LANDSCAPE PERFORMANCE SERIES

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Methods Document Final Deliverables:
Virtua Voorhees Hospital
West Virginia University

Research Fellow:
Shan Jiang, PhD, Assistant Professor of Landscape Architecture, West Virginia University

Research Assistant:
Sofija Kaljevic, M.Arch, PhD Candidate in Human and Community Development Program, West Virginia University

Firm Liaisons:
Kirsten Staloch, M.S., AIA Associate, EDAC, LEED Green Associate,
Austin Evert, Landscape Designer,
HGA Architects and Engineers

Participating Firm: HGA Architects and Engineers

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The full case study can be found at:
https://landscapeperformance.org/case-study-briefs/virtua-voorhees-hospital

Figure 1: Virtua Voorhees Hospital Site Plan (HGA Architects and Engineers)

A series of courtyards, green roofs, newly-constructed wetlands, preserved wetlands, and preserved plant buffers compose a network of green infrastructures that efficiently control stormwater runoff on the Virtua Voorhees site (see Figure 2 for the network of green infrastructures). The newly-constructed wetlands serve as buffer zones, receive stormwater runoff from building rooftops, hardscapes and parking lots, and process and filter the water to minimize pollution before entering the preserved wetlands. Figure 3 demonstrates the stormwater flow and wetland connection. In this section, various environmental benefits of wetlands and green roofs are calculated.
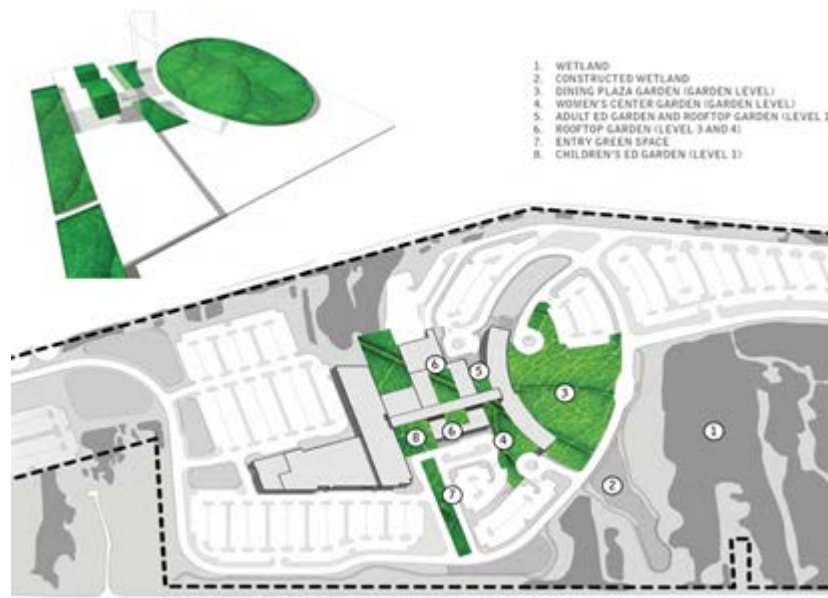

Figure 2: Virtua Voorhees Hospital Green Spaces (HGA Architects and Engineers)

Figure 3: Virtua Voorhees Hospital Stormwater Flow and Wetland Connection (HGA Architects and Engineers)

Environmental Benefits

●   **Retains 98% of stormwater runoff annually, or an estimated 144 million gallons, equivalent to 218 Olympic-sized swimming pools.**

- The site's LID practices reduce annual stormwater runoff by 97% as compared to a conventional scenario. Reduces the site runoff by approximately 77% and reduces the site runoff intensity by 2.4 in/hr for a 50-year storm event, as compared to a conventional scenario.
- The site's LID practices reduce annual runoff by 25.59 inches, reduce days per year with runoff by 54 days, and retain 75 more days of wet days as compared to a conventional scenario. The maximum rainfall retained by the current scenario is 3.7 inches more than a conventional scenario.

Method:

Using EPA's National Stormwater Calculator (1.2.0.0 Beta MSI version), two site development scenarios were estimated. The current scenario is based on the current site design with LID practices, including wetlands, woodlands, street planters and infiltration islands on the parking lot, and green roofs. The conventional scenario is a site design with 70% impervious materials and 30% green spaces, which is the minimal land cover ratios for local regulations. Parameters used for the calculations are listed in the following tables.

Current Scenario - Land Cover

Land Cover		Percentage (%)
Building		5.2
All Paving		26.5
Total Impervious Areas		**31.7**
Wetland/Infiltration Basin		16.6
Forest/Woodland		26
Other landscaped Area	Green Roof	0.3
	Street Planter	3
	Meadow/Lawn	22.4
Total Pervious Areas		**68.3**
Site Total		**100**

As for the parameters entered into the calculator:

Land Cover	Percentage (%)
Forest	26
Meadow	16.6
Lawn	25.7
Desert	0
Impervious	31.7

Current Scenario - LID Controls

LID Practice	What % of your site's impervious area will be treated by the following LID practices? (%)	Capture Ratio of the LID Practice (%)
1. Green Roofs	8.2	N/A
2. Street Planters	16.7	57
3. Infiltration Basins	75.1	70

1. Around 1/2 of the building areas will be treated by the green roofs. Therefore, $0.5*5.2/31.7 = 8.2\%$ of the site's impervious area will be treated by the green roofs.

2. Suppose 20% of the paving areas will be treated by the street planters. Therefore, $0.2*26.5/31.7 = 16.7\%$ of the site's impervious area will be treated by the street planters. Capture Ratio of the Street Planters = Area of the LID/Treated Impervious Areas = $3/(0.2*26.5) = 57\%$

3. The wetlands and infiltration basins will treat 1/2 of the building areas and 80% of the stormwater from the paving areas. Therefore, $(0.5*5.2 + 0.8*26.5)/31.7 = 75.1\%$ of the site's impervious area will be treated. Capture Ratio of the infiltration basins = Area of the LID/Treated Impervious Area = $16.6/(0.5*5.2+0.8*26.5) = 70\%$

Baseline Scenario – Land Cover

Land Cover	Percentage (%)
Total Impervious Areas	70
Total Pervious Areas (Meadow)	30
Site Total	100

Calculation results are illustrated with charts and analyzed as following:

Statistic	Current Scenario	Baseline Scenario
Average Annual Rainfall (inches)	42.97	42.97
Average Annual Runoff (inches)	0.79	26.38
Days per Year With Rainfall	72.62	72.62
Days per Year with Runoff	0.22	54.74
Percent of Wet Days Retained	99.69	24.62
Smallest Rainfall w/ Runoff (inches)	4.05	0.12
Largest Rainfall w/o Runoff (inches)	3.68	0.24
Max. Rainfall Retained (inches)	5.35	1.65

Table 1: Stormwater Performance Comparison between Current Scenario and Baseline Scenario

Reduced amount of annual stormwater runoff in gallons = (Average annual rainfall – Average annual runoff) * Area of the site * Conversions

Therefore,

Reduced annual stormwater runoff in gallons = (42.97 inches – 0.79 inches) * 0.083 in/ft * 126 acres * 43,560 sf/acre * 7.48 liquid gallon/cu.ft. = 143,729,092 gallons

