MASTER PLAN

Stormwater Management Master Plan

Christopher Newport University

PREPARED FOR

CHRISTOPHER NEWPORT UNIVERSITY

1 Avenue of the Arts
Newport News, VA 23606
757.594.7000

PREPARED BY

vhb

4500 Main Street, Suite 400
Virginia Beach, VA 23462
757.490.0132

June 28, 2019

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Acknowledgements

Vanasse Hangen Brustlin, Inc. (VHB) would like to thank our collaboration partners who provided guidance and vision in the planning and preparation of this document.

Christopher Newport University

Christine Ledford- Senior Associate VP for Administration and Finance

Michelle R. Campbell, RA – Director of Capital Outlay Management

Scott Gesele – Facilities Management

David Guglielmo – Facilities Management

R. Dean Whitehead – Director of Grounds

Planning Team

Vanasse Hangen Brustlin, Inc.
Two Columbus Center
4500 Main Street, Suite 400
Virginia Beach VA 23462
www.vhb.com

John M. Stronach, P.E. – Regional Institutional Leader

John D. Hines, P.E. – Principal

Erika Walsh, P.E. – Project Manager

Evan N, Waagen, P.E. – Project Engineer

Katie Anderson, EIT – Site/Civil Designer

Karen Bagnell, EIT – Site/Civil Designer

Noel O'Neil – Lead Designer/Graphics

Dave W. Andrea, L.S. – Survey Manager

List of Abbreviations

Title	Abbreviation
Army Corp of Engineers	ACOE
Best Management Practice	BMP
Chesapeake Bay Local Assistance Department	CBLAD
Chesapeake Bay National Estuarine Research Reserve	CBNERR
Chesapeake Bay Preservation Act	CBPA
Capital Improvement Project	CIP
Christopher Newport University	CNU
Virginia Department of Conservation and Recreation	DCR
Virginia Department of Environmental Quality	DEQ
Department of Game and Inland Fisheries	DGIF
Environmental Protection Agency	EPA
Geographic Information System	GIS
Hydrodynamic Separator	HDS
Intensely Developed Area	IDA
Leadership in Energy and Environmental Design	LEED
Low Impact Design	LID
Minimum Standard	MS
National Fish and Wildlife Federation	NFWF
National Pollution Discharge Elimination System	NPDES
Resource Protection Area	RPA
Stormwater Improvement Project	SIP
Stormwater Management	SWM
Stormwater Management Master Plan	SWMP
Total Maximum Daily Load	TMDL
Vanasse Hangen Brustlin	VHB
Virginia Stormwater Management Handbook	VSMH
Virginia Stormwater Management Program	VSMP
Water Quality Inlet	WQI

Executive Summary

Christopher Newport University (CNU) has contracted with VHB to create a Campus Stormwater Management Master Plan. This Plan will provide guidance for CNU, in the form of stormwater management concepts, to keep pace with the ever changing *Campus Master Plan*. If followed through to construction, the stormwater management concepts provided within will ensure that the Department of Environmental Quality (DEQ) water quality regulatory requirements will be adequately addressed.

In addition, CNU'S Phase II MS4 Permit requires the reduction of overall campus phosphorus loading (TMDL Reduction Requirement) from the property in three permit cycles. CNU is located within the James River Watershed. Thus, the goals were determined using the 2009 Edge of Stream loading rates for the James River Watershed. The goals assume a starting date of July 1, 2009, where an impervious footprint was established. See *Table 1* for a summary.

Table 1: Phase II MS4 - TMDL Reduction Requirement (lbs/yr)

End of Permit Cycle	Campus Area (ac)	Acquired Area (ac)	Impervious Area (ac)	First Permit Cycle Reduction Goal (lbs.)	Second Permit Cycle Reduction Goal (lbs.)	Third Permit Cycle Reduction Goal (lbs.)	Total TMDL Reduction (lbs)
2009 (1)	141.87	0	62.14	1.02	7.14	12.23	20.39
2018 (2)	147.24	5.37	71.59	1.15	8.02	13.74	22.90
2018 (3)	158.17	10.93	76.90	1.23	8.61	14.76	24.60
Lake Maury (4)				0.07	0.51	0.88	1.46
2018 Total	**158.17**	**16.30**	**76.90**	**1.30**	**9.12**	**15.64**	**26.06**
Acquired Property (5)	3.75	3.75	2.65	-	0.31	0.48	0.79
2023/2028 Total	**161.92**	**3.75**	**79.55**	**1.30**	**9.43**	**16.02**	**26.85**

(1) Based on Christopher Newport University- Chesapeake Bay TMDL Action Plan by Koontz-Bryant, P.C. dated September 2015

(2) Based on Christopher Newport University- Municipal Separate Storm Sewer System (MS4) Annual Report- Reporting Year July 1, 2017-June 30, 2018

(3) Includes Acquired Property- impervious area based on GIS linework

(4) Per Guidance Memo 15-2005 additional removal is required for grandfathered projects. Based on Special Condition 7, the additional removal is determined by reducing the campus impervious percentage by 10%. Grandfathered projects for the campus were master planned using Lake Maury.

(5) Includes additional acreage and impervious for the Shenandoah River Hall transfer from real estate foundation to campus property.

***Values obtained from Watershed Model for James River Basin as part of the Commonwealth of Virginia, Chesapeake Bay Watershed Implementation Plan, dated November 29th, 2010. These values represent required reductions to**

meet the L2 Implementation levels for non-federal MS4s. Spreadsheets can be found in Appendix B: Baseline Condition and TMDL Target.

Refer to **Appendix B: Figures and Calculations - Baseline Condition and TMDL Target** for a summary of Campus projects to the TMDL requirements for Phosphorus, Nitrogen, and Total Suspended Solids.

The development of this comprehensive stormwater management plan was initiated through collection and review of existing data and reports documenting site conditions and engineering design of past projects. A key element of the project methodology was a planning meeting (refer to **Appendix G: References**) that was conducted to discuss alternatives for stormwater management and water quality improvement.

There are three main strategies that can be employed to address the Campus Phosphorus removal goals.

1. Construct a series of stand-alone **Stormwater Improvement Projects (SIPs)**—BMPs integrated into the CNU existing stormwater management system that are not tied to Capital Improvement Projects or budgets.

2. Require all **Capital Improvement Projects (CIPs)** to reduce post-construction phosphorus loading by more than minimum standard per project.

3. Purchase **Nutrient Credits.**

Stormwater Improvement Projects

The first strategy identifies stand-alone Stormwater Improvement Projects (SIP), which are stormwater management solutions that are not associated with a particular building project. These projects do not have pollution reduction requirements; they simply reduce the campus pollutant loading by the net change in existing versus proposed loading with the incorporation of a BMP.

CNU used this strategy for the first permit cycle (2018) goals. The University installed the BMP at Parking Lot A which includes a Bioretention (Level 1) and provides 1.44 lbs of removal. **Therefore, CNU has met the TMDL goal for 2018.** However, a significant deficit remains for 2023 and 2028. Refer to **Appendix B: Figures and Calculations - Baseline Condition and TMDL Target** for a summary of Campus projects to the TMDL requirements for Phosphorus, Nitrogen, and Total Suspended Solids.

Table 2 provides a summary and breakdown of potential SIPs for the second two permit cycles (2023 & 2028). Refer to **Appendix D** for figures and calculations for SIPs.

When evaluating potential SIPs, the Lake Maury Outfall- Stream Restoration appears most efficient in terms of both cost and phosphorus removal. The solution would provide treatment for CNU owned property, City of Newport News owned property, and some

privately-owned property. The solution would require coordination with the City, DEQ, ACOE, and NFWF. The stream restoration would mitigate a large portion of the remaining TMDL goals.

While the remaining SIPs provide less phosphorus removal than the stream restoration the Lot E2/E3- Hydrodynamic Structure is more efficient in terms of phosphorus removal and cost.

Table 2: Stormwater Improvement Project Summary

Type of BMP	Project Name	Location	Percent Removal	P-Removal (lbs/yr)	SWM Cost ($)	Cost per Pound of P-Removal ($/lbs)
Stream Restoration	SIP-1	Lake Maury Outfall		24.55	644,628	26,258
Hydrodynamic Structure	SIP-2A	Lot E1	20	1.33	207,000	155,639
Water Quality Structure	SIP-2B	Lot E1	50	3.32	565,800	170,422
Hydrodynamic Structure	SIP-3	Lot E2/E3	20	4.21	289,800	68,836
Bioretention (Level 1)	SIP-4	Lot H	25	0.93	286,350	307,903
Water Quality Structure	SIP-5A	Lot I	50	1.69	317,400	187,811
Water Quality Inlets	SIP-5B	Lot I	50	1.08	469,200	434,444
Hydrodynamic Structure	SIP-6	Lot C1	20	0.70	151,800	216,857
			Total	**37.81**	**2,931,978**	**-**

Capital Improvement Projects

The second strategy identifies stormwater management practices targeted for future Capital Improvement Projects (CIPs) on campus. These practices will be constructed with specific future building projects outlined in the current Comprehensive Campus Master Plan. The provided solutions are a guide and can be adjusted once the actual site designs begin. However, the overall pollutant removal goals should remain similar for each site. Each CIP site was evaluated as re-development based on existing conditions.

The following Capital Improvement Projects (CIPs) were constructed during the first permit cycle between 2013 and 2018.

- David Student Union- Regattas
- Luter Hall Lawn Phase I (New Hall Parking Lot Demo and Walkway Design)
- Hoinkes Plaza/ Bell Tower
- Greek Village Phase 1
- Eyre Tennis Courts Phase II
- Trible Library Expansion
- E4 Gravel Lot

BMPs in addition to Lake Maury were not installed with these projects and therefore **do not help CNU meet the TMDL goal.**

See Table 3 for a summary and breakdown of potential CIPs. See **Appendix C** for figures and calculations for CIPs.

Table 3: Capital Improvements Projects Summary

	Minimum Requirement		
Capital Improvement Project Name	**P-Removal Required (lbs/yr)**	**SWM Cost ($)**	**Cost per Pound of P Removal ($/lb)**
Fine Arts Center	Under Design		
Captains Turf Field Replacement	Under Design		
C2 Parking	Under Design		
Shenandoah River Hall	1.03	$622,895	$604,753
Alumni Hall Lawn	0.00	-	-
2023 Permit Cycle Total	**1.03**	**$622,895**	**$604,753**
Greek Housing Phase II	1.53	$874,890	$571,823
Luter Hall Lawn Phase II	0.00	-	-
2028 Permit Cycle Total	**1.53**	**$874,890**	**$571,823**
Grand Total	**2.56**	**$1,497,785**	**$585,072**

When evaluating potential CIPs, no project appears efficient in terms of both cost and phosphorus removal. All the proposed CIPs provide approximately equal pollutant removal at similar costs per pound of phosphorus removal. Due to similar project site areas in addition to existing and proposed cover types, each project site carries similar redevelopment phosphorus removal requirements. In addition, proposed BMPs for each project site are similar due to site and stormwater constraints present on the CNU campus.

Nutrient Trading Strategy

Capital Improvement Projects – In order to reduce the amount of phosphorus from the watershed entering the receiving Chesapeake Bay, the General Assembly is taking a more extensive approach in nutrient trading. Effective as of July 1st, 2014 nutrient credits can be purchased to offset the phosphorus loading from developments. There are several benefits in using nutrient credits, most notably there are no perpetual operation and maintenance costs to consider. Permits allowing nutrient credits are issued by Virginia Stormwater Management Program authorities (VSMP) based on the following benchmarks, where:

- Less than five (5) acres will be disturbed, or
- There is less than ten (10) pounds of phosphorus removal requirement, or
- 75% of the required phosphorus is captured on site (the remaining 25% may be obtained offsite), or
- It was not practicable to capture 75% on site (the remaining amount potentially 100%, may be obtained offsite)

Stormwater Improvement Projects (TMDL) – In addition to using nutrient credits to aid CIPs in meeting their development goals the "General VPDES Permit for Discharges or Stormwater from Small Municipal Separate Storm Sewer Systems" effective November 1, 2018 allows the use of nutrient credits to meet TMDL requirements. Refer to **Appendix G** for a copy of CNU's MS4 permit (VAR040090). The following requirements must be met based on the VPDES Permit:

- The credits are generated and applied to a compliance obligation in the same calendar year
- The credits are generated and applied to a compliance obligation in the same tributary
- The credits are acquired no later than June 1 immediately following the calendar year in which the credits are applied, **AND** the permittee certifies on an MS4 Nutrient Credit Acquisition Form that the permitted has acquired the credits.
- Total **nitrogen and total phosphorus credits** shall be either point source credits generated by point sources covered by the Watershed Permit for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed general permit issued pursuant to 62.1-44.19:14 of the Code of Virginia, or nonpoint source credits certified pursuant to 62.1-44.19:20 of the Code of Virginia.
- **Sediment credits (TSS)** shall be derived from:
    - Implementation of BMP in a defined area outside of an MS4 service area, in which case the necessary baseline sediment reduction of such defined area shall be achieved prior to the permittee's use of additional reductions as credits; or
    - A point source waste load allocation established by the Chesapeake Bay TMDL, in which case the credit is the difference between the waste load allocation specified as an annual mass load and any lower monitored annual mass load that is discharged as certified on an MS4 Sediment Credit Acquisition Form.

- Sediment credits shall not be associated with phosphorus credits used for compliance with the stormwater nonpoint nutrient runoff water quality criteria established pursuant to 62.1-44.15:28 of the Code of Virginia.

The current approximate rate of nutrient trading for the James River watershed is **$13,000-$16,000** per pound phosphorus. This is a one-time fee.

Operation and Maintenance

Best Management Practices – There are several stormwater BMP's that currently provide CNU with adequate water quality control. Maintenance of these existing BMP's is paramount in maintaining water quality benefits. With the rapidly changing campus there is a need for Master Planning of future BMP's to account for the increase in impervious area. Implementation of the future components of the Stormwater Master Plan will include:

- Bioretention Basins
- Wet Ponds
- Permeable Pavers
- Water Quality Inlets/ Structures
- Underground Detention
- Hydrodynamic Devices

A summary of existing BMPs that provide water quality control can be found in the Existing Condition section of this report. New BMPs proposed as part of the various CIPs and SIPs are summarized in the Proposed Conditions sections of this report. Operation and maintenance costs for both existing and proposed BMPs are summarized in *Table 4*. Yearly costs included in this table reflect BMP operation and maintenance costs for the existing 2018 baseline condition as well as new CIPs included in each permit cycle. An average cost is included by averaging the existing baseline cost and the new costs associated with the end of 2028 permit cycle. These costs account for inspections and maintenance that are required to maintain these BMPs in working order. See **Appendix F** for BMP descriptions and specific long-term maintenance requirements.

Table 4: Operation and Maintenance Cost Summary

				CIPs					SIPs	
				2018	2023	2028	SUM		SUM	
BMP Type	Typical Cycle (years)	Cycle Cost ($)		Qty	Qty	Qty	Qty	Total Cost ($/year)	Qty	Total Cost ($/year)
Bioretention Basin	1	$1,000	per basin	1	3	0	4	$4,000	1	$1,000
Permeable Pavers	1	$1,500	per acre	0	0.5	0	0.5	$750	0	$0
Hydrodynamic Device	1	$3,000	per structure	0	0	0	0	$0	3	$9,000
Water Quality Inlet	1	$1,500	per structure	0	0	0	0	$0	6	$9,000
Water Quality Structure	1	$2,500	per structure	0	0	2	2	$5,000	0**	$0
Extended Detention	1	$750	per pond	2	0	0	2	$1,500	0	$0
Underground Detention	1	$2,000	per pond	0	1	2	3	$6,000	0	$0
Stream Restoration	1	$5	per lf	0	0	0	0	$0	570	$2,850
Lake Maury*	1	$10,000		1	0	0	1	$10,000	0	$0
			Total					$27,250		$21,850

* Based on Lake Maury Watershed Management Plan dated May 9, 2003

**The SIP option with the larger cost is included in the summary

Institutional Background

Christopher Newport University (CNU) is a public university located in coastal Virginia in the City of Newport News. CNU occupies an institutional footprint of approximately 152 acres. CNU was Founded in 1960 as Christopher Newport College, a two-year branch of the College of William & Mary. The College was originally located in a former public-school building in Downtown Newport News. In 1963 the city of Newport News purchased a 75-acre tract of land on Shoe Lane and give it to the state of Virginia as a permanent site for Christopher Newport, where it became a four-year degree-granting institution in 1971. Christopher Newport College gained independence from the College of William & Mary in 1977 and became a university in 1992. The campus is located in southeastern Virginia and flanks Warwick Boulevard. Approximate campus boundaries include Prince Drew Road to the north, Moores Lane to the west, Avenue of the Arts/ J. Clyde Morris Boulevard to the south, and Warwick Boulevard to the east.

Recent major improvements to the campus include the construction of the Greek Housing Project, Eyre Tennis Courts, and the Trible Library Expansion. Since the early 1980's, considerable attention has been given to managing stormwater runoff. This has led to the creation of multiple regulatory programs aimed at guiding development. Ultimately these regulations will improve water quality in receiving waters, particularly the Chesapeake Bay, for generations to come.

Historically, stormwater management on the CNU campus was handled by Lake Maury on a project-by-project basis. The purpose of this 2018 Campus Stormwater Master Plan is to ensure Christopher Newport University is striving to reach the water quality goals. A decrease in pollutant loading will be provided through the implementation of various low-impact development strategies. These strategies are aimed to minimize the intrusive nature of traditional "pipe to pond" approaches to stormwater management. Additional water quality can be achieved through the retrofitting of existing stormwater management structures on campus. Upgrading existing BMPs into more efficient and effective versions is one example of this strategy.

Existing Conditions

The CNU campus is situated in the coastal plain area upstream of the James River near the Mariners Museum in Newport News. Generally, the entire campus lies between 30 and 35 feet in elevation. The campus is a mix of buildings, surface parking, pedestrian walkways, open lawn, landscaped beds around buildings and a variety of ornamental trees and shrubs.

Fountain located interior to Campus

Geotechnical Information

According to the NRCS Soil Survey maps, the predominant soil types located within the site are classified as Craven-Urban Land Complex (ML) and Chickahominy- Urban land complex (CL). Urban land is classified as previously impervious developed areas, such as parking lots and buildings and by high runoff potential, therefore will typically be classified as Hydrological Soil Group D. Hydrological Soil Group D is characterized by high runoff potential due to very slow infiltration rates. Refer to **Appendix G: References** for the NRCS Soil Survey Map.

The shallow subsurface soils typically consist of 0 to 5 feet of earth fill materials underlain by a fine to coarse SAND (SM, SP-SM) deposit with trace clay, which typically extends to depths ranging from 5 to 40 feet below existing grades. A third layer of silty fine sandy CLAY/ dine sandy silty CLAY is located beneath the SAND stratum. The earth fill materials are typically comprised of a mixture of SAND, SILT, and CLAY soils mixed with varying amounts of debris (concrete, wood, brick, and other deleterious materials).

The groundwater table typically occurs at depths ranging from 10 feet to 20 feet below surface grades. Groundwater conditions will vary with environmental variations and seasonal conditions, such as the frequency and magnitude of rainfall patterns, as well as man-made influences, such as existing swales, drainage ponds, underdrains and areas of covered soil (paved parking lots, sidewalks, etc.). The normal seasonal high groundwater level will fluctuate about 2-3 feet; however, greater fluctuations have been noted in the past. A separation of 2 feet is typically required from the seasonal high groundwater, this may be reduced to 1 foot for bioretentions in the coastal plain.

Infiltration Information

As previously mentioned, the shallow subsurface soils (upper 0 to 5 feet) generally consist of earth fill material underlain by a natural SAND stratum. The earth fill materials, which are typically located within the upper 2 to 6 feet, are non-homogeneous due to the presence of varying amounts of debris. The earth fill material can often be difficult to grade, as large pieces of debris are often encountered. It is anticipated that infiltration rates would fall

between 0.25 in/ hour to 2.0 in/ hour based on soil types. Infiltration testing should be performed on all campus sites as this information is critical when determining the feasibility of any infiltration BMP's on the campus.

Wetlands Information

Based on information contained within the National Wetlands Inventory, a finger of Freshwater Forested/ Shrub Wetlands (PFO1C) extends north of the Avenue of the Arts. Freshwater Forested/ Shrub Wetlands are seasonally flooded non-tidal wetlands whose vegetation includes broad-leaved deciduous trees and shrubs that are shed during the cold or dry season.

Chesapeake Bay Preservation Areas

The James River shoreline and the impounded water body of Lake Maury have been designated as Resource Protection Areas (RPA) in accordance with the Chesapeake Bay Preservation Act (9VAC25-830-80). Both contain a 100-foot RPA buffer. The RPA extends to Museum Drive and Resource Management Areas (RMA) extend to the north of the Avenue of the Arts. An RMA extended a minimum of 100-feet inland from the RPA. The City of Newport News ordinance defines and RMA as an area that' has "the potential for causing significant water quality degradation of for diminishing the functional value of a Resource Protection Area." Development and redevelopment within these sub-basins are regulated by the Division of Chesapeake Bay Local Assistance Department of the Department of Environmental Quality (DEQ), it is required that all development and redevelopment conform to the water quality criteria established in the Virginia Stormwater Management Regulations (9VAC25-870 et al.). Refer to **Appendix A-Figure 1** for CBPA area.

Tidal Conditions

CNU is located directly adjacent to Lake Maury which is disconnected from tidal influence therefore Tidal conditions do not apply.

Floodplain

The campus is not located within floodplain, or Flood Hazard Areas, as shown on the National Flood Insurance Program Flood Insurance Rate Map for **City of Newport News, Virginia Community Panel Numbers 5101030109D, 5101030128D, and 5101030136D**, effective date **December 9, 2014**. The proposed site lies within Flood Zone X, which is defined to be areas outside of the 500-year floodplain, and therefore, not subject to flooding. A small finger of Flood Zone A is located south of the Avenue of the Arts. Flood Zone A is defined to be within 100-year floodplain.

Sea Level Rise

Many studies have been done on Sea Level rise in the United States. Documentation of data available for both Sea Level Rise and Subsidence cannot be denied. Hampton Roads is subject to both of these constraints for development. Sea level rise is defined as the effect of thermal expansion (as ocean water warms, it expands), land-based ice melting and movement of water in the ocean causing the tidal elevations to increase in relation to a land-based datum. Additionally, subsidence is the motion of a surface (usually, the Earth's surface) as it shifts downward relative to a datum, such as sea-level.

While data is still being processed and refined, it is obvious that the risk of flooding is increasing. Areas adjacent to tidal waters of the Chesapeake Bay are anticipated to see significant flooding. Christopher Newport University is upstream of the James River, a tidal river. The FEMA Base Flood elevations of the James River range with a 100-year storm elevation from 9 to 12 (NAVD 1988 Vertical Datum). The Hampton Roads area is expected to see an approximate 1.5' increase in the base flood elevation over the next 50 years. It is anticipated that unless major federal, state and/or municipal projects are undertaken to reduce the impact of sea level rising, the impact to shorelines will continue to worsen. The CNU campus is not expected to experience as big of an impact as more coastal communities as the campus is around elevation 30, however sea level rise could still impact the campus.

Watershed Information

The CNU campus discharges to the Lower James River Basin a part of the larger Chesapeake Bay Watershed. The James River Basin is the largest watershed within the State, draining approximately 10,265 square miles of land area and is comprised of the Upper, Middle, and Lower sub-basins. The James River watershed covers an area that stretches from the western Virginia border and includes area from 38 counties and 17 cities. Land use within the watershed is mostly forested and approximately 12% is considered urban.

The James River Mainstem is included on the 2016 Impaired Waters- 303(d) list as needing a total maximum daily load study with TMDL. The Impaired Waters List describes the impairment group for the James River as category 5A, aquatic life and the cause has Estuarine Bioassessments. Additionally, portions of the James River are included in the Listings under cause category 5A for PCB in fish tissue.

Major Watersheds/ Outfalls

The CNU campus has four (4) major outfalls which discharge to Lake Maury (HUC HL43) and Cooper Creek (HUC JL43). Locations and drainage areas associated with each outfall are shown on **Appendix A-Figure 1**.

Lake Maury

Outfalls 1 through 3 are located adjacent to the Ferguson Center for the Arts west of Warwick Boulevard and drain into an open channel to Lake Maury.

Outfall 1 (48″ RCP) conveys drainage from Lot B, Lot C1, Ferguson Lawn, Ferguson Center Parking Deck, Lot A and a portion of the Ferguson Center for the Arts. Outfall 1 collects runoff from approximately 23.7 acres of the CNU campus.

Outfall 2 (72″ RCP) conveys drainage from the majority of the CNU campus including area basically bound by Prince Drew Road to the North, Moores Lane to the west, Warwick Boulevard to the east and the David Student Union to the South. Outfall 2 collects runoff from approximately 98.6 acres of the CNU campus.

Outfall 3 (48″ RCP) conveys drainage through a concrete channel from Shoe Lane, York River Hall and a portion of the Ferguson Center for the Arts. Outfall 3 collects runoff from approximately 11.4 acres including approximately 7.5 acres of the CNU campus.

CNU has additional properties east of Warwick Boulevard that drain to Lake Maury.

Cooper Creek

Outfall 4 (36″ RCP) that drains via a 48″ RCP to Country Club Lake. Outfall 4 conveys drainage from Moores Ln, Lot G, Lot H, Captains Park Baseball, and a portion of Lot I. Outfall 4 collects runoff from approximately 24.6 acres including approximately 10.6 acres of the CNU campus.

SWM Water Quality Constraints

Regulatory Considerations

In addition to its fundamental interest in developing an environmentally sound stormwater plan, the university must comply with several regulations administered by the Virginia Department of Environmental Quality, Tidewater Regional Office. Regulations governing stormwater management practices include the Virginia Stormwater Management Program (VSMP) Regulations, the Chesapeake Bay Preservation Act (CBPA) Regulations, the Virginia Erosion and Sediment Control Law and Regulations (VESCL&R), and the Municipal Separate Storm Sewer (MS4) Permit Regulations.

These programs were developed to ensure that construction activities and storm sewer system operation in environmentally sensitive areas are conducted in a manner that will protect and improve water quality. Water quality is to be addressed through the use of Low Impact Development (LID) and a number of other Best Management Practices (BMPs), such as wet ponds, infiltration devices, and manufactured water quality inlets. Generally speaking, the requirements of each regulatory program are as follows:

1. Municipal Separate Storm Sewer System (MS4) Regulations

   The Virginia DEQ submitted its final Phase II Watershed Implementation Plan (WIP) to the EPA. The Phase II WIP outlines DEQ's comprehensive strategy for achieving compliance with the Chesapeake Bay TMDL, an EPA-specified "pollution diet" of nitrogen, phosphorus, and total suspended solids.

   The MS4 regulations, one of several strategies outlined in the WIP, establish the degree of stormwater runoff pollution emanating from Chesapeake Bay subwatersheds in Virginia, and set pollution reduction targets for the state's MS4s. Pollutant loading rates were determined according to conditions existing in 2009, and reflect the impact of BMPs operational at that time. The pollutant loading rate also varies per Chesapeake Bay subwatershed, and this is also true of the pollutant reduction rates required. All MS4 operators must demonstrate compliance with the target reduction established for their subwatershed by 2028, although the regulations allow for reductions to be accomplished in 5-year intervals. As such, this study shall present CNU's total pollutant loading and mitigation activities at four (4) intervals:

   - July 1, 2009 "Baseline" condition
   - July 1, 2018 Current conditions (5% reduction)
   - July 1, 2023 conditions (35% reduction)
   - July 1, 2028 conditions (60% reduction)

   Calculations regarding pollutant loading and mitigation techniques shall be performed as prescribed in the Virginia Stormwater Management Handbook (VSMH) and the BMP Clearinghouse guide, as discussed in greater detail below.

2. Virginia Stormwater Management Program Regulations

The VSMP Regulations, the associated Virginia Stormwater Handbook (VSMH), and the BMP Clearinghouse guide serve as the primary guidance documents for estimating pollutant loading and assessing the effectiveness of treatment techniques (BMPs). In particular, VSMP Regulations 9VAC25-870-63, 9VAC25-870-65, and 9VAC25-870-66 provide design criteria related to stormwater quality and quantity management. The VSMH and the BMP Clearinghouse guide are typically utilized as a resource for developers, as the VSMP Regulations require that all land disturbance activities exceeding 2,500 square feet include a post-construction stormwater management plan. For the purpose of this study, the VSMH and the BMP Clearinghouse guide shall be utilized to calculate loading associated with the overall campus, evaluate the performance of BMPs installed since 2009, and forecast the performance of BMPs not yet installed.

VSMP Regulations identify phosphorus loading as the "keystone" indicator of runoff water quality. As phosphorus is present in stormwater runoff in both particulate and soluble form, its concentration in stormwater runoff is considered indicative of the presence of other pollutants (nitrogen, TSS) that exist in either form. Together, the VSMH and the BMP Clearinghouse guide evaluate BMP performance in terms of a percentage of Total Phosphorus (TP) removed.

As of July 1, 2014, the DEQ implemented VSMP regulation 9VAC25-870-62 utilizes a "runoff reduction method" to perform stormwater management calculations. The runoff reduction method establishes rates of phosphorus loading according to more specific cover types, as described by characteristics such as hydrologic soil group, and surface treatment. The new method also increases the degree of water quality remediation required on redevelopment sites.

Provisions of the VSMP regulations, as of the 2014 revisions, require that if a redevelopment project site is less than 1 acre, phosphorus loadings from that site must be reduced by 10% as compared to the existing developed conditions. Phosphorous loadings must be reduced by 20% when the project area is greater than 1 acre. The ultimate goal is to attain the allowable 14% impervious percentage through LID or BMP's to the Chesapeake Bay. This will be accomplished by drastically reducing each projects impervious area or with the use of strategically placed BMP's and nutrient credits.

The last pertinent change established in the new regulations is the increased focus on impervious area disconnect. Impervious area disconnect is the practice of discharging runoff from impervious surfaces to open channels, BMPs, or landscape buffers in lieu of connecting directly into a subsurface closed drainage system. This change to the regulations, as with other changes discussed previously, shall be applied to new projects only, and is not applicable to existing development on the campus and associated BMPs.

3. Chesapeake Bay Protection Act Regulations

The CBPA regulates stormwater management system design within the tidewater-influenced portion of Virginia. As CNU is within this jurisdictional area, the CBPA Regulations are applicable to improvements made on the CNU campus. The CBPA was created in 1988 by the state of Virginia to help improve water quality while allowing development throughout the state to continue. Each Chesapeake Bay Preservation Area must adopt a program that is based on the Chesapeake Preservation Act and the Chesapeake Bay Preservation Area Designation & Management Regulations. Each program includes a plan for development that is completed before receiving a building permit so that the water within the land maintains the necessary quality.

Methodology

The development of a comprehensive Stormwater Master Plan for the CNU campus was initiated through the collection and review of existing data and reports that documented site conditions and engineering design of past development projects. This process included the review of numerous drainage reports and published data describing the general environmental setting of the campus. Engineering plans and GIS databases from CNU were obtained and used to develop an understanding of existing topography, utility locations, and drainage structures. This information was used to evaluate potential design alternatives for addressing stormwater runoff.

A key element of the project methodology was a planning meeting that was conducted to discuss alternatives for stormwater management and water quality improvement. The meeting included representatives from the Christopher Newport University along with engineers and planners from VHB. This forum encouraged collaboration between the various disciplines involved in the plan development with a focus on aesthetics and function. The results of the meeting included a list of specific stormwater management strategies for each of the watersheds within the campus.

Following this meeting, the alternatives were evaluated quantitatively to determine approximate size and suitability for meeting DEQ requirements. After consulting with the CNU staff, an agreement on the water quality model was reached. This information has been compiled in this Stormwater Master Plan, for use by CNU as a guide toward future campus development. The document includes a discussion of existing site conditions. Discussion of the master campus development plan (proposed conditions) is provided, to establish basic design considerations and define stormwater quantity and quality goals. Various management strategies identified during the planning meeting are then presented graphically and quantitatively to demonstrate the ability of the plan to comply with applicable state and local regulations. A recommended implementation plan completes the document.

2009 Baseline Condition

As noted previously, the impact of campus stormwater management facilities constructed prior to July 1, 2009 are accounted for in the MS4 TMDL loading rates developed for the James River watershed. There is, therefore, no treatment credit assumed for these facilities in the Baseline scenario analysis. What follows is an inventory of these facilities for informational purposes only. The existing facilities are shown in **Appendix A – Figure 1** and are summarized below:

(BMP-1) Convocation, Sports & Wellness Center- Wet Pond: This wet pond was located on the southeast corner of the Freeman Center. The BMP was removed with construction of the Freeman Center Expansion.

(BMP-2) James River Residence Hall- Extended Detention Basin: This extended detention basin is located south of James River Residence Hall. The facility serves a portion of the existing building and plaza. Approximately 5.37 acres are routed to this BMP. The expected pollutant removal requirement was 1.07 pounds per year.

(BMP-3) Track Complex Stadium Seating- Extended Detention Basin: This extended detention basin is located east of the Captains Turf Field. The facility serves a portion of the existing field. Approximately 1.70 acres are routed to this BMP. The expected pollutant removal requirement was 0.98 pounds per year.

2009 to 2018 Existing Condition

Multiple construction projects were completed on the CNU campus between July 1, 2009, and the end of the 2018 permit cycle. The existing facilities are shown in **Appendix A – Figure 1** and calculations are located in **Appendix B** and are summarized below:

(BMP-4) Lake Maury: The Lake Maury BMP was designed based on the old CBPA technical criteria and constructed in 2009. Based on the 2008 CNU SWMP by Koontz Bryan the installation of the Lake Maury BMP was to replace the existing campus BMPs. According to CNU Athletics Expansion II- New Tennis Courts (Eyre Tennis Courts Phase II) the water quality capacity of the Lake Maury BMP has been met. Therefore, the Lake Maury BMP cannot be used for any future projects and does not provide treatment credit towards the TMDL Reductions goals. The expected pollutant removal is approximately 52.45 pounds a year, 39.43 pounds per year for the CNU Campus and 13.00 pounds per year for VDOT**.**

(BMP-5) Lot A Bioretention: CNU constructed this bioretention (level 1) to provide water quality treatment for 1.06 acres of impervious area and meet their 2018 TMDL reduction goals. There was no net increase in impervious area with this development. The expected pollutant removal is approximately 1.44 pounds a year**.**

2023 Proposed Condition- Under Design (from July 1, 2018 to July 1, 2023)

As of January 2019, CNU has the following projects currently undergoing design and permitting. See **Appendix A-Figure 2** for the approximate location of these CIPs. See **Appendix C** for calculations for project specific stormwater management techniques and water quality goals for each project.

Fine Arts Center:

This project involves the replacing Lot B with a new Fine Arts Center. The proposed building is located south of the Freeman Center and Lot C1. The existing site cover consists of a parking lot and areas of managed turf. An increase in impervious cover is expected with this project due to the proposed building footprint and surrounding hardscape. Pollution removal will be provided through purchasing nutrient credits. The expected pollutant removal will be approximately **1.74 pounds per year**.

Captains Turf Field Replacement:

This project includes the construction of a new artificial turf multipurpose field, spectator seating, team benches, a press box, and pedestrian pathways. The project site is located north and east of Moores Lane, west of Ratcliffe Hall, and south of Pomoco Stadium. An increase in impervious cover is expected with this project due to the surrounding hardscape. The project removes the Track Complex Extended Detention Basin. Pollutant removal is achieved using a bioretention (level 1) **(BMP 6**) located adjacent to the proposed building and nutrient credits. The bioretention is sized to collect 2.18 acres of drainage. The expected pollutant removal will be approximately **1.92 pounds a year**.

C2 Parking:

This project includes the construction of a new parking lot east of Ferguson Lawn **(BMP 7)**. The project site is located west of Warwick Boulevard. An increase in impervious area is expected with this project. Pollution removal will be provided using a StormKeeper Sediment Strip which will collect approximately 1.39 acres of drainage. The expected pollutant removal requirement will be **0.85** pounds per year.

2023 Proposed Condition (from July 1, 2018 to July 1, 2023)

In conformance with the Comprehensive Master Plan, the projects below are anticipated to be constructed between July 1, 2018 and July 1, 2023. See **Appendix A – Figure 2** for the approximate location of these future projects throughout campus. See **Appendix C** for the calculations for project specific stormwater management techniques and water quality goals for each project. See **Appendix E** for anticipated costs.

Shenandoah River Hall:

This project includes the construction of two new residence halls and a parking lot. The project site is located north of Rappahannock River Hall in place of CNU North. An increase in impervious area is expected with this project. Pollution removal will be provided through a pair of proposed bioretention basins in addition to permeable pavers. The bioretention basins will collect approximately 0.60 acres of drainage. The permeable pavers will be provided in the new parking lot and will receive approximately 1.00 acres of drainage from impervious surfaces. The expected pollutant removal requirement will be **1.03** pounds per year and the expected pollutant removal achieved will be approximately **1.72** pounds per year for an excess of **0.69** pounds per year. A portion of this development drains to Fishers Creek (HUC JL38) and would add additional outfalls to the campus.

Alumni Hall Lawn:

This project includes the removal of a portion of Lot M to construct a lawn area. The project is located to the east of the Kilch Alumni House. There is a decrease in impervious area included with this project. Pollution removal will be provided through the reduction in impervious area. The expected pollutant removal requirement will be **0.00** pounds per year and the expected pollutant removal achieved will be approximately **0.27** pounds a year for an excess of **0.27** pounds per year.

2028 Proposed Condition (from July 1, 2023 to July 1, 2028)

In conformance with the Comprehensive Master Plan, the projects below are anticipated to be constructed between July 1, 2023 and July 1, 2028. See **Appendix A – Figure 2** for the approximate location of these future projects throughout campus. See **Appendix E** for anticipated costs. See **Appendix C** for the calculations for project specific stormwater management techniques and water quality goals for each project:

Greek Housing Phase II:

This project includes the construction of four new residence halls and the relocation of a section of University Place. The project site is located south of the Greek Housing Phase 1 and north Santoro Hall. An increase in impervious area is expected with this project. Pollution removal will be provided through an underground detention system and water quality structures that will collect approximately 2.30 acres of runoff. The expected pollutant removal requirement will be **1.53** pounds per year and the expected pollutant removal achieved will be approximately **1.69** pounds a year for an excess of **0.16** pounds per year.

Luter Hall Lawn- Phase II:

This project includes the removal of a portion of Lot D to construct a lawn area. The project is located to the south of the Warwick River Hall. There is a decrease in impervious area included with this project. Pollution removal will be provided through the reduction in impervious area. The expected pollutant removal requirement will be **0.00** pounds per year and the expected pollutant removal achieved will be approximately **1.11** pounds a year for an excess of **1.11** pounds per year.

Stormwater Management Plan

Approach

The health of our rivers and streams is a direct reflection of the way we choose to live on the land. Site development typically alters a watershed's response to rainfall by reducing opportunities for interception, evaporation and infiltration, while maximizing runoff. Impervious surfaces and efficient hydraulic conveyance systems dramatically increase runoff volume and peak runoff rates associated with most rainfall events. This is especially true for the smaller, higher frequency storms, which tend to have the greatest impact on aquatic habitat, stream morphology, and water quality. In order to protect the ecological integrity of receiving waters, stormwater management measures must replicate the hydrologic function of the predevelopment conditions. This is the core definition of Low Impact Design.

Conventional stormwater management strategies are based on the notion that runoff is undesirable and must be removed from its point of origin as quickly as possible to achieve effective stormwater management. All aspects of traditional development including roadways, driveways, parking areas, roofs, downspouts, drainage swales, culverts, and grading are typically designed to convey water in the most hydraulically efficient manner possible. This approach radically alters the watershed's hydrologic characteristics and sharply increases the magnitude and frequency of significant runoff events. Stormwater management involving detention/retention ponds has been widely used and recognized over the past several decades as acceptable means of reducing negative water quality and hydrologic impacts associated with site development. Extensive field observations and research in recent years, however, has revealed that while these structures can be effective at removing pollutants from runoff, they seldom protect the biological integrity of receiving streams. In addition they consume valuable land area, are costly maintenance burdens, and are generally perceived as unsightly landscape features.

Low Impact Development (LID) and the Runoff Reduction Method (RRM) represent a completely different paradigm for managing and controlling stormwater. Instead of creating hydraulically efficient stormwater conveyance systems and high-maintenance centralized control facilities, the LID approach captures and controls runoff at its source through uniform distribution of various techniques designed to maximize opportunities for interception, infiltration, and evapotranspiration. The principal goal is to ensure maximum protection of the ecological integrity of receiving waters by preserving and/or mimicking the natural watershed processes that control runoff. Proper planning and implementation of LID principles can result in an aesthetically pleasing, hydrologically functional landscape capable of protecting water quality, channel morphology and the aquatic biota of receiving waters.

Although the CNU campus was developed using traditional stormwater management strategies as discussed above, current plans for redeveloping portions of the campus present an excellent opportunity for incorporating stormwater management alternatives, which are

economically viable and environmentally sensitive. A number of LID techniques were presented at the recent project stormwater planning meeting that would be functional and complimentary to the proposed plans for redevelopment. These techniques or practices include Bioretention, Dry Wells, Infiltration Trenches, Rain Barrels, Cisterns, and Engineered Landscaping.

Stormwater Improvement Projects (SIPs)

The proposed Stormwater Improvement Projects (SIPs) have been sized using the Runoff Reduction Method and specifications provided in the Virginia BMP Clearinghouse. Input data and other assumptions required for these calculations are based on current (2018) conditions, including available footprint areas, contributing drainage areas, and other design dimensions. Each SIP was sited to avoid conflict with the location of planned Capital Improvement Projects (CIPs) as much as possible.

The overarching intent regarding SIP selection was to provide a diverse array of best management practices (BMPs). The use of varying treatment mechanisms such as filtration, hydrodynamic separation, and runoff disconnection increases the degree of overall pollutant removal, as pollutants exist in a variety of forms (i.e. soluble vs. particulate). Additionally, as a steward of BMP maintenance, CNU will gain insight into the efficacy and costs associated with several practices. This insight will be useful in the development of future projects at CNU. See **Appendix D** for figures and calculations for SIP's.

