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STORMWATER MANAGEMENT
and
EROSION CONTROL
CALCULATIONS

FOR

COLE PARK VETERINARY HOSPITAL

December 17, 2008

PROJECT # 15016

NORTH CAROLINA PROFESSIONAL SEAL 14025 ENGINEER KENON R. BLACKWOOD, JR.
12-17-08

PREPARED FOR:

Cole Park Veterinary Hospital, Inc.
11500 US Hwy 15-501 North
Chatham County, NC

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STORMWATER MANAGEMENT REPORT

Project Name:	**Cole Park Veterinary Hospital**
Project Number:	15016
Report Date:	December 16, 2008
Project Location:	Southwest of the intersection of U.S. Highway15-501 and Woodbridge Drive, Chatham County, NC
Purpose:	Design stormwater runoff conveyance systems for the site. Design stormwater quality management and erosion control measures to protect downstream natural resources.

SITE DESCRIPTION:

The proposed development site is approximately 1.83 acres in size and located on the southwest corner of the intersection of U.S. Highway 15-501 and Woodbridge Drive in Chatham County. The site is currently wooded with one vacant dwelling on the site. The site slopes to the east and then south in a roadside swale. Site soils are predominantly Wedowee sandy loam (HSG-B) with some Vance sandy loam (HSG-C) in the lower areas. All drainage from the site flows under Highway 15-501 and eventually into a tributary of Wilson Creek. Wilson Creek and its tributaries are classified by the NC Division of Water Quality as "Class IV, Nutrient Sensitive Waters" and are located in the Cape Fear River Basin.

PROPOSED DEVELOPMENT:

The proposed development consists of an 8400 square foot building and associated drives, sidewalks, parking lot and other amenities. The total proposed impervious area for the development is 0.57 acres (31% of the site).

ANALYSIS:

Stormwater Management:

To protect downstream water quality the drainage from the proposed building and parking lot will be collected by storm drains and discharged to a proposed biofiltration cell to be constructed on the east side of the property. The overflow and underdrain flows from the biofiltration cell will discharge to a drainage feature adjacent to the highway. The stormwater flows from the adjacent properties as well as pervious areas from the site will be collected and bypassed to the east of the site eventually flowing into the same drainage feature as the biofiltration cell. Calculations for the sizing of the biofiltration cell are included as a separate report.

Storm Drainage Systems:

Pipe conveyances and culverts have been sized in accordance with Chatham County standards. Stormwater runoff was calculated using the Rational Method. Rip rap aprons have been provided at all outfalls. All swales have been checked for adequate capacity and stability of the proposed linings.

Sedimentation and Erosion Control Measures:

All proposed measures shown on the plan are sized in accordance with State of North Carolina guidelines. The proposed biofiltration area will be used as a temporary sediment trap during construction as the primary means of erosion control for the project. Other measures, such as silt fence, diversion dikes, inlet protection and gravel construction entrance will be used as shown on the plans.

CONCLUSION:

The stormwater conveyance system and erosion control measures presented are based on conventional engineering design principles and meet the requirements of Chatham County and the State of North Carolina.
The stormwater management system presented is based on the conventional use of a biofiltration cell to protect stormwater quality.

ATTACHMENTS:

Site Location Maps

USGS Topographic Map - Farrington Quadrangle
Chatham County Soils Survey
Storm Drainage Area Exhibit - SDEX (Attached)

