

URBAN STORMWATER WETLANDS

Research into Form & Function

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RESEARCH PROBLEM

How do we combine
hydraulic engineering and **landscape design**
to create new forms of constructed wetlands
that offer **urban functions** and **resiliency benefits** for cities?

DESIGN GUIDELINES

Case Study Cities



Los Angeles

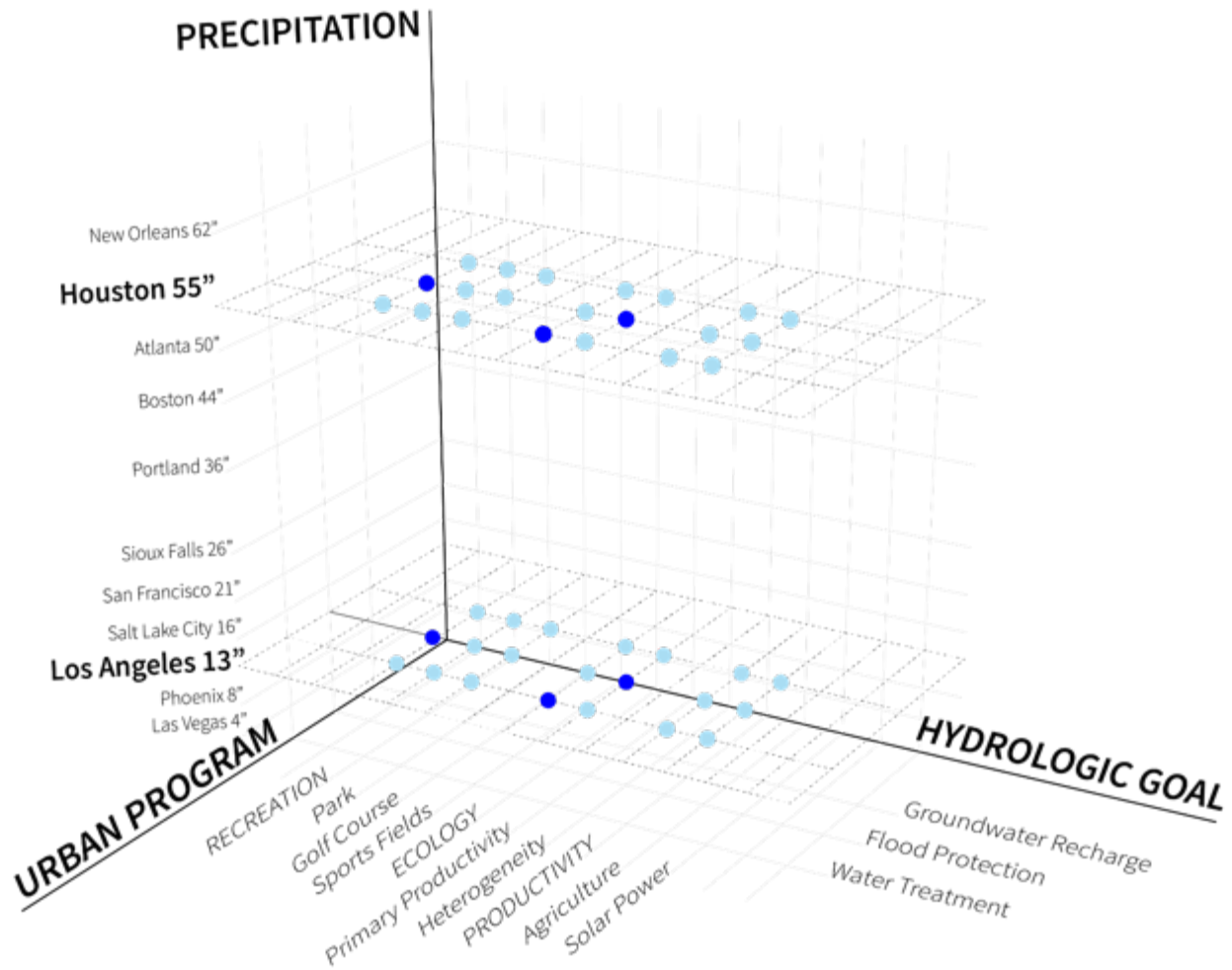
- Hot + dry climate
- Severe water scarcity
- Flooding problems
- #5 fastest growing metro in 2013-2014
- 13 million people



Houston

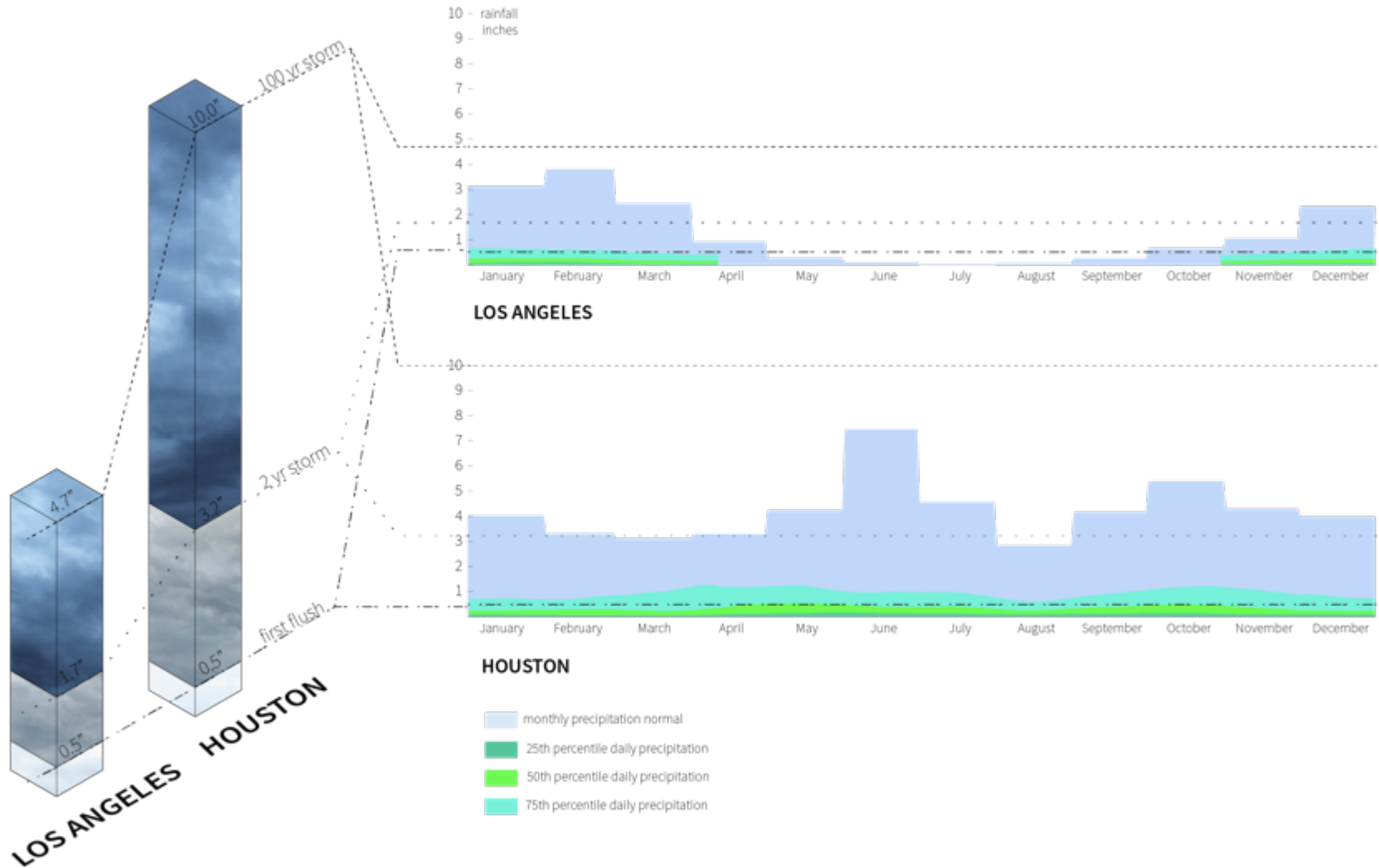
- Hot + wet climate
- Flat and low-lying
- 2016 wettest year in 60+ years, led to severe flooding
- #1 fastest growing metro in 2013-2014
- 6.5 million people

