existing wetlands and stream corridors, providing flood control, water quality improvements and wetland habitat protection. Within the Bluebelt program, the New Creek watershed presented a novel challenge due to its low-lying topography and tidally influenced waterways. The largely residential, 1.25 sq. mi. watershed is lacking adequate drainage infrastructure and contains many streets below legal grade. Additionally, New Creek flows through a pontoon tide gate before discharging into Lower New York Bay. All of these factors contribute to substantial flooding concerns, particularly during high tide.

The watershed's new drainage plan will provide a storm sewer system in combination with BMPs to provide flood detention. The HEC models were employed to evaluate the hydrologic and hydraulic behavior of the watershed and guide BMP and storm sewer design. HEC-RAS outputs indicated the amount of flood storage necessary to minimize flooding downstream and assisted in sizing low-flow orifices and overflow weirs on the BMPs. This information was integrated into the design process for the storm sewer network for the watershed. The results of these analyses illustrated the ability of HEC-RAS to

model unsteady backwater conditions and incorporate a range of hydraulic structures and BMP designs, while serving as a valuable aid in stormwater management and flood control modeling.

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Catskill Stream Turbidity Sources and the Effect of Extreme Events

Rajith Mukundan, Ph.D., City University of New York; Elliot Schneiderman, Ph.D., Don Pierson, Mark Zion, NYC Department of Environmental Protection

Elevated turbidity associated with high stream discharges in the Esopus Creek watershed in the Catskill region of New York State can sometimes limit the use of a part of the drinking water supply from the Ashokan reservoir. Previous analysis indicates that the Esopus Creek watershed contributes over 90% of the annual turbidity load to Ashokan Reservoir, and that as much as 93% of the stream turbidity in the Esopus Creek originates from within the stream channels during large events. The focus of this talk is on methods of quantifying turbidity sources and evaluating the persistence of effects related to extreme events on stream turbidity levels during the low flow periods between events. Low flow periods account for only a small portion of the annual turbidity load, but do account for a large portion of DEP's turbidity monitoring data. Ambient stream turbidity monitoring data from six monitoring stations in the Catskill region were statistically evaluated before and after two extreme events that occurred in 1996 and 2005-2006 period.

After the 1996 event elevated turbidity levels in the Schoharie reservoir and the transport of this turbid water via the Shandaken tunnel resulted in an extended period of elevated low flow turbidity in the Esopus Creek. Tributaries to the Schoharie reservoir also showed significant increases in turbidity during this period. The 2005-2006 events did not result in a prolonged increase in Esopus Creek low flow turbidity. In fact, there was a significant decrease in low flow turbidity that can be attributed to a significant decrease during recent years in the turbidity of the main tributary to Schoharie Reservoir. Tributaries to the Esopus Creek did not show any significant change in turbidity after either event. Such varying watershed responses to extreme events are suggestive of the existence of a geomorphic threshold that could be either intrinsic and related to the geomorphic structure of the system, or extrinsic and related to climate forcing

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Applicability of Parametric Versus Non-Parametric Statistical Methods for Calculation of Mean and Median Pathogen Concentrations in NYC Aqueducts

Christian Pace, Kerri Alderisio, NYC Department of Environmental Protection

New York City's Department of Environmental Protection (NYCDEP) has monitored for Giardia and Cryptosporidium (oo)cysts throughout its watershed since 1992, and has used Method 1623HV since 2002. The results of this monitoring are routinely summarized for reporting purposes, as well as analyzed for trends, seasonal patterns, and for determining potential contamination sources for watershed management and planning. Frequently simple statistics are calculated from this data including; mean, median, detection percentages, etc. However, these parametric statistics may be misleading when attempting to compare different sample sites, or the same site over different years, because such methods depend on a normal distribution in each set of data. With a very low detection rate at the influents and effluents of Kensico Reservoir, especially for Cryptosporidium, NYCDEP is left with a largely censored data set (many non-detects) and a left-skewed distribution. Some non-parametric statistics, being more robust, are more appropriate for handling these censored data issues.

