Water Resource Infrastructure in New York: 
Assessment, Management, & Planning

Prepared September 4th, 2013
The New York State Water Resources Institute (NYS WRI) and the New York State Department of Environmental Conservation (DEC) Hudson River Estuary Program (HREP) has undertaken a coordinated research effort on water resource infrastructure in New York State, with a focus on the Hudson and Mohawk River basins.

The primary objective of this multi-year program is to bring innovative research and analysis to watershed planning and management. In particular, WRI-HREP is working to address the related topics of water infrastructure, environmental water quality, and economic vitality, especially as they pertain to planning and management in the Hudson and Mohawk watersheds. The WRI-HREP program coordinates individual research efforts so as to fit within the context of, and be responsive to, New York State’s growing concerns about aging public infrastructure, economic constraints on public investment, and the recent requirement for State planning agencies to incorporate principals of “smart growth” as promulgated in the 2010 Smart Growth Public Infrastructure Policy Act.

In the following pages we report on progress made in year one (2012-2013). Projects are discussed within the following broad themes:

1) **Infrastructure Assessment** - Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, “green” infrastructure, etc., and their current state and effectiveness at providing water and ecosystem services regionally at reasonable cost

2) **Economic Vitality** - Regional economic vitality with respect to water infrastructure and its effect on private and public investment and industrial development

3) **Integrated Management** - Integration of scientific, economic, planning/governmental and/or social expertise to build comprehensive strategies for public asset and watershed management

4) **Smart Growth** - Smart growth and its implications for water related infrastructure development, regional water quality, and regional economy

5) **Source-Water Protection** - The economic and environmental benefits of source watershed protection strategies and the use of ecological services to meet water supply and quality needs, as opposed to treatment at point of delivery

Following this summary we also include:
- A link to the full versions of final reports, which are available at our website [http://wri.eas.cornell.edu/grants](http://wri.eas.cornell.edu/grants)
- Outreach efforts currently underway
- How we are adapting our efforts in year two to support research and create effective outreach products
- A list of year two projects
- An annotated bibliography discussing some key references cited in the course of our research
Infrastructure Assessment - Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, “green” infrastructure, etc., and their current state and effectiveness at providing water services regionally at reasonable cost.

Cross-cutting impressions

New York State water resource managers employ a wide array of infrastructure systems, technologies, and management approaches. Traditional “grey” infrastructure systems, such as engineered water treatment facilities, sewer distribution networks, and dams, tend to be well characterized and studied in the academic and water service industry literature. Individually, they are generally effective at meeting local water quantity and quality goals. That being said, there is room for improvement in funding and managing grey infrastructure within broader regional and watershed systems. Within the context of limited public funding and increasingly stringent environmental regulation, watershed-scale assessments may yield gains in the effectiveness and efficiency of groups of systems not possible using traditional project-level assessments.

Decentralized and “green” infrastructure approaches, such as the use of septic systems, vegetated stormwater detention basins, and constructed wetlands, are being re-examined and reconsidered throughout the state. Unfortunately, we know less about the effectiveness of such systems, and face challenges in their management. Green infrastructure approaches can have benefits when used in the proper way, but can also suffer from lack of rigorous design or maintenance. For wastewater treatment, septic systems can continue to serve a vital function, but new management approaches may be helpful in achieving better performance in some watersheds.

What researchers found

Project Title: Green infrastructure, water quality, and GHG emissions, Todd Walter (Cornell University)

Green infrastructure refers generally to practices that use vegetation and soil to manage stormwater, as opposed to traditional grey infrastructure like sewers. The intent of green infrastructure is to take advantage of natural processes within our built environments to mitigate nonpoint source pollution and reduce impacts of runoff on peak stream discharge. However, there is limited data on green infrastructure effectiveness and the reports that have been published generally consider short time frames and/or are based on single case studies. In order to help inform design of future green infrastructure in New York State, the goal of this project was to assess the effectiveness of common green infrastructure practices on (1) protecting water quality and (2) reducing greenhouse gas (GHG) emissions. The study took place on the Cornell University campus in Ithaca, NY. Our goal is to be able to support the perceived environmental benefits of these structures, or highlight any negative impacts so that design of these structures can be amended to minimize such impacts. Key findings include:

- Water quality services were variable across 6 measured stormwater basins, with several basins having higher pollutant concentrations in basin outflow
Greenhouse gas (CH$_4$ and N$_2$O) emissions were generally low from 5 measured basins, though nitrous oxide emissions increased in 3, and high methane emissions were observed in the wettest basin.