DESIGN SCENARIOS



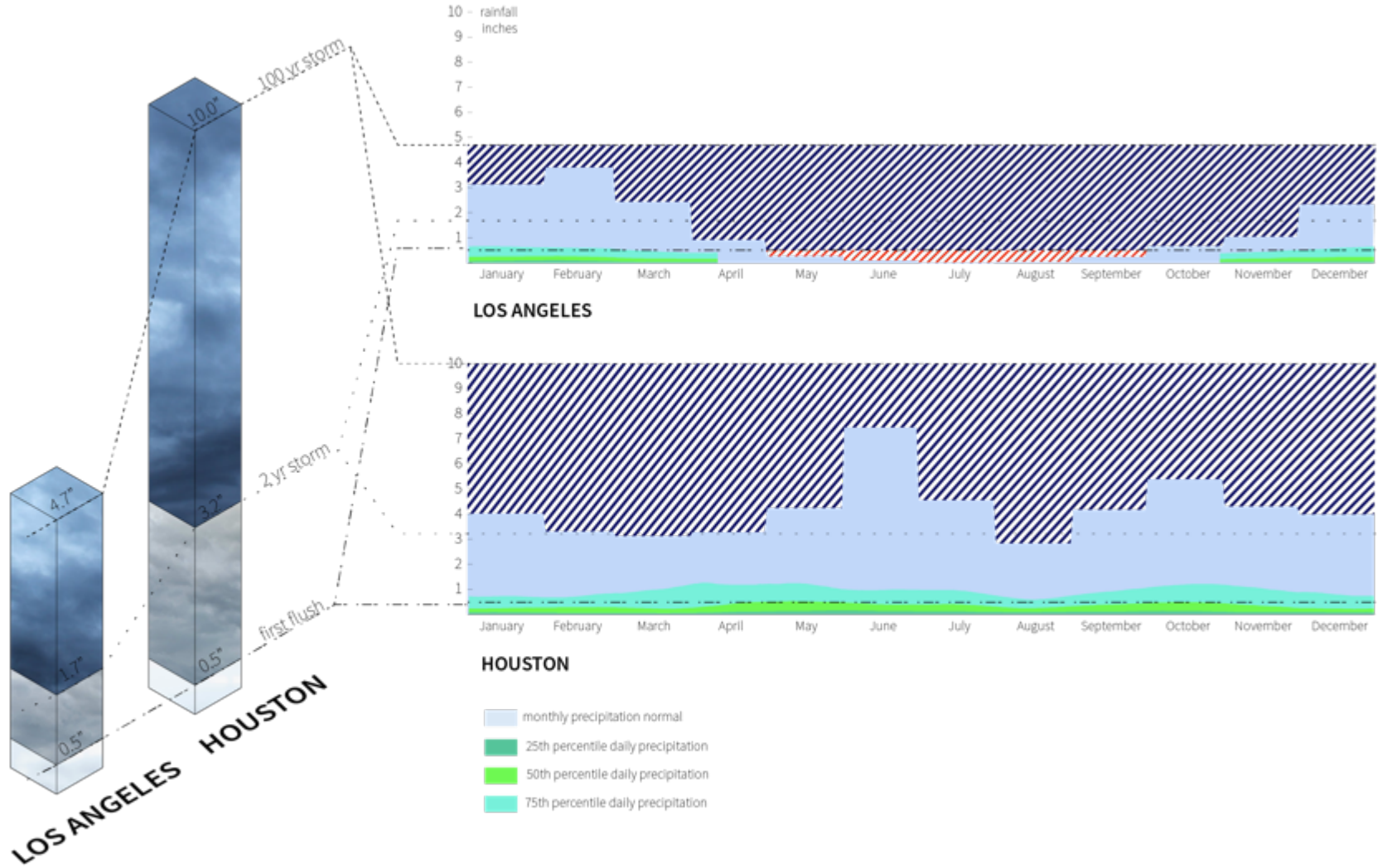
RAINFALL SCENARIOS

NOAA 1981-2010 Climate Normals



RAINFALL SCENARIOS

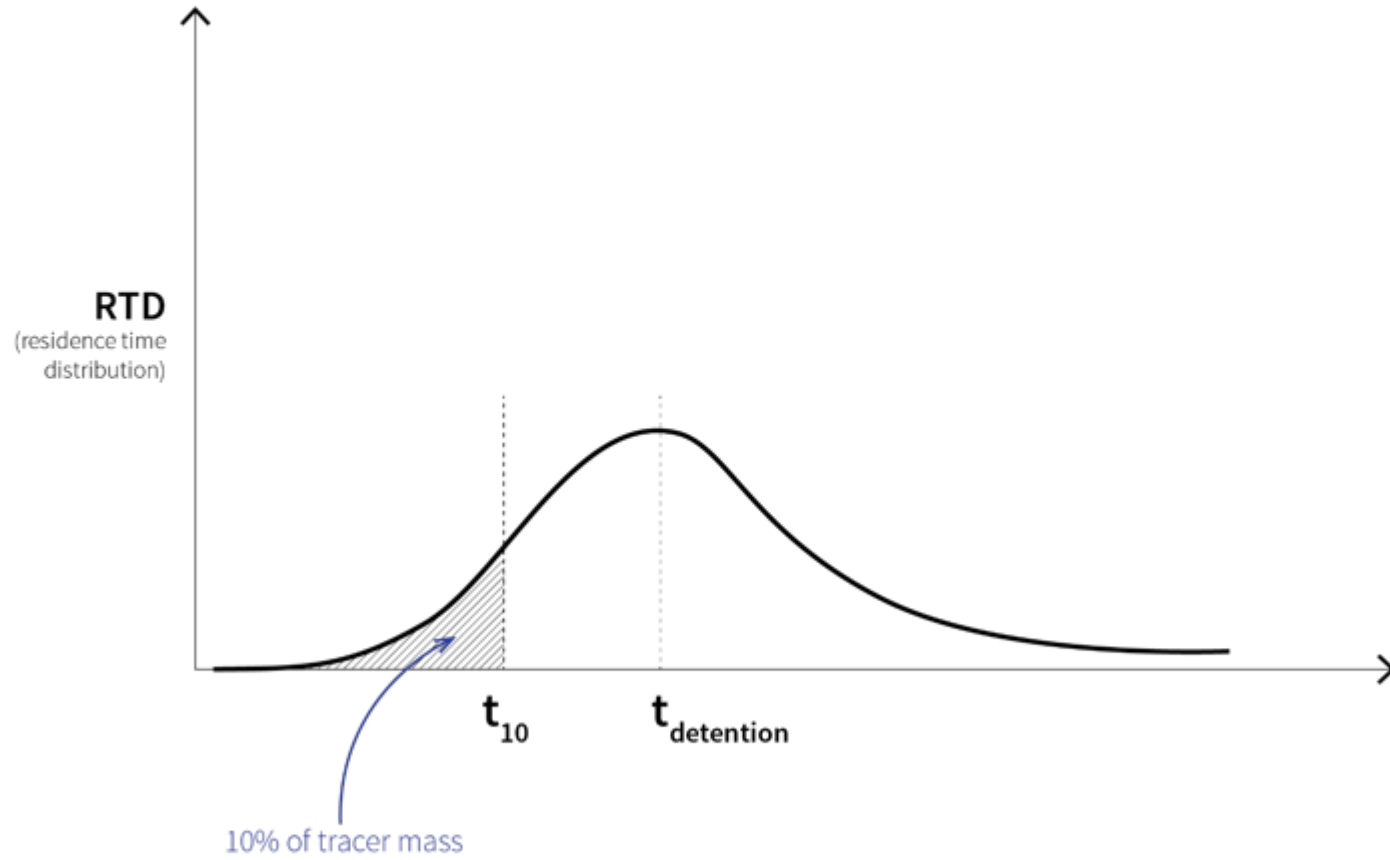
NOAA 1981-2010 Climate Normals



LOW-FLOW AND FLOODPLAINS



COMPARATIVE METRICS





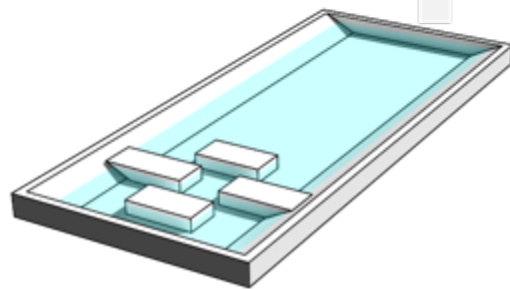
PERFORMANCE METRICS

Theta 10

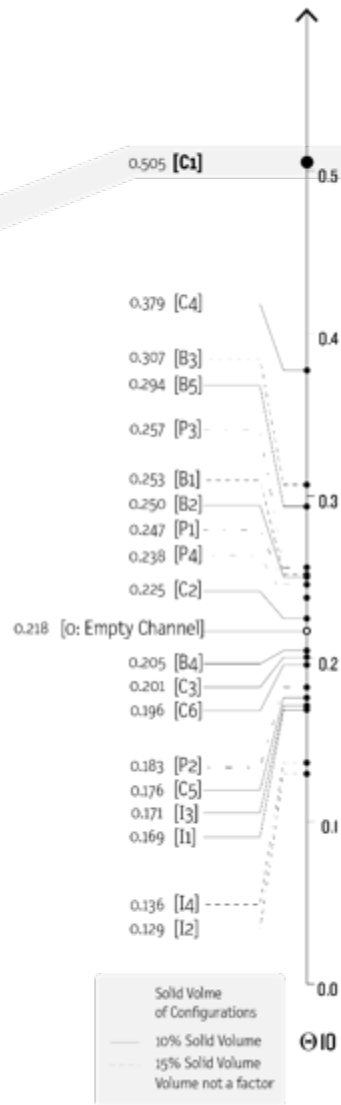
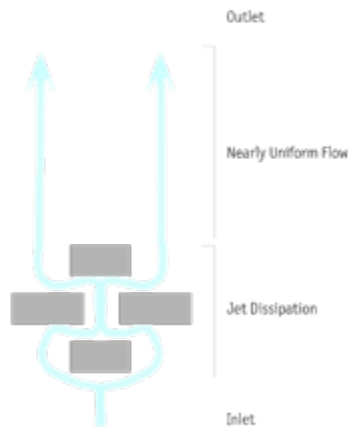
$$\Theta_{10} = T_{10} / T_n$$

Nominal Residence Time

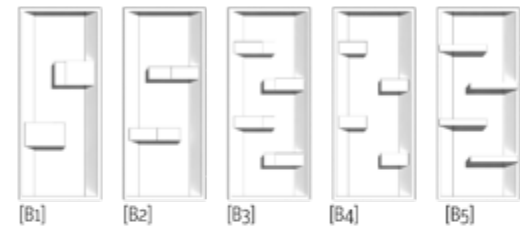
$$T_n = V/Q$$



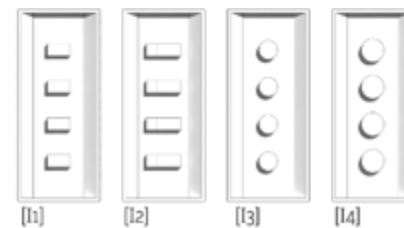
Best performing scenario:
[C1] Island Cluster at Inlet



