(UN)LOADING NUTRIENTS

REGISTRATION # D3
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Project Leads

Mark Dennis *(Landscape Architecture)*
Dylan Reilly *(Landscape Architecture)*
Vince Yi *(Landscape Architecture)*

Project Consultants

Michael Van Wie *(Mechanical Engineering)*
Emma Giese *(Environmental Science and Technology)*
Tuana Phillips *(Environmental Science and Technology)*
Christiane Machado *(Architecture)*

Advisory Team

Dr. Victoria Chanse *(Plant Science and Landscape Architecture)*
Stephen Reid *(Facilities Management)*
Michael Carmichael *(Facilities Management)*
Dr. Peter May *(Environmental Science and Technology, Biohabitats)*
Dr. Mitch Pavao-Zuckerman *(Environmental Science and Technology)*
Dr. Allen Davis *(Civil & Environmental Engineering)*
Diane Cameron *(Civil Engineer)*

Additional Advisors

William Olen *(Executive Director, University of Maryland Design & Construction; Chair of Architectural and Landscape Review Board)*
Christopher Ho *(Civil Engineer, University of Maryland Design & Construction)*
Rick Scaffid *(Vice President of Sales & Estimating, EQR LLC)*
Paul Romero *(Lead Estimator, University of Maryland Design & Construction)*
Oswell Osei *(Estimator, University of Maryland Design & Construction)*
Professor Jack Sullivan *(Plant Science and Landscape Architecture)*
Professor Dennis Nola *(Plant Science and Landscape Architecture, Member of Architectural and Landscape Review Board)*
John McCoy (*Watershed Management-Columbia Association)*

PROJECT ABSTRACT

Students from the University of Maryland's Landscape Architecture program led an interdisciplinary project team to transform a loading dock facility into a green infrastructure amenity for the surrounding campus community. Under the guidance of UMD Facilities Management, the project team, composed of students from Landscape Architecture (3), Environmental Science and Technology (2), Civil Engineering, Mechanical Engineering (1), and Architecture (1), selected a 0.97-acre lot on the southern half of campus that was 96% impervious and lacking stormwater best management practices (BMPs). The goals of this intervention are:

- ◊ To capture and treat the 2-year, 24-hour storm event
- ◊ To create a safe pedestrian environment for students, faculty, and staff while minimizin parking loss and disruptions to the dining hall loading dock activities
- ◊ To increase tree canopy coverage and provide habitat and food resources for wildlife in the context of a changing climate
- ◊ To provide opportunities for students, faculty, and staff o learn about stormwater BMPs

The design for the South Campus Dining Hall's combined loading dock and parking lot area, whose currently untreated runoff is onveyed directly to Guilford Run, has been reimagined with the following outcomes:

- ◊ 6,660 ft^2 of bioretention
- ◊ 103% treatment of a 2-year storm event
- ◊ 7,547 ft^2 or 18% decrease in impervious surface
- ◊ A safer pedestrian experience through the parking lot and loading dock
- ◊ Improved canopy and vegetative cover achieved with a climate-resilient plant palette

UMD CAMPUS INITIATIVES

UMD’s Facilities Master Plan identifies our strategic priorities: excellence, connectivity, sustainability, and stewardship.[1] Regarding connectivity, the plan calls for “universally accessible walkways, campus roads, campus and transportation systems that create a positive experience for pedestrians, bicyclists, and those using scooters, motorcycles or other motorized vehicles.”[2] The transportation section in the Facilities Master Plan envisions a campus that minimizes automobile usage and surface parking lots, which in turn will reduce greenhouse gas emissions, free up valuable land, and reduce confli ts between other modes of transit.

The Master Plan also identifies   ater conservation and stormwater management as part of its focus on sustainability. The University Sustainability Council released a Water Use and Watershed Report that set goals to address these water-related challenges. The council recommends adopting an initiative to reduce purchased potable water 20% by 2020.[3] In addition to addressing water conservation, the Sustainability Council’s work group has also prioritized utilizing BMPs to achieve the goal of treating the first inch of ainfall from 50% of all impervious surface area runoff   y 2020.[4] The work group also recommends that these stormwater management practices be coupled with education and research missions. Creating a living laboratory with informative signage and posters will serve the University’s educational purposes.[5]

Another factor that will greatly influen e the campus’s stormwater management strategy is the new MS4 permit, which is expected to be issued within the next year. UMD Facilities Management is expecting a 20% increase in the volume of required stormwater treatment.[6] While retrofits impleme ted after the last MS4 permit, which was issued in 2005, will count towards this goal, meeting it will require significa t additional stormwater treatment all over campus. Opportunities for mitigating stormwater through new BMPs are becoming scarce as campus continues to develop available open land.[7] Another option for meeting MS4 permit requirements is through a stormwater banking system, but according to the UMD Facilities Management Master Plan, that is no longer a viable option.

