# New York City 2050: Climate Change and Future of New York | Design for Resilience

# NEW YORK CITY 2050

CLIMATE CHANGE AND FUTURE OF NEW YORK
DESIGN FOR RESILIENCE

A Thesis Presented

By

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## ABSTRACT

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The escalating temperature, annual precipitation, sea level rise and carbon footprint will likely lead to an unimagined future which does not have a bright side. With the rise in carbon footprint particularly due to greenhouse gas emissions, burning of fossil fuels and change in land uses; carbon dioxide is 40% higher as compared to era before Industrial Revolution.

The constant increase in temperature is melting the glaciers and increasing the sea levels. The Hudson River is estimated to rise by 1.5-2ft by 2050, directly affecting the low-lying areas of Staten Island, Brooklyn, Queens and Manhattan. Amongst the multiple coastal cities in the world, New York City is one of the most vulnerable to impacts of climate change. Surrounded by water from three sides, the impacts are disastrous with densely populated

neighborhoods along the shoreline. The shoreline needs to be revitalized with the vibrancy and diversity city offers to the people. With the rise in hot summer days which are estimated to be 50 days against 18 days currently; it would generate a warmer island thereby increasing the overall energy demands.

Hurricane Sandy struck the New York City in 2012 and had severe impacts which tested the limitations of the city's planning capacities. The impact on houses, subway system, power stations and overall economy was a major setback costing USD 19 billion. The frequency of such floods and hurricanes would be higher by 2050. The research done observes the impact of climate change and develops a model for New York City's riverfront in the Meat Packing District. Revitalizing the Gansevoort Peninsula by creating public, research and informative spaces would transform the neighborhood allowing locals and visitors to have a visionary approach for future.

The strategies and research in the current project would provide an architectural response to the existing condition and a model to design a more resilient New York City for the future.

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# INTRODUCTION

Hurricane Sandy struck New York City in 2012 causing catastrophic effects on the daily lives and livelihood of the people bringing the New York City to its knees. The climate trend in most coastal cities including New York is changing at a quick pace. The temperatures are rising; annual precipitation is on a rise and the sea level is increasing globally which could take an even worse path in coming century. The major causes of the effects are due to increase in greenhouse gases by burning of fossil fuels and change in land use. Various organizations around the globe are doing their part in initiating resilient models and approaches towards a better future, decreasing the carbon levels and keeping a check at the greenhouse gas emissions.

When we consider the geography of New York City, one third of its area is water; making coastal and low lying areas highly vulnerable to frequent flooding. As projected by 2050 through various study models, the temperatures would rise by 4-6 degree on average, the precipitation level would increase by 5-7% and the sea level Hudson would rise by approximately 20 inches. Such predictions would not be suitable for the current infrastructure, transport, energy demands and economic stability in the New York City. Studying and mapping the climate

changes in the New York City over past decades would be essential to understand the effect and design strategies.

‘Resiliency is the new Sustainability’- Resiliency has been a new topic of research and discussion with politicians, city planners, architects and engineers. Constructions with LEED ratings do not make sense when the building is flooded or is vulnerable to natural and man-made calamities. ‘Sustainability’ means ability to withstand or defend. On contrary, resilience portrays a bigger picture which is variable with time.  (Inhabitat, 2017)

We need to accept the fact that climate change is happening, and we as humans can lower the rate of its change, but cannot stop it. The strategies we initiate would reduce the happening, but cannot avoid it. We need to build and design for a resilient tomorrow, accepting the fact, we are prone to the happenings.
The intent is to design a model with dynamic strategies which would which would allow the city to be more resilient. Ranging from simplest strategies of reducing the carbon footprint, building energy demands to complex strategies like designing a resilient riverfront are a part of the exploration.

Analyzing Hurricane Sandy and its effect in five boroughs would paint a picture of what we could expect in the future decades with our on-going practices. The hurricane Sandy was a warning of what could be more disastrous soon. Sandy left the lives of many New Yorkers changed. The goal now is to be ready and

prepared for such natural disasters with reduced damages and recover as quickly as possible. The true definition of resilience is to first, protected by effective defenses and adapted to mitigate most climate impacts; and second, able to bounce back more quickly when those defenses are breached from time to time (The City of New York, 2013).

The strategies to lower the temperature in the New York City would play a vital role in reducing the overall rise in temperatures. A greener New York is desired by all. New York City has over 6 billion square feet [1](72% of land) as impervious surface which allows the water to flow through into the low-lying areas and the river, resulting in flooding and water logging making them more vulnerable than others.

[1] (Environmental Protection)

# CHAPTER 2

# LITERATURE REVIEW

## 2.1. NPCC 2015 Report

**Report: New York Panel on Climate Change**

NPCC 2015 report on climate change, ‘Building the Knowledge Base for Climate Resiliency, focused on increasing the current and future resiliency of systems, infrastructure and communities in and around New York City.

NPCC is an independent body which consults the city on climate risk and resiliency. It lays out policies, including multilayered citywide resiliency plan and sweeping sustainable initiatives. It includes work with other departments- Office of Sustainability, Mayor’s office of Operations and Dept. of Health and Mental Hygiene.

The report talks about projection of climate change in the future, rise in temperature, precipitation and increase in sea level rise. It also includes topic on public health and hygiene with focus on extreme events and coastal storms, enhanced dynamic coastal flooding modeling incorporating the effects in sea level rise.  (NPCC, 2015)

The implementation starts off in Lower East side with integrated flood protection system, the launch of first ever comprehensive regional analysis of NYCs food supply chain resiliency, key steps to combat the urban heat island effect, and start of approximately $100 million shoreline investment program to protect the most vulnerable waterfront communities. (NPCC, 2015)

Prominent features of the report apart from 2100 projections include:

- New coastal flood risk maps to the end of the century for the current 100-year (1 percent annual chance of occurrence) and 500-year (0.2 percent annual chance of occurrence) coastal flood events.
- Enhanced dynamic flood inundation modeling of future coastal flooding that includes the effects of sea level rise.
- A review of key issues related to climate change health risks relevant to the citizens of New York City.
- A process for enhancing a New York City Climate Resiliency Indicators and Monitoring System. (NPCC, 2015)

The report engages active use of technology available for research across various fields. The investments made towards resiliency in all five boroughs would incorporate latest science support and policies. The report also highlights the risk of climate change in the city. It strongly encourages partnership

developments across communities, government agencies, science and stakeholders.

**Key Recommendations and City Action (**NPCC, 2015)

Today, the City is announcing new progress on several key projects, including:

- The launch of scoping and preliminary design work on the Lower East Side to implement a $335 million integrated, neighborhood-sensitive flood protection system to mitigate risk and help connect the community with the waterfront. This project, which is funded by the U.S. Department of Housing and Urban Development's Rebuild by Design competition, runs from East 23rd Street to Montgomery Street and is intended to be just the first phase of a larger project that will ultimately provide coastal resiliency for all Lower Manhattan. To that end, the City has already allocated additional funds to planning and preliminary design south of Montgomery Street.
- The Office of Recovery and Resiliency (ORR), partnering with the New York City Economic Development Corporation (NYCEDC), has also launched the first-ever, comprehensive regional resiliency analysis of New York City's food supply chain network. The study will examine key distribution assets both locally and in surrounding jurisdictions, examine regional transportation routes, and work with the city's food community to help ensure continuity of operations during a disaster.

- To combat the urban heat island effect, as of the end of 2014, NYC Cool Roofs has coated over six million square feet of building roofs with reflective paint to address the climate change risks associated with urban heat. The City's recent green buildings plan commits to coating at least one million square feet a year more to continue mitigating the urban heat island effect and provide energy savings in affordable housing, public buildings, and non-profit organizations. ORR has also convened urban heat island experts to advance research and understanding on this issue, and continues to focus its heat response protocols on vulnerable populations.
- ORR and NYCEDC have also launched an approximately $100 million shoreline investment program to protect the most vulnerable waterfront communities, including Coney Island Creek and Staten Island's South Shore, and other low-lying parts of the city that will be evaluated as part of the first phase of work. This will include a nine-month first phase to identify and prioritize approximately 43 miles of at-risk shoreline, following by design and construction of site-specific resiliency measures that might include bulkhead upgrades, revetment installation, and living shoreline treatments.

The City has already implemented short-term measures to immediately reduce risk. For example:

- 4.15 million cubic yards of sand placed on city beaches.
- 26,000 linear feet of dunes on Staten Island alone, with additional dunes on the Rockaway peninsula.

- 10,500 linear feet of bulkhead repairs around the city.
- Updated building and zoning codes, including 16 new local laws to improve residential and commercial resiliency.
- $1 billion in resiliency investments being made by ConEd to harden critical assets like substations and other critical distribution equipment.
- Reforms to FEMA's national flood insurance program, critical flood insurance affordability studies, and education efforts for homeowners across the city.

Additional longer-term measures are being advanced across the entire city, including but not limited to:

- Over $450 million to construct new armored levees and other infrastructure along Midland Beach and Staten Island's East Shore, to substantially reduce risk in the future, in partnership with the U.S. Army Corps of Engineers and the State.
- Substantial investment in the next phase of coastal protection in the Rockaways and the communities surrounding Jamaica Bay, in partnership with the Army Corps and State.
- T-groins and beach nourishment in Sea Gate, on which ground was broken on Saturday, in partnership with the Army Corps and the State.
- Dunes and other coastal protection in Breezy Point.
- Integrated flood protection system measures in Red Hook.

- Over $15 million in natural infrastructure resiliency projects funded by the Department of Interior in Jamaica Bay, the Bronx River, and elsewhere.
- Additional coastal protection projects funded by the federal Rebuild by Design program (in addition to the Lower East Side flood protection system), including:
  - Hunts Point Lifelines—food distribution center investments in coastal protection, waterfront access, and energy resiliency.
  - Living Breakwaters—natural infrastructure investments in wave attenuation off Staten Island's South Shore, being implemented by the State.
- Major investments in the Staten Island Bluebelt and other storm water infrastructure across the city to better accommodate increasing precipitation.
- Key resiliency upgrades at critical facilities, such as hospitals like Staten Island University Hospital, Coney Island Hospital, Bellevue, and more.
- NYCHA recovery and resiliency funds to elevate boilers and install emergency generators and flood protection systems.
- Agency recovery and resiliency funds to restore and protect critical City agency services like schools, parks, and other facilities.
- Major flood and coastal protection studies, including at Coney Island Creek, Gowanus Canal, Southern Manhattan, and Newtown Creek, to evaluate the feasibility of additional tidal barrier and surge barrier investments.

- Department of City Planning Resilient Neighborhoods studies to advance land use measures to support the vitality and resiliency of individual communities in the flood zones.
- Small business resiliency support, including new resiliency technologies to be applied through the NYC: RISE competition and assistance through Business PREP, a new program to provide small businesses with education and technical support to enhance their resiliency. (NPCC, 2015)

## 2.2. What Things Do?

**Author: Peter Paul Verbeek**

The reading investigates the use of technology and its impact on the human behavior in the present time. As Heidegger and Jaspers agreed on, the use of technology has led to a less meaningful life in certain context. I believe technology has played a vital role in transformation of life while having both positive and negative effects. At times, people have adopted technology in a manner which has led to human growth showing how useful scientific advancements are in some cases. Whereas, at times, people have become addicted to things, which has had a harmful effect on their self being.

In the present world, everything revolves around technology. If we consider, our daily life tasks, cell phones, watches, music, washing machines, dryers, heating furnace etc. everything is a part of technological advancements. It has played a major role in how we respond to the surroundings now. The impact of industrial design has been closely observed by Verbeek and considerate analysis has been done in ‘material aesthetics’, aiming to contribute to the ongoing discussions of environmentally sound industrial design.

Discussing the materiality, the products can be categorized into its function and its sign value. A very simple example of this is Apple products. All major cell phone, tablets and laptops brands are satisfying the functional aspects of the

product. The Apple products due its style and designs are preferred more by individuals. It is important to say, that form in industrial design has played a major role in selectivity by users. The basic functions are more the less, same for each product, but its design govern its market selling capacity. People appreciate what they see, and that becomes a selling point of the product. Various products are better in functions and tasks than the world leader, but lack design skills. Thus, it's important to maintain a balance between the functions and sign values because materiality of things plays a vital role in present day scenario.

Another example given by Verbeek is a yacht. A yacht is built not only to go to sailing, but to define the status of the owner. These two aspects of the design are closely linked with each other. The movements like Jugendstil which happened in Southern Germany in late 19$^{th}$ century along with Art deco shows the transitional phase in design where work or the art piece is not bound by the engineering or design aspect, but a careful blend of both approaches. The approach involving the socio-cultural utility with materials defines the design theory with distinction. There are currently many products in the market which deal with socio-cultural aspects in the society. An example of such product is a cell phone in India, which the local manufacturers have produced involving basic functions mixed with local language and styles. The display options attract Indians as they are more familiar to the language and it's easier to adapt for people of various ages. Another example of socio-cultural involvement is a car- Reva, which is designed for a

country based on its economy, availability of natural gas/ petroleum, the height of people and leg space, its projected speed and other comfort levels.

As Verbeek stated, there can be two general classification of design products:

- Denotative functions: It denotes for how and what they are to be used. Suppose a bed is used for sleeping. Any object with similar shape and context will portray similar kind of purpose. It tells us what shape maybe used for a product which may have different intrinsic design values attached to its typology.

- Semiotic functions: It denotes connotative functions (functions which featured a lot in most modernism design. Such functions turn the products into symbols. I feel these products leave a longer and deep impact on the minds of people. There are various examples of such products ranging from architectural designs, furniture designs to accessory designs. Empire state building is more of a symbol for New York City. Barcelona pavilions furniture or the European movements furniture served the simple purpose of sitting but are considered more as a symbol for that era. Apple leads the way people think of cell phones in present generation.

The central idea of the product is the use and its function, but its value maybe analyzed through various aspects of design and form making which are called as

secondary functions. Mediation is another important aspect dealing with products, which concerns with the ways in which products function as a material object, not necessarily signs. These products are well designed to serve its purpose and shape human actions and experiences.

The aesthetics of materials has been the focus of industrial revolution since its establishment with mass production techniques which started with Ford assembly line method. The aesthetics are given high priority in lifestyle products which define the symbol of the individual. The Giorgio Armani products are the style symbols in the clothing industry which serve the basic function but are visually pleasing and well designed. As Verbeek mentioned, sometimes, linking the aesthetics to practical design thinking draws a direct connection with the analysis of technological meditation.

Aesthetics and its ethics has been a pivotal component of modern design. Bruno Latour mentioned in his article ‘Where are the missing masses?’ Programs like the car won’t start until the driver has fastened the seat belt or with indication of beeping sound have been important considerations where design has seamlessly blended with the ethics of its function.

It is important for manufacturers to understand how the products shall reflect the moral character of the society and the people. I would like to explore such design strategies that would affect the involvement and participation of people in my

thesis. The design shall not only be visually attractive but should serve a broader perspective. The designs do not have intentions and cannot be held responsible for what they do, but it does not alter the fact that they do act and respond to the environment around.

I believe whatever we design becomes a part of the place and should not be alien to the environment. I would like to explore such possibilities in my thesis, in search of land in the metropolitan cities considering case of extreme dynamics in cities of New York City and Mumbai.

Stability has been a core element of design strategies. The products beings developed have a strong research behind their stability and durable nature. The energy put into developing the products is immense and thus governments and companies are adopting greener approach towards larger and small scale products. The example of Netherlands, the country with most advanced sustainable approach technologies has seen a steady involvement of government and local bodies to prepare models for better living conditions. The approach is labeled as MET- ‘Material Cycle, Energy Consumption and Toxicity’. I believe this approach shall be universally adopted where each product shall be valued based on three factors and its effect in environment. The results of careful approach, which has been a core part of latest architectural designs would allow a sustainable growth and reduce the ill-effects in environment. The other factor which maybe added into this current approach is waste disposal, as it would seek

into the aspects of throwing away of products.  Further research has added other components as Verbeek mentioned- Quality and Longevity should be a part of the MET approach.

A product as MET approach mentions, should have three important aspects:

- Technical
- Economical
- Physiological

An interesting study shows how many products are functioning properly, not functioning properly and not functioning at all. Such comparative analysis should be interesting to see with buildings globally. Architecture is a tool which defines the quality of life of people in a location. Technological advancements have been made to analyze building performances worldwide but building life span is still a question for everyone. How long shall a product or building last to serve its purpose? What should be done with the products or buildings over a period? As plants are eternal, such approach should be put into buildings as well, where designers should think about the future of the products and its diverse function over the period. This would reduce waste, make people more responsible and a factor of care shall be introduced in the scenario.

People have a lot of attachment with certain objects, where the object does not just remain a mere object, but becomes a part of the soul for an individual.

There have been studies showing conceptual framework to understand how objects acquire meaning for people. The meaning and involvement can only be established with active interaction between the people and the objects. For instance, some people have strong attachments to their homes due to their family sentiments. Others may have developed affection for objects which maybe gifted by special people. Objects can acquire meaning to people with their aesthetics, functions or its active interactions with people over time.

Products can be ranging from transparent artifacts to engaging artifacts. The engaging artifacts are easier to relate to as they are directly involved with interaction through functions. Some musical instruments may become more than just objects for musicians due to their involvement and interaction with the musician. The object is more than just an aesthetical body or providing its functional aspect. Similar examples can be seen with traditional houses of people, where people make the ambience rather than its design or aesthetics. The basic function to provide shelter is served along with developing sentiments through other activities.

Individuals can be more linked to the objects in three significant ways:

- Transparency can invite involvement when products become present at hand
- Engaging with products when they are used can solicit human participation both in functioning and its suitability.

- Involvement and attraction through aging process- the features might not become visible unless they age with time. Example- household furniture and wood

So, I believe objects are more than just mere things which serve their function over time. The products should have a deeper meaning in our lives and the factor of care and concern should be higher. Similar approach should be in case of buildings, where aesthetics or function should be overseen with its worth.
The actual worth is more important rather than just mere aesthetics or functions. Also, the products should be environmentally sound and engaging in capacity. The development of technology has played a crucial role how we see the world today. The technology has helped us to shape our future in a new modern outlook, but it's active and considerate use would determine the real future of the planet.

Sustainable approach of products should include various factors in its lifetime including durability, waste disposal, quality, use of energy resources and meaning an individual. The technological advancements should help us shape the experiences and existence but not overlook its impact on planet Earth. It is important to realize that 'are we driving technology or is the technology driving us'?

### 2.3. The Works- Anatomy of a city

**Author: Kate Escher**

The book discovers the secrets of the infrastructure in the New York City. There are many metropolitan cities in the world like London, Tokyo, Shanghai and Mumbai where hundreds of millions of people live and commute to work. The dynamic city New York City has its own grandeur and attractions which is hard to match. My recent visit to New York City changed my perspectives of how a city can function. The vastness and urban fabric of NYC is intrinsically weaved and put together with one of the largest street networks in the world of about 20,000 miles connecting the five boroughs. I would like to expand on certain sections from the book which are related to my thesis ideas:

Subway

New York City's subway system is the busiest urban transit system in the world. It roughly handles 4.5 million passengers, amounting to 1.4 billion in a year. It is spread out to vast areas connecting New Jersey State across the Hudson River as well. By volume, it is one of the largest in the world, surpassed only by Tokyo, Moscow, Seoul and Mexico City.  It has 6200 cars servicing 25 lines which dwarf the fleets of even its largest competitors. The employees of the transit system range from 25 unions amounting to 45,600 employees which is hard to manage every day.