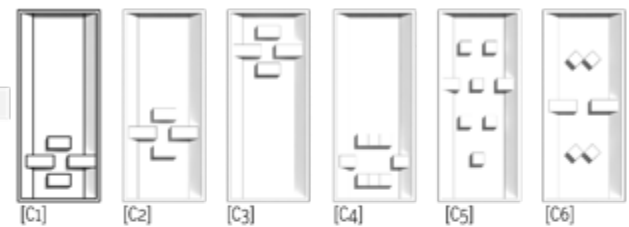
BERMS



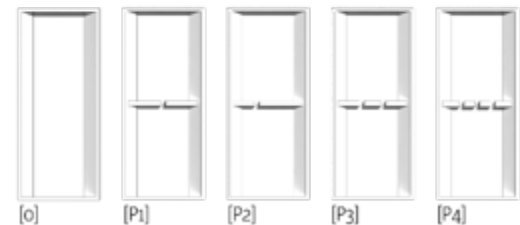
ISLANDS




CLUSTERS

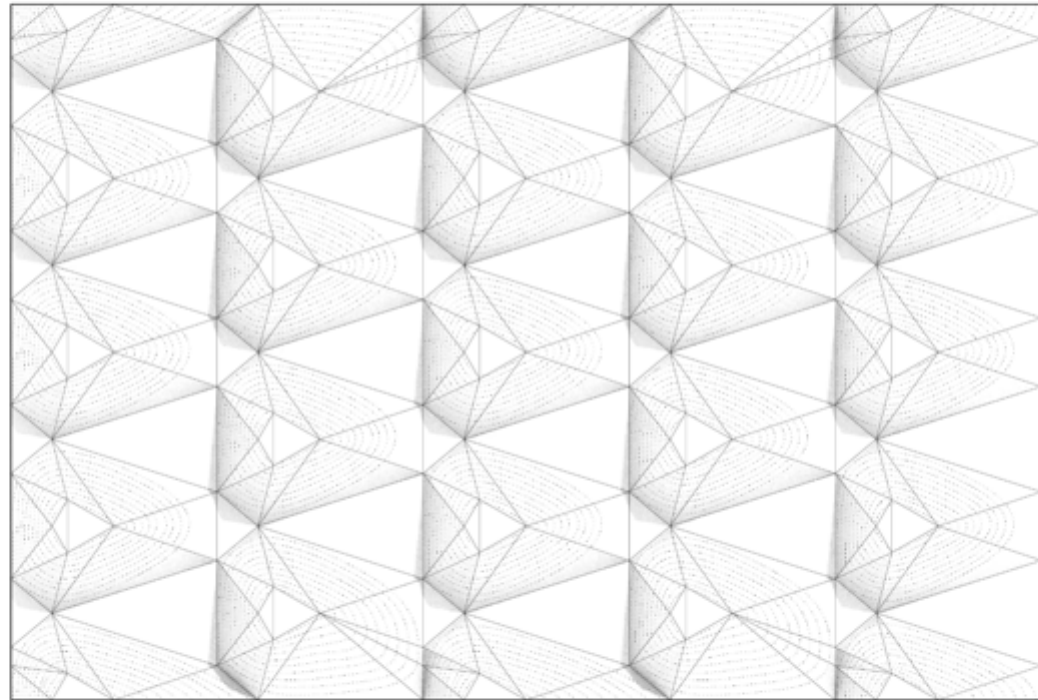


PINCH POINTS



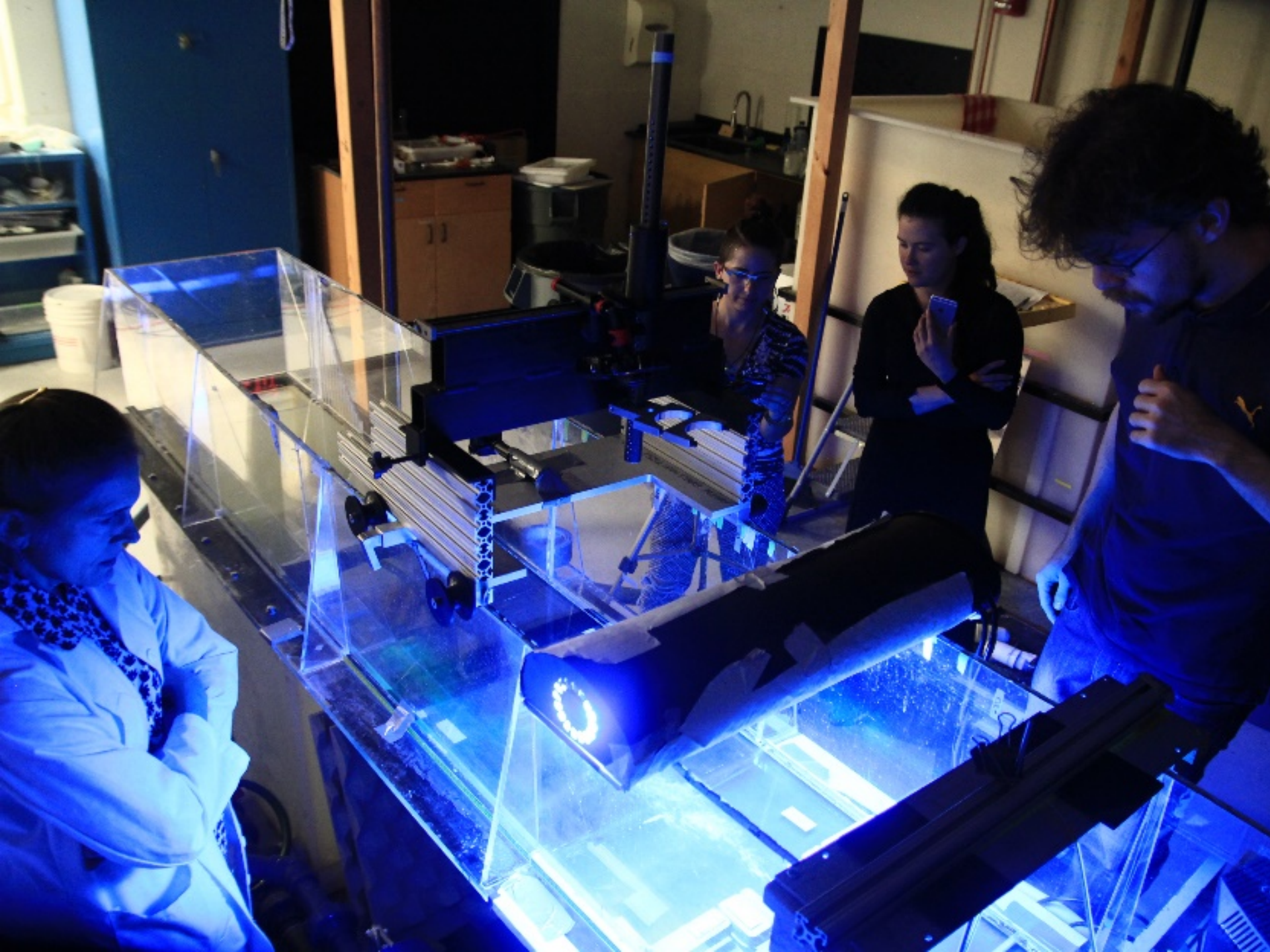
Flow Direction 

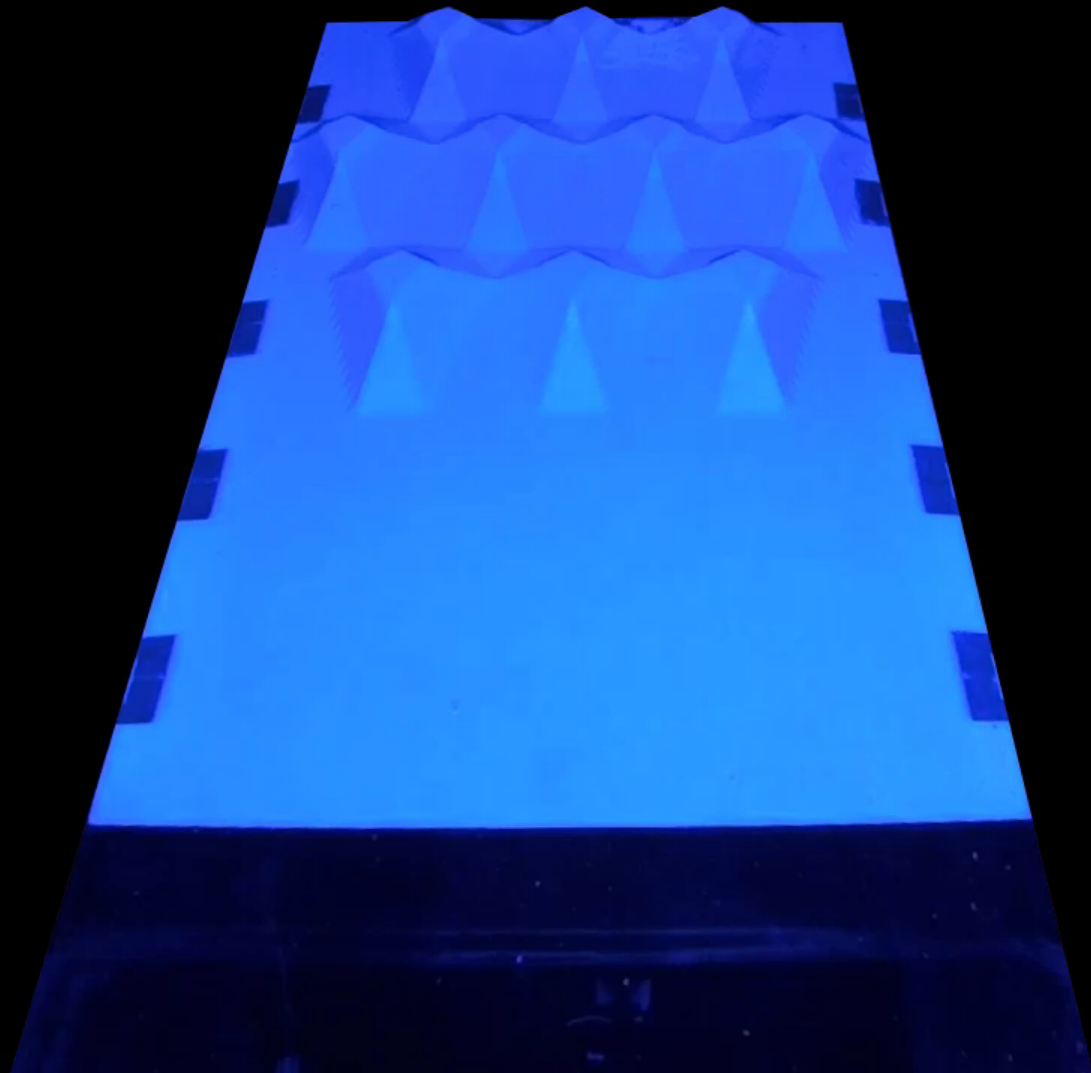
