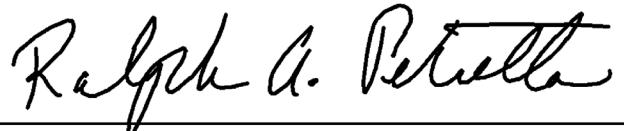


ENGINEERING REPORT

**Parking Lot Expansion
At
Princeton Forrestal Center
Block 701, Lot 31
Plainsboro Township
Middlesex County, New Jersey**

Prepared For:
**The Research Collections and Preservation Consortium
Princeton, New Jersey 08540**



Ralph A. Petrella
New Jersey Professional Engineer #46160
VNHA #45181
July 24, 2024

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I. INTRODUCTION

I. INTRODUCTION

In 2008, the Research Collections and Preservation Consortium (RECAP) submitted a site plan application (Application P08-17 & P11-17) for the construction of four (4) additional storage modules, Modules 8 through 11, at the existing site located on the James Forrestal Campus (Campus) of Princeton Forrestal Center (PFC). This application was conditionally approved by Plainsboro Township and outside regulatory agencies. Since this time, RECAP amended the previous application to receive approval for the construction of three (3) additional storage modules, Modules 8 through 10. Modules 8 & 9 were constructed, while the construction of Module 10 was deferred to a future date. In March of 2022, RECAP began the process of moving forward with construction for Module 10. With construction activities for Module 10 have generally been complete, as of this report, RECAP has determined there is a need for more parking spaces for their site. Project site is situated on Block 701 Lot 31 in the Township of Plainsboro, County of Middlesex, New Jersey and is shown on Tax Map Sheet 7. The Project site is bounded by Lot 29 to the north & west, Lot 30 & Lot 32.04 to the east, and Lot 32.03 to the south.

In order to accommodate more parking for the site, six (6) additional parking spaces are proposed to be added to the existing 26 space parking lot. The project includes the addition of three (3) 9'X18' parking spaces on both sides of the parking lot extending in the westerly direction towards Forrestal Road South. Other improvements include modification of the existing sidewalk and landscaping.

To supplement the existing regional stormwater management facility (Basin 'G'), Basin 'G2' was approved and constructed per DRCC Certificate of Approval #10-3969 with an impervious area credit of 33.68 acres to account for future build out. This basin is sized to meet current stormwater management quantity and quality criteria. Basin 'G2' is located on the East side of Campus Road. All runoff passing through the existing dual 36" pipe culvert under Campus Road discharges into Basin 'G2'. Discharge from Basin 'G2' directs runoff back to the original discharge point into the existing PFC Basin 'G'. The stormwater calculations (not part of this application) for Basin 'G2' include, but not limited to full build out of RECAP on both Lots 30 and 31, a portion of Lot 29 and Lot 32. At the time of the start of construction of Module 10, the impervious area credit remaining is 11.78 acres. In comparison, the proposed project will increase the impervious cover by approximately 0.02 acres.

II. STORMWATER MANAGEMENT

II. STORMWATER MANAGEMENT

A. LAND USE/LAND COVER ANALYSIS

This section demonstrates the ability of the Project's stormwater management system to mitigate the runoff anticipated from the proposed development of the site in its developed condition.

EXISTING PROJECT SITE DESCRIPTION AND METHODOLOGY

The total project stormwater management drainage area is approximately 22.7 acres (see Drainage Area Maps Appendix C). As described previously, the project site is located in the Township of Plainsboro. The current land use/cover within the drainage area is a combination of existing buildings, roadways, a parking lot, and open space.

According to the "Soil Survey Geographic Database" (SSURGO) for Middlesex County, New Jersey, the project site soils consist of Nixon-Urban land complex, 0 to 5% slopes; Nixon moderately well drained variant loam; and Nixon Loam, 0 to 2% slopes. Nixon is considered a Hydrologic Soil Group (HSG) Type B soil, while Urban land is unclassified and makes up 55% of the drainage area, but 100% of the proposed parking spaces.

The RECAP facility is located within the Campus East Tributary Sub-Area. As such, the site is included within a center-wide stormwater management plan previously approved by Plainsboro Township and the Delaware & Raritan Canal Commission (DRCC) in the early 1980's. Stormwater management for the Campus East Tributary Sub-Area is handled through the regional Basin 'G' and Basin 'G2', which provide flood control and water quality through temporary detention of stormwater runoff. The approved overall stormwater master plan anticipated development of this area of Princeton Forrestal Center with an allocation of 60% impervious surfaces over and above the existing impervious surface that existed at that time.

Currently, there is an impervious credit of 11.78 acres within the Campus East Tributary Sub-Area for future development. This impervious credit includes the construction of Modules 6 and 7 (previously approved, not yet constructed), which requires the demolition of the Gas Dynamics building. See Table 1B in the Proposed Project Site Description for the impervious credit progression since the Original Stormwater Management Plan in 1980. The new impervious credit after the proposed development will be 11.76 acres.

PROPOSED PROJECT SITE DESCRIPTION AND METHODOLOGY

The current improvements to the site are consistent with the anticipated development of this parcel under the Princeton Forrestal Center stormwater management approvals previously granted. Basin 'G2' provides full compliance with the current stormwater management water quantity and quality regulations.

The proposed Project improvements is for the addition of six (6) parking spaces and corresponding sidewalk update in Lot 31. These proposed improvements add 972 square feet (0.02 acres) impervious area on site.

A comparison of existing versus proposed impervious coverage within the project area is provided in the following table:

Table 1A - Impervious Coverage		
	Module 10	
	Square Feet	Acres
Existing Conditions	329,314	7.56
Proposed Conditions	330,286	7.58
Impervious	+972	+0.02

See the table below for the impervious credit progression since the Original Stormwater Management Plan.

Table 1 – Basin G-2: Impervious Coverage Balance			
Project	Impervious Credit (Acres)	Proposed Impervious Debit (-)/Credit (+) (Acres)	Impervious Credit Remaining (Acres)
Basin G-2 (Res. No. P10-09)	+39.60 (60% Maximum Impervious Cover Design Criteria)	-5.92 (Existing/Initial Impervious Cover*)	+33.68
RECAP Modules 5-7 (Res. No. P06-05)	+33.68	-0.27 ²	+33.41
RECAP Modules 8-10 (Res. No. P11-17)	+33.41	-1.25	+32.16
Forrestal Road South/ B-Site Connector Road (Res. No. P11-03)	+32.16	-1.10	+31.06
Medical Arts Building/ Forrestal Lot A (Res. No. P12-04)	+31.06	-2.72	+28.34
Forrestal Lot B (Res. No. P15-12)	+28.34	-2.45	+25.89
Forrestal Lot C (Res. No. P14-12)	+25.89	-5.20 ³	+20.69
Lifetime Fitness/ Forrestal Lot D (Res. No. P16-08)	+20.69	-8.91 ⁴	+11.78
Addition of six (6) parking spaces and Sidewalk update on Lot 31	+11.78	-0.02	<u>+11.76</u>

*Existing conditions = prior to construction of RECAP Module 5.

** Impervious lot coverage is a rough approximation and should be used as an estimate only

Basin 'G2' was designed for water quantity and quality requirements assuming a total impervious surface of 39.6 acres will be built in the future. Since that time, approximately 27.82 acres of the 39.6 acres credit has been built, with the remaining future impervious improvements credit being 11.78 acres. The current

addition of 6 new parking spaces will generate 0.02 acres of new impervious surface. The remaining future impervious improvements credit will be 11.76 acres. As there is still a large credit of impervious surfaces that can be built within the drainage area of basin 'G2', the water quantity and quality regulations are addressed.