The subway history dates to 1827, when 12 seat stagecoach was started along Broadway whereas the elevated ones made its debut in 1827. The IRT (Interborough Rapid Transit) line started in 1904 and expanded to Bronx. It then expanded to Brooklyn in 1908 and Queens in 1915. The IRT and IND were both purchased by city after the Great Depression.

Naming system of subway was introduced following the unification of the independent subway lines in 1940s, and then the color codes were introduced in 1979 to tie together, graphically, trains running across the same lines. Understanding the subway is easy, and thus it's easy to commute larger distances even for new travelers.

In the 660 miles' track, 2/3rd is underground which forms the core of the system. The elevated part is around 156miles and grade is 57miles. Many of them run parallel to support local and express line system, thus only 230 distant miles exist. A detailed subway network along the NYC is shown in the next page.


The lines extend to the five boroughs and New Jersey City. Important aspect to observe in the subway is the vacant stations.

The abandoned stations:

Over hundred years of existence, there are many stations, platforms and levels which are no longer in use. The most notable in the City Hall station known for its

soaring ceilings, skylights and chandeliers. The sharp curves proved too much for trains, and it's been abandoned since 1945. There are 9 total abandoned stations in the city- 5 of which can be seen from passing subway trains. These include 91st St., East 18th St., Worth St., old city hall station, the Myrtle Ave mainly.


**Figure 1: City Hall abandoned station**

**Figure 2: Abandoned underground track**

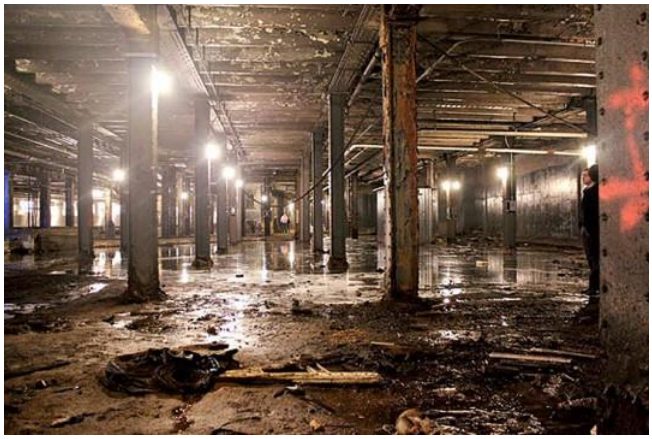


**Figure 3: Abandoned platform under Delancey Street**

Bridges and Tunnels:

New York's fabulous harbor and multiple waterways once made it a trade center, but today it's a city of bridges and tunnels. Several agencies claim the system including Port Authority of New York and New Jersey, MTA, DOT, NY State Transportation, NYC Department of Environmental Protection (DEP), Amtrak and the New York City Department of Parks.

Nearly all of city's tunnels or bridges have set records. The Holland tunnel was world's first vehicular tunnel opened in 1927.The Washington and Verrazano bridges were world's longest suspension bridges when they opened in 1931 and 1964 respectively. New York's crossing date back to 1691 when its first bridge known as King's bridge was constructed over Spuyten Creek between Manhattan and the Bronx. There are many more facts about these including one special mention of Highbridge being a part of the new Croton Aqueduct system which is used to carry water since 1843.

Some of these structures have gained landmark status. The Holland Tunnel, operated by Port Authority of NY and NJ, was designated a National Historic Landmark in 1993. The 14-major bridge and tunnels serve millions of people every day across Manhattan, Bronx, Staten Island, New Jersey and Queens.

Various bridge types seen in NYC:

- Cantilever- Queensboro bridge
- Suspension- Washington, Verrazano, Brooklyn, Manhattan bridges
- Trestle bridge
- Girder span bridge
- Steel arch bridge
- Truss bridges

Movable Bridges:

- Retractile bridges- Barden Avenue and Caroll Street bridges
- Swing bridges- Third Avenue, Madison Avenue and Macombs Dam
- Bascule bridges- Pelham, Hamilton Avenue bridges
- Vertical lift bridges- 103rd Street Bridge and Ward's Island Bridge to Queens

The bridge operations boast prominent features which allow a safer and healthy environment to the people in the city and visitors. The Washington bridge

operations incorporates 159 radar detectors, 39 cameras, pavement sensors in asphalt, wind speed- air temperature- visibility sensors, highway advisory telephones and call boxes, VMS sensors.

The tunnels have multiple lanes inside which allows vehicular traffic, rails and bus networks to flow across them.

Between residents, visitors and commuters, millions of journeys are made every day within NYC proximity. Most people travel by mass transit modes including subways and bus, others travel by taxis and cars. The important aspect in the city is to travel quickly, easily and safely. The subway system is one of the busiest urban transit system in the world which is a miracle and boon for the modern NYC.

Streets of course are important to move people around, but subways reduce the level of people on streets manageable. The bridges and tunnels are equally important as they allow movement of people across different islands in New York.

## 2.4. High Line: The inside story of New York City's park in the city

**Author: Joshua David**

"HIGH LINE: THE INSIDE STORY OF NEW YORK CITY'S PARK IN THE CITY"

-Robert Hammond and Joshua David- Friends of High Line in NY

How the original situated ordinariness of Robert and Joshua transformed NYC. Neither of them are leaders, not captains of industry, not city officials, not trained urban planners, designers, architects, they are just the citizen of NYC with an extra eye to see something which others could not. The idea was to create something magical. It has been a creative and innovative idea. Ideas are terrible things to waste; they are to implement and to divine. Who would imagine there would be such buzz at an elevated height?

How other cities are looking at new infrastructure in their cities? It doesn't necessary needs to be a highline in each city, the context is significantly important.

Overview by Robert Hammond:

History of the highline and how the dream got realized and its future?

The highline is an old train track at 10th avenue. It was called the death track, as it used to run on road and killed many people. Then it started to have a horse rider in front of train to warn people of the situation- called the west side cowboy. It was elevated to serve the various warehouses on its way. The highline stopped

development in neighborhood due to many reasons until it was revitalized. The last train road was used in 1980, where just 1 track was used and since then it was unused.

So what was seen from the street, was a steel structure. The community, city officials/ municipality, developers wanted to demolish it. So, it was important to see who was connected to its preservation. It was important to see how and what city officials thought about it?

In the city meeting, only 2 people were interested in the project (to save the railroad) - Robert and Joshua, all others wanted to tear it down or wasn't interested in this. Both had no background into this, having their own careers. As they went up, it was a track of mild flowers in the fall of 1980. When they started, they had no plan, no money and no relevant experience and no vision. They started and saw what could be up there, it just should not be demolished.

The only vision was not preservation, but reuse. What would be the next step? They started with 'Friends of New York' and came up with a logo.
It all started with photographs in all different seasons. The images became the USP of the project, along with developing business cards, concepts, and photomontage. There was such a nice feeling up there, but people could not get to it. The other reason being everything wanted to tear it down, it was important to see what dreams and aspirations people had in the neighborhood.

The developers could easily get these projects which no one wanted, so lawyers were needed to get the rules for railroad, highline, etc. It was a challenge to get the community together and convince them to invest initially. There were a lot of designers, art lovers, studios in the neighborhood, so it was important to convince them. There was economic feasibility study on how this would create value to the neighborhood and increase real estate value over 20 years. They thought it would cost 100 million to build, but it cost 150 million. It was estimated to 250-million-dollar tax revenue, but new study indicated 1-billion-dollar avenue, and currently it came to 2 billion dollars. It was important to develop awareness and thus a competition was organized which ended with 720 entries globally. An exhibition was then organized at Grand Central to invite a city level approach. Community sessions were important to organize as it would let their aspirations come out.

Lastly, it was important to have funds, which was through the Government. Hillary Clinton got the transport/ rail funds sanctioned to start the project. The other thing was to counter the property owners, where they could sell their rights to nearby buildings. It allowed a new zoning to let higher density little away and lower alongside. A design competition had entries from Steven Holl, Zaha Hadid but James Corner Field Operations won the competition. They had a vision to create something new and still had a dilemma on how to go about it. They had a proper landscape and partnered with Pete, a Dutch horticulturist who came up

with palette of plants for the scheme. Every two weeks, it had different plants, difficult to maintain and keep them neat and clean. It was challenging but it was dynamic. The lighting was to have down lights, railings, path and no overhang lights. It was important to see plants merging with the lights and thereby not looking alien in the sky.

The structure was built for heavy transportation and thus some heavy I beams could be removed to pave way for stairs. There was a water feature added for summers. There was a sun deck added which had two good activities, people watching watch other and getting photographs clicked. At 10th Avenue, the steel beams were cut off, to create amphitheater over the street.

The section 1 was opened in 2009, and later ones were opened in successive years. There was a variety of flowers, plants which changed with seasons. The lawn created is now the busiest lawn in NYC per square foot, and thus now, it's closed 3 days a week to let the grass breathe.

The flyover concept was created where you walk through different heights following the track. The Highline had been covered in bill boards which were removed to provide better aesthetics and views down and alongside the track. There are buildings by famous architects alongside the Highline- Zaha Hadid, Frank Gehry, Renzo Piano, Shigeru Ben, etc.

The closer you are to the highline, better the prices, which is kind of reverse in case of subways. The Hudson Railyard had then various proposals for stadiums and sports development, but it came down to mixed use- commercial and residence which is currently in construction along the Section 3 of the highline. The organization 'Friends of New York' is now partnered with NYC Department of Parks and Recreation. 80% of funding for Central Park is private, and 100% funding for high line is private. It is all paid by private funding. The estimation was 300,000 people a year, but that happens in 2 weeks now. Average month visits were then increased to 65,000 people a month. It is said to have 3-4 million this year.

A successful highline would be if it's owned by New Yorkers and locals rather than just focusing on visitors. Festivals – kids, music nights' cultural fests, art exhibits are organized. Telescopes are there to see the sky and watch planets- which is hard to believe but true. Sculptures are there by famous artists. Designer's home, photographs by photographers, local art and culture is focused on. Food kiosks and bar are now getting up on highline which would also generate revenue.

People have taken ownership and used it in different ways which is good to see. There are a lot of stories which they did not intended but developed over years. The most important success reason was to involve the community and staff in the process.

## 2.5. Sustainable Urbanism

**Author: Douglas Farr**

THE BUILT ENVIRONMENT: WHERE WE ARE TODAY

The American Lifestyle on the Wrong Course

“We have met the enemy and he is us.” – Pogo, by Walt Kelly

Americans have been taking pride on being able to pick where to live, work and play. Being a democratic nation, it gives them a right to vote and chose government. Everyone is pursuing their own rational, enlightened self-interest. The presumption may be on a wrong path- the evidence is all around us. The American middle class, having not focusing on public health, shows strong results of deterioration resulting in obesity. Some states are having maximum of 15-19% obesity rates (as per 1991), which increased to shocking 30% by 2005-10. The major reasons for this is the environment we have designed for ourselves.

Abraham Lincoln walked 6 miles each way to library, today an average person walks 4 minutes a day. People have chosen to live indoors cutting the relation to outdoors. A baby born in US spends 87% of time indoors, and another 4% in enclosed transit.

The metaphor of ‘ecological footprint’ approximates and visually illustrates the capacity of nature’s systems to support the demands placed on it by

contemporary lifestyle. It categorizes human demands on land into food, goods, transportation, housing, energy use, location, green practices and income.

The prime villain is all this is the love for automobile. Most Americans rely on cars to meet most basic needs of life. Americans drive the most as compared to any part of the world, and are locked into doing so by choosing the place to work, live and play out of the way places that demand driving.  Thus, 2/3 oil consumes in US is processed into fuel for transportation.

Pioneering Reforms: Setting the Stage for Sustainable Urbanism

“America is ready to turn the page. America is ready for a new set of challenges.”- President Barack Obama

Sustainable urbanism can redefine how people live and work in American cities, with focus to high quality of life and promoting health. Many ideas have been worked out in this respect, along with many books and researches. ‘Design with Nature’ by McHarg’s shows a young man against pollution, ugliness and lack of vegetation.

Sustainable Urbanism aims at benefits of integrating human and natural systems. The smarter growth, new urbanism and green building initiatives provide backbone to sustainable urbanism. They might share the interest in economic, social and environmental scenes, but are different in history, approach and focus.

SUSTAINABLE URBANISM: WHERE WE NEED TO GO

Sustainable Urbanism:

Sustainable urbanism is the walkable and transit- served urbanism integrated with high performance buildings and infrastructure. Compactness (density) and bio philia (human access to nature) are essential to urbanism.

Define Center and Edge:

Important elements are neighborhood's, districts, and mixed-use. They should be compact, pedestrian-friendly and focus on a sustainable city growth module. The pathways, sidewalks and close houses encourage social ability. The size of neighborhood helps in determining the closeness in relationships, behavior etc.

Compactness:

There is an offering of wide spectrum of housing types- ranging from multi-family to single family in same neighborhood. Increased density can incorporate better transit services, market accessibility, goods and services.

Completeness- Daily and Lifelong Utility:

Neighborhoods are places where all daily requirements are easily accessible by foot.

Completeness refers to diversity of housing types it can accommodate in a lifetime. Young adults moving out prefer a small, low cost apartment later shifting to better apartment and finally purchasing condominiums. There is then a reverse

process when old parents move to smaller houses to have easy accessibility and finally to assisted-living facility or nursing home.

Connectedness- Integrating Transportation and Land Use:

People need places to walk, ride, bike, play and even wheelchair movement in neighborhood.

Sidewalks, parks, low speed streets, travel lanes are some approaches which help in achieving connectedness. School children going in bike has reduced to all time low of 30% for those in 1 mile radius and 15% for all others.

Sustainable Corridors:

A major element of sustainable urbanism is the transit services- subways, metros, buses, trolleys, etc. There needs to be development of transit readiness where housing and jobs balance the urban scale rather than municipalities or neighborhoods.

Bio philia- Connecting Humans to Nature

Human life is not possible without services by Earth. The sunlight, water, oxygen, plants and animals are all integral to Humans. Sustainable urbanism aims to connect nature and natural systems, even in dense urban environments.

Having landscaped areas, green corridors, and sidewalks would allow more fresh air in the city. People can interact with these things while doing daily errands, going to workplace or just sitting outside their homes.

High Performance Infrastructure and Integrated Designs:

There needs to be benefits of infrastructure effectiveness over simple efficiency. The government owned infrastructure- streets, parks, schools, sewers, buses, trees and wetlands prove to be the most valuable assets of a municipality.

The green building concern has been the most highlighting feature of the decade with heat island effects, storm water filtration, and recyclable things. The impervious surfaces, concrete and tar absorb the heat which have become the part of urbanization. It raises temperature in a neighborhood with 2-10-degree F (US Environmental Protection Agency).

High Performance Building:

LEED and Living Building Challenge are essential benchmarks to evaluate and monitor our buildings, based on various factors guiding the environmental protection.

Three steps to sustainable urbanism:

- Agreeing to Weights and Measures- Making a market for sustainable urbanism
- Dismantling petroleum- a well-known barrier
- A national campaign to implement sustainable urbanism

Agendas for leaders:

- Promote sustainable urbanism

- Hire sustainable urbanist professionals
- Support and select sustainable urbanist developers
- Benchmark- sustainability goals
- Revise outdated regulations
- Develop a sustainable neighborhood
- Develop a sustainable corridor

Essentials for Sustainable Urbanism Practice (for professionals):

- Understanding and Commitment
- Leadership
- Experience
- Skills
- Expertise

Some case studies which could be adopted for future references:

- Dockside Green: Victoria, Canada
- Lloyd Crossing: Portland, US
- Z Squared: London, England
- New Railroad square: Santa Rosa, California, US
- Uptown Normal: Normal, Illinois, US
- Dongtan: Shanghai, China
- Galisteo Basin Preserve: New Mexico, US

# CHAPTER 3

# RESEARCH AND STRATEGIES

## 3.1. Climate Projections

Every year with advancements in urbanization and development, human activities are increasing risk to the Earth's climate. With changes in land use, burning of fossil fuels and industrial developments, the level of carbon dioxide has increased 40% since Industrial Revolution. Rise in greenhouse gases like methane has gone up by 150% which has severe threats to environment and public health. The global temperatures have increased constantly since the past century, with further projections of 4-6 degree Fahrenheit till 2050 in the New York metropolitan region.

The greenhouse gases are supposed to have destructive effects on the environment:

- Increase in annual average temperature
- Increase in precipitation level with heavier rains
- Melting of ice and snowcaps alongside permafrost
- Rise in sea levels
- Increased acidity of water bodies i.e. oceans, rivers and lakes.
- Increase in magnitude and occurrence of fatal events like floods.
- Paradigm shift in ecosystem and its character

- Effects to human and animal health

These changes will be gradual in nature, with extremes in case of fatal events. In the entire North East, heavier rains causing occasional floods have become frequent while the cold winters are becoming rare. The past winter in 2015-2016 had fewer subzero temperatures than compared to past winters. This is also affecting the natural season cycle, where winters start late and summers start early.

Such impacts have global effects on economy, health and environmental conditions. The changes are already seen in state of New York affecting its water management, energy demands, food supply, natural ecosystem, socio-economic growth.

The northern and southern hemisphere have experienced lower snow. The melting has made the sea level rise by 0.5 to 0.7 inches each decade and the net surfaces have increased by 1.5 degree Fahrenheit since 1880's. (NPCC, 2015). Key mechanisms of Earth's radiative balance are shown in Figure below.