Islands 



Islands 

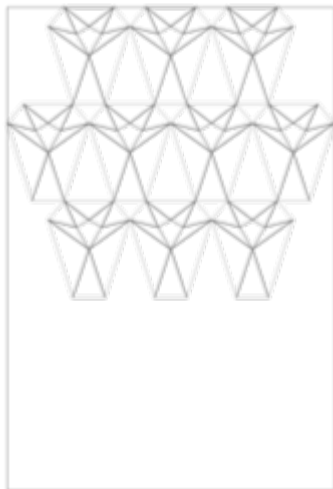
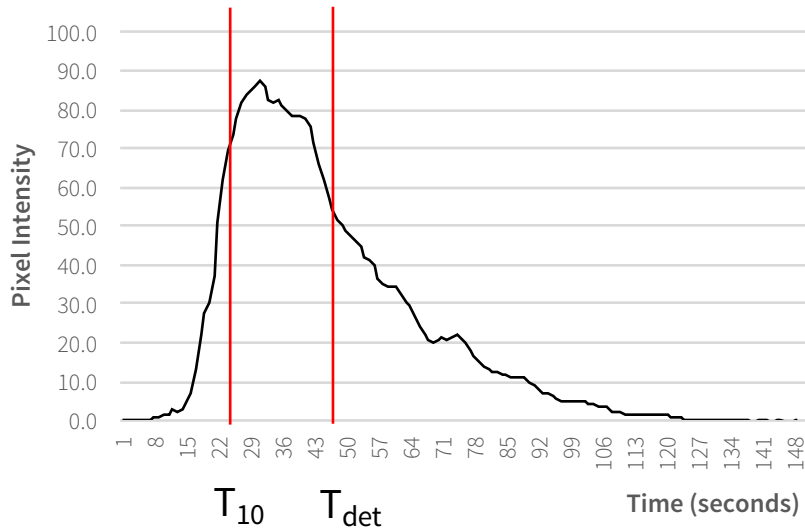






PRELIMINARY DATA

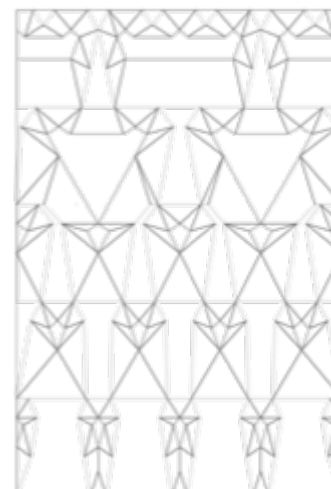
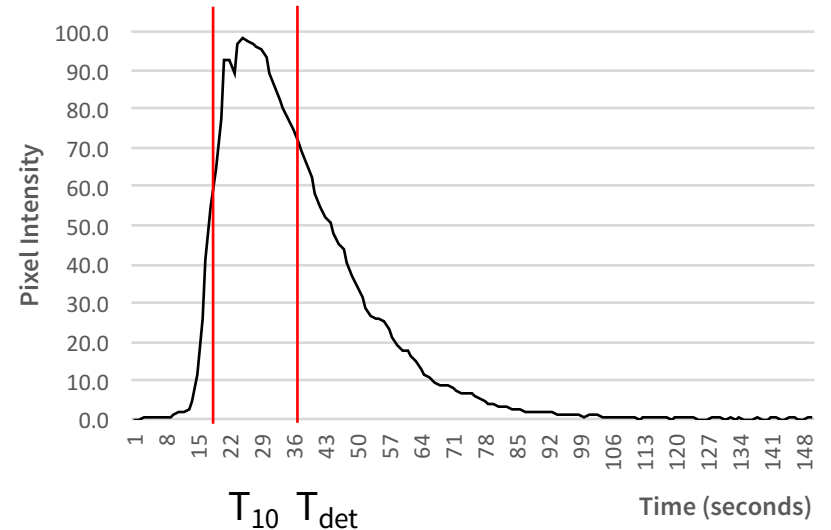
A2: Residence Time Distribution



