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SUSTAINABLE LANDSCAPE PERFORMANCE: BOSTON CASE STUDIES

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Boston Architectural College
School of Landscape Architecture
TSM2200 Spring 2024
Instructor: Hongbing Tang, ASLA, PLA, LEED AP

Acknowledgments

Our sustainable landscape performance case study project sites in Boston are located on the ancestral territory of the Massachusett Tribe, the original occupants of what is now known as Boston (hunap.harvard.edu n.d.). We pay our respects to the past and present Massachusett Tribal members, as well as the land itself, which remains sacred to the Massachusett People.

The class is grateful for the following firms' great support in providing connections and resources for collecting information of our case studies in Boston:

- Arcadis - Boston Chinatown Park
- Arcadis - Christian Science Plaza
- Copley Wolff Design Group - Wharf District Parks
- Reed Hilderbrand - Pier 4
- Richard Burke Associates – Fan Pier Park
- STIMSON – Harvard Science & Engineer Complex

The students would also like to thank Megan Barns from the Landscape Architectural Foundation, Margarita Iglesia, the BAC program director, their course instructor this semester, Hongbing Tang, all the guest speakers and landscape architects who led our field trips.

Image: H. Tang

Project Areas

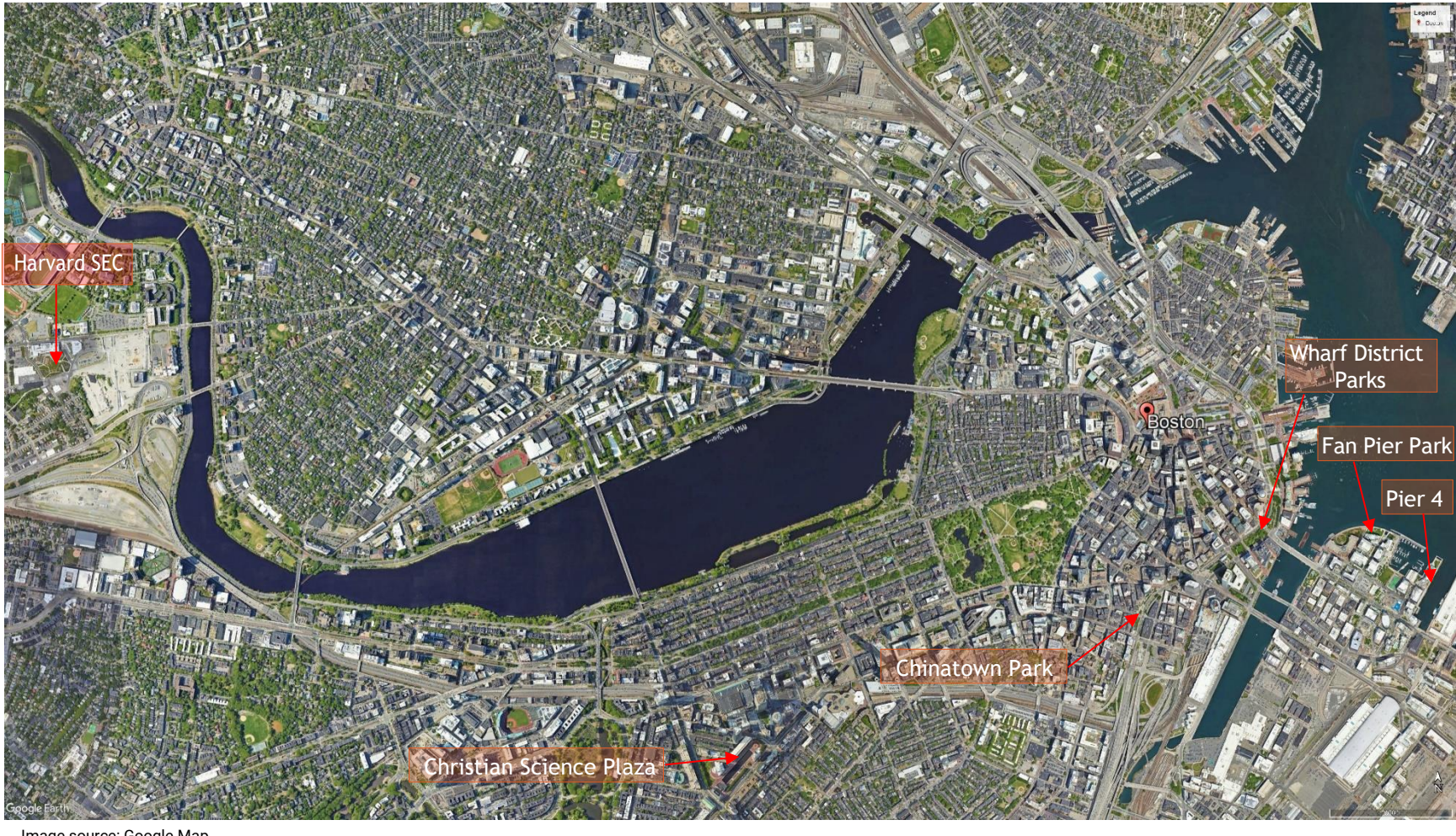


Image source: Google Map

Objectives & Learning Outcomes

- To understand the concept and implications of landscape performance for the contemporary practice of landscape architecture
- To be aware of successfully built projects and design practices demonstrating exemplary landscape performance
- To demonstrate proficiency in developing landscape performance assessment strategies and researching eco-technology processes
- To explore both qualitative and quantitative methods in evaluating landscape performance
- To communicate landscape performance assessment in effective visual and written representation
- To be prepared to advocate for sustainable planning and design strategies, operative landscapes in academic and professional work

Project List

Mustafa Kaplan | **Fan Pier Park**

Hannah Osborn | **Wharf District Parks**

Ashley Pepen | **Christian Science Plaza**

Samer Samarani | **Pier 4 Phase 3**

Zijie Zhu | **Boston Chinatown Park**

Jill Ziegler | **Harvard Science and Engineering Complex (Harvard SEC)**

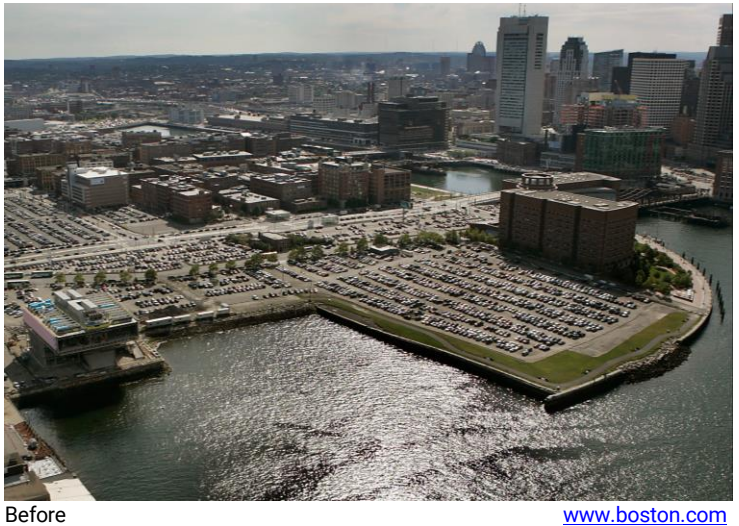
Fan Pier Park

25 Fan Pier Boulevard, Boston, MA

Mustafa Kaplan

Overview

Located in Boston's Seaport District, Fan Pier Park is a two-acre, publicly accessible waterfront park, developed in two phases. Capturing the iconic views of Boston and its bustling Harbor stands as the key design theme of the park. Angular granite terraces gracefully cascade from a central lawn, honoring the waterfront as a dynamic stage for the active harbor. At the heart of Fan Pier Park lies the majestic Tidal Well, strategically positioned along the axis of Fan Pier Boulevard. Fan Pier Park beckons both moments of expansive wonder and tranquil reflection, harmonizing the grandeur of the harbor vistas with inviting spaces for leisure and repose.



Before www.boston.com

After www.fanpierboston.com

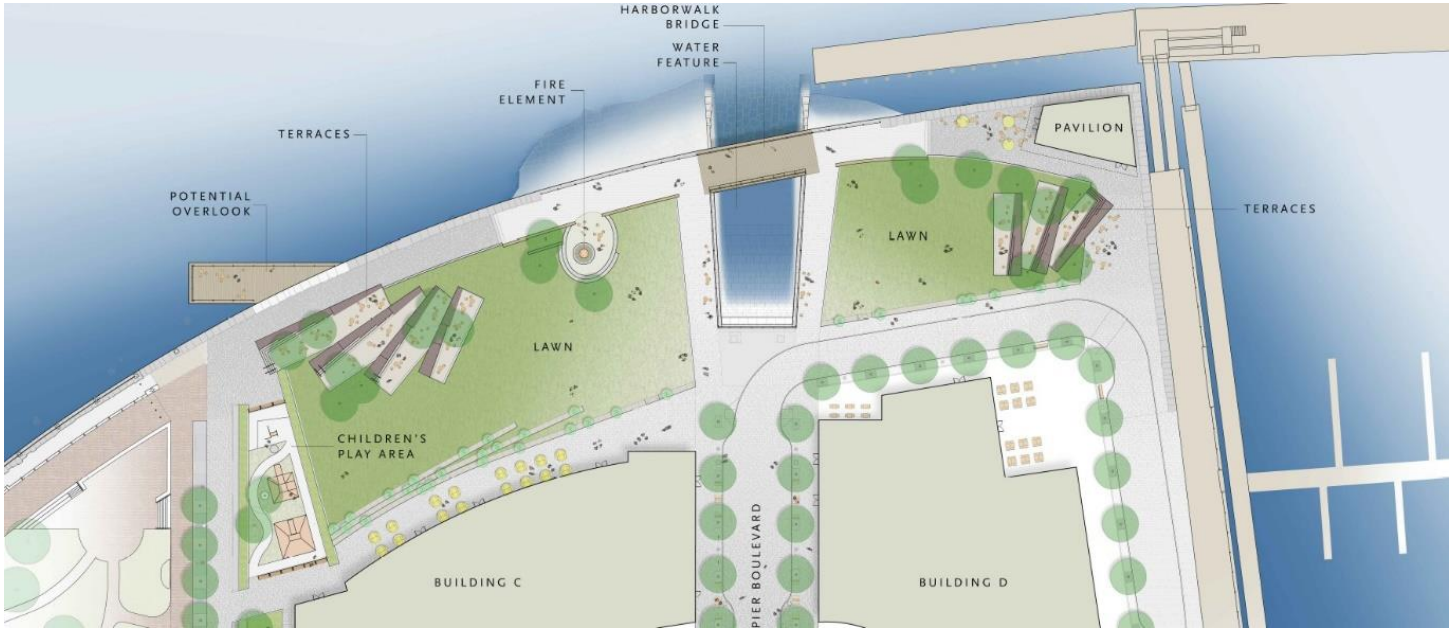
At a Glance

Designer:	Richard Burck Associates (RBA)	**Project Type:**	Waterfront Park
Former Land Use:	Parking lot	**Size:**	2 acres
Completion Date:	2019	**Budget:**	$ 9,800,000

Project Goals

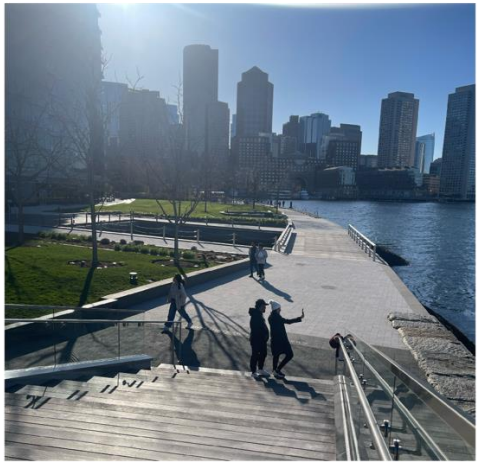
- Create public open spaces and continue Harbor walk along the water to maximize waterfront access and enhance the quality of life for residents and visitors.
- Incorporate the dramatic views of Boston and its Harbor into the park design.
- Integrate the development with transit infrastructure to enhance accessibility and reduce reliance on private vehicles, thereby promoting sustainable urban mobility.
- Promote a variety of activities along the waterfront.

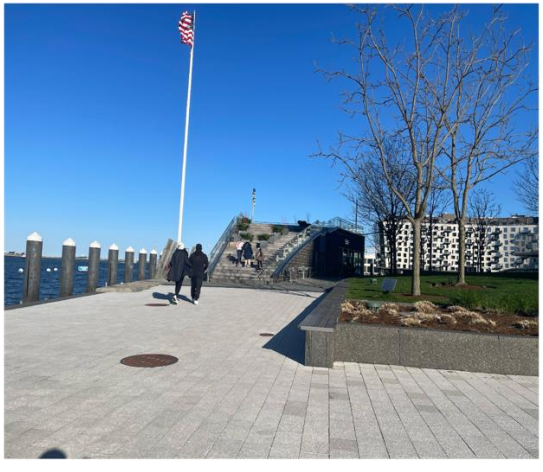
Site Plan

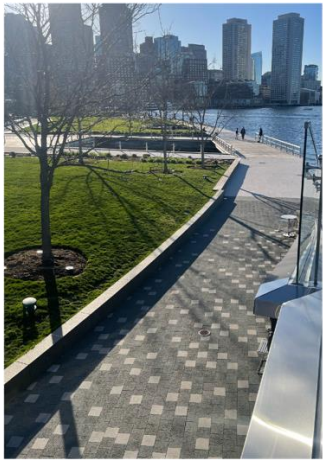


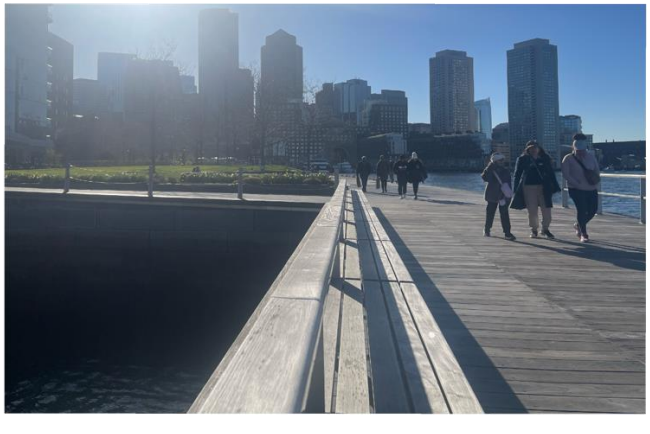
Source: Richard Burck Associates

Site Images









by Mustafa Kaplan

Landscape Performance Benefits

Environmental Benefits

• ***Reduces peak runoff rate for a 100-year storm by an estimated 57.80% and reduces runoff volume by 178,440 gallons for a 100-year, 24-hour storm as compared to pre-development conditions.***

Methods:

Landscape plan provided by RBA to estimate the peak runoff rate for a 100-year storm. AutoCAD was used to calculate the areas of each different surface cover. Modified rational method was adopted as it is a simplified model of the hydrologic process.

Calculation:

Peak runoff rate reduction:
Modified Rational Method Formula: Qp = CCaiA
Qp = peak runoff rate, cubic feet per second (cfs)
C = runoff coefficient (unitless)
CA = antecedent precipitation factor (unitless)
i = rainfall intensity, inches per hour (iph), for storm duration = the time of concentration (Tc)
A = drainage area, acres (ac)

Pre-Development Site Land Cover
Parking surface material: concrete, 100% impervious
Runoff coefficient for concrete: C = 0.95
A = Total site area = 83653.01 sf = 1.920 acres

Landcover	Area (SF)	Acre (ac)	Runoff Coefficient (C)	Adjusted Area C*A
Lawn	29103.1	0.66	0.3	0.198
Stone paving	11642	0.267	0.7	0.1869
Concrete	18164	0.41	0.95	0.3895
Crush stone paving	3753	0.08	0.3	0.024
TOTAL	62662.1	1.357		0.7984

Weighted Runoff Coefficient:
C weighted = Adjusted Area / Total Site Area = 0.7984/1.920= 0.40

100-year storm frequency
The rainfall intensity is 5.4 iph for a 100-year storm frequency from the Rainfall Intensity Chart for Boston, MA

We use 15 minutes for the time of concentration Tc based on the common practice noted in Site Engineering for Landscape Architects (Strom, Nathan, and Woland 2013): "Since it takes several minutes for rain to wet a surface thoroughly, many municipalities permit the use of minimum times of concentration, such as 10 or 15 minutes. This will reduce the intensity used for the computation of the runoff rate" (Strom, Nathan, and Woland 2013, 266).

Formula: Qp = CCAiA
Qpre-development = 0.95 x 1.25 x 5.4 iph x 1.92ac = 12.312cfs
Qpost-development = C average x CA x i x A = 0.40 x 1.25 x 5.4 x 1.92 ac =5.184 cfs
Reduction rate: (12.312 – 5.184)/ 12.312 = **57.80%**
In Summary, 100-year design storm calculations show a 57.80% reduction in peak runoff rate comparing the pre- and post-development conditions.

Reduction of runoff volumes for a 100-year, 24-hour storm

Pre-development site runoff water in gallons:
The pre-project site was 100% impervious and covered with concrete (CN=98) Using the WinTR-55 software developed by NRCS, when inputting the Rainfall Distribution Type (Type III for Massachusetts) and choosing Suffolk County where Boston is located, a table of storm data is shown. For the 100-year storm return period, the 24-hour rainfall amount is 6.6 inches.

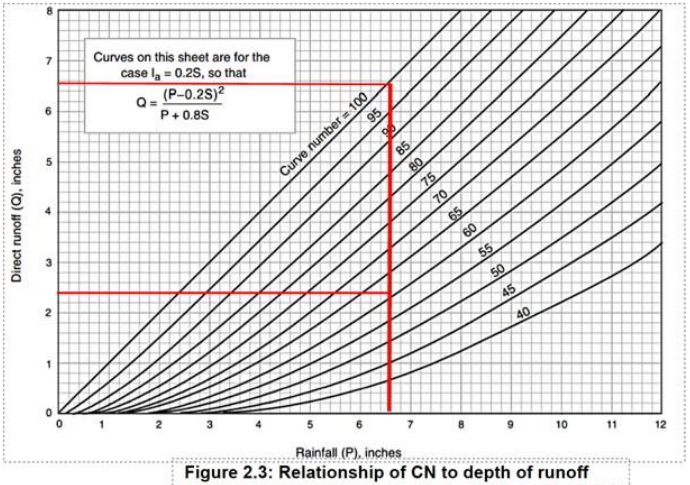


Figure 2.3: Relationship of CN to depth of runoff
Source: 210-VI-TR-55; Strom, Nathan, Woland 2013, 228

Runoff from 6.6-in rainfall on surface with Runoff Curve Number (CN)=98 is 6.55-in

Pre-development Runoff Volume = 6.55in x 1 ft /12 in x 83653.01sf = 45,660 cf
45,660 cf x 7.48 gallons/cf = **341,541 gallons**

Land cover	Curved number	Area (sf)	Runoff generated(inch)
Impervious urfaces	98	29185.2	6.55
Pervious surfaces	61	29620.8	2.38

Runoff Vol. = (6.55 in x 1 ft/ 12 in x 29,185.2sf) + (2.38 in x 1 ft/12 in x 29620.8 sf)

= 15,930.2+5,874.7 = 21,804.9 cf

21,804.9 sf x 7.48 = 163,101.3 gallons

Runoff volume reduction for a 100-year, 24-hour storm: 341,541 – 163,101.3 = 178,440 gallons

Limitation:

Individual errors were conceivable, limiting the accuracy of the calculations.

Sources:

Massachusetts Highway Department. 2006. “Chapter 8: Drainage and Erosion Control.” In 2006 Project Development and Design Guide, 2006th edition, 8-1 to 8-144. https://www.mass.gov/lists/design-guides-and-manuals.
Strom, Steven, Kurt Nathan, and Jake Woland. 2013. Site Engineering for Landscape Architects, 6th edition, 147–56. Hoboken, New Jersey: Wiley

- ***Sequesters an estimated 1,788 lbs of atmospheric carbon annually with the presence of 47 (phase 1+ Phase 2) newly planted trees***

Background:

Before the park's establishment, the site was occupied by a parking lot devoid of trees. In response, initiatives were undertaken during the new construction phase to plant trees, resulting in the presence of 47 newly planted trees on-site. Overall, the park now boasts a total of 47 trees, enhancing its environmental and aesthetic appeal.

Method:

To quantify the CO_2 sequestration capacity of the trees, the i-Tree app was used. This tool necessitated the measurement of the trunk diameter at breast height (DBH) for each tree. Subsequently, these DBH measurements were inputted into the i-Tree software, which furnished insights into stormwater management and CO_2 absorption capabilities. Upon inputting the data for all new 47 trees into i-Tree, the analysis revealed that these trees collectively sequester approximately 1,788 lbs of CO_2 annually (see Figure X). This year alone, the trees are projected to mitigate

atmospheric carbon dioxide (CO2) by 1,788 pounds. Looking ahead, after 50 years, the cumulative sequestration is estimated to reach 62,184 pounds of CO2, equivalent to carbon (refer to Figure Y). In essence, the trees on-site serve a dual purpose. Firstly, they significantly sequester CO2 over a 50-year period, with an estimated total of 109,048 lbs. Additionally, they contribute to the area's well-being by providing emotional benefits such as shade and aesthetic enhancement.

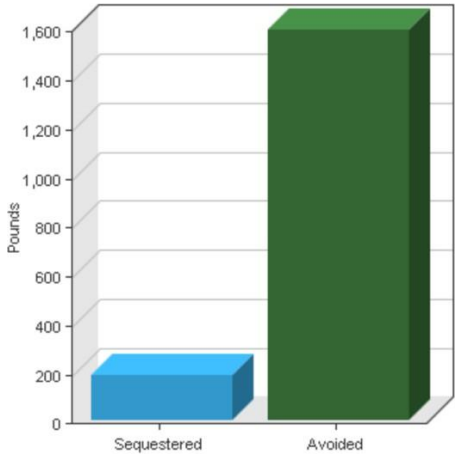


Figure X

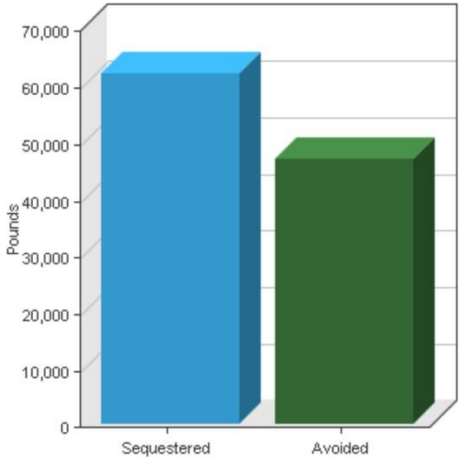


Figure Y

Limitation:

I created the table using measurements taken from the trees on the site, providing descriptions of the existing trees found on the site.

Sources:

i-Tree Tools.

- ***Removes 2,793 lbs of air pollutants over 50 years to improve air quality. It underscores the long-term benefits of planting and maintaining green spaces. 47 newly planted trees help filter out pollutants, improving the overall air quality and creating a healthier environment for everyone in the area.***

Background: Planting trees, perennials, and hedges not only beautifies the landscape but also enhances the environment by providing habitat for wildlife and improving air quality. The fact that 47 trees were added demonstrates a significant commitment to revitalizing the site and creating an ecologically sensitive and sustainable space for people to enjoy.

Trees

GYMNOCLADUS DIDICA
KENTUCKY COFFEETREE

GLEDITSIA TRIACANTHOS 'SKYLINE'
HONEY LOCUST

PLATANUS X ACER
LONDON PLANE

MALUS SARGENTII 'TINA'
TINA SARGENT CRABAPPLE

Hedges

CORNUS SERICEA 'BAILEY!'
RED TWIG DOGWOOD

FOTHERGILLA GARDENII
DWARF FOTHERGILLA

MYRICA PENSYLVANICA
NORTHERN BAYBERRY

Perennials

AMSONIA HUBRICHTII
BLUE STAR

ALCHEMILLA MOLLIS
LADY'S MANTLE

COREOPSIS GRANDIFLORA 'EARLY SUNRISE'
TICKSEED

GERANIUM 'JOHNSON'S BLUE'
CRANESBILL

LAVANDULA ANGUSTIFOLIA 'HIDCOTE'
ENGLISH LAVENDER

SALVIA NEMOROSA 'CARADONNA'
CARADONNA SALVIA

Trees

GYMNOCLADUS DIICA 'ESPRESSO'
KENTUCKY COFFEETREE

GLEDITSIA TRIACANTHOS 'SKYLINE'
HONEY LOCUST

Perennials

ECHINACEA PURPUREA 'WHITE SWAN'
WHITE SWAN CONEFLOWER

HELENIUM 'SHORT N' SASSY'
SHORT N' SASSY SNEEZEWEED

SALVIA NEMOROSA 'MAY NIGHT'
MAY NIGHT SALVIA

Grasses

CALAMAGROSTIS ACUTIFLORA 'KARL FOERSTER'
FEATHER REED GRASS

PANICUM VIRGATUM 'SHENANDOAH'
SHENANDOAH RED SWITCH GRASS

PENNISETUM ALOPECURIODES 'HAMELN'
DWARF FOUNTAIN GRASS

BULBS: COLORBLEND, ITEM SPRING LOADED®
BULBS

Method:

To quantify air pollution removal of the plants, the i-Tree app was used. This tool necessitated the measurement of the trunk diameter at breast height (DBH) for each tree. Subsequently, these DBH measurements were inputted into the i-Tree software.

