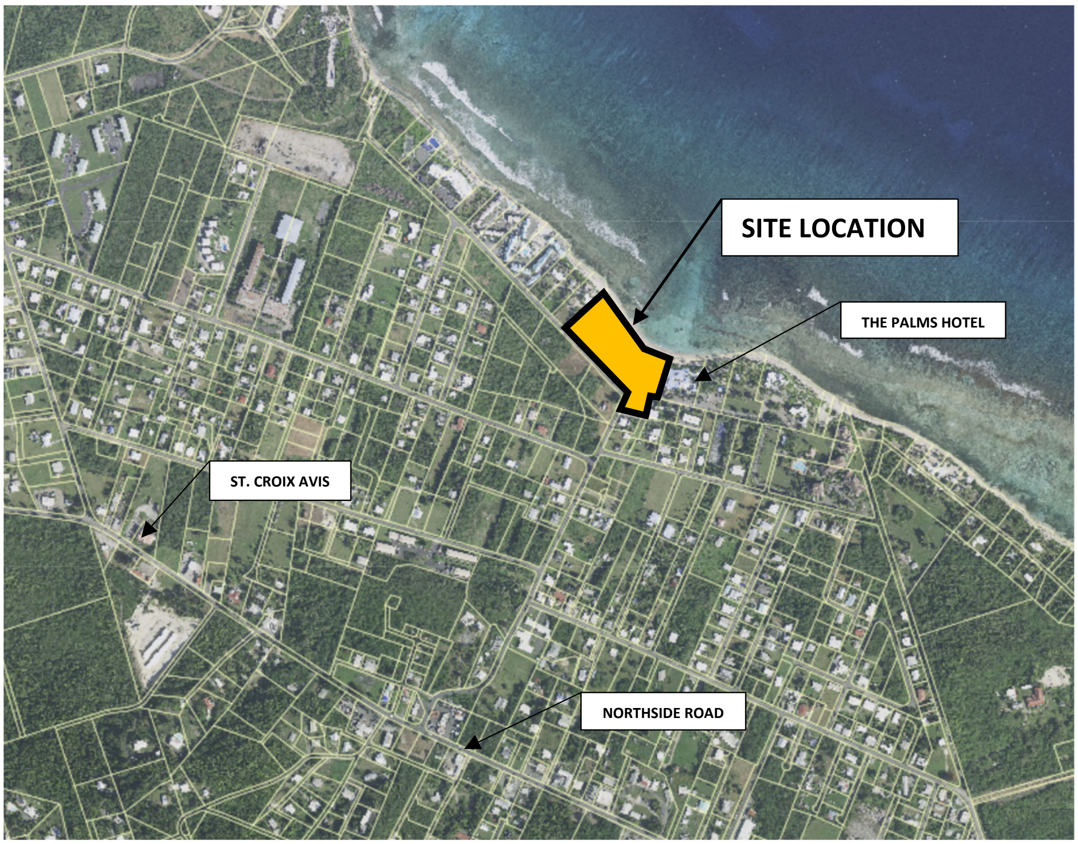
HYDROLOGY STUDY REPORT
HIBISCUS HOTEL PHASE III

PROJECT SITE:

109C, 109D, 109E, 109R, 109S, 109T LA GRANDE PRINCESSE
CHRISTIANSTED, ST. CROIX, USVI 00820



PREPARED BY:

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INTRODUCTION

This site was previously developed as a hotel property. The proposed improvements encompass renovation of the existing buildings and the addition of three new hotel buildings, a generator building and a swimming pool. The new hotel facility will have a total of 104 units.

This hydrology study will focus on a pre-development vs. a post-development analysis to ensure that the proposed improvements do not adversely impact stormwater quality and quantity beyond the pre-existing condition. Any additional impacts will be quantified and properly mitigated in accordance with the Department of Planning and Natural Resources (DPNR) requirements.

SOILS CLASSIFICATION

For Curve Number (CN) determination, there are four (4) main types of Hydrologic Soils Classification which are as follows:

Group A – Soils that have low runoff potential when thoroughly wet. These soils typically have less than 10% clays and more than 90% sand or gravel.

Group B – Soils that have moderately low runoff potential when thoroughly wet. These soils typically have between 10% - 20% clays and 50% - 90% sand.

Group C – Soils that have moderately high runoff potential when thoroughly wet. These soils typically have between 20% - 40% clays and less than 50% sand.

Group D – Soils that have high runoff potential when thoroughly wet. These soils typically have greater than 40% clays and less than 50% sand.

St. Croix Hydrologic Soils Classification (Source: *https://usvi.mapgeo.io*)

Based on the above, the Hydrologic Soils Classification for the Site is ***Group A***. This soil classification type is synonymous with Group A in Table 3.6 below.