Several non-parametric methods exist for hypothesis testing, each with particular weaknesses depending on the distribution of data. Regression on order statistics (ROS), Kaplan-Meier, maximum likelihood estimate (MLE), Mann-Whitney (rank-sum), Wilcoxon signed-rank and modified sign-rank tests will be compared to standard parametric summary statistics, such as: arithmetic means, medians, confidence intervals, and the Student's T-test, for data collected according to Method 1623HV at aqueduct influents and effluents. Non-parametric methods Non-parametric methods may be more appropriate for use in loading estimates, and for determining the significance of differences from influents to effluents, and temporal differences for such a censored pathogen data set.

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The NYC Water Supply Operations Support Tool (OST): Early Use Cases

James H. Porter, Ph.D., NYC Department of Environmental Protection; Grantley W. Pyke, P.E., Hazen and Sawyer, P.C.

The New York City Water Supply is currently developing a decision support system to assist with operating its water supply reservoirs. The Operations Support Tool (OST) links the OASIS water supply model with the CE-QUAL-W2 water quality model, ingests near-real-time data on reservoir and watershed conditions, and utilizes probabilistic ensemble

streamflow forecasts to guide managers making operational decisions. It can also be used for evaluating long-term operating rules and policies, and for assessing the impacts of climate change and potentially indicating mitigation strategies. OST will be complete in late 2013, but a phased deployment approach is being used in which functionality is made available to system operators as soon as it's developed, allowing for both testing of the functionality and for actual use in operating the water supply system. Several early use cases will be discussed, potentially including management of a turbidity event following major storms in Oct and Dec 2010, development of new release policies for NYC's Delaware Basin reservoirs, evaluating community releases from Ashokan reservoir, and assessing the probability of refill in conjunction with specific operations.

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Northeast Orange County, NY Jurisdictions Combine Efforts to Achieve Regional Water Supply and Quality Goals

Michael Principe, Ph.D., HDR Engineering; David Church, Orange County Planning Department

Orange County is located in southeastern New York State, in the lower Hudson Valley, The County relies on water from both surface and ground water sources within 11 watershed basins. The majority of the County's water supply is provided by 160 community water supply districts which draw fresh water from County reservoirs and wells, as well as from the New York City aqueduct system. The multitude of independently controlled water systems across the County presents a formidable management challenge to those operating and maintaining those systems due to the increasing costs associated with staffing, infrastructure improvements, and overall maintenance of system reliability. The results of a recently completed County-wide planning effort by the Orange County Water Authority (OCWA) indicated that by 2018 a number of communities will experience supply deficits due to distribution inadequacies. In addition, the plan highlighted how overall water supply reliability for many County residents could be greatly enhanced by the provision of inter-municipal sharing of water resources between water districts. A direct outgrowth of the plan was the Northeast Orange County Water Supply Feasibility Study. This study, which was completed by the OCWA in November 2010, addressed the future water resource needs of the Towns of Newburg and New Windsor, the City of Newburgh and a number of other municipalities in the northeast region of Orange County, NY. The study evaluated the feasibility of constructing a "regional" water treatment facility that would serve the multiple municipalities in the northeast section of the county and would provide a sustainable return on investment for all involved parties. This paper will present the results of a work-plan that: assessed and analyzed both the existing and proposed water supply capabilities in the northeast section of the county in terms of their meeting both current and future water supply needs.