An Olympic-sized pool measures 50 meters long and 25 meters wide, and a minimum of 2 meters deep. Therefore, an Olympic-sized pool holds 660,430 gallons of water. Therefore,

143,729,092 gallons / 660,430 gallons = 217.6 Olympic-size pools
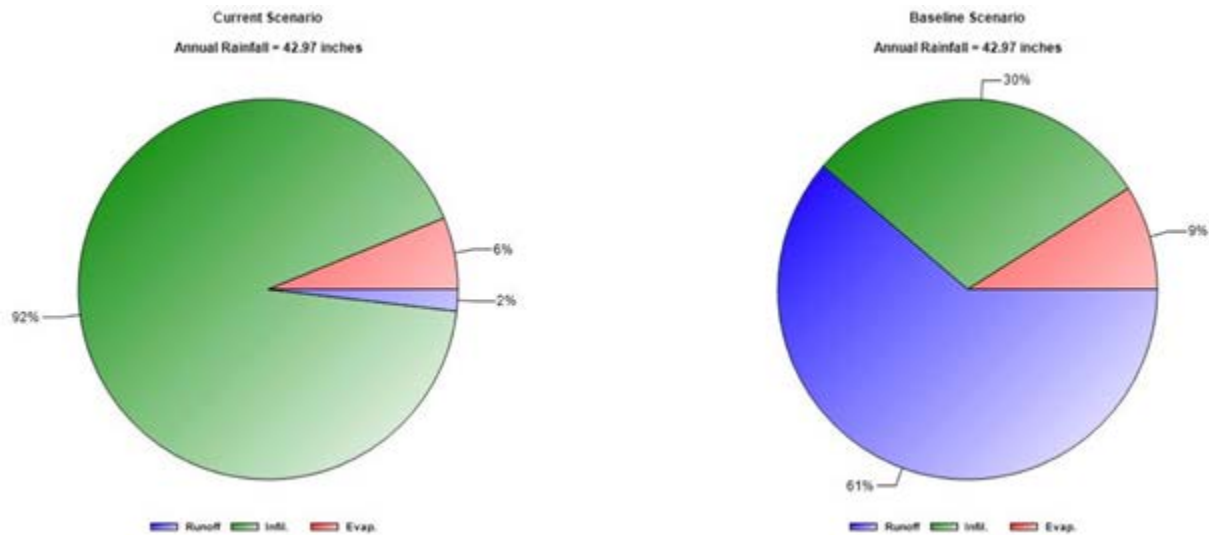

Chart 1: Stormwater Performance Comparison between Current and Baseline Scenario

Managed stormwater runoff annually onsite in the current scenario is: 92% (infiltration) + 6% (evaporation) = 98%

Managed stormwater runoff annually onsite in a conventional scenario is: 30% (infiltration) + 9% (evaporation) = 39%

Reduced stormwater runoff annually compared to a conventional scenario = 98% -39% = 59%
(61% runoff – 2% runoff)/61% runoff = a 97% reduction in runoff
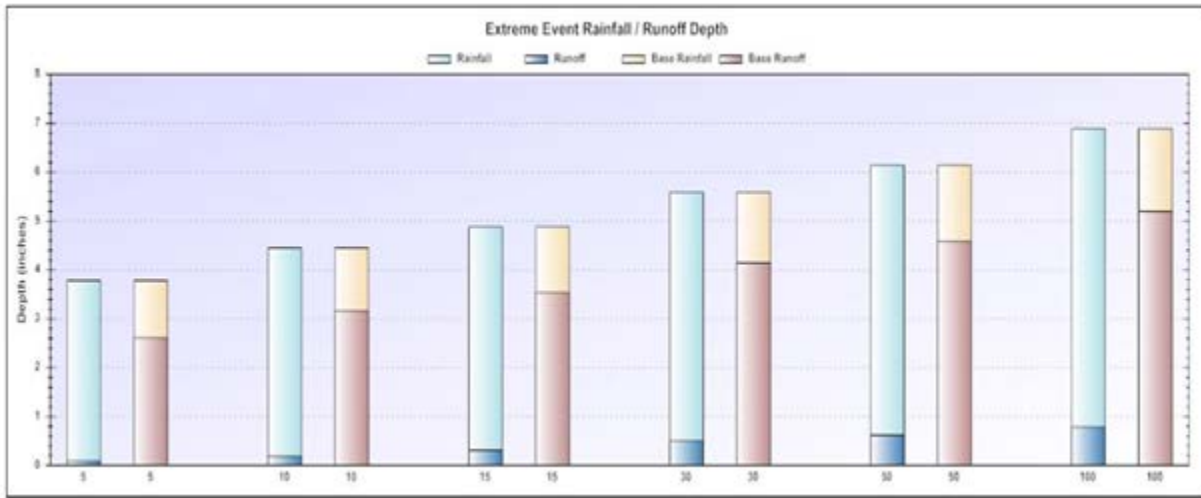
Extreme Events:

Figure 4: Extreme event rainfall / runoff depth comparison between current scenario and baseline scenario

For a 50-year return period, the max daily rainfall depth for both the current scenario and baseline scenario is 6.2 inches. For the current scenario, the stormwater runoff depth is 0.6 inches max per day. For the baseline scenario, the stormwater runoff depth is 4.6 inches max per day. Therefore,

$$(4.6 \text{ inches} - 0.6 \text{ inches})/4.6 \text{ inches} = 87\%$$
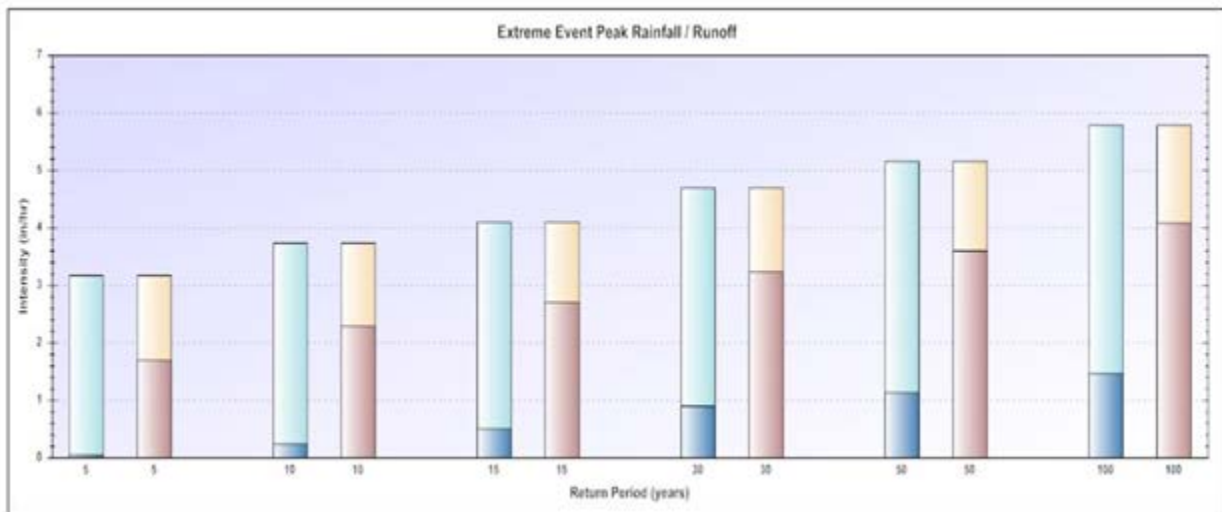

Figure 5: Extreme event rainfall / runoff intensity comparison between current scenario and baseline scenario

For a 50-year return period, the peak runoff intensity is 1.2 in/hr for the current scenario, and 3.6 in/hr for the baseline scenario. Therefore,

$$1.6 \text{ in/hr} - 1.2 \text{ in/hr} = 2.4 \text{ in/hr}$$

Limitations:

To conduct calculations using EPA National Stormwater Calculator, the percentages of types of landcover on the site are necessary. Because of information limitations, the areas of various land covers were traced and measured using AutoCAD based on the construction documents provided by the design firm, hence, human errors were inevitable, which is a limitation to this part of the calculations.