SIP-1: Lake Maury Outfall- Stream Restoration:

The project is located adjacent to the southeast border of the CNU campus immediately upstream of the culvert that outfalls to Lake Maury. This outfall collects approximately 186 acres of runoff from the CNU campus and adjacent areas. From aerial imagery and Newport News GIS data, the existing stream shows very little natural meandering in its flow pattern. A significant portion of the stream channel has been hardened with riprap. Restoring the stream channel and floodplain wetland bench will improve sediment processes, biological function, aesthetics, and chemical processes in the stream and to the downstream Lake Maury. The proposed stream restoration is approximately 570 feet in length and will introduce full pattern, dimension, and profile to the stream. The restored stream will consist of armored "riffle" sections and deeper "pool" sections. The riffle sections will be constructed with a mix of gravel and cobbles and will provide energy dissipation and erosion protection. The pool sections are designed to detain and slow flows as they enter and pass through the stream. Both stream section types ensure that flow velocities remain non-erosive throughout the entire restored stream section. Based on conceptual analysis and reduction rates documented in the Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects, for planning purposes the proposed stream restoration will provide a removal rate of 0.068 pounds of phosphorous per linear foot per year; approximately **38.76 pounds per year** of phosphorus removal, **24.55 pounds per year for CNU**.

SIP-2A: Lot E1- Hydrodynamic Device:

This project involves the installation of a hydrodynamic device downstream of Lot E1 on the trunk line before it merges with the drainage from Lot E2. The water quality structure is proposed to collect runoff from the existing parking lot, an area of 3.40 acres. The expected pollutant removal will be **1.33** pounds per year.

SIP-2B: Lot E1- Water Quality Structure:

This project involves the installation of a water quality structure downstream of Lot E1 on the trunk line before it merges with the drainage from Lot E2. The water quality structure is proposed to collect runoff from the existing parking lot, an area of 3.40 acres. The expected pollutant removal will be **3.32** pounds per year.

SIP-3: Lot E2/E3- Hydrodynamic Device:

This project involves the installation of a hydrodynamic device downstream of Lot E2 on the trunk line before it merges with the drainage from Lot E1. The water quality structure is proposed to collect runoff from the existing parking lots, an area of 14.60 acres. The expected pollutant removal will be **4.21** pounds per year.

SIP-4: Lot H- Bioretention:

This project involves the installation of a bioretention basin (level 1) within the center of parking Lot H. The area is currently a stripped asphalt median. The proposed bioretention basins will collect 1.10 acres of drainage. The expected pollutant removal will be **0.93** pounds per year.

SIP-5A: Lot I - Water Quality Structure:

This project involves the construction of a water quality structure along the trunk line that serves Lot I. The water quality structure is proposed to collect runoff from the existing parking lot, an area of 1.55 acres. The expected pollutant removal will be **1.69** pounds per year.

SIP-5B: Lot I - Water Quality Inlets:

This project involves the installation of water quality inlets along the curb cuts within Lot I. Six (6) water quality inlets are proposed to collect runoff from the existing parking lot, an area of 1.00 acres. The expected pollutant removal will be **1.08** pounds per year.

SIP-6: Lot C1- Hydrodynamic Device:

This project involves the installation of a hydrodynamic device downstream of Lot C1 on the trunk line. The water quality structure is proposed to collect runoff from the existing parking lot, an area of 1.70 acres. The expected pollutant removal will be **0.70** pounds per year.

CNU Specific Stormwater Practices

The following stormwater management practices are State standards that are best suited for the climate, geology and environment on campus. Some of these measures are already being implemented; however, some of these measures will be new to campus:

Simple Rooftop (Impervious Surface) Disconnections

Rooftop disconnection is a strategy to intercept runoff before directing it into a closed drainage system from an impervious area. In simple rooftop disconnection the stormwater is directed from the impervious area via overland flow to an adequate outfall, mostly used by residential or small commercial rooftops. Simple disconnection can be used on all post-construction Hydrologic soil groups; however, soil amendments may be required for Hydrologic soil groups C and D. The erodibility of the soils must be considered when using rooftop disconnect. Simple rooftop Disconnection can remove Total Phosphorous (TP) Mass Load Removal by 50% for Soils A and B and 25% for soils C and D. Rooftop disconnection does not provide nutrient removal; however, it reduces the annual runoff volume, which in turn reduces pollutants.

Permeable Pavers

Traditional pavement is completely impervious. Impervious areas have comparatively high peak stormwater runoff rates because the rainfall cannot infiltrate. Permeable Pavement allows for a portion of the stormwater rainfall to infiltrate into the subsurface. Thus, it decreases peak runoff rates when compared to traditional pavement. Retrofit of existing surface parking lots is a good opportunity to utilize permeable pavers. Care should be taken when locating areas of permeable pavement versus standard pavement.

Areas to avoid using permeable pavers:

- Fire Lanes (although some permeable pavers can withstand these loads)
- Low Points for drainage (where debris can accumulate and clog pores)
- Adjacent to curb lines (where debris can accumulate)
- Main accessible pathways (ADA paths)

Due to the permeability of the in-situ soils an underdrain may be required beneath the section. If high groundwater is observed an impervious liner may be required, although based on the review of geotechnical reports this is not anticipated. A common complaint about permeable pavers is the possibility of becoming a tripping hazard for certain pedestrians, potentially with disabilities. To remedy this problem, the desired walking pathways from point to point will have standard pavers with a visual border, either flush concrete curb or soldier course, separating the permeable from the impermeable material. This will also eliminate the potential of having a non-ADA accessible pathway. The permeable pavers should have openings parallel with the direction of traffic; and, therefore least likely to be caught by snow plows.

Installation Guidelines:

- Place edge restraints before the bedding layer is installed. Permeable paver systems require edge restraints to prevent vehicle loads from moving the paver blocks. Edge restraints may be standard VDOT curbs or gutter pans, or precast or cast-in-place reinforced concrete borders a minimum of 6 inches wide and 18 inches deep, constructed with Class A3/ A4 concrete.
- Place No. 57 stone in a single lift. Level the filter course and compact it into the reservoir course beneath with at least four (4) passes of a 10-ton steel drum static roller until there is no visible movement. The first two (2) passes are in vibratory mode, with the final two (2) passes in static mode. The filter aggregate should be moist to facilitate movement into the reservoir course.
- Place and screed the bedding course material (typically No. 8 stone).
- Fill gaps at the edge of the paved areas with cut pavers or edge units. When cut pavers are needed, cut the pavers with a paver splitter or masonry saw. Cut pavers no smaller than one-third (1/3) of the full unit size.
- Pavers may be placed by hand or with mechanical installers. Fill the joints and openings with stone. Joint openings must be filled with VDOT No. 8 stone, although VDOT No. 8P or No. 9 stone may be used where needed to fill narrower joints. Remove excess stones from the paver surface.
- Compact and seat the pavers into the bedding course with a minimum low-amplitude 5,000-lbf, 75- to 95-Hz plate compactor.
- Do not compact within 6 feet of the unrestrained edges of the pavers.
- The system must be thoroughly swept by a mechanical sweeper or vacuumed immediately after construction to remove any sediment or excess aggregate.
- Inspect the area for settlement. Any blocks that settle must be reset and re-inspected.
- Inspect the facility 18 to 30 hours after a significant rainfall (1/2 inch or greater) or artificial flooding to determine whether the facility is draining properly.

Bioretention Basins

Bioretention Basins (a.k.a. "Rain Gardens") are planting areas installed in shallow basins in which the stormwater runoff is treated by filtering through the landscape bed components with biological and biochemical reactions within the soil matrix and around the root zones of the plants. A dry swale is a linear bioretention basin and is used when site geometric constraints will not allow a basin shape. Properly constructed bioretention areas replicate the ecosystem of an upland forest floor through the use of specific shrubs, trees, ground covers, mulches, and deep, rich soils. Since most bioretention basins are intended to be visual landscape amenities as well as stormwater BMPs, aesthetic considerations may be equally as important in their use as proper engineering

Typically, bioretention filters enhance the quality of stormwater runoff through the processes of adsorption, filtration, volitization, ion exchange, microbial and decomposition prior to exfiltration into the surrounding soil mass. Due to the permeability of the in-situ soils an underdrain may be required beneath the section. If high groundwater is observed an

impervious liner may be required, although based on the review of geotechnical reports this is not anticipated.

Wet Pond

A wet pond provides for long-term water quality enhancement of stormwater runoff. Stormwater inflows may also be temporarily stored above the permanent pool for downstream flood control. Pollutant removal is obtained through gravitational settling, biological uptake and microbial activity. (DEQ, 2013).

Retention ponds that provide flood control are designed with "dry" storage above the permanent pool. The dry storage works with a control structure to reduce the peak rate of runoff from a drainage area. The storage volume above the permanent pool can also be used to control or reduce channel erosion. Channel erosion protection is accomplished by reducing the peak rate of discharge. (DCR, 1999)

Extended Detention Basins

A detention basin provides for short-term water quality enhancement of stormwater runoff. Stormwater inflows are stored for a minimum of 24-36 hours for downstream flood control and particulate settlement.

Removal rates of particulate and soluble pollutants (nutrients) can be achieved in detention basins through gravitational settling, biological uptake and decomposition. When an even higher degree of pollutant removal efficiency is required, the basin can be enhanced by using various modifications relating to the size and design of the water quality volume or biological integration.

Detention ponds provide flood control by use of a flow control outlet structure to reduce the peak rate of runoff from a drainage area. The volume above the primary outlet will help to control or reduce channel erosion. Channel erosion protection is accomplished by reducing the peak rate of discharge.

Hydrodynamic Separators

Hydrodynamic Separators are underground vaults that rely on settling or separation of pollutants from the runoff. There are two types of hydrodynamic separators, chambered separation structures or swirl concentration structures.

Chambered Separation Structures rely on settling of particles from an upper chamber to a lower chamber by way of a downpipe. Flow enters the structure in an upper bypass chamber and is channeled into the lower storage chamber (treatment chamber). The downpipe is designed so that high rates of inflow bypass the treatment chamber. The water quality volume for the drainage area reaches the treatment chamber in a way that forces circular water flow. Centrifugal force as well as gravity help the larger particulates get trapped. The

water leaves the treatment chamber through a riser pipe that extends below the water surface to trap floatables from exiting. The treatment chamber traps floatables and particulate, and protects them from re-suspension during bypass storm events.

Water Quality Inlets

Water Quality Inlets are mini bioretention cells installed beneath trees that can be very effective at controlling runoff, especially when distributed throughout a site. Runoff is directed to the inlet, where it is treated by vegetation and soil before entering a downstream catch basin. The runoff collected in the inlets helps irrigate the plantings.

Water Quality Inlets are based on an effective and widely used bioretention or "rain garden" technology with improvements to enhance pollutant removal, increase performance reliability, increase ease of construction, reduce maintenance costs and improve aesthetics. They can fit into most landscape schemes increasing the quality of life in urban areas by adding beauty, habitat value, and reducing urban heat island effects.

The system consists of a drainage inlet filled with a soil mixture, mulch, under drain system and a shrub or tree. Stormwater runoff drains directly from impervious surfaces through a filter media. Treated water flows out of the system through an under drain connected to a storm drainpipe/inlet or into the surrounding soil. Tree box filters can also be used to control runoff volumes/flows by adding storage volume beneath the filter box with an outlet device. Although these are very effective at removing pollutants, they generally cannot accept large drainage areas (less than 0.5 acres maximum drainage area, typically 0.25 or 0.33 acres served).

Wetlands/Stream Restoration

The main purpose of stream restoration design is to convey stormwater runoff at non-erosive velocities to help reduce downstream sedimentation. Stream restoration design is similar to that of a standard grass swale design including check dams. As the first flush of water from a rain event moves through the channel, water will begin to pool within the system where some absorption/filtration will occur as water percolates into the coarse streambed. Stream restoration incorporates the use of multiple pools with a streambed comprised of coarse sand/gravel.

The total storage within the pools is equal to the water quality volume based on a ½ inch of rainwater over the impervious area within the drainage area. The channels shall be designed to maintain adequate velocity through the 10-year storm. A grassed swale should have the capacity to convey the peak flows from the 10-year design storm without exceeding the maximum permissible velocities. These velocities are determined to avoid re-suspension of deposited sediments, other pollutants, and future scour of the channel. The maximum design velocity 2-year storm is 4 feet per second while the 10-year storm is 7 feet per second. It is anticipated that a 15% phosphorus removal should be provided for the impervious area treated by the stream water quality volume.

Vegetated Roof

Vegetated roofs (also known as green roofs, living roofs or ecoroofs) are alternative roof surfaces that typically consist of waterproofing and drainage materials and an engineered growing media that is designed to support plant growth. Vegetated roofs capture and temporarily store stormwater runoff in the growing media before it is conveyed into the storm drain system. A portion of the captured stormwater evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites.

There are two different types of vegetated roof systems: intensive vegetated roofs and extensive vegetated roofs. Intensive systems have a deeper growing media layer that ranges from 6 inches to 4 feet thick, which is planted with a wider variety of plants, including trees. By contrast, extensive systems typically have much shallower growing media (2 to 6 inches), which is planted with carefully selected drought tolerant vegetation. Extensive vegetated roofs are much lighter and less expensive than intensive vegetated roofs and are recommended for use on most development and redevelopment sites.

Vegetated roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Extensive vegetated roofs are designed to have minimal maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established.

The major design goal for vegetated roofs is to maximize nutrient removal and runoff volume reduction. To this end, designers may choose the baseline design (Level 1) or choose an enhanced (Level 2) design that maximizes nutrient and runoff reduction. In general, most intensive vegetated roof designs will automatically qualify as being Level 2.

Vegetated roofs can be limited by the additional weight of the fully saturated soil and plants, in terms of the physical capacity of the roof to bear structural loads. The civil engineer should consult with a licensed structural engineer or architect to ensure that the building will be able to support the additional live and dead structural load and determine the maximum depth of the vegetated roof system and any needed structural reinforcement.

In most cases, fully-saturated extensive vegetated roofs have loads of about 15 to 25 lbs./sq. ft., which is fairly similar to traditional new rooftops (12 to 15 lbs./sq. ft.) that have a waterproofing layer anchored with stone ballast. For an excellent discussion of vegetated roof structural design issues, consult Chapter 9 in Weiler and Scholz-Barth (2009) and ASTM E-2397, Standard Practice for Determination of Dead Loads and Live Loads Associated with Green (Vegetated) Roof Systems.

The recommended growing media for extensive vegetated roofs is composed of approximately 80% to 90% lightweight inorganic materials, such as expanded slates, shales or clays, pumice, scoria or other similar materials. The remaining media should contain no more than 20% organic matter, normally well-aged compost. The percentage of organic matter should be limited, since it can leach nutrients into the runoff from the roof and clog the permeable filter fabric. The growing media should have a maximum water retention capacity of around 30%. It is advisable to mix the media in a batch facility prior to delivery to the roof. More information on growing media can be found in Weiler and Scholz-Barth (2009) and Snodgrass and Snodgrass (2006).

Vegetated roofs are an ideal stormwater control measure for karst terrain, although it is advisable to direct downspout discharges at least 15 feet away from the building foundation to minimize the risk of sinkhole formation.

Stormwater Conveyance System Overview

The stormwater conveyance system on the CNU campus is made up of sheet flow, subsurface storm drainage systems, and open channels. Runoff from south of Prince Drew Road and west of Warwick Boulevard is conveyed south through a storm sewer system conveyance system that discharges into Lake Maury.

Runoff from west of the Warwick boulevard and south of University Place is conveyed south through a storm sewer system conveyance system that discharges into Lake Maury.

Runoff from south of University Place, York River Hall plaza and Ferguson Center for the Arts, is conveyed south through a storm sewer system conveyance system that discharges into a drainage swale and into Lake Maury.

Runoff from west of Moores Lane is conveyed southwest through a storm sewer system and outfalls to Country Club Lake and Country Club Creek and then to the James River.

Recommendations and Conclusions

During the course of this study VHB has:

- ✓ Researched and reviewed all available plan and calculation records provided by CNU
- ✓ Visited the campus numerous times for site visits and meetings

This Master Plan is intended to provide a "menu" of options that could be employed to the meet the 2028 TMDL Target Goal. Two options presented in this report cover the implementation of Capital Improvement Projects or Stormwater Improvement Projects. However, a selection of both SIPs and CIPs would provide a more cost-effective means of pollutant removal towards the TMDL Target Goal.

General recommendations for stormwater improvements on the CNU campus are provided below and in the Appendices. Please note that only property owned by the state is accounted for in this stormwater master plan. Areas owned by the City of Newport News will not count against the CNU overall pollutant loading.

Best Management Practices

Keeping the campus Stormwater Management Systems functioning properly is vital in achieving adequate water quality on campus. These BMP's should be inspected annually for cracking or erosion of side slopes, sediment buildup and the presence of rodents or invasive plant species that could undermine the functionality of the system. Necessary sediment removal, earth repair and or re-sodding should be performed immediately upon identification of any of these detriments to the BMP. Listed below are the current Best Management Practice (BMP) Stormwater Management Systems on campus.

- **James River Residence Hall- Extended Detention Basin**
- **Track Complex Stadium Seating- Extended Detention Basin**
- **Lake Maury- Wet Pond**
- **BMP at Parking Lot A – Bioretention (Level 1)**

The two extended detention basins are not included within the TMDL phosphorus loading as they were replaced by the Lake Maury BMP. They are to be maintained until they are removed from the campus.

Projects that are currently under design and providing a new stormwater management system that must be maintained on campus are:

- **Captains Turf Field Replacement**
- **Fine Arts Center**
- **C2 Parking**

For Long Term Maintenance and Operation of the campus stormwater Best Management Practices, see **Appendix F.**

Future Maintenance of the Stormwater Master Plan

Stormwater loading credits in the future will be based on the runoff reduction method which accounts for both quality and quantity as opposed to the current impervious area and BMP removal approach. Therefore, all site plans for CNU property should include the applicable area, existing loading and proposed loading on the cover sheet. Additionally, all stormwater calculations (including the runoff reduction spreadsheet) and BMP as-builts shall be submitted to CNU for their record. The loading numbers can then be tabulated to maintain an overall campus loading.

References

Glave & Holmes. Campus Building Plan 2025 – Christopher Newport University: Provided December 2018

Glave & Holmes. Site Plans: CNU Fine Arts Center: October 2018

Koontz Bryant Johnson Williams. Site Plans: CNU BMP at Parking Lot A: June/July 2018

Koontz Bryant Johnson Williams. Site Plans: CNU Parking Lot at Dumpster Lot 2: August 2018

Koontz Bryant Johnson Williams. Site Plans: CNU Warwick Boulevard Parking Lot at Ferguson Center: June 2018

Koontz-Bryant, P.C. Chesapeake Bay TMDL Action Plan: September 2015

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Koontz-Bryant, P.C. Stormwater Quality and Quantity Management Study: December 2008

Stantec Consulting Services, Inc. Christopher Newport University- Municipal Separate Storm Sewer System (MS4) Annual Report- Reporting Year July 1, 2017-June 30, 2018: September 2018

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Virginia Department of Environmental Quality. Chesapeake Bay Preservation Act

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Virginia Department of Environmental Quality. Guidance Memo No. 15-2005. May 2015

Virginia Department of Environmental Quality. 9VAC25-870 Virginia Stormwater Management Program (VSMP) Regulations- Section 6

Appendix A: Figures – Overall Campus

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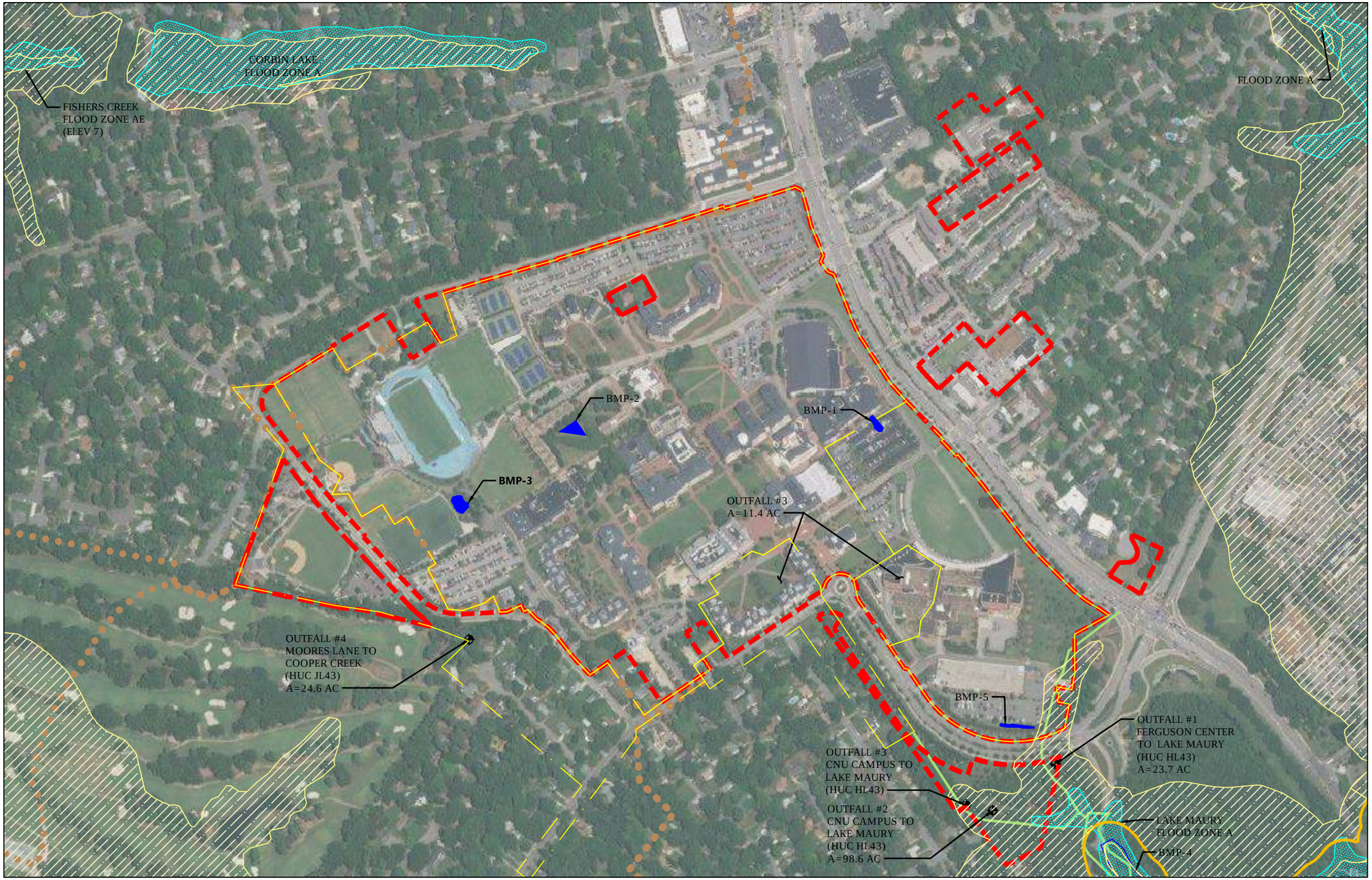

CHRISTOPHER NEWPORT UNIVERSITY

Legend

- CAMPUS AREA
- HUC DIVIDES
- DRAINAGE AREA
- WETLAND
- RESOURCE PROTECTION AREA (RPA)
- RESOURCE MANAGEMENT AREA (RMA)
- FLOOD ZONE
- EXISTING BMP
- DRAINAGE OUTFALL

EXISTING BMP

BMP-1	CONVOCATION, SPORTS & WELLNESS CENTER- WET POND (REMOVED)
BMP-2	JAMES RIVER RESIDENCE HALL- EXTENDED DETENTION BASIN
BMP-3	TRACK COMPLEX STADIUM SEATING- EXTENDED DETENTION BASIN
BMP-4	LAKE MAURY
BMP-5	LOT A- BIORETENTION (LEVEL 1)

OFFSITE CAMPUS AREA

YODER BARN- 660 HAMILTON DR

PRESIDENT'S HOUSE- 1205 RIVERSIDE DR

0 250 500 1000 Feet

Figure 1: Existing Conditions

Stormwater Managment Master Plan

Christopher Newport University

Source:
Prepared for: CNU
Date: May 2019

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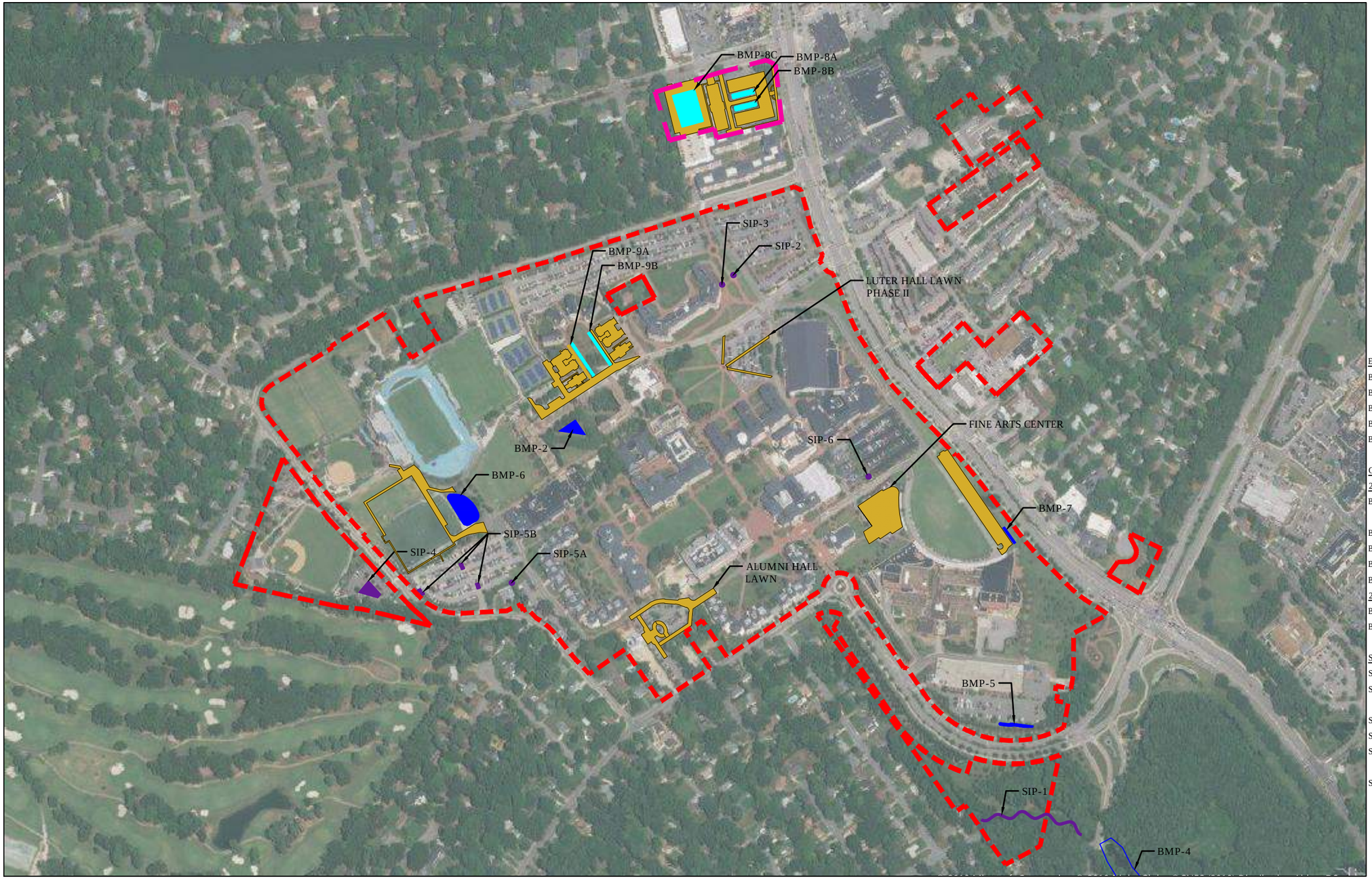


CHRISTOPHER NEWPORT UNIVERSITY

Legend

- CAMPUS AREA
- NEW CAMPUS AREA
- CAPITAL IMPROVEMENT PROJECT
- EXISTING BMP
- CAPITAL IMPROVEMENT BMP
- STORMWATER IMPROVEMENT BMP

EXISTING BMP

BMP-1	REMOVED
BMP-2	JAMES RIVER RESIDENCE HALL- EXTENDED DETENTION
BMP-3	REMOVED WITH BMP-6
BMP-4	LAKE MAURY
BMP-5	LOT A- BIORETENTION (LEVEL 1)

CIP PROJECTS

2023 BMP

BMP-6	CAPTAINS TURF FIELD REPLACEMENT- BIORETENTION (LEVEL 1)
BMP-7	C2 PARKING- STORMKEEPER
BMP-8A	SHENANDOAH RIVER HALL- BIORETENTION (LEVEL 1)
BMP-8B	SHENANDOAH RIVER HALL- BIORETENTION (LEVEL 1)
BMP-8C	SHENANDOAH RIVER HALL- PERMEABLE PAVERS (LEVEL 1)

2028 BMP

BMP-9A	GREEK HOUSING PHASE II- WATER QUALITY STRUCTURE
BMP-9B	GREEK HOUSING PHASE II- WATER QUALITY STRUCTURE

SIP PROJECTS

SIP-1	LAKE MAURY OUTFALL- STREAM RESTORATION
SIP-2	LOT E1- (A) HYDRODYNAMIC DEVICE/ (B) WATER QUALITY STRUCTURE
SIP-3	LOT E2/E3- HYDRODYNAMIC DEVICE
SIP-4	LOT H- BIORETENTION (LEVEL 1)
SIP-5	LOT I- (A) WATER QUALITY STRUCTURE/ (B) LOT I- WATER QUALITY INLETS
SIP-6	LOT C1- HYDRODYNAMIC DEVICE

Figure 2: Proposed Conditions

Stormwater Managment Master Plan

Christopher Newport University

Source:
Prepared for: CNU
Date: May 2019

0 250 500 1000 Feet

vhb

Appendix B: Figures and Calculations - Baseline Condition and TMDL Target

CHRISTOPHER NEWPORT UNIVERSITY

Campus TMDL Summary
Dated May 2019

vhb

			Site Area						BMP Information												TMDL					
Permit Cycle	Year	Project	Area (Acres)	Pre Impervious Area (acres)	Post Impervious Area (acres)	TP Removal Req (1)	TN Removal Req (2)	TSS Removal Req (2)	BMP Name	BMP Type	Location	Drainage Area	Impervious Area	P Percent Removal (1)	P Removal Provided (1)	N Percent Removal (3)	N Removal Provided (4)	TSS Percent Removal (3)	TSS Removal Provided (4)	TP	Campus	TN	Campus	TSS	Campus
		2018 Requirements				**1.23**	**4.95**	**556.51**												-1.23	1.23	-4.95	4.95	-556.51	556.51
	Lake Maury	Lake Maury- Includes Folloiwng Projects	147.24	59.00	72.22	39.43	205.04	16597.40	Lake Maury			153.73	78.73	0.29	39.45	-	-	-	-	-	-	-	-	-	-
2018	2015	Student Success Center (Christopher Newport																							
	2013	New Hall Parking Lot Demo and Walkway Design (Luter Hall Lawn- Phase 1)																							
		CNU Bell Tower/ Hoinkes Plaza																							
	2014	CNU Tennis Center/ Eyre Tennis Courts Phase II																							
		Greek Housing Project - Phase 1																							
		Lake Maury Defecit (36-16%)- Permit 1				0.07	0.36	29.47												-0.07	1.30	-0.36	5.31	-29.47	585.98
		David Student Union- Regattas																		0.00	1.30	0.00	5.31	0.00	585.98
	2012	Grounds Maintenance Facility				1.14	5.93	479.86		Nutrient Credits				-	1.14	-	5.928	-	479.83	0.00	1.30	0.00	5.31	-0.04	586.01
	2012	Demo Moores Lane	0.36	0.15	0.00	-0.20	-1.04	-84.19												0.20	1.10	1.04	4.27	84.19	501.83
	2016	Demo 72 Shoe Lane	0.76	0.16	0.00	-0.19	-0.99	-79.98												0.19	0.91	0.99	3.29	79.98	421.85
	2017-2018	Trible Library Expansion																		0.00	0.91	0.00	3.29	0.00	421.85
	2018	BMP at Parking Lot A	1.69	1.06	1.06	0.00	0.00	0.00	BMP-5	Bioretention (Level 1)	Lot A	1.69	1.06	0.25	1.44	0.45	6.46	0.55	429.68	1.44	-0.53	6.46	-3.17	429.68	-7.83
		2023 Requirements				**8.61**	**34.68**	**3895.55**												-8.61	8.08	-34.68	31.51	-3895.55	3887.72
		Lake Maury Defecit (36-16%)- Permit 2				0.51	2.65	214.68												-0.51	8.59	-2.65	34.16	-214.68	4102.40
	2019	E4 Parking (gravel)	0.90	0.00	0.63	1.12	5.82	471.45												-1.12	9.71	-5.82	39.98	-471.45	893.29
	Under Construction	Fine Arts Center	4.00	2.06	2.44	1.74	9.05	732.42	-	Nutrient Credits				-	1.74	-	3.83	-	0.00	0.00	9.71	-5.22	45.20	-732.42	4834.82
	Under Construction	Captains Turf Field Replacement	5.30	1.33	1.87	1.92	9.98	808.19	-	Nutrient Credits				-	0.54	-	1.19	-	0.00	-1.38	11.09	-8.80	54.00	-808.19	5643.01
									BMP-8	Bioretetion (Level 1)		2.18	0.88	0.20	1.38	0.45	7.81	0.55	399.91	1.38	9.71	7.81	46.19	399.91	5243.10
2023	Under Construction	C2 Parking	2.13	0.48	1.54	2.14	11.13	900.80	-	Nutrient Credits				-	1.29	-	2.84	-	0.00	-0.85	10.56	-8.29	54.48	-900.80	6143.90
									BMP-9	StormKeeper (Filtering Practice)		1.39	0.83	0.40	0.85	0.60	7.02	0.80	494.77	0.85	9.71	7.02	47.45	494.77	5649.13
		Added Property for Shenandoah River Hall				**0.79**	**2.70**	**368.51**												-0.79	10.50	-2.70	50.15	-368.51	6017.64
	future	Shenandoah River Hall	3.75	2.65	2.50	1.03	5.36	433.56		Permeable Pavement		1.00	1.00	0.25	1.27	0.20	1.88	0.55	372.32	0.24	10.26	-3.48	53.63	-61.24	6078.88
										Bioretention (Level 1)		0.60	0.30	0.25	0.45	0.20	0.98	0.55	128.37	0.45	9.81	0.98	52.65	128.37	5950.51
	future	Alumni Hall Lawn	1.45	1.15	0.65	-0.27	-1.40	-113.65												0.27	9.54	1.40	51.25	113.65	5836.85
		2028 Requirements				**14.76**	**59.44**	**6678.08**												-14.76	24.30	-59.44	110.69	-6678.08	12514.93
2028		Lake Maury Defecit (36-16%)- Permit 3				0.88	4.58	370.42												-0.88	25.18	-4.58	115.26	-370.42	6207.28
	future	Greek Housing Phase II	2.80	1.50																0.00	25.18	0.00	115.26	0.00	6207.28
	future	Luter Hall Lawn Phase II	1.65	1.20																0.00	25.18	0.00	115.26	0.00	6207.28

Notes
(1) From Runoff Reduction Spreadsheet
(2) TP * Ratio of Phosphorous Loading Rate to Nitrogen and Total Suspended Solids Loading Rates for Chesapeake Bay Basins
(3) From Guidance Memo 15-2005 Table V.C1- Chesapeake Bay Program BMPs, Established Effciencies
(4) BMP: Based on Loading Rates from Table 2a: Calculation Sheet for Estimating Existing Source Loads for the James River Basin Provided Removal= (Impervious * Loading Rate + Pervious * Loading Rate) * BMP Effciency
(4) Nutrient Credit: Based on Bank ratio of Phosphors to Nitrogen Removal (Cranston Mill Pond LLC bank ratio N= 2.2 *P)

Permit Cycle TMDL Requirements
Adjustments to Permit Cycle TMDL Requirements
No information provided
Based on Established Efficiences and Loading Rates
Nitrogen Removal based on Cranston Mill Pond LLC bank ratio to P of 2.2
Assumes removal based on "Ratio of Phosphorus to Nitrogen and Total Suspended Solids Loading Rates for Chesapeake Bay Basins" for purchased Phosphorus nutrient credits.
No TSS credit provided for purchasing Phosophorus Credits for permit cycles after 2018

Table 2 a: Calculation Sheet for Estimating Existing Source Loads for the James River Basin (* Based on Chesapeake Bay Program Watershed Model Phase 5.3.2)

Subsource	Pollutant	Total Existing Acres Served by MS4 (06/30/09)	2009 EOS Loading Rate (lbs/acre/yr)	Estimated Total POC Load Based on 2009 Progress Run (lbs/yr)
Regulated Urban Impervious	Nitrogen		9.39	
Regulated Urban Pervious			6.99	
Regulated Urban Impervious	Phosphorus		1.76	
Regulated Urban Pervious			0.5	
Regulated Urban Impervious	Total Suspended Solids		676.94	
Regulated Urban Pervious			101.08	

Table 4: Ratio of Phosphorous Loading Rate to Nitrogen and Total Suspended Solids Loading Rates for Chesapeake Bay Basins

Ratio of Phosphorous to Other POCs (Based on All Land Uses 2009 Progress Run)	Phosphorous Loading Rate (lbs/acre)	Nitrogen Loading Rate (lbs/acre)	Total Suspended Solids Loading Rate (lbs/acre)
James River Basin	1.0	5.2	420.9

Table V.C.1 – Chesapeake Bay Program BMPs, Established Efficiencies

Chesapeake Bay Program BMPs	TN	TP	TSS
Wet Ponds and Wetlands	20%	45%	60%
Dry Detention Ponds and Hydrodynamic Structures	5%	10%	10%
Dry Extended Detention Ponds	20%	20%	60%
Infiltration Practices w/o Sand, Veg.	80%	85%	95%
Infiltration Practices w/ Sand, Veg.	85%	85%	95%
Filtering Practices	40%	60%	80%
Bioretention C/D soils, underdrain	25%	45%	55%
Bioretention A/B soils, underdrain	70%	75%	80%
Bioretention A/B soils, no underdrain	80%	85%	90%
Vegetated Open Channels C/D soils, no underdrain	10%	10%	50%
Vegetated Open Channels A/B soils, no underdrain	45%	45%	70%
Bioswale	70%	75%	80%
Permeable Pavement w/o Sand, Veg. C/D soils, underdrain	10%	20%	55%
Permeable Pavement w/o Sand, Veg. A/B soils, underdrain	45%	50%	70%
Permeable Pavement w/o Sand, Veg. A/B soils, no underdrain	75%	80%	85%
Permeable Pavement w/Sand, Veg. C/D soils, underdrain	20%	20%	55%
Permeable Pavement w/Sand, Veg. A/B soils, underdrain	50%	50%	70%
Permeable Pavement w/Sand, Veg. A/B soils, no underdrain	80%	80%	85%

2009 TMDL SUMMARY

DRAFT

James River Basin: James River, Lynnhaven and Poquoson Coastal Basins	Subsource	Pollutant	Total Existing Acres Served by MS4 (7/1/9)	2009 EOS Loading Rate (lbs/ac)	MS4 Required Chesapeake Bay Total Loading Rate Reduction	Difference 2009 Progress -Final Target (lbs/ac)	MS4 Final Target (lbs/ac)	First Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required First Permit Cycle (lbs)	Second Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required Second Permit Cycle (lbs)	Third Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required Third Permit Cycle (lbs)	Total Required Reduction in Loading Rate (lb/ac)	Total Reduction Required (lbs)
	Regulated Urban Impervious	Nitrogen	62.14	9.39	9%	0.85	8.54	**0.04**	4.30	**0.30**	30.08	**0.51**	51.57	**0.85**	85.95
	Regulated Urban Pervious		79.73	6.99	6%	0.42	6.57	**0.02**		**0.15**		**0.25**		**0.42**	
	Regulated Urban Impervious	Phosphorus	62.14	1.76	16%	0.28	1.48	**0.01**	1.02	**0.10**	7.14	**0.17**	12.23	**0.28**	20.39
	Regulated Urban Pervious		79.73	0.5	7.25%	0.04	0.46	**0.002**		**0.01**		**0.02**		**0.04**	
	Regulated Urban Impervious	Sediment	62.14	676.94	20%	135.39	541.55	**6.77**	455.91	**47.39**	3191.36	**81.23**	5470.91	**135.39**	9,118.18
	Regulated Urban Pervious		79.73	101.08	8.75%	8.84	92.24	**0.44**		**3.10**		**5.31**		**8.84**	

Source: Developed from Phase 5.3.2 Watershed Model

* This calculation sheet addresses only existing loads in place prior to July 1, 2009. Increases to the Chesapeake Bay between July 1, 2009 and June 30, 2014 as a result of utilization of an average land cover condition greater than 16% will need to be addressed by the MS4 operator as well. This load can be calculated as follows: For Phosphorus: [(Total acres developed $_{7/1/2009 \text{ thru } 60/60/2014}$) * (P equivalent, $_{\text{Local Average Land Cover Condition}}$ -0.45)]. To develop the equivalent pollutant load for Nitrogen and Sediment, multiply by the appropriate value from the Table below. Note: Where development was required to address a local average land cover condition less than 16%, the difference between the lower average land cover condition and 16% can be ***credited*** towards meeting the overall reduction requirements.

