Micro Pocket Wetlands

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Introduction

This project is for The Two Rivers Ottauquechee Regional Commission's (TRORC) consideration. TRORC is comprised of thirty municipalities in east-central Vermont and is governed by a Board of Representatives appointed by each member town.[1] TRORC's goal is to advocate for the needs of its members and enhance the region's quality of life through a thriving regional economy. Since TRORC covers such a large swath of the state, this project will focus primarily on the Town of Hartford, Vermont. Hartford is made up of five villages: Hartford, Wilder, White River Junction, West Hartford and Quechee.[2]

Hartford, Vermont is like many other towns in central Vermont: rustic and historic. Chartered in 1761, it was the first town east of the Green Mountains.[3] Town life revolves around the White River.[4] As the center of the cluster of villages, the Village of Hartford supported the mill industry and is still a developed area for farming and residential spaces[5]

a. The Town of Hartford

Hartford has dealt with flooding as a significant challenge throughout all of its history, at times wiping out vast amounts of the town and requiring the communities within the town to rebuild each time[6] Thus, the purpose of this project is aligned with the needs of Hartford in combating its ongoing battle with flooding all while providing a sustainable and environmentally friendly approach to keep Hartford the beautiful that attracts visitors annually, and acts as a main reason why people chose to live in the town.

Like most small towns in New England, the Town of Hartford is governed by a Selectboard, with no acting Mayor. The Selectboard—made up of six members and a chairperson—makes decisions on behalf of the Town in conjunction with the Town Manager, and other Boards and Commissioners as needed. Particularly relevant to the needs and goals of this project, the Town has a Conservation Commission, a Planning Commission, and a Resilience Task Force in addition to TRORC. With slightly different methods, each of these groups are working towards making Hartford a more resilient and sustainable town, both culturally and environmentally.

The project seeks to establish statutory language that captures spaces previously deemed too small for wetland consideration and conservation, then propose the development of constructed "micro pocket wetlands" (MPWs) in an effort to mitigate the impacts of climate change. In Section III, the project first defines wetlands and explains their benefits, then looks within the TRORC Regional Plan and the Town of Hartford's statutes to identify the goals these local ordinances wish to achieve. The project also address how to fill holes in the current local codes to expand the criteria for what is defined as a wetland to include the proposed MPW. Additionally, the project will outline specific design criteria for MPWs, including classification and size. This includes an analysis of operation, maintenance, and costs associated with the project. An outline of the challenges and benefits provided by a project of this nature in included within Section III. Finally, in Sections IV and , the project looks at current laws related to the project in other states and delineates what makes this project different than ones already in existence and offers current examples and guidance from other state and local governments that have implemented similar plans and ordinances as references.

Project Explained

This project addresses a major resilience task: stormwater control and flood mitigation. The project takes the concept of pocket wetlands and expands it by creating "micro pocket wetlands," or MPWs. The main goal of this project is to fill regulatory holes in current local codes regarding wetlands by expanding what classifies as a wetland. The project will expand the definition and classification of wetlands through reforming the size and design criteria, cost implications, and the benefits that come from implementation.

According to the Environmental Protection Agency, wetlands are areas where water covers the soil, or is present either at or near the surface of soil for varying periods of time during the year; wetlands are therefore the link between the land and the water.[7] Pocket wetlands are constructed shallow marsh systems designed and placed to control stormwater volume and facilitate pollutant removal.[8] They are man-made; therefore they generally have less biodiversity than natural wetlands, however they still require a base flow to support the aquatic vegetation present.[9] Micro Pocket Wetlands serve similar functions to natural wetlands due to the specific design requirements, explained in Section III of this project. There are few regulations associated with pocket wetlands and most of them deal with specific design criteria. Rarely are they integrated into the general regulation of wetlands, which makes this project so important. This project proposes the idea of micro pocket wetlands (MPWs), which expand the wetland paradigm even further and include even smaller manmade wetlands. MPWs are an even smaller version of pocket wetlands that can be implemented within rural, agricultural, and even urban areas. The design criteria outlined throughout Section III of the project will explain what makes these particular wetlands unique and propose ways for MPWs to become integrated within wetland management plans already in existence; which focus primarily on requiring wetlands when seeking a building permit and conducting a sale or renovation of an existing area for public, commercial and residential projects done.[10]

Two Rivers Ottaquechee Regional Commission (TRORC) noted in their most recent version of the Regional Plan that while the Region's natural resources are in better condition than most other regions in the nation due to the rural nature of the area, the topography has changed significantly.[11] One of these changes includes "enormous swatches of wetlands" being filled, which have resulted in the loss of more than 35 percent of Vermont's original wetland acreage, primarily due to agricultural and large-scale development projects.[12] The Vermont Wetlands Office estimates that while roughly 4 percent of Vermont's lands are classified as wetlands (totaling 244,000 acres), approximately 80,000 acres of wetlands have not been identified because they are too small, thus not covered within the purview of the regulations[13]. The current rate of wetland loss in Vermont has been estimated at eight acres a year through incremental destruction by numerous smaller projects, many of which are less than a single acre, with serious implications for short and long-term wetland values.[14] Engineered micro pocket wetlands, particularly those placed in areas traditionally considered too small to construct even pocket wetlands, will increase the flood mitigation capability of the Town of Hartford even if they "cannot fully replicate the intricate complexities of a wetland formed over tens or hundreds or thousands of years."[15] Thus, MPWs are an effective measure to revert and create wetland areas throughout the region by way of small pocket wetlands being strewn across the Town of Hartford. However it is important to note that while this project focuses on Hartford, VT it is also applicable to other communities throughout the United States (see Section IV).

Micro Pocket Wetlands

This project takes the concept of pocket wetlands and expands it by creating "micro pocket wetlands" or MPWs. This project seeks to reform current local codes regarding wetlands by broadening requirements currently at play. In this section, the project addresses reforming local codes by expanding what classifies as a wetland due to size and design criteria, and the cost implications of constructing or preserving wetlands. Lastly, the project highlights the benefits that come from micro pocket wetlands including biodiversity, wildlife habitat and green house sinks among others in Sections IV and V through a common six step implementation process.

a. Challenges

While this project thus far has acknowledged the ecological challenges and potential cost considerations involved in the construction and implementation of micro pocket wetlands, there must also be an acknowledgement of the real threat of climate change and its impact on the need for creative solutions. The Northeastern portion of the United States, which of course is where Vermont is located, is experiencing noticeable changes that are expected to increase in the future[16]. In addition to projected heat wave increases, the total amount of precipitation and its frequency is projected to rise. Between 1958 and 2012, the Northeast saw more than a 70 percent increase in the amount of rainfall measured during heavy participation, which is more than in any other region of the country. Sea level rise, heavy precipitation, and storm surge are expected to exacerbate already increased floods and coastal erosion, which puts a further strain on the aging infrastructure. The Town of Hartford is no exception.

b. Benefits

One of the main benefits that wetlands, and particularly micro pocket wetlands, offer in an attempt to combat climate change's harmful effects on waterways is carbon sequestration. Carbon dioxide is the most commonly Wetlands are carbon sinks, therefore they are able to absorb carbon dioxide in the atmosphere and hold it in place, using it for the plants within the wetland that can then release oxygen.

The benefits associated with creating a micro pocket wetlands also include improvements to water quality and vegetative settling, and uptake which removes pollutants[17] Furthermore, by constructing a micro pocket wetland, the wetland's primary goal is to mimic the complex biological, chemical, and physical processes[18] Thus, offering a viable way to integrate the natural system of water while mitigating flooding concerns by both temporarily storing and slowly releasing storm water, and reducing water flow allowing sediments that cause pollution to settle out[19] Furthermore, microorganisms called biofilm reside in wetlands eating plants and also reducing the forms of pollutions by processing them[20] Lastly, the roots of the wetland vegetation allows for soils to remain in place, stabilizing the banks or rivers and streams or the land that surrounds them[21]

Impervious surfaces such as parking lots, roads, rooftops contain large amounts of pollutants which then make their way into water ways resulting in algae growth and increased harm to the health of the living environment. Therefore, the creation of micro pocket wetlands can reduce the amount of pollution found in the waterways while providing safe, educational, and esthetic values to the land where they are[22]

Wetlands have the ability to support both aquatic and terrestrial species, and the prolonged presence of water creates conditions that favor the growth of specially adapted plants and promotes the development of characteristic wetlands soils[23] Their functions include water quality improvement, floodwater storage, fish and wildlife habitat, aesthetics, and biological productivity[24] While the main benefits of wetlands are primarily ecological, another significant value of wetlands is the financial estimate of their importance—or the worth of one or more of their functions to society[25] For the context of this project, the importance of wetlands is valued by their contributions to flood mitigation, climate mitigation, and watershed management in the midst of sea-level rise that is already accompanying the global changes in climate, in addition to the ecosystem service they provide.

c. Classification and size

Micro pocket wetlands can be designed to maximize traditional larger wetland benefits26–pollutant removal, sediment control, biodiversity, increasing water quality, climate adaptation and mitigation–while also being less burdensome to private landowners as they are more versatile due to their size and ability to be used in a wide range of areas. Traditional pocket wetlands require a drainage area of five to ten acres.[27] In contrast, micro pocket wetland drainage areas can be less than five acres. Thus, MPWs in total acreage including a drainage area, can be less than an acre as MPWs can be classified as a small marsh or segment of land or lands that are connected or disconnected.