B. STORMWATER QUANTITY/QUALITY

As discussed above, the Project is part of a larger drainage tributary area to a supplemental stormwater management system, known as Basin 'G2'. The runoff from the roadway culverts that receive runoff from the RECAP project discharge directly to basin 'G2' for treatment. Basin 'G2' has been designed to meet the current stormwater management regulations for both quantity control and quality treatment of runoff from the full build out of its drainage area.

Addition of six (6) parking spaces in the existing parking lot will result in an increase of impervious surfaces of 0.02 acres. This is a negligible increase in relation to the 22.7-acre drainage area (0.09% of the drainage area). The increase of 0.02 acres will reduce the impervious credit to Basin 'G2' to 11.76 acres from 11.78 acres. Therefore, the water quantity requirements for the project have been met.

As previously noted, Basin 'G2' was designed to provide water quality in addition to water quantity. It should be noted that there is no differentiation between vehicular and non-vehicular impervious surfaces in the overall impervious credit that will drain to Basin 'G2'. For the overall approval for the construction of Modules 8-10 (same drainage area as for the 6 new parking spaces), the existing vehicular pavement area was reduced by 0.87 acres, enhancing water quality for the drainage area. Including the new parking space impervious surface of 0.02 acres, there would still be a 0.85-acre (0.87 – 0.02) reduction of vehicular pavement or enhancement of water quality with the drainage area. Not accounting for the vehicular pavement reduction, Basin 'G2' was designed for water quality measures and this project's impervious surface of 0.02 acres falls well within the 11.78 impervious area credit. Therefore, the water quality requirements have been met.

C. GROUNDWATER RECHARGE

The groundwater recharge standards at N.J.A.C. 7:8-5.5 and the Township's ordinance applies for any project that disturbs at least one acre of land since February 2, 2004, or increases impervious surface by 0.25 acres since March 2, 2021. As previously indicated above, the proposed project has disturbed over one acre of land since February 2, 2004. Therefore, the recharge requirements apply.

In accordance with NJDEP Stormwater Management Rules (N.J.A.C. 7:8) and the Best Management Practices Manual, groundwater recharge for the site is required such that post-development groundwater recharge meets pre-development groundwater recharge conditions by way of the following:

- Maintain 100% of the site's average annual pre-developed groundwater recharge volume.

During the approval process of Modules 8-10 as well as the Forrestal Road South extension project, compliance with the groundwater recharge requirement was verified through a hydrologic and hydraulic analysis of the site in its existing and proposed conditions utilizing the New Jersey Groundwater Recharge Spreadsheet (NJGRS-32). The design provided for a recharge bed with a total section of 24" thick, consisting of 12" diameter perforated pipes, with 6" of stone around the perimeter of the pipes with 12" spacing between the pipes and an overall footprint of 1,160 square feet (sf) was installed. The design was approved per DRCC Certificate of Approval #11-3422B, which noted a recharge bed with the noted section would need to have a minimum area of 1,096.1 sf, where 1,160 sf was provided. The recharge bed provides more recharge than was required for the Module 8-10 improvements. For the 6 new parking space project, the original NJGRS-32 spreadsheet was modified to assume the 0.02 acres of impervious surface for the new spaces was constructed as part of the Module 8-10 project to determine if the existing recharge bed area is equal to or greater than the area required. The modified

NJGRS-32 reflects a recharge bed with an area of 1,117.9 sf would be required compared to the 1,096.1 sf required for the original project. The existing recharge bed has an area of 1,160 sf, which is still greater than the 1,117.9 sf required. As the existing recharge bed is greater than required by the NJGRS-32, the groundwater recharge requirements have been met. A copy of the previously approved and modified NJGSR-32 spreadsheets can be found in Appendices D of this report for reference.

D. NON-STRUCTURAL STORMWATER MANAGEMENT STRATEGIES

In accordance with N.J.A.C. 7:8-5.2(a) and the Township's ordinance 85-28.1D (5b), the design of any development that disturbs at least one acre of land since February 2, 2004, or increases impervious surface by 0.25 acres since March 2, 2021, must incorporate non-structural stormwater management strategies. Since this project has disturbed more than one acre of land since February 2, 2024, non-structural stormwater management strategies must be incorporated into the design of the site.

To assist in determining that the non-structural stormwater management strategies have been incorporated into the site design "to the maximum extent practical," the New Jersey Department of Environmental Protection has developed the New Jersey Non-structural Stormwater Management Strategies Point System (NSPS) spreadsheet. The NSPS is a tool that quantifies the level of non-structural strategies utilized in the design of a site. Refer to the appendix for a copy of the NSPS, demonstrating that sufficient use of non-structural strategies has been incorporated into the design of this site.

Similar to the groundwater recharge requirements, the previously approved NSPS spreadsheet for the Modules 8-10 project was modified to include the 0.02 acres associated with the new parking spaces as if they were included in the original design. The previously approved NSPS noted 226 total existing site points with a 107% Ratio of Proposed to Existing Site Points where a 95% site points ratio was required. Even with the inclusion of the 0.02 acres of proposed new impervious surface included into the NSPS spreadsheet there is no change to the results. There is 107% Ratio of Proposed to Existing Site Points where 95% is required. The results show the Non-structural stormwater Management Strategies have been met.

E. SOIL EROSION AND SEDIMENT CONTROL

The soil disturbance on the site is less than 5000 square feet, so the Soil Erosion and Sediment Control Plan is not required based on the current Standards for Soil Erosion and Sediment Control of New Jersey.

F. REVIEW AGENCIES

1. Plainsboro Township Planning Board, Minor Site Plan (original P11-17 approved 10/17/2011 with 15-year extended vesting; Still valid)
2. Middlesex County Planning Board, Site Plan approval. (original PL-SP-65 approved 1/17/2021; tied to Municipal Approval; Still Valid)
3. Delaware and Raritan Canal Commission, project certification. Current application for Module 10 only

