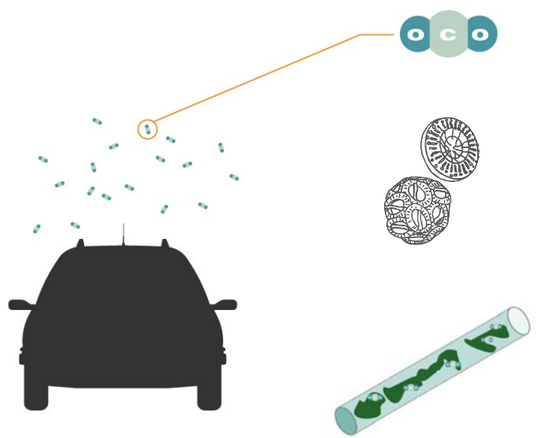
Carbon T.A.P. // Tunnel Algae Park

As Federal, state and local governments undertake consideration of large-scale investments in the renovation and replacement of urban infrastructures, we see a unique opportunity to reconsider the role of these systemic networks and their effect on our contemporary urban landscapes.

In the scenario outlined herein, a new type of green infrastructure is deployed at urban locations comprising concentrated sources of CO2 production. This new infrastructure utilizes a proprietary system of industrial scale algal agriculture to sequester and consume greenhouse gas emissions (in particular CO2) in order to limit their introduction into the atmosphere, while simultaneously creating a new economic resource through the production of oxygen, biofuels, bioplastics, nutraceuticals and/or agricultural feeds. In the scenario shown, this new infrastructure manifests itself as a series of pier-like armatures linked to the ventilation system for the Brooklyn-Battery tunnel.

What is unique about this proposition is not just the introduction of large-scale green infrastructure in the context of a city, but rather the use of this infrastructure to create an exceptional public realm amenity for the city. Rather than considering urban infrastructures as a necessary evil only to be hidden or mitigated, we view the renovation and re-imagination of these systems as opportunities to create new forms of civic and social domain that have the capacity to positively transform the American urban landscape.

Our proposal for a new infrastructural typology that is one part climate action; one part agricultural production; one part ecological preserve; one part public realm; and one part economic catalyst represents what should be the aspiration for all newly deployed urban infrastructures – the ability to fundamentally improve the economic and social quality of a city, as well as the associated lives of its current and future residents.



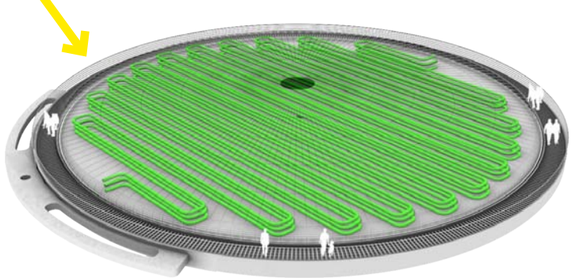
HOW IT WORKS

There are 600 million automobiles in the world as of 2003. 14% of the carbon-dioxide produced globally comes from transportation emissions, particularly automobiles.

Phytoplankton are mostly single-celled photosynthetic organisms that feed fish and marine mammals. They are responsible for nearly 50 percent of the earth's annual carbon-dioxide consumption and more than 45 percent of the oxygen production.

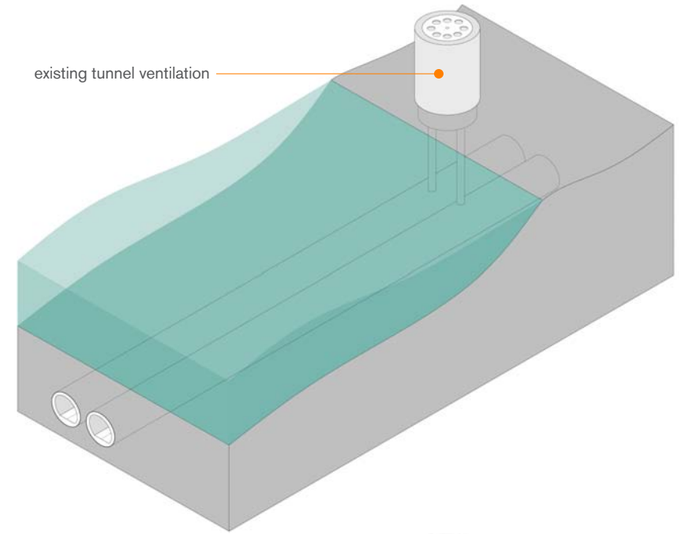
Single-cell algae can consume carbon dioxide or nitrogen oxides and then be "harvested" in a reusable form. This form, a biomass similar to an artist's soft charcoal, can be burned like coal or liquefied into oil or used to make plastics, nutraceuticals or food.