Micro pocket wetlands require perennial base flow, loamy soils (combination soil, normally equal parts of clay, silt, and sand)28 to sustain plant growth, and three distinct zones: a forebay after the inlet, the actual wetland area, and finally a micro-pool prior to the outfall.[29] Each of the three sections serves a unique and important purpose. The forebay and micro-pool are for sediment control; they retain water and are therefore the deepest portions of the micro pocket wetland.[30] As a result, the overall design of a micro pocket wetland can be done in a very similar if not identical manner to that of an already regulated pocket wetland. What makes the notion of micro pocket wetlands unique however is their practicality regardless of locality, as they are suitable for both urban and rural environments given their smaller size.[31]

d. Design

In Vermont, the state Department of Environmental Conservation creates a list of rules and statutes that govern all aspects of wetlands.[32] However, even at local county levels, specific design criteria are still outlined for wetlands in order to be classified as such. For example, the following design considerations have been outlined for pocket wetlands generally, which can be adapted or modified for micro pocket wetlands. First, there must be varying water depths at several levels with the general rule being to allocate a 1% minimum of the contributing drainage area as a starting point for the surface area of the wetland, but 3-5% being the optimal design.[33] Second, the length to width ratio for optimal performance is 2:1.[34] Third, the area known as the bank or transition zone, making up at least a quarter of the area, should be six inches or less in depth.[35] All of the aforementioned design specs should be drafted into the local ordinance so as to fit into their individual goals for MPWs.

Many of the current local codes such as the City of Murfreesboro, Tennessee among them,[36] outline some set of design steps which generally include determining the:

- storage treatment volume, soil conditions and natural slope of area;
- required storage volume;
- dimensions of the wetland to identify the required area for the wetland
- vegetation that will be placed within the wetland (preferably native species);
- filter media volume and volumes associated with the depth criteria outlined; an
- recovery time of the wetland.[37]

Thus, local governments can create codes that require specific criteria for the concept of micro pocket wetlands following the guidelines set forth for pocket wetlands within other local governments as a model.

The notion of pocket wetlands is one where shallow marsh systems are placed to control stormwater volume and remove pollutants. Pocket wetlands are engineered facilities which require a base flow in order to support the aquatic vegetation;[38] their shallow marsh systems control stormwater, sequester carbon, and remove pollutants.[39] The design on the micro pocket wetland would be constructed in a very similar fashion, if not identical, to a pocket wetland that can vary to meet the needs of the stormwater runoff and land. For example, variation can occur in the storage volume, pond depth, and dry storage.[40]

e. Operation and maintenance

The operation and maintenance of a micro pocket wetland will be very similar if not at times identical to that of a general pocket wetland. For example, some counties that have pocket wetlands with required elements that ease maintenance, which include but are not limited to: the requirement of a forebay consisting of a separate cell and of a certain size; direct access for appropriate equipment; and a requirement for sole aquifers a requirement where runoff shall be provided in pretreatment.[41] Maintenance requirements can also be executed as a condition of the plan approval to create or classify the wetland.[42] Furthermore, the EPA wetland management guidebook outlines specific maintenance procedure.[43] For example, the guidebook states that regular inspections are a key component, which should be done by a variety of stakeholders including property manager and homeowners to professional engineers and contractors.[44] Routine inspections include mowing, checking for clogs, and debris removal.[45] The EPA recommends wetlands be inspected on a monthly basis for minor items, and annually for major items such as structural components.[46] However, this schedule is at times not realistic and therefore the EPA states that communities should in reality, inspect every one to three years.[47] Nonetheless, the important key take away is that local governments, using the EPA recommendations, can require maintenance and inspections which they outline may occur however many times they deem fit and are reasonable for their municipalities.[48] Keep in mind that cost of said maintenance will vary along with the required activities and frequency, but a general chart is listed in Appendix D.

f. Cost

The installation cost of a general pocket wetland is at times higher than other storm water management measures if there is a need for excavation to maintain a permanent pool elevation. Some counties put numbers to the price of a pocket wetland that range from "relatively low"[49] which is considered a minimum of $39,000 to a high of $82,000 for a one acre wetland.[50] As for maintenance, the estimated costs is that of –$780 per year of maintenance to as much as $1,600 for maintenance[51] for a one acre wetland.[52] Thus, municipalities should consider the cost of the pocket wetland as a key component given that wetlands in past studies[53] have shown to save communities a great deal of money. That said, it is important to note that due to the wide diversity of regions across the U.S. there can be no single cost or economic benefit that can be used across the board, instead the numbers used are examples of such costs and benefits as done in other areas of the country. Therefore, the value of a wetland to a local municipality can be estimated based on the wetland's ability to diminish pollution.[54] As an example, it is said that a wetland near a city can be estimated to be worth about $98,000 per acre in the year 1997 for the ability to clean water, recycle nutrients, recharge aquifers, control floods, and support wildlife.[55] Another example is that of the Minnesota Department of Natural Resources, which placed a "value of $665 per acre per year (in 1996 dollars) on the ability of wetlands to remove nutrients and sediments from the environment."[56] Further, through an economic assessment of wetland mitigation in northwest Minnesota, the state used a "value of $175 per acre per year as a proxy for the value of water quality protection."[57] As for an added benefit much of the nation's fishing and shell-fishing industries harvest wetland-dependent species. The EPA therefore estimated wetlands to have a value of $15 billion per year.[58] Thus, not only do wetlands provide local governments with the ability to mitigate pollution, while having recreational, historical, scientific, and cultural values but they save local municipalities money[59].

We must also consider the ecosystem service value that wetlands provide within the context of Ecosystem Service Management (ESM). ESM identifies the monetary value for ecosystem services.[60] This metric focuses on two primary questions: "(1) what services do natural ecosystems provide society, and (2) what is the first approximation of their monetary value[61]?" There are four main categories for qualifying ESM: provision of goods or products; cultural services; regulating services; and supporting services. Of the four, wetland development, restoration, and implementation fall within the categories of "regulating services" because they provide climate and flood controls and water filtration, and "supporting services" because of their ability to cycle nutrients and improve soil. Although a small wetland, like the micro pocket wetlands proposed in this project, may not store

as much water as traditional wetlands, a network of small wetlands still has the ability to store large amounts of water.[62] Wetlands have the ability to store floodwaters and reduce the risk of costly property damage, an issue the Town of Hartford knows all too well. Some jurisdictions have already been able to quantify the benefit of wetlands through the use of ESM regimes. For example, the U.S. Army Corps of Engineers found that protecting wetlands along the Charles River in Boston, Massachusetts saved $17 million in potential flood damage because without wetlands the city would have to rebuild infrastructure following floods.[63] The presence of wetlands eliminates the need for the city to expend that cost because the protection is already provided as a result of the wetland ecosystem.

Furthermore, when attempting to determine the costs of a wetland, one must think about other ecosystem services values such as dredging.[64] This specifically means considering the process of removing sediment from a water body and then transporting it and depositing it elsewhere,[65] whether its temporary or permanent[66] or flood mitigation infrastructure. Dredging is done to reclaim material such as: sand, silt, clay, gravel, coral, rock, and boulders.[67] The cost associated with dredging varies depending on several factors: first, how much material is there to dredge? Two, where can you then put said material? And finally, what is the nature of the material that is dredged?[68] However, when it comes to a price tag, dredging has been said to cost anywhere from $20,000 per hectare[69] to $1 million by 2100[70] due to climate change. In the end, the cost of dredging per amount of land used will economically significantly outweigh the most expensive micro pocket wetland created or implemented by a municipality as the most expensive wetland would be around $82,000 total to construct and or implement.[71]

Flood mitigation infrastructure is an additional way in which one can address cost while providing key benefits to the people of the area, while also providing overall benefits to the ecosystems and environment surrounding the area. The micro pocket wetland project, along with other flooding mitigation infrastructure, buffer communities from the negative impacts of climate change. Flooding has been deemed as one of nature's most harmful disasters which are only projected to increase due to sever climate change impacts.[72] One example of flooding costs – damages to surrounding buildings and area–without the implementation of flood mitigation infrastructure has been estimated at anywhere from $52,000 to over $738,000.[73] Whereas cost of damage with green infrastructure, including wetlands, such as the type being proposed here would only range from $53,500 to a max of $453,700.[74] Thus, the data indicates that flooding will result in incrementally increased costs to states and local municipalities if mitigation is not undertaken; including construction and implementation of micro pocket wetlands.

