



Regenstein Learning Campus at the Chicago Botanic Garden Methods

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This investigation was conducted as part of the Landscape Architecture Foundation's 2019 *Case Study Investigation* (CSI) program. CSI matches faculty-student research teams with design practitioners to document the benefits of exemplary high-performing landscape projects. Teams develop methods to quantify environmental, social, and economic benefits and produce Case Study Briefs for LAF's *Landscape Performance Series*.

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The full case study can be found at: <https://landscapeperformance.org/case-studybriefs/regenstein-learning-campus>

Environmental Benefits

- **Reduces stormwater runoff volumes by 12% for a 2-year, 24-hour storm.**

Methods: The project engineer Gewalt Hamilton Associates (GHA) utilized Bentley's PondPack drainage program to calculate the reductions in runoff per 24-hour design storm for a 1-year and 2-year storm. These summated calculations provided the input for the LEED 2009 SS Credit 6.1 Stormwater Design - Quantity Control worksheet. Worksheet calculations showed that the installation of stormwater management infrastructure of rain gardens, native grass areas, and permeable pavement on the project site reduced the runoff volumes for a 1-year and 2-year storm by 11% and 12% respectively.

The total amount of stormwater detained annually was determined first by using the Center for Neighborhood Technology's (CNT) The Value of Green Infrastructure Guide runoff reduction through bioretention and infiltration equation to find the approximate amount of rainfall retained by the stormwater management infrastructure, utilizing as a basis the 1-year 24-hour storm data from the Illinois State Water Survey (ISWS). This calculation yielded 306,872 gallons per 1-year, 24-hr storm. By subtracting 16,117 gallons of runoff during a 1-year, 24-hour storm on the project site per the SS Credit 6.1 worksheet from this total, it was determined that 290,755/306,872 gallons, or approximately 94%, of rainwater that falls on site is detained annually by the project site stormwater infrastructure. With the determination that 94% of runoff for a 1-year, 24-hour storm is captured, the annual amount of stormwater retained on-site was calculated utilizing the variables provided by the same runoff reduction equation for bioretention and infiltration from CNT, resulting in an estimated 4,240,000 gallons of stormwater diverted annually from the sewer system.

Calculations:

Table SS6.1-1. Site Runoff: One-Year, 24-Hour Design Storm

	Rate (cfs)	Quantity (cf/storm)
Predevelopment	0.82	18,121
Postdevelopment	0.75	16,117

Table SS6.1-2. Site Runoff: Two-Year, 24-Hour Design Storm

	Rate (cfs)	Quantity (cf/storm)
Predevelopment	1.11	25,395
Postdevelopment	1.03	23,043

Table 1: LEED document for Stormwater Quantity Control SS Credit 6.1 showing calculations for stormwater runoff reduction. Source: GHA Engineers

Rainwater detained annually

Rainwater fall on project site in 1-yr 24-hr storm = 2.51 inches of precipitation for a 24-hr storm * 196,080 sf of developed site area * 100% of rainfall detained * 144 sq inches/SF * 0.00433 gal/cubic inch = **306,872 gallons of precipitation per 24-hr storm**

Percentage of water detained in 1-yr 24-hr storm = 306,872 gallons per 24-hr storm - 16,117 gallons of runoff in post-development 24-hr storm = 290,755 gallons or **94% of rainfall detained**

Total Runoff Reduction Calculation = 36.89 inches of annual precipitation * 196,080 sf of site area * 94% of rainfall captured/retained * 144 sq inches/SF * 0.00433 gal/cubic inch = **4,240,000 gallons**

Sources:

Gewalt Hamilton Associates, Inc. *LEED 2009 for New Construction and Major Renovations SS Credit 6.1 Stormwater Design - Quantity Control*. PDF. Washington D.C.: US Green Building Council.

PondPack. Computer software. Exton: Bentley Systems Inc.

Table 1. Sectional Mean Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years in Illinois. PDF. Champaign: Illinois State Water Survey, 2007. <https://www.isws.illinois.edu/statecli/RF/table10.pdf>

US Department of Commerce, and Noaa. "Annual Precipitation Amounts for Chicago, IL." National Weather Service. January 04, 2019. Accessed June 30, 2019. https://www.weather.gov/lot/Annual_Precip_Rankings_Chicago

Limitations:

Calculations are based on computer simulations, not actual events.

- ***Reduces the amount of water needed for irrigation by an estimated 63% in July by planting native and adaptive species, saving \$1,300 in irrigation costs for July alone, the month with the highest irrigation demand.***

As part of the Regenstein Learning Campus's LEED goals to create a water efficient landscape, a large percentage of the site is planted with native and adaptive species that do not require irrigation outside of times of extensive drought. This plant selection strategy reduces the need for irrigation by 325,922 gallons in the hottest month of July.

Methods: According to plan documents, 61,636 sq ft or 44% of the planted area is turfgrass that requires regular watering. 69,512 sq ft or 50% of the planted area is native and adaptive species that do not require permanent irrigation. 8,629 sq ft or 6% of the planted area is a native undisturbed area that does not require any watering.

Jacobs/Ryan Associates provided area calculations, species factors (k_s) and density factors (k_d) for three landscape types for the Nature Play Gardens design case compared to a baseline case utilizing the LEED 2009 WE Credit 1 (WEc1) Water Efficient Landscaping worksheet. The landscape types were turf grass; mixed trees, shrubs and groundcover; and existing native undisturbed. Both the baseline and design cases for turf grass required permanent irrigation. For mixed trees, shrubs, and groundcover, the baseline case used average values in which the planting can be maintained in acceptable condition at about 50% of the reference evapotranspiration (ET_o) value with regular irrigation.

The design case, however, substitutes the mixed trees, shrubs, and groundcover with plant materials that are native and adaptive, thus requiring only temporary irrigation for establishment and backup irrigation during times of extended drought. The temporary irrigation method is hand-watering by Chicago Botanic Garden staff, which is not part of an automatic irrigation system. The existing native area is undisturbed. In summary, per the WEc1 worksheet, the baseline case requires 511,626 gallons of irrigation for July, and the design case requires 185,634.

This represents a savings of \$1,300 in the month of July alone at a rate of \$0.00398/gallon, as determined by referencing City of Chicago Water and Sewer rates.

Calculations:

Table WEc1-1. Irrigation Baseline Case (month with the highest irrigation demand)

Note: Click "Calculate" in the summary section of the table to perform the water savings calculations. "Calculate" must be clicked after any or all the data is entered in the table to refresh the calculated values and obtain accurate information.

Landscape Type	Area (sf)	ks	kd	kmc ¹	K _L	Et _o	ET _L	Irrigation Type	IE	TWA (gal)
Mixed trees, shrub	69,512	0.5	1.1	1	0.55	6.3	3.47	Sprinkler	0.625	240,550.56
Turf Grass	61,636	0.7	1	1	0.7	6.3	4.41	Sprinkler	0.625	271,075.42
Native Undisturbed	8,629	0.5	1.1	1	0.55	6.3	3.47			
			0			6.3				
						6.3				
Total area (sf)	139,777	Baseline Total Water Applied (TWA) (gal)								511,626

Notes:

1 For each landscape type, the microclimate factor (kmc) must be the same for the baseline and design case.

Table WEc1-2. Irrigation Design Case (month with the highest irrigation demand)

Note: Click "Calculate" in the summary section of the table to perform the water savings calculations. "Calculate" must be clicked after any or all the data is entered in the table to refresh the calculated values and obtain accurate information.

Landscape Type	Area (sf)	ks	kd	kmc ¹	K _L	Et _o	ET _L	Irrigation Type	IE	CE ²	TWA (gal)
Turf Grass	61,636	0.8	0.6	1	0.48	6.3	3.02	Sprinkler	0.625	1	185,634.42
Mixed trees, shrub	69,512	0	1.3	1	0	6.3	0	Temporary	0	1	
Native Undisturbed	8,629	0				6.3					
Total area (sf)	139,777	Design total water applied (TWA) (gal)									185,634.42
										Nonpotable water used (gal)	0
										Design total potable water applied (TPWA) (gal)	185,634.42

Notes:

1 For each landscape type, the microclimate factor (kmc) must be the same for the baseline and design case.

2 Controller efficiency (CE) may range from 0.7 to 1. If the irrigation system has no weather-based controllers or moisture sensor systems, use a CE value of 1.

