LANDSCAPE ARCHITECTURE FOUNDATION

U.S. Coast Guard Headquarters at St. Elizabeth's Methods Document

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Overview of Research Team Strategy

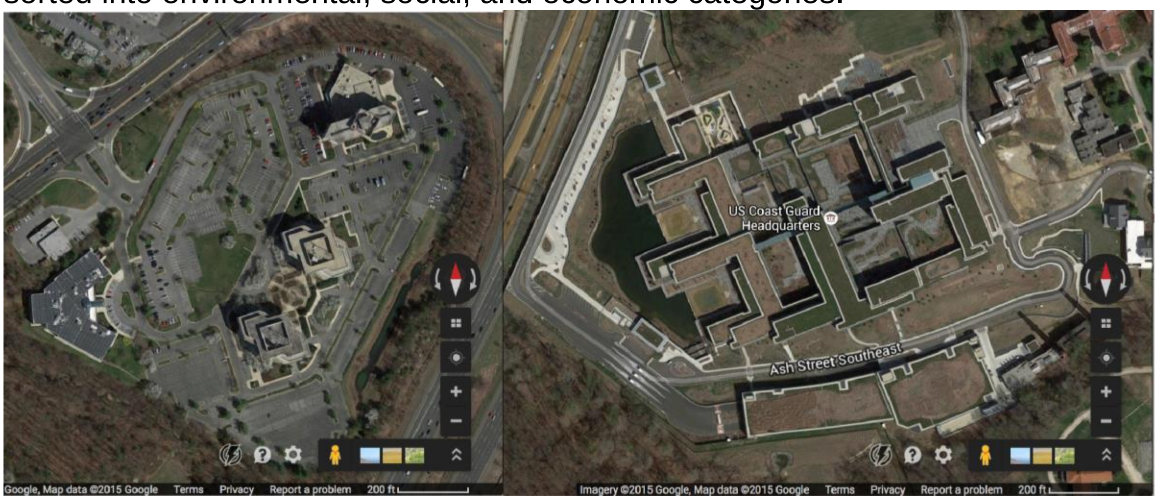
Documenting landscape performance brings together a broad range of scientific methods, recognition of the multifunctional nature of land management, and the goals of sustainable development. Landscape performance examines the effects that designed landscapes have on abiotic, biotic and cultural systems by comparison against studied baselines or established norms. The strength of landscape performance lies in the use of systematic, rigorous and quantifiable methods. Methods include basic statistics, modeling, monitoring, post-occupancy evaluation and a range of other qualitative and quantitative methods that fit identified performance categories. Performance categories differ based on the nature of the project, the biogeographic region and the local social and environmental circumstances. These factors in combination result in unique blends of characteristics for any designed site. For this reason it is important to first identify the appropriate performance categories for a given landscape, and then choose corresponding methods to measure and evaluate the performance in each identified category.

The U.S. Coast Guard headquarters is a 1.2 million square foot office complex with a flat roof, a parking garage, courtyards for social activities and natural light access for the building, walkways and stormwater management facilities. A standard approach to designing a facility such as this is to build a high-rise office building and surround it with an adequate amount of parking. Some consequences associated with the standard approach are an increase in stormwater runoff, high contributions to urban heat island effect, and minimal outdoor space for social gathering. In addition, landscape vegetation goals at standard office complexes are typically to provide shade in the parking lots, to present a tidy garden style entryway, and to fit the standard “mow and blow” approach to landscape maintenance. These goals result in low diversity of vegetated habitat, suboptimal carbon sequestration, and energy consumptive maintenance routines.

The U.S. Coast Guard headquarters design follows a different approach. The building is designed with a low profile, blending into its context more so than most buildings of its size. The roof tops are almost exclusively green roofs, including the parking garage. The planting design in the courtyards emphasizes the use of native plants in a diverse habitat style of aesthetic rather than a more formally structured arrangement. A low percentage of the site is impervious, and where runoff does occur, it is quickly moved into rain gardens designed to infiltrate water back into the ground. A 2.4 acre retention pond at the base of the facility provides water as a resource for irrigation when needed for the green roofs and courtyards.

These design choices affect a number of important measures of sustainability, including: stormwater runoff volume, water conservation, biodiversity, wildlife habitat, carbon sequestration, urban heat island, social interaction, and landscape operational costs. These performance categories were studied in detail at the U.S. Coast Guard headquarters over the past year. The results of the analyses are presented below.

For convenience, some analyses included a comparison with a traditional office park of similar size in the same region (see figure 1) to determine performance against a standard practice or norm. The comparison site was located at 4061 Powder Mill Road in Calverton, Maryland. In addition, a number of direct observations were made on the Coast Guard headquarters site, using the necessary equipment for dependable data results. Finally, a number of professional reports, award applications and construction documents were reviewed to find and quantify the landscape benefits described below. These are sorted into environmental, social, and economic categories.



Left: Traditional Office Site   Right: Coast Guard headquarters

Figure 1 - Comparison of a traditional office complex design and the U.S. Coast Guard headquarters (source: Google Maps)

LANDSCAPE PERFORMANCE BENEFITS

ENVIRONMENTAL BENEFITS

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1. Retains up to 424,000 gallons of rainwater on the green roofs, which is equal to the 95th percentile storm event (1.7 in).

Green Roof Storage Methods

The scope of this landscape performance study consists of the area of the U.S. Coast Guard Headquarters, which accounts for 400,000 square feet or 95% of the total site green roof. The green roof area for U.S. Coast Guard Headquarters was provided by Andropogon Associates, Ltd. To calculate the stormwater retention on the green roof within the study area for the 95^{th} Percentile storm, the following information and calculations were used:

95^{th} Percentile Storm = 1.7 (in) = 0.142 (ft)
Green Roof Area = 400,000 (sf)
Media Depth = 4.25 (in) = 0.35 (ft)
Void Space = 40 percent = 0.40

Stormwater volume for 95th percentile storm = 95th percentile storm depth (ft) x Green Roof Area (sf)
Stormwater volume for 95th percentile storm = 0.142 (ft) x 400000 (sf)
Stormwater volume for 95th percentile storm = 56,666.67 (cf)

Stormwater Retention Volume = Green roof Area (sf) x media depth (ft) x 0.4 percent void space
Stormwater Retention Volume = 400,000 (sf) x (4.25 inches/12 inches per foot) X 0.4
Stormwater Retention Volume = 400000 (sf) x 0.35 (ft) x 0.4
Stormwater Retention Volume = 56,666.67 (cf)

Percent of 95th percentile storm retained = 56,666.67 (cf)/56,666.67 (cf) = 100 percent

Note: Rain depth (1.7 in) is 40 percent of media depth (4.25 in) which explains why the stormwater volume and the retention volume are exactly the same.

Storage volume conversion: 56,666.67 (cf) = 423,896.13 gals

Green Roof Storage Findings

Based on the calculations above, the green roof on the U.S. Coast Guard headquarters retains 423,896 gallons (100 percent) of stormwater during the 95th percentile storm event.

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2. Intercepts 234,000 gallons of rainwater annually in the 985 trees. When the trees reach maturity, they will intercept 766,000 gallons of stormwater annually.

Canopy Interception Methods

To quantify the stormwater benefits of trees, the species and quantities of trees planted on the site were extracted from the construction documents and entered into MS Excel. Construction documents indicated that canopy trees were planted with 3" diameter at breast height (DBH) and conifer/understory trees were planted with a height of 8-10'. The i-Tree Benefits Calculator was used to calculate the benefits from each tree (Brookshire & Luo, 2010).

The calculator requires a zip code tree location, diameter at breast height measurement, and a common name species. The calculator then determines annual stormwater intercepted based on these factors. The zip code for the Saint Elizabeth's Coast Guard Headquarters is 20593. For conifer/understory trees, the height of 8-10' was assumed to be 1" DBH. The model uses only common names, so species were matched as closely as possible. The value of stormwater intercepted annually for each tree was also calculated with future DBH estimates of 3" for conifer/understory and 10" for canopy trees. This is meant to be a future condition if the trees are properly cared for. Annual stormwater interception was determined for each tree species, multiplied by the quantity of each tree species, and then summed to get the total annual stormwater interception for the site. A limitation of this method is that some tree species were not available on i-Tree and had to be substituted with the most similar species available. Depending on the substitution, the stormwater interception may be slightly under or over-estimated.

Total Interception = Sum (Interception by Species x # of Trees in Species)

Canopy Interception Findings

Based on the iTree analysis, the landscape at Coast Guard headquarters intercepts 233,587 gallons of stormwater annually by planting 985 trees of various species. This is just over half the capacity of the green roofs (see below). When the planted conifers/understory trees reach 3" DBH and canopy trees reach 10" DBH they will intercept 766,294 gallons of stormwater annually. This volume is 80% more than the capacity of the green roofs.

Limitations

A limitation of this method is that some tree species were not available on iTree and had to be substituted with the most similar species available. Depending on the substitution, that could have led to an increased or decreased estimation of stormwater interception.

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3. Saves 520,000 gallons of potable water annually by using captured stormwater for all site-based irrigation and water features. This saves $2,770 in water costs per year.

Irrigation Methods

According to the District of Columbia Water and Sewer Authority, the 2016 cost per 1,000 gallons of water in Washington, D.C. will be $5.33. Recycled irrigation volume was estimated at 520,000 gallons annually. The recycled irrigation water data was calculated by the design team for the month of July using LEED's water efficient landscape.

520 (thousands of gallons) x 5.33 ($/thousand gallons) = $ 2771.6 saved annually

While the research team had to use estimated numbers to calculate the benefit from recycling water for irrigation, there is an existing facility on-site with logging capability that is not enabled. This logging station is located in the pump vault adjacent to the stormwater pond. This logging station should be enabled and information should be collected to determine annual water savings and how much irrigation the landscape actually required compared with estimated irrigation needs. The former is important from an operations standpoint, while the latter is important from the landscape design perspective.

Irrigation Findings

The Coast Guard headquarters is saving $2,771 annually on potable water costs.

4. Includes 8 times more native trees and 7 times more native wood plants than the landscape of a conventional office complex nearby.

Native Tree Abundance Methods

To understand the high-performance design for biodiversity at the U.S. Coast Guard headquarters, it was useful to compare the performance with a more traditionally designed office complex that provided similar programmatic functions (see figure 2). The comparison site was located at 4061 Powder Mill Road in Calverton, Maryland. On June 19, 2015, the research team surveyed woody plants within the designed spaces of the traditional office landscape. This traditional office landscape is of similar scale and use as that of the U.S. Coast Guard Headquarters (USCG HQ) and is located in the same metropolitan area. The research team divided the designed landscape into quadrants and labeled them on an aerial Google image to make the field survey more organized. Each quadrant was surveyed individually, moving from 1-4. When plants were positively identified, their scientific name and quantity was recorded by quadrant.

