Climate Change Vulnerability Assessment & Resilience Design Plan for Back River Wastewater Treatment Plant

EHE DESIGN TEAM

Lalitha Aiyar, Ciaran Cole, Emily Klaus, Ricardo Montiel, & Joey Stanley
Department of Environmental Health & Engineering

JOHNS HOPKINS
WHITING SCHOOL of ENGINEERING

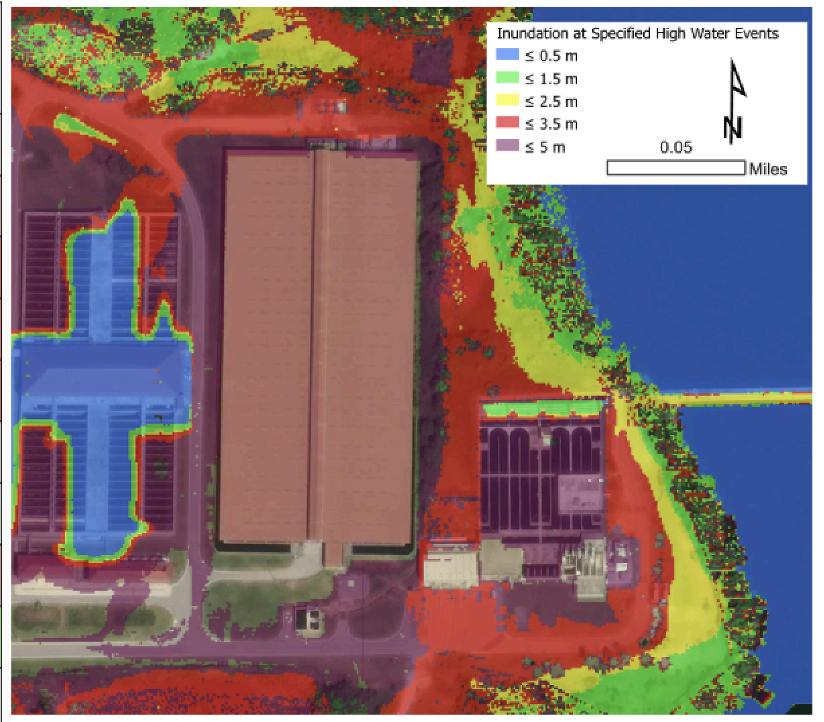
Problem Overview

- The Back River Wastewater Treatment Plant (BRWWTP), above, is a critical piece of infrastructure in Baltimore serving 1.3 million people
- Located on low-lying land along the Back River, the risk of flooding is expected to increase due to higher sea levels & storm intensity
- Flooding risks include damage to the plant and disrupting operations
- The Environmental Engineering Senior Design Team integrated nature-based (green) and conventional (gray) infrastructure solutions to bolster the plant's resilience through the year 2100

Site Hazards & Vulnerabilities

Facility Surrounding Elevation Above Sea Level (m)
Under High Emissions Scenario & 100 Year Storm Surge

Facility	2080	2100	2120
Island Point Road	-0.2	-0.5	-0.8
Activated Avenue	-1.1	-1.4	-1.7
Outfall Pier	-0.9	-1.2	-1.5
Potential Berm	-1.1	-1.4	-1.7
Flushing Water Pump	0.3	0	-0.3
Filtration Facility	1.1	0.8	0.5
Secondary Clarifiers	-0.4	-0.7	-1
Chlorination Shed	2.4	2.1	1.8
East Sludge Lagoon	0.7	0.4	0.1



- Climate hazards that will affect the plant through 2120 include sea level rise, increased storm intensity, and wave forcing
- Major concerns are inundation of the site's infrastructure and surrounding ecosystems and shoreline erosion
- According to NOAA projections and lidar data, several site structures and two roads will be below sea level in future 100-year storm surge scenarios
- Most impacted sites: Island Point Road, Activated Avenue, the Flushing Water Pump Scale, and Secondary Clarifiers
- Increased runoff and sedimentation may also harm the local ecosystem