Limitations:

The air pollution calculation relied on modeling rather than direct measurements, thus there is a possibility of inaccuracies in the results.

Sources: i-Tree Tools.

Social Benefits

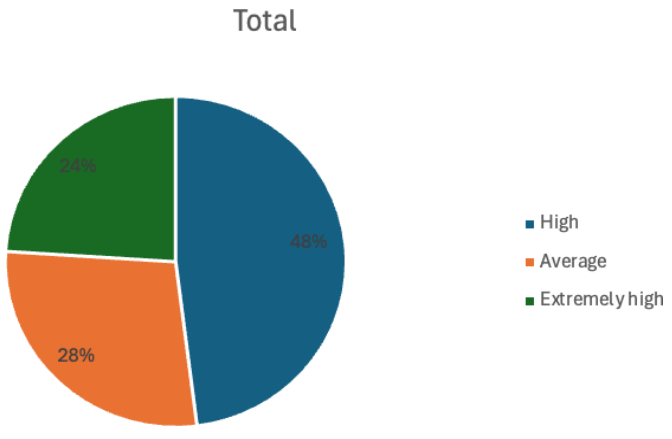
Scenic Quality & Views Improving the visual quality of an area.

- ***Provides high aesthetic value according to 70% of 30 surveyed users reporting they are satisfied or highly satisfied with the Park experience.***

Background:
The Fan Pier location is highly popular and appealing, particularly for those who enjoy walking and visiting the Seaport area in Boston. It's a frequent destination for pet owners, who often stroll through the park with their furry companions. This presents a valuable opportunity to conduct surveys and gather insights from park visitors.

Method:

The evaluation method entails conducting on-site surveys to gather insights from individuals who have visited the park. Participants are asked to respond to question on its aesthetic value. The question utilizes a rating scale ranging from 'Extremely low', 'Low', 'Average', 'High', and 'Extremely high' (refer to Table 1) to evaluate the aesthetic value of the Fan Pier Park.



Source: The survey

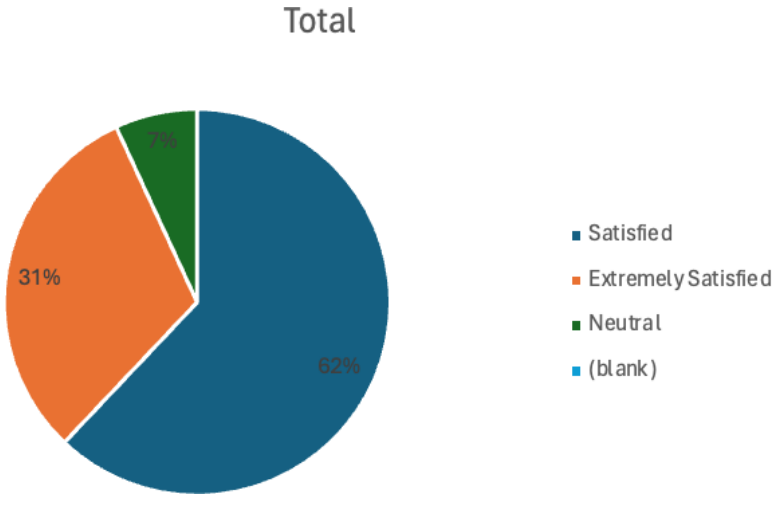
Recreational & Social Value Promoting play, relaxation, and interaction

- ***Provides satisfaction experience amongst 80% of 30 survey participants***

Method:

The evaluation method includes on-site surveys to collect insights from individuals who have visited the park. Participants are prompted to respond to six questions aimed at gauging their overall -user experience with

the park. One of the questions specifically focuses on satisfaction levels, with response options ranging from ‘Extremely dissatisfied’, ‘ Dissatisfied’, ‘ Neutral’, ‘ Satisfied’ and 'Extremely satisfied.'

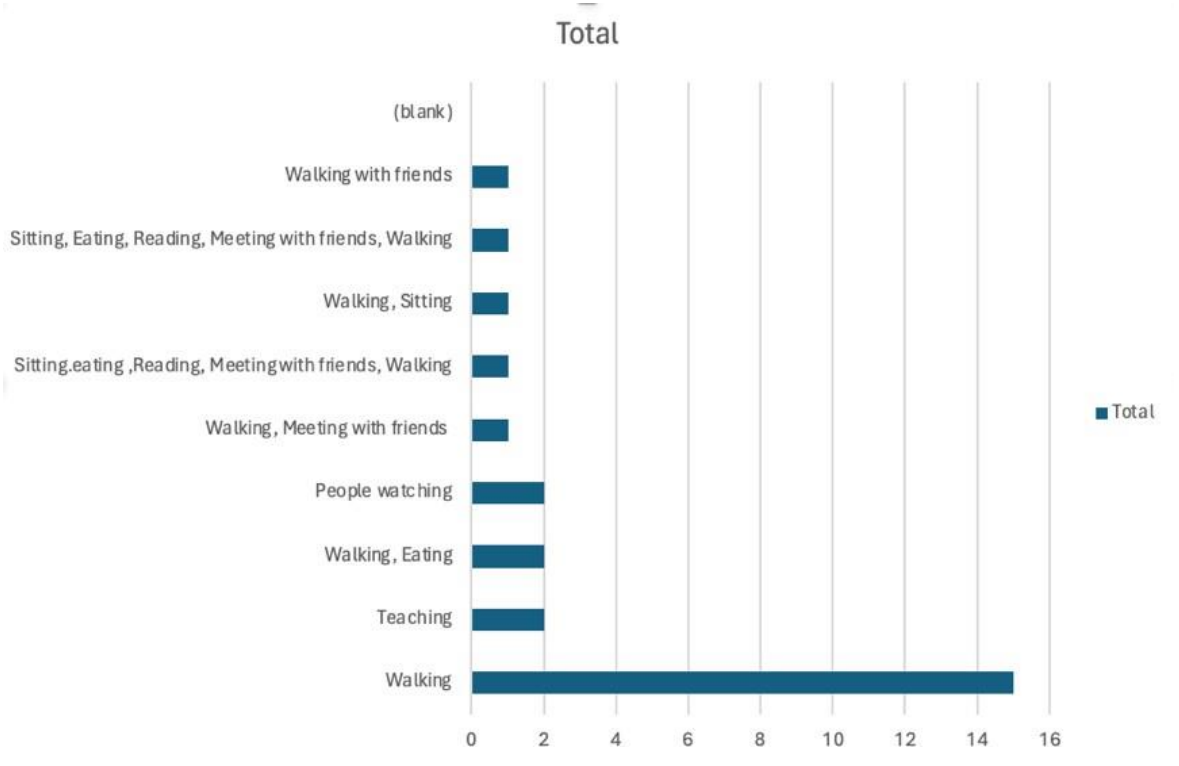


Source: The survey

- ***Provides a range of activity spaces with 10 activity types observed on-site through behavior mapping, and 7 activity types reported by users through 30 surveys. Walking is the most common type of activity, with 53.85% of 31 surveyed users reporting that they often walk in the park. People watching is the 2nd most common type of activity 7.69%, followed by eating outside (7.69%).***

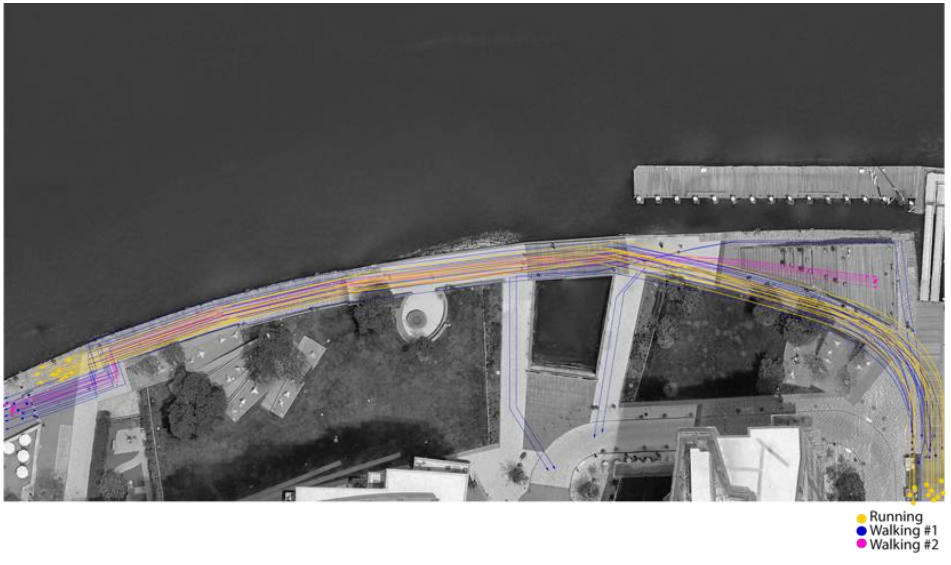
Method:

The evaluation method involves conducting on-site surveys and the site observation to gather insights from individuals who have visited the park. Participants are asked to respond to six questions aimed at understanding the activities they engaged in during their visit. One question specifically focuses on the types of activities people typically do in the park, such as walking, sitting, eating, meeting with friends, reading, running, and watching. This evaluation is conducted with a specific focus on the activities at Fan Pier Park in Boston.



Source: The survey

During a sunny Saturday between 12 PM and 2 PM, it is conducted observations at the Park, which is part of the Sea Port Harbor walk. It is observed 50 people passing by and noted whether they were walking or running. The results indicate that the majority of people were walking, with running being the second most common activity. To determine the percentage of people walking and running, It will be calculated the proportion of walkers and runners out of the total number of observed individuals. Out of the 50 individuals observed, 40 were walking and 10 were running. This indicates that 80% of the people were walking and 20% were running during that time frame.



Additionally, analyzing Google reviews offers a unique window into people's experiences and perceptions of a park landscape. By understanding and reviewing individuals' intentions and experiences shared in these reviews, we gain valuable insights into what shapes their overall impressions. Through the words used in

these reviews, we can paint a vivid picture of how visitors depict the park (refer to picture C), providing valuable context for assessing its impact and appeal.

(Picture A)

Picture A: The Tidal Well Bridge draws (and supports) a crowd during a summer fireworks display over Boston Harbor [Photo: Biruk Belay/Richard Burck Associates]

(Picture B)

References & Sources

"Fan Pier Park". https://www.richardburck.com/projects/fan-pier-park/
"Boston Development Project: Fan Pier". https://www.falloncompany.com/projects/fan-pier
Boston Society of Landscape Architects: 2022 Merit Award

Project Team:

Owner: The Fallon Company
Architects: Tsoi/Kobus & Associates, Elkus Manfredi Architects
Landscape Architect: Richard Burke Associates, Inc.
Civil Engineer: Nitsch Engineering
Contractor: Turner Construction Company

LA Firm Contact Person

Skip Burck
rburck@richardburck.com

Lesson Learned

Fan Pier Park has truly excelled in its versatility, offering a space that seamlessly caters to a wide range of needs and activities throughout the day and across various seasons. Its consistent heavy usage stands as a testament to the success of its thoughtful design. By effortlessly adapting to different purposes and embracing seasonal changes, the park has become important node on Boston Harbor walk. Boston are enamored with the Harbor Walk, particularly praising the design of Fan Pier Park. Its thoughtful layout and scenic beauty have garnered widespread acclaim and admiration.

Wharf District Parks

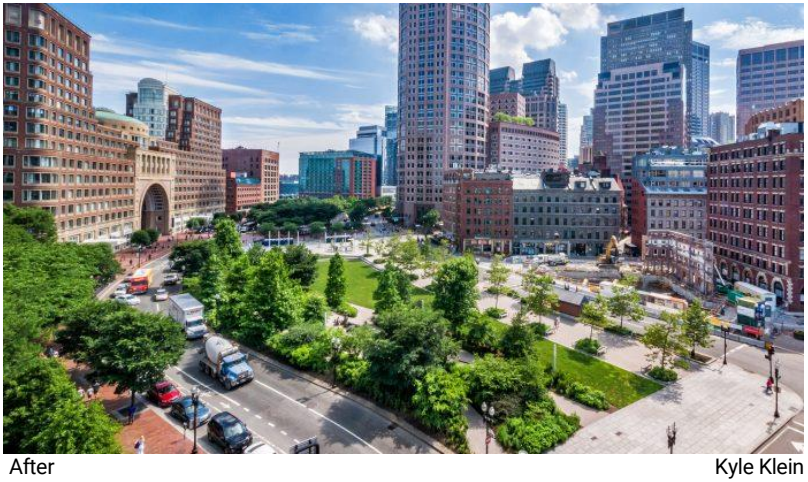
Atlantic Avenue & Milk Street, Boston, MA

Hannah Osborn, MLA Candidate

Overview

The Wharf District Parks project is the central one-third of the Rose Kennedy Greenway park system in Boston, MA. The Greenway replaced what was known as the Central Artery, an elevated highway that bisected downtown Boston from the waterfront and divided neighborhoods, which was demolished during the “Big Dig” project and replaced with an underground tunnel below the new 30-acre park system. The Wharf District Parks were designed for public event use and local pedestrian activity to encourage people to interact with one another and connect with other civic programming. The edge that abuts Downtown Boston features geometric planters and orthogonal lines, while the side closer to the waterfront features curved pedestrian paths and organic shapes to mimic the shoreline. This new, vibrant park system has become a busy and beloved landmark for the City, frequented by locals, students, families and tourists since 2008.

Before — Massachusetts Turnpike Authority



After — Kyle Klein

At a Glance

Designer:	Copley Wolff Design Group	**Project Type:**	Urban Park
Former Land Use:	Elevated Highway	**Size:**	5 acres
Completion Date:	2008	**Budget:**	$16 million

Project Goals

- Create a safe and visually interesting pedestrian-focused space that is not defined by vehicular constraints.
- Offer seasonal experiences through outdoor events and visual experiences, connecting people to civic spaces.
- Collaborate with neighboring communities to achieve high public approval.
- Encourage people to experience and revisit the site multiple times.
- Plant a variety of hardy, urban trees to avoid losing trees to disease.

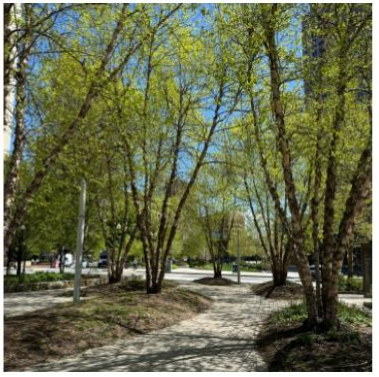
Site Plan

Image: bslanow.org

Site Images

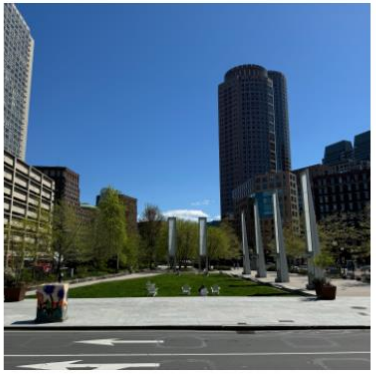

House Sparrow


Harbor Fog sculpture


River Birch forest


Rings Fountain


Rowes Wharf Plaza Park


Color Commons


Red Admiral Butterfly


Bench

photos by H. Osborn

Landscape Performance Benefits

Environmental Benefits

- ***Improves habitat quality by introducing to the site 16 species of bulbs, 21 species of ferns and grasses, 25 species of trees, 70 species of perennials, and 32 species of shrubs.***

Background:
The predevelopment of the site was devoid of an ecosystem, consisting mainly of impervious surfaces and a small number of street trees. There was insignificant biodiversity on site, allowing the addition of the park to make a substantial increase in biodiversity and habitat quality for small mammals, birds, and insects.

Methods:
The Rose Kennedy Greenway website features a PDF containing photos of all species of plants located on site.

Calculation:
Bulbs


***Chionadoxa forbessii* 'Blue Giant'**
Glory-of-the-snow


***Crocus tommasinianus* 'Lilac Beauty'**
Crocus


***Crocus vernus* 'Flower Record'**
Crocus


***Crocus vernus* 'Grand Maitre'**
Crocus


Erythronium americanum
Dog-tooth Violet


***Erythronium* 'Pagoda'**
Trout Lily


Galanthus elwesii
Giant Snowdrop


Galanthus nivalis
Snowdrop


***Galanthus nivalis* 'Flore Pleno'**
Double Snowdrop


***Narcissus* 'Jack Snipe'**
Cyclamineus Daffodil


***Narcissus* 'Jetfire'**
Cyclamineus Daffodil


***Narcissus* 'Minnow'**
Miniature Daffodil


***Narcissus* 'Sailboat'**
Jonquilla Daffodil


***Narcissus* 'Sun Disc'**
Miniature Daffodil


***Narcissus* 'Tete-a-tete'**
Miniature Daffodil


***Scilla siberica* 'Spring Beauty'**
Squill

Ferns & Grasses

Andropogon gerardii
Big Bluestem

Calamagrostis canadensis
Blue Joint

Carex pensylvanica
Pennsylvania Sedge

Carex platyphylla
Silver Sedge

Deschampsia flexuosa
Wavy Hairgrass

Dryopteris marginalis
Marginal Wood Fern

Eragrostis spectabilis
Purple Love Grass

Matteucia struthyopteris
Ostrich Fern

Muhlenbergia capillaris
Pink Muhlygrass

***Panicum virgatum* 'Heavy Metal'**
Switchgrass

***Panicum virgatum* 'Prairie Fire'**
Switchgrass

***Panicum virgatum* 'Rostrahibusch'**
Northern Switchgrass

***Panicum virgatum* 'Ruby Ribbons'**
Switchgrass

***Panicum virgatum* 'Shenandoah'**
Switchgrass

Polystichum acrostichoides
Christmas Fern

Schizachyrium scoparium
Little Bluestem

***Schizachyrium scoparium* 'Carousel'**
Little Bluestem

***Schizachyrium scoparium* 'The Blues'**
Little Bluestem

***Sisyrinchium angustifolia* 'Lucerne'**
Stout Blue-eyed Grass

***Sorghastrum nutans* 'Sioux Blue'**
Indian Grass

Sporobolus heterolepsis
Prairie Dropseed

Trees

***Acer rubrum* 'Franksred'**
Red Maple

***Acer rubrum* 'October Glory'**
Red Maple

Amelanchier canadensis
Shadblow Serviceberry

Amelanchier laevis
Allegheny Serviceberry

***Betula nigra* 'Cully' HERITAGE**
River Birch

***Betulus nigra* 'Dura-Heat'**
River Birch

Carpinus caroliniana
American Hornbeam

Cornus alternifolia
Pagoda Dogwood

Crataegus crus-galli* var. *inermis
Thornless Cockspur Hawthorn

Gleditsea triacanthos* var. *inermis
Honey Locust

Gymnocladus dioicus
Kentucky Coffeetree

Juniperous virginiana
Eastern Red Cedar

***Liquidambar styraciflua* 'Moraine'**
Sweetgum

Liriodendron tulipifera
Tulip Tree

Magnolia virginiana
Sweetbay Magnolia

***Magnolia virginiana* 'Green Shadow'**
Green Shadow Sweetbay Magnolia

Nyssa sylvatica
Black Gum

Ostrya virginiana
Ironwood

***Platanus x acerfolia* 'Bloodgood'**
London Planetree

Quercus bicolor
Swamp White Oak

Quercus macrocarpa
Bur Oak

Quercus palustris
Pin Oak

Quercus rubra
Red Oak

Sassafras albidum
Sassafras

***Ulmus americana* 'Valley Forge'**
American Elm

Perennials

Actaea racemose
Black Cohosh

***Agastache foeniculum* 'Golden Jubilee'**
Anise Hyssop

***Agastache scrophulariifolia* 'Blue Licorice'**
Purple Giant Hyssop

Amsonia 'Blue Ice'
Blue Star

Amsonia hubrichtii
Hubricht's Bluestar

Amsonia tabernaemontana
Common Bluestar

Anemone canadensis
Canada Anemone

Anemone virginiana
Thimbleweed

Antennaria plantaginifolia
Plantain Pussy-toes

***Aquilegia canadensis* 'Little Lanterns'**
Canada Columbine

Asclepias tuberosa
Butterfly Weed

Asclepias verticillata
Whorled Milkweed

***Baptisia* 'Purple Smoke'**
False Indigo

Baptisia australis
False Indigo

Baptisia tinctioria
Yellow Wild Indigo

Boltonia asteroides
Bolton's White Aster

***Boltonia asteroides* 'Snowbank'**
False Aster

***Campanula rotundifolia* 'Olympica'**
Harebell

Coreopsis rosea
Pink Tickseed

***Echinacea purpurea* 'Virgin'**
Cone Flower

***Echinecea purpurea* 'Powwow White'**

Eurybia divaricata
White Wood Aster

***Eutrochium dubium* 'Little Joe'**
Joe Pye Weed

Eutrochium maculatum
Joe Pye Weed

Geranium maculatum
Wild Geranium

***Geranium x cantabrigiense* 'Biokova'**
Hardy Geranium

Helenium 'Rubinzwerg'
Sneezeweed

Helianthus decapetalus
Thinleaf Sunflower

Helianthus strumosus
Paleleaf Woodland Sunflower

***Heliopsis helianthoides* 'Summer Nights'**
Oxeye

***Heuchera villosa* 'Autumn Bride'**
Hairy Alumroot

Hibiscus moscheutos
Swamp Rose Mallow

Houstonia caerulea
Bluets

Iris versicolor
Northern Blue Flag

Liatris aspera
Blazing Star

Liatris pycnostachya
Prairie Blazing Star

Liatris spicata
Dense Blazing Star

***Liatris spicata* 'Floristan Violet'**
Gay Feather

***Liatris spicata* 'Floristan White'**
Marsh Blazing Star

***Liatris spicata* 'Kobald'**
Marsh Blazing Star

Lobelia cardinalis
Cardinal Flower

***Monarda didyma* 'Jacob Cline'**
Bee Balm

Onoclea sensibilis
Sensitive Fern

Opuntia humifusa
Eastern Prickly Pear

Parthenium integrefolium
Wild Quinine

***Penstemon digitalis* 'Husker Red'**
Foxglove Beardtongue

Porteranthus trifoliata
Bowman's Root

Pycnanthemum muticum
Short-toothed Mountain Mint

Rudbeckia laciniata
Cutleaf Coneflower

***Rudbeckia nitida* 'Herbstsonne'**
Cutleaf Coneflower

***Sedum ternatum* 'Larinem Park'**
Wild Stonecrop

Senna hebecarpa
Northern Wild Senna

Silphium laciniatum
Compass Plant

Solidago caesia
Blue-stemmed Goldenrod

***Solidago rugosa* 'Fireworks'**
Rough-stemmed Goldenrod

Solidago sempervirens
Seaside Goldenrod

***Solidago sphacelata* 'Golden Fleece'**
Short-pappus Goldenrod

***Symphyotrichon ericoides* 'Snow Flurry'**
Heath Aster

***Symphyotrichum laeve* 'Bluebird'**
Smooth Aster

Symphyotrichum novae-angliae
New England Aster

***Symphyotrichum novae-angliae* 'Alma Potschke'**
New England Aster

***Symphyotrichum novae-angliae* 'Purple Dome'**
New England Aster

***Symphyotrichum novi-belgii* 'Alert'**
New York Aster

***Symphyotrichum novi-belgii* 'Wood's Pink'**
New York Aster

***Symphyotrichum oblongifolium* 'October Skies'**
Aromatic Aster

***Symphyotrichum oblongifolius* 'Raydon's Favorite'**
Aromatic Aster

Symphyotrichum puniceum
Purplestem Aster

Vernonia glauca
Upland Ironweed

Vernonia noveboracensis
New York Ironweed

***Veronicastrum virginicum* 'Roseum'**
Pink Culver's Root

Viola labradorica
Labrador Violet

Waldsteinia fragarioides
Barren Strawberry

Shrubs

Amelanchier nantucketensis
Nantucket Shadblow

***Arctostaphylos uva-ursi* 'Massachusetts'**
Bearberry

***Clethera alnifolia* 'Compacta'**
Compact Summersweet

***Clethera alnifolia* 'Hummingbird'**
Compact Summersweet

***Clethra alnifolia* 'Ruby Spice'**
Summersweet

Comptonia peregrina
Sweet Fern

***Cornus sericea* 'Kelseyi'**
Red-osier Dogwood

Diervilla lonicera
Bush Honeysuckle

Fothergilla gardenii
Dwarf Fothergilla

***Fothergilla gardenii* 'Mount Airy'**
Dwarf Fothergilla

Gaylussacia bacatta
Black Huckleberry

Hamamelis virginiana
Witch Hazel

***Ilex glabra* 'Densa'**
Ink Berry

***Ilex verticillata* 'Jim Dandy'**
Winterberry

***Ilex verticillata* 'Red Sprite'**
Winterberry

***Juniperus virginiana* 'Grey Owl'**
Eastern Red-cedar

***Lonicera sempervirens* 'Major Wheeler'**
Trumpet Honeysuckle

Myrica pennsyvanica
Northern Bayberry

***Prunus pumila depressa* 'Gus Melquist'**

***Rhus aromatica* 'Gro-Low'**
Fragrant Sumac

***Rhus typhina* 'Laciniata'**
Staghorn Sumac

Rosa virginiana
Virginia Rose

Salix bebbiana
Bebb's Willow

Vaccinium angustifolium
Lowbush Blueberry

***Vaccinium angustifolium* mix ('Little Crisp' and 'Ruby Carpet')**
Lowbush Blueberry

***Vaccinium* 'Chippewa'**
Blueberry

***Vaccinium corymbosum* 'Patriot'**
Highbush Blueberry

***Vaccinium* 'Northsky'**
Blueberry

***Viburnum dentatum* 'Blue Muffin'**
Arrowwood

***Viburnum opulus* var. *americanum* 'Spring Green Compact'**
American Cranberrybush

***Viburnum trilobum* 'Alfredo'**
Alfredo Viburnum

Xanthorhiza simplicissima
Yellowroot

Limitation:

- It cannot be known how many varieties of plants were on site in 1991 to make an accurate comparison between past and present habitats. An estimation can be made but would not be reliable.
- Time of year made on-site observation problematic, as many perennials had not grown in, were cut back, or had died, making plant identification difficult and unreliable.

