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Municipal Stormwater Management Outreach: Improving Surface Water Quality

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MUNICIPAL STORMWATER MANAGEMENT OUTREACH

IMPROVING SURFACE WATER QUALITY

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Abstract

Monitoring and managing stormwater runoff contaminants is a serious issue faced by Massachusetts municipalities in protecting their water quality standards. The goal of this project was to create a master database and an online reporting form to aid municipalities in tracking data and improving stormwater pollution prevention practices. The focus of this guidance was to provide resources to municipalities as they address the three main contemporary stormwater program challenges: budgeting issues, compliance issues and a breakdown in communication and organization.

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Executive Summary

In 1972, the Clean Water Act introduced the National Pollutant Discharge Elimination System (NPDES). The NPDES program was established as the fundamental regulatory mechanism of the Clean Water Act requiring direct discharges of pollutants into waters of the United States to obtain a NPDES permit. The NPDES permit program focused on improving surface water quality by reducing pollutants of industrial process wastewater and municipal sewage. Further research and studies on water quality done by the Environmental Protection Agency (EPA) has revealed stormwater discharges as a significant source of water pollution.

Therefore, municipal stormwater management has become a regulatory function required under the NPDES permit for environmental protection. As a result, in 1990, the NPDES permit started addressing stormwater discharges from municipal separate storm sewer systems (MS4s). The NPDES regulations require that the operator of a small MS4 develop, implement, and enforce a stormwater management plan (SWMP). The objectives of the SWMP are to reduce the discharge of pollutants from the MS4 to the maximum extent practicable, to protect water quality, and to satisfy the appropriate water quality requirements under the MS4 permit. These objectives are accomplished through the implementation of Best Management Practices (BMPS) for each of the six minimum control measures listed below:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Construction Site Stormwater Runoff Control
- Post-Construction Stormwater Management in New Development and Redevelopment
- Pollution Prevention and Good Housekeeping for Municipal Operations

The Massachusetts Department of Environmental Protection (MassDEP) came to WPI when they found that municipalities had difficulties complying and submitting their annual permit forms required under the MS4 permit. They found that many municipalities would benefit from an efficient way to track and complete the MS4 requirements that make sure that stormwater pollutants are at a minimum. They wanted to create a database that would meet the needs of the towns and improve their stormwater management and tracking requirements.

In order to understand the problems that municipalities were having in completing their annual forms, we conducted multiple interviews with town officials that are in charge of stormwater management and third party engineering firms that assist in the development of stormwater management plans that address each of the six minimum control measures. After conducting our research and interviews, we identified three main problems that municipalities are facing: budgeting issues, compliance and policy issues and a breakdown in communication and organization. In order to address these issues to meet the standards of the towns, we created a single easy-to-use database that will allow municipalities to track and follow their stormwater data. This will prevent loss of data and will create an efficient way for municipalities to evaluate their stormwater management and improve upon it.

In addition, the three towns we interviewed, Douglas, Rutland and Ayer, expressed the need of an online report with a standardized format and electronic signatures with each of the minimum requirements listed. An online form will allow them to save the required information on their desktop and when it comes time to submit the report they can easily print it out and submit it, rather than creating their own form, which might contain unnecessary information. Therefore, our group created an online report form to assist the towns with their stormwater

initiatives. We included in the form stormwater projects they can perform in order to improve upon their stormwater management as well as an MS4 compliance form with all of the requirements and fields where they can explain the project and evaluate their techniques.

We have completed the creation of the database with all of the information required under the new 2010 MS4 permit draft. The database was created using ZOHO creator, which our group chose based on the resources it had available for the creation of the database. In order for the database to be adopted successfully by all of the 361 Massachusetts municipalities, our group recommends the MassDEP to have a small number of communities, around ten or twenty, pilot the software for a year. As the towns use the database for their stormwater programs, they will submit criticism to the MassDEP.

The MassDEP and the municipalities find this database extremely helpful to all of the branches involved in stormwater management because it would create one master database to be used by all of the departments. A complete and accurate database is a valuable asset to the stormwater management practices. It will definitely make it easier for the towns to maintain its data and track it more efficiently. Furthermore, it will eventually help in improving water quality in Massachusetts municipalities.

Acronyms

BMP:	Best Management Practice
DCR:	Department of Conservation and Recreation
DEP:	Department of Environmental Protection
DCIA:	Directly Connected Impervious Area
DCR:	Department of Conservation and Recreation
DPW:	Department of Public Works and Utilities
ESA:	Endangered Species Act
EPA:	Environmental Protection Agency
GIS:	Global Information System
GPS:	Global Positioning System
IA:	Impervious Area
IDDE:	Illicit Discharge Detection and Elimination
MBAS:	Methylene-Blue active Substances
MEP:	Maximum Extent Practicable
MPN:	Most Probably Number
MS4:	Municipal Separate Storm Sewer System
NOI:	Notice of Intent
NRHP:	National Register of Historic Properties
NPDES:	National Pollutant Discharge Elimination System
O&M:	Operations and Maintenance
SPCC:	Spill Prevention Control and Countermeasures
SSO:	Sanitary Sewer Overflow
SWMP:	Stormwater Management Plan
SWPPP:	Stormwater Pollution Prevention Plan
TMDL:	Total Maximum Daily Load
UA:	Urbanized Area
WPI:	Worcester Polytechnic Institute
WQ:	Water Quality

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Chapter 1: Introduction

Ever since the beginning of civilization, water pollution has been a major concern. In the 1960s, the environmental movement was revived when Ohio's Cuyahoga River caught on fire as a result of the numerous toxins and pollutants in the water. Additionally, the Potomac River near Washington was overloaded with health warnings because of the algal bloom cover resulting from sewage contaminants. These are just a few examples of water pollution that have affected not only our environment but also our health. In 1972, the Environmental Protection Agency (EPA) put the Clean Water Act in place in order to help protect against one of the major leading causes of water pollution: stormwater runoff.

Stormwater Runoff is generated when rain precipitation and snowmelt accumulates and flows over land or impervious surfaces such as driveways, sidewalks, streets and roofs; all of which prevent stormwater from naturally being absorbed into the ground (EPA[2],2011). In our world today, urban development has been increasing in order to accommodate the growing population. However, as the natural environment decreases and land is covered with more and more impervious surfaces, large quantities of runoff (more than 50%) are able to travel faster and carry many pollutants to rivers, streams and oceans (ANJEC). Contaminants such as excess nutrients, sediments, pathogens, toxic contamination, and salts, are referred to as non-point source pollutants and affect water quality as well as have a huge impact on the economy at the state and local scales (Leavitt, 2007).

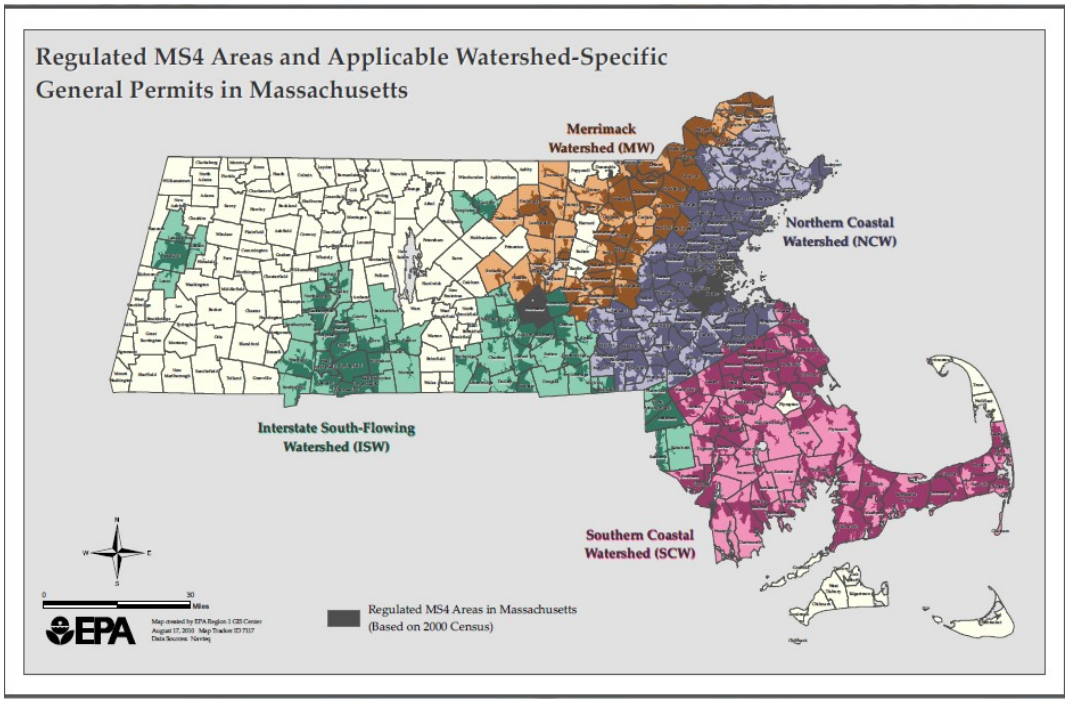


Figure 1:A map of all the Massachusetts Municipalities and Towns that report to the EPA. Retrieved from http://www.epa.gov/region1/npdes/stormwater/ma/MA_PermitType.pdf

Since the towns in Massachusetts watersheds, such as Worcester, Grafton, and Shrewsbury, manage land use, they have a large impact on how water quality is controlled. A map portraying all of the Massachusetts watersheds and towns can be seen above in Figure 1. These watersheds are in part responsible for maintaining pollutants to a minimum in stormwater drains that discharge to surface waters (Peterson, 2010). Each municipality is required to have Municipal Separate Storm Sewer Systems (MS4s) under the National Pollutant Discharge Elimination System (NPDES) permit. An MS4 is a system of drains, pipes, treatment units, gutters and catch basins that are used to collect, treat and discharge stormwater to surface water such as lakes, rivers and oceans (EPA[2], 2010). An MS4 is referred to as a point source, where pollutants can be monitored and recorded in annual forms required by the EPA.

In an ideal situation, all municipalities have the best stormwater management practices set in place. This includes pollution prevention operations, such as, training their employees to have good organization practices and cleaning the storm sewer systems on a regular basis to rid it of any pollution. Other good management practices also include an Illicit Discharge Detection and Elimination (IDDE) program for removal of illicit discharges, maintenance of Total Maximum Daily Load (TMDL) requirements to satisfy the water quality standards and public education, and outreach programs to involve the community in protecting the environment (MassDEP). Many more laws and state legislatures have set forth permits that would help create an ideal situation with minimum pollutants aggregating due to stormwater runoff. However, the reality of the situation is that pollution and contamination does occur and municipalities are either not educated enough on how to handle the situation or they do not have the resources necessary to complete the required annual documentations. The annual permit requirements set forth by the Environmental Protection Agency (EPA) make sure that the best stormwater management practices are taking place (Civian, 2011).

According to a new report released by the United States Public Interest Research Group (US PIRG) researchers, "the average facility discharged pollution in excess of its [NPDES] permit limit by more than 275 percent, or almost four times the legal permit" (Kalman, 2006). Additionally, "according to EPA's Toxic Release Inventory, polluters discharged more than 240 million pounds of toxic chemicals into our waterways in 2005 alone" (Leavitt, 2007). These are striking data, provided that the goal of the Clean Water Act was to eliminate the discharge of pollutants by 1985 (Leavitt, 2007). Further research into the US PIRG report portrayed Worcester County as one of the top 10 counties in the nation with the most facilities exceeding its permits (Leavitt, 2007). As a result, it is crucial that research is directed towards

understanding the reason why local municipalities struggle to protect their storm sewer and drain systems.

With help from our sponsors, our group communicated with the towns of Douglas, Rutland, and Ayer, Massachusetts. We identified the challenges they face in the protection, management and monitoring of stormwater runoff. A significant issue is the fact that town budgets for stormwater management are diminishing, while another was that not enough tracking and testing is being done regarding stormwater. After finding the underlying issues that these municipalities are facing regarding their form submissions, our group designed a working, live database that allows Massachusetts municipalities to easily and efficiently submit their annual reports on their stormwater runoff and gave them other options on how to better their stormwater management practices. In addition, this database makes the job of identifying high areas of pollution much easier for the Massachusetts and federal government.

We used state and federal research resources about stormwater permits and communicated with local municipalities as a primary step in helping the state protect against stormwater runoff. We achieved our goal by reaching our four main objectives, listed below:

1. Communicate the problems faced by municipalities in protecting their MS4s
2. Determine the reason why many municipalities fail to submit their annual forms
3. Create a successful and resourceful database
4. Outreach to the Municipal community on Stormwater runoff protection practices

Chapter 2: Background

2.1 The Importance of Water Protection

Water pollution is a very serious, and often unnoticed, problem. When water is flushed down a drain or dumped out of a pipe, it does not simply disappear; in fact it does the opposite. Water pollution is caused by a number of different things, and has many negative effects on the environment and surrounding communities. Pollution that makes its way into water sources causes the local governments to spend extra time and money in order to find alternative ways to get useable water, such as purifying it or irrigating it (Brenzonik and Stadelmann, 2002). Pollution also poses the risk of causing negative health effects to the communities nearby, making it an even more serious issue. Everyone must take action in protecting their water sources. Our goal was to create a database that will help local government agencies and municipalities monitor their water pollution. When the data are available and collected, people will start looking into improving water systems rather than leaving it unmonitored and ignored until water pollution becomes a threat to the health of millions around the world. This section will discuss different types of water pollution, such as non-point source and runoff, and detail why it is necessary to monitor and reduce water pollution not only in Massachusetts, but across the United States.

2.2 Water Usage

Worcester, Massachusetts has the benefit of being located on a large watershed, the Lake Quinsigamond Watershed, which is an area of land where all of the water that is under it or drains off of it goes into the same place (EPA[5], 2011). The Lake Quinsigamond Watershed is a crucial resource, because it provides residents of Worcester, Shrewsbury, and Grafton with water. The mission of the Lake Quinsigamond Watershed Association states: "[The LQWA] was

incorporated for the purpose of restoring, preserving and maintaining the environmental water quality and recreational quality of the watershed area" (LQWA, 2011). Conservation of water is important to preserving the current state of the watershed, and for maintaining an adequate supply of water for the city. Polluting this resource makes it more difficult for Worcester and other cities to provide enough water to its residents. While attempts to reduce pollution are in practice, the city of Worcester also values the idea of water conservation, and has released a guide to the public on its website, with many water conservation tips (epa.gov). These tips include practices such as:

> *Don't let water run when you brush your teeth or when washing your face... Instead of letting water run in the sink when you want a cool drink, keep a full pitcher or jug in the refrigerator... use the dirty water from a fish tank on your houseplants. It's rich in nitrogen and phosphorus, which gives you a good fertilizer...If you have a pool, cover it. Evaporation can make hundreds, even thousands of gallons of water disappear. Covering the pool will cut the loss by 90% (City of Worcester, 2011).*

Small efforts from the public can help the city of Worcester conserve the Lake Quinsigamond Watershed, making the task of maintaining and supplying water easier on the local governments. However, water conservation, although extremely important to the safety of our environment, is not enough to protect our waters. Government and municipal control is needed in order to set rules and standards on the vast amount of contaminants that reach surface waters each year from pipes and drains. Each municipality should be responsible in maintaining clean water for its watershed. One threat specifically that local municipalities face is stormwater runoff contaminants.