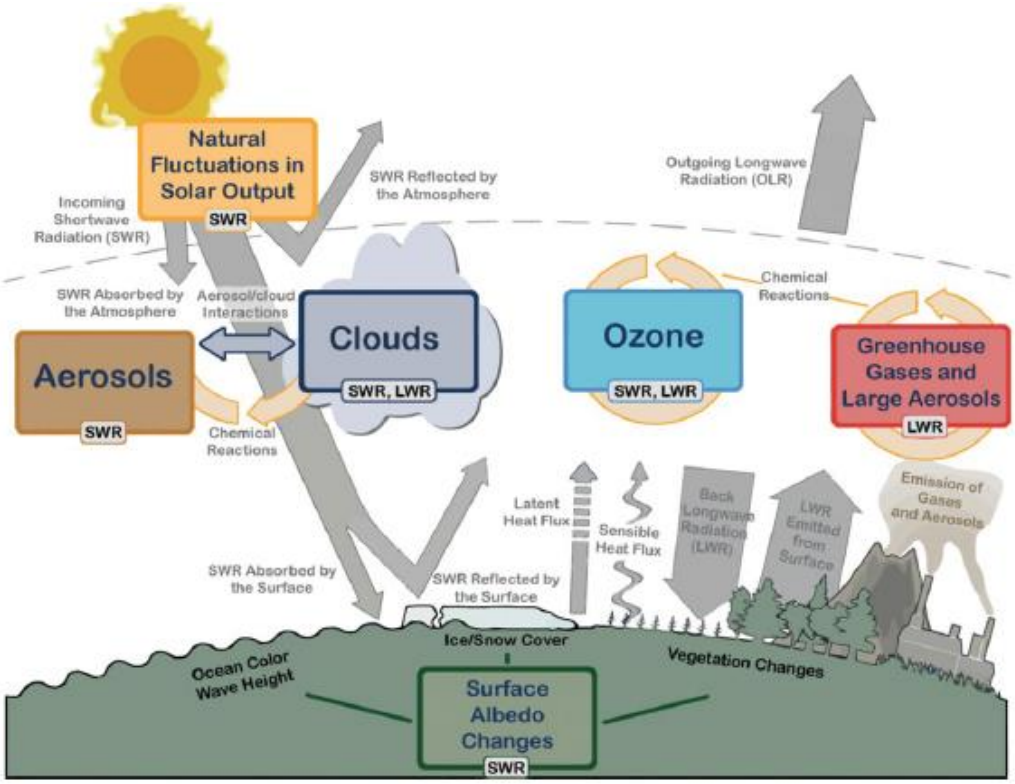



**Figure 4: The main drivers of climate change. Source: IPCC, 2013**

Since 1990's, the levels have risen at 1.3 inches a decade, which has accelerated the process and is expected to have risen by 11-21 inches by 2050. Heat waves are increasing in the process around the globe, giving rise to hotter days in summer. Oceans top layers are getting warmer and more acidic in nature. It directly affects the biological systems of the oceans and is affecting animal and plant life underwater. (IPCC, 2013). With higher levels of GHG in the atmosphere, the projections by 2080-2100 show that climate would rise to 4.7F-8.6F. (IPCC, 2013)

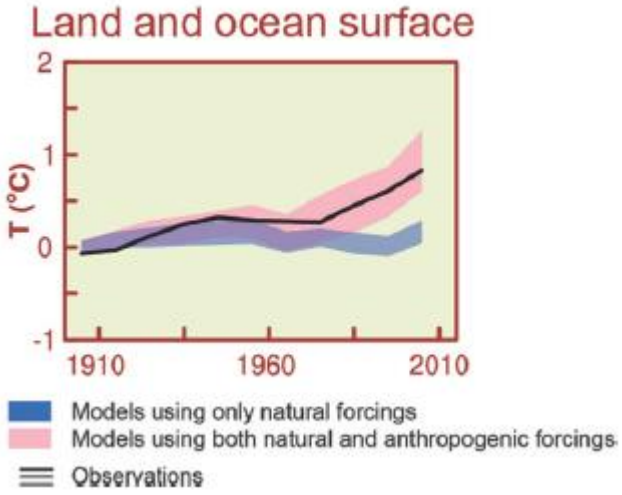



**Figure 5: 20th century observations and global climate model results. Source: IPCC 2013**

The future projections would help us in analyzing the nature of developments and the area concerns. The developments could be planned in a way, which would balance the effect and build towards a resilient environment.

| NPCC 2013 Climate Projections | | | | | | |
|---|---|---|---|---|---|---|
| **Chronic Hazards** | | Baseline (1971-2000) | 2020s | | 2050s | |
| | | | Middle Range (25th - 75th percentile) | High End (90th percentile) | Middle Range (25th - 75th percentile) | High End (90th percentile) |
| **Average Temperature** | | 54 °F | +2.0 to 2.8 °F | +3.2 °F | +4.1 to 5.7 °F | 6.6 °F |
| **Precipitation** | | 50.1 in. | +1 to 8% | +10% | +4 to 11% | +13% |
| **Sea Level Rise[1]** | | 0 | +4 to 8 in. | +11 in. | +11 to 24 in. | +31 in. |
| **Extreme Events** | | Baseline (1971-2000) | 2020s | | 2050s | |
| | | | Middle Range (25th - 75th percentile) | High End (90th percentile) | Middle Range (25th - 75th percentile) | High End (90th percentile) |
| **Heat Waves and Cold Events** | Number of days per year at or above 90°F | 18 | 26 to 31 | 33 | 39 to 52 | 57 |
| | Number of heat waves per year | 2 | 3 to 4 | 4 | 5 to 7 | 7 |
| | Average duration (days) | 4 | 5 | 5 | 5 to 6 | 6 |
| | Number of days per year at or below 32°F | 72 | 52 to 58 | 60 | 42 to 48 | 52 |
| **Intense Precipitation** | Days per year with rainfall exceeding 2 inches | 3 | 3 to 4 | 5 | 4 | 5 |
| **Coastal Floods at the Battery[1]** | Future annual frequency of today's 100-year flood | 1.0% | 1.2% to 1.5% | 1.7% | 1.7% to 3.2% | 5.0% |
| | Flood heights from a 100-year flood (feet above NAVD88) | 15.0 | 15.3 to 15.7 | 15.8 | 15.9 to 17.0 | 17.6 |

**Figure 6: NPCC Climate Projections, Source: Climate Risk Information, NPCC 2013**

### 3.2. Rise in temperature

The increase in global temperatures is around 4°F to 6°F by 2050 and would go up to 8.6°F till 2100. With the increase in greenhouse gas emissions, the temperatures could rise in four different pathways as projected by the figure

created through Representative Concentration Pathways Database (Version 2.0.5) (Agency, 2016)

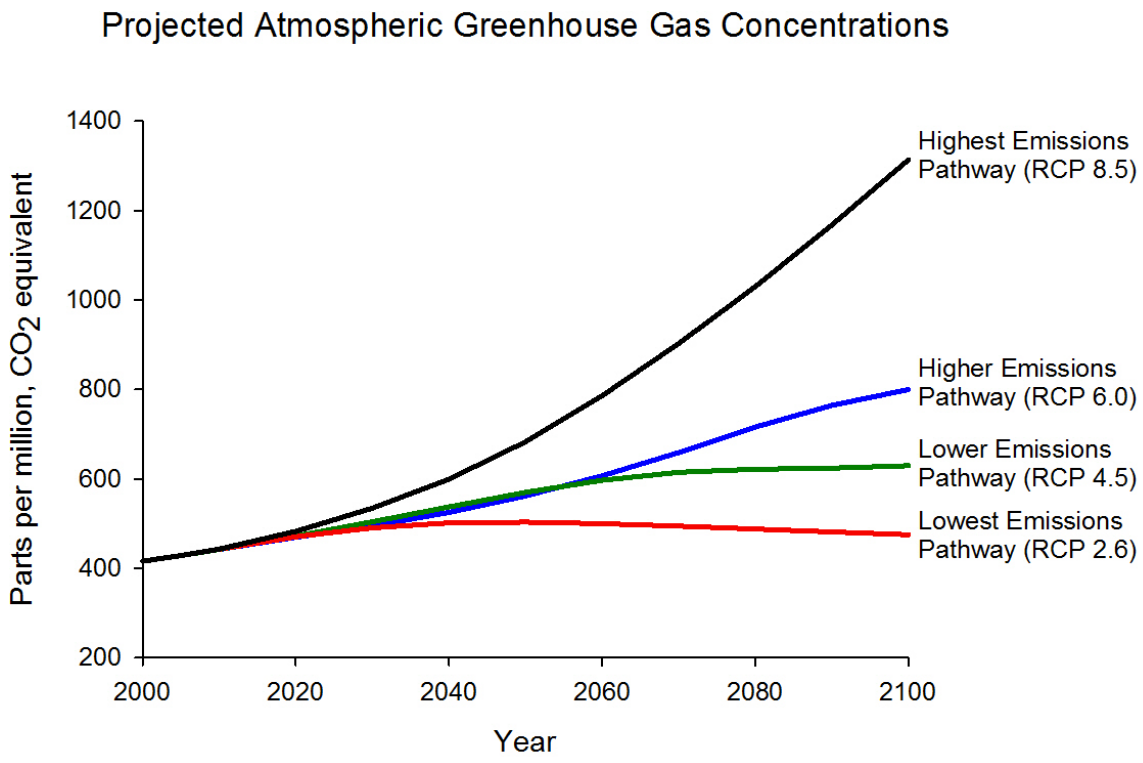



**Figure 7: Projected greenhouse concentrations for four different emissions pathways**

Analyzing the graph:

- The top curve assumes that the GHG emissions will continue to rise throughout century. The carbon dioxide content in air would be very high.
- The bottom curve assumes that the peak is achieved in this current decade and would thereafter decline.

The RCP 2.6 is the supposed to having least impact considering the burning of fossil fuels and change in land use is halted or slowed down drastically.

The RCP 4.5 is medium emissions pathway while RCP 6.0 is medium high emission pathway.

The RCP 8.5 would have catastrophic effects at the current rate as projected.

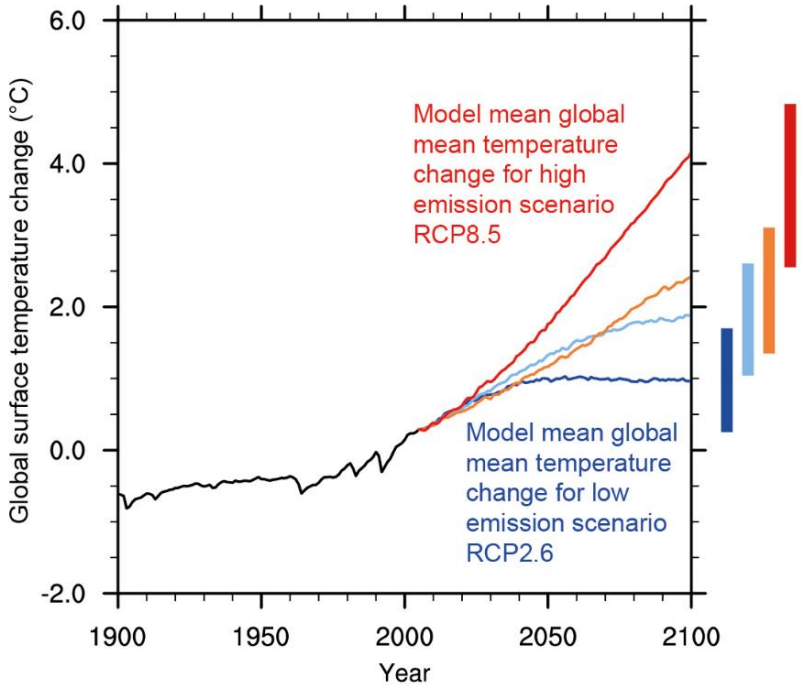



**Figure 8: Observed and projected changes in global average temperature under four emissions pathways. Source: IPCC, 2013**

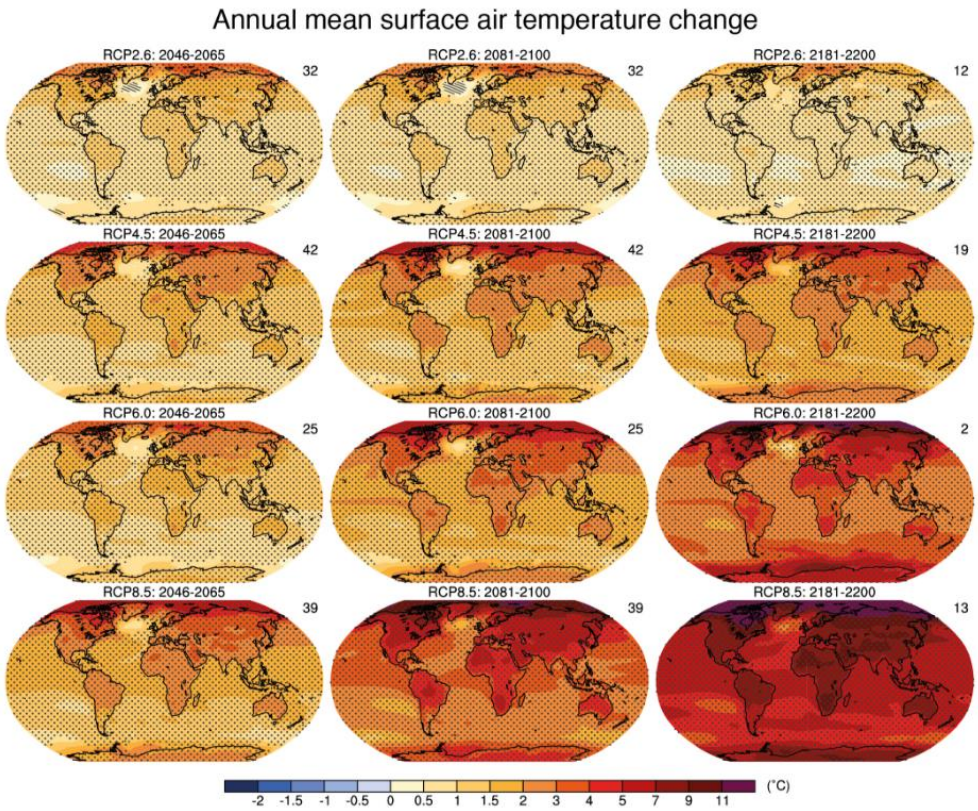



**Figure 9: Projected changes in global average temperature under four emissions pathways (rows) from three different time periods (columns). Pathways are derived from IPCC Fifth Assessment Report. Source: IPCC 2013**

Using the Central Park Observatory, climate analysis has been done for over years in New York City. The mean increase over a decade is roughly 0.3°F from 1990-2013. (NPCC, 2015) The trend is like US projections and especially over North East region.

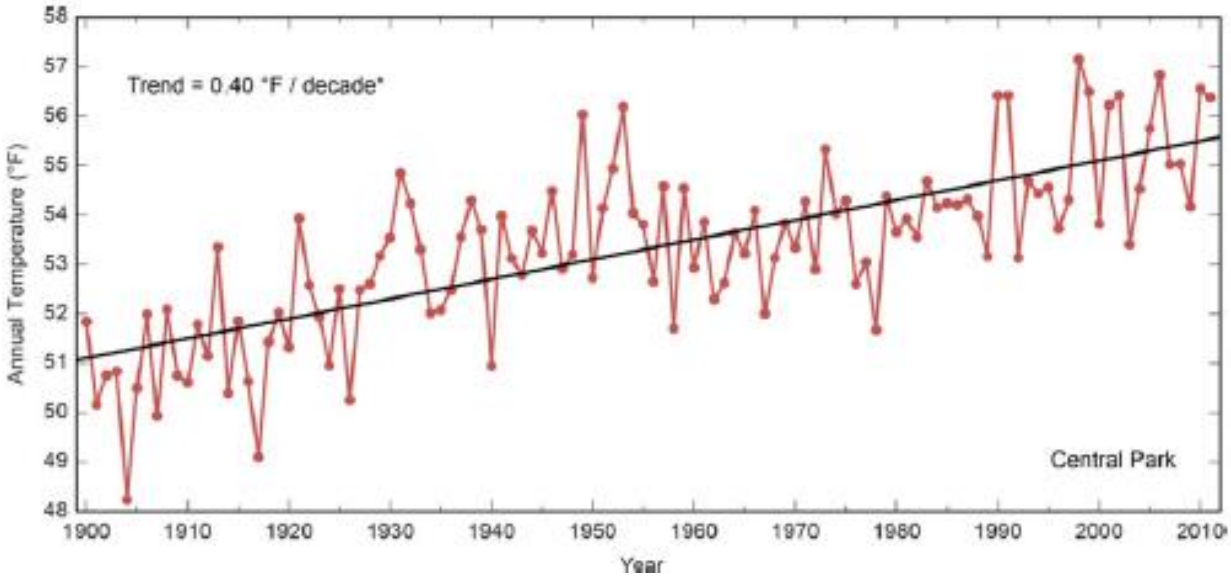



**Figure 10: Observed annual temperature trend in New York City (Central Park) for 1900-2013. Source: USHCN**

A step towards Resiliency:

Heat is the major cause of weather related deaths in the United States in 2012 (NOAA, 2014). New York City is making advancements in announcing and informing people related to heat waves reaching out a much wider audience than ever. The city is providing information about cooling centers and other precautionary measures which could be adopted in case of heat waves. The system is designed to trigger alarms when temperatures reach a heat index of 100°F HI or two days reaching 95°F HI.

Heat island Effect- New York City is highly vulnerable to the impacts of heat due to the heat island effect. The heat gets trapped at night due to more absorbent

surfaces and temperatures can be as high as 8°F. It enhances the risk to health of the citizens of the metropolitan.

As the recent report suggests, 447 emergency heat related visits, 152 hospital admits and 13 deaths occurring annually in New York City. (USCDC, 2013) With the old brick buildings in the city, the heat gets trapped easily without ample insulation from inside or reflective surfaces from outside to result in health diseases and disorders. The heat factors are also causing an effect on the new born children and their birth cycles are affected as well. Morbidity and mortality are caused due to blackouts during heat waves as well. (NPCC, 2015)

In August 2003, North East was under a blackout which caused 90 excess deaths due to failure in respiratory hospitalizations. With existing infrastructure and electric supply under extreme pressure, the heat waves can be a primary reason for future blackouts causing more deaths.

Vulnerability mapping in New York City suggests, that these deaths are more prominent in the areas of higher daytime summer surface temperature than those with excess open green spaces. Such measures could be adopted to re-design the strategies and urban planning for the city. The lack of air- conditioning with poor groups of people cause more deaths at home. The public needs to be addressed regarding such causes and provision of air conditioning substitutes should be provided.

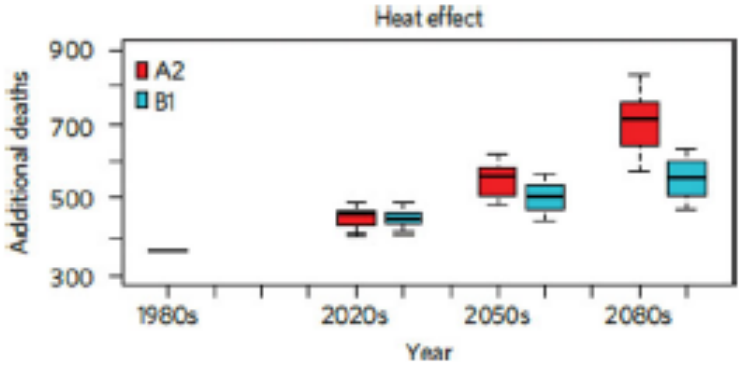



**Figure 11: Distribution of heat related deaths- observed and projected with the two GHG emission scenario. Source: Li et al (2013)**

We need to analyze these situations and work towards a more resilient design approach. The city planning along with other responsible authorities need to design an approach to ensure safety for people in the most vulnerable areas.

Awareness and Information:

A resilient city would develop with good communication network reaching out to broader audiences. The communication system should be able to withstand extreme situations and reach people at the earliest.

Availability of air conditioners:

The availability and affordability of air conditioners needs to be stable. The people in most cases of death did not had access to air conditioning services as it was expensive. Substitutes for such cooling demands needs to be looked upon at the earliest. Higher energy demands are not advisable for the city, but the old buildings are very vulnerable in case of no air-conditioners. The old, sick and

poor people need them the most in case of a heat wave which is expected to go up by 2050. Larger scale equipment's can be supported by communities and neighborhoods in case of emergencies or heat waves in summer.

Open and greener spaces:

Neighborhoods needs to be planned with more open and greener spaces to reduce the overall ambient temperatures. Plantations along the streets and natural house gardens would allow to reflect the heat off ground. This would reduce the temperatures near the surface of the earth.

Rooftop cooling:

In an urban setting, the rooftop surfaces act as primary source to absorb heat directly. Strategies to adopt green roofs would reduce the absorption of direct heat. Using light color surfaces is advisable to reflect most of the heat. Solar panels angled at desirable angles could absorb heat and convert it to energy. Such systems are prevailing in some developments but need to reach out to more projects for an overall impact in the city.

Material selection: Choosing highly sustainable materials like timber is advisable. New York City has upcoming proposals for mixed-use timber buildings, which successfully portrays the strength and durability of timber structures. Analysis of façade is another vital aspect. The material whose preparation would not cause

damage to the environment like dimensioned lumber, fly-ash concrete, earth materials etc. are recommended.

Insulation: Creating a compact zone with negligible amount of energy transfer-heat and cold, would save heating and cooling loads for a building. The maximum energy is consumed by building construction and operations which could be brought down with careful analysis of materials, insulations like spray foam and façade design. This would allow the building to remain at a comfortable temperature and thereby help the environment.