*Based on all land uses 2009 Progress Run. Ratio of Phosphorus to Other POCs	Phosphorus Loading Rate, lbs/ac	Nitrogen Loading Rate, lbs./ac	Sediment Loading Rate, lbs./ac
James River Basin	1.0	5.2	420.9
Potomac River Basin	1.0	6.9	469.2
Rappahannock River Basin	1.0	6.7	320.9
York River Basin	1.0	9.5	531.6

Note: Acreages from From Christopher Newport University- Chesapeake Bay TMDL Action Plan by Koontz-Bryant, P.C. dated September 2015

2018 TMDL SUMMARY

DRAFT

James River Basin: James River, Lynnhaven and Poquoson Coastal Basins	Subsource	Pollutant	Total Existing Acres Served by MS4 (7/1/9)	2009 EOS Loading Rate (lbs/ac)	MS4 Required Chesapeake Bay Total Loading Rate Reduction	Difference 2009 Progress -Final Target (lbs/ac)	MS4 Final Target (lbs/ac)	First Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required First Permit Cycle (lbs)	Second Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required Second Permit Cycle (lbs)	Third Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required Third Permit Cycle (lbs)	Total Required Reduction in Loading Rate (lb/ac)	Total Reduction Required (lbs)
	Regulated Urban Impervious	Nitrogen	71.59	9.39	9%	0.85	8.54	0.04	4.61	0.30	32.28	0.51	55.34	0.85	92.23
	Regulated Urban Pervious		75.65	6.99	6%	0.42	6.57	0.02		0.15		0.25		0.42	
	Regulated Urban Impervious	Phosphorus	71.59	1.76	16%	0.28	1.48	0.01	1.15	0.10	8.02	0.17	13.74	0.28	22.90
	Regulated Urban Pervious		75.65	0.5	7.25%	0.04	0.46	0.002		0.01		0.02		0.04	
	Regulated Urban Impervious	Sediment	71.59	676.94	20%	135.39	541.55	6.77	518.08	47.39	3626.53	81.23	6216.91	135.39	10,361.51
	Regulated Urban Pervious		75.65	101.08	8.75%	8.84	92.24	0.44		3.10		5.31		8.84	

Source: Developed from Phase 5.3.2 Watershed Model

* This calculation sheet addresses only existing loads in place prior to July 1, 2009. Increases to the Chesapeake Bay between July 1, 2009 and June 30, 2014 as a result of utilization of an average land cover condition greater than 16% will need to be addressed by the MS4 operator as well. This load can be calculated as follows: For Phosphorus: [(Total acres developed $_{7/1/2009 \text{ thru } 60/60/2014}$) * (P equivalent, $_{\text{Local Average Land Cover Condition}}$ -0.45)]. To develop the equivalent pollutant load for Nitrogen and Sediment, multiply by the appropriate value from the Table below. Note: Where development was required to address a local average land cover condition less than 16%, the difference between the lower average land cover condition and 16% can be ***credited*** towards meeting the overall reduction requirements.

*Based on all land uses 2009 Progress Run. Ratio of Phosphorus to Other POCs	Phosphorus Loading Rate, lbs/ac	Nitrogen Loading Rate, lbs./ac	Sediment Loading Rate, lbs./ac
James River Basin	1.0	5.2	420.9
Potomac River Basin	1.0	6.9	469.2
Rappahannock River Basin	1.0	6.7	320.9
York River Basin	1.0	9.5	531.6

Note: Acreages from From Christopher Newport University- Municipal Separate Storm Sewer System (MS4) Annual Report- Reporting Year July 1, 2017-June 30, 2018

2018 TMDL SUMMARY + AQUIRED PROPERTY

DRAFT

James River Basin: James River, Lynnhaven and Poquoson Coastal Basins	Subsource	Pollutant	Total Existing Acres Served by MS4 (7/1/9)	2009 EOS Loading Rate (lbs/ac)	MS4 Required Chesapeake Bay Total Loading Rate Reduction	Difference 2009 Progress -Final Target (lbs/ac)	MS4 Final Target (lbs/ac)	First Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required First Permit Cycle (lbs)	Second Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required Second Permit Cycle (lbs)	Third Permit Cycle Required Reduction in Loading Rate (lb/ac)	Total Reduction Required Third Permit Cycle (lbs)	Total Required Reduction in Loading Rate (lb/ac)	Total Reduction Required (lbs)
	Regulated Urban Impervious	Nitrogen	76.90	9.39	9%	0.85	8.54	**0.04**	4.95	**0.30**	34.68	**0.51**	59.44	**0.85**	99.07
	Regulated Urban Pervious		81.27	6.99	6%	0.42	6.57	**0.02**		**0.15**		**0.25**		**0.42**	
	Regulated Urban Impervious	Phosphorus	76.90	1.76	16%	0.28	1.48	**0.01**	1.23	**0.10**	8.61	**0.17**	14.76	**0.28**	24.60
	Regulated Urban Pervious		81.27	0.5	7.25%	0.04	0.46	**0.002**		**0.01**		**0.02**		**0.04**	
	Regulated Urban Impervious	Sediment	76.90	676.94	20%	135.39	541.55	**6.77**	556.51	**47.39**	3895.55	**81.23**	6678.08	**135.39**	11,130.13
	Regulated Urban Pervious		81.27	101.08	8.75%	8.84	92.24	**0.44**		**3.10**		**5.31**		**8.84**	

Source: Developed from Phase 5.3.2 Watershed Model

* This calculation sheet addresses only existing loads in place prior to July 1, 2009. Increases to the Chesapeake Bay between July 1, 2009 and June 30, 2014 as a result of utilization of an average land cover condition greater than 16% will need to be addressed by the MS4 operator as well. This load can be calculated as follows: For Phosphorus: [(Total acres developed $_{7/1/2009 \text{ thru } 60/60/2014}$) * (P equivalent, $_{\text{Local Average Land Cover Condition}}$ -0.45)]. To develop the equivalent pollutant load for Nitrogen and Sediment, multiply by the appropriate value from the Table below. Note: Where development was required to address a local average land cover condition less than 16%, the difference between the lower average land cover condition and 16% can be ***credited*** towards meeting the overall reduction requirements.

*Based on all land uses 2009 Progress Run. Ratio of Phosphorus to Other POCs	Phosphorus Loading Rate, lbs/ac	Nitrogen Loading Rate, lbs./ac	Sediment Loading Rate, lbs./ac
James River Basin	1.0	5.2	420.9
Potomac River Basin	1.0	6.9	469.2
Rappahannock River Basin	1.0	6.7	320.9
York River Basin	1.0	9.5	531.6

Note: Includes aquired property on Shoe Lane, University Place, Sweetbriar Drive, and offsite area

Table 3a

Calculation Sheet for Estimating Existing Source Loads and Reduction Requirments for the James River, Lynnhaven and Little Creek Basins

		A	B	C	D	E	F	G	H	I	J
Pollutant	Subsource	Loading Rate (lbs/ac/ yr)[1]	Existing developed lands as of 6/30/09 served by the MS4 wihtin the 2010 CUA (acres)[2]	Loads (lbs/yr) [3]	Percentage of MS4 required Chesapeake Bay Total L2 loading	Percentage of L2 Required by 6/30/2023 (lbs/yr)	40% Cumulative reduction required by 6/30/2023 (lbs/yr) [4]	Sum of 40% cumulative reduction (lbs/yr) [5]	Percentage of L2 Required by 6/30/2028 (lbs/yr)	100% Cumulative reduction required by 6/30/2028 (lbs/yr)[6]	Sum of 100% cumulative reduction (lbs/yr)[7]
Nitrogen	Regulated Urban Impervious	9.39	76.90	722.09	9%	40%	26.00	39.63	100%	**64.99**	99.07
	Regulated Urban Pervious	6.99	81.27	568.08	6%	40%	13.63		100%	**34.08**	
Phosphorus	Regulated Urban Impervious	1.76	76.90	135.34	16%	40%	8.66	9.84	100%	**21.66**	24.60
	Regulated Urban Pervious	0.5	81.27	40.64	7.25%	40%	1.18		100%	**2.95**	
Sediment	Regulated Urban Impervious	676.94	76.90	52,056.69	20%	40%	4164.53	4452.05	100%	**10411.34**	11130.13
	Regulated Urban Pervious	101.08	81.27	8,214.77	8.75%	40%	287.52		100%	**718.79**	

1. Edge of stream loading rate based on the Chesapeake Bay Watershed Model Progress Run 5.3.2
2. To determine the existing developed acres required in column B, permittees should first determine the existing of their regualted service area based on the 2010 Census urbanized area (CUA). Next, permittees will need to delineate the lands within the 2010 CUA served by the MS4 as pervious and impoervious as of the baseline date of June 30, 2009.
3. Column C= Column A x Column B
4. Column F= Column C x Column D x Column E
5. Column G= The sum of subsource cumulative reduction required by 6/30/23 (lbs/yr) as calcaulted in Column F
6. Column I= Column C x Column D x Column H
7. Column J= The sum of subsource cumulative reduction required by 6/30/28 (lbs/yr) as calcaulted in Column I

Note: From Christopher Newport University- Municipal Separate Storm Sewer System (MS4) Annual Report- Reporting Year July 1, 2017-June 30, 2018. Revised for property on Shoe Lane, University Place, Sweetbriar Drive, and offsite campus area

Table 3a

Calculation Sheet for Estimating Existing Source Loads and Reduction Requirments for the James River, Lynnhaven and Little Creek Basins (REVISED BASED ON 2018 LAND CHANGE)

		A	B	C	D	E	F	G	H	I	J
Pollutant	Subsource	Loading Rate (lbs/ac/ yr)[1]	Existing developed lands as of 6/30/09 served by the MS4 wihtin the 2010 CUA (acres)[2]	Loads (lbs/yr) [3]	Percentage of MS4 required Chesapeake Bay Total L2 loading	Percentage of L2 Required by 6/30/2023 (lbs/yr)	40% Cumulative reduction required by 6/30/2023 (lbs/yr) [4]	Sum of 40% cumulative reduction (lbs/yr) [5]	Percentage of L2 Required by 6/30/2028 (lbs/yr)	100% Cumulative reduction required by 6/30/2028 (lbs/yr)[6]	Sum of 100% cumulative reduction (lbs/yr)[7]
Nitrogen	Regulated Urban Impervious	9.39	2.65	24.88	9%	40%	0.90	1.08	100%	**2.24**	2.70
	Regulated Urban Pervious	6.99	1.10	7.69	6%	40%	0.18		100%	**0.46**	
Phosphorus	Regulated Urban Impervious	1.76	2.65	4.66	16%	40%	0.30	0.31	100%	**0.75**	0.79
	Regulated Urban Pervious	0.5	1.10	0.55	7.25%	40.00%	0.02		100.00%	**0.04**	
Sediment	Regulated Urban Impervious	676.94	2.65	1,793.89	20%	40%	143.51	147.40	100%	**358.78**	368.51
	Regulated Urban Pervious	101.08	1.10	111.19	8.75%	40.00%	3.89		100.00%	**9.73**	

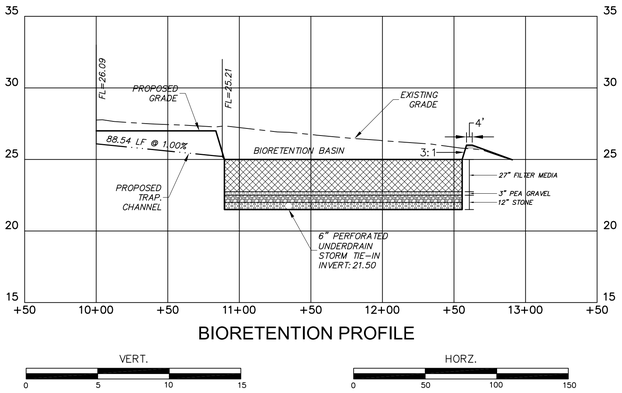
Note: Shenandoah Hall transfer from real estate foundation to campus property.

CHRISTOPHER NEWPORT UNIVERSITY

Project Summary
Dated May 2019

Permit Cycle			Project Post-development Impervious Area (acres)	Project Pre-development Impervious Area (acres)	Post- Pre Impervious Area (acres)	Campus Post-development Impervious Area (acres)	Campus Area (Acres)	Added Area (acres)	% Impervious Area	Total Site Area (Acres)	P Removal Required (lbs)	P Removal Provided (lbs)	Excess P Removal towards TMDL (lbs)	BMP/ Notes
2002						59.00								
2002-2008	5-01-0720-01-1	CNU Residence Hall III (partially built when	0.34	0.00	0.34	59.34								
	5-01-0720-02-1	CNU Track Complex (Stadium Seating)	1.33	1.39	-0.06	59.28								
	5-01-0720-04-0	CNU Performing Arts Center, Phase 1	8.67	9.80	-1.13	58.15								
	S-02-M-03	CNU Performlng Arts Center, Phese II	6.90	8.67	-1.77	56.38								
	S-03-M-01	CNU Track Complex - Football Stadium, Phase 2	0.13	0.00	0.13	56.51								
	S-03-M-02	CNU Soccer Practice Field	-0.79	0.00	-0.79	55.72								
	S-03-M-03	CNU Tennie Courts	0.24	0.00	0.24	55.96								
	S-03-LJ-04	CNU Residence Hall IV	-1.32	0.00	-1.32	54.64								
	S-03-M-06	CNU Parklng Deck	4.16	0.00	4.16	58.80								
	S-03-LJ-07	CNU Clearing, Grubbing and Demolition Plan	0.00	0.00	0.00	58.80								
	S-03-M-OB	CNU Demo 78 Moores Ln.	0.00	0.05	-0.05	58.75								
	5-03-M-09	CNU Demo 82 Mooree Ln.	0.00	0.15	-0.15	58.60								
	S-03-M-10	CNU Demo 262 Prince Drew Dr.	0.00	0.10	-0.10	58.50								
	S-03-M-11	CNU Demo 300 Prince Drew Dr.	0.00	0.04	-0.04	58.46								
	S-03-LJ-12	CNU Storm Sewer Infrastructure	-0.66	0.00	-0.66	57.80								
	5-03-LJ-14	CNU Moores Lane Demo Projects (67, 71, 77 & 79)	0.00	0.37	-0.37	57.43								
	S-03-LJ-15	CNU Baseball Field	0.72	0.00	0.72	58.15								
	S-03-M-15	CNU Warwick Blvd. Demo Projects	0.00	0.00	0.00	58.15								
	S-04-01	CNU Student Center	1.84	0.92	0.92	59.07								
	S-04-02	CNU Library and Information Technology	1.09	0.75	0.34	59.41								
	5-04-07	CNU Demo 87 Moore's Lane	0.00	0.05	-0.05	59.36								
	5-04-08	CNU Temporary Construction Access Road	0.25	0.07	0.18	59.54								
	S-04-11	CNU Demo 61 Moore's Lane	0.00	0.04	-0.04	59.50								
	S-04-15	CNU Demo 63 Moore's Lane	0.00	0.08	-0.08	59.42								
	S-04-17	CNU Baseball Field Press Box and Seating	0.93	0.72	0.21	59.63								
	S-04-18	CNU Softball Field	0.19	0.00	0.19	59.82								
	5-05-03	CNU Fine Arts Loop Road	0.96	1.21	-0.25	59.57								
	5-05-04	CNU Moores Lane Parking Lot	2.57	1.55	1.02	60.59								
	5-05-05	CNU Dumpster Yard	0.16	0.16	0.00	60.59								
	S-05-15	CNU Baseball Field Parking Lot	0.67	0.05	0.62	61.21								
	S-05-16	CNU Student Center Parking Lot	1.27	0.00	1.27	62.48								
	S-07-15	CNU McMurran Hall Liberal Arts Building	1.16	1.56	-0.40	62.08								
	5-08-10	CNU Artificial Turf Field	0.00	0.00	0.00	62.08	141.87							
2011-2012	SW2-09-11	CNU Science Building	2.07	1.67	0.40	62.48								
	5-09-01	CNU Soccer Concession Building	-0.03	0.00	-0.03	62.45								
	SW2-09-13	CNU Track Renovations	1.75	1.39	0.36	62.81								
2011-2012	SW2-09-26	CNU Freeman Center	4.74	3.58	1.16	63.97								
	SW2-09-33	CNU Loop Road Phase 2	0.65	0.55	0.10	64.07								
2011-2012	SW2-10-05	CNU Chapel	0.65	1.30	-0.65	63.42								
	SW2-10-09	CNU New Hall	1.54	1.39	0.15	63.57								
2011-2012	SW2-10-14	CNU Res Hall V	1.46	2.09	-0.63	62.94								
2011-2012	SW2-11-02	CNU Master Plan Parking Lots - Phase 1	9.71	2.50	7.21	70.15								
2011-2012	5-09-21	CNU Ratcliffe Hall Athletic Addition	0.75	0.49	0.26	70.41								
	Per 2011 Master Plan Update	*Adjustment per field changes to the softball fields*	-0.18	0.00	-0.18	70.23								
	Per 2011 Master Plan Update	*Adjustment per field changes to track and concession walks*	0.06	0.00	0.06	70.29								
	Per 2011 Master Plan Update	*Adjustments per field changes of walkways/demo on McMurran Hall and the*	0.77	0.00	0.77	71.06								
	Per 2011 Master Plan	*Adustment for 12 Moores Lane to remain*	0.15	0.00	0.15	71.21								
	Per 2011 Master Plan Update	Adjustment per removal of 30 spaces in Master Parking Lots	-0.11	0.00	-0.11	71.10								
	SW2-12-01	Hiden-Hussey Commons Additions Phase 1	0.33	0.00	0.33	71.43								
	Per WEG - CNU Entry	CNU Entry Plaza - Within CNU Campus	0.05	0.00	0.05	71.48								
	Per WEG - CNU Entry	CNU Entry Plaza - Within Existing VDOT ROW	0.22	0.00	0.22	71.70								
	SW2-12-07	Adjustment per parking lot size Revised CNU Master Plan Parking	-0.11	0.00	-0.11	71.59	147.24		48.6%					Campus Acreage based on 2011 Updated Boundary and IA Map by Koontz Bryant
COMPARED TO 2011 Boundary		remove CNU Entry Plaza VDOT ROW	-	-0.33	-	71.26	145.73	-1.51	48.9%					IA based on GIS
		purchase 68 Shoe Lane	-	0.00	-	71.26	146.27	0.54	48.7%					IA based on GIS
		purchase 416 University Pl- CNU Landing	-	1.30	-	72.56	148.19	1.92	49.0%					IA based on GIS
		purchase 431, 433, 435, 437, 439, 441, 445 University Pl	-	0.72	-	73.28	150.39	2.20	48.7%					IA based on GIS
		purchase 12254 Warwick Blvd	-			73.28	151.12	0.73	48.5%					
		purchase 7/11/17/19 Sweetbriar Drive	-	1.67	-	74.95	152.91	1.79	49.0%					IA based on GIS
Offsite		Yoder Barn- 660 Hamilton Drive	-	1.56	-	76.51	156.10	3.19	49.0%					
		President's House- 1205 Riverside Drive	-	0.39	-	76.90	158.17	2.07	48.6%					1201 RE Foundation
2018	2015	Student Success Center (Christopher Newport Hall)	0.97	1.16	-0.19	76.71	158.17	0.00	48.5%	2.30	-	-	-	Lake Maury
		David Student Union- Regattas				76.71	158.17	0.00	48.5%					
	2013	New Hall Parking Lot Demo and Walkway Design (Luter Hall Lawn- Phase 1)	0.31	1.12	-0.81	75.90	158.17	0.00	48.0%	2.00	-	-	0.00	Lake Maury
		CNU Bell Tower/ Hoinkes Plaza	0.16	0.00	0.16	76.06	158.17	0.00	48.1%		-	-	0.00	Lake Maury
	2014	CNU Tennis Center/ Eyre Tennis Courts Phase II	1.35	1.30	0.05	76.11	158.17	0.00	48.1%	1.99	-	-	0.00	Lake Maury
		Greek Housing Project - Phase 1	1.27	0.37	0.90	77.01	158.17	0.00	48.7%	5.35	-	-	0.00	Lake Maury
	2012	Grounds Maintenance Facility				77.01	158.17	0.00	48.7%		1.14	1.14	0.00	nutrient credits
	2016	demo 72 Shoe Lane	0.00	0.16	-0.16	76.85	158.17	0.00	48.6%	0.76				parcel area/ gis
	~2012	demo 12 Moores Lane	0.00	0.15	-0.15	76.70	158.17	0.00	48.5%	0.36				parcel area/ to remain #
	2017-2018	Trible Library Expansion				76.70	158.17	0.00	48.5%	1.25				nutrient credits
	2018	E4 Parking (gravel)				76.70	158.17	0.00	48.5%	0.90	0.00	0.00	0.00	NO BMP < 1 ac
	2018	BMP at Parking Lot A	1.06	1.06	0.00	76.70	158.17	0.00	48.5%	1.69	0.00	1.44	1.44	Bioretention (Level 1)
2023	In for Approval	Fine Arts Center	2.44	2.06	0.38	77.08	158.17	0.00	48.7%	4.00	1.74	1.74	0.00	purchasing credits (1.74)
	In for Approval	Captains Turf Field Replacement	1.87	1.33	0.54	77.62	158.17	0.00	49.1%	5.30	1.92	1.92	0.00	Bioretention (Level 1) (1.38), purchasing credits (0.54)
	In for Approval	C2 Parking	1.54	0.48	1.06	78.68	158.17	0.00	49.7%	2.13	2.14	2.14	0.00	Storm Keepers (0.85)/ purchasing credits (1.29)
	future	Shenandoah River Hall	2.50	2.65	-0.15	78.53	161.92	3.75	48.5%	3.75	1.03	1.72	0.69	
	future	Alumni Hall Lawn	0.65	1.15	-0.50	78.03	161.92	0.00	48.2%	1.45	0.00	0.27	0.27	REDUCE IMPERVIOUS
2028	future	Greek Housing Phase II	1.50	0.95	0.55	78.58	161.92	0.00	48.5%	2.80	1.53	1.69	0.16	
	future	Luter Hall Lawn Phase II	1.20	0.15	1.05	79.63	161.92	0.00	49.2%	1.65	0.00	1.11	1.11	
											9.50	13.17	**3.67**	

No information provided



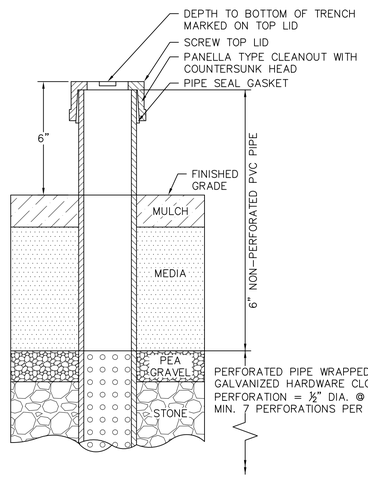
BIORETENTION PROFILE

WATER QUALITY VOLUME

BIORETENTION LEVEL 1 DESIGN:
VRRM Rv (Volumetric Runoff Coefficient) = 0.68
Area(A) = 1.69 AC
Design Treatment Volume (TvBMP) = 4,164 CF
*refer to VRRM redevelopment spreadsheet for TvBMP value

Vr = TvBMP+Vf = 4,549 CF
Vb (Bioretention Volume) = 4,603 ft³ (provided)

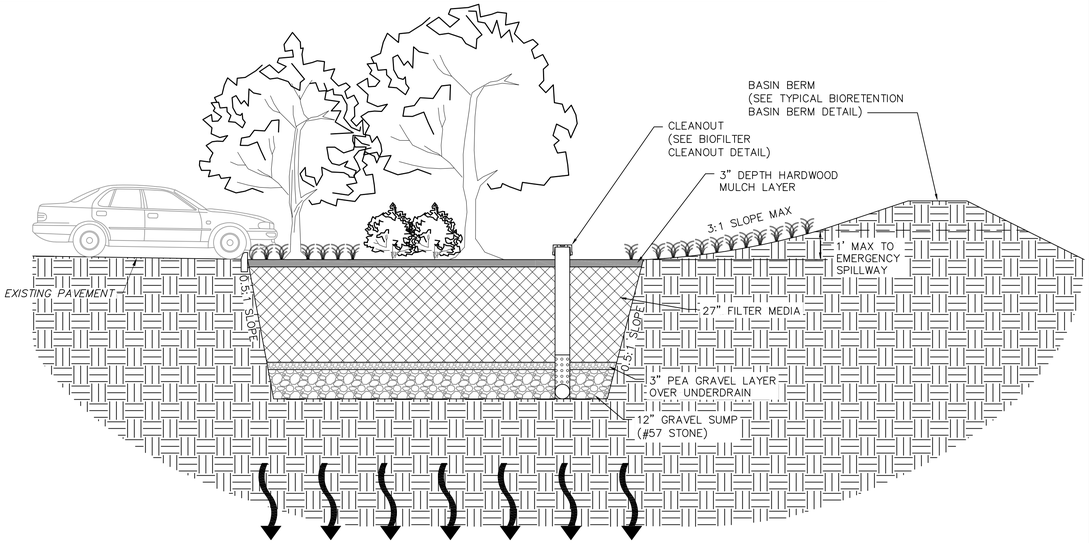
Impervious Acreage = 1.06 AC
Rainfall/Imp. Acreage = 0.10 in
Volume Required = Imp. Acreage * Rainfall/Imp. Acreage
= 1.06*0.10 = 0.11
AC-in to CF conversion factor = 3,630
Vf (Forebay Volume) = Volume Required*3630 = 385 CF



1. CLEANOUTS SHALL BE MADE OF NON-CORROSIVE MATERIAL, SCHEDULE 40 OR EQUAL, WITH AN INSIDE DIAMETER OF AT LEAST 4 INCHES, AND BE INSTALLED ON UNDERDRAINS WHERE INDICATED ON THE PLANS.
2. THE TUBE SHALL HAVE A FACTORY ATTACHED CAST IRON OR HIGH IMPACT PLASTIC COLLAR WITH RIBS TO PREVENT ROTATION WHEN REMOVING SCREW TOP LID. THE SCREW TOP LID SHALL BE CAST IRON OR HIGH IMPACT PLASTIC THAT WILL WITHSTAND ULTRA-VIOLET RAYS.
3. THE DEPTH OF THE INVERT AND "CO" SHALL BE MARKED ON CAP.

BIOFILTER CLEANOUT DETAIL

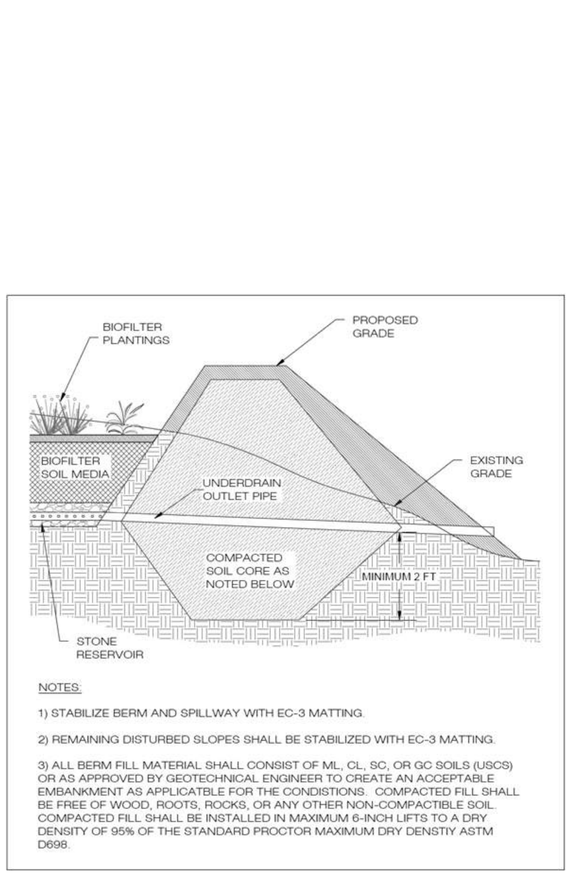
N.T.S.



NOTES:
1. FILTER MEDIA COMPOSITION TO CONTAIN:
   - 85%-88% SAND
   - 7%-12% SOIL FINES
   - 3%-5% ORGANIC MATTER PREFERABLY IN THE FORM OF LEAF COMPOST
2. PLANTING SOIL MIXTURE SHALL BE 50% SAND, 30% LEAF COMPOST (FULLY COMPOSTED) AND 20% TOPSOIL. TOPSOIL SHALL BE SANDY LOAM OR LOAMY SAND OF UNIFORM COMPOSITION, CONTAINING NO MORE THAN 5% CLAY, FREE OF STONES, STUMPS, ROOTS, OR SIMILAR OBJECTS GREATER THAN ONE INCH, OR ANY SUBSTANCE WHICH MAY BE HARMFUL TO PLANT GROWTH.
3. FILTER MEDIUM SHALL BE PLACED IN LIFTS LESS THAN 18 INCHES AND LIGHTLY COMPACTED (MINIMAL COMPACTIVE EFFORT) BY TAMPING OR ROLLING WITH A HAND-OPERATED LANDSCAPE ROLLER.
4. BIO-RETENTION BASIN SHALL BE INSPECTED AND MAINTAINED PER MINIMUM STANDARD 3.11 BIO-DETENTION BASIN PRACTICES OF THE VIRGINIA STORMWATER MANAGEMENT HANDBOOK.
5. SEE SHEET L1.0 CONCEPTUAL LANDSCAPING PLAN FOR PLANT DETAILS.

UNDERDRAIN DETAIL

N.T.S.



NOTES:

1) STABILIZE BERM AND SPILLWAY WITH EC-3 MATTING.

2) REMAINING DISTURBED SLOPES SHALL BE STABILIZED WITH EC-3 MATTING.

3) ALL BERM FILL MATERIAL SHALL CONSIST OF ML, CL, SC, OR GC SOILS (USCS) OR AS APPROVED BY GEOTECHNICAL ENGINEER TO CREATE AN ACCEPTABLE EMBANKMENT AS APPLICATBLE FOR THE CONDISTIONS. COMPACTED FILL SHALL BE FREE OF WOOD, ROOTS, ROCKS, OR ANY OTHER NON-COMPACTIBLE SOIL. COMPACTED FILL SHALL BE INSTALLED IN MAXIMUM 6-INCH LIFTS TO A DRY DENSITY OF 95% OF THE STANDARD PROCTOR MAXIMUM DRY DENSTIY ASTM D698.

FIGURE 9-B2. TYPICAL BIORETENTION BASIN BERM

BIORETENTION DETAILS AND PROFILE

KOONTZ BRYANT JOHNSON WILLIAMS
1703 N. Parham Rd, Suite 202
Henrico, Va 23229
(804) 740-9200
FAX (804) 740-7338
www.KBJWgroup.com

COMMONWEALTH OF VIRGINIA
MARK B. WILLIAMS
Lic. No. 037534
7/31/2018
PROFESSIONAL ENGINEER

REVISIONS

NO.	DATE	DESCRIPTION
1.	2017-11-15	QUANTITIES REDUCTION PER OWNER
2.	2017-11-27	QUANTITIES REDUCTION PER OWNER
3.	2018-04-20	PER OWNER COMMENTS
4.	2018-05-31	PER OWNER COMMENTS
1.	2018-07-31	BMP REVISION

POST APPROVAL

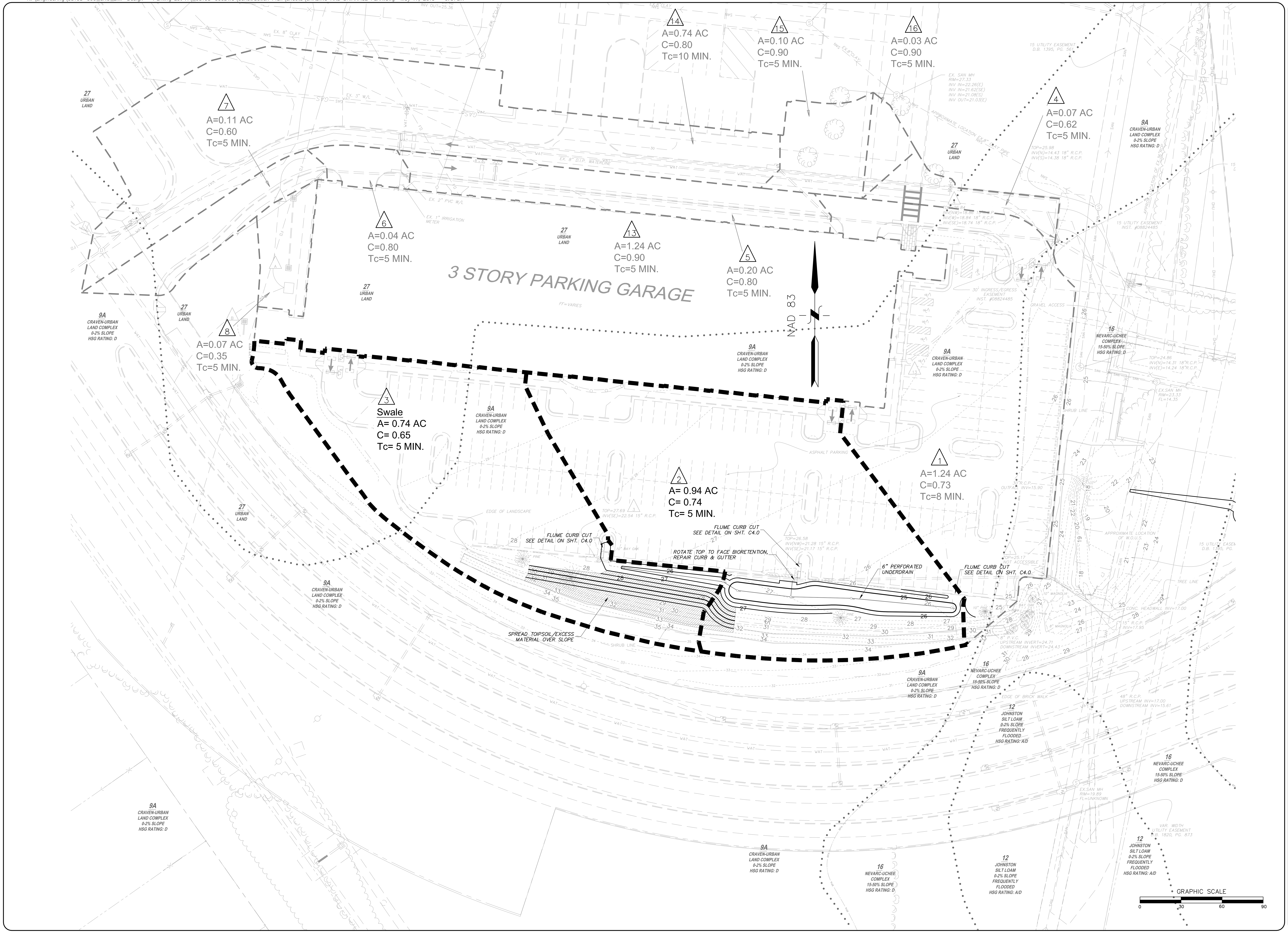
DESIGNED | DRAWN | CHECKED

CNU BMP AT PARKING LOT A
CITY OF NEWPORT NEWS VIRGINIA

SCALE:
DATE: JUNE 5, 2018
PROJECT: 05105-066

C2.4

K:\Engineering\05105-066_CNU_BMP Design - Parking Lot A_05105-066DWG\Construction Plan\Sheets\GRADING AND DRIANAGE PLAN.dwg May 17, 2019 - 9:57am



KOONTZ BRYANT JOHNSON WILLIAMS
1703 N. Parham Rd. Suite 202
Henrico, Va 23229
(804) 740-9200
FAX (804) 740-7338
www.KBJWgroup.com

COMMONWEALTH OF VIRGINIA
GREGORY N. KOONTZ
Lic. No. 16613
07/31/2018
PROFESSIONAL ENGINEER

REVISIONS

NO.	DATE	DESCRIPTION
1.	2017-11-15	QUANTITIES REDUCTION PER OWNER
2.	2017-11-27	QUANTITIES REDUCTION PER OWNER
3.	2018-05-04	PER OWNER COMMENTS
4.	2018-05-31	PER OWNER COMMENTS

POST APPROVAL

DESIGNED BGL/FJPR
DRAWN FJPR/DFW
CHECKED BGL

CNU BMP AT PARKING LOT A

CITY OF NEWPORT NEWS VIRGINIA

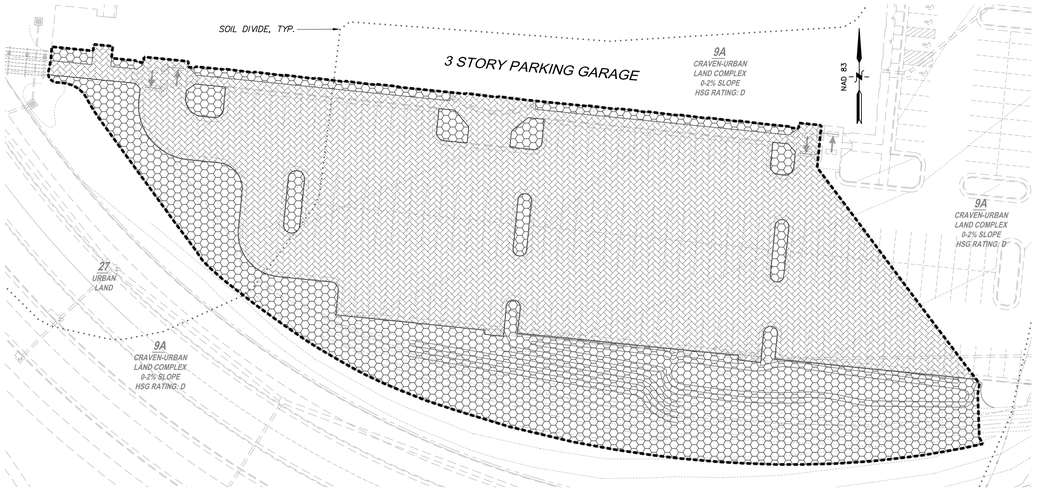
GRADING AND DRAINAGE PLAN

SCALE:
DATE: JUNE 5, 2018
PROJECT: 05105-066

C3.0

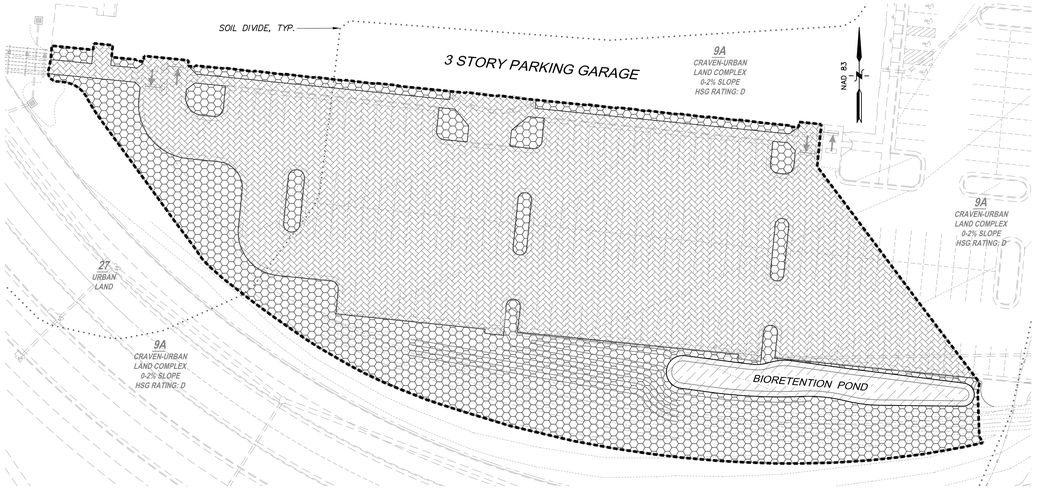
EXISTING PROJECT AREA DATA

SOILS TYPE	"D"
FOREST/OPEN SPACE	0 AC
MANAGED TURF	0.63 AC
IMPERVIOUS COVER	1.06 AC
PROJECT AREA	1.69 AC



PROPOSED PROJECT AREA DATA

SOILS TYPE	"D"
FOREST/OPEN SPACE	0.07 AC
MANAGED TURF	0.56 AC
IMPERVIOUS COVER	1.06 AC
PROJECT AREA	1.69 AC



LEGEND

IMPERVIOUS COVER

MANAGED TURF

FOREST/OPEN SPACE

GRAPHIC SCALE

0 40 80 120

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Update Summary Sheet | Print Preview | Print

Site Summary

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.69**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.63	0.63	37
Impervious Cover (acres)	0.00	0.00	0.00	1.06	1.06	63
					1.69	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total	
Forest/Open (acres)	0.00	0.00	0.00	0.07	0.07	4	*
Managed Turf (acres)	0.00	0.00	0.00	0.56	0.56	33	
Impervious Cover (acres)	0.00	0.00	0.00	1.06	1.06	63	
*** Forest/Open Space areas must be protected in accordance with the Virginia Runoff Reduction Method**					1.69	100	

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.68	0.68	--	0.69
Treatment Volume (ft^3)	4,176	4,176	--	4,227
TP Load (lb/yr)	2.62	2.62	--	2.66

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.57	**1.55**	**1.55**

Total TP Load Reduction Required (lb/yr)	**0.50**	0.50	0

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	18.77	19.00

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	1,665
Total TP Load Reduction Achieved (lb/yr)	1.44
Total TN Load Reduction Achieved (lb/yr)	11.96
Remaining Post Development TP Load (lb/yr)	1.19
Remaining TP Load Reduction (lb/yr) Required	**0.00**

** Total phosphorous removal of 1.44 lbs/yr is achieved by installing the proposed BMP.*
** Reduction of TP contributes towards water quality requirement per MS-4 standards.*

**** TARGET TP REDUCTION EXCEEDED BY 0.94 LB/YEAR ****

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.07	0.00	0.00	0.00	0.00	0.07
Managed Turf (acres)	0.56	0.00	0.00	0.00	0.00	0.56
Impervious Cover (acres)	1.06	0.00	0.00	0.00	0.00	1.06
Total Area (acres)	**1.69**	**0.00**	**0.00**	**0.00**	**0.00**	**1.69**

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	1.44	0.00	0.00	0.00	0.00	1.44
TN Load Reduced (lb/yr)	11.96	0.00	0.00	0.00	0.00	11.96

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.07	0.07	4
Managed Turf (acres)	0.00	0.00	0.00	0.56	0.56	33
Impervious Cover (acres)	0.00	0.00	0.00	1.06	1.06	63
					1.69	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed

Total Impervious Cover Treated (acres)	1.06
Total Turf Area Treated (acres)	0.56
Total TP Load Reduction Achieved in D.A. (lb/yr)	1.44
Total TN Load Reduction Achieved in D.A. (lb/yr)	11.96

Runoff Volume and CN Calculations

	1-year storm	2-year storm	10-year storm
Target Rainfall Event (in)	2.94	3.58	5.53

Drainage Areas	RV & CN	Drainage Area A	Drainage Area B	Drainage Area C	Drainage Area D	Drainage Area E
CN		91	0	0	0	0
RR (ft^3)		1,665	0	0	0	0
1-year return period	**RV wo RR (ws-in)**	2.02	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	1.74	0.00	0.00	0.00	0.00
	CN adjusted	88	0	0	0	0
2-year return period	**RV wo RR (ws-in)**	2.62	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	2.35	0.00	0.00	0.00	0.00
	CN adjusted	88	0	0	0	0
10-year return period	**RV wo RR (ws-in)**	4.50	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	4.23	0.00	0.00	0.00	0.00
	CN adjusted	88	0	0	0	0

KOONTZ BRYANT JOHNSON WILLIAMS
1703 N. Parham Rd, Suite 202
Henrico, Va 23229
(804) 740-9200
FAX (804) 740-7338
www.KBJWgroup.com

COMMONWEALTH OF VIRGINIA
GREGORY R. KOONTZ
Lic. No. 16613
07/31/2018
PROFESSIONAL ENGINEER

REVISIONS

NO.	DATE	DESCRIPTION
1.	2017-11-15	QUANTITIES REDUCTION PER OWNER
2.	2017-11-27	QUANTITIES REDUCTION PER OWNER
3.	2018-04-04	BMP OWNER COMMENTS
4.	2018-05-31	PER OWNER COMMENTS
1.	2018-07-31	BMP REVISION

POST APPROVAL

DESIGNED BGL/FJPR | **DRAWN** FJPR/DFW | **CHECKED** BGL

CNU BMP AT PARKING LOT A

CITY OF NEWPORT NEWS VIRGINIA

CALCULATIONS ~ WATER QUALITY

SCALE:
DATE: JUNE 5, 2018
PROJECT: 05105-066

C5.0

Performance-Based Criteria Water Quality Calculation Procedure Worksheet 1

STEP 1 Determine the applicable area (A) and the post-developed impervious cover (I_{post}).