Table 2: LEED document for Water Efficient Landscaping WE Credit 1 showing calculations for water use reduction through use of higher species factor and density of plants in the design case.

Source: Jacobs/Ryan Associates

Water needed in July: 511,526 gallons (baseline) - 185,634 gallons (design) = **325,922** gallons reduction

Percent water reduction: (325,922 gallons / 511,526 gallons) x 100 = **63%**

Cost savings in July: 325,922 gallons x \$0.00398/gallon = **\$1,297.16**

Sources:

Jacobs/Ryan Associates. *LEED 2009 for New Construction and Major Renovations WE Credit 1 Water Efficient Landscaping*. PDF. Washington D.C.: US Green Building Council.

“Water and Sewer Rates.” City of Chicago: Water and Sewer Rates. June 1, 2019. Accessed June 27, 2019.
https://www.chicago.gov/city/en/depts/fin/supp_info/utility-billing/water-and-sewer-rates.html.

Limitations:

In the LEED 2009 WEc1 worksheet calculations for turfgrass, although there is a higher species factor (.8) and lower density factor (.6) in the design case than there is in the baseline case (.7 species factor, 1.1 density factor), suggesting a greater irrigation need in the design case, the design case still calculates to a lower irrigation requirement. This calculation method has been removed for the WEc1 credit in later versions of LEED, which use EPA calculation standards. Thus, the watering requirement may be different in the actual design conditions.

- **Removes 81% of total suspended solids through natural areas, grass filters, and manufactured water quality treatment devices.**

Methods: In the LEED 2009 SS Credit 6.2: Stormwater Design - Quality Control worksheet, GHA Engineers listed the BMP type, location, percent of the site, and the total suspended solids (TSS) removal efficiency based on manufacturer’s or a national or regional source. The SS6.2 worksheet took a weighted average of each BMP and totaled the weighted averages to determine the TSS removal efficiency of the site. The required LEED minimum of 80% was met.

Calculations:

Table SS6.2-1. TSS Removal Efficiency

BMP Type/Label	BMP Description and/or Location	In Series with BMP Above?	Percent Site Treated by BMP	TSS Removal Efficiency (%)	Source of TSS Removal Efficiency data	Weighted Average TSS Removal Efficiency (%)
Water Quality	Stormceptor #1	N/A	14	82	Manufacturer	11.48
Water Quality	Stormceptor #2	No	18	82	Manufacturer	14.76
Water Quality	Stormceptor #3	No	41	83	Manufacturer	34.03
Native Planting	Area #4	No	7	85	National or regional source	5.95
Grass Filter	Area #5	No	12	65	National or regional source	7.8
Native Planting	Area #6	No	8	85	National or regional source	6.8
Total weighted average TSS removal efficiency (must be at least 80%)						80.82

Table 3: LEED document for Stormwater Quality Control Credit 6.2 showing calculations for water use reduction through the use of higher species factor and density of plants. Source: Jacobs/Ryan Associates

Sources:

Gewalt Hamilton Associates, Inc. *LEED 2009 for New Construction and Major Renovations SS Credit 6.2 Stormwater Design - Quality Control*. PDF. Washington D.C.: US Green Building Council.

Limitations:

This is an estimate. Manufacturer data is likely not as accurate as on-site real-time measurements.

- ***Expands the flood storage capacity of the site by 27,078 cu ft.***

Where grading activity results in soil fill in within a floodplain as in the case of the Regenstein Learning Campus, lost storage must be compensated for (compensatory storage). This protects the Learning Center building from flood damage. Per Cook County regulations for flood protection, compensatory storage must be provided, and an additional 50% flood storage capacity is required on new project sites for even more protection. Post-development flood storage on the Regenstein Learning Campus can accommodate up to 3.97 inches of rainfall at a time, which can manage a 1-hour 100-year rain event (3.56 in), 12-hour 10-year rain event (3.89 in), or a 24-hour 5-year rain event (3.80 in).

Methods:

GHA Engineers performed compensatory storage calculations for the Skokie River and Botanic Garden Lake flood zones, at stations every 25 feet along the project site, to determine the total earthwork fill and cut volumes in 0-10 year strata and 10-100 year strata flood elevations (Tables 4 and 5). The total fill volume from both flood zones equated to the amount of flood storage prior to project construction (33,960 cf), and the total cut volume from both flood zones equated to the amount of flood storage provided after project construction (61,038).

The site's accommodation of flood water levels was determined by converting the post-development flood storage volume from cubic feet to gallons and solving for variable x , x being the maximum number of inches the site flood storage volume could compensate, in the CNT bioretention and infiltration equation. All values less than x inches, found in the Illinois State Water Surveys table of "Sectional Mean Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years in Illinois" (highlighted in yellow in Table 6), were considered to be storms for which the site could detain 100% of rainfall. The retention factor (3.94 inches) was determined through the CNT bioretention and infiltration equation. See Environmental Benefit 1 for details on how this retention factor was determined.

Calculations:

SKOKIE RIVER FLOOD ZONE COMPENSATORY STORAGE CALCULATION

Station	Earthwork From 0-10 yr Flood Elevations				Earthwork From 10-100 yr Flood Elevations			
	Fill Area (ft ²)	Incremental Fill (ft ³)	Cut Area (ft ²)	Incremental Cut (ft ³)	Fill Area (ft ²)	Incremental Fill (ft ³)	Cut Area (ft ²)	Incremental Cut (ft ³)
0	0.0		0.0		0.0		0.0	
		12.5		37.5		0.0		287.5
25	1.0		3.0		0.0		23.0	
		12.5		425.0		0.0		425.0
50	0.0		31.0		0.0		11.0	
		75.0		437.5		50.0		162.5
75	6.0		4.0		4.0		2.0	
		87.5		237.5		112.5		37.5
100	1.0		15.0		5.0		1.0	
		62.5		362.5		125.0		25.0
125	4.0		14.0		5.0		1.0	
		50.0		500.0		62.5		75.0
150	0.0		26.0		0.0		5.0	
		0.0		825.0		0.0		225.0
175	0.0		40.0		0.0		13.0	
		0.0		1037.5		0.0		387.5
200	0.0		43.0		0.0		18.0	
		0.0		537.5		150.0		225.0
225	0.0		0.0		12.0		0.0	
		80.0		0.0		285.0		0.0
235	16.0		0.0		45.0		0.0	
		510.0		0.0		952.5		0.0
250	52.0		0.0		82.0		0.0	
		260.0		0.0		565.0		0.0
260	0.0		0.0		31.0		0.0	
		0.0		0.0		232.5		0.0
275	0.0		0.0		0.0		0.0	
Total (ft ³)		1150.0		4400.0		2535.0		1850.0

Table 4: Skokie River Flood Zone Compensatory Storage Calculation. Source: GHA Engineers.

BOTANIC GARDEN LAKES FLOOD ZONE COMPENSATORY STORAGE CALCULATION

Station	Earthwork From 0-10 yr Flood Elevations				Earthwork From 10-100 yr Flood Elevations			
	Fill Area (ft ²)	Incremental Fill (ft ³)	Cut Area (ft ²)	Incremental Cut (ft ³)	Fill Area (ft ²)	Incremental Fill (ft ³)	Cut Area (ft ²)	Incremental Cut (ft ³)
0	0.0		0.0		0.0		0.0	
		0.0		0.0		0.0		0.0
25	0.0		0.0		0.0		0.0	
		0.0		87.5		0.0		575.0
50	0.0		7.0		0.0		46.0	
		0.0		337.5		0.0		1087.5
75	0.0		20.0		0.0		41.0	
		0.0		537.5		0.0		925.0
100	0.0		23.0		0.0		33.0	
		0.0		612.5		0.0		650.0
125	0.0		26.0		0.0		19.0	
		0.0		462.5		0.0		350.0
150	0.0		11.0		0.0		9.0	
		0.0		137.5		0.0		112.5
175	0.0		0.0		0.0		0.0	
		0.0		0.0		0.0		0.0
200	0.0		0.0		0.0		0.0	
		12.5		0.0		0.0		0.0
225	1.0		0.0		0.0		0.0	
		12.5		75.0		0.0		212.5
250	0.0		6.0		0.0		17.0	
		0.0		725.0		575.0		887.5
275	0.0		52.0		46.0		54.0	
		0.0		1437.5		2200.0		1325.0
300	0.0		63.0		130.0		52.0	
		75.0		1550.0		3600.0		1262.5
325	6.0		61.0		158.0		49.0	
		237.5		1950.0		2937.5		1212.5
350	13.0		95.0		77.0		48.0	
		687.5		2100.0		1862.5		1250.0
375	42.0		73.0		72.0		52.0	
		1462.5		1500.0		1675.0		1462.5
400	75.0		47.0		62.0		65.0	
		2150.0		1187.5		1037.5		1512.5
425	97.0		48.0		21.0		56.0	
		3700.0		1325.0		475.0		1325.0
450	199.0		58.0		17.0		50.0	
		4700.0		1400.0		400.0		1475.0
475	177.0		54.0		15.0		68.0	
		3412.5		1750.0		187.5		2137.5
500	96.0		86.0		0.0		103.0	
		1537.5		3025.0		0.0		2812.5
525	27.0		156.0		0.0		122.0	
		337.5		4150.0		0.0		2725.0
550	0.0		176.0		0.0		96.0	
		0.0		3725.0		0.0		1425.0
575	0.0		122.0		0.0		18.0	
		0.0		1687.5		0.0		225.0
600	0.0		13.0		0.0		0.0	
		0.0		75.0		0.0		0.0
610	0.0		2.0		0.0		0.0	
Total (ft ³)		18325.0		29837.5		14950.0		24950.0