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Removal of Trihalomethanes by Functionalized Hexagonal Mesoporous Silicates

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Adsorption efficiencies of Trihalomethanes (THMs), disinfection by product (DBPs), by using synthesized hexagonal mesoporous silicates (HMSs) were investigated. Hexagonal mesoporous silicate (HMS), which has been studied extensively in chemical reaction fields, has mesoscale pore and uniform surface functional groups. HMS surface can be modified by various methods, *e.g.*, organic ligand modification and metal substitution in crystalline structure, to enhance specific physico-chemical characteristics and specific selectivity. In this study, HMSs were synthesized and modified by grafting surface organic functional groups (3-aminopropyltriethoxy-, 3-mercaptopropyl- and n-octyldimethyl-). Functionalized HMSs were synthesized and characterized physico-chemical characteristics such as crystalline structure, surface and pore structure, surface charge density, existence of surface functional groups, and particle size, etc. by XRD pattern, nitrogen adsorption isotherms, acid-base titration, FT-IR and SEM, etc. Kinetics and adsorption isotherms of 4 types of THMs ($CHCl_3$, $CHBrCl_2$, $CHBr_2Cl$ and $CHBr_3$) at low concentration (0-500 µg/l) were investigated at pH 5, 7 and 9 under ionic strength 0.01 M controlled by phosphate buffer. 3-mercaptopropyl- grafted on HMS surface had highest THMs adsorption capacities comparable with powdered activated carbon (PAC). THMs adsorption kinetics of all adsorbents can be fitted to pseudo second order equation. Obtained adsorption isotherms of all adsorbents also can be fitted better by Freundlich model than Langmuir model with high correlation. Hydrophobic adsorbents had higher adsorption efficiencies of THMs than hydrophilic adsorbents. However, combination of electrostatic interaction and hydrophobicity caused by 3-mercaptopropyl functional group on HMS surface might enhance THMs adsorption capacities compared with stronger hydrophobic n-octyldimetryl group on HMS surface. Adsorption capacities of bromohalomethane group on 3-mercaptopropyl- grafted HMS were higher than chlorohalomethane group.

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Watershed-Based Approaches to Mitigation of Impacts from Urban Stormwater

Sri Rangarajan, Ph.D., HDR Engineers and Architects, P.C.; Nitin Katiyar, HDR/HydroQual

Stormwater management at new or redevelopment sites requires design of detention or retention volumes to meet pre vs. post peak runoff or total suspended solids load reduction regulations. Randomly distributed site controls do not provide watershed managers or regulatory agencies a clear understanding or assessment of their effectiveness in achieving the water quantity/quality goals set forth on a watershed basis. We propose watershed-based approaches to determine storage requirements that can assist managers/practitioners in comparing the performance of existing controls or in assessing future controls needed to achieve those goals. Based on recent NRC recommendations and USEPA emphasis on watershed-based controls, these approaches offer robust adaptive planning and implementation frameworks for implementation.

Two case studies will be reviewed in this presentation to demonstrate the effectiveness of these approaches. In the first one for Rutgers University (NJ) campus, an integrated one and 2-D characterization approach was used to assess the storage requirements for meeting the pre vs. post runoff goal. Channel stability as imposed by the Soil Conservation District focused on erosion potential from upland areas and transport into the Raritan River. Overland and channel velocities were used along with peak flow reductions to estimate the overall detention/retention storage requirements.

In the second case study for Westchester County, the flood mitigation and pollutant load reduction goals necessitated the use of EPA SWMM and SUSTAIN with built-in optimization accounting for stormwater controls' effectiveness and associated costs. Simultaneous achievement of multiple goals in highly urbanized watersheds such as the Bronx River with limited vacant land is very challenging and expensive. A watershed-based approach adopted by the County helped in assessing storage requirements to achieve both quantity and quality goals and then exploring opportunities in upland areas and floodplain for further collaboration with watershed municipalities to conceptualize and implement projects in a cost-effective manner

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Start-Up of Largest Wastewater Treatment Plant in NYC Watershed

Jan Salzman, P.E., Robert Butterworth, GHD; Ed Mahoney, Town of Yorktown; Sharon Robinson, P.E., Lynstaar Engineering