CURVE NUMBER (CN) CLASSIFICATION

The curve number classification is determined based on land use type and hydrologic soil type. The table below indicates CN values for various land uses and hydrologic soil types.

Table 3-6. Typical Curve Number Values for Urban Areas (SCS 1986)

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Based on the above, the site falls into three (3) distinct classifications listed as follows:

Poor Condition (grass cover < 50%) – this accounts for the grass/vegetative cover within the property.

Paved; open ditches (including right-of-way) – this accounts for the paved surfaces and buildings within the property.

Gravel – this accounts for the gravel stone ground cover within the property.

BASIN CHARACTERISTICS

The disturbed area of the site is approximately 3.76 acres broken down into three (3) major ground cover types. The table below shows the breakdown along with a Weighted Curve Number for each category and ultimately for the entire site.

- **PRE-DEVELOPMENT**

TABLE 1 - PRE-DEVELOPMENT BASIN CHARACTERISTICS			
DESCRIPTION	**AREA**	**UNITS**	**WEIGHTED CURVE NUMBER (CN)**
BUILDINGS	0.38	AC	98
CONCRETE SIDEWALK	0.19	AC	98
VEGETATIVE GROUND COVER / SAND	2.68	AC	68
GRAVEL	0.06	AC	76
ASPHALT PAVEMENT	0.45	AC	98

TOTAL AREA	3.76	AC

WEIGHTED CN VALUE	**76**

- **POST-DEVELOPMENT**

TABLE 2 - POST-DEVELOPMENT BASIN CHARACTERISTICS			
DESCRIPTION	**AREA**	**UNITS**	**WEIGHTED CURVE NUMBER (CN)**
BUILDINGS	0.71	AC	98
CONCRETE SIDEWALK	0.23	AC	98
ASPHALT PAVEMENT	0.64	AC	98
GRAVEL	0.18	AC	76
VEGETATIVE GROUND COVER / SAND	2.00	AC	68

TOTAL AREA	3.76	AC

WEIGHTED CN VALUE	**81**

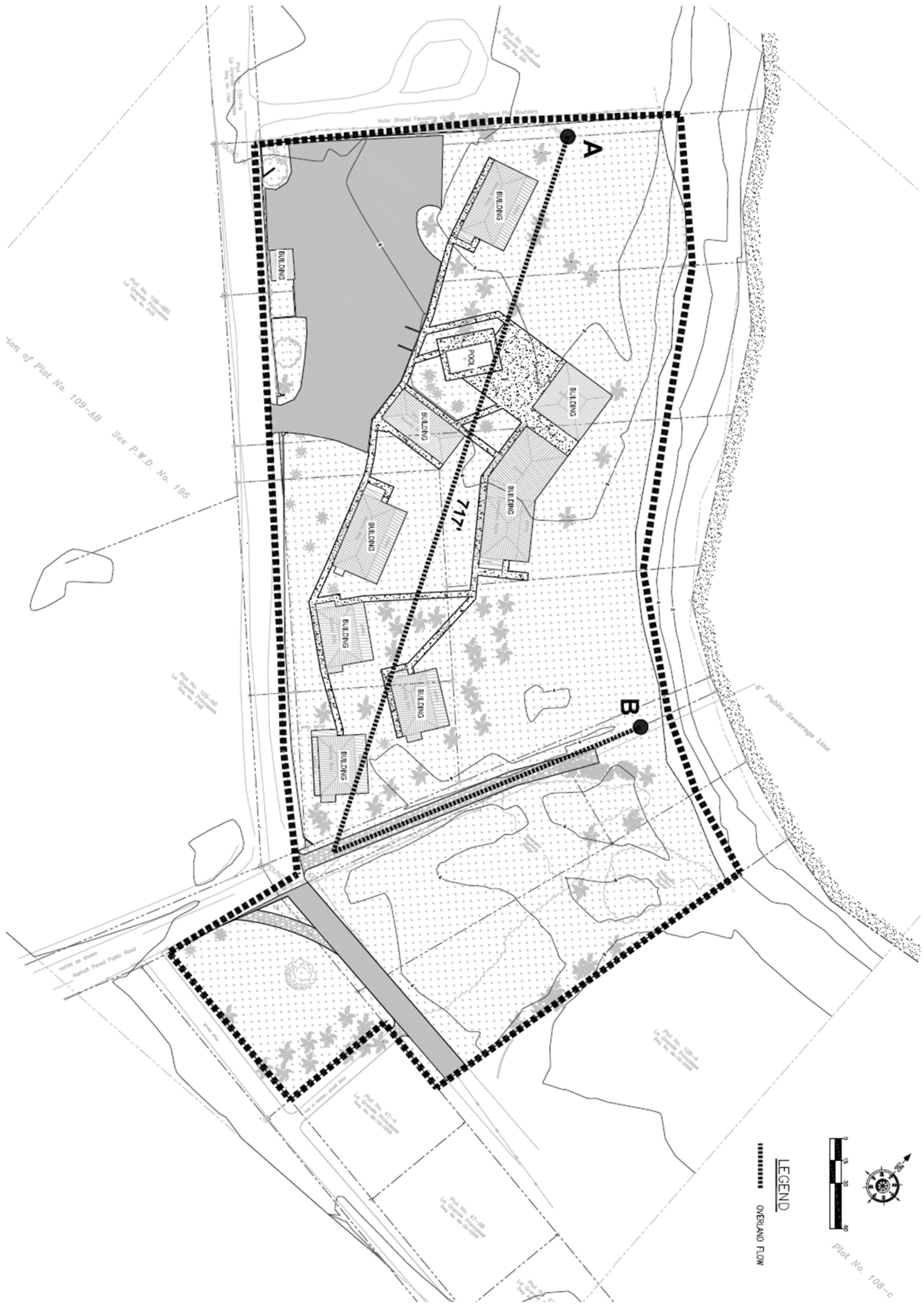
TIME OF CONCENTRATION (Tc)

