Eda U. Gerstacker Grove at the University of Michigan
Methods

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Benefits and Methods

Environmental Benefits

- ***Reduces peak stormwater runoff rates by up to 100% for a 2-year, 24-hour storm event and up to 34% for a 100-year, 24-hour storm event.***

Methods
The landscape architect calculated existing and proposed runoff rate reduction using Autodesk's Hydraflow Hydrographs Stormwater modeling software, which uses the SCS TR-20 method. The grading of the path and grass areas directs 65% of the hard surface stormwater runoff to the infiltration garden area, and 30% to underground storage via pipes, compared to its existing condition where 100% of the site drainage was via catch basins and inlets. Pre-construction impervious surfaces were 0.58 acres (0.05 roof, 0.53 pavement) while post-construction impervious surfaces increased to 1.10 acres (0.05 roof, 1.05 pavement) almost doubling the amount of impervious surfaces (Table 1). The capacity of the infiltration gardens and underground detention basin is designed to meet and exceed the University of Michigan National Pollutant Discharge Elimination System (U of M NPDES) post-construction requirements for the 2 year, 24-hour storm channel protection criteria.

Calculations
Table 1: Land use cover type, area, runoff coefficient (C) and runoff curve number (CN) pre- and post-construction (source: STOSS)

Pre-construction Land Use Summary			
Cover Type	**Area (AC)**	**C**	**CN**
Open space (lawn)	3.25	0.35	78
Roof	0.05	0.95	98
Pavement (walks)	0.53	0.95	98
Totals	3.79	0.45	81
Post-construction Land Use Summary			
Cover Type	**Area (AC)**	**C**	**CN**
Open space (lawn)	2.69	0.35	78
Rain garden/Bioretention	0.03	0.2	49
Roof	0.05	0.95	98

Pavement	1.05	0.95	98
Total	3.83	0.53	84

Table 2: Pre- and post-construction runoff volume and peak runoff rate *without* BMPs (source: STOSS)

Existing Runoff Volume	11,637 CF
Existing Peak Runoff Rate	5.105 CFS
Built Runoff Volume	13,915 CF
Built Condition Peak Runoff	6.15 CFS

Table 3: Pre- and post-construction discharge [Infiltration Beds]
(created from Rainfall Frequency Atlas of the United States, David M. Hershfield)

Storm Event	Total Pre-project Discharge	Total Post-project Discharge	Infiltration Beds Adjusted Discharge	% Reduction in Stormwater Runoff
(year/24 hrs)	(cfs)	(cfs)	(cfs)	(%)
1	1.8624	2.2992	0	100
2	2.1728	2.6824	0	***100***
5	2.4832	3.0656	0.3832	84.57
10	2.7936	3.4488	0.7664	72.57
25	3.4144	4.2152	1.5328	55.11
50	3.7248	4.5984	1.916	48.56
100	4.656	5.748	3.0656	**34.16**

Infiltration beds are an important means of managing stormwater from the increased impervious area post-construction. Infiltration beds on the site manage an estimated 2.6824 cfs (for a 2-year, 24 hour storm). To determine the post-construction adjusted discharge rates ("Infiltration Beds Adjusted Discharge"), this number (2.6824 cfs) was subtracted from the unadjusted post-construction rates ("Total Post-project Discharge").

Example of how "% Reduction in Stormwater Runoff" was determined:
100-year storm event
Total Pre-project Discharge (4.656) – [Post-project] Infiltration Beds Adjusted Discharge (3.0656) = 1.5904
1.5904/4.656 = 0.34 = 34% Reduction in Stormwater Runoff

The infiltration gardens are an important means of managing stormwater from the increased impervious area post-construction. According to Stoss, "(the) five elective infiltration gardens will treat approximately 58% of the required volume prior to being treated again in the hydrodynamic separator. One hydrodynamic separator will treat all of the site drainage and be a Contech CDS unit or equal. Unit shall be sized to meet the removal and peak discharge flow criteria as shown on sheet c-107" (Stoss 2015,Item 6, Paragraph 2).