Relevant Existing Laws

While stormwater wetlands and pocket wetlands are not particularly common and have minimal regulations nationally, the few states and local governments with regulations share some commonalities. First, a pocket wetland should have a minimum flow path[75] of 2:1 (length to width)[76] to ensure that the wetland serves its intended purpose of managing stormwater to avoid runoff. Some ordinances specifically explain that pocket wetlands cannot be located within navigable waters of the U.S. without obtaining a Section 404 permit[77] under the Clean Water Act, and any other applicable state permit.[78] The Trump Administration decided to exclude groundwater as water of the US (WOTUS) since it is not navigable, however pocket wetlands generally use groundwater to replenish their supply.[79] Therefore Section 404 permits would only apply if a wetland is directly connected to a waterway. Since this project proposes potential floating wetlands within waterways and micro wetlands on the edges of farms which may be near waterways, this project would likely require Section 404 permits or the state equivalent. Most of the documents also have provisions alluding to the desire to increase wetland diversity.[80] The use of native species is most ideal.

a. Local Ordinances

While there are no states already requiring or establishing micro pocket wetlands, some have established criteria for designing pocket wetlands. While a pocket wetland generally has a minimum size of five acres, which is far larger than this proposed project, these ordinances and regulations provide a helpful framework for what would be necessary for micro pocket wetlands. Pocket wetlands and micro pocket wetlands are both manmade and specifically designed to store and filter stormwater runoff.

As in most places around the United States, the Town of Hartford's wetlands are regulated at the state level. Vermont's wetland rules were established in 1990 and last amended in 2018.[81] Pursuant to state law, local communities can enact their own regulations as long as they are consistent with the state regulations.[82] The purpose behind the wetland rules created is to highlight one of the greatest benefits that this project brings: wetland preservation and restoration. Wetland areas contain and absorb stormwater and floodwaters; they filter water and protect groundwater; they provide habitat for valued wildlife and endangered plants; they provide recreational benefits;

and they add to the beauty and open nature of Vermont's landscape. There was little consideration for the impacts of climate change, or the necessity to increase wetlands added during the 2018 amendment. We will explore how other states around the country have taken on this project through local ordinances as examples of how Hartford may do so as well.

1. New York

The state of New York has two main documents governing wetland design regulations and guidance for developing local laws for stormwater management. The New York State Stormwater Management Design Manual outlines performance criteria for stormwater management practices in order to meet water quality treatment goals.[83] In New York, wetlands cannot be located within jurisdictional waters or within existing jurisdictional wetlands.[84] These pocket wetlands should not be used in trout waters since studies have shown that these practices increase stream temperatures, which harm trout populations.[85] The state also strongly encourages microtopography[86] to enhance wetland diversity.

The Sample Local Law for Stormwater Management and Erosion & Sediment Control was created to be a "guidance tool for communities subject to the National Pollutant Discharge Elimination System (NPDES) regulations, administered by New York State through the State Pollutant Discharge Elimination System regulations."[87] The overall goal is to reduce stormwater runoff rates and volumes, soil erosion and nonpoint source pollution, wherever possible, and to ensure that these management practices are properly maintained and eliminate threats to public

safety[88]. The contents include: a title and enacting clause, general provisions, proposed amendments to zoning laws (including subdivision and site plan review), erosion and sediment control laws, enforcement regulations, and a list of stormwater management practices acceptable for state water

quality standards. This manual defines a pocket wetland as a "shallow wetland design adapted for the treatment of runoff from small drainage areas that has variable water levels and relies on groundwater for its permanent pool[89]. This sample law is a good practice because local governments can simply insert the name of their municipality and the agency that has given them regulatory power over stormwater management issues. This may be a good model to duplicate for our project.

2. Murfeesboro, Tennessee

The town of Murfreesboro has a statute governing stormwater wetlands. This statute defines pocket wetlands as "wetlands intended for smaller drainage areas of 5 to 10 acres and typically requires excavation down to the water table for a reliable water source to support the wetland system[90]." The ordinance explains the importance of pollutant removal capabilities and outlines target reduction goals[91]. If the removal rate is not deemed sufficient, then more controls may be put in place at the site in a series of "treatment train" approaches[92]. Having a threshold to determine success of a constructed wetland is probably a good practice. The main foreseeable issue would be enforcement, particularly if micro wetlands are constructed on private properties. To whom will that responsibility fall upon

Notably, the statute establishes that it is feasible to allow pocket wetlands in residential subdivisions, high density/ultra-urban areas, and within regional stormwater control plans and hotspot runoff reduction zones.[93] This is relevant to our project because if pocket wetlands can be applied to each of these areas, then a micro pocket wetland can easily be constructed here as well. The general design requirements include:

1. Shallow marsh areas of varying depths with wetland vegetation,
2. Permanent micropool, an
3. Overlying zone in which runoff control volumes are stored[94].

Micro pocket wetlands likely will not require such stringent requirements. The design requirements reflect the ones New York have outlined, but require a micropool, a forebay, and an allocation of surface area of 10/45/40/05% (deep water/low marsh/high marsh/ semi-wet).[95]

3. Weston, Massachusetts

The Charles River Watershed Association in Weston, Massachusetts has created a Low Impact Best Management Practice Information sheet. Here, pocket wetlands are defined as wetlands "excavated to intercept the groundwater table and use groundwater to retain water in the system."[96] The document explains that since these systems do not rely solely on runoff to provide moisture, they can accommodate smaller drainage areas than other types of constructed stormwater wetlands.[97] Similar to Murfreesboro, Tennessee, this watershed has created a list of pollutant removal goals. The document outlines costs and shows example projects that have been successful around the watershed, including a constructed wetland installed in the neighboring towns of Littleton and Leominster, MA.

Implementation

In order for micro pocket wetlands to come into effect, local municipalities will need to pass and adopt an ordinance addressing the proposed project. The ordinance that passes should be drafted in a manner that suits the locality and the goals they seek to combat–such as Hartford with flooding See Appendix A. When it comes to addressing the ever-present threat of severe and damaging flooding in the Town of Hartford, micro pocket wetlands are a solution that may help resolve many of the issues surrounding the current cost and damages resulting from increasing floods. To fully implement the micro pocket wetlands into the Town, several tasks must be completed. As stated in multiple of the sample ordinances and guides from NOAA and New York State, there are six main steps: (1) define the flooding problem particular to that area;[98] (2) assess flooding scenarios without the development of micro pocket wetlands;[99] (3) identify how flood reduction goals will be met with the creation of micro pocket wetlands;[100] (4) assess flooding scenarios with micro pocket wetlands in place;[101] (5) estimate the costs and benefits of micro pocket wetland construction and implementation;[102] and (6) evaluate the strategy and how others have taken it on through analyzing examples and model ordinances (See Appendixes).[103] For specific application of how these six steps and a model ordinance addressing MPWs can be drafted, look at Appendix A. In order for successful implementation of MPWs in the Town of Hartford, the Town should consider these six steps.

Many American municipalities are currently dealing with the result of historically poor flood control strategies. This country has invested a large amount in levees, damns and floodways, which has prevented significant flood damage in many locations but has also encouraged more settlement in areas that are not particularly ecologically suitable locations.[104] This in turn increases the amount of people and property impacted when a flood actually occurs. While this is true in most places, the White River is one of the last “free-flowing rivers” in the state of Vermont and is the longest un-dammed tributary to the Connecticut River.[105] This is an important distinction to make when considering the six steps because it changes the needs of this town versus others.