Storm Pipe Calculations

Hydraflow Storm Sewers Report
Pre-calculated Outlet Apron Spreadsheet

Sediment and Erosion Control Calculations

Sediment Trap Sizing
Drainage Swale Schedule
Swale Flow Calculations

Stormwater Management Analysis

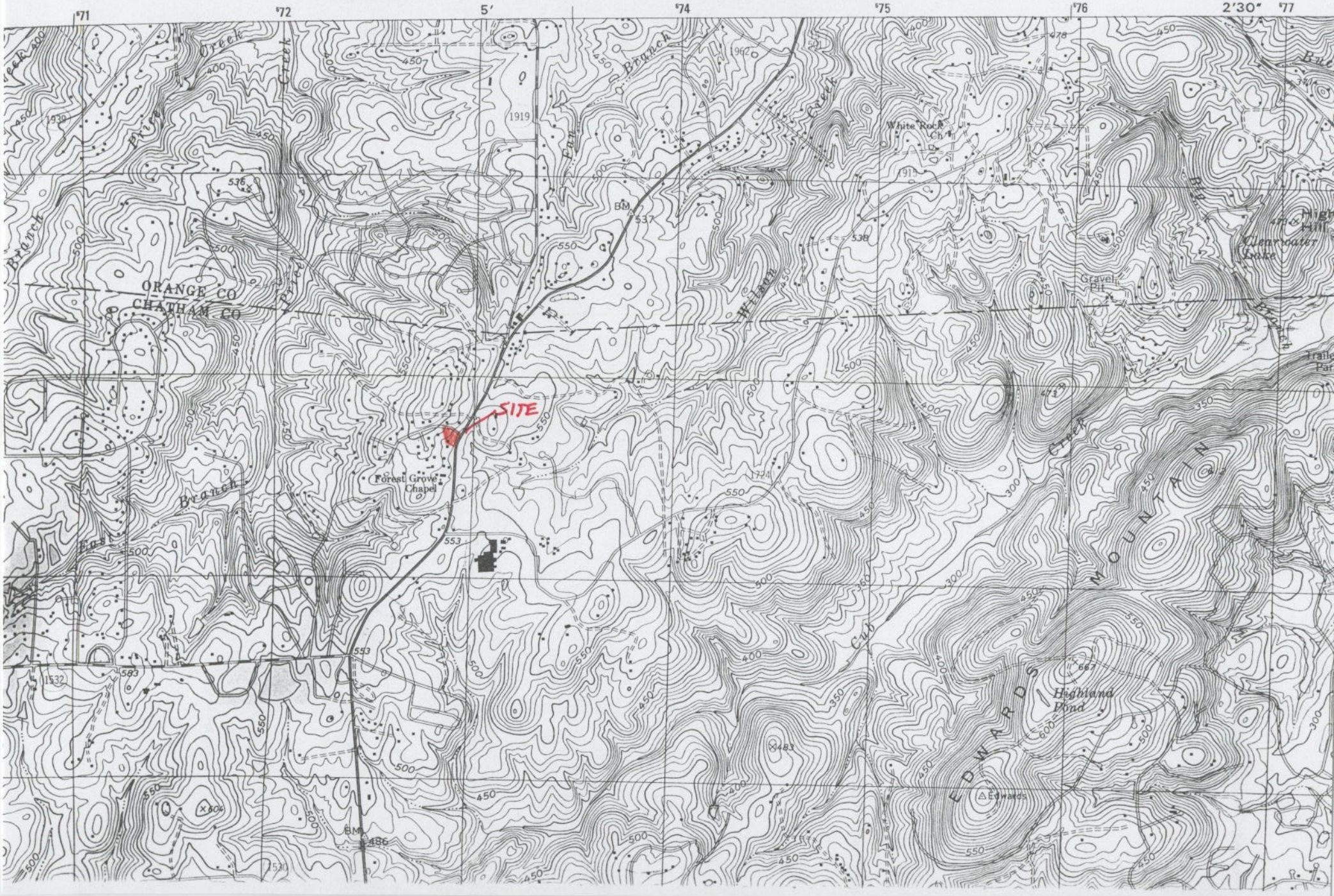
Report and Calculations for the Biofiltration Cell