Table 5: Botanic Garden Lakes Flood Zone Compensatory Storage Calculation. Source: GHA Engineers.

Flood storage converted to gallons

61,038 cubic feet x 7.48 gallons/1 cubic foot = 456,564.24

1-100 yr storm intervals detained 100% by the project site

x inches * 196,080 sf * 94% of rainfall detained * 144 sq inches/SF * 0.00433 gal/cubic inch = 456,564.24

x = 3.94 inches

Table 1. Sectional Mean Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years in Illinois. Units are in inches.

		<i>Sectional code</i>											
		<i>01 - Northwest</i>						<i>06 - West Southwest</i>					
		<i>02 - Northeast</i>						<i>07 - East Southeast</i>					
		<i>03 - West</i>						<i>08 - Southwest</i>					
		<i>04 - Central</i>						<i>09 - Southeast</i>					
		<i>05 - East</i>						<i>10 - South</i>					
Section	Duration	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
02	10-day	2.02	2.48	2.80	3.30	3.79	4.12	4.95	6.04	6.89	8.18	9.38	11.14
02	5-day	1.66	1.98	2.24	2.60	2.99	3.25	3.93	4.91	5.70	6.93	8.04	9.96
02	72-hr	1.53	1.83	2.02	2.34	2.70	2.93	3.55	4.44	5.18	6.32	7.41	8.78
02	48-hr	1.44	1.70	1.90	2.18	2.49	2.70	3.30	4.09	4.81	5.88	6.84	8.16
02	24-hr	1.38	1.61	1.76	2.03	2.31	2.51	3.04	3.80	4.47	5.51	6.46	7.58
02	18-hr	1.26	1.47	1.61	1.86	2.12	2.30	2.79	3.50	4.11	5.06	5.95	6.97
02	12-hr	1.20	1.40	1.53	1.77	2.01	2.18	2.64	3.31	3.89	4.79	5.62	6.59
02	6-hr	1.03	1.21	1.32	1.52	1.74	1.88	2.28	2.85	3.35	4.13	4.85	5.68
02	3-hr	0.88	1.02	1.13	1.30	1.47	1.60	1.94	2.43	2.86	3.53	4.14	4.85
02	2-hr	0.81	0.95	1.05	1.20	1.36	1.48	1.79	2.24	2.64	3.25	3.82	4.47
02	1-hr	0.65	0.76	0.84	0.96	1.09	1.18	1.43	1.79	2.10	2.59	3.04	3.56
02	30-min	0.51	0.60	0.65	0.75	0.86	0.93	1.12	1.41	1.65	2.04	2.39	2.80
02	15-min	0.37	0.44	0.48	0.55	0.63	0.68	0.82	1.03	1.21	1.49	1.75	2.05
02	10-min	0.30	0.35	0.39	0.45	0.51	0.55	0.67	0.84	0.98	1.21	1.42	1.67
02	5-min	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.46	0.54	0.66	0.78	0.91

Table 6: Highlighted values are selected storms for which the project site is estimated as capable of retaining 100% of stormwater. Source: ISWS

Sources:

Compensatory Storage Exhibits. PDF. Vernon Hills: Gewalt Hamilton Associates, Inc., April 24, 2015.

Table 1. Sectional Mean Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years in Illinois. PDF. Champaign: Illinois State Water Survey, 2007. <https://www.isws.illinois.edu/statecli/RF/table10.pdf>

US Department of Commerce, and NOAA. "Annual Precipitation Amounts for Chicago, IL." National Weather Service. January 04, 2019. Accessed June 30, 2019. https://www.weather.gov/lot/Annual_Precip_Rankings_Chicago

Limitations: The Regenstein Learning Campus project site is approximately 4.5 acres, or 0.02%, of the 22 square mile Skokie River watershed, and as such the site does not have a measurable effect on regional flooding. This information is based on models and was not independently verified in the field.

- **Added 57,201 sf of new habitat, resulting in 101,572 sf of habitat for pollinators and wildlife. The site attracts at least 11 observed species of birds and mammals including chipmunks, red-winged blackbirds, and grackles.**

As part of the Regenstein Learning Campus' LEED goals, the project utilized the Nature Play Gardens to protect and restore wildlife habitat. 19,732 sq ft of existing native planting area was preserved during construction, and 81,840 sq ft of native plantings were added. Native plants were selected in order to optimize the amount of habitat created for native wildlife species. Approximately, 24,639 sq ft of habitat was lost during construction for the Learning Center building and the installation of a service road.



Habitat Before (Google Earth, April 2013)

Habitat After (Google Earth, July 2018)

Methods:

Jacobs/Ryan Associates provided area calculations for the LEED 2009 SS5.1 Protect and Restore Habitat Credit, comprising existing and new native planting areas to meet and exceed the SITES required minimum that 50% of the project site be reserved for wildlife habitat. The 101,572 sq ft of habitat equates to 52% of the project site. These metrics provided the amount of habitat area on the project site. Jacobs/Ryan also provided the calculations of the Learning Center building footprint and AutoCAD 2017 was used to perform an area takeoff from project construction drawings of the amount of habitat lost for the new service road.

A wildlife camera provided by the Urban Wildlife Institute at the Lincoln Park Zoo was tied to a tree in the Nature Play Gardens behind the Learning Center building and set to “normal” sensitivity where it took a picture when it sensed movement in its lens. The camera captured activity from June 13, to June 26, 2019. Review of the recordings captured 79 wildlife sightings, providing evidence of 11 species: chipmunk (*Tamias striatus*), gray squirrel (*Sciurus carolinensis*), white-tailed deer (*Odocoileus virginianus*), skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), American robin (*Turdus migratorius*), cottontail rabbit (*Sylvilagus floridanus*), European starling (*Sturnus vulgaris*), red-winged blackbird (*Agelaius phoeniceus*), grackle (*Quiscalus quiscula*), and house sparrows (*Passer domesticus*). Although many of these are common species, is it significant that the Nature Play Gardens can provide them with habitat in a suburban residential context.