This site could serve as a catalyst project by fixing a poo ly functioning space while incorporating innovative stormwater management techniques. As such, this design proposal serves as a potential model for BMP retrofits th t serve the social and academic needs of students while addressing ecological factors that contribute to the poor health of the Chesapeake Bay Watershed.

Site Selection

The project team and UMD Facilities Management advisors recognized the relative scarcity

1 “Facilities Ma ster Plan 2011-2030 - Facilities Management - University ...” 2013. 16 Sep. 2016 <https://www.facilities.umd.edu/documents/fmp/2011-2030%20facilities%20Master%20Plan.pdf>
2 Ibid.
3 Sustainable Water Use and Watershed Report (SWUWR) 2014
4 Ibid pg 10
5 Ibid pg 13
6 Stephen Reid, UMD Watershed Manager, 9/6/2016
7 SWUWR pg 7

of stormwater BMPs in the southern part of campus, so the team focused their search for a site south of the campus mall. The South Campus Dining Hall loading dock and parking lot was one of the potential project sites suggested by the UMD Facilities Management. The team selected this site because of its central location in South Campus and lack of stormwater BMPs. The team envisioned a design that could positively influen e the daily routine of thousands of students,

Figure 1. Site aerial looking south

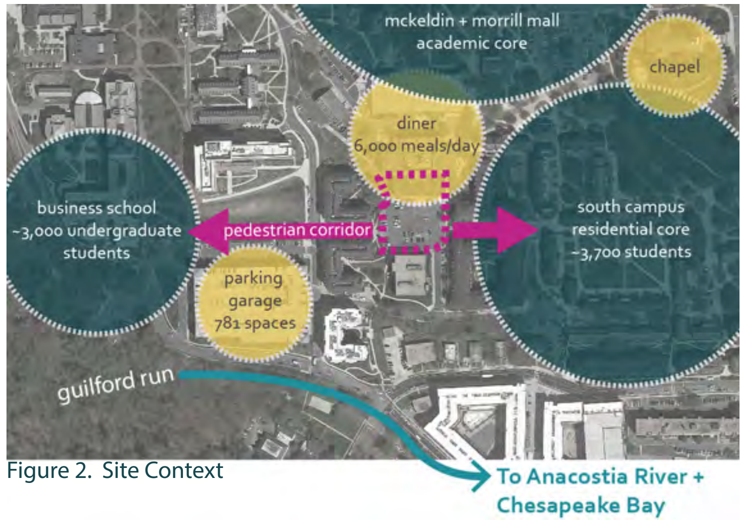

Figure 2. Site Context

faculty, and staff as ell as treat the runoff f om the loading dock/parking lot, which drains into Guilford Run.

SITE ANALYSIS

Context

The loading dock area for the South Campus Dining Hall also serves as a parking lot for residence halls to the east and west and a lecture hall to the south. As the only dining hall south of the campus mall, the South Campus Dining Hall serves meals to thousands of students every day. The building of the dining hall also houses numerous other activities that are important to its surrounding campus community. A rooftop community garden, which was just recently closed to the public, is located on top of the dining hall roof, and student organizations, such as the school newspaper and radio, student legal aid office, and MaryPIRG, a student activist organization, are all located inside the dining hall building.

The dining hall loading dock/parking lot is centrally located between the Washington Quad, which represents the south campus residential core with over 3,700 residents, on the east side and the Robert H. Smith School of Business, which is home to around 3,000 undergraduate students, on the west side. As a result of its proximity to the dining hall and its central location between south campus residential and academic nodes, the site experiences substantial pedestrian traffic.

It is important to note that the site's current layout is utilitarian. It allows delivery trucks to load and unload cargo for the dining hall and holds vehicles for the surrounding buildings. The site lacks any trees or vegetation to provide shade or seasonal interest for pedestrians, nor does it provide any opportunities for students to enjoy the space.