Wetland-like basins experienced high salinity, had higher methane emissions and had mixed water quality services, indicating that very slow infiltration is not desirable when designing green infrastructure.

Project Title: **Wetland mitigation of infill development: an evaluation of green infrastructure effectiveness in a near-urban setting**, Mary Ann Cunningham (Vassar College)

The main aim of this project was to study impacts of “green infrastructure” for stormwater management, particularly constructed wetlands and restoration of a riparian corridor, in an urbanized environment. Our study focused on the Fonteynkill, an urbanized tributary of the Hudson River that drains portions of the City of Poughkeepsie and of the Vassar College campus. One of our central questions is how much green infrastructure is needed to reduce impacts of urbanized tributaries on water quality in the Hudson River. Our goal was to develop a water quality baseline prior to installation of a planned stormwater management wetland, so that we may better understand the hydrological and ecological impacts of such green infrastructure approaches. Future research is planned following wetland construction. Key baseline findings include:

- Continuous water-monitoring sondes indicated distinct seasonal patterns in conductivity responses to precipitation, resulting from dilution by rainfall or from snowfall and road salting activity.
- Chronically high summer salinity with potential impacts on in-stream biotic communities.
- Partial attenuation of in-stream salinity peaks resulting from an artificial lake.

Project Title: **Relative abundance of blueback herring in relation to permanent and removable dams on the Mohawk River**, Karin Limburg (SUNY ESF)

The first goal listed in the Mohawk River Basin Action Agenda is to “understand and manage fish, wildlife and their habitats in the Mohawk River.” Blueback herring is a species of interest because of its important role in sustaining major game fisheries in both the Mohawk River and Hudson River Estuary. The New York State Barge Canal system on the Mohawk River simultaneously creates barriers to fish passage and provides a vector for some fishes to colonize new habitats. The goal of this study was to provide information on 1) how well blueback herring pass migration barriers on the Mohawk River; 2) what parts of the Mohawk River are used throughout the summer by blueback herring; and 3) otolith microchemistry to determine the migratory characteristics of blueback herring. Key findings include:

- No effect of dams on size of spawning blueback herring within the scope of the study.
- A majority of spawning took place downstream of Lock 15.
- Size of spawning blueback herring has declined over the past decade and the sex ratio has skewed toward males.

Blueback herring in the Mohawk (photo - Christopher Legard)
Project Title: **Estimating the use of onsite systems in New York**, Sridhar Vedachalam (Cornell University)

Outside the dense urban core where provision of sewer services is affordable, large sections of rural and suburban communities rely on decentralized methods of wastewater treatment, popularly called septic or onsite systems. The 1990 census estimated that 1.5 million households in New York State, about 20%, rely on onsite systems. Since then, the Census Bureau has stopped collecting this information, making more up to date numbers hard to estimate. The objective of this project was to gather the most recent statistics on onsite systems in New York by contacting state and county health departments. Updated estimates of onsite systems are vital in identifying current growth trends, monitoring threats to waterbodies, and educating homeowners on the proper use and maintenance of these systems. Key findings include:

- **New York does not monitor the existence and new construction of onsite systems**, unlike other states such as Florida
- **Data on onsite systems is usually maintained by municipalities** or not at all
- Using parcel information maintained by the NYS Office of Real Property Tax Services as a proxy for onsite systems, we **estimate the current number of onsite systems in New York to be 1.64 million**

![Onsite systems (percent) by county in New York (2011). Westchester, Nassau, and Suffolk counties are highlighted to bring attention to the missing information](image_url)
Economic vitality - Regional economic vitality with respect to water infrastructure and its effect on private and public investment and industrial development

Cross-cutting impressions

Regional economic vitality is linked in many ways to water resources and the state of our water resource infrastructure. Public investment in water resource infrastructure projects can create a foundation upon which commerce and private investment can thrive. Alternatively, poor public water infrastructure can be a barrier to regional economic growth, and can negatively impact overall quality of life. Poor infrastructure decisions also adversely impact ecological systems, and have indirect environmental consequences. Because water resource infrastructure, such as sewer and distribution piping, and water treatment facilities, are not seen by the public, their value and contribution to economic and environmental well-being is often underestimated.