The time of concentration is necessary to estimate peak discharge and is dependent upon the watershed characteristics. To accurately determine Tc, the hydraulics of each part of the flow path must be considered separately.

➢ PRE-DEVELOPMENT

In the pre-development, the site has one distinct flow path, which is **overland** flow as follows:

- A-B (Overland Flow) – 717 ft. travel distance @ average slope of 0.6%



The flow pattern will be evaluated to determine the Time of Concentration (Tc) which will be used to determine the stormwater water runoff volume.

P_{24} = 4 IN (2yr_24 HOUR CUMMULATIVE RAINFALL AMOUNT)

$$T_t = \frac{(.007)(nL)^{.8}}{(P)^{.5}\ (S)^{.4}}$$ (OVERLAND FLOW)

TABLE 3 - PRE-DEVELOPMENT TIME OF CONCENTRATION Tc (2yr - 24 HOUR STORM)				
SEGMENT DESCRIPTION	SLOPE (S)	LENGTH (L)	MANNING'S COEF. (n)	Tt (hrs)
A-B (OVERLAND FLOW)	0.006	717	0.03	**0.315**

$T_c = \sum T_t =$ **0.315** **hrs** (2YR - 24HR STORM)

➢ POST-DEVELOPMENT

In the post-development, the site has one critical distinct flow path, which include a combination of **overland and pipe** flow as follows:

- A-B (Overland) – 279 ft. travel distance @ average slope of 1.5%
- B-C (Pipe Flow) – 302 ft. travel distance @ average slope of 0.03%
- C-D (Pipe Flow) – 61 ft. travel distance @ average slope of 0.15%

The flow pattern will be evaluated to determine the Time of Concentration (Tc) which will be used to determine the stormwater water runoff volume.

P_{24} = 4 IN (2yr_24 HOUR CUMMULATIVE RAINFALL AMOUNT)

$$T_t = \frac{(.007)(nL)^{.8}}{(P)^{.5}\ (S)^{.4}}$$ (OVERLAND FLOW)

$$T_t = \frac{L}{v}$$ (PIPE FLOW)

$$v = \frac{1.49}{n}(D/4)^{2/3}\ s^{1/2}$$ (PIPE VELOCITY)

TABLE 4 - POST-DEVELOPMENT TIME OF CONCENTRATION Tc (2yr - 24 HOUR STORM)								
SEGMENT DESCRIPTION		SLOPE (S)	LENGTH (L)	PIPE DIA (FT.)	PIPE VELOCITY (FT./S)	MANNING'S COEF. (n)	Individual Tt (hrs)	Cummulative Tt (hrs)
A-B-C-D (OVERLAND & PIPE FLOW)	A-B (OVERLAND)	0.015	279	N/A	N/A	0.03	0.103	0.222
	B-C (PIPE)	0.0003	362	1.5	0.89	0.015	0.112	
	C-D (PIPE)	0.0015	61	2	2.42	0.015	0.007	

Tc = ∑Tt = 0.222 hrs (2YR - 24HR STORM)

RUNOFF (Q) AND STORAGE VOLUME (V)

DPNR Runoff Onsite Storage Requirements as per the ***Territorial Pollutant Discharge Elimination System - General Permit Number VIGSA0000*** is as follows:

1) 3600 cubic feet per acre (1” over 1 acre) or,
2) 2yr – 24 hours storm; whichever is greater

➢ PRE-DEVELOPMENT

PRE-DEVELOPMENT - RUNOFF (Q) AND TOTAL VOLUME (V)

