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“Water Water Everywhere”
Analyzing Long Island’s Water Issues and Finding Solutions For a Sustainable Future

Anthony Becker
Fordham University, May 2014
Abstract

Over three million people call Long Island their home. With access to beautiful landscapes, world-renowned beaches, and proximity to New York City, it is no wonder that so many proudly call this geographic stretch of glacial till their home. However, throughout the years our actions do not necessarily reflect this affection we have to our home. Years of sprawl and human infestation across the island have resulted in widespread environmental degradation. Specifically, the water we drink and the beaches we enjoy have become endangered. I plan on studying the urban ecology of how intensified population growth led to the eutrophication of the estuaries of the south shore as well how it has impacted our sole source aquifer. The natural history of Long Island sets the scene for discussing how these environmental problems arose from colonial outpost to modern day suburb. These water issues are inextricably linked to the loss of the maritime economy that followed. Long Island is surrounded by three main water bodies – the Long Island Sound to the north, the Peconic Estuary to the East, and the South Shore Estuary Reserve to the south. For the purpose of keeping the scope of this thesis concise, I focus on the latter water body. We can utilize overarching ecological design principles in tandem with policy solutions to better live in the place where we live, as well as crucially needed water policies to solve Long Island’s groundwater problem, applying federal and state legislation. My solutions address renewable energy use for the Island by looking at the proposed Long Island Off-Shore Wind Farm. These issues of sustainability are important to address if we want a secure future on this island that we call home. In this thesis, I strive to examine the effects of three million people living on an island with finite resources and how together and through exciting and innovative new designs we can create a more sustainable way of island life.
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In fourth grade we learned about the barrier island. Mrs. Colorusso taught us all about the strip of sandy beach that lays parallel to the south shore that protects us from big waves, storms, and erosion. That same year, probably even in that same lesson, we learned about the lighthouses that help guide and protect people out at sea. We built paper mache versions of the more well-known lighthouses. I remember I was in the group that was assigned to build the Orient Point Lighthouse, going off of just pictures we printed out because most of us had never been there ourselves. Somewhere between learning what erosion was and comparing the histories of these seemingly ancient pillars of the landscape that were so iconic even in the minds of young elementary schoolers, it dawned on me that this place where we live is in fact an island. This may seem silly to people not from the area, obviously it’s an island – it’s even in the name. But when you grow up on Long Island, on this 120 mile long, 23 mile wide fish-shaped place where each town touches the next, slowly, somehow mysteriously blending into “the city” in one direction, and equally slowly fades away to the countryside in the other, it’s easy for your mental geography to take a backseat.

My godfather lives on a farm out in Speonk, near the Hamptons. Every fall, we drive out east to pick pumpkins and help him bring in the harvest from all across the 25 acres behind his house to the front of his yard where people from all over come to buy pumpkins, cheese pumpkins, butternut squash, and odd-shaped gourds of all different hybrid varieties and colors and shapes. I can’t speak for everyone who lives on Long Island when I say that experiences like this are typical for the average Islander. Regular trips to the farm have given my family and I an insight into the Island that was here before Robert Moses. When you pick a 20-pound pumpkin off its prickly vine, fresh from
the cool dirt, and bring it home to decorate for Halloween or bake into a pie, you forget that probably just 10 miles away from wherever you’re standing, a whale is on its migratory path in the open Atlantic ocean. This is the beauty of Long Island. In the midst of an apparent suburban landscape, a beach can always be found 30 minutes away. Despite the common imagery of tropical climates and palm trees that comes to mind when one hears the word “island,” we feel the force of all four seasons – enjoying the beaches in the summer and the snow in the winter. Growing up on an island means that everywhere you go, images of anchors, ships, seagulls, old scrimshaw, and collected shells are sure to be found in houses, on municipal signs, in storefronts – an inescapable part of the cultural iconography. Nautical symbols like these remind us of our geography, but there is something else, something so simple yet profound that has tragically gone overlooked – our water. The size and natural diversity of Long Island do not lend its dwellers to actively think about the quality of our water all the time, yet it is our water that invokes our geological placement most of all. Long Island has what is known as a Sole Source Aquifer, meaning that the only place we get our drinking water from is the aquifers beneath our feet. There is no other alternative. All too often those who study the environment find that things that go unnoticed can be missed most when they’re gone. Right now, the safety of our water – the drinking water that comes out of our faucets as well as the bays and beaches we fish and swim in – is in danger of being contaminated by the effects of 3.4 million people growing, developing, and living on this stretch of glacial till. Runoff from the suburban built environment allows contaminants to get swept away into the surface waters, years of dumping of industrial waste has given us more Superfund sites than anyone would like, outdated infrastructure does not meet our waste
management demands safely, and years of agriculture and population growth have lead to
eutrophication from nitrogen pollution. Due to Long Island’s unique geography, the
ground and surface waters are interconnected, meaning that what goes in the ground will
end up back in our faucets and in our bays. What a shame it would be for our Island’s
waters, so abundant in both quantity and quality, to become tainted to the point that there
is no longer a “drop to drink?” This is a worst-case scenario of course, though totally
possible nonetheless. Throughout this entire thesis, it is important to keep this geological
constant in mind, and it is especially critical in terms of cooperation with land use for
policy solutions. Right now, there are people working hard to bring awareness to what
could be the ultimate tragedy of probably the most common and important resource we
have. Without safe water there can be no human settlements. Our modern world has been
preoccupied with the luxuries that come with a stable foundation for civilization, but now
that stability is threatened for Long Islanders. John Muir said that one who tugs at a
single thing in nature finds it attached to the rest of the world. Unfortunately, Long Island
is a perfect example of the reality of this statement. Fortunately, it is also my home; and I
intend to do my best to explain this pervasive dilemma that affects all of us, as well as
find unique solutions to help Long Island sustain 3.4 million people while still looking
beautiful doing it.

Chapter 1: Got Water?

Water quality is one of the most vital necessities for civilization. On Long Island,
our water resources are increasingly threatened by pollution. Quantitative studies have
shown that volatile organic chemicals, pesticides, and pharmaceutical drugs pose a large
threat to our water resource, but public enemy number 1 is nitrogen. The largest source of this nitrogen contamination is our own wastewater, which either seeps into the ground beneath us and infiltrates into our groundwater aquifers – our only source of drinking water – or is discharged into the water ways around us, both causing contamination and eutrophication of our estuary systems that surround us on all the shores of Long Island. This has also caused harmful algal blooms that further disrupt the ecology of our aquatic systems, and thus indirectly the water-based economy our island depends on. Our groundwater and surface waters are linked, so what contaminates one can reach the other. This is why the water dilemma is so pervasive. Being that this thesis is dealing with discussing a ubiquitous problem of a specified geographical region, the individual problems mentioned are inextricably tied in with other issues. Simply stated, the focus cannot and will not be on just groundwater contamination or estuary eutrophication, but rather a discussion of the whole scope of the impairment of these natural resources.

To understand the water problem on the Island, it is important to first understand the hydrology of the Island. About 20,000 years ago, the Wisconsin glacier plowed down from the north and carved out much of the landscape, separating what would become Long Island from the southern base of Connecticut. The glacier stopped and the rate of melt was equal to the rate of advance. This allowed huge amounts of water and runoff sediment to wash down along the southern moraine, which would become the smoothed south shore. The glacier receded northward and the larger, coarser sediment at the base of

1 Suffolk County Comprehensive Water Resources Management Plan, Executive Summary Jan. 2014
2 Tom Anderson, This Fine Piece of Water: An Environmental History of Long Island Sound
the glacier remained behind, creating the rockier and higher elevated north shore.

Following sea level rise from the rest of the glacial melt, the result was an island formation with a peak along the middle ridge, sloping downward on the north and south sides, with a steeper slope toward the south shore that reaches sea level. Underneath the Island, there are three major aquifers that provide water reserves to the residents above. Long Island’s aquifers are made up of sand and gravel with layers of clay in between various layers of aquifers that slow down the flow of water through the underground matrix. The deepest and cleanest is the Lloyd Aquifer, which is 80-100 million years old. Above that is the Magothy Aquifer in the middle, which is the largest and 50-80 million years old. The Upper Glacial Aquifer is the closest to the surface and is the most vulnerable to contamination, dated to 10-15 million years old. All three of these aquifers receive their freshwater resources from precipitation, or rain, at an average rate of about 44 inches per year. Only about 22 inches of rain actually seeps downward to recharge the groundwater, but in Suffolk County alone that equates to a capacity of around 70 trillion gallons. Of this, 210 million gallons is used and 990 million gallons is left for recharge. The rest mostly flows into rivers and streams, which then flow to the ocean creating thriving estuarine and wetland ecosystems, supporting the various watersheds along the coasts of the Island. The water that does seep down through the soil to the water table goes through what is called the “groundwater divide.” This is a sort of imaginary line underground, actually along the Long Island Expressway, where the water either falls through and flows down the north gradient and out into the Long Island Sound, or flows

3 http://www.citizenscampaign.org/campaigns/long-island-groundwater.asp
down the south gradient and out into the southern bays and Atlantic Ocean. The first two aquifers, the Upper Glacial and the Magothy, are recharged by rain that falls on the perimeter of the Island, particularly where it falls in the middle of the Island where the elevation is highest. This is the deep-flow recharge zone, where water is able to permeate quickly through the pressurized strata of layers of clay and sand. This process filters out any imperfections in the water. Since water likes to go from areas of high pressure to low pressure, it is pushed to the coastlines where the pressure is lower than under the ground. What does all of this geology have to do with pollution?

It is important to note that our groundwater is some of the best quality in the nation due to these complex, naturally geological filtration systems. However, Adrienne Esposito of the Citizen’s Campaign for the Environment put it best when she said, “the beauty of Long Island is that we’re an island, the challenge of Long Island is that we’re
an island.” The EPA has designated Long Island’s aquifers as sole source aquifers, meaning that 100% of our drinking water comes from these aquifers. There is no other source. Most of the public supply wells draw water from the Magothy aquifer rather than the closer Upper Glacial, because the Magothy is less contaminated. According to the United Stated Geologic Survey (USGS), Nassau and Suffolk counties used more than 375 million gallons each day in 2000 for public, domestic, industrial, and irrigation uses4. Today, Nassau and Suffolk counties draw up over 138 billion gallons of water each year. Kings and Queens counties utilize the same upstate Catskills municipal water supply as the rest of the city, but increasing populations have led to controversial situations in which southwestern Queens has started drawing up groundwater. Coastal areas, particularly the areas of southeastern Nassau, Great Neck peninsula, Port Washington peninsula, the Huntington necks, and the North and South Forks, that draw their freshwater from groundwater are vulnerable to or are currently experiencing the problem of saltwater intrusion. This happens when groundwater is pumped out of the aquifer at a faster rate than it can recharge, which means there is less water flowing outward into the estuaries, reducing the pressure of that flow, and the saltwater from the Atlantic flows back into the aquifer, causing the groundwater to become saline5. This highlights one of the more interesting aspects of our hydrological cycle – our groundwater and surface waters are connected. This has huge implications not only on the security of our freshwater reserves, but also the health of the ecosystems that benefit from these same hydrological processes that we do. Being that these aquifers are our only source of

4 Long Island Aquifers, NYS Department of Environmental Conservation

5 http://www.citizenscampaign.org/campaigns/long-island-groundwater.asp
drinking water, the reality becomes more ominous when we look at everything that we’ve been throwing on the ground through the years.