The exact specifications for the underground detention basin were not provided to the CSI research team by Stoss or the University in order to determine how much was being managed in the underground detention basin. Stoss does state that the basin be a Stormtech model 3500 or equal (Stoss 2015, note 3). This model, however, has a number of installation options that could drastically change the total per chamber unit storage capacity (3.11 - 5.38 m3) (Stormtech MC3500 information sheet).

The increased runoff volume and rate resulting from the project for a 2-year, 24-hour storm are 2,278 cf and 1.04 cfs respectively (from Table 2). The underground infiltration/detention basin is designed to infiltrate the volume and reduce the rate to or below existing conditions as required by the U of M NPDES permit. Additionally, the basin has an overflow bypass for larger storms. The infiltration/detention basin then discharges to a 48" storm sewer that drains to the west.

Sources
Stoss Landscape Urbanism (2015) *Stormwater Management Plan Summary Sheet, Drawing Number C-105*

U.S. Department of Commerce, prepared by Hershfield, David M. (1961). Technical Paper No. 40, Rainfall Frequency Atlas of the United States. U.S. Government Printing Office, Washington 25, D.C. Retrieved from
https://www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf

https://www.stormtech.com/download_files/pdf/MC3500_Information_Sheet_06-19.pdf

https://ehs.umich.edu/construction-projects/environmental-considerations/storm-water-management/

Limitations
Limitations of the method include the calculations being done using a model. Actual site conditions may vary.

- ***Improves water quality by removing up to 80% of total suspended solids for a 2-year, 24-hour storm event.***

Methods
The grading of the path and grass areas directs 65% of the hard surface stormwater runoff to the infiltration garden area, and 30% to underground storage via a hydrodynamic swirl concentrator. The hydrodynamic separator is a required BMP and is specified to treat a minimum of 80% of total suspended solids (TSS) for the volume of a 2-year, 24-hour storm. Each of the five infiltration basins is an elective BMP and has an overflow bypass for larger storms (e.g. larger than a 2 year, 24-hour event). Basins are connected to the hydrodynamic separator located under the northwest volleyball court as a required BMP. According to the landscape architect, the infiltration garden and hydrodynamic separator can remove 80% of TSS.

Calculations
Derived from materials provided by Stoss Landscape Urbanism.

Sources
Stoss Landscape Urbanism

Limitations
Limitations of the method include the calculations being done using a model. Actual site conditions may vary.

- **Sequesters an estimated 1 ton of atmospheric carbon annually in 179 newly-planted trees and approximately 1 ton of atmospheric carbon annually in 39 preserved existing trees. The tree canopies intercept an estimated 27,000 gallons of stormwater annually.**

Methods
i-Tree Eco V6 is a software tool that was developed by the U.S. Forest Service to provide forestry analysis and benefits assessment (i-Tree Eco V6). Benefits from the forest level down to the individual tree can be viewed in an easily accessible format. Tree species and DBH of each tree, as well as surrounding land use, was input into i-Tree. Species and DBH were confirmed by the research team through supporting plant schedules and field observations on June 11, 2019.

Results illustrate carbon sequestration in pounds, carbon storage in pounds, and avoided runoff in cubic feet. This process was done in two separate submissions to separate preserved trees from the newly-planted trees. Benefits are expected to increase as the trees mature. These figures demonstrate the value of preserving trees as much as possible through construction, the new plantings contribute to significant future ecosystem services.

Calculations
 i-Tree has a built-in database that provides values for different tree species and sizes. At Gerstacker Grove, there were 39 trees preserved and 179 newly-planted trees, for a total of 218 trees. Annually, these 218 trees sequester 4,000 pounds or 2 tons of carbon.

The current estimate of carbon being stored by the trees is about 137 tons (24.9 tons new/ 112.4 tons existing), which is equivalent to 503 (91.4 new/ 412.2 existing) tons of CO2. The amount of carbon dioxide equivalent is found by multiplying carbon sequestration by the ratio of their atomic weights (44/12) (i-Tree Eco V6).

Newly-planted trees infiltrate about 15,089.5 gallons of water while the existing trees intercept about 11,965.8 gallons. Together the trees on the site intercept over 27,000 gallons of water annually with an estimated avoided runoff value of $248.