G. PROJECT SITE SOIL TYPES

1. NkpB Nixon-Urban land complex, 0 to 5% slopes; Type B Soil/Unclassified,

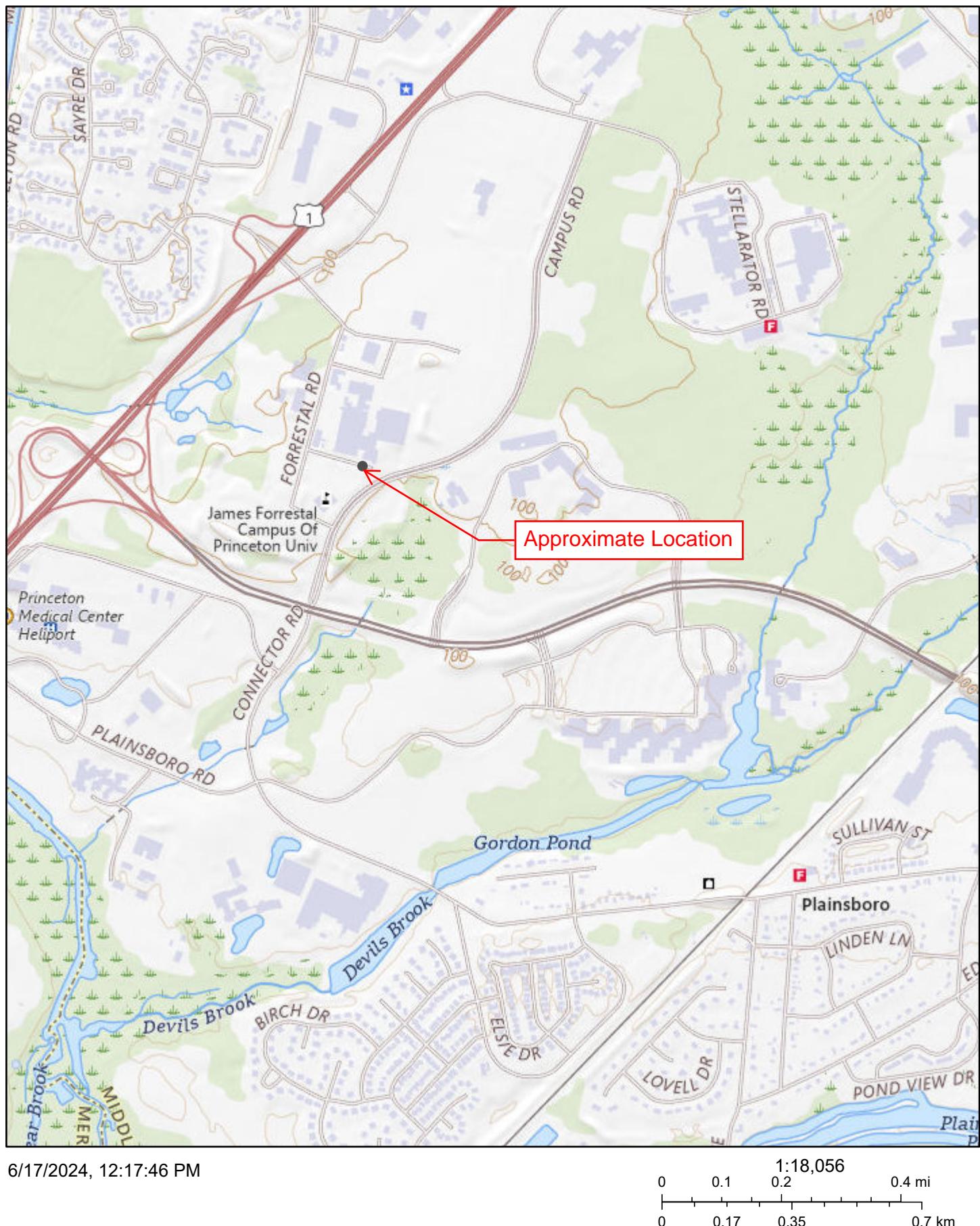
H. REFERENCES

1. Blick, S.A., F. Kelly, and J.J. Skupien. April 2004. New Jersey Stormwater Best Management Practices Manual. New Jersey Department of Environmental Protection, Division of Watershed Management. Trenton, New Jersey.

2. New Jersey Department of Agriculture. November 2000. Standards for Soil Erosion and Sediment Control in New Jersey. State Soil Conservation Committee. Trenton, New Jersey.
3. Plainsboro Township, Code of the Township of Plainsboro.
4. United States Department of Agriculture, Natural Resource Conservation Service. May 24, 1999. Soil Survey Geographic (SSURGO) Database for Middlesex County, New Jersey. United States Department of Agriculture, Natural Resource Conservation Service. Fort Worth, Texas.

APPENDIX A
USGS PROJECT SITE LOCATION MAP

The National Map Advanced Viewer



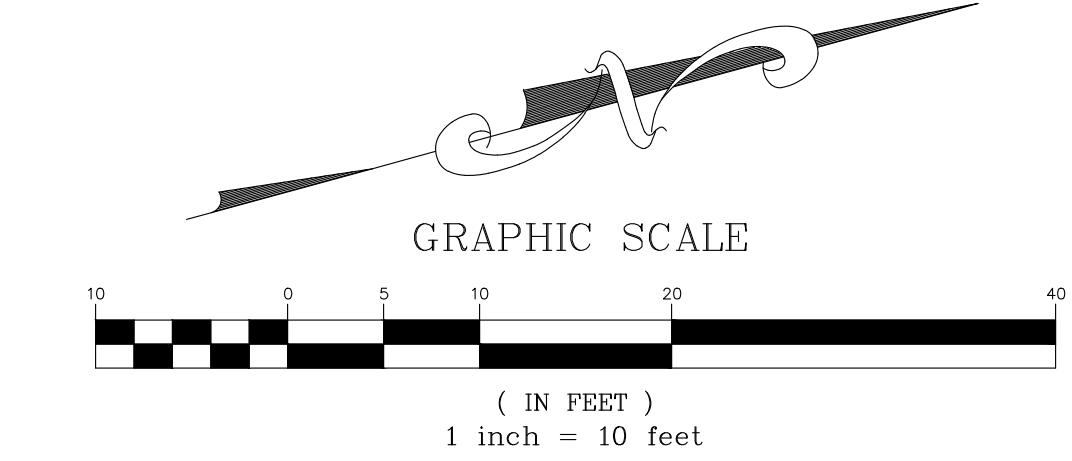
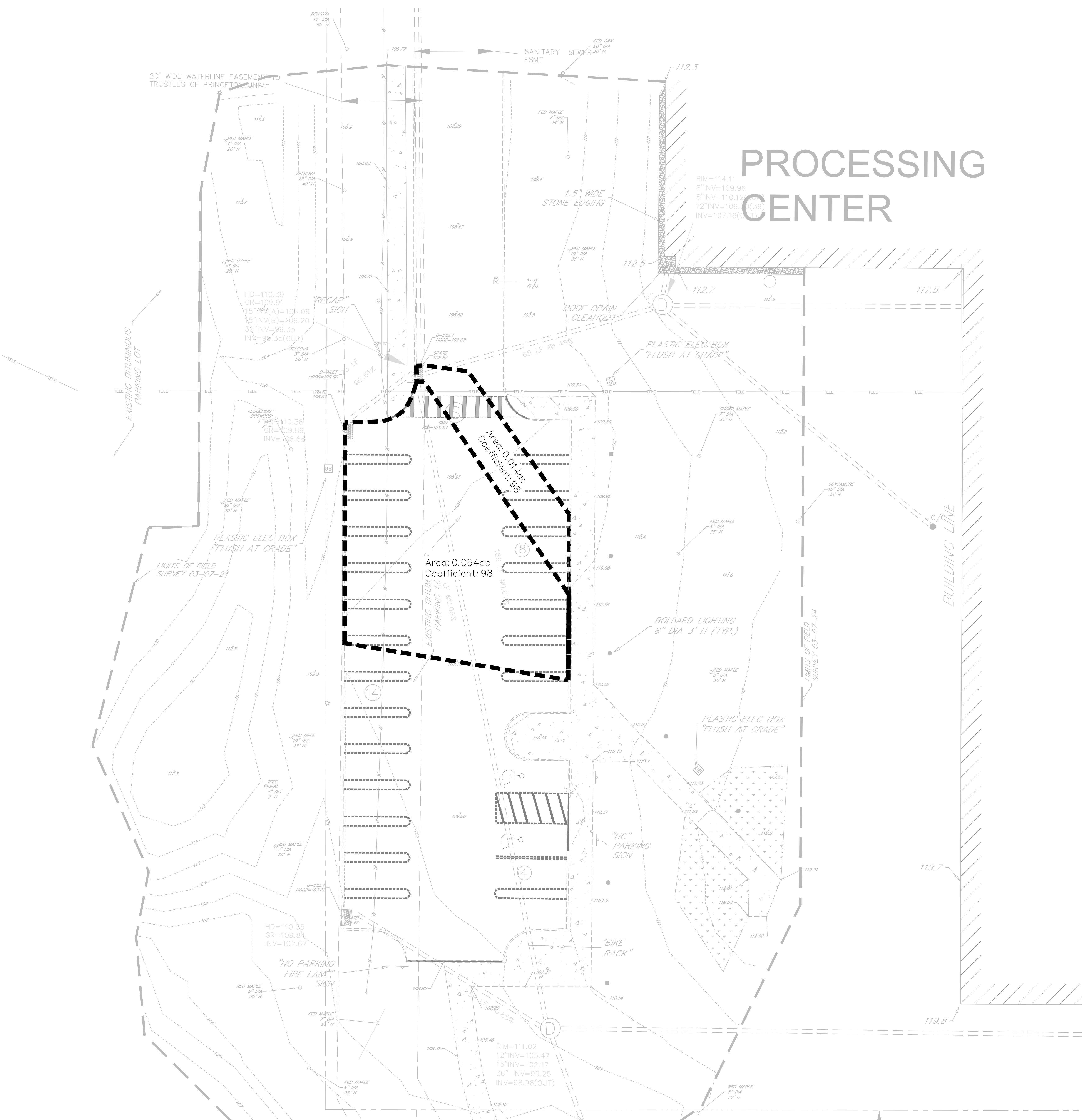
USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road data; Natural Earth Data; U.S.

