

**V(A). Planned Program (Summary)**

**Program # 1**

**1. Name of the Planned Program**

Climate Change - Water Quality & Quantity

Reporting on this Program

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	10%		10%	
111	Conservation and Efficient Use of Water	20%		20%	
112	Watershed Protection and Management	40%		40%	
133	Pollution Prevention and Mitigation	20%		20%	
605	Natural Resource and Environmental Economics	10%		10%	
	<b>Total</b>	100%		100%	

**V(C). Planned Program (Inputs)**

**1. Actual amount of FTE/SYs expended this Program**

Year: 2014	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	15.0	0.0	4.0	0.0
<b>Actual Paid</b>	10.3	0.0	3.6	0.0
<b>Actual Volunteer</b>	185.0	0.0	1.0	0.0

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
156974	0	249638	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
913479	0	929801	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
152900	0	166735	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

- Work with municipalities to help them meet their regulatory responsibilities on stormwater management and watershed restoration
- Perform experiments to investigate what the current nutrient loads are in NJ water
- Determine the best methodologies for developing Total Maximum Daily Load (TMDL) values for NJ waterways
- Examine the effectiveness of alternative onsite wastewater treatment systems
- Provide scientifically sound advice to state regulatory bodies on water quality issues
- Math modeling of contamination transport in surface and groundwaters
- Create a program comprising of faculty, staff, volunteers, industry partners and government officials

**2. Brief description of the target audience**

- Municipalities
- State Department of Environmental Protection
- Staff and students who gain valuable scientific experience
- Industry partners who learn ways to meet water quality standards
- Communities who learn watershed restoration methods
- NJAES Faculty and Staff involved in water research/outreach
- School age youth
- Residents

**3. How was eXtension used?**

eXtension was used in this program through participation in the animal waste CoP. Faculty answered ask the expert questions, developed collaborative educational products and provided leadership to the CoP.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	1506	3000	96	0

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

Year: 2014  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

<b>2014</b>	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Actual</b>	6	22	28

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications, and publications. In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected.

<b>Year</b>	<b>Actual</b>
2014	1

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Short term - Knowledge of nutrient loads in various NJ waterways. Find the best methodologies for determining TDMLs
2	Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.
3	Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
4	Transformations and Bioavailability of Mercury in Aquatic Ecosystems - Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.
5	Green Infrastructure for Municipal Officials - Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.
6	Biodegradation of Petroleum Contaminants in Groundwater Aquifers - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
7	Climate Change and Atmospheric Forcing of Water Quality Changes in the Mullica River-Great Bay Estuary, NJ - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
8	Natural Resources Management - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
9	Community Based Stormwater Education - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
10	Earth-Wise Lawn and Landscape Care Educational Program - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
11	Cluster Rain Garden Program - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

## **Outcome #1**

### **1. Outcome Measures**

Short term - Knowledge of nutrient loads in various NJ waterways. Find the best methodologies for determining TDMLs

Not Reporting on this Outcome Measure

## **Outcome #2**

### **1. Outcome Measures**

Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.

### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Action Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Microbially Mediated Dehalogenation of Organohalide Contaminants in Anaerobic Environments

Halogenated organic compounds constitute one of the largest groups of environmental pollutants. These toxic, bioaccumulating pollutants include legacy industrial chemicals, such as polychlorinated biphenyls (PCBs), ubiquitous polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) which continually enter the environment via anthropogenic and natural inputs, as well as current commercial manufacturing chemicals including the brominated flame retardants (BFRs). These pollutants are problematic due to their recalcitrance and toxicity, and furthermore, are often present as complex mixtures. Remediation of soils and sediments contaminated with these toxic chemicals continues to be a major challenge.

#### **What has been done**

An NJAES researcher is using laboratory studies of contaminated river sediments to identify the microbial communities and processes responsible for anaerobic reductive dehalogenation of organohalide compounds, including brominated flame retardants, polychlorinated dibenzo-p-dioxins, polychlorinated biphenyls and diverse pesticides.