Sources:

Plants & Landscapes. The Rose Kennedy Greenway. (2024, April 22). https://www.rosekennedygreenway.org/visit/plants-landscapes/

- ***Sequesters 165,204 pounds of carbon over 20 years with 135 trees.***

Methods:

I used the planting list provided by Copley Wolff Design Group to find the quantity of tree species planted on site. I then applied this data to iTree's Planting Tool to estimate the amount of carbon sequestered over a 20-year period.

Calculation:

Group Identifier	Initial Numberof Trees	Species	CO2 Sequestered (pounds)
1	10	Magnolia spp(Magnolia)	10,270.50
2	8	Red maple(Acer rubrum)	18,688.60
3	13	River birch(Betula nigra)	26,389.90
4	11	American hornbeam(Carpinus caroliniana)	6,225.70
5	4	Dogwood spp(Cornus)	4,034.00
6	3	Honeylocust(Gleditsia triacanthos)	6,367.90
7	5	Tulip tree(Liriodendron tulipifera)	8,101.10
8	5	Black tupelo(Nyssa sylvatica)	5,424.30
9	55	London planetree(Platanus x hybrida)	41,073.80
10	5	Common chokecherry(Prunus virginiana)	11,987.30
11	4	Scarlet oak(Quercus coccinea)	8,100.30
12	5	Northern red oak(Quercus rubra)	6,173.00
13	7	American elm(Ulmus americana)	12,367.90
SUM	135		165,204.30

Figure 1.1: iTree Sequestered Carbon Table

Limitation:

- iTree asks for the diameter of the trunk to calculate maturity of the tree species. Copley Wolff Design Group provided the diameter of the trees as they were planted, but current tree diameter information was not collected.
- iTree assumes perfect conditions for its calculations.
- iTree database does not have data for all species of trees, out of 25 species planted on-site, iTree could only calculate data for 13 species.

Sources:
https://www.itreetools.org/

Social Benefits

Overall Methods:
Surveys were handed out to people who had recently visited the park. Of the thirty people who were surveyed, 28 of which were paper surveys and two were digitally completed. See appendix for survey questions. Behavior mapping was completed by recording photos and videos of the site during a time window to understand how people use and move through the site.

- ***Provides satisfaction amongst 73.3% of 30 survey participants.***

Calculation:
Out of 30 surveys, one user rated their satisfaction of the park a score of 2 (Dissatisfied), seven users rated the park a score of 3 (Neutral), fifteen users rated the park a score of 4 (Satisfied), and seven users rated the park a score of 5 (Extremely Satisfied).

Twenty-two total users were Satisfied or Very Satisfied with the park.

$$15\ satisfied + 7\ extremely\ satisfied = 22\ users \qquad \frac{22}{30} = 73.3\%$$

Figure 2.1: Satisfaction Chart

Limitation:

- Small survey sample size, many participants were of the same age group.

Sources:

Data came from survey.

- ***Provides aesthetic value to 73.3% of 30 survey participants.***

Calculation:
Out of 30 surveys, one user rated the aesthetic value of the park a score of 2 (Low), seven users rated the park a score of 3 (Neutral), sixteen users rated the park a score of 4 (High), and six users rated the park a score of 5 (Extremely High).

Twenty-two total users rated the park either High or Extremely High.

$$16\ high + 6\ extremely\ high = 22\ users \qquad \frac{22}{30} = 73.3\%$$

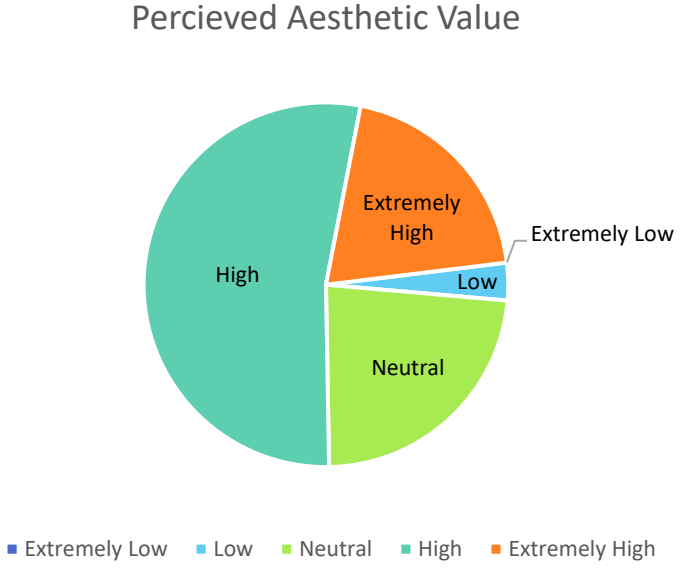


Figure 2.1: Aesthetic Value Chart

Limitation:

- Small survey sample size, many participants were of the same age group.

Sources:
Data came from survey.

- ***Provides a range of activities for park users. 12 activity types were observed across both on-site observation and survey responses, with walking being the most common activity (78.8%), followed by sitting (16.2%).***

Methods:
Utilized survey data along with on-site observation to calculate the amount of activities seen on site. Photos and videos were taken of the site across one seven-minute period and one thirty-three-minute period to gather information on site users. Users in these videos and images were then counted and organized according to their activity.

Calculation:
Out of 30 surveys, there were 23 users reports of walking in the park, 5 reports of sitting, 5 reports of eating food, 5 users reports of meeting with friends, 2 reports of reading, 1 report of teaching, and 1 report of looking at the water. Survey participants could report more than one activity.

Of on-site observations on 4/13/2024, there were 43 users walking through the park, 3 users sitting, 2 users walking dogs, one user jogging, and one user playing in the grass.

Of on-site observations on 5/7/2024, there were 39 users walking through the park, 14 users sitting, 5 users standing and talking, 3 users walking dogs, 1 user eating, and 1 user laying down in the grass.

The total number of people surveyed or observed on-site was 142. Out of this number, 112 users walked on site, 23 users sat, 6 users walked dogs, 5 users stood, 1 user jogged, 1 user played in the grass, 1 user laid in the grass, and 1 user ate food.

Date: 4/13/2024				Weather: Overcast						Temperature: 50'F
group	M	F	dog	Age						Time
				0-6	7-18	18-34	35-50	51-65	65+	
1	1		X			X				
2	1	1				X				10:50AM
3	1					X				10:50AM
4	3	5		2	1	2	2	1		10:50AM
5	1	1			2					10:50AM
6	5	3				8				10:50AM
7	1	1				2				10:50AM
8		1					1			10:50AM
9	1					1				10:50AM
10		1				1				10:50AM
11	2	2				2	2			10:50AM
12	1					1				10:50AM
13	1	1				2				10:50AM
14	1	2				1		2		10:55AM
15	1	1					2			10:55AM
16		3				3				10:55AM
17	1	1				2				10:56AM
18	1					1				10:56AM
19		2				1				10:56AM
20	1	1				2				10:57AM
21	1		X				1			10:57AM
Total:	24	26		2	3	29	8	3	0	

Figure 3.1: 4/13/2024 Observation Data

Figure 3.2: Behavior Mapping

Date: 5/7/2024				Weather: Sunny						Temperature: 72'F
group	M	F	dog	Age						Time	
				0-6	7-18	18-34	35-50	51-65	65+		
1	1	1				2				2:22PM	
2	2	1	X				2			2:22PM	
3		1	X			1				2:22PM	
4	1	1				2				2:22PM	
5	1						1			2:23PM	
6	1	1					2			2:23PM	
7	1	1					2			2:23PM	
8	1	1		1		1				2:23PM	
9	1					1				2:23PM	
10		1						1		2:23PM	
11	1						1			2:23PM	
12	1	1				2				2:24PM	
13	1						1			2:24PM	
14		1				1				2:24PM	
15	1					1				2:24PM	
16	2	2				3	1			2:25PM	
17	1					1				2:25PM	
18	1					1				2:25PM	
19	1					1				2:26PM	
20	2					2				2:26PM	
21		1				1				2:26PM	
22		1	X			1				2:26PM	
23		3			1		2			2:26PM	
24	1					1				2:26PM	
25		1				1				2:26PM	
26	1						1			2:28PM	
27		2				2				2:28PM	
28	2					1		1		2:28PM	
29	2						2			2:28PM	
30	1					1				2:38PM	
31	1	1						2		2:38PM	
32		2				2				2:40PM	
33	1						1			2:40PM	
34	1					1				2:40PM	
35	1						1			2:40PM	
36	1	1					2			2:40PM	
37	1					1				2:43PM	
38	1						1			2:43PM	
39		1					1			2:43PM	
40	1						1			2:45PM	
41	1	1				2				2:45PM	

Figure 3.3: 5/7/2024O Observation Data

Figure 3.4: Behavior Mapping

Limitation:

- One observation period was much shorter than the other and was on an overcast day, while the other period took place during more enjoyable weather.
- Both observation periods took place on weekdays.
- I stayed in one location for the first observation period and observed users across all parcels during the second period.
- There is no singular vantage point to observe the entire park so the number of users in the park is lower than the actual value.
- When observing, some people would appear quickly and you could not understand where they exactly arrived from, and some people would disappear from sight before you knew where they went.

Sources:
Data came from survey and on-site observations.

Economic I Benefits

- ***Raised property values of parcels adjacent to the park by an average of 8.5% compared to non-adjacent parcels that decreased by 4.4% two years post-park completion.***

Methods:
I used the City of Boston's Assessing On-Line tool to find the assessed value history of parcels adjacent and non-adjacent to the site. Property values were taken at the end of the Central Artery deconstruction in 2006, at the end of park construction in 2008, and two years post-completion in 2010. Adjacent properties were considered to be parcels that are located within 100 feet of the park. Non-adjacent parcels were located at least 100 to 300 feet from the park. For each adjacent property there was a non-adjacent property chosen from the same street or block of buildings to compare the change in value due to proximity to the park.

Calculation:

Property	Value in 2006	Value in 2008	Value in 2010	Change from 06 to 08	Change from 08 to 10
Group 1	$990,081.00	$1,292,463.00	$1,338,405.00	30.5%	3.6%
Group 2	$2,735,003.00	$3,625,119.00	$3,386,378.00	32.5%	-6.6%
Group 3	$2,759,587.00	$3,602,395.00	$3,730,448.00	30.5%	3.6%
Group 4	$450,000.00	$459,500.00	$432,000.00	2.1%	-6.0%
Group 5	$846,000.00	$1,073,000.00	$1,140,500.00	26.8%	6.3%
Group 6	$1,545,693.00	$2,170,887.00	$2,106,150.00	40.4%	-3.0%
Group 7	$3,009,500.00	$3,813,500.00	$4,808,000.00	26.7%	26.1%
Group 8	$387,500.00	$536,000.00	$524,000.00	38.3%	-2.2%
Group 9	$2,793,500.00	$3,698,500.00	$3,812,500.00	32.4%	3.1%
Group 10	$2,819,000.00	$3,722,000.00	$3,566,500.00	32.0%	-4.2%
			Adj. Average Increase	29.4%	8.5%
			Non-Adj. Average Increase	29.1%	-4.4%

Figure 4.1: Assessed Value Table

Properties that are both adjacent and non-adjacent to the park had similar increases in assessed value between 2006 and 2008, however following the impacts of the 2008 Recession, the properties closest to the park retained value compared to non-adjacent properties.

Limitation:

- The Assessment On-Line tool lacked values for some properties before 2007, removing some adjacent properties from consideration due to lack of data.
- The calculations do not consider the land-use of the building, but only its assessed value.

Sources:

Assessing online. City of Boston. (n.d.). https://www.cityofboston.gov/assessing/search/

Lessons Learned

Wharf District Parks plays its part in encouraging the people of Boston to use their outdoor spaces by providing a visually interesting oasis that wraps itself around Downtown Boston. The park provides a break in infrastructure, softening the pedestrian experience as one moves from the center of the city to the waterfront.

Project Team:

Client: MassDOT (formerly Massachusetts Turnpike Authority)
Engineers: Fay, Spofford, & Thorndike, Inc.; FST/HNTB, A Joint Venture
Structural Engineer: LIM Consultants, Inc.
Water Display: WET Design
Irrigation: EDAW, Inc.

Special Thanks:

Copley Wolff Design Group

Appendix 1:

Boston Parks/Open Spaces Survey

Part 1: Questions on the user experience of selected Boston parks & open spaces

1. **How often do you come to the following parks and open spaces in Boston? A. Only once; B. More than once but only occasionally; C. Once a month; D. Several times a month; D. Several times a week; E. Daily F. Other (please specify)**
   Pier 4 _____
   Fan Pier Park_____
   Wharf District Parks_____
   Chinatown Park_____
   Christian Science Plaza_____
   Harvard Science & Engineering Complex_____

2. **What kind of activities do you do in the following parks and open spaces? e.g., walking, sitting, eating, meeting with friends, reading, phone calling, etc.**
   Pier 4 _____
   Fan Pier Park_____
   Wharf District Parks_____
   Chinatown Park_____
   Christian Science Plaza_____
   Harvard Science & Engineering Complex_____

3. What are your feelings or emotional status when you are in the following parks and open spaces? Try to use 2-3 adjectives to describe your feelings.

Pier 4 _____
Fan Pier Park_____
Wharf District Parks_____
Chinatown Park_____
Christian Science Plaza_____
Harvard Science & Engineering Complex_____

4. Please rate the aesthetic value of the following parks and open spaces in Boston. 1. Extremely low 2. Low 3. Average 4. High 5. Extremely high

Pier 4 _____
Fan Pier Park_____
Wharf District Parks_____
Chinatown Park_____
Christian Science Plaza_____
Harvard Science & Engineering Complex_____

5. Rate your satisfaction with your experience in the following parks/open spaces. 1. Extremely dissatisfied; 2. Dissatisfied; 3. Neutral; 4. Satisfied; 5. Extremely Satisfied

Pier 4 _____
Fan Pier Park_____
Wharf District Parks_____
Chinatown Park_____
Christian Science Plaza_____
Harvard Science & Engineering Complex_____

6. Any comments/suggestions on the landscape design and/or maintenance of the following parks and open spaces in Boston?

Pier 4 _____

Fan Pier Park_____

Wharf District Parks_____

Chinatown Park_____

Christian Science Plaza_____

Harvard Science & Engineering Complex_____

Part 2: Demographic Information

1. Which age group do you belong to?

A. 18-29 years old

B. 30-49 years old

C. 50-64 years old

D. 65 years old and above

2. What is your gender? _____

3. What is your zip code? _____

Christian Science Plaza Restoration & Repair

210 Massachusetts Avenue, Boston, MA

Ashley Pepén

Overview

The Christian Science Plaza is one of Boston's most iconic landscapes designed in the 1970s by architects I. M. Pei and Araldo Cosutta. The plaza is recognized as a protected landmark by the Boston Landmarks Commission. However, after fifty years, it deteriorated. The plaza restoration and repair work was led by the Arcadis IBI Group. The project focused on revitalizing the plaza's iconic features. Central to the endeavor was the reconstruction of the reflecting pool, coupled with improvements to its basin paving for enhanced reflectivity and seasonal allure. Additionally, efforts were directed toward making entrances more inviting, improving wayfinding, and integrating amenities to facilitate year-round usage. The restoration showcased a harmonious blend of meticulous design and technical innovation, ensuring the plaza's enduring legacy as a cherished urban oasis.

Before renovation

After renovation

Source: Arcadis IBI Group

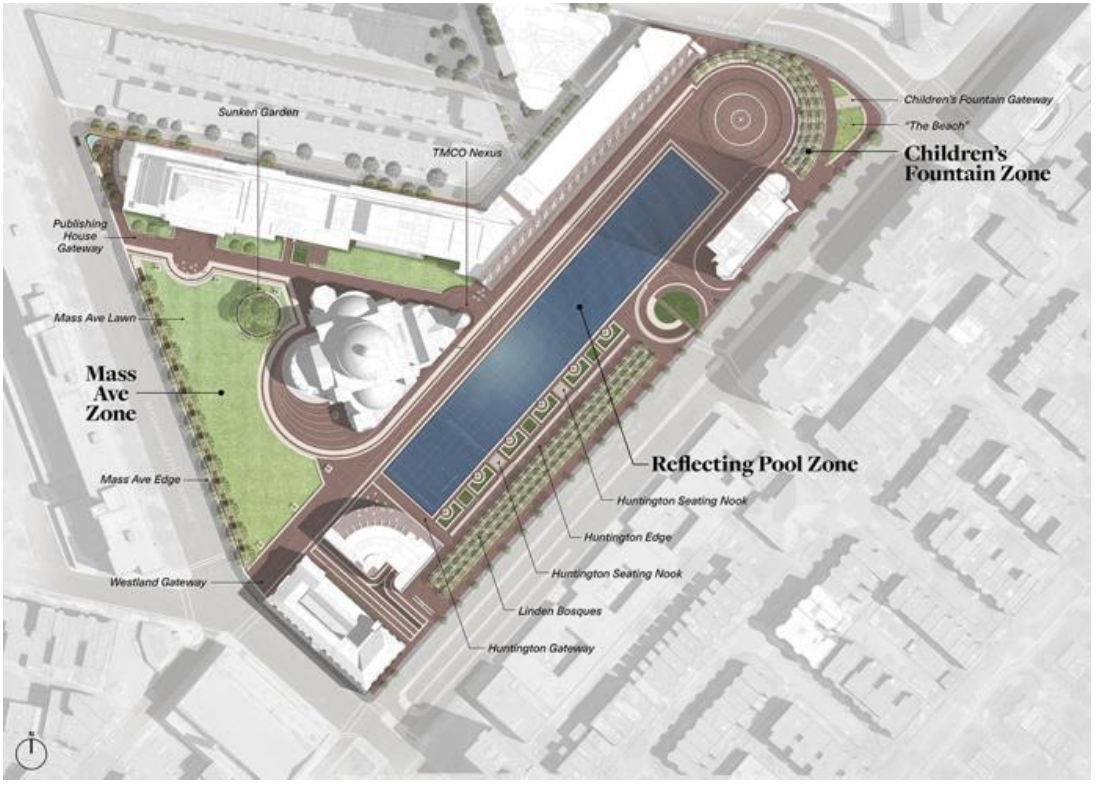
At a Glance

Designer:	Arcadis IBI Group	**Project Type:**	Restoration & Repair
Former Land Use:	Public Plaza	**Size:**	Approximately 14 acres
Completion Date:	2022	**Budget:**	

Project Goals

- Preserve, repair, and restore the character-defining features of this landmark landscape.
- Enhance the plaza's welcoming ambiance by creating inviting gateways with additional seating areas.
- Implement sustainable practices to improve the plaza's environmental impact.
- Support real estate development around the plaza to generate additional revenue streams.
- Mitigate the risk of groundwater contamination and groundwater depletion.
- Foster community engagement and participation in the restoration process.

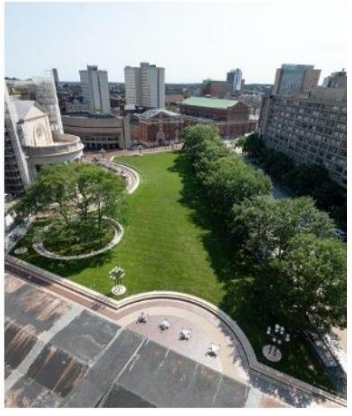
Site Plan



Source: Arcadis IBI Group Site Plan

Site Images

Mass Ave. Lawn



Mass Ave. Sitting Areas

Huntington Ave. View

eflecting Pool and Huntington Ave. edge

Planters along Reflecting Pool

Christian Science Reflecting Pool

Source: Arcadis IBI Group | Landscape Forms

Landscape Performance Benefits

Environmental Benefits

- ***Reduces stormwater runoff by 70%, decreasing the burden on municipal drainage systems and mitigating the risk of urban flooding. By promoting infiltration and groundwater recharge, the restoration project helps replenish local aquifers and maintain ecological balance in the surrounding ecosystem.***

Methods:
To assess the effectiveness of the stormwater management strategy, we employed a data collection method focused on measuring the volume of stormwater runoff before and after implementing stormwater management measures.

Calculations:
Utilizing the data provided by the design firm, we quantified the reduction in stormwater runoff and the increase in infiltration rates achieved through the implementation of green infrastructure. By comparing the volume of stormwater runoff before and after the introduction of stormwater management measures, we were able to determine the tangible impact of these interventions.

Limitation:
Second hand data from the design firm

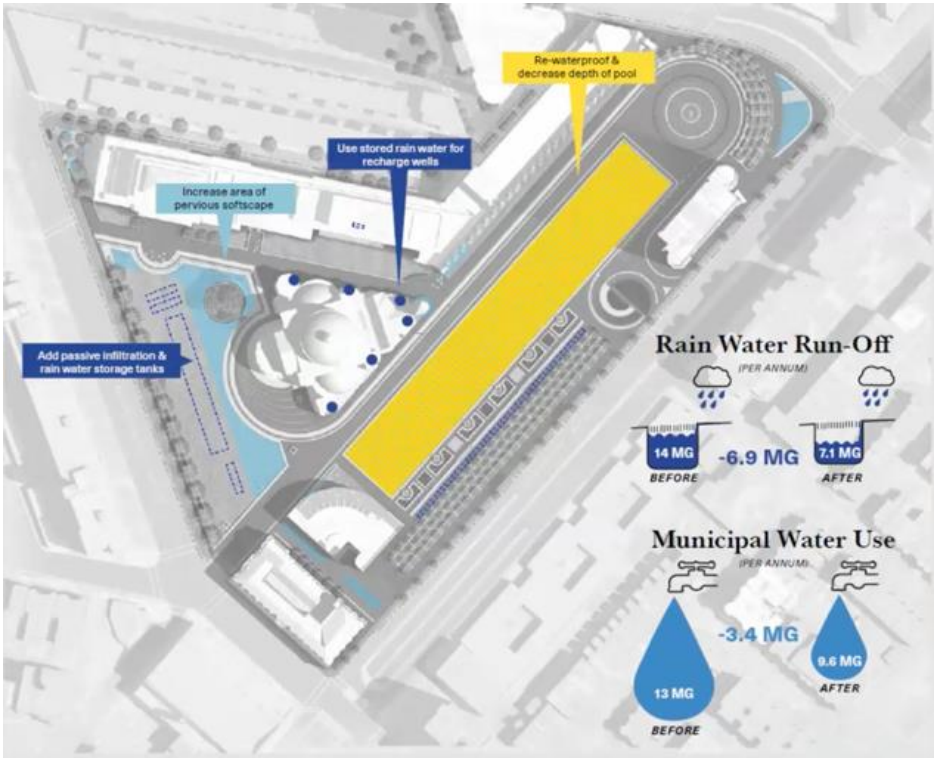
Source:
Arcadis IBI Group

- ***Reduces the Municipal Water Use Strategy resulted in a remarkable by two-thirds of the amount of water required annually, equating to an impressive saving of 14million gallons of water annually. By shortening the length of the 213-m (700-ft) pool by 4.8 m (16 ft) on the southwestern end and minimizing reliance on potable water for landscaping and irrigation purposes, the restoration project contributes to conserving valuable freshwater resources and mitigates the environmental impact associated with municipal water extraction and distribution.***

Methods:
The data collection involved monitoring water consumption patterns within the plaza both before and after the implementation of water-saving technologies and practices.