First, as was discussed in the Introduction, the Town of Hartford has dealt with flooding for centuries. The town sits in the county with the highest number of reported flood-related events and FEMA disaster declarations in the state of Vermont. [106] The Town of Hartford remains susceptible to flooding that puts residents and businesses at risk even without damns or levees. In 2011 when Hurricane Irene hit the southeast portions of New York and the southwest portions of New England, the Town of Hartford suffered considerably. Increased climate temperatures significantly heighten the likelihood of more events of that magnitude, or even larger numbers of smaller severe weather events.[107]

As a result, the Town of Hartford enacted a set of regulations exclusively for flood hazard areas.[108] The goal of these regulations is to: (1)“minimize and prevent loss of life and property and the disruption of commerce...and the extraordinary public expenditures and demands...that result from flooding and other flood related hazards;” (2) “ensure that the design and construction of development in flood or other hazard areas are accomplished in way that minimize or eliminate the potential for flooding;” (3) manage all flood hazard areas; and (4) ensure the flood insurance and disaster recovery and hazard mitigation funds eligibility for the state, municipalities and individuals.[109]

Since there is no specific market value for the benefit of wetlands, we must consider historical patterns of financial loss resulting from flooding. Financially, the Town of Hartford has seen significant loss from flooding. For example, in 2012 the Town experienced $175,493,766 in property and crop damage from flooding alone.[110] The development of manmade MPWs will likely reduce the severe effects of flooding by increasing the amount of permeable surface area where water be absorbed instead of it rising and causing damage on land during storm events. With smaller swaths of wetland being captured by the proposed new regulatory language, areas that probably once considered too small for consideration will now be regulated. This ensures the protection of smaller areas that have the potential to have a significant positive impacts. Greater quantities of small, protected wetlands increases the possibility of lessened flood risks. Many hands make light work.

Appendix A. (Model Ordinance)

MODEL WETLAND (PROTECTION) ORDINANCE

Section 1: Findings of Fact

The legislative body of .....(local government name) determines that:

- Many of the wetlands of.....(local government name) have already been lost to drainage and fills. This has increased downstream water pollution, flooding, and erosion and the loss of habitat. This ordinance has been adopted to create and protect wetlands and water resources.

- Wetlands and associated buffers function to provide a variety of goods and services including:

  o Provide flood conveyance and storage;
  o Provide stormwater detention and stormwater purification
  o Provide living, breeding, nesting and feeding environments for many forms of wildlife including waterfowl, shorebirds, salamanders, frogs, and deer
  o Provide linkages between aquatic systems (lakes, rivers, etc.);
  o Maintain potable water supplies
  o Treat polluted surface/subsurface waters through biological degradation and chemical oxidation
  o Prevent additional nonpoint pollution of waters by providing buffers;
  o Serve as nursery grounds and sanctuaries for fish; and,
  o Provide recreation areas for fishing, boating, hiking, bird watching, photography and other recreation uses.

- Activities in wetlands and associated buffers are often subject to flood, erosion, and subsidence and exacerbate hazards on other lands.
- Further loss of wetland and wetland buffer quality and quantity is contrary to the public health, safety, and general welfare.

Section 2: Purposes

The purpose of this ordinance is to protect health, safety, and general welfare of the residents of .....(local government name). More specific goals include:

- Protect the quality and quantity of all waters;
- Achieve no net loss in the quantity, quality, and biological diversity of land and associated buffers including functions and goods and services
- Avoid direct or indirect impacts from activities that destroy or diminish the quantity, quality and biological diversity of wetlands and adjacent buffers
- Reduce the expense to the city for flooded roads, sewer, and water and for disaster and flood assistance;
- Provide an ecologically sound transition between wetlands and upland areas;
- Replace and create wetland and buffer functions, values, and acreage where avoidance of activities is not practical and all practical measures have been taken to reduce impacts;
- Minimize impacts to existing land uses and lots by preventing increases in flood, erosion, and other natural hazards due to destruction of wetland and buffer areas/
- Incorporate wetland protection into the.....(local government name) land use planning and management and development approval procedures to create new wetlands.

Section 3: Authority

This ordinance has been adopted pursuant to and in accordance with..... (statutory cite).

Section 4: Definitions

“Board” means the .....(Specify one: Wetland Review Board, Board of Adjustment, or Planning Board. Note, the local government must choose the regulatory entity it wishes to authorize to issue wetland permits. Permits are typically be issued by the Board of Adjustment or Planning Board if state statutes do not specifically allow the creation of a separate wetland or environmental board with regulatory powers such as a conservation commission.).

"Buffer" means the area surrounding a wetland that helps maintain the wetland's functional integrity and furnishes protection against the impacts to the wetland from activities in adjacent upland areas.

"Compensatory mitigation" means the replacement of wetland acreage, function, and value to compensate for losses.

"Creation" means a human activity bringing a wetland into existence at a site in which it did not formerly exist.

"Enhancement" means the manipulating the physical, chemical or biological characteristics of a wetland to increase or improve specific functions or to change the growth stage or vegetation present.

"Floodplains" mean areas subject to periodic inundation when a river, stream, or other watercourse overflows its banks. They are relatively flat areas or lowlands adjoining the channel of a river, stream or watercourse or other body of water. They include but are not limited to those mapped by the Federal Emergency Management Agency shown as flood hazard areas on the .....(name of municipal government) Flood Insurance Rate Map (FIRM) issued by the Federal Emergency Management Agency for the administration of the National Flood Insurance Program numbered and dated.....

"Floodway" means the channel of any rivers, stream or other watercourse and the portions of the adjoining floodplain required to carry a discharge flood without raising flood waters and velocities more than a defined amount.

"National Wetlands Inventory Maps (NWI)" are a series of maps produced by the U.S. Fish and Wildlife Service showing the general location and classification of wetlands.

Some wetlands, particularly smaller wetlands, are not shown on these maps. In addition the criteria used for mapping wetlands in the NWI does not fully coincide with the definition of wetland provided below. The definition of wetland provided below and field surveys provided by the Board or provided by a permit applicant and reviewed and approved by the Board shall provide the basis for more specific and accurate designation of wetlands and wetland.

"Ordinary High Water Mark" means the point of the bank or shore up to which the presence and action of surface water is so continuous as to leave a distinctive mark such as by erosion, destruction or prevention of terrestrial vegetation, predominance of aquatic vegetation, or other easily recognized characteristic.

"Regulated Activities" means all activities in regulated wetlands and associated buffer areas which involve filling, excavation, dredging, clear-cutting, dumping, excavation, changing of drainage, grading, placing of objects in water, excavation or any other alteration or use which will damage or destroy a wetland or associated buffer area.

"Restoration" means manipulating the physical, chemical or biological characteristics of a site to achieve a former condition with improved wetland functions, values, and acreage.

"Riparian Area". The area adjacent to rivers, streams, creeks, washes, arroyos, and other bodies of water or channels having banks and bed through which waters flow at least periodically. These areas are subject to periodic flooding and are generally characterized or distinguished by a difference in plant species composition or an increase in the size and/or density of vegetation as compared to upland areas.

"Watercourses" mean rivers, streams, intermittent streams, ditches, brooks, channels, lakes, ponds, manmade ponds, estuarine waters, swamps, bogs, vernal pools, playas, and all other bodies of water, natural or artificial, intermittent or permanent, public or private which has defined banks and water at least a portion of each year. These areas are typically shown on the United States Geologic Survey topographic maps of the community.

"Wetlands". Wetlands are areas and waters that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically

adapted for life in saturated conditions. Wetlands generally include but are not limited to lands and waters meeting this definition and otherwise often referred to as swamps, marshes, bogs swamps, wetland meadows, ephemeral and tributary streams vernal pools, banks, reservoirs, ponds, lakes, and lands under water bodies. The primary ecological parameters for identifying wetlands include hydric soils, hydrophytic vegetation, and hydrologic conditions reflecting temporary or permanent inundation or saturation. (Note, we are utilizing the Corps of Engineers regulatory wetland definition here but have added an additional explanatory sentence. A community may wish to substitute its own definition.)

"Wetlands Delineation" means the establishment of wetland boundaries.

Section 5: Wetland Review Board

(Note, this is an optional section. Appointment of a local wetland review board can enhance local expertise in reviewing wetland permit applications. Some states specifically authorize conservation commissions (e.g., Massachusetts) to adopt wetland and related regulations. Others do not specifically authorize separate commissions with regulatory powers. In such instances a community may, nevertheless, form an advisory wetland review board to make recommendations on individual permit applications to the planning commission or board of adjustment which issues the actual wetland permits.

The wetland review board may also provide input to the community governing body or boards on other wetland issues.)

The Council of ..... (local government name) shall appoint a Wetland Review Board

(hereafter referred to as the Board) of not more than eight but not less than four members for terms to be specified by the Council. The Board may issue, deny or conditionally issue wetland permit applications on forms provided by the Board and consistent with the standards, goals, and criteria set forth in this ordinance. (Note, the ordinance should vest permitting powers in the Board of Adjustment or Planning Commission if the Wetland Board is to be advisory only.)

