Sarah E. Goode STEM Academy – Chicago, IL
Methodology for Landscape Performance Benefits

Environmental

1. **Reduces stormwater runoff by 38.9% or 311,683 gallons for a 2-year, 24-hour storm event.**

Stormwater runoff reduction is increasingly mandated through stormwater ordinance and is a significant aspect of sustainable site design. Documentation of the reduction in stormwater run-off for Sarah E. Goode (SEG) Academy is provided by the project's LEED application stormwater modeling by project engineers.

LEED submittal documentation for SS Credit 6.1: Stormwater Design, Quantity Control[1] states that the site reduces runoff by 41,666-CF between pre- and post-development. Pre-development runoff is calculated at 107,162-CF or 802,627.5 gallons, while post-development runoff is 65,496-CF or 489,944 gallons. The runoff calculations represent a reduction from 1.2403 CFS to 0.75805 CFS, or total reduction in runoff by 311,683 gallons. Calculations for runoff reduction rates are provided.

The project achieved LEED credit SS 6.1 primarily through reduction in imperviousness of the site by over 50%. The site implemented a series of water-absorbing features through green roofs, permeable pavements, fields and infiltration gardens. Figure 1.1 diagrams the site's various permeable surfaces and their holding capacities.

The Rainfall Frequency Atlas of the Midwest[2] states that for Chicago's region, a 2-year, 24-hour storm would produce 3.04 inches of rainfall, over the site's 17.3 acres this storm event would produce 1,419,984 gallons of water. The site would infiltrate approximately 930,040 gallons of water post-development compared to 618,357 gallons pre-development. Table 1.1 is a portion of Table 1 from the Rainfall Frequency Atlas of the Midwest.

Stormwater Runoff Calculations for a 2-yr/24-hr Storm Event
Site area = 17.3 acres
1 in rain over 1 acre = 27,000 gallons
3.04 in rain over 1 acre = 27,000 gal x 3.04 in = 82,080 gallons
Total rainfall during a 2-yr / 24-hr storm onsite = 17.3 ac x 82,080 gal = 1,419,984 gallons
1 CF = 7.48502 gallons
Pre-development runoff in gallons = 107,162 CF x 7.48052 = 801,627.5 gallons
Rainfall infiltration onsite pre-development = 1,419,984 gal - 801,627.5 gal = 618,356.5 gallons
Post-development runoff in gallons = 65,496 x 7.48052 = 489,944.1 gallons
Rainfall infiltration onsite post-development = 1,419,984 gal - 489,944.1 gal = 930,039.9 gallons
Runoff decrease in gallons = 801,627.5 - 489,944.1 = 311,683.4
Runoff decrease as percent = 311,683.4 gal / 801,627.5 gal = 38.88%

Pre-development runoff rate = 1.2403 CFS
Pre-development runoff quantity = 1.2403 CFS x (24 x 60 x 60) SEC = 107,162 CF
Post-development runoff rate = 0.75805 CFS

[1] LEED for Schools 2007 Submittal Template SS Credit 6.1: Stormwater Design, Quantity Control, January 2010

[2] Huff, Floyd A. and James R. Angel. Rainfall Frequency Atlas of the Midwest. Midwest Climate Center and Illinois State Water Survey. 1992. http://www.isws.illinois.edu/pubdoc/b/iswsb-71.pdf.

Post-development runoff quantity = 0.75805 CFS x (24 x 60 x 60) SEC = 65,496 CF
Runoff decrease = 107,162 CF - 65,496 CF = 41,666 CF
Runoff decrease as percent = 41,666 CF / 107,162 = 38.88%

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

Sectional code (see figure 1 on page 4)

01 - Northwest	*06 - West Southwest*
02 - Northeast	*07 - East Southeast*
03 - West	*08 - Southwest*
04 - Central	*09 - Southeast*
05 - East	*10 – South*

Rainfall (inches) for given recurrence interval

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*
01	10-day	2.14	2.60	2.97	3.50	4.02	4.37	5.23	6.30	7.14	8.39	9.64	11.09
01	5-day	1.76	2.12	2.38	2.76	3.17	3.45	4.13	5.10	5.91	7.21	8.36	9.97
01	72-hr	1.58	1.90	2.11	2.45	2.82	3.06	3.73	4.67	5.42	6.59	7.64	8.87
01	48-hr	1.47	1.74	1.93	2.24	2.58	2.80	3.42	4.28	4.96	6.07	7.02	8.07
01	24-hr	1.40	1.64	1.80	2.08	2.36	2.57	3.11	3.95	4.63	5.60	6.53	7.36
01	18-hr	1.30	1.52	1.66	1.92	2.18	2.37	2.86	3.63	4.26	5.15	6.01	6.92
01	12-hr	1.23	1.43	1.57	1.81	2.06	2.24	2.71	3.43	4.03	4.88	5.66	6.51
01	6-hr	1.06	1.24	1.37	1.56	1.77	1.93	2.33	2.96	3.48	4.20	4.90	5.69
01	3-hr	0.91	1.06	1.16	1.33	1.52	1.65	1.99	2.53	2.97	3.59	4.18	4.90
01	2-hr	0.84	0.97	1.06	1.23	1.40	1.52	1.83	2.33	2.74	3.31	3.86	4.47
01	1-hr	0.67	0.78	0.86	0.98	1.11	1.21	1.46	1.86	2.18	2.63	3.07	3.51
01	30-min	0.52	0.61	0.68	0.77	0.87	0.95	1.15	1.46	1.71	2.07	2.42	2.77
01	15-min	0.38	0.45	0.50	0.57	0.64	0.70	0.84	1.07	1.25	1.51	1.76	1.99
01	10-min	0.31	0.36	0.40	0.46	0.52	0.57	0.68	0.87	1.02	1.23	1.44	1.62
01	5-min	0.17	0.20	0.22	0.25	0.29	0.31	0.37	0.47	0.56	0.67	0.78	0.89
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

Table 1.1, Selected Portion of Rainfall Data from *Rainfall Frequency Atlas of the Midwest*