Calculations:
Utilizing the data provided by the design firm, we adopted water-saving measures such as water-efficient landscaping and irrigation systems. By quantifying the decrease in water consumption post-implementation, we were able to attribute the savings directly to the implemented strategies.

Analysis:
Our analysis centered on scrutinizing the water consumption data collected throughout the study period. By employing analytical methods, we quantified the savings achieved through the implementation of water conservation measures. This analysis provided insights into the effectiveness of the strategies in reducing municipal water use within the plaza.



Source:
Arcadis IBI Group

Limitation:
Second hand data from the design firm

Social Benefits

Overall Methods:

Field Observations
Field observation is a type of field research method that involves collecting data by observing the behavior, actions, or interactions of people or animals in a natural setting. The researcher does not interfere with the subjects or manipulate any variables but simply records what they see and hear.

Behavior Mapping or PSPU method

Surveys

- ***Provides a range of activities for park users. A total of 20 activity types were observed on-site and reported by 39 survey respondents, with walking being the most common (accounting for 82% of responders), followed by sitting (21%), meeting with friends (21%), and jogging (13%). Other activities include dog walking, biking, eating, people watching, water bird watching, calling, reading, baby strolling, kids playing with water, watching kids playing, participating in a group event, guiding tour group and talking, photo taking, contemplating, scootering, and waiting.***

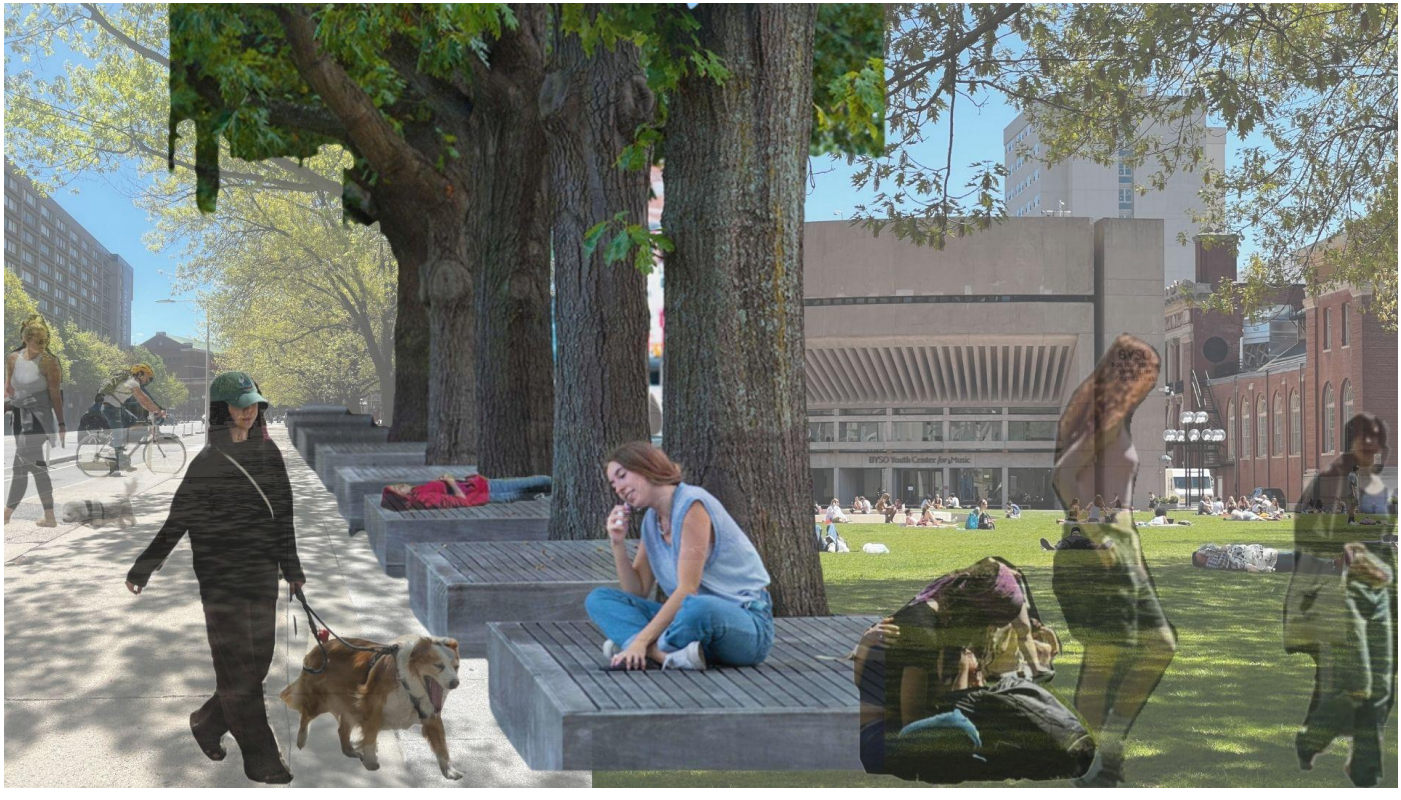
Calculation:
Out of 39 surveys, the following activities were reported: 32 users reported walking, 8 users reported sitting, 8 users reported meeting with friends, 4 users reported eating food, 2 users reported reading, 1 user reported talking on the phone, and 1 user reported looking at the water. Please note that survey participants could report multiple activities.

During the observation period, various activities were noted. Among them, 43 users were observed walking, 3 users were seen sitting, 2 users were walking dogs, 1 user was jogging, and 1 user was playing in the grass.

Limitation:
Limited survey sample size, particularly the small sample size of 39 survey respondents, which may not fully represent the diversity of park users and their experiences. Also, I was located at the Mass. Avenue.

Source: Data came from class surveys and my own field observations.

Collage of Social Behaviors
Source: Photos by Ashley Pepén



Source: Collage by Ashley Pepén

Date: 4/23/24 Weather: Temperature: ID: S=staff P=patient V=visitor N=can't tell

group	M	F	dog	race	ID	Age						Time	Notes: W=whiye B=Black, A=Asian
						0-6	7-18	18-34	35-50	51-65	65+		
1	x				v			x				11:00	
2	x				v			x				11:00	
3	x				v			x				11:00	
4	x				v			x				11:00	
5	x				v			x				11:00	
6	x				v			x				11:00	
7		x			N				x			11:00	
8		x			v			x				11:00	
9	x				v			x				11:00	
10		x			v			x				11:30	
11		x			v			x				11:30	
12		x			v			x				12:00	
13		x			N		x					12:00	
14		x			v			x				12:00	
15		x			v			x				1:00	
16		x			v			x				1:00	
17		x			v				x			1:00	
18	x				v			x				1:00	
19	x				v			x				1:00	
20	x				v			x				1:00	
21	x				v			x				1:00	
22	x				v			x				1:00	
23	x				v			x				1:00	
24	x				v			x				1:00	
25		x			v			x				1:00	
26		x			v			x				1:00	
27		x			v			x				1:00	
28		x			v			x				2:00	
29		x			v			x				2:00	
30		x			v			x				2:00	
31		x			v			x				2:00	
32		x			v			x				2:00	
33		x			v			x				2:00	
34		x			v			x				2:00	
35		x			v			x				2:00	
36		x			v			x				2:00	
37		x			v			x				2:00	
38		x			v			x				2:00	
39	x				v			x				2:00	
40	x				v			x				2:00	
41		x			v			x				2:00	
42		x			v			x				2:00	
43		x			v			x				2:00	
Total:	16	#					1	40	2				

Activity Types	Percentage
Walking	82%
Sitting	21%
Meeting with friends	21%
Jogging	13%
Dog Walking	13%
Biking	8%
Eating	8%
People watching	8%
Water bird watching	8%
Calling	3%
Reading	3%
Baby strolling	3%
Kids playing with water	3%
Watching kids playing	3%
Participating in a group event	3%
Guiding tour group and talking	3%
Photo taking	3%
Contemplating	3%
Scootering	3%
Waiting	3%

Source: Data came from class surveys and templates and my own field observations.

Boston Parks/ Open Spaces User Expereince Survey - Christian Science Plaza

Survey File Name (Quantity: 39 Surveys)	Survey Date	1. How often do you come to the park(s) / open spaces in Boston? A. Only once; B. More than once but only occasionally; C. Once a month; D. Several times a week; E. Daily F. Other (please specify)	2. What kind of activities do you do in the park(s) and open spaces? e.g., walking, sitting, eating, meeting with friends, reading, phone calling, etc.	3. What are your feelings or emotional status when you are in the park(s) and open spaces? Try to use 2-3 adjectives to describe your feelings.	4. Please rate the aesthetic value of the park(s) and open spaces in Boston. 1. Extremely low 2. Low 3. Average 4. High 5. Extremely high	5. Rate your satisfaction with your experience in the park(s)/open spaces. 1. Extremely dissatisfied; 2. Dissatisfied; 3. Neutral; 4. Satisfied; 5. Extremely Satisfied	6. Any comments/suggestions on the landscape design and/or maintenance of the park(s) and open spaces in Boston?	Demographic Info 1. Which age group do you belong to? A. 18-29 years old B. 30-49 years old C. 50-64 years old D. 65 years old & above	Demographic Info 2. What is your gender?	What is your zip code?
Ashley-1	4/12/2024	A. Only once	Walking	Inspired	3. Average	3. Neutral	N/A	18-29 years	Female	01002
Ashley-2	4/12/2024	F. Tourist	Walking	Nice	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	Female	01003
Ashley-3	4/12/2024	B. More than once but only occasionally	Walking	Happy	5. Extremely high	5. Extremely Satisfied	N/A	30-49 years old	Female	01862
Ashley-4	4/12/2024	D. Several times a week	Sitting, Walking, Talking	Relax, Happy	5. Extremely high	3. Neutral	N/A	18-29 years	Female	02131
Ashley-5	4/24/2024	C. Once a month	Walking, Eating, Meeting with friends	Calming, connected	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-6	4/24/2024	F. Several times at month	Walking, looking water	N/A	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-7	4/24/2024	F. Several times at month	Walking	Contempt	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	Female	N/A
Ashley-8	4/24/2024	D. Several times a week	Walking	Calming, connected	4. High	5. Extremely Satisfied	N/A	18-29 years	Female	N/A
Ashley-9	4/24/2024	F. Several times at month	Walking	Happy	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-10	4/24/2024	D. Several times a week	Walking	Connected	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-11	4/24/2024	C. Once a month	Walking	Happy, calm, jovial	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-12	4/24/2024	D. Several times a week	Walking	Calm	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-13	4/24/2024	D. Several times a week	Walking	Inspiring	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-14	4/24/2024	F. Several times at month	Walking	Happy	4. High	4. Satisfied	N/A	18-29 years	Female	N/A
Ashley-15	4/24/2024	D. Several times a week	Walking, sitting and relaxing, meeting with friends	Calm	4. High	4. Satisfied	N/A	30-49 years old	Male	N/A
Ashley-16	4/24/2024	F. Several times at month	Walking, sitting and relaxing, meeting with friends, eating outside	Happy, Charming site	4. High	4. Satisfied	N/A	18-29 years	N/A	N/A
Ashley-17	4/24/2024	D. Several times a week	Walking, Sitting, Reading, meeting with friends	Relax, Calm	4. High	5. Extremely Satisfied	N/A	18-29 years	N/A	N/A
Ashley-18	4/24/2024	D. Several times a week	Walking, sitting and relaxing, meeting with friends	Contempt, Calm, Peaceful, Serene, Happy	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	Female	N/A
Ashley-19	4/24/2024	F. Several times at month	Walking, Eating	Happy, connected	4. High	4. Satisfied	N/A	18-29 years	N/A	N/A
Ashley-20	4/24/2024	F. Everyday	Walking	Calm	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	N/A	N/A
Ashley-21	4/24/2024	F. Several times at month	Walking	N/A	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	N/A	N/A
Ashley-22	4/24/2024	F. Several times at month	Walking, Eating	Relax	4. High	4. Satisfied	N/A	30-49 years old	N/A	N/A
Ashley-23	4/24/2024	F. Several times at month	Walking, Reading	Calm	4. High	4. Satisfied	N/A	18-29 years	N/A	N/A
Ashley-24	4/24/2024	C. Once a month	Walking, Sitting, Eating, using phone	Happy, Serene	4. High	4. Satisfied	N/A	18-29 years	N/A	N/A
Hannah-1	4/12/2024	Check mark	Walking	Strange	2. Low	3. Neutral	N/A	50-64 years old	Male	01060
Hannah-2	4/12/2024	C. Once a month	Walking, meeting with friends	Neutral	3. Average	4. Satisfied	Could be more colorful	18-29 years	Female	02215
Hannah-3	4/12/2024	A. Only once	Mapparium	Not so much	1. Extremely Low	2. Dissatisfied	N/A	65 years old & above	Male	01002
Hongbing-3	4/12/2024	A. Only once	N/A	N/A	N/A	N/A	N/A	18-29 years	Male	02038
Hongbing-4	4/12/2024	A. Only once	Walking, taking photos	Fun, elegant	4. High	4. Satisfied	N/A	50-64 years old	Female	01002
Hongbing-5	4/12/2024	A. Only once	Driving	Play	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	Male	01002
Hongbing-8	4/12/2024	B. More than once but only occasionally	Walking, Sitting	Peace	2. Low	4. Satisfied	N/A	50-64 years old	Male	01075
Hongbing-10	4/12/2024	B. More than once but only occasionally	Walking	Good, cool	4. High	4. Satisfied	N/A	18-29 years	Female	02100
Hongbing-13	4/12/2024	A. Only once	Walking	Happy	4. High	3. Neutral	N/A	18-29 years	Female	01003
Hongbing-14	4/12/2024	A. Only once	Landscape viewing	Calming, Peaceful	5. Extremely high	4. Satisfied	N/A	65 years old & above	Male	01002
Jill-1	4/12/2024	B. More than once but only occasionally	Walking, meeting with friends	Open	3. Average	3. Neutral	N/A	18-29 years	Male	02022
Jill-2	4/12/2024	A. Only once	Sitting	N/A	5. Extremely high	1.Extremely dissatisfied	N/A	30-49 years old	N/A	02110
Zijie-3	4/12/2024	F. Tourist	Walking, Sitting, Reading	Severed, Stimulated, Energized	5. Extremely high	4. Satisfied	N/A	18-29 years	Female	01002
Zijie-4	4/12/2024	B. More than once but only occasionally	Meeting with friends	Peaceful, content	5. Extremely high	5. Extremely Satisfied	N/A	18-29 years	Female	03106
Zijie-5	4/12/2024	B. More than once but only occasionally	Walking	N/A	4. High	4. Satisfied	N/A	65 years old & above	Female	N/A

Source: Data came from class surveys and my own field observations.

Source: Data came from class surveys and Words Cloud Generator

Economic l Benefits

- ***Reduced the reflecting pool's water demand from 3 million gallons to 800,000 gallons at the Christian Science Plaza, considering the largest water bill amount per 1,000 gallons is $11,501 they Saved 2,200,000 gallons which is $25,302.20.***

Calculation:

Assume the Christian Science Plaza saved 2,200,000 gallons of water by reducing the reflecting poll from 3 million gallons to 800,000 gallons.

1. Total Water Savings: 2,200,000 gallons
2. Rate per 1,000 Gallons: $11.501

Total Saving = (Total Annual Water Savings/1,000) x Rate per 1,000 Gallons
Total Savings = (2,200,000/1,000) x 11.501
Total Savings = 2,200 x 11.501
Total Savings = $25,302.20

Limitation:
The calculation assumes a specific volume of water savings. Actual savings may vary based on weather conditions, effectiveness of water-saving measures, and usage patterns. Also, water rates can change annually. This calculation is based on the 2024 rates and may not be accurate for future years without adjustment.

Lessons Learned

The lessons learned from the Christian Science Plaza Restoration & Repair project are that preserving and restoring the character-defining features of landmark landscapes, along with adding modern innovations for sustainability and functionality, are of utmost importance. The focus of the project on improving the inviting ambiance of the plaza and supporting community engagement demonstrates the importance of public spaces within urban environments. Besides, the implementation of sustainable practices that go beyond only reducing the environmental impact but also contribute to the conservation of resources and resilience to urban challenges such as stormwater runoff and water scarcity. The project's reduction of stormwater runoff and reduction of municipal water use proves the effectiveness of green infrastructure and water-saving technologies in the management of urban landscapes. Also, the social benefits of providing different activities for park users point out the importance of inclusive design and user-centered planning to create vibrant and inclusive public spaces. However, the limitations encountered were relatively small sample sizes of surveys since this was a one person’s project, this underline the use of solid data collection methodologies and comprehensive stakeholder involvement for project outcome evaluation. In general, the case of the Christian Science Plaza Restoration & Repair presents a powerful case study on the intersection of heritage preservation, sustainable design, and community revitalization in urban landscape management.

References & Sources

The Christian Science Plaza Official Website.
https://www.christianscienceplaza.org/
(Accessed February 4, 2024).

Arcadis IBI Group Official Website. https://www.ibigroup.com/
(Accessed February 5, 2024).

Project Team:

Arcadis IBI Group
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Bartlett Tree Experts
Irrigation Consulting, Inc.
GEI Consultants, Inc.
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Special Thanks:

John Amodeo, FASLA and James Kros, Arcadis IBI Group
Professor Hongbing Tang

Pier 4 Phase III

300 Pier 4 Boulevard, Boston, MA

Samer Samarani

Overview

The Pier 4 project in Boston's Seaport district revitalizes a historic site, once home to Anthony's Pier 4 restaurant, buried under layers of asphalt and structures. Embracing the area's coastal heritage, the project incorporates granite seawalls, wood pilings, and stone revetments, while also addressing the challenges of rising sea levels by intentionally breaking down seawalls to allow water movement. The design creates a dynamic waterfront experience with tidal terraces, panoramic viewpoints, and public plazas, bridging the gap between historic downtown Boston and the emerging waterfront neighborhood.

The Pier 4 development includes 2.5 acres of public open space, including a one-acre public park along Boston’s waterfront (the largest public park along Boston’s waterfront). Additionally, the development served to reconnect the Harbor Walk between the ICA and Seaport Boulevard, adding approximately one-half mile of new Harbor Walk along the perimeter of the site.

Before bostonproperrealestate.com/pier-4/

After www.broadboutique.com/buildings/300-pier-4/

At a Glance

Project: PIER 4 / PHASE 3
Project Type: RESIDENTIAL / PUBLIC SPACE / WATERFRONT
Location (Google Maps address): MAP HERE
Budget:
Awards: LEED Gold

Designer: REED HILDERBRAND LLC
Former Land Use: HARBOR/PARKING LOT
Size: 1 ACRE
Completion Date: 2019

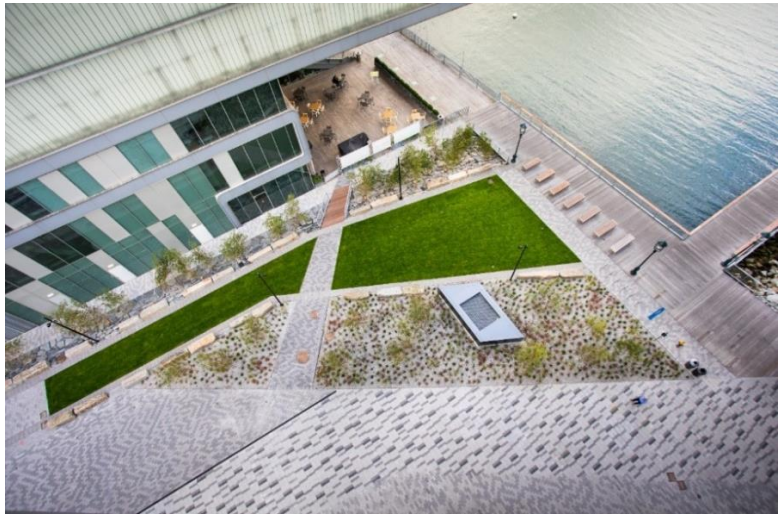
Project Goals

- Revitalize a historic site in Boston's Seaport district.
- Incorporate passive recreation and education for people to experience the Pier, its natural habitat, and views of the surrounding neighborhoods.
- Address the challenges of rising sea levels and coastal dynamics.
- Create a dynamic waterfront experience for visitors and residents.
- Bridge the gap between historic downtown Boston and the emerging waterfront neighborhood.
- Enhance public access and interaction with the water's edge.
- Transform a privately developed landscape into a public-facing plaza and park while supporting residential and commercial needs.

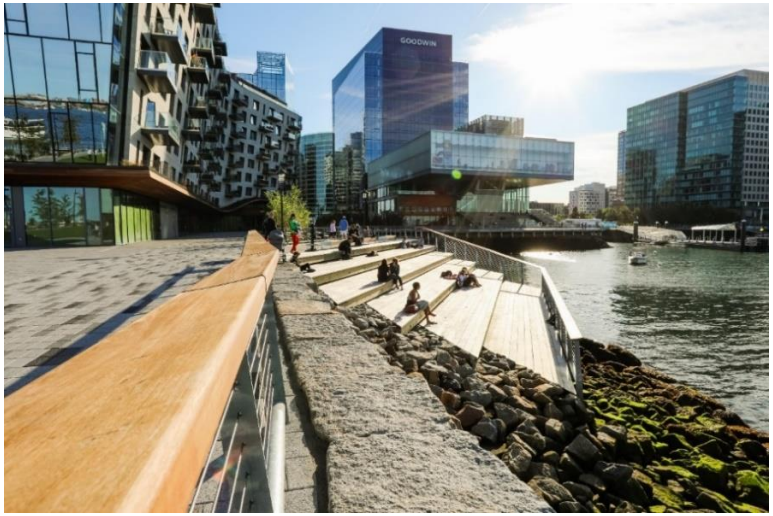
Site Plan

Source: REED HILDERBRAND

Site Images

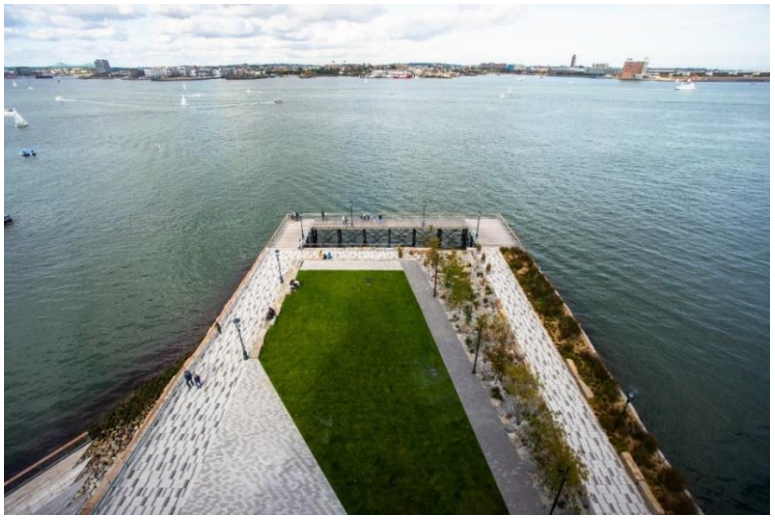


Pedestrian Path between ICA and Pier4



Tidal terraces

Pier 4 Entrance



Slopped Lawn and Harbor Walk

Images: REED HILDERBRAND

Landscape Performance Benefits

Environmental Benefit

- ***Reduces peak runoff rate for a 100-year storm by an estimated 26% and reduces runoff volume by 278,619 gallons for a 100-year, 24-hour storm as compared to pre-development conditions.***

Methods:
Use historic satellite imagery of the site from 2002, and the implemented landscape plan provided by Reed Hildebrand to estimate the peak runoff rate for a 100-year storm (Time of Concentration Tc = 15 min). AutoCAD was used to calculate the areas of each different surface cover. The modified Rational Method was adopted as it is a simplified model of the hydrologic process. It can be used to estimate the peak runoff rate for an area of less than 20 acres based on a design rainfall intensity.

