LANDSCAPE PERFORMANCE SERIES

Buffalo Bayou Promenade – Houston, TX
Methodology for Landscape Performance Benefits
The University of Texas at Arlington's Case Study Investigations 2013; Klyde Warren Park, University of Texas at Dallas Campus Identity and Landscape Framework Plan and Buffalo Bayou Promenade[1]

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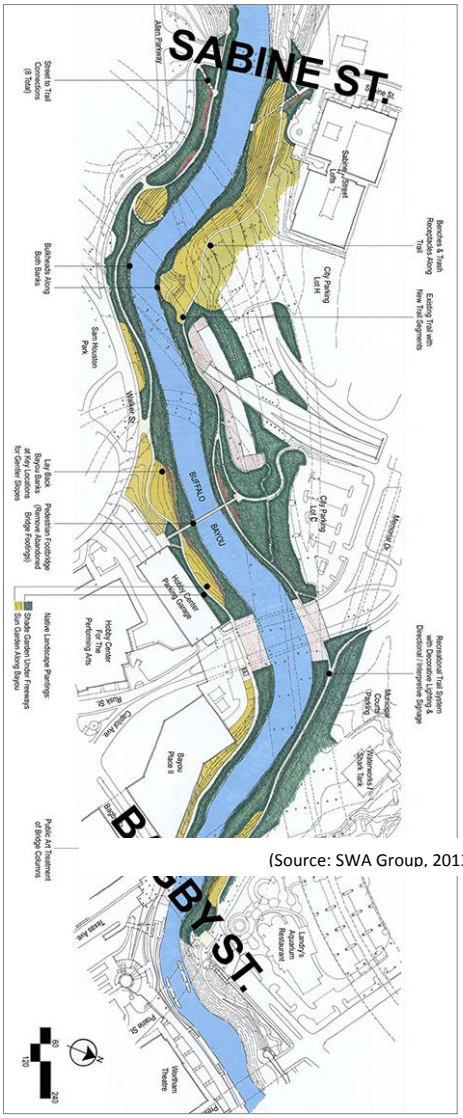

(Source: SWA Group, 2013)

Overview of UT Arlington's Research Strategy for All Three Case Studies

Introduction:

The purpose of this research is to investigate the landscape performance of three acclaimed landscape architectural projects, including Buffalo Bayou Promenade, in Houston, Texas, designed by SWA Group. This research is conducted as part of 2013 Case Study Investigation (CSI) program funded by Landscape Architecture Foundation (LAF).

The case studies are pre-outlined by LAF to present project profile and overview, sustainable features, challenges/solutions, lessons learned, role of landscape architects, cost comparisons, and performance benefits. Within the LAF framework, the UT Arlington research team, with its professional firm partners, collected, reviwed, and

[1] This white paper can be cited as; Ozdil, T., & Modi, S, & Stewart, D.(2013). 2013 LAF's CSI Program Landscape Performance Series: The University of Texas at Dallas Campus Identity & Landscape Framework Plan Methodology. The University of Texas at Arlington. Arlington, Texas.

analyzed/synthesized project related data for over 20 weeks to prepare the case studies published online at LAF website. The UT Arlington research team organized its investigation strategy and efforts under the three sub-category headings; environmental, economic, and social (including cultural and aesthetic) to establish a comprehensive and systematic framework for the research, ease the research process for multiple case studies, and to not loose sight to document diverse set of findings. These sub-categories are used primarily to identify and organize the performance benefits of landscape architecture projects in this collaborative investigation.

The UT Arlington research combines quantitative and qualitative methods to document three landscape architectural projects, and to assess their performance benefits (Deming et. al., 2011; Ozdil, 2008; Murphy, 2005; Moughtin, 1999). Methodological underpinnings of this case study research are primarily derived from a systematic review of performance criterias and variables from: (1) the Landscape Architecture Foundation's landscape performance series *Case Study Briefs* (LAF, 2013), (2) the case study methods that are developed for designers and planners in related literature (Francis, 1999; Gehl, 1988; Preiser et. al., 1988; Marcus et. al. 1998), and (3) the Primary data collection methods through; surveys (Dilman, 1978), site observations, behavior mapping, and assessment techniques (Marcus et. al. 1998; Whyte, 1980 & 1990), (4) and finally project related secondary data collected from project firms, project stakeholders, public resources and databases. The data gathered from all the research instruments are further analyzed, synthesized and summarized as the performance benefits for the three case studies under investigation. The findings are organized within the LAF framework, as it is outlined earlier in this document for online publication. The research is designed to highlight the values and the significance of landscape architecture projects by utilizing objective measures and by documenting and evaluating their performances to inform future urban landscapes.