**Results**

Results from micro- and mesocosm experiments using contaminated sediments (e.g., Anacostia River MD, Hackensack River NJ and Kymijoki River Finland) have revealed diverse communities of dehalogenating microorganisms. Although Dehalococcoides species are the most likely candidates for PCDD/F and PCB dechlorination, there are other Chloroflexi microorganisms that have been shown to be active in dechlorination. The addition of halogenated co-amendments might be one tool to enhance dechlorination of PCBs and PCDD/Fs in historically contaminated sediments.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

**Outcome #3**

**1. Outcome Measures**

Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

**3c. Qualitative Outcome or Impact Statement**

### **Issue (Who cares and Why)**

#### **Water Allocation**

All producers who irrigate crops must complete paper work to register their irrigation intakes and establish a water use allocation deemed acceptable by the New Jersey Department of Environmental Protection (NJ DEP). Those who irrigate less than 3.1 million gallons a month (MGM) are required to apply for an agricultural water use registration whereas those who irrigate above 3.1 MGM must apply for an agricultural water use certification. Once approved, this permit is effective for a five year period and annual water use form must be submitted to NJ DEP by February 28 of the year following the one when the water was utilized.

### **What has been done**

Producers who irrigate and need to establish and/or maintain an agricultural water use registration or certification must obtain documentation as well as approval from the county agricultural agent. One-on-one assistance with filling out the application is provided when needed since the paperwork can prove to be overwhelming to producers. Assistance can be anything from helping calculate water use, to creating maps or diversion sources, to helping interpret unclear language on the application forms.

### **Results**

With permits numbered up to SA0217, the rules of NJ DEP regarding water use and allocation effects a majority of the farming operations in Salem County. Since Salem County is one of the largest agricultural counties in the state, outreach to the farmers who utilize irrigation in their operation about water allocation has been a priority for the Salem County Extension office. In November of 2014, a one day workshop was held with representatives from NJ DEP, Division of Water Supply and Salem County Extension personnel where appointments were established and Salem County farmers with Agricultural Water Usage permits were able to renew and/or modify their permits. These workshops were very effective, having the participation of about twelve producers resulting in the renewal and/or modifications of nearly forty Agricultural Water Usage permits. Beyond the updating of the permits, the interaction between extension personnel, NJ DEP representatives and agricultural producers helped establish understanding and a positive relationship between all parties involved. Overall, in 2014, sixty-four total permits were processed for Salem County. Four Salem County farmers were approved for new agricultural water use certifications, forty-nine farmers were approved for permit renewals, and eleven farmers had modifications (both major and minor combined) processed on their agricultural water use certifications. Due to the result of DEP studies in watersheds within Salem County, much of the county has been deemed a critical area for water use. In a deemed critical area, any producer applying for water use rights from the NJDEP Bureau of Water Supply will be limited to receiving an agricultural water use registration (less than 3.1 MGM) regardless of the size of the operation or crop water needs. Producers who own Farmland Preserved properties where no water use rights have been established and want to receive an agricultural water use certification are limited to an agricultural water use registration as well. Assisting in obtaining and maintaining agricultural water use certifications and registrations has proven to bring great relief to producers who irrigate and who may be intimidated by the formal process of application.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships

111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

#### **Outcome #4**

##### **1. Outcome Measures**

Transformations and Bioavailability of Mercury in Aquatic Ecosystems - Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.

##### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

##### **3a. Outcome Type:**

Change in Action Outcome Measure

##### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

##### **3c. Qualitative Outcome or Impact Statement**

###### **Issue (Who cares and Why)**

Transformations and Bioavailability of Mercury in Aquatic Ecosystems

Mercury is a potentially serious public health concern due to its accumulation in aquatic and terrestrial food chains. The consumption of marine and freshwater fish containing elevated concentrations of mercury by women of child-bearing age has been linked to adverse health outcomes for their children. Recent research results point to a need for greater understanding of the bioaccumulation of mercury at the base of aquatic food webs and the mercury isotopic fractionation associated with mercury transformations in aquatic environments.

###### **What has been done**

NJAES researchers are examining the biological and abiotic mechanisms that lead to the mobilization, transformation, and bioaccumulation of mercury in subsurface, estuarine, and marine environments. Understanding the fate of mercury in some of the most densely populated states in the U.S. will link process studies focused on biological cycling, speciation, and bioaccumulation to environmental management of the nation's aquatic natural resources. Through collaborations with microbiologists, geochemists, and marine ecologists, the

bioavailability of methylated mercury in aquatic food webs, the effects of environmental factors during photochemical reductions of Hg (II) and MeHg in aquatic systems we examined these areas through the field work and laboratory experimentation.