Calculations:

Peak runoff rate reduction:
Modified Rational Method Formula: Qp = CCAiA

Qp = peak runoff rate, cubic feet per second (cfs)
C = runoff coefficient (unitless)
CA = antecedent precipitation factor (unitless)
i = rainfall intensity, inches per hour (iph), for storm duration = the time of concentration (Tc)
A = drainage area, acres (ac)
The post-development conditions are the result of the site design using LID techniques, which include rain gardens, street planters, perennial planting, and green roofs. The pre-development condition was 100% impervious concrete surface as part of the former shipyard.

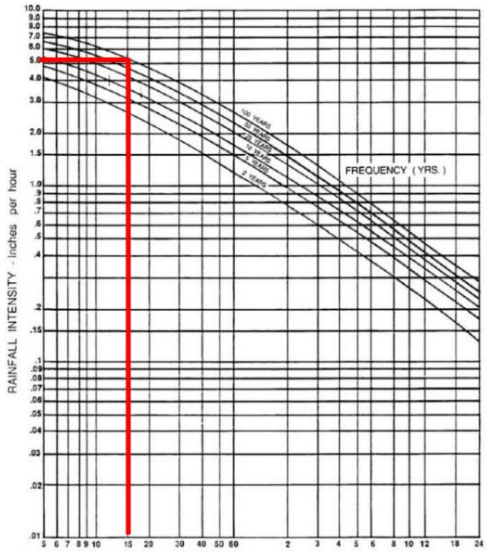
● **Pre-Development Site Land Cover**
Parking surface material: concrete, 100% impervious
Runoff coefficient for concrete: C = 0.95
A = Total site area = 236,475 sf = 5.43 acres

● **Post-Development Site Land Cover**

Landcover	Area (SF)	Acre (ac)	Runoff Coefficient (C)	Adjusted Area C*A
Lawn / Ground Garden	23,590	0.54	0.1	0.054
Green Roof	3,620	0.08	0.3	0.024
Regular Roof	54,256	1.25	0.95	1.187
Hardscape	10,000	0.24	0.95	0.228
Stone Paving	145,009	3.32	0.7	2.324
Subtotal	**236,475**	**5.43**		**3.817**

Weighted Runoff Coefficient:
C weighted = Adjusted Area / Total Site Area = 3.817/5.43= 0.70

100-year storm frequency
The rainfall intensity is 5.4 iph for a 100-year storm frequency from the Rainfall Intensity Chart for Boston, MA



100 storm rainfall intensity (Tc=15 min.)
Figure 2.2: Rainfall intensity Chart for Boston, MA
Source: Mass. Highway Department 2006

We use 15 minutes for the time of concentration Tc based on the common practice noted in Site Engineering for Landscape Architects (Strom, Nathan, and Woland 2013): "Since it takes several minutes for rain to wet a surface thoroughly, many municipalities permit the use of minimum times of concentration, such as 10 or 15 minutes. This will reduce the intensity used for the computation of the runoff

rate" (Strom, Nathan, and Woland 2013, 266).

Modified Rational Method formula was used with a recommended CA antecedent precipitation factor = 1.25 for 100-year storm (Strom, Nathan, and Woland 2013, 218).

Formula: Qp = CCAiA
Qpre-development = 0.95 x 1.25 x 5.4 iph x 5.43 ac = 34.81 cfs
Qpost-development = $C_{average}$ x CA x i x A = 0.70 x 1.25 x 5.4 x 5.43 ac =25.65 cfs
Reduction rate: (34.81 – 25.65)/34.81 = **26.40%**
In Summary, 100-year design storm calculations show a **26.40%** reduction in peak runoff rate comparing the pre- and post-development conditions.

Reduction of runoff volumes for a 100-year, 24-hour storm
A. Calculations of pre-development site runoff water in gallons:
The pre-project site was 100% impervious and covered with concrete (CN=98) Using the WinTR-55 software developed by NRCS, when inputting the Rainfall Distribution Type (Type III for Massachusetts) and choosing Suffolk County where Boston is located, a table of storm data is shown. For the 100-year storm return period, the 24-hour rainfall amount is 6.6 inches.

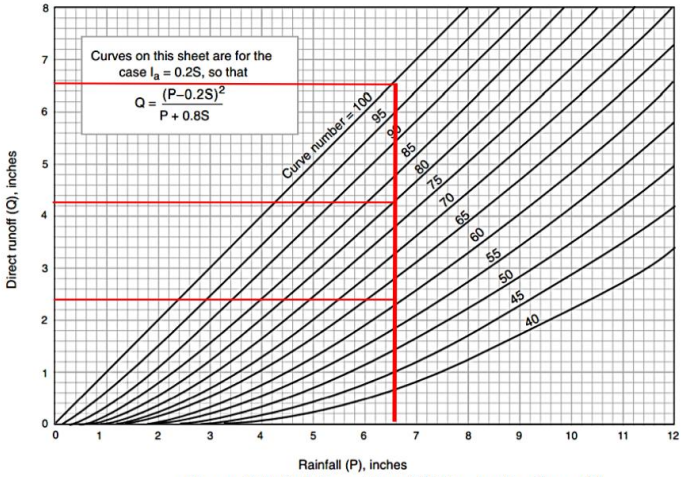


Figure 2.3: Relationship of CN to depth of runoff
Source: 210-VI-TR-55; Strom, Nathan, Woland 2013, 228

Runoff from 6.6-in rainfall on the surface with Runoff Curve Number (CN)=98 is 6.55-in
Pre-development Runoff Volume = 6.55in x 1 ft /12 in x 236,475 sf = 129,075 cf
129,075 cf x 7.48 gallons/cf = **965,481 gallons**

B. Calculation of post-development site stormwater runoff in gallons:

Land Cover	Curved Number	Area (sf)	runoff generated (inch)
Impervious surfaces	98	64,256	6.55
Pervious surfaces	61	27,210	2.38
Environmental plaza rough stone paving	79	145,009	4.25

Post-development site (236,475 sf) is 71.60% impervious (64,256 sf).
Runoff Vol. = (6.55 in x 1 ft/ 12 in x 64,256 sf) + (2.38 in x 1 ft/12 in x 27,210 sf) + (4.25 x 1 ft/12 in x 145,009)
= 35,073+5,396 +51,357 = 91,826 cf
91,826 sf x 7.48 = 686,861 gallons
Runoff volume reduction for a 100-year, 24-hour storm: 965,481 – 686,861 = **278,619 gallons**

Limitation:
When doing stormwater runoff estimation, AutoCAD was used to trace and measure areas of various land covers based on the construction documents provided by the design firm and the client. Human errors were conceivable, limiting the accuracy of the calculations.

Sources:
Massachusetts Highway Department. 2006. “Chapter 8: Drainage and Erosion Control.” In 2006 Project Development and Design Guide, 2006th edition, 8-1 to 8-144. https://www.mass.gov/lists/design-guides-and-manuals.
Strom, Steven, Kurt Nathan, and Jake Woland. 2013. Site Engineering for Landscape Architects, 6th edition, 147–56. Hoboken, New Jersey: Wiley

● Provides habitat for at least 10 bird species observed in the ground-level outdoor spaces and immediately adjacent areas.

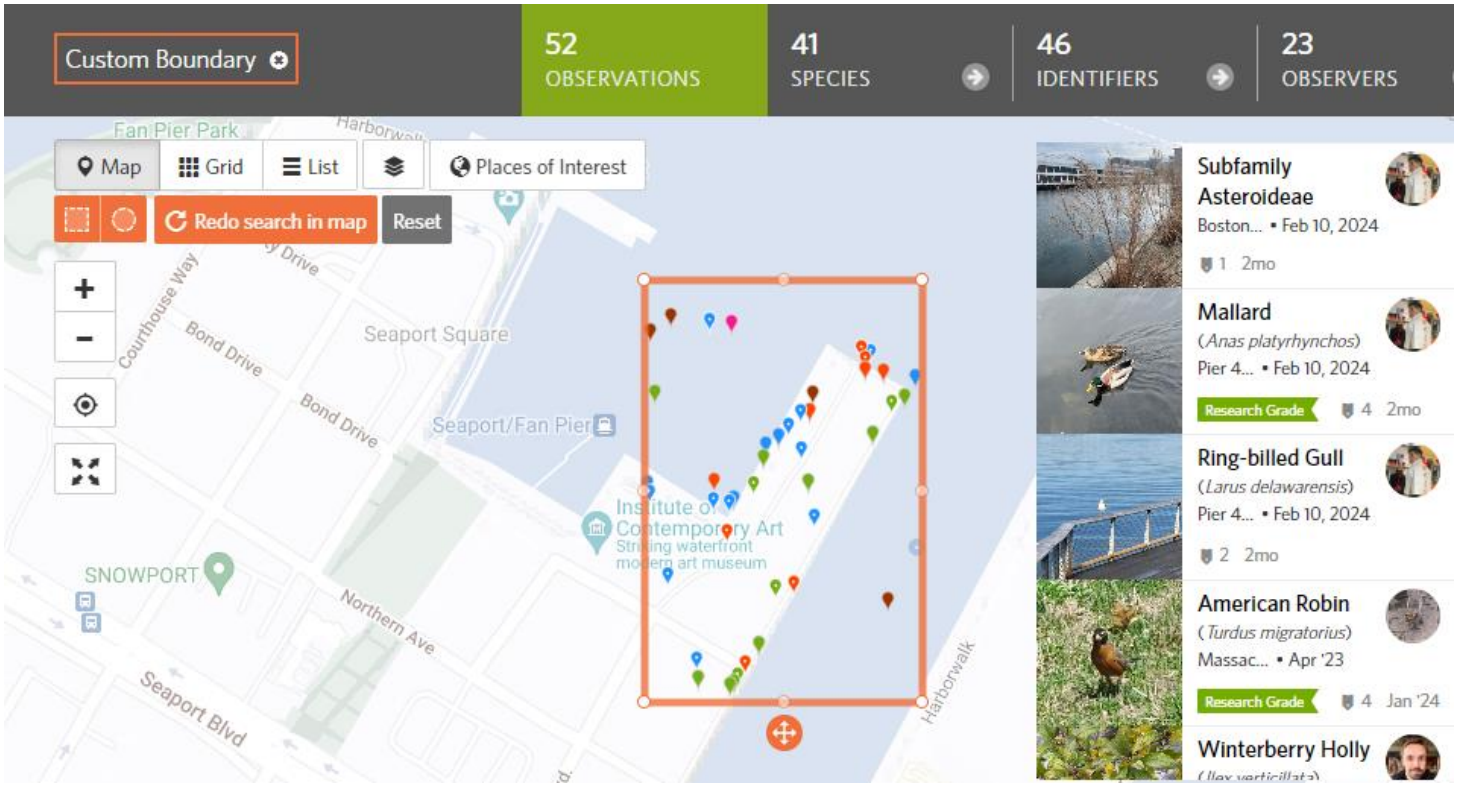
Background:
Pier 4 is situated on the harbor of Boston, offering panoramic views of the Boston Harbor. People living along Boston's shoreline are frequently affected by the repercussions of climate change. Urban biodiversity supports ecosystem services and processes, many with direct benefits and value to human beings (Ahern 2013). Promoting biodiversity can help lessen the detrimental effects of climate change. Pier 4 was a brownfield with contaminated soil and insignificant biodiversity. There has been a significant increase in urban biodiversity since the project was built in 2020 with brownfield remediation and landscape design implementation.

Methods:

1- **Observations from iNaturalist.org**

One useful tool for studying biodiversity is iNaturalist,. Observers from the seaport community have recorded and identified more than 55 species around the Pier 4 project.
Link: Pier 4 - Inaturalist.org

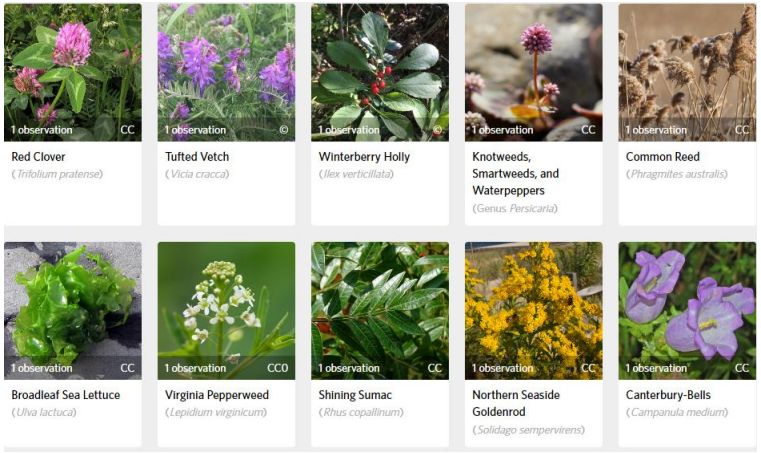
Figure below shows total 23 observations with 41 plant and animal species identified by 23 observers within an approximate 1500 x 900 ft area. 20 of them are in the immediately adjacent locations with date, location, common and Latin names provided.



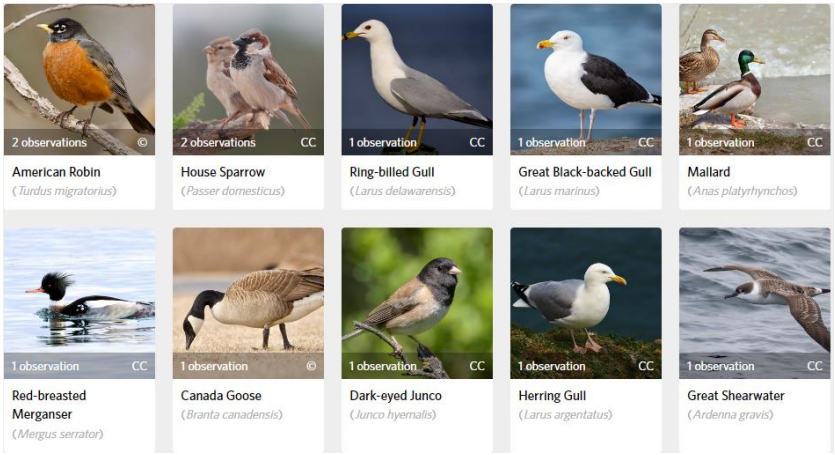
Source: inaturalist.org

Calculation:

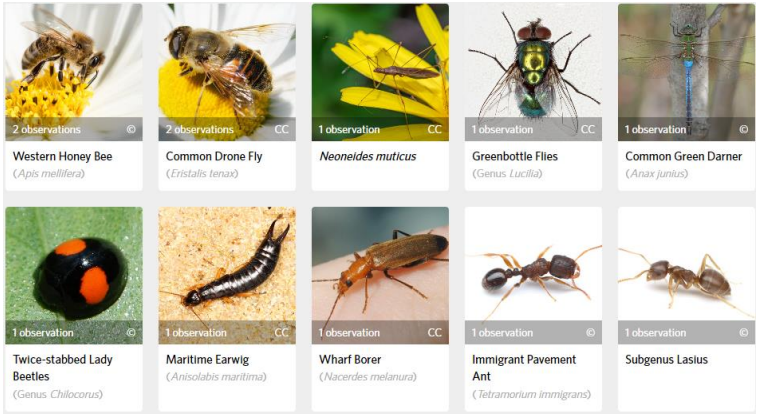
Plantae:



Aves:



Insecta:



Limitation:

- Our wildlife and plant inventories were limited due to time constraints. Second-hand information came from iNaturalist.
- The usefulness of the iNaturalist tool is limited by the number of observations people happen to submit from a given location. The absence of observations does not mean the absence of species.

Sources and references: iNaturalist.org

- ***Sequesters 334,882 pounds of CO2 over 20 years with 120 tree plantings compared to conventional planting***

Calculations

PLANTING LEGEND - PLAZA

TREES

SYMBOL	KEY NAME	BOTANICAL NAME	COMMON NAME	SIZE	QUANTITY	DESCRIPTION
	BP-M	BETULA POPULIFOLIA "WHITESPIRE"	GRAY BIRCH	14' - 16' HT	36	B&B, MULTI-STEM, 3-4 STEMS PER TREE, UPRIGHT HABIT
2	BP-S1	BETULA POPULIFOLIA "WHITESPIRE"	GRAY BIRCH	14'-16' HT	6	B&B, SINGLE TRUNK, PRUNED IN FIELD. AS DIRECTED BY L.A. DO NOT PRUNE WITHOUT APPROVAL
	BP-S2	BETULA POPULIFOLIA "WHITESPIRE"	GRAY BIRCH	12' - 14' HT	12	B&B, SINGLE TRUNK, PRUNED IN FIELD AS DIRECTED BY L.A. DO NOT PRUNE WITHOUT APPROVAL

PLANTING LEGEND - NORTH CUT

SYMBOL	KEY NAME	BOTANICAL NAME	COMMON NAME	SIZE	QUANTITY	DESCRIPTION	DETAIL REFERENCE	SPEC REFERENCE
	NS-1	NYSSA SYLVATICA	BLACKGUM	2.5"	1	B&B, (LOW BRANCHING)	7/L803	329300
	NS-2	NYSSA SYLVATICA	BLACKGUM	3.5" CAL	1	B&B, (LOW BRANCHING)	7/L803	329300
	QP-1	QUERCUS PALUSTRIS	PIN OAK	2" CAL	2	B&B, (LOW BRANCHING)	7/L803	329300
	QP-2	QUERCUS PALUSTRIS	PIN OAK	4" CAL	4	B&B, (LOW BRANCHING)	7/L803	329300
	QS	QUERCUS ILLICIFOLIA	BEAR OAK	#2 CONT.	2	B&B, (LOW BRANCHING)	7/L803	329300
	RT	RHUS TYPHINA	STAGHORN SUMAC	#10 CONT.	8	MULTI-STEM, UPRIGHT HABIT	7/L803	329300
	AL-1	AMALANCHIER LAEVIS	ALLEGHENY SERVICEBERRY	10'-12'	3	B&B, MULTI-STEM, 3-4 STEMS PER TREE, UPRIGHT HABIT	7/L803	329300

SHRUBS

	BH-1	BACCHARIS HALIMIFOLIA	GROUNDSELBUSH	24" - 30" HT	5	#7 CONTAINER
	IVS	ILEX VERTICILLATA 'SOUTHERN GENTLEMAN'	WINTERBERRY	30"-36" HT	1	#7 CONTAINER
	IVW	ILEX VERTICILLATA 'WINTER RED'	WINTERBERRY	30"-36" HT	6	#7 CONTAINER

Source: REED HILDERBRAND

Limitation:

- iTree requires the diameter of the trunk as an input. While Reed Hilderbrand architects provided the diameter measurements of the trees when they were initially planted, updated diameter measurements reflecting the current sizes of the trees were not collected.

- The calculations performed by iTree are based on an assumption of ideal or perfect growing conditions for the trees, which may not accurately reflect the actual conditions the trees have experienced.

Source: MyTree/Itreetools.
https://mytree.itreetools.org/#/benefits/total
Construction Design Set -

SOCIAL BENEFITS

Overall Methods:

Behavior mapping

Behavior mapping, also known as activity mapping, is a type of field observation method. In this process, the researcher observes who (a particular user type) is acting in a certain way (behavior), when (certain times of the year/month/day), and where (certain locations in space) (Sachs, 2017). Behavior mapping entails the research team observing users onsite and recording their behavior on a site map. The research team performed behavior mapping across 2site visits over 2 different days to estimate the organic use of the site visitors.

Surveys

Surveys have the advantage of having a larger sample size and thus providing more statistical power (Jones, Baxter, and Khanduja 2013). The research team conducted most in-person paper surveys on-site during multiple field trips in April. The Class team also assisted in the administration of paper surveys for the visitors.

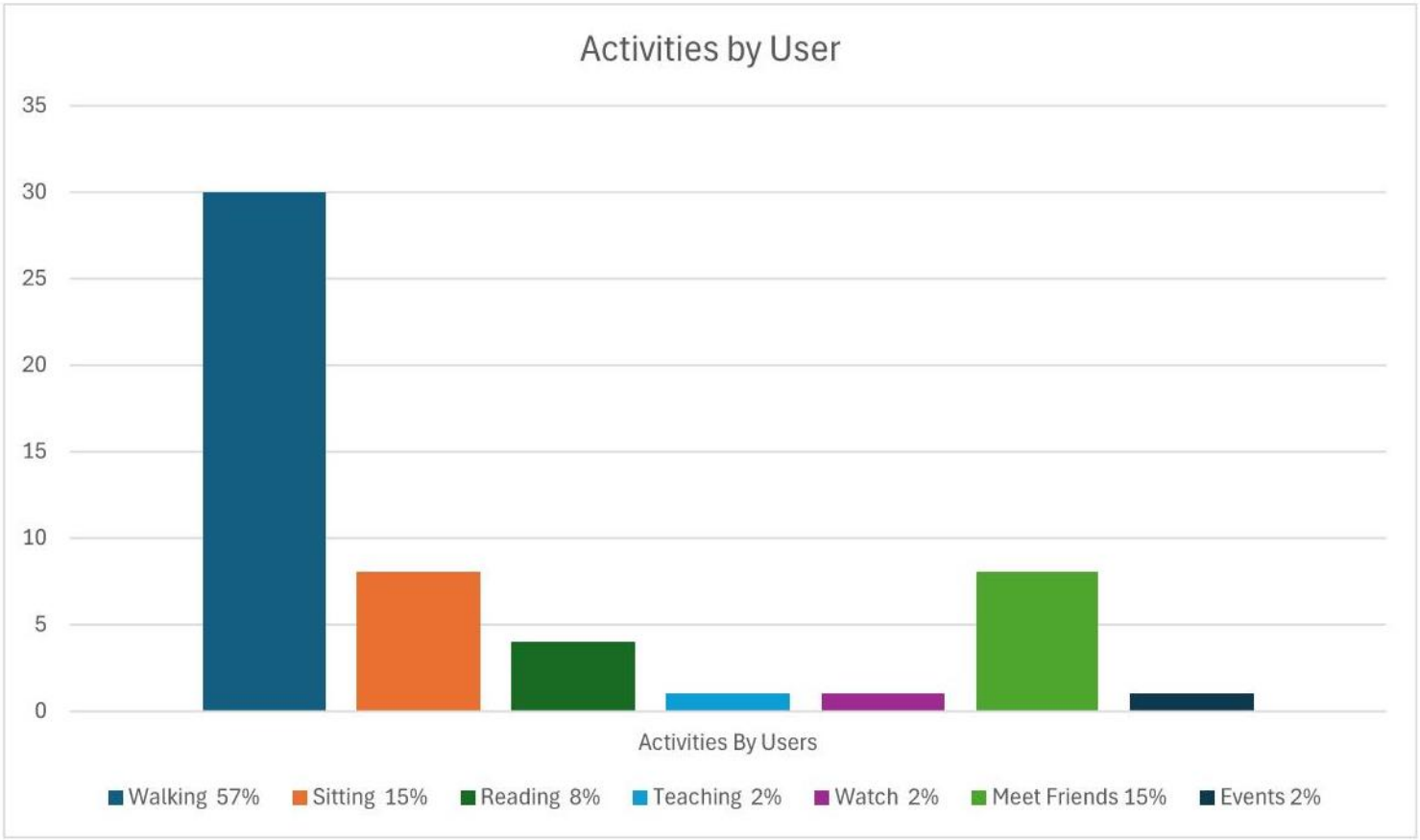
Limitations:

- Behavior mapping can be inaccurate when conducted by a single party covering a large space.
- Surveys can suffer from low response rates, which can affect the representativeness and generalizability of the results. On a voluntary basis, people may skip certain questions. Some answers may contain false or incomplete information. This can introduce bias and errors in data collection.

