Overview

- Context / Project Goals
- Neighborhood Integration
  - 3 Protoblocks
- Efficiency: Protoblock Form
  - NV
  - Daylighting
  - PV/Energy Usage
- Resiliency: Block Distribution
  - Coastal Flooding
  - Climate Change
  - Permeable pavement / green roofs
  - park/ block distribution
- Livability: Access to Amenities
  - Walkability, parking, UTCI
  - Paths + 3rd Place
- Exploring Tradeoffs: PV vs. GR
- Conclusions
Introduction
Introduction
Urban Analysis

South Boston

Convention Center

Innovation District

Current Site
<table>
<thead>
<tr>
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<th>Resiliency</th>
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<td>Thermal comfort</td>
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Efficiency

Energy
Daylighting
Natural ventilation
Renewables

Resiliency

Extreme events
Coastal flooding
Urban stormwater runoff
Risk-based zoning

Livability

Pedestrian-oriented
Green spaces
Access to amenities
Thermal comfort
Protoblock Development
Protoblock Design

Houses and Corners
mostly residential + some commercial
Protoblock 1

Stepped Mixed Use
residential above + commercial / retail below
Protoblock 2

Environmental Mixed Use
Residential towers + commercial / retail below
Protoblock 3
Protoblock Design

Houses and Corners
mostly residential + some commercial
Protoblock 1

Stepped Mixed Use
residential above + commercial / retail below
Protoblock 2

Environmental Mixed Use
Residential towers + commercial / retail below
Protoblock 3
Climate Analysis

21% NV feasible days
Ave DB Temperature : 10.59 C
Ave Relative Humidity : 65.67 %

Ave Wind Direction : 219 from North
Ave Wind Speed : 5.48 m/s
Environmental Consideration

Envelope Design
Natural Ventilation
Daylighting
Envelope Upgrade

<table>
<thead>
<tr>
<th>Construction</th>
<th>U - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Facade</td>
<td>Double-leaf brick + Insulation 0.073</td>
</tr>
<tr>
<td>Commercial Roof</td>
<td>Slate tile + Insulated concrete 0.040</td>
</tr>
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<td>Residential Facade</td>
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<tr>
<td>Residential Roof</td>
<td>Slate tile + Insulated concrete 0.045</td>
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Optimized WWR

S: 50%
N: 10%
W: 30%
E: 30%
Outdoor CFD

Running outdoor CFD On Protoblock

Wind Pressure Mapping On Protoblock
Openings and Chimneys
Buoyancy + Cross Ventilation

Adaptive Comfort:
96 days out of 8760 was out of adaptive comfort zone 80% boundary
Solar-Driven Design

Daylighting Simulation

Massing Optimization
Protoblock Design Development - Daylighting

1

2

3

Alternatives

Selected
Urban Block Development
Protoblock Design Development - Daylighting

Average sDA: 28
Average cDA: 49
Result of Analysis

Natural Ventilation Design

Daylighting Design
Protoblock Design Development - Energy Efficiency

Design upgrades (from typical neighboring building stock):

- Facade upgrades (wall/roof insulation)
- Window upgrades
  - + Savings from natural ventilation, photovoltaics
Protoblock Design Development - Energy Efficiency

Baseline

Upgrades

![Bar chart comparison between Baseline and Upgrades showing energy efficiency improvements. The chart illustrates the reduction in energy consumption across various categories such as lighting, pv, hot water, heating, equipment, and cooling.](chart.png)
Protoblock Design Development - Energy Efficiency

Baseline

Upgrades

Results:

10% Savings on heating / cooling

26% Potential savings through PV
Efficiency

- Energy
- Daylighting
- Natural ventilation
- Renewables

Resiliency

- Extreme events
- Rising temperatures
- Coastal flooding
- Urban stormwater runoff

Livability

- Pedestrian-oriented
- Green spaces
- Access to amenities
- Thermal comfort
Flooding Scenario

<table>
<thead>
<tr>
<th>Zone ID</th>
<th>Description</th>
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<tbody>
<tr>
<td>AE</td>
<td>Flood risk</td>
</tr>
<tr>
<td>X</td>
<td>No current flood risk</td>
</tr>
</tbody>
</table>
Climate change
Stormwater Runoff

Waterflow Scenario
Low Impact Development (LID Practice)

Percentile Data (95th): 38.6 mm

Annual Average Rainfall: 41.92 (inches)
Annual Average Runoff: 23.34 (inches)
Max rainfall Retained: 1.58 (inches)

Total Rainfall: 1577.89 M3
Urban Surface Typical Design

<table>
<thead>
<tr>
<th></th>
<th>Areas</th>
<th>Runoff</th>
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</thead>
<tbody>
<tr>
<td>Roofs</td>
<td>Asphalt</td>
<td>68532</td>
</tr>
<tr>
<td>Open Space</td>
<td>Good Grass 75%</td>
<td>25392</td>
</tr>
<tr>
<td>Impervious Paving</td>
<td>Curbs &amp; Sewers</td>
<td>33721</td>
</tr>
<tr>
<td>Road</td>
<td></td>
<td>40780</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>168425</td>
</tr>
</tbody>
</table>