The Board may also advise the Council with regard to wetland policies and activities and may help the Council undertake the following activities.

- The mapping and delineation of wetlands, floodplains, and riparian buffers,
- The assessment of wetland functions and values,
- The location of wetland boundaries on the ground,
- The initiation of wetland or riparian area enforcement actions, and
- The acquisition of wetland and related wildlife or recreation areas.

Section 6: Wetlands Regulated by This Ordinance

All wetlands and associated buffer areas within the boundaries of ..... (local government name) are subject to regulation by this ordinance. More specifically, wetlands subject to regulation include:

- All wetlands shown on National Wetland Inventory maps series.....(specify series and date) and associated 75 foot buffer areas. National Wetland Inventory maps delineate the general location and boundaries of wetlands. Copies of these maps are available for inspection in the office of the.....(specify). Mapped wetlands and regulations shall function as an overlay district to all other districts.

- All other wetlands and associated 75 foot buffer areas meeting the wetland definition criteria set forth above.

(Note: This ordinance as written applies to both mapped and unmapped wetlands. Many communities only regulate mapped wetlands. This ordinance also includes a 75 foot regulated buffer)

Section 7: Delineation of Wetlands and Buffers

Any property owner who believes that designation of an area as wetland or wetland buffer or the wetland boundary is incorrect may petition the Board to clarify or change the designation and/or boundary. All petitions for a clarification or change in designation shall be submitted in writing and shall include all relevant facts and circumstances which support the change. For proposed changes in boundaries, the petitioner shall provide expert proof that the designation is inconsistent with the definition of wetland provided in this ordinance and the delineation procedures provided by the l987 Wetlands Delineation Manual of the U.S. Army Corps of Engineers.

The wetland buffer area shall be measured perpendicularly from the boundaries of a wetland.

Section 8: Permitted Uses

The following uses are permitted in wetlands and associated buffer areas, providing they do not alter the natural hydrology, destroy wetland functions and values, or increase flood or erosion hazards on other lands:

- Conservation of soil, vegetation, water, fish, shellfish and wildlife.
- Outdoor recreation including nature study, hiking, horseback riding, swimming, camping, boating, trapping, hunting, fishing, shell fishing, cross- country skiing where otherwise legally permitted.
- Grazing, farming, nurseries, gardening, forestry and harvesting of crops. However, road construction, erection of buildings, or relocation of wetlands or watercourses, clear cutting of timber, or the mining of topsoil, peat, sand or gravel from wetlands shall require a permit as provided below.
- Recreational open space and other types of open space for adjacent residential, commercial, and industrial property including subdivisions.
- Control of noxious weeds if the control does involve the drainage or fill of a wetland
- Maintenance of existing ditches, watercourses, farm pounds, utilities, roadways providing the activity does not involve the expansion of roadways, drainage ditches or related improvements into previously unimproved rights of way or portions of rights of way.
- Construction for nature study and educational purposes trails, boardwalks, viewing platforms, information kiosks, and trail signs.
- Maintenance of existing structures consistent with standards set forth in Section below.
- Emergency work necessary for protection of the public, health, or safety.
- Restoring wetlands not associated with any development project, providing such restorati

Section 9: Activities Requiring a Permit

All activities in regulated wetlands and associated buffer areas involving filling, excavation, dredging, clear-cutting, dumping, excavation, changing of drainage, grading, placing of objects in water, excavation or any other alteration or use of a wetland not permitted by section 8 shall require a permit from the Board.

Section 10: Coordination With Other Regulatory Agencies

(Note, this is an optional section. It is designed to help coordinate regulatory reviews and maximize the use of available expertise. Some communities have developed more formal referral or joint permit processing procedures with other regulatory agencies.)

Upon receipt of a permit application, the Board shall coordinate with other planning and regulatory with jurisdiction or potential jurisdiction over the proposed activity. The Board may require that an applicant obtain other federal, state, or local regulatory permits needed for a proposed activity before applying for a wetland permit from the Board. The Board may also provide comments to other agencies in their permitting activities. The following activities may require additional state, federal, or local permits as well as a permit from the Board.

(Note, this section needs to be tailored to state laws and local needs. Additional permits which are required will depend upon

the type of activity, the type of wetland affected, and the local government and state regulations in effect. Typical activities requiring a permit from other agencies include the following:)

- Construction of any dam regulated by .....(name of regulatory agency, statutory cite.)
- Construction, encroachment or placement of any obstruction within a stream channel, lake, or tidal water regulated by ..... (name of regulatory agency, statutory cite)
- Diversion of water including withdrawals in excess of ..... gallons per day regulated by ..... (name of regulatory agency, statutory cite.
- Discharges of fills or pollutants into the waters of the state regulated by(name of regulatory agency, statutory cite.)
- The undertaking of any regulated activity in a floodplain or floodway regulated by ..... (name of regulatory agency, statutory site.)
- The construction of septic tank/soil absorption fields in any wetland or buffer area requiring a permit from..... (name of regulatory agency, statutory site.)
- Any filling or grading requiring a permit from..... (name of regulatory agency, statutory site.)
- Any land use, building construction, or subdivision permit required from ..... (name of the local regulatory agency, statutory site.)
- The discharge of fill or dredged material into wetlands and watercourses

regulated by the U.S. Army Corps of Engineers pursuant to Section 10 of the Rivers and Harbor Act or Sections 404 and 401 of the Federal Clean Water Act, as amended.)

Section 11: Information to be Provided by the Permit Applicant

Individuals or public or private corporations seeking a permit for a regulated activity within a wetland or wetland buffer area shall apply for a wetland permit from the Board on a permit application form provided by the Board.

All applications shall include the following information in writing, in maps, or in drawings unless exempted in writing by the Board:

- Name, address, telephone number and e-mail address of owner and permit applicant (if different). This should include an appropriate engineer's or land surveyor's stamp if one has been used by the applicant
- A description of existing uses of the property including any structures, fills, grading, or drainage;
- Photographs of the proposed project site showing the existing condition of the site;
- A description of the proposed activity including the type of proposed activity, its dimensions, distance from any road or water body, and when and how it will be carried out;
- An explanation why this activity cannot be located at an upland location;
- A description of all measures proposed to reduce or compensate for project impacts;
- A wetland map or boundary survey to identify which may be affected by the proposed activity;
- A sketch map showing the entire parcel of land owned by the applicant including lot sizes and property boundaries;
- A description of when the property was acquired and the price paid for the property;
- A description of the zoning classification and restrictions;
- A description of the vegetative cover of the affected area, including dominant species;
- The 100 year flood elevation and floodplain and floodway boundaries at the project site if FEMA or other flood maps are available for the area;
- The sites and specifications for all proposed drainage, filling, grading, dredging, and vegetation removal that may affect the wetland or buffer area;
- A description of any existing or proposed waste disposal or water supply including septic tanks and soil absorption field and distances to wetlands, wetland buffers and other water bodies;
- A description of restoration vegetation now in existence and proposed for all surfaces; and
- A description of the construction sequencing and timetable for any proposed activities including description of future phases.

The Board may require the permit applicant to submit additional information if the Board deems such information necessary to determine compliance of a proposed regulated activity with the standards and criteria set forth in this ordinance. Such information may include:

- More detailed site plans;
- Description of wetland ecological communities and functions;
- Description how the application will change, diminish, or enhance the ecological functions;
- Engineering reports and analyses where the proposed activity may be subject to flood or erosion hazards or increase such hazards of other types;
- Mapping or more detailed investigation of soil types where onsite waste disposal is proposed;
- Analysis of chemical or physical characteristics of any fill material;
- A stormwater management plan (if applicable);
- A wetland management plan; and
- A compensatory mitigation plan.

In the event that an application requires ..... (name of the community) to incur additional expenses for technical assistance in the review of an application, the applicant shall pay the reasonable expenses incurred by the community. The applicant shall be notified of the expenses and shall deposit necessary funds prior to the cost being incurred by the community.

Section 12: Public Notice, Hearings

Any person filing a permit application shall give written notice thereof, by certified mail (return receipt requested) or hand delivered, to all abutters at their mailing addresses shown on the most recent applicable tax list of the assessors. The notice to abutters shall include a copy of the permit application or shall state where copies may be examined and obtained by abutters.

(Note, a community could also require a permit applicant to provide notice to others. For example, a permit applicant could be required to submit a copy of the permit application to the municipal engineer if any portion of the affected area is shown as a floodplain.)

No sooner than 30 days and not later than 60 days after receipt of a permit application and after notice the permit application has been published in one newspaper having general circulation in the area, the Board may hold a public hearing on the application unless the Board finds that the activity is so minor as not to affect wetland functions, values, or acreage or have impact upon public properties or the public at large. All hearings shall be open to the public.