Data Collections Methods:

The research involves collection of primary and secondary data through on-site or online survey, site observations and systematic review of available secondary data. As a first step, the research team acquired necessary permissions from Institutional Review Board at UT Arlington prior to primary data collection involving human subjects.

Survey: A survey instrument is developed to collect social performance data for all three sites. The survey is developed to measure user perception on topics such as; quality of life, sense of identity, health and educational benefits, safety and security, presence of arts, and availability of informal and organized events, and etc. The survey is informed by relevant literature as well as by other survey instruments prepared for parks and other landscapes projects (such as Dallas Park & Recreation Survey, New York's Central Park Survey to name a few). The survey instrument and the variables questioned within is kept almost identical in all three cases in order to develop a more homogenous measure to study varying sites, and provide LAF with replicable and generalizable instrument. The survey simply asks the visitors for their perceptions and experiences of the site.

The survey is composed of three parts. The first part of the questionnaire attempts to document user profiles as well as user perception and choices on activities available on the site by using multiple choice questions. The second part of the survey asks users to rate performance related statements with Likert scale questions. The final portion of the survey was kept for additional comments/concerns of visitors who want to share additional information with the research team.

The survey was voluntary and the identity of the respondents was assured to be kept confidential to ease privacy concerns. The survey is kept short (15 minutes to complete) and prepared for both online and on-site platforms in order to increase its utilization by potential respondents. Due to time and resources limitations, researchers utilized online and on-site survey interchangeably in some case studies. Surveys for all three sites are conducted over the summer months. The surveys are conducted on both weekdays and weekends in random intervals for better representation of the varying visitors using each site. While on-site surveys had more concentrated time frame (day or week) online surveys were open to users for a longer period of time.

Site Observations: Passive observations, photography, video recording, site inventory and analysis techniques (such as use of street furniture counts/measurements, etc.), as well as behavior mapping and tracing methods are also utilized in some instances to better understand the case study features and the performance of the case study sites. The research team primarily benefited from site visits and observations to understand the user behavior about the way the spaces are being used. Observational methods utilized in this research did not involve any intrusive interaction with the subjects and necessary precautions are taken not to impede or govern the subjects' activities. Although photography or video recording is used, the identity of the space users is blurred unless they allow researchers to use their images. The research team in all three case studies informed the stakeholders prior to site visits, and acquired necessary permissions. While on site for data collection, the research team used signs at various locations and informed consent forms to secure permissions from the subjects.

Archival and Secondary Data: This research is heavily benefited from archival and secondary data attained from project firms, project stakeholders, public resources, and private databases. As part of LAF's mission this research was a product of a partnership among academic research team, project firm, and LAF. Where and when data were available from the secondary sources such as from the landscape architecture firm, client(s), project partners, scholarly literature, and publicly the project team systematically collected and organized the data, diligently reviewed its content, assessed its rigor and integrity. The research team later used the relevant data to document the project, and assessed the landscape performance for all three sites.

Data Analysis and Research Design:
The UT Arlington team designed its research strategy under three focused thematic areas; environmental, economic, and social (including cultural and aesthetic) for all three case studies. In the beginning of the investigation, the research team benefited from this strategy to conduct a systematic research that produces replicable performance criterias and methods for all three sites. After the measurable criterias are identified and the possibilies are exhaushed, the UT Arlington team further refined its approach by customising performance criteria and procedures to each case study site to better document and report the varying qualities of each site independently. While achieving a comparable set of performance benefits for all sites was the goal and this strategy produces the greater framework for the research, customising detailed performance criteria later in the process helped the research team to overcome the concerns about data availability, varying project typologies, project goals and outcomes.