### 3.3. Rise in annual precipitation

Annual precipitation level in New York City is rising each decade. Currently, the annual precipitation ranges around 43-50 inches. It is measured to be increasing at 0.8 inch per decade since 1900 to 2013 in Central Park. (NPCC, 2015)

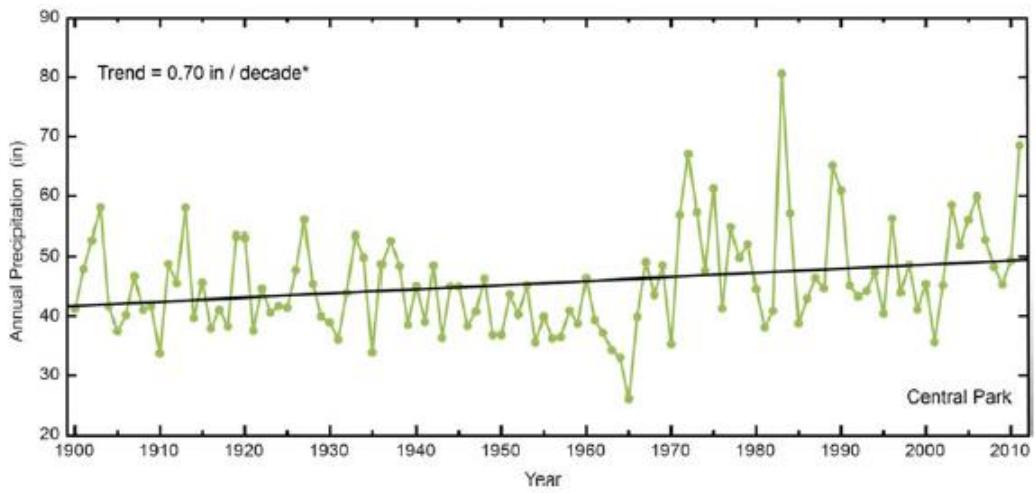



**Figure 12: Observed annual precipitation in NY from 1900 to 3013. Source: NOAA United States Historical Climatology Network (USHCN)**

- The precipitation level is expected to increase, although the changes in level might vary based on the regions.
- They are projected be higher in tropical and high- latitude regions.
- The magnitude and intensity of winds associated with the storm is likely to increase as well. This would be a major threat in case of extreme events.

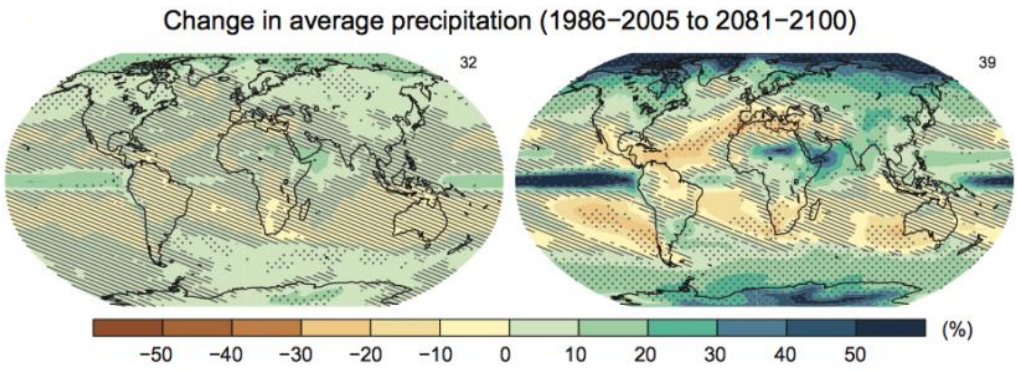



**Figure 13: Changes in annual mean precipitation (projection in two scenarios), Source: IPCC, 2013**

New York City and North East are expected to become wetter in winter and spring season. This would have effects on the season cycle and disturb the ecological system as well. Frequent events with snow followed by heavy rains are predicted in coming years, which would be uncomfortable for daily activities apart from harming the cycle.

The heavy downpours are expected to rise in areas which might have decreased precipitation levels. The heavy downpour events which happens once in twenty years might increase to up to five times by 2100.  (Environmental Protection)

The increase in proportions of precipitation in form of rains would increase. The proportion in form of ice would decrease in New York City.

The intensity and frequency of Atlantic storms is expected to increase as ocean warms. There is an increase in the strongest hurricanes (Category 4 and 5) along with heavy downpours.

With the movement in the storm paths, which are moving northwards, the effect would be worse in North East. The storms are predicted to be stronger and frequent in winters.

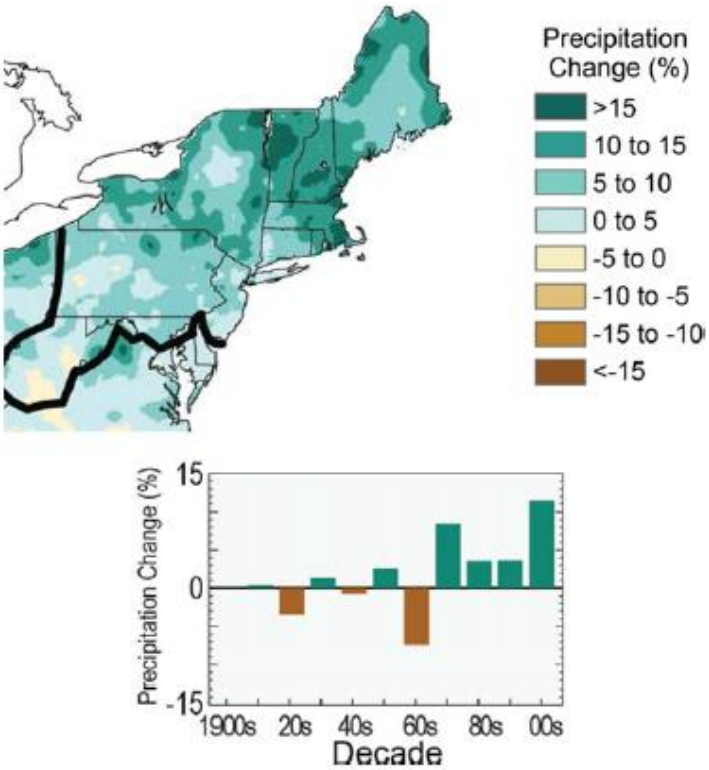



**Figure 14: Observed precipitation in NE, showing % change for 1991-2012 compared to 1901-1960. Source: Melillo et al.,2014; Horton et al., 2014**

### 3.4. Rise in Sea Level

New York City is surrounded by water bodies on three sides. The densely planned city is home to a large population from diverse backgrounds. The low-lying areas in New York are at constant threat with frequent flooding and over the past few decades. They have been severely damaged with season tropical storms like Hurricane Sandy and cold season nor'easters.

In the past decade, sea levels have risen by approximately 12 inches in New York City, and thus in case of storms like Hurricane Sandy, the exposed threat increase to over 25 square miles. This led to flooding homes of 80,000 people in New York City and New Jersey (Climate Central 2013) (NPCC, 2015)

In general, over the past few decades the sea level has risen by 0.5 to 0.7 inches per decade, but facts vary per location. There have been variations in sea level rise in the past century where the maximum has been 1.3 inches (approximately). The multiple reasons contribute to the sea level rise like change in ocean mass distribution and density, change in mass of glaciers, ice caps, ice sheets, water storage on land, vertical land movements, and gravitational, elastic and rotational effects resulting from ice mass loss. (NPCC, 2015)

In New York City, approximately 40% increase in sea level is due to land subsidence and 60% is due to global climate change. Thus, it has worse effects

on the sea level in the area with frequent tropical storms and high tides. In case of Hurricane Sandy, the peak surge coincided with high tide and the results were catastrophic resulting in over 300 deaths. There has been significant increase in level of sea rise due to tide gauges along Atlantic coast between Cape Cod to Cape Hatteras. (Corlett, 2012)

Coastal storms-

New York City experiences two kinds of storms in particular-

- Tropical cyclones (hurricanes and tropical storms): They are seasonal storms which strike New York City between July and October. They can be produce high magnitude of storms along with wind damages.

- Nor'easters: They usually occur between months of November and April. They are not that strong as tropical cyclones but have significant impact when at their peak. They have more frequency as compared to tropical cyclones and may struck more than once a year. They are longer duration, less magnitude storms, but prolonged duration may cause more damage with high water waves and winds. They can cause significant flooding and beach erosion as in case of Hondula and Dolan in 2010. (NPCC, 2015)

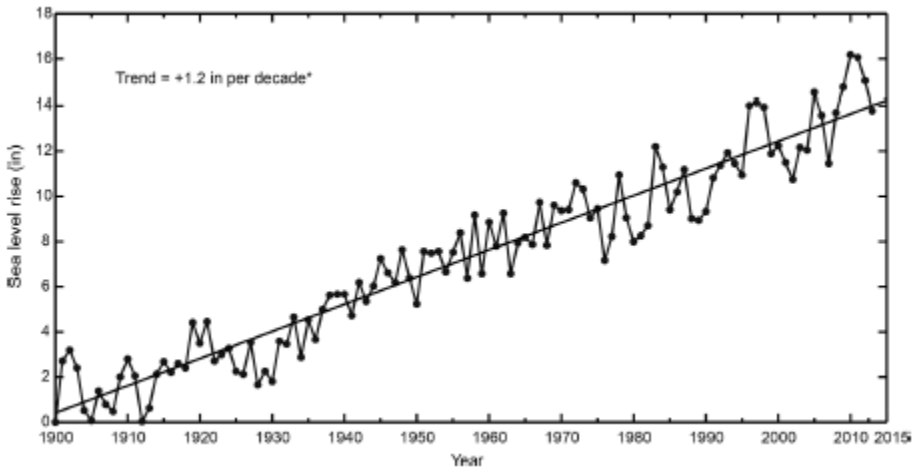



**Figure 15: Observed Sea level rise in New York City from 1900 to 2013. Data are from Permanent Service for Mean Sea Level (PSMSL).**

There has been an increase in the magnitude and strengths of hurricanes (category 4 and 5) in Atlantic Basin since past few decades.

Sea Level Projections:

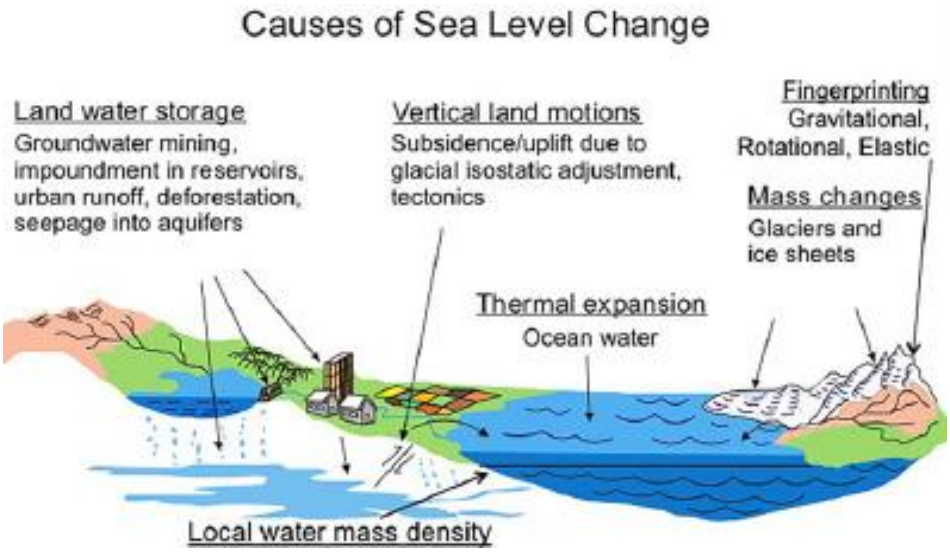



**Figure 16: Causes of Sea Level Rise, Source: NPCC 2015 Report**

## 3.5. Strategies for a resilient city

| | Spatial scale of projection | Direction of change by the 2080s | Likelihood | Sources |
|---|---|---|---|---|
| Heat index | New York metropolitan region | Increase | Very likely | NPCC, 2010; IPCC, 2012; Fischer and Knutti, 2012 |
| Short-duration drought | New York metropolitan region | Increase | More likely than not | Rosenzweig *et al.*, 2011 |
| Multi-year drought | New York metropolitan region | Unknown | — | Dai, 2013 |
| Seasonal snowfall | New York metropolitan region | Decrease | Likely | IPCC, 2007; 2012; Liu *et al.*, 2012 |
| Ice storms/freezing rain | New York metropolitan region | Unknown | — | NPCC, 2010; Rosenzweig *et al.*, 2011 |
| Downpours | New York metropolitan region | Increase | Very likely | IPCC, 2012; Melillo *et al.*, 2014 |
| Lightning | New York metropolitan region | Unknown | — | Melillo *et al.*, 2014; Price and Rind, 1994 |

**Figure 17: Upcoming challenges for New York Metropolitan region**

Additional steps towards a resilient New York City:

Prepared Community:

- Knowing the gaps in the emergency backups for power, transport and medical supplies.
- Establish safe and green city centers for shelter and multi-purpose activities within neighborhoods. It may include recreational, cultural, hot meals and educational discussions for youth and seniors.

- Enhancing the quality of these centers based on seismic, flood-prone, and energy analysis. Such centers should be able to serve the purpose in case of extreme events.
- Evaluating the efficiency for municipal authority plans and their feasibility in case of an event. It could be tested with mock drills and events involving the residents of the place.
- A stronger connection between neighbors and neighborhood communities. The connection is vital in case of extreme events when the supply of resources is uncertain. It is fairly important to focus on socially isolated seniors and residents with disabilities.
- Access to funding for recovery post disaster. The city has the ability to reclaim funds which are usually governed through strict regulations. Communities need to know their rights. They should have the ability to access funds in proper time, which may be through FEMA, federal funding or private insurances.

Develop a clean energy micro-grid network:

- We need to move beyond conventional energy set-ups like diesel generators which are not energy efficient causing noise and air pollution. Developing solar and wind options would be ideal for prolonged power breakdowns.
- Pooling up energy requirements from a community or neighborhood could bring down energy costs and allocate funds for cleaner energy backups.

Areas of Sonoma have such practices prevailing in time of power crisis and frequent breakdowns.

- Means of electric transportation- electric cars, buses and pods would lower the emission of greenhouse gases in environment. Charging stations should be provided at reasonable distances to allow public to start using electric cars.
- A transition needs to be done from natural gas to electricity for heating and cooling requirements in offices, residences and institutions which are the leading energy consumption sector. This is vital in lowering the greenhouse gas emissions in New York City.
- People need to come forward and express their ideas to allow public debate and discussions in what could be the best solutions in present time and how we could plan to have a better tomorrow.

Adaption to changing climate:

- The water level along the shores of New York City is rising at an alarming rate since past few decades. The increase in level has doubled since past century and is expected to rise in coming years. This has led to frequent small scale flooding in many low-lying areas of Brooklyn, Staten Island and Long Island and Manhattan.
- Sustainable and green infrastructure needs to be widely accepted at city planning approach and needs to be implemented all over the city. It is a measure to mitigate floods and keeping a check at rise in sea-levels.

Absorbing the rainwater, treating and re-using the storm water into various activities like landscaping, rain gardens, rooftop gardens etc. should be encouraged. Permeable surfaces should be used to allow the water to be absorbed by Earth's surface rather than flowing into the low-lying areas of the city.

- The water supply system needs to be more efficient. Strategies for water conservation should be adopted which could be used for draughts or maintaining landscapes around the city.
- Rooftop strategies needs to be addressed concerning the rise in heat effects. The city has heat island effect which could be worse if precautionary steps are not taken immediately. Cooler roofs can be achieved by using light and reflective colors. Adoption of green roofs could serve dual purpose- it can provide community areas and reflect the sunrays to keep the building cool. Heat needs to be reflected using various strategies rather than been trapped which would further increase the temperature.
- Landscaping needs to be a part of design at initial stages. Urban forests and parks needs to be encouraged which would not only reflect heat, but provide important public spaces for a better community living. Examples like Bryant Park, Battery Park, Prospect Park and Central Park are good examples.
- New lessons regarding urban design and development needs to be taken on how to develop a new land looking at climate response. The land use

planning is not an efficient tool which supports capitalism while ignoring environmental impacts.

- Material and site selection should be a supervised carefully specially in case of coastal regions. Low-impact materials should be encouraged whenever possible. Conserving wetlands is vital and developments should be strictly banned on such sites.

Team work and togetherness:

- Equal participation from people and organizations would develop a stronger and sharper community. Awareness, information sharing and means of communication should be highly efficient.
- Survey and feedback methods should be adopted to explore the loopholes in the system.
- Multi-departmental approach would enhance the decision-making skills of the city and the neighborhood. Municipal authorities need to collaborate with different city and state bodies like Water management, Energy consultants, Drainage, Storm water management, Park authorities, Road and Highway authorities and many more to obtain better results.
- Applying strategies which have been proven in different nations like Netherlands.

Regional Resilience:

- Developing regional resilience strategies through open competitions. It should include students and working professionals from fields of design, architecture, landscape architects, urban design, planning, ecology, finance and economics. The feasibility reports should be studied along with its practicality and implementation at various levels.
- Regional Water-summit would allow people to know and share ideas about water as a resource. Conservation and usage of water could be understood at individual unit, neighborhood and city levels.
- Lifelines Councils which can supervise transport, water, energy, communications and public spaces could be created within neighborhoods. Such councils would have ever-lasting impact in growth of a neighborhood.
- Regional Infrastructure investments could be done where old parts of the city need renovations for buildings, drainage, storm water systems and analyze the impacts in case of floods and power crisis.
- Regional Alliance for policy advocacy should be implemented where neighborhood or communities should share knowledge on effective strategies to advance their database and skills. These communities have been living together since ages and develop a bond over time which could be fruitful in case of emergencies and public participation for betterment of a city. Such policies in low lying areas of New York City would be helpful in case of floods.

CHAPTER 4

SITE AND CONTEXT

## 4.1 New York City

New York City is one of the most densely populated coastal cities in the world experiencing climate change and its effects. The Manhattan shoreline has been on a continuous expansion since the 1600s. The expanded land currently acquires land masses which are low lying and more prone to flooding and water collection. Such an approach has been adopted by various coastal cities in the world who are now in crisis in case of extreme events like floods and hurricanes.

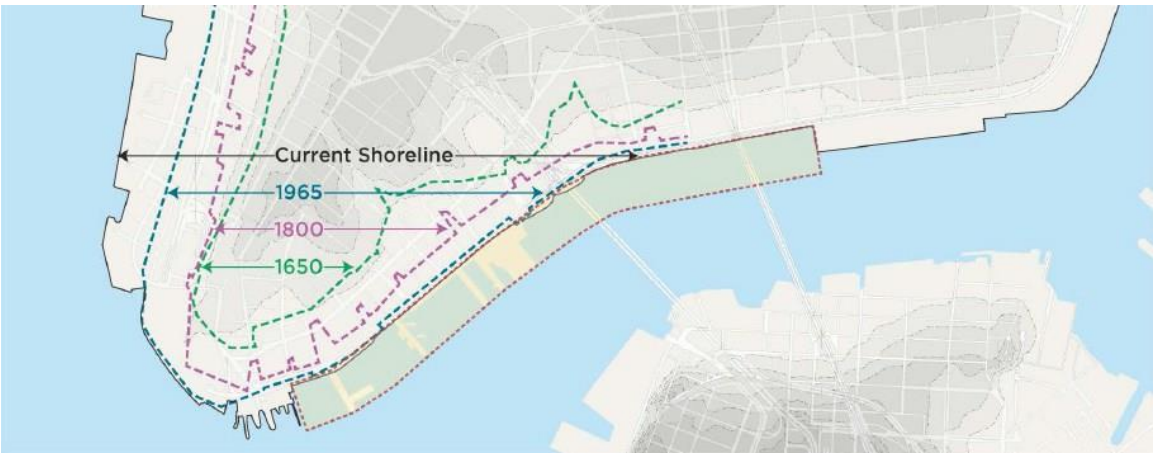



**Figure 18: Manhattan Shoreline, Source: Seaport City Study**

It was critical to study the landforms in the city and identify a complex and challenging site, both prone to sea level rise and connected to a vibrant

neighborhood. Meatpacking district offers a unique neighborhood which holds a vital place in historical persona and contemporary architecture.