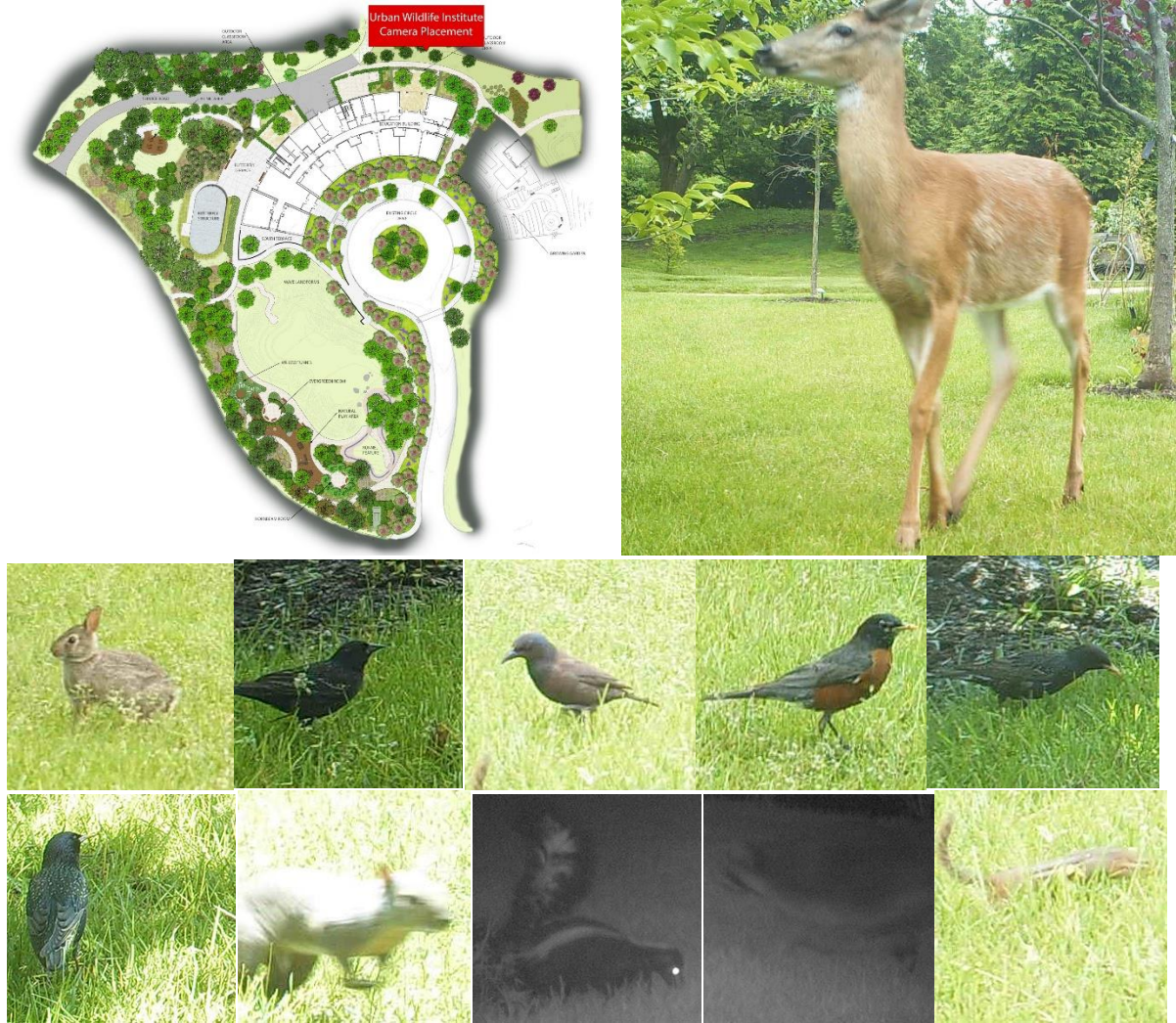


Figure 1: Images captured from camera provided by Urban Wildlife Institute, Lincoln Park Zoo, June 2019. Source: Urban Wildlife Institute

Calculations:

Protected and restored habitat and the Learning Center building footprint square footage were provided by Jacobs/Ryan Associates' SS5.1 LEED calculations document. AutoCAD provided the area of the service road from a drawing scaled to a 1:1 scale.

Habitat Lost: 18,427 sq ft building footprint + 6,212 sq ft service road = 24,639 sq ft of lost habitat

Habitat Gained: 81,840 sf (newly added) - 24,639 sf (lost) = 57,201 sf gained

Sources:

Landscape Regenstein Learning Campus Record Drawings 12-08-2016. PDF. Chicago: Jacobs/Ryan Associates, December 8, 2016.

Photos provided by Urban Wildlife Institute Camera, Chicago Botanic Garden Regenstein Learning Campus. Automated photograph by Bushnell camera. June 13-26, 2019.

Limitations:

Wildlife sightings are limited by the lens size and direction of the wildlife cameras and the limited time and seasonality of recording. It is also unknown if the wildlife observed by this research inhabited the project site prior to the project installation.

Social Benefits

- ***Supports engagement with the outdoors and a greater understanding of nature. 65% of 17 field trip teachers reported outdoor activities as helpful for their field trip program.***

Methods: The CBG Education Department provided field trip evaluation responses from field trip teachers surveyed from 2017-2019 with teachers identifying class activities, strategies, and resources that were helpful to the field trip program. Teacher responses with keywords such as garden, planting, digging, observing, discovery, outdoor and explore were considered as responses citing use of the Nature Play Gardens. 11/17 of these responses had such keywords (Table 12).

Calculations:

School Field Trip Teacher Evaluation Responses
Q2. Please identify classroom activities, strategies, and resources that were helpful for the field trip program.
Exploration and planting
They loved the scavenger hunt and using the hand lenses
We read books and completed worksheet activities
hands on learning is the best ! The children loved planting and using magnifying glasses.
The hands on learning of the planting, exploring and digging.
Hands on plant trays. Outdoor plant science observation/ sketching. Plant part search outside.
Exploring Garden, Finding Parts of plants/ seed song. Planting Sage.
The TV/board was super interactive, the magnifying glasses and insect tests were interesting.
Nice balance of time with kids being seated & movement: getting up to act out the stages of the plant life cycle was excellent opportunity to break up the lesson with some movement.
The hands-on activities as well as the use of pictures.
Using senses to explore. Getting to plant & take it home!
Learning about the senses. Being scientist and observing nature.

Planting seeds, digging out/planting root vegetables. Touching & observing pepper plants. Life cycle presentation.
The hands-on experience were great!
Planting was a great experience. The students also enjoyed acting out the plant life cycle, and arranging the picture.
Discovery & acting our life cycle
1)Acting out life cycle 2) Planting 3) Getting to pull out plants & replant

Table 12: School field-trip evaluation responses from teachers between 2017-2019. Source: Chicago Botanic Garden

Sources:

School Field Trip Evaluations - Discovering Plants. Excel. Glencoe: Chicago Botanic Garden Education Department.

Limitations:

Teacher evaluation responses tallied for this metric did not include other words such as “hands-on”, “insect tests”, “movement” and “scavenger hunt” as they did not explicitly suggest outdoor participation, though they may have been outdoors, which would have strengthened this metric.

- Contributed to an estimated 30% increase in participation in drop-in educational programs between 2014 and 2018. In 2018, the Nature Play Gardens attracted 53,222 participants for 1,233 formal programs including field trips, camps, nature preschool, scouts, and family programs.**

The Regenstein Learning Campus hosts a series of events annually, many of which utilize the Nature Play Gardens. Since the completion of the Nature Play Gardens, 100% of drop-in programs in the Education Department were changed from facilitated activities to open-ended nature play activities that foster connections between families and nature. Other educational programming also utilizes the Nature Play Gardens.

Methods: The Education Department provided 2018 figures for program and participation numbers for activities specifically utilizing the Nature Play Gardens at the Regenstein Learning Campus (Table 9). These numbers were totaled to get program and participation figures for the year. Chicago Botanic Gardens (CBG) provided the total garden attendance from 1999-2018. Education programming participation for 2018 was calculated as a percentage of the 2018 CBG attendance: 5% of total CBG attendance. The department estimated the increase in drop-in programs.

Calculations:

Increase in participation in drop-in programs from 2014-2018 self-reported by the Education Department at the Chicago Botanic Gardens. Number of 2018 participants by program reported below. Total Chicago Botanic Garden attendance for 2018 is reported below for context.

2018 Educational Programming in Nature Play Gardens		
Program Type	Number of Programs	Participation per Program
Teacher Programs	5	50
Field Trips	813	25,812
Camp Programs	185	2,108
Nature Preschool	5	70
Family Programs	164	23,816
Scout Programs	61	1,366
TOTAL	1233	53,222

Total 2018 Chicago Botanic Garden Attendance	1,045,721
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Table 9: 2018 metrics for Nature Play Garden Programs and CBG Attendance

Sources:

Chicago Botanic Garden Education Department. 2018 Educational Programming Participation Numbers. Raw data. Glencoe, Illinois.

Limitations: Raw data for the 30% increase in drop-in programs was not available to independently confirm self-reported data.

- Supports important developmental skills in children. When observed playing together through almost 4,000 observations, 27% of children demonstrated motor skills, 22% problem-solving, 20% risk-taking, and 15% empathy.***

Regenstein Learning Campus Nature Play Garden supports the growth of important developmental skills in children through the employment of unstructured nature play, preparing them for STEM learning and success in life.