APPENDIX B
DRAINAGE AND IMPERVIOUS AREA MAPS

PRE-DA
DRAINAGE AREA: 0.174ac
IMPERVIOUS AREA: 0.174ac

DA-1: 0.014ac
DA-2: 0.064ac

PROCESSING CENTER



REV.	DESCRIPTION	DATE	DFT.BY	CKD.BY
 <u>07/24/24</u> <small>DATE OF SIGN.</small>				
RALPH A. PETRELLA N.J. PROFESSIONAL ENGINEER LIC. NO. GE 46160				
van note-harvey associates, inc. consulting engineers, planners & land surveyors 103 College Road East • Princeton, NJ 08540 • 609-987-2323 211 Bayberry Drive • Cape May Court House, NJ 08210 • 609-465-2600 www.vannoteharvey.com Certificate of Authorization No. 24GA28271300				
 van note-harvey associates - Since 1894 -				
EXISTING DRAINAGE AREA MAP OF PARKING LOT EXPANSION PREPARED FOR THE RESEARCH COLLECTIONS AND PRESERVATION CONSORTIUM SITUATED IN PLAINSBORO TOWNSHIP SCALE 1" = 10'				
MIDDLESEX CO., N.J. JULY 24, 2024				
DRAWN BY KAP DATE 07/24/24	FIELD BK PAGE	ORDER No. 45181- 800-01	FILE No.	SHEET No. DA-1
CHECKED BY RAP DATE 07/24/24				

PRE-DA
DRAINAGE AREA: 0.88ac
IMPERVIOUS AREA: 0.88ac

DA-1: 0.014ac
DA-2: 0.029ac
DA-3: 0.045ac

PIPE-SIZE CHECK:

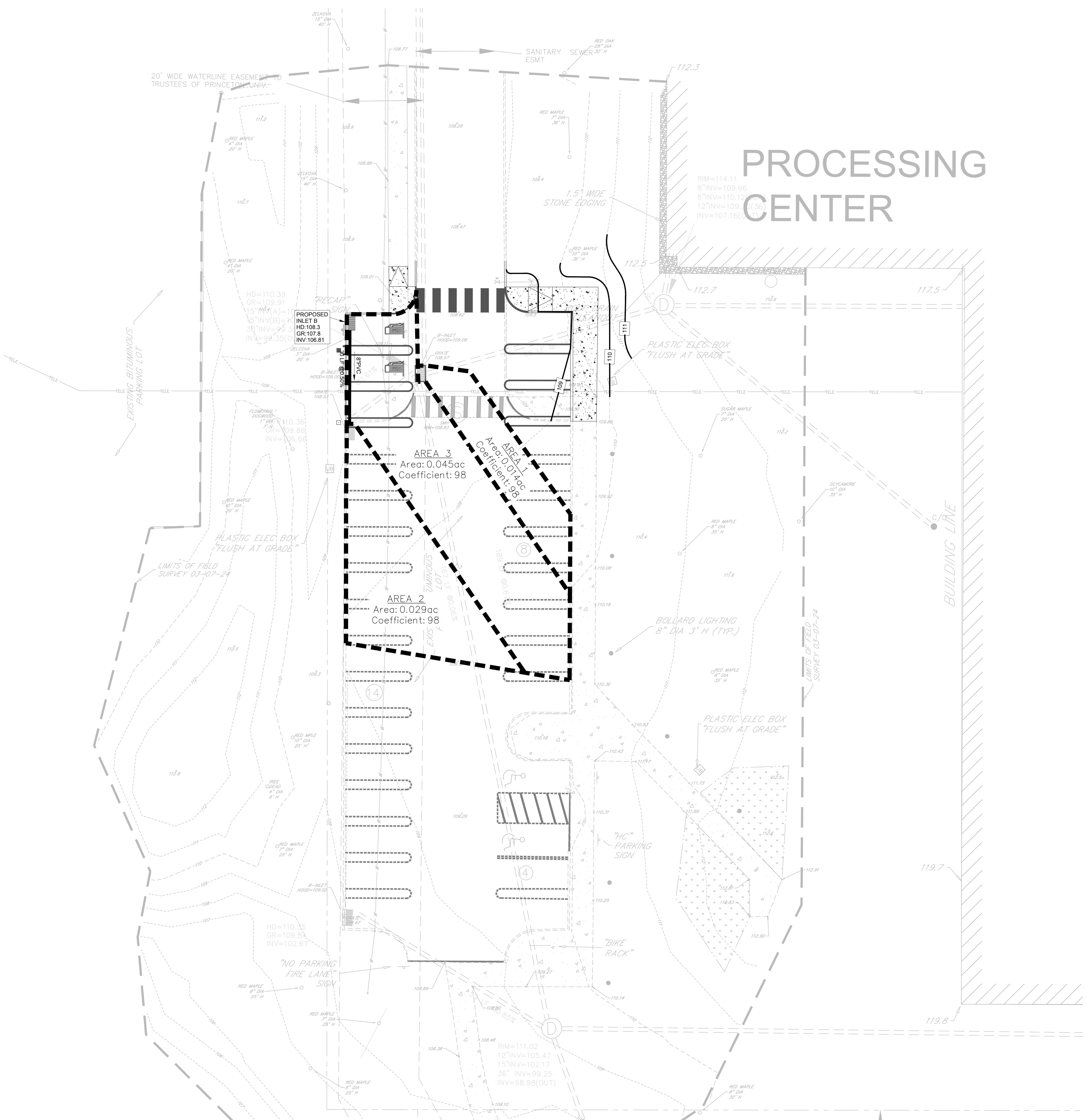
DA-1: NO CHANGE TO THE DRAINAGE AREA. EXISTING PIPE SIZING SHOULD BE SUFFICIENT.

DA-2: DRAINAGE AREA SIZE HAS DECREASED. EXISTING PIPE SIZING SHOULD BE SUFFICIENT.