Private and industrial investment in water resource infrastructure is also essential for regional economic vitality since so much commerce and economic activity is centered on regional waterways. There is likely untapped potential to harness economic benefits from better use, marketing, and branding of Hudson regional water resources. There is also an opportunity to better promote regional water-related businesses in response to global demand for water technologies. At the same time, poor coordination among regional stakeholders threatens to result in infrastructure decision-making and policy that can lead to or exacerbate environmental risks.

What researchers found

Project Title: Water-related economic development opportunities in the Hudson & Mohawk valleys, Mark Milstein (Cornell University)

Given the global challenges around access to clean water and the growth of a global water technology market, the region’s water assets should be valuable to the private sector as a part of manufacturing processes (e.g., semiconductors), an input for value-added products (e.g., food), and as a catalyst for water-related, service-based businesses (e.g., tourism). The goal of this research was to better understand how existing policy and practice are encouraging or inhibiting the formation of businesses (and therefore local economies) that depend upon water infrastructure in the Hudson and Mohawk watersheds in a way that helps to remediate and maintain regional water resources over time. Analysis was framed from the perspective of whether and how upstate water resources could be leveraged more effectively for the development of private sector firms which, in turn, would depend, take advantage of, promote, and protect those same resources. Key findings include:

• Given the variety and strength of regional water resource-related companies, there is an opportunity to promote a “water cluster” focused on meeting growing global demand for water-related technologies – a $500 billion market expected to expand 3-5% annually (8-10% annually in emerging markets) over the coming decade

• New York should more effectively manage its waterways as world-class, tourism assets which can support a strong service sector

• Significant barriers to maintaining and establishing regional ventures include undervaluation of water assets by the private sector, underinvestment in infrastructure to meet manufacturing needs, a comparatively unfavorable business environment, poor coordination among regional stakeholders, and the threat of drought and flooding from climate change
Project Title: A New Role for the Port of Albany-Rensselaer in the Global Economy: What are the Economic and Environmental Issues? Dr. Susan Christopherson (Cornell University)

For the first time in over twenty years, industrial activity is increasing at The Port of Albany. This new industrial activity, emphasizing oil and other commodity exports, affects the Port’s role in the global economy and in the Capital region. It also has implications for environmental risks at the Port and for the Hudson River estuary. Making environmental and economic policy for ports is particularly complex because ports are parts of multiple systems, each with its own set of stakeholders. Although there is overlap among these stakeholders, they may operate and make decisions in disconnected systems with conflicting policy priorities. The goal of this project is to analyze why and how activities at the port are changing and to raise issues about what these changes imply for regional and port lands planning and environmentally sustainable port practices. Key findings include:

- The Port of Albany-Rensselaer is playing a key export role in global oil markets; transport and transfer of shale oil creates environmental risks for the Hudson River estuary and for port lands and adjacent urban areas
- Direct employment impacts from increasing export traffic are unlikely to be significant because of the capital-intensive character of the industrial activities; an analysis of how expanding Port activity might be leveraged for regional economic development is needed
- Fragmented decision-making regarding the Port estuary and Port lands creates challenges for addressing environmental, safety and security risks from hazardous cargo moving into the region and through the estuary

Oil tanker railcars at the Port of Albany (Photo credited to Lori Van Buren & the Times Union)
**Integrated management** - Integration of scientific, economic, planning/governmental and/or social expertise to build comprehensive strategies for public asset and watershed management

**Cross-cutting impressions**

At the municipal level, the effective management of water resource assets requires much more than the right technology. Appropriate financing and economic management; sound planning and governance; maintenance of expertise and community relationships; all are critical for the establishment of successful integrated management of water resource infrastructure systems.

At the watershed and/or regional scale, water resource management presents a challenge because of various and competing stakeholder perspectives, and because of the lack of incentive to plan in a coordinated fashion. That being said, analyses at the watershed scale do reveal region-specific characteristics that could help inform water resource management decision making. Overall, watershed scale planning and goal-setting may be a way to increase infrastructure system effectiveness and efficiency in the context of diminishing federal funding, and should be used alongside current practices that focus on individual projects.