Total Runoff : 1167.64 M3
Stormwater Runoff Design

Urban LID Practical Design 1

<table>
<thead>
<tr>
<th>Area</th>
<th>Runoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofs Asphalt</td>
<td>39754</td>
</tr>
<tr>
<td>Green roofs</td>
<td>28778</td>
</tr>
<tr>
<td>Open Space Good Grass</td>
<td>25392</td>
</tr>
<tr>
<td>Impervious Paving Road</td>
<td>18710</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>22070</td>
</tr>
</tbody>
</table>

Total Runoff: 883.24 M3
Stormwater Runoff Design

Urban LID Practical Design 2

<table>
<thead>
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<th>Areas</th>
<th>Runoff</th>
</tr>
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<tbody>
<tr>
<td>Roofs Green roofs</td>
<td>68532</td>
</tr>
<tr>
<td>Open Space Bioretention</td>
<td>25392</td>
</tr>
<tr>
<td>Impervious Paving Road</td>
<td>18710</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>55791</td>
</tr>
</tbody>
</table>

Total Runoff: 466.8 M3
## Equivalent Residential Unit (ERU)

<table>
<thead>
<tr>
<th></th>
<th>LID 1</th>
<th>Maintenance</th>
<th>Capital Cost</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green roofs</td>
<td>$ 750,600 - $ 1,512,400</td>
<td>$ 8,400 - $ 84,300</td>
<td>$ 1,761,700 - $ 3,542,000</td>
<td>$ 19,800 - $ 198,300</td>
</tr>
<tr>
<td>Bioretention</td>
<td>$ 24,400 - $ 50,300</td>
<td>$ 900 - $ 21,500</td>
<td>$ 58,900 - $ 122,600</td>
<td>$ 2,400 - $ 57,400</td>
</tr>
<tr>
<td>Street Platers</td>
<td>$ 145,600 - $ 353,000</td>
<td>$ 2,400 - $ 56,400</td>
<td>$ 145,600 - $ 353,000</td>
<td>$ 2,400 - $ 56,400</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>$ 920,600 - $ 1,915,600</td>
<td>$ 11,700 - $ 162,200</td>
<td>$ 3,842,100 - $ 6,493,100</td>
<td>$ 45,800 - $ 400,600</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$ 920,600 - $ 1,915,600</td>
<td>$ 11,700 - $ 162,200</td>
<td>$ 3,842,100 - $ 6,493,100</td>
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ERU cost for Typical design: $ 16,787 (143,033 m²)
Efficiency

- Energy
- Daylighting
- Natural ventilation
- Renewables

Resiliency

- Extreme events
- Coastal flooding
- Urban stormwater runoff
- Risk-based zoning

Livability

- Pedestrian-oriented
- Green spaces
- Access to amenities
- Thermal comfort
# Street Design

<table>
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<tr>
<th></th>
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<th>Retail</th>
<th>Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Parking</td>
<td>800</td>
<td>450</td>
<td>160</td>
</tr>
<tr>
<td>On-street</td>
<td>1150</td>
<td>Garage</td>
<td>260</td>
</tr>
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Outdoor Thermal Comfort

UTCI Universal Thermal Climate Index
3rd Place Analysis

Facilities
Amusement
Health
Sotre
Food
Transportation

5 mins
6 mins
10 mins
15 mins
Urban Exploration

View analysis

Amenities on map

Trees on map

Slope analysis

UTCI on map

All on map
Walk Score: 82
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Horizontal Surfaces - PV or GR?

PV

Green Roofs
PV vs. GR

Based on NREL (2014) and Blackhurst (2010)
PV vs. GR
PV vs. GR
PV vs. GR

Best PV Samples

Best GR Samples
PV vs. GR

Best PV Samples

Best GR Samples

Graph showing simple ROI vs. building lifetime with two lines: one representing high ROI and the other representing low ROI.
PV vs. GR

Design Goals:
PV vs. GR

Design Goals:
Offset at least 20% of energy loads
PV vs. GR

Design Goals:

- Offset at least 20% of energy loads
- Select design that outperforms curve
PV vs. GR

Design Goals:

Offset at least 20% of energy loads

Select design that outperforms curve
PV vs. GR

Desired Minimum PV Potential
PV vs. GR

Desired Minimum PV Potential
PV vs. GR

~ 70% PV / 30% GR
Offsets 20% of energy loads
Stores 3% of runoff from 3 hr storm
~ $15.3 million cost / 1.4 million annual savings
PV vs. GR

~ 70% PV / 30% GR
Offsets 20% of energy loads
Stores 3% of runoff from 3 hr storm
~ $15.3 million cost / 1.4 million annual savings
## Financial Analysis

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<th>PV/GR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial construction costs (m $)</strong></td>
<td>454.6</td>
<td>188.5</td>
<td>93</td>
<td>15.3</td>
<td>751.4</td>
</tr>
<tr>
<td><strong>Annual Revenue (m $)</strong></td>
<td>78.8</td>
<td>81</td>
<td>29.7</td>
<td>1.4</td>
<td>190.9</td>
</tr>
<tr>
<td><strong>Investment Yield</strong></td>
<td>19.978%</td>
<td></td>
<td></td>
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<td></td>
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Urban Energy Modeling
Boston Seaport District: Nathan Brown, Mario Giampieri, Ellie Jungmin Han, NJ Namju Lee