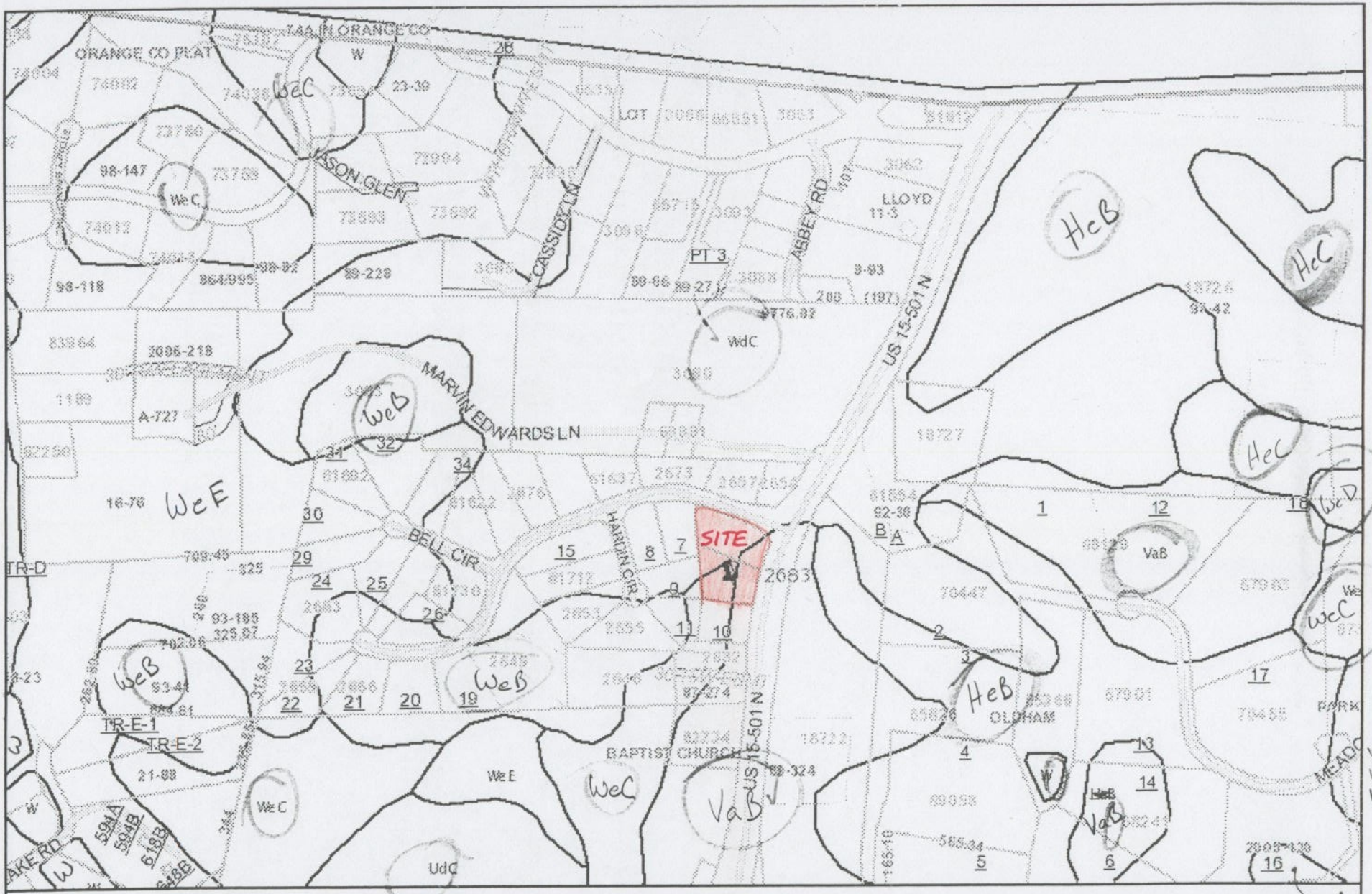
Site Location Maps

FARRINGTON QUAD

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

STATE OF NORTH CAR
DEPARTMENT OF ENVIRONMENT AND NA AL RESOURCES
DIVISION OF LAND RESOURCES
NORTH CAROLINA GEOLOGICAL SURVEY





CHATHAM COUNTY, NC

Property Map

Disclaimer:
The data provided on this map are prepared for the inventory of real property found within Chatham County, NC and are compiled from recorded plats, deeds, and other public records and data. This data is for informational purposes only and should not be substituted for a true title search, property appraisal, survey, or for zoning verification.