● **Saves 3,270 kWh of energy annually, an average savings of $1,100 in energy costs through the use of a green roof as compared to a conventional dark roof.**

Methods:

Method: Green Roof Energy Calculator by Urban Climate Research Center – Arizona State University was adopted for the calculation. The calculation output is as following:

Annual Energy Savings compared to a Dark Roof (albedo = 0.15)

Electrical Savings:	3267.3 kWh
Gas Savings:	32.1 Therms
Total Energy Cost Savings(1):	$1111.77

Tabel 11: Annual energy savings between a green roof and a conventional dark roof

As specified in the parameters, an Old Office Building in Newark, NJ with a total roof area of 10,259 ft2. The Green Roof specified for this building has a Growing Media Depth of 4 inches, a Leaf Area Index of 1, covers approximately 73% of the total roof area (the rest being a dark roof), and is not irrigated. For reference, the annual whole building electricity consumption for the specified green roof was 550,909 kWh and the annual gas consumption of this green roof was 3,254 Therms.

Green areas of the rooftop are all covered with ground materials/turfgrass. Due to equipment inadequacy, the team was not able to measure LAI directly onsite. As a result, the value 1 was adopted in the calculation for a conservative estimation.

● Improves air quality by taking up between about 2.23 and 3.55 lbs of NO_2 , between about 4.38 and 6.85 lbs of O_3 annually by the green roofs on level 3 and level 4. Additionally, 2.59 lbs direct SO_2 is taken up and 17.3 lbs of emissions are avoided from reduced cooling and heating energy use annually by the calculated green roof areas, and they also take up between about 0.85 and 1.00 lbs of PM-10 on average annually.

Methods:

Air quality benefits calculation of green roofs on level 3 and level 4 were conducted. The following pollutants removed by green roofs were calculated, including NO2, O3, SO2, and PM-10, following the methods and equations suggested by the Center for Neighborhood Technology (2010).

- The sum of areas of practice for Rooftop Gardens no. 6, level 3 and 4 is 7,440 sf.

- The range values of magnitude approximation of annual lbs of pollutant removed per square foot of practice installed:

	Low (lbs/SF)	High (lbs/SF)
NO$_2$	3.00x10^{-4}	4.77x10^{-4}
O$_3$	5.88x10^{-4}	9.20x10^{-4}
SO$_2$	2.29x10^{-4}	4.06x10^{-4}
PM-10	1.14x10^{-4}	1.33x10^{-4}

Table 5: Currie and Bass (2008); and Yang, Qian, and Gong (2008)

Additional info for pollutant removal:

NO2:

Annual Direct NO$_2$ Uptake

Formula:

$$\text{area of practice (sf)} *$$
$$\text{average annual pollutant uptake/disposition (lbs/sf)}$$
$$= \text{total annual air pollutant uptake/ disposition (lbs/sf)}$$

Therefore,

Lower bound: 7440.64 sf * 3.00x10^{-4} lbs/sf = 2.23 lbs total annual NO$_2$ uptake
Upper bound: 7440.64 sf * 4.77x10^{-4} lbs/sf = 3.55 lbs total annual NO$_2$ uptake
Average: 2.89 lbs total annual NO$_2$ uptake

Annual Indirect Reduction in NO$_2$ Emissions

Benefit from kWh of Electricity Saved

- Reduced electricity use of the rooftop garden is 3,267.7 kWh per 7440.64 sf area (as calculated by the Green Roof Energy Calculator.

- Based on the online eGRIDweb application, the US EPA provides the following annual output emission rate of national electricity production for NO$_2$ 1.937 lbs/MWh >> 0.001937 lbs/kWh

Given the reduced electricity use of 3,267.7 kWh, the NO_2 emissions benefits from that reduction are:

Formula:

$$\text{annual electricity reduction (kWh)} *$$
$$\text{emission factor (lbs/ kWh)}$$
$$= \text{annual avoided pollutant emissions (lbs)}$$

Therefore,

3,267.7 kWh * 0.001937 lbs/kWh = 6.33 lbs avoided NO_2 emissions from savings annually

Benefit from Btu of Heating Natural Gas Saved

- Reduced gas use of the rooftop garden is 32.1 Therms, therefore 3,209,234 Btu per 7440.64 sf area

- Based on the online eGRIDweb application, the US EPA provides the following annual output emission factor Btu of natural gas input for NO_2 0.721 lbs/Million Btu

Formula:

$$\text{annual heating natural gas savings (Million Btu)} *$$
$$\text{emission factor (lbs/Million Btu)}$$
$$= \text{annual avoided criteria pollutant emissions (lbs)}$$

Therefore,

3.209234 Million Btu * 0.721 lbs NO_2 / Million Btu = 2.31 lbs avoided NO_2 emissions from heating natural gas savings annually

Total Benefit from Electricity and Heating Natural Gas Savings

Formula:

$$\text{annual avoided pollutant emissions from reduced electricity (lbs)} +$$
$$\text{annual avoided criteria pollutant emissions from reduced heating natural gas (lbs)}$$
$$= \text{total avoided criteria pollutant emissions from electricity and heating natural gas savings annually}$$

Therefore,

6.33 lbs avoided NO_2 + 2.31 lbs avoided NO_2 = 8.64 lbs avoided NO_2 emissions from reduced cooling and heating energy use annually

Total annual NO_2 Benefit

Formula:

annual direct NO2 uptake +
annual indirect reduction in NO2 emissions
= Total annual NO2 Benefit

Therefore,

2.89 lbs + 8.64 lbs = 8.25 lbs NO_2 annual benefits

O3:

Annual Direct O_3 Uptake

Formula:

area of practice (sf) *
average annual pollutant uptake/disposition (lbs/sf)
= total annual air pollutant uptake/ disposition (lbs/ sf)

Therefore,

Lower bound: 7440.64 sf * 5.88×10^{-4} lbs/ sf = 4.38 lbs total annual O_3 uptake
Upper bound: 7440.64 sf * 9.20×10^{-4} lbs/ sf = 6.85 lbs total annual O_3 uptake

SO2:

Annual Direct SO_2 Uptake

Formula:

area of practice (sf) *
average annual pollutant uptake/disposition (lbs/sf)
= total annual air pollutant uptake/ disposition (lbs/sf)