**What researchers found**

Project Title: **New York state wastewater treatment inventory analysis**, Sridhar Vedachalam (Cornell University)*

In New York State (NY), projected capital needs for wastewater systems total nearly $30 billion over the next two decades alone. Financing these needs is a significant challenge, as Federal funding for the Clean Water Act has been reduced by 70% during the last twenty years. There is an urgent need for new approaches to assist states and other decision makers to prioritize wastewater maintenance and improvements. We present a methodology for performing an integrated quantitative watershed-scale goals assessment for sustaining wastewater infrastructure. We applied this methodology to ten watersheds of the Hudson-Mohawk basin that together are home to more than 2.7 million people, cover 3.5 million hectares, and contain more than 36,000 kilometers of streams. We assembled data on 183 POTWs treating approximately 1.5 million m$^3$ of wastewater per day. Key outcomes include:

- An analysis of each watershed based on eight metrics integrated into three goals for watershed-scale management: *Tributary Protection, Urban Development, and Urban-Rural Integration*
- Quantifiable differences in environment character, economic need, and the appropriateness of different management strategies among the ten watersheds
- Feasibility demonstration of watershed-scale goals assessment to augment existing approaches to wastewater infrastructure analysis and planning


*New York State (inset) and the ten studied watersheds within the Mohawk-Hudson basin*
Smart growth - Smart growth and its implications for water related infrastructure development, regional water quality, and regional economy

Cross-cutting impressions

Smart growth principles can potentially provide direction in our efforts to plan water resource management activities and investment in more effective and efficient ways. While smart growth has some well-established meanings in the context of urban development and transportation, it is less clear what smart growth implies for water resources infrastructure, particularly in rural regions, or in urban areas that may be losing population.

There is evidence that recent efforts by NY State may be successfully promoting smart growth related to water infrastructure. However, gains in economic efficiency or technological effectiveness still rely greatly on the degree to which local municipalities and decision-makers buy into system planning goals. Overall, local conditions remain extremely important in shaping smart growth planning and its success.

What researchers found

Project Title: Hudson water and sewer smart growth infrastructure, David Kay (Cornell University) This project was designed primarily to educate about and conduct new research into the extent and manner in which New York’s Smart Growth Public Infrastructure Policy Act is being implemented in New York State, and the implications for the state’s local governments. Our goals were to 1) better understand and document the extent of PIPA implementation by state agencies with jurisdiction over water and sewer infrastructure; 2) better understand the implications of the Act for New York’s communities and local governments and; 3) to document and draw attention to the current state of awareness of the Act on the part of local government. Key findings include:

• Many, but not all, key agencies are working diligently to implement the act; some have issued detailed guidance documents, others have not taken significant implementation steps
• Protocols and standards used by the Environmental Facilities Corporation are among the most comprehensive and most fully aligned with the Act’s Smart Growth principles; there are more apparent tensions between the mission of the Department of Health and Smart Growth goals
• The ability of the Act to advance Smart Growth principles in practice depends greatly on the alignment of local plans with Smart Growth principles

Project Title: Potential Cost Savings due to Financial Consolidation of Water Infrastructure, Peter Woodbury (Cornell University) Residents of the Hudson-Mohawk River Watershed and the state of New York face serious challenges during coming years to maintain water infrastructure, including both water supply and sewage treatment. For example, maintaining wastewater infrastructure is expected to cost more than $36 billion by 2028. Given this extremely high cost, one of the few potential opportunities for substantial cost savings is consolidation of water infrastructure entities. A critical review of the literature on this topic was conducted to estimate the potential for cost savings and the strengths and weaknesses of consolidation for reducing overall costs. The focus of this project is on organizational consolidation without physical consolidation because it will be applicable to all entities, while physical consolidation is applicable to just the very few entities that could feasibly be physically connected. Key findings include:

• A lack of convincing evidence in the literature of meaningful cost savings due to consolidation
• Consolidation likely involves a mix of short term costs due to the time required for planning and implementation, balanced against long term cost savings in operations
• Potential non-financial benefits might be realized, such as (1) additional technical expertise (2) improving risk management for rare events (3) improving technical capacity for financial and technical planning
Source water protection - The economic and environmental benefits of source watershed protection strategies and the use of ecological services to meet water supply and quality needs, as opposed to treatment at point of delivery

Cross-cutting impressions

In New York State, the New York City watershed management program serves as an example of how source water protection can be a viable strategy for meeting water supply quality goals without extensive water treatment, and by efficient use of available funds, the program has documented economic and environmental benefits. Other ecosystem services are performed by riparian corridors around streams and lakes, and by wetlands that naturally filter stormwater. However, less is known about these natural systems and the trade-offs between maintenance of ecosystem services and the engineered grey infrastructure that is often built to replace them. More research is urgently needed to characterize the economic and environmental costs and benefits of ecosystem services, particularly in areas where grey infrastructure is aging and funding is limited.