$T_{10} = 24$ sec
 $T_{det} = 46$ sec
 $\Theta_{10} = 0.53$

A2

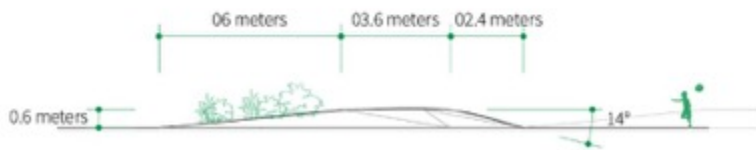
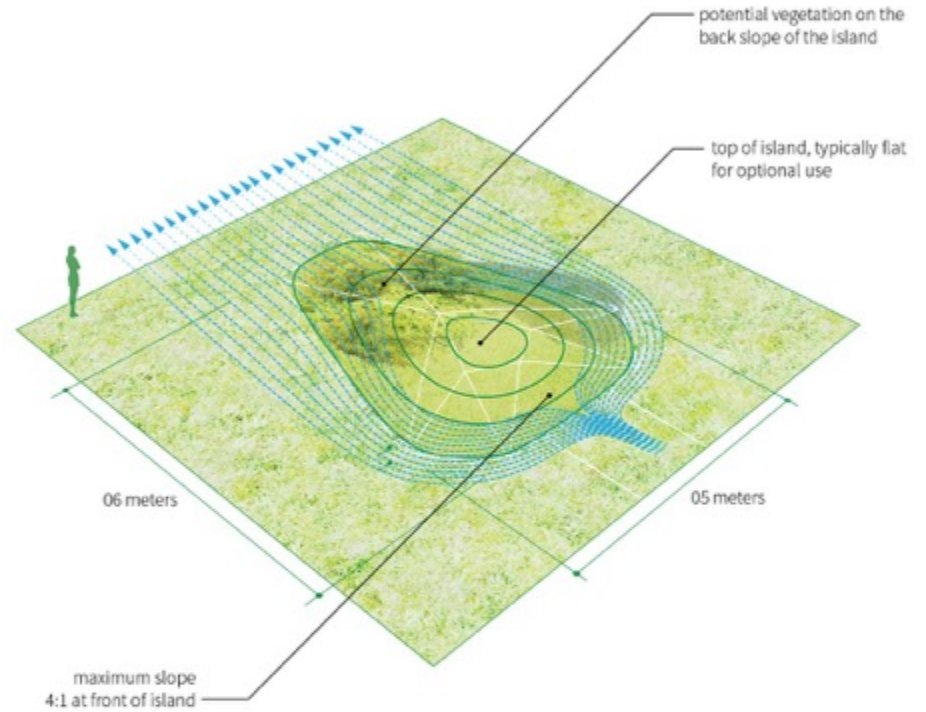
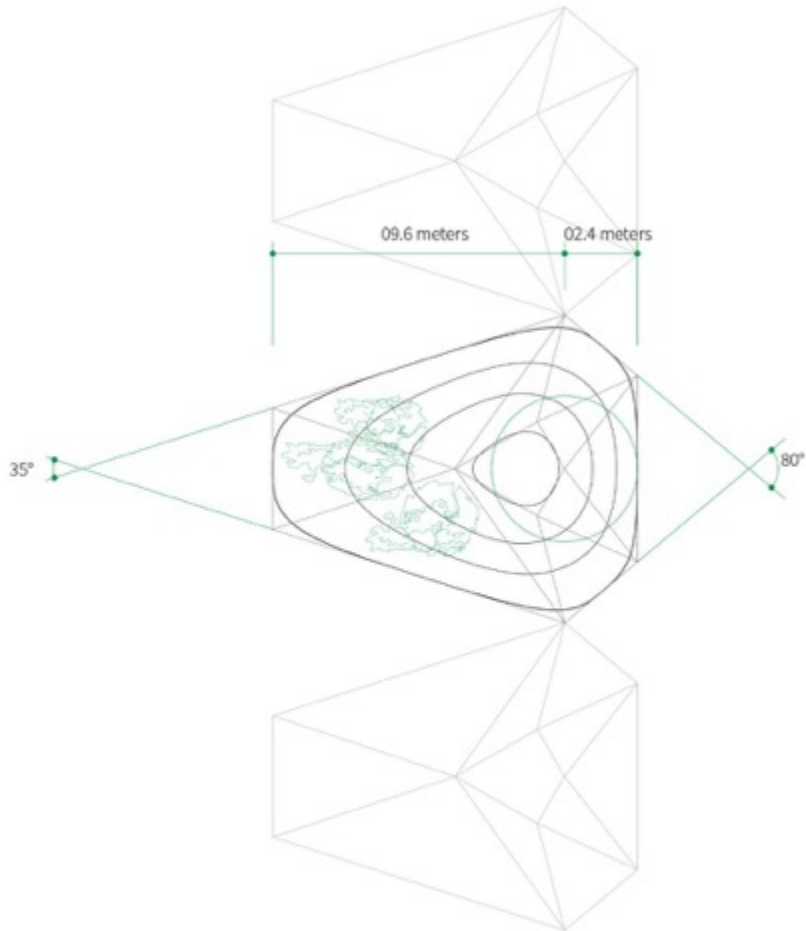
I1: Residence Time Distribution