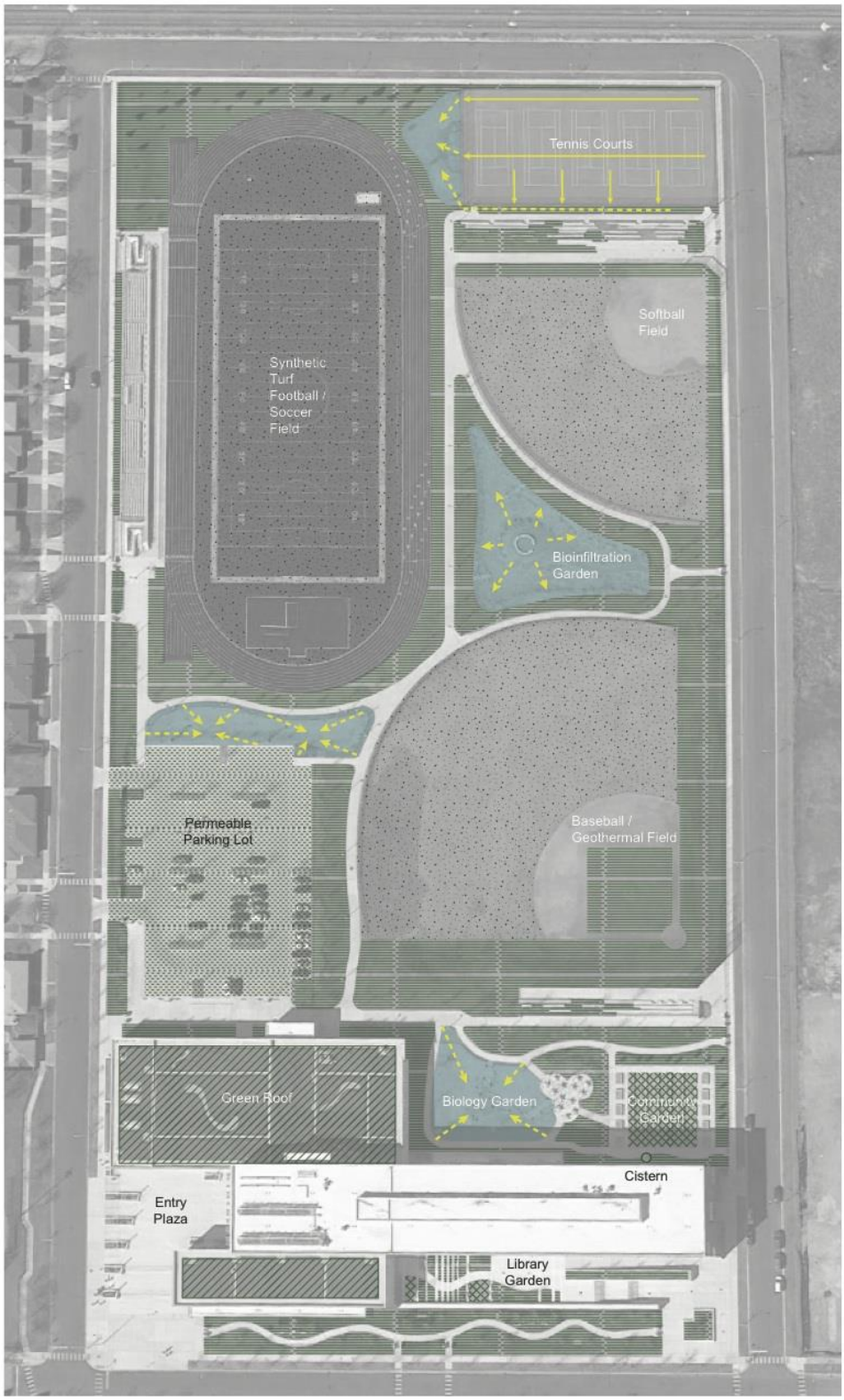


Figure 1.1, Permeable Surfaces at Sarah E. Goode STEM Academy

Limitation of research:
This documentation of reduction is limited to one storm event based on pre-development conditions, and does not account for total reductions in runoff for a variety of storm events.

2. **Captures and treats 100% of stormwater runoff from average annual rainfall, removing an estimated 80% of total suspended solids (TSS).**

The National Oceanic and Atmospheric Administration (NOAA) monitors rainfall at Midway International Airport, which is 4.5 miles from Sarah E. Goode (SEG) Academy. The National Weather Service, a branch of NOAA, lists average rainfall at Midway to be 39.09 inches.[3] LEED submittal documentation for SS Credit 6.2: Stormwater Design, Quality Control[4] states that the site captures and treats 100% or 18,258,939 gallons of average annual rainfall resulting in an 80% reduction in total suspended solids (TSS). This provides a significant water quality benefit such that infiltration of rainwater will recharge the aquifer without these solids. For any overflow, municipal treatment facilities will not have to cleanse these solids as they enter the treatment facility.

Non-structural controls are accounted for in 4 primary areas for the site, predominantly associated with landscape features, the most significant of which are the turf field and ball field. Figure 2.1 delineates the tributary areas, in addition to the Tributary Areas information.

Average Annual Rainfall & Runoff Calculations
Average annual rainfall at Midway International Airport = 39.09 inches
1 in rain over 1 acre = 27,000 gallons
39.09 in rain over 1 acre = 27,000 gal x 39.09 in = 1,055,430 gallons
Average annual rainfall at SEG Academy in gallons = 17.3 acres x 1,055,430 gal = 18,258,939 gallons

Tributary Areas, Rainfall Treatment
Tributary Area 1 : Infiltration Trench, 46,860 sf = 46,860 / 748,274 = 6.3% of annual rainfall treated by this BMP
Tributary Area 2 : Permeable Pavers, 61,453 sf = 61,453 / 748,274 = 8.2% of annual rainfall treated by this BMP
Tributary Area 3 : Turf Field Underdrain System, 262,381 sf = 262,381 / 748,274 = 35% of annual rainfall treated by this BMP
Tributary Area 4 : Ball Field Underdrain System, 377,580 sf = 377,580 / 748,274 = 50.5% of annual rainfall treated by this BMP
Total annual rainfall treated = 50.5 + 35 + 8.2 + 6.3 = 100%

Tributary Areas, Rainfall Treatment in Gallons
Tributary Area 1 area = 46,860 sf / 43,560 sf = 1.08 acres
Tributary Area 1 average annual rainfall treated = 1.08 x 1,055,430 gallons = 1,139,864.4 gallons
Tributary Area 2 area = 61,453 sf / 43,560 sf = 1.41 acres
Tributary Area 2 average annual rainfall treated = 1.41 x 1,055,430 gallons = 1,488,156.3 gallons
Tributary Area 3 area = 262,381 sf / 43,560 sf = 6.02 acres
Tributary Area 3 average annual rainfall treated = 6.02 x 1,055,430 gallons = 6,353,688.6 gallons
Tributary Area 4 area = 377,580 sf / 43,560 sf = 8.67 acres
Tributary Area 4 average annual rainfall treated = 8.67 x 1,055,430 gallons = 9,150,578.1 gallons