Circulation

The South Campus Dining Hall loading dock area is a busy node for pedestrian, bicycle, and vehicular traffic. Trucks and vans of all sizes make deliveries throughout the week, and students, faculty, and staff pa k in the 28 available spaces in the lot. Any proposed design for the lot will have to accommodate Dining Services's need for easy and quick access for delivery vehicles. This includes keeping much of the site open and paved for semi-trailer trucks' loading zone requirement. Additionally, a significa t number (7) of the 28 existing parking spaces are set aside for handicapped accessible parking spaces, so those will need to remain in the design as well.

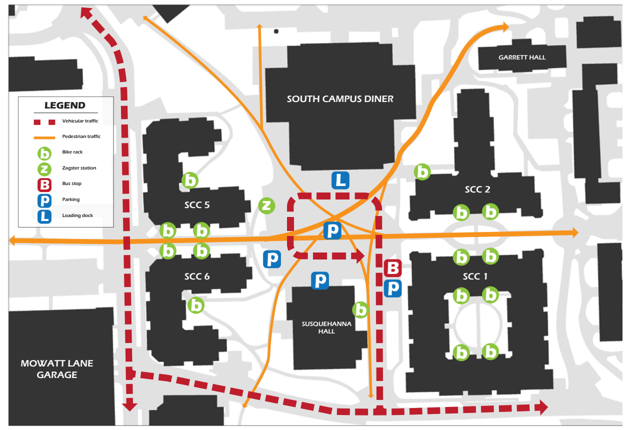

Figure 3. Existing circulation

The loading dock/parking lot interrupts a major pedestrian corridor that runs from the residential core on the east side to the Robert H. Smith School of Business on the west side. Pedestrian traffic is especially h vy during mealtimes and between classes. In addition to vehicular and pedestrian traffic, a significa t number of bicyclists pass through the site. The campus introduced a new bike share program this past summer and installed a station on the northwest corner of the site. The only sidewalks in the area runs along the lecture hall to the south and the residence halls on the east. Currently, pedestrians crossing the loading dock/parking lot simply walk across the asphalt in a fairly unpredictable manner. Without visible and designated vehicular and pedestrian travel lanes and zones of use, this site presents a public safety issue and the potential for collisions.

Utilities

With the goal of proposing a practical and cost-effici t stormwater retrofit in min , the project team obtained a map of the underground utilities from Facilities Management and created a design that prevented potential confli ts. The team also located two existing storm drains located in the southwest corner of the parking lot, but one of the drain inlets is clogged with construction debris. The ground around the working drain is not graded properly, so ponding occurs around the drain during rain events.

Drainage

The high point of the South Campus Dining Hall loading dock/parking lot is located at the northeast corner, and the site is graded such that runoff gene ally fl ws from northeast to southwest. The site is 96% impervious, so the vast majority of the rainfall does not infilt ate.

Instead, the runoff flows quickly across the site into the one working storm drain in the southwest corner. This stormdrain eventually leads to an outfall on Guilford Run, a tributary of the northeast branch of the Anacostia River. Rain that falls on the roof of the surrounding buildings drains internally and does not contribute to the runoff on the si e.

The project team completed TR-55 calculations for site conditions before our design interventions. The stormwater runoff values from TR-55 were used to size BMPs for the 2- yr, 24-hr storm event. The team did an initial site visit with the utilities map in hand to better understand the drainage areas that were contributing runoff o the site. Using information from the site visit and satellite imagery, the team delineated the watershed for our site and digitized land cover types using GIS. Of the 43,564.38 sq ft in the watershed of the current stormdrain in the southwest corner of the parking, only 1,682 sq ft is grass. The rest, 41,881 sq ft, is impervious surface.