Runoff equation

$$Q = \frac{\left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2}{P + 0.8\left(\frac{1000}{CN} - 10\right)}$$

where:
Q = runoff (in)
P = rainfall (in)
CN = runoff curve number

Volume Equation

V = QA

where:

Q = runoff (ft)

A = Area (ac)

DPNR Runoff Onsite Storage Requirements
(Territorial Pollutant Discharge Elimination System - General Permit Number VIGSA0000)

1) 3600 cubic feet per acre (1" over 1 acre), or

2) 2 yr - 24 hour storm; whichever is greater

1) 3600 CUBIC FEET PER ACRE

Disturbed Site Acreage = 3.76 ac

V= 0.31 ac-ft

2) 2 YR - 24 HOUR STORM

STORM EVENT	P (in)	CN	Q (in)	Area (ac)	V (ac-ft)
2 - YEAR	4	76	1.74	3.76	**0.54**

➢ POST-DEVELOPMENT

POST-DEVELOPMENT - RUNOFF (Q) AND TOTAL VOLUME (V)

Runoff equation

$$Q = \frac{\left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2}{P + 0.8\left(\frac{1000}{CN} - 10\right)}$$

where:
Q = runoff (in)
P = rainfall (in)
CN = runoff curve number

Volume Equation

$$V = QA$$

where:

Q = runoff (ft)

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DPNR Runoff Onsite Storage Requirements
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1) 3600 cubic feet per acre (1" over 1 acre), or

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1) 3600 CUBIC FEET PER ACRE

Disturbed Site Acreage = 3.76 ac

V= 0.31 ac-ft

2) 2 YR - 24 HOUR STORM

STORM EVENT	P (in)	CN	Q (in)	Area (ac)	V (ac-ft)
2 - YEAR	4	81	2.12	3.76	**0.66**

CONCLUSION

The proposed improvements result in a net increase in building and impervious areas over the existing condition which is evident in the pre vs. post runoff coefficient increasing from 76 to 81.

The storage required for 1” over the entire site area = **0.31 ac-ft**.

The storage required from a pre vs. post analysis of the 2yr – 24hour storm (0.66 ac-ft – 0.54 ac-ft) = 0.12 ac-ft.

Based on the above results, the 1” over the entire site controls.

HIBISCUS HOTEL
RETENTION AREA STAGE/STORAGE CALCULATIONS

Stormwater Retention Area Calculations

RETENTION AREA No. 1

Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
1.0	882	0.020			
2.0	1,325	0.030	0.03	0.03	0.03
3.0	1,840	0.042	0.04	0.04	0.06
4.0	2,421	0.056	0.05	0.10	0.16

RETENTION AREA No. 2

Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
2.0	178	0.004			
3.0	405	0.009	0.01	0.01	0.01
4.0	689	0.016	0.01	0.01	0.02

RETENTION AREA No. 3

Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
3.0	491	0.011			
4.0	1,026	0.024	0.02	0.02	0.02

RETENTION AREA No. 4

Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
4.0	757	0.017			
5.0	1,519	0.035	0.03	0.03	0.03

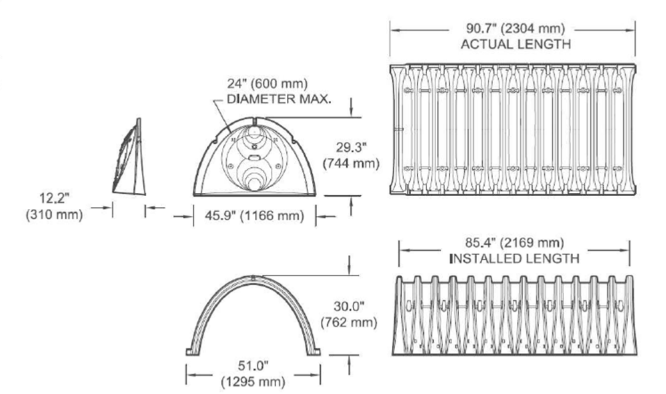
Proposed Cumulative Pond Storage of 0.23 Ac-ft < Required Storage of 0.31 Ac-ft.
StormTech SC-740 Underground Storage Chambers will be utilized in conjunction with the retention areas to make up the additional required 0.08 ac-ft of storage. Refer to StormTech Calculations attached.

STORAGE POND LAYOUT FOR A TOTAL VOLUME OF 0.23 AC-FT

The balance of 0.08 ac-ft of storage (0.31 ac-ft – 0.23 ac-ft) will be accounted for by utilizing Stormtech Underground Storage Chambers. These chambers will be placed beneath the new asphalt parking lot as illustrated on Plan Sheet 02-C11.