Methods:

In July and August of 2017, Chicago Botanic Garden trained seven volunteers in observational methods based on best practices in nature play. Volunteer evaluators observed users of the Nature Play Garden making observations about the natural world, problem solving and investigation, risk-taking, using gross and fine motor skills, collaborating, using natural materials, demonstrating empathy for living things, enjoying quiet time in nature, and other non-nature play related activities. Observations were made on weekdays and weekends, morning and afternoon, at 20-minute intervals focused on specific features of the Nature Play Garden including the runnel, rolling hills, hollow logs, and willow tunnel. A total of 3,915 observations were made of primarily adult-child pairs, secondarily children together, and least observed were adults alone. Results are found in Figure 2. For all groups combined, the primary activities observed were making observations (23%) and motor-skills activities (23%), though they vary

significantly by user type. Least common activities include expressing empathy for the natural world (1%) and non-nature related activities (2%). Exact number observed is not available.

Calculations:

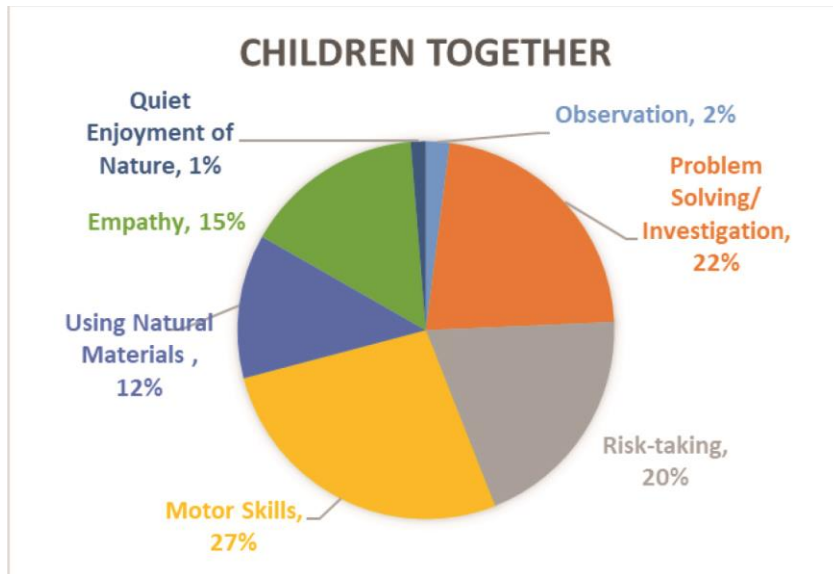


Figure 2: Observations made of children interacting together in July and August 2017.

Source: Chicago Botanic Garden

Sources:

Chicago Botanic Garden Education Department. *Nature Play Garden Evaluation Complete*. PDF. Glencoe: Chicago Botanic Garden.

Limitations:

Not performed or independently verified by the CSI Research Team.

Additional information about program participation unrelated to landscape elements:

- ***Financial aid increased participation in educational programs on-site by students from schools that serve low-income populations by an estimated 72% from 2016-2018.***

A portion of fundraising revenue generated by the Chicago Botanic Garden (CBG) was directed towards financial aid to assist in funding Title 1 school field trips at the CBG. Because of this funding, it was expected that more low-income students would be able to participate in activities at the NPG.

Methods:

To determine the percentage of low-income students participating in school field trips at the Nature Play Gardens, the CBG Education Department categorized school field trip classes into 0-24%, 25-49%, 50-74%, 75-89%, 90% or greater, or unknown regarding the percentage of students that may be categorized as low-income based on the demographics available on the

individual schools. The number of students in each income category were tallied, which determined the percentage of the total number of students in each category (Table 12). These percentages were applied to the number of students recorded as visiting by the CBG. In 2016, 3,176 field trip students were from schools where 50% or more of the students were low-income. In 2018, 5,486 field trip students were in the same category, an increase of 2,310 students. This increase of 2,310 was divided by the 3,176 students in 2016 to get a 72.7% increase in the number of field trip students attending schools that serve low-income populations.

Calculations:

Categories are based on the percentage of low income students at the school						
	No Data	0-24%	25-49%	50-74%	75-90%	90%+
2016	42%	29%	10%	10%	6%	2%
2017	28%	30%	12%	12%	5%	12%
2018	31%	24%	17%	9%	7%	12%

Table 12: Student financial demographics. Source: Chicago Botanic Gardens

Increase in low-income students: $(5,486 \text{ students} - 3,176 \text{ students}) = 2,310 \text{ student increase} / 3,176 \text{ students} = .73 \times 100 = \mathbf{73\%}$

Sources:

Chicago Botanic Gardens Education Department. Field Trip Demographics Over Time. Raw data. Chicago Botanic Garden, Glencoe.

Limitations:

Data was not available for 31% of field trip students in 2018 and 42% of students in 2018. Exact numbers of students were not available.

Economic Benefits

- ***Created 1 full-time and 6 seasonal teaching positions along with 1 part-time maintenance position.***

Teaching positions were added in anticipation of the Regenstein Learning Campus programs. There is now 1 full-time year-round position, the Early Childhood Programs Manager & Nature Preschool Director, and 3 seasonal lead teachers and 3 seasonal assistant teachers (2 lead teachers are full time and the rest of teachers are all part time; all of these teachers work September through May)

Methods: The Chicago Botanic Garden (CBG) Education Department provided the numbers of positions added for the campus programs, all of the positions of which operate within the Nature Play Gardens as part of their job description.

Calculations:

Data reported by the CBG Education Department and the Executive Vice President and Director.

Sources:

Chicago Botanic Garden Education Department. Positions Added for Regenstein Learning Campus. Raw data. Chicago Botanic Garden, Glencoe.

Limitations:

Not all teaching responsibilities take place in the Nature Play Gardens, but all occur on the Regenstein Learning Campus.

- ***Generated \$2.25 million in capital funds and catalyzed over \$130,000 in scholarships for youth education, part of which supported 15 student scholarships for free or reduced-cost camp and Nature Preschool sessions.***

Methods: The Executive Vice President and Director of the Chicago Botanic Gardens provided the amounts for capital funds raised dedicated specifically to areas in the Nature Play Garden and raised for youth education. Funds raised for youth education were used for financial aid for Title 1 schools, 10 full scholarships for students to attend 15 camp sessions, and 5 students to attend Nature Preschool at a reduced cost or free of charge.

Calculations:

Data reported by the Chicago Botanic Garden Executive Vice President and Director.

Sources:

Chicago Botanic Garden Administration. Capital funds raised for Nature Play Garden. Raw data. Chicago Botanic Garden, Glencoe.

Limitations:

The exact amount of funds received for individual components of youth education (camp scholarships, Nature Preschool cost of attendance, etc.) were not provided.

Additional Benefits: Nature Preschool

- ***Increases the amount of time families spend outside per week through the Nature Preschool as reported by 59% of 41 surveyed parents. 27% of 33 surveyed parents visit the Nature Play Gardens 1-3 times per week.***

The Nature Play Gardens is unique at the Chicago Botanic Gardens (CBG) as an open recreational space for adults and children to engage with nature informally. Prior to the construction of the Regenstein Learning Campus and Nature Play Gardens (NPG), for example,

children would spend less time in the garden before and after classes because there was not an open play space at the CBG. 100% of parents surveyed chose Nature Preschool for their children because of the outdoor experiences.

Methods: The CBG Education Department surveyed parents of Nature Preschool participants after the 2018-2019 school year. When asked how much time they spent outside as a family before and after their child attending Nature Preschool, 24/41, or 59%, of parents self-reported more hours spent outside. In the same survey, when asked what factors helped them select Nature Preschool, 41/41, or 100% selected “outdoor experiences” (Table 10). In a separate survey distributed to parents by the CSI Research Team on June 19 and July 17, 2019, parents were asked how often they visit the NPG, 9/33, or 27%, reporting that they visit 1-3 times per week (Table 11). The complete CSI survey is found in Appendix A.