Table1. Change in impervious surface composition

Pre-Design

IMPERVIOUS (sqft)	PERVIOUS (sqft)	% IMPERVIOUS
41,881.71	1682.67	96.14%

Post-Design

IMPERVIOUS (sqft)	PERVIOUS (sqft)	% IMPERVIOUS
34,334.61	9229.77	78.81%

18% Reduction in Impervious Surface

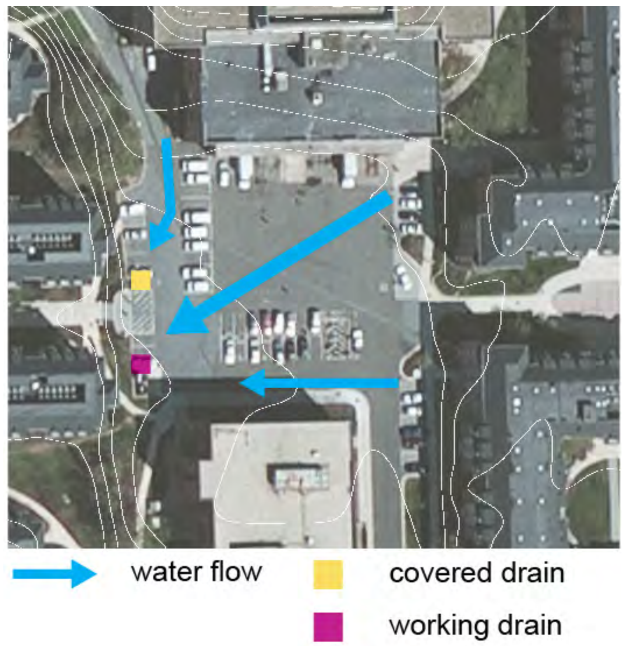

Figure 4. How stormwater fl ws through the site

LITERATURE REVIEW

Pollutant Loads from Loading Docks and Parking Lots

Parking lots and loading docks present their own unique challenges in terms of pollution. An initial concern for the project team was the possibility of the project site being characterized as a pollutant hotspot. Polycyclic aromatic hydrocarbons (PAHs), petrochemicals, and other pollutants can accumulate in a loading dock and parking lot setting. After the team consulted with an advisor at UMD Facilities Management, who investigated the MDE Stormwater Manual 2.41, it became clear that the dining hall loading dock/parking lot is likely not a hotspot because Dining Services is not loading or unloading chemical or industrial materials that could be dangerous if spilled.[8]

Bioretention Cells

8 MDE 2000 Maryland Stormwater Design Manual

The site is characterized by asphalt pavement and parked and idling vehicles, both of which can lead to the accumulation of PAHs. Fortunately, bioretention facilities have been shown to significa tly reduce PAHs from urban stormwater runoff.[9] Bioretention areas are also effici t at removing Total Suspended Sediment (TSS) from stormwater, with reduction ranging from 54% to 99%.[10] To achieve significa t phosphorus reductions, a deeper bioretention profile is ne essary, or the media can be supplemented with alum, Fe or steel slag.[11] An antecedent dry period is necessary to lower existing moisture content, which can further increase the bioretention cell's treatment capacity, thus making selection of drought tolerant plants an important consideration in the project.[12] In addition to the stormwater quality benefit , bioretention swales in urban landscapes can enhance invertebrate biodiversity.[13]

Pavedrain

Pavedrain is a permeable interlocking concrete paver (PICP) that provides ample storage and retention of stormwater. More significa t for the project site use, Pavedrain is designed to handle heavy loads from significa t truck traffic. Use of this material follows the University of Maryland's Design Criteria/Facility Standards Manual, which specifies th t concrete pavers are to be used over utilities whenever possible.[14] The team reached out to the local Pavedrain supplier, who provided expected stormwater quantity performance calculations based on our needs and design. PICP also has a significa t effect on stormwater quality. Studies have shown that PICP can reduce levels of phosphorus, nitrogen[15] and heavy metals,[16] and demonstrate a greater buffering capacity against acidic rainfall.[17]

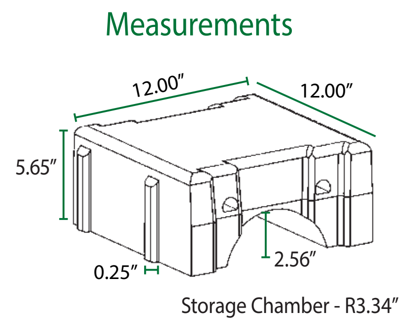

Figure 5. Detail of PaveDrain paver

DESIGN PROCESS AND SOLUTION: UNLOADING NUTRIENTS

Stakeholder Involvement & Interdisciplinary Collaboration

The project team chose this site after consulting with UMD Facilities Management. The project team met with stakeholders including facilities staff, campus civil engineers, cost estimators and designers throughout the design process. The team developed a proposal to address issues of stormwater treatment, maintenance, safety, functionality, and visibility. They presented multiple iterations of the design to Executive Director of Planning and Construction, Facilities Management, and design and engineering faculty in multiple interim design reviews. After