Applicable area (A)* = 147.24 acres

Post-development impervious cover:

structures = 26.31 acres

parking lot = 20.40 acres

roadway = 9.48 acres

sidewalk = 12.07 acres

other = 3.96 acres

Total = 72.22 acres

I_{post} = (total post-development impervious cover ÷ A) × 100 = 49.05 %

* The area subject to the criteria may vary from locality to locality. Therefore, consult the locality for proper determination of this value.

STEP 2 Determine the average land cover condition ($I_{watershed}$) or the existing impervious cover ($I_{existing}$).

Average land cover condition ($I_{watershed}$):
If the locality has determined land cover conditions for individual watersheds within its jurisdiction, use the watershed specific value determined by the locality as $I_{watershed}$.

$I_{watershed}$ = 36 %

Otherwise, use the Chesapeake Bay default value:

$I_{watershed}$ = 16 %

Existing impervious cover ($I_{existing}$):
Determine the existing impervious cover of the development site if present.

Existing impervious cover:

structures = _____ acres

parking lot = _____ acres

roadway = _____ acres

other = _____ acres

Total = 0.00 acres

$I_{existing}$ = (total existing impervious cover ÷ A*) × 100 = 0 %

* The area should be the same as used in STEP 1.

STEP 3 Determine the appropriate development situation.

The site information determined in STEP 1 and STEP 2 provide enough information to determine the appropriate development situation under which the performance criteria will apply. Check (_) the appropriate development situation as follows:

_____ **Situation 1:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is less than or equal to the average land cover condition ($I_{watershed}$) and the proposed improvements will create a total percent impervious cover (I_{post}) which is less than or equal to the average land cover condition ($I_{watershed}$).

I_{post} 49.05 % ≤ $I_{watershed}$ = 36 %

X **Situation 2:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is less than or equal to the average land cover condition ($I_{watershed}$) and the proposed improvements will create a total percent impervious cover (I_{post}) which is greater than the average land cover condition ($I_{watershed}$).

$I_{existing}$ 0 % ≤ $I_{watershed}$ = 36 %

I_{post} 49.05 % > $I_{watershed}$ = 36 %

_____ **Situation 3:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is greater than the average land cover condition ($I_{watershed}$).

$I_{existing}$ 0 % > $I_{watershed}$ = 36 %

_____ **Situation 4:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is served by an existing stormwater management BMP(s) that addresses water quality.

If the proposed development meets the criteria for development Situation 1, than the low density development is considered to be the BMP and no pollutant removal is required. The calculation procedure for Situation 1 stops here. If the proposed development meets the criteria for development Situations 2, 3, or 4, then proceed to STEP 4 on the appropriate worksheet.

Performance-Based Criteria Water Quality Calculation Procedure Worksheet:

Situation 2

Summary of Situation 2 criteria: from calculation procedure **STEP 1** thru **STEP 3**, Worksheet 1:

Applicable area (A)* = 147.24 acres

I_{post} = (total post-development impervious cover ÷ A) × 100 = 49.05 %

$I_{watershed}$ = 36 % **or** $I_{watershed}$ = 16 %

$I_{existing}$ = (total existing impervious cover ÷ A*) × 100 = 0 %

$I_{existing}$ 0 % ≤ $I_{watershed}$ = 36 %

I_{post} 49.05 % > $I_{watershed}$ = 36 %

STEP 4 **Determine the relative pre-development pollutant load (L_{pre}).**

$L_{pre(watershed)} = [0.05 + (0.009 \times I_{watershed})] \times A \times 2.28$ **(Equation 5-16)**

where: $L_{pre(watershed)}$ = relative pre-development total phosphorous load (pounds per year)
$I_{watershed}$ = average land cover condition for specific watershed or locality or the Chesapeake Bay default value of 16% (percent expressed in whole numbers)
A = applicable area (acres)

$L_{pre(watershed)}$ = [0.05 + (0.009 × 36)] x 147.24 x 2.28

= 125.55 pounds per year

STEP 5 **Determine the relative post-development pollutant load (L_{post}).**

$L_{post} = [0.05 + (0.009 \times I_{post})] \times A \times 2.28$ **(Equation 5-20)**

where: L_{post} = relative post-development total phosphorous load (pounds per year)
I_{post} = post-development percent impervious cover (percent expressed in whole numbers)
A = applicable area (acres)

L_{post} = [0.05 + (0.009 × 49.05)] x 147.24 x 2.28

= 164.98 pounds per year

STEP 6 **Determine the relative pollutant removal requirement (RR).**

RR = L_{post} - $L_{pre(watershed)}$

RR = 164.98 - 125.55

= 39.43 pounds per year

STEP 7 **Identify best management practice (BMP) for the site.**

1. Determine the required pollutant removal efficiency for the site:

EFF = (RR ÷ L_{post}) × 100 **(Equation 5-21)**

where: EFF = required pollutant removal efficiency (percent expressed in whole r
RR = pollutant removal requirement (pounds per year)
L_{post} = relative post-development total phosphorous load (pounds per yea

EFF = 39.43 ÷ 164.98 x 100

= 24 %

2. Select BMP(s) from **Table 5-15** and locate on the site:

BMP 1: Lake Maury
BMP 2:
BMP 3:

3. Determine the pollutant load entering the proposed BMP(s):

$L_{BMP} = [0.05 + (0.009 \times I_{BMP})] \times A \times 2.28$ **(Equation 5-22)**

where: L_{BMP} = relative post-development total phosphorous load entering proposed BMP (pounds per year)
I_{BMP} = post-development percent impervious cover of BMP drainage area (percent expressed in whole numbers)
A = drainage area of proposed BMP (acres)

L_{BMP1} = [0.05 + (0.009 × 51.21)] x 153.73 x 2.28

= 179.07 pounds per year

L_{BMP2} = [0.05 + (0.009 × _____)] x _____ x 2.28

= _____ pounds per year

L_{BMP3} = [0.05 + (0.009 × _____)] x _____ x 2.28

= _____ pounds per year

4. Calculate the pollutant load removed by the proposed BMP(s):

$L_{removed} = Eff_{BMP} \times L_{BMP}$ **(Equation 5-23)**

where: $L_{removed}$ = Post-development pollutant load removed by proposed BMP (pounds per year)
Eff_{BMP} = pollutant removal efficiency of BMP (expressed in decimal form)
L_{BMP} = relative post-development total phosphorous load entering proposed BMP (pounds per year)

$L_{removed/BMP1}$ = 0.29 x 179.07 = 52.45 pounds per year

$L_{removed/BMP2}$ = _____ x _____ = _____ pounds per year

$L_{removed/BMP3}$ = _____ x _____ = _____ pounds per year

5. Calculate the total pollutant load removed by the BMP(s):

$L_{removed/total} = L_{removed/BMP1} + L_{removed/BMP2} + L_{removed/BMP3} + \ldots$ **(Equation 5-24)**

where: $L_{removed/total}$ = total pollutant load removed by proposed BMPs
$L_{removed/BMP1}$ = pollutant load removed by proposed BMP No. 1
$L_{removed/BMP2}$ = pollutant load removed by proposed BMP No. 2
$L_{removed/BMP3}$ = pollutant load removed by proposed BMP No. 3

$L_{removed/total}$ = 52.45 + 0.00 + 0.00 +…

= 52.45 pounds per year

6. Verify compliance:

$L_{removed/total} \geq$ **RR**

52.45 ≥ 39.43 CNU required removal
13.00 VDOT required removal
52.43 Compliance

Note: No credit was taken for existing BMPs due to age, location and condition.

CNU Campus				
		Project Post-development Impervious Area (acres)	Project Pre-development Impervious Area (acres)	Campus Post-development Impervious Area (acres)
				59.00
S-01-0720-01-1	CNU Residence Hall III (partially built when flown)	0.34	0.00	59.34
S-01-0720-02-1	CNU Track Complex (Stadium Seating)	1.33	1.39	59.28
S-01-0720-04-0	CNU Performing Arts Center, Phase 1	8.67	9.80	58.15
S-02-LJ-03	CNU Performing Arts Center, Phase II	6.90	8.67	56.38
S-03-LJ-01	CNU Track Complex - Football Stadium, Phase 2	0.13	0.00	56.51
S-03-LJ-02	CNU Soccer Practice Field	-0.79	0.00	55.72
S-03-LJ-03	CNU Tennis Courts	0.24	0.00	55.96
S-03-LJ-04	CNU Residence Hall IV	-1.32	0.00	54.64
S-03-LJ-06	CNU Parking Deck	4.16	0.00	58.80
S-03-LJ-07	CNU Clearing, Grubbing and Demolition Plan (Baseball Facility)	0.00	0.00	58.80
S-03-LJ-08	CNU Demo 78 Moores Ln.	0.00	0.05	58.75
S-03-LJ-09	CNU Demo 82 Moores Ln.	0.00	0.15	58.60
S-03-LJ-10	CNU Demo 262 Prince Drew Dr.	0.00	0.10	58.50
S-03-LJ-11	CNU Demo 300 Prince Drew Dr.	0.00	0.04	58.46
S-03-LJ-12	CNU Storm Sewer Infrastructure Improvements	-0.66	0.00	57.80
S-03-LJ-14	CNU Moores Lane Demo Projects (67, 71, 77 & 79)	0.00	0.37	57.43
S-03-LJ-15	CNU Baseball Field	0.72	0.00	58.15
S-03-LJ-15	CNU Warwick Blvd. Demo Projects	0.00	0.00	58.15
S-04-01	CNU Student Center	1.84	0.92	59.07
S-04-02	CNU Library and Information Technology Center	1.09	0.75	59.41
S-04-07	CNU Demo 87 Moore's Lane	0.00	0.05	59.35
S-04-08	CNU Temporary Construction Access Road	0.25	0.07	59.53
S-04-11	CNU Demo 61 Moore's Lane	0.00	0.04	59.50
S-04-15	CNU Demo 63 Moore's Lane	0.00	0.08	59.42
S-04-17	CNU Baseball Field Press Box and Seating Area	0.93	0.72	59.63
S-04-18	CNU Softball Field	0.19	0.00	59.82
S-05-03	CNU Fine Arts Loop Road	0.96	1.21	59.57
S-05-04	CNU Moores Lane Parking Lot	2.57	1.55	60.59
S-05-05	CNU Dumpster Yard	0.16	0.16	60.59
S-05-15	CNU Baseball Field Parking Lot	0.67	0.05	61.21
S-05-16	CNU Student Center Parking Lot	1.27	0.00	62.48
S-07-15	CNU McMurran Hall Liberal Arts Building	1.16	1.56	62.08
S-08-10	CNU Artificial Turf Field	0.00	0.00	62.08
SW2-09-11	CNU Science Building	2.07	1.67	62.48
S-09-01	CNU Soccer Concession Building	-0.03	0.00	62.45
SW2-09-13	CNU Track Renovations	1.75	1.39	62.81
SW2-09-28	CNU Freeman Center	4.74	3.58	63.97
SW2-09-33	CNU Loop Road Phase 2	0.65	0.55	64.07
SW2-10-05	CNU Chapel	0.65	1.30	63.42
SW2-10-09	CNU New Hall	1.54	1.39	63.57
SW2-10-14	CNU Res Hall V	1.48	2.09	62.94
SW2-11-02	CNU Master Plan Parking Lots - Phase 1	9.71	2.50	70.15
S-09-21	CNU Ratcliffe Hall Atheletic Addition	0.75	0.49	70.41
Per 2011 Master Plan Update	*Adjustment per field changes to the softball fields*	-0.18	0.00	70.23
Per 2011 Master Plan Update	*Adjustment per field changes to track and concession walks*	0.06	0.00	70.29
Per 2011 Master Plan Update	*Adjustments per field changes of walkways/demo on McMurran Hall and the Science Building including the Chiller Plant*	0.77	0.00	71.06
Per 2011 Master Plan Update	*Adjustment for 12 Moores Lane to remain*	0.15	0.00	71.21
Per 2011 Master Plan Update	Adjustment per removal of 30 spaces in Master Parking Lots	-0.11	0.00	71.10
SW2-12-01	Hiden-Hussey Commons Additions Phase 1	0.33	0.00	71.43
Per WEG - CNU Entry Plaza	CNU Entry Plaza - Within CNU Campus	0.05	0.00	71.48
Per WEG - CNU Entry Plaza	CNU Entry Plaza - Within Existing VDOT ROW (in Transfer)	0.22	0.00	71.70
SW2-12-07	Adjustment per parking lot size Revised CNU Master Plan Parking	-0.11	0.00	71.59
In for Approval	Proposed Student Success Center	0.97	1.16	71.40
In for Approval	Proposed New Hall Parking Lot Demo and Walkway Design	0.31	1.12	70.59
In for Approval	CNU Bell Tower	0.16	0.00	70.75
Proposed	CNU Tennis Center	1.35	1.30	70.80
In for Approval	Proposed Greek Housing Project	2.64	1.22	72.22
	Total CNU Campus Study Area			147.24
	Percent Impervious Area			49.05%

	Impervious Area (Acres)					
Project	Structures	Parking Lot	Roadway	Sidewalk	Other	Total
CNU McMurran Hall Liberal Arts Building	21.20	20.50	8.70	8.90	2.78	62.08
CNU Artificial Turf Field	21.20	20.50	8.70	8.90	2.78	62.08
CNU Science Building	21.98	20.50	8.70	8.52	2.78	62.48
CNU Soccer Concession Building	22.02	20.50	8.70	8.45	2.78	62.45
CNU Track Renovations	22.02	20.50	8.70	8.45	3.14	62.81
CNU Freeman Center	23.02	20.50	8.70	8.61	3.14	63.97
CNU Loop Road Phase 2	23.02	19.95	9.35	8.61	3.14	64.07
CNU Chapel	23.35	18.73	9.35	8.85	3.14	63.42
CNU New Hall Building	24.12	18.07	9.35	8.89	3.14	63.57
CNU Residence Hall V	24.89	16.16	9.35	9.40	3.14	62.94
CNU Master Plan Parking Lots - Phase 1	24.09	23.16	9.47	10.29	3.14	70.15
CNU Ratcliffe Hall Atheletic Addition	24.35	23.12	9.52	10.28	3.14	70.41
Adjustment per field changes to the softball fields	24.35	22.95	9.54	10.24	3.15	70.23
Adjustment per field changes to track and concession walks	24.35	22.95	9.54	10.30	3.15	70.29
Adjustments per field changes of walkways/demo on McMurran Hall and the Science Building including the Chiller Plant	23.92	22.95	9.54	11.22	3.43	71.06
Adjustment for 12 Moores Lane to remain	24.01	22.95	9.58	11.22	3.45	71.21
Adjustment per removal of 30 spaces in Master Parking Lots	24.01	22.84	9.58	11.22	3.45	71.10
Hiden-Hussey Commons Additions Phase 1	24.19	22.84	9.58	11.34	3.48	71.43
CNU Entry Plaza - Within CNU Campus	24.19	22.84	9.58	11.34	3.53	71.48
CNU Entry Plaza - Within Existing VDOT ROW (in Transfer)	24.19	22.84	9.58	11.34	3.75	71.70
Adjustment per Revised CNU Master Plan Parking Lots	24.19	22.73	9.58	11.34	3.75	71.59
ProposedCNU Student Success Center	24.53	22.73	9.58	10.81	3.75	71.40
Proposed CNU New Hall Parking Lot Demo and Walkway Design	24.53	21.61	9.58	11.12	3.75	70.59
Proposed CNU Bell Tower	24.53	21.61	9.58	11.28	3.75	70.75
Proposed CNU Tennis Center	25.46	20.52	9.58	11.28	3.96	70.80
Proposed CNU Greek Housing	26.31	20.40	9.48	12.07	3.96	72.22

AS-BUILT DRAWINGS

GLAVÉ & HOLMES ARCHITECTURE

2101 East Main Street
Richmond, Virginia 23223

T 804 649 9303 F 804 343 3378
W www.glaveandholmes.com

SEAL

COMMONWEALTH OF VIRGINIA
Robert J. Parise
Lic. No. 015194
7/16/14
ARCHITECT

KOONTZ-BRYANT, P.C.
Site Development Solutions

1703 NORTH PARHAM ROAD, SUITE 202
RICHMOND, VIRGINIA 23229 (804)
740-9200 FAX (804) 740-7338
kbpc@koontzbryant.com

SEAL

COMMONWEALTH OF VIRGINIA
DANIEL I. JAMISON
Lic. No. 38979
PROFESSIONAL ENGINEER

CHRISTOPHER NEWPORT UNIVERSITY
1 Avenue of the Arts
Newport News, VA 23606

PROJECT TITLE
CNU Athletics Expansion II
New Tennis Courts

PROJECT NUMBER
PC# 242-17361-005

JN:
05105-059

DATE
July 16, 2014

DRAWN BY: DFW APPROVED BY: DJJ

REVISIONS

NO.	DATE	DESCRIPTION
		This Sheet Only EJK 4.17.15 ET

SHEET TITLE
CBPA CALCULATIONS

SHEET NUMBER
C5.2

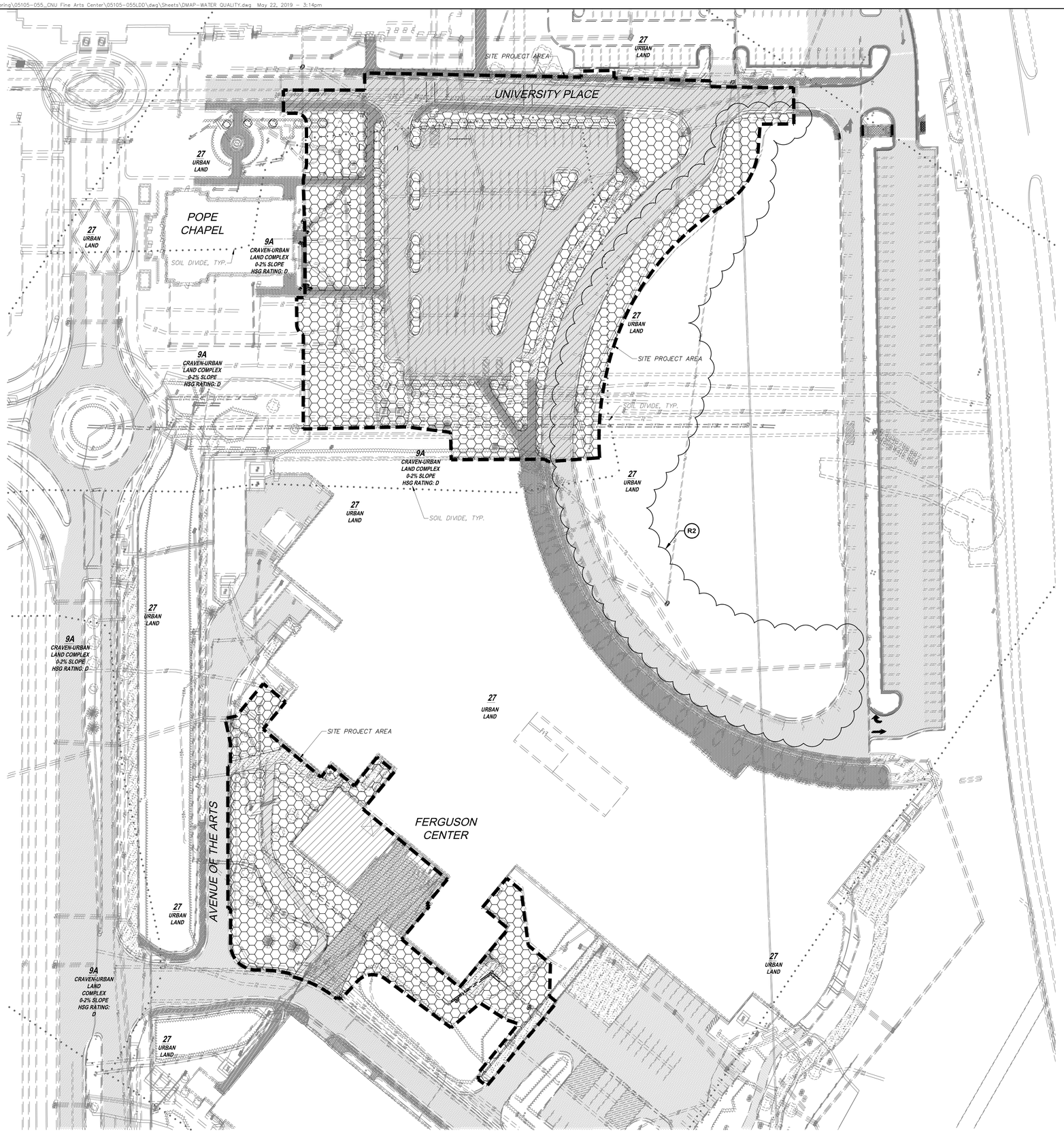
K:\Engineering\05105-059_CNU_Tennis_Center_05105-059DWG\Construction Plan\Sheets\05105-059 C5.2.dwg dwilliams 8/1/2014 7:56 AM

CHRISTOPHER NEWPORT UNIVERSITY

Appendix C: Figures and Calculations – Capital Improvement Projects

vhb

K:\Engineering\05105-055_CNU Fine Arts Center\05105-055LDD\dwg\Sheets\DMAP-WATER QUALITY.dwg May 22, 2019 - 3:14pm



EXISTING PROJECT AREA DATA

SOILS TYPE	"D"	
FOREST/OPEN SPACE	0.00	AC
MANAGED TURF	1.94	AC
IMPERVIOUS COVER	2.06	AC
TOTAL PROJECT AREA	4.00	AC

PRE-DEVELOPED LAND COVERAGE

SITE AREA = 4.00 AC

PRE-DEVELOPED % IMPERVIOUS = (2.06/4.00) * 100 = 51.50%

LEGEND

IMPERVIOUS COVER: ASPHALT / CONCRETE / GRAVEL

MANAGED TURF

R2

CREDIT AVAILABILITY LETTER

C.B.N.L.T. "Tomorrow's Natural Resources Today"

Chesapeake Bay Nutrient Land Trust, LLC.

May 10, 2019

Koontz Bryant Johnson Williams
ATTN: Mr. Kevin Reichert
1703 North Parham Road, Suite 202
Henrico, VA 23229

RE: CBNLT/Cranston's Mill Pond – Nutrient Credit Availability
Chesapeake Bay Nutrient Land Trust, LLC

Project Reference: Christopher Newport University – Fine Arts Center

Attention Mr. Reichert:

This letter is to confirm the availability of authorized Nutrient Credits sufficient to meet your project requirements at our Cranston's Mill Pond facility, which is registered with the Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Conservation and Recreation (DCR). These Nutrient Credits are generated and managed under the terms of the Cranston's Mill Pond Nutrient Reduction Implementation Plan dated April 20, 2010 which was authorized by the Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Conservation and Recreation (DCR) on July 13, 2010.

The Cranston's Mill Pond project has been authorized to provide Nutrient Credits for use in the James River watershed. These Credits are transferable to those entities regulated under DEQ's Stormwater Management Program in accordance with VA Code § 62.1-44.15:35. Currently our Cranston's Mill Pond facility has **201.35** pounds of Phosphorus Credits available and will be able to meet your project's phosphorus requirement of up to **1.74** pounds.

If we can provide further assistance please feel free to contact our office.

Sincerely,

Chesapeake Bay Nutrient Land Trust, LLC

By Its Manager
EarthSource Solutions, Inc.

Scott A. Reed

Scott A. Reed
Vice President

Chesapeake Bay Nutrient LandTrust, LLC. • 5735 S. Laburnum Avenue • Richmond, VA 23231 • P: 804.222.5114 • www.cbnlt.com

R2

NAD 83

GRAPHIC SCALE

40 0 20 40 80

1 inch = 40 feet

GLAVÉ & HOLMES ARCHITECTURE

2101 East Main Street
Richmond, Virginia 23223

T 804 649 9303 F 804 343 3378
W www.glaveandholmes.com

PROJECT TITLE

CNU FINE ARTS CENTER

CHRISTOPHER NEWPORT UNIVERSITY

CONSULTANTS

CIVIL ENGINEER
Koontz Bryant Johnson Williams
1703 North Parham Road, Suite 202
Henrico, VA 23229
T (804) 740-9200
F (804) 740-7338
W www.kbjwgroup.com

STRUCTURAL ENGINEER
Lynch Mykins Structural Engineers
1503 Santa Rosa Road, Suite 210
Richmond, VA 23229
T (804) 346-3935
F (804) 346-1171
W www.lynchmykins.com

MEP ENGINEER
Mueller Associates
1306 Concourse Drive, Suite 100
Linthicum, MD 21090
T (410) 646-4500
F (410) 646-4738
W www.muellerassociates.com

A/V ENGINEER
Miller Beam Paganelli, Inc.
12040 South Lakes Drive, Suite 104
Reston, VA 20191
T (703) 506-0005
F (703) 506-0009
W www.millerbp.com

FIRE PROTECTION
GHD Engineers
121 North 20th Street, Suite A
Richmond, VA 23223
T (804) 237-0300
F (703) 506-0009
W www.ghd.com

SEAL

COMMONWEALTH OF VIRGINIA
GREGORY N. KOONTZ
Lic. No. 16613
10/17/18
PROFESSIONAL ENGINEER

PROJECT NUMBER
G&HA#: 16029
PC#: 242-18086-000
WO#: XX

DATE
OCTOBER 17, 2018

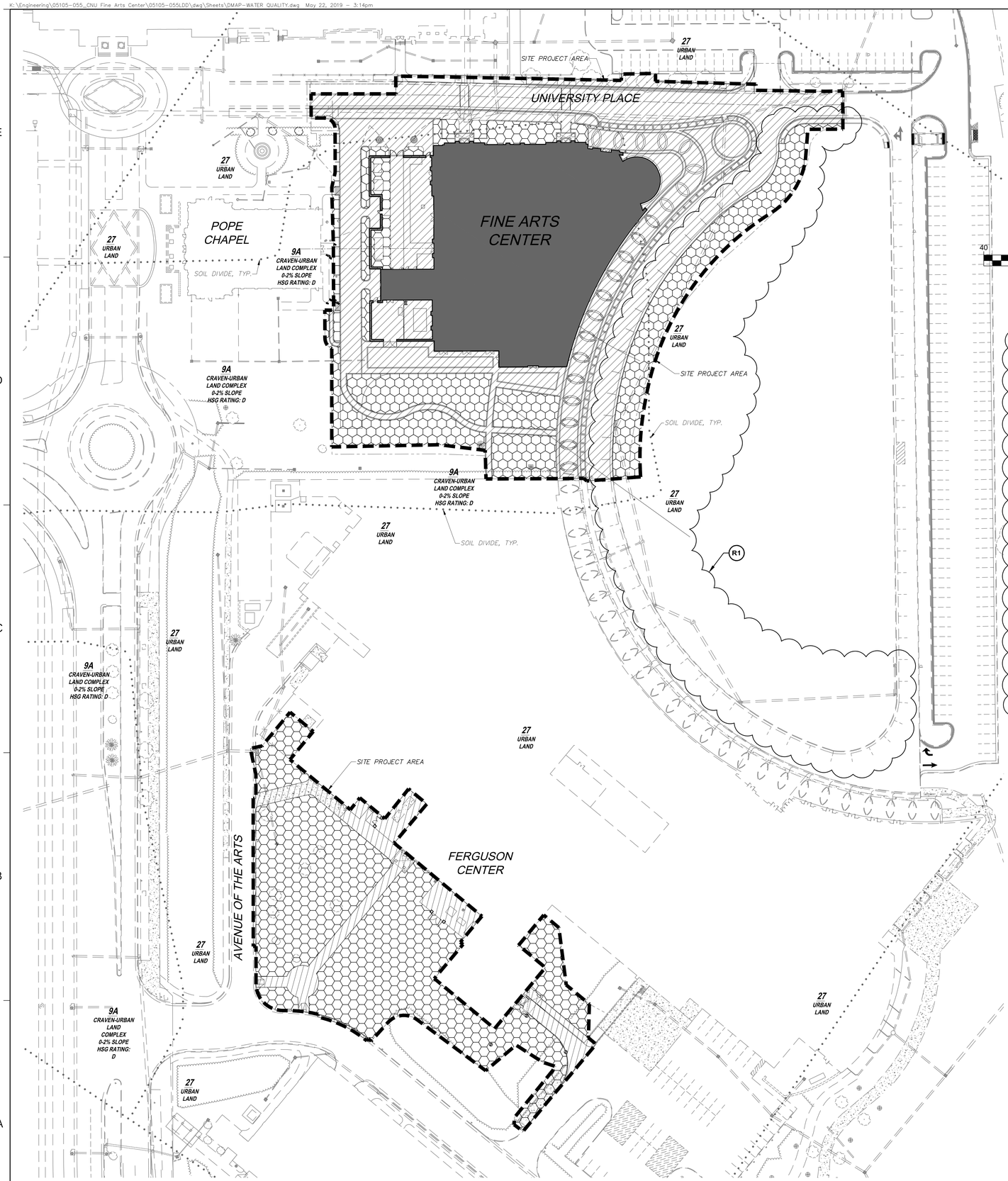
DRAWN BY: DFW APPROVED BY:

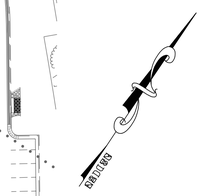
REVISIONS

NO.	DATE	DESCRIPTION
R1	2/25/2019	CLARIFICATION 03
R2	5/15/2019	BID REVISION 3 & VE

SHEET TITLE
WATER QUALITY ~ EXISTING CONDITIONS

SHEET NUMBER
C9.3





PROPOSED PROJECT AREA DATA

SOILS TYPE	"D"	
FOREST/OPEN SPACE	0.00	AC
MANAGED TURF	1.56	AC
IMPERVIOUS COVER	2.44	AC
TOTAL PROJECT AREA	4.00	AC

POST-DEVELOPED LAND COVERAGE

SITE AREA = 4.00 AC

POST-DEVELOPED % IMPERVIOUS = (2.44/4.00) * 100 = 61.00%

LEGEND

- IMPERVIOUS COVER: ASPHALT / CONCRETE / GRAVEL
- IMPERVIOUS COVER: BUILDING
- MANAGED TURF

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Update Summary Sheet | Print Preview | Print

Site Summary

Total Rainfall (in):	43
Total Disturbed Acreage:	4.00

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.94	1.94	49
Impervious Cover (acres)	0.00	0.00	0.00	2.06	2.06	52
					4.00	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.56	1.56	39
Impervious Cover (acres)	0.00	0.00	0.00	2.44	2.44	61
					4.00	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.68	0.65	0.95	0.65
Treatment Volume (ft^3)	9,830	8,520	1,310	8,520
TP Load (lb/yr)	6.18	5.35	0.82	5.35

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.48	1.54	1.48

Total TP Load Reduction Required (lb/yr)	1.74	1.07	0.67

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	44.18	39.84

R1

VRRM COMPLIANCE SUMMARY

SITE'S :

TP LOAD REDUCTION REQUIRED = 1.74 LB/YEAR

TP REDUCTION WILL BE ACHIEVED BY PURCHASING CREDITS

GLAVÉ & HOLMES ARCHITECTURE

2101 East Main Street
Richmond, Virginia 23223

T 804 649 9303 F 804 343 3378
W www.glaveandholmes.com

PROJECT TITLE

CNU FINE ARTS CENTER

CHRISTOPHER NEWPORT UNIVERSITY

CONSULTANTS

CIVIL ENGINEER
Koontz Bryant Johnson Williams
1703 North Parham Road, Suite 202
Henrico, VA 23229
T (804) 740-9200
F (804) 740-7338
W www.kbjwgroup.com

STRUCTURAL ENGINEER
Lynch Mykins Structural Engineers
1503 Santa Rosa Road, Suite 210
Richmond, VA 23229
T (804) 346-3935
F (804) 346-1171
W www.lynchmykins.com

MEP ENGINEER
Mueller Associates
1306 Concourse Drive, Suite 100
Linthicum, MD 21090
T (410) 646-4500
F (410) 646-4738
W www.muellerassociates.com

A/V ENGINEER
Miller Beam Paganelli, Inc.
12040 South Lakes Drive, Suite 104
Reston, VA 20191
T (703) 506-0005
F (703) 506-0009
W www.millerbp.com

FIRE PROTECTION
GHD Engineers
121 North 20th Street, Suite A
Richmond, VA 23223
T (804) 237-0300
F (703) 506-0009
W www.ghd.com

SEAL

COMMONWEALTH OF VIRGINIA
GREGORY N. KOONTZ
Lic. No. 16613
10/17/18
PROFESSIONAL ENGINEER

PROJECT NUMBER
G&HA#: 16029
PC#: 242-18086-000
WO#: XX

DATE
OCTOBER 17, 2018

DRAWN BY: DFW APPROVED BY:

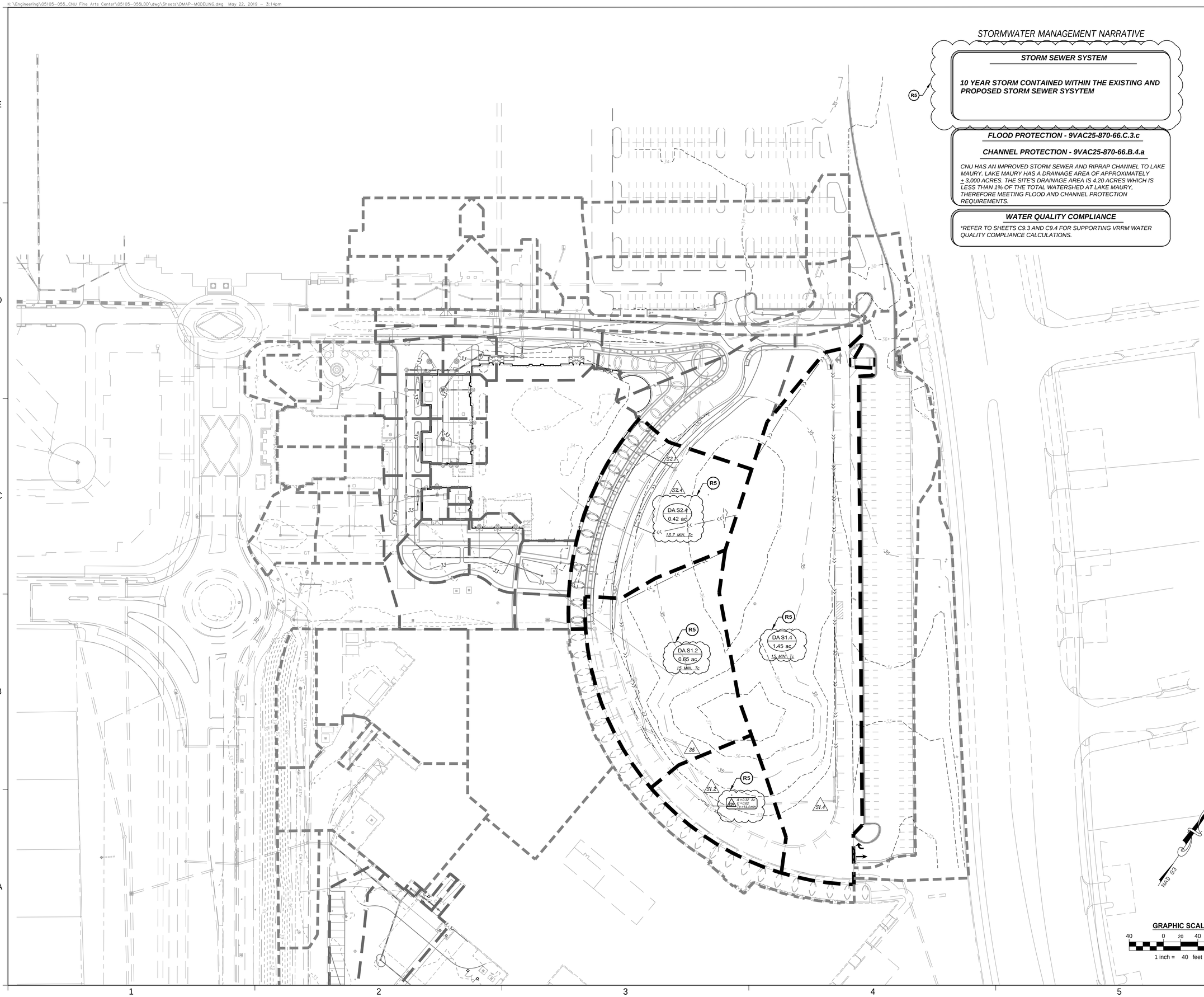
REVISIONS

NO.	DATE	DESCRIPTION
R1	5/15/2019	BID REVISION 3 & VE

SHEET TITLE
WATER QUALITY ~ PROPOSED CONDITIONS

SHEET NUMBER
C9.4

K:\Engineering\05105-055_CNU Fine Arts Center\05105-055LDD\dwg\Sheets\DMAP-MODELING.dwg May 22, 2019 - 3:14pm



STORMWATER MANAGEMENT NARRATIVE

STORM SEWER SYSTEM

10 YEAR STORM CONTAINED WITHIN THE EXISTING AND PROPOSED STORM SEWER SYSYTEM

FLOOD PROTECTION - 9VAC25-870-66.C.3.c

CHANNEL PROTECTION - 9VAC25-870-66.B.4.a

CNU HAS AN IMPROVED STORM SEWER AND RIPRAP CHANNEL TO LAKE MAURY. LAKE MAURY HAS A DRAINAGE AREA OF APPROXIMATELY ± 3,000 ACRES. THE SITE'S DRAINAGE AREA IS 4.20 ACRES WHICH IS LESS THAN 1% OF THE TOTAL WATERSHED AT LAKE MAURY, THEREFORE MEETING FLOOD AND CHANNEL PROTECTION REQUIREMENTS.