DA-3

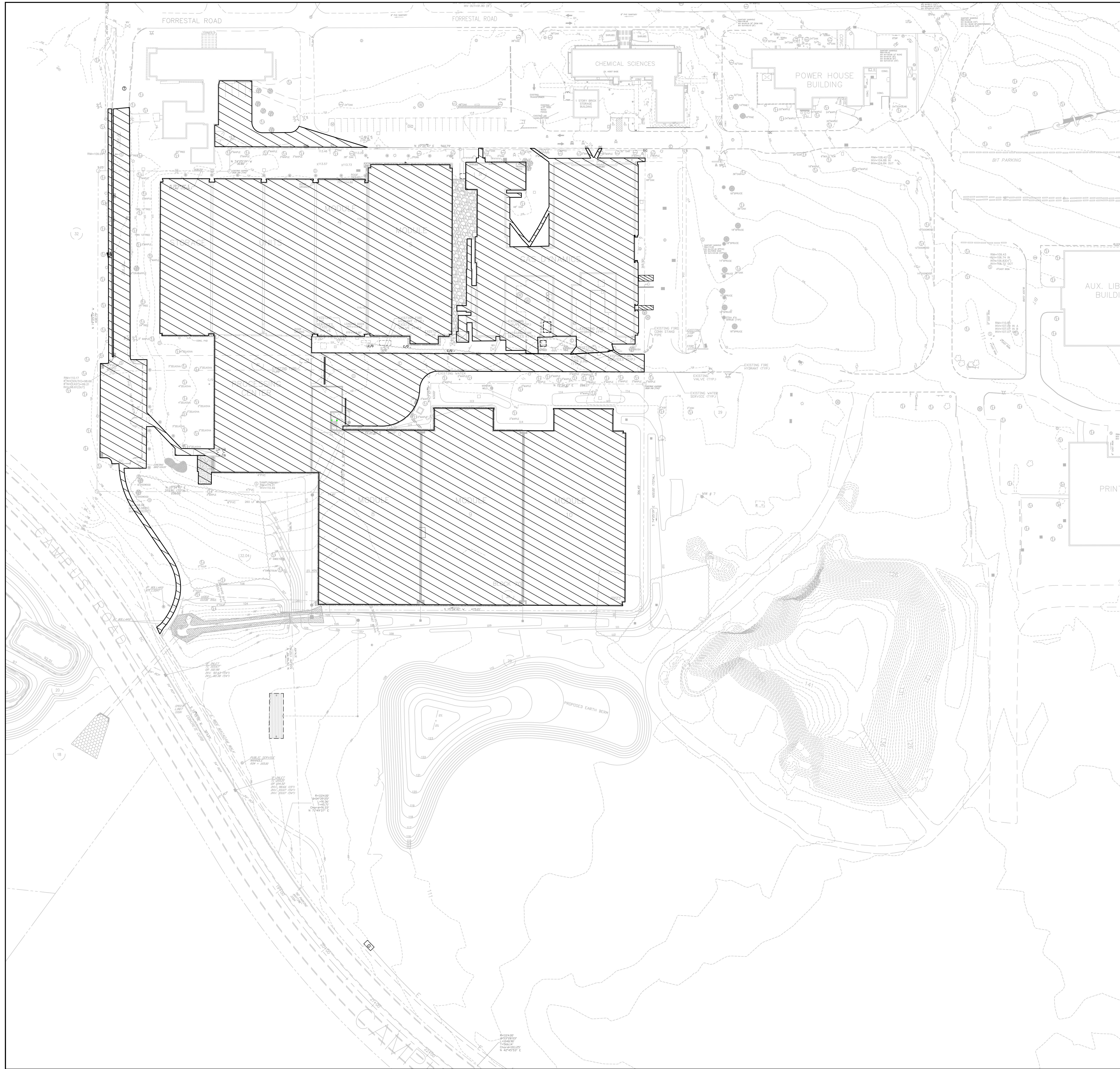
Q = CiA
Q = (0.99)(7.21 in/hr)(0.045 ac)
Q = 0.321 CFS

Q = $(1.49/n)AR^{(2/3)}S^{(1/2)}$
0.321 = $(1.49/0.009)AR^{(2/3)}(0.005)^{(1/2)}$
Radius = 2.41 in, Diameter = 4.82 in
Proposed Pipe Diameter = 8 inch



REV.	DESCRIPTION	DATE	DFT.BY	CKD.BY
Ralph A. Petrella 07/24/24 DATE OF SIGN				
RALPH A. PETRELLA N.J. PROFESSIONAL ENGINEER LIC. NO. GE 46160				
PROPOSED DRAINAGE AREA MAP OF PARKING LOT EXPANSION PREPARED FOR THE RESEARCH COLLECTIONS AND PRESERVATION CONSORTIUM SITUATED IN PLAINSBORO TOWNSHIP MIDDLESEX CO., N.J. SCALE 1" = 10'				
van note-harvey associates, inc. consulting engineers, planners & land surveyors 103 College Road East • Princeton, NJ 08540 • 609-987-2323 211 Bayberry Drive • Cape May Court House, NJ 08210 • 609-465-2600 www.vannoteharvey.com Certified Authorization Since 1944				
KAP FIELD BK ORDER NO. FILE NO. SHEET NO. DA-2				
DATE 07/24/24 PAGE 45181-800-01				
CHECKED BY RAP DATE 07/24/24				

EXISTING IMPERVIOUS AREA MAP
7.56 Ac. IMPERVIOUS AREA



GRAPHIC SCALE
(IN FEET)
1 inch = 50 ft.

REV.	DESCRIPTION	DATE	DFT.BY	CKD.BY
<i>Ralph A. Petrella</i>				
07/24/24				
EXISTING IMPERVIOUS AREA MAP OF PARKING LOT EXPANSION PREPARED FOR THE RESEARCH COLLECTIONS AND PRESERVATION CONSORTIUM SITUATED IN				
PLAINSBORO TOWNSHIP		MIDDLESEX CO., N.J.		
SCALE 1" = 10'		DATE 07/24/24		
KAP	FIELD BK	ORDER NO.	FILE NO.	SHEET NO.
DATE 07/24/24	PAGE	45181-	800-01	DA-3
checked by RAP DATE 07/24/24				

RALPH A. PETRELLA
N.J. PROFESSIONAL ENGINEER LIC. NO. GE 46160

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consulting engineers, planners & land surveyors
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211 Bayberry Drive • Cape May Court House, NJ 08210 • 609-465-2600
www.vannoteharvey.com Certified Authorization
by Association of Professional Surveyors and Land Surveyors of New Jersey



EXISTING IMPERVIOUS AREA MAP
OF
PARKING LOT EXPANSION
PREPARED FOR
THE RESEARCH COLLECTIONS AND
PRESERVATION CONSORTIUM
SITUATED IN

PLAINSBORO TOWNSHIP MIDDLESEX CO., N.J.

SCALE 1" = 10'

DATE 07/24/24

KAP FIELD BK ORDER NO. FILE NO.