9 Diblasi et al. 2009
10 Davis et al. 2009
11 Li and Davis 2016
12 Mangaka et al 2014
13 Kazemi et al. 2011
14 DC/FS Executive Committee 2012
15 Bean et al. 2007
16 Drake et al 2014
17 Collins et al. 2010

Table2. Performance goals and outcomes

Goal	Technique	Outcomes
Store and treat 2-year storm	Bioretention cells and PICP	-Bioretention cells capable of removing -extra design capacity to accommodate increased precipitation intensity
Improve pedestrian corridor	Installed buffered walkway	-960 sq ft of sidewalk -Crosswalks give priority to pedestrians -4500 sq ft of pervious paver
Mitigate heat island effect	Increased tree canopy coverage and installed light colored pavers	-10 new trees installed -3,000 sq ft of vegetative cover
Create resilient plantings and improve habitat	Plants chosen for adaptability across climate extremes	-Plant palette is salt-tolerant and can endure temperature and precipitation extremes -Bloom times overlap and create window of opportunity for pollinators
Develop learning opportunities for students	Proposed research opportunity	-Controlled experiments allow for comparison of bioretention media -Interpretive signage introduces the campus community to BMPs

numerous critiques and iterations, the team arrived at a feasible and affordable design solution. The team consisted of students from four UMD programs: Landscape Architecture, Environmental Science and Technology, Mechanical Engineering, and Architecture.

Reconnecting the Pedestrian Corridor

The unpredictability of the existing circulation patterns and the lack of a designated pedestrian path in the South Campus Diner loading dock/parking lot is one of the major challenges the project team addressed. The proposed design created a pedestrian island that reconnected the existing pedestrian corridor running east to west. In addition to creating a buffered, designated pedestrian path, the island also includes bioretention basins to capture runoff f om the loading dock/parking area and helps create a more predictable, directed vehicular traffic ttern. Vehicles move counterclockwise around the pedestrian/bioretention island in the new design. The pedestrian/bioretention island is connected

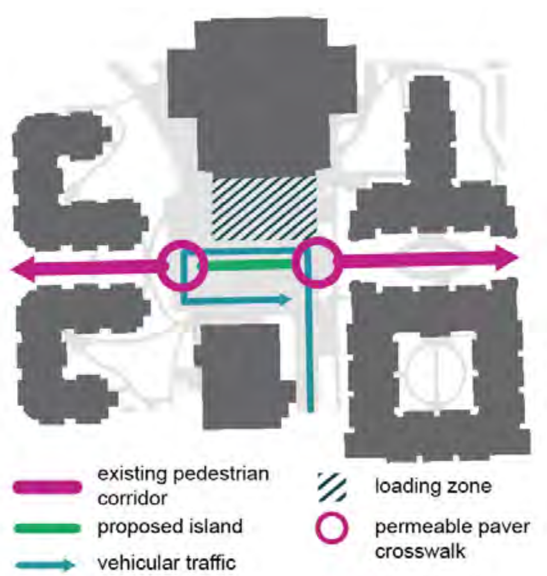

Figure 6. Proposed circulation pattern

to the existing pedestrian corridor with permeable paver crosswalks that capture runoff and calm traffic.

Another challenge the design team had to consider was the accommodation of existing loading dock usage and parking needs. With the proposed island, delivery trucks are still able to access the loading docks, and Dining Services vehicle parking spaces are relocated to the northwest corner of the site to improve traffic w and give trucks more space when backing into loading docks. All existing handicapped-accessible parking spaces are saved and relocated along the lecture hall on the south side of the site. In all, 21 of 28 parking spaces were saved.

Treatment Process

The proposed design placed a number of BMPs, which includes permeable pavement and bioretention cells, to capture and treat runoff f om the parking lot and loading dock. Runoff f om the fi e lane in the northwest corner of the site is directed into the northwest permeable paver parking. Runoff the loading dock a ea is directed into one of two permeable paver crosswalks or the bioretention island. The drive lane south of the bioretention island is crowned so that the water is split effici tly between the smaller bioretention basins along the lecture hall and the bioretention island. After passing through the permeable pavement system or bioretention basins, the treated stormwater is directed to the municipal stormwater system westward through existing pipes, which were located using a utilities map provided by UMD Facilities Management.