[3] NOAA. National Weather Service Weather Forecast Office. *Chicago, IL Midway Airport 3 SW.* http://www.crh.noaa.gov/lot/?n=111577_Midway

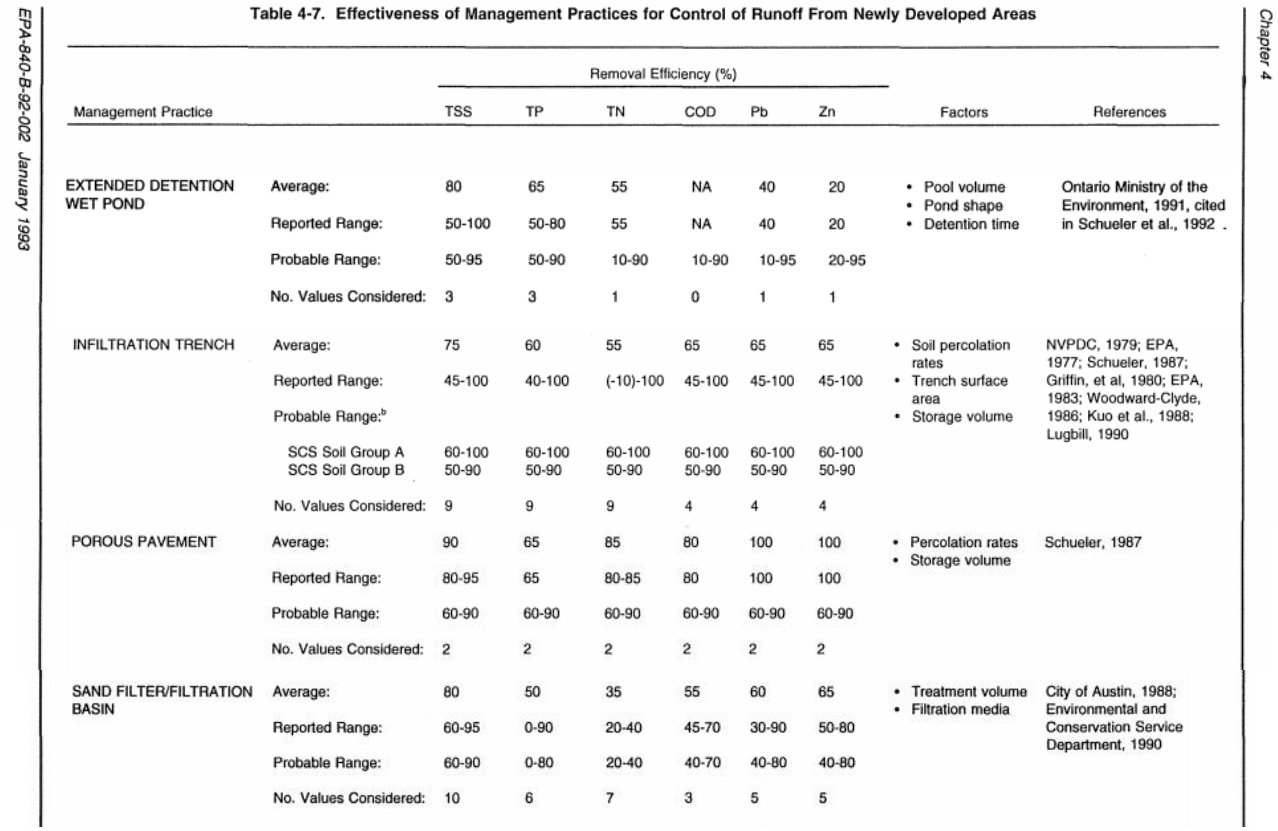
[4] LEED for Schools 2007 Submittal Template SS Credit 6.2: Stormwater Design, Quality Control, January 2010

Tributary Areas, TSS Removal Calculations		*Removal*		*TSS Removal Efficiency*
Tributary Area	*BMP*	*Efficiency (%)*	*Area Ratio*	*for Entire Site*
1 : 46,860 sf	Infiltration Trench	75	0.062624	
0.046968				
2 : 61,453 sf	Permeable Pavers	90	0.082126	
0.073914				
3 : 262,381 sf	Sand Filter / Extended Detention Wet Pond	80	0.350648	
0.280519				
4 : 377,580 sf	Sand Filter / Extended Detention Wet Pond	80	0.504601	
0.403681				
Total: 748,274 sf		**1**		**0.805081**

Total TSS removal as percent = 0.805081 x 100 = 80.5%

The supporting calculations for these percentage values are based on Table 4-7 within the EPA's Guidance Specifying Management Measures for Sources of Non-Point Pollution in Coastal Waters," Chapter 4 "Management Measures for Urban Areas."[5] An applicable portion of Table 4-7 is provided in Figure 2.1.

Stormwater percolates and infiltrates through CA-7 and CA-1 course aggregate and sandy soil sub-layers into the groundwater table located at approximately 8' below surface. Stormwater design to capture the above percentages meets City of Chicago Department of Water Management regulations.



EPA-840-B-92-002 January 1993

Table 4-7. Effectiveness of Management Practices for Control of Runoff From Newly Developed Areas

Chapter 4

Management Practice		Removal Efficiency (%) TSS	TP	TN	COD	Pb	Zn	Factors	References
EXTENDED DETENTION WET POND	Average:	80	65	55	NA	40	20	• Pool volume • Pond shape • Detention time	Ontario Ministry of the Environment, 1991, cited in Schueler et al., 1992
	Reported Range:	50-100	50-80	55	NA	40	20		
	Probable Range:	50-95	50-90	10-90	10-90	10-95	20-95		
	No. Values Considered:	3	3	1	0	1	1		
INFILTRATION TRENCH	Average:	75	60	55	65	65	65	• Soil percolation rates • Trench surface area • Storage volume	NVPDC, 1979; EPA, 1977; Schueler, 1987; Griffin, et al, 1980; EPA, 1983; Woodward-Clyde, 1986; Kuo et al., 1988; Lugbill, 1990
	Reported Range:	45-100	40-100	(-10)-100	45-100	45-100	45-100		
	Probable Range:[b]								
	SCS Soil Group A	60-100	60-100	60-100	60-100	60-100	60-100		
	SCS Soil Group B	50-90	50-90	50-90	50-90	50-90	50-90		
	No. Values Considered:	9	9	9	4	4	4		
POROUS PAVEMENT	Average:	90	65	85	80	100	100	• Percolation rates • Storage volume	Schueler, 1987
	Reported Range:	80-95	65	80-85	80	100	100		
	Probable Range:	60-90	60-90	60-90	60-90	60-90	60-90		
	No. Values Considered:	2	2	2	2	2	2		
SAND FILTER/FILTRATION BASIN	Average:	80	50	35	55	60	65	• Treatment volume • Filtration media	City of Austin, 1988; Environmental and Conservation Service Department, 1990
	Reported Range:	60-95	0-90	20-40	45-70	30-90	50-80		
	Probable Range:	60-90	0-80	20-40	40-70	40-80	40-80		
	No. Values Considered:	10	6	7	3	5	5		