### Results

Ongoing research examined the photochemical reduction of mercury inside marine phytoplankton cells, the mercury isotopic composition of methylmercury in estuarine sediments, mercury isotopic fractionation during microbiologically-catalyzed mercury methylation, mercury concentrations in Antarctic krill, and the physiology and biochemistry of inorganic carbon acquisition in marine diatoms. Results include the following findings:

Photochemical reduction of intracellular mercury in marine phytoplankton is an important pathway of mercury reduction in coastal waters. A method for the separation of methylmercury from estuarine sediments for mercury isotope analysis was developed and tested. The mercury isotope signature of methylmercury from estuarine sediments indicated that there is spatial and temporal variation in the extents of methylmercury recycling through demethylation. The mercury isotope fractionation factor associated with mercury methylation by the ubiquitous iron-reducing anaerobe *Geobacter sulfurreducens* was determined. Dissolved elemental mercury concentrations in surface waters along the West Antarctic Peninsula increased with proximity to the shore. Along the West Antarctic Peninsula, concentrations of methylmercury were higher in juvenile krill, which undergo development near shore and feed on sea-ice algae during overwintering, compared to concentrations found in adult krill. Pyruvate carboxylase (PYC) from the marine diatom *T. pseudonana* was shown to be able to catalyze the decarboxylation of oxaloacetate in vitro. In addition, activities of PYC in *T. pseudonana* were suppressed in cultures acclimated to high CO<sub>2</sub>. This chloroplastic enzyme may therefore help diatoms fix inorganic carbon in the ocean as part of a biochemical carbon concentrating mechanism.

## 4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

## Outcome #5

### 1. Outcome Measures

Green Infrastructure for Municipal Officials - Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Green Infrastructure for Municipal Officials

Many of New Jersey's municipalities are highly urbanized with numerous stormwater and combined sewer issues. During dry weather, the sewage flows to the wastewater treatment plant with no issues, but during wet weather, the system can become overwhelmed and the combined sewage and stormwater is often discharged untreated to a local waterbody. This event poses a risk to both human health and to the water quality of the receiving waterway.

**What has been done**

Green infrastructure is an approach to wet weather management that infiltrates, evapotranspires, captures and reuses stormwater to maintain or restore natural hydrologies within a watershed ([www.epa.gov/greeninfrastructure](http://www.epa.gov/greeninfrastructure)). Many municipalities in the state have received grant funding to implement green infrastructure projects such as rain gardens, but continue to implement traditional engineering approaches to stormwater management. The program educates municipal officials, engineers, decision-makers, and others about green infrastructure and to provide support for communities that need technical assistance in the design and installation of those systems for improved stormwater management, reduction of impervious cover, and reduction of stormwater volume entering the sewer system and local receiving waters. Seminars and workshops have been given in 2014 with programs in Newark, Haworth, Toms River, and Paterson.

**Results**

Passaic County recently committed to a Green Streets Initiative that includes permeable pavement and is out to bid for rain gardens, rainwater harvesting, and permeable pavement systems for 2 locations in Paterson (Grand St. and Haledon Ave.). Passaic County has also expressed interest in partnering with RCE to create a GI best management practices manual for the County.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
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102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

## **Outcome #6**

### **1. Outcome Measures**

Biodegradation of Petroleum Contaminants in Groundwater Aquifers - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Condition Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Biodegradation of Petroleum Contaminants in Groundwater Aquifers

Water quality for human, agricultural and environmental uses can be impacted by contaminants from many different sources. Groundwater is a critical resource needed for drinking water, irrigation and environmental sustainability and is being overexploited and undervalued. In New Jersey it provides almost 50% of the water supply of the state. One of the major concerns for groundwater quality is contamination by organic solvents and petroleum components. These come from leaking underground storage tanks found under gas stations and industrial areas, legal and illegal waste disposal as well as non-point and point source contamination.

#### **What has been done**

By advancing the research in biodegradation, NJAES researcher can expand our understanding of the microorganisms, their physiology, genetics and the biochemical mechanisms of degradation for many organic compounds of interest (including benzene, toluene, xylenes, naphthalene, phenanthrene, other polycyclic aromatic hydrocarbons and alkanes). We studied

the biodegradation by naturally occurring microorganisms of these compounds under the conditions likely to occur in groundwater. More than just serving as a treatment option, knowledge about the biodegradation of these compounds also provides insight into the natural attenuation processes that these microbes can carry out in situ. The overall goal of the work is to understand the microbial processes involved in the metabolism of monocyclic, bicyclic, polycyclic aromatic hydrocarbons (PAH) and alkanes in the absence of oxygen.