Limitations

Plants that could not be positively identified on site were photographed for later identification. Plants not clearly within the designed space were not counted.

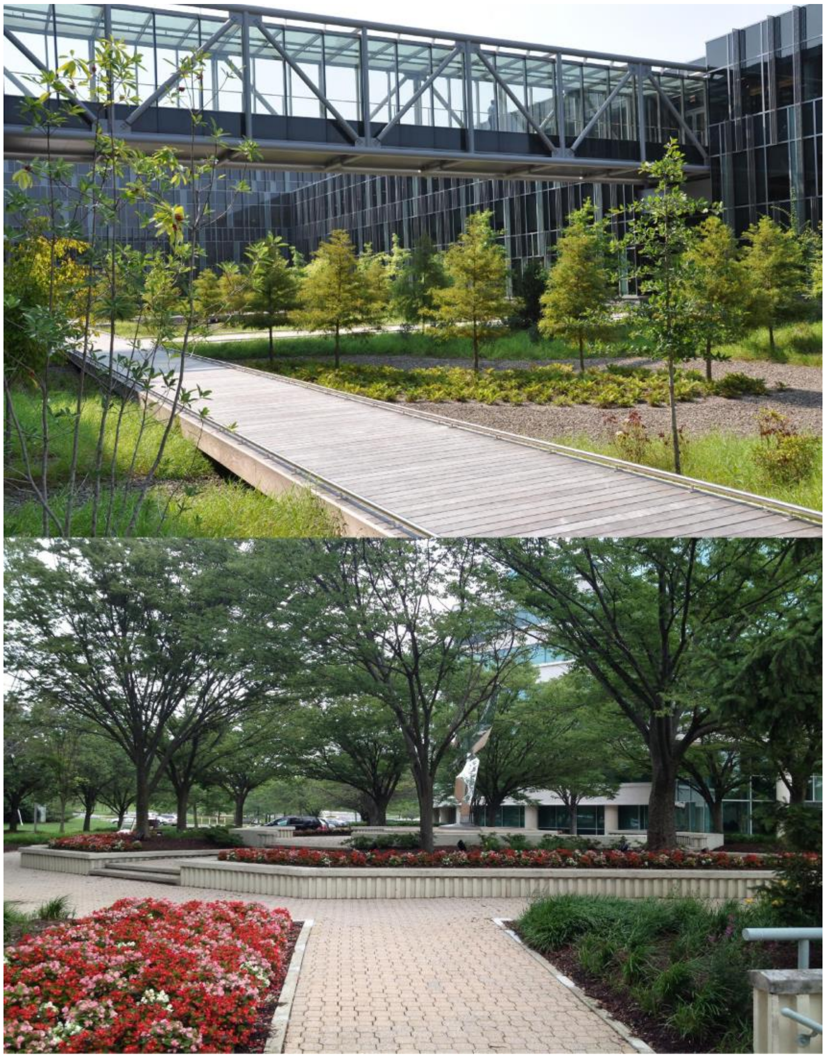

Figure 2 - Top: Native habitat themed courtyard at Coast Guard headquarters (Photo by Andropogon, 2014) **Bottom: Formal garden style courtyard at Traditional Office Park** (Photo by Dylan Reilly)

The tree list (see figure 3) for the U.S. Coast Guard headquarters was assembled from the planting plans. With lists of native trees from both sites, the following comparison was made possible:

Native Trees Difference = Native Trees (USCG HQ) – Native Trees (Traditional)
Native Trees Difference = 900 (USCG HQ) – 109 (Traditional)
Native Trees Difference = 791
Native Trees Ratio = Native Trees (USCG HQ) / Native Trees (Traditional)
Native Trees Ratio = 900 (USCG HQ) / 109 (Traditional)
Native Trees Ratio = 8.26

Native Tree Abundance Findings

The landscape at Coast Guard headquarters harbors more than eight times more native trees than a traditional office landscape by incorporating ecosystem themed courtyards and forest regeneration areas.

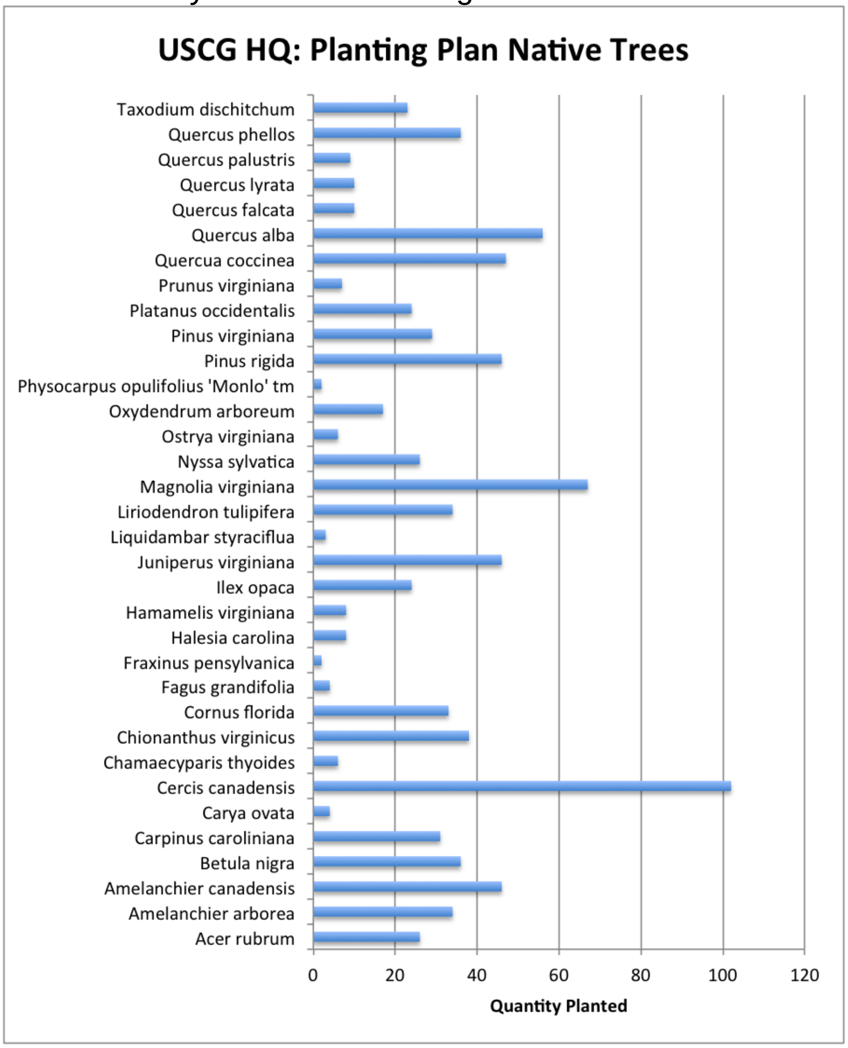

Figure 3 – Tree list for the Coast Guard headquarters.

Limitations

There is difficulty in counting individual plants in dense hedges and groundcover, as well as the inherent differences between an on-site survey of woody plants and a planting plan. Such inherent differences include the mortality and replacement of original plantings and the difficulty in determining designed versus volunteer plants on the site edges. Another limitation was the exclusion of non-woody plants from the traditional site survey. This exclusion was due to limited time and difficulty of counting individuals in herbaceous clumps. To account for this limitation, herbaceous plants were excluded from both site lists for comparisons. Even with these limitations, the research team believes this to be a valid method that has captured the overall character of each site.

Woody Plant Richness Methods

The U.S. Coast Guard headquarters and a traditional office complex (see figure 1) sites were compared by calculating native woody plant richness. Woody plant species at the traditional office complex were identified and recorded as described in the previous section. To be clear, herbaceous plants were not surveyed at the traditional site. The woody plant species at the U.S. Coast Guard headquarters were derived from the planting plan lists (see figure 4). The native woody richness values and comparison ratio were calculated as follows:

Native Woody Richness (NWR) Difference = NWR (USCG HQ) – NWR (Traditional)

NWR Difference = 65 species (USCG HQ) – 9 species (Traditional)

NWR Difference = 56 species

Native Woody Richness (NWR) Ratio = NWR (USCG HQ) / NWR (Traditional)

NWR Ratio = 65 species (USCG HQ) / 9 species (Traditional)

NWR Ratio = 7 time more species at the Coast Guard headquarters

Woody Plant Richness Findings

The landscape at Coast Guard headquarters includes 7 times more native woody plant species than a traditional office landscape by incorporating ecosystem themed courtyards.

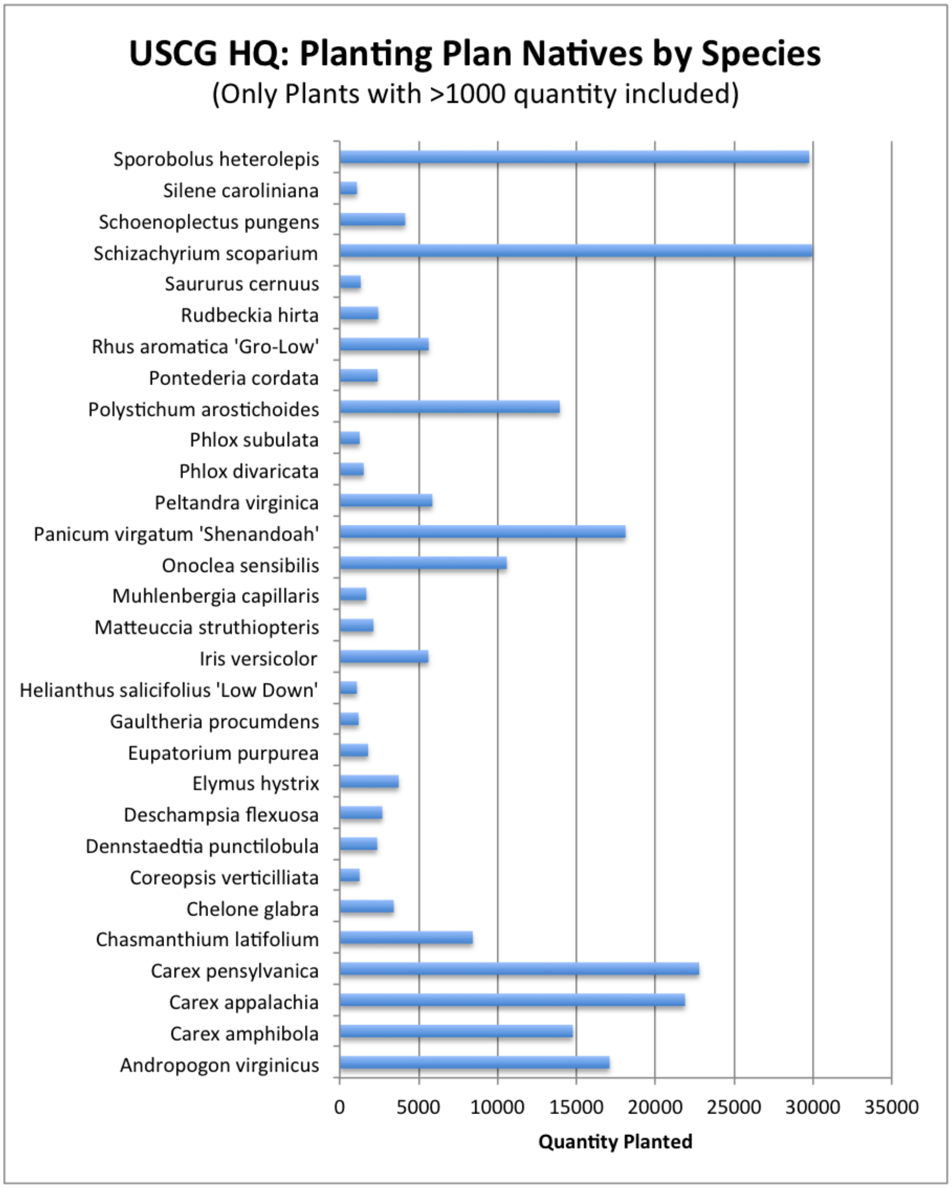

Figure 4 – Woody plant list for the U.S. Coast Guard headquarters.