[5] Table 4-7 Effectiveness of Management Practices for Control of Runoff from Newly Developed Areas is located on page 25 of http://water.epa.gov/polwaste/nps/czara/upload/czara_chapter4_urban.pdf

Table 2.1, Portion of Management Practices for Runoff Control from the *EPA*

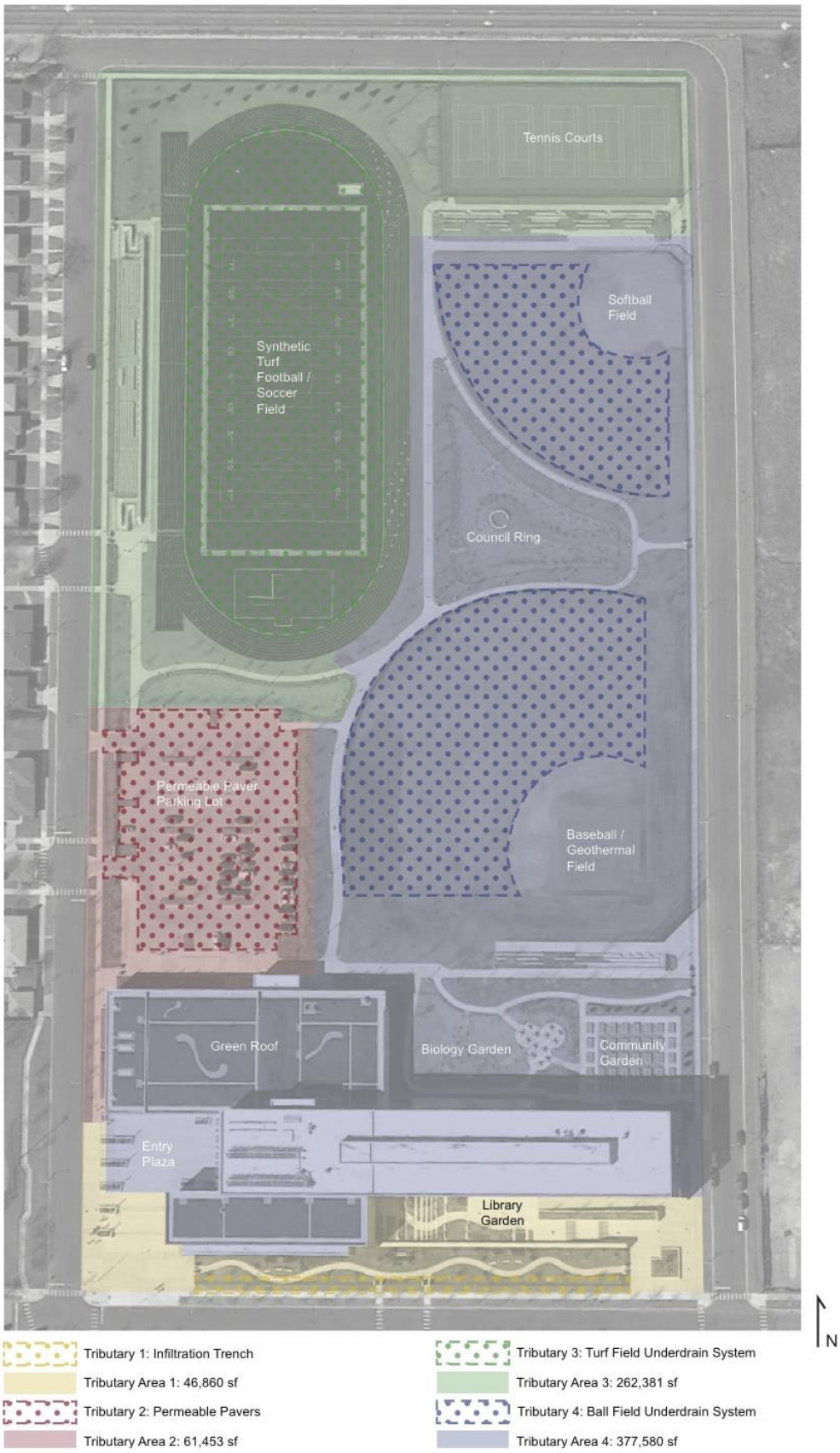


Figure 2.1, Tributary Drainage Map for Sarah E. Goode STEM Academy

3. **Reduces annual irrigation needs by 3.45 million gallons as compared to a landscape of fully irrigated, non-native plants.**

LEED submittal documentation for WE Credits 1.1-1.2: Water Efficient Landscaping[6] states that the site as designed and installed requires no permanent irrigation, and that temporary irrigation for establishment of plants would be removed after one year. Temporary irrigation can be provided through hand watering by connecting to a hose bib on the building or to a quick coupler provided on site.

The landscape is able to achieve drought-tolerance by the use of native and adapted planting, as well as topographic grading that conveys and collects water into the primary infiltration gardens. The landscape architects estimate that if the site were to be fully irrigated, non-native plants would require between 1/2" to 1" of water weekly in the growing season. The Prairie Research Institute at the University of Illinois at Urbana-Champaign estimates Chicago's growing season to last between 170-175 days, or approximately 23-24 weeks.[7] Irrigation would total over 4 millions gallons of water per year.[8] This number is arrived at by using the amount of vegetative open space (calculated from the project's LEED submittal credit SS5.2: Maximize Open Space) and multiplying it by an average amount of water for irrigation, 0.75", and the average growing season of 23.5 weeks. Calculations are shown below.