### **Results**

Our investigations have shown that the anaerobic biodegradation of petroleum components can occur naturally in anoxic groundwaters in NJ. These processes are not rapid, but are specifically identifiable as taking place anaerobically through the identification of specific and unique metabolites of the degradation pathway. Furthermore, specific genes known to be responsible for anaerobic activation and degradation of petroleum components are also a key identification mechanism unique to anoxic habitats. In previous studies we demonstrated that at a NJ MGP contaminated ground water site, natural attenuation was demonstrated by the presence of specific hydrocarbon metabolites produced by specific hydrocarbon degrading anaerobes. Since these compounds are unique and cannot be produced by other means, it provides strong evidence for natural attenuation of the contamination taking place over time. The concentrations also decrease with distance from the source, further supporting the natural attenuation process. In this current project we were able to gain access to the same site 9 years later to examine changes in conditions over this time period. Furthermore, we now have biomolecular tools that can be used to detect and measure the specific genes that are responsible for the attack on the hydrocarbon molecule during its degradation under anaerobic conditions. By measuring the metabolic biomarker and also the genetic biomarker the site conditions can be comprehensively described. The observations show that both the biomolecular and the chemical metabolite data support each other give stronger support and further credence to natural attenuation taking place in the subsurface. These data support the ongoing discussion on using natural attenuation as a means of groundwater cleanup. With this knowledge we can better manage, treat and clean up our valuable groundwater resources. On a national level 40% of the water supply comes from groundwater with agriculture using most of it, and in NJ more than 300,000 wells provide water to more than 4.3 million residents (USGS 2007). As the population of the state grows, maintaining a safe and reliable water supply for state residents, for agriculture and the environment is vital to the welfare and security of the State. With knowledge gained from this work, we provide improved remediation tools for State and local water quality officials.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

## **Outcome #7**

### **1. Outcome Measures**

Climate Change and Atmospheric Forcing of Water Quality Changes in the Mullica River-Great Bay Estuary, NJ - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Condition Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Climate Change and Atmospheric Forcing of Water Quality Changes in the Mullica River-Great Bay Estuary, NJ

The Mullica River-Great Bay Estuary is the most pristine estuarine system in New Jersey. Water quality in this estuary has historically been excellent, and therefore it can serve as an ideal reference for assessing human impacts on other shallow coastal bays in New Jersey and elsewhere. Changes in the frequency and intensity of storms and droughts influence hydrologic and water quality conditions in the estuary that can significantly affect biotic communities and habitats. Collection of spatial and temporal data from this estuary with respect to meteorological forcing factors will be useful to resource managers tasked with making critical decisions involving the condition of New Jersey's coastal waterbodies, habitats, and commercial and recreational fisheries.

#### **What has been done**

An NJAES researcher oversees a data collection of water quality and meteorological measurements consistently in the Mullica River-Great Bay Estuary over the study period from October 1, 2013 through September 30, 2014. A series of water quality parameters (temperature, salinity, DO concentration, DO percent saturation, pH, and water depth) are recorded continuously (every 15 minutes) at four long-term sampling stations (i.e., Lower Bank, Chestnut Neck, Buoy 139, and Buoy 126) along the Mullica River-Great Bay estuarine gradient using an integrated system of moored, automated YSI 6-series data loggers. On a monthly basis, nutrients

(nitrogen and phosphorus) are monitored by collecting discrete water samples at these four stations and analyzing them for nitrogen and phosphorus concentrations along the estuarine salinity gradient. In addition, one day a month, nitrogen and phosphorus concentrations are determined every two hours over a 24-hour period via an ISCO sampler deployed at Buoy 126. A Campbell weather station located at the Richard Stockton College Marine Field Station on the Mullica River concurrently provides continuous recordings of wind speed, direction and velocity, solar radiation, barometric pressure, and humidity in the area to correlate with water quality parameters collected at the moored estuarine sampling sites. Precipitation measurements are obtained at the U.S. Weather Bureau Station in nearby Atlantic City. Two of the water-quality monitoring platforms (Chestnut Neck and Buoy 126) are equipped with telemetry capability that broadcast the water quality data collected at both stations to a GOES satellite, which will post the data on the World-Wide Web in near real-time for public use.