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5. Sequesters 153,000 pounds of carbon annually in 985 trees. When the trees reach maturity, they will sequester 883,000 pounds of carbon annually, about 4 times the carbon sequestration of a conventional site.

Carbon Sequestration Methods

The species type and the quantities of trees planted on the Coast Guard headquarters site were determined from the construction documents and entered into a MS Excel spreadsheet. Construction documents indicated that canopy trees were planted with 3" diameter at breast height (DBH) and conifer/understory trees were planted with a height of 8-10'. The i-Tree Calculator was used to calculate the benefits from each tree (Casey Trees & Davey Tree Expert Co.). The calculator requires a zip code tree location, diameter at breast height, and common name species. The calculator determines annual carbon sequestered based on these factors. The zip code for the Saint Elizabeth's Coast Guard headquarters is 20593. For conifer/understory trees, the height of 8-10' was assumed to be 1" DBH. The model uses only common names, so species were matched as best as possible with those common names. The value of carbon sequestered annually for each tree was also calculated with future "mature" DBH estimates of 3" for conifer/understory and 10" for canopy trees. This is meant to be a future condition if the trees are properly cared for. Annual carbon sequestration was determined for each tree species, multiplied by the quantity of trees for each species, and then summed to get the total annual carbon sequestration for the site.

The tree species and quantities for the traditional office complex site trees were also analyzed for carbon sequestration. Trees were analyzed at the same sizes as the headquarters site to make a fair comparison. Tree specifications, 3" canopy trees and 1" understory/ conifer trees, were used to represent "planted state" for the traditional office complex. The mature state was represented with 10" canopy trees and 3" understory/conifer trees.

U.S. Coast Guard Headquarters Tree Total:	985 trees
U.S. Coast Guard Headquarters Planted:	152,517 lbs/year
U.S. Coast Guard Headquarters Mature:	883,306 lbs/year
Traditional Office Complex Tree Total:	318 Trees
Traditional Office Complex Planted:	39,042 lbs/year
Traditional Office Complex Mature:	219,516 lbs/year
USCG HQ/Traditional Planted Ratio:	152,517 / 39,042 = 3.91
USCG HQ/Traditional Mature Ratio:	883,306 / 219,516 = 4.02

Carbon Sequestration Findings

The landscape at Coast Guard headquarters sequesters 152,517 pounds of carbon annually by planting 985 trees. When planted conifers/understory trees reach 3" DBH and canopy trees reach 10" DBH, they will sequester 883,306 pounds of carbon annually. This is equivalent to about four times the carbon sequestered on a traditional office complex.

Limitations

Some tree species were not available on iTree and therefore had to be substituted with the most similar species available. Depending on the substitution, this may have led to an increased or decreased estimation of carbon sequestration.

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6. Reduces July average surface temperatures on the sedum green roof by 4° F and maximum surface temperatures by 12° F compared to a conventional rubber roof. Average and maximum sedum green roof surface temperatures were 83° F and 115° F, respectively.

7. Reduces July average surface temperatures on the tall grass green roof by 4° F and maximum surface temperatures by 10° F compared to a conventional rubber roof. Average and maximum tall grass green roof surface temperatures were 84° F and 177° F, respectively.

8. Reduces the July average temperature for all surfaces on the site by 1.6° F compared to the modeled for a conventional office complex nearby.

Surface Temperature Methods

The albedo of different surface types has been used as a metric to measure contribution to urban heat island (UHI) in past landscape performance studies (Mattson *et al.*, 2014). In particular, the percent of surfaces with a solar radiation index (SRI) of at least 29 was cited as a benefit. For the Coast Guard headquarters a similar technique was used, measuring surface areas in GIS, while also taking direct measurements of surface temperature on site. Direct measurement of surface temperature has been used as a metric in past landscape performance studies (Ellis *et al.*, 2011; Ozdil *et al.*, 2014; Yang *et al.*, 2011) to address UHI and human comfort. Both infrared thermometers (Yang *et al.*, 2011) and thermometers resting on the surface (Ellis *et al.*, 2011) have been employed in previous studies. It should be noted that the focus here is on the *contribution* to UHI and not necessarily on ambient air temperatures on site.

For this study, surface temperatures were used because of an interest in how surfaces affect human comfort and impact UHI. Surface temperatures were measured for seven different surface types: traditional flat roof, concrete, courtyard stone, courtyard planting bed herbaceous, courtyard planting bed trees, green roof sedum, and green roof tall grass. Surface temperatures were measured using HOBO temperature pendant data loggers (UA-001-08). For the initial monitoring period, the loggers were installed in 2” PVC end caps for shading with two rows of ¼” holes drilled in them and about 3/4” between rows to allow airflow while protecting the logger from solar radiation. Inside the housing, the logger was suspended horizontally about 1” off the surface. Logger housings were secured in place using zip ties and ¼” x 1½” solid PVC stakes driven 6” into the ground. On the stone, concrete, and asphalt surfaces, data loggers were installed on the edge of the surface to allow the stakes to be driven into adjacent soil. This was done to minimize potential for disturbance by foot traffic and maintenance activities. The location may bias the surface measurements to be impacted by the adjacent land cover, but close proximity of the logger to the intended surface, ~1”, may minimize this effect. Data loggers located on soil were sited towards the middle of the assigned surface. Loggers were installed on 5/12/2015 and set to sample every hour (see figure 5).

After analyzing data collected on 6/9/2015 from all loggers, the monitoring strategy was refined to eliminate anomalous conditions and to add additional measurement controls. On 6/30/2015, three loggers were relocated to measure a traditional roof, a courtyard planting bed under trees, and ambient air temperature in one courtyard. On the same day, PVC caps were removed from all the loggers.

Left: Temperature Logger on Sedum Greenroof. **Right**: Temp Logger on Flat Black Roof

Photo Credit: *Dylan Reilly*

Figure 5 – Data loggers on surfaces.

For context, one logger was deployed on 6/30/2015 to measure ambient air temperature at 1.5 meters above the ground in the same courtyard. The siting of this logger followed protocols for urban temperature measurement laid out in the World Meteorological Organization, Instruments and Reporting Methods, Report #81 (Oke, 2006). The logger was installed in a radiation shield, used to prevent solar radiation from affecting ambient air temperature measurements. The radiation shield was constructed using corrugated plastic, foil tape, and zip ties — a design created and tested by a team of scientists from the Forest Service, University of Montana, and University of Idaho (Holden, Klene, Keefe, & Moisen, 2013).

Temperature measurements taken on the green roof and the traditional flat roof were compared to understand their relative contributions to UHI. Understanding the contribution of different materials and land use is becoming more important as cities work to mitigate the heat island effect (Gartland, 2008). Rainfall data and ambient air temperatures for Washington, D.C. were obtained from the Reagan National Airport weather station through Weather Underground and used to control for the effect of weather conditions on the monitoring data (Weather Underground, 2015).

Results from the comparison between the green roof and the traditional rubber roof for the month of July originally showed a familiar pattern, where green roof average daily and maximum daily temperatures are lower than those for the traditional rubber roof. After July 15, this pattern inverted with most green roof maximum daily and average daily temperatures greater than the traditional roof. The research team does not have a definitive answer as to why this inversion occurred. It could reflect a true change in the relationship, such as lack of water on the green roof for evapotranspiration, or it could represent the appearance of a confounding factor, like reflected light from a building hitting the temperature logger. When the temperature logger from the traditional roof was retrieved on 8/5/2015, it was no longer in the original testing location. It had been moved closer to the roof edge with evidence that it had been pecked by a bird (presumably). A review of the data suggests that the new location might have had increased shade in the morning hours that affected the traditional roof readings. Figure 6 shows the difference between the initial and later temperature readings.

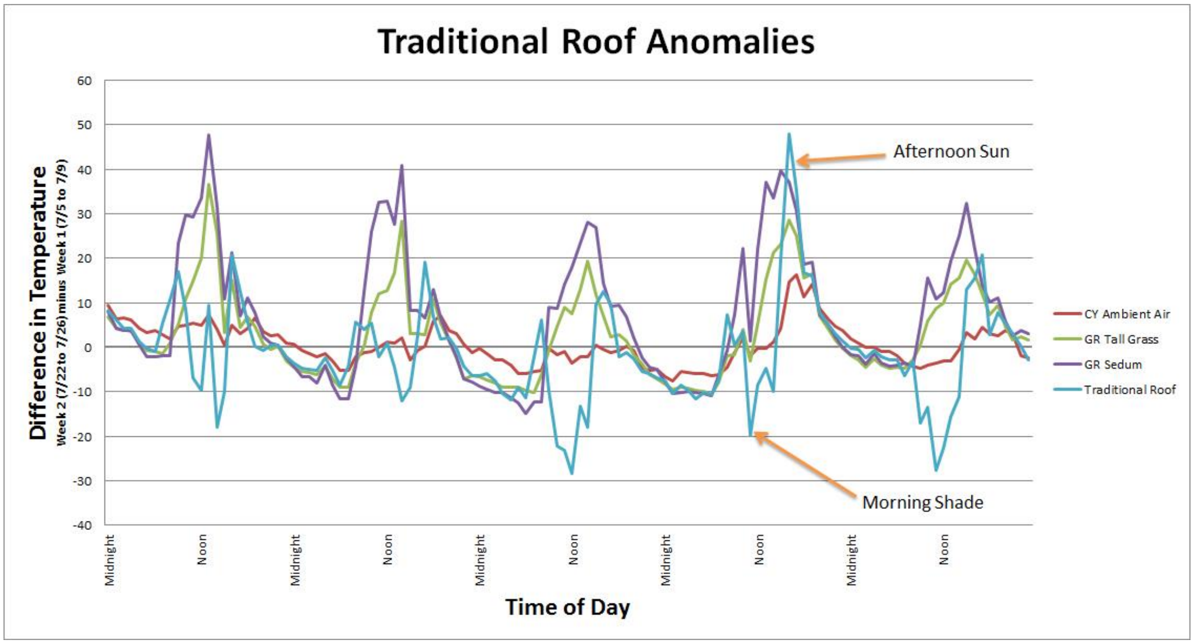

Figure 6 – Traditional roof temperature anomalies.