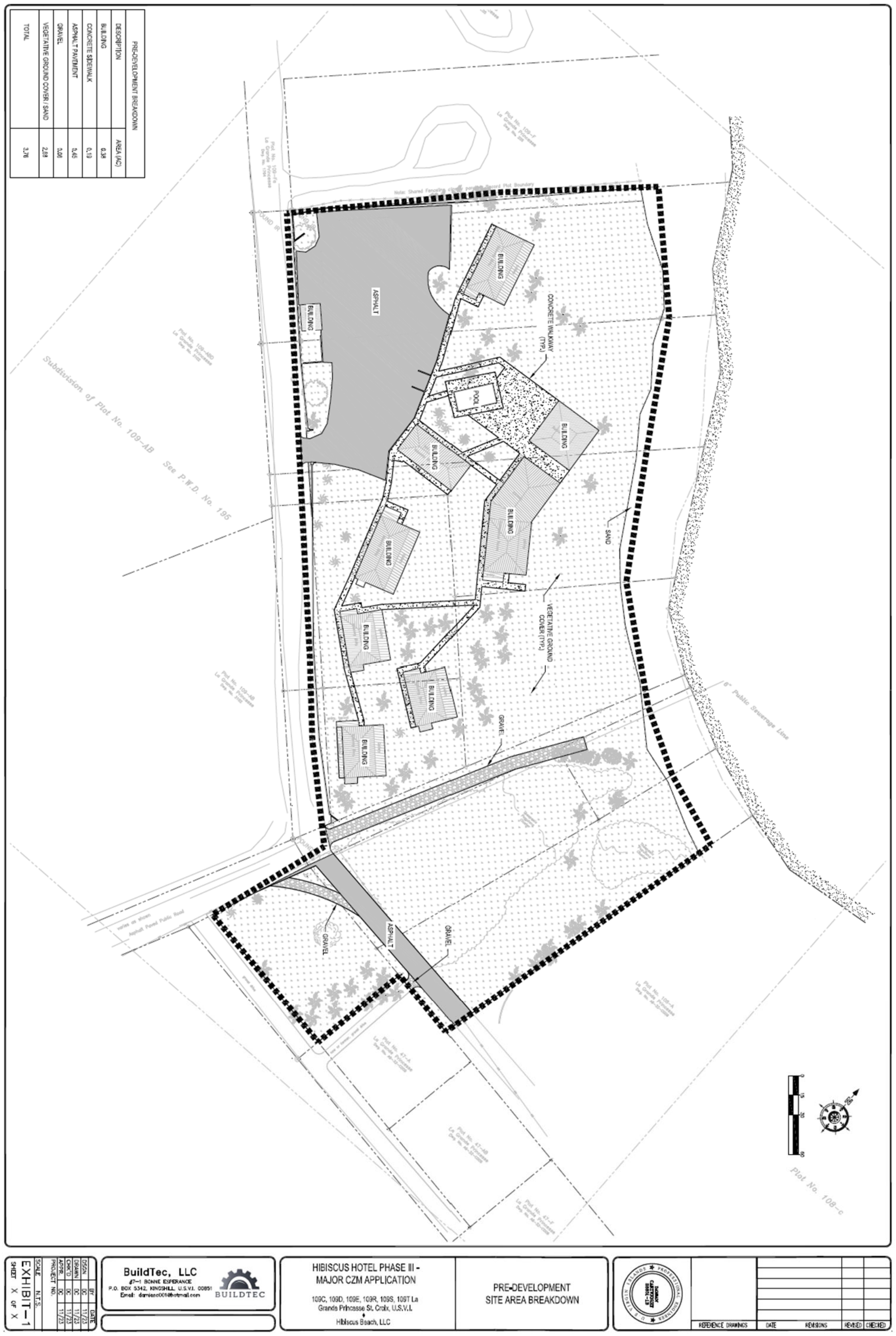
HIBISCUS HOTEL
STORMTECH UNDERGROUND STORAGE CHAMBERS CALCULATIONS

StormTech Underground Storage Chambers Calculations				
Required Storage =	0.31 ac. ft - 0.23 ac. Ft =	0.08	ac-ft	
System Invert Elevation =		1.00	ft	
System Top Elevation =		4.00	ft	
Depth of Water in System =		3.00	ft	
Storage Volume Per Chamber =		81.7	ft^3	
		0.0019	ac-ft	
No. of Required Chambers =		43.00	each	
No. of Chambers Provided =		45.00	each	OK!
Length of Required Chambers		326.00	linear feet	
Length of Chambers Provided		340.00	linear feet	OK!
Chamber Dimensions =			ac-ft	