### **Results**

These data are being used to assess the temporal and spatial trends of physicochemical conditions in the estuarine system and to document relationships between meteorological conditions (e.g., precipitation, temperature flux, storms and extreme events) and water quality in estuarine waters (dissolved oxygen, nutrients, etc.). The data are also useful for the analysis and assessment of habitat conditions and habitat utilization by commercial and recreational fish species and other organisms in the estuary. The data collected in this project therefore will have value not only to these investigators but also to recreational and commercial fishermen who utilize these waters. Resource management programs in estuarine and marine waters of the region will also benefit since these data can be useful in the development of new strategies to sustain biotic resources. Environmental monitoring employed in this project is part of the Life on the Edge Exhibit of the Tuckerton Seaport, a venue visited by more than 10,000 people each year. There are many education and outreach programs, websites, workshops, conferences, ecological tours, and other events which serve as vehicles for the dissemination of project results to millions of potential project users in New Jersey and nationwide. The data are also accessible for use by people in other countries.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

### **Outcome #8**

#### **1. Outcome Measures**

Natural Resources Management - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

## 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2014	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Natural Resources Management

Monmouth County faces several major natural resource and environmental issues related to land use and water supply. These concerns include residential, industrial and open space needs, water quantity/quality for irrigation and recreation, non-point source pollutants, stormwater runoff, healthy food, and drinking water supplies. Over 75% of county streams are rated as moderately to severely impaired by the NJ Department of Environmental Protection. Monmouth is unique within the state in having the headwaters of six watersheds originate within its boundaries. These important watersheds draw their water from lands used by rural and suburban populations, farms, golf courses, parks, state forests, light industry, commercial fisherman, commercial boaters and recreational activities. The Jersey Shore of Monmouth County is a major destination site. Important beaches, rivers and lakes for residents and tourists are frequently closed due to pollution that prevents swimming, fishing, clamming, crabbing and other recreational and commercial activities. Climate change has created extreme weather patterns such that storm damage and rainfall events are much more of a hazardous problem- flooding, saltwater intrusion and stormwater pollution coastal areas is an ever increasing threat. These economic impediments threaten a one hundred million dollar revenue stream of the county economy and over 1 billion dollars of the entire coastline economy.

#### What has been done

A two book final report was prepared by the Wreck Pond technical working group. This 200-page document included a two-year agricultural characterization of the Wreck Pond watershed conducted by Rutgers Cooperative Extension of Monmouth County which was summarized at 7 municipal and county meetings. This report was utilized in 2011-2014 by the U.S. Army Corps of response to a need for East Coast farmers to remain economically viable, a U.S. Department of Engineers to begin their remediation planning and estimated resource investment. 2. 76 stormwater and rain garden seminars, 12 town meetings and 18 community sessions were provided for municipal officials, landscapers, environmental organizations, home owners and the general public from 2007 to 2014.

**Results**

RCE has effectively engaged and assisted the key target audiences - a diversity of natural resource interests and organizations. Over 300 of his farmer clients have adopted approved practices that build soil fertility, improve water infiltration, re-charge aquifers, provide streamside buffering and/or aid flood control. The Agent has provided soil analysis recommendations that have reduced excessive phosphorus fertilization by 85,000 pounds each year from 2006-2009 and 800,000 pounds total on 2000 acres from 2010 through 2014. Sixty-five public rain gardens were completed by the end of 2014 and 550 private rain gardens. Over 4 million gallons of rainfall were recaptured to groundwater and aquifers by these small bio-detention basins.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

**Outcome #9**

**1. Outcome Measures**

Community Based Stormwater Education - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Community Based Stormwater Education

Due to the dense population and intense development within New Jersey, stakeholders face many problems with water quantity and quality issues as well as groundwater recharge.

#### **What has been done**

The Community Based Stormwater Education and Outreach Program I've educated community members, citizens, schools, churches, municipal centers (including Department of Public works), and developers, on watershed management and conservation in order to implement best management practices for sustainable communities. Community outreach was increased through training and joint efforts with Master Gardeners, Cooperative Extension 4H volunteers, AmeriCorps Watershed Ambassadors and AmeriCorps Transitional Education and Employment Management Gateway Volunteers.