There is also a need to better understand the economic and environmental implications of water withdrawals at the watershed level, particularly now that NY has passed legislation regarding water withdrawal permitting. More generally, water managers can benefit by understanding how local, state, and federal policies can be harnessed to protect water supply sources with limited funding, and what alternatives to expensive grey infrastructure may exist.

What researchers found

Project Title: Water withdrawals and their impact on valued fish (brook trout) habitat, Bill Fisher (Cornell University; USGS – New York Cooperative Fish and Wildlife Research Unit)

Mohawk River Basin with brook trout population status and the extents of the Marcellus and Utica Shale deposits

Eastern brook trout are native to the eastern United States and a good indicator species of anthropogenic disturbance in streams because they require clean cold water, intact habitat, and a strong supporting food web to maintain healthy populations. Brook trout have been reduced or extirpated across much of their native range primarily because of anthropogenic land and water alterations, which have resulted in habitat reduction and fragmentation, water quality and temperature changes, and modification of the biological environment through introduction of other species. This declining species faces further pressure from the rapid expansion of natural gas extraction activity in the Marcellus Shale region, which overlaps twenty-six percent of the historical distribution of brook trout habitat. The objective of this study is to observe and model the effects of shale gas infrastructure development (well pads, roads and pipelines) on brook trout habitat and populations in Pennsylvania and New York. Key findings include:

- We identified three primary pathways by which brook trout are potentially affected: 1) changes in hydrology associated with water withdrawals, 2) elevated sediment inputs associated with supporting infrastructure, and 3) water contamination from introduced chemicals or wastewater
- Observed statistically significant differences in both the length and weight distributions of brook trout in some PA streams undergoing varying levels of shale gas infrastructure development; however,
- More data analysis and collection are required to form any conclusions about the cause of these differences
Project Title: **Pollution trade-offs associated with the use of riparian zones as best management practices**, Philippe Vidon (SUNY ESF)

Riparian zones (near stream zones) are widely recommended best management practices (BMP) to mitigate the impact of agriculture on the quality of our waters owing to their inherent ability to remove nitrate from subsurface flow. However, recent research suggests that the strong biogeochemical gradient often observed in riparian zones as water moves from the upland environment to streams also influences the fate and transport of many other redox sensitive elements such as phosphorus, sulfate and iron, as well as the production and/or consumption of greenhouse gases. There is therefore a critical need to quantify potential pollution trade-offs associated with the use of riparian zones as BMPs within the context of stream restoration. We conducted a study that focused on the impact of stream meander geometry (i.e. curvature) on pollution trade-offs (GHG production, P, S, and Fe release) in a typical central NY riparian zone. Key findings include:

- **Clear differences in hydrological conditions, nitrogen dynamics, and GHG production/consumption** between the various landscape elements found in the floodplain
- **Variations in biogeochemical conditions**, with elevated NO$_3^-$ loss, N$_2$O and CH$_4$ emissions within the oxbow formation suggesting geomorphology plays a significant role in setting subsurface biogeochemistry and associated pollution trade-offs

![Theoretical and observed stream geomorphologies](image)

This grant funded a Land Use Leadership Alliance Training (LULA) program for selected individuals in the Hudson Valley watershed. LULA programming creates and enhances communication and regional dialogue regarding watershed protection and preservation. This includes communicating science-based information to local decision-makers about ways to manage and conserve water resources and increasing their understanding regarding the correlation between proper land use planning and watershed management. The landscape around the Hudson River Estuary is undergoing rapid change; both the rate and impact of development challenges the capabilities of local, volunteer decision makers. Against the weight of development pressures, the local land use decision makers need to understand a) the scope of their responsibility and authority under law, b) how their decisions about growth and development relate to infrastructure investment; and c) to have access to and awareness of tools and techniques for natural resource and watershed protection. Key outcomes include:

- **Delivery of powerful tools to on-the-ground decision-makers** on land use actions that will help encourage proper development and land use planning to protect watersheds
- **Introduction and practice of collaborative process techniques to encourage collaboration** within and across communities between informed leaders
- **The evaluation of intermunicipal potential for watershed planning**
Full versions of final reports are available at our website
http://wri.eas.cornell.edu/grants

Outreach – How have we been communicating results of our work?