The findings of the investigations in all cases focused on first, site related performance benefits, then its immediate adjecencies, and finally on the project block group/neigborhood/district or zip code. For example, performance benefits that are most direct and telling about the project site is more emphasized in comparison to indirect performance benefits and findings about the project adjacencies, or neigborhoods. This strategy is also used in the reporting of the findings to clarify the document and to ease the review.

In conclusion, the data collected through these strategies were systematically reviewed and appropriate methods for analysis for specific performance criterias are highlighted in the detailed methodology below. The following section presents research design specifics for the Buffalo Bayou Promenade, a basic summary of the performance criteria under investigation, and the data sources and the procedure involved in measuring that particular performance criteria.

Overview of UT Arlington's Research Strategy for the Buffalo Bayou Promenade:

(Source: SWA Group, 2013)

Figure.1 Buffalo Bayou Promenade, Before and After

Buffalo Bayou Promenade (also known as Sabine-to-Bagby Promenade) is a 23-acre urban park and a recreation area created by SWA Group in the impenetrable edge condition that separate midtown from downtown for the City of Houston. Completed in 2006, the park has transformed an impermeable urban greyfield into a functioning green infrastructure and a thriving urban waterfront. The project converts a neglected, overgrown, trash-soaked eyesore (intimidating to pedestrians and detrimental to flood control efforts) into 3,000 linear feet of urban park. The $15 million landmark project was the result of a public/private partnership to revitalize the Buffalo Bayou. By reclaiming a marginalized space beneath the freeway, the promenade has revitalized portion of Buffalo Bayou as green infrastructure and introduced

urban amenity for the citizens of Houston. Improvements include naturalization of gently sloping banks, extensive native landscaping, hike and bike trails, public art, dramatic lighting, 12 street-to-bayou entryways, and a new pedestrian bridge which connects the north and south sides of the bayou (for the first time), and interpretive signage. 1.4 miles of paved trails through Buffalo Bayou Promenade link to over 20 miles trail system for the entire revitalized Bayou. The newly activated space provides an urban amenity for visitors throughout the year for physical activity, event gatherings, and overall passive and active recreation opportunities along the banks as well as on the water.

The research team followed the comprehensive investigation strategies outlined earlier in this document by concentrating environmental, social, and economic implications of the project. The team's approach to identify performance benefits for Buffalo Bayou Promenade are mainly driven by detecting the contextual challenges(see above), reviewing its exemplary flood controlling techniques through engineering and the mimicry of the pre-development stream conditions, and by evaluating the adoption of natural fauna and flora as landscape elements. Its destination and recreational qualities as an urban park for urban dwellers and visitors encouraged research team to have a deeper understanding of user perceptions. After reviewing the relevant literature, the project information, and the firm archives with SWA group, UT Arlington research team developed detailed procedures and performance measures which can be tied to project's initial challenges, goals and objectives (see figure.2 for research design).