SUNLIGHT + 6CO2 + 6 H2O = C6H1206 + 6O2 (Photosynthesis)



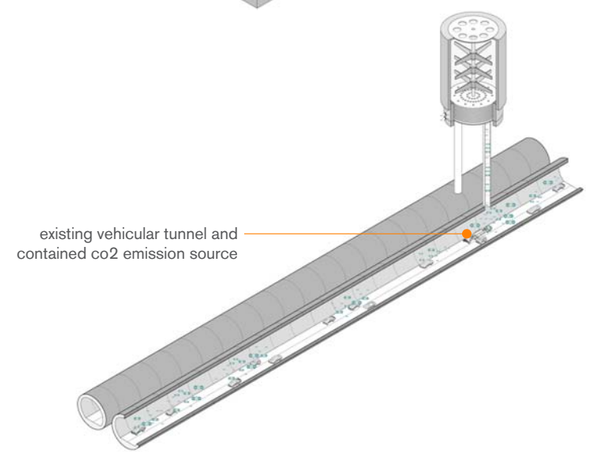
BIOREACTOR

Algae are one of the most robust classifications of life on earth. Thriving on every continent, they are highly adaptive to any physical environment where they are able to derive energy from photosynthesis and the uptake of organic carbon, particularly in the form of CO2. Algae bioreactors consist of bundled, clear, water-filled tubes oriented to maximize sun exposure. The tubes create a controlled environment to to both maximize algae growth and streamline harvest.



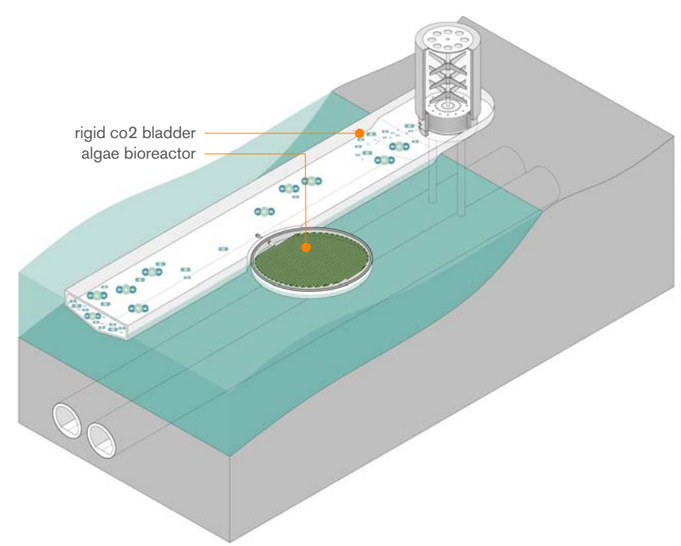
CONTAINED SOURCE

Atmospheric CO2 concentrations are not high enough for industrial scale production of algae. However, concentrated CO2 sources such as Coal / CoGen power plants or manufacturing facilities offer potential sources of high level CO2 concentrations. **Vehicular tunnels in particular can produce hundreds of millions of cubic feet of CO2 per year.**



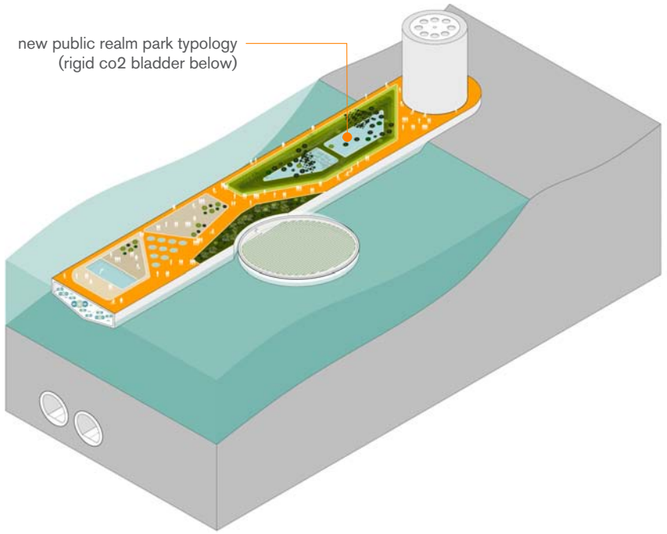
CAPTURE

Capturing even a small fraction of these CO2 emissions would offer an enormous food source for large-scale algae production. However, the challenge of these sources is holding the CO2 before it is delivered to some vessel containing the algae. **In our scenario we use a 2-part system for the capturing of CO2 and providing its controlled delivery to an industrial-scale algae bioreactor.**