Therefore,

Lower bound: 7440.64 sf * 2.29×10^{-4} lbs/ sf = 2.16 lbs total annual SO_2 uptake
Upper bound: 7440.64 sf * 4.06×10^{-4} lbs/ sf = 3.02 lbs total annual SO_2 uptake

Benefit from kWh of Electricity Saved

- Reduced electricity use of the rooftop garden is 1,960.7 kWh per 7440.64 sf area

- Based on the online eGRIDweb application, the US EPA provides the following annual output
emission rate of national electricity production for SO_2 5.259 lbs/MWh >> 0.005295 lbs/kWh
Given the reduced electricity use of 3267.3 kWh, the SO_2 emissions benefits from that reduction are:

Formula:

$$\text{annual electricity reduction (kWh)} * \text{emission factor (lbs/ kWh)}$$
$$= \text{annual avoided pollutant emissions (lbs)}$$

Therefore,

3267.3 kWh * 0.005295 lbs/kWh = 17.3 lbs avoided SO_2 emissions from savings annually

Benefit from Btu of Heating Natural Gas Saved

- Reduced gas use of the rooftop garden is 32.1 Therms, therefore 3,209,234 Btu per 7440.64 sf area

- Based on online eGRIDweb application, the US EPA provides following annual output emission factor Btu of natural gas input for SO_2 0.266 lbs/Million Btu

Formula:

$$\text{annual heating natural gas savings (Million Btu)} *$$
$$\text{emission factor (lbs/Million Btu)}$$
$$= \text{annual avoided criteria pollutant emissions (lbs)}$$

Therefore,

3.209234 Million Btu * 0.266 lbs NO_2 / Million Btu = 0.85 lbs avoided SO_2 emissions from heating natural gas savings annually

Total Benefit from Electricity and Heating Natural Gas Savings

Formula:

$$\text{annual avoided pollutant emissions from reduced electricity (lbs)} +$$
$$\text{annual avoided criteria pollutant emissions from reduced heating natural gas (lbs)}$$
$$= \text{total avoided criteria pollutant emissions from electricity and heating natural gas savings annually}$$

Therefore,

17.3 lbs avoided SO2 + 0.85 lbs avoided SO2 = 18.15 lbs avoided SO2 emissions from reduced cooling and heating energy use annually

Total annual SO_2 Benefit (Direct Uptake + Indirect Reduction Emissions)

Formula:

$$\text{annual direct SO2 uptake} +$$
$$\text{annual indirect reduction in SO2 emissions}$$
$$= \text{total annual SO2 Benefit}$$

2.59 lbs + 18.15 lbs = 20.74 lbs SO_2

PM-10:

Annual Direct PM-10 Uptake

Formula:

$$\text{area of practice (sf)} *$$
$$\text{average annual pollutant uptake/disposition (lbs/ sf)}$$
$$= \text{total annual air pollutant uptake/ disposition (lbs/ sf)}$$

Lower bound: 7440.64 sf * 1.14×10^{-4} lbs/ sf = 0.85 lbs total annual PM-10 uptake
Upper bound: 7440.64 sf * 1.33×10^{-4} lbs/ sf = 1.00 lbs total annual PM-10 uptake

The 7440.64 sf green roofs on average take up between about 0.85 and 1.00 lbs of PM-10, an average of 0.93 lbs annually.

Limitations:

Although some of the benefits are not significant, the calculation methods are meaningful resources that could guide future studies. Air quality benefits were estimated in a conservative manner because of insufficient information and a lack of up-to-date parameters for above calculations.

Social Benefits

● **Creates positive attitudes about the aesthetics and quality of the campus landscape design and maintenance in 100% of interviewed staff members. Increases staff satisfaction and sense of pride about their work environment according to 80% of interviewed staff members.**

Methods:

2 focus group interviews were conducted on-site to explore usage of the garden spaces as well as user perceptions and attitudes. In total 10 user representatives attended the studies. Demographic information of the participants is described in Table 10. The focus groups were structured according to a list of predetermined questions, as shown in the Appendix.

Age Group	Number
18-29 years old	1
30-49 years old	4
50-64 years old	4
Above 65 years old	1

Gender	Number
Female	5
Male	5

Professional Background	Number
Maintenance	5
Medical Administration	2
Nurse	3

Table 10: Demographic information of focus group participants at Virtua Voorhees Hospital

Through content analysis of the focus group transcript, a total of 314 codes were identified that fall into 4 types of topics, including (1) general descriptive topics, (2) overall usage preference and attitude, (3) user behaviors and activities, and (4) domains of garden restorativeness and design features. Each topic covers several sub-topics. Details and frequencies of discussion are listed in Table 11 and Diagram 4.

Topic Type	Sub-Topic	Number of Codes	Frequency of Discussion	Frequency of Discussion Sum
General Descriptive	Site and Location	36	11%	11%
	Users	39	12%	12%
Overall Usage Preference and Attitude	Positive Perception/Attitude	26	8%	14%
	Negative Perception/Attitude	19	6%	
User Behaviors and Activities	Existing Behaviors/Activities	12	4%	8%
	Desired Behaviors/Activities	12	4%	
Domains of Garden Restorativeness and Design Features	Access and Visibility	43	14%	55%
	Nature Engagement	31	10%	
	Path and Paving	8	3%	
	Places to Rest	14	5%	
	Sense of "Being Away"	1	0%	
	Aesthetics and Maintenance	40	13%	

Other Desired Features	18	6%
Sustainable Design	15	4%

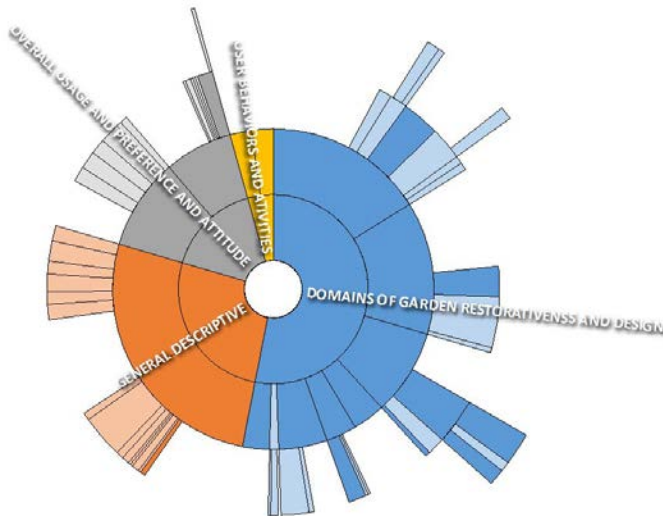Table 11: Focus Group Transcript Content Analysis Results

Diagram 4: Visual distribution of focus group interviews sub-themes

The most prevailing theme throughout both focus group interviews was the visual accessibility of the campus' green spaces from various indoor areas. It correlates with the results presented in Table 11, where the code subtopic "Access and Visibility" covered altogether 43 codes (14% of all codes), among which the "visual access" theme included 27 codes. Participants commented:

> "Yeah I always look at all those gardens; it's more of seeing from inside and less go out and sit outside. I see it's not very functional... Maybe we could put more chairs there I agree. Since it's more about visually pleasing, looking at them from the inside… "

For hospital staff, the 360-degree-views the new hospital building offers from its interior are much more beneficial than physical use of the various green spaces outside. This is completely understandable considering that employees usually have only one 30-minute lunch break per day, and the use of outdoor space is limited by season and weather conditions. When combined with the data collected through behavioral observation of the Dining Garden, on average, the hospital staff members spend around 12 minutes altogether in the Dining Garden during the lunch period during days with good weather. Therefore, visual access to nature through windows has the most efficient restorative benefits for medical care providers and hospital staff. One of the participants also stated:

> "I just love being able to see it, you know. It doesn't matter, it is not my office. I am hustling out of my office and I can see the outside all the time. So, I think...when you feel good you are always more productive and do a good job."