$T_{10} = 20$ sec
 $T_{det} = 37$ sec
 $\Theta_{10} = 0.55$

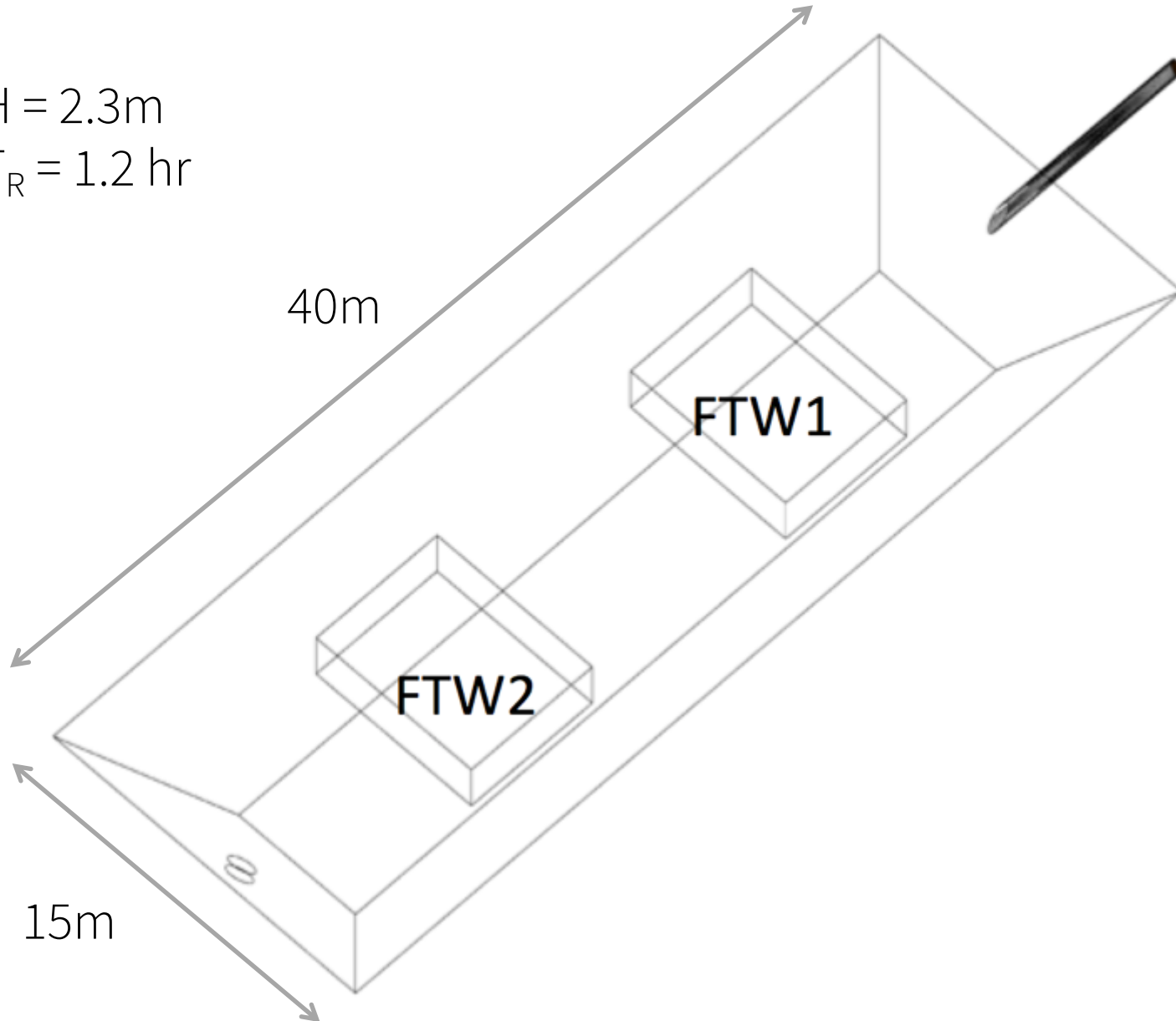
I1

ISLAND SHAPE & WATER FLOW

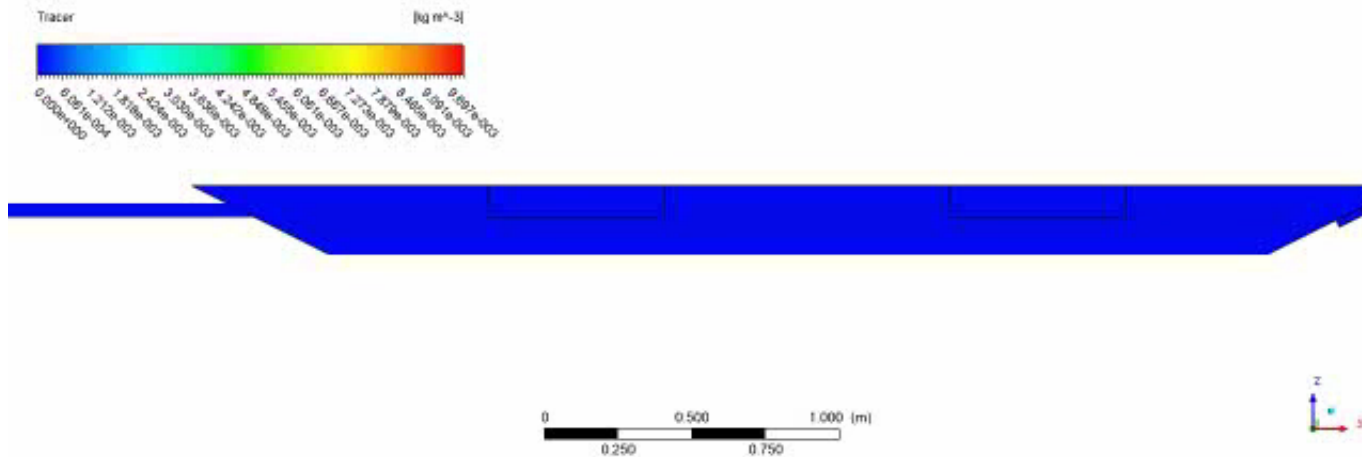
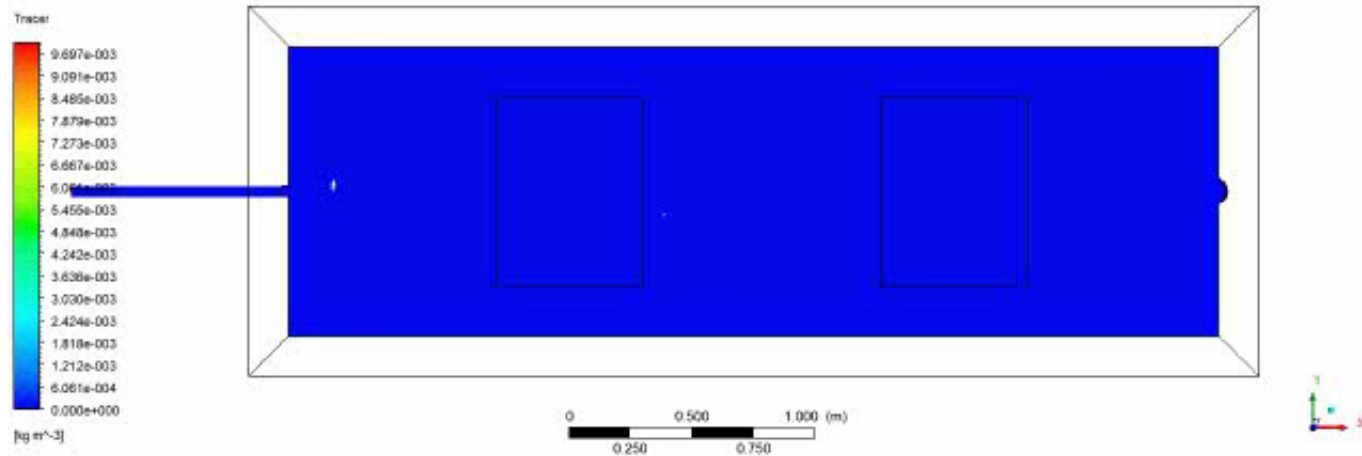


CFD modeling of Stormwater Pond with FTW based on pond described in Khan et al 2013

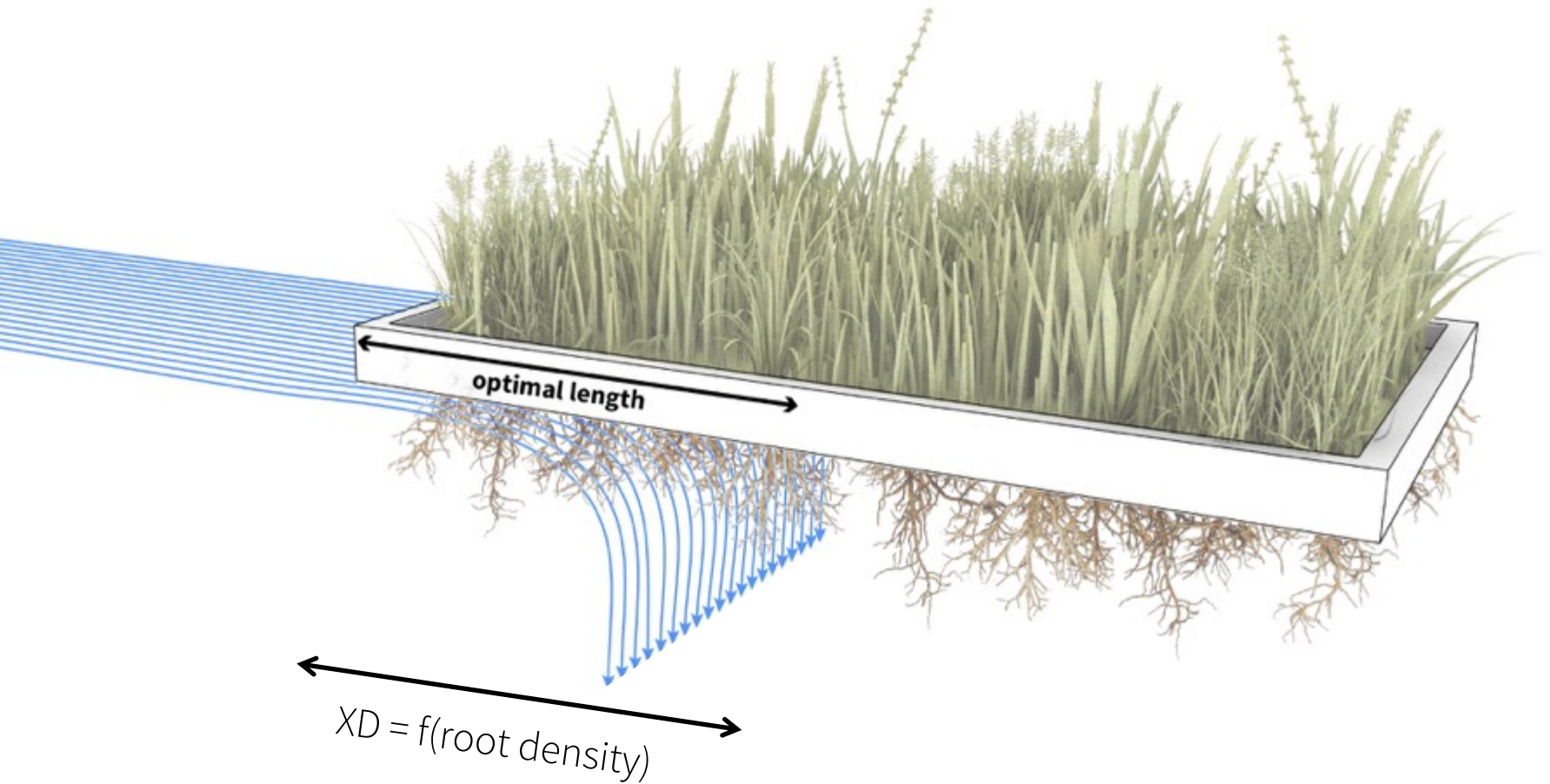
$H = 2.3\text{m}$
 $T_R = 1.2\text{ hr}$