1 cu ft = 7.48052 gallons
2,107.17 cu ft + 1,599.6 cu ft = 3706.77 cu ft = 27,055.3 gallons

Avoided runoff is estimated based on local weather from the nearest weather station. The total annual precipitation in 2015 was 27.1 in. The avoided runoff value is calculated based on the price of $0.067 per cubic foot, the value achieved through savings in "gray" stormwater infrastructure (i-Tree Eco V6).

Sources
 i-Tree Eco v6. Accessed June 20, 2019. https://www.itreetools.org/eco/index.php

Limitations
The i-Tree results do not take into account any shrubs or groundcover on the site.

Table 4: Preserved and newly planted vegetation

Preserved Trees				
Species	Name	Caliper (in)		
Acer saccharum	Sugar Maple	2		
Acer saccharum	Sugar Maple	2		
Acer saccharum	Sugar Maple	5		
Acer saccharum	Sugar Maple	8		
Acer saccharum	Sugar Maple	14		
Celtis occidentalis	Common Hackberry	10		
Celtis occidentalis	Common Hackberry	11		
Celtis occidentalis	Common Hackberry	11		
Celtis occidentalis	Common Hackberry	10		

			Height	Count
Gleditsia triacanthos	Honey Locust	20		
Malus ioensis	Prairie Crabapple	11		
Malus ioensis	Prairie Crabapple	8		
Malus ioensis	Prairie Crabapple	10		
Malus ioensis	Prairie Crabapple	10		
Malus ioensis	Prairie Crabapple	7		
Malus ioensis	Prairie Crabapple	8		
Malus ioensis	Prairie Crabapple	10		
Malus ioensis	Prairie Crabapple	13		
Quercus macrocarpa	Bur Oak	16		
Quercus macrocarpa	Bur Oak	13		
Quercus macrocarpa	Bur Oak	12		
Tilia americana	American Linden	10		
Tilia americana	American Linden	12		
Tilia americana	American Linden	10		
Tilia americana	American Linden	12		
Tilia americana	American Linden	15		
Tilia americana	American Linden	14		
Tilia americana	American Linden	15		
Tilia americana	American Linden	13		
Tilia americana	American Linden	13		
Tilia americana	American Linden	13		
Tilia americana	American Linden	14		
Tilia americana	American Linden	14		
Tilia americana	American Linden	13		
Tilia americana	American Linden	12		
		391		
New Trees			Height	Count
Acer rubrum	Red Maple	3		5
Acer saccharum "Autumn Flame"	Sugar Maple	3		4
Acer saccharum "Green Mountain"	Sugar Maple	3		4

Amelanchier arborea	Serviceberry	3		71
Carya cordiformis	Bitternut Hickory	3		1
Carya ovata	Shagbark Hickory	3		1
Fagus grandifolia	American Beech	3		10
Gymnocladus dioicus	Kentucky Coffee Tree	3		2
Juglans cinerea	American Butternut	3		1
Liriodendron tulipifera	Tulip Poplar	3		5
Nyssa sylvatica	Black Gum	3		3
Platanus occidentalis	American Sycamore	3		5
Quercus alba	White Oak	3		3
Quercus acutissima	Sawtooth Oak	3		2
Quercus imbricaria	Shingle Oak	3		2
Quercus macrocarpa	Bur Oak	3		4
Quercus rubra	Red Oak	3		6
Quercus velutina	Black Oak	3		5
Taxodium distichum	Bald Cypress		10-11	44

Social Benefits

- **Accommodates significant foot and bike traffic even outside of the standard school year. An average of over 430 visitors per hour, primarily students, were observed using the space on three weekdays in the summer.**

Methods
A people moving count developed by the Gehl Institute was used to assess site user numbers and activities. A sample of site users was conducted on Thursday June 27th, Monday July 1st, and Monday July 8th during the summer of 2019. The People Moving Count was performed three times by three individuals in three locations within the site for 15 minutes per session. The Count These numbers were then transcribed into a spreadsheet where post-processing analysis was performed.