2.3 Stormwater Runoff Contaminations

Stormwater runoff is one of the greatest and most serious causes of pollution in the United States (Brenzonik and Stadelmann, 2002). It is caused by excess water from rain or melted snow that runs over ground surfaces and through storm drains until it reaches larger water bodies. The EPA considers stormwater a serious issue because it can pick up debris, chemicals, dirt, and other pollutants that flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the water bodies we use for swimming, fishing and providing drinking water (EPA[5], 2011).

Figure 2: An example of a typical storm drain. Retrieved from http://wakeupwakecounty.com

With urban expansion and development across the country, it becomes harder to keep stormwater from flowing into lakes and rivers. Instead of being absorbed and filtered by soil, stormwater flows over impervious surfaces like concrete and asphalt. It is then able to pick up oils and various pollutants until it is collected by a storm drain, as shown above in Figure 2, and carried into surface waters.

The pollutants picked up can include nutrients, dirt, pesticides and fertilizers, petroleum, and any other chemicals found on roofs, roads, and lawns. Adding these to large bodies of water can cause seriously damaging effects. Too much phosphorous or nitrogen present causes algal blooms to grow and drain dissolved oxygen from the water, killing the fish population. Chemicals in the water can kill wildlife, or make people sick if they drink or eat fish from that body of water, and trash can harm animals that might try to eat it.

2.3.1 Point Source and Non-Point Source Pollution

Point source and non-point source pollution are two types of water pollution. Point source is pollution that comes from a main point or single area, such as dumping from an industrial plant, an example of which can be seen in Figure 3. Because the origins of point source pollution are easily identifiable, it can be controlled with laws and regulations (Brenzonik and Stadelmann, 2002).

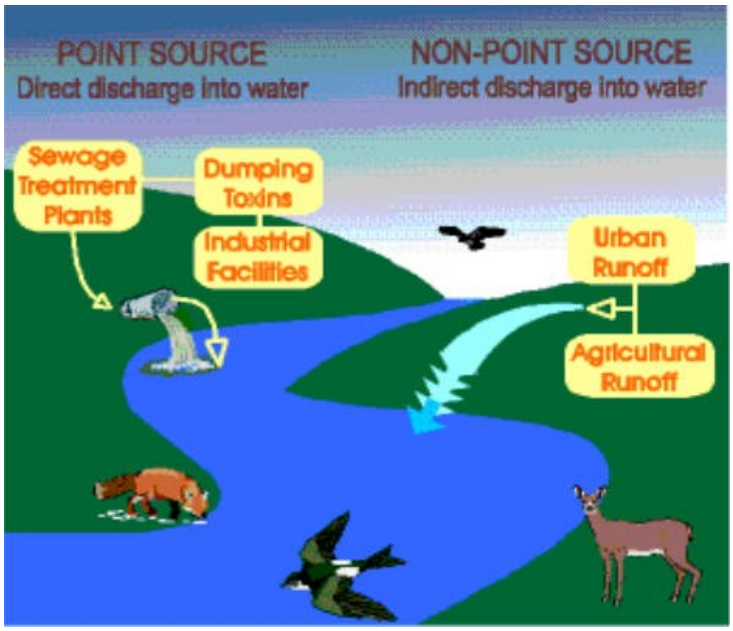


Figure 3: Examples of Point source and Non-Point source pollution. Retrieved from http://connecticutwatertrails.com

Non-point source pollution is much different, because it cannot be traced to a single discharge point. Stormwater pollution is considered a form of non-point source pollution. As stormwater flows over impervious urban ground, it covers a large surface area and collects chemicals and debris before reaching a drain or water body. It does not get filtered or treated in any way, and introduces many foreign substances and pollutants into these water sources. Because it has no point of origin, it is also much more difficult to control (Brenzonik and Stadelmann, 2002).

2.4 Side Effects of Stormwater Runoff

The five major categories of pollutants found in stormwater runoff are, sediment, nutrients, temperature, bacteria, and toxic contaminants (Civian, 2011). Pollutants carried by runoff can have multiple negative effects on the ecosystem. One negative effect caused by runoff can be flooding, which can cause detrimental damage to infrastructure, land, and private homes. Runoff can also erode the land it flows over, increasing the rate and amount of runoff from the watershed. Bodies of water may no longer be aesthetically pleasing, which can impair the recreational use of the water and the economic benefits in a tourist area (Land-Of-Sky Regional Council, 2011). Other possible effects of stormwater runoff are contaminated drinking water and damage to environmental reserves and its wildlife.

Sediment pollution from stormwater runoff is a major concern to local municipalities, especially in construction sites, areas with loose soil, and eroding stream banks. The sediment picked up from the runoff gets mixed and dispersed throughout the water, causing the water to look cloudy and murky. This type of water blocks the sunlight from the aquatic life below and can potentially kill the underwater plants. Once this sediment is dispersed throughout the water,

it settles and goes to the bottom, possibly burying these plants. The sediment picked up from stormwater can also cause problems reshaping the landscape when the runoff reaches higher velocities (Civian, 2011).

Nutrient pollution from runoff has been the biggest threat to bodies of water in most areas (Civian, 2011). Nutrients include fertilizers, pesticides, and sewage. Specifically, two of the most tested for nutrients are Nitrogen (N) and Phosphorous (P). These two nutrients are necessary for the growth of all living organisms, but in excess they can ruin the water quality. Too much nitrogen in a body of water stimulates excess plant growth, which can create algae blooms that consume the surface of the water. These algae blooms block the sunlight from the plants on the bottom and causing these plants to die. Additionally, they consume excess oxygen in the water causing fish and shellfish to die. Nitrogen can also be transmitted through the air and can be found in high concentrations on the roofs of buildings (Civian, 2011).

The temperature of the runoff coming from impervious surfaces such as asphalt can cause problems when entering surface waters. This sudden increase of temperature is harmful to cold water species such as trout (EPA[7], 2011). The increase in temperature can also promote excessive plant growth, and the spread of invasive species such as infectious mosquitoes. Runoff can also transport bacteria from animal waste and failing septic systems. This can contain harmful diseases which contaminate the surface waters and nearby species.

The final type of pollutant found in runoff is toxic contaminants. These include heavy metals such as Mercury, cleaning compounds, industrial byproducts, and vehicle leakage such as gas and oil (EPA[7], 2011). This type of pollutant is especially dangerous because it is harmful to

humans and animals at extremely low levels. If consumed, the toxic contaminants do not break down and instead are stored in fat tissue where they can lead to mutations, disease, and cancer.

2.5 The Stormwater Runoff issue and possible solutions

Runoff has been such a problem to limit because it is caused mostly by nonpoint source pollution. Meaning, unlike pollution from industrial plants, it comes from many different sources. This makes the pollution harder to limit since just one source cannot be monitored. Even though it is impossible to stop the pollutants in the runoff from entering surface waters, there are many different ways to limit the pollutants in the runoff.

One of the most important ways to limit runoff pollution is by educating the public about how dangerous it can be and how it can be limited. Citizens should make sure pet waste, debris, and leaves do not drain into the street gutters, because the street gutters lead straight to lakes, rivers, and other surface waters. Lawn and garden chemicals should also be avoided if possible and if not, they should be used sparingly. Oil, antifreeze, and other household chemicals should all be cleaned up if spilled and properly disposed of by a community program for collecting hazardous household wastes, not just washed into the street. Septic systems should be inspected every three to five years and pumped when necessary to make sure they are working properly (EPA[6], 2011).

There are three different ways the environment removes pollutants from water. One of these ways is the physical removal of the pollutants. This way has the pollutants catch on thick plants the runoff is flowing over, or the pollutants fall and settle on the bottom. Another way pollutants are removed is chemically. Many nutrients such as nitrogen bond to the soils below the runoff, also the soils absorb many of the metals such as copper, lead and iron. Pollutants in

runoff are also removed biologically. Aquatic plants consume nutrients such as nitrogen and phosphorous which are necessary for their growth (EHS, 2011).

The best way to address a stormwater pollution problem is first to plan where to allow future urban development. It is important to use as little land as possible and preserve the open space that is left. It is helpful to stay away from building on sensitive areas such as watersheds where stormwater pollution would do the most harm.

When designing a new construction, it should be made to manage runoff effectively. There are many features that can be added to the design that can help limit runoff pollution. When building on land with streams passing by, builders used to redirect the flowing water away from the construction site using pipes. This would destroy the plant life and animal habitats that were previously there. To limit the destruction to plant life and animal habitats, underground streams and waterways can be opened up and made into canals (Koshaley, 2008). This process is called day lighting streams, in this way the water can be redirected to flow near the surface allowing the ecosystem to thrive. Creating wetlands make habitats for animals and aquatic plants, which can naturally remove pollutants caused by runoff. Creating ponds can also create a habitat for aquatic plant life, but ponds can store large amounts of water for long periods of time, allowing pollutants to settle at the bottom. Wherever possible, asphalt should be avoided and native plants should be planted to absorb pollutants and stabilize the soil (Rammohan, 2006). Areas with large sloping surfaces should have some type of irrigation system to slow the water flow and filter the pollutants (Nelson, 2011).

2.6 Water Policy: Federal and State Regulations and Stormwater Acts

There are many water needs and with that comes misuse of water leading to pollution. Our group focused on the Northeastern part of the United States, particularly Massachusetts, which is influenced by laws and policies at the federal, state and municipal scales. Federal, state and municipal stormwater permits and regulations provide the basis against harmful waste disposal and dangerous contaminating pollutants from being dumped into streams, rivers and lakes. This would cause a catastrophic overload of dangerous contaminants that will ultimately lead to very poor quality of drinking water and many health concerns for many communities. A study preformed regarding the Clean Charles River Initiative, which took place in 1995 after the Clean Water Act was put in place, portrays the effect of the laws and regulations on reducing the amount of contaminants in the Charles River. The Environmental Protection Agency's goal was to restore the River to a better ecological health state that is "fishable and swimmable" (EPA[1], 2011). The rules set forth by the Clean Water Act and many others allowed for better stormwater management practices, such as measuring the amount of allowable loadings from all pollutant sources and monitoring algal growth to prevent algal blooms (MassDEP and EPA, 2007).

It is impossible to deny that the laws and regulations that have been set forth have improved the quality of our water; however, more actions need to be taken in order to continue preserving our environment. With more urbanization, stormwater runoff has become a major contributor to the contamination of our waters (Civian, 2011). Municipalities need to take action in regulating and monitoring their stormwater runoff systems. As a result, the Environmental Protection Agency (EPA) has set forth major acts that can protect against illegal and improper stormwater and waste disposal. The first act proposed was the Clean Water Act.

The Clean Water Act (CWA) was passed by the congress in 1972. It was the first law directed towards improving the quality of our waters (Cullingworth, 1997). It is referred to as a "landmark law intended to restore and maintain the physical, chemical and biological integrity of the nation's waters" (Leavitt, 2007). Creating a new system of water pollution control, the EPA set new standards for water quality and water discharge, mainly prohibiting discharge of water that is at toxic and hazardous levels (EPA[2], 2011). The Act changed the guidelines by which municipalities discharge their pollutants into streams and lakes. Municipalities are now required to create built plans and submit annual forms that abide with the federal water quality standards (EPA[3], 2011). Additionally, the Clean Water Act was a major step forward to creating and implementing more state and national pollution control programs, which includes wastewater standards for factories and industries (Cullingworth, 1997). Furthermore, all of the pollutants that are considered damaging to the environment are listed in order for municipalities to specifically survey for these pollutants and make sure that they are eliminated from the water.

The Clean Water Act aimed to "making all U.S. waterways fishable and swimmable by 1983" (Leavitt, 2007). Although the act did improve the quality of water, it was not able to meet its goal. Studies show that "approximately 39% of our rivers, 46% of our lakes and 51% of our estuaries are impaired for one or more uses and thus still too polluted for safe fishing or swimming" (Leavitt, 2007). As a result, the CWA was not sufficient to cover all forms of pollution and contaminants and more federal regulations needed to be set in place (EPA[3], 2011). Permit programs such as NPDES and the MS4s aided municipalities to apply further specific stormwater management and assessment plans (Civian, 2011).

The National Pollutant Discharge Elimination System (NPDES) permit has been added as a requirement of the Clean Water Act. The NPDES controls specific discharge from point sources to surface waters (EPA[2], 2011). The permit consists of standards that municipalities must follow in order to fulfill their reporting requirements for the permit. The standards set by the NPDES permit limit the amount of pollutants discharged and requires municipalities to monitor their levels of toxicity. The NPDES permit is used mainly for point sources that can be monitored, such as specific pipe discharges, sewage treatment plants and individual pipes that enter surface water. The permit does not cover non-point source pollution because it comes from multiple sources that cannot be specifically tracked down to one facility or organization (Leavitt, 2007).

An NPDES stormwater permit begins with the municipality submitting a Notice of Intent (NOI) in order to request coverage. The next step is to design a program that will allow the municipality to cover all the necessary requirements by the NPDES permit. This plan is typed up in report form and submitted to EPA for review. Additionally, it is important that records are kept safe in order for the EPA to be able to receive the information at any time. Furthermore, part of the NPDES program is public outreach and education about stormwater management. All of the information required would be written in an NPDES permit including a section of definitions, a section on jurisdictions and includes valuable information about endangered species and historic properties (EPA[4], 2011). Each permit allows for a five-year term and is based upon the planning of each municipality (EPA[4], 2011).

Each municipality is required by NPDES permits to contain a Municipal Separate Storm Sewer System or an MS4. An MS4 is a system of drains, pipes, treatment units, gutters and catch basins that are used to collect, treat and discharge stormwater to surface water such as lakes,

rivers and oceans (EPA[3], 2011). It is important that each municipality is knowledgeable about the pollutants that enter their storm drain systems. Since, municipal storm drains are one of the major sources of pollutants to our waters, it is important for municipalities to carefully follow the MS4 permit in order to manage and control stormwater discharges. Sources of pollution into an MS4 are many, including construction sites, impervious surfaces and other commercial facilities (MassDEP, 2011). Each municipality is required for any illegal pipes that pass through their MS4, which could lead to increased levels of pollution and contamination (Civian, 2011). About 250 Massachusetts towns discharge their stormwater into our rivers, streams and oceans. In order to protect our environment, the EPA has incorporated annual monitoring and management systems required by an MS4 permit in order to report the progress of their facility (MassDEP, 2011).

These annual reports are due each May 1st and are required every year until the termination of the permit term. The NPDES Phase II regulations require that the operator of a small MS4 develop, implement, and enforce a stormwater management plan (SWMP). The objectives of the SWMP are to reduce the discharge of pollutants from the MS4 to the maximum extent practicable (MEP), to protect water quality, and to satisfy the appropriate water quality requirements of the CWA (EPA[2], 2011). These objectives are accomplished through the implementation of Best Management Practices (BMPs) for each of the required six minimum control measures according to the Environmental Protection Agency (EPA). Each of the measures and its purpose is represented below in Table 1.

The EPA is currently undergoing revisions of the 2003 MS4 permit and have developed a 2010 MS4 permit draft with some new requirements. Appendix I portrays the major differences

between the 2003 permit and the 2010 permit draft. Part of our goal was to communicate the new permit requirements to the town officials.