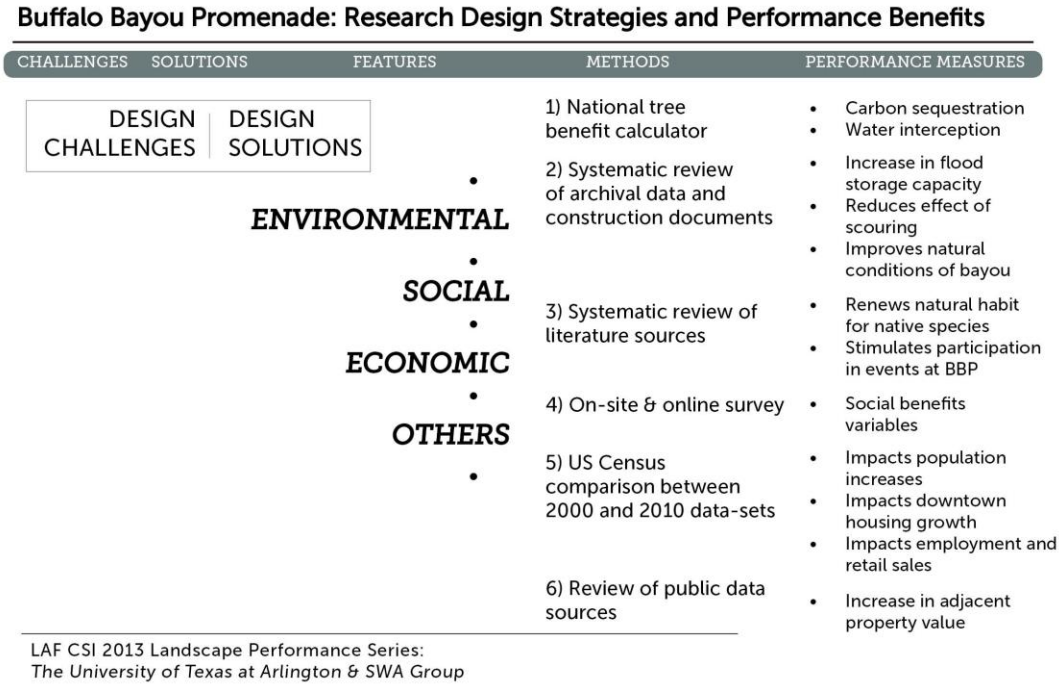

Figure.2 Research Strategy and Design

Although the research team members have had various exposures to Buffalo Bayou Promenade as an exemplary Texas landscape before the LAF's CSI initiative, the distance between the research team and the case study site become influential in determining some of the primary data collection methods and accessing the site in multiple occasions in the limited

duration of this research. After testing the possibility of both on-site user survey and users passive observations as data collection methods the research team concluded that the site–conditions are not favoring such methods in the summer months in Houston heat and humidity. Moreover, as it is highlighted in the survey results, most users were active, moving through the site for exercise purposes, or using the site as a leisurely access route to reach various destinations around the site challenging on-site data collection methods. Therefore, the research team moved forward with adopting an on-line survey tool developed for the case study. After acquiring Institutional Review Board permissions for human subjects the survey is distributed via e-mails, social media outlets, and/or professional network. Buffalo Bayou Partnership social media connections become instrumental in reaching out to most of the site users and to recruit potential respondents. The outcome was rewarding in collecting social performance data from the promenade users as it is highlighted with a brief report later in this document.

The research procedure also involved documenting the economic performance indicators for this case study. Various secondary data sources reviewed to determine projects economic influence, and numerous positive indicators are found representing the larger context of the project site. However, the causality between the improvement and the economic changes was mostly indirect and not specific enough to the project, and not as informative as researcher desired. Therefore only selected few economic performance measures are highlighted for the Buffalo Bayou Promenade case study. Following pages summarizes the performance indicators and the methods utilized as well as the limitations of the procedures adopted for this research.

Performance Indicator: The following bullet points are listed below in their full form. They are formatted to comply with the online portal restrictions. The list below contains more detail.

Environmental

Increases the flood storage capacity of the promenade section of the Buffalo Bayou by 18.65 acre feet through the excavation of 23,013m3 of soil.

Methods: Systematic review of literature, archival, and secondary data provided by The SWA Group (2013).
Limitations: Although reliable sources are adopted for this research the information provided above comes from secondary sources and may have inherent data omissions and errors that cannot be detected or confirmed by UT Arlington research team.

Improves the channel's ability to withstand stormwater velocity (shear stress) by 400%, thus reducing the damaging effects to the stream channel. Prior to development the channel was able to withstand less than 2lb/ft2 shear stress, post development the channel is able to withstand 8lb/ft2 of shear stress.

Method: Systematic review of literature, archival, and secondary data provided by The SWA Group (2013).
Limitations: Although reliable sources are adopted for this research the information provided above comes from secondary sources and may have inherent data omissions and errors that cannot be detected or confirmed by UT Arlington research team.

Sequesters 29.74 US tons (59,480 lbs) of CO2 annually through 641 newly planted trees. This is equivalent to CO2 emitted from driving approximately 79,226 miles in a single passenger vehicle.
Intercepts approximately 337,411 gallons of stormwater runoff annually through tree canopies only which is equivalent to annual water usage of approximately 4 American residents.