1. ***Promotes outdoor space occupancy by supporting a variety of activities, with 15 activity types observed on-site in the spring and 7 activity types reported by users through 41 surveys. Most common activities include walking (57% of 41 surveyed users), Meeting Friends (15%), and Reading (8%).***

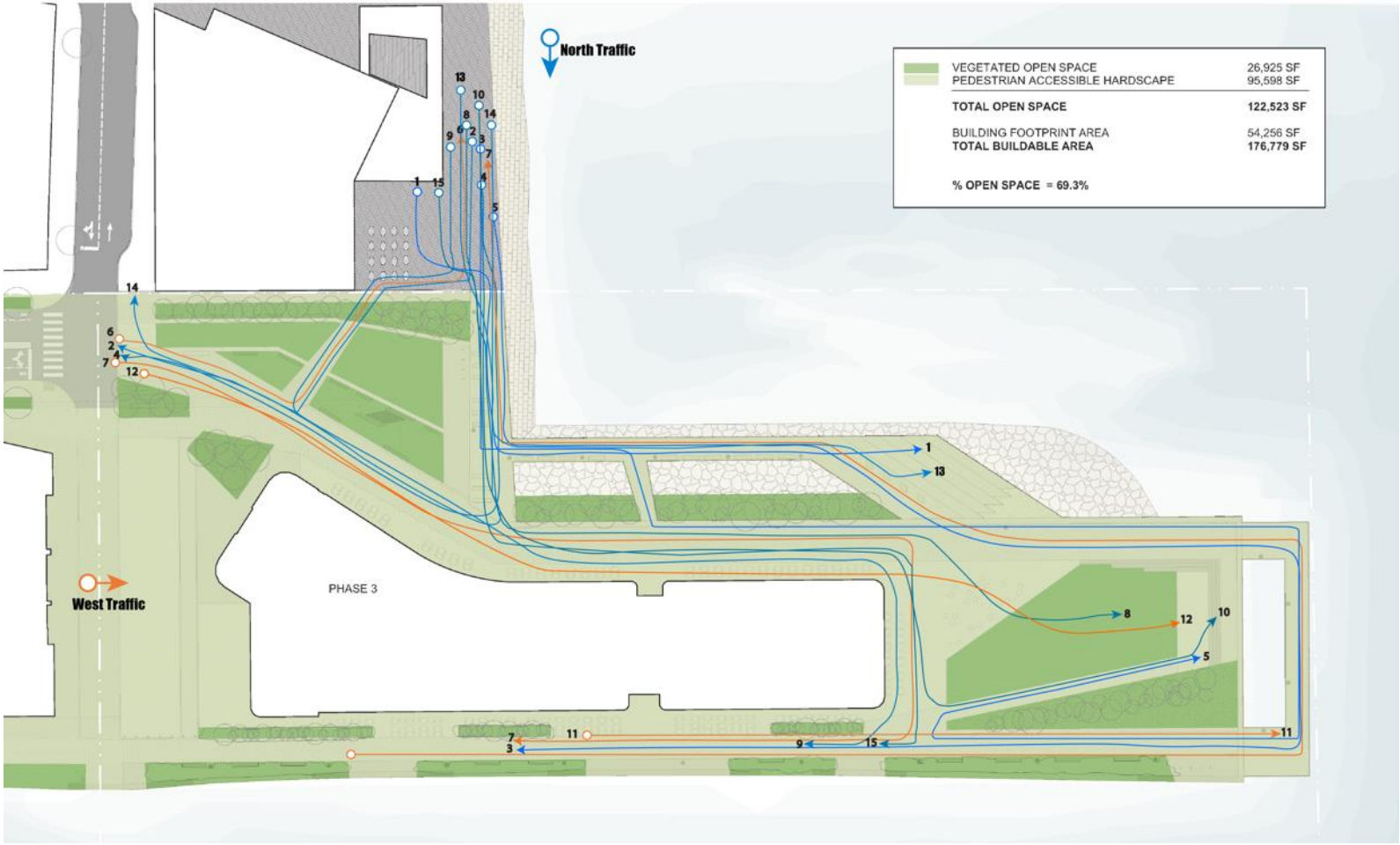
Calculations:

Activities learned from surveys.
A total of 7 activity types were reported by survey participants. Most significant activities include walking (57%), meeting friends (15%), and Reading (8%).



Behavior mapping

One behavior mapping exercise was recorded at 12:00 pm on April 28th 2024. The session lasted approximately 45 minutes and focused on the movement of users through space.



Date: 04/28/2024
Weather: Sunny High 65*F
Air Quality: 68 (Moderate)
Total 15 people

Limitations:

Most of the surveys were collected by people walking, sitting, or visiting. Many individuals were engaged in activities that could not be disturbed, such as jogging or meditating.

Sources:

Data came from surveys and my own field observations.

- ***Provides high aesthetic value at Pier 4 according to 71% of 41 surveyed users***

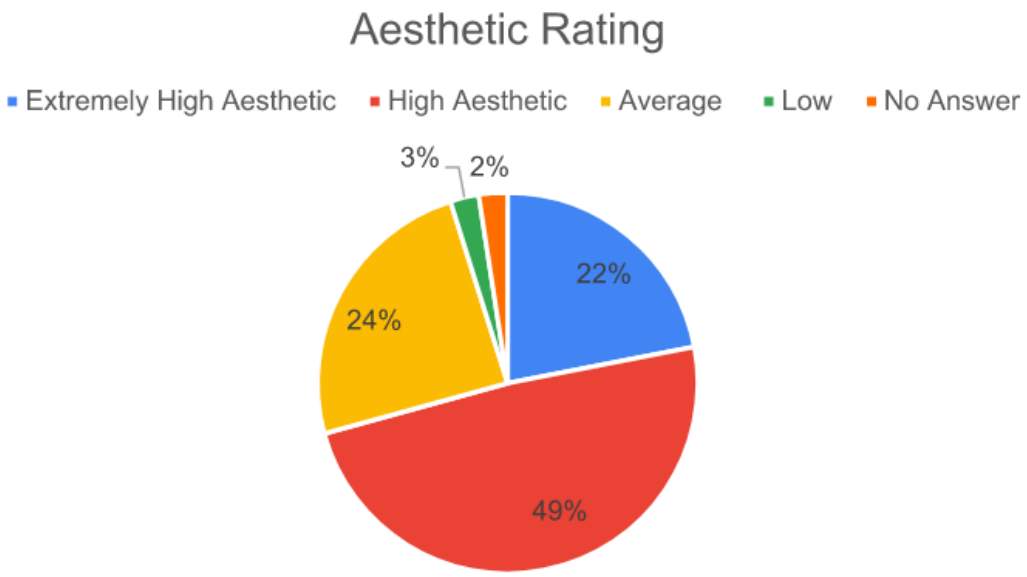
Calculations: 41 total participants were surveyed across two time periods. The first surveys were conducted off-cite during a field trip where students from another university were visiting Boston. The second survey session was conducted on site the same day as the behavior mapping. For both sessions, the same questions were used. Users were asked to answer the following questions:

4. Please rate the aesthetic value of the Harvard SEC open spaces
    1. Extremely Low 2. Low 3. Average 4. High 5. Extremely High

The following chart shows the results. 22% of surveyed users reported the site had Extremely high aesthetic value while 48.8% reported the site had High Aesthetic value.

learned from surveys

	Extremely High Aesthetic	High Aesthetic	Average	Low	No Answer	Total
Surveys	9	20	10	1	1	41
Percentage	22.0%	48.8%	24.4%	2.4%	2.4%	100.0%



Limitations:

Only 41 surveys were conducted on-site.

Sources:

Data came from surveys and my own field observations.

- ***Provides satisfactory experience with 73% of surveyed users recording they are satisfied or highly satisfied with the Pier 4 Harbor Walk and open spaces.***

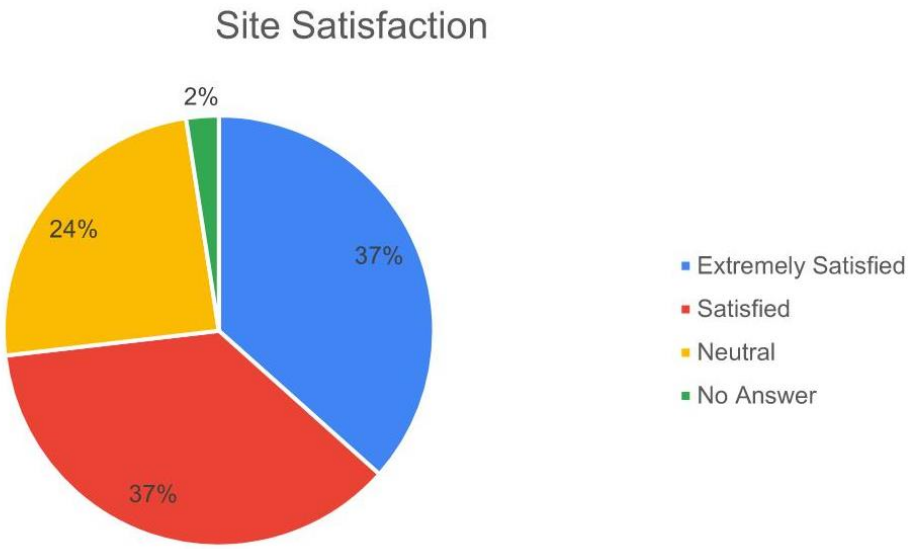
Calculations:

41 total participants were surveyed across two time periods. For both sessions the same questions were used. Users were asked to answer the following question:

6. Rate your satisfaction with your experience in the Harvard SEC open spaces.

1.Extremely dissatisfied 2. Dissatisfied 3. Neutral 4. Satisfied 5.Extremely Satisfied

	Extremely Satisfied	Satisfied	Neutral	No Answer	Total
Surveys	15	15	10	1	41
Percentage	36.6%	36.6%	24.4%	2.4%	100.0%



Limitations:

Only 41 surveys in total were conducted on-site and offsite.

Sources:

Data came from surveys and my own field observations.

- **Promotes positive emotional status with most common feelings about the space including happy (30%), calm (17%), and relaxed (17%), with 81% of surveyed users reporting positive emotional status when on site.**

Calculation:
41 total participants were surveyed across two time periods. For both sessions the same questions were used. Users were asked to answer the following question:

Word Cloud Map

Survey Question 3. What are your feelings or emotional status when you are in the Harvard SEC open spaces? Try to use 2-3 adjectives to describe your feelings.

Source: Answers of Survey Question 3

Lessons Learned

Over several weeks of research and check-ins, I gained insights into conducting surveys, behavior mapping, and stormwater analysis. I also learned how to use new tools to emphasize the social and economic benefits of a project. Working on the

report has enhanced my understanding of what a professional report should look like. My analysis of the site revealed that the most significant takeaway is the importance of collaboration. For a university project to yield extensive benefits, there must be close cooperation between the university, design firm, engineers, and the public.

References & Sources

i-Tree Planting. i-Tree Software Suite v5.x. (n.d.). Web. Accessed 2nd of May. 2024. http://www.itreetools.org
https://www.inaturalist.org/
Reed Hilderbrand Landscape Architecture
Tishman Speyer
Shop Architects

Project Team:

Gary Hilderbrand
Eric Kramer
Elizabeth Randall
Stephanie Hsia
Tishman Speyer
SHoP Architects
Elkus Manfredi Architects
CBT Architects

Recognition

Living on the Edge," by Marni Elyse Katz, Boston Common, Winter 2017

Trying to dish up a friendlier waterfront park" by Tim Logan, Boston Globe, December 13, 2019

2022 Honor Award, Boston Society of Landscape Architects

Chinatown Park

70 Beach St, Boston, MA

Zijie Zhou

Overview

As the first park completed along Boston's Rose Fitzgerald Kennedy Greenway, Chinatown Park is in front of the traditional gate of the Chinatown neighborhood in Boston, Massachusetts. Occupying approximately 0.75 acres, the park is built on the site of an abandoned off-ramp from the Central Artery Dewey Square tunnel. The designers envision creating a space that combines the Chinese migrant's memory and prophecy with traditional Chinese cultural elements. As the most significant open space in Chinatown, the south portion of the park was designed to accommodate the bustling social life of the Asian community by creating an open plaza for everyday activities and large festivals and celebrations. The north portion of the park features a winding path through gardens with lush plants of Asian origin, offering a break from the city's busy streets. Chinatown Park is the culmination of a multi-year planning, design, and construction effort with active community engagement.

Before Hongbing Tang

After Zijie Zhou

At a Glance

Designer: Arcadis IBI Group (Formerly Carol R. Johnson Associates)
Former Land Use: Highway off-ramp
Completion Date: 2007

Project Type: Park/Open Spaces
Size: 0.75 acres
Budget: 1.8 million USD

Project Goals

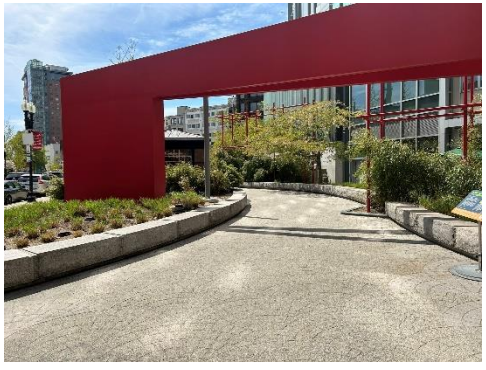
- Eliminate vehicular traffic and improve pedestrian mobility.
- Create greenway connections in Boston's downtown corridor.
- Create a space to accommodate festivals, celebrations, and daily activities for the Chinese communities.
- Create a visually appealing space that blends traditional Chinese design with contemporary elements.

Site Plan

Source: Arcadis IBI Group

Site Images

The Red Gate

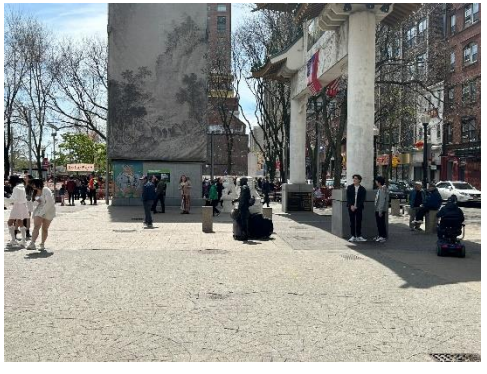


Water Fall

Ancient Lace Bark Pine

PlayCubes™

Entry Plaza



Winding Path

Photos by Zijie Zhou

Landscape Performance Benefits

Environmental Benefits

- ***Reduces peak runoff rate for a 100-year storm by an estimated 24% and reduces runoff volume by 23,667 gallons for a 100-year, 24-hour storm as compared to predevelopment conditions.***

Methods:
AutoCAD was used to calculate the areas of each different surface cover. Modified Rational Method was adopted as it is a simplified model of the hydrologic process. It can be used to estimate the peak runoff rate for an area of less than 20 acres based on a design rainfall intensity. The stormwater runoff volume comparison for pre- and post-development was calculated using the Natural Resources Conservation Service (NRCS) Method for a 100-year, 24-hour storm.

Calculation:

- **Pre-Development Site Land Cover highway surface material: concrete, 100% impervious**
  Runoff coefficient for concrete: C = 0.95
  A = Total site area = 32,228 sf = 0.74 ac

- **Post-Development Site Land Cover**

Land Cover	**Area(sf)**	**Area(ac)**	**Runoff Coefficient C**	**Adjusted Area C*A**
Ground-level gardens	8,709	0.199	0.1	0.019
Stone paving	782	0.018	0.7	0.013
Hardscape	22,737	0.523	0.95	0.500
Subtotal	32,228	0.74		0.523

- **Weighted Runoff Coefficient:**
  Cweighted = Adjusted Area / Total Site Area = 0.523/0.74 = 0.72

- **Formula: Qp = CCAiA**
  Qpre-development = 0.95 x 1.25 x 5.4 iph x 0.74 ac = 4.745 cfs
  Qpost-development = Caverage x CA x i x A = 0.72 x 1.25 x 5.4 x 0.74 ac =3.596 cfs
  Reduction rate: (4.745 – 3.596)/4.745 = **24.21%**

  In Summary, 100-year design storm calculations show a 24.21% reduction in peak runoff rate comparing the pre- and post-development conditions.

- **Reduction of runoff volumes for a 100-year, 24-hour storm**
  1. Calculations of pre-development site runoff water in gallons:
     Pre-development Runoff Volume = 6.55in x 1 ft /12 in x 32,228 sf = 17,521 cf
     17,521 cf x 7.48 gallons/cf = 131,057 gallons

  2. Calculation of post-development site stormwater runoff in gallons:

Land Cover	**Curved Number**	**Area (sf)**	**Runoff generated (inch)**
Impervious surfaces	98	22,737	6.55
Pervious surfaces	61	8,709	2.38
Environmental plaza rough stone paving	79	782	4.25

  Post-development site (32,228 sf) is 70.55% impervious (22,737 sf).

  Runoff Vol. = (6.55 in x 1 ft/ 12 in x 22,737 sf) + (2.38 in x 1 ft/12 in x 8,709 sf) + (4.25 x 1 ft/12 in x 782) = 12,361+1,720 +276 = 14,357 cf
  14,357 sf x 7.48 = 107,390 gallons

  Runoff volume reduction for a 100-year, 24-hour storm: 131,057 – 107,390 = 23,667 gallons

Limitation:

- When doing stormwater runoff estimation, AutoCAD was used to trace and measure areas of various land covers based on the construction documents provided by the design firm and the client. Human errors were conceivable, limiting the accuracy of the calculations.

Sources:

- ***Provides biodiversity by creating habitats for at least 19 Perennials species, 33 Shrubs species, and 15 trees species observed in the ground-level outdoor spaces.***

Background:

Chinatown Park was formerly a highway off-ramp, so no vegetation was on-site before construction.

Method:

- Data collected from The Green Way, Rose Kennedy Greenway Conservancy Plant Identification Information website.

Calculation:

Perennials species

Shrubs species

***Chaenomeles speciosa* 'Texas Scarlet'**
Flowering Quince

***Chaenomeles speciosa* 'Toyo Nishiki'**
Flowering Quince

***Fothergilla major* 'Mt Airy'**
Fothergilla

***Ilex crenata* 'Green Luster'**
Japanese Holly

***Ilex glabra* 'Densa'**
Inkberry

***Ilex glabra* 'Shamrock'**
Inkberry

***Ilex verticillata* 'Jim Dandy'**
Winterberry

***Ilex verticillata* 'Red Sprite'**
Winterberry

***Ilex verticillata* 'Winter Red'**
Winterberry

Microbiota decussate
Russian Arborvitae

Neillia sinensis
Chinese Neillia

***Paeonia suffruticosa* 'Hana-kisoi'**
Tree Peony

***Paeonia suffruticosa* 'Luoyang Red'**
Tree Peony

***Paeonia suffruticosa* 'Shin-jitsu-getsu-nishiki'**
Tree Peony

***Pinus strobus* 'Hillside Creeper'**
Eastern White Pine

***Rhododendron* (Indica Type) 'Macratha Pink'**
Macrantha Azalea

***Rhododendron* (Kurume Hybrid) 'Hino-crimson'**
Kurume Azalea

***Rhododendron* (Mezitt/Weston Hybrid) 'April Snow'**
P.J.M. Rhododendron

***Rhododendron* (Mezitt/Weston Hybrid) 'Olga Mezitt'**
P.J.M. Rhododendron

***Rhododendron* (Mezitt/Weston Hybrid) 'Weston's Vyking'**
Weston Azalea

***Rhododendron* (Satsuki Hybrid) 'Gumpo Pink'**
Satsuki Azalea

***Rhododendron* (Shammarello Hybrid) 'Yaku Prince'**
Shammarello Rhododendron

***Rhododendron* ['PJM' cultivar]**
P.J.M. Rhododendron

***Rhododendron* 'Mikkeli'**
Rhododendron

***Rhododendron mucronulatum* 'Cornell Pink'**
Korean Rhododendron

***Rhododendron* 'Nova Zembla'**
Koster Rhododendron

***Rhododendron* 'Purple Gem'**
Dwarf Azalea

Rhododendron yedoense* var. *poukhanense
Korean Azalea

***Rosa* 'Radrazz' (Knock Out Red)**
Knock Out Rose

***Rosa* 'Radcor' (Rainbow Knock Out)**
Knock Out Rose

***Rosa* 'Wekcisbako' PP18552**
Home Run Rose

***Rosa* x 'Noarre' P.P.#11308**
Flower Carpet Rose

***Viburnum carlesii* 'Compactum'**
Dwarf Korean Spice Viburnum

Tree species

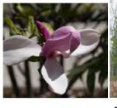
Abies fraseri
Frasier Fir

***Chamaecyparis obtusa* 'Gracilis Compacta'**
Compact Hinoki Cypress

Cornus kousa
Kousa Dogwood

Ginkgo biloba
Ginkgo

Koelreuteria paniculata
Goldenrain Tree



***Magnolia* 'Jane'**
Magnolia

Pinus bungeana
Lacebark Pine

***Pinus sylvestris* 'Hillside Creeper'**
Scotch Pine

Prunus subhirtella
Higan Cherry

Prunus x yedoensis
Yoshino Cherry

***Salix babylonica* 'Niobe'**
Weeping Willow

***Styphnolobium japonicum* 'Regent'**
Pagoda Tree

***Ulmus* 'Frontier'**
Elm

***Ulmus parvifolia* 'Dynasty'**
Chinese Elm

***Ulmus parvifolia* 'Emerald Vase'**
Chinese Elm

Sources:
The Rose Kennedy Greenway - Plants & Landscapes. http://www.rosekennedygreenway.org/visit/plants-landscapes/

- ***Sequesters an estimated 3,164.8 lbs of atmospheric carbon in planted trees in 2024.***

Methods:
i-Tree Canopy was used to estimate annual carbon sequestration of trees and shrubs.
First, the project area was defined in Google Earth through the i-Tree Canopy web application. Several classes of trees were added to the analysis to create an accurate data set.

Calculation:
- The diameter of trees was measured on-site. (Due to the condition of the park, some trees' diameters were estimated.)
- The i-Tree Canopy web application set a project area in Google Earth. In this case, the project area was set to be the boundaries of Boston Chinatown Park.
- Tree classes were added to the analysis.
- Insert the diameter of the trees.
- I-Tree calculated the amount of atmospheric carbon sequestered in 2024.
- According to the calculations of i-Tree, Chinatown Park sequestered an estimated 3,164.8 lbs of atmospheric carbon in 2024.

MyTree Benefits

Tree Collection Totals, ()

Serving Size: 29 trees
Estimated this year: $1,390.36
Discover benefits of all your community trees!

	Annual values:
Carbon Dioxide Uptake	**$269.88**
Carbon Sequestered[1]	3,164.8 lbs
CO_2 Equivalent[2]	11,604.26 lbs
Storm Water Mitigation	**$424.47**
Runoff Avoided	47,501.01 gal
Rainfall Intercepted	92,803.1 gal
Air Pollution Removal	**$668.51**
Carbon Monoxide	18.18 oz
Ozone	464.65 oz
Nitrogen Dioxide	126.42 oz
Sulfur Dioxide	10.81 oz
$PM_{2.5}$	16.31 oz

Figure 5.1: Result from i-Tree

Limitation:

- The diameter of the trees is measured by hand. Human errors were conceivable, limiting the accuracy of the calculations.
- Although i-Tree is a scientifically developed tool, it is still an approximation for on-site conditions.

Sources:
i-Tree: https://mytree.itreetools.org/

Social Benefits

Overall Methods:

Field Observations
Field observation is a type of field research method that involves collecting data by observing the behavior, actions, or interactions of people or animals in a natural setting. The researcher does not interfere with the subjects or manipulate any variables but simply records what they see and hear.

Surveys
Surveys are a common and simple research method. Surveys have the advantage of having a larger sample size and thus providing more statistical power. Surveys were conducted with the same set of questions as interview questions (Appendix 1).

Interviews
Interviews can provide more in-depth, qualitative data than a survey can offer.

- ***Provides a range of activity spaces with 13 activity types observed on-site through field observation and 6 activity types reported by users through 21 surveys and 9 interviews. Walking is the most common type of activity (50% of 30 surveyed and interviewed users), eating (30%), followed by visiting (20%).***

Calculation:

- 21 people in total were surveyed, and 9 people were interviewed.
- On-site observation with photos.

- Out of 21 surveys, 12 users report of walking in the park, 4 reports of eating, 2 reports of sitting, 1 user report of meeting with friends and phone calling. Out of 9 interviews, 6 users reports of visiting in the park, 5 reports of eating, 3 reports of walking, 2 reports of biking, and 1 report of meeting with friends.