Yorktown's WPCP is the largest treatment plant that discharges into the NYC Watershed. Diversion of Yorktown's treated effluent out of the watershed was the initial engineering recommendation. Diversion was not the selected option since years went by and the required approval of multiple governmental agencies was not obtained, and costs for diversion were higher than originally thought. Thus, upgrading the existing treatment facilities to meet NYCDEP Watershed requirements was the selected option. This option was inspired by a consent order from NYSDEC that required a final study of both alternatives and immediately followed by design and construction via the Consent Order schedule. This presentation describes final design and approval process, innovative design aspects such as equalization tank and other methods to handle peak flows. Start-up of treatment plant equipment was initiated in May 2008. Process sampling data will be presented to show the improvements in water quality.

The Town of Yorktown had to obtain a final decision on whether flow from its treatment plant could be diverted out of New York City's Watershed to the Peekskill Treatment Plant, or if the treatment plant should be upgraded to meet NYC Watershed improvements. Two projects were designed and constructed at the same time:

1. Install a 2 million gallon equalization tank to capture peak storm flows. Replace existing sand filters, install microfiltration equipment, and replace chlorination/ dechlorination with ultraviolet disinfection.
2. Install RBCs to remove ammonia and upgrade other treatment plant equipment to provide reliable operation for the next 20 years.

The completed upgrade construction provides advanced treatment methods, greatly increases the reliability of process equipment, eliminates disinfection byproducts from chlorination, stores peak flows for later treatment, and will help protect the NYC Watershed in the long term.

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Protecting Riparian Buffers on DEP Conservation Easements

Duncan Schmitt, NYC Department of Environmental Protection

DEP's Land Acquisition Program has acquired 18,000 acres of Conservation Easements in the upstate watersheds since 2001. Easement acquisitions are focused on sub-basins that are less than 20% protected by government ownership, and are limited to sites that contain significant watercourse buffers and wetland areas. Our experience on these sites has been that the majority of small watercourses and wetlands are not mapped, and thus the proportionate acreage of these resources in the upper elevations of our sub-basins is underestimated. As a result, the LAP easement program is protecting a greater percentage of actual riparian buffer in the NYC watersheds than is apparent from the existing watercourse and wetlands mapping.

The easement deed prohibits residential construction and subdivision, and restricts tree cutting, farming and disturbance within wetlands and within 50' of watercourses. Easements are inspected each year by a combination of aerial inspections that cover the entire property, and foot inspections around the building envelopes where landowners are most active. Timber harvests are performed during appropriate conditions pursuant to the terms of a Forest Harvest Plan, with inspection before, during and after the harvest by DEP foresters. Enforcement issues such as vegetation removal in wetland and riparian areas are dealt with through site walks with the landowner and replanting of the impacted areas, and by working with state or local authorities where their regulations are violated.

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Effects of Land Use and Management on Dissolved Nutrient Loads and Eutrophication in Cannonsville Reservoir Under NYC Filtration Avoidance

Elliot Schneiderman, Ph.D., Don Pierson, Mark Zion, NYC Department of Environmental Protection; Soni Pradhanang, City University of New York

Since the first NYC Filtration Avoidance Determination (FAD) granted by the USEPA in 1993 NYC has funded an aggressive campaign to reduce nutrient loads and eutrophication in Cannonsville Reservoir. Waste Water Treatment Plants (WWTPs) have been upgraded to reduce point source of nutrients, and watershed management programs have implemented best management practices (BMPs) to control nutrients from agriculture, urban runoff, and septic systems. At the same time a shift in land use towards reduced agriculture and farm livestock has also occurred independently of deliberate land use management. Considerable reductions in nutrient loads and eutrophication in Cannonsville Reservoir have been observed in stream and reservoir water quality monitoring data collected between 1992 and 2009.