Common name	DBH (inches)	CO2 sequestered by one tree (lbs)	Quantity of trees	Total CO2 sequestered (lbs)
Red Maple	6	179	16	2864
River Birch	6	121	56	6776
Red bud	6	59	12	708
Green Ash	6	119	74	8806
Green Ash	6	119	57	6783
Green Ash	3	36	104	3744
Loblolly Pine	6	90	28	2520
Sycamore	6	119	73	8687
Cottonwood	6	119	22	2618
Mexican Plum	6	59	3	177
Burr Oak	6	119	15	1785
Live Oak	6	198	5	990
Dwarf Palmetto	4	37	27	999
Bald Cypress	9	108	48	5184
Winged Elm	6	121	26	3146
American Elm	3	36	63	2268
Cedar Elm	6	119	12	1428
Total			**641**	**59483**

Table.1 Plant List Source: Adopted from SWA, 2013

Method: As illustrated in the table above the carbon sequestered is calculated with National Tree Benefit Calculator (http://www.treebenefits.com/calculator/).

For an example: A single maple tree of 6" DBH sequesters 179 lbs of CO2. There are total 16 maple trees in the planting plan of Buffalo Bayou Promenade. Thus, the total amount of CO2 sequestered by 16 maple trees would be:

179 lbs*16 = 2864 lbs

One US ton comprises of 2000 lbs. Thus, the total CO2 sequestered with the help of all the trees would be:

59483/2000 ~ **29.74 US tons**

The numbers for the miles travelled in a year (11,318) and average (21.4mpg) of the passenger vehicle is set as bench mark (for comparison of the CO2 emitted) from Federal Highway Administration (FHWA) 2013 data as can be seen below:

Annual Vehicle Distance Travelled in Miles and Related Data - 2011 (1) By Highway Category and Vehicle Type March 2013						
YEAR	IITEM Motor-Vehicle Travel:(millions of vehicle-miles)	LIGHT DUTY VEHICLES SHORT WB (2)	MOTOR-CYCLES	SUBTOTALS		ALL MOTOR VEHICLES
				ALL LIGHT DUTY VEHICLES (2)	SINGLE-UNIT 2-AXLE 6-TIRE OR MORE & COMBINATION TRUCKS	
2011	Number of motor vehicle registered	192,513,278	8,330,210	233,841,422	10,270,693	253,108,389
2010		190,202,782	8,009,503	230,444,440	10,770,054	250,070,048
2011	Average miles traveled per vehicle	10,614	2,221	11,318	26,016	11,640
2010		10,650	2,311	11,493	26,604	11,866
2011	Average fuel consumption per vehicle (gallons)	460	51	530	4,126	666
2010		456	53	534	4,180	681
2011	Average miles traveled pergallon of fuel consumed	23.1	43.5	21.4	6.3	17.5
2010		23.3	43.4	21.5	6.4	17.4

Table.2 Source: http://www.fhwa.dot.gov/policyinformation/statistics/2011/vm1.cfm

With the help of Carbon Calculator (http://www.americanforests.org/discover-forests/carbon-calculator/), a gas fuelled passenger vehicle travelling 11,318 miles in a year at 21.4 mpg average emits 9394 lbs of CO2 which is equivalent to 4.69 US tons.

9394/2000 ~ 4.69 US tons

The total CO2 sequestered by trees is equivalent to approximately CO2 emitted from 7 passenger vehicles in a year.

29.74/4.69 ~ 7 passenger vehicles

11,318 miles*7 = **79226 miles**

Finally, the 29.74 US tons of CO2 sequestered by the trees is equivalent to 79226 miles travelled in a year in a single passenger vehicle.

Limitations: Since the planting plan which was referred was designed in the year 2006, the DBH for the plants was increased assuming that the trees have grown significantly from 2006 to 2013. The data highlighted in the table for the passenger vehicle to set as a benchmark is the US national average of the year 2011. (Data is retrieved in 2013 from FHWA website).