Table 1: Summary of the Six Minimum Control Measures required under the MS4 permit

Minimum Control Measure	Purpose
1) Public Education and Outreach	Municipalities are required to implement public education programs and distribute educational materials. Public education and outreach is a major contributor to preventing pollutants from non-point sources. If communities are educated about the pollution from stormwater runoff then they could work to prevent it by reducing their contamination into lakes, rivers and streams.
2) Public Involvement and Participation	Under the BMPs, towns are recommended to form a Stormwater Advisory Committee (SWAC) in order to allow for public input and involvement.
3) Illicit Discharge Detection and Elimination	An Illicit Discharge Detection and Elimination (IDDE) program is necessary to eliminate any illicit charges that contain bacteria and other contaminants that come from other illegal hookups in the storm sewer system. As a result, municipalities are required to have a storm sewer map that identifies the location of all the storm drain outfalls.
4) Construction Site Stormwater Runoff Control	Municipalities are required to include the development and implementation of a regulatory mechanism to require erosion and sediment controls as well as waste control and procedures for site plan review.
5) Post-Construction Stormwater Management in New Development and Redevelopment	Municipalities are required to have site inspection and maintenance practices and include a combination of structural and non-structural BMPs.

6) Pollution Prevention/Good Housekeeping for Municipal Operations	Pollution prevention approaches and good housekeeping operations are necessary and must address runoff, salt storage areas, salt pile cleaning, catch basin cleaning and road construction; all of which would help in preventing stormwater contamination into streams, lakes and rivers.

2.7 The Problems faced by Municipalities

Although many laws and regulations have been set in place, many municipalities in Massachusetts have not yet been educated about stormwater management and prevention strategies. Those that have been educated are still facing problems in legally enforcing mechanisms and participation into abiding by the MS4 permit guidelines mentioned above (MassDEP, 2011). Through personal communication from Fred Civion of the DEP, the following emerging issues are faced when municipalities try to complete their annual MS4 permits:

- Controversy in wet weather sampling: some municipalities are not aware of how to monitor their storm water runoff. If measurements are taken when it is raining and the catch basin is full with rain water then the sample will be too diluted and the results would not be accurate.
- Another problem is illegal hookups into the storm sewer system from private properties that add more pollutants from houses such as surfactants that are used in cleaning and other pollutants such as excess nutrients and fertilizers.
- Additionally, many municipalities overload their TMDL requirements and therefore allow the pollutants to reach toxicity levels causing many health and environmental concerns.
- Furthermore, as the cost of compliance increases, municipalities are not able to maintain and constructing new storm sewer discharge pipes. Instead some municipalities do not clean out their catch basin and therefore as the storm water sewer system ages it will not function properly. Thereby releasing many pollutants into the rivers without treatment.

It is important that municipalities follow the permit rules in order to be able to file their annual forms. Although many municipalities have been fined for not completing their annual forms, those that filed their annual forms need a database that will track their requirements and allow the EPA to easily interpret the data for the NPDES program. This is because some of the forms submitted to the EPA by the municipalities are being misplaced and not easily tracked. In order to have efficient stormwater management, the data must be tracked in order to know whether or not the permits and regulations are improving the level of pollution in surface waters. By creating a database, available data on water quality in the United States will portray the types of pollution entering our water systems and its gross estimate (Leavitt, 2007).

Moreover, many towns need help in developing their Geographic Information System or GIS. A GIS is a technological tool that allows us to interpret, comprehend and analyze multiple data regarding water pollution. In general the GIS is a very useful tool in organizing geographic data and reading maps relating to projects and tasks. For example, municipalities would use a GIS system to map where pollution is most prevalent and to be able to identify the major factors that are affecting their stormwater systems (Civian, 2011). Many municipalities in the Massachusetts Watersheds do not have enough information on the use and manipulation of GIS systems. If municipalities implemented this system it would be a great benefit for their stormwater management practices and would help them face many of the challenges in infrastructure improvements.

2.8 Summary

This background section identifies stormwater runoff and the major problems arising from it. This emphasizes major concepts and ideas dealing with our project. We give a

background on stormwater pollution and the rules and regulations required to protect it. Additionally, we describe the problems that municipalities are facing in completing their annual requirements, which includes compliance issues and a lack of resources for the sampling information.

Through interviews with three municipal officials, we gained perspective of the tracking information that would best suit the needs of the towns. From the information we gathered, we created a live, working database that allows for easy data collection so that no information is lost when municipalities compile the records to fill out their annual permits. This allows municipalities to easily monitor their stormwater runoff pollution and creates a systematic way to identify the trends that cause stormwater runoff, as well as helping with the development of necessary solutions to any problems that may arise. Additionally, we communicated the new permit draft requirements and created an online form with a list of activities municipalities could perform in order to improve their stormwater management and water quality standards.

Chapter 3: Methodology

The goal of this project was to investigate and analyze the problems in municipal stormwater management systems around Massachusetts. We focused on the fact that many municipalities violate the Clean Water Act, NPDES and MS4 permits. We investigated why municipalities are having difficulty filling out their forms and what is being done to remedy the problem. Analysis of the data obtained led to the creation of a centralized easy-to-use database and online report form, both of which allow facilitated data collection and submission.

A number of methods were used to determine the alarmingly high ranking of Massachusetts municipalities regarding their NPDES and MS4 permit exceedances. First we examined and analyzed the 2010 MS4 permit draft. We looked closely at the information required under each minimum control measure. Next, we looked at past annual permit form submissions. The team analyzed each report and identified missing information that municipalities are required to track. Interviews were then conducted with municipal town officials, superintendents of the Department of Public Works, GIS managers and employees from third party engineering firms. These interviews were conducted primarily for the purpose to identify the interviewee's awareness of the permit requirements and the problems they are facing in tracking their stormwater permit information.

3.1 Stormwater Raw Data Collection

Our group obtained the current stormwater practices of each municipality we worked with. A great amount of information was provided by government organizations, such as the Environmental Protection Agency (EPA) and Massachusetts Department of Environmental Protection (MassDEP). Learning about their strategies gave our group insight into how the town

handles stormwater, and the effectiveness of their strategies. This information not only allowed us to identify the problems more easily, but also gave us perspective on what ideas work best for certain situations. We particularly gathered past MS4 submissions and information regarding budgeting for stormwater programs as discussed below.

3.1.1 Forms

The MS4 permit forms are the most important piece of municipality stormwater management. They are required annually, and contain information on stormwater runoff and pollution for each area. The overall goal of our group's project was to create an easy yet effective way for these Massachusetts municipalities to record information for these forms, and submit them. By analyzing past MS4 permits submitted by the towns of Shrewsbury, Douglas, Rutland and Dudley, we were able to identify missing information that municipalities were unable to track. Additionally, many towns struggled with their form submissions, such as the Town of Douglas, which did not submit an annual report and was consequently fined by the EPA. Additionally, we were able to determine the types of projects used to satisfy each of the minimum control measures presented in the permit. The data we gathered from the forms alone helped illustrate the ever-increasing problems that municipalities face in submitting their forms and the severity of the situation.

3.1.2 Budgeting

The budgeting of stormwater and pollution management are equally important items that our group considered while studying the raw data from the government documents. While a municipality's budget may be a few million dollars, a small portion given to stormwater management can be difficult to manage. Mr. Civian gave our group the example of his town,

Dedham, Massachusetts. The budget is a few hundred million dollars, but half of that is immediately diverted to the Board of Education. The other half must be used to fund everything else in the town, including pollution mitigation. Even giving 1% of the budget to stormwater and pollution management means thousands of dollars that cannot be used to pay for roads or police officers. Our team discovered that many towns were facing financing challenges that were affecting the quality of the stormwater management and water protection programs that they have. As we started interviewing towns, we gained a better perspective on the funding challenges they are facing and how that affected their completion and submission of the MS4 annual permit.

3.2 Interviews with Municipality Officials

After thorough research and raw data collection about the MS4 permit, our team proceeded to interview municipal officials because they are the ones primarily going through the process of collecting, monitoring and submitting stormwater data through the MS4 permit. It was necessary to collect feedback about their concerns, along with any issues they needed to resolve.

Each MS4 permit form is submitted annually, and many of the current systems in each area involve different departments gathering data and accumulating it until the report is due. However, as explained by Mr. Civian, when that time comes, the information may have gotten misplaced, or it is not in an acceptable format for submission.

In order to determine the best approach to create the database for data tracking and monitoring, we conducted a series of interviews with certain town and city officials. In order to conduct these interviews, we filled out the forms provided to us from the Institutional Review Board (IRB). The three municipalities that our group worked with, Douglas, Ayer, and Rutland, were decided by our sponsor, and were based upon their willingness to improve their current

stormwater practices. The selection of these individuals was based on their position in the local government, as well as their position's responsibilities regarding the MS4 forms and stormwater management in general.

Our group first interviewed the highest official that deals with stormwater management, followed by other individuals in the municipality that handle stormwater and pollution management, and the MS4 permit forms. These individuals included heads of the Department of Public Works, municipal GIS managers, and employees for third party engineering firms. We gathered information regarding the current stormwater practices in place, pollution management in the town budget, how often local storm drains are checked, how the municipality officials submit the annual MS4 form, and what challenges they face. The first interview was conducted with William Cundiff, the town engineer for the Town of Douglas and his GIS contact person, Steve Zisk. In this interview, we designed questions to obtain information on how the GIS system worked and if they have faced any enforcement actions that dealt with permit requirements.

The second interview took place in Rutland, MA with the Superintendent of Public Works, Gary Kellaher. Rutland is one of the towns that is able to meet the minimum MS4 permit requirements. As a result, our questions were more geared towards identifying some of the methods used in tracking their information and any difficulties they faced during the process.

The third interview was conducted with the DPW superintendent of Ayer, Daniel Nason. We asked the same type of questions to Mr. Nason as we did to Mr. Cundiff and Mr. Kellaher. These series of interviews reinforced the idea that municipal facilities need help tracking and planning information for each minimum control measure required under the permit Appendix II

portrays the interview consent form each town signed and Appendix III represents a list of general questions asked to each official. Two of the towns (Rutland and Ayer) provided us with contact information to third party engineering firms that collect and submit the data for the towns.

Phone interviews with third party engineering firms, such as Weston and Sampson (associated with the Town of Rutland) and AMEC (associated with Ayer) gave insight into how the submitted forms are maintained. Additionally, the purpose of speaking with Hillary Lacirignola from Weston and Sampson and Rich Niles from AMEC was to find out firsthand how third party firms deal with the MS4 reports on an annual basis and their concerns regarding compliance with the town officials.

As we completed the interviews, our group identified trends in the results. These trends allowed us to alleviate the municipalities' problems on a larger scale, instead of much smaller, area specific ones. We used the information to find the best way to develop a database for data storage and form submission that can be accessed and used without difficulty. Next, we presented our database and form templates to the municipal officials and the third part engineering firms we interviewed to test our prototype. After each official looked through our template, and made suggestions of what we should add, we continued to improve our template and communicate with the municipalities on their opinions.

3.2.1 Sampling Data and Storm Drain Cleaning

The municipal separate storm sewer system (MS4) is a system that consists of storm drains and pipes that help move the large amounts of rain and stormwater out of the area and back into larger water bodies. Because of the large quantities of water present during a storm,

and the need to remove it before there is any damage to the surrounding urban areas, the MS4 system does not have any water treatment section. This causes anything that flows into a storm drain to remain untreated, which can then pollute the body of water. In order to reduce the amount of pollution, the MS4 drains are set up in a way that requires a certain level to be reached before any water flows into the pipes. This allows sediment and pollutants to gather at the bottom, removing them from the water.

Outlined by 2010 MS4 permit draft (MassDEP), local municipalities are required to clean the sediment out of the drains. It must either be done twice per year, or the town may develop its own plan to clean them, but the plan must be followed through, and submitted with the annual form. This not only removes harmful substances from the storm drains, but can be used to test whether or not illegal substances are being dumped into the drains. Additionally, dry and wet weather sampling for each catch basin must be performed at least twice annually as required under the permit. Our group found out the frequency of the storm drain cleaning for the municipalities we are working with, and asked whether these drains are free from illegal pollutants. We also gathered information regarding the frequency of catch basin sampling, Based on the information provided, we developed an easy way to submit the results of sediment and sampling tests to the Massachusetts Department of Environmental Protection, so any issues may be dealt with before a serious problem arises.

3.3 Organization of the Database

After gathering the data from our interviews, our group created a spreadsheet that can manage all of the paper forms required by the MS4 annual permits. First, we created data

collection sheets for each of the forms that require field measurements and observations on a regular basis. Examples of data collection sheets that were included were the following:

- Illicit Discharge Inspection spreadsheet: this will allow municipalities to carefully track the pollutants discharged directly or indirectly in our surface water. It contains date of inspection, weather conditions, time of discharge, description of discharge and the primary inspector.
- Construction and Post-Construction Evaluations: this form allows them to submit data regarding the inspection frequency of catch basins, the water quality and the drainage class.
- Field inspection form: this form described the overall condition, water level, and what to sample for dry and wet weather conditions in the storm drains.

The forms mentioned above will allow for easy data collection and management and will all be incorporated into the spreadsheet in order for municipalities to easily gather the information. The database will be shared by the municipality; therefore, it would be easily accessible and no information will be lost if the date is recorded on a frequent basis.

3.3.1 Choice of Database Software

In order to gain professional insight on what software should be used for the database, Professor Kasouf directed us to two individuals within WPI who were able to help us decide. The first was Debra Dexter who is a Software Solutions Specialist. Our team has decided between three different types of software: Google Documents, ZOHO Creator, or Microsoft Access; however, we were not sure of the resources available by each type of software. We asked Debra to give us an overview on the different features of Microsoft Access, including how to make tables and connect the forms.

After meeting with Debra about Microsoft Access, we wanted an additional expert's opinion on the resources that live online databases provide and how the programs would function

with multiple users. As a result, we made an appointment to meet with Professor Diane Strong of WPI's MIS Program. We showed her our prototypes of the database in Google Documents and ZOHO Creator and she helped point out some advantages and disadvantages of each type of software. After interviewing with Ms. Dexter and Prof. Strong, we had a clear idea of which software we wanted to use in order to develop an easy-to-use live online database that best suit the needs of the municipalities.

Our sponsor's goal was to create a user friendly database for stormwater data submission for local municipal officials. As outlined in this chapter, our group conducted a series of interviews and reviewed past municipal reports in order to compile the necessary information. When the database and reporting forms were completed, we collected information on factors we can improve according to how the municipalities responded.

Chapter 4: Results

As we performed the interviews and collected data, we identified common trends, all of which can be considered factors affecting the stormwater management and pollution prevention system. As we performed our research, we thought of how we could best assist the communities with compliance activities, helping the towns and at the same time protecting water quality. The purpose of the following results section was to learn exactly what each of the towns would like in terms of assistance with their stormwater management practices. In each interview, we looked for problems they were facing in complying with the stormwater MS4 permit. Our research has identified three major problems that municipalities are facing: budgeting issues, compliance and policy issues and a breakdown in communication and organization.

4.1 Budgeting Issues

Many towns are unable to implement stormwater management resources due to the costs involved. Throughout the many interviews and archival research conducted, one of the major underlying issues was money. Throughout the discussions we had with our sponsor, Fred Civian at the MassDEP, we learned that there was a poor organization of the budget, with only a small amount allocated towards stormwater management. Additionally, he mentioned that it was nearly impossible to request additional money at town meetings. As stated by Mr. Civian, "we are good as a society at making rules to better the community, but not good at marketing the rules to the community." Furthermore, he pointed out that the budget itself has decreased throughout the past decade, which makes it even harder for towns to comply with the old permit requirements, never mind the additional new requirements.