45181- 800-01 DA-3

APPENDIX C

NEW JERSEY GROUNDWATER RECHARGE SPREADSHEET (NJGRS)

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓		Average Annual P (in)	Climatic Factor
MIDDLESEX CO., PLAINSBORO TWP		44.9	1.43
Pre-Developed Conditions			
Land Segment	Area (acres)	TR-55 Land Cover	
1	16.15	Open space	
2	0.6	Gravel, dirt	
3	5.93	Impervious areas	
4	0		
5	0		
6	0		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		
Total = 22.7		Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
		10.0	822,947

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

Project Name: RECAP- 6 Parking Spaces

Description: 45181

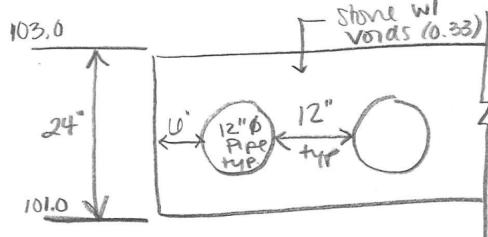
Analysis Date: 06/10/24

Post-Developed Conditions							
Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)		
1	14.88	Open space	Nixon	13.7	739,187		
2	0.47	Gravel, dirt	Nixon	9.5	16,192		
3	7.33	Impervious areas	Nixon	0.0	-		
4	0						
5	0						
6	0						
7	0						
8	0						
9	0						
10	0						
11	0						
12	0						
13	0						
14	0						
15	0						
Total = 22.7				Total Annual Recharge (in)	Total Annual Recharge (cu.ft)		
				9.2	755,379		
% of Pre-Developed Annual Recharge to Preserve =				100%	Total Impervious Area (sq.ft) 319,295		
Post-Development Annual Recharge Deficit= 67,568 (cubic feet)							
Recharge Efficiency Parameters Calculations (area averages)							
RWC= 4.62 (in)		DRWC= 0.00 (in)					
ERWC = 1.32 (in)		EDRWC= 0.00 (in)					

Recharge Area provided = 1160 SF > 1117.9 SF.
Therefore Adequate Recharge is Provided

Project Name	Description			Analysis Date	BMP or LID Type		
RECAP- 6 Parking Spaces	45181			06/10/24			
Recharge BMP Input Parameters		Root Zone Water capacity Calculated Parameters				Recharge Design Parameters	
BMP Area	ABMP	1117.6	sq.ft	Empty Portion of RWC under Post-D Natural Recharge	ERWC	1.32	in
BMP Effective Depth, this is the design variable	dBMP	11.0	in	ERWC Modified to consider dEXC	EDRWC	0.00	in
Upper level of the BMP surface (negative if above ground)	dBMPu	48.0	in	Empty Portion of RWC under Infilt. BMP	RERWC	0.00	in
Depth of lower surface of BMP, must be>=dBMPu	dEXC	72.0	in				
Post-development Land Segment Location of BMP , Input Zero if Location is distributed or undetermined	SegBMP	0	unitless				
				BMP Calculated Size Parameters		CALCULATION CHECK MESSAGES	
				ABMP/Aimp	Aratio	0.02	unitless
				BMP Volume	VBMP	1,024	cu.ft
Parameters from Annual Recharge Worksheet				System Performance Calculated Parameters			
Post-D Deficit Recharge (or desired recharge volume)	Vdef	67,568	cu.ft	Annual BMP Recharge Volume		67,568	cu.ft
Post-D Impervious Area (or target Impervious Area)	Aimp	66,200	sq.ft	Avg BMP Recharge Efficiency		100.0%	Represents % Infiltration Recharged
Root Zone Water Capacity	RWC	4.62	in	%Rainfall became Runoff		77.7%	%
RWC Modified to consider dEXC	DRWC	0.00	in	%Runoff Infiltrated		35.1%	%
Climatic Factor	C-factor	1.43	no units	%Runoff Recharged		7.3%	%
Average Annual P	Pavg	44.9	in	%Rainfall Recharged		5.7%	%
Recharge Requirement over Imp. Area	dr	2.5	in				
<p>How to solve for different recharge volumes: By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and total proposed impervious area "Aimp" from the "Annual Recharge" sheet to "Vdef" and "Aimp" on this page. This allows solution for a single BMP to handle the entire recharge requirement assuming the runoff from entire impervious area is available to the BMP.</p> <p>To solve for a smaller BMP or a LID-IMP to recharge only part of the recharge requirement, set Vdef to your target value and Aimp to impervious area directly connected to your infiltration facility and then solve for ABMP or dBMP. To go back to the default configuration click the "Default Vdef & Aimp" button.</p>							

Proposed Recharge System Schematic



Ratio of void space to cross-sectional area:
 $= 0.44 \therefore dBMP = 0.44 \times 24'' = 11''$

Ground surface = 107.0 (MIN) $\left. \begin{array}{l} dBPU = 48'' \text{ down} \\ dEXC = 72'' \text{ down} \end{array} \right\}$
 Top of recharge bed = 103.0
 Bottom of recharge bed = 101.00

PREVIOUSLY APPROVED NJGSR32

New Jersey
Groundwater
Recharge
Spreadsheet
Version 2.0
November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
MIDDLESEX CO., PLAINSBORO TWP	44.9	1.43

Pre-Developed Conditions					
Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	16.15	Open space	Nixon	13.7	802,276
2	0.6	Gravel, dirt	Nixon	9.5	20,671
3	5.93	Impervious areas	Nixon	0.0	-
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	22.7			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				10.0	822,947

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

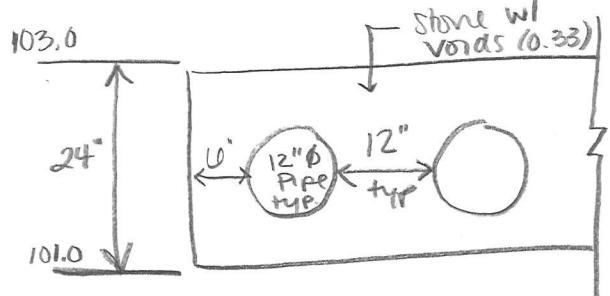
Project Name:	RECAP Mods 8-10
Description:	40349.400.21
Analysis Date:	07/13/11

Post-Developed Conditions					
Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	14.9	Open space	Nixon	13.7	740,181
2	0.47	Gravel, dirt	Nixon	9.5	16,192
3	7.31	Impervious areas	Nixon	0.0	-
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	22.7			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				10.0	822,947
Annual Recharge Requirements Calculation↓					9.2 756,373
% of Pre-Developed Annual Recharge to Preserve =					Total Impervious Area (sq.ft) 318,424
Post-Development Annual Recharge Deficit=					(cubic feet)
Recharge Efficiency Parameters Calculations (area averages)					
RWC=	4.62	(in)	DRWC=	0.00	(in)
ERWC =	1.32	(in)	EDRWC=	0.00	(in)

→ Recharge Area Provided = 1100sf > 1096.1sf required
 \therefore Adequate Recharge provided