Method: As illustrated in the table above the stormwater intercepted is calculated with National Tree Benefit Calculator (http://www.treebenefits.com/calculator/).

For an example: A single maple tree of 6" DBH intercepts 640 gallons of stormwater runoff. There are total 16 maple trees in the planting plan of Buffalo Bayou Promenade. Thus, the total amount of stormwater intercepted by 16 maple trees would be:

640 gallons*16 = 10240 gallons

The EPA's Water Trivia Facts states that an American resident uses 100,000 gallons of water annually. (http://water.epa.gov/learn/kids/drinkingwater/water_trivia_facts.cfm).

337411 gallons/100,000 gallons ~ **4 American residents**

Finally, 4 American residents uses 337411 gallons of water annually, equivalent to the stormwater intercepted by the trees in Buffalo Bayou Promenade.

Limitations: Since the planting plan which was referred was designed in the year 2006, the DBH for the plants was increased assuming that the trees have grown significantly from 2006 to 2013.

Social

Provides recreational, interpretive and education opportunities for an estimated 22,500 visitors per year based on 2009 counts (not including everyday users). Activities include the KBR Kids Day on Buffalo Bayou and the Regatta boat race that attracts over 500 participants and hundreds more in spectators.

Methods: Data sourced from a systematic review of archival data and literature from the Buffalo Bayou Partnership, 2013 and SWA Group, 2009.

Limitations: Matrix shown below is only current to 2009.
The Buffalo Bayou Partnership estimates that approximately 22,500 people visit the Buffalo Bayou Promenade each year for organized events. Below is a breakdown of each major educational event.

Visitors	Event
10,000	KBR Kids Day on Buffalo Bayou (annual event)
8,000	Pontoon Boat Tours (private and public)
2,000	Other City events
2,000	Misc. Outreach
500	Bayou Bash (annual event)
	* Please note: These figures do not include everyday users
22,500	Total

According to the Buffalo Bayou Survey conducted by the UT Arlington research team, respondents agree with the statement that Buffalo Bayou Promenade (N: 108):

- **Improves the quality of life for 99% of the survey respondents primarily through increasing physical activity, providing a place to be outdoors, and reducing mental stress.**
- **Is perceived favorably by 98% of the respondents (69% strongly agree).**
- **Promotes healthy living for 97% of the survey respondents primarily through cycling, jogging/running, and passive activities.**
- **Increases outdoor activity for 88% of the survey respondents.**
- **Creates a sense of identity for 84% of the survey respondents.**
- **Promotes art and artistic activities for 71% of the survey respondents primarily through sculptures, garden design, and water features.**
- **Promotes scheduled/organized events for 68% of the survey respondents through music concerts, festivals, athletic events**
- **Promotes a better understanding of sustainability for 67% of the survey respondents through urban greenery, walkability, native planting, and stormwater management.**
- **Promotes a safe & secure environment for 66% of the survey respondents primarily through the lighting design, visibility, and planting scheme.**
- **Encourages them to live within walking distance for 62% of the survey respondents (while 25% neutral about this statement).**
- **Accessible for all (American Disability Act-ADA) for 49% of the survey respondents (15% do not consider this question applicable).**
- **Promotes educational activities for 46% of the survey respondents (40% neutral).**

Survey notes: 108 Buffalo Bayou Promenade (BBP) users are surveyed between mid-July and early August, 2013 by UT Arlington research team. 97 of the responses come from off-site surveys while 11 responses come from on-site surveys circulated via email lists and social media. **88%** of the park users surveyed noted themselves as '**resident'** while **8%%** as '**visitor' and 7% as "employee".** Survey findings also illustrated that only **4%** of the users were visiting the park **first time** while **87%** visits the park **at least one time per month**. Additionally, nearly **45%** of the respondents arrives BBP by using a **personal vehicle** while **31%** arrives by bicycle and **26%** arrives BBP **on foot.**

Method: Please see the data collection methods in the beginning of the paper.
Limitations: Survey recruitment letters were circulated among various e-mail lists, and social media groups throughout Houston. However, the majority of the responses collected after the recruitment letter were circulated to the Buffalo Bayou Partnership social media site. Although this assured park users filled out the surveys, it also may have introduced potential bias in the findings.