Potable Water Savings Calculations
Non-native plants irrigation requirement = 0.5" - 1" per week during growing season
Minimum Irrigation requirement = 0.5" of water = 0.325 gallons per sf or 0.5" of water = 13,500 gallons per acre
Maximum Irrigation requirement = 1" of water = 0.65 gallons per sf or 1" of water = 27,000 gallons per acre
Vegetative open space = 316,147 sf / 43,560 sf = 7.26 acres
Chicago growing season = 23 - 24 weeks
Minimum Water Savings = 7.26 acres x 13,500 gallons x 23.5 wks = 2,303,235 gallons per year
Maximum Water Savings = 7.26 acres x 27,000 gallons x 23.5 wks = 4,605,033.78 gallons per year
Average Water Savings = (4,605,033.78 + 2,303,235) / 2 = 3,454,134.39 gallons per year

Limitation of research:
Figures shared are based on calculations for the site as designed; there is no current onsite monitoring of irrigation to confirm these figures.

4. **Increased ecological quality by over 10 times that of the former industrial site based on the Floristic Quality Assessment, a measurement of native biodiversity of plants.**

Previously, the site was used as an industrial food manufacturing facility. Site and foundation pavements remained over 75% of the site, as documented in LEED credit SS6.1.[9] The residual area, approximately 24% of the site, was sparsely vegetated with compacted soils typical of vacant land. While the pre-existing plant species were not officially documented, a photograph of the pre-existing site and the landscape architects' knowledge of prior conditions were utilized to catalog the vegetation. Non-native forbs dominated the site including queen annes lace, chickweed, common purslane, wild chervil, chicory, white clover, and thistle. Horseweed, a native

[6] LEED for Schools 2007 Submittal Template WE Credit 1.1 & 1.2: Water Efficient Landscaping, January 2010
[7] Prairie Research Institute, University of Illinois at Urbana-Champaign. *Illinois State Water Survey. State Climatologist Office for Illinois.* http://www.isws.illinois.edu/atmos/statecli/Frost/growing_season.htm. Accessed 8 July 2014.
[8] Narrative provided by Adam White of Jacobs Ryan, in LEED for Schools 2007 Submittal Template WE Credit 5.1: Water Efficient Landscaping, January 2010

[9] LEED for Schools 2007 Submittal Template SS Credit 6.1: Stormwater Design, Quantity Control, January 2010

forb, was also identified. Additionally, the landscape drawings issued for construction catalog existing trees to be protected or removed. From drawing L2.2, we know that the site contained elm and honey locust trees.

The redeveloped site maximizes use of native plants to promote habitat for a variety of species. To understand the impact of the plant palette in enhancing the ecological impact of the site, the Universal Floristic Quality Assessment (FQA) tool[10] was utilized. The FQA method, as described in *Floristic Quality Assessment for Vegetation in Illinois: A Method for Assessing Vegetation Integrity,* assigns value to species based on their "tolerance to disturbance" and "fidelity to habitat integrity."[11] Wilhelm and Masters, *Floristic Quality Assessment in the Chicago Region and Application Computer Programs,* was also used to understand the methodology.[12] Using the Chicago Region 1994 FQA database, an inventory assessment of the planting conditions pre- and post-development were conducted online.

Ten species were included in the floristic quality assessment for the pre-development conditions; 3 native and 7 non-native. The total mean coefficient of conservatism was 0.5 and the adjusted floristic quality index (FQI) was 9.3. The plant list for Sarah E. Goode Academy contains 144 species, 82 of which were located in the FQA database. Of the 82 species used to calculate the FQA value, 70 or 85.4% classified as native and 12 (14.6%) as non-native. The total mean coefficient of conservatism for the plants was 5.1, while the adjusted FQI was 55.4. The post-development conditions reflect a total mean coefficient of conservatism that is over 10 times higher than pre-development. The complete floristic quality assessment for each condition is provided.

Additionally, the over 90,000-square feet of native and/or adaptive gardens onsite provide ample habitat for animals, birds and insects. By using over 40 different species of native and/or adaptive plants, these gardens can serve as attractions for various wildlife. The most common species these plantings attract include monarch butterflies, various songbirds, and chipmunks. In addition, the green roof includes placed logs to provide habitat for birds. During a site visit on June 11, 2014, the research team sighted killdeer - a mother bird with several chicks were adjacent to the rain gardens and baseball field. Killdeer, unlike other birds, do not feed from within a nest, but lead chicks to feeding areas shortly after they've hatched.

Table 5.1 lists plants used in the gardens onsite that attract wildlife based on the USDA Natural Resources Conservation Service Plants Database.[13] Of the 42 different species planted in the gardens, 23 are wildlife attractors. The USDA Plants Database lists the most common reason prairie plants attract animals is for nectar, seed consumption, and habitat or protection.

Post-development FQA

Conservatism-Based Metrics:
Total Mean C: 0.5
Native Mean C: 1.7
Total FQI: 1.6
Native FQI: 2.9
Adjusted FQI: 9.3
% C value 0: 80%
% C value 1-3: 20%
% C value 4-6: 0%
% C value 7-10: 0%
Native Tree Mean C: 2.5
Native Shrub Mean C: n/a
Native Herbaceous Mean C: 0

Species Richness:
Total Species: 10
Native Species: 3 (30%)
Non-native Species: 7 (70%)

Species Richness:
Mean Wetness: 2.5
Native Mean Wetness: -0.3

Physiognomy Metrics:
Tree: 2 (20%)
Shrub: 0 (0%)
Vine: 0 (0%)
Forb: 8 (80%)
Grass: 0 (0%)
Sedge: 0 (0%)
Rush: 0 (0%)
Fern: 0 (0%)
Bryophyte: 0 (0%)

Duration Metrics:
Annual: 2 (20%)
Perennial: 6 (60%)
Biennial: 2 (20%)

Native Annual: 1 (10%)
Native Perennial: 2 (20%)
Native Biennial: 0 (0%)

[10] Universal Floristic Quality Assessment. http://universalfqa.org/view_inventory/525. 6 August 2014.

[11] Taft, John, Gerould Wilhelm, Douglas Ladd, Linda Masters. *Floristic Quality Assessment for Vegetation in Illinois: A Method for Assessing Vegetation Integrity.* Reprinted with permission from the IL Native Plant Society. http://wwx.inhs.illinois.edu/files/5413/4021/3268/Wilhelm_Illinois_FQA.pdf. Web.

[12] Wilhelm, Gerould and Linda Masters. *Floristic Quality Assessment in the Chicago Region and Application Computer Programs.* June 1995. http://www.conservationresearchinstitute.org/assets/chicagoareafqa.pdf. Web.