Project Name	Description			Analysis Date			BMP or LID Type																
Recharge BMP Input Parameters				Root Zone Water capacity Calculated Parameters			Recharge Design Parameters																
Parameter	Symbol	Value	Unit	Parameter	Symbol	Value	Unit	Parameter	Symbol	Value	Unit												
BMP Area	ABMP	1096.1	sq.ft	Empty Portion of RWC under Post-D Natural Recharge	ERWC	1.32	in	Inches of Runoff to capture	Qdesign	0.18	in												
BMP Effective Depth, this is the design variable	dBMP	11.0	in	ERWC Modified to consider dEXC	EDRWC	0.00	in	Inches of Rainfall to capture	Pdesign	0.26	in												
Upper level of the BMP surface (negative if above ground)	dBMPu	48.0	in	Empty Portion of RWC under Infiltr. BMP	RERWC	0.00	in	Recharge Provided Avg. over Imp. Area		12.1	in												
Depth of lower surface of BMP, must be >= dBMPu	dEXC	72.0	in					Runoff Captured Avg. over imp. Area		12.1	in												
Post-development Land Segment Location of BMP, Input Zero if Location is distributed or undetermined	SegBMP	0	unitless																				
BMP Calculated Size Parameters																							
ABMP/Aimp		0.02	unitless	CALCULATION CHECK MESSAGES																			
BMP Volume		1,005	cu.ft	Volume Balance-> OK dBMP Check---> OK dEXC Check---> OK																			
Parameters from Annual Recharge Worksheet																							
Post-D Deficit Recharge (or desired recharge volume)	Vdef	66,574	cu.ft	Annual BMP Recharge Volume		66,574	cu.ft	BMP Location---> Location is selected as distributed or undetermined															
Post-D Impervious Area (or target Impervious Area)	Aimp	66,200	sq.ft	Avg BMP Recharge Efficiency		100.0%	Represents % Infiltration Recharged	OTHER NOTES															
Root Zone Water Capacity	RWC	4.62	in	%Rainfall became Runoff		77.7%	%	Pdesign is accurate only after BMP dimensions are updated to make rech volume= deficit volume. The portion of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations. Results are sensitive to dBMP, make sure dBMP selected is small enough for BMP to empty in less than 3 days. For land Segment Location of BMP if you select "impervious areas" RWC will be minimal but not zero as determined by the soil type and a shallow root zone for this Land Cover allowing consideration of lateral flow and other losses.															
RWC Modified to consider dEXC	DRWC	0.00	in	%Runoff Infiltrated		34.6%	%																
Climatic Factor	C-factor	1.43	no units	%Runoff Recharged		7.2%	%																
Average Annual P	Pavg	44.9	in	%Rainfall Recharged		5.6%	%																
Recharge Requirement over Imp. Area	dr	2.5	in																				
How to solve for different recharge volumes: By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and total proposed impervious area "Aimp" from the "Annual Recharge" sheet to "Vdef" and "Aimp" on this page. This allows solution for a single BMP to handle the entire recharge requirement assuming the runoff from entire impervious area is available to the BMP.																							
To solve for a smaller BMP or a LID-IMP to recharge only part of the recharge requirement, set Vdef to your target value and Aimp to impervious area directly connected to your infiltration facility and then solve for ABMP or dBMP. To go back to the default configuration click the "Default Vdef & Aimp" button.																							

Proposed Recharge System Schematic



Ratio of void space to cross-section area:
 $= 0.44 \therefore dBMP = 0.44 \times 24" = 11"$

Ground surface = 107.0 (Min)
 Top of recharge bed = 103.0
 Bottom of recharge bed = 101.0
 $\therefore dBMP = 48" \text{ down}$
 $dEXC = 72" \text{ down}$

APPENDIX D
NON-STRUCTURAL POINT SYSTEM SPREADSHEET (NSPS)

NJDEP Nonstructural Strategies Points System (NSPS)

Version: January 31, 2006

Note: Input Values in Yellow Cells Only

Project: RECAP - Modules 8-10 (modified with 6 new parking spaces)

Date: June 10, 2024

User: RAP/KP

Notes: Based on Modules 8-10 - 22.7 Ac. Study Area

Step 1 - Provide Basic Major Development Site Information

A. Specify Total Area in Acres of Development Site Described in Steps 2 and 3 = 22.7 Acres

B. Specify by Percent the Various Planning Areas Located within the Development Site:

State Plan Planning Area:	PA-1	PA-2	PA-3	PA-4	PA-4B	PA-5	Total % Area
Percent of Each Planning Area within Site:		100.0%					100.0%

Note: See User's Guide for Equivalent Zones within Designated Centers and the NJ Meadowlands, Pinelands, and Highlands Districts

Step 2 - Describe Existing or Pre-Developed Site Conditions

A. Specify Existing Land Use/Land Cover Descriptions and Areas:

Site Segment	Land Use/Land Cover Description	Specify Land Use/Land Cover in Acres for Each HSG				Use/Cover Subtotals	Points
		HSG A	HSG B	HSG C	HSG D		
1	Wetlands and Undisturbed Stream Buffers				0.0		0
2	Lawn and Open Space	15.5			15.5		226
3	Brush and Shrub				0.0		0
4	Meadow, Pasture, Grassland, or Range				0.0		0
5	Row Crop				0.0		0
6	Small Grain and Legumes				0.0		0
7	Woods - Indigenous				0.0		0
8	Woods - Planted				0.0		0
9	Woods and Grass Combination				0.0		0
10	Ponds, Lakes, and Other Open Water				0.0		0
11	Gravel and Dirt				0.0		0
12	Porous and Permeable Paving				0.0		0
13	Directly Connected Impervious	7.2			7.2		0
14	Unconnected Impervious with Small D/S Pervious				0.0		0
15	Unconnected Impervious with Large D/S Pervious				0.0		0
HSG Subtotals (Acres):		0.0	22.7	0.0	0.0	Total Area: 22.7	
HSG Subtotals (%):		0.0%	100.0%	0.0%	0.0%	Total % Area: 100.0%	
							Points Subtotal: 226
							Total Existing Site Points: 226

Step 3 - Describe Proposed or Post-Developed Site Conditions

A. Specify Proposed Land Use/Land Cover Descriptions and Areas:

Site Segment	Land Use/Land Cover Description	Specify Land Use/Land Cover in Acres for Each HSG				Use/Cover Subtotals	Points
		HSG A	HSG B	HSG C	HSG D		
1	Wetlands and Undisturbed Stream Buffers					0.0	0
2	Lawn and Open Space		15.1			15.1	220
3	Brush and Shrub					0.0	0
4	Meadow, Pasture, Grassland, or Range					0.0	0
5	Row Crop					0.0	0
6	Small Grain and Legumes					0.0	0
7	Woods - Indigenous					0.0	0
8	Woods - Planted					0.0	0
9	Woods and Grass Combination					0.0	0
10	Ponds, Lakes, and Other Open Water					0.0	0
11	Gravel and Dirt					0.0	0
12	Porous and Permeable Paving					0.0	0
13	Directly Connected Impervious		7.6			7.6	0
14	Unconnected Impervious with Small D/S Pervious					0.0	0
15	Unconnected Impervious with Large D/S Pervious					0.0	0
HSG Subtotals (Acres):		0.0	22.7	0.0	0.0	Total Area: 22.7	
HSG Subtotals (%):		0.0%	100.0%	0.0%	0.0%	Total % Area: 100.0%	
Points Subtotal:						220	

B. Compare Proposed Impervious Coverage with Maximum Allowable Impervious Coverage:

Total Directly Connected Impervious Coverage =
Total Unconnected Impervious Coverage with Small D/S Pervious =
Total Unconnected Impervious Coverage with Large D/S Pervious =
Total Site Impervious Coverage =
Effective Site Impervious Coverage =

33%	% of Site
0%	% of Site
0%	% of Site
33%	% of Site
33%	% of Site

Specify Source of Maximum Allowable Impervious Coverage:

None	(None or Table)

Points Subtotal: 0

C. Compare Proposed Site Disturbance with Maximum Allowable Site Disturbance:

Total Proposed Site Disturbance =
Maximum Allowable Site Disturbance by Municipal Ordinance =

	% of Site
	% of Site

Points Subtotal: 0

D. Describe Proposed Runoff Conveyance System:

Total Length of Runoff Conveyance System =
Length of Vegetated Runoff Conveyance System =
% of Total Runoff Conveyance System That is Vegetated =

3580	Feet
550	Feet
15%	

Points Subtotal: 20

E. Residential Lot Clustering:

Percent of Total Site Area that will be Clustered =
Minimum Standard Lot Size as Per Zoning (Note: 1/2 Acre or Greater) =
Maximum Proposed Cluster Lot Size (Note: 1/4 Acre or Less) =
Percent of Clustered Portion of Site to be Preserved as Vegetated Open Space =