Watershed and reservoir simulation models were used to evaluate the factors responsible for the observed changes in Cannonsville water quality. Reductions in dissolved phosphorus (P) loads to the reservoir were mainly attributable to Waste Water Treatment Plant (WWTPs) upgrades, implementation of agricultural BMPs by the Watershed Agricultural Program, and a decline in farm livestock. Loading reductions produce improvements in reservoir water quality by not only reducing the long term mean values of epilimnetic chlorophyll, but by also dramatically reducing the frequency of extreme chlorophyll values; which is important since it is extreme events that often influence the usability of the reservoirs as sources of drinking water.

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Evaluating the Implementation Status of Five-Year Old WAC Forest Management Plans

John Schwartz, NYC Department of Environmental Protection; Joshua VanBrakle, Watershed Agricultural Council

The Watershed Forestry Program was established in 1997 and has since become a component of DEP's Long-Term Watershed Protection Strategy as well and the Filtration Avoidance Determination (FADs). The Watershed Forestry Program is funded by DEP in partnership with the Watershed Agricultural Council (WAC); it is also supported with matching grants and technical assistance from the USDA Forest Service. Forest management planning has always been a core focus of the Program given that 75% of the watershed is covered by forests and a majority of this land is privately owned. A primary goal of the Watershed Forestry Program is to support and maintain well-managed working forests as a beneficial land use for watershed protection. The voluntary adoption of written, long-term forest management plans by private watershed landowners serves to educate them about their forests, promote the importance of good forest stewardship practices, encourage long-term investment in forestry as an enterprise, and ultimately help to maintain large, unfragmented tracts of healthy forests for multiple purposes. To date, the Watershed Forestry Program has supported the development of 900 forest management plans covering over 160,000 watershed acres, of which an estimated 128,000 acres are forested. Pursuant to WAC standards, every plan includes a 15-year work schedule of silvicultural prescriptions along with detailed descriptions of current and proposed roads, soil and water resources, riparian areas, and best management practice (BMP) recommendations for water quality protection. The first WAC plans were completed in 1998; DEP and WAC began evaluating the implementation status of five-year old WAC plans in 2003. During the period 2003-2010, DEP and WAC evaluated over 530 forest management plans that were completed during 1998-2005 and subsequently reached their five-year old status. This presentation summarizes the results of this eight-year forest management plan implementation evaluation project.

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Application of the Water Quality Model for Management Support in the Neversink Watershed

Feng Shi, Ph.D., Delaware River Basin Commission

The Neversink River is a major tributary of the Delaware River located in southeastern New York State. The Neversink reservoir is one of the three reservoirs which feed the New York City water supply system. Moreover, it also provides water for multiple uses in downstream areas in New York State. In recent years portions of the Neversink Watershed is under the pressure of rapid growth and development, which leads to increasing pollutant discharge from both point source wastewater dischargers and nonpoint source due to landcover changes.

Neversink River drains into the main stem of Delaware River at Port Jervis, NY, where the stretch was designated as Special Protection Waters (SPW) by Delaware River Basin Commission (DRBC) in 1992. Implementation of the SPW program requires evaluation of new or expanding discharges to maintain existing high water quality when flowing into Delaware River. Due to the number of projects in the SPW watershed and the complexity of watershed pollutant discharge and instream routing process, DRBC proposed to conduct a cumulative impact analyses using models to consider all type of watershed influences.

We developed a Neversink River Water Quality Model (NR-WQM) as a technical tool for evaluating the impact of proposed projects and better assisting water quality management in the future. The model was employed on a portion between the Neversink Reservoir and the mouth of the Neversink River. For increasing its practical reliability, the model was continuously refined as additional data are available through ongoing data collection effort. The refined model can be a useful tool to assist the DRBC and NYDEC in the scientific decision-making process of watershed management, such as discharge permit issuance, environmental impact assessment, or TMDL evaluation. In addition, the model is also transferable to similar watershed in New York State facing the risk of water quality impairment.