Calculations

	Roof	Duderstadt	Middle	
	Walking	Walking	Walking	Total of averages
6/27 15 min	45	145	95	
7/1 15 min	41	215	127	
7/8 15 min	47	131	127	
Average	44.3	163.6	116.3	324.3
	Bicycles	Bicycles	Bicycles	Total of averages
	1	2	1	
	1	1	1	
	1	2	1	
Average	1	1.6	1	3.6

Total of averages for all 3 observation locations per 15 minutes (walking) = 324.3 / 3 (average of total) 108.1 (per 15 minute period) x 4 = 432.4 average per hour over the entire site

Total of averages for all 3 observation locations per 15 minutes (bicycles) = 3.6 / 3 (average of total) 1.2 (per 15 minute period) x 4 = 4.8 average per hour over the entire site

432.4 (walking) + 4.8 (bicycles) = **437.2 average per hour**

Sources
CSI research team observations in the field using Gehl Institute observation methods.

Gehl Institute. People Moving Count. https://gehlinstitute.org/tool/people-moving-count/

Limitations
These numbers are taken as a snapshot in a point in time, and as such are an estimate of space use. These observations were done on weekdays in the summer when student foot traffic is minimal and actual use during term-time could vary widely. As the results of an observational method, the counts are subject to human error.

- **Creates a safe environment with to 98% of 52 surveyed users reporting that they feel safe or very safe on-site.**

- **Provides a community and civic/ceremonial space. Of surveyed users, 78% felt it performs well as a civic/ceremonial space and 78% said it performs well at being a neighborhood space for playing, relaxing, and being social.**

Methods
A survey was developed (guided by the Participant Survey Worksheet created by the Gehl Institute) to assess site user behavior and experience and deployed via Qualtrics. A convenience sample of site users were selected via intercept sampling which was conducted on Thursday June 27th, Monday July 1st, and Monday July 8th during the summer of 2019 from 9 am to 5 pm. Respondents completed a digital survey on an iPad to assess their perceptions of the site based on 39 questions (Appendix A), which also included demographic questions. Results from respondents (N=60) were summarized (Qualtrics and SPSS).

Sources
Survey Questions (see Appendix A)

Gehl Institute. Participant Survey Worksheet. https://gehlinstitute.org/tool/participant-survey/

Calculations
The data was collected using Qualtrics online survey platform and analyzed with SPSS.

- 98% of respondents (N=52) feel "safe" or "very safe" in Gerstacker Grove.

- 78% of respondents (N=52) feel that Gerstacker Grove performs well or very well at being a neighborhood space (with space to play, relax, or be social).

Limitations
Due to the timeline of this case study and the necessity of IRB review, the survey was administered in the summer semester. The sample size was limited due to the number of hours the research team could spend in the field. Additional respondents would improve the reliability of the statistical results.

Notable results of the survey regarding ways in which the landscape contributes to the academic and social value of the site are as follows:

- 93% of respondents (N=52) feel strongly positive or somewhat positive about the North Campus at the University of Michigan
- 93% of respondents (N=52) feel strongly positive or somewhat positive about Gerstacker Grove.

- 79% of respondents (N=41) feel that Gerstacker Grove performs as a civic/ceremonial space very well.
- 53% of respondents (N=32) felt proud of Gerstacker Grove
- The top three words to describe Gerstacker Grove are: open (frequency=19), green (frequency=13), and beautiful (frequency=9).

Economic Benefits

- **Saves an estimated 12 labor hours, 13.2 gallons of fuel, and 144 lbs of fertilizer each year resulting in a total estimated savings of $410 as compared to turf within the infiltration beds and no-mow grass areas.**

Methods
A number of sources were used to find the time and cost associated with the maintenance of turf based on industry standards. This cost was broken down to according to the reduction in turf area and cost savings were reverse-engineered from these numbers.