	% of Site
	Acres
	Acres
	% of Clustered Site Portion

Points Subtotal: 0

F. Will the Following be Utilized to Minimize Soil Compaction?

Proposed Lawn Areas will be Graded with Lightweight Construction Equipment:
Percent of Proposed Lawn Areas to be Graded with Such Equipment:

No	(Yes or No)
	% of Lawn Areas

Points Subtotal: 0

G. Are Any of the Following Stormwater Management Standards Met Using Only Nonstructural Strategies and Measures?

Groundwater Recharge Standards (NJAC 7:8-5.4-a-2):
Stormwater Runoff Quality Standards (NJAC 7:8-5.5):
Stormwater Runoff Quantity Standards (NJAC 7:8-5.4-a-3):

No	(Yes or No)
No	(Yes or No)
No	(Yes or No)

Points Subtotal: 0

Note: If the Answers to All Three Questions at G Above are "Yes", Adequate Nonstructural Measures have been Utilized

Total Proposed Site Points: 241

Ratio of Proposed to Existing Site Points: 107%

Required Site Points Ratio: 95%

Nonstructural Point System Results:

Proposed Nonstructural Measures are Adequate

PREVIOUSLY APPROVED NSPS

NJDEP Nonstructural Strategies Points System (NSPS)

Version: January 31, 2006

Note: Input Values in Yellow Cells Only

Project:	RECAP - Modules 8 through 10
Date:	July 13, 2011
User:	CEY
Notes:	Based on Modules 8 through 10 - 22.7 Ac. Study Area

Step 1 - Provide Basic Major Development Site Information

A. Specify Total Area in Acres of Development Site Described in Steps 2 and 3 = Acres

B. Specify by Percent the Various Planning Areas Located within the Development Site:

State Plan Planning Area:	PA-1	PA-2	PA-3	PA-4	PA-4B	PA-5	Total % Area
Percent of Each Planning Area within Site:		100.0%					100.0%

Note: See User's Guide for Equivalent Zones within Designated Centers and the NJ Meadowlands, Pinelands, and Highlands Districts

Step 2 - Describe Existing or Pre-Developed Site Conditions

A. Specify Existing Land Use/Land Cover Descriptions and Areas:

Site Segment	Land Use/Land Cover Description	Specify Land Use/Land Cover in Acres for Each HSG				Use/Cover Subtotals	Points
		HSG A	HSG B	HSG C	HSG D		
1	Wetlands and Undisturbed Stream Buffers					0.0	0
2	Lawn and Open Space	16.2				16.2	236
3	Brush and Shrub					0.0	0
4	Meadow, Pasture, Grassland, or Range					0.0	0
5	Row Crop					0.0	0
6	Small Grain and Legumes					0.0	0
7	Woods - Indigenous					0.0	0
8	Woods - Planted					0.0	0
9	Woods and Grass Combination					0.0	0
10	Ponds, Lakes, and Other Open Water					0.0	0
11	Gravel and Dirt	0.6				0.6	5
12	Porous and Permeable Paving					0.0	0
13	Directly Connected Impervious	5.9				5.9	0
14	Unconnected Impervious with Small D/S Pervious					0.0	0
15	Unconnected Impervious with Large D/S Pervious					0.0	0
HSG Subtotals (Acres):		0.0	22.7	0.0	0.0	Total Area: 22.7	
HSG Subtotals (%):		0.0%	100.0%	0.0%	0.0%	Total % Area: 100.0%	

Points Subtotal: **241**

Total Existing Site Points: **241**

Step 3 - Describe Proposed or Post-Developed Site Conditions

A. Specify Proposed Land Use/Land Cover Descriptions and Areas:

Site Segment	Land Use/Land Cover Description	Specify Land Use/Land Cover in Acres for Each HSG				Use/Cover Subtotals	Points
		HSG A	HSG B	HSG C	HSG D		
1	Wetlands and Undisturbed Stream Buffers					0.0	0
2	Lawn and Open Space		14.9			14.9	217
3	Brush and Shrub					0.0	0
4	Meadow, Pasture, Grassland, or Range					0.0	0
5	Row Crop					0.0	0
6	Small Grain and Legumes					0.0	0
7	Woods - Indigenous					0.0	0
8	Woods - Planted					0.0	0
9	Woods and Grass Combination					0.0	0
10	Ponds, Lakes, and Other Open Water					0.0	0
11	Gravel and Dirt		0.5			0.5	4
12	Porous and Permeable Paving					0.0	0
13	Directly Connected Impervious		7.3			7.3	0
14	Unconnected Impervious with Small D/S Pervious					0.0	0
15	Unconnected Impervious with Large D/S Pervious					0.0	0
HSG Subtotals (Acres):		0.0	22.7	0.0	0.0	Total Area: 22.7	
HSG Subtotals (%):		0.0%	100.0%	0.0%	0.0%	Total % Area: 100.0%	
							Points Subtotal: 222

B. Compare Proposed Impervious Coverage with Maximum Allowable Impervious Coverage:

Total Directly Connected Impervious Coverage =
Total Unconnected Impervious Coverage with Small D/S Pervious =
Total Unconnected Impervious Coverage with Large D/S Pervious =
Total Site Impervious Coverage =
Effective Site Impervious Coverage =

32%	% of Site
0%	% of Site
0%	% of Site
32%	% of Site
32%	% of Site

Specify Source of Maximum Allowable Impervious Coverage:

Table	(None or Table)
-------	-----------------

Allowable Site Impervious Cover from Maximum Impervious Cover Table:
Note: See Maximum Impervious Cover Table Worksheet for Details

0%

Points Subtotal:

C. Compare Proposed Site Disturbance with Maximum Allowable Site Disturbance:

Total Proposed Site Disturbance =
Maximum Allowable Site Disturbance by Municipal Ordinance =

	% of Site
	% of Site

Points Subtotal:

D. Describe Proposed Runoff Conveyance System:

Total Length of Runoff Conveyance System =
Length of Vegetated Runoff Conveyance System =
% of Total Runoff Conveyance System That is Vegetated =

3580	Feet
550	Feet
15%	

Points Subtotal:

E. Residential Lot Clustering:

Percent of Total Site Area that will be Clustered =
Minimum Standard Lot Size as Per Zoning (Note: 1/2 Acre or Greater) =
Maximum Proposed Cluster Lot Size (Note: 1/4 Acre or Less) =
Percent of Clustered Portion of Site to be Preserved as Vegetated Open Space =

	% of Site
	Acres
	Acres
	% of Clustered Site Portion

Points Subtotal:

F. Will the Following be Utilized to Minimize Soil Compaction?

Proposed Lawn Areas will be Graded with Lightweight Construction Equipment:
Percent of Proposed Lawn Areas to be Graded with Such Equipment:

No	(Yes or No)
	% of Lawn Areas

Points Subtotal:

G. Are Any of the Following Stormwater Management Standards Met Using Only Nonstructural Strategies and Measures?

Groundwater Recharge Standards (NJAC 7:8-5.4-a-2):
Stormwater Runoff Quality Standards (NJAC 7:8-5.5):
Stormwater Runoff Quantity Standards (NJAC 7:8-5.4-a-3):

No	(Yes or No)
No	(Yes or No)
No	(Yes or No)

Points Subtotal:

Note: If the Answers to All Three Questions at G Above are "Yes", Adequate Nonstructural Measures have been Utilized.

Total Proposed Site Points:

Ratio of Proposed to Existing Site Points:

Required Site Points Ratio:

Nonstructural Point System Results:

Proposed Nonstructural Measures are Adequate