The research team also found a sudden increase in maximum daily temperatures. After 7/14/2015, the average maximum daily temperature for the green roof increased from 115-136°F, while the traditional roof stayed fairly constant at 128°F. It is possible that reduced evapotranspiration could be a potential answer. After 7/14/2015, average daily precipitation dropped from 0.32 to 0.08 inches.

Surface Temperature Findings

From 7/1/2015 to 7/14/2015, the average surface temperature of the sedum green roof was 83° F—four degrees lower than the traditional rubber roof (see figure 7). During the same period, the average maximum daily surface temperature of the sedum green roof was 115° F—twelve degrees lower than the traditional rubber roof.

While the performance of the sedum green roof fluctuates during the study period, the performance of the tall grass green roof is more consistent. From 7/1/2015 to 8/4/2015 the average surface temperature for the tall grass green roof was 84° F—four degrees lower than the traditional rubber roof. During the same period, the maximum daily surface temperature of the tall grass green roof was 177° F—10° F lower than the traditional rubber roof.

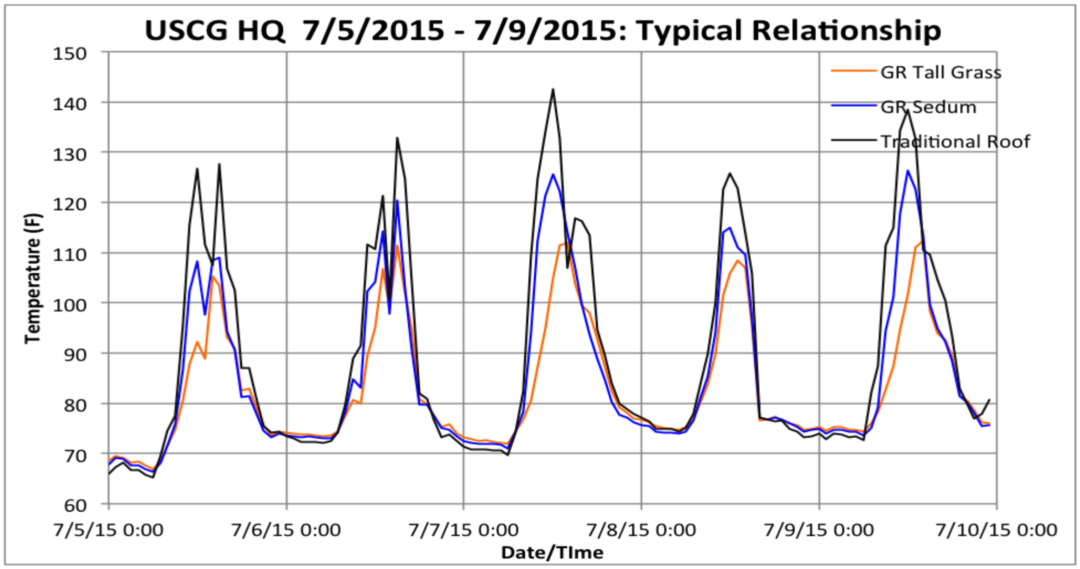

Figure 7 – Surface temperatures comparing green roofs with a traditional roof.

Heat Island Comparison Method

To test the heat island performance of the Coast Guard site, a method was devised to measure the weighted average surface temperature of the site, and to compare that value to the weighted average surface temperature of a more traditional office complex. The site used for comparison is described in the overview and biodiversity sections of this report.

The acres of each land cover type at the headquarters and at a nearby traditional office complex were measured and used to weight an overall surface temperature contribution separately for each site. The area of stone, concrete, asphalt, mowed grass, traditional rubber roof, sedum green roof, and tall grass was recorded for both the traditional office complex and Coast Guard headquarters using GIS. For each hour between 7/5/2015 and 7/10/2015, the research team multiplied measured surface temperatures (degrees) by the area (acres) for each surface type. These “degree x acres” were then summed for the entire five day study period and divided by each site’s total area to normalize the data to weighted average degrees. An example calculation for one time period is provided in the table below (see figure 8).

Average Weighted Temperature Calculations for 7/5/15 at 10:00 AM

	7/5/15 10:00 AM	USCG		Traditional Office Complex	
Surface Type	Degrees (D)	Acres (A)	D x A	Acres (A)	D x A
Stone	114.039	1.43	163.07577		
Planting beds	106.624	3.17	337.99808		
Tall green plants	103.512	3.5	362.292		
Low green plants	108.964	12.32	1342.43648	7.79	848.82956
Asphalt/roof	127.699	1.53	195.37947	15.08	1925.70092
Concrete	116.562	5.03	586.30686	1.21	141.04002
Total		26.98	2987.48866	24.08	2915.5705
Weighted Average Temperature			110.7297502		121.0785091

Figure 8 – Example showing average weighted temperature calculations for one time period.

It should be noted that the surface temperatures were collected only for one site—the U.S. Coast Guard Headquarters. An assumption was made that temperatures for surfaces at one location would be constant at the other site. For example, under the same conditions, concrete at one site should perform the same as concrete at another site. Similarly, short plants at one site should perform the same as short plants at another site. Trying to compare real time sensors at two sites simultaneously is problematic due to differences in wind conditions, cloud cover, and other weather-related variables. Substituting identical surface temperatures from one site to another, while not actual measured readings, make for an arguably better comparison by eliminating the confounding effects of variable weather conditions.

Also, not all surface temperatures were measured, so some substitutions had to be made. In particular, traditional rubber roof temperatures were substituted for asphalt at both sites and green roof sedum was used to represent mowed grass at both sites. On the Coast Guard headquarters site, tall grass and green roof tall grass were assumed to perform the same for the purposes of surface temperatures.

Heat Island Comparison Findings

From 7/5/2015 to 7/10/2015, the weighted average surface temperature for the Coast Guard headquarters was 86.7° F while the traditional office complex was 88.3° F — an average difference of 1.6° F. This value is nearly within the range of the annual mean temperature differences between dense urban areas and their surroundings, as reported by the U.S. EPA. The differences ranged from 2° F in the late evenings/early mornings where the traditional site reported cooler temperatures, to 15° F during midday when the traditional office complex was much warmer — meaning, the traditional office complex had a more extreme temperature range and was warmer on average than the U.S. Coast Guard headquarters (see figure 9).

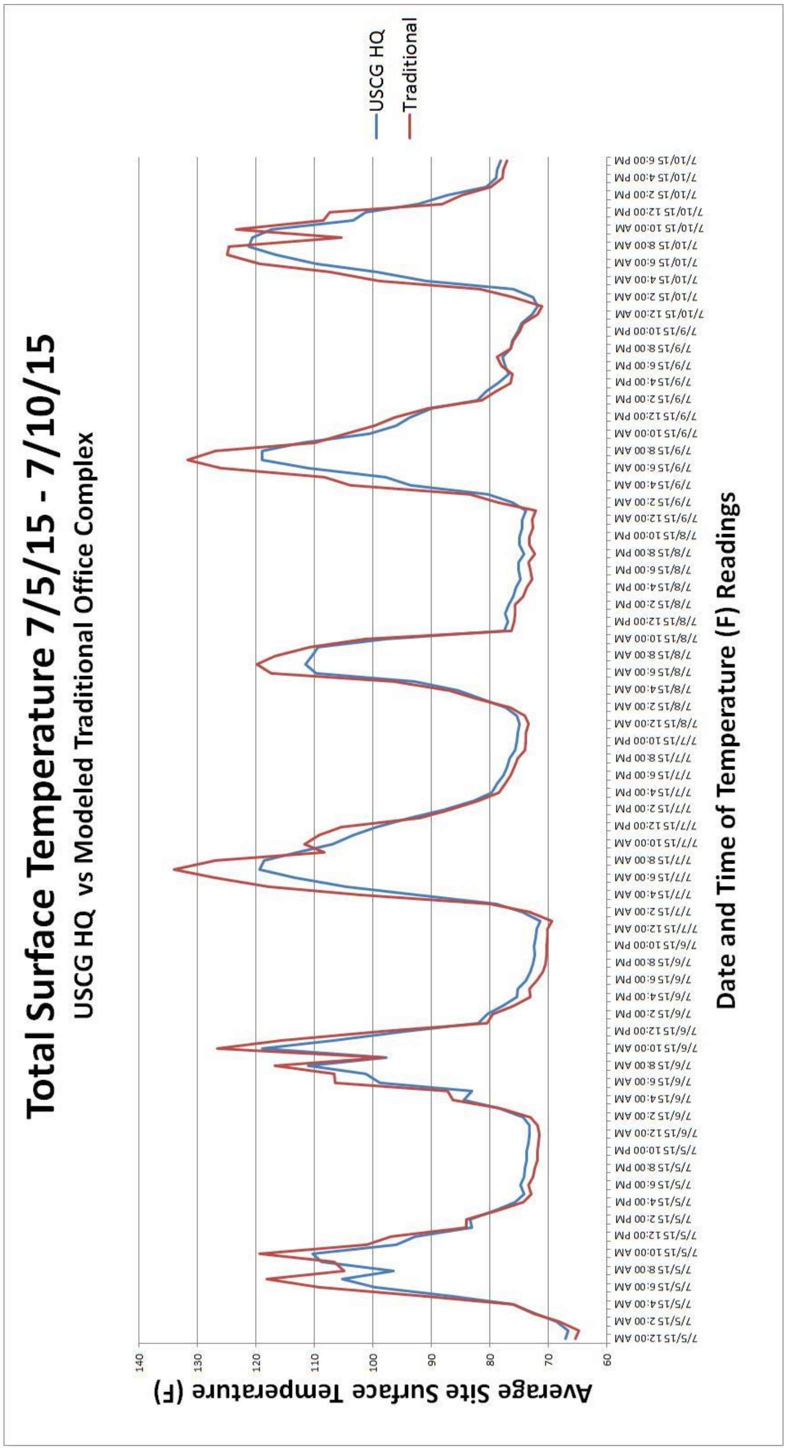

Figure 9 - Graph of average weighted surface temperatures.

SOCIAL BENEFITS

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1. Supports alternative modes of transportation for employees, with 478 observed arriving by public bus, 55 by bicycle, and 147 on foot at the main entrance during the morning commute.