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Aerial Orthoimagery, LiDAR, and Derived GIS Products in the NYC Watersheds

Terry Spies, NYC Department of Environmental Protection

The NYCDEP Bureau of Water Supply uses geographic information not only to manage the City's interests in the upstate Water Supply System for both land and facilities, but also to display and evaluate water quality information and watershed protection programs through mapping and queries. To accomplish this, DEP obtains the best possible high-resolution ortho-imagery, as well as updates of land use and land cover, impervious surfaces, LiDAR elevation models, parcel data refinement, and historic data to allow evaluation of trends.

In 2009-2010, DEP collaborated with the New York State Office of Cyber Security and Critical Infrastructure Coordination (NYS CSCIC) to collect wall-to-wall aerial data products over all NYC watersheds and aqueducts as part of NYS CSCIC's Digital Orthoimagery Program. DEP's datasets encompass a total area of approximately 2,700 square miles, and include 1 meter Light Detection and Ranging (LiDAR) based topography, 1 foot Leaf-off 4-band orthoimagery, and 1 foot Leaf-on 4-band orthoimagery. These aerial data, which provide a seamless, synoptic view of DEP's area of responsibility, were collected in Spring and Summer 2009 and delivered in Summer 2010.

LiDAR produces high resolution digital elevation models and elevation contours. It will be further used for delineating basin drainage areas more accurately, and to derive more accurate streams data. Leaf-off (Spring) aerial imagery, in addition to being useful basemap data, will also be used to map impervious surfaces. Leaf-on (Summer) aerial imagery will be used to map land cover and land use, especially when combined with other supporting data sources such as impervious surfaces and tax parcel assessments.

These data will enable the BWS GIS to continue to be a useful tool to perform analysis of land cover, estimate the effects of watershed management programs on long-term water quality, and support terrestrial and reservoir modeling of water quantity and quality in the watersheds.

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NYC Department of Environmental Protection's Early Detection/Rapid Response Plan for Invasive Species

Michael Usai, John Schwartz, Barbara Dibeler, NYC Department of Environmental Protection

DEP's Invasive Species Working Group is developing an early detection/rapid response plan that calls for monitoring for priority species to allow for detection of incipient populations while they are small enough to manage. An ED/RR plan is a critical component to any invasive species strategy. Early detection requires vigilance and regular monitoring to detect a species at the earliest time after its introduction. When an invasive species is detected, a rapid response is initiated to determine the extent of its establishment and distribution, potential for spread, decide on a response and provide the logistical and financial means to implement the response.

In March 2011 the ISWG finished development of an outline of an ED/RR plan that set goals and objectives for development of the plan with deliverables and deadlines. Elements of the plan include risk assessment and a priority

species list; active and passive monitoring and education for early detection; rapid response protocols and adaptive management. To date DEP developed a risk assessment protocol and generated a priority invasive species list; established a centralized reporting protocol to allow DEP staff and the public to report potential new IS; modified the DEP website to include information on IS and provide a means for the public to report IS and an outreach and communication strategy is nearing completion. Further details and protocols for the remaining plan elements are currently being developed by the ISWG and the full plan is due to be finalized in mid-2012.

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The Occurrence of Sodium Chloride in the Croton Watershed: An Evaluation of Sources, Possible Impacts, and Strategies for Reduction

Richard Van Dreason, NYC Department of Environmental Protection

On average the reservoirs of NYC's Croton Watershed supply 10 percent of the water needs for downstate customers but can supply up to 30% if needed. The Croton System is the oldest component of NYC's water supply (portions of the system have been in service since 1842) and lie primarily in the rapidly urbanizing Westchester and Putnam counties.

Recent reports have indicated a significant upward trend in sodium and chloride concentrations in waterways throughout the North Eastern United States. This trend was attributed to increased urbanization and in particular to increases in road deicer usage.

According to a 1961 NYC Bureau of Water Supply report, average sodium and chloride concentrations leaving the New Croton Reservoir (terminal reservoir of the Croton system) were 3.75 mg L-1 and 8.87 mg L-1 respectively. By 2010, sodium had progressively increased to about 35 mg L-1 while chloride had increased to about 70 mg L-1.