Our first interview with Bill Cundiff, the town engineer for the Town of Douglas came to the same conclusion. Mr. Cundiff described how there was not enough money being directed towards stormwater management practices. The lack of financial support has led many programs to fail, including the implementation of sampling resources for the IDDE requirements. Mr. Cundiff pointed out that every time he requested more money at town meetings for stormwater pollution prevention practices, his requests failed. With the decline of budgets and failure of money requests, the towns will not be able to restructure their catch basin and stormwater facilities. This leads to an accumulation of concentrated pollutants in the storm drains, resulting in an increase in stormwater contamination of surface waters.

Our second interview with Gary Kelleher of the DPW from Rutland gave us a different perspective on the funding issue. Mr. Kelleher discussed how he had difficulties with data gathering and processing. As more requirements were set, it even became harder to track the data they had. Therefore, their budget was geared towards consultants and third party engineering firms with experience in compiling their data and placing it into a form. Although Rutland still suffered from the incapability to sample their catch basins and outfalls, they were in better standing than the Town of Douglas because they had an engineering firm, Weston & Sampson, which completed the forms for them with the data they gathered. It is beneficial to have experienced personnel complete the forms because it protects the towns from receiving fines from EPA. However, it is more important that their resources are spent on the management practices for the reduction of stormwater runoff pollution. In the situation of Rutland, Mr. Kelleher was very eager about the idea of developing a database, which will help them organize their data and focus on more stormwater management programs. He provided us with contact information of Hillary Lacirignola from Weston & Sampson in order to gain information about

how they organize their forms. Additionally, he gave us contact information for Larry Pistrang from the Department of Conservation and Recreation (DCR) of the Wachusett Watershed, who had the same goal as ours of helping municipalities with their tracking requirements and communicating the permit requirements.

Similar to Rutland, Ayer also had a third party engineering firm, AMEC, which assisted with the reporting of the MS4 permit. During the interview with Daniel Nason, the town official of Ayer, he discussed that his town is still not able to get a budget for a GIS system. As a result, they were still not able to map their catch basins and outfalls or perform any sampling. Without sampling information, towns will not be able to track their stormwater runoff pollution and therefore will not be able to manage and reduce it. Mr. Nason was very interested in the possibility of having and online submission for the forms and a template that can be useful for both tracking and submitting stormwater data. He was also interested in testing out our final product and he gave us the contact information for Rich Niles who he worked with from AMEC to complete the forms.

It is difficult to determine the cause of municipal funding problems, but there is no doubt that this is one of the major issues contributing towards the poor stormwater management. However, we have gathered more factors that also contribute to poor stormwater management including compliance and policy issues.

4.2 Compliance and Policy Issues

Throughout the interviews, we saw that many towns lacked the knowledge necessary and had difficulty understanding the requirements of the permit. The GIS manager from the Town of Douglas, Steve Zisk, expressed his concerns by pointing out the necessity of a systematic and

standardized way of representing the requirements for each control measure. He mentioned that he had difficulty understanding what the permit requires in terms of sampling and he strongly suggested the creation of a unit dictionary. The resources in the dictionary should contain dropdown menus and preset options to specifically identify a unified set of measurements that all municipalities need in order to complete the required sampling portion of the permit. Although the towns of Douglas and Rutland had GIS and GPS systems, they only used them to map the locations of the catch basins without the sampling portion because of their lack of knowledge on what to sample. We took Mr. Zisk's concerns into account when creating the database. The snapshot of the database below presents a clear representation of the features the database consisted of. The complete database screenshots can be seen in Appendix IV.

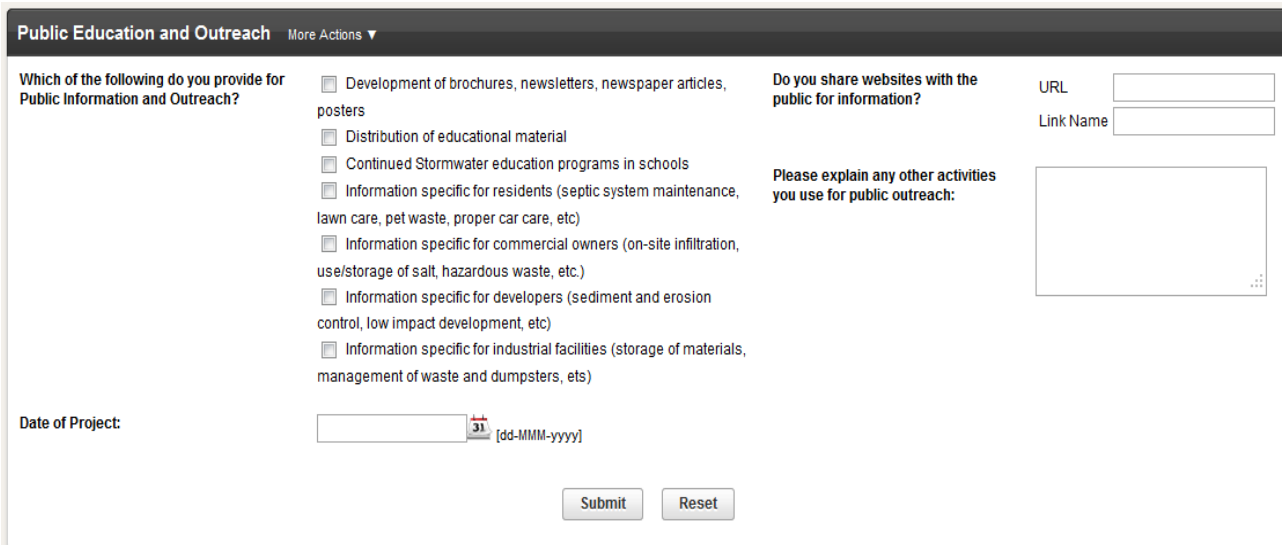


Figure 4: A snapshot of Minimum Control Measure 1 (Public Education and Outreach) portraying the different features of the ZOHO Database: checkboxes, date fields, URL fields, radio buttons and file upload options.

As we gathered more information from our interviews, we saw a striking trend that many town officials were unaware of the information required from them under the permit. This was a major concern that municipalities needed assistance with. As a result, our team decided to gain a

more in depth knowledge about the sampling and permit requirements from interviews with the third party engineering firms and Larry Pistrang from DCR, all of whom have experience with filling out the forms and attaining the required information.

We had a phone conference with Rich Niles from AMEC on Wednesday, February 16. Rich has been working on filling out these reports for over eight years. He explained to us how local towns hire him to help with the reports because he can simplify and break down the requirements and tell towns exactly what they need to do. He also writes out plans for towns to complete the reports and highlights areas of the report that need to be updated by the towns. According to Rich, the towns struggle to maintain and track reports. Towns struggle to keep an organized paper trail and they don't deal with filling out the reports until it is close to the time the reports are due. The larger towns and cities, such as Shrewsbury and Worcester, have an even more difficult time completing the reports than the relatively smaller towns we interviewed. Towns such as Ayer and Rutland don't need to work too hard to track down data since there aren't many different branches that need to be contacted for information to complete the reports. The larger the municipality, the more scattered the information required for the forms are going to be. For example the head engineer of a small town may need to contact only the DPW and a few other branches for information. However, a large town would need to contact multiple branches within the town, as well as state offices like the Department of Transportation (DOT).

Rich strongly believes making a standard electronic template would help the towns out as well as the EPA. With the standard electronic template, form submission would be more consistent, easier to review, and make form submission standardized. The EPA used to have a recommended format, but it was not effective in the long run because only a few towns followed

it. Rich believes towns should also provide an evaluation of how effective the requirements they completed were. For example, answering how a town's project affects the water quality over all. He believes the template should require explanations of how the project helped in order to demonstrate that it is worthwhile and effective. We took all of these measures into account while creating our database and online tracking form.

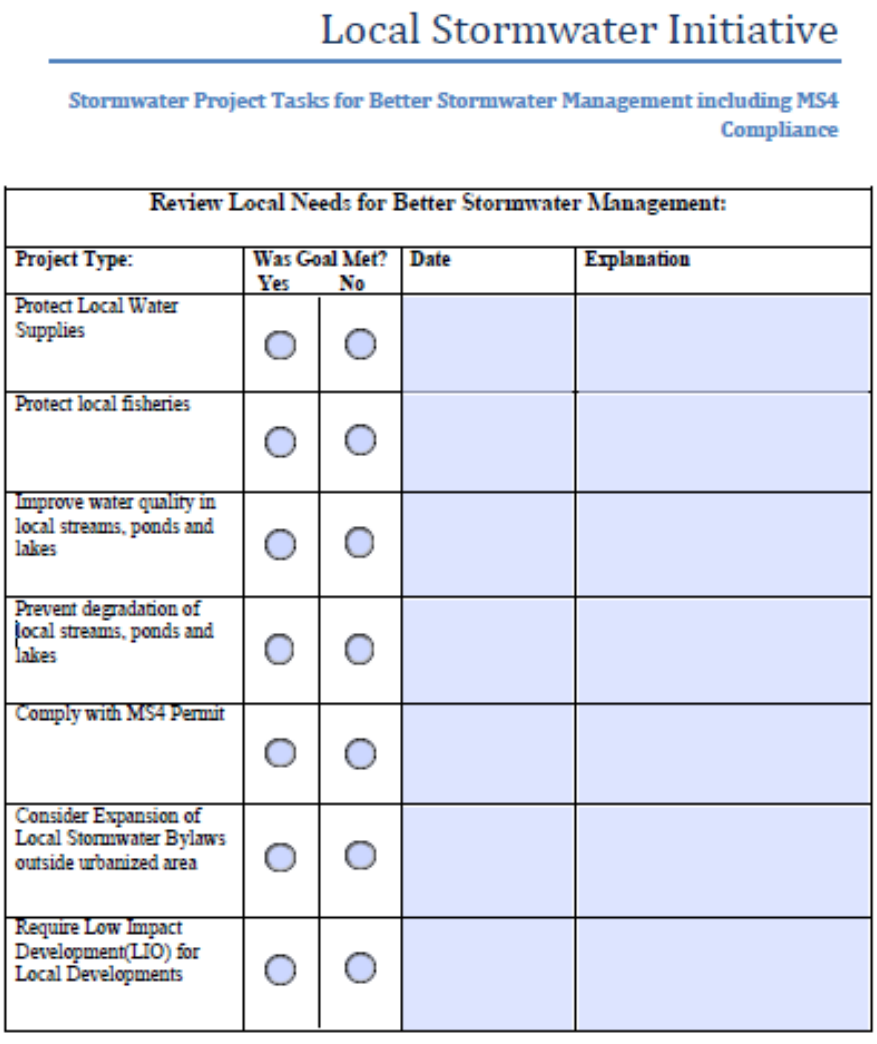
To gain more insight into this issue, we talked with an environmental analyst, Larry Pistrang from the Department of Conservation and Recreation, who have contacted Rutland regarding their MS4 permit. The goal of Mr. Pistrang is to preserve the Wachusett Watershed and to maintain the water quality standards to match those of the Clean Water Act. He mentioned the importance of reducing stormwater contaminants in order to preserve water quality. He has been communicating with the towns on the Wachusett Watershed, including Rutland in order to make sure they are knowledgeable about the new permit requirements and different ways by which they can complete their BMP requirements. Additionally, Mr. Pistrang explained to us how towns have been unaware of the resources provided by their respective watersheds. Towns are intimidated by the new permit and additional sampling requirements because they fail to utilize information and resources. The watershed organizations already have sampling data, and the local towns are capable of using this information in their annual reports. He was very enthusiastic about the creation of a centralized database where all the data required can be collected and analyzed. He provided us with resources regarding the new permit requirements, which we used in developing our database.

4.3 Communication and Organization Issues

Another major contributing factor towards poor stormwater management is the breakdown of communication between the departments and the lack of organization regarding stormwater management programs. Throughout the interviews we had with town officials, it was brought to our attention that many towns were unable to gather necessary data from other departments. When Mr. Nason was describing his experience with filling out the MS4 permit, he mentioned having difficulty reaching out to different departments within Ayer, such as the public outreach coordinator for their data. He was also unable to receive some required signatures and information until the day before the permit was due.

We saw the same problems in the towns of Douglas and Rutland as we did in the interview with Ayer. As a result, all of these towns expressed the need of an online report with a standardized format and electronic signatures with instructions on how to fulfill the minimum requirements of each control measure along with the centralized database. An online form will allow them to save the required information on their desktop and when it comes time to submit the report they can easily print it out and submit it, rather than creating their own form, which might contain unnecessary information. Therefore, our group created an online report form to assist the towns with their stormwater initiatives. We included in the form stormwater projects they can perform in order to improve upon their stormwater management as well as an MS4 compliance form with all of the requirements and fields where they can explain the project and evaluate their techniques. Additionally, we included a self-assessment field for them to evaluate their progress so far. This form can be seen in Appendix V below. We have reviewed this form with town officials and the MassDEP and they saw it as an excellent method for organization of

the data and the requirements needed for better stormwater management and water quality. A snapshot of the first page of the form can be seen below in Figure 5. The first page is titled stormwater initiative and discusses implementable projects to improve water quality standards, such as, protecting local fisheries, expansion of local stormwater bylaws outside of urbanized area, requiring low impact developments for local developments and complying with the MS4 permit. In order for them to comply with the MS4 permit, we went into explicit details in the next pages of the form describing the requirements of each control measure as seen in Appendix V.



Local Stormwater Initiative

Stormwater Project Tasks for Better Stormwater Management including MS4 Compliance

Review Local Needs for Better Stormwater Management:				
Project Type:	Was Goal Met? Yes	No	Date	Explanation
Protect Local Water Supplies	○	○		
Protect local fisheries	○	○		
Improve water quality in local streams, ponds and lakes	○	○		
Prevent degradation of local streams, ponds and lakes	○	○		
Comply with MS4 Permit	○	○		
Consider Expansion of Local Stormwater Bylaws outside urbanized area	○	○		
Require Low Impact Development(LIO) for Local Developments	○	○		

Figure 5: First page of the online live reporting form created to improve stormwater management by municipalities.

4.4 Selection of Database Software for data input

After collecting the information required to create a centralized database, we worked on selecting the most suitable software to meet the needs of the towns. All of the towns requested an easy to use database with dropdown menus, checkboxes and file upload options. They wanted clear and step by step instructions on the minimum requirements they needed to track and an efficient way to compile it. Through interviews with software professionals, we were able to decide on the most suitable software for the database.

First, we met with Debra Dexter who is a Software Solutions Specialist. We discussed with her the three different types of software options we were considering: Microsoft Access, ZOHO Creator and Google Documents. Next, we asked her to assist us in learning more about Microsoft Access and the resources it has available. Debra gave us an overview of what a database would look like on Access and she presented the function of each feature. She explained to us how to include checkboxes, pull down menus, and radio buttons in different situations and she mentioned some limitations in using Microsoft Access as our database. Access is not a program used to make a live database and it wouldn't be capable of supporting a database as complex as ours.