[13] USDA Natural Resources Conservation Service Plants Database. http://plants.usda.gov/java/

Post-development FQA

Conservatism-Based Metrics:
Total Mean C: 5.1
Native Mean C: 6
Total FQI: 46.2
Native FQI: 50.2
Adjusted FQI: 55.4
% C value 0: 17.1%
% C value 1-3: 12.2%
% C value 4-6: 30.5%
% C value 7-10: 40.2%
Native Tree Mean C: 5.5
Native Shrub Mean C: 8.3
Native Herbaceous Mean C: 5.9

Species Richness:
Total Species: 82
Native Species: 70 (85.4%)
Non-native Species: 12 (14.6%)

Species Wetness:
Mean Wetness: 1
Native Mean Wetness: 0.4

Physiognomy Metrics:
Tree: 22 (26.8%)
Shrub: 9 (11%)
Vine: 1 (1.2%)
Forb: 37 (45.1%)
Grass: 8 (9.8%)
Sedge: 5 (6.1%)
Rush: 0 (0%)
Fern: 0 (0%)
Bryophyte: 0 (0%)

Duration Metrics:
Annual: 2 (2.4%)
Perennial: 80 (97.6%)
Biennial: 0 (0%)

Native Annual: 2 (2.4%)
Native Perennial: 68 (82.9%)
Native Biennial: 0 (0%)

Conservatism-Based Calculations:[14]

Coefficient of Conservatism values range from 0 - 10

$$MeanC = \overline{C} = \frac{\sum_{i=1}^{n} C_i}{N}$$

$$FQI = \overline{C} * \sqrt{N}$$

$$AdjustedFQI = \overline{C}_{AllSpecies} * \sqrt{N_{AllSpecies}}$$

Pre-development Total Mean C = 0.5
Post-development Total Mean C = 5.1
Increase = 5.1 / 0.5 = 10.2

[14] U.S. Army Corps of Engineers. Public Works Technical Bulletin 200-2-65. *Floristic Quality Assessments.* 1 January 2009. http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_2_65.pdf. Web.

Plant Species (Scientific Name)	Plant Species (Common Name)	Quantity Planted	Attracts Wildlife
Acorus calamus	Sweet Flag	324	Waterfowl, muskrats, wood ducks
Andropogon gerardii 'Red Bull'	Red Bull Big Bluestem	141	Nesting birds & insects, songbirds, prairie chicken, white-tailed deer
Asclepia incarnata	Swamp Milkweed	205	Monarch & Queen butterflies, hummingbirds
Asclepias tuberosa	Butterfly Weed	679	Monarch butterflies, milkweed bugs, milkweed beetle
Aster novae-angliae	New England Aster	1831	Butterflies, moths, bees
Bouteloua curtipendula	Sideoats Grama	1069	Deer
Echinacea palida	Pale Purple Coneflower	598	Harvest mice, deer, hummingbirds, goldfinches, other birds
Echinacea purpurea	Purple Coneflower	1616	Harvest mice, deer, hummingbirds, goldfinches, other birds
Eragrostis spectabilis	Purple Love Grass	577	Deer
Eupatorium maculatum	Joe Pye Weed	737	Butterflies
Glyceria striata	Fowl Manna Grass	205	Deer, muskrats, waterfowl, birds
Helianthus mollis	Downy Sunflower	209	Pollinating insects - bees, butterflies, caterpillars, game & nongame birds including goldfinch, sparrows, larks, cardinal, small rodents including rabbits, and deer
Koeleria cristata	June Grass	158	Deer
Lobelia siphilitica	Blue Lobelia	318	Hummingbirds
Monarda didyma 'Marshall's Delight'	Marshall's Delight Bee Balm	205	Hummingbirds
Monarda fistulosa	Wild Bergamot	461	Hummingbirds
Panicum virgatum 'Shenandoah'	Shenandoah Switch Grass	1387	Rabbits, pheasants, quail, dove, songbirds
Ratibida pinnata	Drooping Coneflower	463	Birds, butterflies
Rudbeckia hirta	Black Eyed Susan	409	Song and game birds
Schizachyrium scoparium	Little Bluestem	5794	Nesting & roosting habitat for birds including finches, sparrows, and junco, small mammals, dusky skipper butterflies and caterpillars
Silphium laciniatum	Compass Plant	210	Songbirds, small mammals
Spartina pectinata	Prairie Cordgrass	463	Game and song birds, small mammals
Zizia aurea	Golden Alexanders	38	Butterflies, bees, short-mouthed insects

Table 4.1, Plant Species Habitat, based off of the USDA Plants Database

5. Diverted over 20,700 tons of materials from landfills by reusing 90% of concrete, asphalt, and aggregate excavated from the site as backfill and recycling other site preparation materials.

A primary sustainability strategy of the project was the demolition and re-use of pre-existing materials from the former food manufacturing facility onsite. Many of these materials were used as backfill to regrade toward the north of the site. Additional materials were re-used to create site topography, including two berms that serve as landform scaffolds for concrete seatwall bleachers. Each of the seating berms is approximately 185-LF and 250-LF and 5-ft in height. As well, a low-lying berm with a minimum of 15-inches in height around the north and northwest boundaries transitions the site to street grade along 75th Street.

A narrative of the waste management plan[15] for site preparation describes the various pre-existing site materials (including building materials) that were recycled and non-recycled, imported recycled and non-recycled items, as well as other local and regional material sourcing. The document lists concrete pavement, base and foundation,

[15] *Waste Management, Recycled Content, and Local/Regional Material Plan*, produced by Hill Mechanical Services, Franklin Park, IL, no date provided

aggregate, and bituminous pavement as the primary materials reused onsite. Concrete removed from future building site was crushed on the larger property, just outside of the project boundary. Asphalt removed from site for crushing returned to be reused throughout the site. Aggregate from an existing location onsite moved to various areas throughout the greater site, including space adjacent to the building and excess was distributed throughout the unused section of the property. Within this methodology, estimates of materials amounts are provided, and final LEED submittal provides documentation of actual amounts recycled onsite. A list of material amounts appears on the next page.

LEED submittal documentation for MR Credit 2.1-2.2: Construction Waste Management Divert 50%/75% From Disposal[16] states that the majority of existing materials were reused onsite. The following list accounts for materials that were reused for site preparation and backfill.