WATER QUALITY COMPLIANCE

**REFER TO SHEETS C9.3 AND C9.4 FOR SUPPORTING VRRM WATER QUALITY COMPLIANCE CALCULATIONS.*

GRAPHIC SCALE

40 0 20 40 80

1 inch = 40 feet

GLAVÉ & HOLMES ARCHITECTURE

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PROJECT NUMBER
G&HA#: 16029
PC#: 242-18086-000
WO#: XX

DATE
OCTOBER 17, 2018

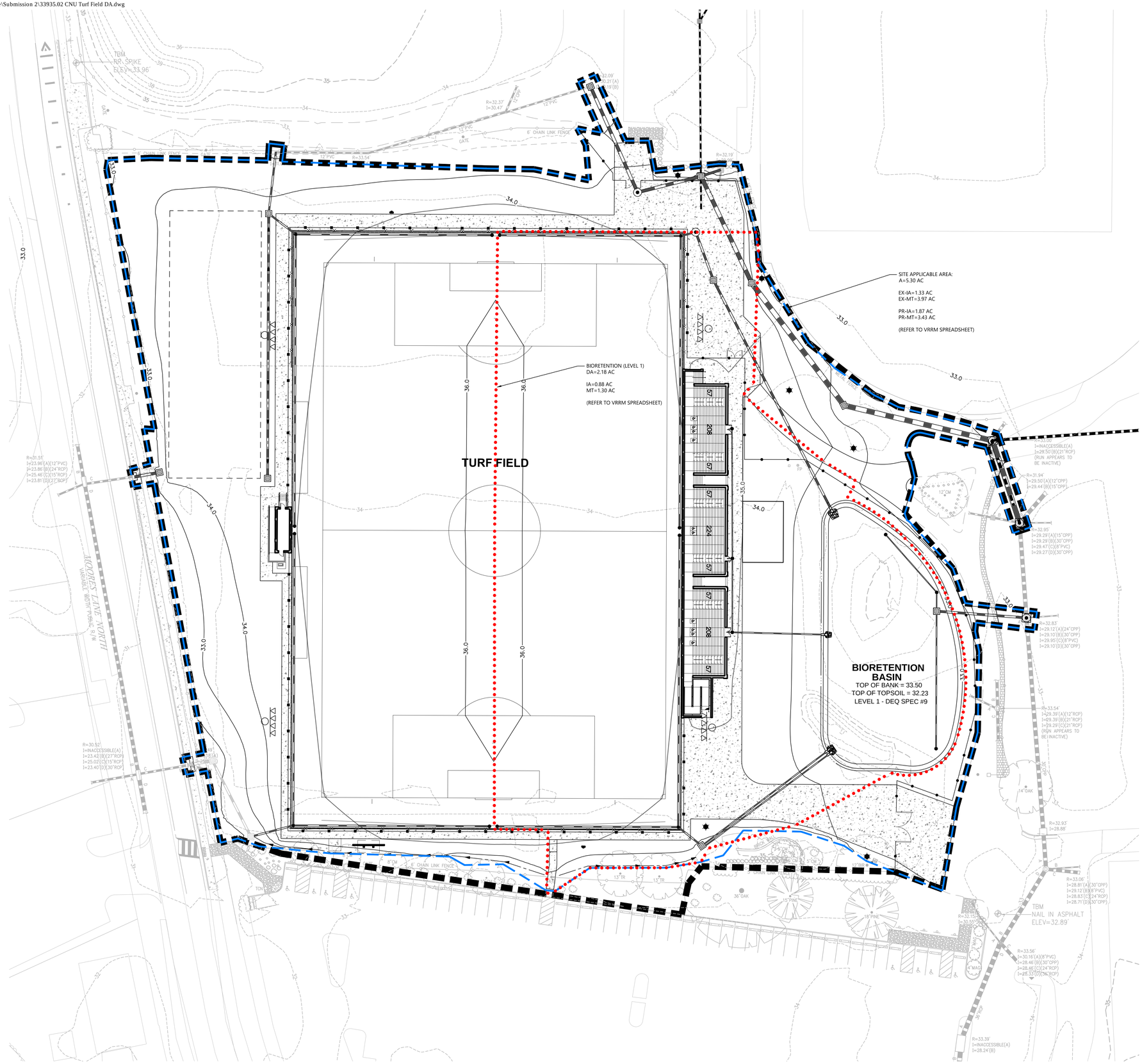
DRAWN BY: DFW APPROVED BY:

REVISIONS

NO.	DATE	DESCRIPTION
R1	1/17/2019	CLARIFICATION 01
R2	2/6/2019	CLARIFICATION 02
R3	2/25/2019	CLARIFICATION 03
R4	3/1/2019	CLARIFICATION 04
R5	5/15/2019	BID REVISION 3 & VE

SHEET TITLE
WATER QUANTITY ~ MODELING DRAINAGE AREA MAP

SHEET NUMBER
C9.5



DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

☑ 2011 BMP Standards and Specifications ☐ 2013 Draft BMP Standards and Specifications

CLEAR ALL

data input cells | calculation cells | final results

Project Name:	CNU Turf Field 50% Analysis
Date:	6-Mar-19
Linear Development Project?	No

Site Information

Post-Development Project (Treatment Volume and Loads)

Enter Total Disturbed Area *(acres)* → 5.30

Check:

Maximum reduction required:	*20%*
The site s net increase in impervious cover (acres) is:	*0.54*
Post Development TP Load Reduction for Site (lb/yr):	*1.92*

BMP Design Specifications List: 2011 Stds & Specs
Linear project? No
Land cover areas entered correctly? ✔
Total disturbed area entered? ✔

Pre-ReDevelopment Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				3.97	3.97
Impervious Cover (acres)				1.33	1.33
					5.30

Post-Development Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				3.43	3.43
Impervious Cover (acres)				1.87	1.87
Area Check	OK.	OK.	OK.	OK.	5.30

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Land Cover Summary-Pre

Pre-ReDevelopment	Listed	Adjusted[1]
Forest/Open Space Cover (acres)	0.00	0.00
Weighted Rv(forest)	0.00	0.00
% Forest	0%	0%
Managed Turf Cover (acres)	3.97	3.43
Weighted Rv(turf)	0.25	0.25
% Managed Turf	75%	72%
Impervious Cover (acres)	1.33	1.33
Rv(impervious)	0.95	0.95
% Impervious	25%	28%
Total Site Area (acres)	**5.30**	**4.76**
Site Rv	**0.43**	**0.45**

Land Cover Summary-Post (Final)

Post ReDev. & New Impervious	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	3.43
Weighted Rv (turf)	0.25
% Managed Turf	65%
Impervious Cover (acres)	1.87
Rv(impervious)	0.95
% Impervious	35%
Final Site Area (acres)	**5.30**
Final Post Dev Site Rv	**0.50**

Land Cover Summary-Post

Post-ReDevelopment	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	3.43
Weighted Rv (turf)	0.25
% Managed Turf	72%
ReDev. Impervious Cover (acres)	1.33
Rv(impervious)	0.95
% Impervious	28%
Total ReDev. Site Area (acres)	**4.76**
ReDev Site Rv	**0.45**

Land Cover Summary-Post

Post-Development New Impervious	
New Impervious Cover (acres)	0.54
Rv(impervious)	0.95

Treatment Volume and Nutrient Load

Pre-ReDevelopment Treatment Volume (acre-ft)		
Pre-ReDevelopment Treatment Volume (cubic feet)	8,189	7,699
Pre-ReDevelopment TP Load (lb/yr)	**5.15**	**4.84**
Pre-ReDevelopment TP Load per acre (lb/acre/yr)	0.97	1.02
Baseline TP Load (lb/yr) (**0.41 lbs/acre/yr** applied to pre-redevelopment area excluding pervious land proposed for new impervious cover)		*1.95*

Treatment Volume and Nutrient Load

Final Post-Development Treatment Volume (acre-ft)	0.2195
Final Post-Development Treatment Volume (cubic feet)	9,561
Final Post-Development TP Load (lb/yr)	**6.01**
Final Post-Development TP Load per acre (lb/acre/yr)	1.13

Post-ReDevelopment Treatment Volume (acre-ft)	0.1768
Post-ReDevelopment Treatment Volume (cubic feet)	7,699
Post-ReDevelopment Load (TP) (lb/yr)*	**4.84**
Post-ReDevelopment TP Load per acre (lb/acre/yr)	1.02
Max. Reduction Required (Below Pre-ReDevelopment Load)	**20%**
TP Load Reduction Required for Redeveloped Area (lb/yr)	**0.97**

Post-Development Treatment Volume (acre-ft)	0.0428
Post-Development Treatment Volume (cubic feet)	1,862
Post-Development TP Load (lb/yr)	**1.17**
TP Load Reduction Required for New Impervious Area (lb/yr)	**0.95**

[1] *Adjusted Land Cover Summary:*
Pre ReDevelopment land cover minus pervious land cover (forest/open space or managed turf) acreage proposed for new impervious cover.

Adjusted total acreage is consistent with Post-ReDevelopment acreage (minus acreage of new impervious cover).

Column I shows load reduction requriement for new impervious cover (based on new development load limit, 0.41 lbs/acre/year).

Post Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	**1.92**

Nitrogen Loads (Informational Purposes Only)

Pre-ReDevelopment TN Load (lb/yr)	36.81	Final Post-Development TN Load (Post-ReDevelopment & New Impervious) (lb/yr)	42.98

Drainage Area A

Drainage Area A Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals	Land Cover Rv
Forest/Open Space (acres)				0.00	0.00	0.00
Managed Turf (acres)				3.43	3.43	0.25
Impervious Cover (acres)				1.87	1.87	0.95
				Total	5.30	

CLEAR BMP AREAS

Total Phosphorus Available for Removal in D.A. A (lb/yr)	6.01
Post Development Treatment Volume in D.A. A (ft^3)	9,561

Stormwater Best Management Practices (RR = Runoff Reduction)

--Select from dropdown lists--

Practice	Runoff Reduction Credit (%)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	Volume from Upstream Practice (ft^3)	Runoff Reduction (ft^3)	Remaining Runoff Volume (ft^3)	Total BMP Treatment Volume (ft^3)	Phosphorus Removal Efficiency (%)	Phosphorus Load from Upstream Practices (lb)	Untreated Phosphorus Load to Practice (lb)	Phosphorus Removed By Practice (lb)	Remaining Phosphorus Load (lb)	Downstream Practice to be Employed	Nitrogen Removal Efficiency (%)	Nitrogen Load from Upstream Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs)	Remaining Nitrogen Load (lbs)
1. Vegetated Roof (RR)														**1. Vegetated Roof (RR)**				
1.a. Vegetated Roof #1 (Spec #5)	45				0	0	0	0		0.00	0.00	0.00		0		0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	60				0	0	0	0		0.00	0.00	0.00		0		0.00	0.00	0.00
2. Rooftop Disconnection (RR)														**2. Rooftop Disconnection (RR)**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	50			0	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	25			0	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	50			0	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1, Micro-Infilration #1 (Spec #8)	50			0	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2, Micro-Infiltration #2 (Spec #8)	90			0	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1, Micro-Bioretention #1 (Spec #9)	40			0	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2, Micro-Bioretention #2 (Spec #9)	80			0	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	0			0	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter, Urban Bioretention (Spec #9, Appendix A)	40			0	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement (RR)														**3. Permeable Pavement (RR)**				
3.a. Permeable Pavement #1 (Spec #7)	45			0	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	75				0	0	0	25		0.00	0.00	0.00		25		0.00	0.00	0.00
4. Grass Channel (RR)														**4. Grass Channel (RR)**				
4.a. Grass Channel A/B Soils (Spec #3)	20			0	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	10			0	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	30			0	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
5. Dry Swale (RR)														**5. Dry Swale (RR)**				
5.a. Dry Swale #1 (Spec #10)	40	1.30	0.88	0	1,686	2,529	4,214	20	0.00	2.64	1.38	1.27		25	0.00	18.92	10.41	8.51
5.b. Dry Swale #2 (Spec #10)	60			0	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention (RR)														**6. Bioretention (RR)**				
6.a. Bioretention #1 or Micro-Bioretention #1 or Urban Bioretention (Spec #9)	40			0	0	0	0	25	0.00	0.00	0.00	0.00	None	40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 or Micro-Bioretention #2 (Spec #9)	80			0	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration (RR)														**7. Infiltration (RR)**				
7.a. Infiltration #1 (Spec #8)	50			0	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	90			0	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond (RR)														**8. Extended Detention Pond (RR)**				
8.a. ED #1 (Spec #15)	0			0	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	15			0	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00

9. Sheetflow to Filter/Open Space (RR)													
9.a. Sheetflow to Conservation Area, A/B Soils (Spec #2)	75			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area, C/D Soils (Spec #2)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip, A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	

9. Sheetflow to Filter/Open Space (RR)				
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00

TOTAL IMPERVIOUS COVER TREATED (ac)	0.88	AREA CHECK: OK.
TOTAL MANAGED TURF AREA TREATED (ac)	1.30	AREA CHECK: OK.
TOTAL RUNOFF REDUCTION IN D.A. A (ft^3)	1,686	
TOTAL PHOSPHORUS AVAILABLE FOR REMOVAL IN D.A. A (lb/yr)	6.01	
TOTAL PHOSPHORUS REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	1.38	
TOTAL PHOSPHORUS REMAINING AFTER APPLYING RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	4.63	

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

TOTAL RUNOFF REDUCTION IN D.A. A (ft^3)	1,686	
NITROGEN REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	10.41	

SEE WATER QUALITY COMPLIANCE TAB FOR SITE CALCULATIONS (Information Only)

10. Wet Swale (no RR)													
10.a. Wet Swale #1 (Spec #11)	0			0	0	0	0	20	0.00	0.00	0.00	0.00	
10.b. Wet Swale #2 (Spec #11)	0			0	0	0	0	40	0.00	0.00	0.00	0.00	

10. Wet Swale (Coastal Plain) (no RR)				
25	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00

11. Filtering Practices (no RR)													
11.a.Filtering Practice #1 (Spec #12)	0			0	0	0	0	60	0.00	0.00	0.00	0.00	
11.b. Filtering Practice #2 (Spec #12)	0			0	0	0	0	65	0.00	0.00	0.00	0.00	

11. Filtering Practices (no RR)				
30	0.00	0.00	0.00	0.00
45	0.00	0.00	0.00	0.00

12. Constructed Wetland (no RR)													
12.a.Constructed Wetland #1 (Spec #13)	0			0	0	0	0	50	0.00	0.00	0.00	0.00	
12.b. Constructed Wetland #2 (Spec #13)	0			0	0	0	0	75	0.00	0.00	0.00	0.00	

12. Constructed Wetland (no RR)				
25	0.00	0.00	0.00	0.00
55	0.00	0.00	0.00	0.00

13. Wet Ponds (no RR)													
13.a. Wet Pond #1 (Spec #14)	0			0	0	0	0	50	0.00	0.00	0.00	0.00	
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	0			0	0	0	0	45	0.00	0.00	0.00	0.00	
13.c. Wet Pond #2 (Spec #14)	0			0	0	0	0	75	0.00	0.00	0.00	0.00	
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	0			0	0	0	0	65	0.00	0.00	0.00	0.00	

13. Wet Ponds (no RR)				
30	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00

14. Manufactured Treatment Devices (no RR)													
14.a. Manufactured Treatment Device-Hydrodynamic	0			0	0	0	0	20	0.00	0.00	0.00	0.00	
14.b. Manufactured Treatment Device-Filtering	0			0	0	0	0	50	0.00	0.00	0.00	0.00	
14.c. Manufactured Treatment Device-Generic	0			0	0	0	0	20	0.00	0.00	0.00	0.00	

14. Manufactured BMP (no RR)				
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00

TOTAL IMPERVIOUS COVER TREATED (ac)	0.88	AREA CHECK: OK.
TOTAL MANAGED TURF AREA TREATED (ac)	1.30	AREA CHECK: OK.
TOTAL PHOSPHORUS REMOVAL REQUIRED ON SITE (lb/yr)	1.92	
TOTAL PHOSPHORUS AVAILABLE FOR REMOVAL IN D.A. A (lb/yr)	6.01	
TOTAL PHOSPHORUS REMOVED WITHOUT RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.00	
TOTAL PHOSPHORUS REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	1.38	
TOTAL PHOSPHORUS LOAD REDUCTION ACHIEVED IN D.A. A (lb/yr)	1.38	
TOTAL PHOSPHORUS REMAINING AFTER APPLYING BMP LOAD REDUCTIONS IN D.A. A (lb/yr)	4.63	

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	10.41	
NITROGEN REMOVED WITHOUT RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.00	
TOTAL NITROGEN REMOVED IN D.A. A (lb/yr)	10.41	

Site Results (Water Quality Compliance)

Area Checks	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	AREA CHECK
FOREST/OPEN SPACE (ac)	0.00	0.00	0.00	0.00	0.00	OK.
IMPERVIOUS COVER (ac)	1.87	0.00	0.00	0.00	0.00	OK.
IMPERVIOUS COVER TREATED (ac)	0.88	0.00	0.00	0.00	0.00	OK.
MANAGED TURF AREA (ac)	3.43	0.00	0.00	0.00	0.00	OK.
MANAGED TURF AREA TREATED (ac)	1.30	0.00	0.00	0.00	0.00	OK.
AREA CHECK	OK.	OK.	OK.	OK.	OK.	

Site Treatment Volume (ft^3)	9,561

Runoff Reduction Volume and TP By Drainage Area	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	TOTAL
RUNOFF REDUCTION VOLUME ACHIEVED (ft^3)	1,686	0	0	0	0	1,686
TP LOAD AVAILABLE FOR REMOVAL (lb/yr)	6.01	0.00	0.00	0.00	0.00	6.01
TP LOAD REDUCTION ACHIEVED (lb/yr)	1.38	0.00	0.00	0.00	0.00	1.38
TP LOAD REMAINING (lb/yr)	4.63	0.00	0.00	0.00	0.00	4.63
NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	10.41	0.00	0.00	0.00	0.00	10.41

Total Phosphorus	
FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	6.01
TP LOAD REDUCTION REQUIRED (lb/yr)	1.92
TP LOAD REDUCTION ACHIEVED (lb/yr)	1.38
TP LOAD REMAINING (lb/yr):	4.63
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.54

Total Nitrogen (For Information Purposes)	
POST-DEVELOPMENT LOAD (lb/yr)	42.98
NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	10.41
REMAINING POST-DEVELOPMENT NITROGEN LOAD (lb/yr)	32.57

STORMWATER MANAGEMENT NARRATIVE

STORM SEWER ADEQUACY - 10:10 DETENTION

PRE ≥ POST

STR # E1

10 YEAR 4.40 CFS ≥ 4.39 CFS

**THE POST-DEVELOPED FLOWS ENTERING THE STORM CONVEYANCE SYSTEM IS EQUAL TO THE PRE-DEVELOPED FLOWS, THUS STORM SEWER ADEQUACY IS ENSURED.*

FLOOD PROTECTION - 9VAC25-870-66.C.3.c

CHANNEL PROTECTION - 9VAC25-870-66.B.4.a

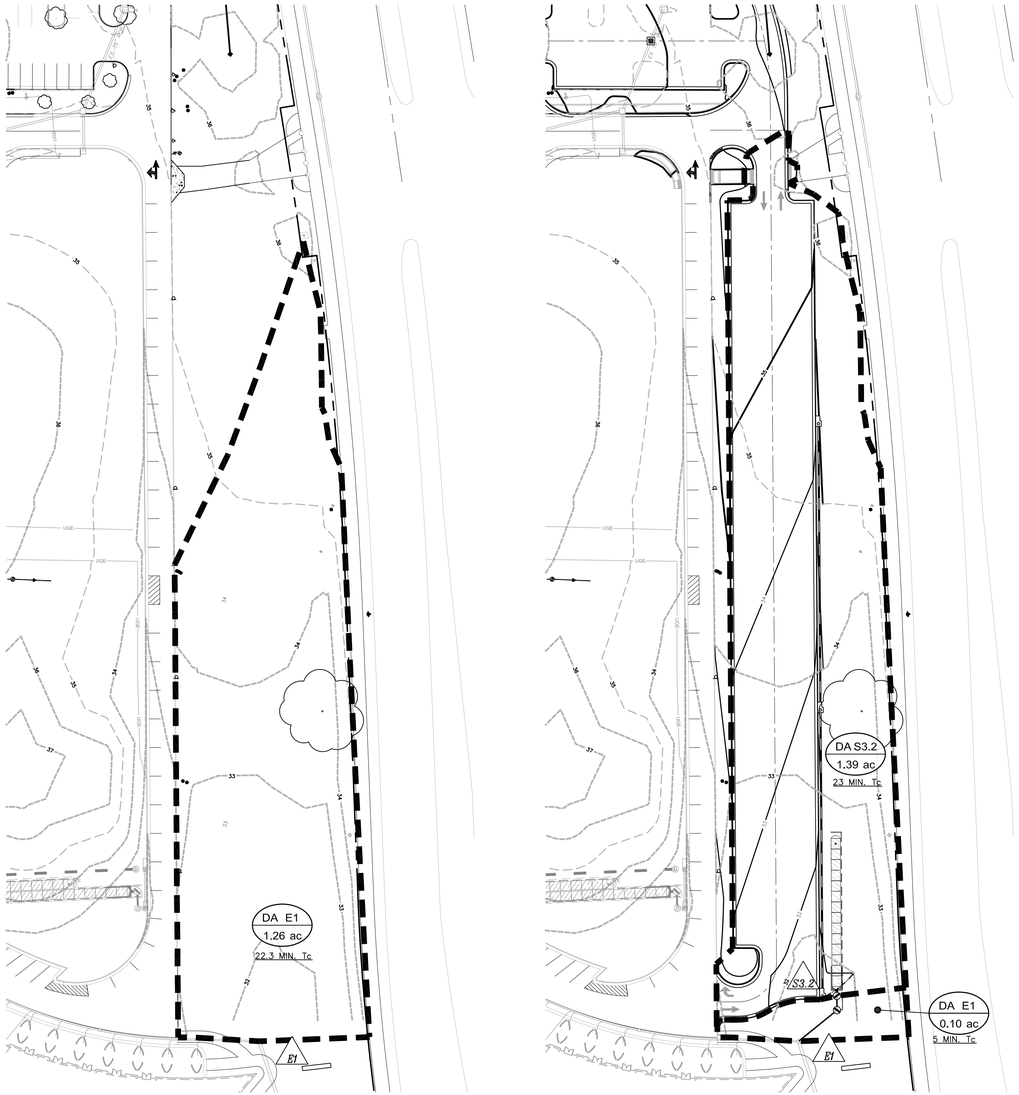
CNU HAS AN IMPROVED STORM SEWER AND RIPRAP CHANNEL TO LAKE MAURY. LAKE MAURY HAS A DRAINAGE AREA OF APPROXIMATELY ± 3,000 ACRES. THE SITE'S DRAINAGE AREA IS 2.13 ACRES WHICH IS LESS THAN 1% OF THE TOTAL WATERSHED AT LAKE MAURY, THEREFORE MEETING FLOOD AND CHANNEL PROTECTION REQUIREMENTS.

WATER QUALITY COMPLIANCE

**REFER TO SHEETS C6.3 AND C6.4 FOR SUPPORTING VRRM WATER QUALITY COMPLIANCE CALCULATIONS.*

WEIGHTED CURVE NUMBER COMPUTATIONS

	SOIL GROUP D			
Drainage Areas/ Subbasin	50-75% Grass Cover, Good (acres) 80	Impervious Areas (acres) 98	Total Area (acres)	Weighted Curve Number
			0.00	**0.00**
Pre - DA E1	1.26	0.00	**1.26**	**80.00**
Post - S3.2	0.56	0.83	**1.39**	**90.75**
Post - DA E1	0.10	0.00	**0.10**	**80.00**



GRAPHIC SCALE

50 0 25 50 100

1 inch = 50 feet

NAD 83

KOONTZ BRYANT JOHNSON WILLIAMS
1703 N. Parham Rd. Suite 202
Henrico, Va 23229
(804) 740-9200
FAX (804) 740-7338
www.KBJWgroup.com

COMMONWEALTH OF VIRGINIA
GREGORY N. KOONTZ
Lic. No. 16613
11/30/2018
PROFESSIONAL ENGINEER

REVISIONS

NO.	DATE	DESCRIPTION
1.	11/30/18	ADDENDUM 1 - SIDEWALK, REVISED PARKING LAYOUT & STORM SEWER

POST APPROVAL

DESIGNED FJPR | DRAWN WLP | CHECKED

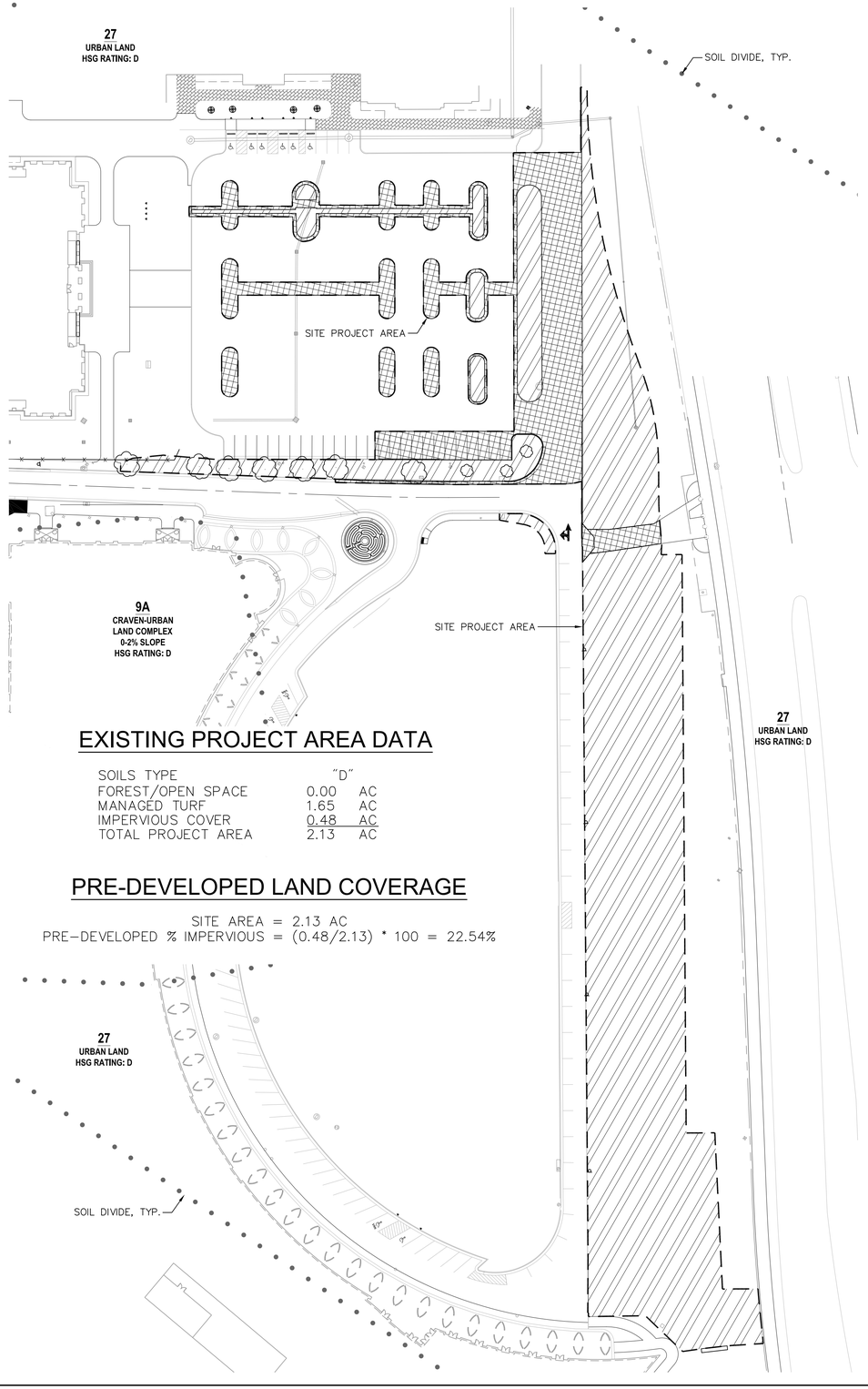
CHRISTOPHER NEWPORT UNIVERSITY
PARKING AREA C1 & C2
CITY OF NEWPORT NEWS VIRGINIA

DRAINAGE AREA MAP ~ WATER QUANTITY

SCALE:
DATE: 10/04/18
PROJECT: 05105-073

C6.2

EXISTING PROJECT CONDITIONS



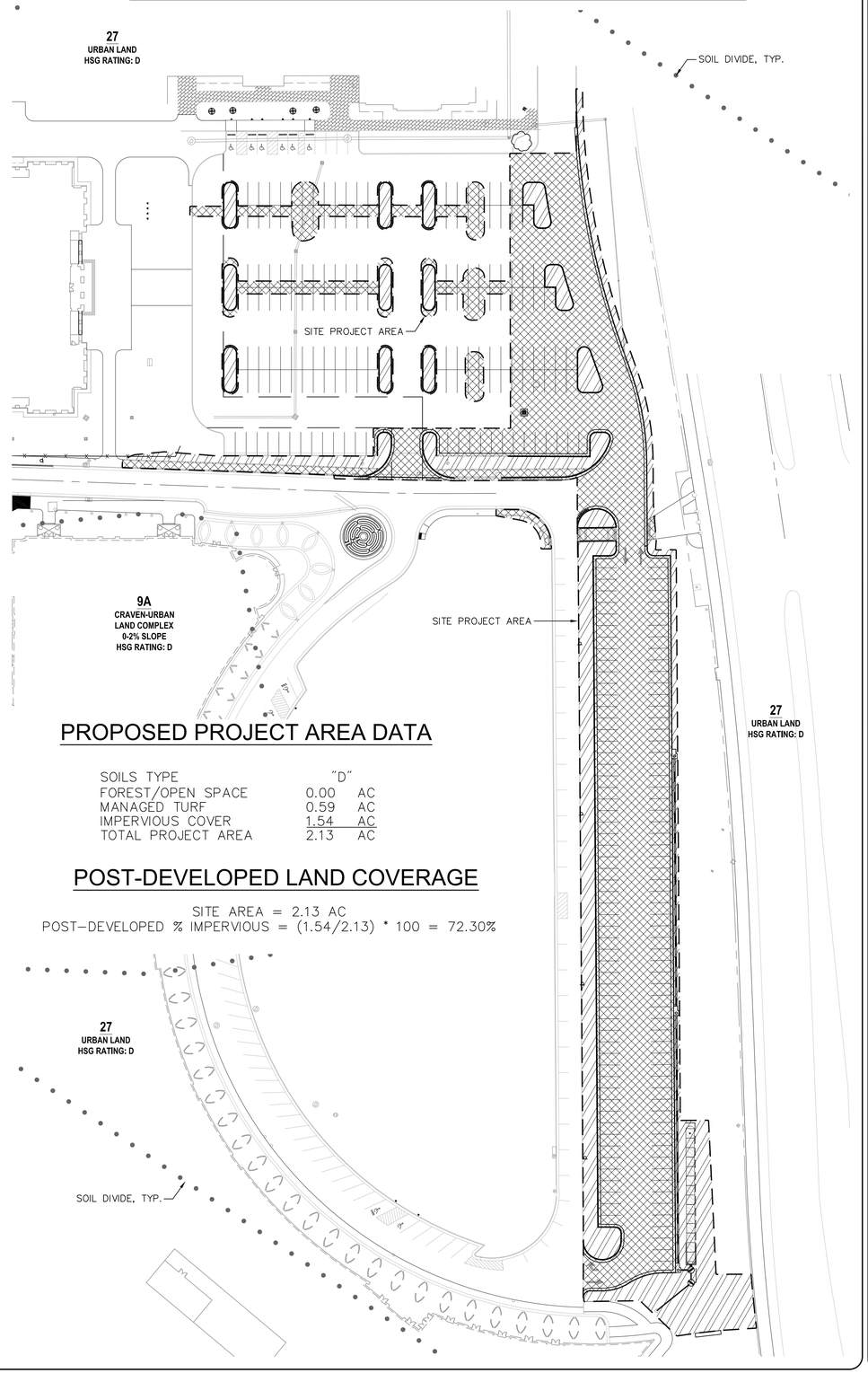
EXISTING PROJECT AREA DATA

SOILS TYPE	"D"	
FOREST/OPEN SPACE	0.00	AC
MANAGED TURF	1.65	AC
IMPERVIOUS COVER	0.48	AC
TOTAL PROJECT AREA	2.13	AC

PRE-DEVELOPED LAND COVERAGE

SITE AREA = 2.13 AC
PRE-DEVELOPED % IMPERVIOUS = (0.48/2.13) * 100 = 22.54%

PROPOSED PROJECT CONDITIONS



PROPOSED PROJECT AREA DATA

SOILS TYPE	"D"	
FOREST/OPEN SPACE	0.00	AC
MANAGED TURF	0.59	AC
IMPERVIOUS COVER	1.54	AC
TOTAL PROJECT AREA	2.13	AC

POST-DEVELOPED LAND COVERAGE

SITE AREA = 2.13 AC
POST-DEVELOPED % IMPERVIOUS = (1.54/2.13) * 100 = 72.30%

Legend

IMPERVIOUS (SWALKS, PAVEMENT, ETC.)

PERVIOUS

NAD 83

GRAPHIC SCALE

50 0 25 50 100

1 inch = 50 feet

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POST APPROVAL

DESIGNED FJPR | DRAWN WLP | CHECKED

CHRISTOPHER NEWPORT UNIVERSITY
PARKING AREA C1 & C2
CITY OF NEWPORT NEWS VIRGINIA

CALCULATIONS ~ WATER QUALITY

SCALE: 1" = 50'
DATE: 10/04/18
PROJECT: 05105-073

C6.3

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Update Summary Sheet

Print Preview | Print

Site Summary

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**2.13**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.65	1.65	77
Impervious Cover (acres)	0.00	0.00	0.00	0.48	0.48	23
					2.13	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.59	0.59	28
Impervious Cover (acres)	0.00	0.00	0.00	1.54	1.54	72
					2.13	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.76	0.56	0.95	0.56
Treatment Volume (ft^3)	5,846	2,191	3,655	2,191
TP Load (lb/yr)	3.67	1.38	2.30	1.38

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.29	**1.72**	**1.29**

Total TP Load Reduction Required (lb/yr)	**2.14**	0.28	1.86

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	26.28	14.17

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0.85
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	2.83
Remaining TP Load Reduction (lb/yr) Required	1.29

VRRM COMPLIANCE SUMMARY

SITE'S :
TP LOAD REDUCTION REQUIRED = 2.14 LB/YEAR

DRAIANGE AREA A :
TP LOAD REDUCTION ACHEIEVED = 0.85 LB/YEAR

REMAINING TP LOAD REDUCTION REQUIRED = 1.29 LB /YR

**REMAINING TP REDUCTION WILL BE ACHIEVED BY PURCHASING CREDITS*

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	0.57	0.00	0.00	0.00	0.00	0.57
Impervious Cover (acres)	1.50	0.00	0.00	0.00	0.00	1.50
Total Area (acres)	**2.07**	**0.00**	**0.00**	**0.00**	**0.00**	**2.07**

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	0.85	0.00	0.00	0.00	0.00	0.85
TN Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.57	0.57	28
Impervious Cover (acres)	0.00	0.00	0.00	1.50	1.50	72
					2.07	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed

Total Impervious Cover Treated (acres)	0.83
Total Turf Area Treated (acres)	0.56
Total TP Load Reduction Achieved in D.A. (lb/yr)	0.85
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

STORM SEWER COMPUTATIONS

Design Storm Year = 10 **Locality =** CITY OF NEWPORT NEWS

POINT	DOWNSTREAM STRUCTURE	DRAIN AREA	RUNOFF COEFF.	CA INCR	CA ACCUM	INLET TIME	RAIN FALL	RUNOFF Q	INVERT ELEVATIONS UPPER	INVERT ELEVATIONS LOWER	LENGTH FEET	SLOPE FT./FT.	DIA INCHES	CAPA-CITY C.F.S.	VEL F.P.S.	FLOW TIME SEC	REMARKS DEPTH OF BOX
		ACRES	C			MIN	IN/HR	C.F.S.									
3		0.32	0.90	0.29	0.29	5.00	7.71	2.22									
	2								31.92	29.41	200.00	0.0126	15	7.2	5.2	38.6	3.00 FT
2		0.36	0.90	0.32	0.61	5.64	7.48	4.58									
	1								29.31	27.50	200.00	0.0090	15	6.1	5.5	36.5	4.10 FT
1		0.32	0.90	0.29	0.90	6.25	7.27	6.54									
									27.40	27.20	10.00	0.0200	15	9.1	8.1	1.2	4.10 FT

STORM INLET COMPUTATIONS

Design Storm Year = 10 **Locality =** CITY OF NEWPORT NEWS

INLET NUMBER	TYPE	LENGTH	STATION	A (ACRES)	C	CA	I	Q_{BYP} (CFS)	Q_{UP} (CFS)	Q_T (CFS)	$S_{GUTTER\ BLDPF}$ (FT/FT)	S_X (FT/FT)	T (FT)	W (FT)	WT	S_W (FT/FT)	S_W/S_X	E_O	a	S'_W	S_X (FT/FT)	L_T (FT) OR $B_{FF\ LESS}$ (FT)	LR_T OR d (FT)	E OR h (FT)	Q (CFS) OR dh	Q_T (CFS) OR T_{SPREAD}	REMARKS
1	DI-3B	6.00		0.32	0.90	0.29	4.00	1.15	0.04	1.19	0.0000	0.0208		2.0		0.08						9.6	0.14	0.46	0.3	6.86	
2	DI-3B	6.00		0.36	0.90	0.32	4.00	1.30	0.02	1.31	0.0074	0.0208	8	2.0	0.25	0.08	4.00	0.67	3.54	0.15	0.12	7.0	0.86	0.97	1.3	0.04	
3	DI-3B	6.00		0.32	0.90	0.29	4.00	1.15	0.00	1.15	0.0074	0.0208	8	2.0	0.25	0.08	4.00	0.67	3.54	0.15	0.12	6.6	0.91	0.99	1.1	0.02	

HYDRAULIC GRADE LINE COMPUTATIONS

Design Storm Year = 10 **Locality =** CITY OF NEWPORT NEWS

INLET STATION	OUTLET WATER SURFACE ELEV	L_D	D_O	Q_O	S_{TO}	H_T	JUNCTION LOSS V_O	H_O	Q_{IN}	V_{IN}	$Q_O*V_O V_O^2/2g$	H_I	ANGLE	H_D	H_T	1.3H_T	.5H_T	FINAL H	INLET WATER SURFACE ELEV.	RIM ELEV
		FT	IN	C.F.S.	FT/FT	FT	F.P.S.	FT	C.F.S.	F.P.S.		FT								
	30.29	10.00	15	6.54	0.010	0.10	8.1	0.3												
1									4.6	5.5	25.1	0.5	0.16	90	0.33	0.74	0.97	0.48	0.59	30.88	31.50
	30.88	200.00	15	4.58	0.005	1.00	5.5	0.1												
2									2.2	5.2	11.5	0.4	0.15	0	0.00	0.26	0.34	N/A	1.35	32.22	33.41
	32.22	200.00	15	2.22	0.001	0.24	5.2	0.1												
3													0.00	0	0.00	0.10	N/A	N/A	0.34	32.56	34.92

NUTRIENT CREDIT AVAILABLILTY LETTER

C.B.N.L.T. *"Tomorrow's Natural Resources Today"*

Chesapeake Bay Nutrient Land Trust, LLC.

November 30, 2018

Koontz, Bryant, Johnson, Williams
ATTN: Greg Koontz
1703 N. Parham Road, Suite 202
Henrico, VA 23229

RE: CBNLT/Cranston's Mill Pond – Nutrient Credit Availability
Chesapeake Bay Nutrient Land Trust, LLC

Project Reference: CNU Project, City of Newport News

Attention Mr. Koontz:

This letter is to confirm the availability of authorized Nutrient Credits sufficient to meet your project requirements at our Cranston's Mill Pond facility, which is registered with the Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Conservation and Recreation (DCR). These Nutrient Credits are generated and managed under the terms of the Cranston's Mill Pond Nutrient Reduction Implementation Plan dated April 20, 2010 which was authorized by the Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Conservation and Recreation (DCR) on July 13, 2010.

The Cranston's Mill Pond project has been authorized to provide Nutrient Credits for use in the James River watershed. These Credits are transferable to those entities regulated under DEQ's Stormwater Management Program in accordance with VA Code § 62.1-44.15:35. Currently our Cranston's Mill Pond facility has **230.77** pounds of Phosphorus Credits available and will be able to meet your project's phosphorus requirement of up to **1.29** pounds.

If we can provide further assistance please feel free to contact our office.

Sincerely,

Chesapeake Bay Nutrient Land Trust, LLC

By Its Manager
EarthSource Solutions, Inc.

Scott A. Reed

Scott A. Reed
Vice President

Chesapeake Bay Nutrient LandTrust, LLC. • 5735 S. Laburnum Avenue • Richmond, VA 23231 • P: 804.222.5114 • www.cbnlt.com

Stormwater Best Management Practices (RR = Runoff Reduction)

Practice	Runoff Reduction Credit (%)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	Volume from Upstream Practice (ft^3)	Runoff Reduction (ft^3)	Remaining Runoff Volume (ft^3)	Total BMP Treatment Volume (ft^3)	Phosphorus Removal Efficiency (%)
14. Manufactured Treatment Devices (no RR)								
14.c. Manufactured Treatment Device-Generic	0	0.56	0.83	0	0	3,370	3,370	40

KOONTZ BRYANT JOHNSON WILLIAMS
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COMMONWEALTH OF VIRGINIA
GREGORY N. KOONTZ
Lic. No. 16613
11/30/2018
PROFESSIONAL ENGINEER

REVISIONS

NO.	DATE	DESCRIPTION
1.	11/30/18	ADDENDUM 1 - SIDEWALK REVISED PARKING LAYOUT & STORM SEWER

POST APPROVAL

DESIGNED FJPR | DRAWN WLP | CHECKED

CHRISTOPHER NEWPORT UNIVERSITY PARKING AREA C1 & C2
CITY OF NEWPORT NEWS VIRGINIA

CALCULATIONS ~ WATER QUALITY & STORM

SCALE:
DATE: 10/04/18
PROJECT: 05105-073

C6.4

STORMKEEPER SEDIMENT STRIP SIZING SUMMARY

STRUCTURE	S3.3
1 YEAR FLOW (CFS)	*2.89*
SK180 CHAMBERS REQ'D	*13 EA*

1 YEAR FLOWS ARE BASED ON SCS METHOD. SK180 CHAMBERS CAN ACCOMMODATE 0.24 CFS PER CHAMBER (PER STORMKEEPER DESIGN GUIDELINES)

GENERAL NOTES ~ CONTECH STORMGATE STRUCTURES

1) STORMGATE BY CONTECH STORMWATER SOLUTIONS; PORTLAND, OR (800) 548-4667; SCARBOROUGH, ME (877) 907-8676; LINTHICUM, MD (866) 740-3318.
2) PRECAST MANHOLE TO BE CONSTRUCTED IN ACCORDANCE WITH ASTM C478. DETAIL DRAWINGS REFLECT DESIGN INTENT ONLY. ACTUAL DIMENSIONS AND CONFIGURATION OF STRUCTURE SHALL BE SHOWN ON PRODUCTION SHOP DRAWINGS.
3) STRUCTURE AND ACCESS COVERS TO MEET AASHTO H-20 LOAD RATING AND VDOT MH-1 STANDARDS.
4) INLET AND OUTLET PIPING SPECIFIED WITHIN DATA SHEETS (THIS SHEET). PRECAST STORMGATE MANHOLE EQUIPPED WITH EITHER CORED OPENINGS OR KNOCKOUTS AT INLET AND OUTLET LOCATIONS.
5) CONTRACTOR TO ADJUST WEIR TO DESIGN ELEVATION SPECIFIED IN DATA TABLE BELOW. DO NOT EXCEED 5.0 FT-LBS TORQUE WHEN TIGHTENING SCREWS ON WEIR FRAME. SEAL WEIR TO FRAME WITH RTV SILICONE SEALANT AFTER FINAL ADJUSTMENT. WHEN AN ORIFICE IS SPECIFIED, THE WEIR PLATE SHALL BE DRILLED PRIOR TO DELIVERY WITH THE SPECIFIED SIZE AND INVERT RELATIVE TO THE TOP OF THE WEIR PLATE.