After meeting with Debra we wanted an expert's opinion on which database software would best suit our needs and how the programs would function with multiple users. As a result, we made an appointment to meet with Diane Strong of WPI's MIS Program. We presented our prototypes of the database in Google Documents and ZOHO Creator and she gave us feedback on each. Google Documents did not have the necessary resources required to create an easy-to-use database. For example, there were no features for checkboxes and radio buttons. We were

attracted to ZOHO Creator because it did not require programming language in terms of the creation of the database. Additionally, it had file upload options, which we found as a great way for municipalities to be able to make online records of additional data they had. Furthermore, it had an option for saving the data as a pdf or excel file. Prof. Strong thought ZOHO creator would best suit our needs. She also suggested SQL server, another software to design databases. However, since SQL server requires programming knowledge, which our group did not have, we were not able to use that software. Prof. Strong also had doubts about how ZOHO Creator would function with multiple users logging on and accessing the same file at the same time. However, we discussed with her that only the town officials would have access to their own database.

After the advantages and disadvantages we compiled on each database, we decided to choose ZOHO Creator because it had the resources required to create and maintain an online-live database. Appendix IV portrays screenshots of each spreadsheet that our team created in the database for each of the six minimum control measures required under the MS4 permit. As the progress of the project continued we gained more feedback from our sponsors and town officials on what to add to our database. In addition to the minimum control measures, we also created a sampling form for wet and dry weather sampling with all the requirements and units on what to sample in a catch basin. We have attached this form in the database as well as in the online form report in Appendix V.

4.5 Database interface

In order to use ZOHO, the municipalities will each be given a unique username and password from the DEP, separating their data from other towns. The DEP will be in charge of the master account and will be able to access all of the information submitted by the towns. After

the towns submit their data in the database for each control measure, they would be able to export their data in a number of ways, including excel spreadsheets, pdf forms, and graphs with data trends. These features, alongside ZOHO's simple interface will facilitate better and more organized results.

Chapter 5: Conclusion and Recommendations

Stormwater runoff is a serious issue that affects towns in Massachusetts and across the world. The goal of this project was to investigate and analyze the problems in municipal stormwater management systems around Massachusetts. Our group worked with a number of stormwater officials throughout the state, and investigated why municipalities are having difficulty filling out their forms and what is being done to remedy the problem. This chapter provides the conclusions our group came to after completing our research, as well as our recommendations to our sponsor as they move forward.

5.1 Municipal Stormwater Database

Using the methods described in our report, our group gathered information on each town and engineering firm we interviewed. It was apparent what was needed from the database we were developing, and after exploring many different types of software, our group determined

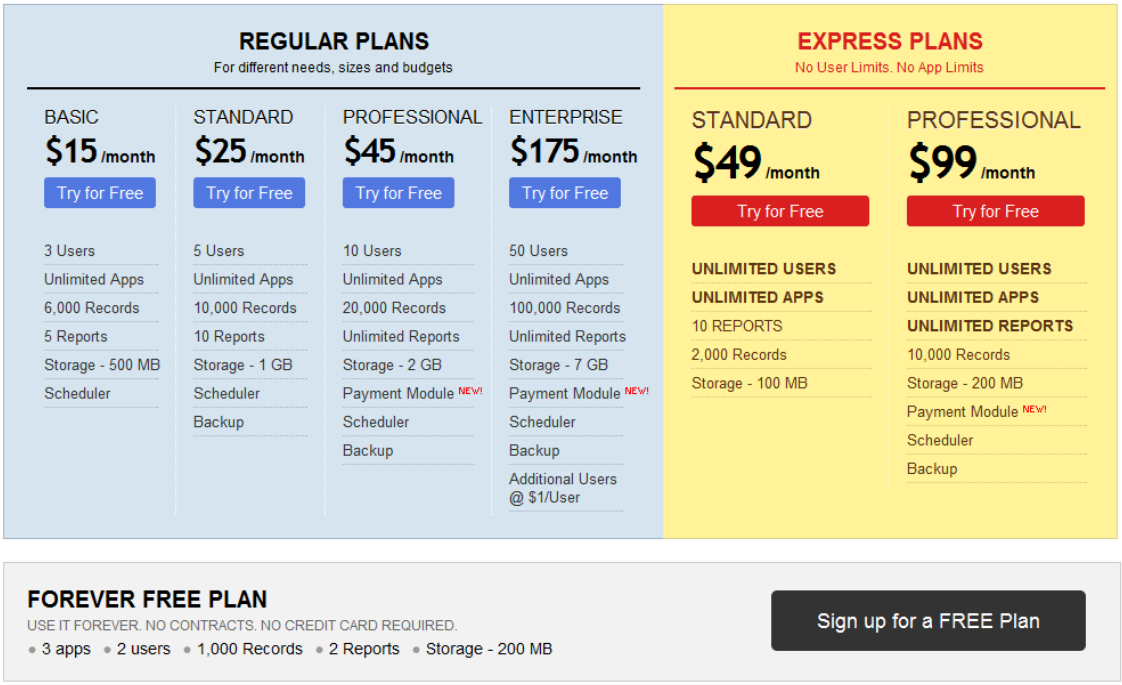


Figure 6: The seven different license options offered by ZOHO Creator. Retrieved from http://www.ZOHO.com/creator/pricing.html

ZOHO Creator was the best option. The database our group developed offers a live and easy to use method of data storage and organization. The software also offers multiple license options, seen in Figure 6, for the Massachusetts Department of Environmental Protection to use. Because the MassDEP is a non-profit organization, ZOHO will offer a 15% discount across all plans and subscriptions.

5.2 Recommendations

Our research and data proved that a live, online database was the approach needed in order to help Massachusetts municipalities with their stormwater management. The ZOHO database software is the best option for the MassDEP to help municipalities with their current stormwater management, and make the transition to the new MS4 permit requirements much easier.

In order for the database to be adopted successfully by all 361 Massachusetts municipalities, our group recommends the MassDEP have a small number of communities, around ten or twenty, pilot the software for a year. As the towns use the database for their stormwater programs, they will submit criticism to the MassDEP. Our group has taught Andrea Briggs to use the ZOHO software, so that she can make the necessary changes as it is piloted and critiqued by these communities.

In the event the ZOHO license cannot be funded through the Massachusetts Municipal Watershed Association, our group has also created and recommends the MassDEP uses our online forms, seen in Appendix V. These forms will help keep the organization of data and the MS4 forms relatively paperless, and offer an easy to understand version of the new permit

requirements. If our database and online forms are both implemented, municipalities' approaches toward monitoring their stormwater runoff will become a much smoother process, and will help make great strides towards controlling non-point source pollution in the state of Massachusetts.

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Appendix I

2003 MS4 Permit vs. 2010 Draft Permit

The following is a summary of the major changes between the 2003 General Permit for stormwater discharges from small MS4s and the 2010 Draft General Permit for stormwater discharges provided by the EPA. It is important to note that this draft is still under review by EPA.

2003 Final Permit	2010 Draft Permit
Area of Coverage	
Small MS4s in the: • Commonwealth of Massachusetts; • State of New Hampshire; • Indian Country lands within the States of Connecticut, Massachusetts, and Rhode Island; and • Federal Facilities within the State of Vermont.	Small MS4s owned by: • cities and towns, • a state, a county, or the United States, and • Indian Country lands within the State of Massachusetts located in the Interstate, Merrimack and South Coastal Watersheds as shown here: http://www.epa.gov/region1/npdes/stormwater/ma/MA_PermitType.pdf
Notice of Intent Requirements	
• Name and contact information of person responsible for SWMP coordination; • Name of the permittee and location; • Legal status of the operator of the MS4; • Names of all known waters that receive a discharge from the MS4. If known, indicate the number of outfalls discharging to each water; • Describe how the eligibility criteria for listed species/critical habitat and historic properties have been met; • Identify BMPs for each MCM ; • Identify measurable goals for each BMP including implementation time frames and contact person; and • NOI signed by an appropriate official and contain certification statement.	In addition to NOI requirements from MS4-2003, small MS4s covered must also submit: • Responsible party email; • Location of SWMP; • Status of outfall map; • Status of Bylaws/Ordinances; • Number of outfalls contributing to each receiving water; and • Summary and assessment of 2003 SWMP. Small MS4s not covered by the May 1, 2003 small MS4 general permit (MS4-2003) must use the form designated by the MassDEP. NOI due to EPA and MassDEP 90 days from the effective date of the final permit.
Stormwater Management Program (SWMP)	
Develop a program implementing the six MCMs. For each MCM, identify the BMPs for the MCM, identify responsible party, measurable goals, and timelines and milestones for implementation.	Permittees must develop written SWMP within 120 days of date of authorization. Permittees covered by the MS4-2003 shall modify or update their existing SWMP to meet the terms and conditions of this permit.

2003 Final Permit	2010 Draft Permit
	SWMP must be signed and dated by appropriate official as defined in Appendix B. Any significant revisions shall also be signed and dated by appropriate official defined in Appendix B. SWMP must contain: • Names and titles of people responsible for program implementation. • List of all receiving waters, their classification under the applicable state water quality standards, any impairments, and number of outfalls that discharge to each water. • Documentation of ESA compliance; • Documentation of NHPA compliance; • MS4 system map; • Description of practices to achieve compliance with Water Quality Based Effluent Limitations, discharges to impaired waters, and new and increased discharges. • Documentation of compliance with MCMs. Identify BMPs for each MCM, the person(s) or department responsible for the measure, measurable goal(s) for each BMP (include milestones and timeframes for its implementation and have a quantity or quality associated with its endpoint. Each goal shall have a measure of assessment associated with it) • Description of measures to avoid or minimize impacts to public drinking surface water and groundwater. • Documentation of outfall monitoring program • Documentation of compliance with additional state requirements • Annual program evaluation
Discharge to Impaired Waters *with* an Approved TMDL	
Determine whether the approved TMDL is for a pollutant likely to be	Comply with approved TMDL and permit provisions to ensure that

2003 Final Permit	2010 Draft Permit
found in storm water discharges from the MS4 and if TMDL includes a pollutant waste load allocation (WLA), BMP recommendations or other performance requirements for storm water discharges. Assess whether the WLA is being met through implementation of existing stormwater control measures or if additional control measures are necessary. Describe in SWMP and annual reports all measures to control pollutants of concern identified in approved TMDL(s). Include a schedule of implementation for all planned controls. Document the assessment which demonstrates that the WLA will be met including any calculations, maintenance log books, or other appropriate controls.	discharges from the small MS4 do not cause or contribute to an exceedance of water quality standards. Implement specific BMPs and other permit requirements to meet applicable WLA for MS4 discharges Permittees located in the interstate watersheds that are subject to an approved TMDL for phosphorus and those in the Long Island Sound that are subject to an approved TMDL for nitrogen, must identify the sources of nutrients and reduce the levels to be consistent with the approved TMDL. Permittees located in the Shawsheen River Basin that are subject to an approved TMDL for bacteria shall highlight in their annual report all control measures implemented during the reporting period or planned to be implemented in the upcoming reporting period to control the pollutants identified in the approved TMDLs. Permittees located in the south coastal watersheds that are subject to an approved TMDL for nitrogen must maintain or decrease the nitrogen level. Permittees located in the south coastal watersheds that are subject to approved TMDLs for pathogens shall include in the annual report and the SWMP the basis supporting the permittee's determination that such controls are adequate to meet the waste load reductions required by the TMDL. (Please refer to the draft permit for a listing of approved TMDLs.)
Discharge to Impaired Waters *without* an Approved TMDL	
Determine whether storm water discharges from any part of the MS4 contribute, either directly or indirectly, to a 303(d) listed water body. SWMP include description of how the program will control the discharge of the pollutants of concern and ensure that the discharges	Comply with requirements to meet state water quality standards (Part 2.1.1). Address in SWMP and annual reports how any MS4 discharges which contribute to pollutant loads and/or conditions identified as causing the

2003 Final Permit	2010 Draft Permit
will not cause an instream exceedance of the water quality standards. Identify control measures and BMPs that will control the discharge of the pollutant(s) of concern.	impairment will be controlled such that they do not cause or contribute to the impairment. This includes assessing the potential for discharges from the MS4 to the impaired waters to contribute the pollutant(s) of concern;. identifying BMPs in addition to or modified from those already existing in the SWMP to ensure that discharges do not cause or contribute to the impairment; and implementing identified additional BMPs and include the appropriateness of each BMP in each annual report.
SWMP - Minimum Control Measures	
Develop a program implementing the six MCMs. All elements of the SWMP must be implemented by permit expiration date of May 1, 2008. Can share implementation with another entity.	If covered under the MS4-2003, continue to implement existing SWMP developed under MS4-2003 while updating SWMP pursuant to the new permit. Compliance deadlines set forth in the MS4-2003 are not extended. MCM implementation can be shared with another entity or other entity may fully implement measure. A legally binding written agreement concerning this obligation is required. Cooperation between interconnected municipal separate storm sewer systems is strongly encouraged. MS4 system map required as part of the IDDE program must show interconnections.
Public Education and Outreach	
Develop education program to distribute educational material to the community. Provide information concerning the impact of storm water discharges on water bodies and steps/actions the public can take to reduce the pollutants in runoff.	At a minimum, provide information concerning the impact of stormwater discharges on water bodies within the community, especially those waters that are impaired or identified as priority waters. The program shall identify steps and/or activities that the public can take to reduce the pollutants in stormwater runoff and their impacts to the environment. Educational program must include education and outreach efforts to (1) residents, (2) businesses, institutions, and commercial facilities, (3) developers (construction), and (4) industrial facilities.

2003 Final Permit	2010 Draft Permit
	Distribute a minimum of two educational messages over the permit term to each of the four audiences, for a total of at least eight educational messages. Space distribution at least a year apart. Educational program must express specific messages, define the targeted audience for each message, and identify responsible parties for program implementation. Focus on pollutants of concern for impaired waters and priority waters (such as beaches, shell fishing areas, and drinking water supplies) within the MS4. For MS4s subject to approved TMDLs (as listed in Appendix G, Tables G-1, G-2, G-3 and G-4), additional requirements apply. Please refer to the permit
Public Participation and Involvement	
Comply with state public notice requirements. Provide opportunities for the public to participate in implementation and review of SWMP program.	Comply with state public notice requirements (Massachusetts General Laws Chapter 39 Section 23B). Make the SWMP and all annual reports available to the public. Annually provide the public an opportunity to participate in the review and implementation of the stormwater management program Report on the activities undertaken to provide public participation opportunities.
Illicit Discharge Detection and Elimination (IDDE) Program	
Develop, implement, and enforce a program to detect and eliminate illicit discharges. Develop a MS4 map showing location of all outfalls and receiving waters and names.	During the development of the new components of the IDDE program required by this permit, permittees authorized by the MS42003 shall continue to implement the IDDE program required by the MS4-2003. Prohibit Sanitary Sewer Overflows (SSOs) and all other illicit discharges to MS4 and require removal of such discharges.