Calculations:

Which factors helped you select Nature Preschool?		
Fee	6	14.63%
Distance from your home	15	36.58%
Attended prior CBG programs	13	31.70%
Reputation of the program	16	39.02%
Outdoor experiences	41	100%
Licensing	6	14.63%
Quality of teachers	23	56.09%
Member discount on registration	10	24.39%
Increase in amount of time family spent outside per week		
Yes	24	58.54%
No	17	41.46%
	41/41	

Table 10: Program Evaluation for Nature Preschool 2018-2019. Source: Chicago Botanic Garden

3. How often do you visit the Regenstein Learning Campus Nature Play Garden and outdoor classrooms at the Chicago Botanic Garden? (Please circle one of the following)		
First time	10	30.30%
1 to 3 times per week	9	27.27%
1 to 3 times per month	6	18.18%
1 to 3 times per season	6	18.18%
1 to 3 times per year	2	6.06%
	33/33	

Table 11: Frequency of visitation as self-reported on June 19 and July 17, 2019. Source: CSI Research Team

Sources:

Callone, Matt. Regenstein Learning Campus User Survey. July 17, 2019. Raw data. Regenstein Learning Campus, Glencoe.

Education Department. Program Evaluation-Nature Preschool 2018-2019. June, 2019. Raw data. Regenstein Learning Campus, Glencoe.

Limitations: There was no clear majority of visitation frequency to the NPG as self-reported in the Regenstein Learning Campus User Survey. Bias may be assumed in surveying just parents who participate in CBG programs.

- ***34% of 41 surveyed parents whose children participated in Nature Preschool programming reported that their child has seen the greatest development in their “love for,” “knowledge of,” or “understanding of” the natural world.***

Methods: The CBG Education Department surveyed parents of Nature Preschool participants after the 2018-2019 school year. When asked what areas they have seen the greatest development or growth in their child, 14/41, or 34%, responded with answers expressing that their child has a greater “love”, “knowledge” or “understanding” of the “natural world” or “nature”. **“What areas have you seen the greatest development or growth in your child?”**

Question asked in Program Evaluation for Nature Preschool after 2018-2019 school year.

Sources:

Education Department. Program Evaluation-Nature Preschool 2018-2019. June, 2019. Raw data. Regenstein Learning Campus, Glencoe.

Limitations:

Parent responses tallied for the Program Evaluation for Nature Preschool consisting of “outdoors” or “outside” were not included as they did not explicitly mention nature and have less correlation to the Nature Play Gardens.

Appendix A:

Regenstein Learning Campus Visitor Survey

Regenstein Learning Campus Visitor Survey

1. Are you a member of the Chicago Botanic Garden?
 - a. Yes (*Please circle one of the following*)
 - i. Garden Plus member
 - ii. Garden member
 - iii. Educator Garden member
 - iv. National Garden member
 - v. Not sure
 - b. No

 2. How often do you visit the Chicago Botanic Garden? (*Please circle one of the following*)
 - a. First time
 - b. 1 to 3 times per week
 - c. 1 to 3 times per month
 - d. 1 to 3 times per season
 - e. 1 to 3 times per year

 3. How often do you visit the Regenstein Learning Campus Nature Play Garden and outdoor classrooms at the Chicago Botanic Garden? (*Please circle one of the following*)
 - a. First time
 - b. 1 to 3 times per week
 - c. 1 to 3 times per month
 - d. 1 to 3 times per season
 - e. 1 to 3 times per year

 4. Would you visit the Chicago Botanic Garden if the Regenstein Learning Campus Nature Play Garden did not exist?
 - a. Yes
 - b. No

 5. Do you have a child or children enrolled in Nature Preschool at the Chicago Botanic Garden?
 - a. Yes
 - b. No

 6. Does your child talk about the Nature Play Garden and/or Nature Preschool at home? If so, please describe what your child says about the Nature Play Garden and/or Nature Preschool.
-

-
-
7. When visiting the Chicago Botanic Garden, how much time do you generally spend at the Nature Play Garden?
- a. 30 minutes or less
 - b. 31 minutes to 60 minutes
 - c. 1 hour to 2 hours
 - d. 2 hours to 3 hours
 - e. More than 3 hours



8. When in the Nature Play Garden, what are your top 3 areas to spend time in? (*Complete for both adults and children if applicable. List in order of preference with 1 as your favorite. Refer to diagram on the previous page.*)

Adult Users

- ___ Willow Tunnel
- ___ The Logs
- ___ Water Feature
- ___ The Hills
- ___ Butterflies and Blooms
- ___ Evergreen Room
- ___ Hornbeam Room
- ___ Rain Gardens

Child Users

- ___ Willow Tunnel
- ___ The Logs
- ___ Water Feature
- ___ The Hills
- ___ Butterflies and Blooms
- ___ Evergreen Room
- ___ Hornbeam Room
- ___ Rain Gardens

9. Please rank your reasons for visiting the Regenstein Learning Campus Nature Play Garden and outdoor classrooms today? (*Please list your primary reason as 1 and 6 as lowest reason*)

- ___ To play and get exercise outside
 - ___ To learn in Nature Preschool
 - ___ To learn informally and play creatively in nature
 - ___ To get together with friends
 - ___ To explore nature
 - ___ To feel restored
 - ___ Other, please describe:
-

10. Do you go to other parts of the Learning Campus before or after visiting the Nature Play Garden and outdoor classrooms? (*Please select all that apply*)

- a. I often go to the Kleinman Family Cove.
- b. I often go to the Grunsfeld Children's Growing Garden.
- c. I sometimes go to the Kleinman Family Cove.
- d. I sometimes go to the Grunsfeld Children's Growing Garden.
- e. No, I do not go to other parts of the Learning Campus.

11. If you didn't visit the Learning Campus Nature Play Garden today, where would you have gone instead?

- a. A park in my neighborhood
- b. A community center
- c. A playground
- d. Lake Michigan lakefront park

- e. Stayed at home
 - f. Other, please describe:
-

12. Please rank the statements below based on your opinion. (*Please rank all that apply with 1 being most important*)

- ___ The Nature Play Garden provides me and/or my child opportunities for physical exercise that we would not have access to elsewhere.
- ___ The Nature Play Garden provides me and/or my child opportunities to experience nature that we would not have access to elsewhere.
- ___ The Nature Play Garden provides me and/or my child opportunities to have free play outdoors that we would not have access to elsewhere.
- ___ The Learning Campus and Nature Play Garden provides me and/or my child opportunities to take a class or camp that we would not have access to elsewhere.
- ___ None of the above.

Appendix B:

Full Report - Nature Play Gardens Before Condition FQI (not reported in Benefits)

Nature Play Gardens - Former Conditions						
6/24/2019						
Nature Play Gardens	Glencoe	Cook			Illinois	
United States						
FQA DB Region:	Chicago Region USACE					
FQA DB Publication Year:	2017					
FQA DB Description:	https://www.lrc.usace.army.mil/Missions/Regulatory/FQA.aspx					
Practitioner:	Matt Callone					
Latitude:	42.151406					
Longitude:	-87.791315					
Private/Public:	Private					
Conservatism-Based Metrics:						
Total Mean C:	2.8					
Native Mean C:	4.8					
Total FQI:	13.1					
Native FQI:	17.3					
Adjusted FQI:	36.9					
% C value 0:	45.5					
% C value 1-3:	18.2					
% C value 4-6:	18.2					

% C value 7-10:	18.2					
Native Tree Mean C:	4.8					
Native Shrub Mean C:	n/a					
Native Herbaceous Mean C:	n/a					
Species Richness:						
Total Species:	22					
Native Species:	13	59.10%				
Non-native Species:	9	40.90%				
Species Wetness:						
Mean Wetness:	1					
Native Mean Wetness:	0.6					
Physiognomy Metrics:						
Tree:	21	95.50%				
Shrub:	1	4.50%				
Vine:	0	0%				
Forb:	0	0%				
Grass:	0	0%				
Sedge:	0	0%				
Rush:	0	0%				
Fern:	0	0%				
Bryophyte:	0	0%				
Duration Metrics:						
Annual:	0	0%				
Perennial:	22	100%				
Biennial:	0	0%				
Native Annual:	0	0%				
Native Perennial:	13	59.10%				
Native Biennial:	0	0%				

Species:

Scientific Name	Family	Native?	C	W	Physiognom y	Duration	Common Name
Acer campestre	Aceraceae	non-native	0	2	tree	perennial	hedge maple
Acer saccharinum	Aceraceae	native	1	1	tree	perennial	silver maple
Acer x freemanii	Aceraceae	native	0	2	tree	perennial	freemans maple
Catalpa speciosa	Bignoniaceae	non-native	0	1	tree	perennial	northern catalpa
Cercidiphyllum japonicum	Cercidiphyllaceae	non-native	0	2	tree	perennial	katsura tree