Site Prep Materials Diverted and Reused Onsite

Concrete : removed, crushed onsite & reused for backfill

13,411 tons site prep concrete

Bituminous asphalt : removed, crushed, & brought back to the site for re-use

5,773.68 tons site prep asphalt

Aggregate : relocated within but not removed from site, aggregate re-used for site preparation & excess spread over unused portion of the property

no quantity given

Total Materials Reused Onsite = 19,184.68 tons + *aggregate* (unfortunately this quantity is not known, and therefore left out of the total)

Additional Site Prep Materials Diverted/Recycled

Miscellaneous : general recyclable materials, smaller quantities

Scrap Metals	88.64	
Untreated/Unpainted or Painted Wood		508.13
Drywall	155.81	
Cardboard and Paper	125.13	
Concrete		108.93
Concrete Block	256.98	
Brick	207.72	
Roofing Material		16.30
Site Prep Brick	36.92	
Site Prep Metal	13.33	
Site Prep Wood	27.16	
Site Prep Old Corrugated Cardboard	1.22	

Total Materials Recycled = 1,546.27 tons

Total materials diverted from landfills = 19,184.68 + 1,546.27 = 20,730.95 tons

Note on above list:

Three categories of materials listed here (site prep brick, site prep metal, and site prep wood) were left out of the calculations of reused materials, because despite their moniker, the narratives provided by F.H. Pachen and Hill indicated that these were not included in the reused site materials.

Site Prep Materials for Landfill

Trash : 478.31 tons

[16] LEED for Schools 2007 Submittal Template MR Credit 2.1/2.2: Construction Waste Management, January 2010

Site Prep Trash : 70.27 tons
Total Landfill Materials = 548.58 tons

Percentage of Materials Reused on Site = 21,279.53 / 19,184.68 = 90.15%

Limitations of research:
Pay Applications are available though the Chicago Public Building Commission website,[17] and were evaluated, however they do not provide further detail beyond categorical work for the materials discussed in this performance benefit. Asphalt paving, concrete paving and earthwork are listed as work to be completed on the initial pay application from November 15, 2010. No further detail is provided.

6. **Reduces urban heat island effect by using a green roof and materials with a solar radiation index (SRI) of at least 29 on over 70% of all hardscape and roof surfaces.**

Located in the south side of Chicago, on a former industrial site, the maximized vegetation and temperature reducing strategies at Sarah E. Goode Academy are welcome additions to the Ashburn neighborhood. While residential housing is located south and west of the school property, adjacent to the north and east sit industrial land and a rail yard. An EPA case study of Chicago found that commercial and industrial areas of the city have the lowest percentage of vegetative cover at approximately 10-16%.[18] In addition, 70-80% of Chicago is paved, making heat island effect a valid concern. The school site has been designed to address surface materials that provide cooling through reflectivity and permeability of both roof and non-roofs areas.

The project team, in designing towards achieving LEED credit to promote sustainable solutions, worked to reduce localized temperatures thereby mitigating heat island effect. In order to achieve lower temperatures onsite, reflective paving, shading, permeable pavement, and a green roof were utilized. As documented in LEED submittal credits SS 7.1 and 7.2,[19] sidewalks and the entry plaza, the parking lot and the building roof qualify for heat island reduction strategies. While LEED documentation includes more surfaces within hardscape areas, for the purposes of this research, we isolated key surfaces that help reduce heat island effect.

The City of Chicago within its Urban Heat Island Ordinance from 2009, states that all low-sloped roofs must have a minimum reflectance of 0.72.[20] This value signifies that the roof must reflect 72% or more sunlight and can only absorb 28% of the sunlight received. Reflectance values range from 0 to 1. For the building roof, LEED documentation calculates the reflectance of the light colored reflective roof surface to understand its ability to reflect heat and maintain cooler temperatures. The Sarah E. Goode Academy roof reflectance rate is 0.84, 1.17 times greater than Chicago's minimum standard. If a standard asphalt roof were to be used, the average reflectance of this blacktop surface would be 0.12. The SEG Academy reflective roof is 7 times more reflective than a standard asphalt roof surface.

Roof Surfaces *Reflectance*

[17] Public Building Commission general contractor pay applications for Sarah E. Goode Academy : http://www.pbcchicago.com/content/projects/project_detail.asp?pID=CPS-42

[18] US EPA, *Chicago Area Case Study.* pg. 111. 08 Sept. 2005. http://www.epa.gov/hiri/resources/pdf/post_chicago/chicago_chap4&5.pdf. Web. Accessed 8 July 2014.

[19] LEED for Schools 2007 Submittal Template SS Credit 7.1 & 7.2: Heat Island Effect: Non-Roof & Roof, January 2010

[20] http://adaptationstories.com/2013/09/16/with-new-rooftops-chicago-tries-to-keep-its-cool/

Average asphalt roof	0.12	
SEG Academy Reflective roof	0.84	
Chicago 2009 Minimum Standard	0.72	

SEG Roof = 0.84 / 0.12 = 7 times greater than conventional roof
SEG Roof = 0.84 / 0.72 = 1.17 times greater than Chicago minimum standard

Area of Hardscape Surfaces	*SF*		*Area with SRI of 29 or Greater*
Sidewalks & Plaza		82,391	82,391 sf
Permeable Parking Lot	37,219		37,219 sf
Tennis Courts	30,238		
Rubberized Track		41,486	
Vegetative Roof - Sedum Plantings		32,111	32,111 sf
Reflective Roof	48,529		48,529 sf
Total	**271,974 sf**		**200,250 sf**

Total Area of Heat Island Reduction Strategies = 200,250 sf / 271,974 sf = 73.63%

Please note:

LEED documentation included synthetic turf field in the calculation of hardscape surfaces.

Figure 6.1, Surfaces at Sarah E. Goode STEM Academy

Social

7. Projected to yield nearly 3,500 pounds of food, which has an estimated value of $9,850, through community garden plots.