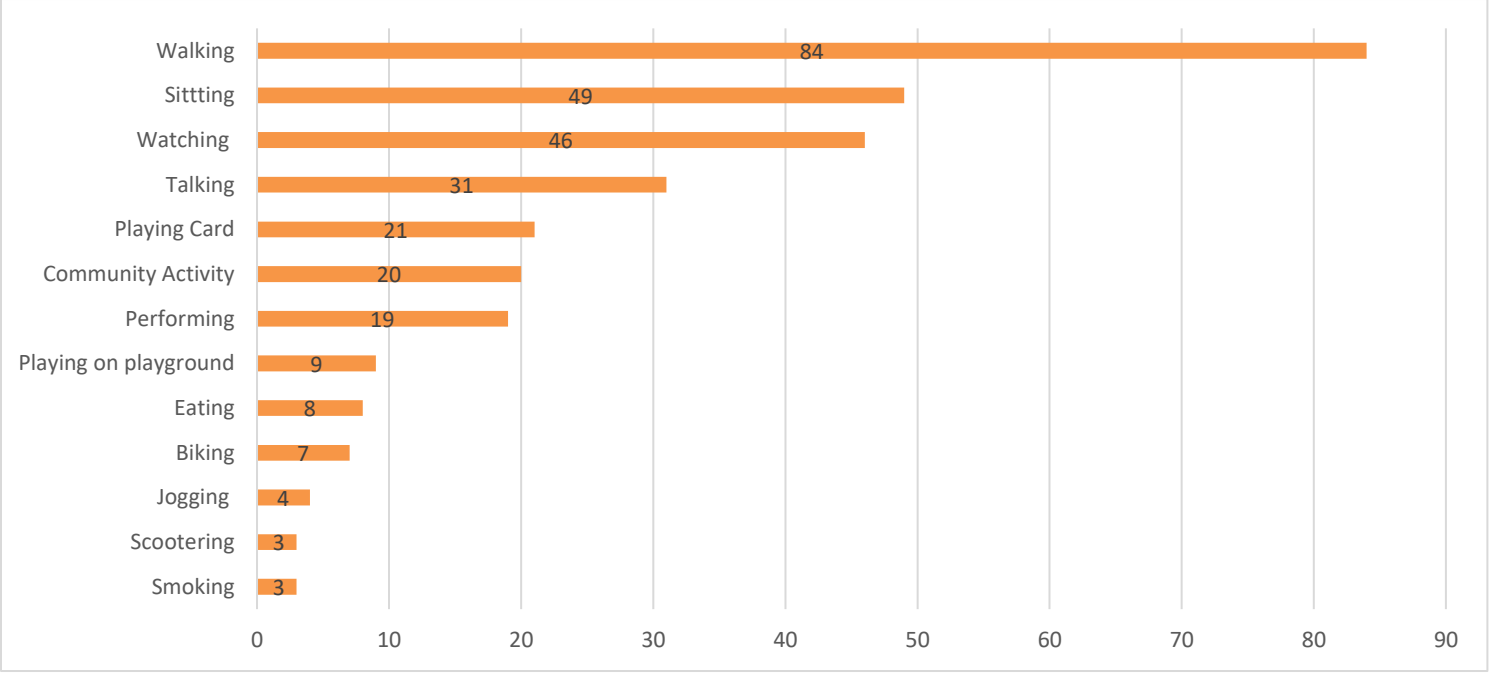


Figure 5.2: On-site observation activities.

Date: 4/27/2024 Weather: Sunny Temperature: 68F ID: S=staff P=patient V=visitor N=can't tell

group	M	F	dog	race	ID	Age 0-6	7-18	18-34	35-50	51-65	65+	Time	Notes: W=whiye B=Black, A=Asian
1	1	1		A			1		1			12:44PM	Sitting
2		2		A						2		12:48PM	Sitting
3	3	2		A/W				5				12:49PM	Sitting
4		3		A					3			12:50PM	Sitting
5	8			A/W				1	7			12:52PM	Sitting
6	1	2		A/W					3			12:58PM	Performance
7	3			A					2	1		12:59PM	Watching
8	1	2		W				3				12:55PM	Walking
9	1			W				1				12:55PM	Sitting
10		2		A					2			12:57PM	Sitting
11		2		A			1	1				12:57PM	Sitting
12	4	4		A					4			12:58PM	Playing card
13	1			A					1			12:58PM	Smoking
14		3		A				3				1:00PM	Walking
15	2			A				2				1:01PM	Meeting
16	2			A					2			1:01PM	Sitting
17	1	5		A				2	4			1:03PM	Walking
18	5	1		B			1	5				1:05PM	Sitting
19	37	5		A					42			1:01PM	Playing card
20		20		A			5	15				1:10PM	Community Program
21	1	2		A						3		1:10PM	Sitting
22		2		A/W				2				1:17PM	Biking
23	3			W				3				1:15PM	Eating
24	1	1		W						2		1:17PM	Walking
25	2	4		A/W				4	2			1:20PM	Performance
26	4	9		A/W				8	5			1:24PM	Performance
27	2			W				2				1:26PM	Walking
28	1	2		W				3				1:28PM	Walking
29	8			A					9			1:30PM	Playing card
30		1		A				1				1:31PM	Eating
31	2	1		A/W		3						1:33PM	Playing
32	1	1		W				2				1:35PM	Walking
33	1	1		W				2				1:38PM	Biking
34	1	1		A				2				1:40PM	Eating
35	1	2		A/W				1	2			1:41PM	Watching performance
36	1			W					1			1:42PM	Biking
37	2			W						2		1:42PM	Sitting
38	1	2		A		1			2			1:42PM	Eating
39	1	1		W						2		1:43PM	Walking
Total	104	80				4	8	65	89	12			

184

Figure 5.3: Record of on-site observation.

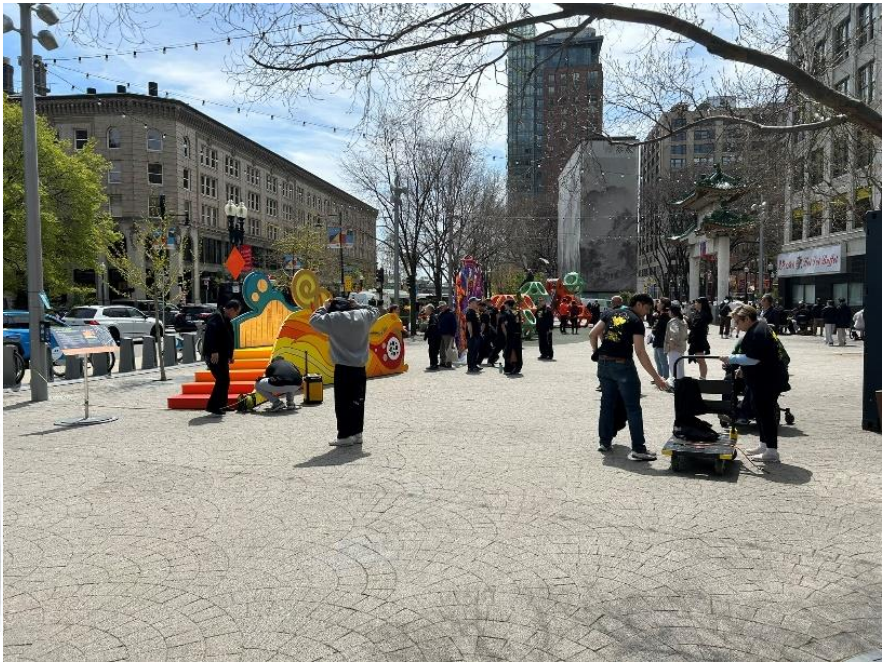


Figure 5.4: On-site observation photo by Z. Zhu.

Limitation:

- Human error may occur during field observations.
- Some survey and interview participants have only been to the park once, which may have resulted in limited on-site experience.

Sources:

Data came from class surveys and my own interviews and field observations.

- ***Provides high aesthetic value according to 80% of 30 survey and interview participants.***

Calculation:

- 21 people were surveyed, and 9 people were interviewed.
- The following table and chart show the results. 50% of the users rated the aesthetic value as very high, while 30% said the aesthetic value was extremely high.

	Low	Average	High	Extremely high	Total
Surveyed	1	5	9	6	21
Interviewed	0	0	6	3	9
Percentage	3%	17%	50%	30%	100%

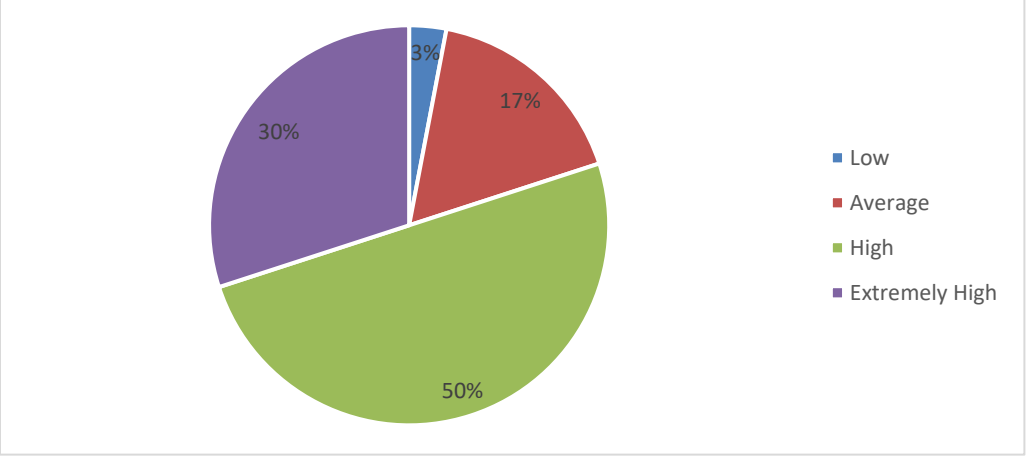


Figure 5.5: Percentage of the aesthetic value.

Limitation:

- Some survey and interview participants have only been to the park once, resulted in limited experience on-site.

Sources:

- Data came from surveys and interviews.

- ***Provides user satisfaction with 77% of 30 survey and interview participants recording they are satisfied or highly satisfied with Chinatown Park. The most common feelings about the space include cultural (10%), dirty (10%), and happy (7%).***

Calculations:

- 21 users in total were surveyed, and 9 people were interviewed.
- The following table and chart show the results. 63% of the total interviewees rated the experience in the park as satisfied, while 14% rated the experience in the park as extremely satisfied.

	Dissatisfied	Neutral	Satisfied	Extremely Satisfied	Total
Surveyed	1	4	13	3	21
Interviewed	0	2	6	1	9
Percentage	3%	20%	63%	14%	100%

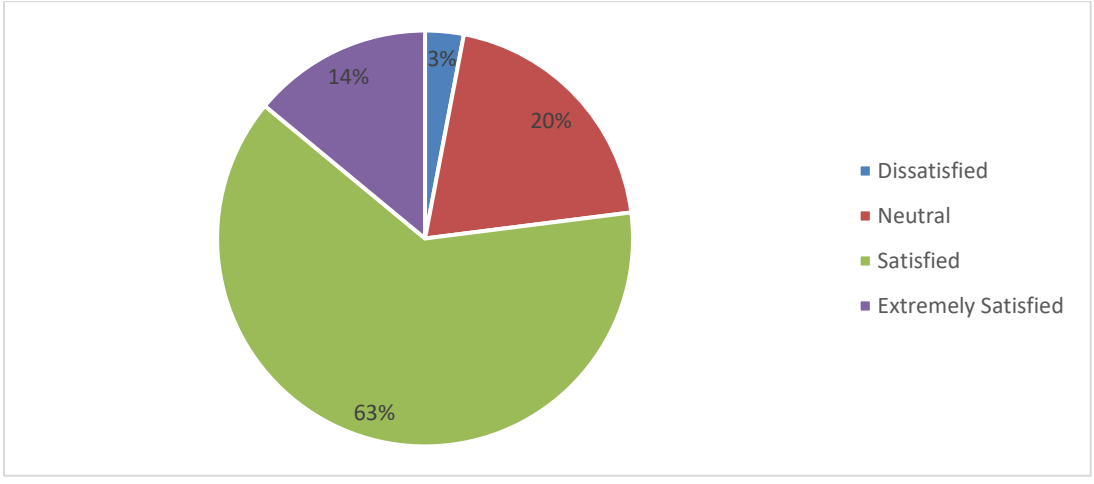


Figure 5.6: Percentage of satisfaction with Chinatown Park

Figure 5.7: Word cloud compiling all the words people described their feelings.

Limitation:

- Some survey and interview participants have only been to the park once, which may have resulted in limited experience on-site.

Sources:

- Data came from surveys and interviews.

Economic I Benefit

- ***Average a 12% increase in adjacent property values of the park after three years of construction (2010), compared to pre-construction (2006).***

Method:
Gather adjacent property values of the park from the City of Boston. The pre-construction adjacent property values were compared to those after three years of construction. 6 adjacent property values were compared.

Calculation:
The table and bar chart below show the % of increased values of the adjacent property.

- Note: Property 1's property type had changed from industrial to commercial after the park's construction. The change has affected its values. In this case, Property 1 will be considered as an outlier, its value will not be included in the final calculation.
- % of increase = (property values of the park after 3 years of construction – property value pre-construction)/ property value pre-construction

	2006	2010	% of increase
Property 1 Value (Outlier)	*$2,851,500.00*	*$4,029,000.00*	*41*
Property 2 Value	$2,674,000.00	$2,924,000.00	9
Property 3 Value	$3,758,500.00	$4,440,500.00	18
Property 4 Value	$872,000.00	$930,500.00	6
Property 5 Value	$547,500.00	$572,500.00	4
Property 6 Value	$2,287,000.00	$2,536,500.00	10
In total	$12,990,500.00	$15,433,000.00	18
In total (without property 1)	$10,139,000.00	$11,404,000.00	12

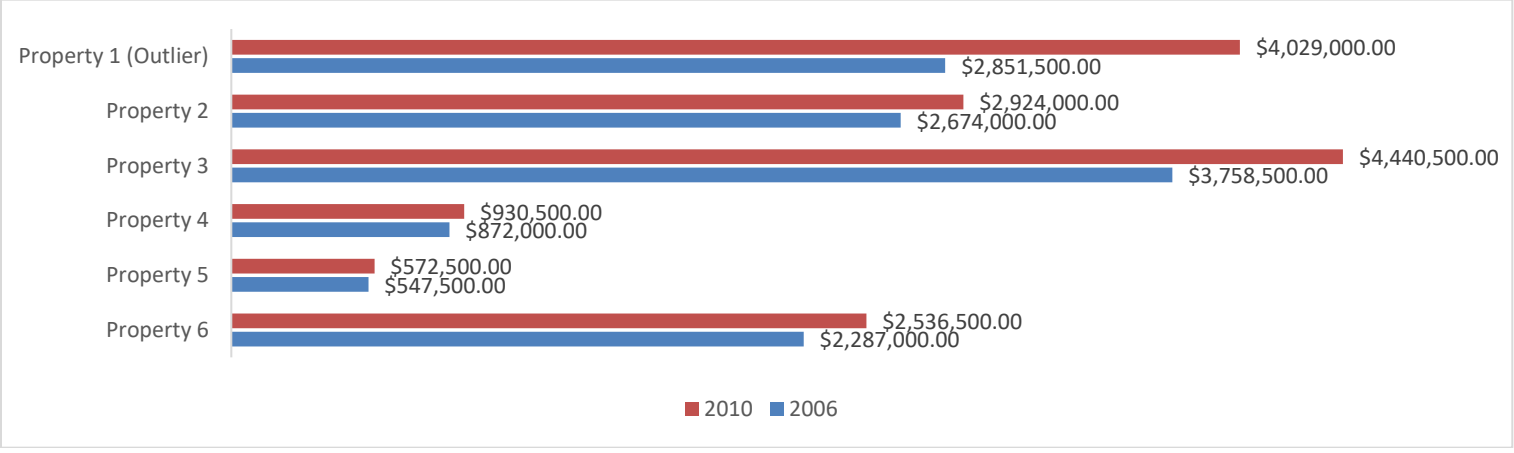


Figure 5.8: Property value comparison.

Figure 5.9: Adjacent properties in Chinatown Park (from Boston Tax Parcel Viewer)

Limitation:

- The increase in land values cannot exclusively be attributed to the introduction of Chinatown Park. Other forces across local, national, and global scales were at play during the study period, affecting the reported data.

Sources:

City of Boston: https://www.cityofboston.gov/assessing
Boston Tax Parcel Viewer: https://app01.cityofboston.gov/parcelviewer/

Lessons Learned

The park's design reflects and respects the cultural heritage of its community. Incorporating Chinese symbolism and cultural elements creates a space that feels authentic and welcoming to residents and visitors alike.

Chinatown Park did a great job of being a versatile space, catering to various needs and activities throughout the day and across different seasons. The heavy usage of the park is a testament to its successful design.

Based on the feedback from the surveys and interviews, the lack of cleanliness in the park is a major concern for the users. Chinatown Park needs more maintenance from the public service.

References & Sources

- Arcadis IBI Group Chinatown-park: https://www.ibigroup.com/ibi-projects/chinatown-park/
- The Rose Kennedy Greenway - Plants & Landscapes: http://www.rosekennedygreenway.org/visit/plants-landscapes/
- City of Boston: https://www.cityofboston.gov/assessing

Project Team:

- Landscape Architecture: Arcadis IBI Group (Formerly as Carol R. Johnson Associates)
  Turenscape (sub-consultant at the design competition phase)
- Lighting: AECOM (2023)
- Playground: Richard Dattner and PlayCubes™ (2016 Playground)

Harvard Science & Engineering Center

150 Western Avenue, Allston, Boston, MA

Jillian Ziegler

Overview

Built on a former brownfield site, the Harvard Science and Engineering Complex is the first project in the evolution of Harvards Allston, Massachusetts campus. Designed as the new home for the School of Engineering and Applied Sciences (SEAS), the site features a variety of public green spaces, green roof terraces, and sunken courtyards. Sensitive to the nearby river and potential for flooding, an emphasis was placed on stormwater retention and large bioretention ponds were designed to mimic the salt marshes and hummocks of Allston's past. The stormwater system includes a 78,000-gallon reuse tank cutting the potable water needs on site by more than half by supplementing toilet, lab, and irrigation water.

Before Google Maps

After J.Ziegler

Before Google Earth Pro

After Google Earth Pro

At a Glance

Designer: Stephen Stimson Associates
Former Land Use: Brownfield
Completion Date: 2021
Awards: LEED Platinum, Living Building Challenge
AIA COTE® Top Ten Award | 2023
BSLA Merit Award 2024
Best of Design Award in the category of 'Green Building' | 2021

Project Type: School/University
Size: 274,528 sq. ft.
Budget:

Project Goals

- Retain the majority of the site's stormwater for reuse in the building and irrigation system.
- Provide enjoyable green space for Harvard students and community members.
- Reduce irrigation demand through Smart Irrigation technology and use of native plants.
- Collaborate with Harvard's Arnold Arboretum to sequester carbon and include unique plantings.

Site Plan

Source: Stephen Stimson Associates

Site Images

Seating Area by Entrance

Top Floor View

Pedestrian Path

Bike Path and Informational Plaque

Images courtesy of Stephen Stimson Associates

Landscape Performance Benefits

Environmental Benefits

- ***Sequesters 434,392 pounds of CO2 over 20 years with 440 tree plantings compared to conventional planting.***

Method:
i-tree is a peer-reviewed software site from the USDA Forest Service that provides various analysis and benefit assessment tools. The i-tree 'Planting' tool was designed to help estimate the long-term environmental benefits from a tree planting project in terms of carbon dioxide, air pollution, stormwater impacts, energy savings, and canopy cover. While it is advertised as a tool that can make a case to developers about planting more trees, it worked well as a simple tool to calculate the carbon savings of these specific species.

Calculation:

TREES				
Scientific Name	**Common Name**	**Count**	**Native/ Non-native/ Hybrid**	**Conserved**
Amelanchier x grandiflora `Autumn Brilliance`	`Autumn Brilliance` Serviceberry clump	3	Hybrid	
Acer rubrum `October Glory` TM	October Glory Maple	4	Native	
Acer griseum	Paperbark Maple	1	Non-native	yes
Acer saccharum `Green Mountain` TM	Green Mountain Sugar Maple	1	Native	
Acer triflorum	Three Flowered Maple	3	Non-native	
Chamaecyparis thyoides	Atlantic White Cedar	15	Native	
Carpinus caroliniana	American Hornbeam	2	Native	
Celtis occidentalis	Common Hackberry	3	Native	

Table 6.1. Sample of Tree Data Entered into i-tree Planting Tool. Source: Stephen Stimson Associates

Using the tree planting information provided by STIMSON, information for Diameter at Breast Hight, Count, Direction and Distance from building, were entered for each species. Accounting for all the trees classified under Tree and Thicket, 440 trees were planted on site but only 427 were able to be entered for analysis. The i-tree tool processed this information and using the assumptions above, calculated the toal carbon sequestered over 20 years to be 434,392.10 pounds of CO2.

Limitations:

- Only 427 of the total 440 trees were accounted for since i-tree did not have the option to include *Heptacodium miconioides* Seven Sons Flower

- DBH provided in the planting list was used for calculations which may not reflect the current day DBH 3 years after project completion
- The i-tree Planting tool only allows for a city to be entered instead of an exact address, which could impact the calculations
- Emissions Factors and Annual Tree Mortality were kept at the standard provided by i-tree which may be inaccurate to this region and have an unknown effect on the total sequestered carbon

Sources:

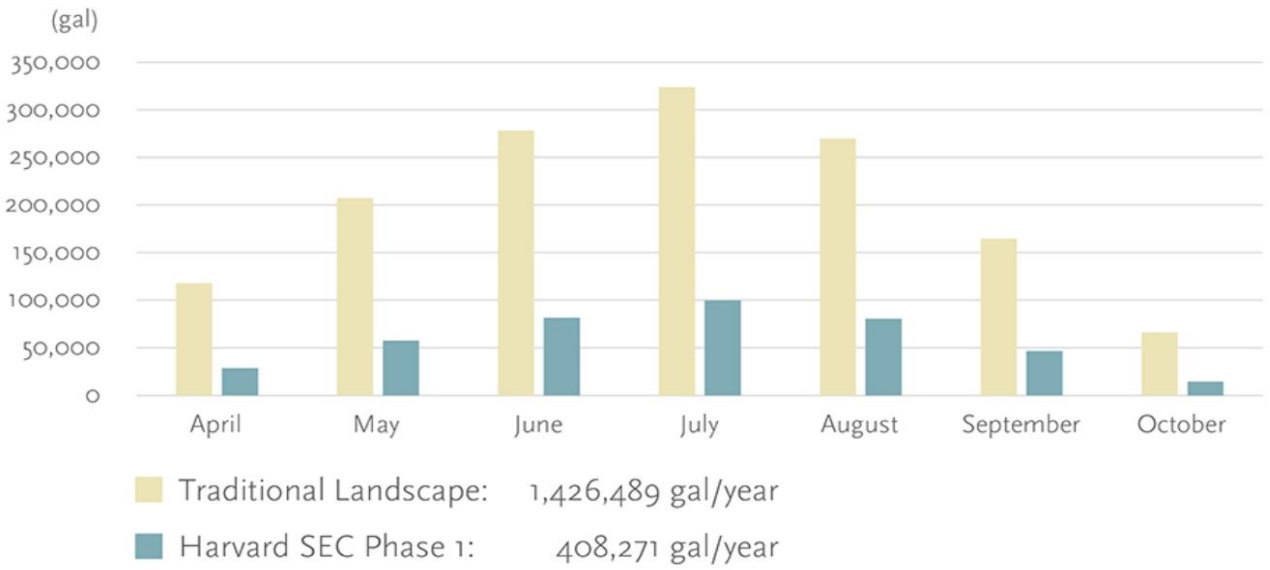
i-Tree Planting. i-Tree Software Suite v5.x. (n.d.). Web. Accessed 2nd of May. 2024. http://www.itreetools.org

- ***Saves an estimated 1,018,218 gallons of water anually by implementing water-conscious landscape design techniques. 42% of 60 species planted are native and 7% are conserved in partnership with the Arnold Arboretum.***

Methods:

In order to reduce water consumption on site various strategies were implemented, the most prominent being the 75,000 gallon cistern on site. In addition the the cistern, 5 stormwater basins are set in the landscape to collect and filter rainwater before it enters the cistern below ground (Figure 1). Because a major goal of the project is to reduce water consumption, irrigation demand was lessened by implementing a water-conscious design including reducing turf, planting native species, installing soil moisture and weather sensing, and adjusting watering for rainy/dry and hot/cool weather conditions. Stimson worked with the Arnold Arboretum to choose a variety of plants that would provide native species benefits, landscape interest, and include some popular hybrid or conserved species from the arboretum.