#### **Results**

This program is continually under evaluation through the rain water harvesting follow-up online survey. This survey will evaluate the utilization of rain barrels for water conservation by the attendees following training. To date, of the survey responders, 82% have installed their rain barrels at home and 24 % have installed additional barrels; 94% reported no difficulty installing the rain barrel; 19% have implemented additional stormwater runoff conservation practices; and 59% have adopted additional water conservation mechanisms following the training. Input will also be used to structure future workshops. Has participating in a rain barrel workshop made you more interested in other environmental actions? ?Native plants 55% ?Composting 68% ?Reduce energy use 55% ?Recycle more 55% ?Driving less 30% Detention Basin Management, Maintenance and Enhancement Program Cherry Hill Public Works supervisor estimates that the five basins that have been naturalized in his area, has reduced maintenance costs by \$20,000 annually. Based the success of reduce maintenance within the stormwater basins, the DPW has started implementing "no-mow" zones on other Township properties. Watershed Restoration for Healthy Ecosystems Use of the installed aeration system at Hopkins Pond, severely reduce the occurrence of cyanobacteria blooms during the first summer of operation. Oxygen levels were within 0.25ppm from surface to bottom (14 feet deep), demonstrating that the system is circulating water properly. There was no fish kill during 2014.

#### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

#### **Outcome #10**

##### **1. Outcome Measures**

Earth-Wise Lawn and Landscape Care Educational Program - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

## 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2014	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Earth-Wise Lawn and Landscape Care Educational Program

Maintaining a healthy lawn and landscape while reducing the unnecessary use of pesticides, fertilizers and water is essential to the preservation of the environment.

#### What has been done

Master Gardeners and landscapers throughout the state are provided with 2 to 3 hours of training. Students make a commitment to make positive behavioral changes to reduce unnecessary pesticide, fertilizer and water use. Also students learn how to properly manage landscape plants to insure health.

#### Results

90% of 275 students have made commitments to reduce their unnecessary use of pesticides, fertilizers and water use. Students have committed to recycle grass clippings to the lawn and utilize clovers to add Nitrogen back to the lawn. A total of 75 acres of lawns are now being managed using principles outlined in this program. Nitrogen inputs reduced by over 3,000 pounds to local landscapes. Over 22 million gallons of water via irrigation is reduced to these landscapes. Over 40,000 pounds of grass clippings are recycled onto lawns and do not end up clogging landfills.

## 4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

## **Outcome #11**

### **1. Outcome Measures**

Cluster Rain Garden Program - Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Condition Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	0

### **3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**  
Cluster Rain Garden Program

Stormwater runoff is a significant issue in the Troy Brook watershed in Morris County. A Stormwater Management Plan has been developed by Rutgers Water Resources Program that identified a specific neighborhood, the Hills of Troy neighborhood, as an area that both contributed to, and suffered from increased flooding and water quality impairments due to increased impervious surfaces in the watershed.

#### **What has been done**

Partnerships developed with the President of the Homeowner's Association of the Hills of Troy neighborhood were utilized to assist with outreach regarding the 2014 initiative along with mailed flyers. The goal was to double the number of rain gardens in the neighborhood to 10 rain gardens. Each homeowner attended a design studio with an engineer and landscape architect to help design their own rain garden. Each resident who received a rain garden received a calendar with pictures of Hills of Troy rain gardens for each month and a note reminding them of maintenance along with an individual maintenance manual.

#### **Results**

12 additional rain gardens have been installed with at least three more scheduled for the spring of 2015, bringing the total to 20 rain gardens. This will achieve 10% of the home in the Hills of Troy neighborhood have their roof and/or driveway runoff disconnected by a rain garden. This achieves a reduction of 354,747 gallons of stormwater annually and 15,320 square feet of

impervious surfaces disconnected.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

#### V(H). Planned Program (External Factors)

##### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

##### Brief Explanation

External factors did not affect outcomes.

#### V(I). Planned Program (Evaluation Studies)

##### Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine effectiveness on both a qualitative and quantitative level. For KASA and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessments. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned program. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results of each initiative.

**Key Items of Evaluation**

None to report.