Calculations
- Lawn Mowing
  - Lawn maintenance crew average pay: $44,000 salary ($22/Hour)
  - Area of beds (25,480 sf),
  - 28 weeks of mowing (standard for Ann Arbor, MI)
  - Total time to mow one acre (20 min with 60" bed mower)
  - 17 Minutes saved per week (8 hours a year)
  - Eight hours multiplied by 22 dollars an hour = **$176**
- Fuel
  - 28 weeks of Mowing
  - Total time to mow one acre (20 min with 60" bed mower)
  - 17 Minutes saved per week (8 hours a year)
  - 1 gallon of fuel per hour
  - $3.16 price per gallon for diesel
  - 8 hours of motor running multiplied by $3.16 price of diesel = **$25.28**
- Fertilizer
  - Area of beds (25,480 sqft) removed from the total turf area
  - 36lbs of fertilizer per application (144lbs a year)
  - $40 for 50 lbs multiplied by 144lbs = **$120**
- Other Maintenance
  - Reduction in mower use time
  - Aerating the turf
  - Estimated 4 additional hours added to labor reduction = **$88**

Sources:

https://extension.illinois.edu/lawnfaqs/fertilizing.cfm
https://www.grasshoppermower.com/fuel-calculator/#stage_2
https://www.siteone.com/

Limitations

The University of Michigan Facilities and Operations were not able to provide specific information requested on maintenance. As a result, calculations are based on industry standards and were completed by the research team.

LAF Outdoor Space Evaluation

Consent Letter

Dear outdoor space user:
Your input on this outdoor space is important to research we are conducting. I am a graduate student under the direction of Dr. Mark Lindquist in the School for Environment and Sustainability at The University of Michigan. I invite you to participate in a research study that is being conducted under the auspices of the Landscape Architecture Foundation to understand your perception of this space. You must be 18 years of age or older to participate. Your participation will involve taking a questionnaire that may take about 10 minutes. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time without penalty or loss of benefits to which you are otherwise entitled. If you decided to stop or withdraw from the study, the information/data collected from or about you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed. Your data is confidential and only researchers will have access to data stored on password-protected devices. The results of the research study may be published, buy your name or any identifying information will not be used. In fact, the published results will be presented in summary form only.

The Findings from this project may provide information on how you and others perceive this space. There are no known risks or discomforts associated with this research. At the end of the survey, you will be given the opportunity to be entered into a drawing for a $25 gift card for your participation.

If you have questions about this research project, please feel free to contact me at evgill@umich.edu.

By checking the box below, you are agreeing to participate in the above-described research project.

Thank you for your consideration and for providing your insight on this outdoor space. Please keep this letter for your records.

Sincerely,

Evan Gill and Mark Lindquist

○ Agree and continue

○ Disagree

What is your age?
o   18-24
o   25-34
o   35-44
o   45-54
o   55-64
o   65-74
o   75+

What is the highest level of education you have completed?
o   Less than 9th grade
o   Some High School
o   Completed High School (through grade 12)
o   Some college, no degree
o   Bachelor's or Associate's Degree
o   Graduate or Professional Degree

Do you identify as
o   Male
o   Female
o   Gender nonconforming
o   None of the above
o   Prefer not to say

Do you identify as (one or more boxes)
☐   American Indian or Alaska Native
☐   Asian, including the Indian subcontinent
☐   Black or African American
☐   Hispanic / Latino / Spanish origin
☐   Native Hawaiian or other Pacific Islander
☐   White
☐   None of the above
☐   Prefer not to say

In which country have you spent the majority of your life?

▼ Afghanistan ... Zimbabwe

Are you currently employed?
o   Yes
o   No

What is your job?

_____

Are you currently a student?
o   Yes
o   No

What is the address of your current residence? (This will only be used for determining service area of the plaza)

_____

How often do you visit this place?
o   Daily
o   Weekly
o   Every few months
o   Rarely (once per year or less)
o   First time here

How did you get here today? (Select option traveled for longest distance)
o   Walk
o   Bike
o   Bus
o   Private Car
o   Taxi/Rideshare

o   Other _____

What brings you to this space today? (Main reason)
o   Just passing through
o   School
o   Work
o   Spending time with my family
o   Meeting up with friends
o   Spending time by myself
o   Sightseeing
o   Recreation/Sports/Exercise
o   Walking my pet
o   Cultural event/Performance
o   Political Event/Protest

Are you headed anywhere in particular?
o   Home
o   Work
o   School
o   Cultural institution
o   Restaurant/Bar
o   Store
o   Another public space
o   Other _____

How much time do you plan on spending here today?
o   Less than 10 min.
o   10 min.
o   20 min.
o   30 min.
o   45 min.
o   1 hour or more

End of Block: Frequency and Duration of Visits

Start of Block: Sentiment

What best describes your relationship to Gerstacker Grove? (check all that apply)
☐   Neighbor/Resident
☐   Employee (of nearby institution/business)

- ☐   Student (of nearby school)
- ☐   Tourist Attendee (cultural event or institution)
- ☐   Other. Please describe _____

How do you feel about North Campus at The University of Michigan?