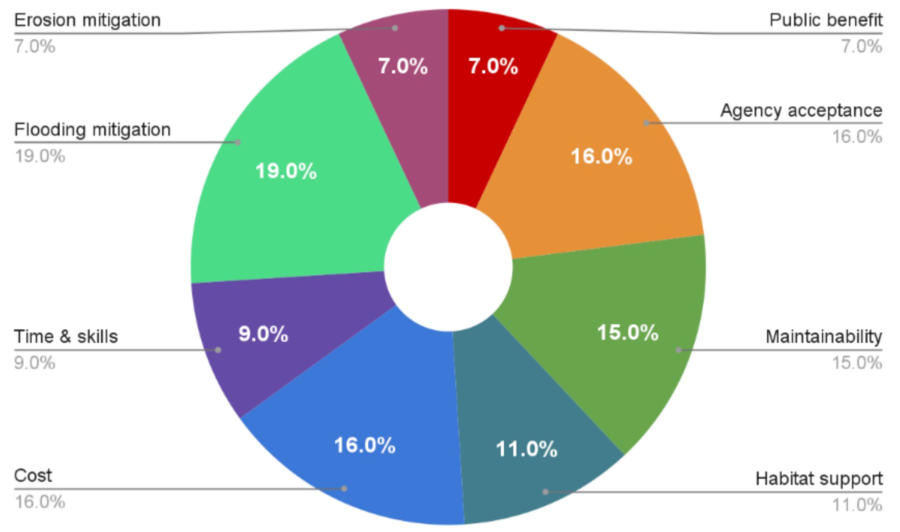
Multi-Criteria Decision Analysis

Alternatives Considered

	Wetland	Road realignment	Revetment	Seawall
A1: No Action	✗	✗	✗	✗
A2: Wetland	✓	✗	✗	✗
A3: Road realignment	✗	✓	✗	✗
A4: Seawall	✗	✗	✗	✓
A5: Realignment, revetment	✗	✓	✓	✗
A6: Wetland, realignment	✓	✓	✗	✗
A7: Wetland, realignment, & revetment	✓	✓	✓	✗

- Combinations of four adaptations were considered: a constructed wetland (also known as a living shoreline), road realignment, revetment, & a seawall
- 7 alternative combinations (including 'No Action' as a baseline) were assessed and are shown in the table above

Criteria & Weights Used



- The 7 alternatives were assessed on 8 criteria, which were weighted based on importance (shown above)
- Flooding mitigation, cost, and maintainability were some of the most important factors