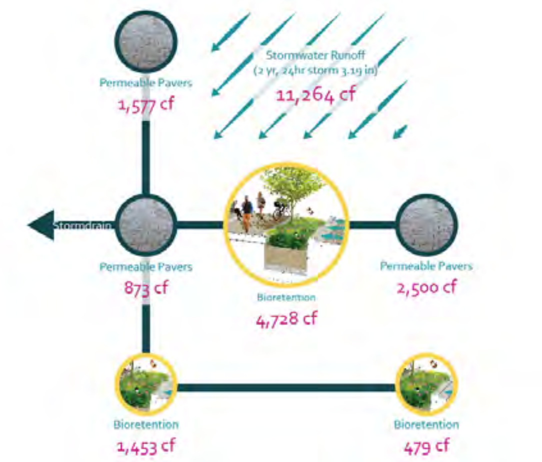

Figure 7. Stormwater fl ws to bioretention and permeable pavement systems for treatment

Climate Adaptation and Resiliency

The design for this stormwater retrofit can t eat 125% of the 1-year 24-hour storm, which is 2.63 inches for this region. To account for a changing climate in the future, which is expected to bring more intense storms and variable temperatures,[18] the bioretention basins and permeable pavers are actually sized to capture the current 2-year 24-hour storm. This extra capacity will accommodate anticipated increases in future precipitation events.

In addition, the plant palette has been selected to withstand extremes of temperature and precipitation. The proposed plant material tolerates a range of hardiness zones, including up to zone 9, and has been selected such that bloom periods overlap to create a continuous window of opportunity for pollinators. The 10 native trees selected for the bioretention basins can withstand wet and dry conditions as well as extreme heat. Red maples and blackgums provide brilliant fall leaf color and habitat and food resources for birds, small mammals, and pollinators. Shrubs,

18 https://www.epa.gov/sites/production/files/2016-08/docume ts/climate_indicators_2016.pdf

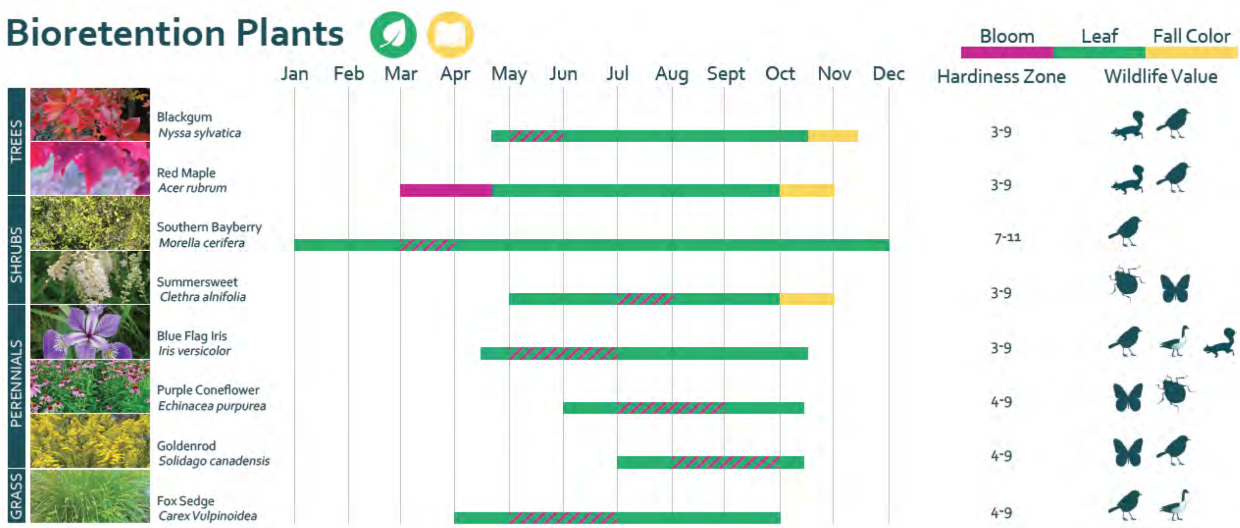

Figure 8. Plant palette shows seasonal interest and tolerance for varied conditions

planted with trees in the bioretention basins bordering the loading dock, include native southern bayberry and summersweet, which provide visual interest and fragrance.[19] Fox sedge, purple conefl wer, and goldenrod are planted amongst the shrubs and trees in the basins and provide food and habitat resources for wildlife. This consideration contributes to the overall resiliency and adaptability of the ecosystem[20] and provides continuous visual interest for passing pedestrians.