- o   Strongly positive
- o   Somewhat positive
- o   Neutral
- o   Somewhat negative
- o   Strongly negative

How do you feel about this particular public space?

- o   Strongly positive
- o   Somewhat positive
- o   Neutral
- o   Somewhat negative
- o   Strongly negative

What three words would you use to describe this public space?

- o   First _____
- o   Second _____
- o   Third _____

What two things would you like to do in the public spaces of this area that you can't do now?

- o   First _____
- o   Second _____

List some things you wish were here but aren't:

_____

How do you feel this public space performs as a civic/ceremonial space?

- o   Very well
- o   Somewhat well
- o   Neutral
- o   Somewhat poorly
- o   Very poorly
- o   Don't know

How do you feel the public spaces of this area perform as neighborhood spaces? (for example, as places to play, relax, be social)
o   Very well
o   Somewhat well
o   Neutral
o   Somewhat poorly
o   Very poorly
o   Don't know

How would you rate your feelings of safety in this space right now?
o   Very safe
o   Somewhat safe
o   Neutral
o   Somewhat unsafe
o   Very unsafe
o   Don't know

What would make you feel safer in this space?
_____

"I am proud of Gerstacker Grove"
o   Strongly Disagree
o   Disagree
o   Neutral
o   Agree
o   Strongly Agree
o   Don't know

What is your favorite place in Gerstacker Grove?
_____

What is your favorite part of Gerstacker Grove?
_____

End of Block: Sentiment

Start of Block: Seasonality

Do you spend time outdoors in the winter?

o   No, I don't spend much time outdoors in the winter

o   I spend limited time outdoors in the winter

o   Only if the weather is nice

o   Yes, I spend time outdoors in the winter, rain or shine

You spend time outdoors in winter, Where do you go? (select all that apply)

☐   I leave the city

☐   I mostly leave the city, but occasionally go Downtown

☐   I spend time in the city, but rarely/never Downtown

☐   I spend time Downtown

If you spend time outdoors in winter, What do you do? (select all that apply)

☐   I spend time commuting to and from work, school, etc.

☐   I spend time shopping/errands

☐   My occupation requires me to be outdoors

☐   I meet up with friends/family

☐   I sit outside enjoying food and drink

☐   I enjoy my garden/terrace

☐   I walk my pet

☐   I take my children to the playground

☐   I spend time engaging in recreational activities

☐   Other. please describe _____

What would encourage you to spend more time outdoors this winter? (select all that apply)

☐   More shelter from the snow/rain/wind

☐   More seating, protected from snow/rain/wind

☐   Heated outdoor serving areas, food and drinks

☐   More/improved lighting

☐   More activities on sunny days

☐   More activities on snowy/rainy/cold days

☐   More events/activities, such as

_____

☐   Other. Please describe _____

End of Block: Seasonality

Start of Block: Social Mixing

Please take a few moments to look at the people here. Do you recognize anyone you weren't already planning to meet?

o   No, I don't recognize anyone here right now.

o   Yes, I recognize a familiar face, but I don't 'know' them

o   Yes, I recognize someone I know but didn't plan to meet

Did you interact with someone here today who you did NOT come with?

o   Yes, I have interacted with people

o   No

Did you know them before today?

o   Yes, my friend

o   Yes, a friend of a friend

o   No, but I recognized them from somewhere

o   No, I have never seen them before

What brought about your interaction? (select all that apply)

☐   I knew the person

☐   Pets

☐   Children

☐   An activity. Please describe

☐   Volunteering

☐   Sat next to each other

☐   Other. Please describe _____

End of Block: Social Mixing

Start of Block: Green Infrastructure

Do you know, or believe you know, what Green Infrastructure is?

o   Yes

o   Maybe

o   No

End of Block: Green Infrastructure