STORMGATE MANHOLE DATA

STRUCTURE ID				S3.1
10-YR PEAK INFLOW RATE, *Qpeak* (cfs)				6.24
10-YR DETAINED OUTFLOW RATE, *Qpeak* (cfs)				4.32
MANHOLE DIAMETER (48", 60", 72")				48
RIM ELEVATION				ROUND
PIPE DATA:	I.E.	ORIENTATION	MATERIAL	DIA.
INLET PIPE	26.10	90°	DW-HDPE	12"
DIVERSION PIPE OR SECOND INLET PIPE	25.10	6.40°	ADS-N12	6"
PEAK FLOW OUTLET PIPE	25.10	213.90°	DW-HDPE	12"
ORIFICE TYPE (RECTANGULAR OR ROUND)				RECTANGULAR
ORIFICE DIMENSIONS OR DIAMETER (in)				7.6" W x 7.7" H
ORIFICE ELEVATION				25.10
ORIFICE TYPE (RECTANGULAR OR ROUND)				
ORIFICE DIMENSIONS OR DIAMETER (in)				
ORIFICE ELEVATION				
ORIFICE TYPE (RECTANGULAR OR ROUND)				
ORIFICE DIMENSIONS OR DIAMETER (in)				
ORIFICE ELEVATION				
WEIR CREST ELEVATION				30.30
HEAD OVER WEIR, H (ft) (10-yr)				N/A
WSE at 10-yr Qpeak				30.29
WEIR ORIENTATION				135 & 315°
FLOOR (SUMP) ELEVATION				24.60

NOTES/SPECIAL REQUIREMENTS:

PIPE ORIENTATION KEY: 90° INLET, 180°, 0°, 270° OUTLET, WEIR

STORMGATE MANHOLE DATA

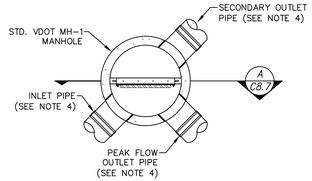
STRUCTURE ID				S3.2
10-YR PEAK INFLOW RATE, *Qpeak* (cfs)				N/A
10-YR DETAINED OUTFLOW RATE, *Qpeak* (cfs)				N/A
MANHOLE DIAMETER (48", 60", 72")				48"
RIM ELEVATION				ROUND
PIPE DATA:	I.E.	ORIENTATION	MATERIAL	DIA.
INLET PIPE	26.40	90°	DW-HDPE	24"
DIVERSION PIPE OR SECOND INLET PIPE	27.20	180°	DW-HDPE	15"
PEAK FLOW OUTLET PIPE	26.40	270°	DW-HDPE	12"
ORIFICE TYPE (RECTANGULAR OR ROUND)				N/A
ORIFICE DIMENSIONS OR DIAMETER (in)				
ORIFICE ELEVATION				
ORIFICE TYPE (RECTANGULAR OR ROUND)				
ORIFICE DIMENSIONS OR DIAMETER (in)				
ORIFICE ELEVATION				
ORIFICE TYPE (RECTANGULAR OR ROUND)				
ORIFICE DIMENSIONS OR DIAMETER (in)				
ORIFICE ELEVATION				
WEIR CREST ELEVATION				28.05
HEAD OVER WEIR, H (ft) (10-yr)				N/A
WSE at 10-yr Qpeak				30.29
WEIR ORIENTATION				45 & 225°
FLOOR (SUMP) ELEVATION				24.40

NOTES/SPECIAL REQUIREMENTS:

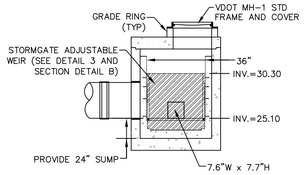
PIPE ORIENTATION KEY: INLET, 90°, 180°, 0°, OUTLET, 270°, WEIR

EQUIVALENT SUBSTITUTE MANHOLES

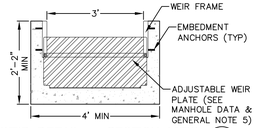
EQUIVALENT SUBSTITUTE MANHOLES MAY BE USED IN PLACE OF STORMGATE MANHOLES FOR THE CONSTRUCTION OF CHAMBER SYSTEM. SUBSTITUTES MUST BE CONSTRUCTED TO THE SAME DESIGN REQUIREMENTS STATED ON STORMGATE MANHOLE DATA SHEETS.



STORMGATE MANHOLE - PLAN VIEW 1
CONTECH, INC.
N.T.S.

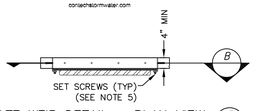


STORMGATE MANHOLE OUTLET (STR. #S3.1) - SECTION VIEW A
CONTECH, INC.
N.T.S.

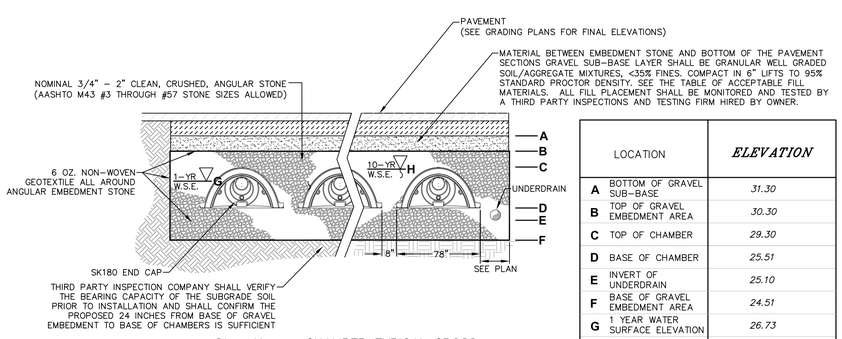


STORMGATE WEIR DETAIL - SECTION VIEW B
CONTECH, INC.
N.T.S.

STORMGATE MANHOLE - TOP VIEW 2
CONTECH, INC.
N.T.S.



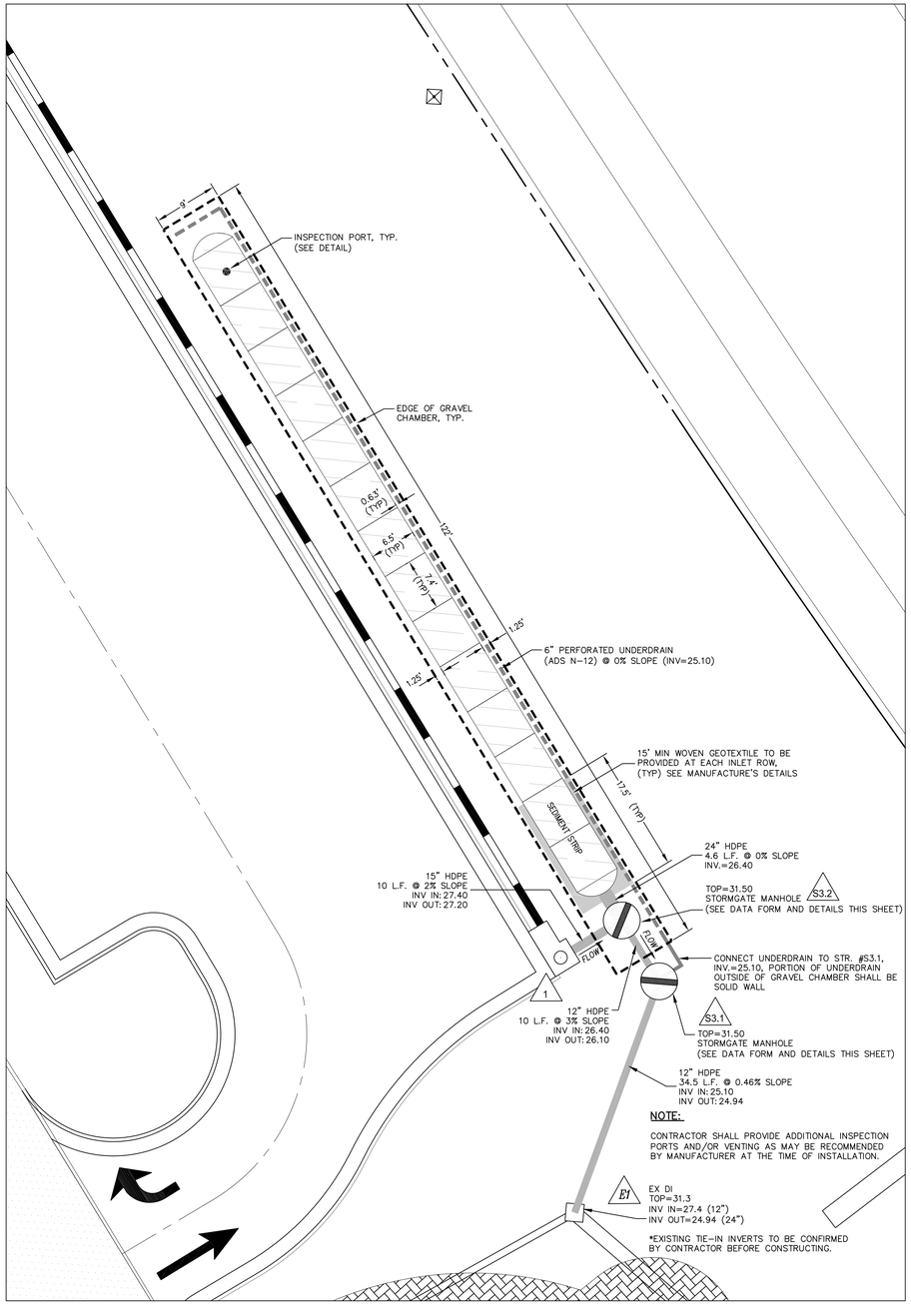
STORMGATE WEIR DETAIL - PLAN VIEW 3
CONTECH, INC.
N.T.S.



StormKeeper CHAMBER TYPICAL CROSS SECTION
N.T.S.

	LOCATION	*ELEVATION*
A	BOTTOM OF GRAVEL SUB-BASE	*31.30*
B	TOP OF GRAVEL EMBEDMENT AREA	*30.30*
C	TOP OF CHAMBER	*29.30*
D	BASE OF CHAMBER	*25.51*
E	INVERT OF UNDERDRAIN	*25.10*
F	BASE OF GRAVEL EMBEDMENT AREA	*24.51*
G	1 YEAR WATER SURFACE ELEVATION	*26.73*
H	10 YEAR WATER SURFACE ELEVATION	*30.29*

★ VARIES BASED ON PAVEMENT GRADES AND PROPOSED PAVEMENT SECTION. (SEE DETAILS FOR PROPOSED PAVEMENT SECTIONS)



PARKING LOT C1 & C2 ~ StormKeeper SK180 CHAMBER SYSTEM (14 TOTAL CHAMBERS)
SCALE: 1" = 10'

KOONTZ BRYANT JOHNSON WILLIAMS
1703 N. Parham Rd. Suite 202
Henrico, Va 23229
(804) 740-9200
FAX (804) 740-7338
www.KBJWgroup.com

COMMONWEALTH OF VIRGINIA
GREGORY N. KOONTZ
Lic. No. 16613
11/30/2018
PROFESSIONAL ENGINEER

REVISIONS

NO.	DATE	DESCRIPTION
1.	11/30/18	ADDENDUM 1 - SIDEWALK, REVISED PARKING LAYOUT & STORM SEWER

POST APPROVAL

DESIGNED	DRAWN	CHECKED
FJPR	WLP	

CHRISTOPHER NEWPORT UNIVERSITY
PARKING AREA C1 & C2
CITY OF NEWPORT NEWS VIRGINIA

DETAILS - STM CHAMBERS

SCALE:
DATE: 10/04/18
PROJECT: 05105-073

C7.1

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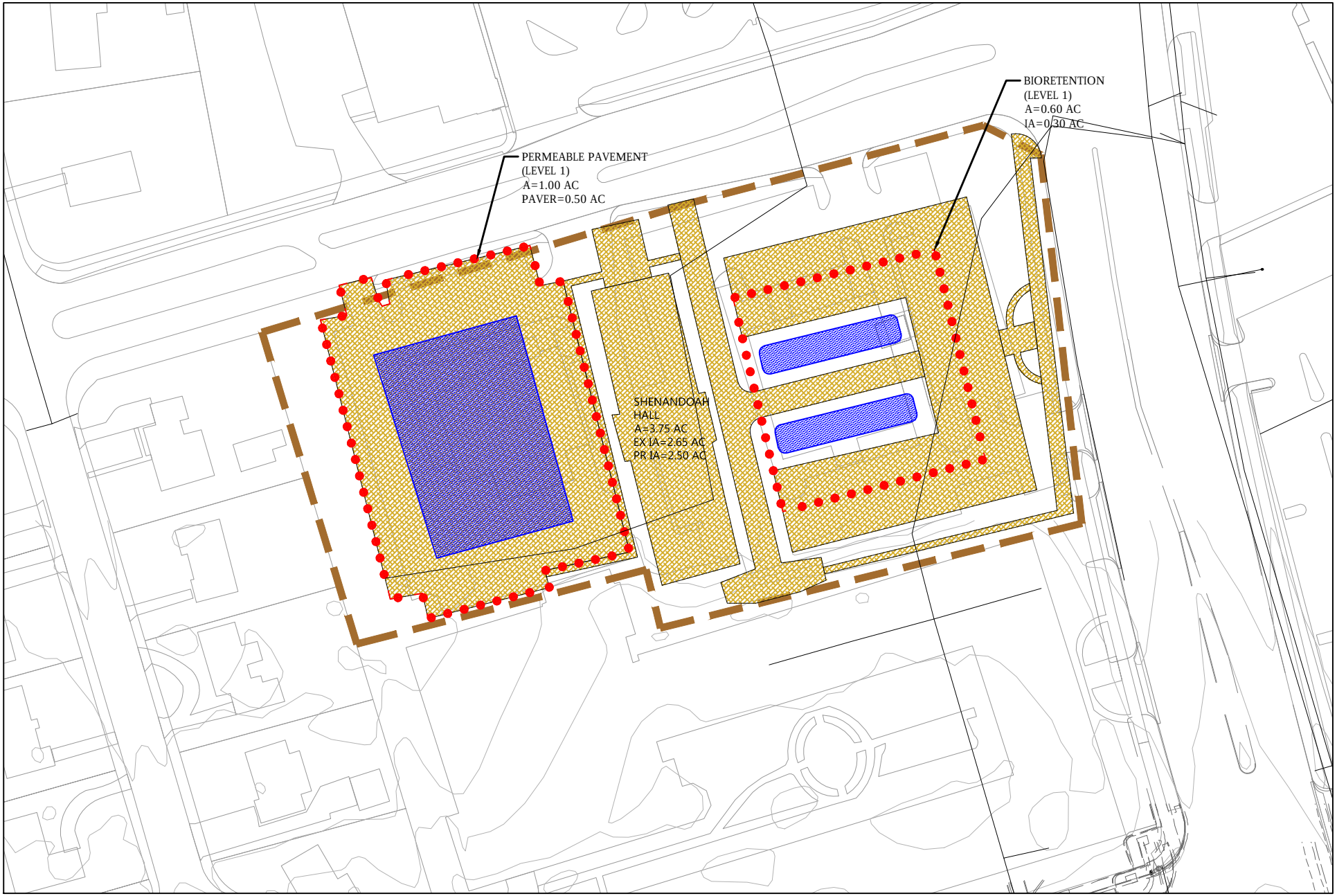

Legend

- DISTURBED AREA
- DRAINAGE AREA
- BEST MANAGEMENT PRACTICE (BMP)
- PROPOSED IMPERVIOUS AREA

0 50 100 Feet

vhb

Christopher Newport University
Stormwater Master Plan
CIP- Shenandoah RIver Hall
Permeable Pavement & Biortentions

May 2019

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_CIP SHENANDOAH RIVER HALL
Date: 43482

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**3.75**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.10	1.10	29
Impervious Cover (acres)	0.00	0.00	0.00	2.65	2.65	71
					3.75	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.25	1.25	33
Impervious Cover (acres)	0.00	0.00	0.00	2.50	2.50	67
					3.75	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.72	0.72	--	0.74
Treatment Volume (ft^3)	9,756	9,756	--	10,137
TP Load (lb/yr)	6.13	6.13	--	6.37

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.70	**1.63**	**1.63**

Total TP Load Reduction Required (lb/yr)	**1.03**	1.03	0

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	43.85	45.56

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	2,075
Total TP Load Reduction Achieved (lb/yr)	1.72
Total TN Load Reduction Achieved (lb/yr)	12.85
Remaining Post Development TP Load (lb/yr)	4.41
Remaining TP Load Reduction (lb/yr) Required	**0.00**

**** TARGET TP REDUCTION EXCEEDED BY 0.69 LB/YEAR ****

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	1.25	0.00	0.00	0.00	0.00	1.25
Impervious Cover (acres)	2.50	0.00	0.00	0.00	0.00	2.50
Total Area (acres)	**3.75**	**0.00**	**0.00**	**0.00**	**0.00**	**3.75**

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	1.72	0.00	0.00	0.00	0.00	1.72
TN Load Reduced (lb/yr)	12.85	0.00	0.00	0.00	0.00	12.85

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.25	1.25	33
Impervious Cover (acres)	0.00	0.00	0.00	2.50	2.50	67
					3.75	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
3.a. Permeable Pavement #1 (Spec #7)		1	3,448.50	0.00	2.16	1.27	0.89	
6.a. Bioretention #1 or Micro-Bioretention #1 or Urban Bioretention (Spec #9)	0.3	0.3	1,306.80	0.00	0.82	0.45	0.37	

Total Impervious Cover Treated (acres)	1.30
Total Turf Area Treated (acres)	0.30
Total TP Load Reduction Achieved in D.A. (lb/yr)	1.72
Total TN Load Reduction Achieved in D.A. (lb/yr)	12.85

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Legend

- DISTURBED AREA
- DRAINAGE AREA
- BEST MANAGEMENT PRACTICE (BMP)
- PROPOSED IMPERVIOUS AREA

0 50 100 Feet

Christopher Newport University
Stormwater Master Plan
CIP- Alumni Hall Lawn
Reduce Impervious Area

February 2019

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_CIP ALUMNI HALL LAWN
Date: 43511

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.45**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.30	0.30	21
Impervious Cover (acres)	0.00	0.00	0.00	1.15	1.15	79
					1.45	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.80	0.80	55
Impervious Cover (acres)	0.00	0.00	0.00	0.65	0.65	45
					1.45	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.56	0.56	--	0.81
Treatment Volume (ft^3)	2,968	2,968	--	4,238
TP Load (lb/yr)	1.86	1.86	--	2.66

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.84	**1.29**	**1.29**

Total TP Load Reduction Required (lb/yr)	**-0.27**	-0.27	0

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	13.34	19.05

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0	
Total TP Load Reduction Achieved (lb/yr)	0.00	
Total TN Load Reduction Achieved (lb/yr)	0.00	
Remaining Post Development TP Load (lb/yr)	1.86	
Remaining TP Load Reduction (lb/yr) Required	**0.00**	**** TARGET TP REDUCTION EXCEEDED BY 0.27 LB/YEAR ****

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Total Area (acres)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00
TN Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00

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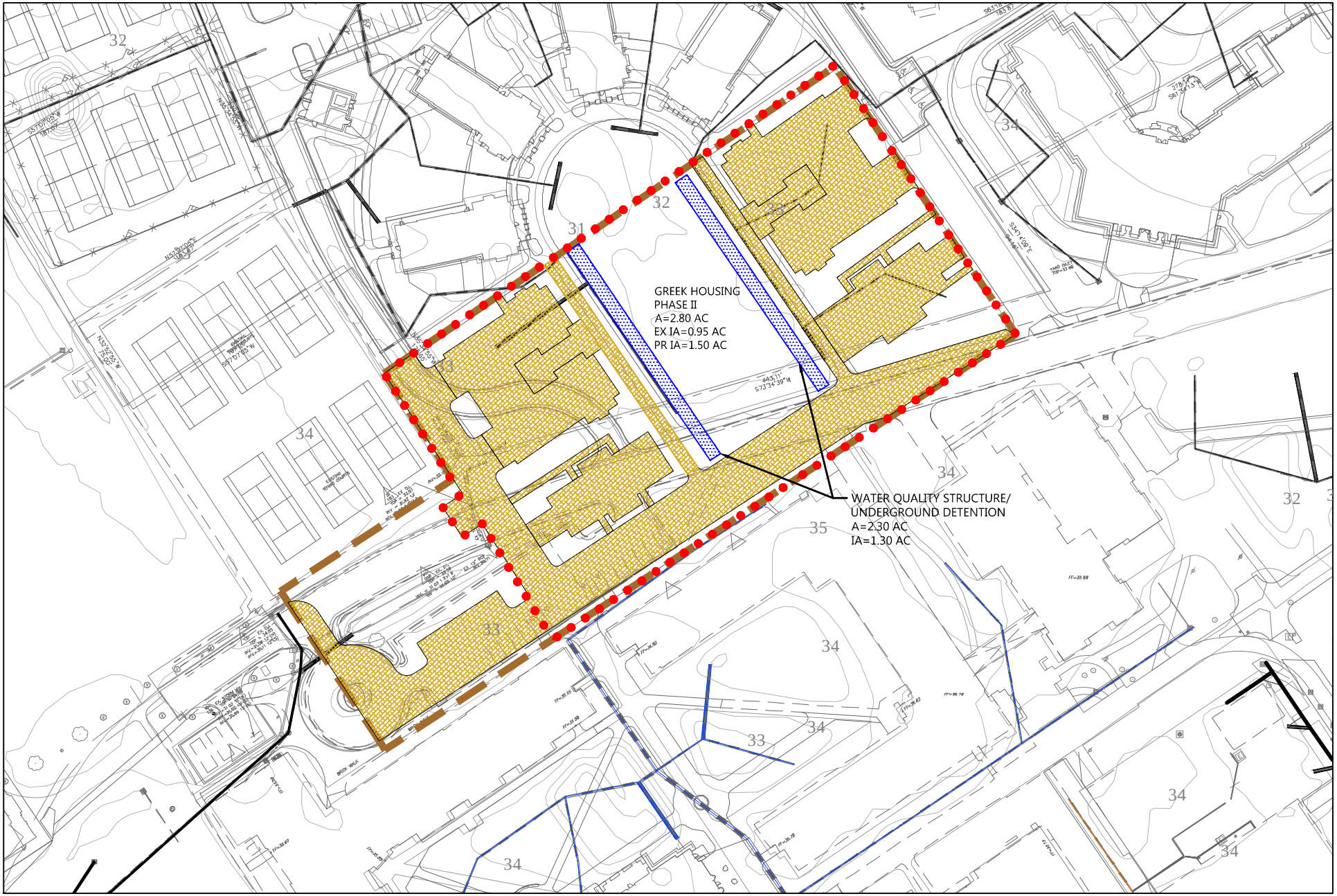

Legend

- DISTURBED AREA
- DRAINAGE AREA
- BEST MANAGEMENT PRACTICE (BMP)
- PROPOSED IMPERVIOUS AREA

0 50 100 Feet

vhb

Christopher Newport University
Stormwater Master Plan
CIP- Greek Housing Phase II January 2019
Underground Detention- Water Quality Structure

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_CIP GREEK HOUSING PHASE II
Date: 43482

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**2.80**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.85	1.85	66
Impervious Cover (acres)	0.00	0.00	0.00	0.95	0.95	34
					2.80	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.30	1.30	46
Impervious Cover (acres)	0.00	0.00	0.00	1.50	1.50	54
					2.80	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.63	0.55	0.95	0.55
Treatment Volume (ft^3)	6,353	4,456	1,897	4,456
TP Load (lb/yr)	3.99	2.80	1.19	2.80

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.24	**1.43**	**1.24**

Total TP Load Reduction Required (lb/yr)	**1.53**	0.56	0.97

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	28.55	22.27

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	1.69
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	2.30
Remaining TP Load Reduction (lb/yr) Required	**0.00**

**** TARGET TP REDUCTION EXCEEDED BY 0.17 LB/YEAR ****

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	1.30	0.00	0.00	0.00	0.00	1.30
Impervious Cover (acres)	1.50	0.00	0.00	0.00	0.00	1.50
Total Area (acres)	**2.80**	**0.00**	**0.00**	**0.00**	**0.00**	**2.80**

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	1.69	0.00	0.00	0.00	0.00	1.69
TN Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.30	1.30	46
Impervious Cover (acres)	0.00	0.00	0.00	1.50	1.50	54
					2.80	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.b. Manufactured Treatment Device-Filtering	**1**	**1.3**	**5,390.55**	**0.00**	**3.38**	**1.69**	**1.69**	

Total Impervious Cover Treated (acres)	1.30
Total Turf Area Treated (acres)	1.00
Total TP Load Reduction Achieved in D.A. (lb/yr)	1.69
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

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Legend

- DISTURBED AREA
- DRAINAGE AREA
- BEST MANAGEMENT PRACTICE (BMP)
- PROPOSED IMPERVIOUS AREA

0 50 100 Feet

vhb

Christopher Newport University
Stormwater Master Plan
CIP- Luter Hall Lawn Phase II
Reduce Impervious

February 2019

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_CIP LUTER HALL LAWN PHASE II
Date: 43511

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.65**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.45	0.45	27
Impervious Cover (acres)	0.00	0.00	0.00	1.20	1.20	73
					1.65	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	1.50	1.50	91
Impervious Cover (acres)	0.00	0.00	0.00	0.15	0.15	9
					1.65	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.31	0.31	--	0.76
Treatment Volume (ft^3)	1,879	1,879	--	4,547
TP Load (lb/yr)	1.18	1.18	--	2.86

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.73	**0.72**	**0.72**

Total TP Load Reduction Required (lb/yr)	**-1.11**	-1.11	0

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	8.44	20.44

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0.00
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	1.18
Remaining TP Load Reduction (lb/yr) Required	**0.00**

**** TARGET TP REDUCTION EXCEEDED BY 1.11 LB/YEAR ****

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Total Area (acres)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00
TN Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00

CHRISTOPHER NEWPORT UNIVERSITY

Appendix D: Figures and Calculations – Stormwater Improvement Projects

vhb

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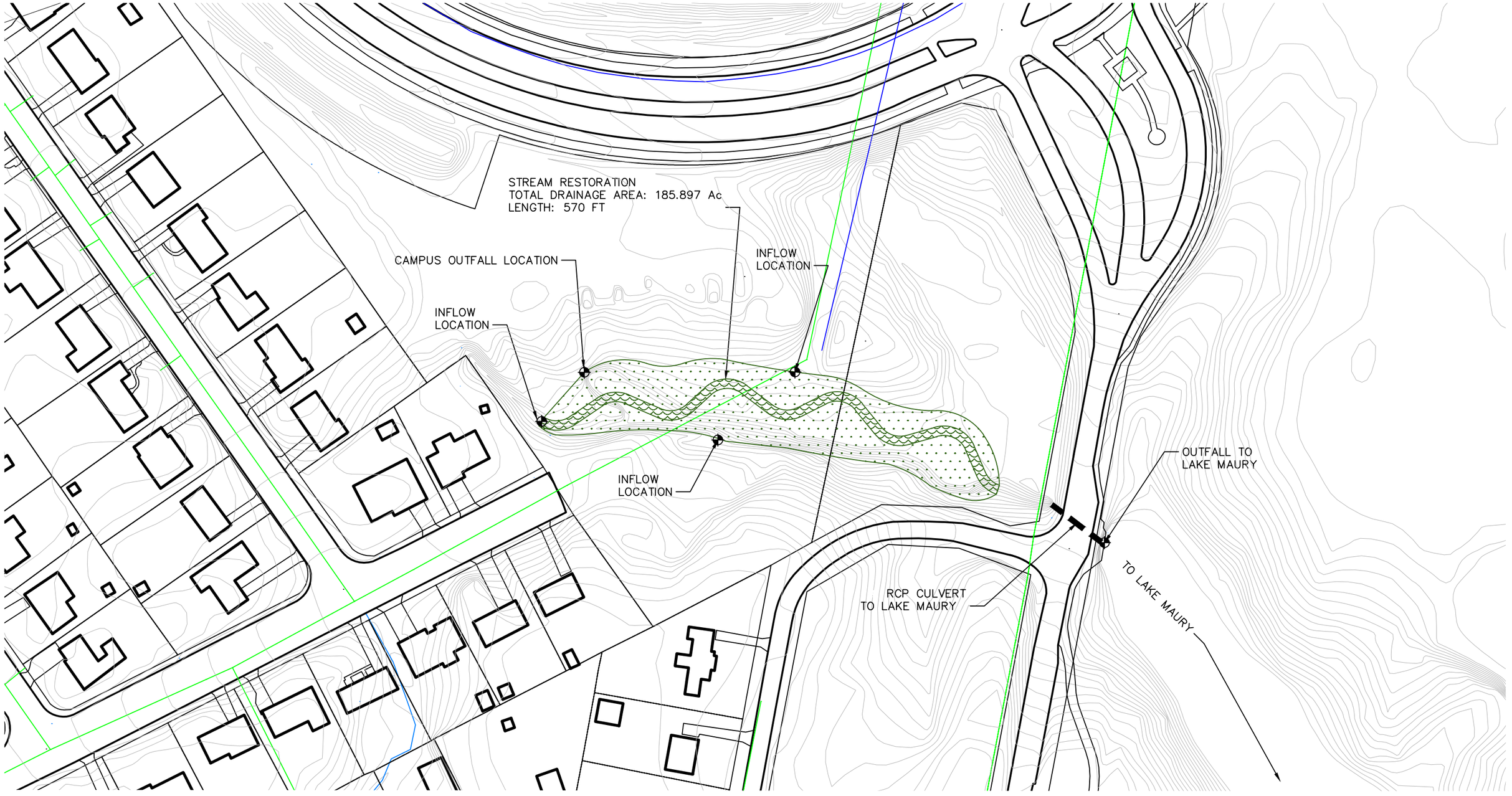

0 50 100 Feet

Lake Maury Outfall - Stream Restoration

Site Area Map

Christopher Newport University

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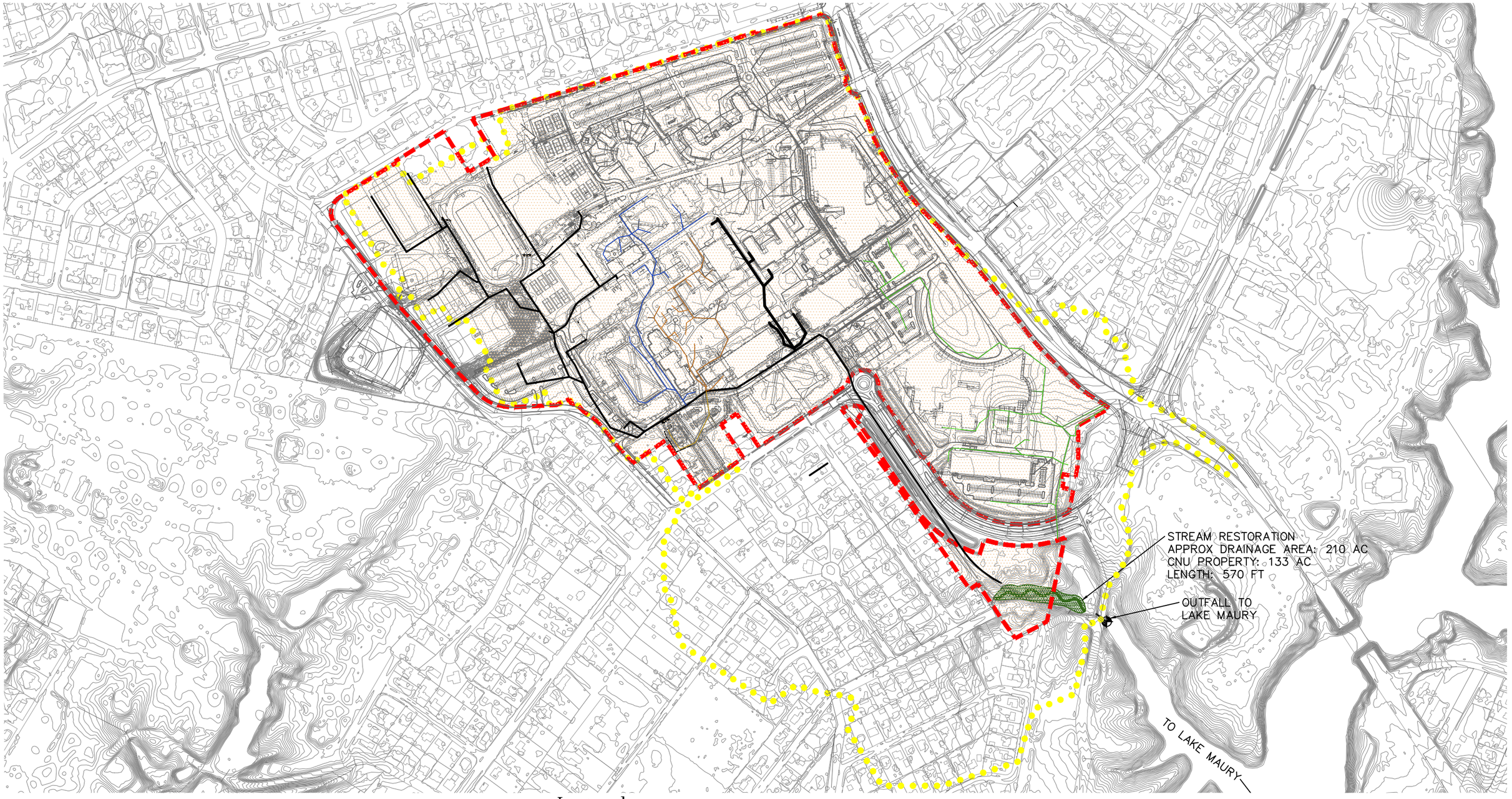

Legend

- CAMPUS AREA
- CAMPUS AREA TO BMP
- DRAINAGE AREA
- BEST MANAGEMENT PRACTICE (BMP)

0 250 500 Feet

vhb

February 2019

Christopher Newport University
Stormwater Master Plan
SIP#1 Lake Maury Outfall
Stream Restoration

Stream Restoration

Project Name: Lake Maury Outfall
Christopher Newport University
Project Location: Newport News, Virginia

Proj. No.: 33935.04
Date: 5/22/2019
Calculated by: ENW
Checked by: JDH

Stream Restoration

Input Cells

Stream Length, L=	570	lf
Removal Rate*=	0.068	lbs/ lf
Phosphorus Removal=	**38.76**	**lbs**

* Removal Rate based on conceptual analysis and reduction rates documented in the Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects. The actual removal rate will differ based upon the completion of a Bank Assessment for Nonpoint Source Consequence of Sediment (BANCS) study using the Bank Erosion Hazard Index method (BEHI) and the restoration design.

Total Drainage Area, DA=	210	ac
Campus Drainage Area=	133	ac
% Campus Area=	**63%**	
CNU Phosphorus Removal=**	**24.55**	**lbs**

** CNU Removal Rate based on ratio of campus acreage to total drainage area. The removal difference is the anticipated City share.

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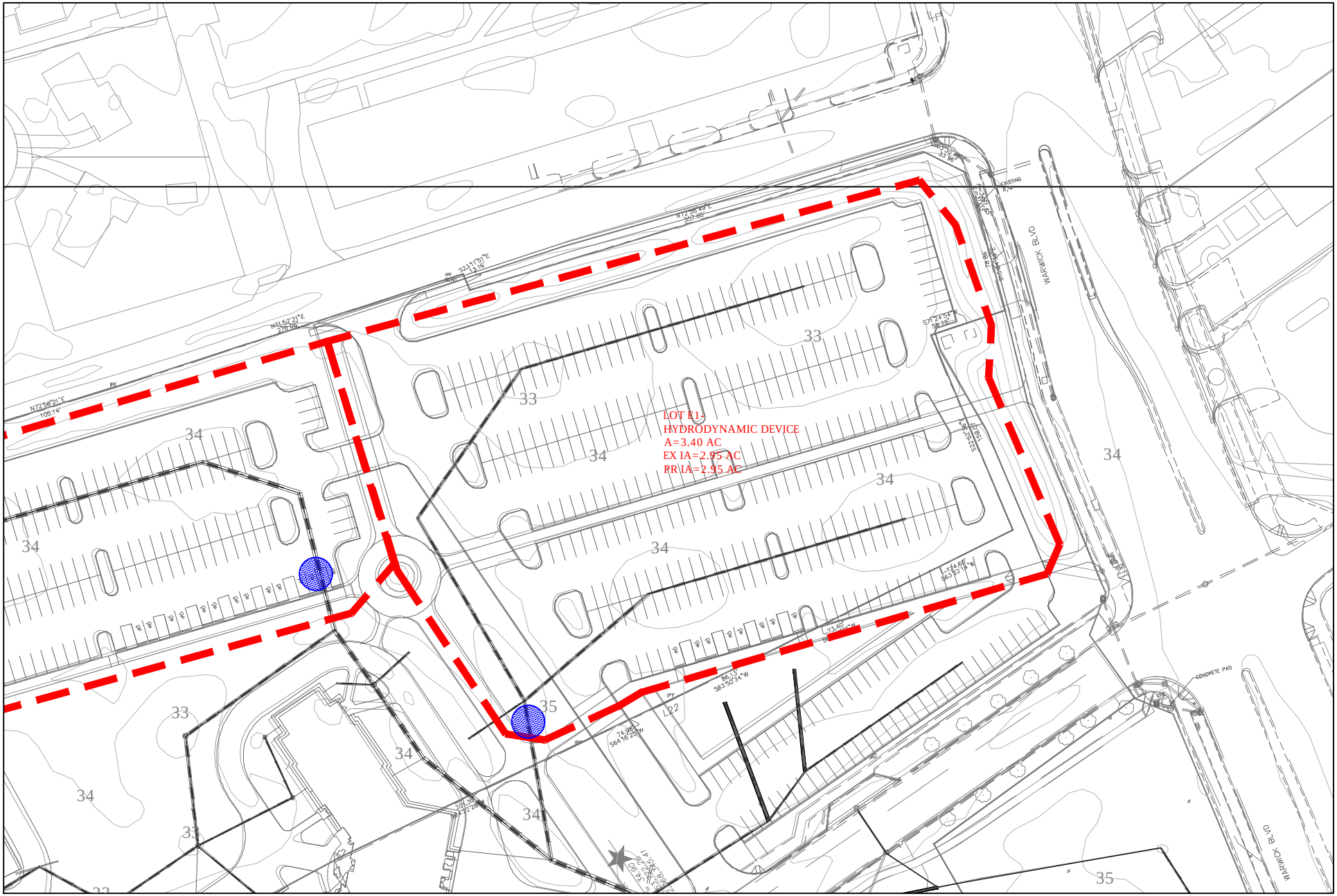

Legend

DRAINAGE AREA

BEST MANAGEMENT PRACTICE (BMP)

0 50 100 Feet

Christopher Newport University
Stormwater Master Plan
SIP#2- Lot E1 May 2019
(2A) Hydrodyamic Device or (2B) Water Quality Stucture

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_SIP LOT E1
Date: 43479

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**3.40**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.45	0.45	13
Impervious Cover (acres)	0.00	0.00	0.00	2.95	2.95	87
					3.40	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.a. Manufactured Treatment Device-Hydrodynamic	**0.45**	**2.95**	**10,581.45**	**0.00**	**6.64**	**1.33**	**5.31**	

Total Impervious Cover Treated (acres)	2.95
Total Turf Area Treated (acres)	0.45
Total TP Load Reduction Achieved in D.A. (lb/yr)	1.33
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_SIP LOT E1_OPT 2
Date: 43537

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**3.40**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.45	0.45	13
Impervious Cover (acres)	0.00	0.00	0.00	2.95	2.95	87
					3.40	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.b. Manufactured Treatment Device-Filtering	**0.45**	**2.95**	**10,581.45**	**0.00**	**6.64**	**3.32**	**3.32**	

Total Impervious Cover Treated (acres)	2.95
Total Turf Area Treated (acres)	0.45
Total TP Load Reduction Achieved in D.A. (lb/yr)	3.32
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

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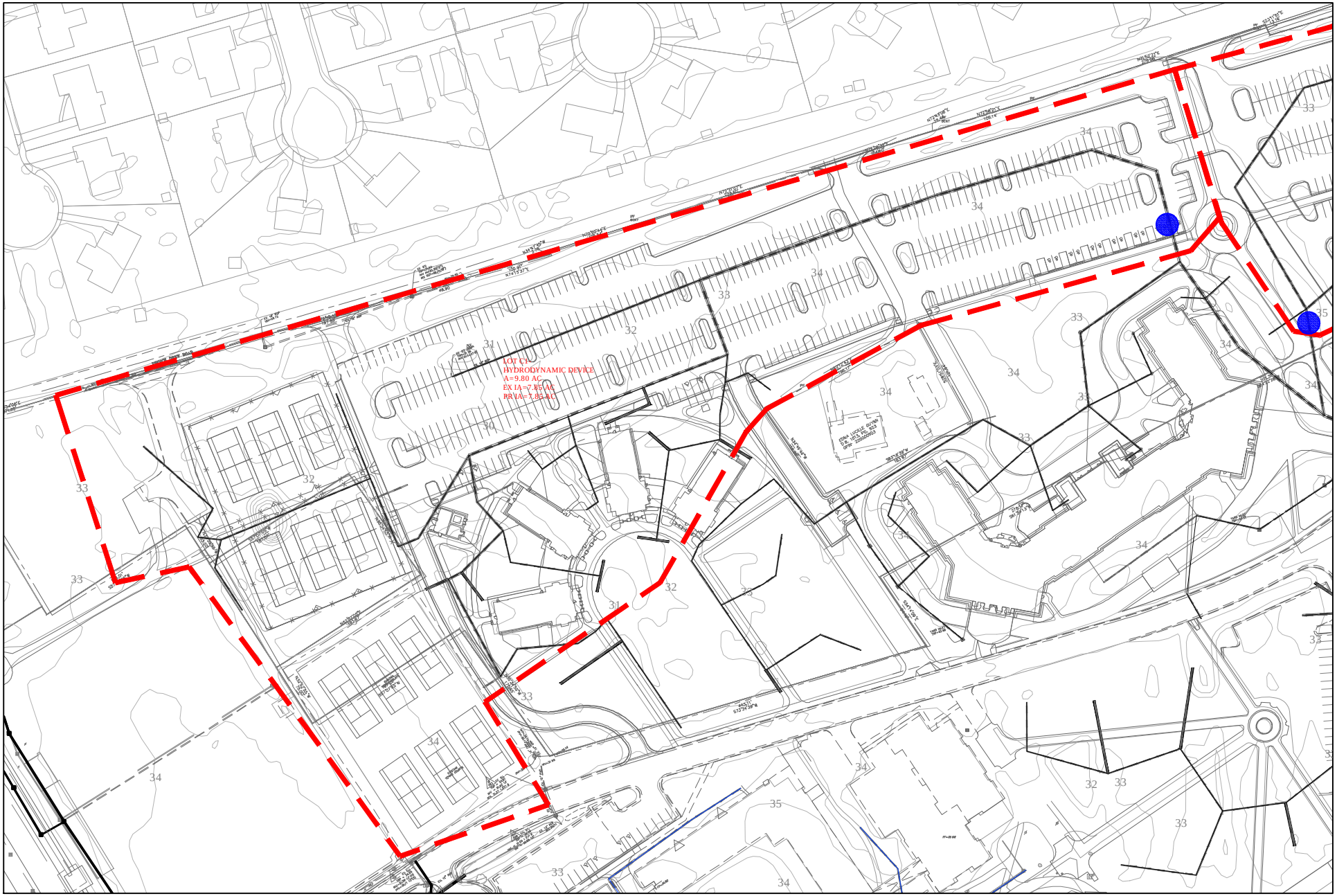

Legend

DRAINAGE AREA

BEST MANAGEMENT PRACTICE (BMP)

0 75 150 Feet

Christopher Newport University
Stormwater Master Plan
SIP#3- Lot E2/E3
Hydrodyamic Device