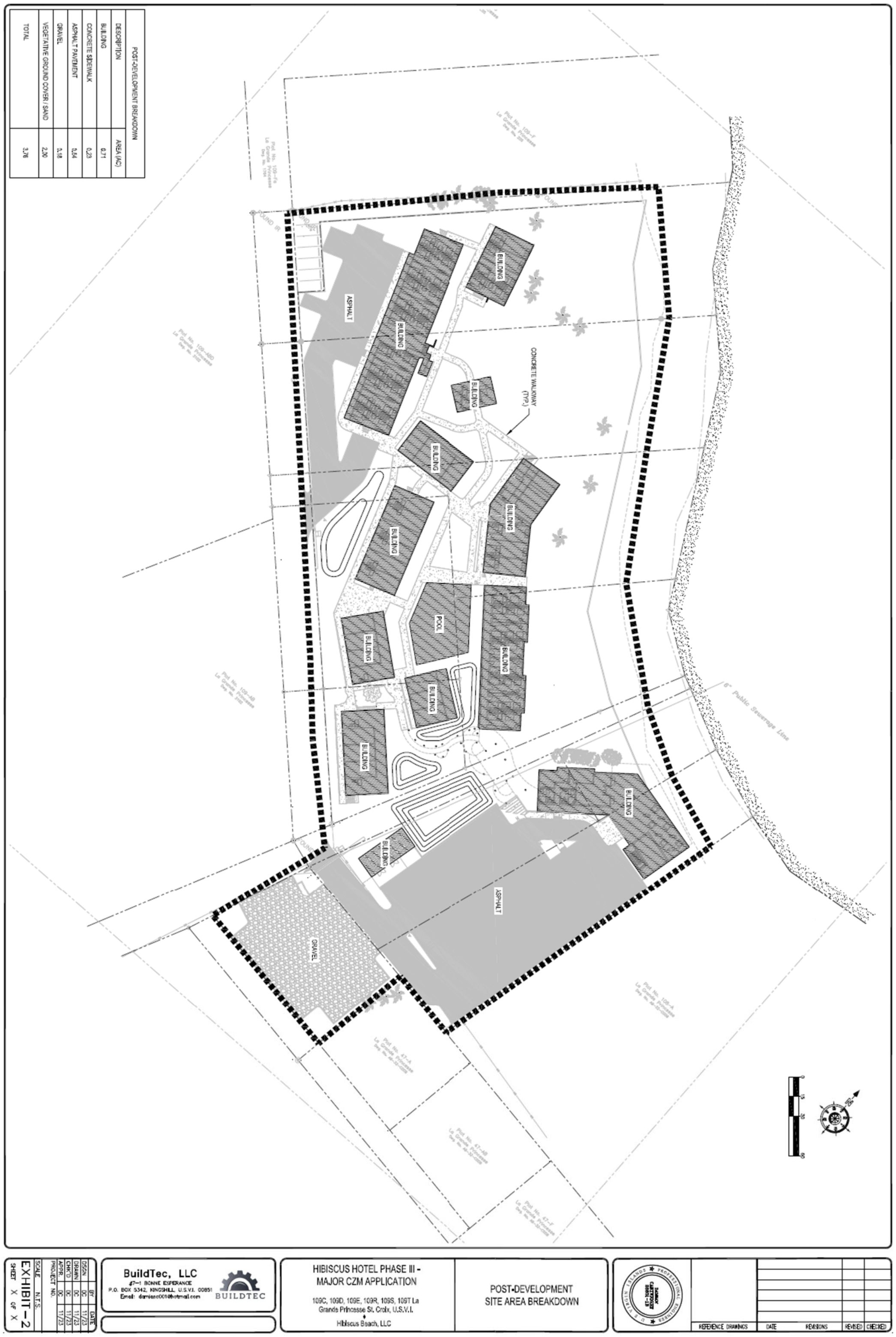


In addition to runoff storage calculations, pipe flood routing calculations were also performed to ensure that the piping network is adequately sized to convey the runoff to the retention storage areas. These calculations are included in the attached Appendices.

APPENDICES



PRE-DEVELOPMENT SITE AREA BREAKDOWN



POST-DEVELOPMENT SITE AREA BREAKDOWN

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HIBISCUS HOTEL PHASE III

109C, 109D, 109E, 109R, 109S, 109T La Grande Princesse, C'sted, St. Croix, USVI 00820

PIPE FLOOD ROUTING SIZING ANALYSIS

CURRENT ISSUE DATE: 11/29/23

PREPARED BY: DAMIAN CARTWRIGHT, P.E.