Section 13: Standards and Criteria for Issuance of Wetland/Buffer Area Permits

The Board shall not issue or conditionally issue a permit unless it finds that the proposed activity will not, taking into account individual and cumulative effects, threaten health or safety, result in fraud, cause nuisances, impair public rights in public waters, threaten rare or endangered plant or animal species, violate pollution control standards, or violate other regulations. In addition, the Board shall not issue a permit unless it finds that

- The permit applicant has, to the extent practical, avoided wetland and buffer areas for the proposed activity;
- The permit applicant has, to the extent practical, reduced impacts to the wetland and wetland buffer. The height, width and length of structures will be limited to the minimum dimension necessary to achieve the desired functions;
- The proposed activity will not cause a net loss of wetland functions specified in Section 1 of this ordinance;
- The proposed activity will not cause a net decrease in wetland values or acreage, taking into account the cumulative adverse effects of past and reasonably anticipated future activities;
- The proposed activity will be set back a minimum of 25 feet from the top of the bank of any river, stream, creek, or arroyo. The Board may require a larger setback based upon flooding, erosion, pollution, endangered species, riparian or wetland functions and values, or other relevant factors;
- The proposed activity will, to the extent practical, avoid

fragmentation of wetlands and the separation of wetlands from other wetlands, broader aquatic systems, and uplands by activities such as construction of dikes, levees, ditches, roads, structures, and other impediments to movement of water or biota;
- The proposed activity will not increase flood, erosion, subsidence or other hazard on other lands and the proposed activity will not, in itself, be subject to flood and erosion hazards;
- The proposed activity will not result in adverse modification of habitat for or jeopardize plant, animal, or other wildlife species listed as threatened or endangered by the U.S. Fish and Wildlife Service or (State Wildlife Agency); and
- The proposed activity will not violate other applicable federal, state, and local water quality, flood loss reduction, fill and grading, coastal zone management, stream protection, water supply protection, comprehensive zoning, sanitary code, and other statutes, regulations and ordinances.

The Board shall consider all relevant facts in making its decision on any application for a permit including but not limited to the following:

- The goals and purposes of the ordinance;
- The environmental impact of the proposed action including

o Infilling of the wetland or other modification of natural topographic contours,
o Disturbance or destruction of natural flora and fauna,
o Influx of sediments or other materials causing increased water turbidity and/or substrate alteration,
o Removal or disturbance of wetland soils,
o Reductions in wetland water supply,
o Interference with wetland water circulation,
o Damaging reduction or increases in wetland nutrients,
o Influx of toxic chemicals and/or heavy metals,
o Damaging thermal changes in wetland water supply, and
o Destruction of natural aesthetic values.

- The impact of the proposed activity and reasonably anticipated similar activities upon flood flows, flood storage, and storm barriers,
- Threats to the proposed activity from flooding, erosion, hurricane winds, subsidence, soil limitations and other hazards;
- The impact of the use and existing and reasonably anticipated similar uses upon neighboring land uses;
- The adequacy of water supply and waste disposal for the proposed activity;
- Alternatives to the proposed action and alternative sites for the activity on the applicant's property or other properties;
- Whether all reasonable and practical measures have been taken to minimize the impact of activities; and
- The relationship between short-term uses and long term productivity of the site; and
- The consistency of the activity with local, state, and federal comprehensive land use plans and watershed plans.

The Board shall make written findings on any permit applicant stating the reason why the proposed permit is issued, denied, or conditionally issued or denied. The Board may consider the following in making its decision on the application:
- The application and supporting documentation
- Public comments, evidence, and testimony
- Reports or comments from other local, state, tribal, or federal agencies and commissions, an
- Comments on the application from regional planning agencies, soil and water conservation districts, or other regional organizations.

Section 14: Conditions Which May Be Attached to Permits

The Board may conditionally approve permits. The following sorts of conditions may be attached to permit approvals:

- Design measures to reduce project impacts
- Relocation of the proposed activity to reduce project impacts;
- Compensatory mitigation measures to offset losses to wetland acreage, functions, and values
- Flood and erosion loss reduction measures to prevent hazard losses to both proposed activities and activities on other lands. This may include a requirement that structures be elevated on piles, floodproofed or otherwise protected from hazards including flood heights, velocities, and erosion potential;
- Modification of waste disposal and water supply facilities to reflect flooding, high ground water, and erosion hazards;
- Inclusion in the deed for the property a warning that the property contains a wetland and/or wetland buffer area and that any activities in the wetland or buffer are subject to wetland, floodplain and other regulatory requirements;
- Deed restrictions, covenants, or execution of conservation easements regarding the future use of lands including but not limited to preservation of undeveloped areas and restrictions on vegetation removal;
- Set-backs for structures from a river, stream, or other water body of a distance appropriate for the proposed activity and the particular wetland area;
- Erosion control and storm water management measures
- The clustering of structures or development;
- Erection of wetland area markers and signs including survey stakes delineating the boundary between wetland areas and adjacent lands
- Long term monitoring and management requirements including control of exotic plant and animal species; and
- Other conditions necessary to protect wetland functions, offset losses, and prevent increased natural hazard losses in the community.

The Board may also require the development of a wetland management plan and/or a compensatory mitigation plan to comply with these standards and criteria. See Sections 15 and 16 below.

Section 15: Wetland Management Plans

The Board may require that a permit applicant submit a wetland management plan to the Board if the Board believes such a plan is needed to meet the goals and standards of this ordinance including conditions attached to the issuance of a wetland permit. In general, plans are need for larger projects involving the manipulation of water levels, control of exotic plant species, or mitigation measures. Such management plans may include the procedures and timing of the proposed project, water level manipulation, removal of exotic species, replanting (if necessary) and other active management activities over time. It may be combined with a compensatory mitigation plan as provided in Section 16 of this ordinance.

The plan shall be consistent with the following:

- The plan shall describe any long term management proposed for the site to minimize or compensate for project impacts, how this management is to be carried out, and who will undertake the management.
- Site development shall be fitted to the topography and soil so as to create the least potential for vegetation loss and site disturbance;
- Vegetation and soil removal shall be limited to the minimum amount necessary for the development of the site.
- Vegetation indigenous to the site or plant community shall be restored in areas affected by construction activities. Temporary vegetation, sufficient to stabilize the soil, may be required on all disturbed areas as needed to prevent soil erosion. New planting shall be given sufficient water, fertilizer and protection to insure reestablishment.

Section 16: Compensatory Mitigation

The Board may require that the permit applicant submit a compensatory mitigation plan developed by qualified professionals to achieve no net loss of wetland functions, values, and acreage if the Board believes such a plan is needed to meet the goals and standards of this ordinance including conditions attached to the issuance of a wetland permit.

Compensatory mitigation may take the form of wetland and/or buffer area restoration, creation, or enhancement. Such plans shall include design, implementation, maintenance, and monitoring elements.

A mitigation plan shall:

- Describe any residual impacts to functions, values, or acreage;
- Identify riparian, wetland, and watercourse areas that are to be protected and those that will be impacted;
- Provide a plan for compensating for impacts;
- Describe proposed habitat manipulation activities in detail
- Provide replacement of affected vegetation with appropriate plant species in ratios which will result in simulation of pre-alteration vegetation within five years;
- Specify construction methods;
- Provide for periodic monitoring of mitigation; and
- Provide for the posting of performance bonds or other financial assurances.

In general, compensatory mitigation shall be onsite and in kind. However, the Board may allow use of offsite and out of kind mitigation including the use of mitigation banks if such use will have net ecological benefits, will not cause nuisances, will not violate other laws, and will not result in fragmentation of the wetland ecological system. Use of mitigation banks will be allowed to compensate for impacts only where onsite measures are, in addition, applied to ensure that flooding, water pollution, erosion, and other problems do not occur at the original site.

Where feasible, mitigation projects shall be completed prior to activities that will disturb wetlands. In other cases, mitigation shall be completed immediately following disturbance and prior to use or occupancy of the activity.

There shall be no introduction of any plant or wildlife into a mitigation project for any wetland or wetland buffer which is not native to the area unless authorized by a state or federal permit or approval.

In general the following ratios shall be provided for restoration, creation, and enhancement: x:x for restoration, x:x for creation, and x:x for enhancement. The Board may increase the ratios if uncertainties exist with regard to the success of the proposed mitigation, a significant period of time will elapse between impact and replication of wetland functions, the mitigation will result in reduced wetland functions relative to the wetland being impacted, or the impact was an unauthorized impact. The Board may decrease rations if the proposed mitigation has a high likelihood of success, the proposed mitigation will provide functions and values significantly greater than the wetland being impacted, or the proposed mitigation is conducted in advance of the impact and has been shown to be successful.