WdC
WeC > Wedowee sandy loam (HSG-B)

VaB - Vance sandy loam (HSG-C)

One Inch = 500 Feet

Storm Pipe Calculations

STORM DRAINAGE STRUCTURE SCHEDULE

STRUCTURE DATA								PIPE DATA					APRON DATA			
Structure Number	Structure Type	Rim/TOC Elevation	Invert In North	Invert In East	Invert In South	Invert In West	Invert Out	To	Pipe Length Out	Pipe Slope	Design Diameter	Pipe Material	Stone Class	Thickness	Length	Width
#		elev	elev	elev	elev	elev	elev		ft	%	in		in	in	ft	ft
A01	FES	-	-	-	-	-	567.60	-	-	-	-	RCP	B	18	9	11
A02	NCDOT STD 840.05	572.00	-	-	-	568.20	568.00	A01	40.0	1.00%	18	RCP	-	-	-	-
A03	NCDOT STD 840.15	573.00	-	-	-	-	569.00	A02	77.0	1.04%	15	RCP	-	-	-	-
B01	FES	-	-	-	-	-	567.00	-	-	-	-	RCP	B	18	8	9
B02	NCDOT STD 840.15	573.00	-	-	-	-	570.60	B01	180.0	2.00%	15	RCP	-	-	-	
C01	OPEN PIPE END	-	-	-	-	-	580.00	-	-	-	-	RCP	B	18	8	9
C02	OPEN PIPE END	-	-	-	-	581.00	-	C01	64.0	1.56%	15	RCP	-	-	-	-

FOR CURB INLETS, ELEVATION SHOWN AS RIM/TOC IS FOR TOP BACK OF CURB.
FOR CATCH BASINS, ELEVATION SHOWN AS RIM/TOC IS FOR TOP OF GRATE.
FOR JUNCTION BOXES, ELEVATION SHOWN AS RIM/TOC IS FOR TOP OF LID.
FOR YARD INLETS, ELEVATION SHOWN AS RIM/TOC IS FOR FLOW LINE.
PIPE LENGTHS SHOWN ARE APPROXIMATE. LENGTHS ARE MEASURED FROM THE CENTER OF DRAINAGE STRUCTURES; AND WHERE APPLICABLE, INCLUDE THE TOTAL LENGTH OF THE FLARED END SECTION.