STORAGE

In this system, CO2 emissions are captured and held in what is essentially a giant bladder or rigid balloon which is configured to deliver CO2 to a series of 20,000sf bio-reactors which can be detached for harvesting and processing of their algae crop (see floating algae bioreactor prototype rendering, far left).

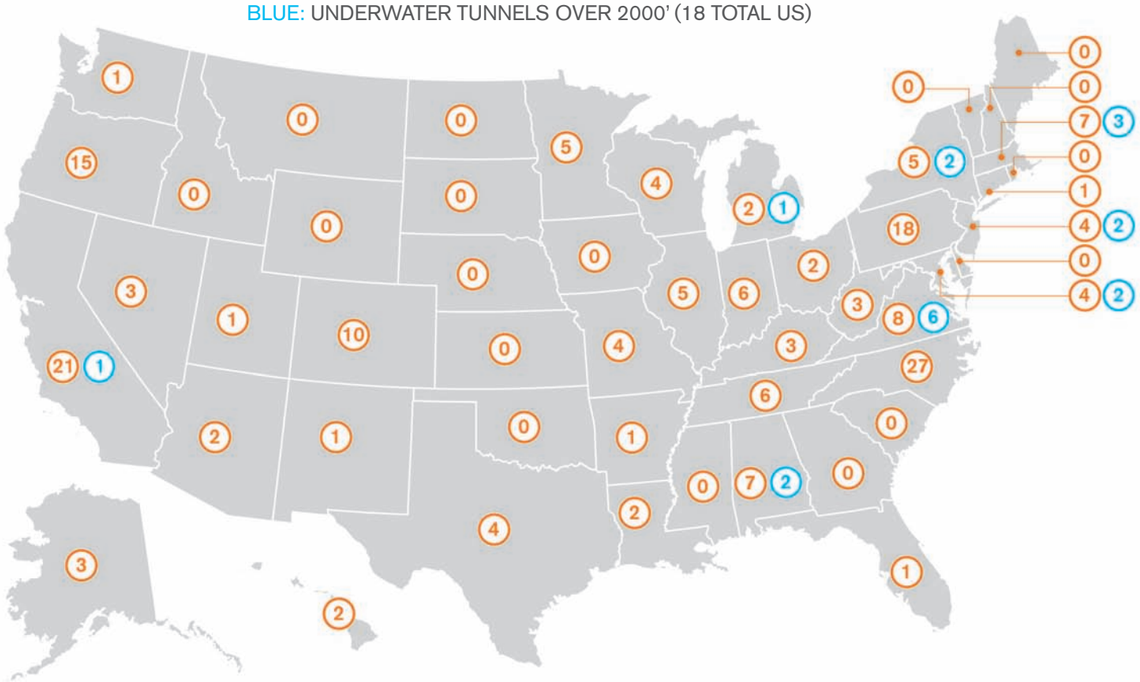


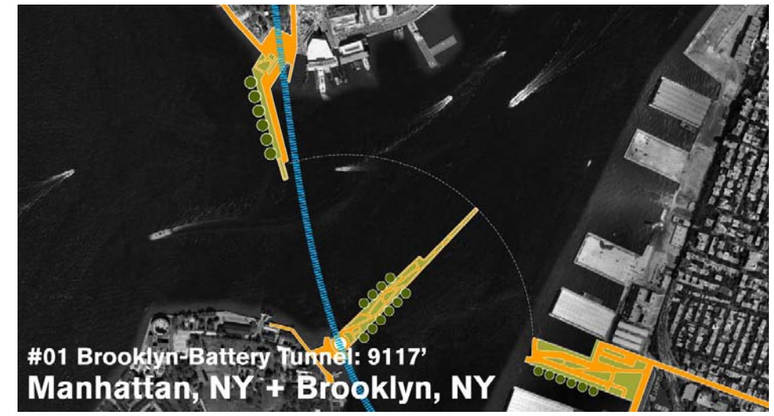
CARBON T.A.P. TUNNEL ALGAE PARK

Many of these concentrated CO2 sources are sited near bodies of water allowing the CO2 bladder to function as essentially a large pier or expanded waterfront. As the volume of CO2 needed and produced is quite large, thoughtful integration of the pier into its urban context is an absolute. That said, we propose that these algal piers become the sites of a new typology of public open space that bundles waterfront access with productive green infrastructures.