Although a health based standard does not exist for sodium (or chloride) EPA recommends that drinking-water sodium not exceed 20mg L-1 for individuals on a very low sodium diet (500 mg/day). For individuals on a moderately restricted diet the figure jumps to 270mg L-1. To avoid adverse effects on taste, EPA recommends that sodium concentrations in drinking water not exceed 30 to 60 mg L-1 and that chloride not exceed 250 mg L-1.

New Croton Reservoir is fed by 11 upstream reservoirs and 3 controlled lakes. Although all water bodies in the Croton watershed have experienced increases in sodium chloride the rate and patterns of increase have differed throughout the watershed. To discern probable sources we will compare long-term sodium and chloride trends and spatial patterns with trends in urbanization throughout the watershed. One particular focus will be the efforts of municipalities within the Croton Watershed to reduce the need for deicer products.

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Stormwater Best Management Practices

Terry Wright, Trans Terra Corporation

The PEQST process is actually a design platform in which the volume of the tank is configured to fit within the site geography and handle the first flush volume. This is accomplished by a driven decanter that elevates the discharge point to above the first flush volume.

The influent feed system provides scouring of the end walls and tank floor when the liquid levels in the tank are low. As the liquid level rises the tank acts more like a primary clarifier. The actual dimensions of the tank meet the design standards of a primary clarifier. In wastewater applications there will always be 2-units to provide redundancy and to serve as an overflow when flows exceed the expected peak.

The major difference is that the discharge is screened thus prevent the discharge of neutrally bouyant materials. A baffle protects the screen and discharge from fats, oils and greases (FOG) from fouling the screen and exiting the system. The screening and chemical addition systems are selected & sized to meet the specific needs of the receiving body of water and application.

A flow meter is placed on the influent pipe to the tank. When the flows reach an Owner set point the decanter will raise and activate chemical feed systems. A pressure transducer is placed in the basin to provide a liquid level within the tank.

The liquid remaining in the tank can be tested prior to discharge or simply discharged by lowering the decanter via the control system. The trapped solids can be removed via a vac truck or by pump if the location of the unit is at a wastewater treatment plant.

The energy requirement is <1.0 Hp which makes it more practical to power via battery and solar. Controls are developed to meet the specific needs of the client and application.

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Simulation Modeling for NYC Water Supply Operations to Control Turbidity – 2010 Case Study

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The New York City Water Supply obtains the majority of its water from the Catskill and Delaware subsystems, and water from these subsystems mix at Kensico Reservoir prior to entering the water supply distribution system. Turbidity is a primary factor that potentially limits use of the Catskill System water. The impacts of this turbidity to the water supply as a whole can be mitigated by operating the system to minimize turbidity inputs to the terminal Kensico Reservoir while maximizing the storage and settling capacity of upstream Catskill System reservoirs. During turbidity events daily decisions are carefully taken to optimize system operations for turbidity control, while ensuring adequate water storage levels. To support these decisions, a combination of watershed, reservoir water quality and water system simulation models are used to evaluate alternative operational scenarios within a probabilistic framework. These simulation models form the basis for the Operational Support Tool currently under development by DEP.

During the fall and winter of 2010 a number of storms caused elevated levels of turbidity in Catskill System reservoirs. As these storm events occurred, various model simulations were performed to analyze the effects of alternative operational strategies on Kensico Reservoir effluent water quality. Operational strategies investigated included use of the Ashokan Reservoir waste channel, implementation of stop shutters in the Catskill Aqueduct to limit flow of turbid water into Kensico Reservoir and the blending of Catskill and Delaware System waters to maintain adequate water quality in Kensico effluents. This presentation describes model simulation results which helped to inform system operation decisions during these periods of elevated Catskill System turbidity.

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