The studying of the natural historic features included:

- Tidal Wetlands
- Tidal flats
- Barrier beaches
- Freshwater wetlands

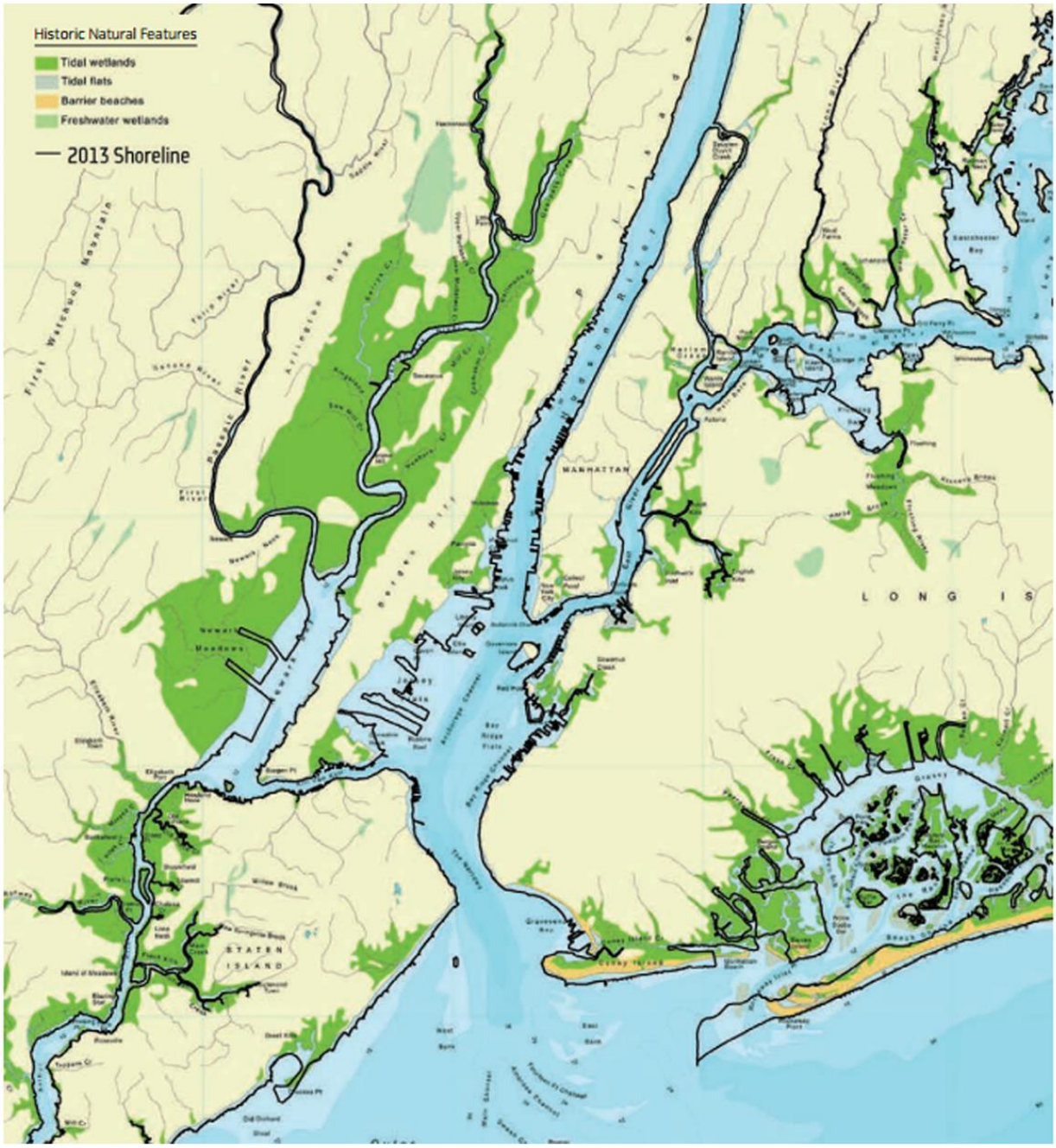



**Figure 19: Shoreline over the years, Source: DCP Pluto, CUNY Institute for Sustainable Cities**

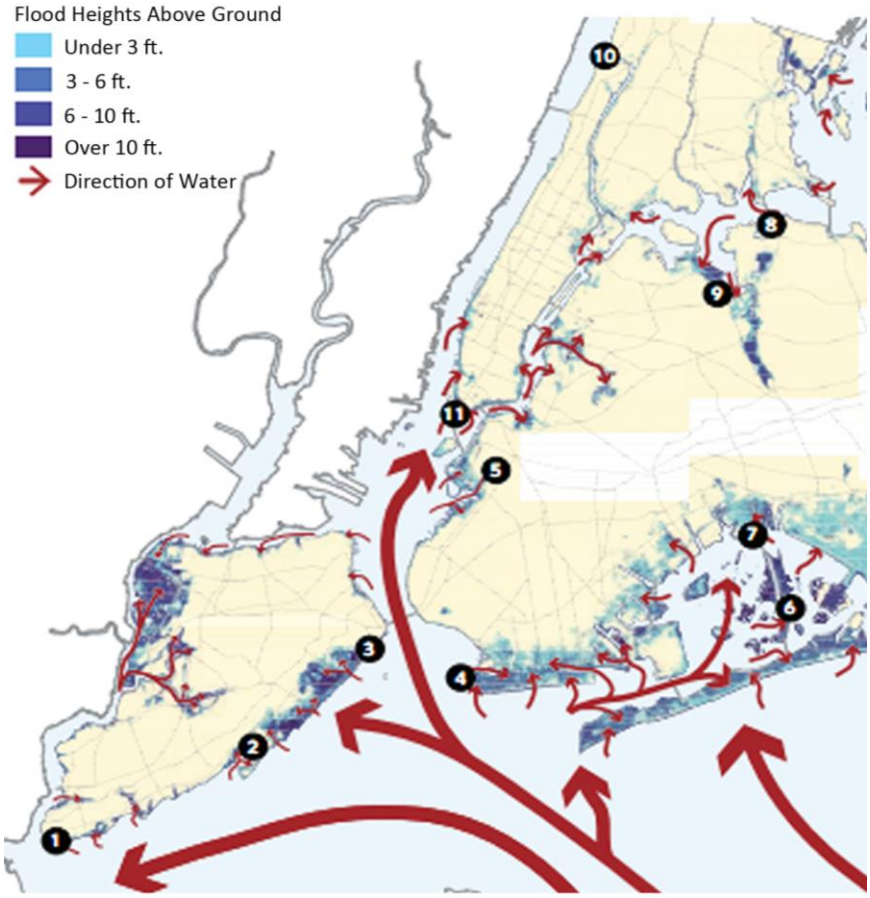
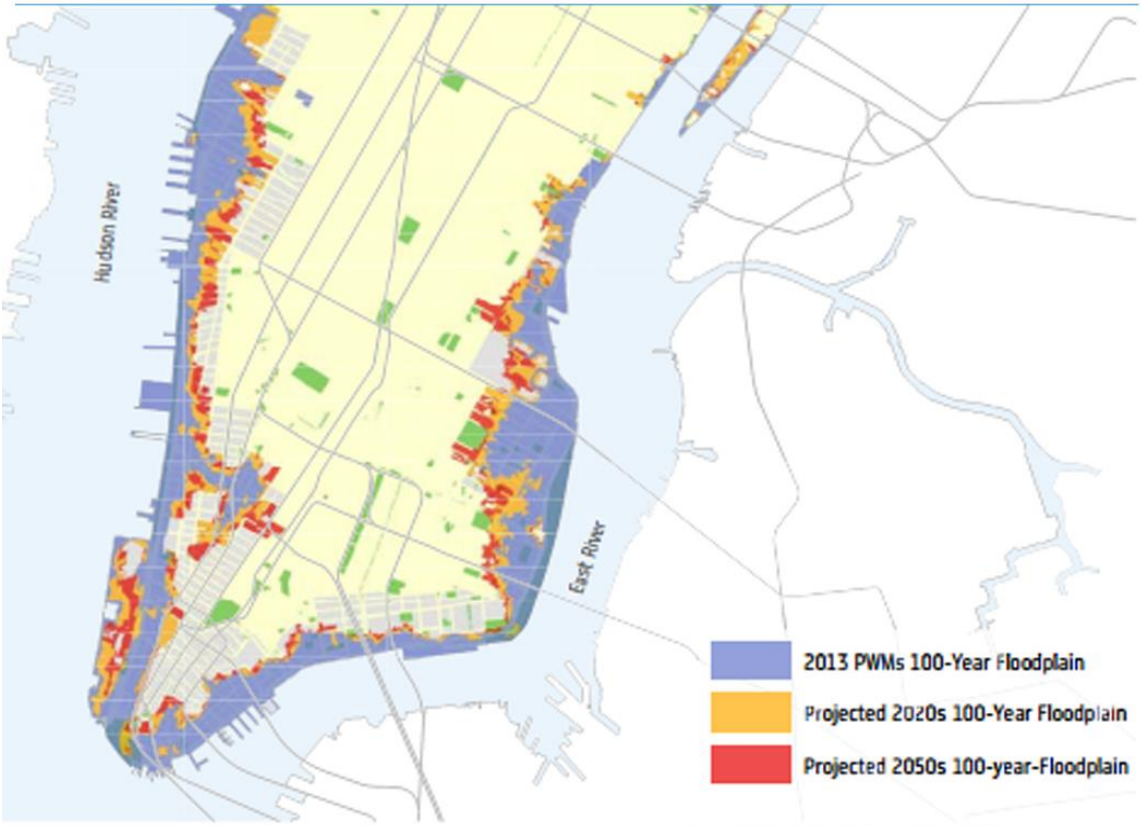



**Figure 20: Peak Storm Surge Elevations during Sandy, Source: FEMA MOTF 11/6 Hindcast surge extent**

| Location | Time Oct. 29, 2012 | Water Level in Feet (NAVD88) |
|---|---|---|
| 1. Tottenville, Staten Island | 8:38 p.m. | +16.0 |
| 2. Great Kills Harbor, Staten Island | 8:52 p.m. | +13.2 |
| 3. South Beach, Staten Island | 8:23 p.m. | +15.0 |
| 4. Sea Gate, Brooklyn | 8:23 p.m. | +13.3 |
| 5. Gowanus Canal, Brooklyn | 9:04 p.m. | +11.1 |
| 6. Broad Channel, Queens | 9:18 p.m. | +10.4 |
| 7. Howard Beach, Queens | 9:23 p.m. | +11.2 |
| 8. Whitestone, Queens | 10:06 p.m. | +10.6 |
| 9. World's Fair Marina, Queens | 10:06 p.m. | +10.4 |
| 10. Inwood, Manhattan | 10:06 p.m. | +9.5 |
| 11. The Battery, Manhattan | 9:24 p.m. | +11.3* |

**Figure 21: TimeLine projections, equivalent to 14ft above Mean Lower Low Water (MLLW), Source: USGS, NOAA**

A study of Hurricane Sandy's inundation was essential to see how the water flowed in the city. The identification of low lying and vulnerable areas acknowledge the site design process. The color coding in the picture above shows the accumulation of water in the land post Hurricane Sandy in 2012.




Source: FEMA, CUNY Institute for Sustainable Cities

| Buildings in the Floodplain | | | | |
|---|---|---|---|---|
| Buildings & Units | 100-Year Floodplain | | | |
| | 1983 FIRMs | 2013 PWMs | Projected 2020s | Projected 2050s |
| Residential Buildings | 450 | 940 | 1,400 | 1,650 |
| Residential Units | 32,000 | 42,000 | 60,800 | 68,000 |
| Commercial and Other Buildings | 480 | 670 | 910 | 1,080 |

**Figure 22: Buildings in the Flood Plain, Source: FEMA, CUNY Institute for Sustainable Cities**

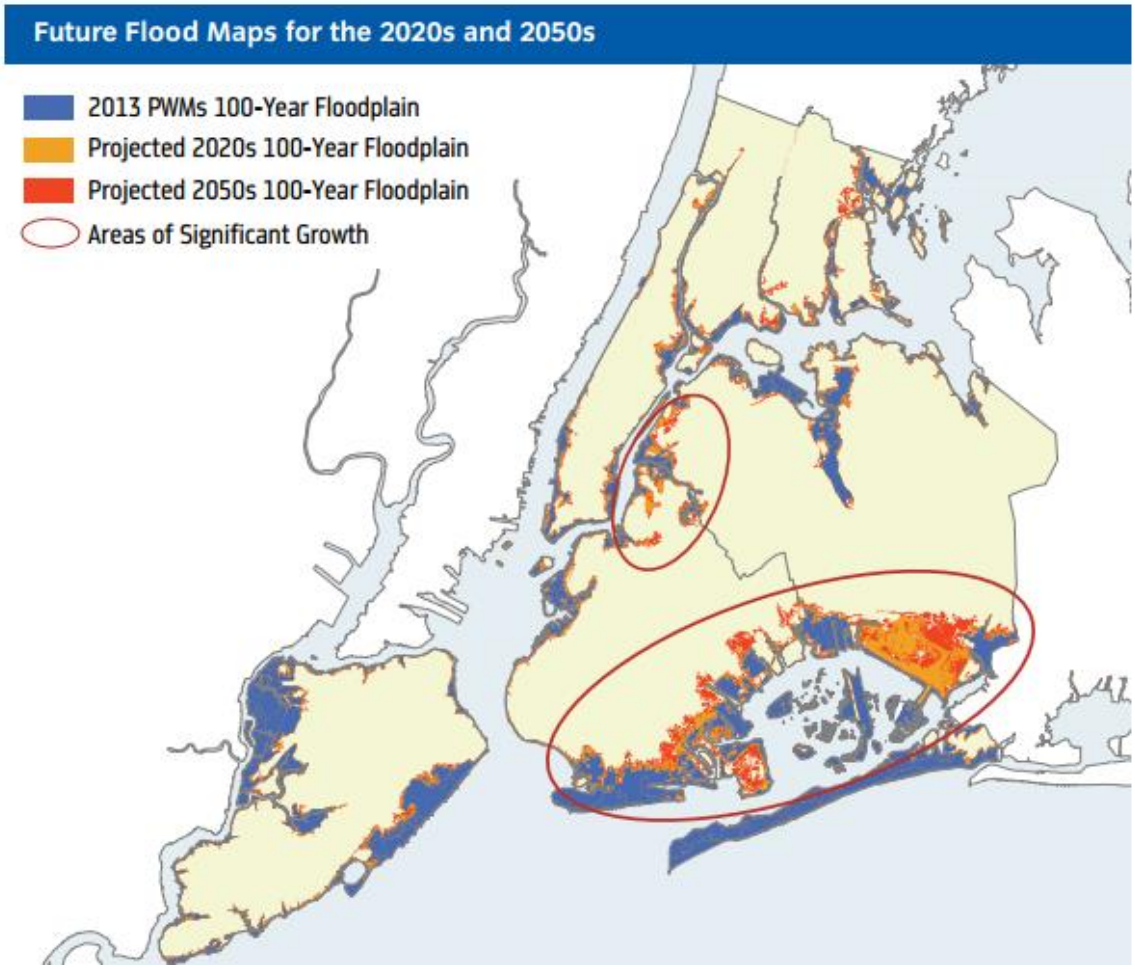



**Figure 23: Future Flood Maps for the 2020's and 2050's, Source: FEMA, CUNY Institute for Sustainable Cities**

| Potential Sea Level Rise Impacts | | | |
|---|---|---|---|
| **Borough** | **Waterfront** (miles) | **At Risk of Tidal Flooding** (miles) | (%) |
| Bronx | 86.7 | 6.2 | 7% |
| Brooklyn | 113.3 | 11.5 | 10% |
| Manhattan | 44.8 | 1.3 | 3% |
| Queens | 155.1 | 21.4 | 14% |
| Staten Island | 120.1 | 2.6 | 2% |
| **Total** | **520** | **43** | **8%** |

**Figure 24: Potential Sea level Rise Impacts, Source: DCP**

**Figure 25: Coastal Geomorphology, Source: DCP**

The map showing the coastal geomorphology helped in analyzing and understanding the coastal features. The analysis helped in Urban Waterfront Adaptive Strategies (UWAS) study.


**Figure 26: Coastal landforms, Source: DCP**

The landfills are most vulnerable to flooding as they have been part of the water body which have been transformed to land mass with soil accumulation. Next

vulnerable areas are the low-lying areas in Glacial Outwash Plains shown in the figure above. The glacial till plains are at a higher level and little prone to 100-year flooding. Bedrocks hills and ridges are at maximum elevation in the city and could be considered as safer areas. These regions are mostly present in Bronx and northern side of NYC.

## COASTAL GEOMORPHOLOGY CATEGORIES

Based on the mapping of geologic landforms, shoreline condition, and wave exposure, nine geomorphology types emerged as representative of the range of factors present in New York City. Each type is a composite of these three factors. These types can be analyzed for their degree of exposure to sudden and gradual coastal hazards.