And a female nurse confirmed the benefits of viewing nature from the building interiors:

"It makes you feel calm...and if you can just look out there sometimes, especially if is the stressful kind of message getting delivered. You see pretty flowers, or the fall foliage... it is just kind of like: We can do this!"

Sub-topic "Aesthetics and Maintenance" covered altogether 40 codes (13% of all codes) from which the "aesthetic and beauty" theme included altogether 19 different codes. Furthermore, the sub-topic "Nature Engagement" covered altogether 31 codes (10% of all codes), almost exclusively correlating with visual engagement with surrounding nature and rarely physical engagement with the landscape. Although all of the participants have visited green spaces at least once, they are generally more familiar with and affected by the specific garden "views" from the inside than with the garden experience itself. Sentences like "I do not get out of the building very often, and I don't just walk around it a lot," or "I am cooped up in my office, and I do not go outside anywhere" are the most often-repeated responses provided by the hospital employees, maintenance staff excluded. That could be the sole reason why the major aesthetic experiences explained are created by looking out through the hospital windows:

"Typically radiology is in the basement and, so for me, to be able to look out the window and see all of this is... it's very beautiful, you know what I mean. I love to look at, I love with the change of the seasons, and when it snows, when, you know, just... It is very you know, like it has very therapeutic effect to me."

As presented, the most often-repeated theme that represents the visual experience of the adjacent landscape is the change of the seasons. It is mentioned 14 times during the interviews. Usually the gardens that are not extensively physically used, like rooftop gardens or Pediatric Garden where the movement of staff and visitors is limited for various reasons, are tied to the most rich and memorable visual experiences throughout different weather seasons. The fall, due to its rich colors, and the winter, because of the snow and the holiday seasons, are extensively described through the interviews and are the most impressive scenes from landscape to recall:

"And then, during holiday time the staff go out and decorate, put the lights up. So when you are walking down that spine you see lit up Christmas trees in that area. And as A pointed out, it becomes a conversation amongst lots of people. And you can then see it from the other levels too."

The Dining Garden is the most-used green space on the campus. It is situated close to the main employee entrance and is directly connected to main hospital entrance, the women's and children's entrance, and the employee and visitor parking lots. Internally, it has a direct connection to the interior dining area, cafeteria and café. This unique location as a traffic hub means a higher level of daily usage by all kinds of users. Data collected through behavioral observations showed that during the morning period (10am-11am) the garden is generally utilized as a main employee entrance, with around 35 people coming into the hospital per hour. During lunch time (11:45am-12:45pm), the area is exclusively used for dining, with a total of around 50 users that spent an average of 12 minutes in the garden individually or as a group. And later in the afternoon (4:00pm-5:00pm), the dining garden is mostly used as an exit for employees, with 81 employees counted in one hour leaving the hospital through this garden. Additionally, hospital

staff agreed through interviews that the Dining Garden area is usually the most used garden space by employees:

> "I used to love sitting outside, like during lunches and things like that, during the nice weather... Just to be able to get a feel for the outside. Cause, we are cooped up inside all day. So I did love that area right out there." (gestures to the garden outside)

> "Beautiful, really nice to walk through there to come through the employee entrance every day and the flowers, the waterfall...but I don't get out a lot and it is really coming in to drive around here, it is gorgeous, it makes you happy to come in."

This Dining Garden, and almost all other garden spaces, are rarely used by patients of the hospital. For the Angel's Garden and the Dining Garden, there were multiple entrances designed to the garden space; however, most of them are locked or only open for a limited time period, which becomes a significant barrier for visitors and family members to enter the spaces. The main reasons are directly tied to hospital safety rules. As a lesson learned from the case study, communications with hospital safety administrators and simulation studies of user behaviors at early phase of design may help resolve such conflicts.

- **Provides a significant level of restorativeness for hospital patients and staff, achieving a GATE rating of 8.1 for the Angel's Garden, 8.8 for the Dining Garden, and 7.8 for the Pediatric Garden, based on a 1-10 scale.**

- **Improves visual and physical access to nature from building interiors, achieving a GATE rating of 8.0 for the Angel's Garden and 8.3 for the Dining Garden. Improves users' engagement with natural features, achieving a GATE rating of 9.6 for Angel's Garden, and 9.4 for the Dining Garden, based on a 1-10 scale.**

- **Creates a sense of "being away" as reflected by high GATE ratings in "places to rest," achieving a rating of 9.9 for the Dining Garden, based on a 1-10 scale.**

<u>Methods:</u>

3 landscape areas were evaluated using the Garden Assessment Tool for Evaluators (GATE) (Sachs, Cooper Marcus & Barnes, 2016), including (1) Angel's Garden, (2) Dining Garden, and (3) Pediatric Therapy Garden. Two evaluators conducted the evaluations onsite. There are 5 domains that measure the level of restorativeness of a given space, including (1) Access and Visibility, (2) Sense of "Being Away", (3) Nature Engagement, (4) Walking and Activities, and (5) Places to Rest.

2 evaluators conducted evaluations on-site using an individual scale for each of the mentioned gardens. Mean scores for each domain were calculated. Background information for the evaluation activities, as well as evaluators, is shown in Table 6. Within each domain there are sub-domains that cover multiple design variables. Scoring details of the sub-domains are demonstrated in the following tables. The overall restorativeness score for each of the areas was calculated as indicated by the "Actual GATE Score".

Name of Facility and Location	Type of Facility or Patients Served	Evaluated Gardens in the Facility	Evaluation Date	Weather
Virtua Voorhees Hospital, Voorhees, NJ	General Acute Care, Inpatient, Mother and Baby	(1) Angel's Garden (2) Dining Garden (3) Pediatric Therapy Garden	06/28-06/29/2017	Sunny

Name of Garden	Location and Type of Garden	Evaluator	Role of Evaluator	Evaluation Time	Temperature(F)
(1) Angel's Garden	Central Courtyard	A	Researcher	10:20 AM	77
		B	Architect and PhD Student	2:15 PM	84
(2) Dining Garden	Front Entry Garden	A	Researcher	5:45 PM	78
		B	Architect and PhD Student	5:30 PM	79
(3) Pediatric Therapy Garden	By Children's ED Entrance	A	Researcher	11:10 AM	79
		B	Architect and PhD Student	2:55 PM	84

Table 6: Site Background and Evaluator Information

Complete evaluation scores using Garden Assessment Tool for Evaluators (GATE) toolkit for all garden areas are listed below.

Angel's Garden:

The Angel's Garden is the central courtyard at the Women and Children's and Health Administration sections. This garden offers many opportunities for nature engagement for users through its plantings (scores 9.4 on a 1-10 scale) and water feature (scores 9.8 on a 1-10 scale).