May 2019

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_SIP LOT E2/E3
Date: 43537

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**14.60**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	6.60	6.60	45
Impervious Cover (acres)	0.00	0.00	0.00	8.00	8.00	55
					14.60	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.a. Manufactured Treatment Device-Hydrodynamic	**6.6**	**8**	**33,577.50**	**0.00**	**21.07**	**4.21**	**16.86**	

Total Impervious Cover Treated (acres)	8.00
Total Turf Area Treated (acres)	6.60
Total TP Load Reduction Achieved in D.A. (lb/yr)	4.21
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

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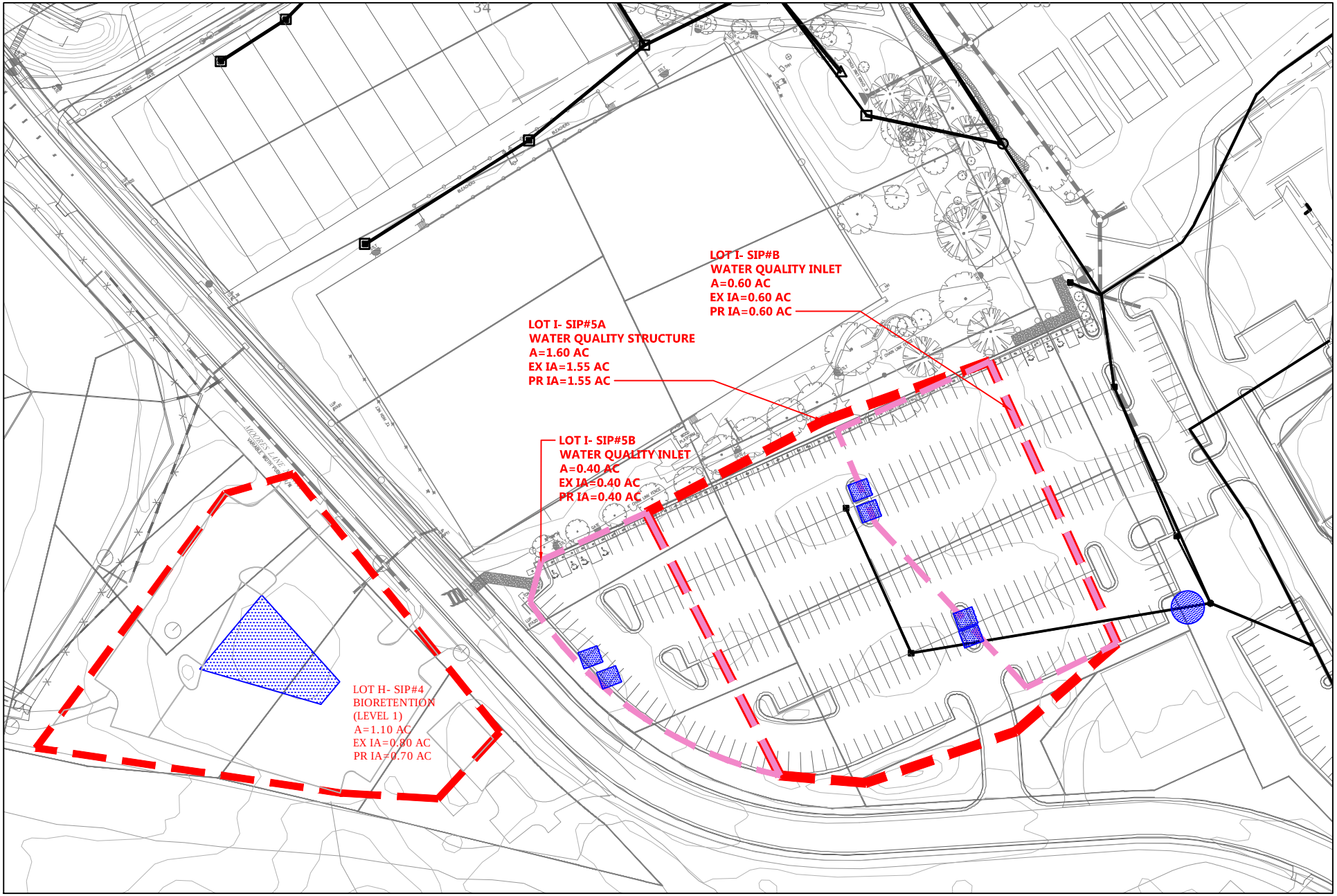

Legend

DRAINAGE AREA

BEST MANAGEMENT PRACTICE (BMP)

0 50 100 Feet

Christopher Newport University
Stormwater Master Plan
SIP#4- Lot H Bioretention (Level 1) May 2019
SIP#5- Lot I (5A) Water Quality Structure (5B) Inlets

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_SIP LOT H
Date: 43482

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.10**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.10	0.10	9
Managed Turf (acres)	0.00	0.00	0.00	0.30	0.30	27
Impervious Cover (acres)	0.00	0.00	0.00	0.70	0.70	64
					1.10	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
6.a. Bioretention #1 or Micro-Bioretention #1 or Urban Bioretention (Spec #9)	**0.3**	**0.7**	**2,686.20**	**0.00**	**1.69**	**0.93**	**0.76**	

Total Impervious Cover Treated (acres)	0.70
Total Turf Area Treated (acres)	0.30
Total TP Load Reduction Achieved in D.A. (lb/yr)	0.93
Total TN Load Reduction Achieved in D.A. (lb/yr)	7.72

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_SIP LOT I-5A
Date: 43482

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.60**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.05	0.05	3
Impervious Cover (acres)	0.00	0.00	0.00	1.55	1.55	97
					1.60	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.b. Manufactured Treatment Device-Filtering	**0.05**	**1.55**	**5,390.55**	**0.00**	**3.38**	**1.69**	**1.69**	

Total Impervious Cover Treated (acres)	1.55
Total Turf Area Treated (acres)	0.05
Total TP Load Reduction Achieved in D.A. (lb/yr)	1.69
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_CIP LOT I_5B
Date: 43479

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.00**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.00	0.00	0
Impervious Cover (acres)	0.00	0.00	0.00	1.00	1.00	100
					1.00	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.b. Manufactured Treatment Device-Filtering		**1**	**3,448.50**	**0.00**	**2.16**	**1.08**	**1.08**	

Total Impervious Cover Treated (acres)	1.00
Total Turf Area Treated (acres)	0.00
Total TP Load Reduction Achieved in D.A. (lb/yr)	1.08
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

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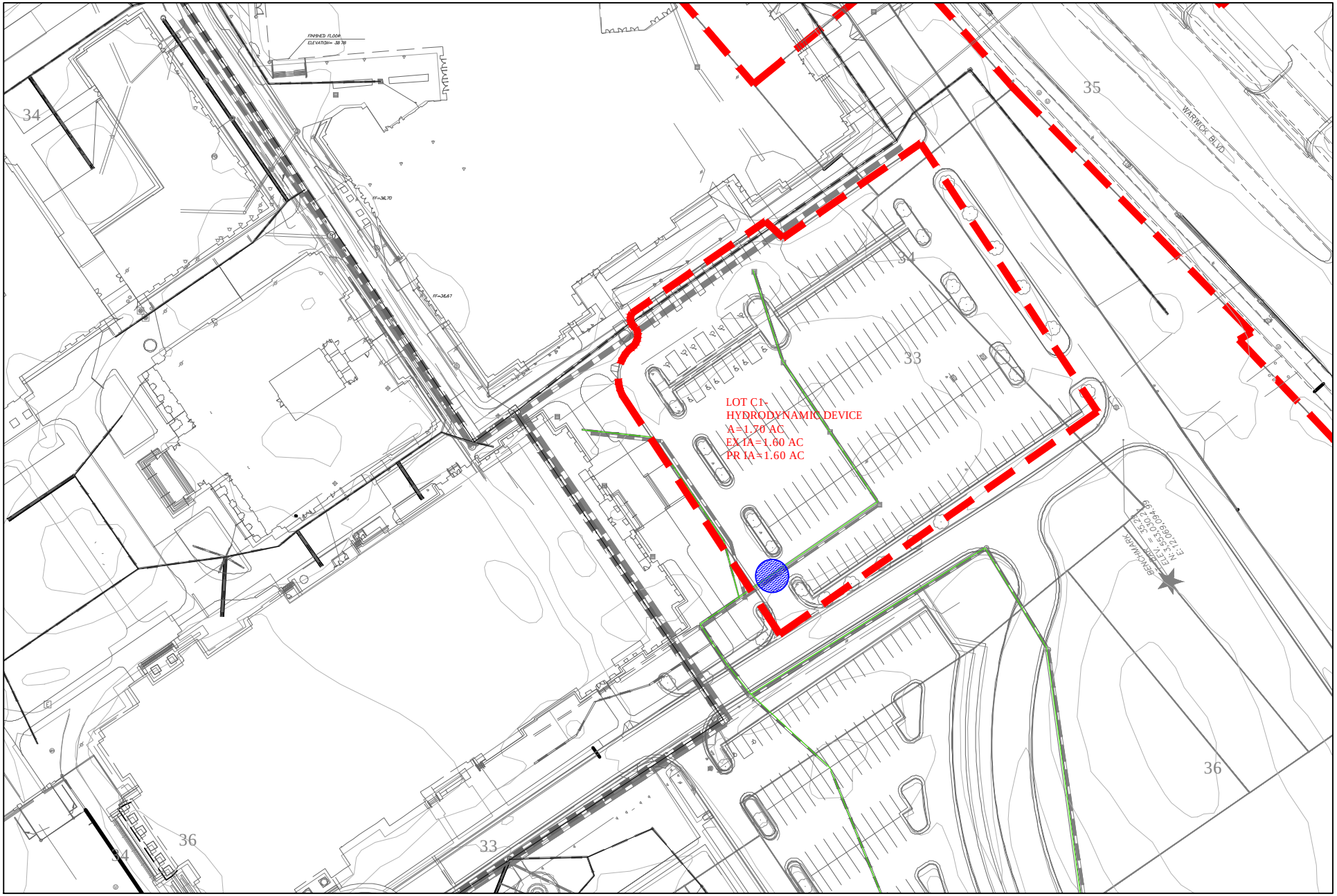


Legend

DRAINAGE AREA

BEST MANAGEMENT PRACTICE (BMP)

0 50 100 Feet

vhb

Christopher Newport University
Stormwater Master Plan
SIP#6- Lot C1
Hydrodynamic Device

May 2019

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: CNU SWMP_SIP LOT C1
Date: 43537

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**1.70**

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.10	0.10	6
Impervious Cover (acres)	0.00	0.00	0.00	1.60	1.60	94
					1.70	

BMP Selections

Practice	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft^3)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
14.a. Manufactured Treatment Device-Hydrodynamic	**0.1**	**1.6**	**5,608.35**	**0.00**	**3.52**	**0.70**	**2.82**	

Total Impervious Cover Treated (acres)	1.60
Total Turf Area Treated (acres)	0.10
Total TP Load Reduction Achieved in D.A. (lb/yr)	0.70
Total TN Load Reduction Achieved in D.A. (lb/yr)	0.00

Appendix E: Construction Cost Opinions – Capital Improvement Projects and Stormwater Improvement Projects

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 2019

BASIS FOR ESTIMATE:
X STUDY
PRELIMINARY DESIGN
FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion CIP.xls]SUMMARY

450 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	COST/ LBS	LBS REMOVAL	TOTAL COST	LBS REQUIRED	EXCESS REMOVAL FOR TMDL (LBS)	ADDITIONAL COST FOR EXCESS REMOVAL
	CAPITAL IMPROVEMENT PROJECTS						
2023							
1	SHENANDOAH RIVER HALL (2023)	$604,753	1.72	$1,040,175	1.03	0.69	$417,279.51
2	ALUMNI HALL LAWN (2023)	-	1.11	-	0	1.11	-
			2023 SUBTOTAL	**$1,040,175**	**1.03**	**1.80**	
2028							
2	GREEK HOUSING PHASE II (2028)	$571,823	1.69	$966,381	1.53	0.16	$91,491.71
3	LUTER HALL LAWN (2028)	-	0.27	-	0	0.27	-
			2028 SUBTOTAL	**$966,381**	**1.53**	**0.43**	
			CAPITAL IMPROVEMENT PLAN TOTAL COST	**$2,006,556**	**2.56**	**2.23**	

NOTES:
1. EXCESS REMOVAL FOR TMDL (LBS)= LBS REMOVAL - LBS REQUIRED
2. ADDITIONAL COST FOR EXCESS REMOVAL= COST/ LBS * EXCESS REMOVAL FOR TMDL (LBS)

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion CIP.xls]Shenandoah

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL OF COSTS	COMMENTS
	SHENANDOAH RIVER HALL (2023)					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$25,000	
4	BIORETENTIONS (MATERIALS & INSTALLATION)	4,550	SF	$35	$159,250	
5	PERMEABLE PAVERS (MATERIALS & INSTALLATION)	21,780	SF	$25	$544,500	
						Pounds Phosphorus Removed
						1.72
						Initial Cost per Pound of Phosphorus Removed
						$604,752.91

TOTAL	**$753,750**
15% Design Contingency	$113,063
8% General Conditions	$60,300
15% Construction Contingency	$113,063
TOTAL	**$1,040,175**

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion CIP.xls]Greek

4500 Main Street
Suite 400
Virginia Beach, VA
23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL OF COSTS	COMMENTS
	GREEK HOUSING PHASE II (2028)					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$25,000	
4	UNDERGROUND DETENTION CHAMBERS	2	EA	$250,000	$500,000	
5	WATER QUALITY STRUCTURE	2	EA	$100,000	$200,000	
						Pounds Phosphorus Removed
						1.81
						Initial Cost per Pound of Phosphorus Removed
						$571,823.20
				TOTAL	**$750,000**	
				15% Design Contingency	$112,500	
				8% General Conditions	$60,000	
				15% Construction Contingency	$112,500	
				TOTAL	**$1,035,000**	

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]SUMMARY

450 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	COST/ LBS	LBS REMOVAL	TOTAL COST	NOTES
	STORMWATER IMPROVEMENT PROJECTS				
1	LAKE MAURY OUTFALL - STREAM RESTORATION	$26,258	24.55	$644,628	CNU portion only
2A	LOT E1 - HYDRODYNAMIC DEVICE	$155,639	1.33	$207,000	
2B	LOT E1 - WATER QUALITY STRUCTURE	$170,422	3.32	$565,800	
3	LOT E2/E3 - HYDRODYNAMIC DEVICE	$68,836	4.21	$289,800	
4	LOT H - BIORETENTION (LEVEL 1)	$307,903	0.93	$286,350	
5A	LOT I - WATER QUALITY STRUCTURE	$187,811	1.69	$317,400	
5B	LOT I - WATER QUALITY INLETS	$434,444	1.08	$469,200	
6	LOT C1 - HYDRODYNAMIC DEVICE	$216,857	0.70	$151,800	

STORMWATER IMPROVEMENT PLAN TOTAL COST $2,931,978

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]Stream

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LAKE MAURY OUTFALL - STREAM RESTORATION					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	STREAM RESTORATION (MATERIALS, INSTALLATION, & MONITORING)	570	LF	$1,250	$712,500	
						Pounds Phosphorus Removed
						38.76
						Initial Cost per Pound of Phosphorus Removed
						$26,258
				TOTAL	**$737,500**	
				15% Design Contingency	$110,625	
				8% General Conditions	$59,000	
				15% Construction Contingency	$110,625	
				TOTAL	**$1,017,750**	

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]Lot E1

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT E1 - HYDRODYNAMIC DEVICE					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$25,000	
4	HYDRDYNAMIC DEVICE	1	EA	$100,000	$100,000	
						Pounds Phosphorus Removed
						1.33
						Initial Cost per Pound of Phosphorus Removed
						$155,639
				TOTAL	**$150,000**	
				15% Design Contingency	$22,500	
				8% General Conditions	$12,000	
				15% Construction Contingency	$22,500	
				TOTAL	**$207,000**	

VHB - Stormwater Group

2019 CNU Stormwater Master Plan
Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:
X STUDY
PRELIMINARY DESIGN
FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]Lot E1- WQS

vhb
4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT E1 - WATER QUALITY STRUCTURE					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$25,000	
4	WATER QUALITY STRUCTURE	1	EA	$360,000	$360,000	
						Pounds Phosphorus Removed
						3.32
						Initial Cost per Pound of Phosphorus Removed
						$170,422

TOTAL	**$410,000**
15% Design Contingency	$61,500
8% General Conditions	$32,800
15% Construction Contingency	$61,500
TOTAL	**$565,800**

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]Lot E2-3

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT E2/E3 - HYDRODYNAMIC DEVICE					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$25,000	
4	HYDRDYNAMIC DEVICE	1	EA	$160,000	$160,000	
						Pounds Phosphorus Removed
						4.21
						Initial Cost per Pound of Phosphorus Removed
						$68,836
				TOTAL	**$210,000**	
				15% Design Contingency	$31,500	
				8% General Conditions	$16,800	
				15% Construction Contingency	$31,500	
				TOTAL	**$289,800**	

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]LOT H

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT H - BIORETENTION (LEVEL 1)					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$25,000	
4	BIORETENTION (MATERIALS & INSTALLATION)	4,500	SF	$35	$157,500	
						Pounds Phosphorus Removed
						0.93
						Initial Cost per Pound of Phosphorus Removed
						$307,903

TOTAL	**$207,500**
15% Design Contingency	$31,125
8% General Conditions	$16,600
15% Construction Contingency	$31,125
TOTAL	**$286,350**

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]LOT I

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT I - WATER QUALITY STRUCTURE					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$10,000	$10,000	
3	UTILITY ADJUSTMENTS	1	LS	$10,000	$10,000	
4	WATER QUALITY STRUCTURE	1	EA	$200,000	$200,000	
						Pounds Phosphorus Removed
						1.69
						Initial Cost per Pound of Phosphorus Removed
						$187,811
				TOTAL	**$230,000**	
				15% Design Contingency	$34,500	
				8% General Conditions	$18,400	
				15% Construction Contingency	$34,500	
				TOTAL	**$317,400**	

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]LOT I - INLET

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT I - WATER QUALITY INLETS					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$20,000	$20,000	
3	UTILITY ADJUSTMENTS	1	LS	$10,000	$10,000	
4	WATER QUALITY INLETS	6	EA	$50,000	$300,000	
						Pounds Phosphorus Removed
						1.08
						Initial Cost per Pound of Phosphorus Removed
						$434,444

TOTAL	**$340,000**
15% Design Contingency	$51,000
8% General Conditions	$27,200
15% Construction Contingency	$51,000
TOTAL	**$469,200**

VHB - Stormwater Group

2019 CNU Stormwater Master Plan

Construction Cost Opinion

PROJECT/PROJECT # : 33935.04

LOCATION : Newport News, VA

CLIENT: Christopher Newport University

DATE PREPARED : May 22, 2019

BASIS FOR ESTIMATE:

X STUDY

PRELIMINARY DESIGN

FINAL DESIGN

FILE NAME: \\vhb\gbl\proj\VirginiaBeach\33935.04 CNU SWMP\tech\Stormwater\FINAL\Cost Opinion\[Cost Opinion SIP.xls]Lot C1

4500 Main Street Suite 400
Virginia Beach, VA 23462
P 757.490.0132
F 757.490.0136

ITEM NO	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	COMMENTS
	LOT C1 - HYDRODYNAMIC DEVICE					
1	MOBILIZATION	1	LS	$10,000	$10,000	
2	DEMOLITION	1	LS	$15,000	$15,000	
3	UTILITY ADJUSTMENTS	1	LS	$25,000	$15,000	
4	HYDRDYNAMIC DEVICE	1	EA	$70,000	$70,000	
						Pounds Phosphorus Removed
						0.70
						Initial Cost per Pound of Phosphorus Removed
						$216,857
				TOTAL	**$110,000**	
				15% Design Contingency	$16,500	
				8% General Conditions	$8,800	
				15% Construction Contingency	$16,500	
				TOTAL	**$151,800**	

CHRISTOPHER NEWPORT UNIVERSITY

Appendix F: Long Term Maintenance of Campus Best Management Practices

vhb

Long Term Maintenance of Campus BMPs

Pavement Systems

Standard Asphalt Pavement

Inspections and Cleaning

- Sweep or vacuum standard asphalt pavement areas at least four times per year with a commercial cleaning unit and properly dispose of removed material.
- Recommended sweeping schedule:
  - Oct/Nov
  - Feb/Mar
  - Apr/May
  - Aug/Sep
- More frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.

Yearly Maintenance Cost

The annual cost to maintain the campus paved areas will be approximately **$1000 per acre.**

Permeable Pavers

The primary maintenance requirement for permeable pavers is to clean the surface drainage voids. Fine debris and dirt accumulate in the drainage openings and reduce the pavement's flow capacity. Even though some irreplaceable loss in permeability should be expected over the paver's lifetime, you can increase the longevity of the system by following the maintenance schedule for vacuum sweeping and high-pressure washing, restricting the area's use by heavy vehicles, limiting the use of de-icing chemicals and sand, and implementing a stringent sediment control plan.

Preventing Clogging of Permeable Paver Surface Areas

- Patio areas and/or other areas with permeable pavers shall be cleaned annually with vacuums or washed with high pressure washers.
- Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface.
- Maintain vegetated areas adjacent to areas with permeable pavers to prevent washout of soil onto surface.
- Do not apply any type of sealant to permeable pavers.

Removing Snow and Ice

- Shovel snow off permeable pavers as necessary.
- Do not apply abrasives such as sand or grit on or adjacent to permeable pavers.
- Avoid plowing of areas with permeable pavers.

Inspecting the System

- Inspect areas paved with permeable pavers monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts. After the initial period, inspect yearly.
- The drawdown rate should be measured at the observation well for three (3) days following a storm event in excess of 1/2 inch in depth. If standing water is still observed in the well after three days, this is a clear sign that clogging is a problem.
- Inspect the surface of the permeable pavement for evidence of sediment deposition, organic debris, staining or ponding that may indicate surface clogging. If any signs of clogging are noted, schedule a vacuum sweeper (no brooms or water spray) to remove deposited material. Then, test sections by pouring water from a five-gallon bucket to ensure they work.
- Inspect the structural integrity of the pavement surface, looking for signs of surface deterioration, such as slumping, cracking, spalling or broken pavers. Replace or repair affected areas, as necessary.
- Check inlets, pretreatment cells and any flow diversion structures for sediment buildup and structural damage. Note if any sediment needs to be removed.
- Inspect the condition of the observation well and make sure it is still capped.
- Generally, inspect any contributing drainage area for any controllable sources of sediment or erosion.

Repairing Damages

- Do not apply any type of sealant to permeable pavers.
- If necessary, add additional aggregate fill material made up of clean sand or gravel.
- Damaged interlocking paving blocks should be replaced.

Yearly Maintenance Cost

The annual cost to maintain the campus permeable pavers will be approximately **$1,500 per acre**.

Bioretention Basins

Rain gardens require routine maintenance (like conventional landscaping maintenance) to ensure that the system both functions well as a stormwater management practice while also maintaining an aesthetic quality compatible with the surrounding land uses.

Mulching is an important part of rain garden maintenance. Mulch keeps the soil moist, allowing for easy infiltration of rain water. Un-mulched surfaces may develop into a hardpan, a condition in which the soil surface becomes cemented together, forming a hard, impervious layer. Mulching also protects plants and reduces weed growth.

Initial Post-Construction Inspection

- During the initial period of vegetation establishment pruning and weeding are required twice in first year.
- Any dead vegetation found after the first year must be replaced.
- Proper mulching is mandatory and regular watering may be required initially to ensure proper establishment of new vegetation.

Long-Term Maintenance

- Weeds and invasive plant species shall be removed by hand.
- Leaf litter and other detritus shall be removed twice per year.
- If needed to maintain aesthetic appearance, perennial plantings may be trimmed at the end of the growing season.
- Trees and shrubs should be inspected twice per year to evaluate health and attended to as necessary.
- Re-mulch rain gardens with hardwood mulch to a depth of 3 inches each spring or whenever erosion is evident. The entire area may require mulch replacement once every two to three years. Mulch depth shall not exceed 3 inches.
- Seeded ground cover or grass areas shall not receive mulching.
- Fertilizers should not be used in the rain garden as excessive nutrients in the rain garden may migrate to the underdrain and be discharged to adjacent surface waters.
- Test pH of the soils in the planting bed annually. If the pH is below 5.2, limestone should be applied to increase it. If the pH is above 8.0, iron sulfate plus sulfur should be added to reduce it.
- Rain gardens may require watering during periods of extended drought.

Inspections and Cleaning

- Rain gardens shall be inspected twice during the first year and annually thereafter for sediment buildup, erosion, vegetative conditions, etc. If sediment build-up is found, core aeration or cultivating of un-vegetated areas may be required to ensure adequate filtration.

- The inflow location should be inspected annually for clogging. Sediment build up is a common problem where runoff leaves an impervious surface and enters a vegetative or earthen surface. Any built-up sediment should be removed to prevent runoff from bypassing the facility.
- The overflow structure and underdrain standpipes should be inspected annually to ensure that they are functioning.
- Check for any winter- or salt-killed vegetation and replace it with hardier species.
- Inspect rain gardens after a large storm event to ensure that proper drainage is occurring. Water that remains ponded on the surface of the rain garden after 48 hours of dry weather could indicate a problem with the subsurface drainage system or clogging of the underdrain. While the plants selected for the rain garden are tolerant of wet soils, they are not wetland species that can survive long periods of inundation. Immediate attention is required to prevent the loss of plant materials.
- Remove and replace dead plants. Since up to 10% of the plant stock may die off in the first year, construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85% survival of plant material and 100% survival of trees.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$1,000 per basin**.

Dry Swale

Dry swales are designed to carry water collected from large storms to storm sewer inlets or to a body of water. Water from smaller storms will be infiltrated into the dry swales Water quality improvements occur as the water is either infiltrated or is carried through the dry swales during larger storms.

Initial Post-Construction Inspection

- During the initial period of vegetation establishment pruning and weeding are required twice in first year.
- Any dead vegetation found after the first year must be replaced.
- Regular watering may be required initially to ensure proper establishment of new vegetation.

Long-Term Maintenance

- Weeds and invasive plant species shall be removed by hand.
- Leaf litter and other detritus shall be removed twice per year.
- If needed to maintain aesthetic appearance, perennial plantings may be trimmed at the end of the growing season.
- Trees and shrubs should be inspected twice per year to evaluate health and attended to as necessary.

Inspections and Cleaning

- The inflow location should be inspected annually for clogging. Sediment build up is a common problem where runoff leaves an impervious surface and enters a vegetative or earthen surface. Any built-up sediment should be removed to prevent runoff from bypassing the facility.
- The overflow structure and underdrain standpipes should be inspected annually to ensure that they are functioning.
- Check for any winter- or salt-killed vegetation and replace it with hardier species.
- Remove and replace dead plants. Since up to 10% of the plant stock may die off in the first year, construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85% survival of plant material and 100% survival of trees.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$1,000 per basin**.

Wet Ponds

Wet ponds are basins that are continually hold a consistent amount of water. The maintenance of the infiltration basins may affect the functioning of stormwater management practices.

Initial Post-Construction Inspection

- All basins should be inspected after every major storm for the first few months to ensure proper stabilization and function.
- Emerging wetland species should be planted along the aquatic benches.
- Trees planted within the buffer area need to be watered throughout the extent of the first growing season. Eroding or bare areas need to be stabilized with grass coverage.

Long-Term Maintenance

- The grass on the side slopes and in the buffer areas should be mowed, and grass clippings, organic matter, and accumulated trash and debris removed.
- Sediment should be removed from all basins when 50% of the storage capacity has been filled, every 5 to 7 years.
- Routinely pick up and remove litter from the parking areas, islands and perimeter landscape areas in addition to regular pavement sweeping

Inspections and Cleaning

- Measure sediment accumulation levels in forebay.

- Monitor the growth of wetlands, trees and shrubs planted. Record the species and their approximate coverage and note the presence of any invasive plant species.
- Inspect the condition of stormwater inlets to the pond for material damage, erosion or undercutting.
- Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine embankment integrity.
- Inspect pond outfall channel for erosion, undercutting, rip-rap displacement, woody growth, etc.
- Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.
- Inspect condition of all trash racks, reverse sloped pipes or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.
- Inspect maintenance access to ensure it is free of woody vegetation, and check to see whether valves, manholes and locks can be opened and operated.
- Inspect internal and external side slopes of the pond for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$1,000 per basin**.

Extended Detention Basins

The detention ponds are partially vegetated basins that are designed to detain, clean and infiltrate roadway and rooftop runoff. The maintenance of the infiltration basins may affect the functioning of stormwater management practices. This includes the condition of the side slope vegetation and the sediment deposits in the bottom of the ponds.

Initial Post-Construction Inspection

- All basins should be inspected after every major storm for the first few months to ensure proper stabilization and function.

Long-Term Maintenance

- The grass on the side slopes and in the buffer areas should be mowed, and grass clippings, organic matter, and accumulated trash and debris removed, at least twice during the growing season.
- Deep tilling can be used to break up a clogged surface area in an infiltration basin.
- Sediment should be removed from all basins when six inches has accumulated along the bottom. Removal procedures should not take place until the floor of the basin is thoroughly dry, unless maintaining a wet pond, then dredging will be required.
- Routinely pick up and remove litter from the parking areas, islands and perimeter landscape areas in addition to regular pavement sweeping

Inspections and Cleaning

- Measure sediment accumulation levels in forebay.
- Monitor the growth of wetlands, trees and shrubs planted. Record the species and their approximate coverage and note the presence of any invasive plant species.
- Inspect the condition of stormwater inlets to the pond for material damage, erosion or undercutting.
- Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine embankment integrity.
- Inspect pond outfall channel for erosion, undercutting, rip-rap displacement, woody growth, etc.
- Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.
- Inspect condition of all trash racks, reverse sloped pipes or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.
- Inspect maintenance access to ensure it is free of woody vegetation, and check to see whether valves, manholes and locks can be opened and operated.
- Inspect internal and external side slopes of the pond for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$750 per basin**.

Stream Restoration

Stream Restoration is the process of repairing and improving a stream system that has been eroded and become unstable. Measures include planting new vegetation, removing factors creating instability within the system, and cleaning out any trash and debris as well as dead or dying vegetation.

Initial Post-Construction Inspection

- A gauge station to monitor water elevation levels should be installed within the first year.
- Visual monitoring should be conducted using photographic stations to monitor the banks, stream channel, and in stream structures.
- Inspect vegetation for signs of erosion or bare areas.

Inspections and Cleaning

- Streams are held to 7 years of monitoring within a 10-year period after being restored.
- Each monitoring year check the end points of each installed survey transect for stability.

- Monitoring plan sheets shall include the pattern measurements that should be measured within the field during a monitoring inspection. Survey the entire longitudinal profile established when stream is being restored.
- Each in-stream structure should be evaluated by photographing each structure and creating a surveyed profile of the elevation of each structure. Structures should be inspected for erosion and stability.
- Each monitoring year a reach pebble count, a cross-sectional pebble count for each riffle wetted-perimeter, and a weighted bar sample should be provided.
- The Bank Erodibility Hazard Index (BEH) should be completed for the length of the channel within the mitigation area each monitoring year along with the U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975).
- Monitor the stream for debris and dying/ dead vegetation, and remove any debris found within the stream or dead/dying vegetation to prevent erosion and help the flow of stream water.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$5 per LF.**

Vegetated Roof

Initial Post-Construction Inspection

- During the initial period of vegetation establishment, fertilization is required at least twice in the first year.
- Any dead vegetation found after the first year must be replaced.
- Weekly watering, manually or by irrigation system, is mandatory throughout the first six months.

Inspections and Cleaning

- Inspect the roof membrane at least twice a year for rupture since this is the most critical element to a proper functioning vegetated roof. Common areas for rupture are where the roof meets any vertical walls, roof vent pipes, outlets, A/C units and along the perimeter. If a roof leak is suspected, it is advisable to perform an electric leak survey (i.e., Electrical Field Vector Mapping) to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.
- Provide cleaning of the drainage flow paths at least once per year.
- Water plants weekly until established, then no more watering is required throughout the life of the roof (±40 years).
- Occasional weeding of the rooftop, monthly in the establishment phase, will be required, remove any invasive, dead, or dying plants, and plant replacement vegetation.
- The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of the waterproof membrane. Also, power-washing and other exterior maintenance operations should be avoided so that

cleaning agents and other chemicals do not harm the vegetated roof plant communities.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$1,000 per roof**. Studies have shown that initial and yearly maintenance costs are compensated by decreases in yearly building operational and maintenance costs.

Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of stormwater management practices. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings.

Inspections and Cleaning

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should not be cut to a height less than four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas but should not be applied on a regular basis unless necessary.
- Follow the guidelines of the Nutrient Management Plan

Yearly Maintenance Cost

The annual cost to maintain the campus vegetated areas will be approximately **$2,000 per acre**.

Manufactured BMP Systems

Water Quality Inlet

Inspections and Cleaning

- Check specific manufacturer's instructions on O&M requirements and methodology.
- All basins shall be inspected at least twice per year and cleaned a minimum of at least once per year.
- Maintenance is simple, safe and inexpensive. It typically takes less than 30 minutes to maintain 1 unit. Trash and heavy sediments accumulate on top of the mulch and that is typically all that is removed. This waste is easily removed and disposed of in trash bags or buckets. Fresh mulch is then replaced on top of the engineered media and not removed until the next maintenance visit. Hardwood mulch is a highly effective and an inexpensive pretreatment layer that protects not only the engineered media but also the plant in all weather conditions. Mulch should be replaced at least twice per year.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$1,5000 per structure**.

Water Quality Structure

Inspections and Cleaning

- Check specific manufacturer's instructions on O&M requirements and methodology.
- Inspect devices monthly for the first three months after construction.
- After initial three-month period, all water quality units are to be inspected at least twice per year and cleaned a minimum of at least once per year (when sediment typically reaches 6" in depth).
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary.
- Follow manufacturer instructions and contact manufacturer if system is malfunctioning.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$2,500 per structure**.

Hydrodynamic Separator

Inspections and Cleaning

- Check specific manufacturer's instructions on O&M requirements and methodology.
- Inspect devices monthly for the first three months after construction.
- After initial three-month period, all water quality units are to be inspected at least twice per year and cleaned a minimum of at least once per year (when sediment typically reaches 6" in depth).
- Cleaning the vault with a vacuum truck is generally the most effective method to excavate sediment buildup.
- Using ultra adsorbent pads to remove the hydrocarbon accumulation is preferable, since they are generally cheaper to dispose of than the oil water emulsion that may be created by vacuuming the oily layer.
- Trash should be netted out separately.
- Follow manufacturer instructions and contact manufacturer if system is malfunctioning.

Yearly Maintenance Cost

The annual cost to maintain this BMP will be approximately **$3,000 per structure**.

Appendix G: References

CHRISTOPHER NEWPORT UNIVERSITY

CAMPUS MAP

BUILDINGS/AREAS:

1. Christopher Newport Hall
   a. Admission Welcome Center
2. CNU Apartments
   a. Harrison
   b. Jefferson
   c. Madison
   d. Monroe
   e. Washington
3. CNU Crossing
4. CNU Landing
5. CNU North
6. CNU Village
   a. Taylor
   b. Tyler
   c. Wilson
7. Commonwealth Hall
8. David Student Union
   a. Captains Locker
   b. Regattas
9. Ferguson Center for the Arts
   a. Diamonstein Concert Hall
   b. Peebles Theatre
   c. Studio Theatre
10. Ferguson Center Parking Deck
    a. Parking Services
11. Forbes Hall
12. Freeman Center
    a. Field House
    b. Gaines Theatre
    c. Trieshmann Health and Fitness Pavilion
    d. Windsor Health and Counseling Center
13. Gosnold Hall
14. Great Lawn
15. Greek Village
16. Grounds Department
17. Hiden-Hussey Commons
18. Hoinkes Plaza/Bell Tower
19. James River Hall
20. Klich Alumni House
21. Luter Hall
22. McMurran Hall
23. Military Science Building
24. Plant Operations Warehouse
25. Pope Chapel
26. Potomac River Hall
    a. North
    b. South
27. Rappahannock River Hall
28. Ratcliffe Hall
29. Santoro Hall
30. Saunders Plaza
31. Trible Library
    a. Einstein's Cafe
32. Trible Plaza
33. University Police
34. Warwick River Hall
35. York River Hall
    a. East
    b. West

PARKING: (Lots are named by letter)

- CNU Apartments, CNU Landing, CNU Crossing
- CNU Village Parking Deck
- Main Campus Residents
- Main Campus Residents, Faculty/Staff
- Main Campus Residents, Day Student, Faculty/Staff
- Day Student, Faculty/Staff
- Faculty/Staff
- Rappahannock River Hall Parking Deck
- Open (with any valid CNU decal)
- Visitor Parking
- Retail Only

ATHLETICS:

A1. Belk Track
A2. Captains Field - Soccer
A3. Captains Park - Baseball
A4. Captains Park - Softball
A5. Captains Turf Field - Field Hockey/Lacrosse
A6. Eyre Tennis Courts
A7. POMOCO Stadium - Football
A8. Practice Fields

CIPS (2018-2028)

CIPS (COMPLETED 2013-2018)

2018: E4 gravel lot

2018: Eyre Tennis Courts Phase II

2018: Greek Village Phase 1

2028: Greek Housing Phase II

2023: Captains Turf Field Replacement

2023: Shenandoah River Hall

2028: Luter Hall Lawn, Phase II

2018: Hoinkes Plaza/ Bell Tower

2018: David Student Union- Regattas

2023: Alumni Hall Lawn

2018: Trible Library Expansion

2023: Fine Arts Center

2023: C2 Parking

Legend

Academic

Residential

Gathering

Facilities

Not Owned

Foundation

Scale: not to scale

August 2018

Campus Building Plan 2025

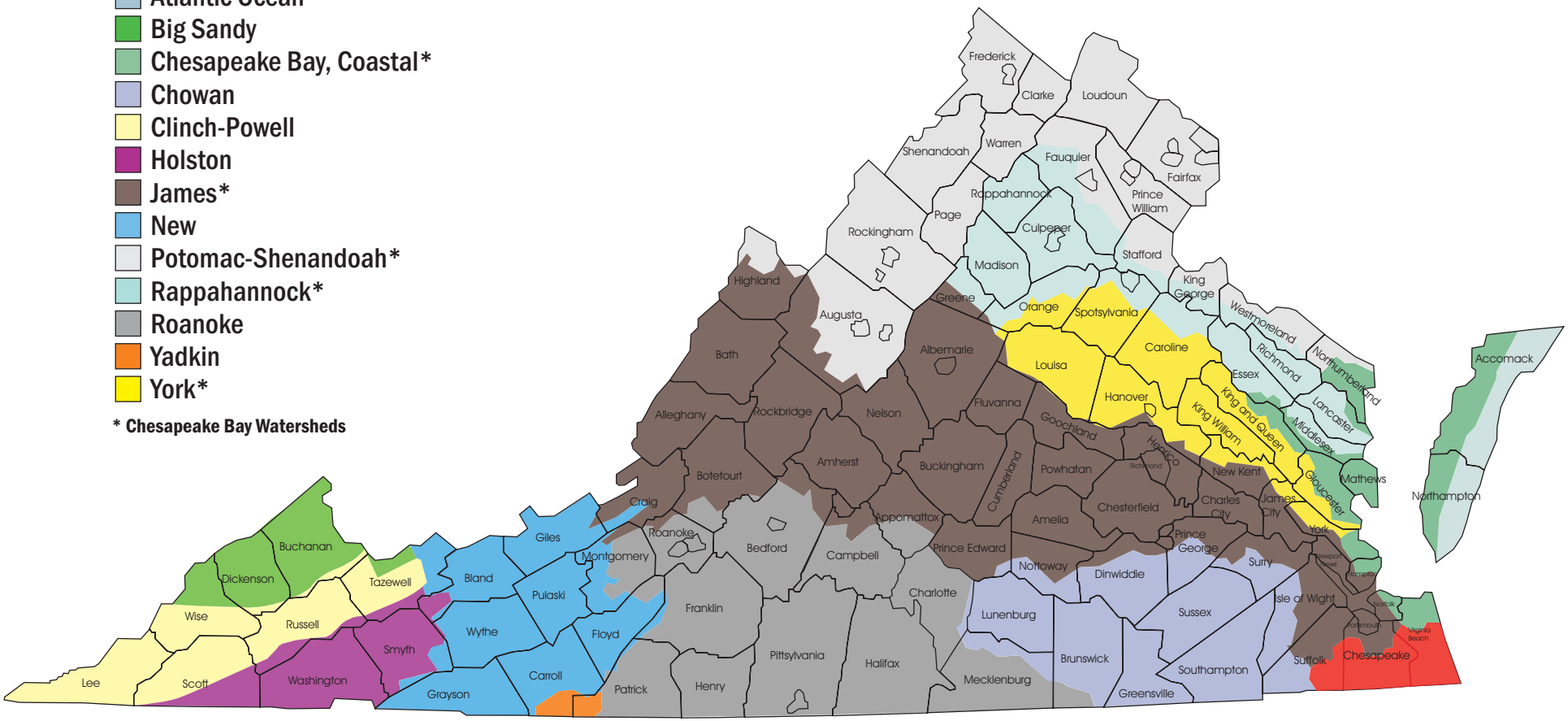
Christopher Newport University

GLAVE & HOLMES ARCHITECTURE

Virginia's Major Watersheds

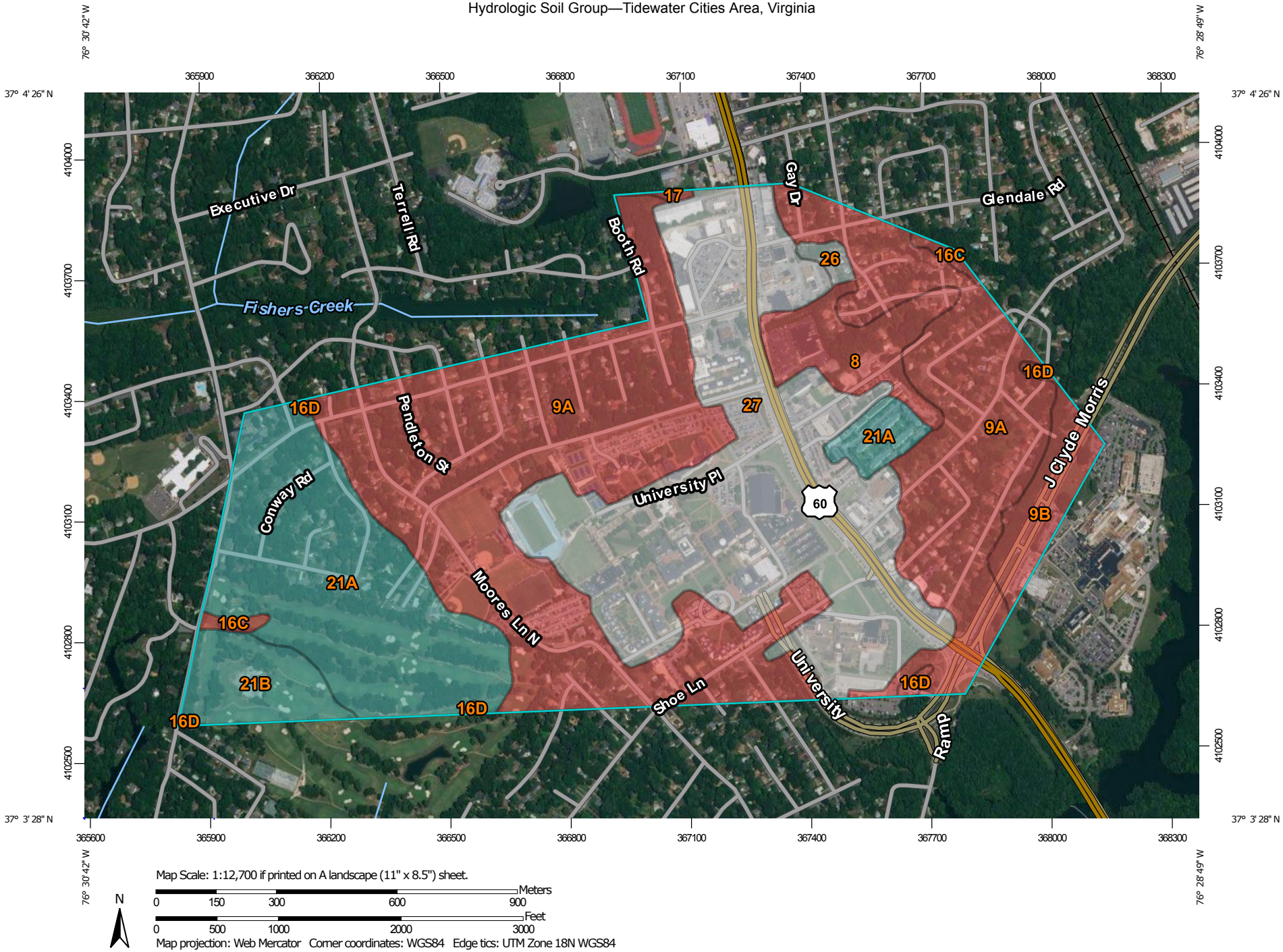
- Albemarle Sound, Coastal
- Atlantic Ocean
- Big Sandy
- Chesapeake Bay, Coastal*
- Chowan
- Clinch-Powell
- Holston
- James*
- New
- Potomac-Shenandoah*
- Rappahannock*
- Roanoke
- Yadkin
- York*