In 2002, the USGS found trace amounts of hormones, antibiotics, contraceptives, and steroids in 80% of the waters they tested nationwide. These pharmaceutical drugs enter the waterways through human waste and improper flushing of unwanted or unused pharmaceuticals. Flushing these drugs has been an accepted method of disposal for years, but now we know this is certainly not the case. Sewage, storm water, and drinking water infrastructure were never built to handle wastes like these, and thus these chemicals end up in trace amounts in our drinking water supplies, especially on Long Island where what goes into the ground comes back through our faucets. We don’t fully know the effects that constant exposure to these chemicals could have on our daily lives, but the prime concerns tend to be that they can cause antibiotic resistance, hormone disruption, and other unknown synergistic effects. In Suffolk County alone, the USGS and the Department of the Interior partnered with the Suffolk County Water Authority and found low but measurable amounts of pharmaceutically active compounds in 28 out of 70 samples taken from 61 groundwater wells in the Upper Glacial and Magothy aquifers. The most common drugs they found were carbamazepine, an antiepileptic drug, and sulfamethoxazole, a common antibiotic. They also found acetaminophin, caffeine, codeine, cotinine, and gemfibrozil, ibuprofen, phthalates (a known hormone disruptor), and 1,4-dioxane, commonly found chemical in detergents. The fact that these compounds are being detected means that they are not getting filtered through any current wastewater treatment systems. A study on the effects of treated sewage effluent on the marine life in Jamaica Bay in 2002 found a direct correlation between trace amounts of pharmaceuticals
and feminization of nearby winter flounder populations. The ratio of female to male flounder was 10:1, suggesting that the estrogen-mimicking compounds in the water were impacting these fish in their embryonic development stages. Long Island has a notorious history of being the center of a breast cancer epidemic, with higher rates of breast cancer than the national average. The Long Island Breast Cancer Study received $30 million in federal funding to find some correlation between our seemingly higher rates of cancer and environmental factors such as exposure to PAHs (a known carbon-based carcinogen) and organocarbons (found in pesticides like DDT), but turned up very little evidence. Still, some remain skeptical – myself included – that being the nation’s first suburb has yielded no effects whatsoever on the integrity of the health of those living here. The puzzling negative conclusion has spurred more follow up studies. Separately from this huge study, there have been correlations between cancer rates and residential proximity to the infamous Grumman Plume in Bethpage, but more on that later. Household hazardous wastes (HHW) are an increasing problem because they come from such a wide range of commonly used products. These are defined as any commonly found household item with the potential to ignite, cause a violent chemical reaction, be a dangerous corrosive, or be harmful to human health. Every year, over 100,000 tons of HHW are improperly disposed of in New York, with the average person accumulating about 6 pounds of it per year. The most common of these are antifreeze and brake fluids, automotive batteries, electronics and household batteries, household cleaners and beauty products, medicines, mercury, motor oil, paint thinners, solvents, wood preservatives, and

6 http://www.citizenscampaign.org/campaigns/pharmaceutical-disposal.asp

pesticides. A very dangerous class of household wastes are those called volatile organic compounds (VOCs), contained in a wide range of products like paint thinners, office supplies, and cleaning products. They’re being found in increasing frequencies, and particularly high concentrations in the Magothy aquifer, Nassau County’s main drinking water source, and have been found in high concentrations in 70% of community supply wells. The three most common volatile organic compounds are tetrachloroethene (PCE), trichloroethylene (TCE), and 1,1,1-trichloroethane (TCA), a known carcinogen. PCE is currently found in 4 times as many wells than they found back in 1987, and levels of TCE were found to have increased 150%. The third group of dangerous substances that pollute our waters are pesticides. The top three pesticides found in our drinking water are imidacloprid, metalaxyl, and atrazine. Imidacloprid is toxic to fish and crustaceans, leaches quickly through soils, and have been detected in regional groundwater for the past 11 years. Metalaxyl has been linked to kidney and liver damage, is toxic to birds, and is highly soluble in water. It also classifies in the EPA’s Acute Toxicity Class II, meaning it’s defined as “moderately toxic.” Atrazine is a known teratogen and endocrine disruptor. We also know it causes birth defects, low birth weights, menstrual problems, and causes demasculinization in some species of frogs. The technical definition of a pollutant is anything that occurs in an ecosystem in too high amounts. This constitutes the presence of pharmaceutical drugs, household wastes, and pesticides as definite pollutants in the groundwater supply, and ultimately in the larger environment around us.

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8 http://www.citizenscampaign.org/campaigns/long-island-groundwater.asp
10 http://www.citizenscampaign.org/campaigns/pesticides.asp
Estuaries are ecotones by nature, which are areas where differing ecosystems merge and harbor the most biodiversity. Secure from the waves of the open ocean that pound the coasts, yet renewed by continual tides, currents, and rivers that infuse estuarine waters with oxygen, the fertility of estuaries is comparable to coral reefs and tropical rainforests and even richer than grasslands, temperate or boreal forests. Between the south shore of Long Island and the barrier islands are the southern bays, though they are technically lagoons. Fresh water from the rivers, streams, and underground aquifer feed Jamaica Bay, South Oyster Bay, Great South Bay, Moriches Bay, and Shinnecock Bay, mixing with the salt water from the Atlantic Ocean, creating a continuous 499 square mile long area estuary, now under the umbrella term of the South Shore Estuary Reserve, in which about 1.5 million people live. The largest of these five bays is the Great South Bay, which is also considered one of the continent’s most productive marine habitats. Production here is the amount of carbon dioxide fixed by photosynthetic organisms per unit of time, and it is the bedrock force behind any ecosystem. The bays are composed of a variety of organisms, from the various seaweeds, green, red, and brown algae, sea lettuce and green fleece represent the protists, while the eelgrass is the only true green plant that has colonized Long Island’s bays. This important seagrass serves as both nursery and supermarket to other forms of life in the bays, providing a place to spawn and grow as well as food and habitat for 210 species of special emphasis, including 43

11 Tom Anderson, This Fine Piece of Water: An Environmental History of Long Island Sound
12 South Shore Estuary Reserve Council Draft Comprehensive Management Plan
species of fish, 101 species of birds, and a long list of other federally protected species15. Of the animals, there are hard clams, bay scallops, the pen-shaped Atlantic jackknife clam, as well as more familiar megafauna like loggerhead turtles and harbor seals. The underwater prairies of the seagrass communities are rivaled in their ecological importance only by the salt marshes. As one of the most productive habitats on earth, salt marshes host a plethora of inhabitants such as mussels, snails, worms, insects, and birds16, and in the South Shore Estuary Reserve they made up 15% of the total estuarine acreage17. A salt marsh forms when streams carry fine sediments and particulate matter that accumulate toward the surface of calm waterways. Eventually, cordgrasses grow on these mounds and anchor themselves in the sediments. This stabilizes mucky substrate from dissolving in tidal action. Salt marshes are always changing and moving, and they provide habitat for an array of birds and spawning finfish as well as intricate vegetation, like the pink swamp rose. Together with sea grass communities, these two habitats allow for an explosion of biodiversity and the maintenance of ecosystem services that benefit everyone in the environment, including us. However, this large stretch of bustling estuarine habitat is endangered by an insidious threat.

Nitrogen is a nutrient that is actually essential for ecosystems to function and is also the most abundant element in the air we breathe and a natural fertilizer. However, when there is too much nitrogen in the ecosystem, the various primary producing algae

17 Memorandum from CDM to Mr. Martin Trent on Suffolk County Comprehensive Water Resources Management Plan Task 6.2 – Coastal Marine Resources
organisms take it in and grow and multiply faster than the ecosystem can handle, producing harmful algal blooms (HABs). These algae have short life spans and when they die in huge numbers the decomposition process consumes vast amounts of oxygen in the water, creating hypoxia (lowered levels of dissolved oxygen) or in the worst cases, anoxia (zero levels of dissolved oxygen). This is called eutrophication and it wreaks havoc on entire aquatic ecosystem communities, causing habitat degradation, alterations in the food-web, and reductions in biodiversity. The blooms also become so dense that they block the amount of sunlight that reaches the benthic lower layers of aquatic ecosystems, damaging aquatic plants and filter feeding organisms that normally rely on planktonic food sources. For humans, an increased ingestion of nitrogen in the form of polluted drinking water with levels above the EPA’s limit of 10 mg/L induces methemoglobinemia, which blocks the ability of hemoglobin in the blood to carry oxygen. This leads to “blue baby syndrome” and headaches, convulsions, even asphyxiation, in infants, as well as brain damage in adults. In 1987, nitrogen levels were at 3 mg/L in the Upper Glacial aquifer and 1 mg/L in the Magothy. Since 2005, there’s been a 40% increase of levels in the Upper Glacial and a 70% increase of levels in the Magothy, which is very alarming. Some levels have been reported in wells in Northport of 8-12 mg/L, and current projections are looking at a breach of the EPA’s 10 mg/L standard by the year 2050. Algal blooms can be very toxic to the aquatic organisms and humans depending on the type of phytoplankton that explodes in population. These

18 Nutrient Pollution, EPA. http://www2.epa.gov/nutrientpollution/problem

are commonly referred to as either the brown, red, or rust rides. The brown tide is caused by the Aureococcus anophagefferens algae and just last year it has returned in concentrations 20x the normal harmful levels to shellfish. It’s called the brown tide because it turns the water a coffee color, and it has been forming in the south shore bays for the past 25 years in increasing levels. Though not harmful to humans, it poisons marine life and blocks out the sunlight from reaching aquatic vegetation. The Alexandrium and Cochlodinium algae are responsible for the red tide, also called the rust tide. Cochlodinium has appeared in Long Island waters since 2004 and in some studied cases have caused fish kills of killifish, snapper, and black sea bass, all found with a coating of orange slime. The alga Alexandrium is particularly sinister because it produces saxitoxin, a neurotoxin also known as Paralytic Shellfish Poisoning. Eating a mollusk with saxitoxin accumulated in its tissues causes numbness and tingling in the face and extremities, along with headache, dizziness, nausea, loss of coordination, and potentially severe paralysis, respiratory failure, or even death. The toxic blooms of these dinoflagellates have been known to damage the gills of fish and clog the filtering bodies of shellfish. All of these algal blooms have been enhanced by increasing nitrogen levels. Nitrogen also causes explosions in sea lettuce populations, which then wash ashore in troves and release hydrogen sulfide gas that not only smells like rotting eggs, but can also damage the brain and nervous system if inhaled. One of the most alarming threats nitrogen poses is its effect on the ecosystem services of seagrasses. Too much nitrogen on top of algal blooms causes these seagrasses’ roots to shrink and weaken their hold in the sandy substrate. We know that their health is a key component in the wetlands’ ability to reduce vulnerability from storm surge, as they reduce wave height by 80% over short
distances. With climate change’s promise of future storms like Sandy, it is imperative that our seagrasses maintain their health and thus their beneficial function for Long Islanders.

So where is all of the nitrogen coming from? Nitrogen is already one of the most abundant elements in the environment, but increases in anthropogenically produced nitrogen saturate the natural environment above its needs. The largest source of nitrogen pollution to the watershed surfaces, at 55%, comes in the form of nitrate from wastewater. Atmospheric deposition of nitrogen onto land in the form of stormwater runoff from the built environment contributes 31%, and the heavy use of fertilizers contributes 15%.21 This same study conducted by Erin L. Kinney and Ivan Valiela in

2009 for the Journal of Coastal Research concluded that specifically the Great South Bay is low on the range of eutrophication estuaries nationally, but the retention of nitrogen within the watersheds is still high. Every day of every year, excess nitrogen from human sources is diverted into the watersheds that feed into the ground and southern bays. Estuaries and salt marshes are among nature’s best filters of nitrogen because their naturally high rates of production require so much of it. But this reassures that nature has enough already. Millions of pounds of nitrogen are generated on Long Island each year as microorganisms break down sewage, animal feces, decaying plants, and fertilizers. Large centralized sewage treatment plants filter out more nitrogen from wastewater than the septic tanks on individual properties. While most of Nassau County is seweried, these sewage treatment plants don’t do enough to extract nitrogen. Unfortunately, most of Suffolk County residents have septic tanks or cesspools, which don’t filter out nitrogen and thus leach most of their waste into the ground. So the wastewater-derived nitrogen from Nassau comes in the form of point sources from the outflow of the various sewage treatment plants and large amounts of non-point sources from storm water runoff. The primary cause for Suffolk’s contribution is its non-point sources of the 350,000 cesspools throughout the county that discharge effluent into the groundwater, and thus toward the bays. Great South Bay is the largest of these bays, and it was found that annual nitrogen loads from the watershed as a nonpoint source add up to 38 kg of nitrogen per hectare per year. As a matter of fact, 69% of the total nitrogen load for the Great South Bay comes from septic systems and cesspools. It is evident that land use and eutrophication of

coastal water are “tightly coupled,” since the transport of nitrogen takes place via groundwater and surface water flow into the receiving waters, more so than usual on Long Island due to the unconsolidated sands that permit relatively free movement of water through the soil.23 Interestingly, algal bloom expert Chris Gobler of the Stony Brook School of Marine and Atmospheric Sciences says that, “groundwater travels at a rate of about a couple of feet per day, which means that the bays are just now getting hit with the effects of explosive development from the 1960’s and 1970’s”24. This is what is called nitrogen’s “legacy.” The 2009 study also pointed out that the nitrogen load entering the bays via atmospheric deposition from runoff of impervious land surfaces is due to the Island’s high amount of development, especially along the coast and in Nassau County, which prevents the water from directly entering the ground to recharge and instead travels along the man-made roads and impervious environments, picking up pollutants before finally ending up in the water ways. Our constant fertilization and agriculture is also to blame. Organic nitrogen that occurs naturally in the soil is fixed by plants and bacteria, taken up by plants, and used for growth only as needed. However, dissolved inorganic or chemical nitrogen travels readily in water and allows for tons of excess amounts to become washed away in the first rainstorm.25 Suffolk County contains most of the Island’s farmland, which is where the abundance of the fertilizer runoff comes from. Historically, this has been attributed to the duck farms out east, a major

source of nitrogen runoff from the fecal matter left by the ducks, but we now know that
the seepage of nitrogen contaminated groundwater in conjunction with fertilizer-laden
surface runoff is the main culprit. The dramatic changes that have occurred in the bays as
the result of man’s presence have been relatively instantaneous compared with the natural
geological processes that created the south shore estuary and its surrounding land areas.26
The south shore bays of Long Island were among the nation’s first waterways and
shorelines impacted by such intense urbanization, and this has been very critical to the
environmental health of the Island and all its inhabitants.

Chapter 2: Paumanok

Long Island’s historical legacy is not to be swept away under the label as merely
America’s first suburb, though being New York City’s tributary did indeed direct the
course of the Island’s development, and consequentially its environment. Long Island
was called “Paumanok” by the indigenous Native Americans who lived here first, a word
that means “the island that pays tribute,” because the more powerful neighboring tribes
forced the original Long Islanders to pay tribute to avoid attacks.27 It would appear that
this function of the Island would continue to its colonial age, when New York City grew
from the materials and bounty provided by the Island to the east. What happened once
these lands were colonized was a downward spiral for the environment. The fact that
healthy economies hinge on healthy environments would spell out danger for the early

26 Schubel, J. R., T. M. Bell, and H. H. Carter. The Great South Bay, Albany: State University of New

27 Long Island Indian Tribes, Richmond Hill Historical Society.
http://www.richmondhillhistory.org/indians.html
settlers of the Island throughout its history, but they would have no way of knowing. The waters don’t pollute themselves, so the story of our environmental degradation is inherently the story of how we got here and what we did to the land.

Long Island started to witness European settlement in the 17th century as the Dutch claimed the area of Nassau County and the British claimed Suffolk. As the central focus shifted to investing in the island of Manhattan, this urbanization extended to Kings and Queens counties over a century ago. Meanwhile, Nassau and Suffolk grew slowly until the end of World War II when they became two of the fastest growing counties in the nation. Throughout the development of the Island geographically from the west to the east, groundwater provided the drinking water supply starting in Kings and Queens counties through shallow wells or from streams. The first groundwater studies conducted in 1900s by the United States Geologic Survey were some of the most intensive investigations of groundwater at the time. However, once New York City Water Tunnel 1 was built in 1917, these two city counties effectively were severed from the rest of the Island politically once they started getting their water supply from the upstate source with the rest of New York City, gradually diminishing their reliance on groundwater until 1947 for Brooklyn and 1974 for Queens when saltwater intrusion ended it as a viable water source altogether, at least for some time28. While Brooklyn and Queens can rely on their Catskills crutch, Nassau and Suffolk are entirely dependent on groundwater. For the most part, the Island’s history was centered around its agricultural roots. Out east,

vineyards and potato farms continue to be a large part of the economy like they have for years before, fisheries provided sustenance for locals through the Island, the east end served as a huge national nucleus for whaling, and development started along the coast and slowly crept inland. The Railroad was built at the latter part of the 19th century, further connecting rural Long Island to the urban hub to the west, and in the early 20th century, Robert Moses came on the scene. His interconnected system of highways virtually, and somewhat unintentionally, opened up the rest of undeveloped Long Island to the explosion of sprawl it has become today. The Southern State highway, Northern State highway, Meadowbrook Parkway, and Wantagh Parkway channeled city dwellers to the scenic nooks and crannies all over the Island, and eventually towns and communities popped up everywhere. Large-scale development really got going after World War II, when the economy was in full force and people wanted to escape the cities for that American dreamscape they found in suburbia and rurality. Ridiculously cheap gas prices after the War made this possible, and probably inevitable. From 1960 to 1990, undeveloped land gave way to bulldozers and planning at an unprecedented rate, and more houses, shopping malls, corporate headquarters, and highways were built up than during the previous 300 years. This had some serious consequences that apparently were only so obvious in hindsight.

“Development attacks the landscape’s autoimmune defenses against pollution,” Tom Anderson writes in *This Fine Piece of Water*. Impermeable structures like roads, driveways, sidewalks, and buildings cover the land and compact the soils, wiping out

their natural sponginess. When rain falls on an area of woods or natural vegetation, as it did for millions of years before the Dutch caught sight of the Island, it percolates through the trees, shrubs, and soil, sifting out organic matter and nutrients as the water rides along rivers and streams to its finish line in the ocean. However, developed land’s ability to perform this natural filtration is obliterated, and the result is a thousand times as many particles hitting the waterways, all at once, with each event of precipitation. What this means for nitrogen pollution is constant release of an already omnipresent element in unbalanced amounts. Even an acre of well-managed farmland that utilizes nitrogen-rich fertilizers will release 100x less soil than land that has been cleared for a housing development, and at the time of the economic boom, developers went nuts. With the increase in populations moving to the coastal areas of Long Island, so did their penchant for the suburban life, with its perfectly verdant lawns as well as the increase in agriculture to feed them. It’s no surprise, then, that chemical nitrogen fertilizers have been around since World War II, and that their production had increased 1,050% just 25 years after their introduction to the market. This problem is not limited to densely developed suburbs, as houses built in areas with large-lot zoning, like the kind found in much of Nassau and Suffolk, can pollute on a similar scale.30 Basically, increasing population means increasing, well, poop.

30 Tom Anderson, This Fine Piece of Water: An Environmental History of Long Island Sound
The development of the land naturally led the populations to come up with ways to deal with their waste. As Nassau County became highly developed, its sewer system became necessary. Suffolk County continued to remain more rural, it didn’t require intense sewage systems for its more sparsely located populations, so their individual-lot septic systems stuck around. This infrastructural remnant in conjunction with a steadily creeping population rise ensured a large part of the water problems occurring today. The gradual eastward movement of people led Nassau County to become and still remain to this day the more densely populated county. At the turn of the 20th century, the population on Long Island was approximately 133,000, then by 1940 the population was up to about a half million people. Nassau County’s population grew by 93% in the 1950’s, while Suffolk saw in increase of 142% between the years of 1960 and 197031. These steadily huge increases in population lead to enormous pressures on the coastal

waters, where eventually most of our wastes end up. For Nassau, this warranted the development of sophisticated sewage treatment plants, abbreviated as STPs. There are two primary, county-run STPs that process 85% of the county’s sewage, the Bay Park STP and the Cedar Creek Water Pollution Control Plant, which happens to be mere miles from my house. Together, these two plants treat about 58 million gallons each day, which is actually operating below their respective permitted capacities of 70 and 72 million gallons per day. The Bay Park facility was built in 1949, serves 42% of Nassau’s population – more than 500,000 people – and is in dire need of update. Sewage is 99.5% water and 0.5% suspended solid material, so Nassau’s sewage system uses intense amounts of water. This, in tandem with the higher levels of developed, impervious urban groundcover that doesn’t allow for natural rates of groundwater recharge, accounts for the county’s increased threat of saltwater intrusion and thus the need to use and conserve water wisely. Suffolk County faces a waste problem of a different shape. 350,000 on-site septic systems serve the County’s waste needs. Septic systems have two key components, a receiving tank and a leaching system. A sewage line carries wastewater from the kitchen, bathroom, and laundry room to the underground septic tank where heavy particles settle out of the liquid. A layer of heavy sludge forms on the bottom of the tank and a layer of lighter scum forms on top. Bacteria break down the heavy sludge at the bottom at a rate that, hopefully, remains constant to the rate of flushing and dumping into the tank each day. However, each addition of wastewater into the septic tank displaces an equal amount of liquid into the leaching system, which is designed to allow the effluent

to be released into the surrounding soil on purpose where bacteria further break down the waste in it. This was a benign design when the number of septic tanks were far less in number and density than they are now. Many of the homes near the estuary are at elevations so low that there is little unsaturated soil between the tank system and the groundwater, and this reduces the opportunity for soil bacteria to denitrify the wastewater, allowing more unfiltered wastewater to enter the watershed. This flaw in our infrastructure has had some quantifiably devastating effects on the bays around us.

The majority of the nitrogen entering the estuary is from historic inputs of contaminated groundwater, meaning that the pollution entering the bays today came from historic activities from years to tens of years ago. This is referred to as the nitrogen’s “legacy,” as science points out that much of the nitrogen hitting the bays now is the nitrogen that was deposited into the watershed back in the ‘60s and ‘70s. As long as these

33 Long Island Sound Study Factsheet
nitrogen loads remain unchanged, the algal blooms will keep recurring every year, and
probably become worse and worse. One of the most well-known historic causes of high
nitrogen inputs are the duck farms. Starting in the late 1800s, there were once 80 duck
farms producing up to six million Peking white ducks a year. Now there are four, but
the duck farms were so much a part of Long Island agriculture, the iconic giant duck
house is still a lively tourist attraction (we used to pass it all the time on our trips out
east). Their droppings went unimpeded onto the land, into the Forge River watershed,
and ultimately into the Moriches Bay, which is still today one of the worst anoxic zones
on the island. Throughout the years, continuous nitrogen loading as a nonpoint source to
the bays from agriculture and increasing human populations have caused steady,
widespread degradation. Between 1954 and 1971, there was a 47% loss in wetlands.
The NYS Department of Environmental Conservation estimates that an 18-36% loss in
Great South Bay’s tidal wetlands had occurred between 1974 and 2001. There used to be
200,000 acres of seagrass in 1930, now there are only about 22,000, and every year since
2004, the rust-tide has appeared in the form of orange slime in certain parts of our waters,
killing killifish, snappers, and black sea bass. Blooms like these have occurred every
now and then in years past, but there was never a “toxic” algal bloom before 2006 (Liz
Smith, personal communication). Now they get worse every year.


36 Schubel, J. R., T. M. Bell, and H. H. Carter. The Great South Bay, Albany: State University of New

I have fond memories of clamming in the Great South Bay with my family when I was young. My grandma would show us how to prepare clams for dinner that same night, and it’s a tradition I hope to be able to pass on. Perhaps the entire history of the southern bays’ fall from grace can be explained synonymously with the Island’s shellfishing industry. Those who work the bays for their once abundant shellfish stocks are called the baymen. Their livelihoods were tied to the water, and it appears that their heyday has come and gone. The first settlers on Long Island knew of its massive shellfish supply from the Native Americans, and they subsisted off this resource comfortably. Real commercial industrialization of the bays began when oysters were harvested. The Great South Bay became well known regionally for its “Blue Point oysters,” and as a matter of fact the name “blue points” is still protected from misapplication by New York State Environmental Conservation Law 13-0323.1. Unfortunately, after World War I a combination of social, economic, and environmental factors brought on by the leasing of the Bay bottom to individuals and companies and increased use (and subsequent prohibition) of technological advances in dredging that allowed for dramatic increases in oysters landings, or catches, resulted in a slow end to the oyster fishery. Overharvesting reduced oyster numbers, and a couple of extensive algal blooms in the 1930s that were particularly harmful to the oysters decimated their numbers. The oyster populations never recovered from the traumatic blooms, but the decreased competition for food sources increased the levels of hard clam populations. Thus, as the oyster industry waned, the hard clam industry began to grow, though by necessity. Those baymen who had harvested oysters were now funneled into the increasingly crowded hard clam business. The hard clam fisheries were booming effectively until the mid-1970s when
overexploitation again terminated the lucrative business for many and brought governmental attention, regulation, and management to the bays. The biogeochemical chain reaction that starts with increased levels of nitrogen from human waste to the ruin of the shellfish economy is fascinating to say the least, however, it is just one of the many examples of the effect that environmental problems have on our water-based economy.

**Chapter 3: There Ain’t No Island Left for Islanders Like Me**

A major part of Long Island’s allure is its natural beauty. The convenience of its location nestled in the shadow of one of the greatest cities in the world makes the Island a coveted place to live and work. Years of development and the urbanization of the New York metropolitan area have only enhanced the appeal of our open spaces, beaches, and greenery. Those who study the environment and with any bit of foresight understand that no economy survives without a healthy environment, the links between them are too infinite, since everything we obtain comes from the natural environment. This logic is lacking lately. The economic means that drive society are a constant teetering balance atop a mutual relationship with one’s environment. In the environmental world, we call this “ecosystem services.” One can only imagine that in an environment where the water is threatened and threatening to the ecosystems it supports, the effects can only be negative for the organisms, which includes people, who inhabit such an area. Long Island’s south shore has a more traditional, historical economy that revolved around using its landscape and natural resources of shellfish and water bodies as major economic

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drivers. The relatively calm, protected waters and abundant resources of the south shore estuary provide the basis for the water-related economy. Over the years, this has evolved from harvesting oysters, hard clams, salt hay, and boat building, to recreational boating, sport fishing, waterborne transportation, and tourism. Today, our maritime economy is largely based on fishing, swimming, and tourism. The South Shore estuary is home to the largest concentrations of commercial and recreational vessels, marinas, and other water-dependant businesses in the whole State, supporting over 3,000 water-dependent and water-enhanced businesses that employ about 30,000 people. The greater the population, the greater will be its recreational demand, its impact on the bays, and the bays’ capacity to fulfill that demand. Present trends that degrade the natural environment must be offset. Pollution has a direct damaging impact on shellfish and recreation industries and an indirect damaging impact on most marine activities. A sound marine economy, therefore, rests on a properly conserved marine environment. The environmental degradation of Long Island’s groundwater and surface waters are to blame for decreases in economic productivity.

The study of ecosystem services is really studying the culmination of how our civilizations interact with the natural world. The environment provides provisioning services, regulating services, habitat or supporting services, and cultural services. Long Island’s provisioning services are the food, raw materials, and fresh water that we obtain from nature, which are currently in danger from the current unsustainable practices. Our

39 Chapter 5: Sustain and Expand the Estuary-related Economy, LISSE CMP

regulating services would be the local climate and air quality regulation and carbon sequestration which occur everywhere there are natural areas of vegetation, the moderation of extreme events, such as our costal areas’ natural buffering of storms, wastewater treatment, erosion prevention and maintenance of soil fertility, pollination, and biological control of vector borne diseases. Our cultural services obtained from nature would be benefits toward our recreation and mental and physical health – just ask anyone who’s enjoyed the Jones Beach bike path, for example; tourism, aesthetic appreciation and inspiration for culture, art, design; and spiritual experiences and senses of place41. The integrity of natural ecosystems is vital for all of these human-derived functions. To narrow the scope to Long Island’s environmental characteristics, wetlands preserve genetic and community diversity and provide food, purify water, build soil from sediments, regulate groundwater recharge and discharge, and provide local and global climate stabilization, yet, they’re typically seen as having marginal value and have historically become convenient targets for development42. With the main driver of economic downturn here being nitrogen, increased levels from anthropogenic sources and runoff cause the red and brown tides, which then cause beach closures and unsustainable seafood harvests. Again, the ubiquitous nature of water makes it an obviously crucial resource to protect, as it affects quality of life in many obvious and unseen ways. Much work has been done to study how this type of pollution affects economics.

The Trust for Public Land reports that the direct economic benefits of open space to our region amount to $2.74 billion each year, from boosting tourism to reducing government costs to improving air quality and public health. In 2012, the tourism industry alone was valued at $5.1 billion. Property values are also tied to the condition of water resources. As a matter of fact, 12-25% of the property value is tied to just perceptions of water quality, actual water quality problems affect property values by 75%, and major hedonic studies are showing more of this with fracking. Since open space is often protected for quality benefits or improvements (think protection of the Pine Barrens), this is where we can obtain the correlation between water quality and property values (Liz Smith, personal communication). Our economy is heavily dependent on a robust tourism industry, which contributes around $4.7 billion each year from marine sports, sport fishing, commercial fishing, beach use, and more, and supports 700,000 jobs. Only with the foundation of healthy surface waters is any of this achievable or sustainable.

For me personally, one of Long Island’s greatest appeals is its beaches. However, water pollution in the form of the harmful algal blooms threatens this source of happiness and leisure for everyone. The number of beach closings since 2001 has steadily gone up, as noted in Martin Cantor’s report Economic Impact of Regional Beach Closings on the Long Island Economy. The report, prepared for Senator Charles Schumer in 2007, highlights that $27,937,813 of economic activity is lost from this missing attendance. Using an economic multiplier of 1, the total economic impact is $55,875,626. But, when

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43 The Economic Benefits and Fiscal Impacts of Parks and Open Space in Nassau and Suffolk Counties, New York
factoring in the 8.625 sales tax lost along with the direct revenue, the total loss amounts to a whopping $60,694,898, and that was just for the year of 2007. We know that the harmful algal blooms have increased in their duration and prevalence, so if this study were done again today we can only expect much higher numbers and losses. We wonder why our taxes increase over time, or why cuts in services or funding to schools, for example, occur more often. The deficits are coming from the losses in these ecosystem services that happen right under our nose and we only see what we lose from a societal standpoint. We need to make environmental protection more transparent, but only if we acknowledge and account for the full range of costs that are occurring.

Perhaps a more poignant example of the loss of ecosystem services is what has already happened to our once robust commercial fishing and shellfishing industry, which has been compromised by the rapid development and population growth within our watersheds. The National Oceanic and Atmospheric Administration estimates that in 2007 the port of Montauk valued its 12 million pound landing at $15.7 million. Clams are simply amazing. They provide a fascinating ecosystem service that becomes critical to the environment in which they make their home and ultimately to us too. The hard clam, also known as the northern quahog (Mercenaria mercenaria), is a bivalve mollusk. Their presence in the water is incredibly important because just by being alive, they clean the bay. Clams are suspension-filter feeders, meaning they eat by beating specialized cilia to pump water through their gills, which are primarily their feeding organs, but also

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function secondarily in respiration. Most bivalves can remove particles larger than 5\(\mu\)m with nearly 100% efficiency. They also have an enormous reproductive capability, so their population numbers are naturally very high. Hard clams are a foundation species, and are called “ecosystem engineers” because they play a critical ecological role in the food web through nutrient recycling by feeding on phytoplankton and zooplankton.

What’s really extraordinary about these shellfish is that during their peak numbers they can filter the entire volume of the bay through their bodies every three days. Today, with their numbers in decline and in danger, there are only enough hard clams to filter about 1% of the water daily. After the oyster populations decreased in the 1960’s, the hard clam fishery became New York State’s most economically important commercial fishery. Low entry costs had made the clamming business attractive to locals, and generations of baymen can be noticed throughout many family lines, but now they are a dying breed. Bad news for the clam business means cultural losses as well as socioeconomic.

The problem traditionally agreed upon in the past has been poaching – clammers in the Great South Bay say that up to 50% of all clam diggers used to work uncertified areas, without necessary permits, and take undersized clams. This is a problem because larger clams lay more eggs than small clams by a factor of about 2 to 3, with large clams laying about 6 million eggs whereas small clams lay about 2-3 million. In 1965 there

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47 Restoration Works, Clams for People and Nature, Nature.org
were approximately 5,660 acres of uncertified shellfishing grounds in the Great South Bay. During that time, the population of the towns of Babylon, Brookhaven, and Islip that border the bay was estimated to be around 571,000. Over the years, the population rose to 904,500 in 1986 and it was found that 10,160 acres of those shellfishing grounds had to be closed. During that 21-year period, one acre of shellfishing grounds closed for every 75 people added to the resident population around the bay, demonstrating the direct effect that development and urbanization along the coast has on the aquatic ecosystems. What happened was an unhealthy mix of rapid development, which caused more human wastewater discharge, and a classic clear example of a tragedy of the commons, wherein we take too much from our natural resources and then suffer not only from the acute economic impact of a loss in clam resources but also from the consequential gradual economic impact over time from this lost ecological component, which then turns into more economic damage later down the road. We used to export an impressive 50% of the whole country’s hard clam resources at our peak during the 1970s, when the fishery was valued at over $16 million and amounted to about 700,000 bushels or 4,000 metric tons. But after 1977, the clam populations began to rapidly decline. Now the clam population has fallen by an astounding 93%, endangering the lifestyle of the baymen and the industry and environment from which they make their living48 – a plight that Long Island native Billy Joel has made efforts to elucidate through donations of proceeds from shows and even in the narrative of his song “Downeaster Alexa.” Recently, the Nature Conservancy acquired 20% of the Great South Bay bottom in order to embark on a

restoration effort. In an exciting ecosystem-based approach, they’ve restocked about 3.5 million clams to the bay, providing this integral part of a healthy estuarine community to thrive again. The brown tides affected more than just the clams. Long Island’s lobster landings also declined after peaking in the 1990’s at a value of over $10 million. The harmful effects of these blooms have been chronicled for decades. Much like the Great South Bay’s role in supplying half of the country’s clams, the Peconic estuary out east used to provide 25% of the country’s scallops in the 1980’s. The Suffolk County Department of Health Services estimated the 1982 value of the commercial scallop industry in the Peconic Bay to be worth $13 million. Harmful algal blooms decimate this wealth through direct fish mortality, habitat loss, fish closures, and negative impacts on consumer demand, which can be very hard to revitalize. The money that is lost from permits and licensing of the fisheries, in restaurants, beach closures, and even public health costs cumulate in social welfare losses that at $3.8 million annually (Liz Smith, personal communication). All of this devastation, just from simple algae. Our fisheries used to be and should remain a strong icon of Long Island business, naturally and traditionally local. Only when we take the larger environment into consideration with our development, planning, and policy can we be able to heal our economy and start living as better stewards of our home.
Chapter 4: “Water We Going to Do?”

Given the ubiquitous nature of water, all levels of government – federal, state, and local – play important parts in protecting it. In terms of regulating and remediating the environmental degradation of air, surface water, drinking water, soil, and ecosystems, the U.S. Congress has enacted far-reaching legislation that have already benefited us and will continue to do so for years to come. Federal agencies such as the Environmental Protection Agency are responsible for developing national environmental policies and regulations that set baseline standards for states, which may then provide their own laws that can be stricter than federal standards, but never more lenient. The federal government becomes involved when the pollution of a natural resource or ecosystem affects the economics across state or regional lines and when a resource is deemed to be unique and significant to the entire nation. The EPA provides regulatory controls for most of the state and local environmental regulatory programs that have jurisdiction over the bays, as well as the catalytic spur that was the basis for state and local governments instituting these programs. In terms of federal legislative application to our region of Long Island, its involvement has helped fix the collapse of the riverine and estuarine ecosystems that act as nurseries for fish and shellfish that have historically impacted the businesses of baymen and fishermen all along the Atlantic seaboard as well as the Great South Bay’s capacity to provide 50% of the nation’s commercial clam resources. Groundwater protection, on the other hand, has slightly more direct actions, but is also balanced between varying levels of government. Such major applicable legislation

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includes the Clean Water Act, the Safe Drinking Water Act, the National Estuarine Program, the Tidal Wetlands Act, and the Coastal Zone Management Act.

**Federal.** The Clean Water Act (CWA) is one of the founding pillars in our country’s environmental legislation. It dictates what the EPA must do to carry out such environmental protection by requiring the clean up of our nation’s rivers and surface water bodies for recreational, wilderness, scenic, and water quality values. The law provides explicit instruction on maximum allowable contaminants in rivers and estuaries from point and nonpoint sources and management practices designed to control the contaminant load in U.S. waterways. It also sets standards for allowed levels of key water pollutants and requires polluters to get permits that limit how much they can discharge into aquatic systems. The Act sets forth effluent standards that limit the quantity of pollutants discharged from a point source and ambient water quality standards that limit the concentration of pollutants in the stream. The Act has minimal controls for nonpoint sources of pollution, leaving it mostly up to state programs that are not subject to federal standards. Under the CWA, significant wetlands and waterways of exceptional value are identified and protected from local development. Although the Act does not apply specifically to the protection of groundwater supplies, it does regulate industrial and other activities that would be sources of contamination to groundwater. The CWA does require states to develop their own plans to control non-point sources of pollution, such as irrigation return flows, agricultural and urban runoff, and construction activities,

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however there are no sanctions for failing to implement effective programs. Within the 234-page long document are various sections detailing its responsibilities and relationships to the branching government entities lower down. Section 201 provides grants to localities for the construction of publically-owned treatment works that must conform to an EPA site-specific waste treatment plan that details how the waste discharges will be abated. Section 208 provides the funds for the development of area-wide waste treatment management plans. Section 301 calls for standards and enforcement procedures for effluent limitations, water quality standards, national performance standards and toxic and pretreatment effluent standards. Section 402 created the National Pollution Discharge Elimination System (NPDES), off of which the model for New York State’s program is based. All throughout the nation, the EPA has found that much good has been accomplished since the enactment of the Clean Water Act in 1972; such as: the percentage of Americans served by community water systems that met federal health standards increased from 79% to 94%; the percentage of fishable and swimmable U.S. stream lengths increased from 36% to 60% of those tested; the proportion of the U.S. population served by sewage treatment plants increased from 32% to 74%; and the annual wetland losses decreased by about 80%. Yet there’s more to be done. 45% of the country’s lakes and 40% of its streams are still too polluted for swimming or fishing, and seven out of every ten rivers is polluted from agriculture runoff, particularly from animal


wastes. For groundwater, the most direct protection comes from the Solid Waste Act, also known as the Resource Conservation and Recovery Act (RCRA), which controls every step of hazardous waste generation, transportation, storage, processing, and especially disposal. This Act protects groundwater by necessitating the proper management of dumps and clean up of old sites. When past or current disposal of wastes goes wrong, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is there to dish out strict liability charges of action against anyone who violates the management of hazardous substances from their creation to their disposal, as well as establishing a federal program to clean up hazardous substances in inactive or abandoned sites when stringent investigation finds that no one can be held liable. This is also known as the Superfund Act, and the resource that is most frequently harmed, and thusly sought to protect, is groundwater.

The Safe Drinking Water Act (SDWA) was enacted in 1974 to direct the EPA to establish maximum allowable levels of contaminants in drinking water sources and to require public water suppliers to monitor for these contaminants and chlorinate or filter these sources to meet the federal standards. The two classes of regulated contaminants are 1) those that produce chronic or acute health effects, which are enforced under maximum allowable levels, and 2) those that affect the color, taste, and clarity of water, even if they don’t have adverse health effects. This second class of contaminant is merely managed by

goals encouraging their reduction, however states can create stricter enforcements. The EPA has been experimenting with a discharge trading policy, which functions like a carbon cap-and-trade system but with water pollution discharge. However, the EPA has been lax in regulating and enforcing permits, and much of the enforcement is based on monitoring, reporting, and recommendations. Noncompliance could lead to the dangerous buildup of pollutants in accumulated areas. Under the Act, National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems based on Maximum Contaminant Levels (MCLs). In the case of nutrient pollution in drinking water, the MCL of inorganic nitrate, sourced from fertilizer runoff, septic tank leakage, sewage, or erosion, is 10mg/L. Perhaps the most succinct example of the interconnected mechanisms taken by federal, state, and local governments can be found in Section 1424(e) of the SDWA, which provides for the Sole Source Aquifer Program. Designation as a Sole Source Aquifer means that the EPA reviews certain proposed projects within the area of the designated aquifer. The Program is only offered to areas where 50% of the drinking water comes from an aquifer and that have no alternative drinking water sources, which obviously applies to Long Island. A short while after the Act was created, the Environmental Defense Fund petitioned the EPA in 1975 to designate the area of Nassau and Suffolk County as a sole source aquifer. Our aquifer became the second one in the nation to be granted this title, and after the Kings-Queens

55 Citizens Environmental Handbook: Nassau County
56 Drinking Water Contaminants, United States Environmental Protection Agency
57 Sole Source Aquifer Protection Program, United States Environmental Protection Agency
aquifer received its designation as a sole source in 1979, the entire island came under the Program58 (which made sense geologically).

Surface water protection is provided by a number of pieces of federal legislation. The National Estuarine Program is established under section 320 of the CWA as a network of voluntary community-based programs that safeguards the health of important coastal ecosystems across the country. It is designed to identify nationally significant estuaries that are threatened by pollution, overdevelopment or exhaustive use, and to set management objectives that will improve water and sediment quality and the diversity of marine and coastal life, implemented in Comprehensive Conservation and Management Plan unique to each of the 28 estuaries of national importance. Finally, the Coastal Zone Management Act of 1972 was passed to encourage the 34 coastal states and territories of the nation to preserve, protect, restore, enhance, and wisely develop their coastal resources. The administrative responsibilities were assigned to the Office of Coastal Zone Management in the National Oceanic and Atmospheric Administration of the Department of Commerce, which grants funds to the states to assist in the development of a Coastal Management Program (CMP). When adopted by the state and approved by the Secretary of Commerce, this triggers two federal responses: 1) each approved state and its localities would become eligible for a variety of technical and financial aids to be used to coordinate balance between economic development and environmental preservation, and 2) a federal consistency clause would fall into place. However, the prime jurisdiction

over the area of the bays is in state and local control, and generally no federal agency can use funds or initiate programs unless the action would be in furtherance of the CMP. This brings up an important issue. On Long Island, we have three major estuarine entities. Of these three, only two are federally managed – the Long Island Sound to the north and the Peconic Bay out east. What this means is that the South Shore Estuary Reserve is not managed by the federal government, however, at least 34 departments, agencies, commissions, administrations and legislative bodies exercise, to one degree or another, jurisdiction over the South Shore Estuary Reserve, and this has led to poor management, virtual deadlock, of the southern bays and the people who rely on their ecosystem goods and services59.

**State.** New York State has its own jurisdiction and sets of legislation for water problems, and as the level of government narrows down closer to the geographic area of jurisdiction, the more focused that body’s legislation can be. In terms of groundwater protection, state leadership is critical, as the state is responsible for implementing numerous federal programs. The state has the authority for the use, management, and protection of groundwater. The Department of Environmental Conservation has a leading role in overall management of groundwater, including the specific issues of discharge controls and waste disposal. The Department of Health also plays a lead role in public water supply management and source assessments. The State exercises numerous controls over the bays, which range from environmental review procedures to wetlands

protection and preservation. The NYS Department of State’s (DOS) Division of Coastal Resources and Waterfront Revitalization administers the Coastal Management and Harbor Program. It compiles and uses information about local waterfront areas and makes management recommendations for land use policies consistent with the goals of watershed protection, fish and wildlife preservation, public access, and appropriate commercial development, which are then implemented by towns and villages. The Health Department and the Office of the Secretary of State periodically become involved whenever public health or coastal planning issues arise, such as when Albany invoked edicts in concern over shellfish quality in 1986 prohibiting the sale and use of raw clams. However, the primary presence of state involvement over the bays is carried out by the Department of Environmental Conservation, whose two major areas of responsibility are natural resource management and environmental quality protection. In accordance with the EPA, the DEC regulates nutrient pollution within state waters on narrative standards. This basically means that rather than a specific numerical quantity, the standard is regulated according to a laid out descriptive condition that needs to be met. In New York State, the standard for phosphorus and nitrogen is “none in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages.” Nutrient pollution regulations are based on the narrative standard because these elements occur naturally in the environment and are necessary for healthy


62 Citizens Environmental Handbook: Nassau County
ecosystems in appropriate levels dependent on the particular area and biology, so placing a quantitative number limit on their presence in the environment would be close to impossible. The DEC protects the state’s waters via administration of the Clean Water Act by issuing State Pollution Discharge and Effluent Standards (SPDES) permits that regulate all wastewater treatment plants and industrial facilities that discharge into rivers and other surface water bodies. The SPDES Program in New York State is actually broader in scope than the Clean Water Act normally requires in that it controls point source discharges to groundwaters in addition to surface waters. The DEC also administers the State Environmental Quality Review Act (SEQRA), which requires landowners and municipalities to prepare an Environmental Impact Statement (EIS) for any proposed project that is determined to have a significant environmental impact. An EIS involves three stages: a scoping stage, a drafting stage, and a review stage, as well as opportunities for public input at each stage and alternatives to the project for consideration. Although projects with negative impacts may sometimes receive the green light, the law requires that adverse environmental effects must be mitigated to the greatest degree possible. It is up to the towns and villages to review these EIS’s for local development projects, and they have the right to issue or deny permits for construction activity in wetland areas that are not protected under state or federal statute. This gives these towns and villages a lot of environmental protection power and responsibility to choose wisely which projects they allow and which they don’t. The federal Coastal Zone Management Act of 1972 was the EPA’s recognition of the importance of mitigating

63 Nutrient Criteria, NYS Department of Environmental Conservation

64 Citizens Environmental Handbook: Nassau County
continued growth in the nation’s coastal zones. For New York, it enabled the State to create a Coastal Management Program. Following the passage of this Act, NYS later created the Waterfront Revitalization and Coastal Resources Act, which provides funds to local governments to enable them to carry out waterfront revitalization plans and programs. The DEC is the major state entity responsible for the management of tidal wetlands, management and regulation of the waters to control pollution, promotion and regulation of shellfish, control over fisheries and wildlife, and administration of several programs concerned with flood control and damage mitigation. Since the protection, enhancement, and safe consumption of the bays’ living resources hinges on the quality of their waters, the DEC classifies the bay waters according to state standards and administers control over discharges to the bays. In 2008, the NYSDEC declared under section 303(d) of the Clean Water Act that the South Shore Estuary System is an “impaired water body” due to the excessive amounts of nitrogen from wastewater.

The Environmental Conservation Law established the New York State Department of Environmental Conservation and authorizes its programs, although it is made up of broad provisions that need to be defined and made explicit through the drafting and enforcing of its own regulations. Basically, the Law contains myriad Parts and Articles that describe the State’s endeavors toward environmental conservation. Article 14 is the New York Ocean and Great Lakes Ecosystem Conservation Act, whose legislation recognizes that New York’s “coastal ecosystems are critical to the state’s environmental and economic security, and integral to the state’s high quality of life and culture,” and declares that the policy of the state shall be to “conserve, maintain, and restore coastal ecosystems,” while successfully addressing that “ecological health and
integrity is maintained.” Section 14-0107 establishes a New York Ocean and Great Lakes Ecosystem Conservation Council, one of whose responsibilities include “promoting sustainable and competitive economic development and job creation in tandem with the protection and restoration of our coastal ecosystems. The Act even specifically mentions the southern bays as a necessary area to improve through ecosystem-based management. Part 41 of the ECL holds the State, via the DEC, responsible for certification and inspection of shellfish grounds. Part 47 of the ECL regulates digging permits, maintains records of harvesting and sales of shellfish and monitors the diggers’ recordkeeping. The ECL also establishes water quality standards for the bays’ levels of coliform bacteria, dissolved oxygen, toxic wastes and deleterious substances, garbage, cinders, ashes, oils, sludge or other refuse, pH, turbidity, color, suspended, colloidal or precipitable solids, oil and floating substances, and thermal discharges. Article 25 of the ECL is the Tidal Wetlands Act of 1972, and it provides $30 million for acquisition of important tidal wetlands by DEC and a regulation program requiring the issuance of permits for “any alteration of perturbation of all tidal wetlands and the surrounding uplands to an elevation of 10 feet.”65 This legislation and the implementation of other regulatory programs at the town level have drastically helped curtail the loss of tidal wetlands. The Shinnecock Bay was the first area studied and it was found that successful protection of these wetlands have resulted in a gain of 161 acres of tidal wetlands, as well as a successful 100 acre gain in Moriches Bay66. The problem with the elimination of wetlands is the reduction of


66 Tidal Wetlands, Department of Environmental Conservation
their productive capabilities as the result of pollution. Therefore, stringent preventative controls on development upstream must be practiced to protect the wetlands downstream from point and non-point pollution sources.

**Local.** In the United States, public water supply is for the most part a local responsibility – local governments have a clear stake in protecting the quality and quantity of their groundwater reserves. Also, due to the fact that groundwater quality is significantly affected by local land-use, local governments are further responsible for the protection of groundwater since they are most familiar with land uses in their jurisdictions, as higher levels of government are unable to consider unique local characteristics by their more generalizing nature of land-use management. This is why local governments and regionally based organizations are often in the best position to apply land-use controls and have direct power to implement site-specific groundwater protection. However, municipalities do not always have the financial resources to manage water protection alone. On Long Island, the responsibility for land-use planning, sewage treatment, storm water management, water supply, and regulation of septic systems is divided between local municipalities and counties, in accordance with state and federal law. Sewage treatment plants are at the crux of the nitrogen problem, and in Nassau and Suffolk counties they’re operated by either the county or local municipalities.

There are two regional agencies that fall between the three levels of federal, state, and local government who have jurisdiction over the bays. They are the Interstate

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Sanitation Commission (ISC) and the Long Island Regional Planning Board (LIRPB). The ISC is a three-state compact that covers surface water and air quality in portions of New York, Connecticut, and New Jersey. It was the first and only governmental body that propagated and applied water quality standards for all waters within the Tri-State area of designation. They work with the EPA and NYSDEC to determine compliance with federal and state permits while also carrying out effluent and ambient water quality monitoring programs and inspect samples at wastewater treatment facilities. The LIRPB was created in 1965 as a response to the recognition of the problems that uncontrolled growth from land use, transportation, housing, and other economic development had on communities throughout the island. This agency is advisory, however its members understood from the beginning that the marine environment is an integral and vital feature of the island. In 1965, they produced a report called “The Status and Potential of the Marine Environment of Long Island” that dealt with the issues of dredging, protection of wetlands, and enhancement of the shellfish industry. Much of the policy recommendations covering the management of the bays come from this work68.

One final entity that must be mentioned is the Long Island South Shore Estuary Reserve Council (LISSERC). The Council was established by NY Executive Law Article 46 Section 960 (a.k.a. the Long Island South Shore Estuary Reserve Act) to protect and manage the South Shore Estuary System as a single integrated entity under a comprehensive management plan guided by state and local governments and private citizens to make recommendations that may then be incorporated into state or local

policy, laws, or regulations (NY Code Exec 46). The Council has the power to conduct scientific studies and planning, and utilize staff and facilities of state and local government agencies to carry out the provisions laid out in the Article. Its comprehensive management plan is to make recommendations to integrate and coordinate existing programs and studies, mitigate pollution, balance preservation, recreation, and economic development, protect appropriate existing investment, and of course protect the natural resources. In my personal opinion, this is a good first step to establishing a united entity that has the region’s ecological and economic values and interests in mind. However, it can also be confusing to keep creating separate entities composed of various parts of different levels of government. The benefit of creating a uniform entity responsible for all of Long Island’s water woes is addressed later.

Narrowing the scope further, individual towns can allocate more attention to detail in their environmental management. If we dissect the infrastructure of a town, we can strip apart the urban landscape and perceive the hidden environmental effects of
heavy development. The historically uncontrolled development of the Island for the most part has culminated in a wide array of pollutants that we must now deal with, however our geography is the reason why this is so much more an important problem than normal. As an island, we need to be extra careful with what we do with things that we don’t want to have lingering around. In 2004, the Nassau County Town of Oyster Bay, where I live, produced a report called the South Oyster Bay Stormwater Discharge Identification and Mitigation Plan, which reviews the culmination of the non-point sources of pollution into the estuaries of the South Shore Estuary Reserve that come from urban development and land-use. It found that residential land uses contribute a variety of stormwater contaminants like nutrients from lawn fertilizers, pest extermination, heating oil, gasoline, trace metals, pet wastes, along with whatever automobile emissions that come from residential use. Retail and service commercial operations contribute many of the same runoff contaminants as residential developments, in addition antifreezes, solvents, degreasers, paint and paint thinners, salts, bacteria and viruses, and anything that runs down municipal drainage systems and traffic congestion. A common place we find current pushes for cleaner development practices is in laundromats and dry cleaners, particularly in managing detergents. Gas stations, autobody shops, and car washes contribute the myriad chemicals that come with their businesses and the secondary effects of concentrations of automobiles over impervious surfaces. Highway commercial corridors like shopping malls and central business districts can be especially problematic because of the combination of the high presence of automotive pollutants and most of the groundcover consisting of impervious paving. This concentrates the amount of contaminants up until they reach their point of disposal. A variety of similar and
dissimilar contaminants are produced by other retail and service commercial operations such as veterinary services, commercial and recreational boatyards and marinas, appliance service and repair facilities, beauty and barbershops, photography and printing labs, and funeral service operations. The study also inspected wholesale storage and warehousing, industrial areas and brownfields, transportation, institutional and quasi-public land uses like highways, train stations, junkyards, landfills, hospitals and medical offices. Plant nurseries and areas of recreation like parks, golf courses, and schoolyards are common sources of nutrient pollution. Finally, construction sites and the study of their propensity to leave soil erosion complete the Town’s extensive survey of land-uses. Due to the massive amounts of these byproducts of economy, one hopes that protection of the environment and the public is served by the federal regulations of RCRA and CERCLA, which work to prevent pollution before it happens and strictly clean it up where it does. Proper application of the guidance of urban ecology would look into every aspect of the built environment and the interactions between it and the natural environment, from the chemicals used to treat the wood in marinas to the paint chipping off train station platforms. Needless to say, this task is seemingly impossible, so the best approach would be to learn the fundamental lesson from urban ecology that everything is connected, and use this knowledge to plan new projects wisely and sustainably, with the entirety of the urban landscape’s biological and non-biological components in mind. A boost in morale comes from the study by de Loë & Lukovich, in which they examined Long Island’s management capacity for groundwater protection. Though they

69 Final South Oyster Bay Stormwater Discharge Identification and Mitigation Plan
acknowledge that groundwater’s protection happens in a complex web of interconnected institutional arrangements, they found that Long Island can make considerable progress by the creation of a database that allows local governments to make smarter land-use decisions and take account of groundwater protection, clarification of roles and responsibilities among stakeholders, and commitment of adequate human and financial resources so that groundwater protection becomes an ongoing process rather than ad hoc activity. Our case is a special one because 2.8 million residents rely solely on the water underneath the ground for their public water supply, which has made support for its protection strong since the 1970’s. We’ve created multiple organizations and groups to spearhead ways to protect us and our environment, and we’re beginning to find creatively successful ways of making it happen.

Chapter 5: Thinking Globally, Acting Locally

“Favorable action will not occur until the solution recommended is considered to also be technically competent and politically acceptable.” There are a number of current policy proposals for how to deal with the groundwater and surface water problems. I will explain which parts of the existing policy proposals I think will be most beneficial as well as give my own custom solution proposals using ecological design. I am getting council from Prof. Dickson Despommier on how to use the vertical farm to potentially mitigate nitrogen pollution at the waste’s source. I believe phytoremediation


techniques like these, along with ecosystem restoration in the form of seagrass and clam mariculture, is the answer to many of Long Island’s water problems.

**Policy.** The varying levels of government involvement in Long Island’s unique water problems leave the local entities up to themselves to face the brunt of the management. They say if you want something done right, you have to do it yourself. This is surely the case for Long Islanders in the face of threatened drinking water, but it also means that we can come up with custom tailored solutions to our problems, which were the result of careless historical planning and poor design and management. But steps can be taken at higher levels of government, and must, in tandem with lower levels of government, for a well-working polity to do its job in protecting the environment, and thus protecting the people.

Some environmental scientists call for strengthening the Clean Water Act by giving it more power in the way of regulating water pollution prevention instead of focusing on end-of-pipe removal of specific pollutants. It should allow for larger and mandatory fines for violators. It should also account for agricultural irrigation, which is currently not regulated at all. The Clean Water Act could also be rewritten in the way it was originally intended to function – to protect ALL waterways – so that there’s no confusion over which waterways it applies72. While I was writing this, the EPA announced in March that it’s proposing a new rule to restore protections to the nation’s streams and wetlands to undo the confusion established by the previous administration.

This legislation, if passed, would be very much appreciated on Long Island! Another solution at the federal level would involve the reinstatement of funds for the Clean Water State Revolving Fund (CWSRF) to better protect our waters nationally. Congress created the Clean Water State Revolving Fund in 1987 to give assistance to municipalities for the construction and repair of sewage infrastructure. Now, Congress is continually cutting its funding. In 2013 the fund had $1.38 billion, but just four years ago in 2010 it had $2.1 billion (Citizens Campaign for the Environment Handout). These funds would be available to the local governments and municipalities in need especially during this time of improved education and strengthened public support, as a matter of fact, a poll given by Friends of the Bay showed that out of 600 voters, 72% of Nassau and Suffolk County are very concerned about our water supply and has found that there is an “overwhelming consensus among those voters that local government should spend more money in efforts to clean up and prevent pollution of groundwater, rivers, lakes, and bays”73. These funds will be more crucial than before in the current state of climate change, as coastal areas can expect to experience more severe storms, flooding, and sea level rise. The federal decreasing of the CWSRF is counterproductive to a society faced with climate change and the need to be wary of the importance and protection of the safety and health of our waters. More specifically, if the South Shore Estuary Reserve were federally managed like the two other estuarine systems around Long Island, it would receive far more robust treatment than what is now being desperately applied.

73 http://friendsofthebay.org/?p=1234
For state level policy solutions, we should definitely include a maximum level of harmful algal blooms in the ECL, measured in the amount of chlorophyll $a$, so that roundabout studies and testing don’t have to impair the necessary precautions and actions needed do something about these blooms when they happen. But one of the best examples of state-level policy solutions for both groundwater and the southern bays is Assemblyman Robert Sweeny’s proposed Long Island Water Protection Bill, which has in fact passed the New York State Assembly a year ago on March 7th. He authored the bill to improve the quality of surface and groundwater on the Island by establishing a process for coordination and cooperation. If put into law, the bill would modify the existing Special Groundwater Protection Areas to include Special Surface Water Protection areas, namely the watersheds of all three of Long Island’s subwatersheds – including the South Shore Estuary Reserve watershed. It would also modify the comprehensive management plan for these areas of special protection by requiring them to include the development of an ambient groundwater standard for nitrogen. Interestingly, the bill also seeks to replace the Long Island Regional Planning Board with a Long Island Water Planning Board74 created to appoint as the designated planning entity for special water protection, much like what has been advocated for in the Long Island Clean Water Partnership.

The Long Island Clean Water Partnership is a collaboration between the major organizations of the Group for the East End, the Citizen Campaign for the Environment, the Long Island Pine Barrens Society, and the Nature Conservancy in an effort to

74 http://assembly.state.ny.us/mem/Robert-K-Sweeney/story/51220/
advocate for the holistic management of water across the Island as a top priority, requiring fundamental change in standards, methods, and responsibilities all across the Island. I really like the Partnership and its goals because it communicates our problem in citizen-ready terms. Ideally, the Partnership’s agenda includes reducing nitrogen pollution by 50% so that it doesn’t exceed 2mg/L for groundwater entering the bays, accelerating the use of wastewater treatment technologies (of which I’ve included my own ideas later on), reforming policy to immediately ban some of the most threatening pesticides and establishing new and enforceable water standards, accelerating the clean up of chemical wastes in plumes of contaminated groundwater, and establishing a unified entity either within the DEC or through an existing or newly created entity to promote public education and address comprehensive water protection, conservation, restoration, and management with sufficient funding, technical competence, and regulatory jurisdiction. This will implement the 2mg/L nitrogen limit within 5 years or less. I really like this idea because, from my research experience, the two counties seem to be disjointed in their handling of the water problem, which does not care about political borders and limits of jurisdiction. An effective policy/agency would have the entire Island’s geography and ecology in mind. The Partnership has put together a list of suggested policy solutions on the local and state government levels. It calls on New York State to adopt a Long Island Water Pollution Control Act that would set enforceable ecological standards for nitrogen and an enforceable, a comprehensive clean water quality protection plan that will be overseen and implemented by a government entity to improve the Island’s water management in tandem with what would be a newly mandated “State of the Aquifer” report, restore the health of the bays, and protect the long-term
integrity of our drinking water. This is crucial since there is no singular, Island-wide management agency that exists to oversee the protection and planning for the future of Long Island’s water with final responsibility or public accountability. As a matter of fact, Long Island is the only region in NYS with no oversight agency empowered to preserve and protect the water supply, which is ironic considering how geologically sensitive the groundwater is here. It is estimated that the annual cost to create this Island-wide agency would be equivalent to just one cup of premium coffee per person75. The Partnership also advocates for the DEC to adopt a Pesticide Use Management Plan for Long Island with measurable goals to combat the rising levels of pesticides detected throughout the Island’s water resources. Finally, the Partnership wishes for the state to create financial incentives in working with local governments, the agriculture industry, and other clean water stakeholders to improve present practices, modernize and update existing infrastructure to reduce sources of pollution, and incentivize clean water innovation76.

Steps like these must be taken to properly work in tandem with current ecosystem-based approaches to revitalizing the bay, such as the current work being done by the Nature Conservancy to reseed the bay with mature clams and the Cornell Cooperative Extension Eelgrass Restoration Program. These initiatives are working hard to restore crucial aspects of the bay’s ecology so that the clams and seagrasses can once again fulfill their role in filtration and habitat cultivation, and by extension restore our own coastal economy.

75 http://newyork.sierraclub.org/longisland/L1_Water_Brochure.pdf

76 Next Suggested Steps, Long Island Clean Water Partnership
The Partnership calls on local governments to prepare action plans, such as a Water Quality Action Committee to assure that local water resource management and protection recommendations are advanced enough and well-implemented; the establishment of Watershed Improvement Districts in which local governments, individually or in partnership with neighboring towns, finance long-ranged water quality planning and projects; design Inter-municipal Water Quality Agreements to maximize coordination clean water action priorities among neighboring municipalities; and conduct Wastewater Management Assessments in which local governments develop an inventory of current wastewater infrastructure and future needs assessment to inform planning and prioritization of wastewater management over time. Fortunately, residential and commercial wastewater is one of the best-documented and most well-understood – and therefore manageable – sources of pollution in our groundwater and surface water. I really like the Partnership’s education agenda, in which it would have NYS Department of Education enhance its science curriculum to incorporate water quality protections and restoration as mandatory content to be taught in the 124 public schools on the Island, 60 of which are located within the South Shore Estuary Reserve77. I believe that the introduction of this subject matter in earlier grades would be enormously beneficial, as younger children hold on to lessons more tightly if they are introduced to new concepts at older ages. It would also develop a marketing and awareness campaign to incorporate water protection and conservation efforts into everyday school and work life, helping us to become public citizens rather than private consumers. Constant reminders like this

77 Long Island South Shore Estuary Reserve Comprehensive Management Plan
would become a part of our Island culture, which I vehemently believe is a necessary step in our evolution to a more sustainable Island. The Partnership also suggests that local governments adopt water-wise land use requirements to assure that land use rules and regulations consistently require the highest level of water conservative and protective measures for every approval, as well as implement watershed action plans to identify and develop regional approaches to reduce the impacts of development and agricultural use on water quality. This would come in the form of expanding town land preservation programs and acquisitions to allow for reduced runoff and better quality recharge. It also highlights the need to address infrastructure resiliency in response to sea level rise and extreme storm events. These kinds of steps fully utilize the local government’s power of intimately knowing its area’s problems and using this in depth knowledge to come up with the best plans of action to solve resource-based problems.

As far as it goes for direct protection of the groundwater, purifying already tainted drinking water is very expensive and very difficult. There are probably no better grounds for a heavy reliance on the prevention policy. A minor example is the Bethpage plume, also called the Grumman plume. Years ago, the Grumman Corporation manufactured aircraft for the U.S. Navy in Bethpage, and had been dumping its industrial wastes right into the ground. Due to Long Island’s geography, this created a southward flowing underground plume of toxic chemicals that is currently endangering 32 wells and 255,000 south shore residents in Bethpage, Massapequa, Seaford, Wantagh, Bellmore, and
Merrick78. My own house is in that target range, and our communities have been enraged for some time now. The Bethpage Water District spent $7 million in water filtration equipment and $11 million in VOC filtration, then bonded another $14 million in 2012. Residents are paying $940,000 a year for the next 30 years to have safe drinking water. The Navy still has yet to pay its dues for our public safety. This is a topic that merits an entirely other thesis, but it goes to show that the protection of the integrity of our groundwater should be of the utmost priority. Proper methods should be taken toward preventing the pollution in the first place. There is legislation that limits the amount of nitrogen allowed in fertilizer and that fertilization cannot occur within 200 feet of a water body. There was a time period in which retailers were allowed to phase out all of their products with higher levels of nutrient, but this legislation is almost hard to enforce. I’ve spoken to Mary Anne Taylor, who has been called Long Island’s premier groundwater modeler, and her thoughts are mutual. She agrees that the legislation should apply to lawn care professionals who would then be liable to use only allowable levels of nutrient fertilizers. I’ve talked to her about the prospects of sewer most of Suffolk County, and she has said that this would not be wise. To sewer all of Suffolk County would cause a problem already witnessed in Nassau. Sewering diverts most of the water to specific areas where the effluent is finally discharged, and this change in where the water finally ends up in the environment causes a drying up of the ground and thus the local water bodies like lakes, rivers, and ponds. The same happens due to the runoff caused by impervious land development. Reducing the amount of groundwater recharge also

disrupts the salinity levels, and can cause increases in saltwater intrusion into the aquifer. So, it would not be smart to sewer all of Suffolk, just the areas of high density that need it most. For the rest of the county, which has comparatively low levels of density, alternate on-site methods of wastewater management need to be sought. A report conducted by the Nature Conservancy on nitrogen loading into the Great South Bay confirms this necessary avoidance of the “one size fits all” scenario of sewering the whole area, and supports “nitrogen control options [that] best suit the various parts of the Great South Bay watershed, adapted to the differences in land cover,” finding that “such explorations might end up with more economical and ecologically acceptable means of addressing eutrophication issues,” and that the most cost effective solutions might be a combination of actions at different locations throughout the watershed. I will elaborate on this with my own design ideas, and in accordance with Mary Anne Taylor’s advice that we need a more holistic approach.

The Partnership has also come up with suggestions for Nassau and Suffolk counties. For Nassau, it would have the Bay Park STP upgraded to tertiary-level treatment to filter out nitrogen, as well as provide an ocean outfall pipe. It would also have the Glen Cove STP’s biological nutrient removal upgrades accelerated and use this facility’s surplus capacity to allow the north shore communities that still use cesspools to connect to the treatment plant. Interestingly, the Nassau County government has announced its Sewage Treatment Master Plan, which, when completed, will include a

79 Nature Conservancy’s Management Scenarios (Report on Phase 2), March 2011. Prepared for The Nature Conservancy, Long Island Chapter and New York State Department of State, with funds provided under Title 11 of the Environmental Protection Fund by Erin Kinney and Ivan Valiela, The Ecosystems Center, Marine Biological Laboratory, 7 MBL Street, Woods Hole, MA 02543
program of capital improvements featuring “the very latest technology associated with wastewater industry areas such as advanced treatment (nitrogen reduction), biosolids reclamation/reuse, energy efficiency/recovery (green building designs), and odor control,” among other improvements. This is great news. What's more is that its Consolidation Feasibility Study will focus on areas with wastewater facilities outside of the county’s administrative jurisdiction and study them to determine potential benefits to be had if consolidation of their wastewater services came under a larger County Entity. This language sounds similar to what the Partnership was advocating, though on a Nassau County-wide level, rather than a Long Island-wide one. Still, these steps, I believe, are going in the right direction. The less complex the solutions can be, the better. The Partnership suggests the establishment of a Water Resource Monitoring Program to match the one that Suffolk County has so that Nassau can also collect and evaluate water quality data and implement remedial actions and programs. Also like Suffolk County, it suggests that Nassau create its own version of a Comprehensive Water Resources Management Plan to identify specific actions to reduce nitrogen pollution from Nassau’s septic systems (30% of households), saltwater intrusion, and provide for transparent evaluation of water quality over time. For Suffolk County, the Partnership suggests the county update its Comprehensive Water Resources Management Plan and permanently restore clean water staff to its Department of Environmental Quality so it can responsibly implement the recommendation of the aforementioned Plan. It says the county should also shift the focus of much of its Clean Water Protection Funds to protecting regional

80 Next Suggested Steps, Long Island Clean Water Partnership
water quality and developing incentives for homeowners and businesses to upgrade their septic systems to advanced levels of nitrogen reduction. I have a similar idea for this that I will discuss later. Its last suggestion for Suffolk is to renew its commitment to land preservation, as it famously did with the protection of the Pine Barrens, which has been called “the best decision we’ve ever made as an island.” The groundwater under the Pine Barrens is the cleanest of the whole Island. I fully agree with this and the other of the Partnership’s suggestions, and believe that more open spaces should be protected if even only for the benefit of their function in groundwater recharge.

Though it may seem unrelated, better energy sources are also part of the solution for clean water and an overall clean environment. There has been a proposed idea to treat the wastewater from fracking that would occur upstate using our own sewage treatment plants all the way downstate here in Nassau and Suffolk counties81. This would be incredibly and foolishly imprudent, and obviously should not happen for the danger in which it puts our already vulnerable water resources. I believe that one of Long Island’s most promising future prospects is its ability to harness the wind that blows along its miles of coastline. The current wind capacity of the wind farms in New York State is about 1,812 megawatts (2.6% of the State’s energy supply), which powers more than 500,000 homes. However, this is mostly located upstate. Most of Long Island’s power comes from oil and gas. Fossil fuels contribute to water pollution by emitting nitrous oxide and trace minerals like mercury and lead into the atmosphere that become deposited in water bodies, posing a threat to local fishing. In a Stanford Study in

collaboration with The Solutions Project, it was found that by 2050 the State of New York could run entirely on a 100% renewable energy mix, and that 40% of that mix would comprise of offshore wind. No more if’s, we now know this is completely doable. There are proposals from Deepwater Wind for a Hudson Canyon Wind Farm that would supply much of downstate New York (NYC and Long Island), their Deepwater ONE wind farm off the coast of Montauk that would supply 120,000 homes on the East End with electricity, and from the NYC-Long Island Offshore Wind Project Collaboration that would install an offshore wind farm using 5-megawatt turbines in the New York Bight that would supply up to 700MW to power about 112,000 homes in New York City and on Long Island. This would amount to providing 24.7% of Long Island’s energy, though some of that would be split with NYC’s ConEd. The project would cost around $415 million and currently the only major problem that has been encountered, other than paying for the project, is the necessary transmission upgrades to the currently outdated grid system. In another Stanford study, Mark Jacobson has recently discovered a dual benefit from off-shore wind farms – their ability to sap the energy from on-coming hurricanes! This is very exciting news, especially for the geographic victims of Hurricane Sandy who know first-hand the consequences of climate change that we can only expect to go through again and again. I highly support the NYC-Long Island Offshore Wind and Deepwater Wind proposed projects and believe that

82 http://thesolutionsproject.org/infographic/#ny
83 http://dwwind.com
84 http://www.linycoffshorewind.com/Default.html
whatever energy it does not supply is doubled in the morale boosted for New Yorkers in pursuit of a sustainable future faced with the continuing effects of climate change.

Policy, no matter how progressive and expansive, can only do so much without the full backing of the public. Every citizen has a dual identity as an ecologically-minded conservationist, especially on and island like ours.

**Design.** Improving the waters of Long Island means finding better designs for the processes that use water in our every day lives. As we see more and more environmental degradation, we continually realize that the root causes are in the infrastructural designs of years past that do not work in harmony with nature. Ecological design, my favorite part of environmental studies, seeks to accomplish this type of “end-of-the-pipe” pollution mitigation. We need to design our built environment as man-made ecosystems that possess the recycling characteristics that mimic the way ecosystems handle materials through continuous use and reuse. Only then can we realign the built-up world in which we think we live, with the real world in which we actually live.

What we do with water on the island is of paramount importance because of the fact that we are an island. In conjunction with using water wisely and conserving its quantities, conserving its quality is equally necessary, and the main way we can do this is through wiser treatment of our wastewater. Wastewater is a reality that all civilizations must understand how to manage, or perish in their own effluent. For the health of the Island, wastewater management must be a top priority. The most common wastewater treatment plants treat water through primary and secondary treatment. Primary treatment is the first stage of mechanically screening the blackwater to remove larger objects and
material, and then a series of collection tanks where solids settle out and create a mixture of sludge and brownwater. This removes 30% of the pollutants. Secondary treatment involves the use of bacteria and biologically controlled processes to remove 85-90% of the pollutants. However, treatments plants that provide tertiary treatment remove nutrients like nitrogen and phosphorus that normally get left behind the first two phases in an additional chemical treatment. Without tertiary treatment, all of that nitrogen and phosphorus gets dumped with the rest of the unrecycled greywater, causing large-scale ecological devastation. This famously happened in the Long Island Sound. Sources of wastewater pollution from a much larger watershed encompassing multiple states empty into the Sound, causing extreme pollution and hypoxia problems and gaining it national importance and federal attention and cooperation. Tom Anderson’s *This Fine Piece of Water* chronicles the history and improvement of the Sound, including what can be done at the wastewater treatment level to mitigate nitrogen pollution. He writes about the way one woman, Jeannette Semon, operated a standard secondary treatment plant in Stamford, Connecticut in a way that rids the effluent of much of its nitrogen without extra costs, which from a political standpoint can be a factor that can make or break smart ecological decisions. This particular plant receives 17 million gallons to treat a day, and normal operating conditions would allow for all 4,900 pounds of nitrogen, or 20 milligrams per liter, to come in and go right out uninhibited. This is the problem, the nitrogen must be filtered. The nitrogen in the sewage in these treatment plants is locked up in ammonia, a human waste product and a naturally occurring component of many organic wastes. It is a combination of nitrogen and hydrogen, and dealing with it before it can be released from the plants and out into the environment means breaking it down and preventing this
nitrogen from release. This is achieved by a multitude of consequential chemical processes of nitrification and denitrification, all utilizing the naturally occurring metabolism of bacteria. This is the same way nature’s detritovores, or decomposers, clean up ecosystems and make nutrients available for the base trophic level of any ecosystem. Two specific types of bacteria are utilized first to break down the ammonia in a process called nitrification. They need oxygen to do this, so the treatment plant worker would simply turn up the aerator in the tanks. Microbes called nitrosamonas convert the ammonia into nitrite, then bacteria called nitrobacter turn the nitrite into nitrate. Nitrate is still a form of nitrogen, so next is the denitrification process. Different kinds of bacteria are required for this process, and they must have no oxygen to perform anaerobic respiration to digest the waste further. The plant operator would then turn down the aerator to a level of half a milligram of oxygen per liter or less so that the eight or nine types of bacteria can metabolically convert it into nitrogen gas, which is harmless and bubbles up and out into the atmosphere. This is how sewage can be treated for nitrogen without the use of harmful chemicals, and under optimal conditions – like in the hot summer months – these special tweaks in the system performed by the operator can achieve an 80% reduction of nitrogen in the wastewater. The cost of operation for this modification is about $10,000, roughly .004% of this particular plant’s annual budget of $2.5 million. However, what seems like a perfect solution runs into its own problems. This process requires the plant to operate below the capacity it was designed for. Semon’s nitrogen removal process requires the plant to run at 85% of its maximum
capacity of 20 million gallons a day. However, the solution to this would be to conserve water requirements. Since sewage is basically 95% water, if we can decrease the necessary amount of water required to move along the sewage through the process, via gravity for example, you can increase the amount of room within the plant’s tanks necessary to allow the sludge to gather the bacteria it needs for denitrification to happen. The conservation of water in the very water-intensive process of sewage processing is a wise move regardless because of the dire need to conserve the clean groundwater resources on the Island. I believe we have the capacity to do this with Nassau’s two main sewage treatment plants because they already operate at about 83% of their total capacity. I believe that better and more advanced treatment in the current sewage treatment plants in Nassau County should be implemented as a design solution in helping to mitigate our nitrogen pollution problem.

For Nassau County, the Bay Park sewage treatment plant serves the wastewater needs of 42% of the county, about 550,000 people, and has its own problems. The plant’s outfall pipe dumps the effluent into Reynolds Channel, a part of the Western Bays on the South Shore, within the South Shore Estuary Reserve (SSER). Over $1.6 million in state and federal funds have been used to document the acceleration of this area’s pollution, excessive seaweed growth, degradation of the salt marshes, hypoxia, and disappearing shellfish. It has been found that the Bay Park and the Long Beach STPs are the point-sources that contribute 80% of the nitrogen loading to the Western Bays ecosystem.

86 Tom Anderson, This Fine Piece of Water: An Environmental History of Long Island Sound
Scientific studies have suggested that the outfall pipe should be relocated to the ocean rather than in the bay. Although this is not an ideal solution, to have the effluent disposed into the bay at the level of treatment that the Bay Park facility currently provides is disastrous for the integrity of the bay and public health because of the geology of the area being an enclosed embayment as well as its coastline being a high density populated area. The consensus is that the ocean can handle the treated sewage at dilution rates that the bay cannot, leaving it as our best option. Regardless, as one of Long Island’s oldest sewage plants, the Bay Park plant must also be upgraded with tertiary treatment to filter out nitrogen. Hurricane Sandy flooded the plant with nine and a half feet of seawater and caused it to shut down, releasing approximately 2.2 billion gallons of raw and partially treated sewage into not only the bay but also into streets and homes. This was the first time anything like this has happened on Long Island, and is probably the cause why Bay Park is getting the attention it deserves. FEMA has allocated an unprecedented $810 million to upgrading it – but a necessary expense when looking at the population densities that the plant must serve, but an ocean outfall pipe has not yet been included in the plans.

Since 70% of Suffolk County is not hooked up to sewers, the solution here would seem to be to build new, state-of-the-art sewage treatment plants. However, this is extremely expensive and thus would face much political opposition, no matter how dire the consequences are. As a matter of fact, Suffolk County Executive Stephen Bellone has announced that the top focus of his administration this year will be protecting our surface

87 Citizens Campaign for the Environment Bay Park Handout
and drinking water by reducing nitrogen pollution from the impact of the county’s widespread septic tank and cesspool infrastructure. This March, he’s seeking $1 billion in Sandy recovery aid in an effort to: extend sewers to 12,000 homes along the South Shore, which would cost $750 million, as well as the repair of the outflow pipe at the Bergen Point Sewage Treatment Plant, which would cost $242 million. New York State’s NY Rising Program holds $2.097 billion dollars that has been federally funded to provide rebuilding and revitalization assistance to communities that have been severely impacted by Hurricane Sandy88 to reduce nitrogen in the Great South Bay by 25%. In February I attended a rally that thanked Governor Cuomo and brought attention to his allocation of $730 million in grants to rebuild the outdated infrastructure of the Bay Park Sewage Treatment Plant in Nassau County. The money is there; the problem is in adjudicating the value of the projects it goes toward at the upper levels of government. Although, there may even be a better solution…

In October, I attended a forum on Long Island’s water quality hosted by the Citizens Campaign for the Environment group. This was my first encounter with the immensity of our water problem, and prompted me to write about this topic. Solutions to the problem were broadly discussed at the forum, and it was said that we need new technology, new standards, better and innovated financing, and new government policy. I agree 100%. A large part of this is all about entering an “enlightened period of development,” but one speaker said that “there is every reason to solve our problems with economic incentives,” stressing the value of the ability to make a profit by updating

broken septic systems. Our water problem is more than broken septic systems, and though I was originally a little skeptical about putting all our eggs in the economic incentive-based basket, I feel like the idea of encouraging a profit for finding the solutions to these problems is something that has worked before in our society, so why not here. While researching better ways for NYC to recycle its wastewater in a separate class, I came across the Johkasou. The Johkasou is a Japanese innovation that basically functions like a mini sewage treatment plant. It addresses the need to “reduce the impacts of deteriorating quality public waters (particularly enclosed water bodies) as a result of climate change, in areas that may face declining sanitation conditions” and it is mainly applicable “in response to the need to mitigate impacts in regions where water pollution is occurring due to urban population growth associated with economic growth, or due to rapid industrial development.” The similarities to Long Island, particularly Suffolk County, could not be more apparent. Unsewered communities in Japan use them to treat domestic wastewater so that does not pollute the environment. The recycled graywater that they produce can be used as a reliable water source for a variety of uses, like back into flushing toilets, watering gardens, or safely returning the treated effluent back to the environment in the ground or local water bodies. Small-scale Johkasous for individual homes are relatively affordable, can be installed quickly, and can treat up to 2,641 gallons a day. Larger-scale Johkasous treat up to 264,000 gallons of water a day and can be used for factories, hospitals, and housing developments. The best part about the Johkasou

89 http://www.env.go.jp/recycle/3r/en/asia/02_06/01.pdf

for its application on Long Island is that it filters up to 77% of nitrogen from the influent. The Johkasou would bring jobs in the form of installation, inspection, maintenance, and desludging, which is the process by which (either a private or public entity) comes and removes the sludge from the system about once a year. I’ve run this idea by Mary Anne Taylor, and she agrees that, with its rates of water treatment per gallon and once-a-year desludging, it could be a good alternate solution to the septic tank problem. Current searches are being done by Suffolk County to find alternative septic systems, and I believe the Johkasou should be included in that search. The sludge can then be treated again in other sewage treatment plants or turned into fertilizer or lightweight aggregate building material. If we bring the Johkasou to Long Island, it will probably require some form of federal assistance or aid. The Johkasou is ideal for areas of low population density – again, like many areas of Suffolk County. From my research experience it seems that updating all the septic systems on the Island is costly and invasive, but necessary nonetheless. Japan came up with this system because their geography demanded a safe way to handle the waste that came with their population growth, which is why we on Long Island could mimic this wisdom for our own dire needs. Long Island is geologically and ecologically incompatible with septic systems, but with the population requirements at hand, I can see the benefit of the private sector developing its own version of the Johkasou, thereby protecting the quality of our waters and driving the economy at the same time.

The solutions listed above have so far been prevention based and serve to combat pollution before it happens. I have come up with my own idea of a design plan to deal with pollution already present in our surface waters in a sort of one-two punch, and it consists of using Dickson Despommier’s idea of the vertical farm as a water recovery plant, and Dr. John Todd’s ecological designs to clean up already present nutrient pollution in our surface waters. The vertical farm is basically a multi-level building housing a completely controlled environment that supports the growing of any number of plants and produce through hydroponic agriculture. It conserves far more water space than conventional agriculture, and generates economies naturally in being a revolutionary new way of localizing food sources. But the vertical farm has more uses and benefits than just food production, including the reclamation of greywater. In his landmark book, Professor Despommier explains, “plants obtain their nutrients by pumping water up through their roots, through their leaves, and then out into the atmosphere. This process, referred to as transpiration, allows them to take up nutrients in the form of elements and
organic nitrogen. The elements and nitrogen stay inside the plant and become incorporated into new tissues of the growing parts of the organism, while the water is continually transpired through tiny pores in the leaves called stomata. Remediation of greywater could easily be accomplished by taking advantage of the enormous amount of transpiration that would occur inside vertical farms constructed solely for that purpose.”

My idea here is to connect these specialized vertical farms to our current wastewater treatment plants, Bay Park for example, and allow the plants to do what they do naturally, as a chemical-free and probably cost-effective alternative to expensive installations of conventional tertiary treatment. Although we would not be able to harvest the plants in this specialized vertical farm for eating, we could produce purified drinking water from the blackwater in sewage treatment plants. How awesome is that?

Dr. John Todd of the Ocean Arks Institute in Woods Hole, Massachusetts, had created the Living Machine concept many years ago in much the same ideals using nature’s wisdom to design better integrative systems, and he’s already found a way to achieve the remarkable process outlined above. He is credited with coining the term “living machines” for designed systems that use plants to remediate damaged aquatic ecosystems. He has also worked extensively since the 1960’s to identify the right plant species that best remove materials like pesticides, heavy metals, herbicides, and fertilizers from damaged lakes, wetlands, and estuaries. His designs have been successfully applied for commercial use, including helping many factories manage their effluent and remediating many damaged natural landscapes. While the conventional treatment plant

relies on mechanical filtering, bacteria, and chemicals, the ecologically minded Living Machine relies on the inherent capacity of aquatic ecosystems to purify water. It works like this: a greenhouse is filled to the brim with four rows of large, translucent cylinders that are overflowing with aquatic plants. Each row of cylinders is connected in a long series, taking about four days for the polluted water to flow from the first tank to the last tank. The first tanks contain the simpler members of any nutrient rich pond, including bacteria, algae, snails, and amphipods. As they progress, the tanks contain more delicate creatures, higher plants, clams, mollusks, and fish. In effect, the greenhouse facility replicates the purification of water that occurs in nature as it travels through a wetland. How appropriate that Long Island’s solution to the problem degrading its precious wetlands be inspired by the very areas in threat? The living machine, housed in the greenhouse, is essentially a series of microcosms – tiny artificial ecosystems – that can support all the species necessary to take nutrients, pathogens, and toxins out of the water. John Todd sums up the whole process, “Microscopic bacteria consume the nutrient-laden organic matter from the wastewater and convert toxic ammonia to nitrite and nitrate, which creates suitable food for plants like duckweed. Algae growing on the sides of the tank consume abundant nutrients and grow rapidly. Snails and zooplankton are then eaten by fish, such as striped bass, tilapia, minnows, etc. – and on and on churns the natural food chain cycle of an ecologically engineered system, purifying the wastewater with each step.” The next part of the building simulates the intelligence of tidal marshes, in which the effluent passes through two distinct cycles: one without oxygen to simulate high tide and one with oxygen for low tide. The marshes are planted with bulrushes, cattails, and other species and become important sources of metabolic diversity – again
mimicking Long Island’s own natural ecological diversity. As species diversity increases, so does the range of compounds that can be absorbed or neutralized naturally. The entire process is not only very effective, but beautiful. The warm and inviting aesthetic of the greenhouse, the sound of trickling water all throughout the building, and planter boxes hang from the ceiling – the facility itself could be a local attraction or educational destination for school kids of all ages, generating revenue. The system is a habitat for a wide range of species, affirming the patterns that maintain a healthy ecosystem, and thus achieves a high quality of treatment with minimal energy input and chemical intervention. It’s main source of energy is the sun, and due to the biological aspect, with proper maintenance the system can sustain virtual immortality, as opposed to mechanical machines that wear down and need upkeep over time. The living machine also uses no chlorine, which is used by many treatment systems for sterilization of effluent in many cities. While chlorine may immediately neutralize pathogens with modest effectiveness, it creates highly toxic byproducts that must be accounted for. The diversity of plants and animals in the living machine destroys pathogens just as effectively, produces clean water, does not generate additional toxins or waste nutrients, supports a verdant greenhouse with more desirable functions than one, and looks beautiful doing it. This exact process of using Dr. Todd’s living machines as tertiary treatment for sewage.

treatment plants has already been done upstate at the Omega Institute in Rhinebeck, NY.

I’ve had the pleasure of taking an Ecological Design class taught by Professor Despommier, and thus have been able to seek his council on these custom design ideas to mitigate nutrient pollution. We believe that the idea of using the vertical farm or living machines as the tertiary treatment step in wastewater management is a very practical and feasible project. There are currently no vertical farms implemented for the purpose of water recovery, yet. How amazing would it be for Long Island to build and manage the first vertical farm – a pioneer technology born of necessity to progress society toward sustainability – devoted to wastewater purification? To make this plan a reality is merely a matter of cost, like anything else, and needs only the political will and social acceptance.

Dr. Todd has come up with another design for remediating already-polluted aquatic environments with what he calls his Aquatic Restorer. This is a system of floating patterns linked to an upwelling bottom filter. The Restorers are composed of selected plant ecologies supporting microbial films and an aeration system. Restorers are installed
on impaired water bodies to slow and reverse eutrophication, restore the water’s healthy ecology, and provide increased capacity for the water body to deal with high nutrient loading. Although Dr. Todd’s Aquatic Restorer product is meant for ponds, my idea would be to develop a system that functions just like this but can handle the turbidity of estuarine systems. If this can be done, then Restorers could be scattered all throughout Long Island’s southern bays to passively clean up the remaining nutrient pollution that is here to stay for years to come from the seeping groundwater, while upstream the vertical farms and living machines are filtering out the effluent at the point source. The nutrient pollution problem is similar to the climate change problem in this way that excess pollution in the groundwater is “locked in,” so we must adapt to this new aspect of our environment. Adjusting the way we approach the problem is necessary, and designing with the future in mind with a similar Aquatic Restorer idea to mitigate the remaining nutrient pollution might be the only ecologically sound way to clean up the bays.

Conclusion

Long Island’s inhabitants must abide by the laws of its geography. The sandy geographical makeup of our island that allows for some of the purest drinking water in the nation is in danger of being compromised by current wastewater treatment technology as well as previous development trends that have left our surface waters polluted with excess nutrient runoff. Over time, population growth, the consequent installation of deficient infrastructure to accommodate it, and long-term unsustainable practices by residents and industry have resulted in the eutrophication of our bays and indirectly

94 http://www.toddecological.com/services/aquatic_restorer.php
threatens contamination of our only public drinking water supply as well as our economy that relies on these same resources. The solutions must be swift and as Island-wide as the problem is itself, as well as comprehensive in scope and balanced between all levels of government. Most crucially, we need a mandatory and enforceable nitrogen limit of 2 mg/L for our groundwater and a revamping of wastewater designs and practices. The water problem on Long Island is defined by a series of environmental effects that many other communities have faced, yet shaped by its own unique geological parameters, but still nothing that we can’t solve if we think globally and act locally. Good, scientifically lead policy in tandem with new, innovative designs for wastewater management and land-use infrastructure must usher in a new era of future-minded planning. Education is key for any environmental problem – the more people who are aware of a public threat, the more support rallies behind action to be taken. Great strides are being made by various groups, especially Save the Great South Bay, whose mission it is to raise public awareness by integrating people back into the reality of their environment and advocate for science to lead the way for decisions to secure a healthy, sustainable way of Island life for generations to come.
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