BUILDTEC

7-1 Bonne Esperance, P.O. Box 8269, Christiansted, USVI 00823

Project Name:	HIBISCUS HOTEL PHASE III	**Date:**	November 29, 2023
Project Location:	109C, 109D, 109E, 109R, 109S, 109T La Grande Princesse, C'sted, St. Croix, USVI 008	**Activity:**	Drainage Design_Pipe Flood Routing
Project #:		**Sheet #:**	
Engineer:	DC	**Drawing Ref.:**	

DESIGN OBJECTIVE: Determine runoff and pipe sizing for sub catchments in the Hibiscus Hotel Development

DESIGN REFERENCE ***Standard Handbook for Civil Enginers*** **, Merritt/Lofton/Ricketts**
Design & Constr. Of Urban Stormwter Management Systems, **ASCE**
Drainage Handbook-Hydrology,Oct. 2000, **Florida Dept. of Transportation**
Drainage Handbook-Storm Drains, Aug. 2000, **Florida Dept. of Transportation**
Drainage Manual, Oct. 2000, **Florida Dept. of Transportation**

DESIGN PARAMETERS:

1. Divide area into subcatchments
2. Use Rational formula to determine peak discharge for each sub-catchment

Storm Design Period	yrs	5	
Storm Duration	hrs	6	
FDOT Design Zone		10	Figure F-21, Drainage Handbook-Hydrology
Rainfall Intensity	in/hr	4	IDF Curve, Figure F-31, Drainage Handbook-Hydrology
Average Slope	%	0 to 2	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
Minimum Pipe Flow Velocity	ft/s	2	Sec. 3.6.1 Drainage Manual
C_1 (Woodlands)		0.15	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
C_2 (Pasture, Grass, and Farmland)		0.20	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
C_3 Bare Earth		0.50	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
C_4 Rooftops & Pavements		0.95	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
C_5 Impervious Pavements		0.95	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
C_6 SFR		0.45	Runoff Coeff., Table T-4, Drain. Hndbk-Hydrology (lots < 1/2 Acre)
C_7 MFR		0.75	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology
C_8 Commercial & Industrial		0.95	Runoff Coeff., Table T-4, Drainage Handbook-Hydrology

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Project #:		**Sheet #:**	
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Sub Catchment Number		CA-1		
Total Catchment Area, A	acres	0.38		
Land Use Percentages				
A_1 (Woodlands)		0		
A_2 (Pasture, Grass, and Farmland)		21.1		
A_3 Bare Earth		0		
A_4 Rooftops		34.2		
A_5 Impervious Pavements		44.7		
A_6 SFR		0		
A_7 MFR		0		
A_8 Commercial & Industrial		0		
Total		100	OK	
Weighted Average Runoff Coeff.		0.79		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	1.20		Q = CIA
Total Rainfall Volume	ft^3	25994.74		

Drainage Pipe Sizing

Pipe Material		HDPE		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	16.00		
Pipe Slope, S	ft/ft	0.005		
Flow Velocity	ft/s	4.21	OK	$V= 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	5.88	OK	$Q= 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Project #:		**Sheet #:**	
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Sub Catchment Number			**CA-2**	(Main Trunkline Pipe Check)
Total Catchment Area, A	acres		**0.67**	***(includes contributing area from CA-1)***
Land Use Percentages				
A_1 (Woodlands)			**0**	
A_2 (Pasture, Grass, and Farmland)			**29.9**	
A_3 Bare Earth			**0**	
A_4 Rooftops			**32.8**	
A_5 Impervious Pavements			**37.3**	
A_6 SFR			**0**	
A_7 MFR			**0**	
A_8 Commercial & Industrial			**0**	
Total			100	**OK**
Weighted Average Runoff Coeff.			0.73	$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr		4	
Peak Flow, Q	ft^3/s		**1.95**	Q = CIA
Total Rainfall Volume	ft^3		**42012.22**	

Drainage Pipe Sizing

Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	16.00		
Pipe Slope, S	ft/ft	0.0025		
Flow Velocity	ft/s	2.98	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**4.15**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Project #:		**Sheet #:**	
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Sub Catchment Number		**CA-2**	(Area Drain Pipe Check)	
Total Catchment Area, A	acres	**0.29**		
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**41.4**		
A_3 Bare Earth		**0**		
A_4 Rooftops		**31**		
A_5 Impervious Pavements		**27.6**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.64		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**0.74**		Q = CIA
Total Rainfall Volume	ft^3	**16023.31**		
Drainage Pipe Sizing				
Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	10.00		
Pipe Slope, S	ft/ft	0.0025		
Flow Velocity	ft/s	2.18	**OK**	$V= 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**1.19**	**OK**	$Q= 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Project #:		**Sheet #:**	
Engineer:	DC	**Drawing Ref.:**	