With 18 underwater vehicular tunnels of greater than 2,000 feet across the U.S., and thousands of coal and natural gas driven power plants, deployment of adaptations of this system have the potential to reinvigorate a wide range of urban environments throughout the country.

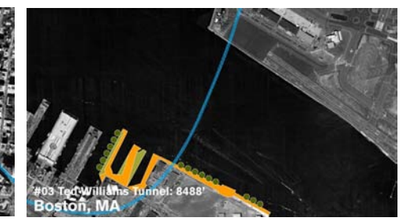
ORANGE: VEHICULAR TUNNELS PER STATE (196 TOTAL US)
BLUE: UNDERWATER TUNNELS OVER 2000' (18 TOTAL US)

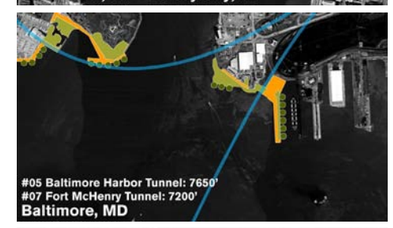


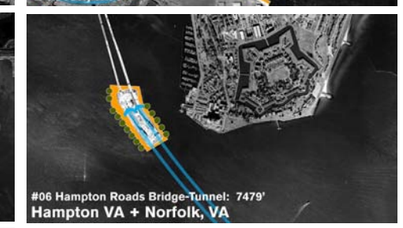


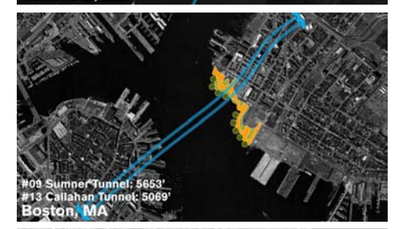
CARBON T.A.P. CASE STUDY:

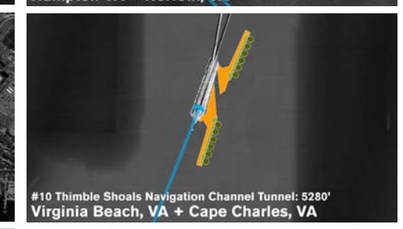
The Brooklyn-Battery Tunnel is the longest underwater tunnel in North America. In 1936 Robert Moses proposed to build a bridge from Red Hook, Brooklyn to the Battery in Lower Manhattan. It was never built. Moses' bridge was the product of the automobile century. Though it traverses a similar route, our proposed Brooklyn-Battery Bridge is a product of the ecological century, representing a new infrastructural paradigm.