- **Oceanfront Beaches**
  Glacial outwash plains, High fetch,
  Low elevation / gradual slopes,
  Unreinforced shorelines, Fine sediment
- **Hardened Oceanfront Plains**
  Glacial outwash plains, High fetch,
  Low elevation / gradual slopes,
  Reinforced shorelines, Fine sediment
- **Coastal Marshes**
  Glacial outwash plains, Low fetch,
  Low elevation / gradual slopes,
  Unreinforced shorelines, Fine sediment
- **Hardened Sheltered Bay Plains**
  Glacial outwash plains, Low fetch,
  Low elevation / gradual slopes,
  Reinforced shorelines, Fine sediment
- **Oceanfront Slopes**
  Glacial till plains & hills, High fetch,
  Medium elevation / medium slopes,
  Unreinforced shorelines, Mix of sediment types
- **Sheltered Bay Slopes**
  Glacial till plains & hills, Low fetch,
  Medium elevation,
  Unreinforced shorelines, Mix of sediment types
- **Hardened Sheltered Bay Slopes**
  Glacial till plains & hills, High fetch,
  Medium elevation / medium slopes,
  Reinforced shorelines, Mix of sediment types
- **Sheltered Bluffs**
  Sheltered bedrock controlled hills & ridges, Low fetch,
  High elevation / steep slopes,
  Unreinforced shorelines, Coarse sediment
- **Hardened Sheltered Bluffs**
  Sheltered bedrock controlled hills & ridges, Low fetch,
  High elevation / steep slopes
  Reinforced shorelines, Coarse sediment

## GEOMORPHOLOGY CATEGORIES

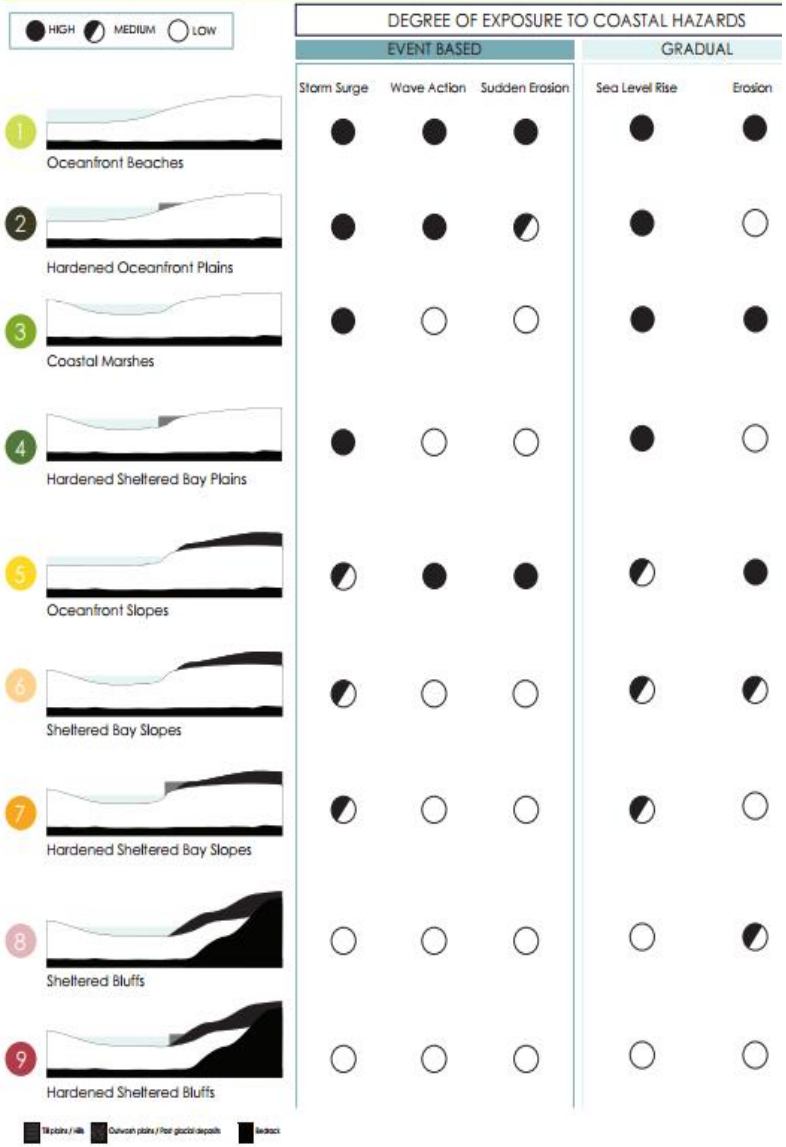


**Figure 27: Categories of Coastal Geomorphology, Source: NYC Urban Waterfron**

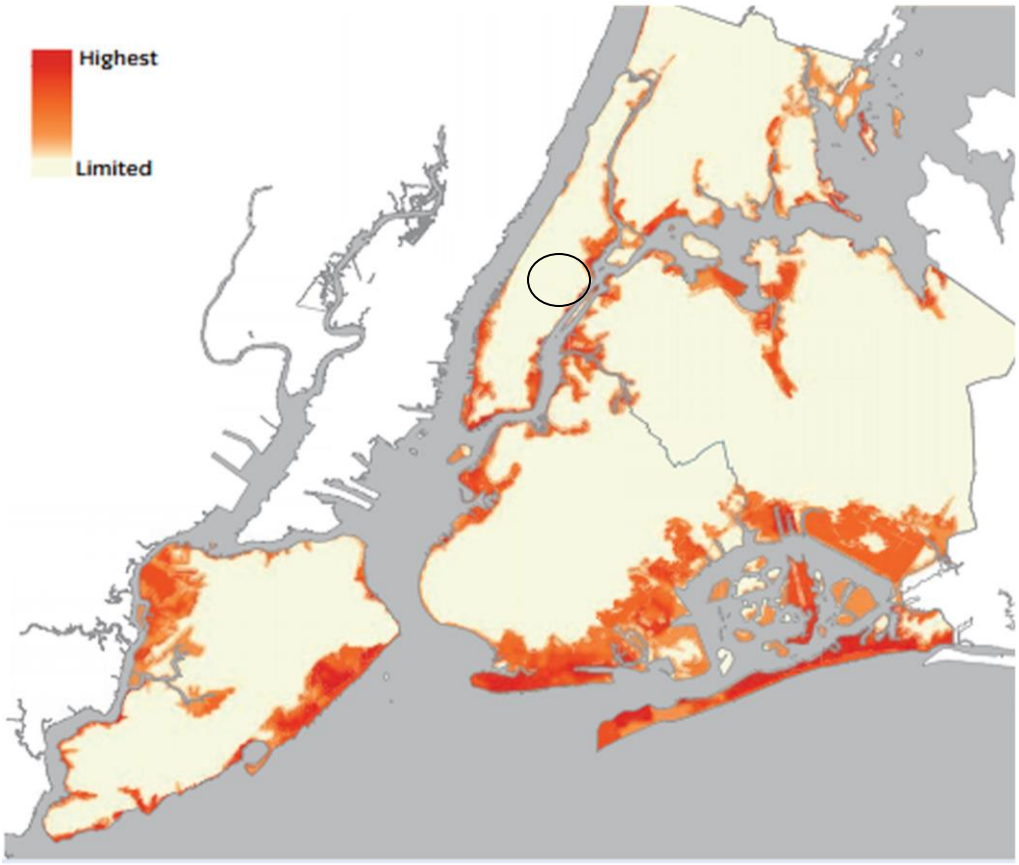



**Figure 28: Coastal Risk Map**

The coastal risk map shows the vulnerable areas. The site of Gansevoort Peninsula falls under Zone AE 13, which symbolizes the maximum wave height as 13ft in case of extreme events.

Most of the risk zones are in Coney Islands, southern parts of Brooklyn and Queens. Governor's island would have a major impact of any flooding along with southern 'U' of Manhattan.

## 4.2 Gansevoort Peninsula and Meat Packing District

### 4.2.1 The Past

One of Manhattan's popular weekend destinations, the Hudson River Greenway bustles with locals and tourists alike, jogging, cycling, or simply enjoying the attractive neighborhoods along the waterfront. But among all the repurposed warehouses and piers, hardly anyone notices one small, fenced-off area untouched by the surrounding development.

Jutting out into the Hudson River west of Eleventh Avenue and between Gansevoort Street and Little West 12th Street, this tiny peninsula is home to some dilapidated buildings as well as a parking lot and depot used by the New York Department of Sanitation. But this apparently out-of-place little nub is all that remains of Manhattan’s lost Thirteenth Avenue.

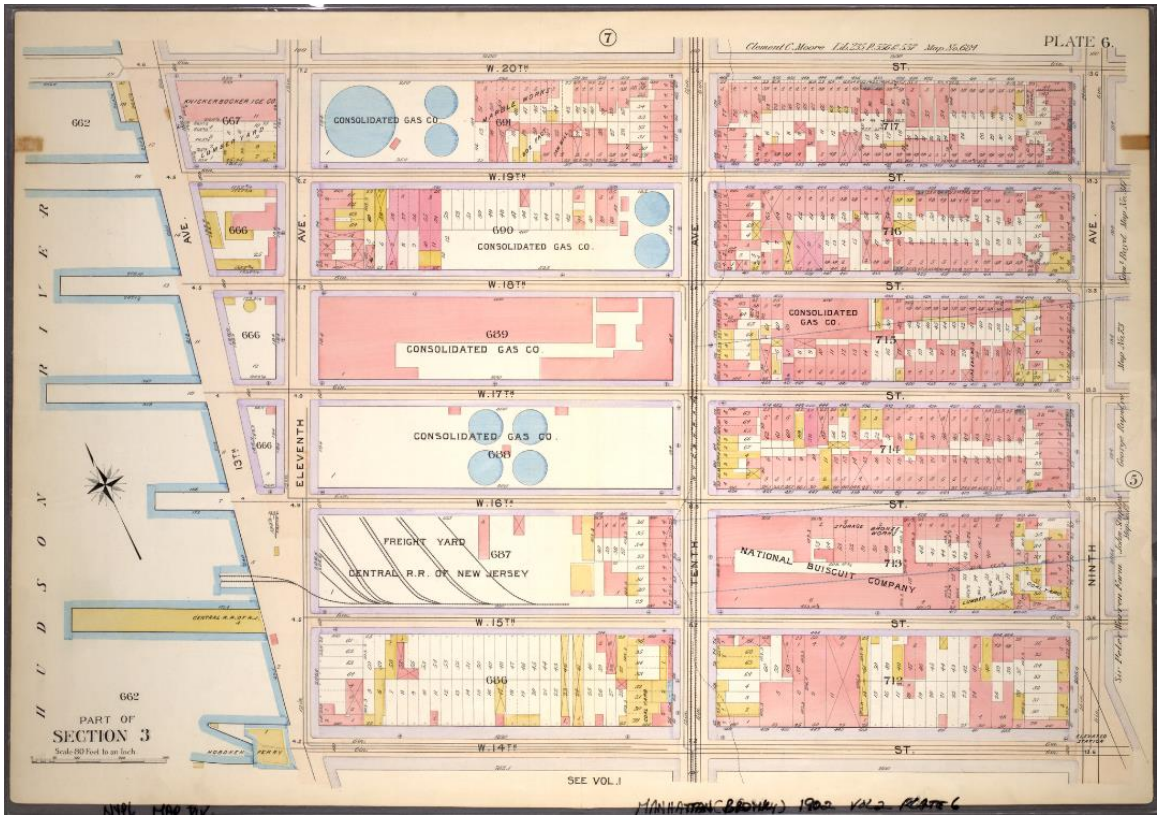



**Figure 29: 1902 Map- 13th Avenue NYC**

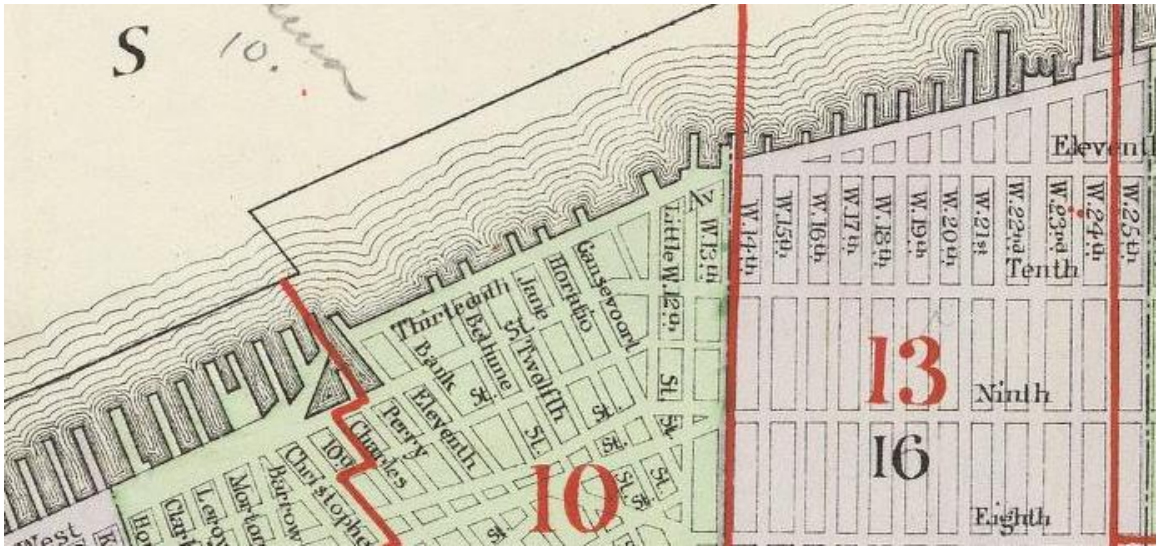



**Figure 30: Plans for 13th Avenue NYC**

The grid street plan created for Manhattan in 1811 called for 12 grand north-south avenues (Lexington Avenue and Madison Avenue were later shoehorned into the layout). In 1837, however, with the city eager to expand and create more commercial shoreline, plans were made to create a 13th avenue by landfilling hundreds of feet of the Hudson River from 11th Street to 135th Street. The city sold underwater plots of 'land' to interested parties who began hauling in trash and dirt and paving the results, allowing Thirteenth Avenue to slowly rise from the waters.

"There are no sidewalks to speak of on Thirteenth-avenue and no surface indications of pavements," one 1886 article reported. "A foot path winds through it, showing the course pedestrians take to dodge the deeper mud holes in wet weather."

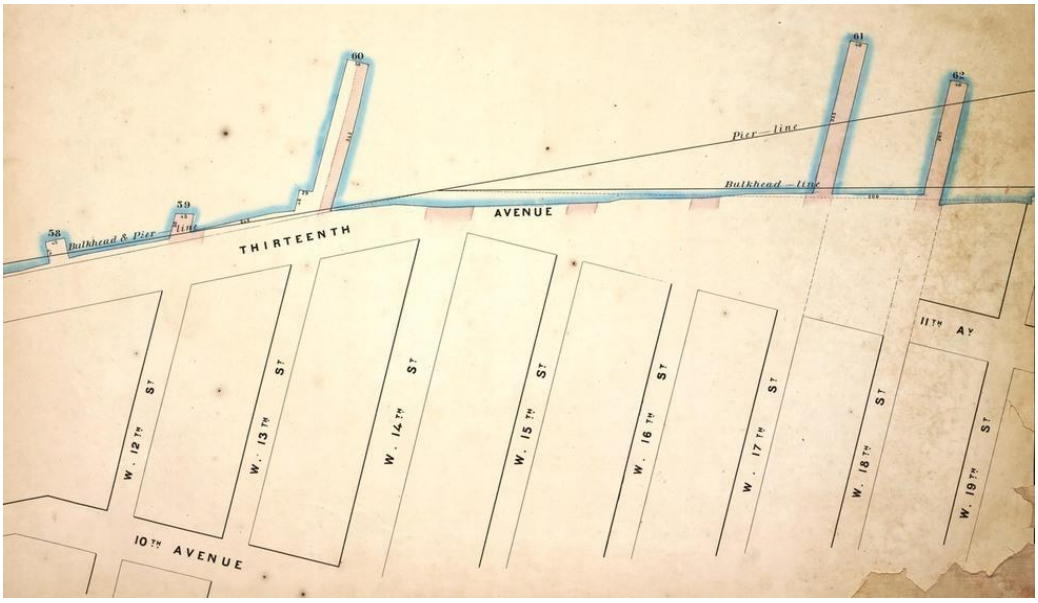



**Figure 31: Change in Shoreline with 13th Avenue proposal**

### 4.2.2 The Present

Pier 52 houses the NYC Sanitation Department, which has been the major building on the peninsula. The bike and pedestrian paths are connected through the greenway along the Hudson waterfront, though there is no public access to Gansevoort Peninsula.

**Figure 32: NYC Department of Sanitation, Gansevoort Peninsula**

Pier 53 houses the NYC Fire Department's Marine Company One, which is still functional as a fireboat house and pier. There is no public access to this pier.

**Figure 33: View of Pier 53**

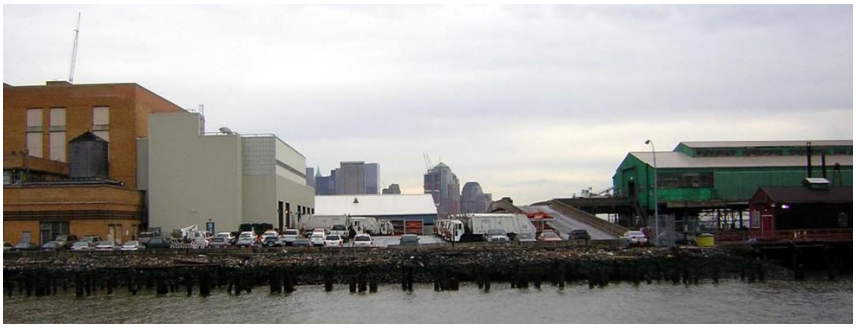


**Figure 34: View of Gansevoort Peninsula from Hudson river**

“The New York City Department of Sanitation, as lead agency, has determined that the proposed City of New York Department of Sanitation (DSNY) Gansevoort Complex Demolition will not have a significant adverse environmental impact. The action involves the demolition and removal of vacant, decommissioned DSNY structures (incinerator and marine transfer station, garages, salt shed, underground fuel tanks), hazardous materials abatement, site remediation via soil excavation and replacement with clean fill, and repair and in-kind replacement of shoreline stabilization structures. The purpose is to comply with the Hudson River Park Act mandate and related consent order to remove

DSNY structures from the 7-acre site within the designated Park boundaries, conduct soil remediation, and to undertake necessary repairs to stabilize the shoreline and replace the existing bulkhead and relieving platforms at the peninsulas' west bulkhead. Relevant permit coverage for the DSNY funded in-water activities was obtained by the Hudson River Park Trust from the New York State Department of Environmental Conservation (NYS DEC) and United States Army Corps of Engineers (US ACE).” (Department of Environmental Conservation, 2014)

“The marine transfer station pilings would be left in place, minimizing any disruption to marine habitat. Storm water discharge under the Proposed Action is authorized under the State Pollutant Discharge Elimination System (SPDES) General Permit for Storm water discharges from Construction Activity Permit No. GP-0-10-001 (Identification Number NYR 10X630). Site remediation will be done in accordance with a remedial action plan with a site-specific construction health and safety plan (CHASP), with oversight of the New York City Department of Environmental Protection. (NYC DEP) Phase I and Phase II studies were done. All relevant environmental impact categories were considered, including land use, zoning and public policy, community facilities and services, open space, historic and cultural resources, urban design/visual resources, natural resources, noise, public health, transportation, air quality, neighborhood character, and construction. Therefore, the Proposed Action would not result in a significant adverse impact on the environment, and an environmental impact statement will

not be prepared. At the southern end, the Gansevoort Peninsula is a 5.65-acre promontory at the intersection of Bloomfield Street and the last remnant of 13th Avenue. The pier is built on a solid ground as opposed to a regular pier construction."  (Department of Environmental Conservation, 2014)

### 4.2.3 The Neighborhood: Meatpacking District

Meat Packing District is a 24-hour neighborhood located on the far west side of Manhattan, bordered by Chelsea to the north and the West Village to the south. In the last 20 years, fashion and graphic designers, architects, artists, restaurateurs, world-renowned stylists and corporate headquarters have moved in alongside existing meatpacking plants. This has created an incredibly interesting and diverse dynamic that is fitting, given all the inherent contrasts of the area.  (Meatpacking District, 2017)

**Figure 35: View of Highline in Meat Packing District**

The neighborhood is historic and holds a place in New York history. Walking through it, one can see high heels straddle the Belgian block stone streets, historical architecture with contemporary structures being built above, and the grit of an industrial backbone and the chic of today's industry. In the districts' office buildings, in this place of storied history, some of the most relevant technology companies are blazing tomorrows trail.  (Meatpacking District, 2017)

**Figure 36: Whitney Museum and Highline start point**

The Meatpacking District is the epicenter of activities with a wide range of restaurants and nightlife venues, people seeking unparalleled experiences and

atmosphere flock to the neighborhood. Despite all the change, the area retains its character historically through its and cobble stone streets, and generally, with its eclectic mix of businesses and a nearby community of active residents and visitors from every community in New York City and around the world.