In evaluating the adequacy of proposed compensatory mitigation, the Board shall consider:

- The risk of failure of the proposed mitigation project based upon the difficulty with which this type of wetland is restored, created, or enhanced, the experience and expertise of the individual or individuals proposing to carry out the mitigation, the proposed buffer and other protection measures, and the proposed management, monitoring and maintenance,
- The societal importance of wetland/buffer functions provided by the mitigation plan in contrast with the societal importance of the functions of the original wetland/buffer,
- Whether the proposed mitigation will require long term maintenance and, if so, the adequacy of any proposed maintenance,
- The need for long term monitoring and whether such monitoring will be provided, and
- Whether there will be offsite impacts of the proposed mitigation such as flooding or adjacent property.

Section 17: Variances

The Board may issue variances to the wetland and buffer requirements of this ordinance where the regulations will otherwise deny landowners all economic use of entire properties taking into account existing uses, reasonably anticipated future uses, market values and sales for comparable properties, taxes, special assessments, and other factors. The Board may issue a variance only for the minimum deviations from permit standards, conditions, or mitigation measures which will be consistent with not denying landowners all economic use of their entire properties. The Board shall not authorize variances for activities which will increase flood and erosion losses on other properties, pose threats to public health and welfare such as flash flooding, pollute potable water supplies, or otherwise cause nuisances. The Board shall also not issue a variance for activities which will violate other laws.

Section 18: Nonconforming Uses

All uses and activities that were lawful before the passage of this ordinance but which do not conform with the provisions of the ordinance, may be continued but may not be expanded, changed, enlarged or altered without a permit as provided above. Nonconforming uses including but not limited to buildings shall not be enlarged or expanded to further encroach into the wetland. No nonconforming activity which has been discontinued for more than two years shall not be resumed. No nonconforming structure which has been destroyed or damaged for more than 50% of its value by flooding, wind, fire, or other natural or man-made force may be rebuilt only with issuance of a permit in conformity with the provisions of this ordinance

Section 19: Bonds and Insurance

Upon approval of the application and prior to issuance of a permit, the Board may require the permit applicant to file a bond with such surety in such amount and in a form approved by the Board.

Release of the bond or surety shall be conditioned on compliance with all provisions of these regulations and the terms, conditions and limitations established in the permit.

The Board may require the applicant to certify that it has public liability insurance against liability which might result from the proposed activity covering any and all damage which might occur within... (specify) years of completion of such operations, in an amount commensurate with the regulated activity.

Section 20: Inspections, Display of Permit, Revocations of Permits

Every permit issued pursuant to this ordinance shall allow the Board or its designated employee the right to inspect a project to determine compliance with conditions and the provisions of this ordinance. A permit applicant shall notify the Board at least five days before project construction is to be begin. The permit shall be prominently displayed at the project site during the undertaking of the activities authorized by the permit. All permits shall be valid for a period of one year from the date of issuance unless the Board indicates otherwise. The Board may issue a Stop Work Order if it finds that the permittee is violating provisions of the permit or of other applicable laws, ordinances, and/or regulations. The Board may, on written notice to the permittee, suspend or revoke a permit issued pursuant to this ordinance if the permittee has not complied with any term or condition of the permit or has failed to undertake the project in the manner set forth in the application.

Section 21: Enforcement and Penalties

Any person who commits, takes part in, or assists in any violation of any provision of this ordinance is guilty of a misdemeanor and may be fined not more than.....(specify) dollars for each offense and subject to imprisonment not exceeding.....(specify) days or both. Each violation of this ordinance shall be a separate offense, and in the case of a continuing violation, each day's continuance thereof shall be deemed to be a separate and distinct offense.

The (community name)..... shall have jurisdiction to enjoin a violation of this ordinance.

All costs, fees, and expenses in connection with such action shall be assessed as damages against the violator. The zoning administrator and other governmental officials learning of a violation shall refer the violation to the City Attorney.

In the event of a violation the (community name) .....shall have the power to order restoration of the wetland area. If the responsible person or agent does not complete such restoration within a reasonable time following the order, the authorized local government shall have the authority to restore the affected wetlands to the prior condition and the person or agent responsible for the violation shall be held liable to the (community name) for the cost of restoration.

Section 22: Appeals

Appeal on actions of the Board shall be made in accordance with provisions of the General Statutes (specify section) .....

Section 23: Conflict and Severance

This ordinance shall be construed as not to conflict with any provision of local, state, or federal law. However, the provisions of this ordinance shall control if more restrictive than other local, state, or federal laws.

If any portion of this ordinance is held invalid or unconstitutional by a court of competent jurisdiction, all remaining provisions of the ordinance shall continue to be of full force and effect.

Section 24: Application Fees

At the time of a permit application, the applicant shall apply a filing fee of (specify).....if the project will involve less than x amount of square feet of disturbance to a wetland and/or buffer area and a filing fee of (specify).....if more.

The Board may also require an applicant to pay fee a for reasonable costs and expenses born by the Board including but not limited to verifying wetland boundaries, analyzing resource functions and values including wildlife evaluations, and hydrogeologic and drainage analyses.

Appendix C. EPA Routine Maintenance Tables[111]

Table 2.2: Typical Inspection/Maintenance Frequencies for Ponds And Wetlands

Frequency	Inspection Items (Skill Level)	Maintenance Items (Related Profile Sheet)
One time - After First Year	- Ensure that at least 50% of wetland plants survive (0) - Check for invasive wetland plants (0)	- Replant wetland vegetation (See M-4 Vegetation Management)
Monthly to Quarterly or After Major Storms (>1")	- Inspect low flow orifices and other pipes for clogging (0) - Check the permanent pool or dry pond area for floating debris, undesirable vegetation (0) - Investigate the shoreline for erosion (0) - Monitor wetland plant composition and health (0-1) - Look for broken signs, locks, and other dangerous items (0)	- Mowing – minimum Spring and Fall (See M-4 Vegetation Management) - Remove debris (M-2 Clogging) - Repair undercut, eroded, and bare soil areas (See M-4 Vegetation Management)
Several Times per Hot/Warm Season	- Inspect stormwater ponds and stormwater wetlands for possible mosquito production (0-1)	- Inspect for mosquitoes (See M-8 Nuisance Issues)
Semi-annual to annual	- Monitor wetland plant composition and health (0-1) - Identify invasive plants (0-1) - Ensure mechanical components are functional (0-1)	- Setup a trash and debris clean-up day - Remove invasive plants (See M-4 Vegetation Management) - Harvest wetland plants (See M-4 Vegetation Management) - Replant wetland vegetation (See M-4 Vegetation Management) - Repair broken mechanical components if needed (See M-7 Mechanical Components)
Every 1 to 3 years	- Complete all routine inspection items above (0) - Inspect riser, barrel, and embankment for damage (1-2) - Inspect all pipes (2) - Monitor sediment deposition in facility and forebay (2)	- Pipe and Riser Repair (See M-3 Pipe Repair) - Complete forebay maintenance and sediment removal when needed (See M-5 Dredging and Muck Removal)
2-7 years	- Monitor sediment deposition in facility and forebay (2)	- Complete forebay maintenance and sediment removal when needed (See M-5 Dredging and Muck Removal)

Table 2.3: Maintenance Activities and Schedules

Category	Management Practice	Maintenance Activity	Schedule
Wetlands	Shallow wetlands, pond wetlands, "pocket" wetlands	— Cleaning and removing debris after major storm events (>2" rainfall — Harvesting of vegetation when a 50% reduction in the original open water surface area occurs — Repairing embankment and side slopes — Repairing control structure	Annual or as needed
		— Removing accumulated sediment from forebays or sediment storage areas when 60% of the original volume has been lost	5-year cycle
		— Removing accumulated sediment from main cells of pond once 50% of the original volume has been lost	20-year cycle
		— Removing accumulated sediment from main cells of pond once 50% of the original volume has been lost	20-year cycle
	Infiltration basin	— Cleaning and removing debris after major storm events; (>2" rainfall) — Mowing and maintenance of upland vegetated areas — Cleaning out sediment	Annual or as needed
		— Removing accumulated sediment from forebays or sediment storage areas when 50% of the original volume has been reduced	3- to 5-year cycle

Appendix B- EPA Cost of Maintenance estimates[112]

Table A-1. Unit costs for pond and wetland maintenance[1]