TR 55 Time of Concentration Worksheet

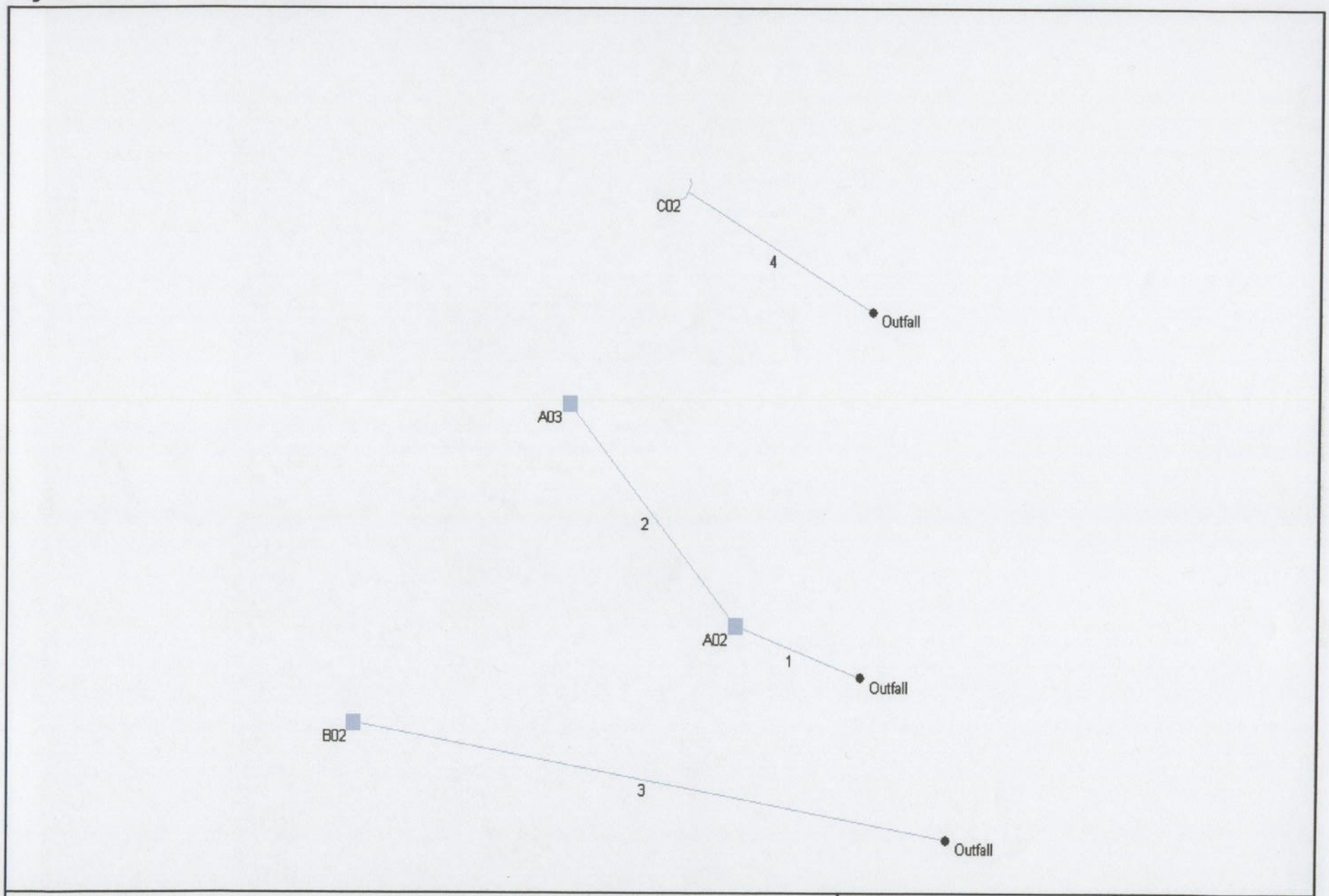
Project Cole Park Veterinary Hospital
Location Woodbridge Drive
Chatham County, NC

Calculated By KRB
Checked By KRB

Date 12/12/2008
Revised

		A and B Drainage Area			D Drainage Area			C Drainage Area		
Sheet Flow										
	Segment ID	AB		Subtotal	AB		Subtotal	AB		Subtotal
1	Surface Description	Woods			Woods			Paved		
2	Mannings Roughness, n (table 3-1)	0.4			0.4			0.011		
3	Flow Length, L in ft (max 300')	80			40			20		
4	Two-year 24-hr rainfall, P2 in inches	3.6			3.6			3.6		
5	Land Slope, s in ft/ft	0.025			0.025			0.020		
6	Tt = 0.007x(nL)^0.8/(P2^0.5xs^0.4) in hr	0.258		0.258	0.148		0.148	0.005		0.005
Shallow Concentrated Flow										
	Segment ID	BC	CD		BC	CD		BC		
7	Surface description (paved or unpaved)	Unpaved	Unpaved		Unpaved	Paved		Unpaved		
8	Flow length, L in ft	220	120		190	200		20		
9	Watercourse slope, s in ft/ft	0.035	0.1		0.1	0.03		0.2		
10	Average velocity, V in ft/s (figure 3-1)	3	5		5	3.5		2.5		
11	Tt=L/3600V in hr	0.020	0.007	0.027	0.011	0.016	0.026	0.002		0.002
Channel Flow										
	Segment ID	DE						CD		
12	Cross Sectional flow area, a in ft^2	0.75						3		
13	Wetted perimeter, pw in ft	3						6		
14	Hydraulic radius, r=a/pw in ft	0.25						0.5		
15	Channel slope, s in ft/ft	0.015						0.06		
16	Manning's roughness, n	0.15						0.15		
17	V=1.49xr^0.667xs^0.5/n in ft/s	0.48						1.53		
18	Flow length, L in ft	100						420		
19	Tt=L/3600V, in hr	0.058		0.058			0.000	0.076		0.076
20	Watershed total Tc in hours			0.34			0.17			0.08
Rainfall Intensity										
21	Time of Concentration, Tc in minutes			20.56			10.48			5.02
22	Intensity of 2 yr storm, I in inches/hour			3.42			4.63			5.74
23	Intensity of 10 yr storm, I in inches/hour			4.58			6.00			7.22
24	Intensity of 100 yr storm, I in inches/hour			6.36			8.17			9.66