(Meatpacking District, 2017)

“This is a place of evolution, an area constantly in flux, leading the city forward. Amongst the greatest redevelopments in recent history was the establishment of the world renowned High Line, beginning with the section located on Gansevoort Street, right here in Meatpacking. The High Line’s arrival brought a new amenity to the neighborhood, allowing visitors a bird’s eye view as they walk on this “park in the sky” from Gansevoort Street through the Meatpacking District and further north. The park’s success brought new light to the district along with a new cadre of visitors from the around the world.”

(Meatpacking District, 2017)


**Figure 37: Steak House in the Meat Packing District**

In 2015 the Meatpacking District became the new home of the Whitney Museum, one of the City's most well respected art institutions. With the opening of its doors, the neighborhood has ballooned with pride and yet another new group of visitors. (Meatpacking District, 2017)

Looking forward to the developments of Pier 57 and 54 and the addition of 600,000 square feet of commercial real estate, another evolution of the Meatpacking will occur, altering the day-to-day dynamic, making it even more interesting.

### 4.2.4 Flood Zone Mapping

Per the flood zone mapping published by FEMA- Region II Coastal Analysis and Mapping the Gansevoort Peninsula falls under Zone AE- High Risk: Flooding at EL 13, signifying flood height at 13ft.

The adjacent piers and in land area roughly till Washington Street fall under AE- High Risk: Flooding zone. It is important to design and strategize the levels mentioned in case of extreme events like Hurricane Sandy. The construction and urban scale development along the Hudson River shall be developed to mitigate the effects of floods both on along the edge and in land.

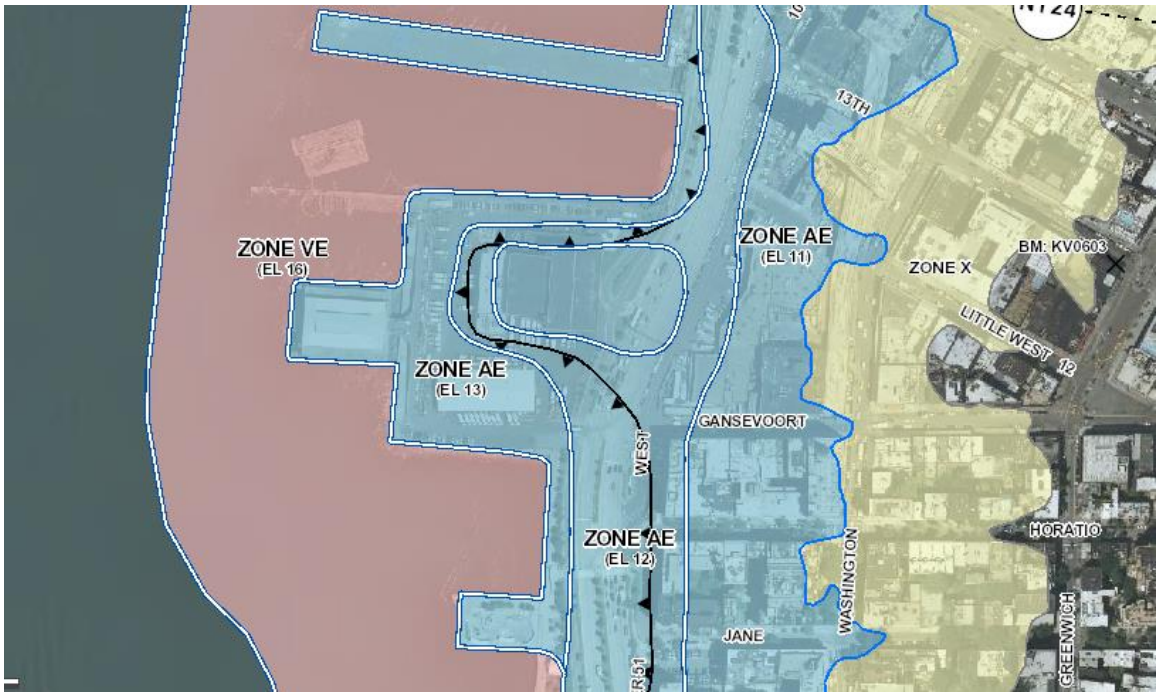



**Figure 38:Flood Map- Gansevoort Peninsula, Source: FEMA - Region II Coastal Analysis and Mapping**

# CHAPTER 5

# DESIGN

## 5.1 Vision

The vision was to develop a resilient design approach along the Hudson Riverfront in New York City which acts as a prototype for the future riverfront developments in the world.

It expands on the strategies to mitigate the effects of climate change in the city, along the streets and the shoreline.

A major focus is to make people more aware of climate change and its impacts while walking through the proposed site which formulates an informative design approach.

New York City has 72% land as impervious surface, thus water flows into the low-lying areas and rivers. The target is to allow more pervious surfaces and green spaces to allow water to pass into the ground and increase the underground water table.

The site should be developed and operated with low energy consumption, considering natural heating and cooling processes. Incorporation of sustainable façade and bio mass production powers the site to net zero energy status.

### 5.2 Strategies

It became essential to study and analyze the various water flows in the city.

- **Storm water/ surface run off water**- Identifying and analyzing the low points in the site allowed storage placements for storm water management. The lowest point of entry in the site, which is the Southern East tip- has been developed into a storm water storage which are further connected to filtration basins.

  The filtration levels would segregate the waste from the storm water, drains like plastic, bottles, bags, etc. Next, would be the removal of oil flown down with street run-off water. Following steps would involve chlorination, disinfection, purification methods which would be done through passing the water in various filtration basins.

  This water would also be used for swimming pools. Re-circulation of water would allow a sustainable use. Excess water would be given back to the city grid for use in Meat Packing District.

- **Rainwater-** The site planning ensures that rainwater falling into the site would be filtered and diverted to the water body. The rainwater would be diverted through natural landforms, sloping green roofs and central pool to main water body in the site.

- **Tidal water**- Tidal water would be used for entertainment and research purposes. The tidal pools created along the water edge would ensure water into reaching into the low-lying water pools, which would be used as recreation means by visitors. The sea water can also be used as potable water or water for various activities on site by removing salt content through a vacuum mechanism.

## 5.3 Site Planning

Various elements in the site have been weaved together to create harmonious experience while a visitor explores the site. The topographical changes throughout the site (14ft. contour change from river edge to the street edge) and the merging of buildings with landscape been two of the essential strategies in the design of the project.

The buildings have been set back from the shoreline and elevated to not be affected by extreme events. The buildings sit at an elevated level of up to 10ft through landform design or elevated columns (in case of sea level rise center).

The edges of the peninsula hosts boulders, which would act as a barrier for high tides in evening time. It would also allow enhanced interaction of visitors with water while sitting on them. This experience would be certainly new in the scheme of activities in Manhattan.

All the buildings have roof access with sloping roofs- so people could go on the top and get good views and experience while moving through the site. The circulation is dynamic and free flowing. The organic nature of paths allows you to walk across the site in a rhythmic manner experiencing multiple destinations along the site. The bridges over the water bodies also allow for great view points while moving around the site.

The filtration basins along with the storm water/ surface run off water storage is kept along the street edge at the lowest elevated point. It is then purified through multiple cleaning steps involving waste/ plastic removal, oil segregation, chlorination, disinfection and purification.

The swimming pools are at an elevated level at river edge. This strategy provides beautiful views to Statue of Liberty, sunset over the Hudson river, New Jersey skyline and Downtown Manhattan.

The children pool and play area are kept at the intersection of pathways, to enhance public activity in those spaces. This would also provide informative spaces related to sea level rise and education. The park at the river edge have unobstructed views which would maintain the vibrancy in this part of the site.


**Figure 39: Site plan showing the various elements of design, landscape features and integrated water and energy systems**

CHAPTER 6

PROGRAM

The program spaces have been carefully crafted to enhance public participation, create a knowledge base (Sea level rise center, Visitor's center, Energy center) and provide leisure activities (swimming pools, exhibition spaces, info gallery) for the people. The design and spaces allow people to experience unmatchable views to New Jersey skyline, sunset over the Hudson River, Statue of Liberty and Downtown Manhattan.


**Figure 40: Section showing various programs in the site**

The topography allows buildings to be setback from the river edge. This creates parks and pathways through the grasslands which enhance public movement along the natural scenic site. The pathways weave around to allow people experience various site features creating awareness while exploration.

The views down the site across Hudson River are enhanced with high and low points in elevation. One can get as close to water along the tidal pools and park riverside, and can be far away on street plaza or top of sloping green roofs.

The following spaces make the major programmatic entities:

1. Sea Level Rise Center
2. Info Gallery
3. Energy Center
4. Visitors Center
5. Water Sculpture
6. Filtration Basins
7. Swimming Pools
8. Street Plaza
9. Children's Play Area and Park
10. Open Air Theatre

**1. Sea Level Rise Center**

This space would be a dedicated Sea Level Rise Center which would enhance research and knowledge about the issues related to rising sea levels. It would work in collaboration with existing Resiliency planning board in New York City and other research labs around the world. It would house research labs, simulation labs, meeting and conference rooms, recreational spaces, lounge and working cubes for the employees. It will have dedicated administration spaces for managing the proposed complex.

**Figure 41: Sea level Rise Center**

The sea level rise center has vertical façade elements which sync with the tall trees while being in harmony with horizontal landscape steps and open air theatre. It has a double skin façade which continues till the parapet.

The lower level has public spaces, and a pathway which connects the bridge acts as a future linkage. The building is beautifully carved out of landforms and seems flowing the horizontal stepped garden.

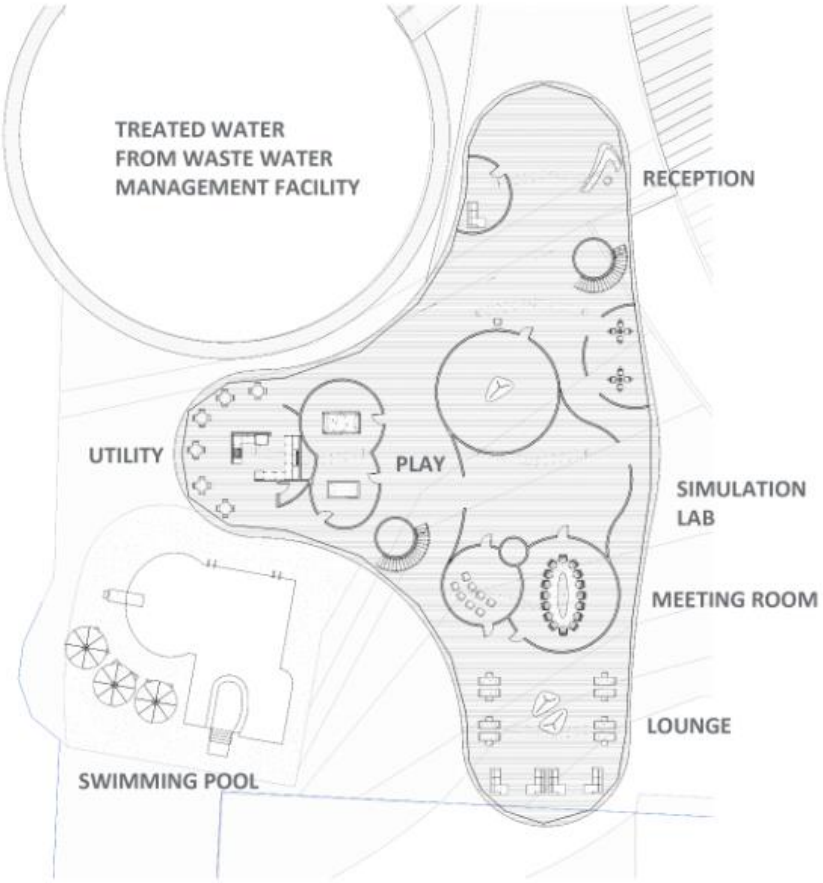



**Figure 42: Plan Level 1- Sea Level Rise Center**

The Sea Level Rise Center is elevated on columns because of its proximity to the river edge. The elevation is almost 13ft from current sea level, which is the maximum wave height in case of an extreme event.

The columns are designed to have minimal effect on landscape underneath. It would also allow the water to pass through/ get stored for landscaping in case of rainfall.  A swimming pool is designed next to the center with extension to a rectangular park which would be used by employees and their families.

2. **Info Gallery**

The space is designed for art exhibits which would inform events and activities related to climate change. The space would have weekly events which would be extended to the terrace steps outside the info gallery.

It would accommodate changing rooms and lockers on the other side of the main pathway facing the swimming pools. The level 2 would have an exhibition space to display art works in the rich artistic Meat Packing District neighborhood.

It forms an arcade on the main pathway side which would allow the passageway to be used in summers proving shade and in winter as a cover to snow and strong winds.  The amenities in the building would be administered by authorities managing the Gansevoort Peninsula complex.

3. **Energy Center**

The energy center hosts technical rooms for maintaining the energy goals of the project. The bio mass is stored under street plaza which then is connected to energy center going through the bio mass boiler.

Bio mass boiler is then connected to steam turbine and containers to store hot water which is then passed through the absorption chillers. The electric chillers are also placed in the building which receives power generated by steam turbine.

The low-grade heat is rejected at the buildings/ plaza which could be used for heating interior spaces, snow melting and other activities.

The remaining power goes to desiccant generators which help in dehumidifying the atmosphere in the complex and buildings. The incorporation of Photovoltaic glass used in the building is also powered through energy center both for input of power and then storing the excess power generated.

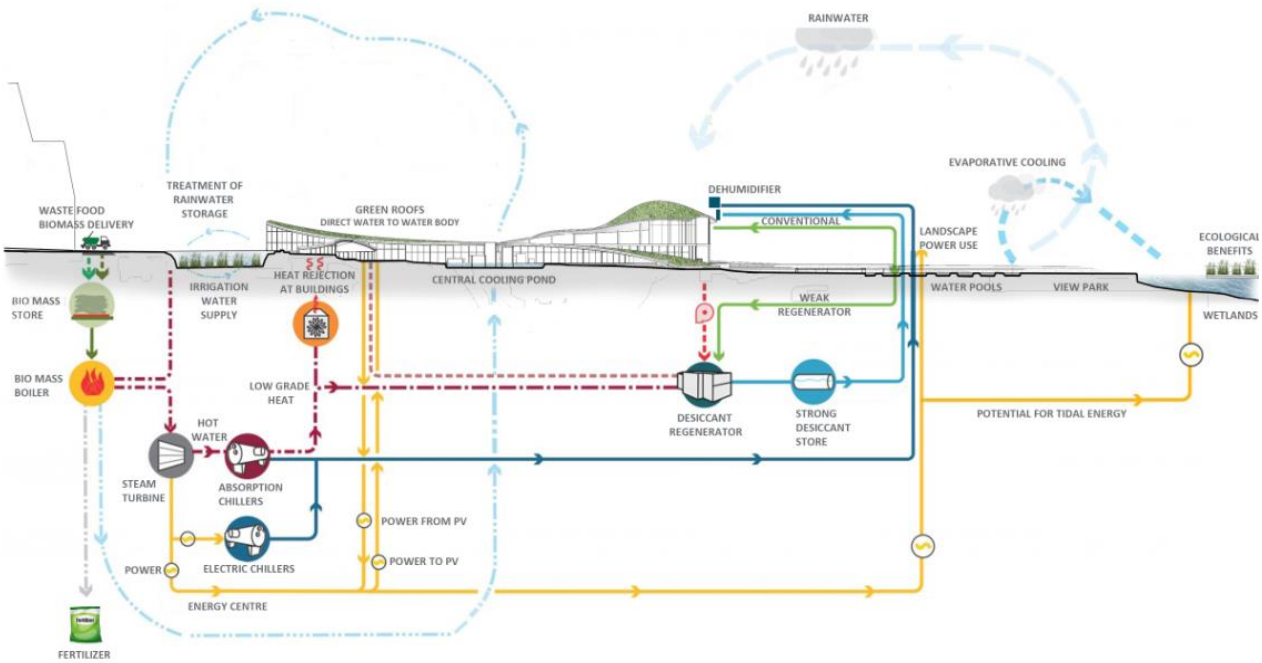



**Figure 43: Energy cycle**

### 4. Visitors Center/ Exhibit space

The visitors center would allow people to interact with the prototypes of energy center. The site's working and the mechanism behind it would be displayed with interactive screens to develop a knowledge base for visitors. It would incorporate giant LED screens with interactive user interface so the user can change settings, views and language to experience the consequences of climate change with 3D effects.

The visitors center would host monthly exhibits which would involve artists working on theme of climate change. The art work can be sculptures, paintings, live models, or sketches. Exhibit spaces would involve flexible and movable furniture requirements which can be adjusted based on monthly exhibit needs.

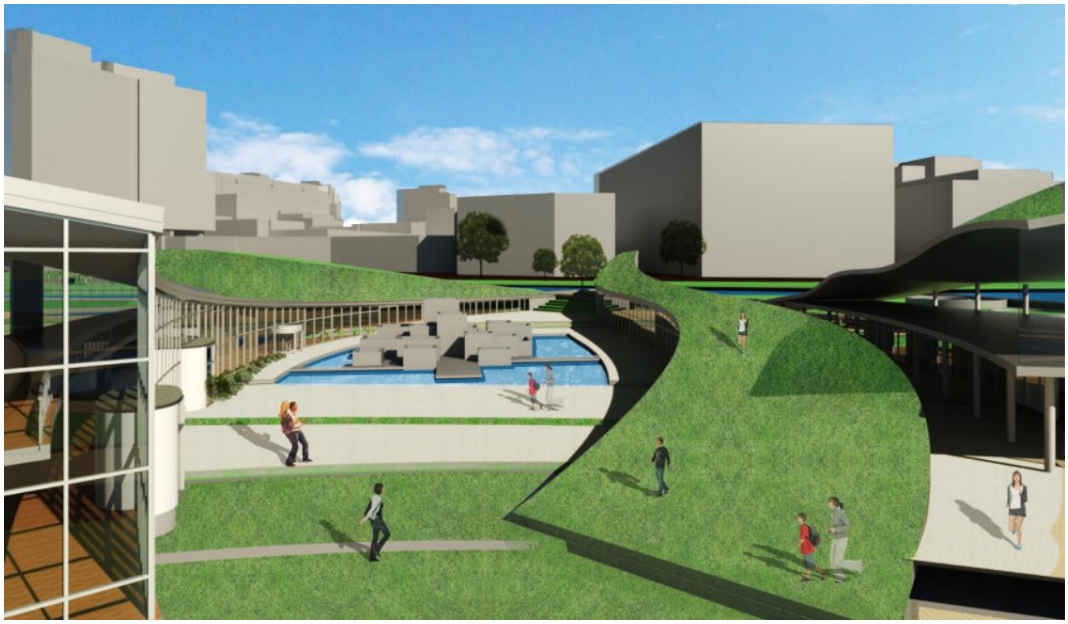


**Figure 44: Energy Center and Visitors Center with water sculpture**

The sloping green roofs allow visitors to access the elevated levels, which can be designed with steps for performances or seating spots to view the sunset across Hudson River.