Non-Vehicular (except bus transit) Commuter Count Methods

The U.S. Coast Guard headquarters design provides access to the site on shared use pathways (bicycle and pedestrian) and covered bus transit stops in addition to vehicular access. There are multiple bus routes that serve the site during commuting hours, with the most common route connecting to the local DC Metro stop: Anacostia. To quantify the non-vehicular (except bus transit) commuter traffic, a morning commute traffic count was conducted looking specifically at bus riders, cyclists and pedestrians (see figures 10 and 11).

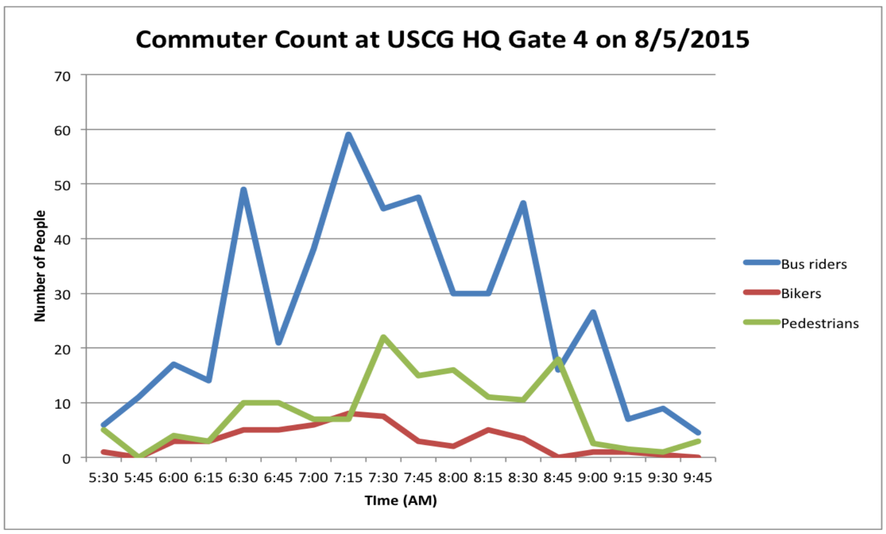

Figure 10 – Transit, bicycle and pedestrian commuter counts.

On August 5th, 2015 the total number of people commuting to the Coast Guard headquarters by non-vehicular means (except bus transit) was quantified during a 4.5 hour morning commute period at Gate 4. Commuter traffic on foot, bicycles, and bus transit was counted from 5:30 am to 10:00 am. This time period is oriented to count most of the commuters throughout the rush hour. Counts were organized by15-minute increments. Two research technicians made independent counts of each mode (pedestrian, bicycle, bus transit) throughout the morning. These counts were compared and averaged to minimize the effects of human error.

One limitation of this count was that other secondary entrances to the site were not monitored. The counts are therefore conservative. Eleven additional bus lines service the MLK Avenue entrance to the St. Elizabeth campus, which may be used to access the Coast Guard headquarters site (United States Coast Guard, 2013). These were not counted by researchers due to project constraints. Another limitation was that some people were seen leaving the site dressed presumably for exercise and may have been double counted when they returned. It is estimated that no more than 5-10 cyclists or pedestrians were double counted this way. During conversations with the on-site team and a bus driver, researchers learned that a number of the pedestrians might be parking in an adjacent neighborhood or at Boiling Air Force Base and walking onto campus due to parking constraints. The research team had no way to substantiate or determine the extent of this commuting practice.

Non-Vehicular (except bus transit) Commuter Count Findings

The bus stop and shared use path enabled 478 employees to commute daily on public bus transit, 55 employees by bicycle, and 147 employees on foot. A total of 679 people arrived at the site by these alternative modes of transportation. The peak arrival time was 7:30-7:45.

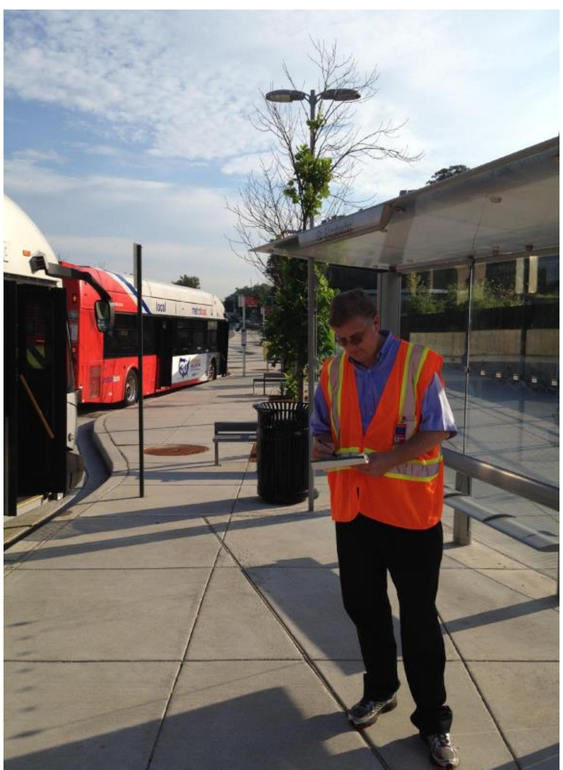

Figure 11 - Recording and tallying bus riders, bikers, and pedestrians on 8/5/2015.
Photo Credit: Dylan Reilly

2. Provides space for employees to spend time outdoors, with 336 distinct individuals observed using the courtyard over a 6-hour period.

Use Density Record Method

The use density record (UDR) was designed to quantify courtyard use and to determine the most common uses in the space. As part of the UDR, one courtyard was photographed every minute (time-lapse) for about six hours on June 9 — a warm, sunny workday. A Canon EOS Rebel Xsi was set up in a high room with good visibility over the courtyard (See figure 12). An Aputure Timer Camera Remote Control Shutter Cable was attached to the camera to enable time-lapse photography. Photographs were taken at 2256 × 1504 pixel resolution to protect the identity of individuals using the courtyard.

Figure 12 - The camera vantage point for the use density record was in an upper level of the building pictured here. *Photo Credit: Matt Tanis 2015*

First, the total number of people in each frame was counted. These numbers were graphed against time (see figure 13) to show how the courtyard was used throughout the day. The graph shows two different characteristics, a series of volatile spikes, and several periods of sustained numbers where the spikes do not return to near zero.

Next, the number of people sitting and standing in each frame was also counted. The volatility in the graph may correspond to people walking through the courtyard. However, it is not possible, given the time frame, to accurately differentiate people standing still from people in motion. Some people may be standing while talking on a cell phone, which is commonplace because reception is not available within the building. Nonetheless, figures 14 and 15 below demonstrate that volatility in the data line likely comes from people walking through the courtyard, while people sitting in the courtyard present a more constant data representation.

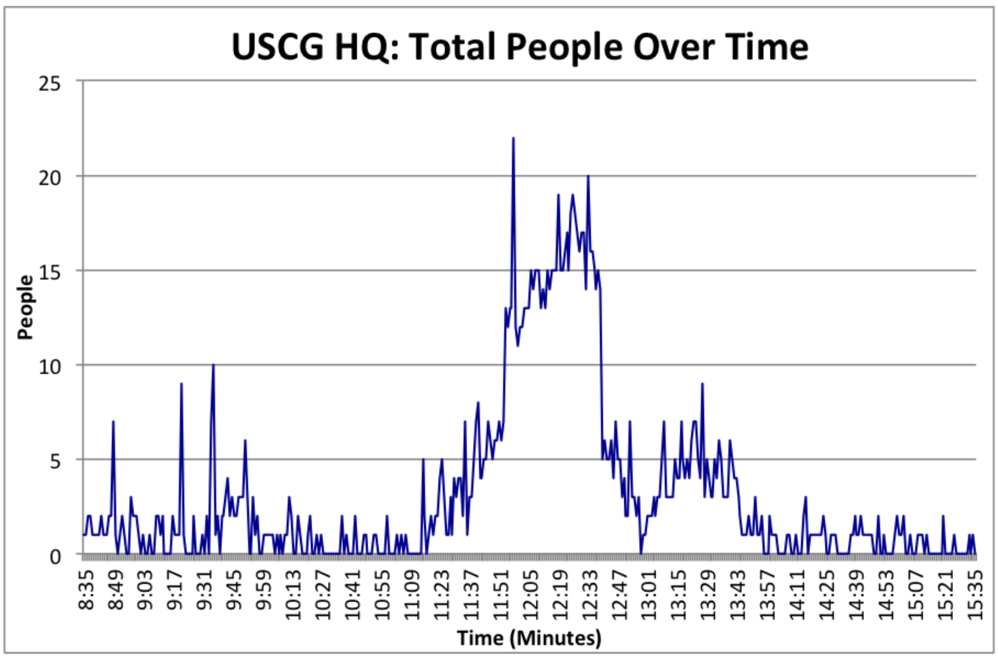

Figure 13 – Total person counts over 6 hour period.

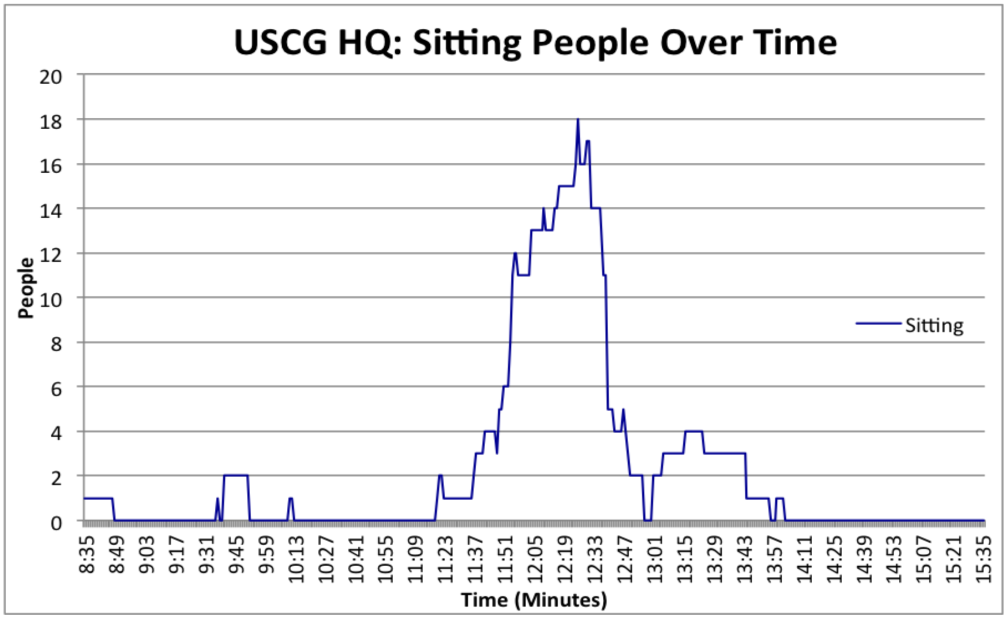

Figure 14 – Counts of people sitting over a 6 hour period.