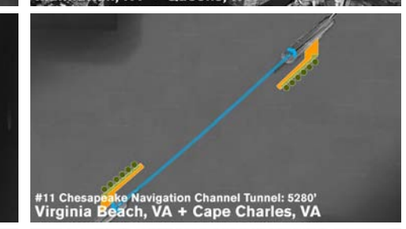




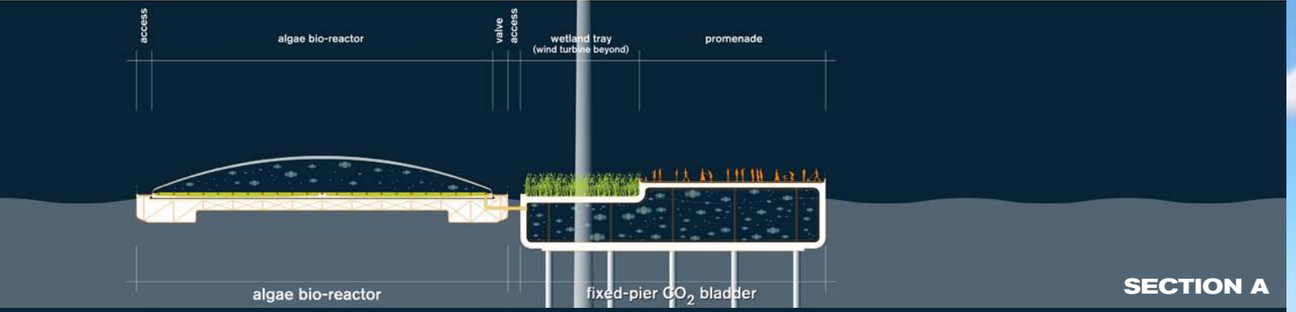




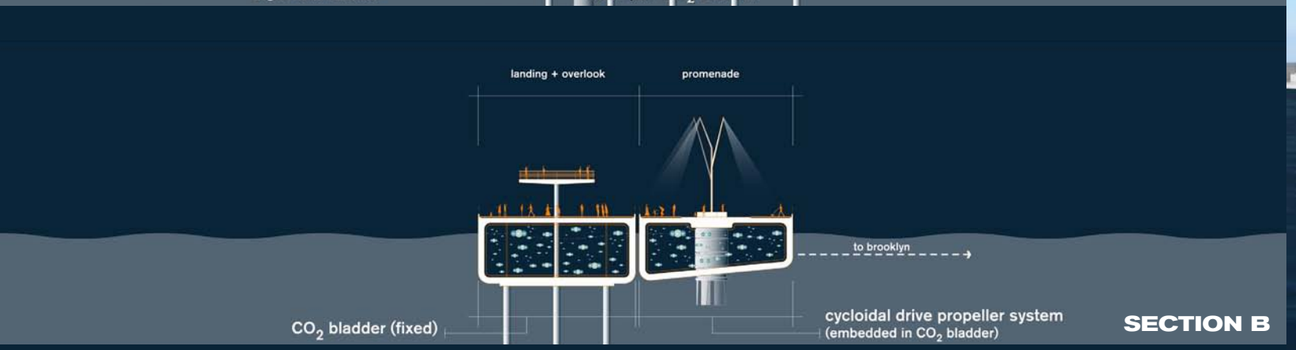




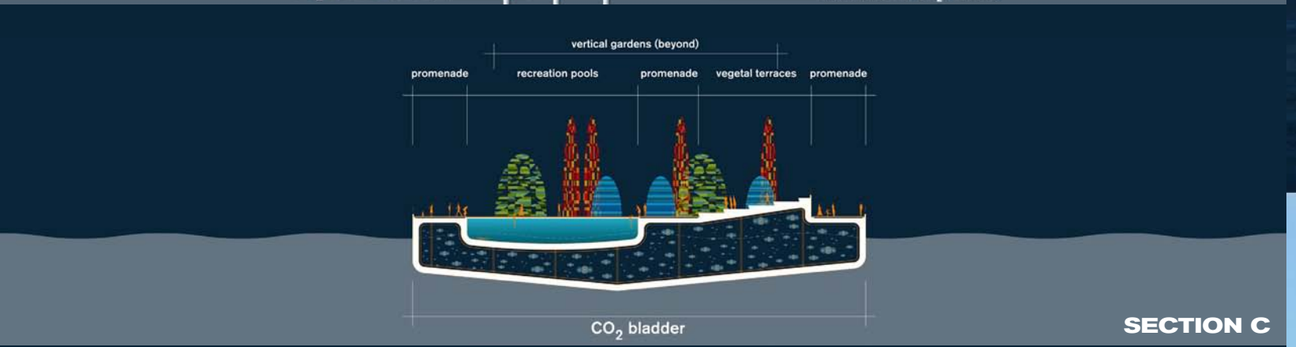

MANHATTAN
BROOKLYN
GOVERNORS ISLAND
The fixed Battery pier is connected to the landside ventilation shaft and is able to function independently from the other two pier elements.
The rotating pier departs on the half hour for the Brooklyn Waterfront.
total travel duration: approximately 20 min.
arc length: 5,280 ft (1mi)
The rotating pier is driven by an integrated cycloidal drive propeller system located at its free end. This system of locomotion is highly maneuverable, allowing for near instantaneous change of thrust direction.
line of brooklyn-battery tunnel below
Like the Battery pier, the fixed Brooklyn pier is able to function independently as a storage and delivery system. It is also home to the processing facility for the entire NYC industrial algae complex.
The rotating pier departs on the hour for the Battery in Manhattan.
The rotating Governors Island pier connects to the existing Brooklyn-Battery tunnel ventilation system via a matrix of flexible ducting that links to the shaft's 53 existing fans and motors.
The floating pier follows a scheduled pivoting sequence connecting to Brooklyn and Manhattan each once every hour.
A
B
C
D
E
1 The Battery Landing
2 The Hive
3 Entry Bosque
4 Recreation Pool
5 Algae Bioreactor (typ.)
6 Wetland Tray (typ.)
7 The Promenade
8 Gov. Island Overlook
9 The Point
10 Vertical Botanic Gardens
11 Recreation Pool
12 Vegetal Terrace
13 Algae Bioreactor (typ.)
14 Tulip Poplar Grove
15 Event Plaza
16 Vegetal Terrace
17 Wetland Tray (typ.)
18 The Hive
19 BBT Ventilation Tower
20 Gov. Island Landing
21 Brooklyn Landing
22 Wetland Tray (typ.)
23 Algae Bioreactor (typ.)
24 Event Plaza
25 Collection Area
26 Processing Plant
26 Entry Bosque
plan scale: 1"=200'
0' 50' 100' 200' 400'