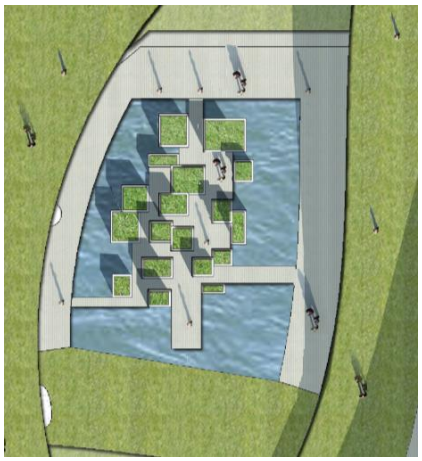
The roofs of Energy Center and Visitors Center go in opposite direction allowing for access to elevated levels from both side to experience the city and river view respectively. The pattern of roofs also allows for shaded spaces with extended overhangs, shading for Open Air Theatre and central plaza.

5. **Water Sculpture**

The central water sculpture is a miniature model of NYC with water on all sides. It is a place for visitors to experience effects of climate change- rise in temperature, increase in precipitation and rise in sea level. The pond with sculpture would allow visitors to enter from different access points and have the picturesque point in the front side facing the river.

The water sculpture would have increased humidification and thus strong desiccant would be required in the summer days.

**Figure 45: Water sculpture in evening time with New Jersey skyline in background**



It would act as a landmark and identity in the site to draw visitors from the busy city life. The lighting in the space along with green roofs with public access makes it a dynamic plaza in the center of the site. The pathway heads to the children's pool and park on the river edge. The island's water is connected to the main water body which helps in diverting the excess rainwater it receives from the rain.

**Figure 46: Plan- water sculpture**

## 6. Filtration Basins

The filtration basins form an important cleaning mechanism in the site for surface run off water and storm water. The water is collected in the water body at site entrance which is the lowest point on the site. The waste is segregated from the body through waste removal process and then allows it to pass for oil removal.

The next processes are disinfection, UV and chlorination followed by purification.

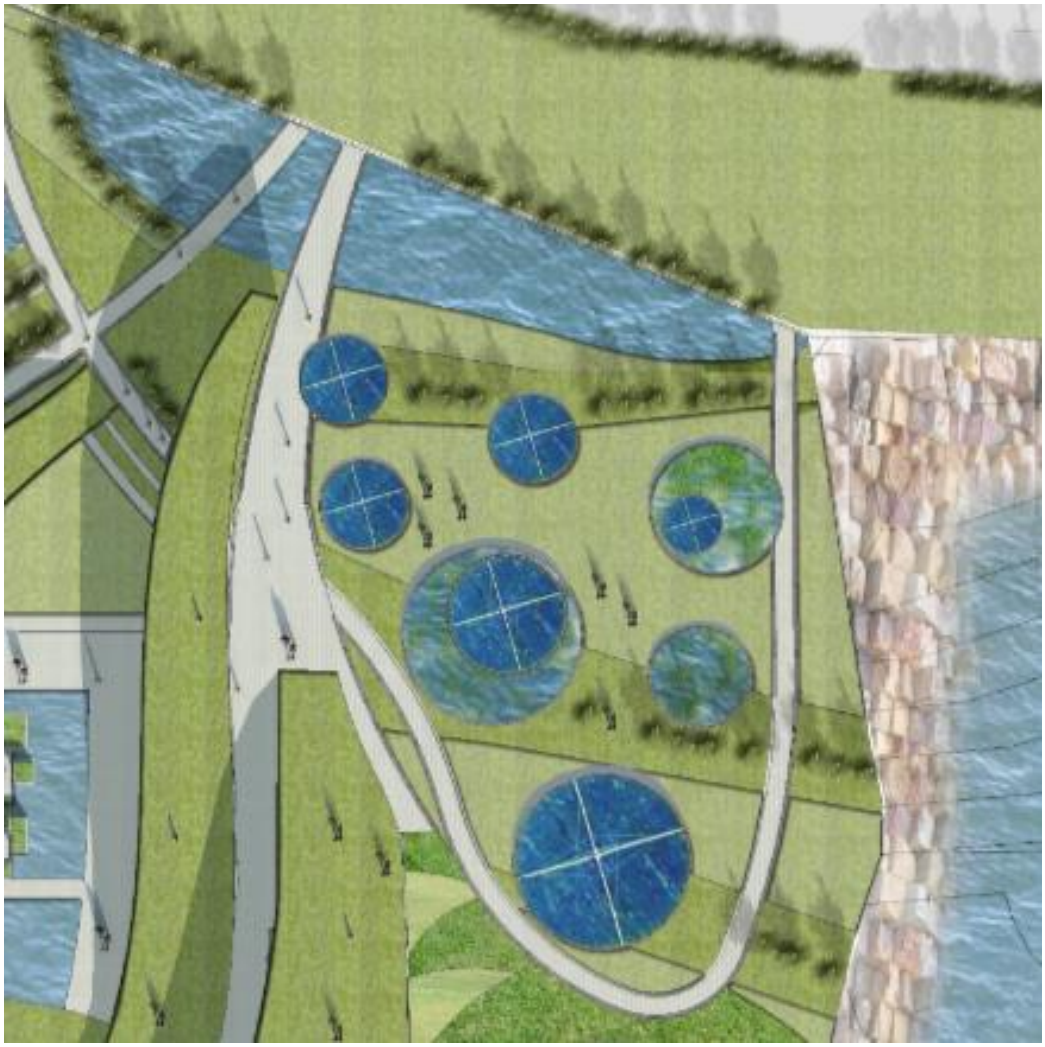


**Figure 47: Filtration basins and water collection**

The water is then used by swimming pools and various landscaping activities in the site. The re-circulation of water allows a sustainable approach towards water management.

### 7. Swimming Pools

The swimming pools are designed extending from the landmass into the river. The elevation is about 8-10ft from the current sea level. The pools receive continuous treated water from filtration basins. The three pools are of different depths for various age groups of people.

**Figure 48: Swimming pools with boulders along the Peninsula periphery**

The pools seem like infinity pools with river at the horizon. The boulders are an additional element placed next to the pools allowing people to connect with water and enhance public interaction on the rocks. The multicolored pattern adds to the artistic nature of the neighborhood.

The changing rooms are in the Info Gallery building which allows easy access to the visitors. The views along swimming pool to Hudson River, Statue of Liberty and Downtown Manhattan are memorable.

8. **Street Plaza**

The street plaza acts as a buffer between the busy FDR and the site. The existing long Hudson Greenway does not have many places to pause, and this plaza right in front of Whitney museum would allow a place to mediate, contemplate and heal. The stepped plaza would take the visitors one step closer to the nature and water.

The plaza is designed with permeable surfaces unlike 72% of New York City. This allows water to reach deep underground and increase the water table for city use.

**Figure 49: Proposed Street Plaza across Whitney Museum**

The street plaza would attract visitors passing by through the Hudson Greenway as a moment of pause and appreciate the site. The elevated nature of the plaza allows you to have unmatchable views to Hudson River and the New Jersey skyline.

Areas of shade would allow people to visit during sunny day time and cold winters. It would encourage students and artists visiting the Whitney Museum to appreciate the building from across the street. The steps shall also allow them to sit and sketch the Whitney Museum from across the FDR.

The stepped landscape design would allow water to be stored at multiple levels which could be used for self-irrigation through well designed drainage system. Soil erosion would not take place due to steps designed in case of heavy rainfalls and extreme events.

The steps also allow to incorporate an underground Bio Mass storage which would be connected to the bio mass boiler and later to the energy center. The trucks would deposit the bio waste at the plaza corner which shall be stored underground. This is a crucial step towards constant renewable energy production in the site.

### 9. Children's Play Area and Riverside Park

Children's play area is along the rectangular extension in the site. The wave pools would allow children to experience water and create awareness of rising water levels. We need to create awareness and allow people to learn beginning at a very young age. The pool has park on all sides, which would allow parents and people of all ages to gather and create a vibrant river edge.

The space does not host any tall trees as it would allow potential for views down the river and Downtown Manhattan. The promenade at the edge with proximity to other adjacent piers would also allow the views to Pier 55 designed by Heatherwick Studio.

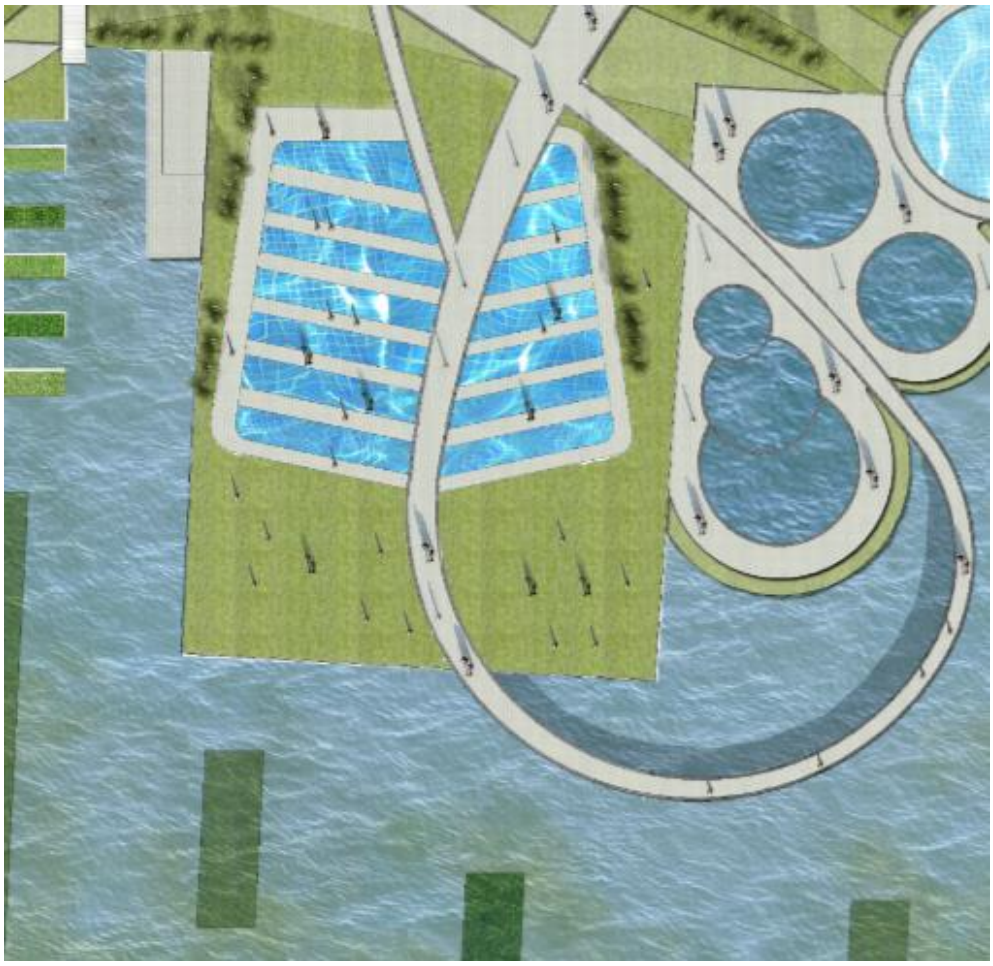


**Figure 50: Children's Pool and Riverside Park**

The pathway through the park forms a water pavilion which sails right atop of the water body in a loop. It allows visitors to have paranoiac views of the city and beyond.

## 10. Open Air Theatre

The open-air theatre is designed as a series of carefully shaped landforms, along the central site area. The natural landforms give rise to functional spaces while descending from higher points in the site. This place serves as a performance space all day around with Hudson River background and children's play area.

**Figure 51: Open Air Theatre**

The proposed design in located between the Sea Level Rise Center and the Visitors center. This allows it to host public events which could be incorporated

with inputs from Sea Level Rise Center, guided by its research and latest developments.

**Water flow in the site**


**Figure 52: Water flow- rainwater and green roofs**

The rain water falls on the site and is directed to the main water body water. The sloping roofs collect the water and further redirects the water to the central water body, followed up by connecting the channel to the main water body in the site. The water flowing down the steps stops at multiple levels and gets adsorbed by the soil, charging the underground water table. This ensures all the water falling on the site is used efficiently.

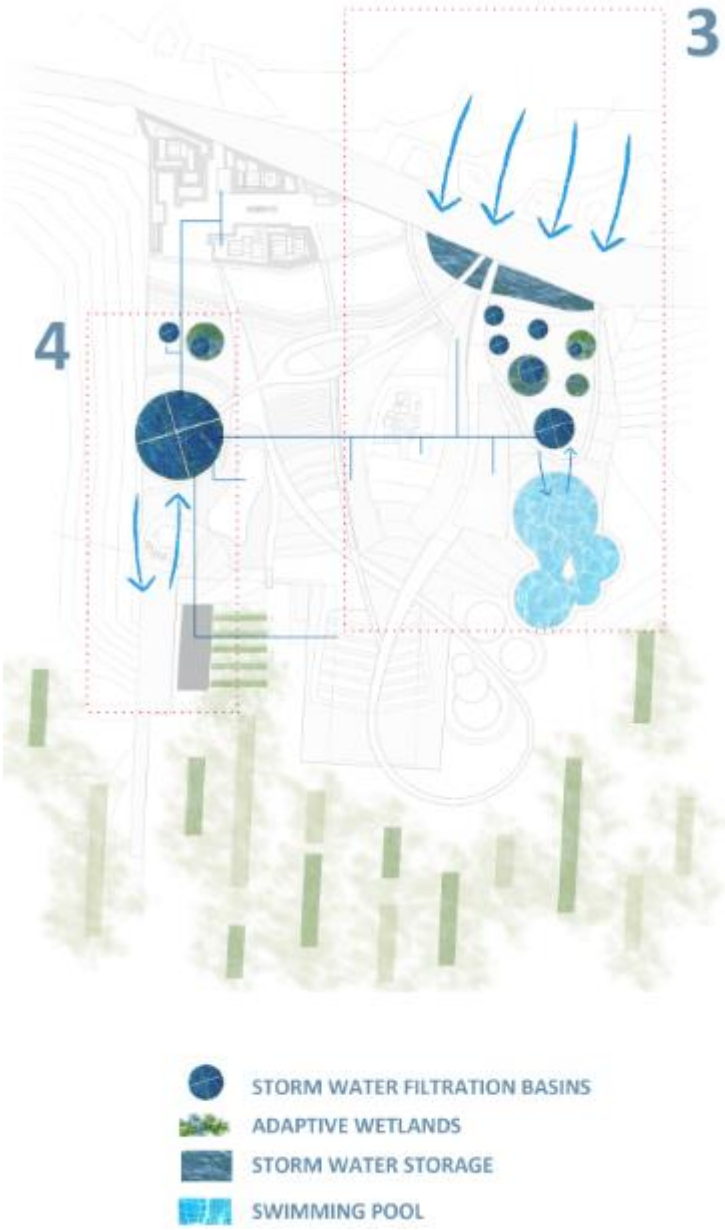



**Figure 53: Water flow- storm water/ surface run off water, adaptive wetlands**

The surface run off water and storm water gets collected on the water body at South side, which is at the lowest point on the entrance near the FDR. It captures water from NYC grid and streets, along the Hudson Greenway which is passed on to the filtration basins. Various steps for cleansing including waste removal, oil

segregation, chlorination, disinfection and purification. It can be done naturally with coal and pebbles flowing over the grasslands or mechanically in specially designed water filtration basins.

The clean water is then used by swimming pools and other water based activities on the site including children's park and pool.


Figure 54: Projections in 2020

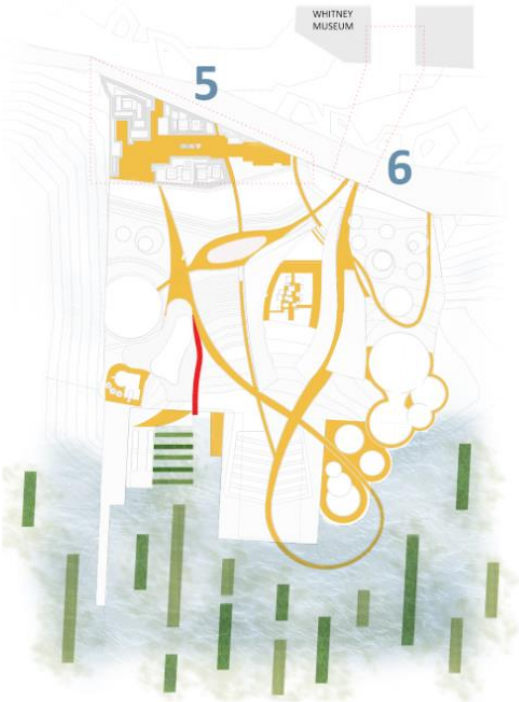



Figure 55: Projections in 2050

## Circulation

The circulation along the site has been designed through various curved axis cutting across the site and potentially exploring the proposed destinations. The intersection of these pathways would further enhance public interaction. The pathways cut through grasslands which would involve a natural ecological experience between the build spaces and water connections.

## Potential for growth in 2050

- Elevated structures may form a connected riverfront promenade.
- Existing pathways would be linked to the future linkages-buildings, entrances and green terraces
- Extension of wetlands would benefit the marine life in Hudson River
- An extended dock allowing small boats and support entertainment rides in the Hudson River
- Renewable sources of energy-tidal energy could be generated from the turbines under water in the Hudson River
- A floating promenade or pad could be installed in the rectangular extended portion of the site which can act as a dock for small boat rides.

# CHAPTER 7

# CONCULSION

Gansevoort Peninsula in New York City marks a site of historic importance which is ready to offer a vibrant and informative environment to the city dwellers. New York City being a coastal city has high risk to flood due to climate change in the future and thus, it's important to build the site on the principles of resiliency. A resilient riverfront approach would act as a prototype for further riverfront developments in the city along the Hudson River.

The site provides balance between ecological benefits to nature and recreational activities for people. The site creates an experience which would allow users to develop a knowledge base about what may happen in the future alongside its mitigation strategies.

Technological advancements like creating an integrated mechanism for water flow and energy needs in the site acts as a focus of the project. It is important to link leisure activities which creates a vibrant place with educational, cultural, artistic, and technical benefits. The sea level rise center would act as a premier institute in the nation to study and observe the sea level rise dedicated research along with live simulations in the Hudson River.

Global climate change is bound to happen. What makes this proposal critical is the way it reacts to the future concerns of rising sea level, rise in temperature, and precipitation levels along with considering the current issues of the New York City.

APPENDIX

FINAL REVIEW BOARDS


UNDERSTANDING THE SITE, CIRCULATION, WATER FLOW AND FUTURE PROJECTIONS
PLAZA - LANDSCAPE DESIGN
DESIGN ELEMENTS
POTENTIAL FOR GROWTH IN 2050
WATER BODY- RAINWATER
GREEN ROOFS
STEPPED LANDSCAPE
STORM WATER FILTRATION BASINS
ADAPTIVE WETLANDS
STORM WATER STORAGE
SWIMMING POOL
PROPOSED SITE
SITE PROJECTIONS IN 2050
GREY WATER FROM SITE
OBSERVATORY
ANAEROBIC SEPTIC TANK
AEROBIC REACTOR
CLARIFIER
INDOOR & OUTDOOR WETLAND
HYDROPONIC FARM
LANDSCAPE DETAILS
SWALE CUT DETAIL
STEP GARDEN SECTION
CURB DETAIL FOR PATHWAYS
PLANS
TREATED WATER FROM WASTE WATER MANAGEMENT FACILITY
RECEPTION
UTILITY
PLAY
SIMULATION LAB
MEETING ROOM
LOUNGE
SWIMMING POOL
SEA LEVEL RISE CENTER LEVEL 1
ARCADE
VIEW TERRACES
INFO GALLERY
PUBLIC SWIMMING POOLS
CHANGING ROOMS
INFO GALLERY LEVEL 1
ENERGY CYCLE
SITE SECTION

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