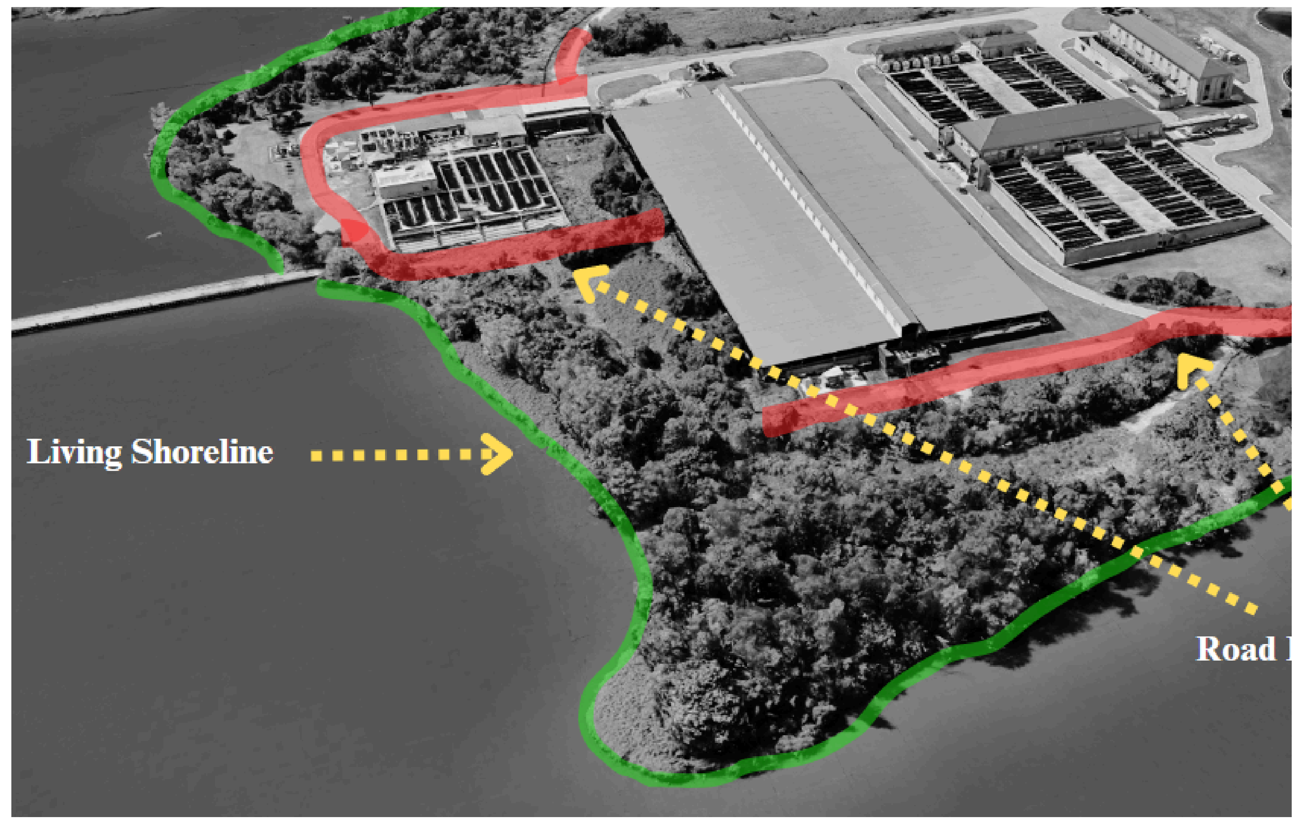
Alternative Scores

	Alternative	Score
1	Road realignment & coastal wetland	3.97
2	Road realignment, revetment, & coastal wetland	3.65
3	Coastal wetland	3.41
4	Road realignment	3.37
5	Road realignment & revetment	3.30
6	Seawall	3.02
7	No Action	2.70

- Based on the weighted scores (above), a combination of wetlands and road realignment were most favorable
- Constructed wetlands performed well across alternatives
- The seawall was least optimal due to high cost and environmental risk

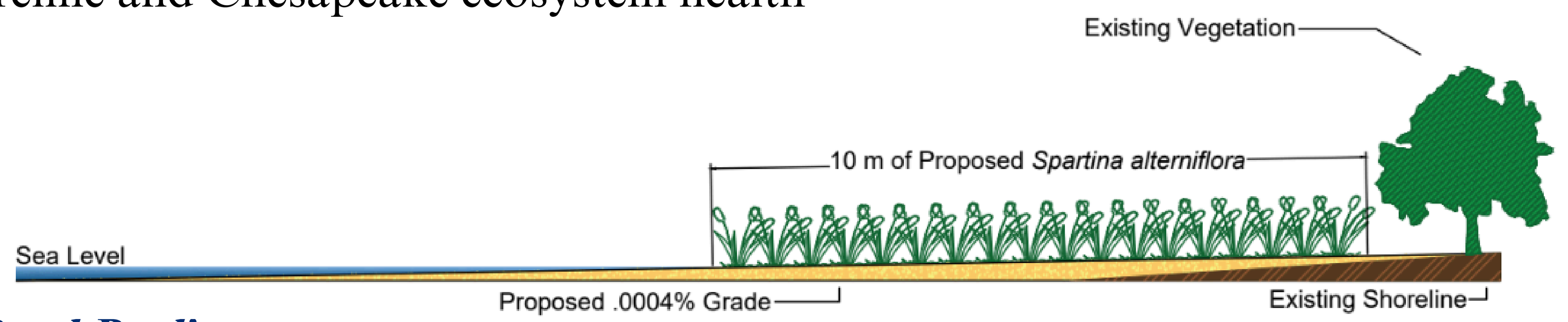
Proposed Design

Based off the decision analysis results, our proposed design couples a living shoreline with an elevated grade road realignment which addresses both shoreline erosion and the increased risk of infrastructure inundation. The solution is cost effective in the long term, benefits local ecology, is aesthetically pleasing, and aligns with Maryland and federal guidelines.



Living Shoreline

- 1500 meters of shoreline restoration through the creation of tidal wetlands planted with native vegetation
- Designed to absorb wave energy, reduce erosion, and treat stormwater runoff before it enters Back River
- Graded design allows for inland marsh migration as sea level rises, enhancing long term adaptability
- Enhances shoreline and Chesapeake ecosystem health



Elevated Grade Road Realignment

- Elevating 530 m of road, including Activated Avenue and Island Point Road, 3.7 m above sea level
- The roads will use permeable interlocking concrete pavement and geogrid reinforced backfill and include underdrain systems for drainage integrity
- Vegetated embankments will stabilize slopes and remain compatible to realigned sections near new wetlands