Crataegus chrysoarpa	Rosaceae	native	4	2	tree	perennial	fireberry hawthorn
Crataegus crus-galli	Rosaceae	native	3	0	tree	perennial	cock-spur hawthorn
Fraxinus pennsylvanica	Oleaceae	native	4	1	tree	perennial	green ash
Ginkgo biloba	Ginkgoaceae	non-native	0	2	tree	perennial	ginkgo
Gleditsia triacanthos	Fabaceae	native	1	1	tree	perennial	honey-locust
Gymnocladus dioica	Caesalpiniaceae	native	8	2	tree	perennial	kentucky coffee tree
Magnolia stellata	Magnoliaceae	non-native	0	2	tree	perennial	star magnolia
Malus baccata	Rosaceae	non-native	0	2	tree	perennial	siberian crab apple
Philadelphus coronarius	Philadelphaceae	non-native	0	2	shrub	perennial	sweet mock orange
Picea abies	Pinaceae	non-native	0	2	tree	perennial	norway spruce
Pinus resinosa	Pinaceae	native	0	1	tree	perennial	red pine
Populus tremuloides	Salicaceae	native	3	0	tree	perennial	quaking aspen
Quercus lyrata	Fagaceae	non-native	0	2	tree	perennial	overcup oak
Quercus macrocarpa	Fagaceae	native	5	0	tree	perennial	burr oak
Quercus muhlenbergii	Fagaceae	native	8	1	tree	perennial	chinkapin oak
Quercus velutina	Fagaceae	native	5	2	tree	perennial	black oak
Thuja occidentalis	Cupressaceae	native	0	1	tree	perennial	eastern arborvitae

Appendix C:

Full Report - Nature Play Gardens 2019 Plant List and FQI (not reported in Benefits)

Nature Play Gardens - Post-Construction Actual							
7/29/2019							
Nature Play Gardens	Glencoe	Illinois					
United States							
FQA DB Region:	Chicago Region USACE						
FQA DB Publication Year:	2017						

FQA DB						
Description:	https://www.lrc.usace.army.mil/Missions/Regulatory/FQA.aspx					
Practitioner:	Matt Callone					
Latitude:	42.151406					
Longitude:	-87.791315					
Private/Public:	Private					
Conservatism-Based Metrics:						
Total Mean C:	3.5					
Native Mean C:	6.1					
Total FQI:	39.9					
Native FQI:	52.5					
Adjusted FQI:	46					
% C value 0:	46.9					
% C value 1-3:	6.2					
% C value 4-6:	20					
% C value 7-10:	26.9					
Native Tree Mean C:	4.7					
Native Shrub Mean C:	7.6					
Native Herbaceous Mean C:	6.5					
Species Richness:						
Total Species:	130					
Native Species:	74	56.90%				
Non-native Species:	56	43.10%				
Species Wetness:						
Mean Wetness:	0.7					
Native Mean Wetness:	0.1					
Physiognomy Metrics:						
Tree:	35	26.90%				
Shrub:	29	22.30%				

Vine:	3	2.30%				
Forb:	52	40%				
Grass:	8	6.20%				
Sedge:	0	0%				
Rush:	0	0%				
Fern:	3	2.30%				
Bryophyte:	0	0%				

Duration Metrics:

Annual:	4	3.10%				
Perennial:	125	96.20%				
Biennial:	1	0.80%				
Native Annual:	2	1.50%				
Native Perennial:	71	54.60%				
Native Biennial:	1	0.80%				

Species:

Scientific Name	Family	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Aceraceae	native	5	0	tree	perennial	red maple
Acer saccharum	Aceraceae	native	5	1	tree	perennial	sugar maple
Acer x freemanii	Aceraceae	native	0	2	tree	perennial	freemans maple
Actaea pachypoda	Ranunculaceae	native	8	1	forb	perennial	white baneberry
Adiantum pedatum	Pteridaceae	native	1	0	fern	perennial	northern maidenhair
Agastache foeniculum	Lamiaceae	native	0	2	forb	perennial	blue giant-hyssop
Ajuga reptans	Lamiaceae	non-native	0	2	forb	perennial	carpet bugleweed
Allium aflatunense	Liliaceae	native	0	2	forb	perennial	ornamental onion
Amelanchier alnifolia	Rosaceae	non-native	0	1	shrub	perennial	saskatoon service-berry
Amelanchier x grandiflora	Rosaceae	non-native	0	2	shrub	perennial	sweet-fruited service-berry
Andropogon gerardii	Poaceae	native	5	0	grass	perennial	big bluestem
Anemone canadensis	Ranunculaceae	native	4	-1	forb	perennial	round-leaf thimbleweed

Aronia melanocarpa	Rosaceae	native	7	-1	shrub	perennial	black chokeberry
Aruncus dioicus	Rosaceae	native	1	0	1 forb	perennial	goats beard
Asarum canadense	Aristolochiaceae	native	1	0	1 forb	perennial	canadian wild ginger
Baptisia australis	Fabaceae	non-native	0	1	forb	perennial	blue wild indigo
Betula pendula	Betulaceae	non-native	0	2	tree	perennial	european weeping birch
Bouteloua gracilis	Poaceae	non-native	0	2	grass	perennial	blue grama
Buxus sempervirens	Buxaceae	non-native	0	2	shrub	perennial	boxwood
Camassia scilloides	Liliaceae	native	7	0	forb	perennial	atlantic camas
Campsis radicans	Bignoniaceae	non-native	0	1	vine	perennial	trumpet-creeper
Carpinus caroliniana ssp. virginiana	Betulaceae	native	8	0	tree	perennial	american hornbeam
Cephalanthus occidentalis	Rubiaceae	native	5	-2	shrub	perennial	common buttonbush
Cercidiphyllum japonicum	Cercidiphyllaceae	non-native	0	2	tree	perennial	katsura tree
Cercis canadensis	Fabaceae	native	5	1	tree	perennial	redbud
Chelone glabra	Scrophulariaceae	native	8	-2	forb	perennial	white turtlehead
Chelone obliqua var. speciosa	Scrophulariaceae	non-native	0	-2	forb	perennial	red turtlehead
Clematis glauca	Ranunculaceae	non-native	0	2	vine	perennial	yellow bell clamatis
Clematis integrifolia	Ranunculaceae	non-native	0	2	vine	perennial	blue virgins-bower
Conoclinium coelestinum	Asteraceae	non-native	0	-1	forb	perennial	blue mistflower
Coreopsis basalis	Asteraceae	non-native	0	2	forb	annual	golden wave
Cornus alba	Cornaceae	native	5	-1	shrub	perennial	red osier
Cornus mas	Cornaceae	non-native	0	2	tree	perennial	cornelian cherry
Cornus obliqua	Cornaceae	native	5	-1	shrub	perennial	pale dogwood
Cotinus coggygria	Anacardiaceae	non-native	0	2	shrub	perennial	european smoke-tree
Crataegus crus-galli	Rosaceae	native	3	0	tree	perennial	cock-spur hawthorn

Crataegus phaenopyrum	Rosaceae	non-native	0	0	tree	perennial	washington hawthorn
Crocus chrysanthus	Iridaceae	non-native	0	2	forb	perennial	golden crocus
Dasiphora fruticosa	Rosaceae	native	1 0	-1	shrub	perennial	golden-hardhack
Deschampsia caespitosa	Poaceae	native	1 0	-1	grass	perennial	tufted hair grass
Deutzia scabra	Philadelphaceae	non-native	0	2	shrub	perennial	fuzzy pride-of-rochester
Dicentra canadensis	Fumariaceae	native	8	2	forb	perennial	squirrel corn
Diervilla lonicera	Caprifoliaceae	native	1 0	2	shrub	perennial	dwarf honeysuckle
Diospyros virginiana	Ebenaceae	non-native	0	0	tree	perennial	common persimmon
Dodecatheon meadia	Primulaceae	native	6	1	forb	perennial	pride-of-ohio
Dryopteris carthusiana	Dryopteridaceae	native	8	-1	fern	perennial	spinulose wood fern
Dryopteris intermedia	Dryopteridaceae	native	9	0	fern	perennial	evergreen wood fern
Echinacea pallida	Asteraceae	native	1 0	2	forb	perennial	pale coneflower
Eupatorium perfoliatum	Asteraceae	native	4	-2	forb	perennial	common boneset
Fagus grandifolia	Fagaceae	native	5	1	tree	perennial	american beech
Filipendula ulmaria	Rosaceae	non-native	0	-1	forb	perennial	queen-of-the-meadow
Forsythia suspensa	Oleaceae	non-native	0	2	shrub	perennial	japanese golden bell
Fraxinus americana	Oleaceae	native	5	1	tree	perennial	white ash
Fraxinus pennsylvanica	Oleaceae	native	4	-1	tree	perennial	green ash
Geranium bicknellii	Geraniaceae	native	4	2	forb	annual	northern cranesbill
Geum aleppicum	Rosaceae	native	3	-1	forb	perennial	yellow avens
Ginkgo biloba	Ginkgoaceae	non-native	0	2	tree	perennial	ginkgo
Gleditsia triacanthos	Fabaceae	native	1	1	tree	perennial	honey-locust