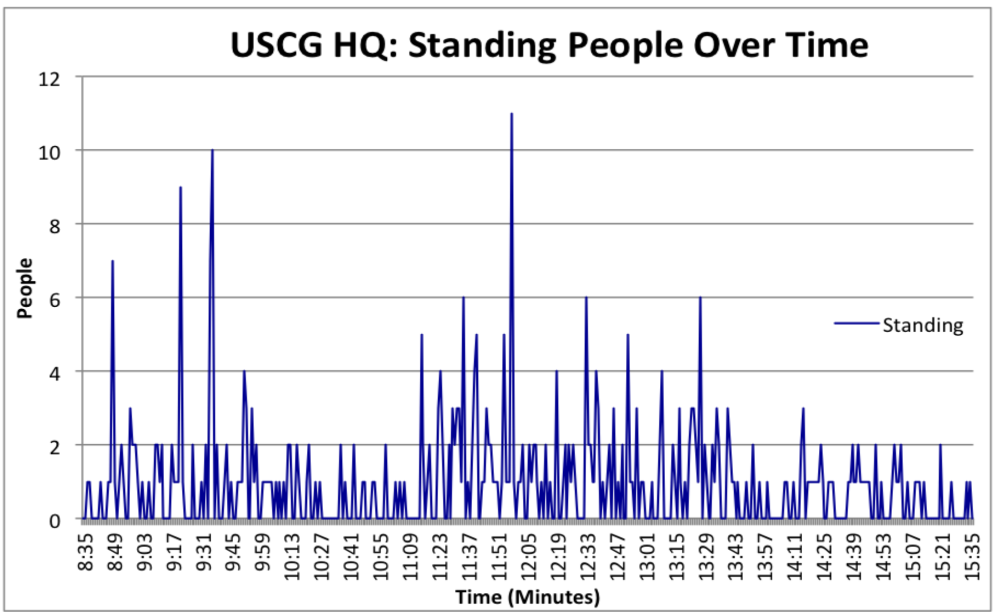

Figure 15 – Counts of people standing over a 6 hour period.

A manual count of distinct individuals that used the courtyard during the study period was conducted. Each subsequent frame was examined and people who were unique in comparison to other frames were tallied. While this method has many limitations, it is effective at removing the “sitting bias” from an overall use total. The sitting bias refers to how one person sitting in the frame for one hour is equivalent to 60 different individuals coming across the frame every minute for an hour, if one totals all people in all frame counts. Sitting people can easily be identified as the same person from frame to frame because they do not move. This method is also good at preventing groups of people traveling together from being counted twice because combinations of clothing make a group more recognizable than an individual. One limitation of the method is the difficulty of identifying individuals who move across the frame at different times because uniforms and suits often worn in this office environment are nearly identical. Women who are not in uniform and are wearing dresses are also more easily identified frame to frame because dresses tend to be more distinct than suits. Many individuals who later sat were first identified standing, biasing the count towards standing. As such, only the total number of distinct persons counted is included.

Total number of distinct persons counted = 336

A site plan of the courtyard was georeferenced into ArcMap. A new point file was created with a field for frame number and a field for pose, standing or sitting. Use observed in each frame was then digitized into GIS using points. A Kernel Density Analysis was completed for one morning, lunch, and afternoon frame to create raster heat maps representing use density. A synthesis heat map was also created in ArcMap, including the points from all frames (see figure 16). Cell size was set to 0.1’ and search radius was set to 1’. The densities were organized into colors using quartiles in symbology. The intervals were then rounded to the hundredth decimal place for ease of understanding. Movement patterns and gathering points were analyzed using the synthesis heat map. The darkest areas near the metal trellis represent major lunch seating areas while lighter colors represent movement patterns.

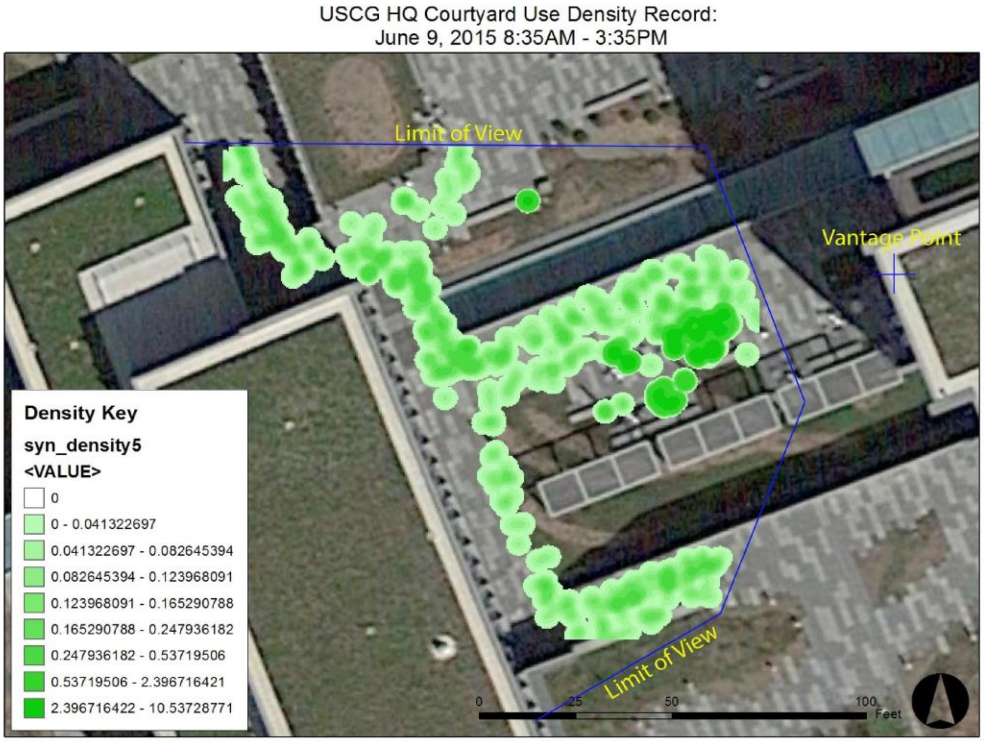

Figure 16 – Kernel density analysis of courtyard use.

Use Density Record Findings

On 6/9/2015, one courtyard provided outside time for 336 distinct individuals as a lunch area and outdoor corridor. The standing counts show a steady flow of one or two individuals throughout the day with a peak of up to nine or ten individuals from 9:00 AM to 10:00 AM and a longer peak of mostly four to six individuals from 11:00 AM to 2:00 PM. One spike of 11 individuals occurred around noon. The sitting counts showed a few people at various times in the morning, but a dominant sustained pattern between 11:00 AM and 2:00 PM. From about 11:45 AM to 12:45 PM, a sustained peak number of 11 to 18 people were sitting in the courtyard at any given time. Otherwise, the count ranged from one to four individuals outside of the peak.

3. Creates outdoor spaces that 77% of 96 survey respondents reported being satisfied with. Satisfaction significantly correlated with respondent's opinion that outdoor space is ample, walkable, and good for social interaction.

Survey Questionnaire Methods

The research team developed a survey questionnaire to be distributed among employees of the U.S. Coast Guard headquarters. The purpose was to help determine the level of satisfaction participants have in the outdoor environment—including the courtyards—and help them to assess how well the landscape is performing along several important dimensions. A copy of the survey questionnaire is included in the appendix. The survey included an informed consent page, which let participants know about the survey and how it would be used (see Appendix). This was required by the University of Maryland (UMD) Institutional Review Board (IRB). The survey was deemed to be exempt from full IRB review due to very low risks to participants.

On August 12, 2015 the survey was distributed on paper to 101 people at a GSA dining hall located adjacent to the Coast Guard headquarters. The dining hall was the only available lunch venue within walking distance of the headquarters and is still within the gated U.S. Government campus. The survey was conducted during lunchtime; from 10 am to 2pm. 96 Surveys were returned. Survey participants had the following attributes: 93% of the respondents worked at the Coast Guard headquarters; 68% were male; 61% were civilian; 68% were white; 15% were black; 5% were Hispanic.

One technique used in the survey was Importance and Performance Analysis (IPA). The importance/performance was of particular interest because when someone rates a landscape function as important, they are more likely to have a considered opinion regarding how well the landscape performs for that function (Martilla & James, 1977). For example, if someone rates walkability as important and rates a landscape's walkability as poor, then their response should be weighted more than someone who rates walkability as unimportant. Essentially, if someone thinks walkability is important, then they are probably a better judge of walkability performance. For this study, seven questions explored the importance of landscape functions and each of these had a corresponding performance question. These questions included: 1) space for physical training, 2) walkability, 3) outdoor views, 4) relief from challenging problems, 5) maintains work productivity, 6) supports social integration, and 7) positively impacts the local ecosystem. Respondents answered on a scale of "strongly disagree" to "strongly agree." The responses were coded along a scale of zero for "strongly disagree” to one hundred for “strongly agree.” A mean of fifty corresponds to a neutral rating.

Survey Questionnaire Findings

The mean scores for each question—both importance and performance—were calculated and then plotted on a graph (see figure 17). The mean scores for all questions together are represented by the green lines where the importance questions had a grand mean of 75.1 and the performance questions had a grand mean of 67.0. It is important to note here that all importance and performance mean scores are above the neutral rating of 50. Meaning, participants generally agreed that the question items were important and that the landscape performed well in this regard. From there, some more subtle conclusions can be made.

First, the upper right quadrant is associated with high importance and high performance, also known as, “keep up the good work.” Only walkability can be found to be very important and functioning well. The upper left quadrant is associated with high performance, but is considered lower in importance relative to other items. In simple terms this is considered a “windfall” category. The survey respondents agreed that there was sufficient space to support physical training and that the workplace positively impacts the local ecosystem. The bottom left quadrant is associated with lower importance and performance scores relative to the other items in the survey. This is oftentimes thought of as the low priority quadrant. The effect of outdoor space and courtyards on work productivity and social interaction fall into this category. However, on average, respondents agree that both of these items are important and performing reasonably well.