Scalar Transport Modeling With First-Order Reaction in Root Zone $Me/Mo = 0.91$



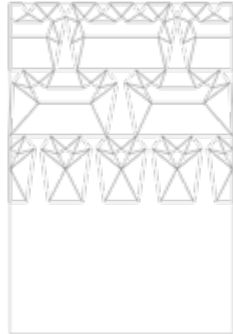
Importance of Leading Edge



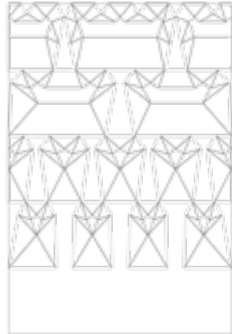
70% of treatment provided in first 1-m of FTW

EXPERIMENT CONFIGURATIONS

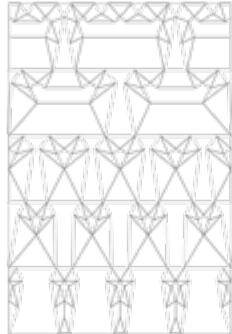
Topographies



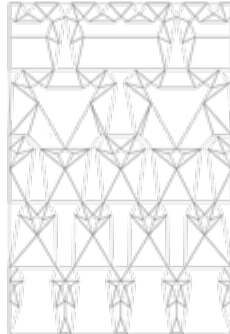
B1



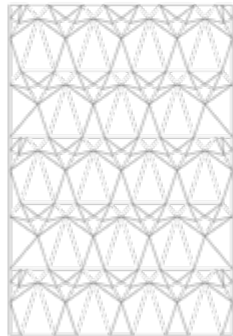
B2



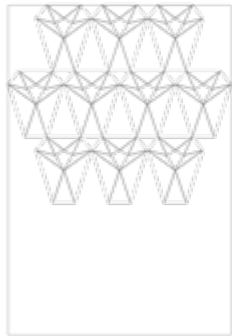
B3



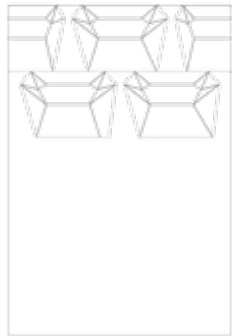
I1



A1



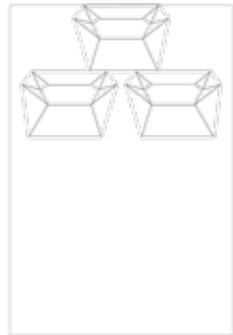
A2



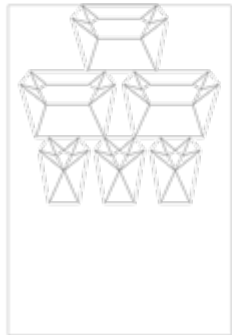
B4



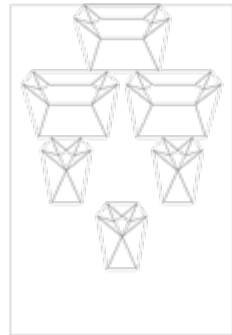
B5



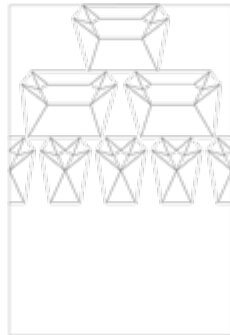
C1



C3

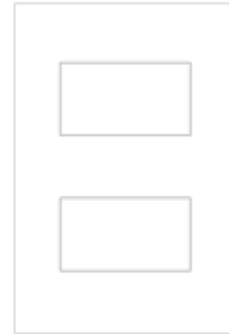


C5



C2

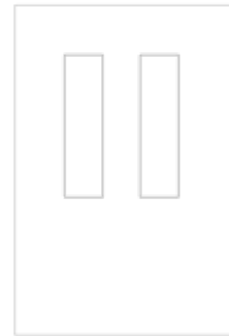
FTW



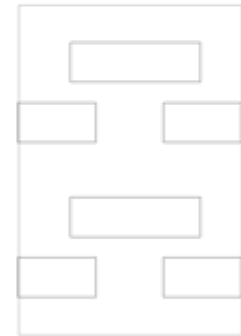
A



B



C

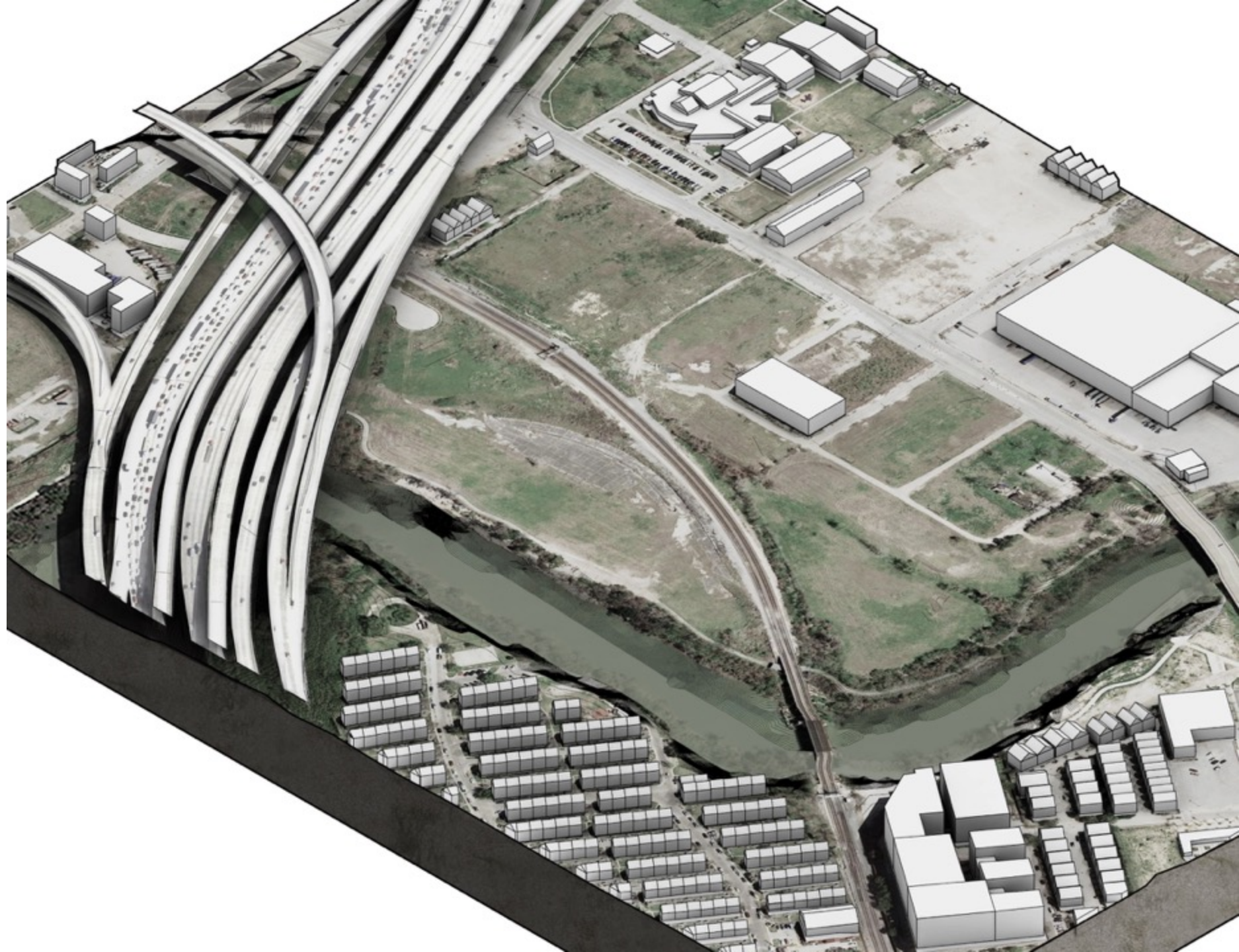