Through site observation and focus group discussion, this garden was found to be mostly used for viewing from the interiors and upper stories. Angel's Wall, a memorial waterfall that commemorates deceased pediatric patients, adds an atmosphere of solemnity to the garden and makes the space more appropriate for viewing and meditation.

There were multiple entrances originally designed to connect surrounding units to the garden; however, because of security considerations, some doors are locked so the garden is only accessible from the outside, near the Women and Children's entrance, which has become a barrier for use of the garden. Communication between the designer and the hospital security administrator at early phase of design may have helped resolve the conflict between the design, user behaviors, and security regulations.

Garden Assessment Tool for Evaluators (GATE) Results

Virtua Voorhees Hospital, Voorhees NJ – Angel's Garden
Total Max: 344   Total Actual: 278.5   Percentile: 81%
Intuitive Restorativeness Score: 9
Actual GATE score (converted to a 1-10 scale): 8.1

Domain 1		Max Total	Mean Score	Percentile	Sum	Percentile
Access & Visibility	Visual Access to the Garden	36	29	81%	57.5	80%
	Physical Access to the Garden	36	28.5	79%		

Domain 2		Max Total	Mean Score	Percentile	Sum	Percentile
Sense of "Being Away"	Sense of "Being Away"	20	15	75%	39.5	82%
	Aesthetics & Maintenance	28	24.5	87.5%		

Domain 3		Max Total	Mean Score	Percentile	Sum	Percentile
Nature Engagement	Plantings	40	37.5	94%	65	96%
	Other Natural Features (e.g., water features)	28	27.5	98%		

Domain 4		Max Total	Mean Score	Percentile	Sum	Percentile
Walking & Activities	Primary Walkway (Path or Paved Thoroughfare)	24	21.5	90%	57.5	76%
	All Paved Areas	16	15.5	97%		
	Lighting, Wayfinding, & Amenities	20	9.5	47.5%		
	Variety & Activities	16	11	69%		

Domain 5		Max Total	Mean Score	Percentile	Sum	Percentile
Places to Rest	Seating Availability & Type	20	20	100%	59	74%
	Private or Social	20	19	95%		
	Aesthetics & Sun	20	19	95%		
	Tables	20	1	5%		

Table 7: GATE Score of Angel's Garden at Virtua Voorhees Hospital, Voorhees NJ

Garden Assessment Tool for Evaluators (GATE) Results

Virtua Voorhees Hospital, Voorhees NJ – Dinning Garden
Total Max: 344   Total Actual: 304   Percentile: 88%
Intuitive Restorativeness Score: 9.5
Actual GATE score (converted to a 1-10 scale): 8.8

Domain 1		Max Total	Mean Score	Percentile	Sum	Percentile
Access & Visibility	Visual Access to the Garden	36	27.5	76%	60	83%
	Physical Access to the Garden	36	32.5	90%		

Domain 2		Max Total	Mean Score	Percentile	Sum	Percentile
Sense of "Being Away"	Sense of "Being Away"	20	14	70%	38	79%
	Aesthetics & Maintenance	28	24	86%		

Domain 3		Max Total	Mean Score	Percentile	Sum	Percentile
Nature Engagement	Plantings	40	37.5	94%	64	94%
	Other Natural Features (e.g., water features)	28	26.5	95%		

Domain 4		Max Total	Mean Score	Percentile	Sum	Percentile
Walking & Activities	Primary Walkway (Path or Paved Thoroughfare)	24	22	92%	63	83%
	All Paved Areas	16	15.5	97%		
	Lighting, Wayfinding, & Amenities	20	15	75%		
	Variety & Activities	16	10.5	66%		

Domain 5		Max Total	Mean Score	Percentile	Sum	Percentile
Places to Rest	Seating Availability & Type	20	20	100%	79	99%
	Private or Social	20	20	100%		
	Aesthetics & Sun	20	19.5	97.5%		
	Tables	20	19.5	97.5%		

Table 8: GATE Score of Dining Garden at Virtua Voorhees Hospital, Voorhees NJ

Garden Assessment Tool for Evaluators (GATE) Results

Virtua Voorhees Hospital – Pediatric Garden
Total Max: 344   Total Actual: 268   Percentile: 78%
Intuitive Restorativeness Score: 6.5
Actual GATE score (converted to a 1-10 scale): 7.8

Domain 1		Max Total	Mean Score	Percentile	Sum	Percentile
Access & Visibility	Visual Access to the Garden	36	28.5	79%	56	78%
	Physical Access to the Garden	36	27.5	76%		

Domain 2		Max Total	Mean Score	Percentile	Sum	Percentile
Sense of "Being Away"	Sense of "Being Away"	20	15	75%	39	81.5%
	Aesthetics & Maintenance	28	24	86%		

Domain 3		Max Total	Mean Score	Percentile	Sum	Percentile
Nature Engagement	Plantings	40	36	90%	40	59%
	Other Natural Features (e.g., water features)	28	4	14%		

Domain 4		Max Total	Mean Score	Percentile	Sum	Percentile
Walking & Activities	Primary Walkway (Path or Paved Thoroughfare)	24	21	87.5%	63	83%
	All Paved Areas	16	15.5	97%		
	Lighting, Wayfinding, & Amenities	20	15.5	77.5%		
	Variety & Activities	16	11	69%		

Domain 5		Max Total	Mean Score	Percentile	Sum	Percentile
Places to Rest	Seating Availability & Type	20	15	75%	70	87.5%
	Private or Social	20	18.5	92.5%		
	Aesthetics & Sun	20	17.5	87.5%		
	Tables	20	19	95%		

Table 9: GATE Score of Pediatric Therapy Garden at Virtua Voorhees Hospital, Voorhees NJ

Dining Garden:

The dining garden is located at the building front that connects the main hospital entrance, Women and Children's entrance, employee entrance, and visitor and staff parking lots. Because of the superb location, the dining garden is the most frequently used garden space by all user types and serves as a transition hub. According to the GATE evaluation and site observation, the dining garden improves users' visual and physical access to nature (scores 8.3 on a 1-10 scale) Various types of seating with tables and shade structure make the dining garden a good place to rest (scores 9.9 on a 1-10 scale). Users are able to choose a pocket space in this garden for private usage, or arrange the landscape furniture at open spaces for a group event, which provides a strong sense of control (scores 10 on a 1-10 scale) and a sense of "being away" (scores 7 on a 1-10 scale). The dining garden also provides various opportunities for users to engage with plantings (scores 9.4 on a 1-10 scale) and water features (scores 9.5 on a 1-10 scale) for restorative purposes.