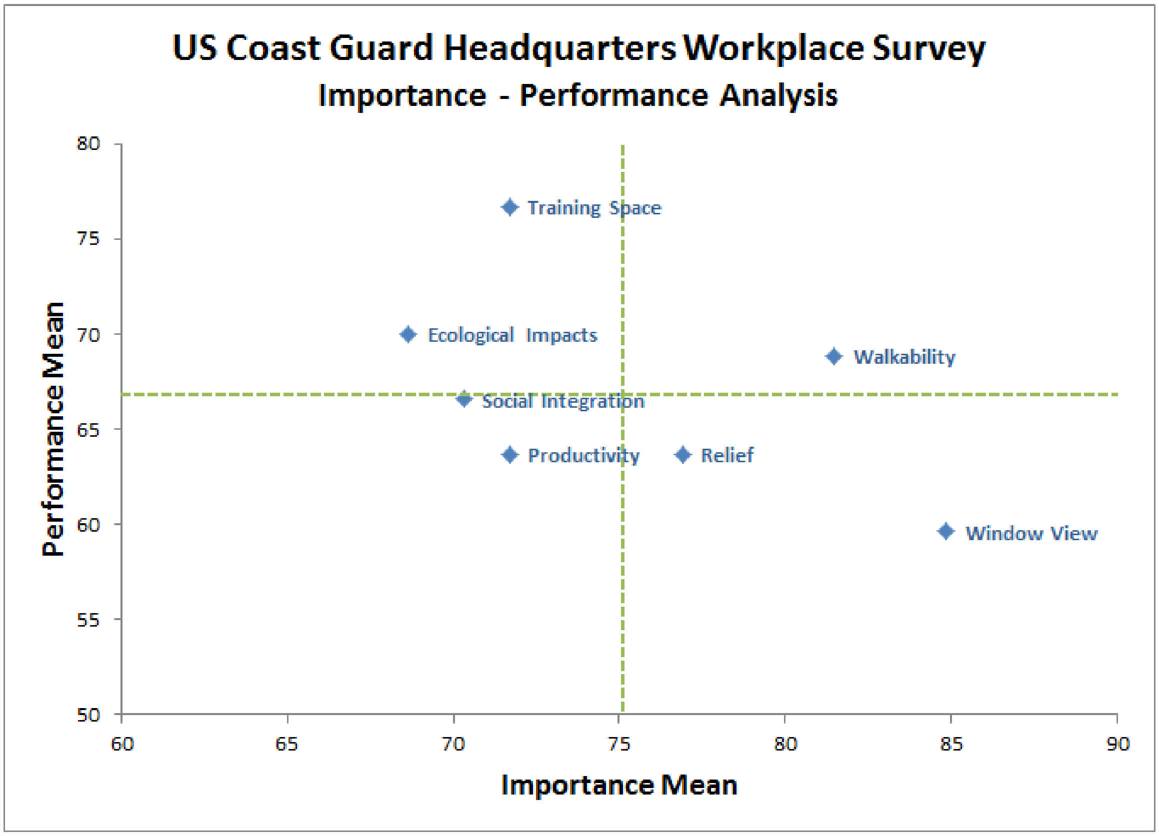

Figure 17 – Importance-performance analysis of the Coast Guard headquarters landscape.

Lastly, the bottom right quadrant is associated with higher importance and lower performance scores relative to other items. This is the "needs work" category. More access to the courtyards for relief from challenging problems and increasing views from respondents' offices might improve these performance ratings. It is interesting that views from the office window is listed as both the highest item in importance and the lowest item in performance. Perhaps this speaks to a human yearning for contact with the outside environment. In terms of access to courtyards for relief from challenges, several respondents indicated that access to the outdoors was not permitted from all building exits except in cases of emergency.

In other findings, 77% reported being satisfied with the outdoor spaces at their workplace. Satisfaction with outdoor space was significantly correlated with respondent's opinion that there was ample (r: 0.48, p< 0.000), walkable (r: 0.48, p< 0.000) outdoor space that was good for social interaction (r: 0.43, p< 0.000). These findings suggest that the headquarters is performing well along multiple landscape dimensions and that these factors may work together in some complex way to support outdoor satisfaction.

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Appendix A: Workplace User Survey

The landscape survey distributed on 8/12/2015 is included here along with the consent form. The survey PDF document is also included in the report package.

Informed Consent:
Landscape Performance Survey

By completing this survey:

I understand that I am one of about 200 participants in a study on Landscape Performance of the U.S. Coast Guard Headquarters. This study will be conducted in Summer 2015 and I understand that if I decide to participate, the survey will last approximately 10 minutes. In this study I will be asked questions relating to overall satisfaction, physical activity, restorative capacity, and ecological awareness in the context of landscape performance. The goal of the survey is to inform future landscape design activities of the GSA.

I understand that there are no known risks to participants. My participation in this research is voluntary. I realize that I am free to withdraw my consent and to discontinue participation in the survey at any time, and I understand that my responses may be removed from the study if I do not complete the survey. I also understand that I may refuse to answer any survey questions. There is no compensation for my participation.

I understand that any questions I have regarding procedures will be answered by the researcher. I also have the assurance of the researcher that my responses in this study will be kept anonymous.

This research study has been reviewed and ruled exempt by the Institution Review Board – Human Subjects in Research, University of Maryland, College Park. For research-related problems or questions regarding subjects' rights, the Institutional Review Board may be contacted through Joseph Smith, IRB manager, Research Compliance Office at (301)-405-4212 (irb.umd.edu).

I agree to participate (CHECK BOX HERE)

If I have any questions, I should contact the following person:

Dr. Christopher D. Ellis
2144 Plant Sciences Building
College Park, MD 20742
Tel: 301-405-7782
Email: cdellis@umd.edu

Landscape Performance Survey: US Coast Guard Headquarters

Check the appropriate box.

Age	☐ 25 or younger	☐ 26 – 40	☐ 41-55	☐ 56 or older		
Gender	☐ Male	☐ Female				
Status	☐ Military	☐ Civilian				
Race	☐ Hispanic	☐ Native American	☐ Black	☐ White	☐ Pacific Islander	☐ Asian
Home Setting		☐ Urban	☐ Suburban	☐ Rural		
Commute Distance		☐ <1 mile	☐ 1-5 miles	☐ 6-10 miles	☐ 11-20 miles	☐ >20 miles
Work at USCG HQ		☐ Yes	☐ No			
Main Commuting Mode		☐ Bike	☐ Walk	☐ Train	☐ Bus	☐ Car

We would like your opinion on the landscape at US Coast Guard Headquarters. Mark "X" on the scale.

Overall, I am satisfied with my workplace.

Strongly Disagree |——|——|——| *Strongly Agree*

Overall, I am satisfied with the outdoor spaces at my workplace.

Strongly Disagree |——|——|——| *Strongly Agree*

Overall, I am satisfied with the courtyards at my workplace.

Strongly Disagree |——|——|——| *Strongly Agree*

Access to outdoor space for physical training is important.

Strongly Disagree |——|——|——| *Strongly Agree*

My workplace provides ample outdoor space.

Strongly Disagree |——|——|——| *Strongly Agree*

Walkability of the outdoor space is important.

Strongly Disagree |——|——|——| *Strongly Agree*

My outdoor space is walkable.

Strongly Disagree |——|——|——| *Strongly Agree*

What do you use the courtyards for? (Open Ended)______________________________________

Landscape Performance Survey: US Coast Guard Headquarters

Check the appropriate box.

What times of day do you use the courtyard? ☐ Morning ☐ Noon ☐ Afternoon ☐ Evening ☐ N/A

How frequently do you use the courtyards? ☐ Daily ☐ Weekly ☐ Monthly ☐ N/A

~~~~~~

We would like your opinion on the landscape at US Coast Guard Headquarters. Mark "X" on the scale.

A view of outdoor space from the workspace is important.

Strongly Disagree |———|———|———| Strongly Agree

My workspace has a view of outdoor space.

Strongly Disagree |———|———|———| Strongly Agree

Access to outdoor space is important to provide relief from challenging problems.

Strongly Disagree |———|———|———| Strongly Agree

Access to outdoor space is important to maintain work productivity.

Strongly Disagree |———|———|———| Strongly Agree

I have ample access to outdoor space at my workplace.

Strongly Disagree |———|———|———| Strongly Agree

Outdoor spaces for social interaction are important in the workplace.

Strongly Disagree |———|———|———| Strongly Agree

The courtyards provide good outdoor spaces for social interaction.

Strongly Disagree |———|———|———| Strongly Agree

It is important that my workplace positively impacts the local ecosystem.

Strongly Disagree |———|———|———| Strongly Agree

I think my workplace positively impacts the local ecosystem.

Strongly Disagree |———|———|———| Strongly Agree

Which elements of the outdoor space do you appreciate most? (Open Ended)________________________________

What wildlife have you observed at your workplace? (Open Ended) ________________________________

Thank You!
~~~~~~

Appendix B: Non-Vehicular Commuter Count

This section includes the data collected on 8/5/2015 by two research technicians at Gate 4. Bikes, pedestrians, and bus riders were all counted. This data is also included as an excel spreadsheet in the report package.

	Bus riders	Bikers	Pedestrians
5:30	6	1	5
5:45	11	0	0
6:00	17	3	4
6:15	14	3	3
6:30	49	5	10
6:45	21	5	10
7:00	38	6	7
7:15	59	8	7
7:30	46	8	22
7:45	48	3	15
8:00	30	2	16
8:15	30	5	11
8:30	47	4	11
8:45	16	0	18
9:00	27	1	3
9:15	7	1	2
9:30	9	1	1
9:45	5	0	3
Total	478	55	147

Averaged count from Dr. Ellis and Dylan Reilly on 8/5/2015
Count was conducted at Gatehouse 4 on St. Elizabeth's Avenue

	Bus riders	Bikers	Pedestrians
5:30	6	1	5
5:45	11	0	0
6:00	17	3	4
6:15	14	3	3
6:30		DID NOT COUNT	
6:45		DID NOT COUNT	
7:00	38	6	8
7:15	59	9	5
7:30	46	8	21

7:45	48	2	14
8:00	30	3	16
8:15	30	5	11
8:30	49	3	10
8:45	11	0	18
9:00	27	1	4
9:15	7	1	1
9:30	9	0	0
9:45	5	0	3

Dylan Reilly data from 8/5/2015 commuter count at the USCG HQ
Count was conducted at Gatehouse 4 on St. Elizabeth's Avenue

	Bus riders	**Bikers**	**Pedestrians**
5:30		DID NOT COUNT	
5:45		DID NOT COUNT	
6:00		DID NOT COUNT	
6:15		DID NOT COUNT	
6:30	49	5	10
6:45	21	5	10
7:00	38	6	6
7:15	59	7	9
7:30	45	7	23
7:45	47	4	16
8:00	30	1	16
8:15	30	5	11
8:30	44	4	11
8:45	21	0	18
9:00	26	1	1
9:15	7	1	2
9:30	9	1	2
9:45	4	0	3

Dr. Ellis data from 8/5/2015 commuter count at the USCG HQ
Count was conducted at turn to Gatehouse 4 on St. Elizabeth's Avenue

Appendix C: Biodiversity Data

The Biodiversity data collected on the traditional site and from Coast Guard headquarters construction documents is too lengthy to be included in this PDF and is therefore included as an excel spreadsheet in the report package.

USCG HQ Planting List Derived from Construction Documents

*This list is comprehensive of the entire site, except the green roofs.

*NRCS Plant Database used to determine native range.