**Not all of the survey results/findings are reported in their entirety do to LAF's online formatting restrictions, therefore the list only includes a sample of the survey findings. For further information, contact the Research Fellow for this case study: Dr. Taner R. Ozdil, ASLA, tozdil@uta.edu.*

Economic Performance Benefits:

Contributes to the emergence of downtown Houston within the two block groups surrounding the promenade through employment, number of establishments, and retail

sales. Employment increased from 1415 to 11,869 in the block group where Buffalo Bayou Promenade resides between 2008 and 2012. The number of establishments increased from 54 to 236. The total retail sales increased from $10,467,000 to $57,281,000. As a comparison, the block group located north of Buffalo Bayou Promenade estimates an employment increase of 26 to 364, a total establishment increase of 3 to 30, and a retail sales increase of $727,000 to $16,108,000.

- *Impacts real estate in its adjacencies. As an example, the 198 unit Sabine Lofts alone has seen its market value increase by approximately 40%.*
- *In the larger urban context, office rental space in downtown Houston increased from 22.26 per square foot in 2003 (class space A) to 28.91 per square foot in 2007 (class space A) when the project was completed. The rental prices stayed steady at this increased rate, even with the economic downturn.*
- *Impacts housing in its block group by contributing to the increase in the number of 'occupied housing units' from 74, in 2000, to 1035, for 2012. The number of 'occupied structures with 50+ units' is projected to increase from 29 to 816. During this same time period, the number of 'renter occupied units' is projected to increase from 51, in 2000, to 521, in 2012.*

Methods: The first bullet is secondary data sourced from the Harris County Appraisal District, 2013. Catalyst for residential real estate with an example being the Sabine Lofts located on the north edge of the promenade. This 198 unit (200,954 rentable area) has seen a jump in its market value from $18,489,073 in 2010, to $25,875,743 in 2013. The second bullet is derived from an systematic review of archival data provided by SWA Group, 2013.

Limitations: Sabine Lofts is actually located in the Block Group: 5101001, which is directly north of the promenade. The parcel itself is adjacent to the park though. Due to the heavy freeway infrastructure located literally on top of the promenade, there is limited adjacent real estate to study. There is a real estate growth though beyond the first block that surrounds the promenade.

Methods: The data was organized with the SimplyMap software to compare the previous 2000 US Census data, the current 2010 US Census data. SimplyMap projects 2017 numbers from the recorded census data as well.

Limitations: The promenade cannot be looked at as the primary reason for the housing increases within Block Group: 1000003 due to other variables, but its presence from 2006 has generated an identifiable impact.

Variable	BG1000003, Harris Cnty, TX	BG5101001, Harris Cnty, TX	USA
# Housing, Occ. Structure w/ 50+ Units, 2000	29	0	5507998
# Housing, Occ. Structure w/ 50+ Units, 2008	35	0	5648553
# Housing, Occ. Structure w/ 50+ Units, 2010	813	147	6145358

# Housing, Occ. Structure w/ 50+ Units, 2012	816	153	6575052
# Housing, Occ. Structure w/ 50+ Units, 2017	890	175	7348614
Percent Change (2000 - 2012)	2713.8%		19.4%
# Housing, Occupied Units, 2000	51	137	105480101
# Housing, Occupied Units, 2008	71	152	117569221
# Housing, Occupied Units, 2010	775	532	116716292
# Housing, Occupied Units, 2012	807	554	118025427
# Housing, Occupied Units, 2017	860	592	123901241
Percent Change (2000 - 2012)	1482.4%	304.4%	11.9%
# Housing, Renter Occupied, 2000	51	89	35593169
# Housing, Renter Occupied, 2008	71	95	36749955
# Housing, Renter Occupied, 2010	574	423	38288286
# Housing, Renter Occupied, 2012	521	365	41730955
# Housing, Renter Occupied, 2017	544	383	45527611
Percent Change (2000 - 2012)	921.6%	310.1%	17.2%
# Housing, Units, 2000	74	148	115904641
# Housing, Units, 2008	104	165	128864240
# Housing, Units, 2010	989	606	131704730
# Housing, Units, 2012	1035	633	133667681
# Housing, Units, 2017	1134	687	141903899
Percent Change (2000 - 2012)	1298.6%	327.7%	15.3%
# Population (Pop), 2000	865	975	281421535
# Population (Pop), 2008	447	532	303128354
# Population (Pop), 2010	1115	1311	308745538
# Population (Pop), 2012	1159	1357	312796426
# Population (Pop), 2017	1249	1448	324478770
Percent Change (2000 - 2012)	34.0%	39.2%	11.1%
# Vacant Units, 2000	23	11	10424540