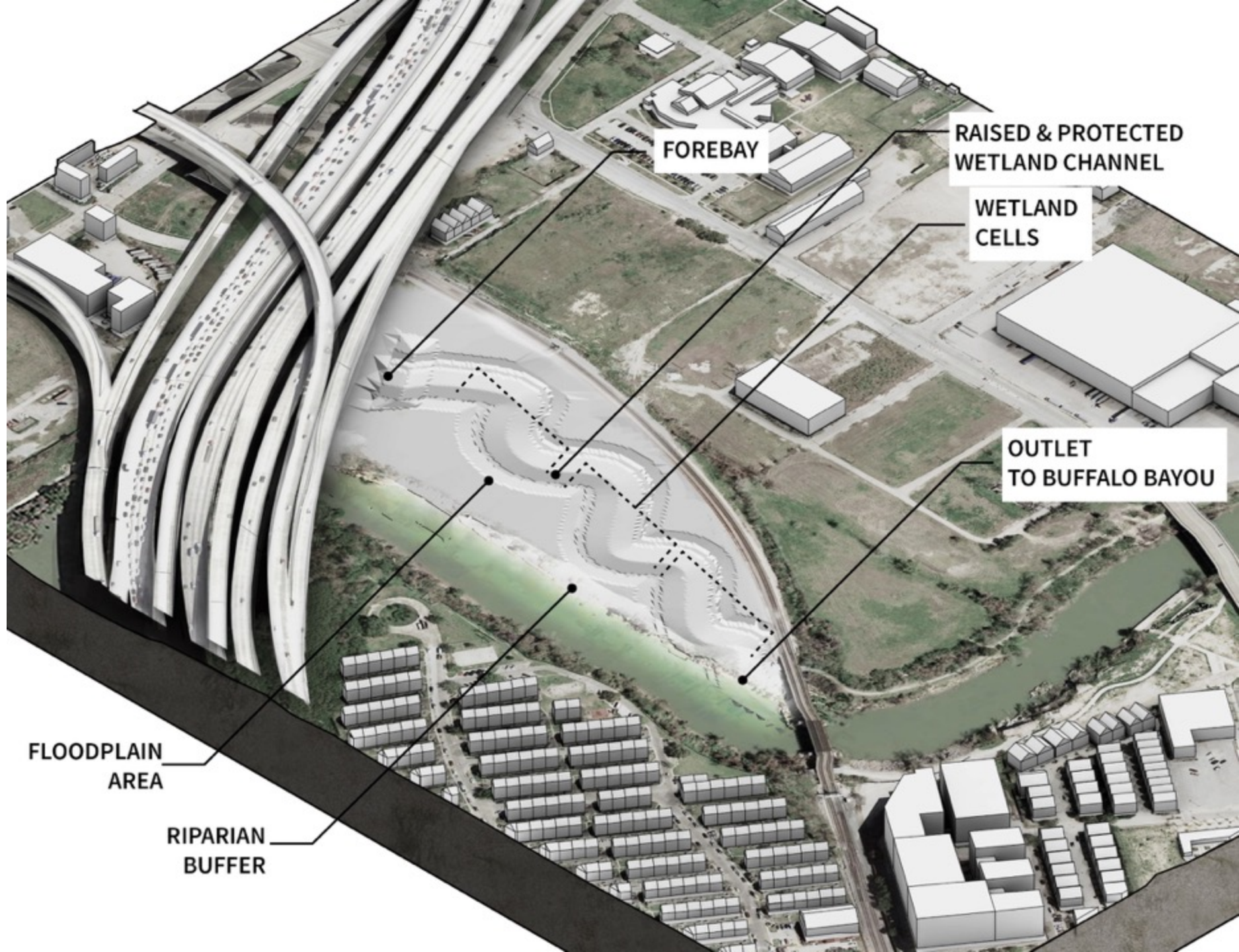
D



SITE DESIGN

Buffalo Bayou
Houston, TX





FOREBAY

RAISED & PROTECTED
WETLAND CHANNEL

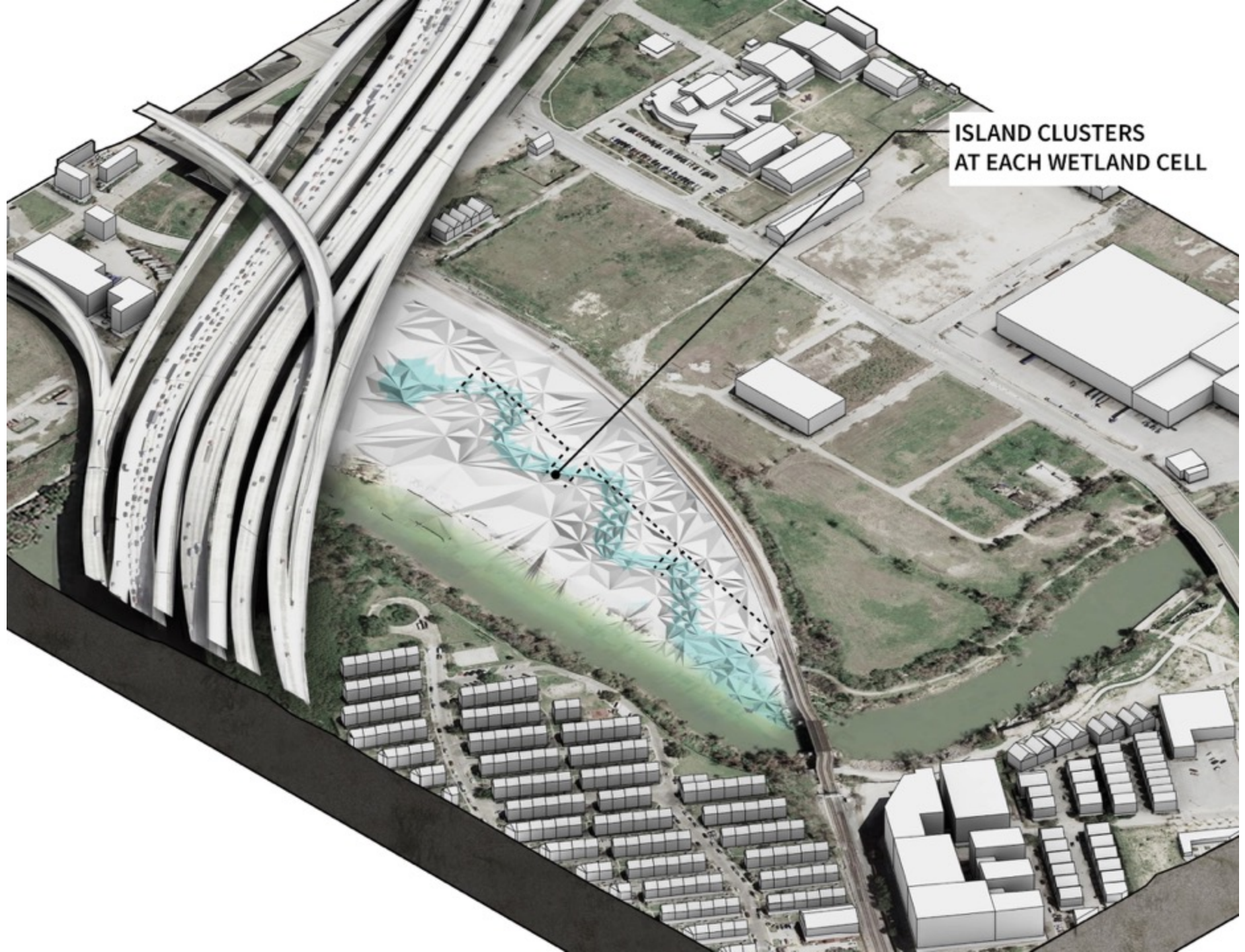
WETLAND
CELLS

OUTLET
TO BUFFALO BAYOU

FLOODPLAIN
AREA

RIPARIAN
BUFFER

**ISLAND CLUSTERS
AT EACH WETLAND CELL**



An aerial architectural rendering of a development project. On the left, a multi-lane highway with several overpasses curves through the scene. To the right of the highway, there is a large, open green field with a winding path. In the foreground, a residential development is shown with numerous small, rectangular buildings arranged in rows. To the right of the field, there are several larger, white industrial-style buildings. The overall scene is a mix of infrastructure, nature, and urban development.

WORK IN PROGRESS

Design Guidelines:
Summer 2017

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