2003 Final Permit	2010 Draft Permit
Effectively prohibit, through a bylaw/ordinance, non-storm water discharges into the MS4 and implement appropriate enforcement procedures and actions. Develop and implement a plan to detect and address non-storm water discharges including illegal dumping, into the MS4. Plan must include procedures to identify priority areas; locate illicit discharge; locate the source of the discharge; remove the source; and document actions and evaluate impacts of removal on MS4. Inform the public employees, businesses, and general public of hazards of illicit discharges and improper waste disposal. Address any allowable non-storm water discharges if they are determined to be significant contributes of pollutants to the MS4.	Upon detection of an illicit discharge, eliminate an illicit discharge as expeditiously as possible. Identify all responsible parties for such a discharge and require immediate cessation of improper disposal practices in accordance with its legal authorities. Where elimination of an illicit discharge within 30 days of its confirmation is not possible, establish an expeditious schedule for its elimination. No later than 6 months after its confirmation such discharge shall be eliminated or appropriate enforcement actions shall be initiated by the permittee against any party responsible for the discharge. At a minimum, the owner of the illicit connection shall be notified in writing about the illicit connection and expected remedy of the situation. In the interim, take all reasonable and prudent measures to minimize the discharge of pollutants to its MS4. Implement control measures to address any allowable non-storm water discharges if they are determined to be significant contributes of pollutants to the MS4. Upon detection, eliminate SSOs immediately and take all interim mitigation measures to minimize the discharge of pollutants into and from its MS4 until elimination is completed. Identify all known SSOs that have not yet been eliminated or for which the underlying cause has not yet been identified or corrected and develop an inventory these SSOs. Update inventory annually. Document in SWMP and annual reports. Provide written notice to EPA and MassDEP of new SSOs. Develop a paper or GIS map of the entire MS4 including catch basins, interconnections to other small MS4s, treatment structures associated with the separate storm sewer system, any other structures associated

2003 Final Permit	2010 Draft Permit
	with the system, and outfalls and receiving waters. The map shall provide a comprehensive depiction of key infrastructure and factors influencing proper system operation and the potential for illicit sanitary sewer discharges. Update map as necessary and report on progress in annual reports. Conduct an outfall inventory for each receiving water within the regulated jurisdiction that receives a discharge from the MS4, beginning with the priority catchments. Label each outfall in the field with a unique identifier and record dimensions, shape, material, spatial location (GPS), physical condition and sensory observations (such as odor, color, turbidity, floatables, or oil sheen). If flow is observed at the outfall during the inventory, a sample of the flow shall be collected and analyzed for conductivity, chlorine, temperature, surfactants (as MBAS), ammonia and *E.coli* or enterococcus. Develop written IDDE program that includes: • Documentation of adequate legal authority (ordinance/bylaw) to prohibit illicit discharges, • Protocol for IDDE program responsibilities; • Assessment of priority catchments and problem catchments; • Systematic procedure for locating and removing illicit connections; • Illicit discharge prevention procedures; • Indicators of IDDE program progress; and • Annual training program. Delineate the small MS4 into catchments and evaluate each catchment for potential illicit discharges. Include catchments on map. Identify Problem Catchments.

2003 Final Permit	2010 Draft Permit
	Using specific screening factors that are reflective of existing conditions of the MS4, rank each catchment not designated as a Problem Catchment as "high," "medium", or "low" for its potential to have illicit discharges. Document results in written IDDE program, in SWMP, and in annual report. Identify and provide information on Problem Catchments in annual report. Develop a written systematic procedure for locating and removing illicit connections that includes dry weather outfall screening, wet weather outfall monitoring, determining the potential source of any illicit connections or discharge, and documenting the elimination of the illicit connection or discharge. Complete systematic implementation of the illicit discharge detection procedure. Document in SWMP and annual reports. Develop and implement mechanisms and procedures designed to prevent illicit discharges and SSOs. Define or describe indicators for tracking program success. Evaluate and report the overall effectiveness of the program based on the tracking indicators in the annual report. Comply with required IDDE milestones. At a minimum, annually train employees about the IDDE program including how to recognize illicit discharges and SSOs. Document in the SWMP and in the annual report.
Construction Site Stormwater Runoff Control	
Develop, implement and enforce a program to reduce pollutant from construction projects disturbing one or more acres (or projects less than one acre if they are part of a larger common plan of development that will disturb one or more acres).	Continue to implement and enforce a program to reduce pollutants in any stormwater runoff discharged to the MS4 from construction activities that result in a land disturbance of greater than or equal to one acre (or disturbances less than one acre if that disturbance is part of a larger common plan of development or sale). Program must include: • An ordinance or regulatory mechanism that requires the use of sediment and erosion control practices at construction sites; • Written procedures for site inspections and enforcement of sediment and erosion control measures at construction sites. Clearly define who is responsible for site inspections as well as who has authority to implement enforcement procedures; • Requirements for construction site operators performing land disturbance activities within the MS4 jurisdiction that result in stormwater discharges to the MS4 to implement a sediment and erosion control program that includes BMPs appropriate for the conditions at the construction site; • Requirements for construction site operators within the MS4 jurisdiction to control wastes, including but not limited to, discarded building materials, concrete truck wash out, chemicals, litter, and sanitary wastes; and • Written procedures for site plan review, including a review of the site design, the planned operations at the construction site, planned BMPs during the construction phase, and the planned BMPs to be used to manage runoff created after development. Incorporate procedures for the consideration of potential water quality impacts; procedures for pre-construction review; and procedures for receipt and consideration of information submitted by the public. Also include evaluation of opportunities for use of low impact design and green infrastructure. Track the number of site reviews, inspections, and enforcement actions in the SWMP and include in each annual report.
2003 Final Permit	2010 Draft Permit
Program must include: • A bylaw/ordinance to require sediment and erosion control at construction sites; • Sanctions to ensure compliance with the program, including monetary and non-monetary penalties; • Requirements for construction site operators to implement a sediment and erosion control program; • Requirements for control of wastes, including but not limited to discarded building materials, concrete truck wash out, chemicals, litter, and sanitary wastes; • Procedures for site plan review which incorporate consideration of potential water quality impacts and include procedures for preconstruction review; • Procedures for receipt and consideration of information submitted by the public; and • Procedures for inspections and enforcement of control measures at construction sites.	
Stormwater Management in New Development and Redevelopment (Post Construction Stormwater Management)	
Develop, implement and enforce a program to address run off from	Continue to implement and enforce a program to address stormwater

2003 Final Permit	2010 Draft Permit
new development and redevelopment projects which disturb one or more acres (or projects less than one acre if they are part of a larger common plan of development that will disturb one or more acres). The program must include: • A bylaw/ordinance to address post construction runoff in new development and redevelopment; • Procedures to ensure long term operation and maintenance of best management practices; and • Procedures to ensure controls will prevent or minimize impacts to water quality.	runoff from new development and redevelopment projects that disturb one or more acres (or disturbances less than one acre if that disturbance is part of a larger common plan of development or sale) and discharge into the municipal stormwater system. The program must include: • An ordinance/bylaw that regulates runoff from new development and redevelopment projects; • Amend or modify, as appropriate, the ordinance or other regulatory mechanism to contain provisions related the Massachusetts Stormwater Management Standards; • Procedures to ensure that any stormwater controls or management practices for new development and redevelopment will prevent or minimize impacts to water quality; • Requirements for submission of as-built drawings within 90 days of completion of construction projects; • Procedures to ensure adequate long-term operation and maintenance of stormwater management practices that are put in place after the completion of a construction project. Develop a report assessing current street design and parking lot guidelines and other local requirements that affect the creation of impervious cover. If the assessment indicates that changes can be made, the assessment shall include recommendations and proposed schedules to incorporate policies and standards into relevant documents and procedures to minimize impervious cover attributable to parking areas and street designs. Report on assessment in SWMP and annual reports. Develop a report assessing existing local regulations to determine the feasibility of making green roofs, infiltration practices, and water harvesting practices allowable when appropriate site conditions exist. Estimate changes in the number of acres of impervious area (IA) and

2003 Final Permit	2010 Draft Permit
	directly connected impervious area (DCIA) tributary to the MS4 from the initial base line provided by EPA or determined by the permittee, tabulated by sub-basins or catchments. Report acres of DCIA that have been added or removed during the prior year in annual reports. Complete an inventory and priority ranking of MS4-owned property and infrastructure (including public right-of-way) that may have the potential to be retrofitted with BMPs designed to reduce the frequency, volume, and peak intensity of stormwater discharges to and from its MS4 Report on MS4 owned properties and infrastructure that have been retrofitted with BMPs designed to reduce the frequency, volume, and peak intensity of stormwater discharges, and also report on their pollutant loadings.
Good Housekeeping and Pollution Prevention	
Develop and implement program with goal of preventing and/or reducing pollutant runoff from municipal operations. Train employees about stormwater. Develop and implement maintenance activities and schedules for parks and open space; fleets; buildings; new construction and land disturbance; road way drainage and stormwater systems. Develop inspection procedures and schedules for long term structural controls.	Develop written operations and maintenance procedures for the municipal activities related to parks and open space, buildings and facilities, and vehicles and equipment. Develop an inventory of all permittee owned facilities. Review this inventory annually and update as necessary. Establish or continue an existing program to repair and rehabilitate its MS4 infrastructure in a timely manner to reduce or eliminate the discharge of pollutants from the MS4. Optimize routine cleaning and maintenance of catch basins. Establish procedures for sweeping and/or cleaning streets, and permittee-owned parking lots. Establish procedures for winter road maintenance including the use and

2003 Final Permit	2010 Draft Permit
	storage of salt and sand. Establish inspection and maintenance frequencies and procedures for the storm drain systems and for all structural stormwater BMPs such as swales; retention/detention basins or other structures. Report on good housekeeping and pollution prevention in the annual report and keep written records of all required activities. Develop and implement a SWPPP for each of the permittee-owned facilities, unless facility is covered by a currently effective Multi-Sector General Permit or other NPDES permit. For MS4s submitted to approved TMDLs (as listed in Appendix G, Tables G-1, G-2, G-3 and G-4), additional requirements apply.
Outfall Monitoring Program	
None required.	For permittees covered by the MS4-2003 permit, implement an outfall monitoring program no later than the beginning of the second year of the permit. Start monitoring of outfalls in highest priority areas. Conduct at least one dry weather screening and analytical monitoring and at least one wet weather analytical monitoring of each outfall within 5 years of the effective date of this permit (with some exceptions). Conduct field screening and analytical monitoring at locations where stormwater from the MS4 is transferred to another MS4 (interconnected monitoring). For permittees not covered by the MS4-2003, monitoring requirements shall commence by the beginning of year four of the permit, unless system map required as part of IDDE program is completed sooner.
Program Evaluation	

2003 Final Permit	2010 Draft Permit
Annual evaluation of SWMP compliance with permit conditions. Evaluate appropriateness of selected BMPs in efforts towards achieving the defined measureable goals.	Annual self-evaluation of permit compliance. Include annual self-evaluation in SWMP. Evaluate the appropriateness of the selected BMPs in achieving the objectives of each control measure and the defined measurable goals.
Record Keeping	
All records required by the permit must be kept for at least five years. Records include information used in the development of the SWMP, any monitoring, copies of reports, and all data used in the development of the NOI. All records related to the permit, including the SWMP, must be available to the public.	All records required by the permit must be kept for a period of at least five years. EPA may extend this period at any time. Records include, but are not limited to: information used in the development of any written program required by this permit, any monitoring results, copies of reports, records of screening, follow-up and elimination of illicit discharges; maintenance records; inspection records; and data used in the development of the notice of intent, SWMP, SWPPP, and annual reports. All records relating to the permit, including the SWMP, must be available to the public.
Reporting	
Submit an annual report due each year by May 1, covering the activities of the previous calendar year. Annual report contains: • self assessment; • BMP appropriateness assessment; • assessment of progress towards achieving measurable goals; • summary of information collected an analyzed including data; • activities for next reporting cycle; • discussion of SWMP and BMP changes; and • identification of reliance on other entities.	Submit an annual report each year by August 1, covering the activities of the previous July 1 through June 30. Annual report contains: • self-assessment; • BMP appropriateness assessment; • status of the any plans or activities required by Part 2.2.1 and/ or Part 2.2.2 (Discharges to Impaired Waters); • assessment of the progress towards achieving the measurable goals and objectives for each of the MCMs and any additional state reporting requirements; • outfall monitoring data that has been collected and analyzed, including data collected as part of the outfall inventory required

2003 Final Permit	2010 Draft Permit
Annual report format allows for optional metrics	in Part 2.4.4 and as part of the outfall monitoring program described in Part 3.0; • for discharges to impaired waters, identification of specific BMPs used to address the pollutant identified as the cause of impairment and the BMPs effectiveness at controlling the pollutant. • activities for next reporting cycle; • discussion of SWMP and BMP changes; and • identification of reliance on other entities.
Requirements for State and Federal Non-Traditional MS4s and Requirements for State Transportation Agencies	
Parts IV and V of MS4-2003	State non-traditional MS4s are properties owned and operated by the Commonwealth of Massachusetts. All requirements and conditions of Parts 1 – 5 above apply to these MS4s with exceptions or adjustments related to public education, ordinances and regulatory mechanisms, assessment of regulations, and federal development and redevelopment projects. State transportation agencies are not covered by this permit.

Appendix II

Interview Consent Form

With each interview we held with the town officials, they were required to sign the following consent:

I agree to participate in two interviews for a study about ways people make meaning of their own personal experience. I understand I will be asked about ordinary experiences (like feeling moved, or being angry or conflicted about some decision, etc.) and also about my experiences related to the Massachusetts Ocean Partnership Fund. I understand that I do not have to answer any questions I choose not to answer. I understand that any excerpts taken from this interview, written or spoken, will disguise all names of persons and places so as to preserve my anonymity and privacy. I understand that I will not receive feedback on my interview. I understand that at the end of this study, the audiotapes will be kept in the privacy of the researcher's archives for future reference if needed. I understand that although most people find these interviews engaging and interesting, should I feel like discontinuing the interview for any reasons we may do so at any time.

If you have questions about the study at any time, contact:
Verna DeLauer
603-862-1935
verna.delauer@unh.edu

Appendix III
Interview Questions

Our team conducted many interviews in order to better understand the concerns of the municipalities regarding stormwater runoff management. We also wanted to see the level of knowledge each municipality had with regards to each of the six minimum control measures. The following are general question we asked each municipality:

Demographic Information:

Name:

Affiliation:

Title/Profession:

Gender:

Questions related to stormwater management:

- What stormwater management practices are currently in place?
- Do you comply with the six minimum control measures?
- How often are the storm drains checked/cleaned?
- How well is pollution budgeted in your town/city?
- What percentage of your town's budget is dedicated to stormwater management?
- How do you submit your annual forms?
- Are there challenges you experience while monitoring and submitting the forms?
- What solutions are you looking into, to approach the challenges experienced?
- Is there anything you would like to add?

Questions regarding the minimum control measures:

1) Public Education and Involvement:

- Do you have any practices now, what they are, what does the public know about stormwater pollution efforts in general?

- What methods they are using to distribute about pollution?
- How are they assessing the effectiveness of their messages, what opportunities they are giving the public to participate in stormwater management?

2) Illicit Discharge Detection and Elimination (IDDE):

- Have you designed a map for the catch basin outfalls?
- Have you previously eliminated any illicit discharge connections? How and how do you track them?
- Are there any sewer system overflows that you have found connected to your outfalls?

3) Construction Site / Post Construction Control:

- What written procedures are in place for regulating sediment and erosion control and for inspection at construction sites?
- What are some of your Housekeeping methods?:
    - How often do you do you clean/check catch basins?
- What are some of your stormwater pollution prevention practices?
- How do you conduct the wet weather sampling/dry weather sampling?
- What procedures are in place to minimize or eliminate pollutants?