# Vacant Units, 2008	33	13	11295019
# Vacant Units, 2010	214	74	14988438
# Vacant Units, 2012	228	79	15642254
# Vacant Units, 2017	274	95	18002658
Percent Change (2000 - 2012)	891.3%	618.2%	50.1%

Table 4: Census data organized in SimplyMap showing housing and population data.

Method: This is primary sourced data from the US Census and SimplyMap for BBP within Block Group: 1000003. The comparison is to Block Group: 5101001.
Limitations: The main limitation is that the 2012 data is an estimate derived by SimplyMap from the 2010 US Census data. Due to time constraints and data availability, the 2000 economic census data was not provided to show an ideal before condition for the block groups as a comparison. Although reliable sources are adopted for this research the information provided above comes from secondary sources and may have inherent data omissions and errors that cannot be detected or confirmed by UT Arlington research team.

Definition: 'Employee' is defined as people employed in all industries. 'Establishment' is defined as a business or industrial unit at a single location that distributes goods or performs services. 'Total retail sales' is defined as total yearly sales from motor vehicles, home furnishings, electrical and appliance stores, building materials and garden stores, food and beverage stores, health and personal care stores, gasoline stations, clothing and accessory stores, sporting goods stores, general merchandise stores, online and catalog sales, food services and miscellaneous store sales (SimplyMap, 2013).

Figure 3: Map of Midtown and Downtown block groups with Buffalo Bayou Promenade.

Variable	BG1000003, Downtown	BG5101001, Midtown	USA
Employees, Total (by Place of Work), 2008	1415	26	0
Employees, Total (by Place of Work), 2010	1777	75	119050433
Employees, Total (by Place of Work), 2012	11869	364	113112248
Percent Change	738.8%	1300.0%	
Establishments, Total (by Place of Work), 2008	54	3	7483528
Establishments, Total (by Place of Work), 2010	51	6	7700385
Establishments, Total (by Place of Work), 2012	236	30	7441013
Percent Change	337.0%	900.0%	-0.6%
Total Retail Sales (including Food Services) ($000), 2008	10467	727	4509214901

Total Retail Sales (including Food Services) ($000), 2010	4588	1729	4253550572
Total Retail Sales (including Food Services) ($000), 2012	57281	16108	4690741823
Percent Change	447.3%	2115.7%	4.0%

Table.5: Census data organized in SimplyMap showing establishments, employment, and retail sales.

Cost Comparison Methodology

Saved $1.4 million (of disposal costs) through use of recycled, concrete gabion walls instead of traditional methods for bank stabilization. Gabions were placed in a wet condition, no coffer dams were required. Total cost of gabions and gabion mattress installation was $3,199,229.00. In comparison, bank stabilization using traditional methods of concrete bulkheads and foundations was estimated at $4,400,000.00.

Methods: *Saves over $1,400,000 in disposal costs with the use of approximately 14,000 tons of recycled concrete in the gabion mattresses used along the bayou's bank (SWA, 2013; Concrete Network, 2013).*
The disposal cost is calculated by multiplying SWA's 14,000 ton (recycled concrete) data with the Concrete Networks figure of $100 per ton for a typical cost of disposal, based on 2013 numbers. The cost comparison for the gabions and concrete bulk heads is derived from a systematic review of archival data provided by SWA Group, 2013.

Limitations: The main limitation is assuming that all of the recycled concrete is derived from on-site.

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