Hydraflow Plan View



Project file: 15016 Cole Park Vet.stm	No. Lines: 4	12-16-2008

Hydraflow Storm Sewers 2003

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	A01 to A02	4.30	18 c	40.0	567.60	568.00	1.000	568.39	569.23	n/a	End
2	A02 to A03	1.21	15 c	77.0	568.20	569.00	1.039	569.23	569.62	n/a	1
3	B01 to B02	0.84	15 c	180.0	567.00	570.60	2.000	567.37	571.10	n/a	End
4	C01 to C02	1.08	15 c	64.0	580.00	581.00	1.563	580.42	581.58	n/a	End

Project File: 15016 Cole Park Vet.stm | Number of lines: 4 | Run Date: 12-16-2008

NOTES: c = circular; e = elliptical; b = box; Return period = 10 Yrs.; * Indicates surcharge condition.

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	40.0	1.14	2.44	0.61	0.70	0.96	10.0	21.3	4.5	4.30	10.50	4.55	18	1.00	568.00	567.60	569.23	568.39	571.00	0.00	A01 to A02
2	1	77.0	1.30	1.30	0.20	0.26	0.26	20.0	20.0	4.6	1.21	6.58	2.12	15	1.04	569.00	568.20	569.62	569.23	573.50	571.00	A02 to A03
3	End	180.0	0.90	0.90	0.20	0.18	0.18	20.0	20.0	4.6	0.84	9.13	2.77	15	2.00	570.60	567.00	571.10	567.37	573.50	0.00	B01 to B02
4	End	64.0	0.30	0.30	0.50	0.15	0.15	5.0	5.0	7.2	1.08	8.07	3.01	15	1.56	581.00	580.00	581.58	580.42	584.00	582.00	C01 to C02

Project File: 15016 Cole Park Vet.stm | Number of lines: 4 | Run Date: 12-16-2008

NOTES: Intensity = 195.00 / (Inlet time + 22.00) ^ 1.00; Return period = 10 Yrs.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	depth (ft)	spread (ft)	depth (ft)	spread (ft)	Dep (in)	
1	A02	4.24	0.00	4.24	0.00	DrGrt	0.0	0.00	3.00	4.00	2.00	Sag	2.00	0.330	0.330	0.000	0.31	3.91	0.31	3.91	0.00	Off
2	A03	1.21	0.00	1.21	0.00	DrGrt	0.0	0.00	3.00	4.00	2.00	Sag	2.00	0.330	0.330	0.000	0.14	2.82	0.14	2.82	0.00	Off
3	B02	0.84	0.00	0.84	0.00	DrGrt	0.0	0.00	3.00	4.00	2.00	Sag	2.00	0.330	0.330	0.000	0.11	2.65	0.11	2.65	0.00	Off
4	C02	1.08	0.00	1.08	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off

Project File: 15016 Cole Park Vet.stm | I-D-F File: DURHAM-REV.IDF | Number of lines: 4 | Run Date: 12-16-2008

NOTES: Inlet N-Values = 0.016 ; Intensity = 195.00 / (Inlet time + 22.00) ^ 1.00; Return period = 10 Yrs. ; * Indicates Known Q added