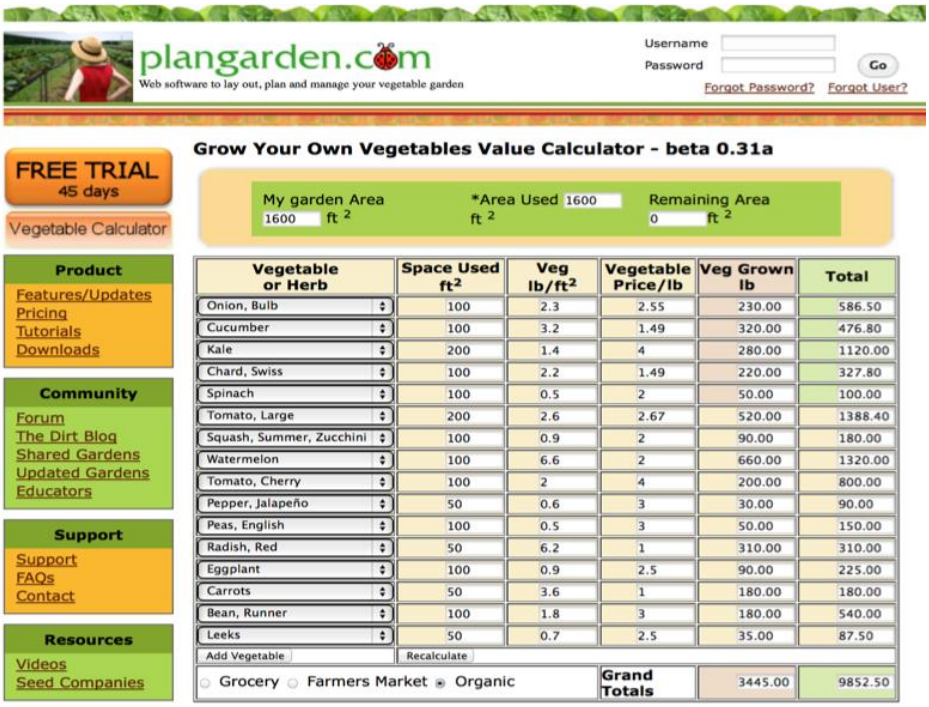
In the context of the global food crisis, growing local food has become a means of empowering local knowledge about food production at a domestic and neighborhood scale. The result is an increase in availability of fresh produce available locally, while lowering its cost and delivering higher-nutritional food into the community. The advocacy and development of gardens within institutional settings for community use has grown in Chicago. Several private, public, and non-profit organizations are developing food education and production programs throughout the City. For example, Growing Power trains at-risk youth in urban agriculture and community food systems, while The Kitchen Community along with the City and CPS have implemented 100 gardens in Chicago Public Schools.[21] Although Sarah Goode Academy has not yet become part of these organizations, future possibilities exist.

In this context, a community garden consisting of 40 raised beds, each 5' x 8', totaling 1,600-sf of growing space was designed for the Sarah E. Goode Academy. These are primarily aimed to provide use for the school and local community. As the school is only two years old, the gardens have not yet been used. We have thus projected the production value of these gardens, once they are in full use.

Using the Vegetable Garden Value Calculator,[22] we selected commonly grown vegetables and alliums in the Chicago area. Utilizing the full 1,600 SF, the calculator estimates 3,445-lb of organic production, estimated at a value of $9,853. The image of the calculations on the following page provides the specific selections made to arrive at this estimated value.

[21] Growing Power. Chicago Farms and Projects, http://www.growingpower.org/chicago_projects.htm. The Kitchen Community, http://thekitchencommunity.org/your-community/chicago/. Chicago Public Schools, http://cps.edu/News/Press_releases/Pages/05_17_2012_PR1.aspx. Chicago Park District, http://www.chicagoparkdistrict.com/facilities/community-gardens/. City of Chicago Press Release, http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2013/december_2013/mayor-emanuel-and-the-kitchen-community-announce-the-installatio.html. 6 July 2014.

[22] Plan Garden, Grow Your Own Vegetables Value Calculator. http://www.plangarden.com/app/vegetable_value/g. Accessed 19 May 2014.



Vegetable or Herb	Space Used ft²	Veg lb/ft²	Vegetable Price/lb	Veg Grown lb	Total
Onion, Bulb	100	2.3	2.55	230.00	586.50
Cucumber	100	3.2	1.49	320.00	476.80
Kale	200	1.4	4	280.00	1120.00
Chard, Swiss	100	2.2	1.49	220.00	327.80
Spinach	100	0.5	2	50.00	100.00
Tomato, Large	200	2.6	2.67	520.00	1388.40
Squash, Summer, Zucchini	100	0.9	2	90.00	180.00
Watermelon	100	6.6	2	660.00	1320.00
Tomato, Cherry	100	2	4	200.00	800.00
Pepper, Jalapeño	50	0.6	3	30.00	90.00
Peas, English	100	0.5	3	50.00	150.00
Radish, Red	50	6.2	1	310.00	310.00
Eggplant	100	0.9	2.5	90.00	225.00
Carrots	50	3.6	1	180.00	180.00
Bean, Runner	100	1.8	3	180.00	540.00
Leeks	50	0.7	2.5	35.00	87.50
			Grand Totals	3445.00	9852.50

Limitation of research:

The school was constructed in 2012 and the community gardens have not yet been utilized. One reason is that users may not realize that they are available for personal cultivation. Conversations with both the landscape architect and civil engineer revealed that an initial plan to partner with the Chicago Botanic Garden for gardening education was discussed but nothing has been implemented at this time. During our site visit, we observed that none of the plots are being utilized. Conversation with a building engineer who was on-site at the time of our visit confirmed that no one has used the plots.

Cost Comparison Methodology

> **A major cost savings to the project involved the reuse of existing materials -- primarily concrete, bituminous asphalt, and aggregate -- as site fill for the new construction. The landscape architect accommodated these materials through special landforms, such as bermed "bleacher" seating adjacent to recreational fields and as noise barriers at the northern edge of the site opposite an adjacent rail yard. The reuse strategy saved an estimated $500,000 in site and landscape construction costs in addition to providing a sustainability benefit by keeping over 20,000 tons of materials out of landfills and eliminating the need to import new materials for site fill.**

We obtained estimated cost savings figure from Darryl Lesny of F. H. Paschen, general contractor for the project, that the project saved an estimated $500,000 by diverting 20,730.95 of a total of 21,279.53 tons of construction debris from the landfill. 90.2% of excavated material was reused onsite, rather than importing all new stone to the project site (as detailed in Performance Benefit #4). 7.2% of this excavated material was recycled. 2.6% of this excavated material was landfilled.

The estimated savings are accounted for as follows:
(Landfill fees + New site fill material costs) - Costs of recycling materials for re-use = Cost savings.
Please note that specific figures were not provided.

Note that recycled materials, and their quantities are taken from LEED MR Credit 2.1/2.2: Construction Waste

Management Divert 50%/75% From Disposal . The Construction Waste Management Plan also provides a description of procedures and strategies.

Please note:
There are additional economic gains for the recycling industry itself, including supporting employment, which are not captured in this benefit, because they are outside of a cost comparison for the project itself.