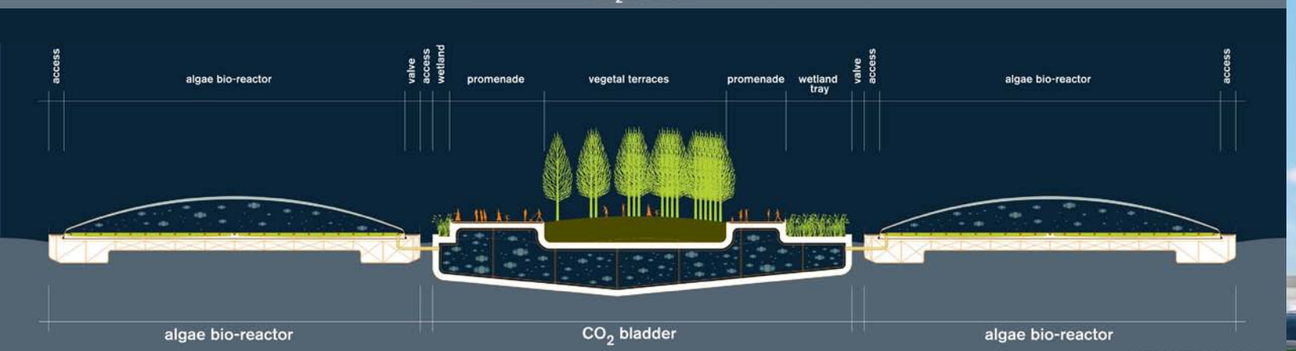
SECTION A



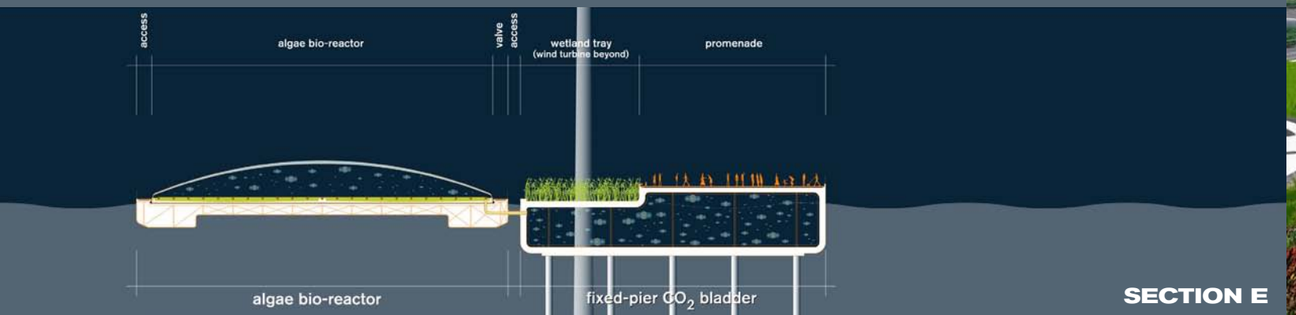
SECTION B



SECTION C



SECTION D



SECTION E

GOVERNORS ISLAND to LOWER MANHATTAN

BROOKLYN-BATTERY TUNNEL CO_2 EMISSIONS/YEAR **26,000,000** lbs^3

CO_2 CONSUMED BY ONE SQUARE FOOT OF ALGAE/YEAR **9.7** lbs^3

AREA OF ALGAE TO CONSUME 45% OF ANNUAL BBT CO_2 EMISSIONS **28** acres

= **1.0** acre of algae