* Chesapeake Bay Watersheds



DCR

Virginia Department of Conservation and Recreation



Map Scale: 1:12,700 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Tidewater Cities Area, Virginia
Survey Area Data: Version 16, Aug 29, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Mar 8, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Chickahominy-Urban land complex, 0 to 2 percent slopes	D	20.3	3.9%
9A	Craven-Urban land complex, 0 to 2 percent slopes	D	230.1	43.9%
9B	Craven-Urban land complex, 2 to 6 percent slopes	D	14.7	2.8%
16C	Nevarc-Uchee complex, 6 to 15 percent slopes	D	2.8	0.5%
16D	Nevarc-Uchee complex, 15 to 50 percent slopes	D	2.2	0.4%
17	Newflat-Urban land complex, 0 to 2 percent slopes	D	0.6	0.1%
21A	Slagle-Urban land complex, 0 to 2 percent slopes	C	86.8	16.6%
21B	Slagle-Urban land complex, 2 to 6 percent slopes	C	17.8	3.4%
26	Udorthents-Dumps complex		2.2	0.4%
27	Urban land		146.4	27.9%
Totals for Area of Interest			**523.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

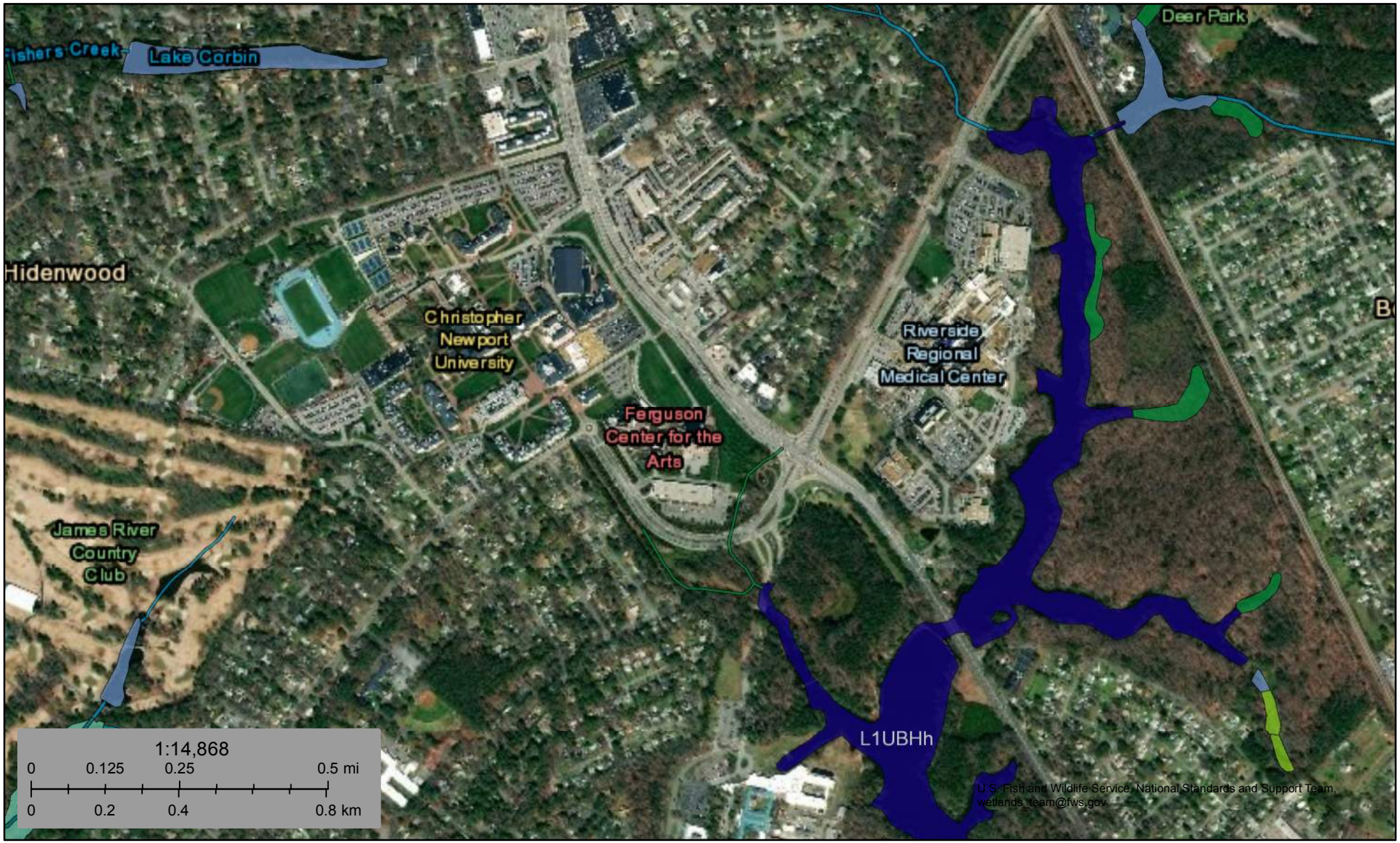
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

U.S. Fish and Wildlife Service
National Wetlands Inventory

Wetlands

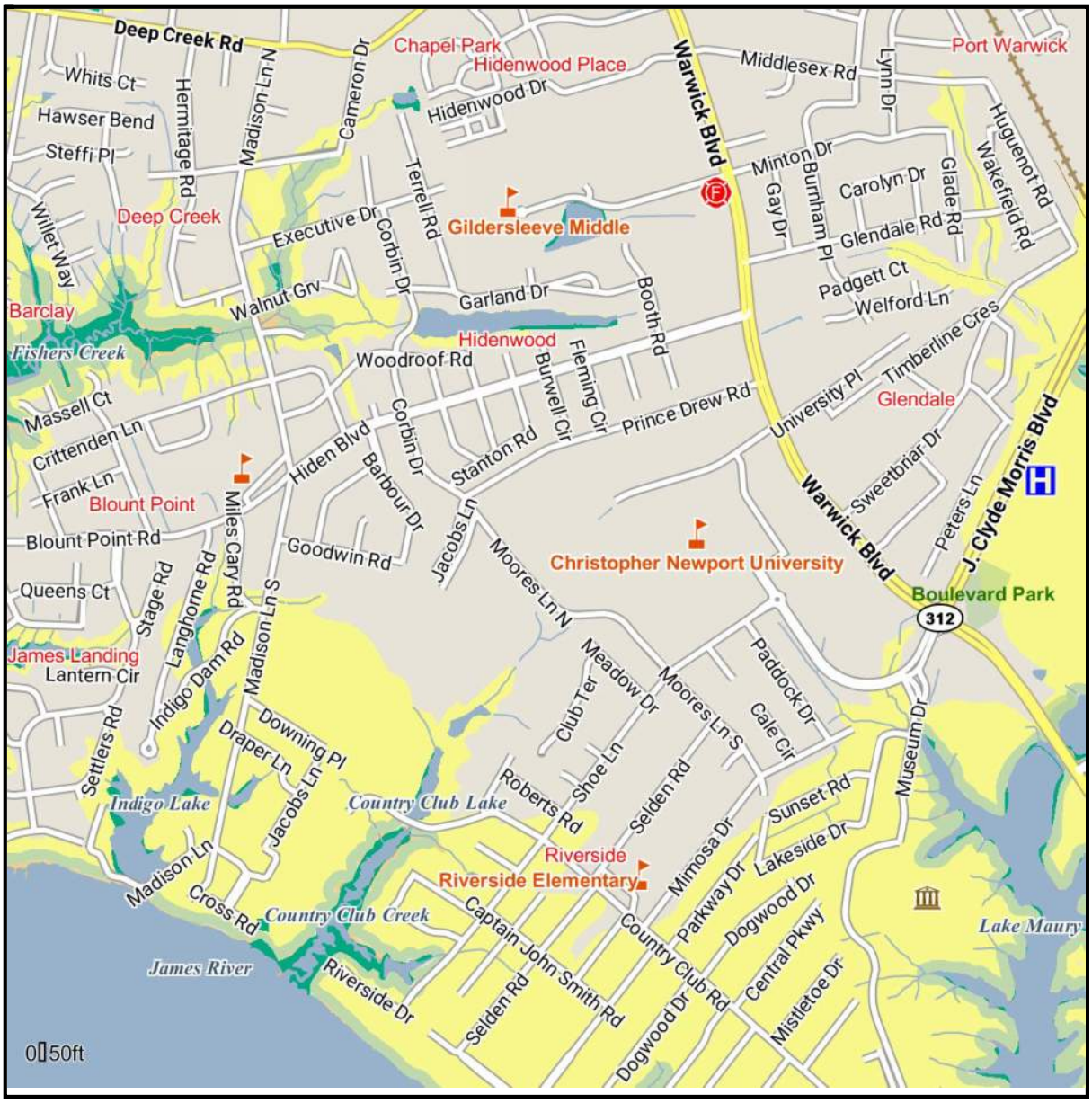


October 16, 2018

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.



Legend

Regional Major Roads
Interstates
Primary Roads
Other
Schools
Hospitals
Police Stations

Fire Stations
Libraries
Museums

Road Centerlines
Interstates
Primary Roads
Vehicular Trails
(cont)

Ramps/Service Roads
Other
Residential Roads
Railroads
Streams
Water Bodies

NWI Wetlands
Airport Runways
Parks

Chesapeake Bay Preservation Areas
IDA
(cont)

Reservoir
RMA
RPA
Shoreline
Wetlands

City of Newport News

Any determination of topography or contours, or any depiction of physical improvements, property lines or boundaries is for general information only and shall not be used for the design, modification, or construction of improvements to real property or for flood plain determination.

2011 CONDITIONS

A_{SITE} TOTAL AREA 147.24

		IMPERVIOUS AREA
A_{DIST}	BUILDINGS	24.01
	PARKING	22.84
	ROAD	9.58
	SIDEWALKS	11.22
	OTHER	3.45
		71.10
	% IMPERVIOUS	48.29%

LEGEND

STUDY BOUNDARY LINE

IMPERVIOUS AREA

PRINCE DREW ROAD
MASTER PLAN PARKING LOTS
RESIDENCE HALL V
LOOP ROAD
PRACTICE FIELD
TRACK
FAIRWAY LANE
EXTENDED DETENTION BASIN (TRACK COMPLEX)
JAMES RIVER RESIDENCE HALL
EXTENDED DETENTION BASIN (JAMES HALL)
GATORS RESIDENCE HALL
HIGH-HARSEY RESIDENCE HALL
McDONALD HALL
THE SCIENCE BUILDING PHASE II
NEW HALL
FRESHMAN CENTER
ADMINISTRATION BUILDING
TRIBLE LIBRARY
THE SCIENCE BUILDING BEFORE PHASE II
THE GREAT LAWN
RATCLIFFE HALL
POTOMAC RIVER TRAIL
McMURRAN HALL
DAVIS STUDENT UNION
CHAPEL
YORK RIVER RESIDENCE HALL
YORK RIVER RESIDENCE TRAIL
SHOE LANE
FERGUSON CENTER FOR THE ARTS
PARKING DECK
J. CLYDE MORRIS BLVD (US RT. 17)
PADDOCK DR
BRIARPATCH PL
MOORES LANE
MUSEUM DR
1"=150'
0' 150' 300' 450'

COMMONWEALTH OF VIRGINIA
PAUL R. HINSON
Lic. No. 023800
12-21-11
PROFESSIONAL ENGINEER

REVISIONS:

DESIGNED: JBM
DRAWN: JBM
CHECKED: PFH

KOONTZ-BRYANT, P.C.
A Full Service Civil Consulting Firm
1703 N PARHAM ROAD, SUITE 202
RICHMOND, VIRGINIA 23229
(804) 740-9200 FAX (804) 740-7338
kbpc@koontzbryant.com

CHRISTOPHER NEWPORT UNIVERSITY
NEWPORT NEWS VIRGINIA

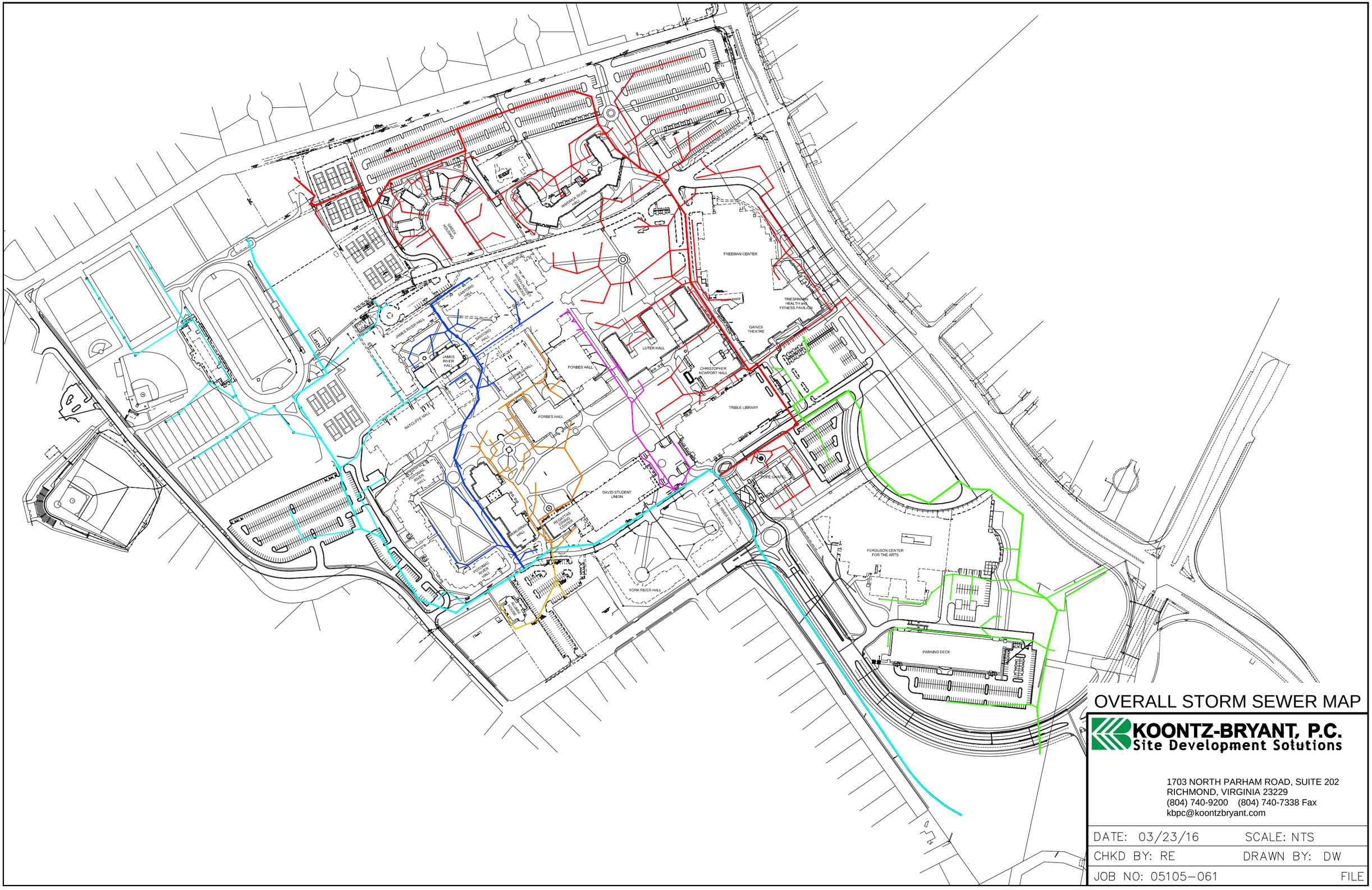
2011 UPDATED BOUNDARY AND IMPERVIOUS AREA

DATE: DECEMBER 21, 2011

SCALE: 1"= 150'

JN: 1585

4-3-1

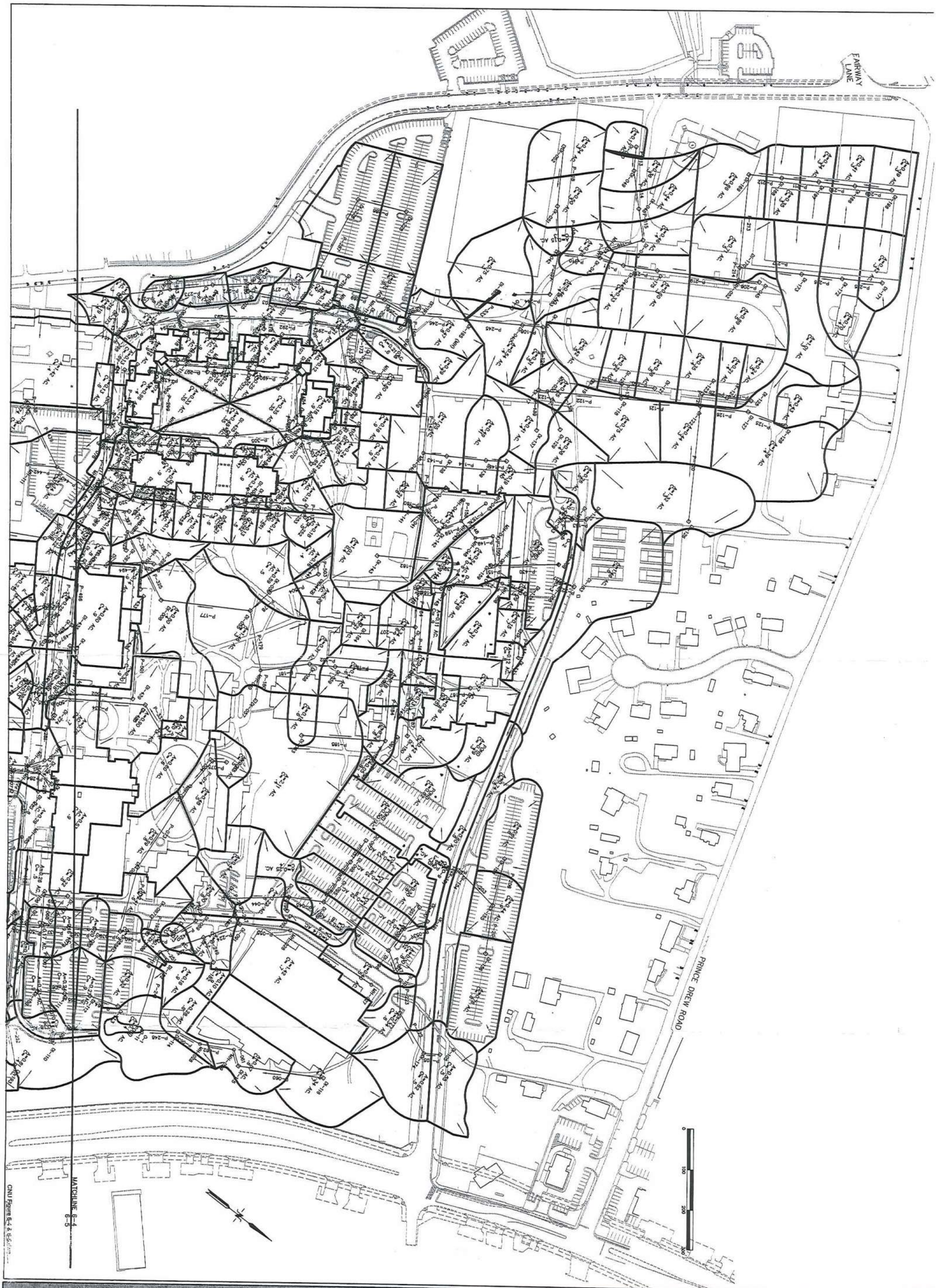


OVERALL STORM SEWER MAP

KOONTZ-BRYANT, P.C.
Site Development Solutions

1703 NORTH PARHAM ROAD, SUITE 202
RICHMOND, VIRGINIA 23229
(804) 740-9200 (804) 740-7338 Fax
kbpc@koontzbryant.com

DATE: 03/23/16	SCALE: NTS
CHKD BY: RE	DRAWN BY: DW
JOB NO: 05105-061	FILE



6-4

JN: 1585

SCALE: 1" = 100'

DATE: APRIL 30, 2002

CHRISTOPHER NEWPORT UNIVERSITY

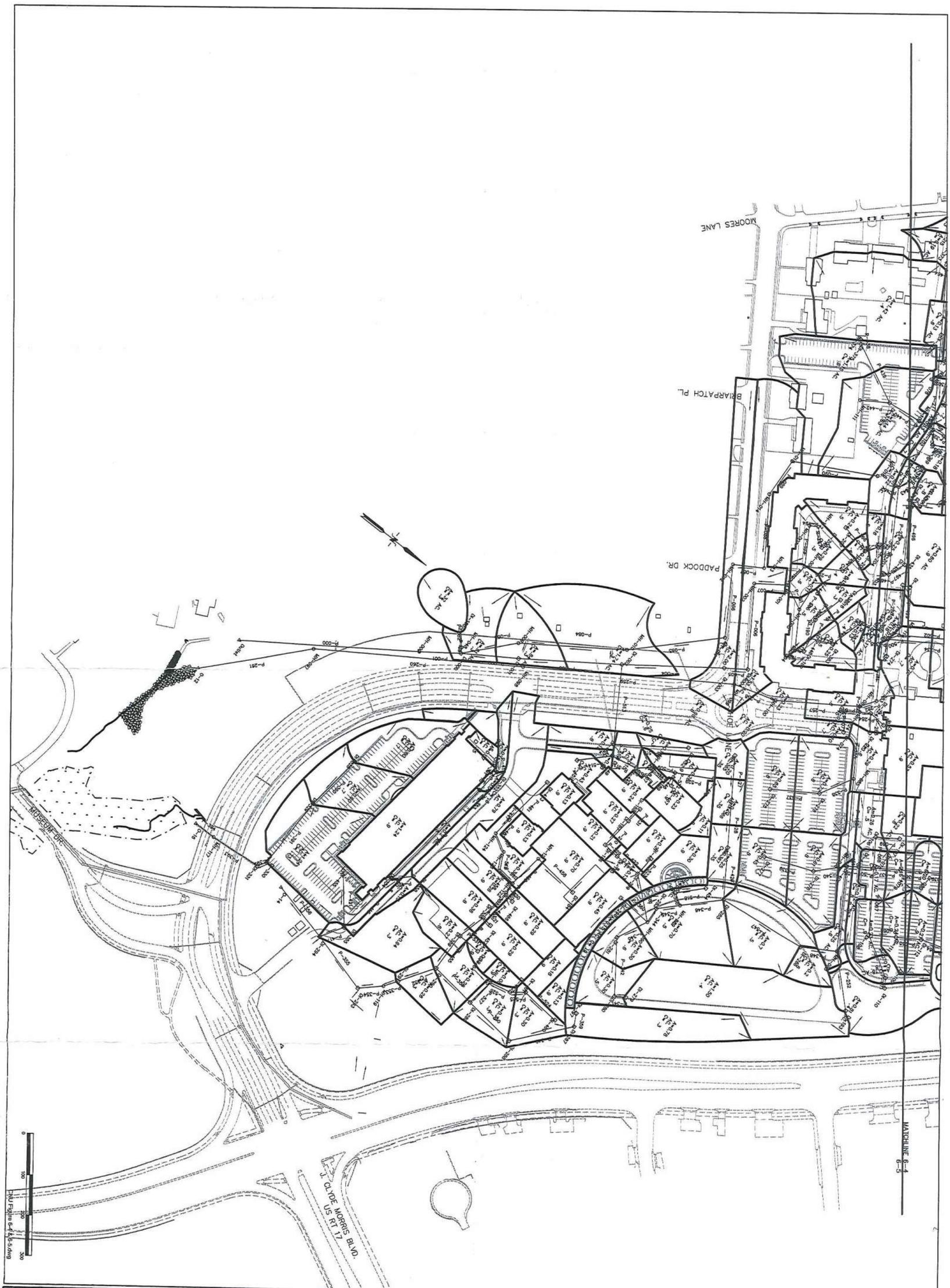
NEWPORT NEWS VIRGINIA

2008 "C" VALUES, DRAINAGE AREAS AND STORM SEWER

KOONTZ-BRYANT, P.C.
A Full Service Civil Consulting Firm
1703 N PARHAM ROAD, SUITE 202
RICHMOND, VIRGINIA 23229
(804) 740-9200 FAX (804) 740-7338
kbpc@koontzbryant.com

DESIGNED: WWW
DRAWN: VLS
CHECKED: PFH

REVISIONS:



6-5

JN: 1585

SCALE: 1" = 100

DATE: APRIL 30, 2002

CHRISTOPHER NEWPORT UNIVERSITY

NEWPORT NEWS VIRGINIA

2008 "C" VALUES, DRAINAGE AREAS AND STORM SEWER

KOONTZ-BRYANT, P.C.
A Full Service Civil Consulting Firm
1703 N PARHAM ROAD, SUITE 202
RICHMOND, VIRGINIA 23229
(804) 740-9200 FAX (804) 740-7338
kbpc@koontzbryant.com

DESIGNED: WWW
DRAWN: VLS
CHECKED: PFH

REVISIONS:

McCALLUM
TESTING LABORATORIES
Geotechnical Engineering, Materials Testing & Environmental Services

July 21, 2017

Christopher Newport University
c/o University Architect's Office
1 Avenue of the Arts
Newport News, Virginia 23606

Attention: **Michelle R. Campbell, R.A.**

Subject: **SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING**
Proposed Fine Arts Center and Marching Band Indoor Building Addition
Christopher Newport University
Newport News, Virginia
MTL Project #17-3513

Dear **Ms. Campbell**:

McCALLUM TESTING LABORATORIES is pleased to present this report of subsurface exploration and geotechnical engineering services for the above referenced project. Included in this report are:

1. A brief description of the project;
2. An outline of the services performed;
3. A tabulation of the subsurface conditions encountered; and
4. Our detailed recommendations for site preparation and the design and construction of foundations and ground slabs.

Should you have any questions concerning this report, please do not hesitate to contact this office at your earliest convenience.

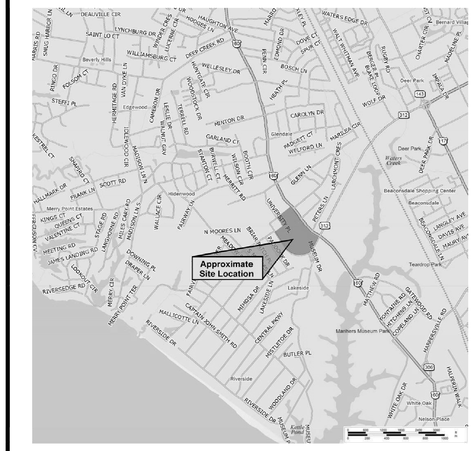
COMMONWEALTH OF VIRGINIA
JON W. EBBERT
Lic. No. 034560
7/21/17
PROFESSIONAL ENGINEER

Very truly yours,

McCALLUM TESTING LABORATORIES

JON W. EBBERT, P.E.
CHIEF ENGINEER

1808 HAYWARD AVENUE, CHESAPEAKE, VA. 23320 • P. O. BOX 13337, CHESAPEAKE, VA. 23325-0337
PHONE (757) 420-2520 • FAX (757) 424-2874

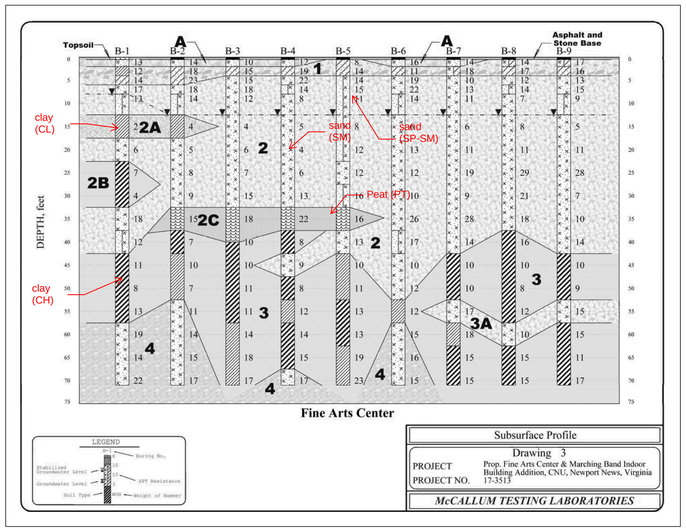


McCALLUM TESTING LABORATORIES

Scale:	As Shown	Approved By: Jon W. Ebbert, P.E.	Date: 7/21/17
Project:	Proposed Fine Arts Center and Marching Band Indoor Building Addition Christopher Newport University Newport News, Virginia		
Drawing Title:	Site Location Plan		Drawing Number: 1

McCALLUM TESTING LABORATORIES

Scale:	NTS	Approved By: Jon W. Ebbert, P.E.	Date: 7/21/17
Project:	Proposed Fine Arts Center and Marching Band Indoor Building Addition Christopher Newport University Newport News, Virginia		
Drawing Title:	Boring Location Plan		Drawing Number: 2



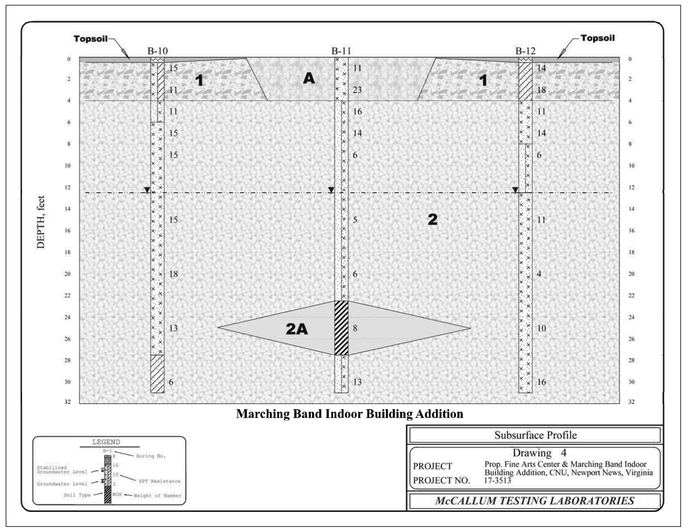
Fine Arts Center

LEGEND
Boring No.
Stabilized Groundwater Level
Groundwater Level
Soil Type
SPT Resistance
Weight of Hammer

Subsurface Profile

Drawing	3
PROJECT	Prop. Fine Arts Center & Marching Band Indoor Building Addition, CNU, Newport News, Virginia
PROJECT NO.	17-3513

McCALLUM TESTING LABORATORIES



Marching Band Indoor Building Addition

LEGEND
Boring No.
Stabilized Groundwater Level
Groundwater Level
Soil Type
SPT Resistance
Weight of Hammer

Subsurface Profile

Drawing	4
PROJECT	Prop. Fine Arts Center & Marching Band Indoor Building Addition, CNU, Newport News, Virginia
PROJECT NO.	17-3513

McCALLUM TESTING LABORATORIES

McCALLUM
TESTING LABORATORIES
Geotechnical Engineering, Materials Testing & Environmental Services

Unified Soil Classification System ASTM Designation D 2487		
Coarse Grained Soils (More than 50% of material retained on the No. 200 Sieve) — Gravels (more than 50% retained the No. 4 Sieve)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
Sands (more than 50% passing the No. 4 Sieve)	SW	Well graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
Fine Grained Soils (More than 50% of material passes on the No. 200 Sieve) — Silts & Clays (LL less than 50)	ML	Inorganic silts, very fine sands, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays
	OL	Organic silts and organic silty clays of low plasticity
Silts & Clays (LL greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, plastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity
Highly Organic Soil	PEAT	Peat and other highly organic soils

Standard Penetration Test (SPT) Resistance Correlations

Coarse Grained Soils
SPT vs. Relative Density

Blows/Ft	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Compact
31 - 50	Compact
Over 50	Very Compact

Fine Grained Soils
SPT vs. Consistency

Blows/Ft	Consistency
0 - 2	Very Soft
3 - 4	Soft
5 - 8	Medium Stiff
9 - 15	Stiff
16 - 30	Very Stiff
31 - 50	Hard
Over 50	Very Hard

GLAVÉ & HOLMES ARCHITECTURE
2101 East Main Street
Richmond, Virginia 23223
T 804 649 9303 F 804 343 3378
W www.glaveandholmes.com

PROJECT TITLE

CNU FINE ARTS CENTER

CHRISTOPHER NEWPORT UNIVERSITY

CONSULTANTS

CIVIL ENGINEER
Koontz Bryant Johnson Williams
1703 North Parham Road, Suite 202
Henrico, VA 23229
T (804) 740-9200
F (804) 740-7338
W www.kbjwgroup.com

STRUCTURAL ENGINEER
Lynch Mykins Structural Engineers
1503 Santa Rosa Road, Suite 210
Richmond, VA 23229
T (804) 346-3935
F (804) 346-1171
W www.lynchmykins.com

MEP ENGINEER
Mueller Associates
1306 Concourse Drive, Suite 100
Linthicum, MD 21090
T (410) 646-4500
F (410) 646-4738
W www.muellerassociates.com

A/V ENGINEER
Miller Beam Paganelli, Inc.
12040 South Lakes Drive, Suite 104
Reston, VA 20191
T (703) 506-0005
F (703) 506-0009
W www.millerbp.com

FIRE PROTECTION
GHD Engineers
121 North 20th Street, Suite A
Richmond, VA 23223
T (804) 237-0300
F (703) 506-0009
W www.ghd.com

SEAL

COMMONWEALTH OF VIRGINIA
GREGORY A. KOONTZ
Lic. No. 16613
10/17/18
PROFESSIONAL ENGINEER

PROJECT NUMBER
G&HA#: 16029
PC#: 242-18086-000
WO#: XX

DATE
OCTOBER 17, 2018

DRAWN BY: DFW APPROVED BY:

REVISIONS

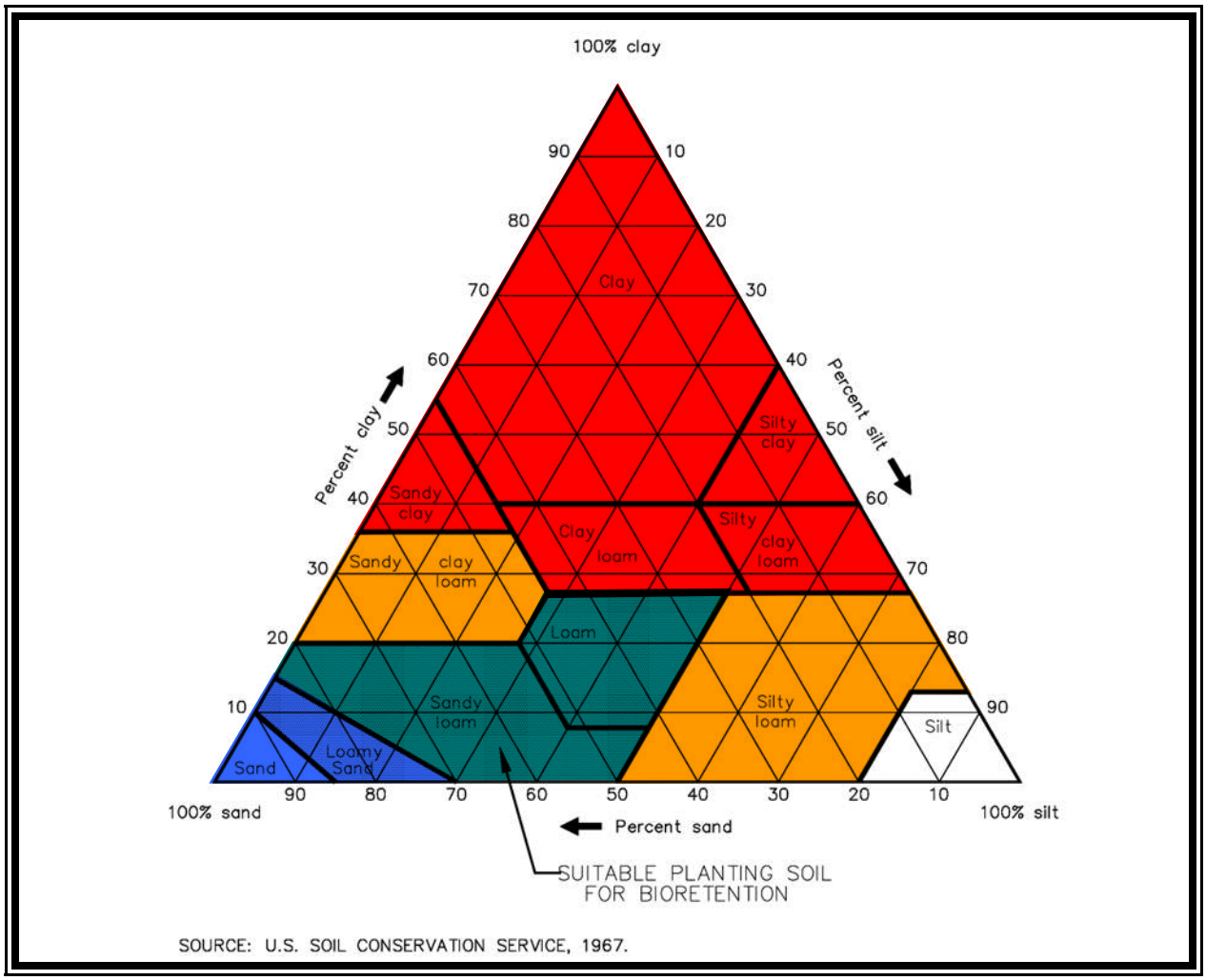
NO.	DATE	DESCRIPTION

SHEET TITLE
BORING REPORT

SHEET NUMBER
B1.0

Soil textures with infiltration rates ***less than 0.52 inches per hour*** *or greater than* ***8.27 inches per hour*** *are* ***not*** ***suitable*** *for infiltration practices.*

FIGURE 3.10 - 2
USDA Textural Triangle



Soils that have a 30% clay content are unacceptable for use with infiltration facilities since they are structurally unstable and susceptible to frost heaving. Similarly, soils that have poor percolation capabilities or excessively drained soils, such as sand, should not be used for infiltration purposes. The soil textures presented in **Table 3.10-2** correspond to the soil textures of the U.S. Department of Agriculture (USDA) Textural Triangle presented in **Figure 3.10-2**. It should be noted that the

difference in soil textures of sand and loamy sand are the percentages of clay found in the soil. While the actual percent of difference is small, a significant difference in infiltration rates can be expected. Note that actual permeability tests may indicate infiltration rates different from those in **Table 3.10-2**.

Predicting the exfiltration of water from an infiltration facility is difficult, especially over an extended period, such as the desired life expectancy of the facility. A factor of safety should be applied in the design to ensure that the facility is sized to function even when partially clogged. (This is discussed further in the **General Design Criteria** presented later in this section.)

TABLE 3.10 - 2
Hydrologic Soil Properties Classified by Soil Texture

Texture Class	Effective Water Capacity (C_w) (inch per inch)	Minimum Infiltration Rate (*f*) (inch per hour)	Hydrologic Soil Grouping
Sand	0.35	8.27	A
Loamy Sand	0.31	2.41	A
Sandy Loam	0.25	1.02	B
Loam	0.19	0.52	B
Silt Loam	0.17	0.27	C
Sandy Clay Loam	0.14	0.17	C
Clay Loam	0.14	0.09	D
Silty Clay Loam	0.11	0.06	D
Sandy Clay	0.09	0.05	D
Silty Clay	0.09	0.04	D
Clay	0.08	0.02	D

2. **Depth to the seasonal high groundwater table and bedrock**.

Typically, infiltration facilities are not recommended in areas with a high groundwater table due to the inability of the soil to adequately filter out pollutants before the stormwater enters the water table. A distance of **2** to **4** feet is required between the bottom of an infiltration