For a complete listing of outreach activities performed by WRI and HREP staff, please see our website at http://wri.eas.cornell.edu/activities

For information on outreach activities performed by faculty researchers at Cornell and elsewhere, please see individual project reports posted at http://wri.eas.cornell.edu/grants

Year Two (2013-2014) – How we are adapting our efforts to support research and create effective outreach products

The first year of this coordinated effort launched a number of analyses. Several resulted in finished products that were ready for dissemination to stakeholders interested in water resources infrastructure. Some analyses were preliminary and are ongoing, or were exploratory in that they served to better define research questions of interest for future work. During the second year, many investigators have been invited to continue their research. In addition, new investigators were invited into the program who have complimentary expertise and interests, and whose projects explore important issues raised during the first year of work. Early year two discussions among all researchers have resulted in several collaborative efforts, which is a trend we will continue to support. For the drafting of year two’s Research Summary, we are considering providing report templates to each researcher so that products have consistent feel and content. Through more thoughtfully structured and frequent communication with researchers, WRI will work harder to ensure that all projects result in products that are useful and understandable. Lastly, WRI will continue to encourage collaborative, multi-disciplinary projects as a way to provide holistic assessment of issues related to water resource infrastructure, and its effect on ecology, environment, people and the economy.

Year Two (2013-2014) – Funded projects for year two

Funded projects fall within two administrative categories. Competitive research involves investigators from institutions across the state who responded to a formal request for proposals. These researchers will work largely independently, but can be contacted and consulted regarding opportunities for cooperation and outreach. Coordinated research involves Cornell faculty who have agreed to meet monthly to facilitate discussion and synergy among individuals, as well as with staff from WRI, HREP and the Mohawk River Basin Program (MRBP).

Competitive Projects

Project Title: Greenhouse gas production as pollution trade-offs in New York wetlands and source water streams (Philippe Vidon – SUNY ESF)

Project Title: Wetland mitigation of infill development: an evaluation of green infrastructure effectiveness in a near-urban setting (Mary Ann Cunningham - Vassar College)

Project Title: Digitizing a 70-year record of land use change in New York State watersheds to examine the effectiveness of non-structural landscape modification on flood control (Stephen Shaw - SUNY ESF)

Coordinated Projects

Project Title: Planning for expanded industrial activity in and around the Port of Albany (Susan Christopherson - Cornell University)

Project Title: Hydraulic fracturing and Brook Trout habitats in the Marcellus Shale region: effects of infrastructure development (Bill Fisher - Cornell University; USGS – NY Coop Fish & Wildlife Res Unit)

Project Title: Hudson water and sewer smart growth infrastructure (David Kay - Cornell University)
Coordinated Projects (continued)

Project Title: **Innovative approaches to making a business case for water resource management** (Mark Milstein - Cornell University)

Project Title: **Green infrastructure, water quality, and GHG emissions** (Todd Walter - Cornell University)

Project Title: **Geospatial analysis as a tool for identifying critical land use and infrastructure impacts on regional environmental water quality** (Peter Woodbury - Cornell University)

Project Title: **A Prototype Planning Support System for Managing Change in Water Infrastructure Systems in Hudson River and Mohawk River Municipalities** (Kieran Donaghy - Cornell University)

Project Title: **How small is too small? Scale economies in New York State water utilities** (Rick Geddes - Cornell University)

Project Title: **Assessment of New York’s water resources infrastructure** (Sridhar Vedachalam - Cornell University)

In addition to the projects listed above, WRI staff and interns, in cooperation with Hudson River Estuary Program and Mohawk River Basin Program staff will conduct research related to infrastructure effectiveness, economic vitality, integrated management, smart growth, and source-water protection. For more information on these efforts please contact either Brian Rahm (bgr4@cornell.edu) or Sri Vedachalam (sv333@cornell.edu).

For information on the HREP and MRBP Action Agendas please see: