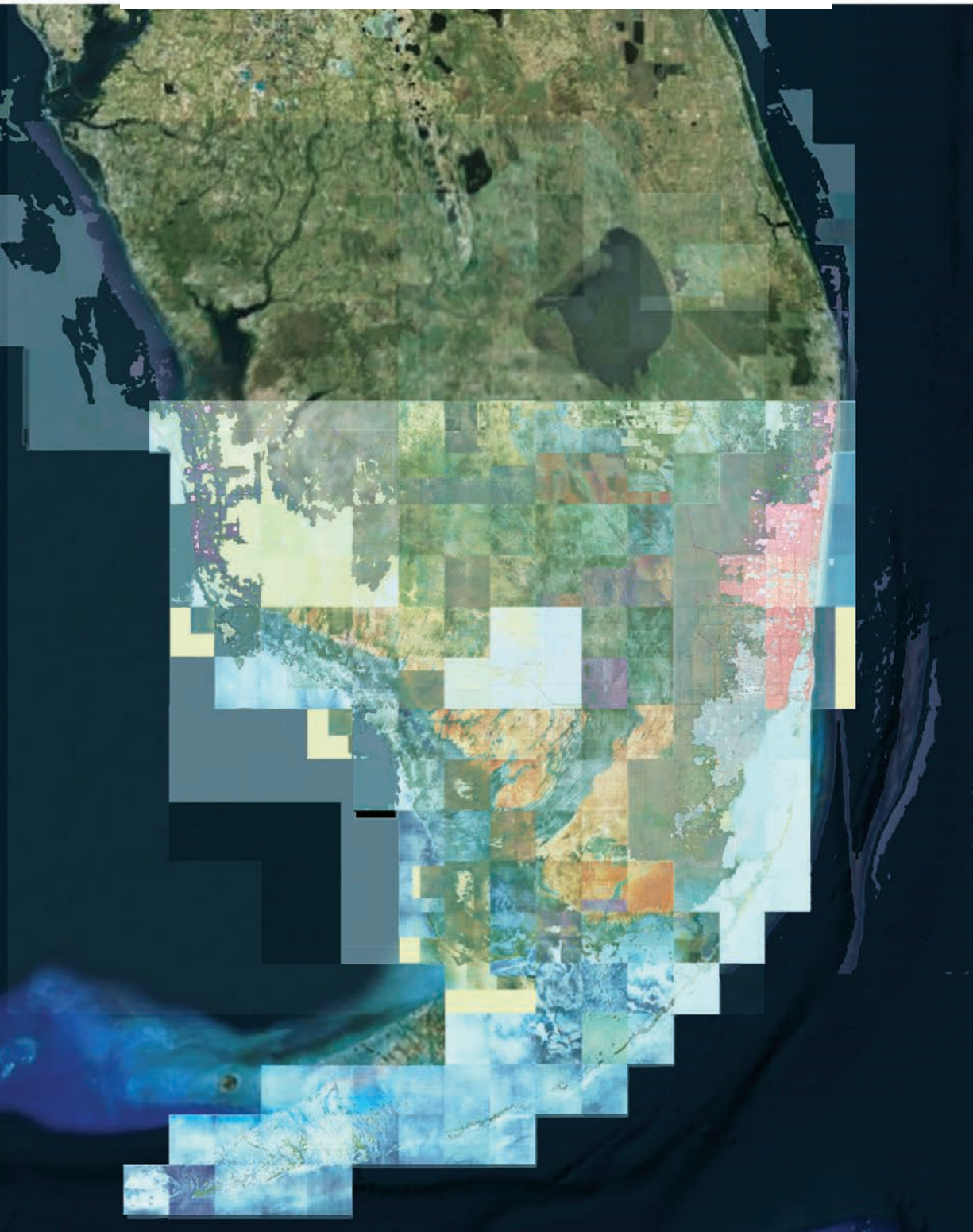
Constructing Nature

Miami's Micro Wastewater Wetland System



Dedicated to:

The University of Detroit Mercy
2018 Masters of Architecture

Special Thanks to:

Advisors Noah Resnick & Wladek Fuchs

My Family, for continued love & support
through my career at UDM.

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Miami's Micro Wastewater Wetland System

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Abstract

Water is arguably the most crucial element of life, but as life is a delicate balance, water becomes detrimental in just moments, destroying the life it helps to create. As we develop in the modern world, we are not free of the strains of water. Droughts, Floods, and Hurricanes, cause thousands of deaths yearly, and those are just examples of immediate impacts of water, we will see the real power of water in our lives as millions are displaced due to sea level rising and the pollution or over extraction of water. As the world and local governments move to develop sustainable designs to counter the effects of climate change, politicians controlled by the slow movement of legislation and are deterred as society questions the necessity of policies as people do not see the more significant impact and anticipate the effects shortly.

The duty falls on those who are closer to the design, those who can affect it at almost an immediate level. As design and construction adhere to meet more LEED and other sustainable design protocols, they fail to step back and not ask only if this is sustainable for the purpose but also to ask if this is sustainable for the environment. As we have developed a society, the assumption that we will create situations that will support themselves without influence from nature. Creating these environments that attempt to replace the natural ones, those that had existed for hundreds of thousands of years become are displaced and destroyed in a matter of decades creating the imbalance we see in climate change.

Abstract

The goal is creating a system that is sustainable as it marries the natural environment with that of the built architectural one. What if design in the 21st century started to restore the native ecosystems as it evolved and supported those usable for humankind? How can a system develop around water, influence that in the built environment? It was the posing of these questions which lead to the development of this thesis, constructing nature.


Thesis Paper
Miami-Dade Design Solution
Support Research
Works Cited

Thesis Paper

What substance understood as one of the most influential aspects of life? Water is necessary for all life; it is one of the first if not the first substance NASA scientist looked for when they discovered a new planet. Up to 60% of the adult body is made up of water, and we are recommended to drink just eight cups a day. Nearly 70% of the Earth's surface covered with water and only around 2.5% of that is fresh water. Water is such an intriguing substance as its chemical make-up allows it to be denser in liquid form than in solid, the reason we are here today. Water, being such an important substance, finds its way into our lives as we would not be able to live without it. We build near it as almost every major U.S. city is located on a body of water. As this thesis explored the essence of sustainable design, it became apparent there is no sustainability without the influence of water, as much of modern life is still so intimately connected.

Sustainability is so closely tied to water as water is such a key to life, it can destroy life as quickly as it sustains it. With the lack of water, causes droughts leading to famine, with storm surges leading to flooding of areas, destruction is just degrees away in the big picture. As the climate changes, it becomes more apparent that there need to be steps taken to help prevent that destruction and help to reverse the mistakes humankind has made over the past centuries. With research of relatively recent events such as the Dust Bowl, display how the minor influence of humanity on the water can have significant impacts on the world we live in today. The problems that lead to the outcomes of the Dust Bowl never were indeed solved but none the less, the "sustainable" solution came out to help fix the water problem. That solution was supplementing the natural rainfall to water the plains with the water drawn from the Ogallala Aquifer, that supplementing has grown into a full dependence. There is no sense of sustainability in the overdrawing of the aquifer, which has brought up the thought of how to limit our reliance on fresh sources of water. Is there a way to develop a sustainable cycle of water that allows for the growth of crops and support of humankind but also the natural ecosystems?

For the most part that seems to be an underlining thought for many of the sustainable advances and set regulations that have come forward in the past century. We are looking to protect the sources of water we have and seek to regulate the ecosystems we co-exist with, but we do not seem to make that the focus of our efforts. In 1948, the Federal Water Pollution Control Act, which was the first of its kind as it set out to address water pollution. The amendment best known as the Clean Water Act came out in 1972. Vital as it allowed everyone the rights to clean water no matter what body of water it was or where it located. These acts and regulations have continued to this day but seem to be becoming more politically charged and more generic then the solutions to the climate change must be. The most straightforward example of how politicized these motions can grow is to present is the development of the Paris Climate Accord.

On April 22, 2016, 72 countries came together to set this agreement to ban together to help prevent and reverse effects of climate change. The agreement, "...aims to strengthen the global response to the threat of climate change..." and one of the most important aspects of that response is holding the global average Temperature to below 2°C above the pre-industrial levels. The agreement sets different standards to be meet by the lower developed, middle developed and developed countries, due to different economic abilities of those varying countries. The commission of the United Nations review yearly to check how the goals set are being met. But the idea is that the global economic and social pressures will keep a check on the goals and progress of each country. The idea that the

country that sets its goals and progresses toward them will be at an advantage sustainable along with economically. As the review of the document started, the opening statements were of a lot of importance, the first being, "Recognizing the need for an effective and progressive response to the urgent threat of climate change on the basis of the best available scientific knowledge" quoted from the document. So this is important as then there can be no disagreement, the officials must acknowledge with the signing of the document that there is real danger and it needs to be dealt with immediately. This statement makes the leaders of their respective body of people, to recognize and move for "effective and progressive" actions in hopes the sooner the action the better the result.

This starts to level the ground of that this problem is everyone's and everyone can do something to make a difference. "Emphasizing the intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty" This statement works with the idea that there is a relationship between the economics of climate change and the actions we as society can make against climate change. Understanding that there is a way to take the concept of sustainability to the level of eradicating poverty along with climate change and vice versa must be the goal when conducting these responses. Ideas such as passive Haus low income housing, where then if the housing is government subsidized, energy bills will be low and allow all to benefit, as an example. But there needs to be implementations to be set to help work towards equality socially through developing sustainability. "Acknowledging

that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity" This statement plays off of the previous two highlighted, as a call for social justice, in the sense of sustainability, the rights of those who are dealing or will deal with effects of climate change should not be exploited or disrespected. It is important to give everyone the equal opportunity for assistance to deal with these problems regardless class or so on.

Sustainability may be a costly venture in some senses, but that doesn't mean it should only go to those who can afford it as it will be counterproductive in that sense as some of the biggest polluters in the world are those countries that are poor or underdeveloped. "Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of "climate justice", when taking action to address climate change" This statement is about the "Climate Justice" this is an important statement as it brings up the idea that as we as humans look for a sustainable life style, we should not forget that the sustainability should not negatively affect the ecosystems as they are just as important to sustainability as the methods we employ as humans. It seems common knowledge but when you look at most human development in the world,

and we have not necessarily developed with nature in mind, instead we have developed, and nature has adapted. Now it is important to understand that not all ecosystems can do that so we cannot keep with that idea that nature will always adapt as it is obvious it isn't with climate change, so it is important that the future sustainable development works to not destroy or hugely effect those ecosystems and should work to help promote them. "Also recognizing that sustainable lifestyles and sustainable patterns of consumption and production, with developed country Parties taking the lead, play an important role in addressing climate change" This is the final highlighted statement and is important as it follows the ideas of learning from each other, and sharing the ideas that work. As stated earlier when dealing with competition sometimes there is a negative effect where information isn't shared, this document looks to reverse that to help promote collaboration and sharing. This idea can help spread useful techniques and hopefully allow methods from several situations work together to mitigate the problems faster. The Paris Agreement is the most inclusive global agreement on climate change to date. Previous accords focused on cutting emissions from the developed world. In contrast, the agreement set a global goal to which every country has agreed to contribute. The agreement was always designed to be a starting point, not an ending point, and the Paris Agreement allows for its continual improvement.

As shown in the research, this event came as a surprise, on June 1st, 2017, President Donald Trump, removed the United States from involvement in the Paris agreement. This

event caused huge kickbacks on many levels of government along with many CEOs of huge companies in the private sector. This huge kickback leads to a re-commitment and support of hundreds of American business Leaders, political leaders, such as Mayors, Governors, and even the Secretary of State, Rex Tillerson; the goal being was to keep America on the track to stay ahead of the curve. As of today, 196 countries are in the agreement, recently added Nicaragua, who was holding out for more strict conditions of the developed countries but has recently signed. Leaving the United States as the only major country not in the group committed to the agreement. This ability for a global leader to step out and disband all the progress toward a sustainable future show where a huge problem falls with large entities taking on these responsibilities. The focus should be more localized. And with the negatives of the political sides of these topics, there are positives, as there are many local and independent entities that have taken on the burden to provide a sustainable future in response.

Many smaller entities are working on plans to make themselves more sustainable, notably, the cities of the City Energy Project as they have a formulated system and set criteria to adhere. The requirements cover many topics of sustainability in cities, many of the plans include strategies to deal with issues of Social justice to ecological demand for water and energy. Using these as case studies to understand methods on implementation and sizing of systems to be able to affect an entire city.

Los Angeles's pLAn

LA's sustainability plan has already been implemented and recently reviewed, and they met almost all goals set in 2015 for 2017 and they are 90% on track to meet the ones set for 2025 and 2035. Their strategic plan breaks down into 14 sections dealing with different topics such as Mobility & Transport, to Waste and Landfills, including Local Solar and several other issues. This research moved to highlighted are two sections that deal with LA's water and the ecosystems around water bodies, as the goal of this thesis is to relate an innovative design that deals with water as it is so essential for sustainability. As LA continues to experience severe drought conditions, the Local water goals set out in the pLAn ensure a secure and healthy future for the City's growing economy while protecting this precious resource. The plan to reduce our dependency on imported water by developing local water supply, capturing, and cleaning stormwater, recycling wastewater, and recharging our groundwater basins. The pLAn also positions Los Angeles to bounce back from possible disasters while keeping rivers and beaches clean, accessible, and thriving with wildlife. As it is known that the LA river has nearly any water running in it let alone any bit of an ecosystem surrounding it, the goal is to cut water needs to allow for water to return to the river and help promote the ecosystem that is native to the river. L.A.'s "wild places" covers efforts to revitalize urban ecosystems, including the Los Angeles River, go hand-in-hand with prioritizing public access to outdoor spaces—which requires balance in developing the richness of those spaces in terms of services, amenities, biodiversity, and urban agriculture.

Boston's Climate Ready Plan

Boston has a very comprehensive multi-layered plan; the research conducted highlighted the few strategies more involved with water aspects. One of the approaches dealing with creating a coastal protection system to address flood risk. The Coastal and riverine flooding poses an immediate threat to communities along Boston's waterfront and to the vitality of the city itself, as seen in the past years with hurricane flooding and so on. The City and its regional partners should investigate primary "gray" and "green" infrastructure investments to address flood risk, so as the city has developed over time, it has gotten rid of the original ability to deal with storm surges with nature. The city needs to look at the more sustained design to help allow for development without the risk of harm to those who live there. The next strategy deals with Boston needing to invest in infrastructure but doing so with the intent to be able to deal with future conditions, while this may be forward thinking it also may show that some development is not necessary. The committee would develop planning and design standards aligned with current climate projections, identify cascading vulnerabilities, establish coordination mechanisms, and align adaptation efforts with other planning priorities. However, there needs to be a call to is the money that will spend worth being spent or is there another option and looking for possible collaboration. Which leads to the next strategy which focuses around decentration, which may be vital in designing for sustainability. As there will be carrying capacities and understanding and planning for that will help create a better environment. The last strategy

covered is brought back the basics of sustainability, as we look to improve life in the cities we have to pay back the green. Green stormwater infrastructure helps many levels of these challenges cities face. It relies on natural processes, can address these challenges, and improve the safety and beauty of the public realm.

Chicago's Green Stormwater Infrastructure Strategy

Chicago's suitability plan centers around the aspects of water and its devastating effects on the city, with the constant risk of flooding, piggybacking from the Green Alley Handbook, they are working to have changes to their present built environment that will allow for better stormwater management. It has already significantly invested in green infrastructure, and it has played off, so their sustainability plan sets out more initiatives to continue to work. The city looks to integrate greener stormwater infrastructure into future public capital projects, one to put the money to good use and to display to the private sector that is a worthwhile approach. Another approach is with the use of Bioswales in the urban environment. Benefit with beauty along with practicality in as they deal with water filtration and stormwater management.

These case studies allowed for the development of this thesis to take on an aspect of a plan for a whole city. The direction of was set to develop on a major American city that is attempting to renovate or replace an existing infrastructure that deals with water.

Site Selection

South Florida, Miami-Dade County.
Miami's Green Print

As this thesis looked for a city heavily influenced by water and looking to redevelop an existing infrastructure, Miami arose as a high candidate. Water cover Miami, to the east its bordered by the Atlantic Ocean and Biscayne Bay, to the west the Everglades, the county is cut through by the Miami River and the complex network of canals. These water systems all sit upon the Biscayne aquifer the largest freshwater aquifer in south Florida. In its Green Print, Miami's Sustainable Futures plan, it highlights that there will be an overhaul of the existing stormwater and wastewater systems as the present demands are straining the current system. The new system would also allow for the expansion of the population as Miami-Dade figures it can grow as much as 2 million people in the next 50 years. As this plan is comprehensive and implemented immediately, but there is a reason to investigate this problem and solution further. Most of Miami's freshwater comes from the Biscayne aquifer. The massive existing population of Miami puts a burdening strain on the aquifer, and that in combination with the underused canal system is leading to higher rates

of saltwater infiltration into the aquifer. This problem is not going to solve itself plan proposed in the Green Print, but it could lead to the collapse of this great American city. As it is understood, Miami is an Atwater city, which with sea-level rise may become flooded but this thesis does not look to solve the problems that may arise due to sea-level rise but instead hopes to propose a system that can help prevent the draining and salination of the freshwater aquifer.

Technology

As this thesis developed around the problem of freshwater in Miami, there needed to be a sustainable system to design around, that system would need to be able to recycle water, integrating it into the operations of water, wastewater, and stormwater. As research ensued the networks of Constructed Wastewater Wetlands became a focus of this thesis as it would become the central system to develop. Building off of designs and understanding of John Todd, pioneer of what he trademarked as living machines, this thesis developed the system further. The living machine is a system of local native plants, animals and other organisms that work through an integrated order to allow for the cleaning of a kind of polluted water to allow it to become potable again. Using this technology, the technology of nature, a system to allow for localized cleaning and recycling of water to eliminate the strain of chemically treating water or drawing on new freshwater.

Program

Developing a program is centered around the idea that sustainability uses existing systems along with allowing the harmony between all levels of life. The canal system of south Florida is a crucial system as it was built out through the early 20th century, it allowed for the draining of the marshland to then allow development on the surface. The system nearly destroyed all of the native ecosystems of the area. The canals presently sit relatively unused and but continue to harm the environments, as they influence a faster saltwater infiltration and then they also allow for spreading of the invasive species almost unchecked through south Florida. The program of this design solution will look to implement a new layer to the existing systems of Miami, which will allow for the restoration of the native ecosystem while the human environment continues to thrive.

Design Solution

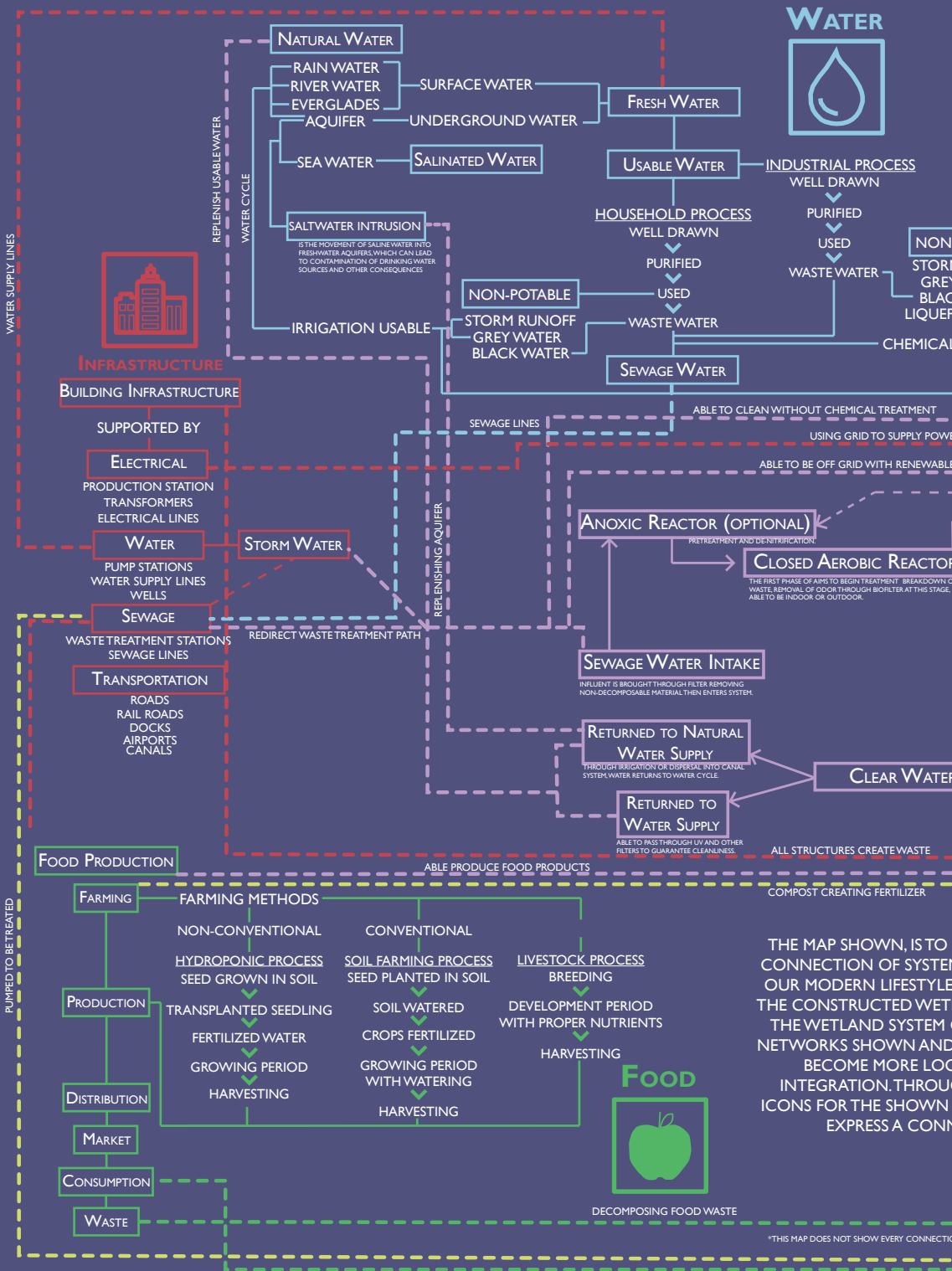
The design began with the understanding of the complexity of the existing systems and infrastructures. The knowledge leads to the development of how constructed wetlands could influence and implement into these current systems. Relationships between the water system and farming systems and waste systems with the energy systems started to become apparent. Following the program, a search for sites suitable, following the main criteria of Near and or adjacent to canals or body of water, and adhering to one or more of the following;

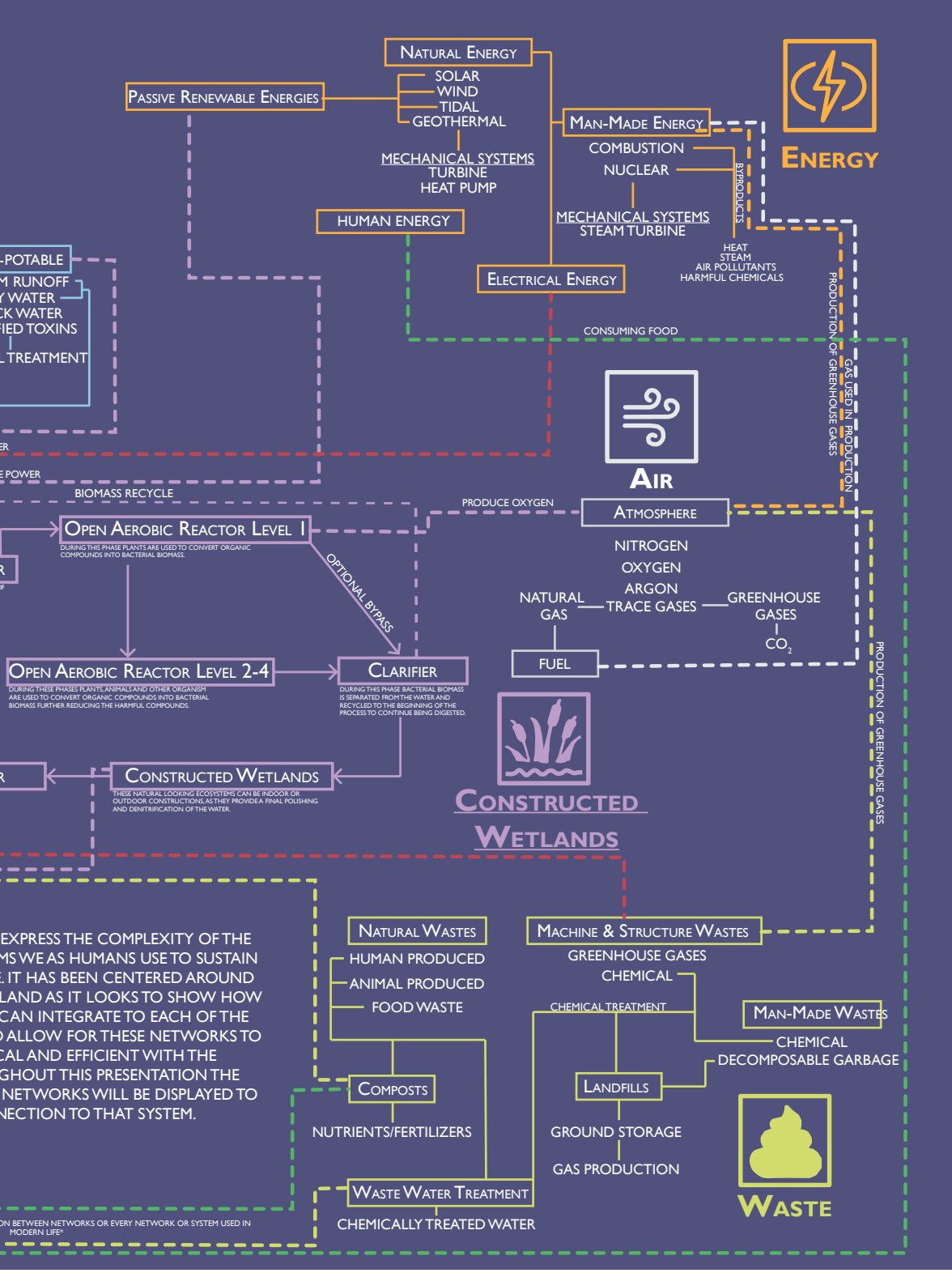
- Proximity environmentally damaged areas
- Proximity border of the Everglades
- Proximity Farmland
- Proximity to the sewage system
- Proximity to residential area
- Proximity to institution

These criteria lead to the labeling of 250+ potential sites across the developed areas of southeast Florida. These sites would be suitable to house one of the three-phase approaches to the design. The phases would allow for different direct programming of the places with the underlining factor of that they are design and constructed wetlands first. The stages would focus on specific categories; the first phase is centered around education and the communities as they are the highest demand and strain on the present systems. The second phase would allow for the creation and renovation of existing buildings to then become part of the system and sustainably support their functions. The third phase takes on the aspects of fully integrating the system, as it is attaching to existing systems, the proposal of a wetland boat system would allow for the circulation across and full integration of the canal and wetland systems. As this implemented three phases system, the phases would not be set to have to follow each other in order. As this design solution would perform over several years to decades, the phases could start simultaneously.

Conclusion

By attempting to create a system that would allow for a real sustainable life centering around water, central aspects of modern life challenged. The understanding that our perfect design at the time may cause destruction and other problems in the future but to is essential to continue to develop the existing. As the understanding of sustainability established that it is something that envelopes a given aspect of life and allows for the development of a system but also the support of surrounding systems, it reaches further than itself. This thesis has started to provide an understanding of how we as humankind can once again live in the native environment without destroying or displacing it. As we know we have already done so much damage to the world, this thesis leads to the question of how do we start to design and build for ourselves in a world that will be much more unpredictable? What will we do as we have to become much more adaptable to the environment rather than making the situation adapt to us as we have done over the past centuries? As this thesis explored sustainability at such a grand scale down to a local level, to take away that the plans that will begin to impact and have a significant influence on humankind. Are those that start and develop on the local scale, and they can lend themselves to become transferable to other areas and eventually build up a system that is then influential at a global level.


WATER
NATURAL WATER
RAIN WATER
RIVER WATER
EVERGLADES
SURFACE WATER
AQUIFER
UNDERGROUND WATER
SEA WATER
SALINATED WATER
FRESH WATER
USABLE WATER
INDUSTRIAL PROCESS
WELL DRAWN
PURIFIED
USED
WASTE WATER
HOUSEHOLD PROCESS
WELL DRAWN
PURIFIED
SALTWATER INTRUSION
IS THE MOVEMENT OF SALINE WATER INTO FRESHWATER AQUIFERS, WHICH CAN LEAD TO CONTAMINATION OF DRINKING WATER SOURCES AND OTHER CONSEQUENCES
NON-POTABLE
USED
WASTE WATER
STORM RUNOFF
GREY WATER
BLACK WATER
IRRIGATION USABLE
SEWAGE WATER
CHEMICAL
REPLENISH USABLE WATER
WATER CYCLE
WATER SUPPLY LINES
INFRASTRUCTURE
BUILDING INFRASTRUCTURE
SUPPORTED BY
ELECTRICAL
PRODUCTION STATION
TRANSFORMERS
ELECTRICAL LINES
WATER
PUMP STATIONS
WATER SUPPLY LINES
WELLS
STORM WATER
SEWAGE
WASTE TREATMENT STATIONS
SEWAGE LINES
REDIRECT WASTE TREATMENT PATH
TRANSPORTATION
ROADS
RAIL ROADS
DOCKS
AIRPORTS
CANALS
REPLENISHING AQUIFER
SEWAGE LINES
ABLE TO CLEAN WITHOUT CHEMICAL TREATMENT
USING GRID TO SUPPLY POWE
ABLE TO BE OFF GRID WITH RENEWABLE
ANOXIC REACTOR (OPTIONAL)
PRETREATMENT AND DENITRIFICATION.
CLOSED AEROBIC REACTOR
THE FIRST PHASE OF AIMS TO BEGIN TREATMENT BREAKDOWN O
WASTE, REMOVAL OF ODOR THROUGH BIOFILTER AT THIS STAGE,
ABLE TO BE INDOOR OR OUTDOOR.
SEWAGE WATER INTAKE
INFLUENT IS BROUGHT THROUGH FILTER REMOVING
NON-DECOMPOSABLE MATERIAL THEN ENTERS SYSTEM.
RETURNED TO NATURAL WATER SUPPLY
THROUGH IRRIGATION OR DISPERSAL INTO CANAL SYSTEM, WATER RETURNS TO WATER CYCLE.
CLEAR WATE
RETURNED TO WATER SUPPLY
ABLE TO PASS THROUGH UV AND OTHER FILTERS TO GUARANTEE CLEANLINESS.
ALL STRUCTURES CREATE WASTE
FOOD PRODUCTION
ABLE PRODUCE FOOD PRODUCTS
COMPOST CREATING FERTILIZER
PUMPED TO BE TREATED
FARMING
FARMING METHODS
NON-CONVENTIONAL
CONVENTIONAL
HYDROPONIC PROCESS
SEED GROWN IN SOIL
SOIL FARMING PROCESS
SEED PLANTED IN SOIL
LIVESTOCK PROCESS
BREEDING
PRODUCTION
TRANSPLANTED SEEDLING
FERTILIZED WATER
GROWING PERIOD
HARVESTING
SOIL WATERED
CROPS FERTILIZED
GROWING PERIOD WITH WATERING
HARVESTING
DEVELOPMENT PERIOD WITH PROPER NUTRIENTS
HARVESTING
FOOD
DISTRIBUTION
MARKET
CONSUMPTION
WASTE
DECOMPOSING FOOD WASTE
THE MAP SHOWN, IS TO
CONNECTION OF SYSTE
OUR MODERN LIFESTYLE
THE CONSTRUCTED WET
THE WETLAND SYSTEM
NETWORKS SHOWN AND
BECOME MORE LO
INTEGRATION. THROU
ICONS FOR THE SHOWN
EXPRESS A CONN
*THIS MAP DOES NOT SHOW EVERY CONNECTI


NATURAL ENERGY
SOLAR
WIND
TIDAL
GEOTHERMAL
PASSIVE RENEWABLE ENERGIES
MECHANICAL SYSTEMS
TURBINE
HEAT PUMP
MAN-MADE ENERGY
COMBUSTION
NUCLEAR
BYPRODUCTS
ENERGY
HUMAN ENERGY
MECHANICAL SYSTEMS
STEAM TURBINE
HEAT
STEAM
AIR POLLUTANTS
HARMFUL CHEMICALS
ELECTRICAL ENERGY
-POTABLE
M RUNOFF
Y WATER
CK WATER
FIED TOXINS
L TREATMENT
CONSUMING FOOD
PRODUCTION OF GREENHOUSE GASES
GAS USED IN PRODUCTION
AIR
BIOMASS RECYCLE
PRODUCE OXYGEN
ATMOSPHERE
OPEN AEROBIC REACTOR LEVEL 1
DURING THIS PHASE PLANTS ARE USED TO CONVERT ORGANIC COMPOUNDS INTO BACTERIAL BIOMASS.
OPTIONAL BYPASS
NITROGEN
OXYGEN
ARGON
TRACE GASES
NATURAL GAS
GREENHOUSE GASES
CO_2
FUEL
OPEN AEROBIC REACTOR LEVEL 2-4
DURING THESE PHASES PLANTS, ANIMALS AND OTHER ORGANISM ARE USED TO CONVERT ORGANIC COMPOUNDS INTO BACTERIAL BIOMASS FURTHER REDUCING THE HARMFUL COMPOUNDS.
CLARIFIER
DURING THIS PHASE BACTERIAL BIOMASS IS SEPARATED FROM THE WATER AND RECYCLED TO THE BEGINNING OF THE PROCESS TO CONTINUE BEING DIGESTED.
CONSTRUCTED WETLANDS
THESE NATURAL LOOKING ECOSYSTEMS CAN BE INDOOR OR OUTDOOR CONSTRUCTIONS, AS THEY PROVIDE A FINAL POLISHING AND DENITRIFICATION OF THE WATER.
CONSTRUCTED WETLANDS
PRODUCTION OF GREENHOUSE GASES
EXPRESS THE COMPLEXITY OF THE
MS WE AS HUMANS USE TO SUSTAIN
. IT HAS BEEN CENTERED AROUND
LAND AS IT LOOKS TO SHOW HOW
CAN INTEGRATE TO EACH OF THE
O ALLOW FOR THESE NETWORKS TO
CAL AND EFFICIENT WITH THE
GHOUT THIS PRESENTATION THE
NETWORKS WILL BE DISPLAYED TO
NECTION TO THAT SYSTEM.
NATURAL WASTES
HUMAN PRODUCED
ANIMAL PRODUCED
FOOD WASTE
MACHINE & STRUCTURE WASTES
GREENHOUSE GASES
CHEMICAL
CHEMICAL TREATMENT
MAN-MADE WASTES
CHEMICAL
DECOMPOSABLE GARBAGE
COMPOSTS
NUTRIENTS/FERTILIZERS
LANDFILLS
GROUND STORAGE
GAS PRODUCTION
WASTE WATER TREATMENT
CHEMICALLY TREATED WATER
WASTE
ON BETWEEN NETWORKS OR EVERY NETWORK OR SYSTEM USED IN MODERN LIFE"

DESIGN SOLUTION

MIAMI-DADE COUNTY
FLORIDA, UNITED STATES OF AMERICA

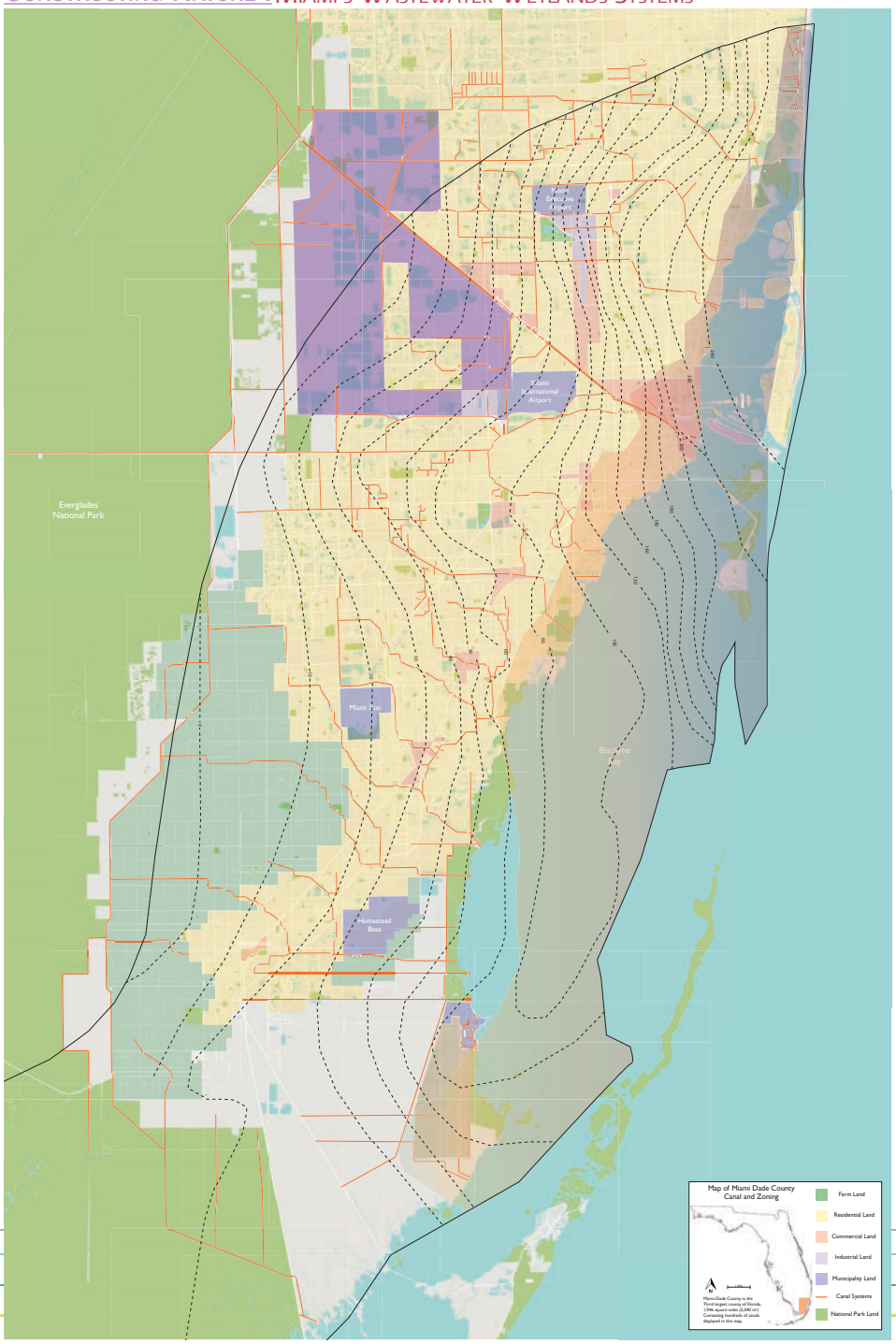


 Figure 1. Map of Canal System of South Florida

Miami-Dade County Canal System

The human-made canals of coastal southeast Florida are part of an extensive, interconnecting network of channels that primarily constructed in the early 1900's for drainage, flood protection, and water storage purposes. Today's uses are labeled mainly as:

Regulate water levels

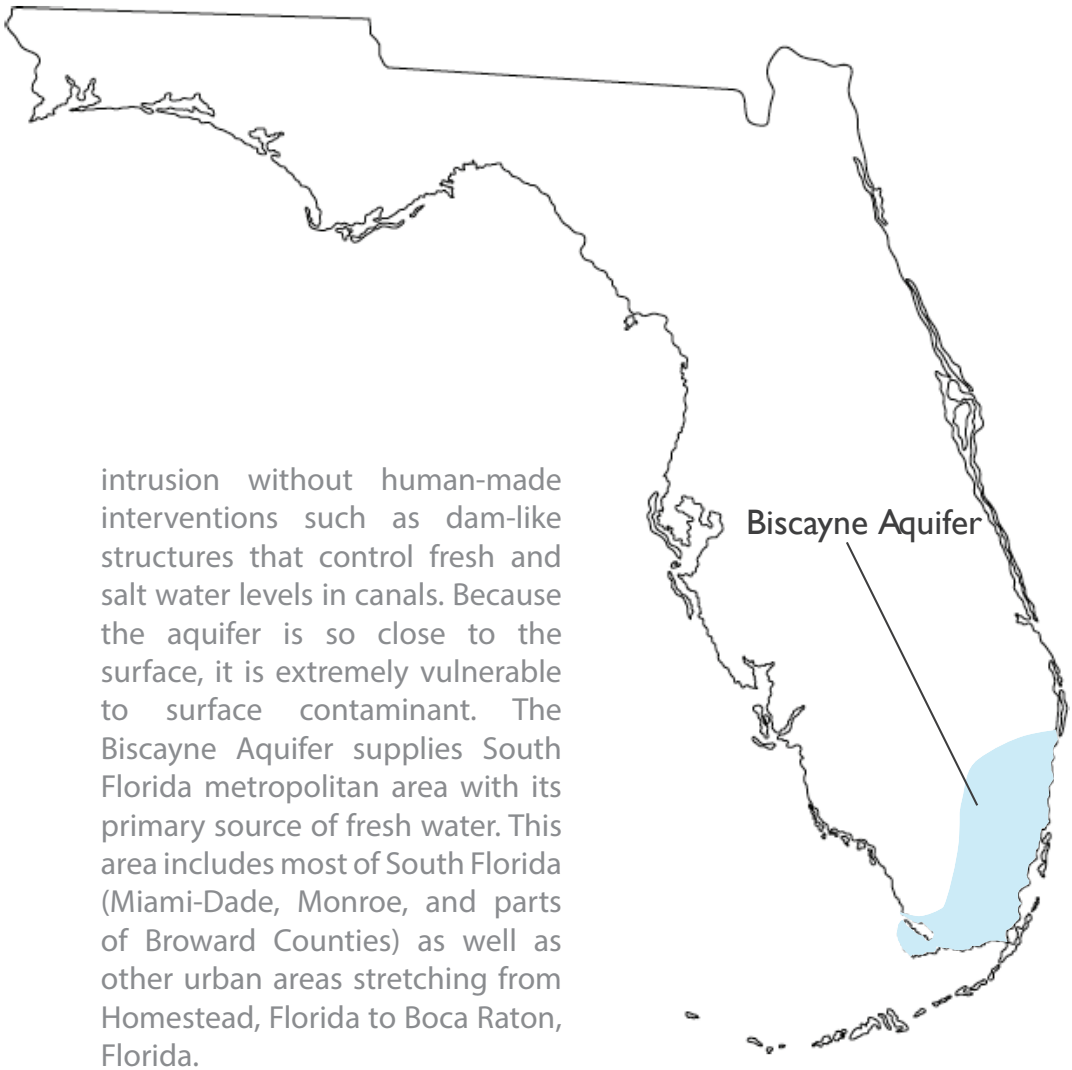
- Move water seasonally or prior to a storm event to lower surface and groundwater levels and enhance local basin storage
- Move water to maintain water levels below ground to enhance seepage and crop production
- Move water to maintain groundwater levels that recharge wellfields and protect aquifers from saltwater intrusion
- Move water to maintain appropriate water levels in lakes or wetlands

Provide conveyance

- Drain surface water and groundwater over time to transform wetlands into dry land suitable for human use
- Remove surface runoff rapidly from critical areas to minimize or avoid loss of life or damage to crops or human structures
- Move excess water to tide
- Move water for human consumption or irrigation
- Move water to maintain appropriate flows in rivers and streams and maintain salinity conditions in estuaries

Miami-Dade County
Biscayne Aquifer

The Biscayne Aquifer, named after Biscayne Bay, is a surficial aquifer. It is a shallow layer of highly permeable limestone under a portion of South Florida. The area it underlies includes Broward County, Miami-Dade County, Monroe County, and Palm Beach County, a total of about 4,000 square miles (10,000 km2). Surficial aquifers are shallow aquifers typically less than 50 feet (15 m) thick, but more extensive surficial aquifers of about 60 feet (18 m) mapped. They mostly consist of unconsolidated sand enclosed by layers of limestone, sandstone or clay and the water is commonly extracted for urban use. The aquifers are replenished by streams and from precipitation and can vary in volume considerably as the water table fluctuates. Being shallow, they are susceptible to contamination by fuel spills, industrial discharge, landfills, and saltwater. The water-absorbing layers of rock underlying south Florida divide into three segments. The Biscayne Aquifer is closest to the surface, and because of this it directly interacts with natural and human-made bodies of surface water, such as streams, lakes, canals, and reservoirs. The groundwater and the aquifer currently are managed as an integrated water system. Because the top part of the Biscayne aquifer is the water table, this aquifer is known as an unconfined aquifer. Since it merges with the floor of Biscayne Bay and with the Atlantic Ocean, it is also a coastal aquifer. Both of these factors contribute to its potential contamination. Lowered water tables, primarily from over-pumping, could allow saltwater



intrusion without human-made interventions such as dam-like structures that control fresh and salt water levels in canals. Because the aquifer is so close to the surface, it is extremely vulnerable to surface contaminant. The Biscayne Aquifer supplies South Florida metropolitan area with its primary source of fresh water. This area includes most of South Florida (Miami-Dade, Monroe, and parts of Broward Counties) as well as other urban areas stretching from Homestead, Florida to Boca Raton, Florida.

MIAMI-DADE COUNTY CANAL SYSTEMS

When the water level and pressure in an aquifer or groundwater is higher than that in the canal that penetrates it, water moves toward and into the channel. (Figure 2.1)

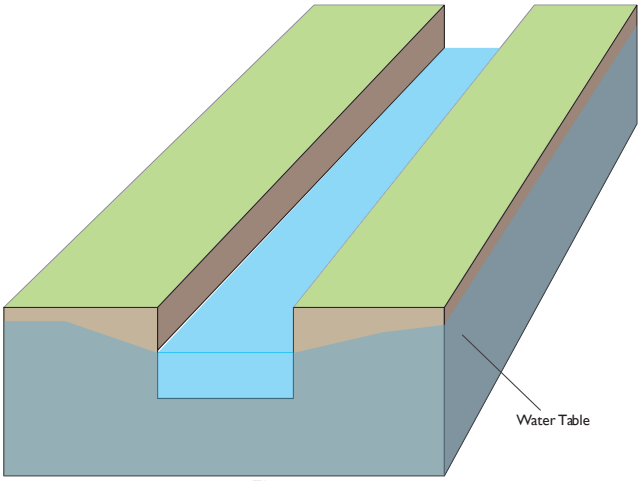


Figure 2.1

When the water level in a canal is higher than that in the aquifer or groundwater it penetrates, causing seepage, water moves into the aquifer. (Figure 2.2)

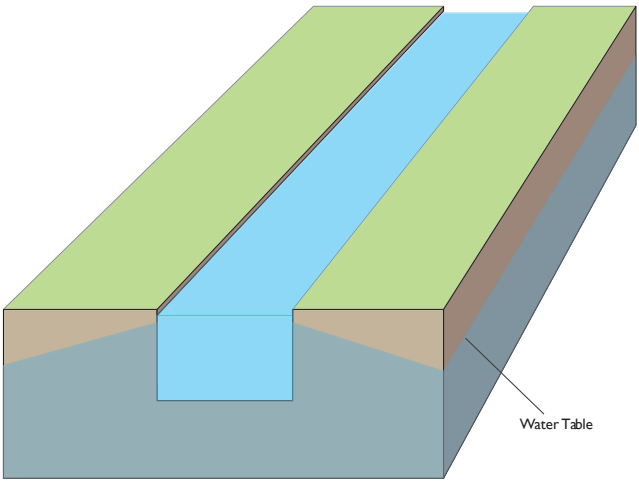


Figure 2.2

Miami-Dade County Salt Intrusion

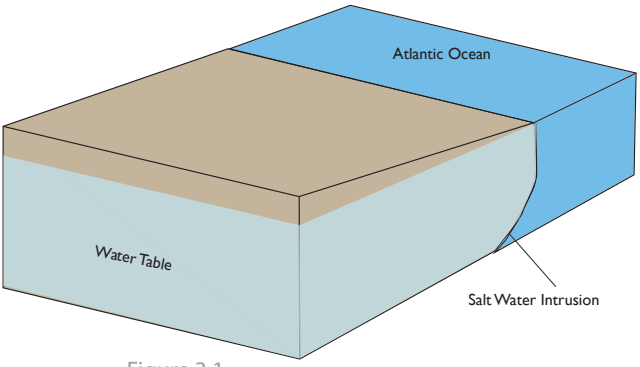


Figure 3.1

Land with no Canal
Before canals, the freshwater and saltwater interface was near stable.

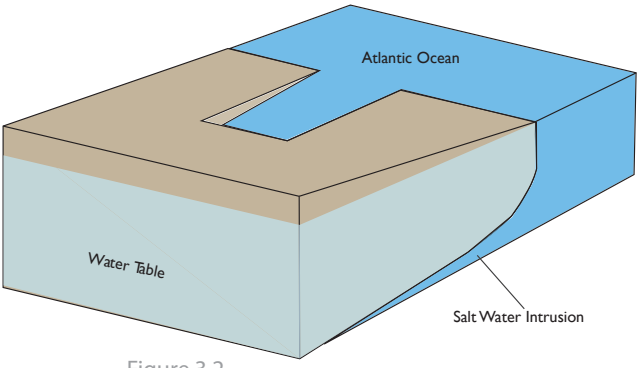


Figure 3.2

Land with Inlet Canal
Inlet canals caused the first saltwater intrusion as the freshwater levels lowered and an open channel to the sea on the surface provided.

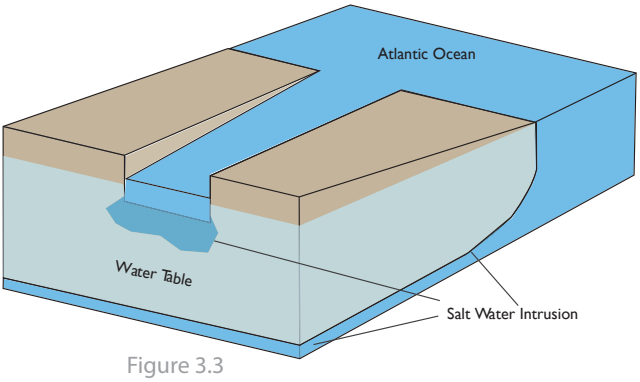


Figure 3.3

Land with Full Canal
Canals that extend into the area cause saltwater intrusion as the freshwater levels lower by the drawing of wells, which then the salt water can replace faster, this has been mitigated slightly with control structures.

Image of residential common condition

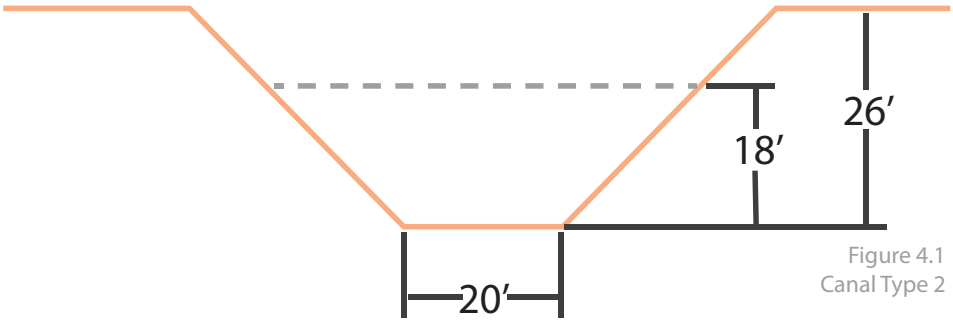


Figure 4.1
Canal Type 2

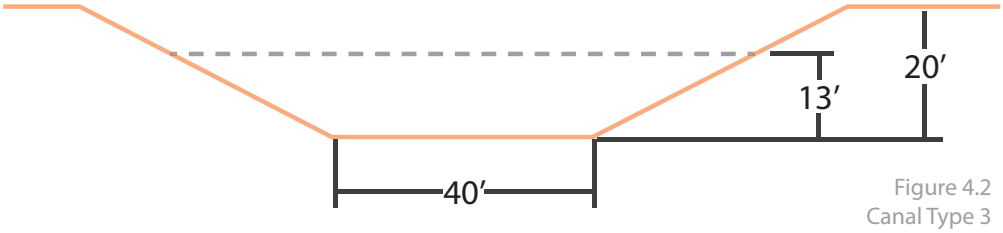


Figure 4.2
Canal Type 3

Miami-Dade County Canal Typologies

The Canal through Residential developments is very similar to what an alleyway is but without the present ability for usable space. Easement space sides the canal on both sides, which in the south Florida weather tends to be overgrowth.

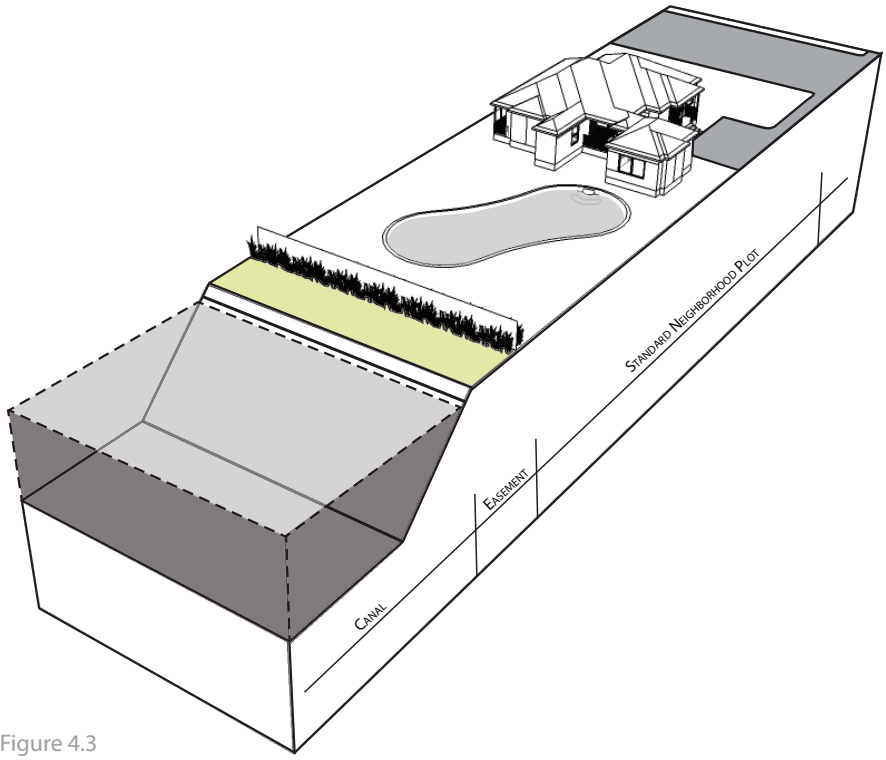


Figure 4.3
Canal Axion

Image of rural/highway common condition

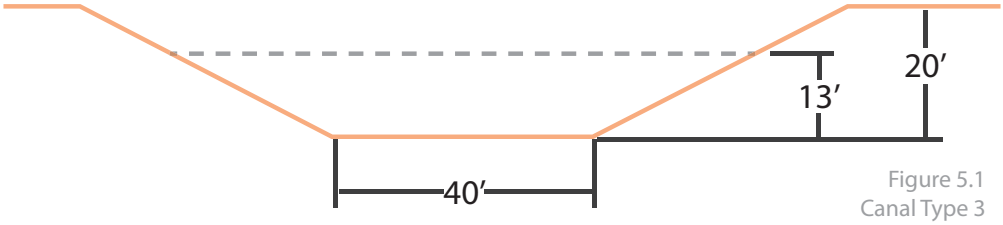


Figure 5.1
Canal Type 3

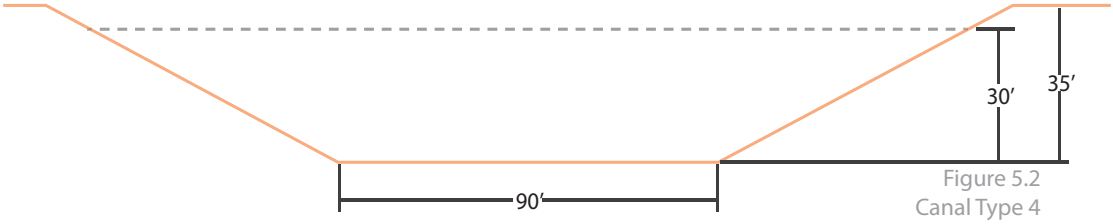


Figure 5.2
Canal Type 4

Miami-Dade County Canal Typologies

This Canal type tends to run along larger thoroughfares and highways; they tend to side along large easements on both sides. This type sets as the border canals that set the edge between development and the Everglades.

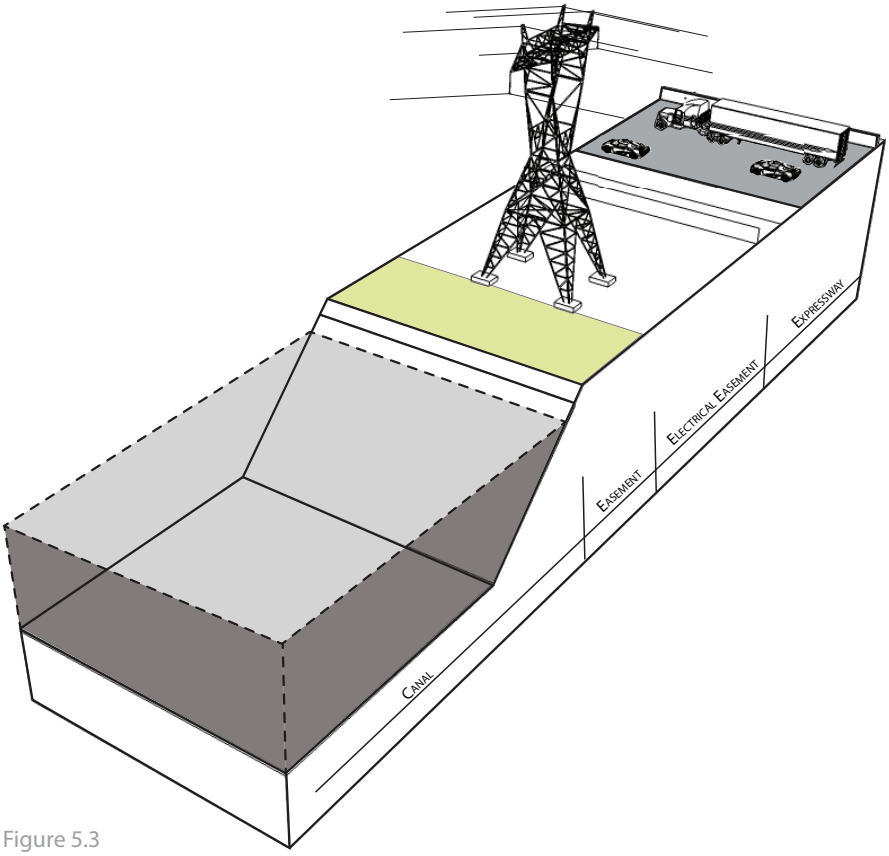


Figure 5.3
Canal Axion

Image of urban common condition

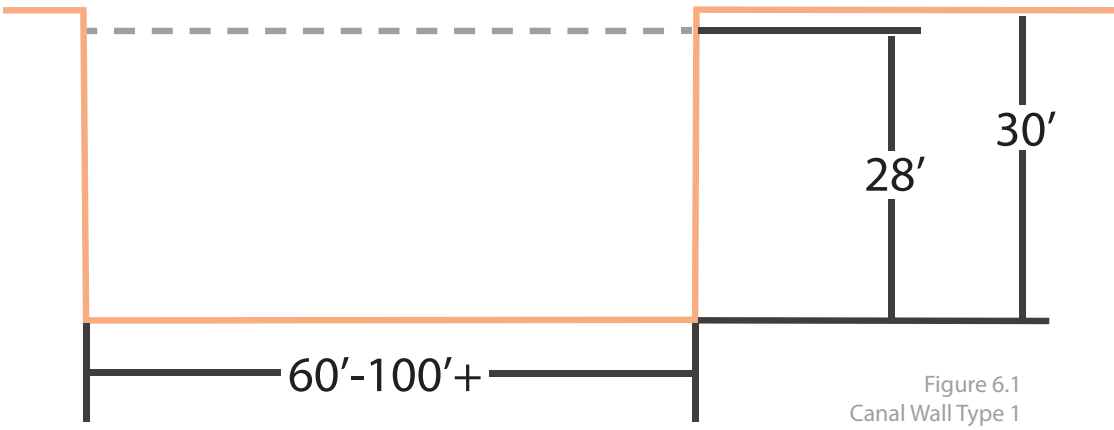


Figure 6.1
Canal Wall Type 1

Miami-Dade County Canal Typologies

The Canal through inner-urban developments tends to be a seawall design. As the wall serves for the more developed foundations of the buildings, the wall also allows the boat traffic to come right up to the edge of the water.

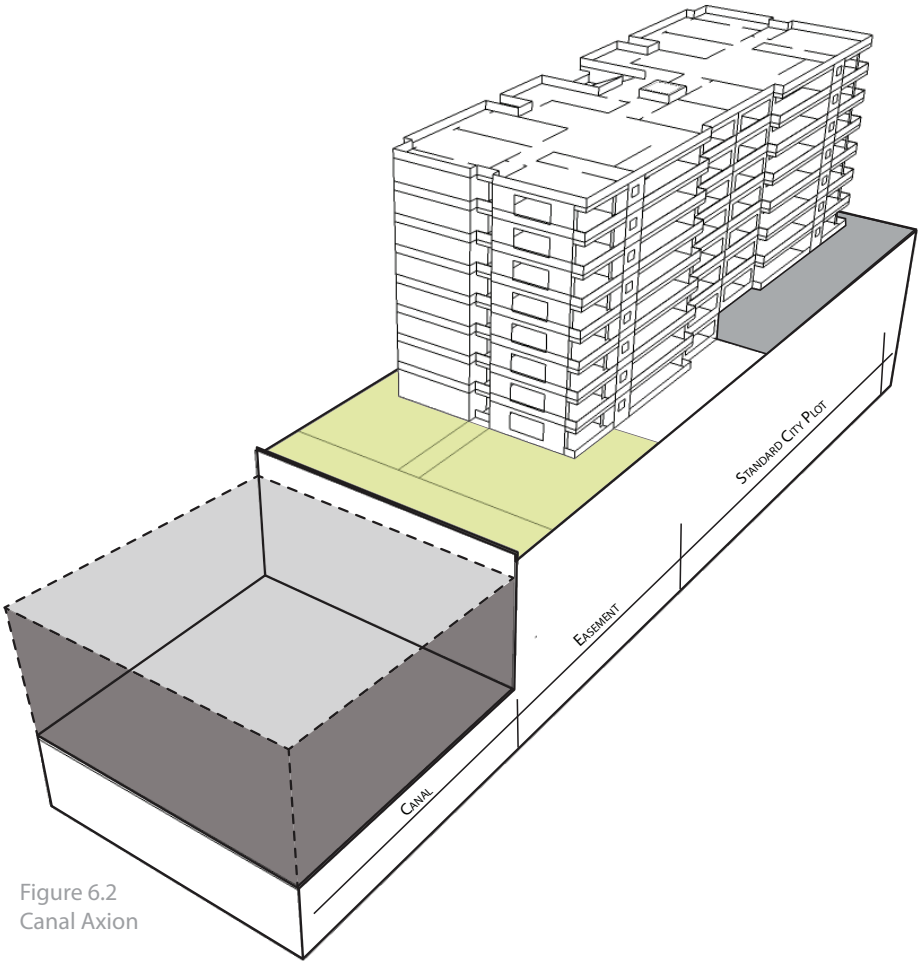


Figure 6.2
Canal Axion

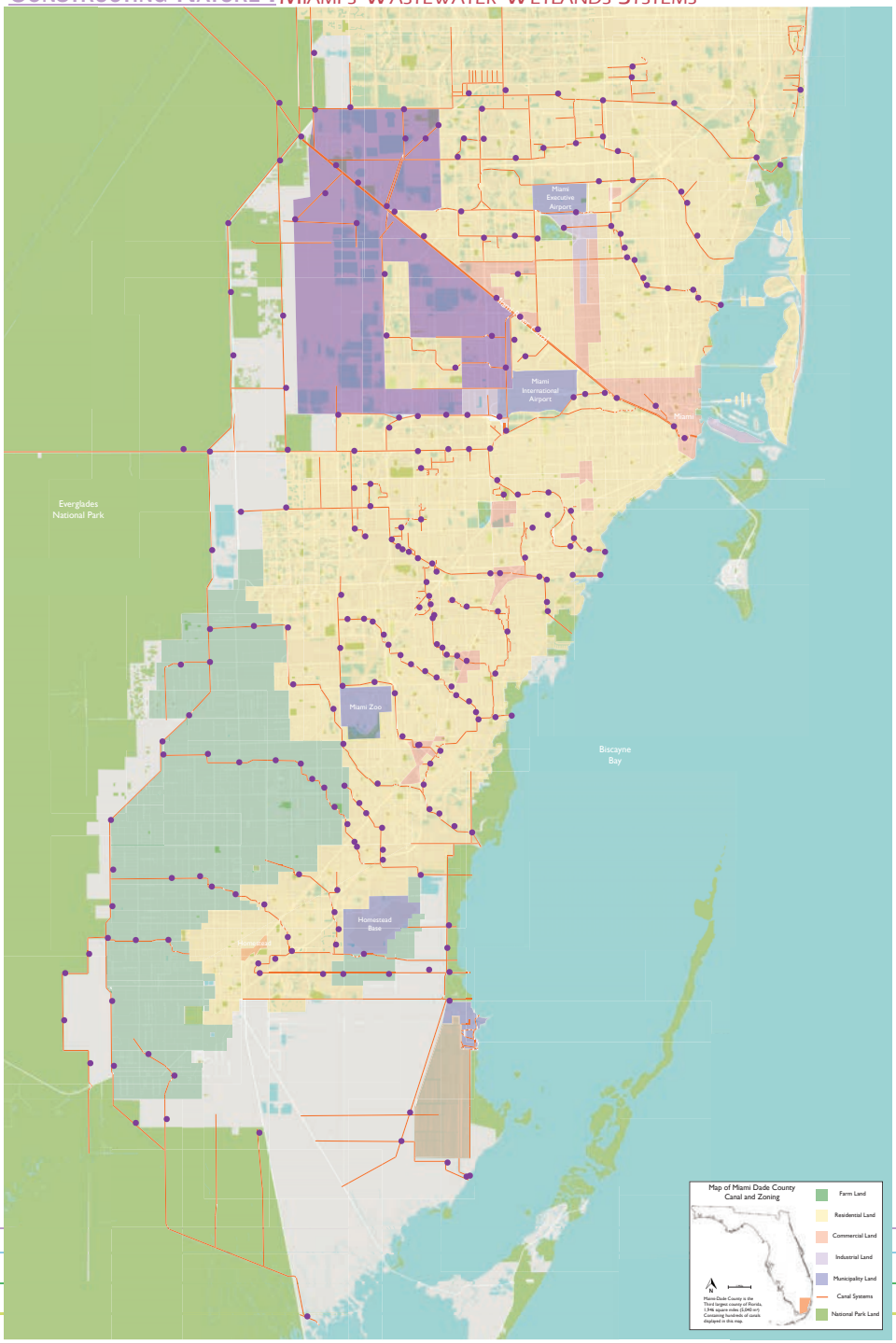


 Figure 7. Map of Canal System with possible Wetland sites of South Florida

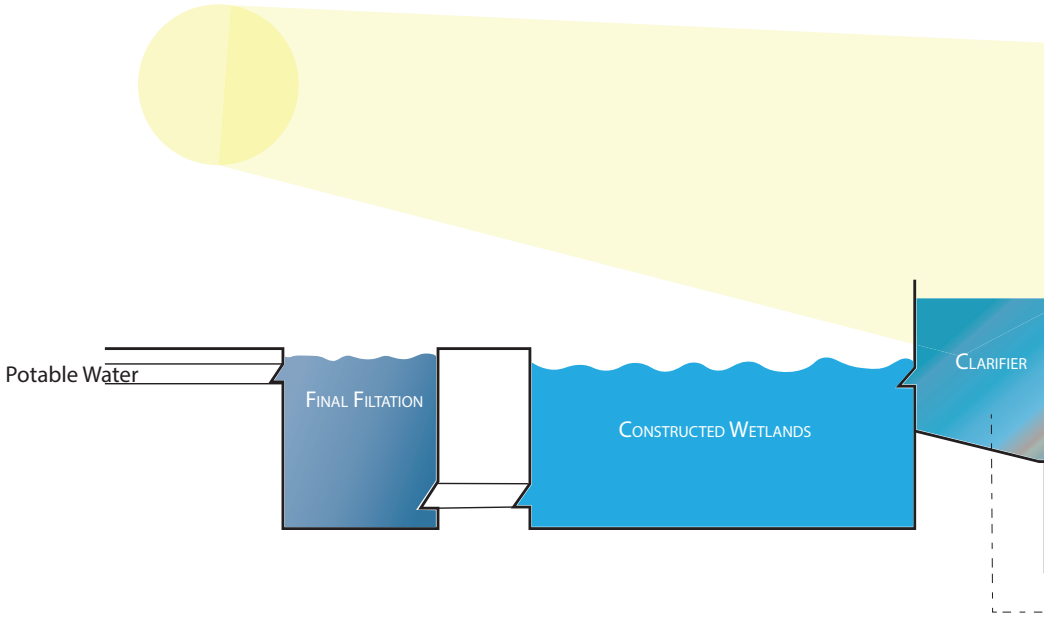
Miami-Dade County Wetland Sites

Following the program, a search for sites suitable, following the main criteria of Near and or adjacent to canals or body of water, and adhering to one or more of the following;

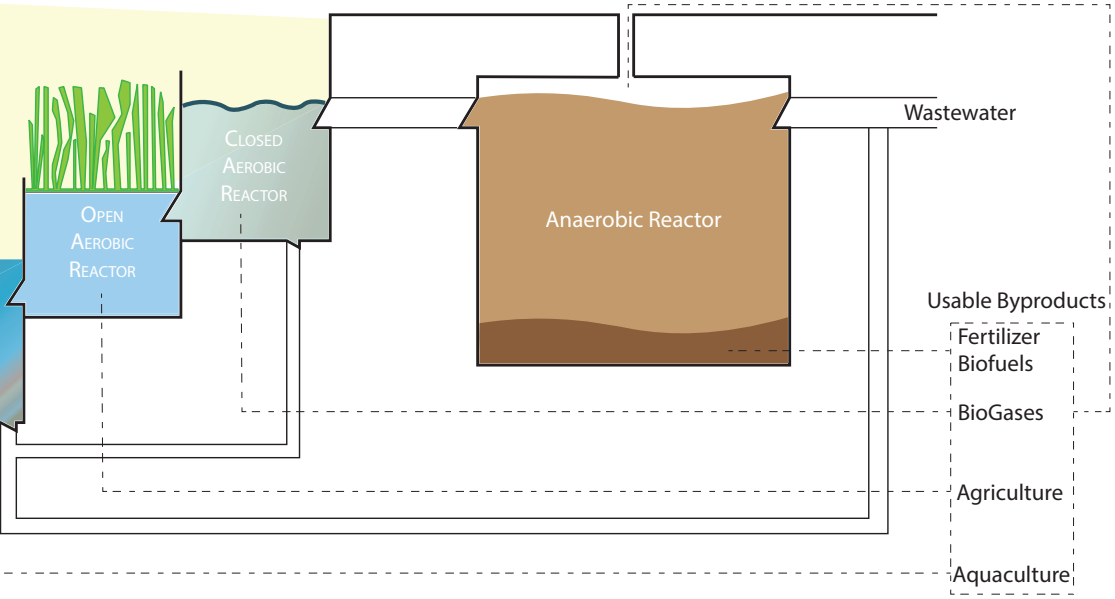
- Proximity environmentally damaged areas
- Proximity border of the Everglades
- Proximity Farmland
- Proximity to the sewage system
- Proximity to residential area
- Proximity to institution

Constructed Wetland System

The System Displayed processes wastewater into clean potable water in one cycle.



Breakdown of Constructed Wetland, for more details on system refer to the Supported Research Section.


Closed
Aerobic
Reactor
Open
Aerobic
Reactor
Anaerobic Reactor
Wastewater
Usable Byproducts
Fertilizer
Biofuels
BioGases
Agriculture
Aquaculture

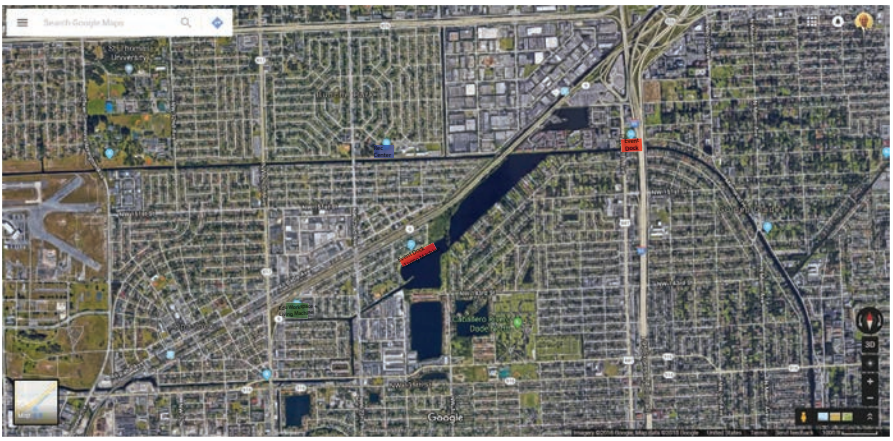


Figure 8.1 following sites are suitable event spaces blended with the Wetland Systems.

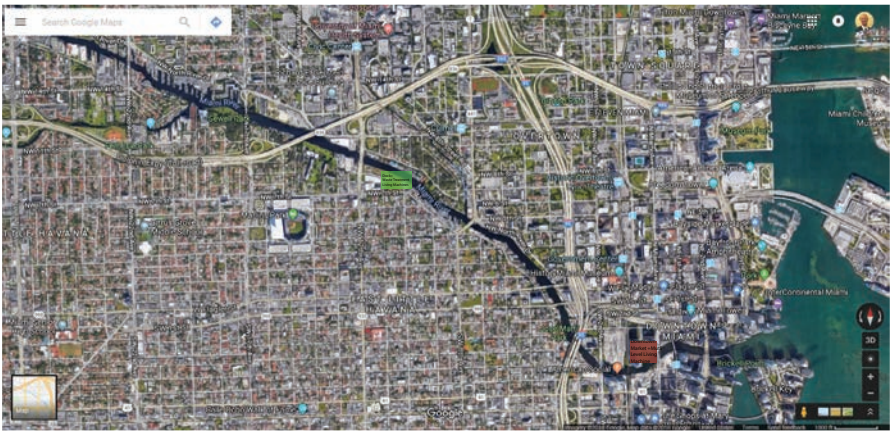


Figure 8.3 following sites are suitable docking spaces & integrated buildings blended with the Wetland Systems.

Wetland Site Program Diagrams

Figure 8.2 following sites are suitable educational spaces, farming & event spaces blended with the Wetland Systems.

Figure 8.4 following sites are suitable educational spaces, farming & rec center spaces blended with the Wetland Systems.

Figure 8.5 following sites are suitable fitness center spaces blended with the Wetland Systems.

Figure 8.7 following sites are suitable educational spaces, integrated buildings & farming blended with the Wetland Systems.

Wetland Site Program Diagrams

Figure 8.6 following sites are suitable community spaces, & event spaces blended with the Wetland Systems.

Figure 8.8 following sites are suitable restorative farming & integrated building spaces blended with the Wetland Systems.

Figure 9.1 following site located in residental setting is suitable for a single story size.

Figure 9.3 following site in the campus setting is suitable for several single to multi level integrated building systems.

Wetland Site Mass Diagrams

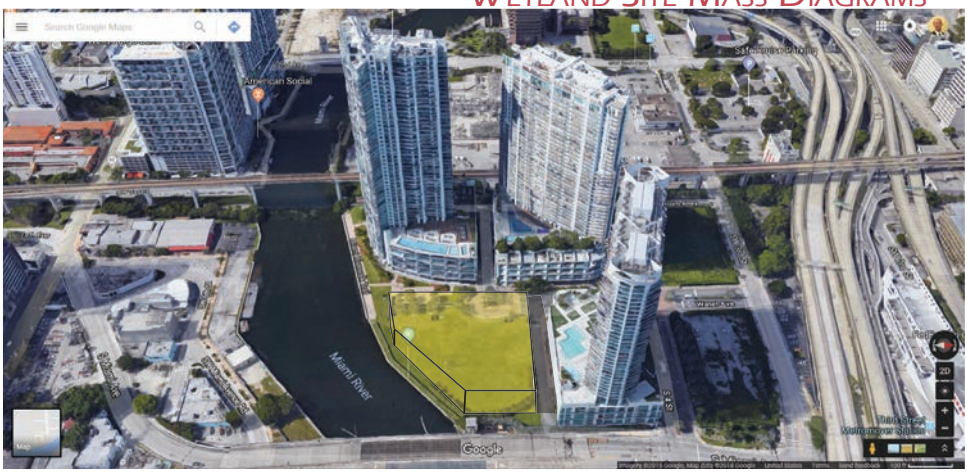


Figure 9.2 following site located in urban setting is suitable for a multistory integrated building.

Figure 9.4 following site is suitable for a warehouse size/style integrated building.

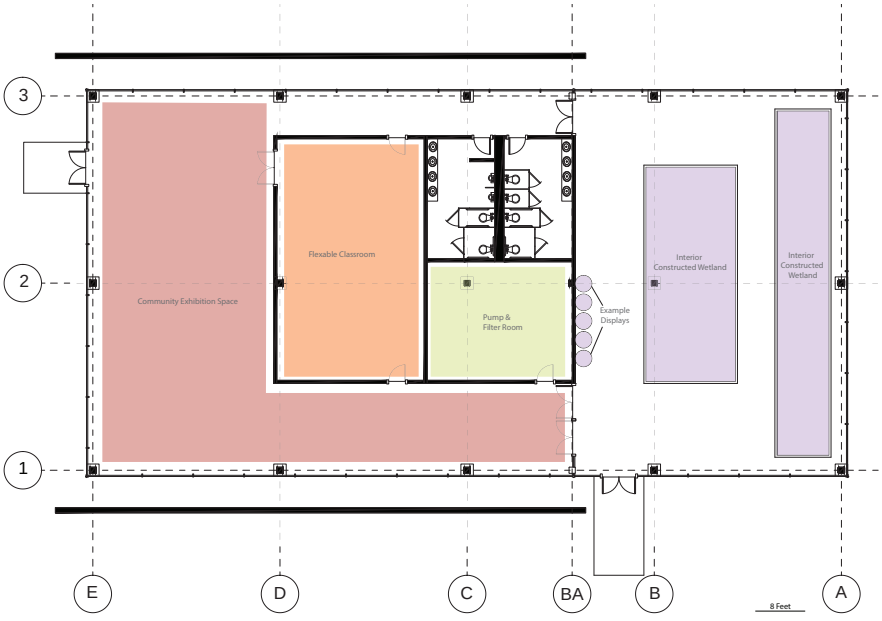


Figure 10.1 Floorplan Program Breakdown

Phase 1: Wetland Demonstration Site 1

This phase focused on bring the constructed wetlands technology to the regions of people it will have a significant immediate impact. This building and site are meant to create a large publicly owned center when classes can come and learn how the constructed wetlands function and how the natural ecosystem of south Florida work, as the site will restore to the natural habitat it once housed through the constructed wetland system. The building allows space for flexible exhibition spaces along with educational spaces. The site creates a nature reserve with a path that allows the user to experience the nature, as the site can serve as a haven for local species.

Figure 10.2 Site Map with Wetland Tributary Area

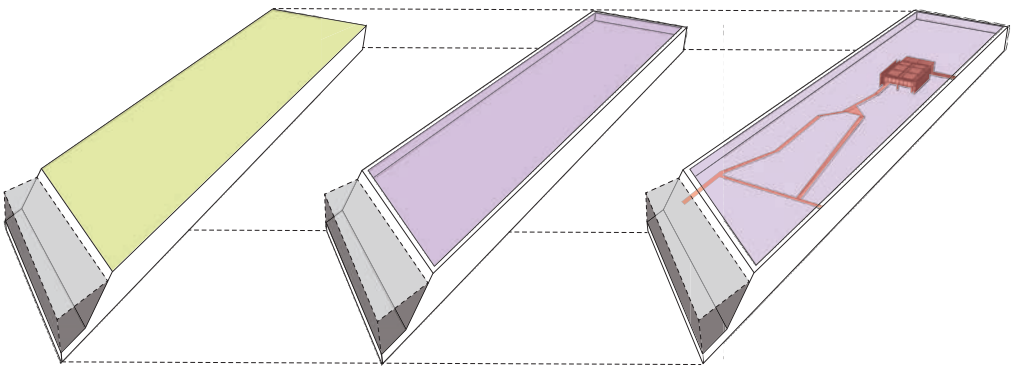


Figure 10.3 Site Transformation Diagram

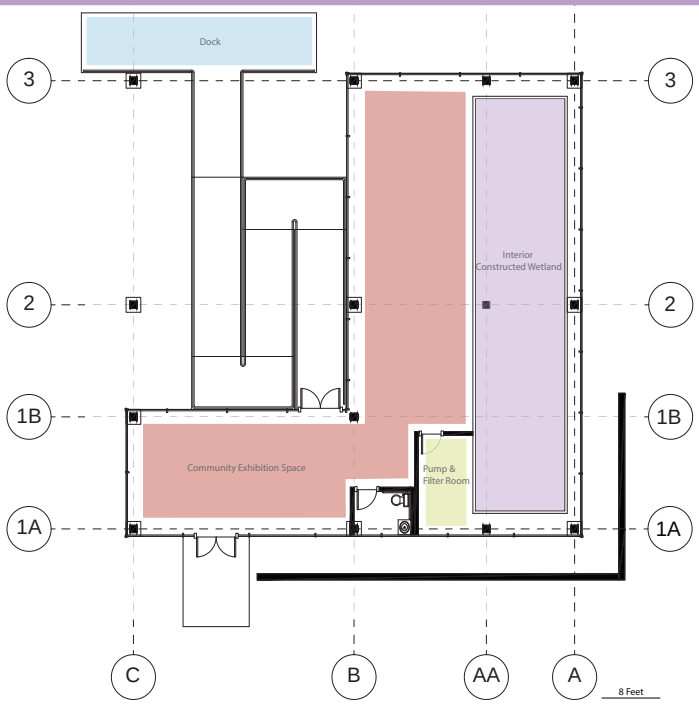


Figure 11.1 Floorplan Program Breakdown

Phase 1: Wetland Demonstration Site 2

This phase focused on bringing the constructed wetlands technology to the regions of people it will have a significant immediate impact. This site looks to Reintegrating the site to the natural marshland by removing different fill and allowing the water to reintegrate into the site along with allowing the fertilized soil to provide for a community garden. This building and site are meant to create a locally operated, publicly owned community center, that can house community events and some educational workshops with the constructed wetlands. Have the ability to serve as a primary docking site for whomever. Along with restoring to the natural habitat.

Figure 11.2 Site Map with Wetland Tributary Area

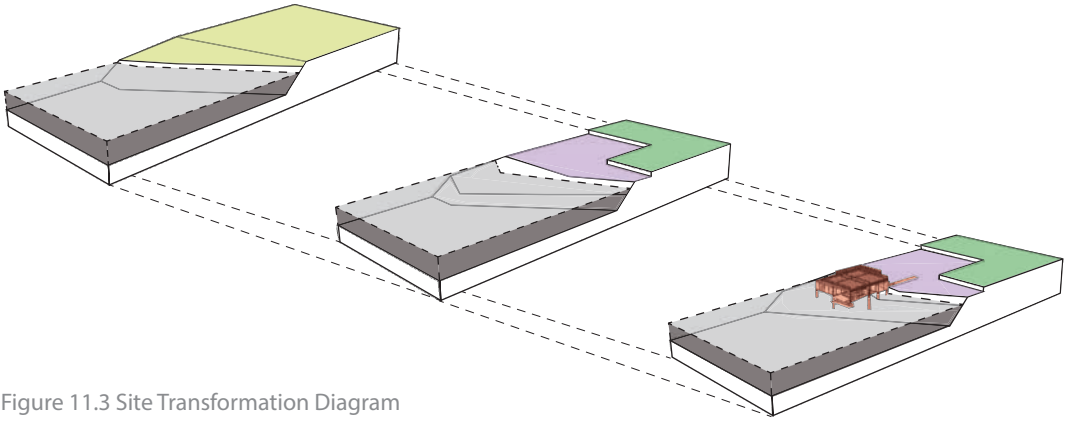


Figure 11.3 Site Transformation Diagram

Phase 2 : Wetland Retrofitting Site 1

This phase looks to bring the constructed wetlands technology to architecture directly, by integrating it into the new buildings or by retrofitting existing buildings to allow the technology to develop the area surrounding. This demonstration allows for systems such as light shelves to add to the building which would house the wetlands and then provide for a garden to support the occupants of the building.

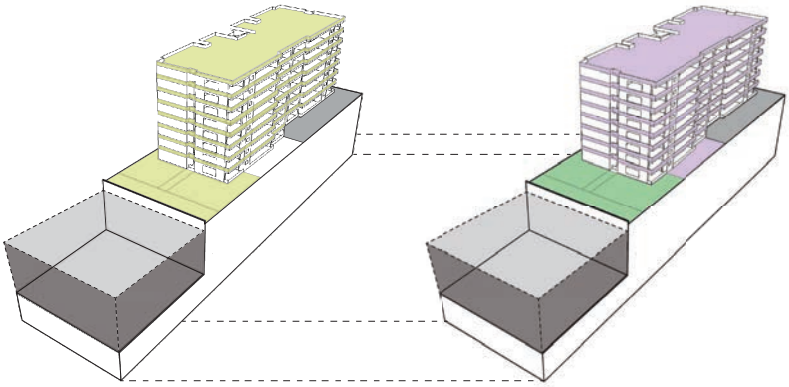


Figure 12 Retrofitting Transformation Diagram

Phase 3 : Wetland Boat System

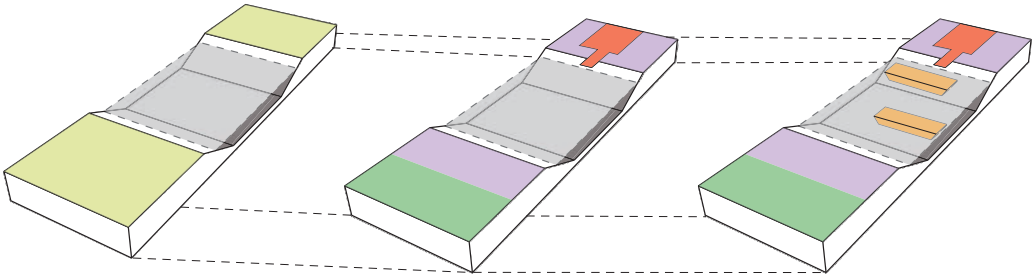


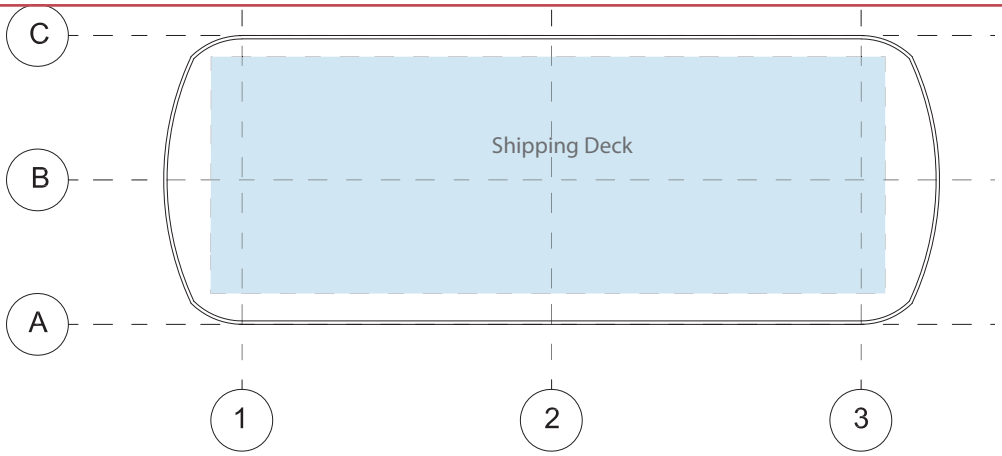
Figure 13 Canal System Transformation Diagram

This phase focused on fully integrating the canal system into the constructed wetland system. These boats would allow for many different programs from ordinary houseboats, to schools and restaurants on them. This system would use byproducts from the wetlands and on some of them even house micro versions on board.

School Boat Example

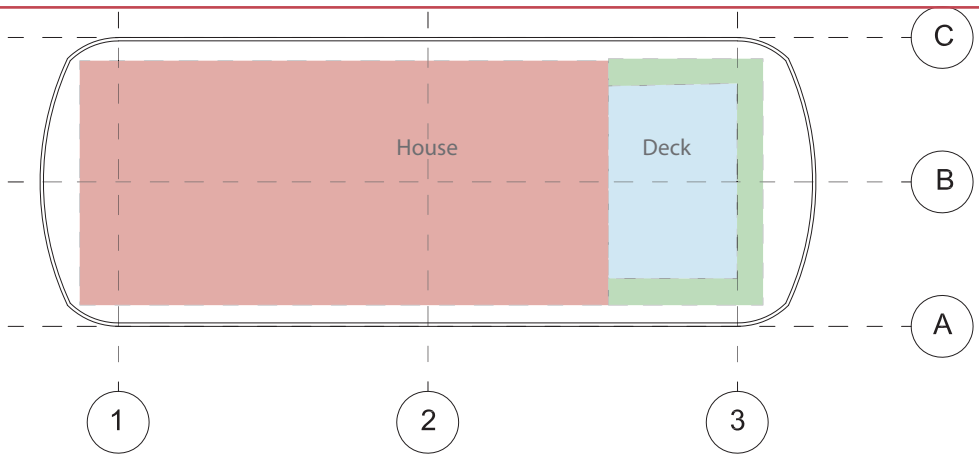
Shipping Boat Example

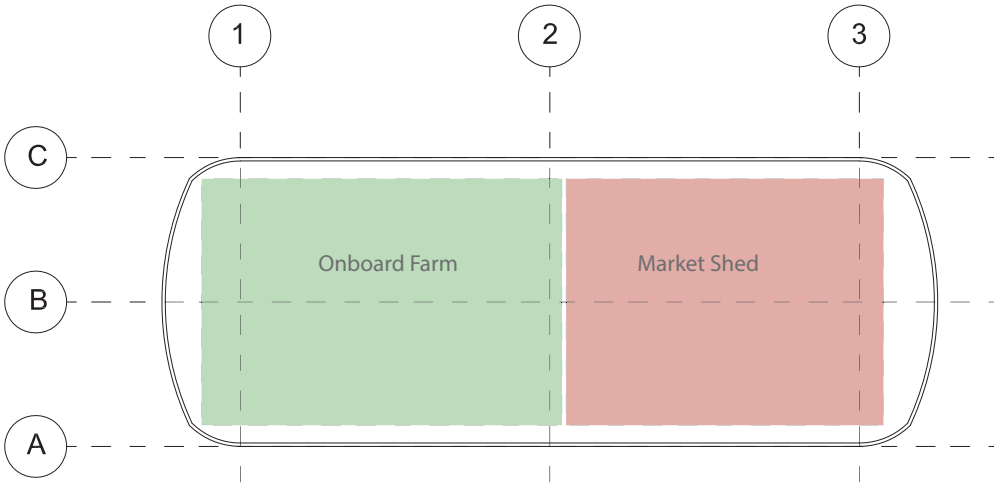
This system would be centered the concept of boat shipping, which is not a new system but a reinvented concept as the traffic on the canals would be far less than the roads, and they could carry a much more substantial load.



House Boat Example

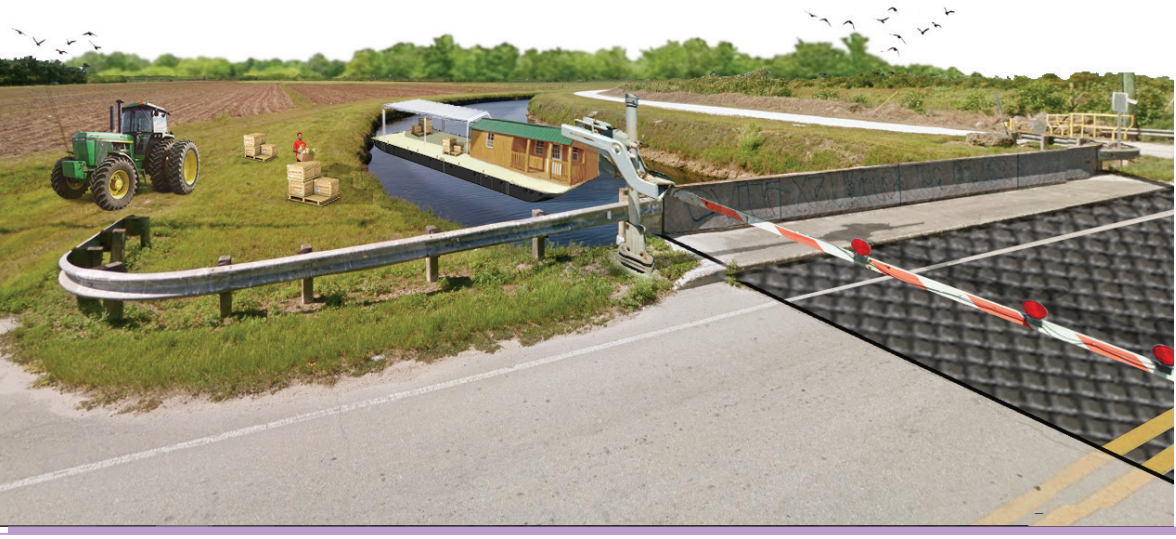
This system would center around the already existing system of houseboats, but this system would take and integrate a constructed wetland into that boat, so then the boat could be independent.

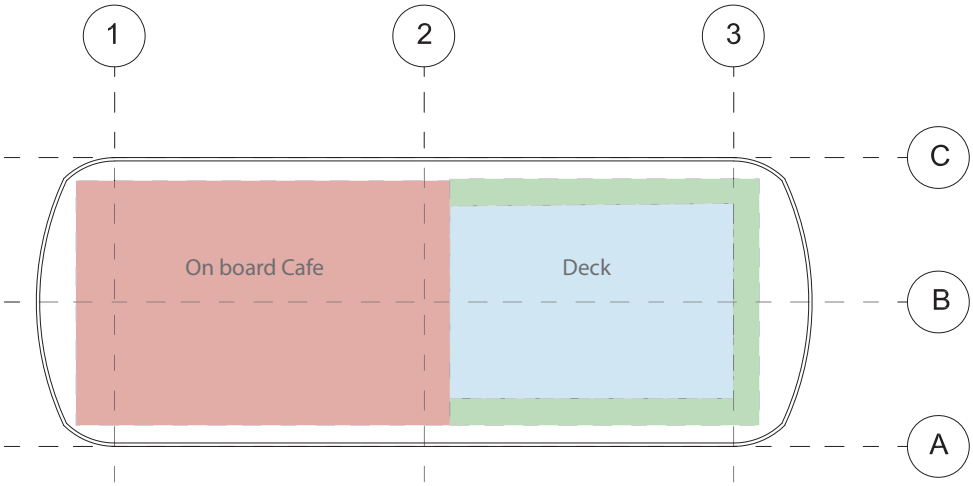




Farming Boat Example

This system would be centered the farming and market of goods, as the boats would have the ability to grow crops but also to move to areas where a farmers market is needed and disburse the products.





Cafe Boat Example

This system would be centered around using the proximity of the canal to the existing population areas to provide them a unique experience of dining immersed in the environment.

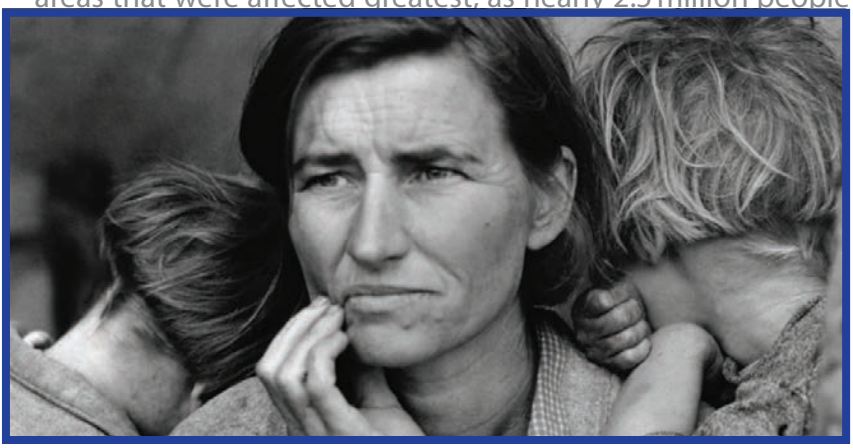
Support Research

Beginning research into what looking to set out what is sustainable, what are the guides to be green, where is the precedence of environmentally friendly design. As research progressed, it worked through past events that display poor sustainability techniques and others of more proper 'Green' events, current events such as the Paris Climate Accord, a ground-breaking document. The agreement brought together 72 countries initially to agree to guidelines that have the primary focus of keeping the global average temperature to below 2 degrees Celsius above pre-industrial times. As of today, 196 countries have agreed on the only important country, not in the accord is the United States who left on June 1st of 2017. The resignation of the US caused much backlash which included the formation of the group that refers to themselves as the climate mayors. This chapter will go through events assembled to display and comment on the growth of modern lifestyles as they attempt to move to a more sustainable style.

The Dust Bowl and Impact of Aquifers

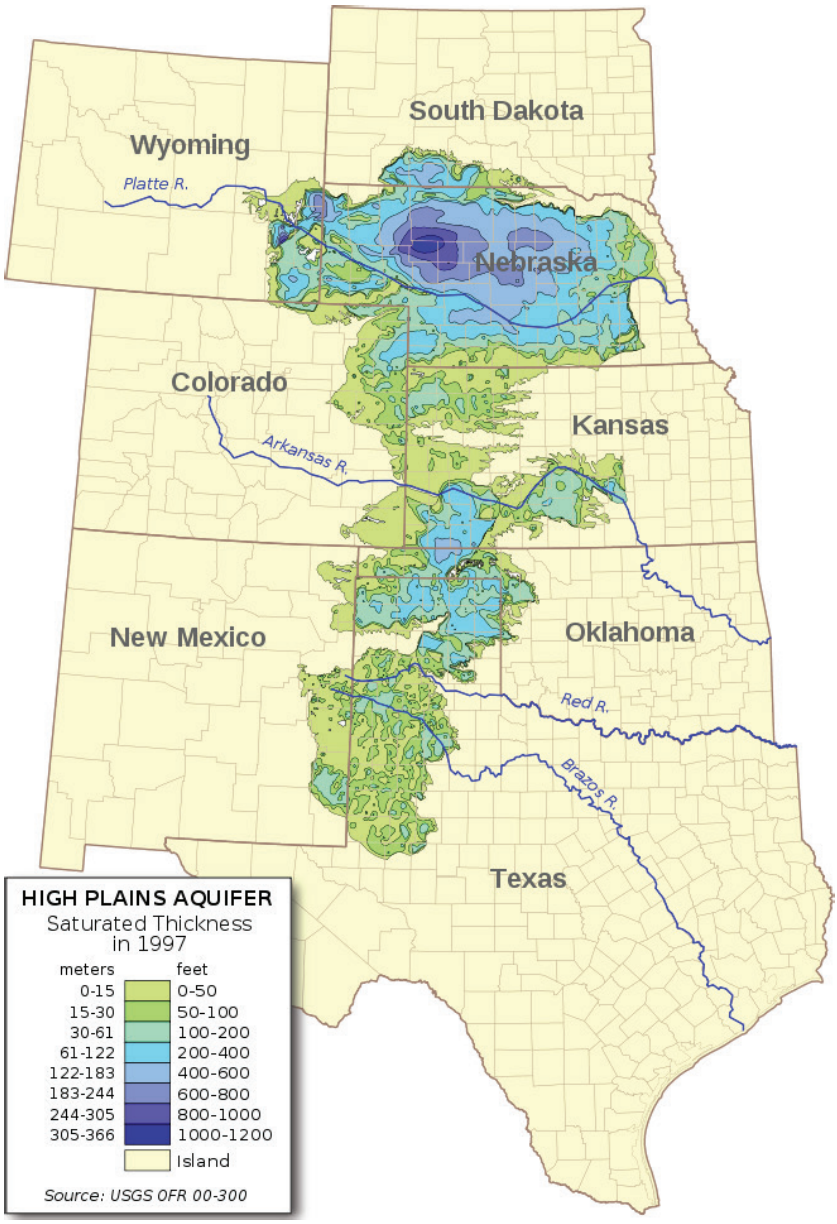
The research progressed on a created time line as highlighting events started to become of more importance. The first major event highlighted was the event of the Dust Bowl which effected hundreds of thousands of Americans through the better part of a decade. On the onset of a drought in 19311,the fields of America's bread basket were exposed bare. Without the roots of the native prairie grasses, the soil blew away. As far as the Atlantic Ocean, as reports of dust in New York City and even some ships reported dust settling on their top decks. Nicknamed the "Dirty Thirties" as the economic impacts of Great Depression added to the literal dirtiness of the massive dust storms. In 1934, nearly 35 million acres were rendered useless for farming, as almost another 125 million acres was rapidly losing soil.

As the farmers finally started to understand how this was a man-made disaster by decades of poor farming techniques, they began to look for more sustainable methods of farming. The New Deal Programs helped to bring back people into the areas that were affected greatest, as nearly 2.5 million people



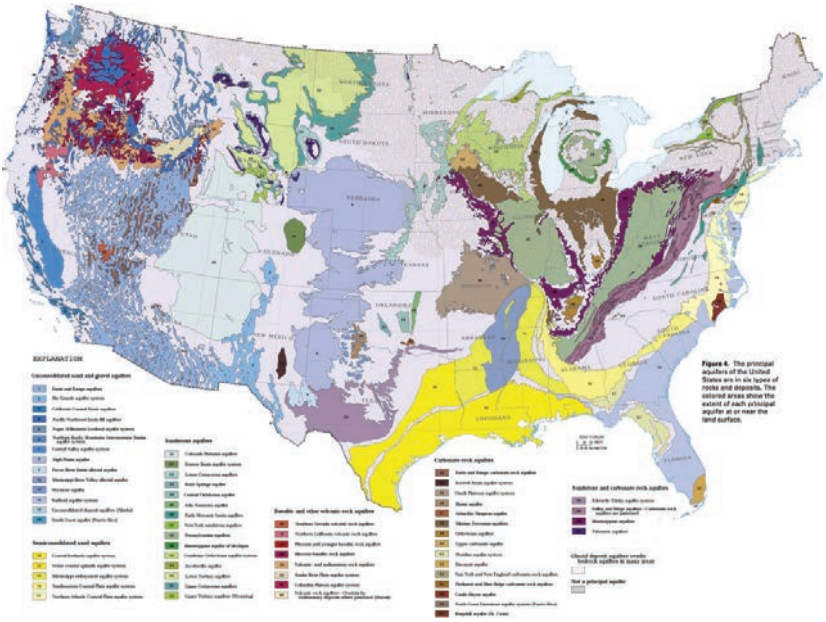
left the states of Texas, New Mexico, Colorado, Nebraska, Kansas, and Oklahoma. As the search for sustainable farming techniques continued through the end of the decade, the use of well water from the Ogallala Aquifer became more common even with the return of regular rain fall in the area in 1939. The Ogallala Aquifer is a shallow water table aquifer surrounded by sand, silt, clay, and gravel located beneath the Great Plains in the United States. One of the world's largest aquifers, it underlies an area of approximately 174,000 sq. mi (450,000 km2) in portions of eight states, South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas. The aquifer is part of the High Plains Aquifer System, and rests on the Ogallala Formation, which is the principal geologic unit underlying 80% of the High Plains. Today about 27% of the irrigated land in the entire United States lies over the aquifer, which yields about 30% of the ground water used for irrigation in the United States. The aquifer is at risk for over-extraction and pollution. Since 1950, agricultural irrigation has reduced the saturated volume of the aquifer by an estimated 9%. Once depleted, the aquifer will take over 6,000 years to replenish naturally through rainfall. The aquifer system supplies drinking water to 82% of the 2.3 million people who live within the boundaries of the High Plains study area. The question of sustainability rose again with this research as the parts of the aquifer could be depleted in the next 15-20 years with present farming techniques.

Aquifers are very prevalent in the United States and they are in constant threat from pollution and over use. Groundwater is a valuable resource both in the United States and throughout the world. Where surface water, such as lakes


South Dakota
Wyoming
Platte R.
Nebraska
Colorado
Kansas
Arkansas R.
New Mexico
Oklahoma
Red R.
Brazos R.
Texas
HIGH PLAINS AQUIFER
Saturated Thickness in 1997
meters
feet
0-15
0-50
15-30
50-100
30-61
100-200
61-122
200-400
122-183
400-600
183-244
600-800
244-305
800-1000
305-366
1000-1200
Island
Source: USGS OFR 00-300

and rivers, are scarce or inaccessible, groundwater supplies many of the hydrological needs of people everywhere. In the United States, it is the source of drinking water for about half the total population and nearly all of the rural population, and it provides over 50 billion gallons per day for agricultural needs. Groundwater depletion, a term often defined as long-term water-level declines caused by sustained groundwater pumping, is a key issue associated with groundwater use. Many areas of the United States are experiencing groundwater depletion. Possible impacts include:

-reduction of water in streams and lakes
-deterioration of water quality
-increased pumping costs
-land subsidence



Brief History of Environmental Regulations

There are regulations set out by the government to attempt to mediate polluting water. In 1948, with the Federal Water Pollution Control Act, which was the first of its kind as it set out to address water pollution. And as public awareness grew, the amendment best known as the Clean Water Act came out in 1972.4The 1972 amendments established the basic structure for regulating pollutant discharges into the waters of the United States. Giving the EPA the authority to implement pollution control programs such as setting wastewater standards for industry. Maintained existing requirements to set water quality standards for all contaminants in surface waters. Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. Funded the construction of sewage treatment plants under the construction grants program. This program set standards to allow the average citizen to the equal rights along with taking into account the need for the environment to have clean usable water. This act helped to move other government programs forward, such as the New York Recycling laws, in 1989, and New York's Operation Greenthumb, which remains to be the nation's largest community gardening program. The incentives for this program, outside of being a beautification program for the city, allows for more sustainable city living, as the gardens help to deal with heat island effect in the city, along with storm water capture.

In 1992, Agenda 21 came out of the world summit in Rio, which is a non-binding, voluntary action plan of the United Nations regarding sustainable design. Agenda 21 is a comprehensive plan of action to be taken globally, nationally, and locally by organizations of the United Nations System, Governments, and Major Groups in every area in which human impacts on the environment. More than 180 Governments adopted agenda 21, the Rio Declaration on Environment and Development, and the Statement of principles for the Sustainable Management of Forests at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, June 1992. The Commission on Sustainable Development (CSD) was created to monitor and report on the implementation of the agreements at the local, national, regional, and international levels. This was an important stepping point as it is one of the first steps of having implementation and review of anti-climate change regulations. This has helped to set a format for more modern

Declarations such as the Paris Accords. Having a Commission on Sustainable design also was an essential aspect of the UNCED, which lead to other formations to combat and critique the fight against climate change. In 2000, the state of New York created a tax incentive program to help popularize green design. This step was one of the firsts in a more direct or influenced plans of Government, as it influences Sustainable Design. The U.S. Green Building Council is another commission that influences the sustainable design, as it was founded in 1993, as a member-based nonprofit focused on promoting sustainability in building design, construction, and operation. Its Leadership in Energy and Environmental Design (LEED) is one of the councils most recognizable developments. The LEED Green Building Rating System (LEED) is a program that provides third-party verification of green buildings. The LEED rating systems address both a wide variety of buildings types, including commercial buildings, homes, neighborhoods, retail, healthcare, and schools, as well as every phase of the building lifecycle including design, construction, operations, and maintenance. Projects may earn one of four levels of LEED certification (Certified, Silver, Gold, or Platinum) by achieving a given number of point-based credits within the rating system. This is a point where it become apparent that having these councils play an important part in sustainable design.


U.S. GREEN BUILDING COUNCIL
LEED
USGBC

The selection of a city awarded with the title of European Green Capital is assessed on the basis of twelve environmental indicators:

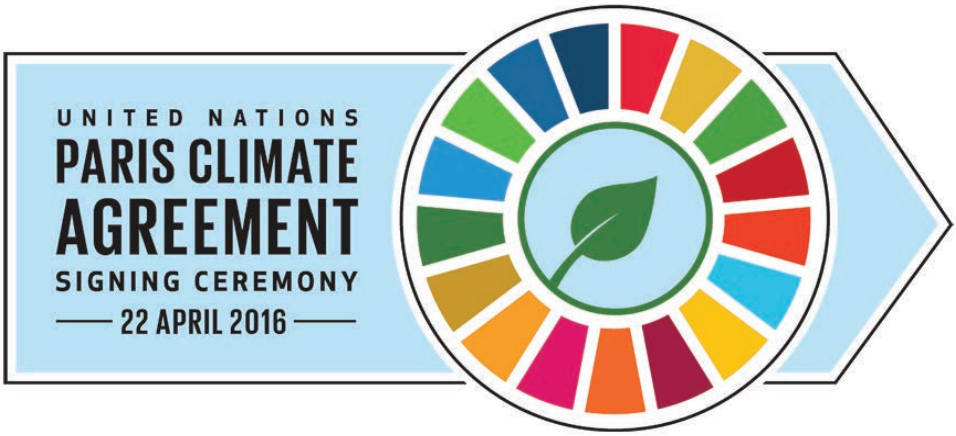
- Climate change: mitigation
- Climate Change: adaptation
- Sustainable urban mobility
- Sustainable land use
- Nature and biodiversity
- Air quality
- Noise
- Waste
- Water
- Green Growth and Eco-innovation
- Energy performance
- Governance

One of the more recent Commissions that created a competition is the European Green Capital City Award, (EGCA) created was in 2009, by the European Commission. The award recognizes and rewards local efforts to improve the environment, the economy, and the quality of life in cities. The EGCA is given each year to a city, which is leading the way in environmentally friendly urban living and which can thus act as a role-model to inspire other cities. Cities differ enormously and sharing concrete examples of what a European Green Capital can look like, the criteria can also be very subjective. In review, cities that are better off economically are at a better advantage from the start. Previous winning cities include Stockholm, Hamburg, Nantes, Copenhagen, Bristol, Essen, and Oslo, all cities that are very progressive, forward-thinking cities, but also very developed and established cities. Dealing with Europe in contrast with the United States, there is a more developed social system and can be see more progressive on average then even some of the most progressive American Cities, such as New York, Boston, or L. A. The figure to the right shows the set of standards that the apply cities must meet, the 12set a good understanding of what is necessary to have cities be "Green" and in that sense Sustainable.

The Paris Climate Agreement

On April 22, 2016,72 countries came together to set this agreement to ban together to help prevent climate change. The agreement, "...aims to strengthen the global response to the threat of climate change..." and one of the most critical aspects of that response is holding the global average Temperature to below 2°C above the pre-industrial levels. The agreement sets different standards to be meet by the lower developed, middle developed and developed countries, due to different economic abilities of those varying countries. It is important to note that the agreement is in fact voluntary, like the Agenda 21, and that there are no real punishments for those countries that do not reach their ratified goals. The commission of the United Nations review yearly to check how the goals set are being met.

But the idea is that the global economic and social pressures will keep a check on the goals and progress of each country. The idea that the country that sets its goals and progresses toward them will be at an advantage sustainable along with economically. If companies can snowball in their home Nation, they will be in good standing to grow Globally which will bring significant economic benefits to those companies and those countries. That is why this event came as a surprise, as of June 1st, 2017,President Donald Trump, removed the United States from involvement in the Paris agreement.



This event caused huge kickbacks on many levels of government along with many CEOs of huge companies in the private sector. This kickback leads to a re-commitment and support of hundreds of American business Leaders, political leaders, such as Mayors, Governors, and even the Secretary of State, Rex Tillerson; the goal being was to keep America on the track to stay ahead of the curve. As of today, 196 countries are in the agreement, recently added Nicaragua, who was holding out for more strict conditions of the developed countries, but has recently signed. Leaving the United States as the only major country not in the group committed to the agreement.

"PARIS AGREEMENT
The Parties to this Agreement,

-Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

-Pursuant to the Durban Platform for Enhanced Action established by decision 1/CP.17 of the Conference of the Parties to the Convention at its seventeenth session,

-In pursuit of the objective of the Convention, and being guided by its principles, including the principle of equity and common but differentiated responsibilities and respective capabilities, in the light of different national circumstances,

-Recognizing the need for an effective and progressive response to the urgent threat of climate change on the basis of the best available scientific knowledge,

-Also recognizing the specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, as provided for in the Convention,

-Taking full account of the specific needs and special situations of the least developed countries with regard to funding and transfer of technology,

-Recognizing that Parties may be affected not only by climate change, but also by the impacts of the measures taken in response to it,

-Emphasizing the intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty,

-Recognizing the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change,

-Taking into account the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities,

-Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity,

-Recognizing the importance of the conservation and enhancement, as appropriate, of sinks and reservoirs of the greenhouse gases referred to in the Convention,

-Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of "climate justice", when acting to address climate change,

-Affirming the importance of education, training, public awareness, public participation, public access to information and cooperation at all levels on the matters addressed in this Agreement,

-Recognizing the importance of the engagements of all levels of government and various actors, in accordance with respective national legislations of Parties, in addressing climate change,

-Also recognizing that sustainable lifestyles and sustainable patterns of consumption and production, with developed country Parties taking the lead, play an important role in addressing climate change"

Shown on the previous three pages, are the opening remarks of the Paris agreement document, highlighted are the points that are seen in this research as more influential in the document. Going through the statements, the first dealing with the recognition of the urgent threat of climate change.

Recognizing the need for an effective and progressive response to the urgent threat of climate change on the basis of the best available scientific knowledge

Important as the disagreance in the public causes officials to be influenced in both directions, in support of progressive responses or in support of those past or present actions that may be adding to the climate issue. This statement makes the leaders of their respective body of people, to recognize and move for "effective and progressive" actions in hopes the sooner the action the better the result.

Emphasizing the intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty

The next statement works with the idea that there is a relationship between the economics of climate change and the actions we as society can make against climate change. Understanding that there is a way to take the concept of sustainability to the level of eradicating poverty along with climate change and vice versa must be the goal when conducting these responses.

Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity

This statement is a call for social justice, in the sense of sustainability, the rights of those who are dealing or will deal with effects of climate change should not be exploited or disrespected. It is important to give everyone the equal opportunity for assistance to deal with these problems regardless class or so on.

Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of "climate justice", when taking action to address climate change

"Climate Justice" this is an important statement as it brings up the idea that as we as humans look for a sustainable life style, we should not forget that the sustainability should not negatively affect the ecosystems as they are just as important to sustainability as the methods we employ as humans.

Also recognizing that sustainable lifestyles and sustainable patterns of consumption and production, with developed country Parties taking the lead, play an important role in addressing climate change

This is important as it follows the ideas of learning from each other, and sharing the ideas that work. This idea can help spread useful techniques and hopefully allow methods from several situations work together to mitigate the problems faster.

These statements set the Paris Agreement out as a very forward thinking and it allows for the agreement to work off the social and economic pressures. While it does not bind any one country to any one solution, it focuses all players on the same challenge. The Paris Agreement is the most inclusive global agreement on climate change to date. Previous accords focused on cutting emissions from the developed world. In contrast, the agreement set a global goal to which every country has agreed to contribute. The agreement was always designed to be a starting point, not an ending point, and the Paris Agreement allows for its continual improvement.

So, what is happens when the United States removes themselves from the agreement, aside from the agreement losing one of the most influential countries in the modern developed world, but a kick back of hundreds of mayors, governors, and other politicians, along with company CEO and other leaders of hundreds of American Businesses and Companies. There were hundreds of very important pledges to uphold the standards set forward by the Paris Agreement even without the acceptance of the United States as a whole country. One group that stuck out in research as these leaders have some of the most influence of local development was the group formally named "The Climate Mayors".

The Development of Resistance

The Climate Mayors are a group of American Mayors that have banded together to adopt, honor, and uphold the original commitments of the United States in the Paris Agreement. 386 U.S. Mayors representing more than 68 million Americans are committed to working to fight the 1.5 degrees Celsius change and their investing in to create 21st century as the century of clean energy. The Mayors came together to show how they will continue to lead and continue investment in renewable energy, they also are known for making the opposition to the plans such as Paris Agreement, and the recent EPA repeal of the Clean Power Plan. One of the major leaders of this groups is former Mayor Eric Garcetti, of Los Angeles. He is the co-founder of the group and remains a Chair of the Climate Mayors. In this research, Mayor Garcetti became very important as he also helped L.A, join the City Energy Project. A collaborative across 20 Cities in the United States, where each city develops a set of tailored policies or programs that are meant to improve buildings energy performances drastically. The is to lead by example, to then be a catalyze for private energy efficiency measures.

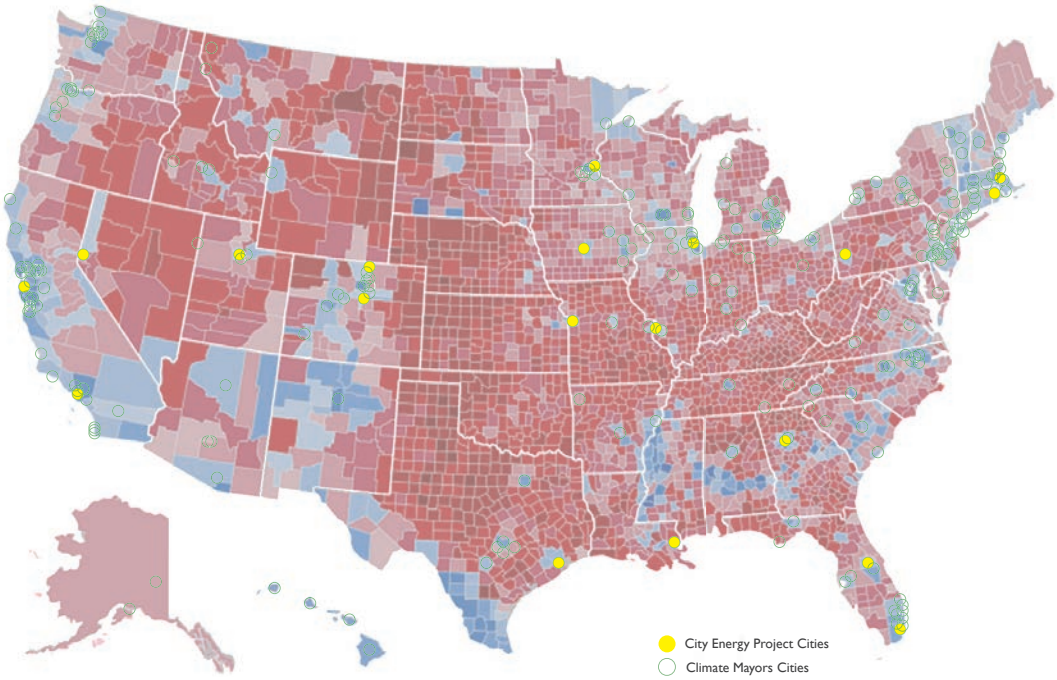
Key strategies of the City Energy Project are to:

-Provide information about building energy use that will help owners and managers cut waste

- Align financial incentives for energy efficiency

-Ensure that building systems function optimally

-Encourage leadership from universities, hospitals, and other major stakeholders.



This figure displays the 386 Climate Mayor Cites, Along with the 20 City Energy Cities. Following the figure is the list of Mayors and their City They Govern.

Mayor Eric Garcetti
City of Los Angeles, CA*
Mayor Martin J Walsh
City of Boston, MA*
Mayor Bill de Blasio
New York City, NY
Mayor Sylvester Turner
City of Houston, TX*
Mayor Madeline Rogero
City of Knoxville, TN
Mayor Rahm Emanuel
City of Chicago, IL*
Mayor Ed Murray
City of Seattle, WA
Mayor Jim Kenney
City of Philadelphia, PA*
Mayor Kasim Reed
City of Atlanta, GA*
Mayor Lioneld Jordan
City of Fayetteville, AR
Mayor Trish Herrera Spencer
City of Alameda, CA
Mayor Kathy Sheehan
City of Albany, NY
Mayor Peggy McQuaid
City of Albany, CA
Mayor Sharon Konopa
City of Albany, OR
Mayor Allison Silberberg
City of Alexandria, VA
Mayor Ed Pawlowski
City of Allentown, PA
Mayor Jeanne Sorg
City of Ambler, PA
Mayor Gary Goosman
City of Amesville, OH
Mayor Ethan Berkowitz
City of Anchorage, AK
Mayor Terence Roberts
City of Anderson, SC
Mayor Christopher Taylor
City of Ann Arbor, MI
Mayor Van W Johnson
City of Apalachicola, FL
Mayor Susan Ornelas
City of Arcata, CA
Mayor Peter R Porcino
City of Ardsley, NY
Mayor Esther Manheimer
City of Asheville, NC
Mayor Steve Skadron
City of Aspen, CO
Mayor Steve Patterson
City of Athens, OH
Mayor Steve Adler
City of Austin, TX
Mayor Catherine E Pugh
City of Baltimore, MD
Mayor Gordon T Ringberg
City of Bayfield, WI
Mayor Denny Dole
City of Beaverton, OR
Mayor Christopher Koch
City of Bellevue, ID
Mayor Kelli Linville
City of Bellingham, WA
Mayor Charles Stone
City of Belmont, CA
Mayor Jesse Arreguin
City of Berkeley, CA
Mayor Robert Donchez
City of Bethlehem, PA
Mayor Michael P Cahill
City of Beverly, MA
Mayor Lili Bosse
City of Beverly Hills, CA
Mayor Ben Kessler
City of Bexley, OH
Mayor Richard C David
City of Binghamton, NY
Mayor William Bell
City of Birmingham, AL
Mayor Ron Rordam
City of Blacksburg, VA
Mayor John Hamilton
City of Bloomington, IN
Mayor Tari Ranner
City of Bloomington, IL
Mayor Gene Winstead
City of Bloomington, MN
Mayor Dave Bieter
City of Boise, ID
Mayor Suzanne Jones
City of Boulder, CO
Mayor Carson Taylor
City of Bozeman, MT
Mayor Eric Mamula
City of Breckenridge, CO
Mayor Joseph P. Ganim
City of Bridgeport, CT
Mayor William W Moehle
City of Brighton, NY
Mayor Lori S Liu
City of Brisbane, CA
Mayor Brenda Hess
City of Buchanan, MI
Mayor Byron W Brown
City of Buffalo, NY
Mayor Ricardo Ortiz
City of Burlingame, CA
Mayor Miro Weinberger
City of Burlington, VT
Mayor Elizabeth B Kautz
City of Burnsville, MN
Mayor E Denise Simmons
City of Cambridge, MA
Mayor Edwin Garcia
City of Camuy, PR
Mayor Robert Moffatt
City of Cape May Point, NJ
Mayor Jim Brainard
City of Carmel, IN
Mayor Lydia E Lavelle
City of Carrboro, NC
Mayor Albert Robles
City of Carson, CA
Mayor Mike Webb
City of Carver, MN
Mayor Deborah Frank Feinen
City of Champaign, IL
Mayor Pam Hemminger
City of Chapel Hill, NC
Mayor John J Tecklenburg
City of Charleston, SC
Mayor Scott Rogers
City of Charles Town, WV
Mayor Jennifer Roberts
City of Charlotte, NC
Mayor Mike Signer
City of Charlottesville, VA
Mayor Andy Berke
City of Chattanooga, TN
Mayor Chuck Cahn
City of Cherry Hill, NJ
Mayor Mary Casillas Salas
City of Chula Vista, CA
Mayor John Cranley
City of Cincinnati, OH
Mayor Larry Schroeder
City of Claremont, CA
Mayor Ted Terry
City of Clarkston, GA
Mayor Frank G Jackson
City of Cleveland, OH
Mayor Rebecca Tooley
City of Coconut Creek, FL
Mayor Stephen K Benjamin
City of Columbia, SC
Mayor Brian Treece
City of Columbia, MO
Mayor Andrew Ginther
City of Columbus, OH
Mayor Jim Bouley
City of Concord, NH
Mayor Jeff Katz

City of Cooperstown, NY
Mayor Jim Cason
City of Coral Gables, FL
Mayor Diane Furst
City of Corte Madera, CA
Mayor Brian Tobin
City of Cortland, NY
Mayor Biff Traber
City of Corvallis, OR
Mayor Susan Harvey
City of Cotati, CA
Mayor Jeffrey Cooper
Culver City, CA
Mayor Savita Vaidhyanathan
City of Cupertino, CA
Mayor Peggy R. Bell
City of Cutler Bay, FL
Mayor Michael S Rawlings
City of Dallas, TX
Mayor Glenn Sylvester
Daly City, CA
Mayor Robb Davis
City of Davis, CA
Mayor Cary Glickstein
City of Delray Beach, FL
Mayor Michael Hancock
City of Denver, CO*
Mayor T M Franklin Cownie
City of Des Moines, IA*
Mayor Mike Duggan
City of Detroit, MI
Mayor Josh Maxwell
City of Downingtown, PA
Mayor David Haubert
City of Dublin, CA
Mayor Roy D Buol
City of Dubuque, IA
Mayor Emily Larson
City of Duluth, MN
Mayor Edmond P. Minihan
City of Dunn, WI
Mayor William V Bell
City of Durham, NC
Mayor Brad Cohen
Township of East Brunswick, NJ
Mayor Mark Meadows
City of East Lansing, MI
Mayor Nancy Tyra-Lukens
City of Eden Prairie, MN
Mayor Kris Teegardin
City of Edgewater, CO
Mayor Jim Hovland
City of Edina, MN
Mayor Dave Earling
City of Edmonds, WA

Mayor Janet Abelson
City of El Cerrito, CA
Mayor André Quintero
City of El Monte, CA
Mayor David Kaptain
City of Elgin, IL
Mayor Catherine Blakespear
City of Encinitas, CA
Mayor Lucy Vinis
City of Eugene, OR
Mayor Stephen H Hagerty
City of Evanston, IL
Mayor Ray Stephanson
City of Everett, WA
Mayor Karl W. Kassel
Fairbanks North Star, AK
Mayor David Meyer
City of Fairfax, VA
Mayor Edward Malloy
City of Fairfield, IA
Mayor Peter Lindstrom
City of Falcon Heights, MN
Mayor David Tarter
City of Falls Church, VA
Mayor Colleen Mahr
City of Fanwood, NJ
Mayor David Coulter
City of Ferndale, MI
Mayor Coral J Evans
City of Flagstaff, AZ
Mayor Karen Weaver
City of Flint, MI
Mayor Lindy Peters
City of Fort Bragg, CA
Mayor Wade Troxell
City of Fort Collins, CO*
Mayor Jack Seiler
City of Fort Lauderdale, FL
Mayor Tom Henry
City of Fort Wayne, IN
Mayor Bob Scott
City of Franklin, NC
Mayor Lily Mei
City of Fremont, CA
Mayor Gary Wilkinson
City of Frisco, CO
Mayor Kachen Kimmell
City of Gambier, OH
Mayor Karen Freeman-Wilson
City of Gary, IN
Mayor Tammy Stempel
City of Gladstone, OR
Mayor Bruce J Packer
City of Glen Rock, NJ
Mayor Bryan Kennedy

City of Glendale, WI
Mayor Vartan Gharpetian
City of Glendale, CA
Mayor Sefatia Romeo Theken
City of Gloucester, MA
Mayor Marjorie Sloan
City of Golden, CO
Mayor Paula Perotte
City of Goleta, CA
Mayor Rosalynn Bliss
City of Grand Rapids, MI
Mayor Emmett V Jordan
City of Greenbelt, MD
Mayor Nancy Vaughan
City of Greensboro, NC
Mayor Knox H White
City of Greenville, SC
Mayor Samuel Henderson
City of Gulfport, FL
Mayor Debbie Ruddock
City of Half Moon Bay, CA
Mayor Joy Cooper
City of Hallandale Beach, FL
Mayor Karen Majewski
City of Hamtramck, MI
Mayor Luke Bronin
City of Hartford, CT
Mayor Peter Swiderski
City of Hastings-on-Hudson, NY
Mayor Harry Kim
City of Hawai'i , HI
Mayor Barbara Halliday
City of Hayward, CA
Mayor Shaun McCaffery
City of Healdsburg, CA
Mayor Nancy R Rotering
City of Highland Park, IL
Mayor Gayle Brill Mittler
City of Highland Park, NJ
Mayor Patrick Taylor
City of Highlands, NC
Mayor Tom Stevens
City of Hillsborough, NC
Mayor Dawn Zimmer
City of Hoboken, NJ
Mayor Josh Levy
City of Hollywood, FL
Mayor Alex B Morse
City of Holyoke, MA
Mayor Kirk Caldwell
City of Honolulu, HI
Mayor Paul Blackburn
City of Hood River, OR
Mayor Tiffany Martin Hamilton
City of Hudson , NY

Mayor Candace B Hollingsworth
City of Hyattsville, MD
Mayor Serge Dedina
City of Imperial Beach, CA
Mayor Jim Throgmorton
Iowa City, IA
Mayor Brian C. Smith
City of Irvington, NY
Mayor Svante Myrick
City of Ithaca, NY
Mayor Pete Muldoon
City of Jackson , WY
Mayor Steven M Fulop
Jersey City, NJ
Mayor Bobby J Hopewell
City of Kalamazoo, MI
Mayor Sly James
Kansas City, MO*
Mayor Bernard P Carvalho
City of Kauai, HI
Mayor John Antaramian
City of Kenosha, WI
Mayor Nina Jonas
City of Ketchum, ID
Mayor Steven T Noble
City of Kingston, NY
Mayor Amy Walen
City of Kirkland, WA
Mayor Jose Alvarez
City of Kissimmee, FL
Mayor Tim Kabat
City of La Crosse, WI
Mayor Christine Berg
City of Lafayette, CO
Mayor Shari L. Horne
City of Laguna Woods, CA
Mayor Adam Paul
City of Lakewood, CO
Mayor Michael Summers
City of Lakewood, OH
Mayor J Richard Gray
City of Lancaster, PA
Mayor Virg Bernero
City of Lansing, MI
Mayor William Sprague
City of Lapeer, MI
Mayor Ken Miyagishima
City of Las Cruces, NM
Mayor Richard J Kaplan
City of Lauderhill, FL
Mayor Craig A Moe
City of Laurel, MD
Mayor Leslie Soden
City of Lawrence, KS
Mayor Theodore W Becker
City of Lewes, DE
Mayor Mark Stodola
City of Little Rock, AR
Mayor Robert Garcia
City of Long Beach, CA
Mayor Adam Schneider
City of Long Branch, NJ
Mayor Dennis Coombs
City of Longmont, CO
Mayor Mary Prochnow
City of Los Altos, CA
Mayor Gary Waldeck
City of Los Altos Hills, CA
Mayor Marico Sayoc
City of Los Gatos, CA
Mayor Greg Fischer
City of Louisville, KY
Mayor Nicola Smith
City of Lynnwood, WA
Mayor Robert Reichert
City of Macon-Bibb County, GA
Mayor Paul R Soglin
City of Madison, WI
Mayor Gary Christenson
City of Malden, MA
Mayor Skylar Peak
City of Malibu, CA
Mayor David J. Lesser
City of Manhattan Beach, CA
Mayor Nicole Nicoletta
City of Manitou Springs, CO
Mayor Nora Slawik
City of Maplewood, MN
Mayor Barry Greenberg
City of Maplewood, MO
Mayor Jonathan Hornik
Township of Marlboro, NJ
Mayor Rob Schroder
City of Martinez, CA
Mayor Alan M Arakawa
City of Maui, HI
Mayor Stephanie M Burke
City of Medford, MA
Mayor Jim Strickland
City of Memphis, TN
Mayor Kirsten Keith
City of Menlo Park, CA
Mayor Tomas Regalado
City of Miami, FL *
Mayor Philip Levine
City of Miami Beach, FL
Mayor Gurdip Brar
City of Middleton, WI
Mayor Daniel Drew
City of Middletown, CT
Mayor Sean Strub
City of Milford, PA
Mayor Benjamin G Blake
City of Milford , CT
Mayor Reuben D Holober
City of Millbrae, CA
Mayor Jeff Silvestrini
City of Millcreek, UT
Mayor Tom Barrett
City of Milwaukee, WI
Mayor Mark Gamba
City of Milwaukie, OR
Mayor Betsy Hodges
City of Minneapolis, MN
Mayor Wayne Messam
City of Miramar, FL
Mayor John Engen
City of Missoula, MT
Mayor Mary O'Connor
City of Monona, WI
Mayor Matt Brolley
City of Montgomery, IL
Mayor John Hollar
City of Montpelier, VT
Mayor Timothy Dougherty
City of Morristown, NJ
Mayor Jamie Irons
City of Morro Bay , CA
Mayor Arlene Burns
City of Mosier, OR
Mayor Fred Courtright
City of Mount Pocono, PA
Mayor Ken Rosenberg
City of Mountain View, CA
Mayor Jill Techel
City of Napa, CA
Mayor Jim Donchess
City of Nashua, NH
Mayor Megan Barry
City of Nashville, TN
Mayor Kristopher Larsen
City of Nederland, CO
Mayor Jon Mitchell
City of New Bedford, MA
Mayor Toni N Harp
City of New Haven, CT
Mayor Mitch Landrieu
City of New Orleans, LA*
Mayor Tim Rogers
City of New Paltz, NY
Mayor Ras J Baraka
City of Newark, NJ
Mayor Donna D Holaday
City of Newburyport, MA
Mayor McKinley Price

City of Newport News, VA
Mayor Setti Warren
City of Newton, MA
Mayor Paul Dyster
City of Niagara Falls, NY
Mayor Chris Koos
City of Normal, IL
Mayor Connie Leon-Kreps
City of North Bay Village, FL
Mayor Francis M Womack
City of North Brunswick, NJ
Mayor Smith Joseph
City of North Miami, FL
Mayor David J Narkewicz
City of Northampton, MA
Mayor Jennifer White
City of Nyack, NY
Mayor Libby Schaaf
City of Oakland, CA
Mayor Johnny Johnston
City of Ojai, CA
Mayor Cheryl Selby
City of Olympia, WA
Mayor Buddy Dyer
City of Orlando, FL*
Mayor Victoria Gearity
City of Ossining, NY
Mayor Greg Scharff
City of Palo Alto, CA
Mayor Jack Thomas
Park City, UT
Mayor Donald Grebien
City of Pawtucket, RI
Mayor Frank C. Ortis
City of Pembroke Pines, FL
Mayor David Glass
City of Petaluma, CA
Mayor Greg Stanton
City of Phoenix, AZ
Mayor Joseph M. Corradino
City of Pinecrest, FL
Mayor Cindy S Perry
City of Pittsboro, NC
Mayor William Peduto
City of Pittsburgh, PA *
Mayor Peter Cantu
City of Plainsboro, NJ
Mayor Kurt R Metzger
City of Pleasant Ridge, MI
Mayor Lamar Fisher
City of Pompano Beach, FL
Mayor Deborah Stinson
City of Port Townsend, WA
Mayor Ted Wheeler
City of Portland, OR
Mayor Ethan Strimling
City of Portland, ME
Mayor Jack Blalock
City of Portsmouth, NH
Mayor Liz Lempert
City of Princeton, NJ
Mayor Jorge O. Elorza
City of Providence, RI*
Mayor Nancy McFarlane
City of Raleigh, NC
Mayor Donald Terry
City of Rancho Cordova, CA
Mayor John Marchione
City of Redmond, WA
Mayor John Seybert
Redwood City, CA
Mayor Hillary Schieve
City of Reno, NV*
Mayor Levar Stoney
City of Richmond, VA
Mayor Tom Butt
City of Richmond, CA
Mayor Lovely Warren
City of Rochester, NY
Mayor Joanne Aagaard
City of Rockaway Beach, OR
Mayor Daniel Guzzi
City of Rockwood, MI
Mayor Mike Fournier
City of Royal Oak, MI
Mayor Darrell Steinberg
City of Sacramento, CA
Mayor Alan Galbraith
City of Saint Helena, CA
Mayor Christopher Coleman
City of Saint Paul, MN*
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City of Salem, OR
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City of Salem, MA
Mayor Jacob Day
City of Salisbury, MD
Mayor Jackie Biskupski
Salt Lake City, UT*
Mayor Ron Nirenberg
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Mayor Bob Grassilli
City of San Carlos, CA
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City of San Diego, CA
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City of San Fernando, CA
Mayor Ed Lee
City of San Francisco, CA
Mayor Sam Liccardo
City of San Jose, CA*
Mayor Pauline Russo Cutter
City of San Leandro, CA
Mayor Heidi Harmon
City of San Luis Obispo, CA
Mayor John Thomaides
City of San Marcos, TX
Mayor David Lim
City of San Mateo, CA
Mayor Miguel Pulido
City of Santa Ana, CA
Mayor Helene Schneider
City of Santa Barbara, CA
Mayor Lisa M. Gillmor
City of Santa Clara, CA
Mayor Cynthia Chase
City of Santa Cruz, CA
Mayor Javier M. Gonzales
City of Santa Fe, NM
Mayor Ted Winterer
City of Santa Monica, CA
Mayor Chris Coursey
City of Santa Rosa, CA
Mayor Shelli Freeland Eddie
City of Sarasota, FL
Mayor Joanne D. Yepsen
City of Saratoga Springs, NY
Mayor Frank P. Catino
City of Satellite Beach, FL
Mayor Chris Lain
City of Savanna, IL
Mayor Michael J. Gonnelli
City of Secaucus, NJ
Mayor George Van Dusen
City of Skokie, IL
Mayor Ken Wray
City of Sleepy Hollow, NY
Mayor Scott A. Saunders
City of Smithville, TX
Mayor Matt Larson
City of Snoqualmie, WA
Mayor Rachel Hundley
City of Sonoma, CA
Mayor Joe Curtatone
City of Somerville, MA
Mayor Pete Buttigieg
City of South Bend, IN
Mayor Philip K. Stoddard
City of South Miami, FL
Mayor Sheena Collum
City of South Orange Village, NJ
Mayor Domenic J. Sarno
City of Springfield, MA
Mayor Lyda Krewson
City of St Louis, MO*

Support Research

Mayor Len Pagano
City of St Peters, MO
Mayor Rick Kriseman
City of St Petersburg, FL
Mayor David Martin
City of Stamford, CT
Mayor Elizabeth Goreham
City of State College, PA
Mayor Michael Tubbs
City of Stockton, CA
Mayor Glenn Hendricks
City of Sunnyvale, CA
Mayor Michael J. Ryan
City of Sunrise, FL
Mayor Daniel E. Dietch
City of Surfside, FL
Mayor Timothy P. Kearney
City of Swarthmore, PA
Mayor Thomas Fromm
City of Swedesboro, NJ
Mayor Stephanie A. Miner
City of Syracuse, NY
Mayor Marilyn Strickland
City of Tacoma, WA
Mayor Kate Stewart
City of Takoma Park, MD
Mayor Andrew Gillum
City of Tallahassee, FL
Mayor Bob Buckhorn
City of Tampa, FL
Mayor Drew Fixell
City of Tarrytown, NY
Mayor Sean Murphy
City of Telluride, CO
Mayor Mark Mitchell
City of Tempe, AZ
Mayor Paula Hicks-Hudson
City of Toledo, OH
Mayor Patrick J. Furey
City of Torrance, CA
Mayor Jim Carruthers
Traverse City, MI
Mayor Eric E. Jackson
City of Trenton, NJ
Mayor Lou Ogden
City of Tualatin, OR
Mayor Jonathan Rothschild
City of Tucson, AZ
Mayor Brian Stack
Union City, NJ
Mayor Shelley Welsch
University City, MO
Mayor Diane W. Marlin
City of Urbana, IL
Mayor Dave Chapin
City of Vail, CO
Mayor Timothy D. Leavitt
City of Vancouver, WA
Mayor Erik Nasarenko
City of Ventura, CA
Mayor Robert Blais
City of Village of Lake George, NY
Mayor Muriel Bowser
City of Washington, D.C.
Mayor Oscar Rios
City of Watsonville, CA
Mayor Sam Cunningham
City of Waukegan, IL
Mayor Shari G. Cantor
City of West Hartford, CT
Mayor Edward O'Brien
City of West Haven, CT
Mayor John Heilman
City of West Hollywood, CA
Mayor John Dennis
City of West Lafayette, IN
Mayor Felix E. Roque
City of West New York, NJ
Mayor Jeri Muoio
City of West Palm Beach, FL
Mayor Christopher Cabaldon
City of West Sacramento, CA
Mayor Daniel Corona
City of West Wendover, NV
Mayor William R. Wild
City of Westland, MI
Mayor Herb Atchison
City of Westminster, CO
Mayor Daniel J. Stermer
City of Weston, FL
Mayor Joyce Jay
City of Wheat Ridge , CO
Mayor Thomas M. Roach
City of White Plains, NY
Mayor John Muhlfeld
City of Whitefish, MT
Mayor Ryan Reynolds
City of Whitney Point, NY
Mayor Debora Fudge
City of Windsor, CA
Mayor Diana Willits
City of Windsor Heights, IA
Mayor Allen Joines
City of Winston Salem, NC
Mayor Angel Barajas
City of Woodland, CA
Mayor Joseph M. Petty
City of Worcester, MA
Mayor Mike Spano
City of Yonkers, NY

Mayor Amanda Maria Edmonds
City of Ypsilanti, MI

Los Angeles's Sustainability Plan

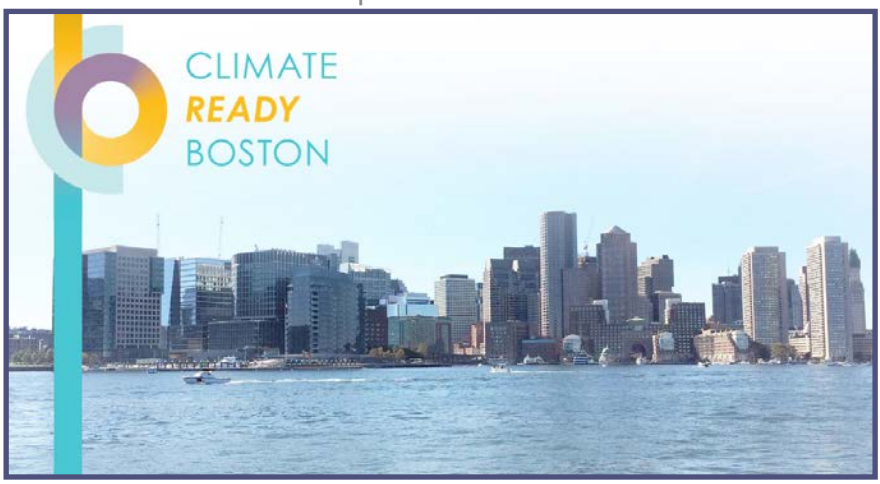
As the research continued through the City Energy Project, a selection of several cities was selected to do a case study and review of the Sustainability Plans that create for each municipality. Beginning with the city of Los Angeles, as they recently reviewed, and they met almost all goals set in 2015 for 2017 and they are 90% on track to meet the ones set for 2025 and 2035. Their strategic plan breaks down into 14 sections dealing with different topics such as Mobility & Transport, to Waste and Landfills, including Local Solar and several other issues. Highlighted are two parts that deal with LA's water and the ecosystems around water bodies. LA continues to experience severe drought conditions. Local water goals set out in the pLAn ensure a stable future for the City's growing economy while protecting this precious resource. The plan to reduce our dependency on imported water by developing local water supply, capturing and cleaning stormwater, recycling wastewater, and recharging our groundwater basins. The pLAn also positions Los Angeles to bounce back from possible disasters while keeping rivers and beaches clean, accessible and thriving with wildlife.

L.A.'s "wild places" and parks improve all residents' quality-of-life and increase the economic, physical and social well-being of our communities. Efforts to revitalize urban ecosystems, including the Los Angeles River, go hand-in-hand with prioritizing public access to outdoor spaces—which requires balance in developing the richness of those spaces regarding services, amenities, biodiversity, and urban agriculture.


PLAN

BOSTON'S SUSTAINABILITY PLAN

Boston has a very comprehensive multi-layered plan; the research conducted highlighted the few strategies more involved with water aspects.



Strategy 5

Create a coastal protection system to address flood risk.

WHY Coastal and riverine flooding poses a significant and increasing threat to communities along Boston's waterfront and to the vitality of the city itself.

WHAT the City and its regional partners should investigate primary "gray" and "green" infrastructure investments to address flood risk. The City should ensure that development in flood-prone areas does not prevent the future implementation of flood protection. The flood protection system should incorporate building-scale, district-scale, and harbor-wide measures.

Strategy 6

Coordinate investments to adapt infrastructure to future climate conditions.

WHY Boston's infrastructure for power, water, transportation, communication, and more is a complex network with many public and private owners, operators, and regulatory authorities. As climate change presents new risks of failure, all stakeholders need to understand the totality of vulnerabilities better and to coordinate action to address them.

WHAT the City should establish an Infrastructure Coordination Committee with the region's major infrastructure organizations. The committee would develop planning and design standards aligned with current climate projections, identify cascading vulnerabilities, establish coordination mechanisms, and align adaptation efforts with other planning priorities.

Strategy 7

Develop district level energy solutions to increase decentralization and redundancy.

WHY Decentralized infrastructure of many kinds has the potential to combine climate adaptation with greenhouse gas reduction and economic development. Local sources that can keep operating during broader power failures could maintain the community's capacity to stay safe and cool as the frequency and intensity of heat waves rise.

WHAT the City should pursue community energy solutions, such as district energy systems or microgrids, that increase energy reliability and decrease greenhouse gas emissions. Priority sites should include areas with clusters of affordable housing or critical facilities.

Chicago's Sustainability Plan

Chicago's suitability plan centers around the aspects of water and its devastating effects on the city, with the constant risk of flooding, piggybacking from the Green Alley Handbook, they are working to have changes to their present built environment that will allow for better stormwater management. Three Initiatives are keys to the strategy.

Initiative 1
Capital Projects

-Chicago will incorporate green stormwater infrastructure into future public capital projects.

Initiative 2
Permeable Streets

-Chicago will incorporate permeable pavement into appropriate sewer main replacement projects.

-Taking the Green Alley Program as a precedent.

Initiative 3
Bioswales

-Chicago will increase the use of green stormwater infrastructure in streetscape projects.


CITY OF
CHICAGO
GREEN
STORMWATER
INFRASTRUCTURE
STRATEGY
CITY OF CHICAGO
INCORPORATED 4th MARCH 1837
MAYOR RAHM EMANUEL

Constructed Wetland Technology

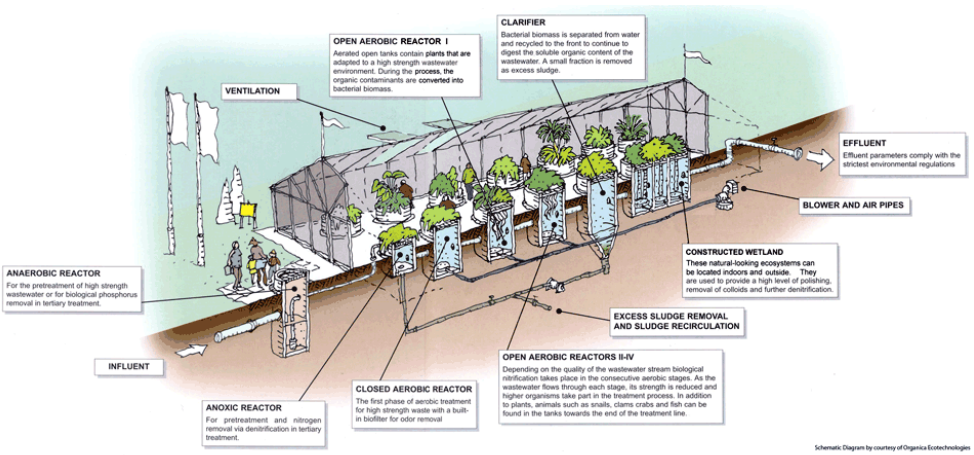
Living Machine is a trademark and brand name for a patented form of biological sewage treatment designed to mimic the cleansing functions of wetlands. Similar to Solar Aquatics Systems, the latest generation of the technology based on fixed-film ecology and the ecological processes of a natural tidal wetland, one of nature's most productive ecosystems. The diversity of the ecosystem produced with this approach allows operational advantages over earlier generations of Living Machines and conventional wastewater treatment technologies.

The Living Machine system was commercialized and marketed by Living Machine Systems, L3C, a social benefit corporation based in Charlottesville, Va. The trademark Living Machine owned by Dharma Group, LC, the parent company of Worrell Water Technologies.

The Living Machine is an intensive bioremediation system that can also produce beneficial byproducts, such as reuse-quality water, ornamental plants, and plant products—for building material, energy biomass, animal feed. Aquatic and wetland plants, bacteria, algae, protozoa, plankton, snails and other organisms are used in the system to provide specific cleansing or trophic functions. The tidal process operates outdoors in tropical and temperate climates. In colder climates, the system of tanks, pipes, and filters may be housed in a greenhouse to prevent freezing and raise the rate of biological activity.

The initial development of the technology in the United States is credited to Dr. John Todd, an ecological designer, and evolved out of the bioshelter concept developed at the now-defunct New Alchemy Institute. The Living Machine system falls within the emerging discipline of environmental

engineering, and many systems using earlier generations of the technology built without being dubbed a Living Machine. The scale of Living Machine systems ranges from the individual building to community-scale public works. Some of the earliest Living Machines were used to treat domestic wastewater in small, ecologically-conscious villages, such as Findhorn Community in Scotland, Some treated the mixed municipal sewage for semi-urban areas, such as South Burlington, Vermont (this plant closed recently). The latest-generation Tidal Flow Wetland Living Machines used in significant urban office buildings, military bases, housing developments, resorts and institutional campuses.



Each system is designed to handle a specific volume of water per day, but the system is tailored to the qualities of the particular influent. For example, if the influent contains high levels of heavy metals, ecological wastewater treatment systems must be designed to include the proper biota to accumulate the metals. During the "spring cleaning" season, there may be high levels of bleach in the water. This sudden concentration of a toxin is an example of a steep gradient.

• Steep gradients are drastic changes in conditions throughout the system that challenge the ecosystem to become resilient and stable. A well-designed treatment system requires little management, so managers may intentionally create abrupt environmental or biochemical changes to promote ecosystem self-regulation. This mimics nature's power and trains the ecosystem to adapt to influent variations.

- Designers seek to increase the surface area of contact that biota has with the sewage to promote high reaction rates. When organisms have ready access to the sewage, they can treat it more thoroughly.

- Ecological wastewater treatment systems are cellular, as opposed to monolithic, in design. If the influent volume or makeup changes, new cells can be added or omitted without halting or disturbing the ecosystem.

- Photosynthetic plants and algae are essential for oxygenating water, providing a medium for biofilms, sequestering heavy metals and many other services.
Species diversity is a design goal that promotes complexity and resiliency in an ecosystem. Functional redundancy (the presence of multiple species that provide the same function) is an essential example of the need for biodiversity. Snails and fish filter sludge and act as diagnostics; when a toxic load enters, snails will rise above the water level on the wall of the tank.

- The micro-ecosystem of a Living Machine system can be integrated with the macro-ecosystem just as ecosystems fade into one another naturally. This connection commonly made with an outdoor constructed or natural wetland into which the effluent flows. Some living machines are partially or entirely open to the outdoors, and this promotes interaction with the surrounding environment.

Some ecological wastewater treatment systems, including first-generation Living Machine systems, employed hydroponics and even aquaculture. However, these processes are not part of today's Tidal Flow Wetland Living Machine systems.

- The first step of the process is an anaerobic settling tank. This closed anaerobic tank serves as a pre-treatment to allow solids to fall out of suspension and precipitate to the bottom of the reactor to reduce the turbidity of the water. A variety of anaerobic bacteria are present in this tank; they generate acids and ferment methane. This step may be unnecessary if the influent has low levels of solids.

- Next, the sewage flows through a biofilter of bark and humic materials. This gives the influent its first filtration and reduces the odors prevalent in anaerobic conditions.

- The mixture then moves into a series of aerobic tanks. The first tank is a dark, closed-top aerobic reactor that serves as a transitional step. The next tank is an open-top, aerobic reactor that contains photosynthetic algae that fix oxygen back into the formerly anoxic, turbid water. This provides oxygen and organic food (dead algae) for biological metabolism and respiration. Microbial communities proliferate, and eventually must consume all of the photosynthetic algae so that the algae do not choke out macrophytes in later steps.

- Many types of bacteria immobilize pollutant minerals, but certain species of bacteria are crucial to nutrient conversion. Specifically, Nitrosomonas and Nitrobacter work in steps to nitrify ammonia, making it into nitrates, which are available for plant and microbial uptake. These bacteria need calcium carbonate to catalyze this reaction, so managers must maintain sufficient calcium levels in the water. Denitrifying bacteria such as Pseudomonas fluorescens convert nitrates into gaseous nitrogen, which is volatilized in these open aerobic tanks. Denitrification is the most desirable sink for nitrogen in living machines. Protozoa have been shown to be capable of coliform and pathogen suppression. Microbial breakdown is the primary biological treatment of both the conventional activated sludge process as well as these aquatic ecosystem sludge reactors.

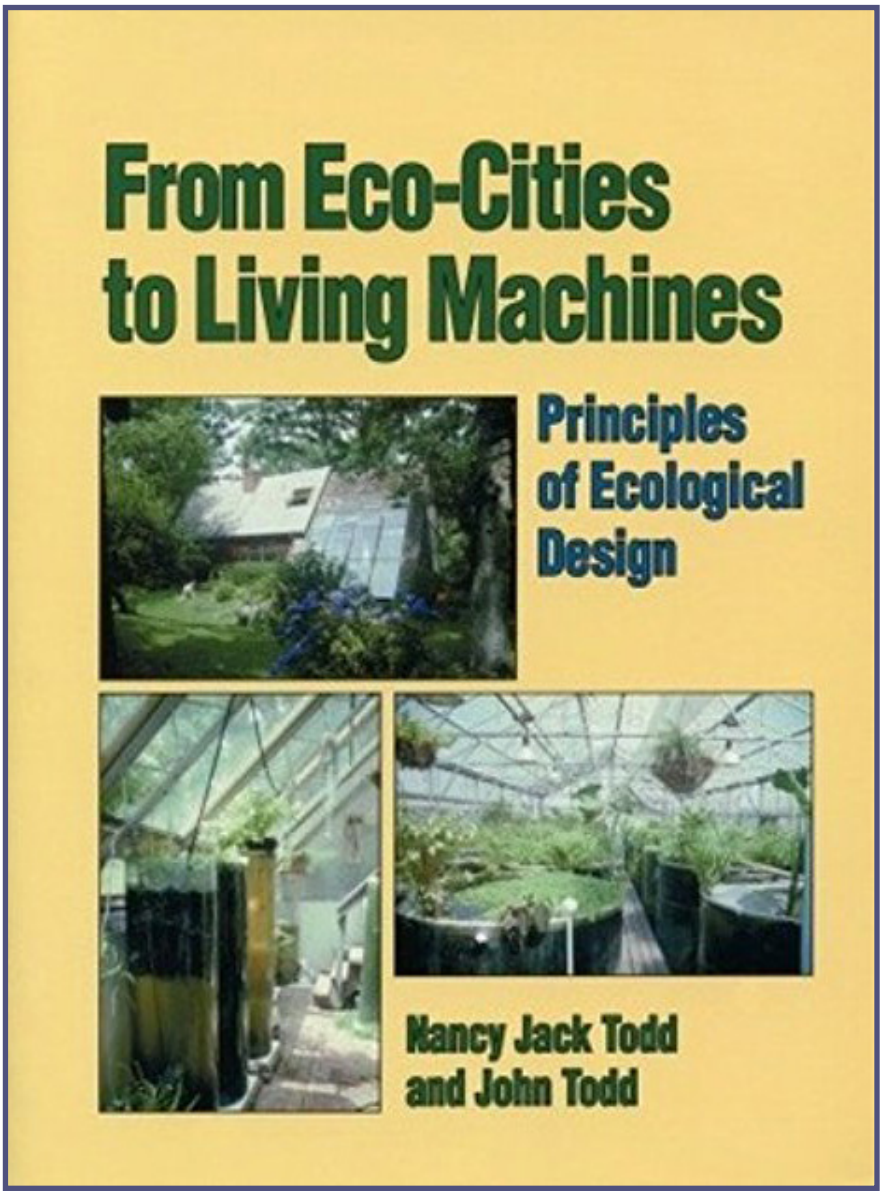
- Higher plants are grown hydroponically in the aerobic tanks and provide multiple services. The most common plant used is water hyacinth (Eicchornia crassipies), which has filamentous aquatic roots with a high specific area. These feather-like roots provide a stable habitat for microbes, and over time a bacterial biofilm builds up around the roots. Water hyacinth, bulrush and other macrophytes sequester heavy metals. The bodies of these plants can be harvested and burned, and the heavy metals can be chemically isolated to take them out of the environment. Brassica juncea growing in waste streams has been found to contain up to 10% of its dry weight in lead.

- Plankton carries out multiple functions in the system with varying efficacy. Zooplankton feed on extremely small (<25 µm) particles. In juvenile stages they feed on particles smaller than 1 µm. Conventional waste treatment cannot process these fine suspended solids. Although zooplankton does consume these fine particles, which are difficult for conventional treatment systems to process, the placement of plankton in the system is more valuable as a trophic link. Plankton can eat microbes, which are abundant in the system, and the plankton is an ideal food for filter-feeding fish and mollusks. This food chain transfers biomass to higher trophic levels and increases the diversity and complexity of the ecosystem. John Todd thinks that "Since zooplankton can exchange the volume of a natural body of water several times per day it is difficult to overstate their importance in ecological engineering."

- According to Björn Guterstam, another one of the most well-published and experienced ecological engineers, this theoretical role has not been as successful in practice. He concedes that phytoplankton populations have been limited by toxic and somewhat deoxidized water at the bottom of tanks, as well as light limitations. Phytoplankton are primary producers, which provide food for larger zooplankton species, so the zooplankton population drops with its photosynthetic counterpart. Because these principles have been implemented only on a small scale, these systems have a lowered buffering capacity due to issues of scale and separation from the macro-ecosystem, even though genetic and functional diversity is encouraged.

- Aquaculture can take place in more dilute tanks downstream after the eutrophication-causing contaminants have been ameliorated. Snails slide along the tank walls and graze on slime and sludge buildup, cleaning the tank. This self-regulation improves light penetration, which stimulates photosynthetic forms of algae, bacteria and plankton. Filter feeders sift through large volumes of water each day and consume the bacteria and plankton that are small enough to pass through. Mollusks such as mussels and snails, as well as some fish, are filter feeders. Detritus-feeding fish consume larger particles of suspended biosolids. Herbivorous fish are excluded from tanks where macrophytes carry out useful functions (such as biofilm hosting), but when plants are eventually harvested from the system, this plant tissue can be fed to a tank of herbivorous fish for aquaculture production.

• A single Anodonta freshwater clam can filter as much as 40 litres/day of water, absorbing colloidal materials and other suspended solids at a removal rate of 99.5%. Many freshwater clams are in danger of extinction, in part because some have gills that perform poorly in polluted environments. Since some of these clams can sequester colloids from streams or lakes, this provides an ecosystem service by slowing the erosion of soil colloids. Humans can strike up a symbiotic relationship with the clam genera Unlo and Anodonta by providing a clean habitat (when the water reaches the clam tank it is cleaner than some of their wild habitats). In exchange for a good home, the clams could aid humans by filtering colloids and suspended solids out of our wastewater. It is yet to be determined if the clams break up these colloids at all or if it is feasible to recycle clam compost back into field (which increases cation exchange capacity—-an agricultural benefit). Ecological engineering supports symbiotic relations between different species to serve the needs of humans as well as promoting the health of the ecosystem.

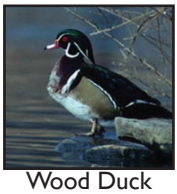

From Eco-Cities to Living Machines
Principles of Ecological Design
Nancy Jack Todd and John Todd

ECOLOGY OF SOUTH FLORIDA : BIRDS

Initiatives to produces landscape-oriented conservation plans for native birds that establish population goals and habitat objectives have grown in the past years. A All bird conservation is a high priority for Florida given the diversity of species in the state. The Florida Bird Conservation Initiative was formed as a voluntary public-private partnership that seeks to promote the sustainability of native Florida birds and their habitats through coordinated efforts that strategically address critical needs related to conservation planning, delivery of conservation programs, research and monitoring, education and outreach, and public policy.


Bald Eagle


American Bittern


Wood Duck


Eastern Bluebird


Sandhill Crane


Mottled Duck


Anhinga

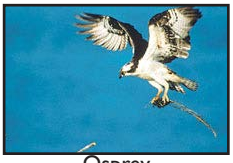

Limpkin


Fulvous Whistling Duck


Florida Snail Kite


Whooping Crane


Turkey


Osprey


Peregrine Falcon


Vulture


Florida Grasshopper Sparrow


Florida Scrub-Jay


Roseate Spoonbill


Barn Owl


American Kestrel


Swallow-tailed Kite


American Oyster catcher


American White Pelican


Brown Pelican

ECOLOGY OF SOUTH FLORIDA : MAMMALS

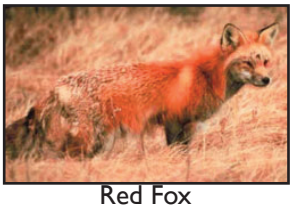
With human influence, there is not nearly enough land for the native animals to live in conjunction with humans creating a category of Nuisance animals and a solution of relocation. Relocation sounds appealing, but it is tough on the transported animals and can have negative impacts on the animal populations where they are released. A goal to co-exist with Florida's wild animals seeking low stress and hopefully a non-lethal solution to nuisance animal problems. All live-captured bobcats must be released. Other live-captured nuisance wildlife must be released or euthanized within 24 hours of capture or trap inspection.


Opossum


River Otter


Wild Hog


Beaver


Red Fox


Pocket Gopher


Grey Squirrel


Bat


Armadillo


Black Bear


Coyote


Deer

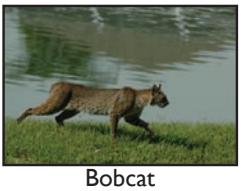

Florida Panther


Fox Squirrel


Key Deer


Marsh Rabbit


Mink


Bobcat


Raccoon


Cottontail Rabbit


Grey Fox


Mouse


Skunk

ECOLOGY OF SOUTH FLORIDA : FRESHWATER FISH

Miami bordered by the Atlantic Ocean to the East and land full of lakes, freshwater springs, rivers, marshes, bays and the "river of grass" that is the Everglades to the West. Native species of fish, are dependent on the health of these aquatic habitats. These aquatic habitats are at risk as freshwater is used rapidly, and contaminated more often.

Channel Catfish

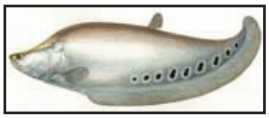
Flathead Catfish

Florida Gar

Shoal Bass

Sunshine Bass

Striped Bass



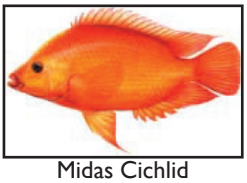
Clown Knifefish

Common Carp

Black Acaria

Grass Carp

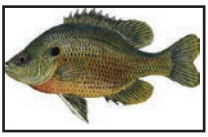
Jaguar Guapote



Midas Cichlid

Bowfin

Brown Bullhead



Spotted Sunfish

Redear Sunfish

Spotted Bass

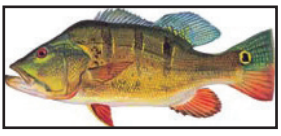
Chain Pickerel

White Catfish

White Bass

Warmouth

Bullseye Snakehead

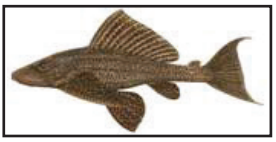


Butterfly Peacock

Yellow Bullhead

Mayan Cichlid

Spotted Tilapia



Sailfin Catfish

ECOLOGY OF SOUTH FLORIDA : REPTILES & AMPHIBIANS

Residents and visitors enjoy the beauty and diversity of the state's waterways as they go boating, fishing, paddling, viewing wildlife, hunting waterfowl, swimming, snorkeling or just stopping to soak up the views. Many of these animals are being deemed as nuisance animals and removed or killed. Along with many invasive reptiles killing off native spices and spreading rapidly.


Alligator


American Crocodile


Liguus Tree Snail


Bay Scallop


Freshwater Turtle


Jellyfish


Butterfly


Gopher Tortoise


Eastern Indigo Snake

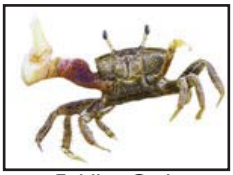

Water Snake


Loggerhead Turtle


Green Sea Turtle


Leatherback Turtle


Florida Manatee


Fiddler Crab


Dolphin


Eastern Coachwhip


Rattlesnake


Cottonmouth


Kemp's Ridley Turtle


Hawksbill Turtle


Gopher Frog

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