MAINTENANCE

Bioretention Basins

The EPA's 2016 Technical Memorandum on operations and maintenance recommends the following:[21]

◊ Aesthetic Maintenance
- *Prune and weed as needed especially during establishment*
- *Renew or replace mulch where disturbed.*
- *Remove trash and debris, inspect clean outs and over drain inlets for signs of clogging or damage.*
- *Replace vegetation to achieve 90% ground coverage*
- *Remove any dead or dying vegetation*

◊ Performance Maintenance
- *Record visual observations regarding structures, standing water*
- *Measure flow of runoff*
- *Collect data during precipitation events*

19 Dirr 2009
20 Hunter 2011
21 US EPA "Operation and Maintenance of Green Infrastructure Receiving Runoff f om Roads and Parking Lots"

Permeable Pavers

The PaveDrain manufacturer's Maintenance Manual recommends the following:[22]

◊ Assess PaveDrain system for infilt ation during storm event
  - *Visual inspection*
  - *Insert ruler between joints.*
  - *Vacuum when ruler is obstructed after 2 inches*

◊ Replace cracked or broken pavers as needed

◊ Vacuum using PaveDrain Vac Head

◊ Alternative option: Elgin Whirlwind or Megawind Vacuum Truck

◊ Extreme option
  - *Remove PaveDrain mats to clean aggregate layer and replace after operation*

BUDGET

The project team emphasized creating a valuable design that would be a serious candidate for implementation. The costs of the proposed intervention were evaluated after consultation with UMD Facilities Management's Lead Estimator for Design and Construction and the Vice President of Sales and Estimating from a local engineering fi m, EQR, LLC. The costs outlined in the table below represent the current, all-in market prices calculated from UMD's construction estimating team.

Table3. UMD's all-in cost of construction

MATERIALS	TOTAL COST
Bioretention Cells	$67,200.00
Concrete	$40,965.50
Aggregate	$1,820.00
Excavating	$10,114.81
PaveDrain	$46,950.00
Asphalt	$29,145.71
Striping	$2,646.00
Plant material	$12,280.00
	$211,122.03

A potential funding source to implement this design is the UMD Sustainability Fund, which offers grant money for projects that improve environmental sustainability and enhance the student experience. The team will apply for funding to mockup the parking lot intervention, which is described in the next section. A successful mock-up will convince the Office of Sustainability, UMD Facilities Management, and the President's Office to look more closely at implementing the design in its entirety.

ENGAGING THE CAMPUS COMMUNITY

Research Opportunity

The three equally-sized bioretention cells on the south side of the island would be utilized for research on popular bioretention media specific tions. Dr. Allen Davis, who researches the performance of stormwater BMPs and the role of alum in removing the nonpoint source pollutant,

22 PaveDrain Maintenance Manual

phosphorus could serve as the principal investigator. With local landscape architecture and engineering fi ms as a potential funding source, three commonly used bioretention media mixes would be chosen for comparison in the three bioretention basins. Water sampling equipment could be deployed at various depths in the media and at the inlet and outlet of each bioretention cell to determine the nutrient and pollutant removal effic y of the different media mixes.

Park(ing) Day Mock-up

Current layout and use of the site as a parking lot and loading dock present it as an open canvas for temporary interventions. As part of a push for implementation, there is an opportunity to mockup the design at full scale on site. This mock up will take place on Park(ing) Day 2017, which is an international celebration in September that transforms parking spaces into vibrant public open space. This proposal responds to the University of Maryland's Fearless Ideas campaign and takes this proposal beyond the conceptual phase into an actionable, real-life intervention.

The team would quickly learn how the design impacts pedestrians, cars, and trucks as they move through the space through observations and informal interviews. For instance, the team would observe and record pedestrian movement through the site to better understand how well our design intervention improves pedestrian safety and comfort. The team would also talk to people who walked through the transformed space and see if the mockup opened their eyes to the possibilities of the currently barren parking lot.

The mock up would require approval and support of multiple campus departments, including the Landscape Architecture Department, UMD Facilities Management, Campus Dining Services, Department of Transportation, and the Architectural Review Board. Several organizations and companies, including Ruppert Nurseries, Maryland Chapter of the American Society of Landscape Architects, and Pavedrain, could potentially partner with the team on this mockup and provide the necessary materials.

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