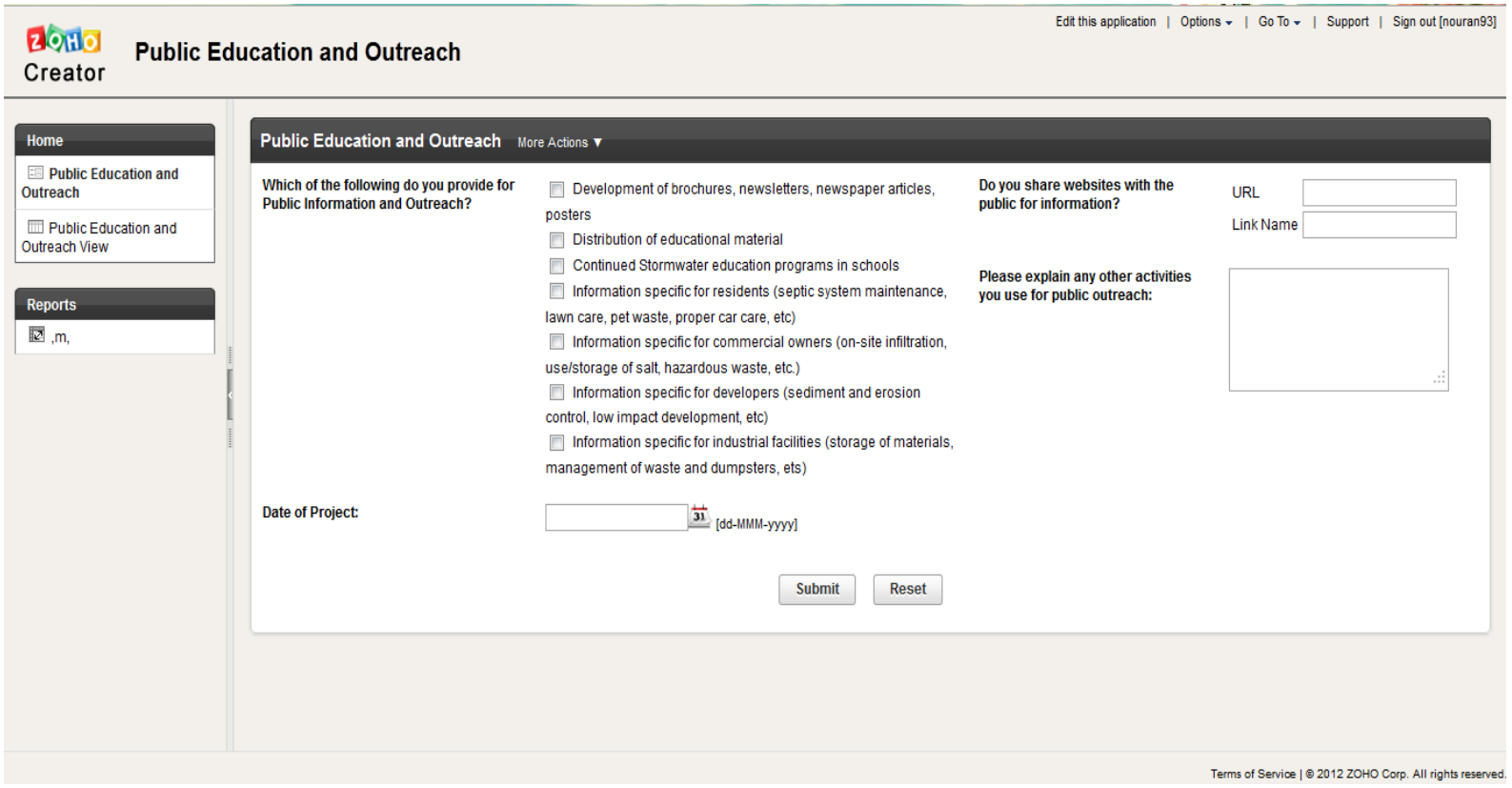
Database specific questions:

- How time consuming is it to get the information acquired from other branches that collect data?
- What information should we put in the database that will help keep track of the data?
- What is more difficult: Filling out the forms or tracking the information?
- Do you have any complaints about the form: how it is worded or how it is formatted?

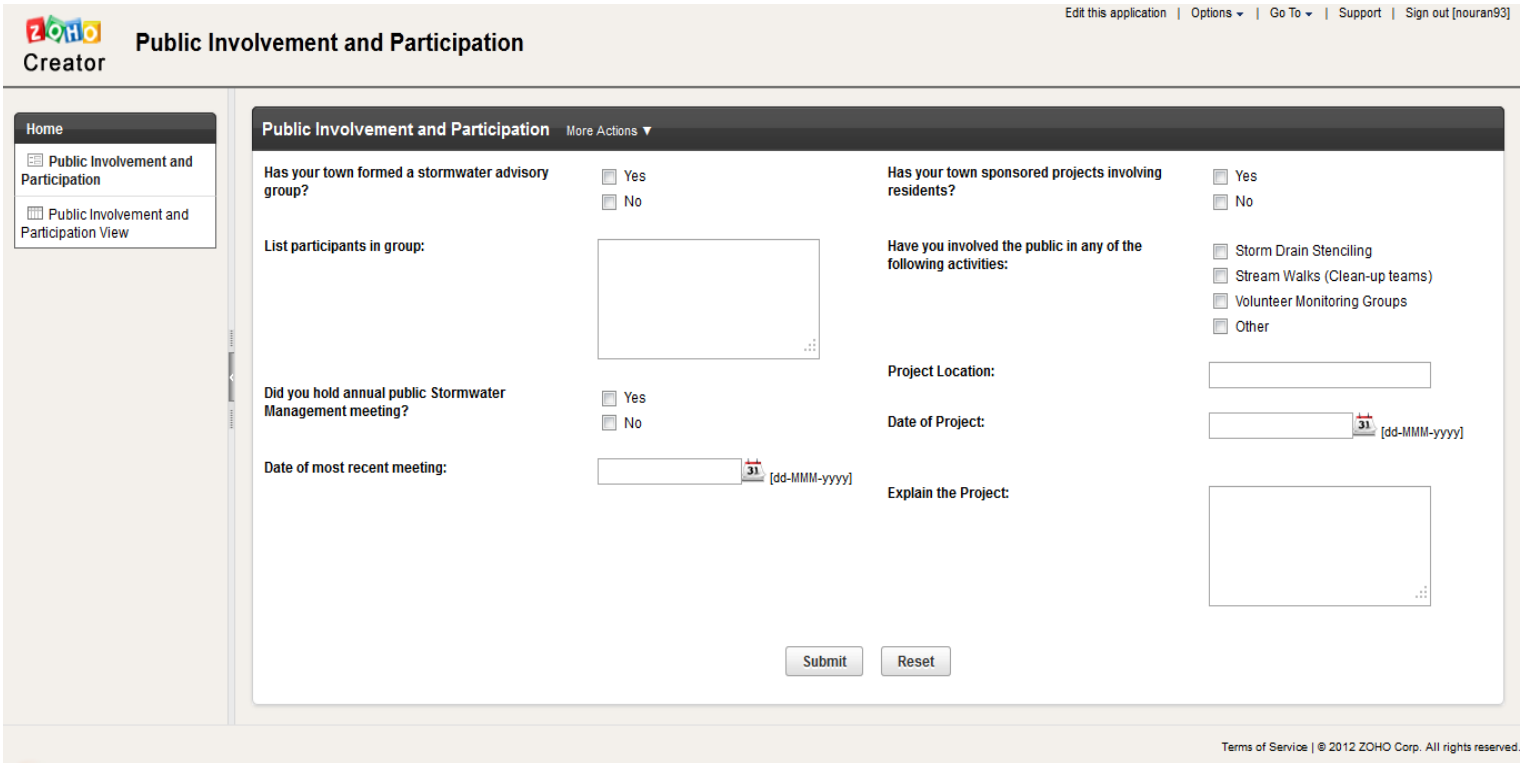
Appendix IV
ZOHO Creator Database Screenshots

The following are screenshots of the database we created. Our team made different spreadsheets for each of the six minimum control measures and the sampling form in order to keep the data organized. As our project progressed, different additions were made in order to best meet the needs of the towns.

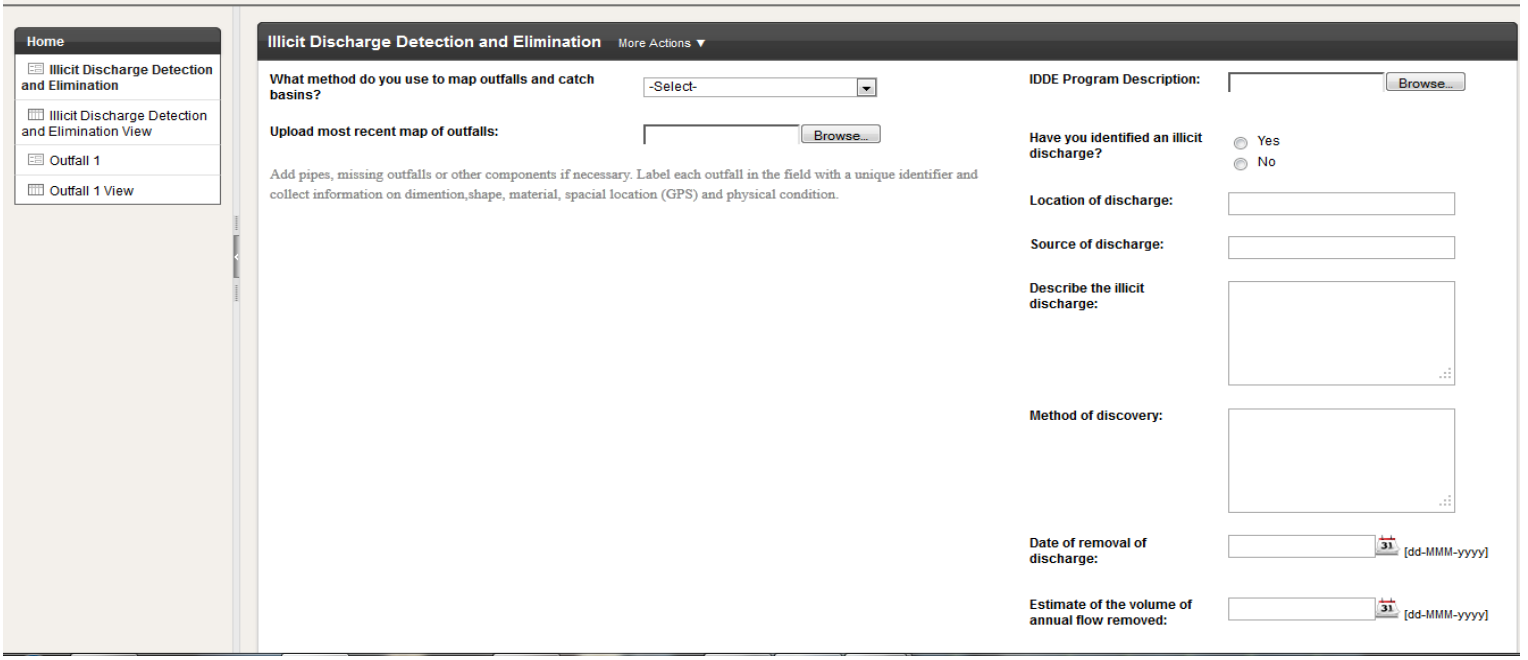
1) Public Education and Outreach



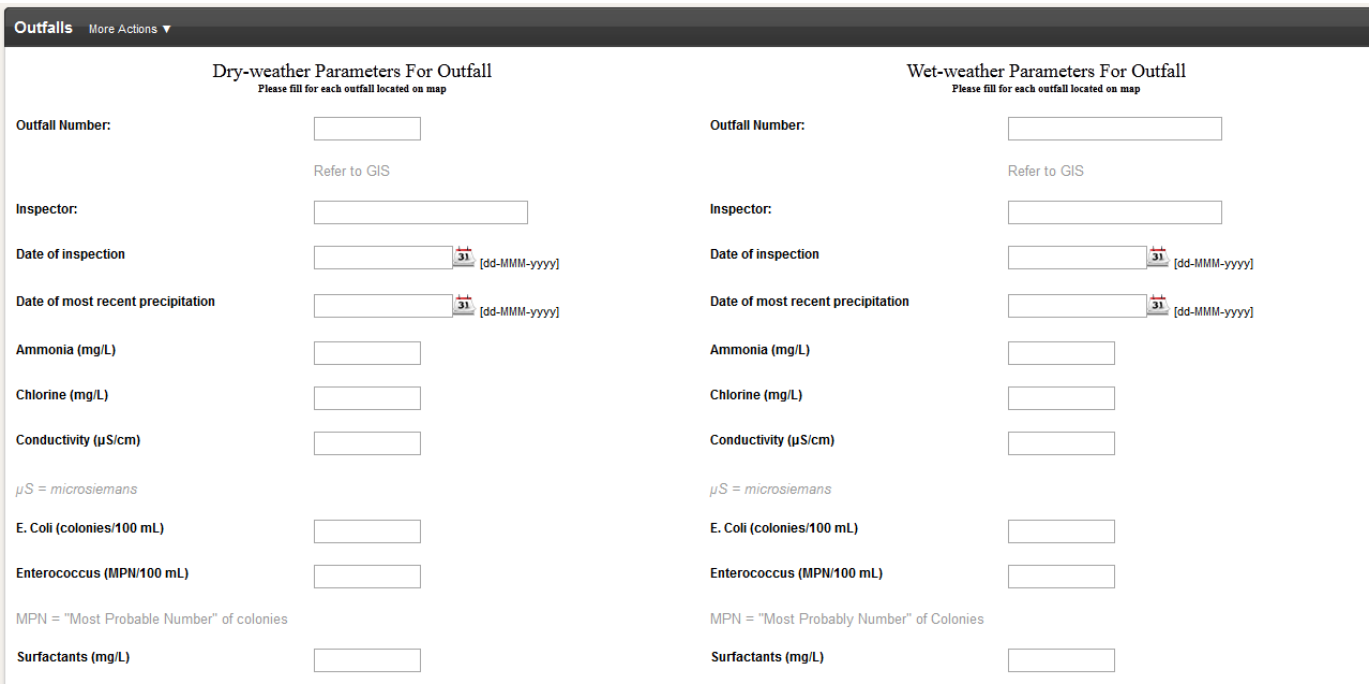
2) Public Involvement and Participation



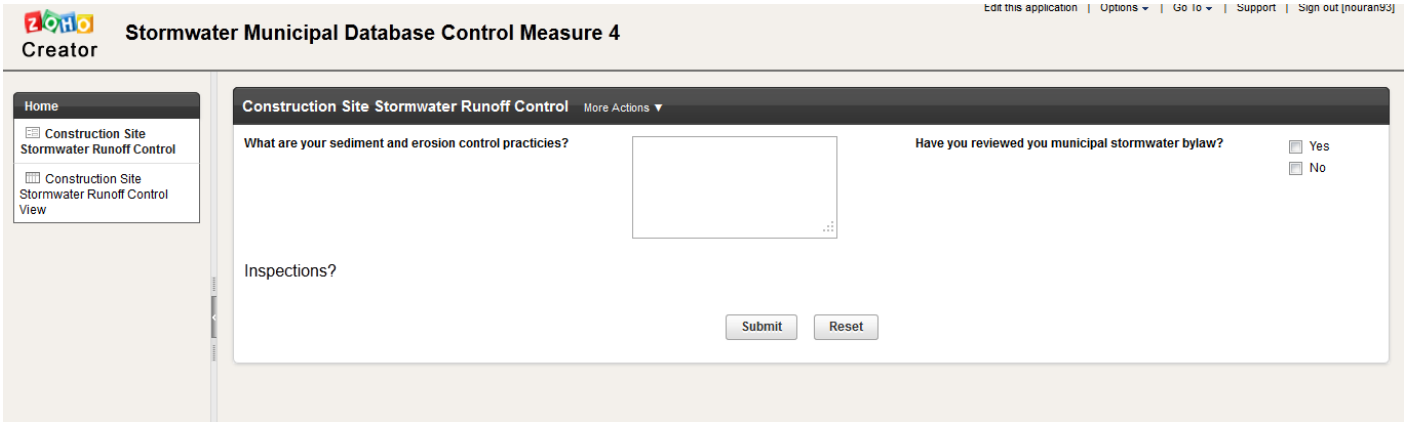
3) Illicit Discharge Detection and Elimination (IDDE) Program