Sub Catchment Number		**CA-3**	(Main Trunkline Pipe Check)
Total Catchment Area, A	acres	**1.07**	***(includes contributing areas from CA-1 & CA-2)***
Land Use Percentages			
A_1 (Woodlands)		**0**	
A_2 (Pasture, Grass, and Farmland)		**36.4**	
A_3 Bare Earth		**0**	
A_4 Rooftops		**29**	
A_5 Impervious Pavements		**34.6**	
A_6 SFR		**0**	
A_7 MFR		**0**	
A_8 Commercial & Industrial		**0**	
Total		100 **OK**	
Weighted Average Runoff Coeff.		0.68	$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4	
Peak Flow, Q	ft^3/s	**2.90**	Q = CIA
Total Rainfall Volume	ft^3	**62587.30**	

Drainage Pipe Sizing

Pipe Material		**HDPE**	
Mannings No., n		0.012	Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	18.00	
Pipe Slope, S	ft/ft	0.0025	
Flow Velocity	ft/s	3.22 **OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**5.69** **OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Sub Catchment Number		**CA-3**	(Area Drain Pipe Check)	
Total Catchment Area, A	acres	**0.40**		
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**47.5**		
A_3 Bare Earth		**0**		
A_4 Rooftops		**22.5**		
A_5 Impervious Pavements		**30**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.59		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**0.95**		Q = CIA
Total Rainfall Volume	ft^3	**20520.00**		

Drainage Pipe Sizing

Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	10.00		
Pipe Slope, S	ft/ft	0.0025		
Flow Velocity	ft/s	2.18	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**1.19**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Sub Catchment Number		**CA-4**		
Total Catchment Area, A	acres	**1.94**	***(includes contributing areas from CA-1, CA-2, CA-3 & CA-7)***	
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**37.1**		
A_3 Bare Earth		**0**		
A_4 Rooftops		**17**		
A_5 Impervious Pavements		**45.9**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.67		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**5.21**		Q = CIA
Total Rainfall Volume	ft^3	**112596.05**		
Drainage Pipe Sizing				
Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	18.00		
Pipe Slope, S	ft/ft	0.0025		
Flow Velocity	ft/s	3.22	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**5.69**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Sub Catchment Number		**CA-5**		
Total Catchment Area, A	acres	**0.03**		
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**33.3**		
A_3 Bare Earth		**0**		
A_4 Rooftops		**0**		
A_5 Impervious Pavements		**66.7**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.70		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**0.08**		Q = CIA
Total Rainfall Volume	ft^3	**1815.05**		

Drainage Pipe Sizing

Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	10.00		
Pipe Slope, S	ft/ft	0.008		
Flow Velocity	ft/s	3.89	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**2.12**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Sub Catchment Number		**CA-6**		
Total Catchment Area, A	acres	**0.11**		
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**54.5**		
A_3 Bare Earth		**0**		
A_4 Rooftops		**45.5**		
A_5 Impervious Pavements		**0**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.54		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**0.24**		Q = CIA
Total Rainfall Volume	ft^3	**5144.04**		

Drainage Pipe Sizing

Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	10.00		
Pipe Slope, S	ft/ft	0.0033		
Flow Velocity	ft/s	2.50	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**1.36**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Sub Catchment Number		**CA-7**		
Total Catchment Area, A	acres	**0.51**		
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**2**		
A_3 Bare Earth		**0**		
A_4 Rooftops		**3.9**		
A_5 Impervious Pavements		**94.1**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.94		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**1.91**		Q = CIA
Total Rainfall Volume	ft^3	**41199.84**		

Drainage Pipe Sizing

Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	18.00		
Pipe Slope, S	ft/ft	0.001		
Flow Velocity	ft/s	2.04	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**3.60**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE

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Sub Catchment Number		**CA-8**		
Total Catchment Area, A	acres	**1.04**		
Land Use Percentages				
A_1 (Woodlands)		**0**		
A_2 (Pasture, Grass, and Farmland)		**0**		
A_3 Bare Earth		**72.1**		
A_4 Rooftops		**27.9**		
A_5 Impervious Pavements		**0**		
A_6 SFR		**0**		
A_7 MFR		**0**		
A_8 Commercial & Industrial		**0**		
Total		100	**OK**	
Weighted Average Runoff Coeff.		0.63		$C = \Sigma C_i A_i / A$
Rainfall Intensity	in/hr	4		
Peak Flow, Q	ft^3/s	**2.60**		Q = CIA
Total Rainfall Volume	ft^3	**56209.42**		

Drainage Pipe Sizing

Pipe Material		**HDPE**		
Mannings No., n		0.012		Sec. 3.6.4, Drainage Manual
Pipe Dimension, D	in	12.00		
Pipe Slope, S	ft/ft	0.0075		
Flow Velocity	ft/s	4.26	**OK**	$V = 0.590/n \times D^{2/3} \times S^{1/2}$, eqn. 21.33b, SHCE
Full Flow Pipe Capacity	ft^3/s	**3.34**	**OK**	$Q = 0.463/n \times D^{8/3} \times S^{1/2}$, eqn. 21.33c, SHCE