Gymnocladus dioicus	Caesalpiaceae	native	8	2	tree	perennial	kentucky coffee tree
Hamamelis virginiana	Hamamelidaceae	native	8	1	shrub	perennial	american witch-hazel
Helenium amarum	Asteraceae	non-native	0	1	forb	annual	yellowdicks
Hemerocallis fulva	Liliaceae	non-native	0	2	forb	perennial	orange day-lily
Heuchera americana	Saxifragaceae	native	1	0	1 forb	perennial	american alumroot
Hibiscus laevis	Malvaceae	native	7	-2	forb	perennial	halberd-leaf rose-mallow
Hibiscus moscheutos	Malvaceae	native	7	-2	forb	perennial	crimson-eyed rose-mallow
Hyacinthoides non-scripta	Hyacinthaceae	non-native	0	2	forb	perennial	english bluebell
Hydrangea arborescens	Hydrangeaceae	native	1	0	1 shrub	perennial	wild hydrangea
Hypericum kalmianum	Clusiaceae	native	1	0	-1 shrub	perennial	kalms st. johns-wort
Iris ?avescens	Iridaceae	non-native	0	2	forb	perennial	pale yellow iris
Lamium maculatum	Lamiaceae	non-native	0	2	forb	perennial	spotted dead nettle
Liquidambar styraciflua	Hamamelidaceae	non-native	0	-1	tree	perennial	sweet-gum
Liriodendron tulipifera	Magnoliaceae	native	5	1	tree	perennial	tuliptree
Magnolia stellata	Magnoliaceae	non-native	0	2	tree	perennial	star magnolia
Malus baccata	Rosaceae	non-native	0	2	tree	perennial	siberian crab apple
Muscari botryoides	Hyacinthaceae	non-native	0	2	forb	perennial	grape hyacinth
Myosotis sylvatica	Boraginaceae	non-native	0	2	forb	perennial	woodland forget-me-not
Narcissus pseudo-narcissus	Amaryllidaceae	non-native	0	2	forb	perennial	daffodil
Nepeta cataria	Lamiaceae	non-native	0	1	forb	perennial	catnip
Oenothera biennis	Onagraceae	native	0	1	forb	biennial	kings-cureall
Pachysandra terminalis	Buxaceae	non-native	0	2	shrub	perennial	japanese spurge
Panicum capillare	Poaceae	native	0	0	grass	annual	common panic grass
Panicum virgatum	Poaceae	native	3	0	grass	perennial	wand panic grass
Pennisetum alopecuroides	Poaceae	non-native	0	2	grass	perennial	foxtail fountain grass

Penstemon calycosus	Scrophulariaceae	native	5	1	forb	perennial	long-sepal beardtongue
Philadelphus coronarius	Philadelphaceae	non-native	0	2	shrub	perennial	sweet mock orange
Phlox maculata	Polemoniaceae	native	1	0	-1 forb	perennial	wild sweetwilliam
Phlox paniculata	Polemoniaceae	native	1	1	forb	perennial	fall phlox
Phlox pilosa	Polemoniaceae	native	8	1	forb	perennial	downy phlox
Physocarpus opulifolius	Rosaceae	native	5	-1	shrub	perennial	atlantic ninebark
Physostegia virginiana	Lamiaceae	native	4	-1	forb	perennial	obedient-plant
Picea abies	Pinaceae	non-native	0	2	tree	perennial	norway spruce
Platanus occidentalis	Platanaceae	native	5	-1	tree	perennial	american sycamore
Polemonium reptans	Polemoniaceae	native	8	0	forb	perennial	greek-valerian
Populus tremuloides	Salicaceae	native	3	0	tree	perennial	quaking aspen
Quercus bicolor	Fagaceae	native	5	-1	tree	perennial	swamp white oak
Quercus ellipsoidalis	Fagaceae	native	4	2	tree	perennial	hills oak
Quercus lyrata	Fagaceae	non-native	0	-2	tree	perennial	overcup oak
Quercus macrocarpa	Fagaceae	native	5	0	tree	perennial	burr oak
Quercus muhlenbergii	Fagaceae	native	8	1	tree	perennial	chinkapin oak
Quercus rubra	Fagaceae	native	5	1	tree	perennial	northern red oak
Quercus velutina	Fagaceae	native	5	2	tree	perennial	black oak
Rhododendron groenlandicum	Ericaceae	native	1	0	-2 shrub	perennial	rusty labrador-tea
Rubus idaeus ssp. idaeus	Rosaceae	non-native	0	1	shrub	perennial	common red raspberry
Salix fragilis	Salicaceae	non-native	0	2	tree	perennial	crack willow
Salix purpurea	Salicaceae	non-native	0	-1	shrub	perennial	purple willow
Salix x glatfelteri	Salicaceae	native	2	-1	tree	perennial	hybrid black willow
Salvia azurea var. grandiflora	Lamiaceae	non-native	0	2	forb	perennial	blue sage

<i>Sambucus nigra</i> ssp. <i>canadensis</i>	Caprifoliaceae	native	4	-1	shrub	perennial	black elder
<i>Schizachyrium</i> <i>scoparium</i>	Poaceae	native	5	1	grass	perennial	little false bluestem
<i>Scilla non-scripta</i>	Hyacinthaceae	non-native	0	2	forb	perennial	common blue squill
<i>Scilla sibirica</i>	Hyacinthaceae	non-native	0	2	forb	perennial	squill
<i>Sedum acre</i>	Crassulaceae	non-native	0	2	forb	perennial	mossy stonecrop
<i>Silene dioica</i>	Caryophyllaceae	non-native	0	2	forb	perennial	red campion
<i>Spiraea japonica</i>	Rosaceae	non-native	0	2	shrub	perennial	japanese meadowsweet
<i>Spiraea x</i> <i>vanhouttei</i>	Rosaceae	non-native	0	2	shrub	perennial	n/a
<i>Sporobolus</i> <i>heterolepis</i>	Poaceae	native	1	0	1 grass	perennial	prairie dropseed
<i>Stachys aspera</i>	Lamiaceae	native	1	0	-1 forb	perennial	gritty hedge-nettle
<i>Stachys byzantina</i>	Lamiaceae	non-native	0	2	forb	perennial	lambs-ears
<i>Symphoricarpos</i> <i>orbiculatus</i>	Caprifoliaceae	non-native	0	1	shrub	perennial	coral-berry
<i>Symphotrichum</i> <i>boreale</i>	Asteraceae	native	1	0	-2 forb	perennial	boreal american-aster
<i>Symphotrichum</i> <i>oblongifolium</i>	Asteraceae	native	9	2	forb	perennial	oblong-leaf aster
<i>Taxus cuspidata</i>	Taxaceae	non-native	0	2	shrub	perennial	japanese yew
<i>Thuja occidentalis</i>	Cupressaceae	native	1	0	-1 tree	perennial	eastern arborvitae
<i>Tilia americana</i> var. <i>neglecta</i>	Tiliaceae	native	1	1	tree	perennial	roadside linden
<i>Tulipa fosteriana</i>	Liliaceae	non-native	0	2	forb	perennial	emperor tulip
<i>Vaccinium</i> <i>corymbosum</i>	Ericaceae	native	8	-1	shrub	perennial	highbush blueberry
<i>Vernonia baldwinii</i>	Asteraceae	non-native	0	2	forb	perennial	western ironweed
<i>Veronica</i> <i>americana</i>	Scrophulariaceae	native	1	0	-2 forb	perennial	american brooklime
<i>Viburnum</i> <i>dentatum</i>	Caprifoliaceae	non-native	0	0	shrub	perennial	southern arrow-wood
<i>Viburnum nudum</i> var. <i>cassinoides</i>	Caprifoliaceae	native	1	0	-1 shrub	perennial	possumhaw