Expected Irrigation Demand



Traditional Landscape:
Rain Sensor Only (Required by Law in Massachusetts):
Traditional Landscape (80% Turf, 20% Mixed Shrubs, Trees, Groundcovers)
No Smart Irrigation
No Soil Moisture or Weather Sensing,
Set to Apply Enough Water for Peak Summer Demand for minimum oversight

Harvard SEC:
Water-conscious landscape design for integration with stormwater features. Smart irrigation through soil-moisture sensing, allowing irrigation controller to automatically adjust watering for rainy/dry and hot/cool weather.

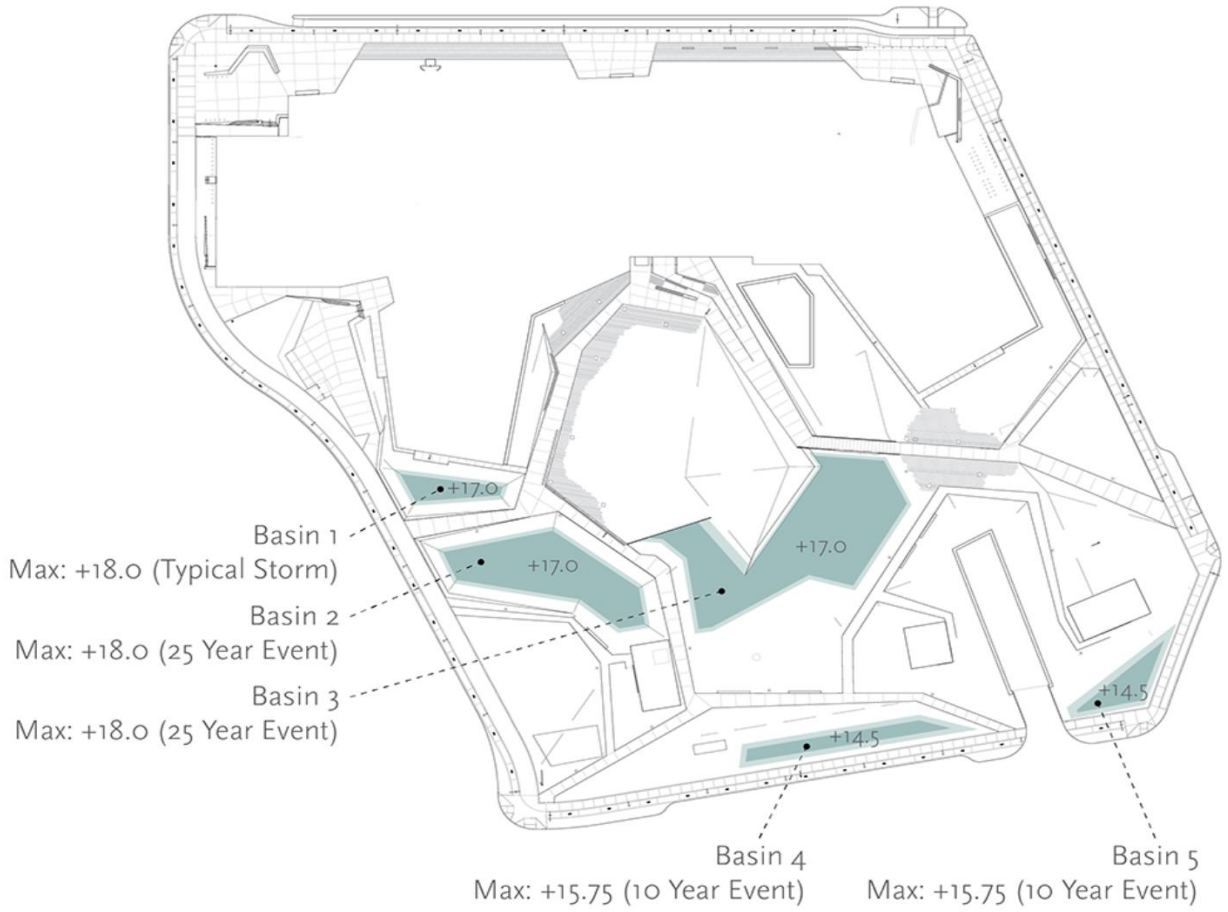


Figure 6.1. Expected Irrigation Demand Graph and Basin Map. **Source: Stephen Stimson Associates**

Calculation:
Using the graph provided in Figure 1. a traditional landscape is estimated to use 1,426,489 gallons per year on irrigation alone. With the introduction of smart irrigation and water-conscious design techniques the Harvard SEC phase 1 is estimated to use 408,271 gallons per year. This means an estimated 1,018,218 gallons of water savings annually or 71% reduction in irrigation water use.

1,426,489 - 408,271 = 1,018,218 / 1,426,489 = 0.7137 or 71%

One major aspect of the water-conscious design techniques is using lots of plantings instead of turf and making sure to use native species in those plantings. Using the table and chart below, we can see that of the 60 species planted on site

Species Classification	Count	Percent
Native	25	42%
Non-Native	24	40%
Hybrids	7	11%
Conserved	4	7%
TOTAL	60	100%

Table 6.2. Native Plant Species Distribution

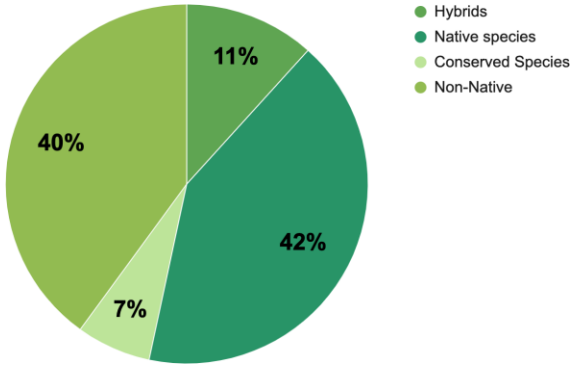


Figure 6.2. Native Plant Species Distribution

Limitations:
- Without access to the final irrigation savings calculations only the provided estimate can be used which may not reflect the final numbers found by the STIMSON team

Sources:
Stephen Stimson Associates for planting information and Figure 1. https://www.stimsonstudio.com/harvard-allston-science-and-engineering-complex

- ***Saved 395,770 gallons of water in 2022 by reusing captured rainwater for irrigation and toilet flushing, compared to conventional water systems.***

Method:
In order to reduce water consumption on site various strategies were implemented, the most prominent being the 75,000 gallon cistern on site. This collected rainwater can then be used on site for outdoor or indoor uses. The distribution of water to each of these uses can be tracked by various water sensors allowing the data to be recorded and compared year-to-year. Since the project's opening in late 2021, the first full year of water use was 2022 and that is the year we will be analyzing here. With the assumption that any collected rain water used would have been city water in a conventional system, we can easily compare the amount of water saved using the data below.

Calculation:

Irrigation Water Data 2022						
MONTH	JAN	FEB	MAR	APR	MAY	JUN
City Water	0	0	0	2,843	273,212	374,229
Rain Water	0	0	0	0	6,546	281,096
Total (Gallons)	0	0	0	2,843	279,758	655,325
MONTH	JULY	AUG	SEP	OCT	NOV	DEC
City Water	253,464	703,092	168,424	84,287	0	0
Rain Water	388,142	562,471	163,765	98,438	0	0
Total (Gallons)	641,606	1,265,563	332,189	182,725	0	0
Toilet Flush Water Use 2022						
MONTH	JAN	FEB	MAR	APR	MAY	JUN
City Water	0	522	124	1,657	5,045	59
Rain Water	7,044	7,196	2,738	881	2,952	1,494
Total (Gallons)	7,044	7,718	2,862	2,538	7,997	1,553
MONTH	JULY	AUG	SEP	OCT	NOV	DEC
City Water	464	1,129	0	0	18,575	26,803
Rain Water	584	607	552	491	443	362
Total (Gallons)	1,048	1,736	552	491	19,018	27,165

Table 6.3. Irrigation and Toilet Flushing Water Use Data for 2022 **Source: Stephen Stimson Associates**

Using the data provided in Table 4., the total annual savings for 2022 was calculated by finding the sum of rain water from each month from the irrigation sensors then the toilet sensors. The rain water use for each type was then totalled to find the annual savings that year. The total savings came out to 396,770 gallons for 2022.

Water Savings 2022	
Irrigation	388,142
Toilet flushing	7,628
Total Savings (gallons)	**395,770**

Table 6.4. Total Water Savings in 2022

Limitations:

- Only data from 2022 was analyzed so it is difficult to make generalizations about the typical annual water savings
- It was noted that in the Fall of 2022 some of the toilet sensors experienced issues and were corrected. It is unclear how that impacted the data used in these calculations.

Sources:

Stephen Stimson Associates

Social Benefits

Overall Methods:

Behavior Mapping

Behavior mapping, also known as activity mapping, is a type of field observation method which enables real-time recording of how users interact with public spaces and their infrastructure. This can reveal what people do in these spaces, how users activities relate to one another, and how the space encourages or hinders certain activities. The data collected from this method can be used by designers to help articulate the social dimensions of any place, pre-and post-intervention (Bishop, 2024). Behavior mapping was performed once to get an estimate of how Harvard students/faculty/staff and community members interact with the site.

Surveys

Due to the sensitive nature of building a survey that avoids being leading or biased, all students went through Human Research Protection Training from the U.S. Department of Health and Human Services (HSS) Office for Human Research Protections (OHRP). The final survey questions were provided by the course instructor, Hongbing Tang, and any edits were approved by her before the

surveys could be conducted. 30 Surveys were conducted in person across two time frames using the set of questions in Appendix 1.

References:

Bishop, Kate, Nancy Marshall, Homa Rahmat, Susan Thompson, Christine Steinmetz-Weiss, Linda Corkery, Christian Tietz, and Miles Park. 2024. "Behavior Mapping and Its Application in Smart Social Spaces" *Encyclopedia* 4, no. 1: 171-185. https://doi.org/10.3390/encyclopedia4010015

Limitations:

- Since only 30 surveys were answered, low response rates can affect how well the data represents the general population. On a voluntary basis, people may skip certain questions and some answers may contain false or incomplete information. This can introduce bias and errors in data collection

- Behavior mapping should be done repeatedly in different conditions (day of week, weather, time of day). Due to the constraints of the class only one behavior mapping exercise was conducted.

- ***Promotes outdoor space occupancy by supporting a variety of activities, with 13 activity types reported by: users through 30 surveys and personal observations. Most common activities include walking (32% of surveyed or observed activities), Sitting (21%), and eating outside (20%).***

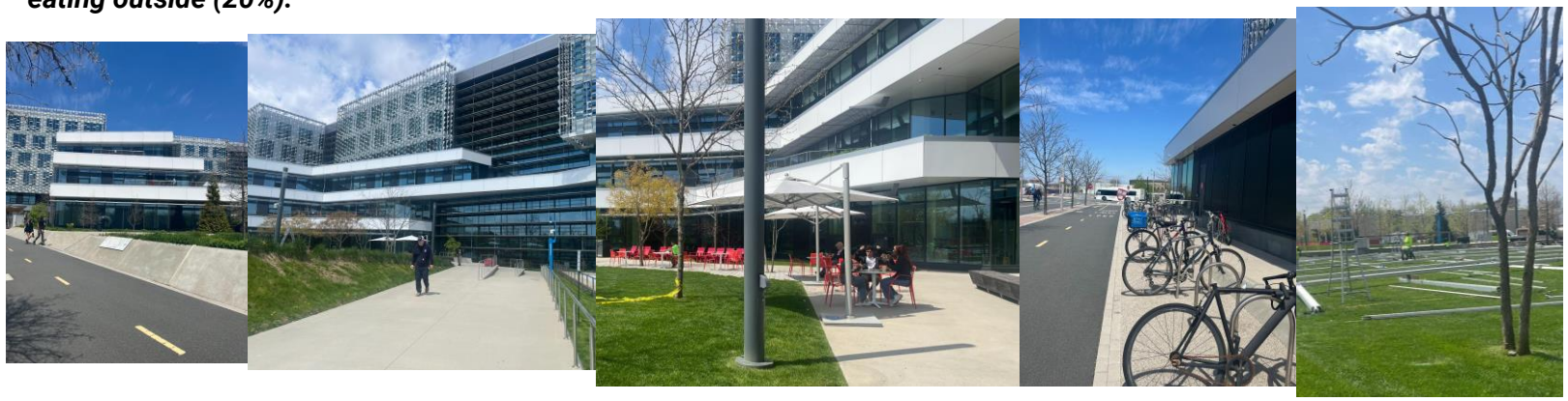


Figure 6.3. Photos taken on Site May 2nd Showcasing Various Activities

Calculation:

The Harvard SEC outdoor areas provide space for a variety of different activities. A total of 13 activity types was reported by the surveys and observation sessions. The most significant activities include Walking (32%), Sitting (21%), and eating outside (20%).

Additionally, 10% of individuals used the outdoor spaces for meeting friends or coworkers while 4% use the space for studying. Behavior mapping was conducted for a two hour period on May 2nd, 2024 between 11 am and 2 pm in partly cloudy weather with a high of 72 degrees Fahrenheit. During the session 7 activity types were observed

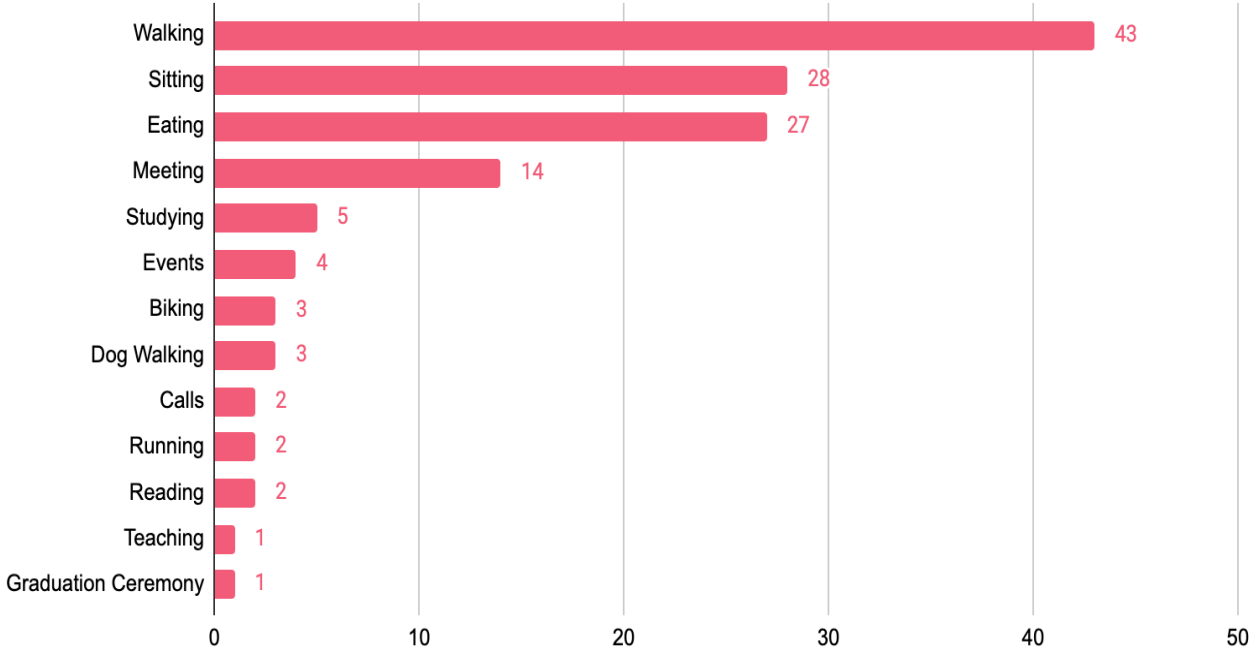


Figure 6.4. Activity Types Recorded Through Surveys and Observations

Limitation:

- Behavior mapping was only conducted on a single day for two hours when it was still chilly weather. This influences peoples behavior and different activities may have been observed during other sessions in other weather conditions.

Sources:
Data came from surveys and my own field observations.

- ***Provides aesthetic value with 83% of 30 surveyed users reporting high or extremely high aesthetic.***

Calculation:
30 total participants were surveyed across two time periods. The first surveys were conducted off-cite during a field trip where students from another university were visiting Boston. The second survey session was conducted on site the same day as the behavior mapping. For both sessions the same questions were used. Users were asked to answer the following question:

4. Please rate the aesthetic value of the Harvard SEC open spaces
    1. Extremely Low 2. Low 3. Average 4. High 5. Extremely High

The following chart shows the results. 24% of surveyed users reported the site had Extremely high aesthetic value while 60% reported the site had High Aesthetic value.

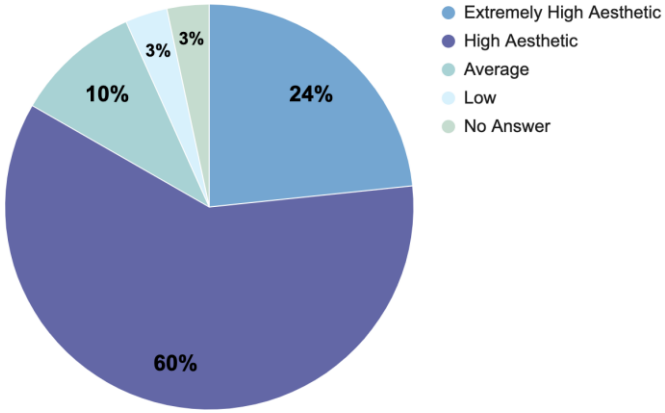


Figure 5. Survey Results of Aesthetic Value

Limitation:

- Surveys can have inaccuracies especially when conducted off-site as the first half of surveys were
- Only 30 total users were surveyed representing a small percentage of the population that uses the site daily

Sources:
Data came from class surveys and my own field observations.

- ***Provides satisfactory experience with 80% of surveyed users reporting they are satisfied or highly satisfied with the Harvard SEC open spaces.***

Calculation:
30 total participants were surveyed across two time periods. For both sessions the same questions were used. Users were asked to answer the following question:

6. Rate your satisfaction with your experience in the Harvard SEC open spaces.
    1. Extremely dissatisfied 2. Dissatisfied 3. Neutral 4. Satisfied 5. Extremely Satisfied

Out of the 30 surveyed users 17% reported being highly satisfied with the site while 63% reported being satisfied with the open spaces, 10% said neutral, and 10% did not provide an answer.

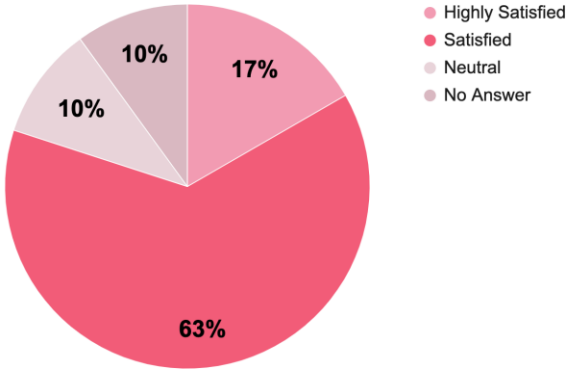


Figure 6.5. Survey Results of Experience Satisfaction

Limitation:
- Surveys can have inaccuracies especially when conducted off-site as the first half of surveys were
- Only 30 total users were surveyed representing a small percentage of the population that uses the site daily

Sources:
Data came from class surveys and my own field observations.

- ***Promotes positive emotional status with most common feelings about the space including happy (30%), calm (17%), and relaxed (17%), with 81% of surveyed users reporting positive emotional status when on site.***

Calculation:
30 total participants were surveyed across two time periods. For both sessions the same questions were used. Users were asked to answer the following question:

> 3. What are your feelings or emotional status when you are in the Harvard SEC open spaces? Try to use 2-3 adjectives to describe your feelings.

The following chart and word cloud shows the results. The word cloud shows that the most common word was Happy, with 9 surveyed users or 30% using the term, while Relaxing and Calm both had 5 users of 17% of people surveyed using those words to describe their emotional status at the site. The only negative words used were Cold (7%), Busy (3%), and Stressed (3%).

Figure 6.6. Word Cloud of Words Users Used to Describe their Emotional Experience

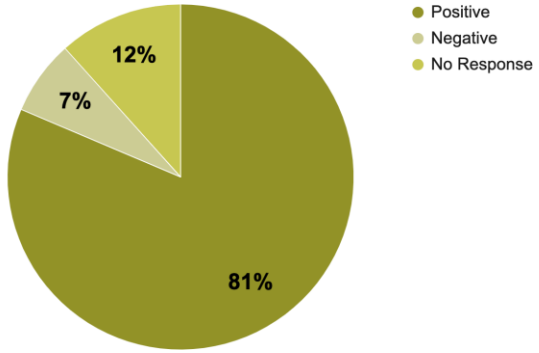


Figure 6.7. Emotional Status of Surveyed Users while at the site

By breaking down which emotional statuses mentioned were positive or negative, I was able to make this chart which shows 81% of terms used to describe feeling were positive while only 12% were negative and 7% had no response.

Limitation:

- Surveys conducted off site often left this questions blank as it is hard to feel emotions towards a site when not currently experiencing it

Sources:
Data came from class surveys and my own field observations.

Economic Benefits

- ***Contributed to increased property values in Harvard's Allston campus by an average 87% between 2018 and 2023, when adjusted for inflation.***

Method:
Property valuation data was retrieved from the City of Boston 'Boston Tax Parcel Viewer' map. Two periods were recorded to compare the trend in property values on Harvards Allston Campus.

Fiscal Year 2018 (FY2018) takes into account Lower Allston property values before construction of the Harvard SEC
Fiscal Year 2023 (FY2023) takes into account Lower Allston property values after construction of the Harvard SEC

Using the Boston Tax Parcel Viewer interactive map from the City of Boston Analytics Team, lots close to the site could be chosen and some property information would appear. Included in that information is a link to more information will provides the entire property value history for that lot. A total of 25 lots were chosen within a half-mile radius of the site. Each property was evaluated by the percent change in the Assesed Value (includes property and land value) of the lot. To consider inflation between 2018 and 2023, a US inflation rate was applied to the FY2018 values to normalize the data. According to usinflationcalculator.com the inflation rate between 2018 and 2023 was 21.3%. After averaging the percent change for each property, the approximate percent change on Harvards Allston campus showed an 87% Increase in property value from 2018 to 2023.

Calculation:
Sample Data Entry and Calculation for One Property:

Parcel ID	Owner	Assessed Value (FY2018)	Assessed Value (FY2023)
2200510000	Harvard College	$4,582,000.00	$5,113,400.00

Table 6.7. Sample Data Entry for Parcel 220051000. Source: City of Boston

Sample Percent Change Calculation for One Property:

$4,582,000.00	X 1.21	=	$5,544,220.00			
FY18 Assesed Value	*X 21% for Inflation*		*FY18 Adjusted*			
$5,113,400.00	- $5,544,220.00		-$430,820.00			
FY23 Assessed Value	*- FY18 Adjusted*		*Difference*			
-$430,820.00	/ $5,544,220.00	=	-0.0777	X 100	=	-7.77%
Difference	/ *FY18 Adjusted*			percent conversion		

Parcel 2200510000, Owner: President and Fellows of Harvard College
Overall Property Value Change for all 20 properties was calculated by summing all the properties percent change and dividing by 20. The total change in property value across all properties is 87% increase.

Limitation:

- Only 20 lots surrounding the site were sampled
- This analysis does not account for any changes made to the sampled lots like new construction or change in ownership
- Property rate influx or deflux due to COVID-19 pandemic are likely and could not be accounted for in this small sample

Sources:

Boston Tax Parcel Viewer, accessed through the City of Boston Analytics Team website. https://app01.cityofboston.gov/parcelviewer/
US Inflation Calculator Websit

Lessons Learned

In the process of creating this report we went on many site visits and got to hear about each design project from a firm representative. Through weeks of research and check-in's I learned about conducting surveys, behavior mapping, stormwater analysis, property value comparison and more. By working on the report I also feel more comfortable in my understanding of what a professional report can look like. Through the analysis of my site, the biggest takeaway is the power of collaboration. In order for a project of this type (university) to provide this many benefits, there must be intense collaboration between the university, design firm, engineers, and public. The result is the most sustainable building on Harvards campus

References & Sources

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US Inflation Calculator Website

Project Team:

Landscape Architect: Stephen Stimson Associates
Client: The President and Fellows of Harvard College
Architecture: Behnisch Architekten
Laboratory Planners: Jacobs Laboratory Planning Group
General Contractor: Turner Construction Company
Stormwater Design and Permitting: Nitsch Engineering

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