Investigators also conducted onsite observations at the Dining Garden area during 3 periods in a day and mapped users' behaviors to demonstrate the usage pattern of the site. Onsite observations of users' behaviors and activities in the dining garden were conducted during 3 periods on June 29, 2017. Users' behaviors were mapped and demonstrated by Diagram 1-3.
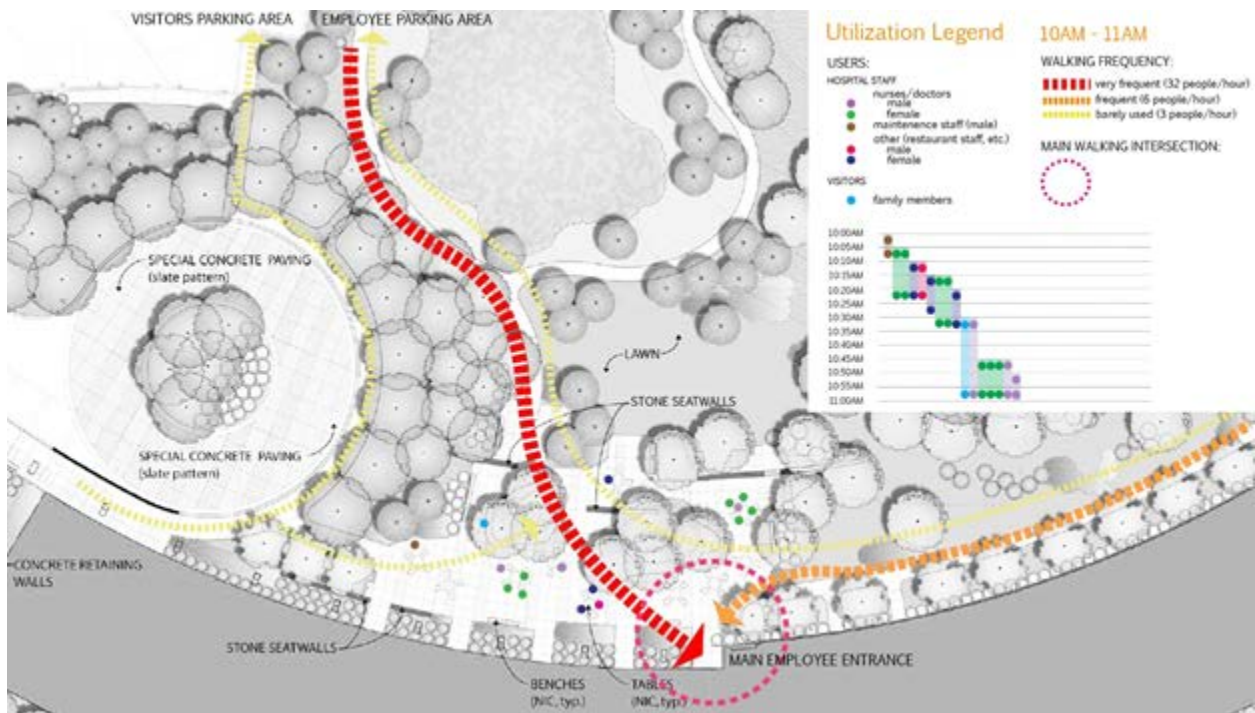

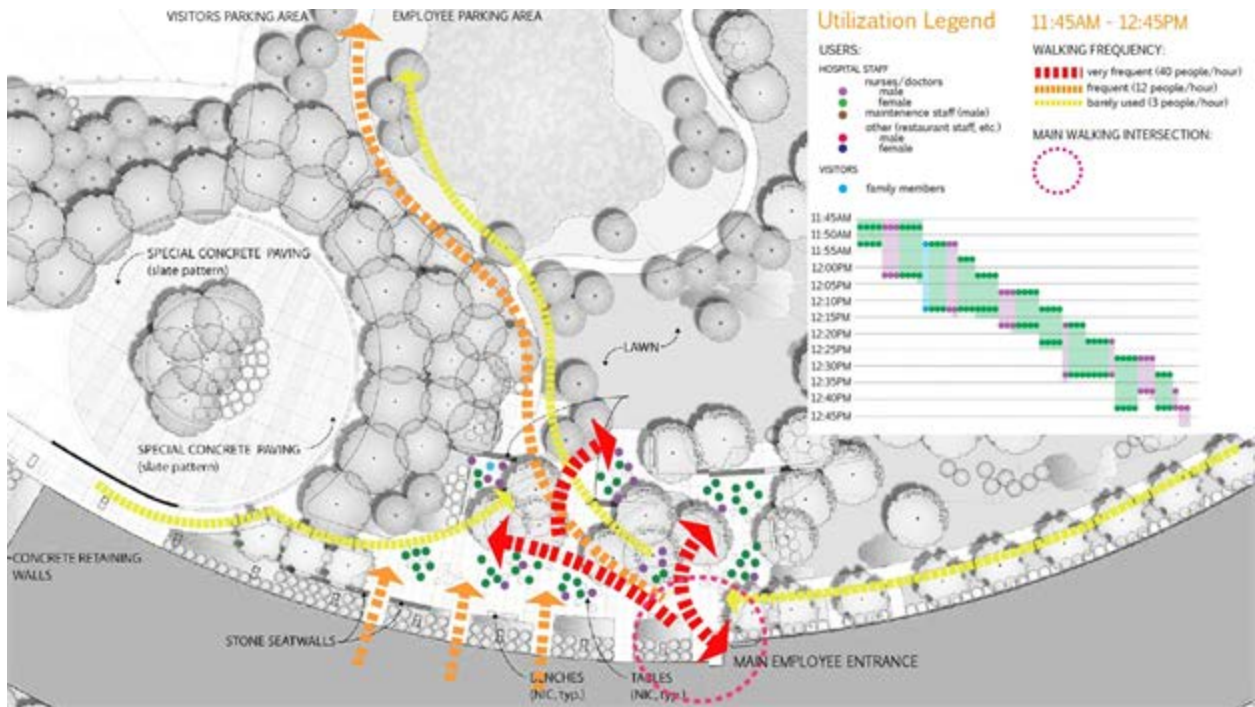Diagram 1: Dining Garden user behavior maps 10:00AM-11:00AM

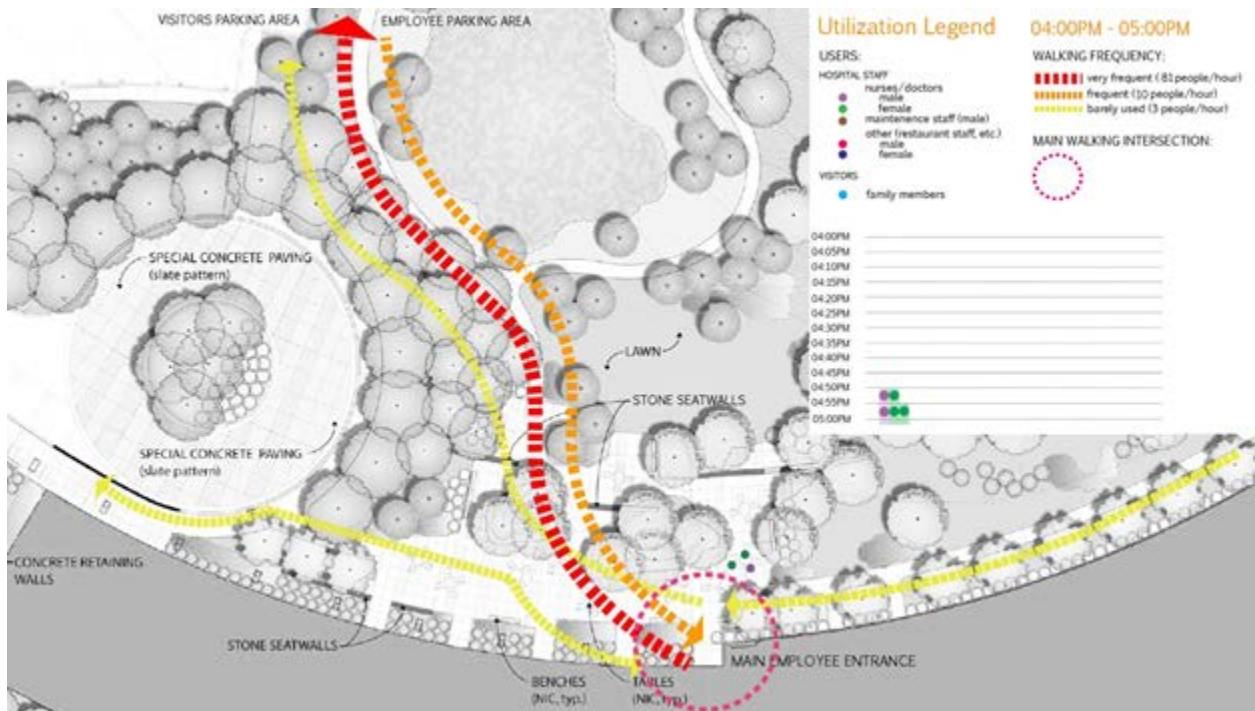Diagram 2: Dining Garden user behavior maps 11:45AM-12:45AM