Maintenance Item	Unit Price ($)	Unit	Mobilization Cost ($)[2]	Maintenance Interval (yrs)[3]
Permanent Pool Issues				
Dam/ Embankment				
unclog internal drains for embankments	10	lf	1,500	R(10)
repair low spots in dam or berm	170	cy	1,500	R(5)
Clogging				
debris removal (preventative)	350	event	0	0.25-1
clear outfall channel of sediment	130	cy	0	5-15
clogged low flow	750	event	800	0.25-1
Pipe Repairs				
Structural - Riser and Barrel				
re-tar CMP barrel	11	sf	800	15-20
install new elbow underground	1,200	ea	800	R
repair CMP barrel joint leak	530	ea	800	R (3-5)
repair leaking concrete principal spillway joint	1,200	ea	0	R (5-10)
replace riser (CMP)	12,000	ea	>2,500	R (25)
replace riser (concrete)	20,000	ea	>2,500	R (50)
replace barrel	1,000	lf	>2,500	R (25-50)

1) These costs were largely derived from data from the Maryland region, based on bid project and actual 2005 project data.
2) Cost at four levels: $0 for no mobilization; $800 for minimal mobilization; $1,500 for small project mobilization; >$2,500 for large project mobilization. Note that these are approximations. For items with no mobilization cost, it is assumed that the mobilization cost is incorporated into the overall unit cost, or that the maintenance can be completed during inspection.
3) Bottom number in range represents ideal maintenance interval. Top number represents maximum interval between maintenance activities. R indicates repair items, whose frequency is somewhat unpredictable. The frequencies sometimes reported in parentheses represent an estimate of typical repair frequency.

Maintenance Item	Unit Price ($)	Unit	Mobilization Cost ($)[2]	Maintenance Interval (yrs)[3]
Structural - Pipes				
replace existing underground elbow	1,400	ea	800	R (10)
slip line failing pipes	90	lf	>2,500	R
replace end sections <36”	600	ea	1,500	R
remote control TV video pipes	1	lf	800	5-25
Structural - Other Concrete				
concrete work under ground	600	cy	1,500	R
concrete work above ground	450	cy	1,500	R
grout cracks	50	lf	0	R
parge spalling	25	sf	0	R
repair gutter spalling	230	event	800	R
injection grout concrete leaks	180	lf	800	R
Structural - Metal				
new low flow trash rack	1,700	ea	800	R (5-10)
install high stage trash rack 4’x2’	1,100	ea	1,500	R (20+)
replace CMP anti-vortex device <48”	1,500	ea	1,500	R (10-15)
replace CMP anti-vortex device <48”	4,600	ea	1,500	R (10-15)
remove bolts, lift lugs, form nails	80	ea	800	R

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2. Cost at four levels: $0 for no mobilization; $800 for minimal mobilization; $1,500 for small project mobilization; >$2,500 for large project mobilization. Note that these are approximations. For items with no mobilization cost, it is assumed that the mobilization cost is incorporated into the overall unit cost, or that the maintenance can be completed during inspection.
3. Bottom number in range represents ideal maintenance interval. Top number represents maximum interval between maintenance activities. R indicates repair items, whose frequency is somewhat unpredictable. The frequencies sometimes reported in parentheses represent an estimate of typical repair frequency.

Maintenance Item	Unit Price ($)	Unit	Mobilization Cost ($)[2]	Maintenance Interval (yrs)[3]
Vegetation Managment				
sod	3.30	sy	800	1-2
seed and top soil bare areas (3 inch depth)	4.40	sy	800	1-2
plant 1.5 inch tree	84	ea	0	R[3]
plant shrub	15	ea	0	R
mowing	300	ac	0	0.5-1
clear outfall and channel of trees	5.50	sy	800	0.5-1
clear embankment of small trees by hand	3.30	sy	800	0.5-1
clear embankment trees with Ambusher or Brushhog	0.90	sy	800	0.5-1
remove live tree (<12 inches)	130	ea	800	R (1-10)
remove live trees larger than 12 inches, <24 inches	250	ea	800	R (10-25)
remove downed timber (up to 40 cy of material)	2,200	event	0	0.25-1
remove dumped vegetative material (up to 40 cy)	2,600	event	0	0.25-1
install wetland plant	6	ea	800	R (3-5)
remove invasive wetland vegetation (machine remove phragmites) (up to 40 cy)	3,000	event	0	R
spray for algae (0.25 ac pond)	600	ea	0	R
spray for cattails (0.25 ac pond)	330	ea	0	R
repair low spots in dry pond bottom	25	sy	1,500	R
remove woody vegetation from dry pond bottom	1,700	event	0	5-10

1. These costs were largely derived from data from the Maryland region, based on bid project and actual project data.
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3. Bottom number in range represents ideal maintenance interval. Top number represents maximum interval between maintenance activities. R indicates repair items, whose frequency is somewhat unpredictable. The frequencies sometimes reported in parentheses represent an estimate of typical repair frequency.

Maintenance Item	Unit Price ($)	Unit	Mobilization Cost ($)[2]	Maintenance Interval (yrs)[3]
Dredging and Mucking				
dredge wet ponds (jobs larger than 1000 cy) haul offsite	60	cy	>2,500	5-15
dry pond sediment removal	7,600	event	0	15-25
dewater pond	900	event	0	15-25
muck out undergrounds	390	cy	0	0.5-1
dewater and remove sludge from underground facilities	1	gal	0	0.25-1
typical sediment dump fee (not including trucking)	66	ton	0	NA
truck day for landfill to transport underground dredge materials (minimum, assume 2 to 4 trips in one day)	800	trip-day	0	NA
Access/ Safety				
install warning signs	210	ea	0	R
add manhole steps	100	ea	800	R
new manhole cover	250	ea	0	R
create 12' access road (permanent, cut/fill balances)	40	lf	1,500	R
create 12' access road (permanent, cut/fill non-balance)	65	lf	1,500	R
create 12' access road (temp)	12	lf	1,500	R
install chainlink fence	26	lf	800	R
install ladder (8 foot)	220	each	800	R
install three rail fence	15	lf	800	R
repair asphalt path	26	cy	800	R
supply lock and chain for first one (additional at $30 apiece)	130	ea	0	4-8

1. These costs were largely derived from data from the Maryland region, based on bid project and actual project data.
2. Cost at four levels: $0 for no mobilization; $800 for minimal mobilization; $1,500 for small project mobilization; >$2,500 for large project mobilization. Note that these are approximations. For items with no mobilization cost, it is assumed that the mobilization cost is incorporated into the overall unit cost, or that the maintenance can be completed during inspection.
3. Bottom number in range represents ideal maintenance interval. Top number represents maximum interval between maintenance activities. R indicates repair items, whose frequency is somewhat unpredictable. The frequencies sometimes reported in parentheses represent an estimate of typical repair frequency.

Maintenance Item	Unit Price ($)	Unit	Mobilization Cost ($)[2]	Maintenance Interval (yrs)[3]
Mechanical Components				
remove old valve	300	ea	800	R (10)
install new valve (<36 inches)	4,600	ea	1,500	R
install new valve (< 24 inches)	3,100	ea	1,500	R
install new valve (<11 inches)	1,300	ea	1,500	R
install new valve (<7 inches)	460	ea	800	R
lubricate valves (same price for first four)	300	ea	0	1-2
Nuisance Issues				
pond/ wetland aeration	560	ea	0	1
treat pond for mosquitoes	1,000	acre	0	R
trap beavers (one week, one location, family of 6)	1,000	event	0	R
fill animal burrows	23	sy	800	R (5-10)
remove graffiti	310	day	800	1-3
Erosion/ Channel Maintenance				
establish new riprap pilot channels (8' wide, 1' deep)	38	lf	1,500	5-15
remove and replace rip rap or pea gravel	160	sy	1,500	15-25
shoreline protection	50	lf	1,500	R
new riprap (general)	80	cy	1,500	R (5-10)
erosion repair	1,100	event	0	R (2-5)
jet clean rip rap (6X 15, 1' silt)	2,500	event	0	15-25

4) These costs were largely derived from data from the Maryland region, based on bid project and actual project data.
5) Cost at four levels: $0 for no mobilization; $800 for minimal mobilization; $1,500 for small project mobilization; >$2,500 for large project mobilization. Note that these are approximations. For items with no mobilization cost, it is assumed that the mobilization cost is incorporated into the overall unit cost, or that the maintenance can be completed during inspection.
6) Bottom number in range represents ideal maintenance interval. Top number represents maximum interval between maintenance activities. R indicates repair items, whose frequency is somewhat unpredictable. The frequencies sometimes reported in parentheses represent an estimate of typical repair frequency.

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