*Native means native to the east coast of the United States

Native	*Botanical Name*	QTY
1	*Acer rubrum*	26
0	*Aesculus hippocastanum*	11
1	*Alium schoenoprasum*	66
1	*Allium cernuum*	782
1	*Alnus serulata*	6
1	*Amelanchier arborea*	34
1	*Amelanchier canadensis*	46
1	*Andropogon virginicus*	17097
1	*Aster divaricatus* 'Eastern Star'	276
1	*Aster ericoides*	109
0	*Astilbe thunbergii* 'Ostrich Plume'	229
1	*Baccharis halmifolia*	6
1	*Betula nigra*	36
0	*Calamagrostis x Acutiflora* 'Karl Foerster'	62
1	*Callicarpa americana*	10
1	*Carex amphibola*	14770
1	*Carex appalachia*	21878
0	*Carex muskingumensis*	8576
1	*Carex pensylvanica*	22777
1	*Carpinus caroliniana*	31
1	*Carya ovata*	4
1	*Ceanothus americanus*	83
1	*Cephalanthus occidentalis*	61
1	*Cercis canadensis*	102
1	*Chamaecyparis thyoides*	6
1	*Chasmanthium latifolium*	8427
1	*Chelone glabra*	3418

1	*Chionanthus virginicus*	38
1	*Clethra alnifolia*	19
1	*Coreopsis verticilliata*	1250
0	*Cornus amomum*	16
1	*Cornus florida*	33
1	*Dennstaedtia punctilobula*	2369
1	*Deschampsia flexuosa*	2693
1	*Echincea purpurea* 'Magnus'	498
1	*Elymus hystrix*	3731
1	*Eupatorium purpurea*	1791
1	*Fagus grandifolia*	4
1	*Fothergilla gardenii*	48
1	*Fraxinus pensylvanica*	2
1	*Gaultheria procumdens*	1187
1	*Geum triflorum*	267
1	*Halesia carlina*	8
0	*Hamamelis vernalis*	5
1	*Hamamelis virginiana*	8
1	*Helianthus salicifolius 'Low Down'*	1081
0	*Hemerocallis* hybrid 'Joan Senior'	196
0	*Hosta* hybrid 'Sum and Substance'	83
0	*Hosta sieboldiana* 'Elegans'	56
1	*Hydrangea quercifolia*	22
1	*Ilex decidua*	6
1	*Ilex glabra*	163
1	*Ilex opaca*	24
1	*Ilex verticillata*	43
1	*Iris versicolor*	5611
1	*Itea virginica 'Henry's Garnet'*	177
1	*Juniperus virginiana*	46
1	*Kalmia latifolia*	8
0	*Lavandula angustifolia* 'Hidcote'	107
1	*Leucothoe axillaris*	31
1	*Liatris spicata*	265
1	*Lindera benzoin*	19
1	*Liquidambar styraciflua*	3
1	*Liriodendron tulipifera*	34
0	*Magnolia stellata*	5
1	*Magnolia virginiana*	67

1	*Matteuccia struthiopteris*	2132
1	*Mertensia virginica*	421
0	*Metasequoia glyptostroboides*	4
1	*Muhlenbergia capillaris*	1681
1	*Nepetax faassenii*	105
1	*Nymphaea odorata*	879
1	*Nyssa sylvatica*	26
1	*Onoclea sensibilis*	10581
1	*Ostrya virginiana*	6
1	*Oxydendrum arboreum*	17
1	*Panicum virgatum 'Shenandoah'*	18107
1	*Peltandra virginica*	5864
0	*Pennisetum alopecuroides* 'Little Bunny'	42
1	*Phlox divaricata*	1512
1	*Phlox subulata*	1260
1	*Physocarpus opulifolius* 'Monlo' tm	2
1	*Pieris floribunda*	4
1	*Pinus rigida*	46
1	*Pinus virginiana*	29
1	*Platanus occidentalis*	24
1	*Polystichum arostichoides*	13944
1	*Pontederia cordata*	2397
1	*Prunus virginiana*	7
1	*Quercua coccinea*	47
1	*Quercus alba*	56
1	*Quercus falcata*	10
1	*Quercus lyrata*	10
1	*Quercus palustris*	9
1	*Quercus phellos*	36
1	*Rhododendron calendulaceum*	4
1	*Rhododendron maximum*	6
1	*Rhododendron periclymenoides*	20
1	*Rhododendron viscosum*	19
1	*Rhus aromatica 'Gro-Low'*	5628
0	*Rhus carolina*	11
1	*Rhus glabra*	20
0	*Rosemarinus officinalis*	29
0	*Rubus* 'Bristol'	12
1	*Rudbeckia hirta*	2434

1	*Rudbeckia lacinata*	308
0	*Salix triandra* 'Noir de Villane'	20
1	*Salvia lyrata* 'Purple Knockout'	929
1	*Sassafras albidum*	36
1	*Saururus cernuus*	1322
1	*Schizachyrium scoparium*	29932
1	*Schoenoplectus pungens*	4143
0	*Sedum x* 'Autumn Joy'	134
1	*Silene caroliniana*	1087
1	*Solidago sphacelata* 'Golden Fleece'	353
1	*Sporobolus heterolepis*	29749
0	*Stachys byzantina* 'Silver Carpet'	27
0	*Talinum calycinum*	1579
1	*Taxodium dischitchum*	23
0	*Thymus citriodorus*	106
1	*Vaccinum angustifolium*	53
1	*Vaccinum corymbosum*	22
1	*Viburnum dentatum* 'Arrowwood'	22
1	*Viburnum prunifolium*	5
0	*Vinca minor*	101
1	*Viola sororia*	538

USCG HQ Woody Planting List Derived from Construction Documents

*This list is comprehensive of the entire site, except the green roofs.
*NRCS Plant Database used to determine native range.
*Native means native to the east coast of the United States

Native (EUS)	*Botanical Name*	QTY
1	*Acer rubrum*	26
0	*Aesculus hippocastanum*	11
1	*Alnus serrulata*	6
1	*Amelanchier arborea*	34
1	*Amelanchier canadensis*	46
1	*Baccharis halmifolia*	6
1	*Betula nigra*	36
1	*Callicarpa americana*	10
1	*Carpinus caroliniana*	31
1	*Carya ovata*	4

1	*Ceanothus americanus*	83
1	*Cephalanthus occidentalis*	61
1	*Cercis canadensis*	102
1	*Chamaecyparis thyoides*	6
1	*Chionanthus virginicus*	38
1	*Clethra alnifolia*	19
1	*Cornus amomum*	16
1	*Cornus florida*	33
1	*Fagus grandifolia*	4
1	*Fothergilla gardenii*	48
1	*Fraxinus pensylvanica*	2
1	*Gaultheria procumbens*	1187
1	*Halesia carolina*	8
0	*Hamamelis vernalis*	5
1	*Hamamelis virginiana*	8
1	*Hydrangea quercifolia*	22
1	*Ilex decidua*	6
1	*Ilex glabra*	163
1	*Ilex opaca*	24
1	*Ilex verticillata*	43
1	*Itea virginica 'Henry's Garnet'*	177
1	*Juniperus virginiana*	46
1	*Kalmia latifolia*	8
0	*Lavandula angustifolia* 'Hidcote'	107
1	*Leucothoe axillaris*	31
1	*Lindera benzoin*	19
1	*Liquidambar styraciflua*	3
1	*Liriodendron tulipifera*	34
0	*Magnolia stellata*	5
1	*Magnolia virginiana*	67
0	*Metasequoia glyptostroboides*	4
1	*Nyssa sylvatica*	26
1	*Ostrya virginiana*	6
1	*Oxydendrum arboreum*	17
1	*Physocarpus opulifolius* 'Monlo' tm	2
1	*Pieris floribunda*	4
1	*Pinus rigida*	46
1	*Pinus virginiana*	29
1	*Platanus occidentalis*	24

1	*Prunus virginiana*	7
1	*Quercua coccinea*	47
1	*Quercus alba*	56
1	*Quercus falcata*	10
1	*Quercus lyrata*	10
1	*Quercus palustris*	9
1	*Quercus phellos*	36
1	*Rhododendron calendulaceum*	4
1	*Rhododendron maximum*	6
1	*Rhododendron periclymenoides*	20
1	*Rhododendron viscosum*	19
1	*Rhus aromatica 'Gro-Low'*	5628
1	*Rhus carolina*	11
1	*Rhus glabra*	20
0	*Rosemarinus officinalis*	29
0	*Rubus* 'Bristol'	12
0	*Salix triandra* 'Noir de Villane'	20
1	*Salvia lyrata* 'Purple Knockout'	929
1	*Sassafras albidum*	36
1	*Taxodium dischitchum*	23
0	*Thymus citriodorus*	106
1	*Vaccinum angustifolium*	53
1	*Vaccinum corymbosum*	22
1	*Viburnum dentatum* 'Arrowwood'	22
1	*Viburnum prunifolium*	5
0	*Vinca minor*	101

Traditonal Site Plantings Derived from On-site Survey

*See methods for more information

*NRCS Plant Database used to determine native range.
*Native means native to the east coast of the United States

Native (EUS)	*Botanical Name*	QTY
0	*Platanus* x *acerfolia*	106
0	*Forsythia* x *intermedia*	21
1	*Pinus strobus*	77

1	*Juniperus horizontalis*	137
0	*Unknown*	7
0	*Abelia x grandiflora*	167
0	*Euonymous alatus* 'Compactus'	367
1	*Fothergilla gardenii*	7
0	*Mahonia aquifolium*	13
0	*Pinus thunbergii*	14
0	*Rosa radrazz*	40
0	*Zelkova serrata*	37
0	*Photinia fraserii*	4
0	*Pyrus calleryana 'Bradford'*	27
0	*Viburnum rhytidolphyllum*	71
0	*Ilex crenata*	37
0	*Prunus laurocerasus*	2
1	*Amelanchier arborea*	5
0	*Taxus*	54
0	*Ilex aquifolium*	15
1	*Acer rubrum*	24
0	*Picea abies*	13
1	*Ilex glabra*	53
0	*Ligustrum ovalifolium*	170
0	*Rhododendron spp.*	30
0	*Acer platanoides* 'Crimson King'	1
0	*Ilex chinensis*	10
0	*Acer palmatum*	4
0	*Lagerstroemia indica*	12
0	*Berberis thunbegii*	49
0	*Cedrus atlantica* 'Glauca'	10
0	*Vinca minor*	10
0	*Picea pungens* 'Glauca'	3
0	*Euonymus japonicus* ‘Aureomarginatus’	35
1	*Quercus phellos*	1
0	*Nandina domestica*	32
0	*Chamaecyparis pisifera* 'Golden Mop'	3
0	*Chamaecyparis nootkatensis* 'Pendula'	1
1	*Thuja occidentalis*	2
1	*Itea virginica*	4
0	*Hydrangea paniculata*	3

0	*Hedera helix*	30
0	*Cotoneaster salicifolius*	20
0	*Euonymous fortunei*	30