Diagram 3: Dining Garden user behavior maps 4:00PM-5:00PM

Pediatric Therapy Garden:

The pediatric therapy garden is located near the entrance of Children's Emergency Department. It is a well-designed, well-maintained garden space, achieving high scores on major GATE domains. However, through onsite observation and focus group discussion the investigators found that the garden is the least-used outdoor space on campus. The major contributor to the low usage is location. The garden is not located in a traffic hub area, and the surrounding units are the emergency department and outpatient specialties; therefore, it is not visible or accessible to inpatients and regular visitors.

Limitations:

Because of time limitations, the onsite observations were conducted during 3 periods, 3 hours total in one day. Structured site observations in repeated days that span across all seasons would increase the accuracy of the study.

Additional Information – Economic

● **Created approximately 2,366 jobs associated with entire project construction during the 2008 Great Recession in the United States, making it a top ranking capital project in New Jersey at that time.**

Methods:

The Regional Industrial Multiplier System II (RIMS II) economic input-output model was developed by the Bureau of Economic Analysis (BEA) to estimate the number of jobs associated with the project construction and, more specifically, the site and landscape construction.

Construction is a final good, so final demand for the site construction equals the actual construction cost for this portion. The Employment Multiplier is the number of jobs created per million dollars of real final demand. Using New Jersey as the final demand region, the multiplier is 7.9 (BEA RIMS II multiplier). Multipliers are based on the 2007 Benchmark Input-Output Table for the Nation and 2015 regional data.

Construction cost for the whole project of Virtua Voorhees Hospital was $336,982,818 (in 2011 dollars). As reported by Bureau of Labor Statistics, the Consumer Price Indexes for 2007 is 2.8, for 2011 was 3.15 (Bureau of Labor Statistics Data).

Equation:

$$\text{Total employment} = \text{construction cost as final demand} \div 1{,}000{,}000 \times \text{CPI2007/CPI2011} \times \text{employment multiplier}$$

Therefore,

Total number of jobs associated with the project construction = 336,982,818 /1,000,000 * 2.8/3.15 * 7.9 = 2,366

<u>Limitations:</u>

Using the bill-of-goods method is the best approach for estimating impacts because RIMS II multipliers for the construction industry are based on national averages across a wide variety of construction projects. Type I multipliers were employed in the calculation for a conservative estimation because of a lack of detailed information. The estimation is for both the building and the site construction. Knowing the cost for the site and landscape construction would make a more relevant estimation.

Appendix
Virtua Voorhees Hospital Focus Group Interview Predetermined Questions
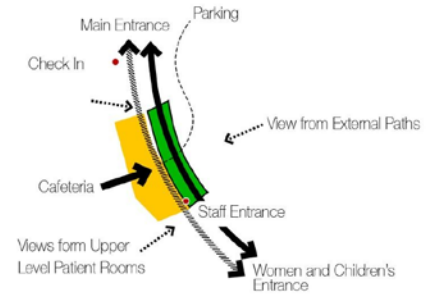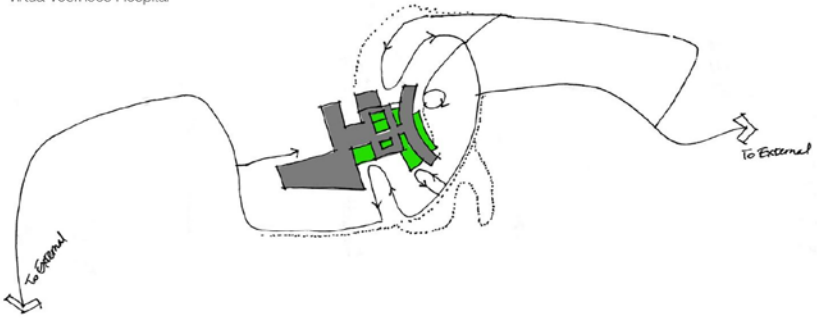
Part 1: Demographic Information

1. What is your age?
2. What is your gender?
3. What is your role/professional background (nurse, medical officer, etc.)?
4. How many years of experience have you had in this current job?
5. How many years have you worked in this health facility?

Part 2: Usage of General Green Spaces of the Hospital

1. Which part of the green spaces on campus and what specific gardens/courtyards do you use the most during staying in the facility, and how do you use them?
2. What are the feelings or emotional status when and after you use the green spaces, try to use some adjectives to describe the feelings?
3. Regarding visibility and accessibility aspects, how do you perceive the green spaces from major indoor areas such as major corridors, waiting areas, dining areas, and patient wards?
4. How do you usually interact with design features in the green spaces, including planting, seats, paving, water feature, sculpture, etc., and have you found any facilitators/barriers to the use of the space?
5. For hospital employee: how do you think the having various green spaces on campus could impact your work performance and satisfaction about the physical environments of your workplace.
6. For family members and hospital visitors: how do you think having various green spaces on campus could impact your satisfaction about the hospitalization environment?
7. Do you have any additional comments about the green spaces on campus?

Compared to other facilities we studied, the Dining Garden at Virtua Voorhees Hospital is very successful as far as location selection. The garden is located at the building's front with a direct connection to two main entrances (Hospital Main Entrance and Women and Children's Entrance) and a staff entrance. This garden is strategically connected with the trail system and is walkable to the visitor and staff parking lot. In addition, the garden is internally adjacent to the cafeteria, coffee shop, and close to the gift shop, which makes this garden a traffic hub. Because of its superb location, this garden is a lively place that attracts a wide range of consistent users everyday.

Virtua Voorhees Hospital

To External

To External

Parking

Main Entrance

Check In

View from External Paths

Cafeteria

Staff Entrance

Views form Upper
Level Patient Rooms

Women and Children's
Entrance

Traffic Hub

Diagram 9: Virtua Voorhees Hospital Dining Garden Location Analysis