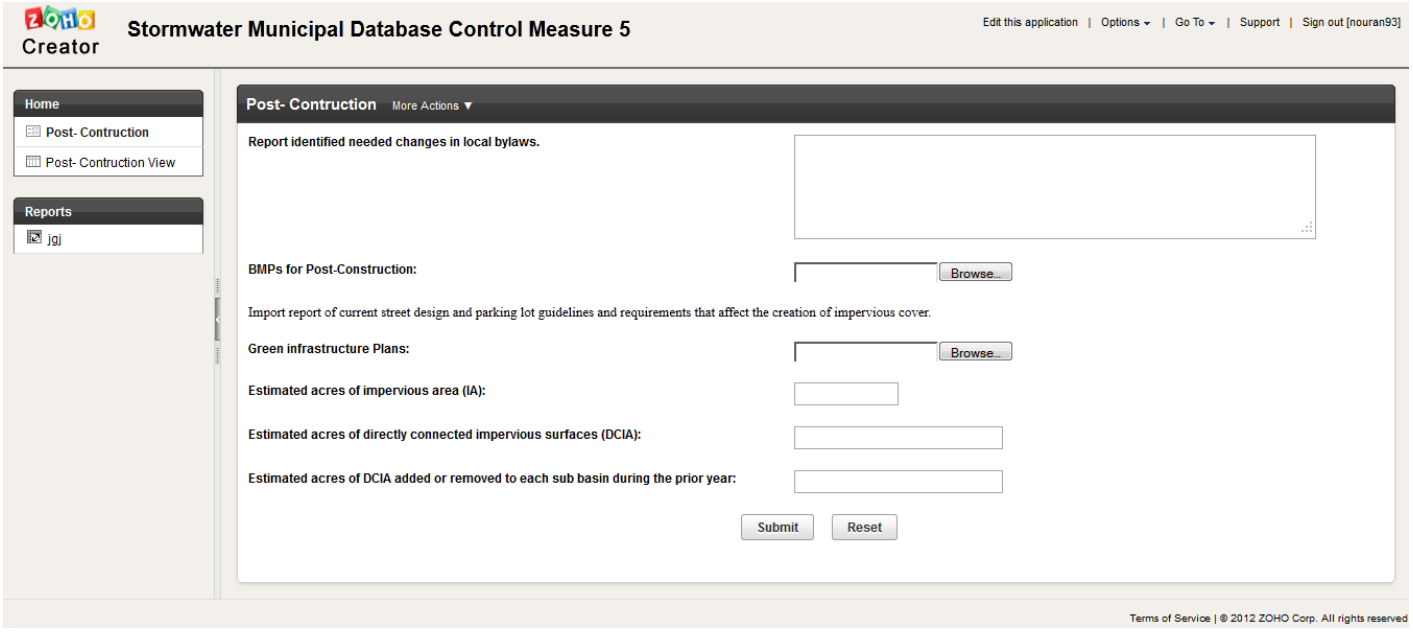
4) Outfall Sampling form



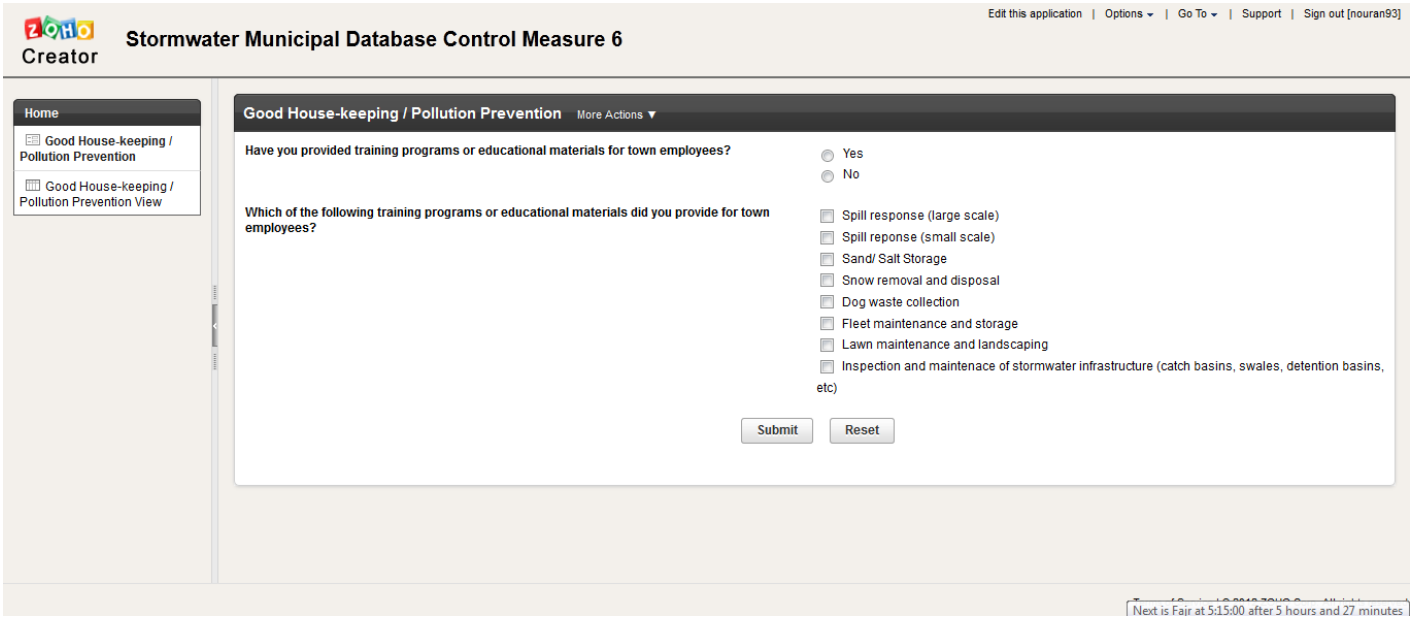
5) Construction Site Runoff Control



6) Post-Construction Site Runoff Control



7) Good Housekeeping/ Pollution Prevention



Appendix V

Online Reporting Form

During our interviews, we saw that all of the town officials were in need of an online reporting form with the minimum requirements needed to complete an MS4 report. Therefore, our team created a form to help the towns with MS4 compliance but also to give them other options and programs that they should implement in order to better their stormwater management. We named this form Local Stormwater Initiative and it will be included as a resource for the municipalities on the MassDEP website.

Local Stormwater Initiative

Stormwater Project Tasks for Better Stormwater Management including MS4 Compliance

Review Local Needs for Better Stormwater Management:				
Project Type:	**Was Goal Met?** **Yes**	**No**	**Date**	**Explanation**
Protect Local Water Supplies	○	○		
Protect local fisheries	○	○		
Improve water quality in local streams, ponds and lakes	○	○		
Prevent degradation of local streams, ponds and lakes	○	○		
Comply with MS4 Permit	○	○		
Consider Expansion of Local Stormwater Bylaws outside urbanized area	○	○		
Require Low Impact Development(LIO) for Local Developments	○	○		

Public Education and Outreach

I. Measurable Goals:

Distribute a minimum of two educational messages to each of the four audiences (residents, commercial owners, developers and industrial facilities) - Part 2.4.2 MS4 Permit

Project type (check all that apply):	**Was goal met?**	**Date of Project/Duration**	**Explanation of Project** (report on the messages for each audience, the method for distribution and the method used to assess the overall effectiveness of the education program). **If goal was not met, explain why.**
☐ Development of brochures, newsletters, newspaper articles, posters	◯ Yes ◯ No		
☐ Distribution of educational material	◯ Yes ◯ No		
☐ Continued Stormwater education programs in schools	◯ Yes ◯ No		
☐ Information specific for residents (septic system maintenance, lawn care, pet waste, proper car care, etc)	◯ Yes ◯ No		
☐ Information specific for commercial owners (on-site infiltration, use/storage of salt, hazardous waste, etc.)	◯ Yes ◯ No		
☐ Information specific for developers (sediment and erosion control, low impact development, etc)	◯ Yes ◯ No		
☐ Information specific for industrial facilities (storage of materials, management of waste and dumpsters, etc.)	◯ Yes ◯ No		
Additional Projects (list below):			
	◯ Yes ◯ No		
	◯ Yes ◯ No		
	◯ Yes ◯ No		

Public Involvement and Participation

I. Measurable Goals:

Provide the public an opportunity to participate in the review and implementation of the stormwater management program and report on the activities undertaken - Part 2.4.3 MS4 Permit

Has your town formed a Stormwater Advisory Group? ◯ Yes ◯ No	If yes, list participants in the group and contact information:
Do you hold annual public Stormwater Management Meetings? ◯ Yes ◯ No	If yes, What is the date of the most recent meeting?

Project type (check all that apply):	**Was goal met?**	**Date of Project/Duration**	**Explanation of Project . If goal was not met, explain why.**
☐ Storm Drain Stenciling	◯ Yes ◯ No		
☐ Stream Walks (clean up teams)	◯ Yes ◯ No		
☐ Volunteer Monitoring Groups	◯ Yes ◯ No		
List Additional Goals below:			
	◯ Yes ◯ No		
	◯ Yes ◯ No		
	◯ Yes ◯ No		
	◯ Yes ◯ No		
	◯ Yes ◯ No		

I. Measurable Goals: Part 2.4.4 MS4 Permit

List of Measurable Goals:	Was goal met? Yes	No	If not met, briefly list the reasons, current status, plans and new date for meeting the goal
Development of a GIS outfall map (add pipes, missing outfalls or other components if necessary. Label each outfall in the field with a unique identifier and collect information on dimention,shape, material, spacial location (GPS) and physical condition)	○	○	
Strategies for tagging outfall pipes if GIS maps are not being developed	○	○	
Development of an illicit discharge detection and elimination plan	○	○	
Complete outfall inventory (conduct a minimum of two dry weather surveys)	○	○	
Development written IDDE Program Document	○	○	
Establishment of a written protocol which clearly identifies responsibilities with regard to eliminating illicit discharges	○	○	
Procedures for tracing the source of an illicit discharge	○	○	
Procedures for removing the source of the illicit discharge	○	○	
Procedures for program evaluation	○	○	
Procedures for inspection of all catch basins for illicit connections and non-stormwater discharges (once a year)	○	○	
Additional Goals: Develop a strategy for illicit discharge education.	○	○	
Development of an inventory of known sanitary sewer overflows (SSOs)	○	○	
Provide written notice of SSOs to EPA	○	○	

Eliminate SSOs	○	○	

List Additional Goals below:	Met?	Date	Explanation
	○ Yes ○ No		
	○ Yes ○ No		
	○ Yes ○ No		
	○ Yes ○ No		
	○ Yes ○ No		

Outfall Number:

Primary Inspector:

Date of inspection:

Date of most recent precipitation:

Tests:

Ammonia (mg/L):

Chlorine (mg/L):

Conductivity (µS/cm):

E. coli (colonies/100mL)

Enterococcus (MPN/100mL):

Surfactants (mg/L):

Temperature (°C):

I. Measurable Goals: Part 2.4.5 MS4 Permit

List of Measurable Goals:	Was goal met? Yes	No	If not met, briefly list the reasons, current status, plans and new date for meeting the goal
Development of a mechanism that requires sediment and erosion control practices at construction sites	○	○	
Procedures for site inspections and enforcement of sediment and erosion control measures at construction sites	○	○	
Written procedures for site plan review	○	○	
Inspect 100% of all construction projects within the regulated area that discharge or have the potential to discharge to the MS4	○	○	
Revision of bylaws and addition of new bylaws if needed	○	○	
Include Additional Goals below:	○	○	
	○	○	
	○	○	
	○	○	

I. Measurable Goals: Part 2.4.6 MS4 Permit

List of Measurable Goals:	Was goal met? Yes	No	If not met, briefly list the reasons, current status, plans and new date for meeting the goal
Development of as-built drawings that depict all on-site controls, both structural and non-structural, designed to manage the stormwater associated with the completed site	○	○	
Report assessing current street design and parking lot guidelines and requirements that affect the creation of impervious cover	○	○	
Develop green infrastructure plans	○	○	

Post-Construction Inspections: Proper Installation of Structural BMPs		
Number of Site Inspections:	Number of Complaints Received:	Number of violations issued:
Summary of Enforcement Actions:		

Post-Construction Site Measurements		
Estimated acres of impervious area (IA):	Estimated acres of directly connected impervious surfaces (DCIA):	Estimated acres of DCIA added or removed to each sub basin during the prior year:
Additional measurements:		

Discharges Causing Excessive Sedimentation				
Outfall ID:	Location:	Description of Problem:	Description of Remediation Taken:	Receiving Water Body Name/ Description

Bylaw Revisions	**Completed?** **Yes**	**No**	**Date**
Report identifying needed changes	○	○	
Decision on proposed bylaw by Town Meeting Approved	○	○	
Bylaw Effective Date	○	○	
Additional Actions:			

Good Housekeeping and Pollution Prevention for Permittee Owned Operations

I. Measurable Goals : Part 2.4.7 MS4 Permit

List of Measurable Goals:	Was goal met? Yes	No	Briefly explain the current status, plans and date for meeting the goal. If not met, explain current status
Training programs or educational materials for town employees	○	○	
Development of an inventory of all permittee owned facilities	○	○	
Development of an inventory of all floor drains within all permittee owned buildings	○	○	
Elimination of all excessive sediment loading	○	○	
Development of a plan for optimizing catch basin cleaning	○	○	
Training programs or educational materials provided for town employees (check all that apply)	○	○	
☐ Spill Response (Large Scale)	○	○	
☐ Spill Response (small scale)	○	○	
☐ Sand/Salt Storage	○	○	
☐ Snow Removal and disposal	○	○	
☐ Dog Waste Collection	○	○	
☐ Fleet maintenance and storage	○	○	
☐ Lawn maintenance and landscaping	○	○	
☐ Inspection and maintenance of stormwater infrastructure (catch basins, sales, detention basins, etc)	○	○	

Good Housekeeping and Pollution Prevention for Permittee Owned Operations continued

Include Additional operations and maintenance procedures below	Completed: Yes	No	Briefly explain the current status, plans and date for meeting the goal. If not met, explain current status
	○	○	
	○	○	
	○	○	
	○	○	
	○	○	
	○	○	

Self Assessment

NPDES PII SMALL MS4 GENERAL PERMIT

ANNUAL REPORT

EPA NPDES Permit Number: _____

Reporting Period : _____

Annual Report Number (check one):

Year 1 **Year 2** **Year 3** **Year 4** **Year 5**

Operator of MS4

Name of town:			
Mailing Address:			
City:	State:	Zip:	Phone:
Contact Person:	Title:		

Certification

I certify under penalty of law that this document and all attachments were prepared under the direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Printed Name: _____

Title: _____

Date: _____

Signature: _____