Hydraulic Grade Line Computations

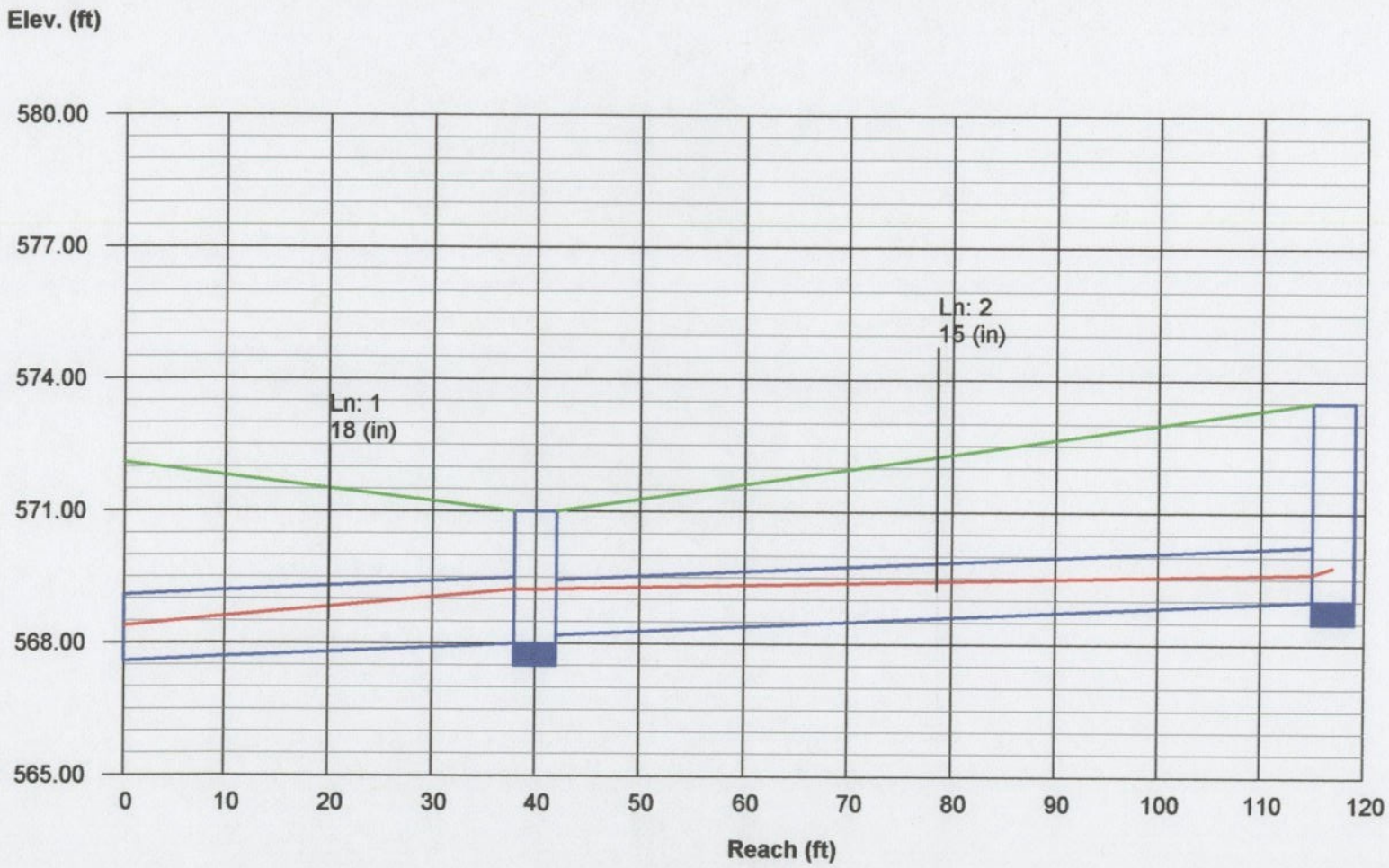
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
1	18	4.30	567.60	568.39	0.79	0.95	4.55	0.32	568.71	n/a	40.0	568.00	569.23i	0.79	0.95	4.55	0.32	569.55i	n/a	n/a	0.519	0.70	n/a
2	15	1.21	568.20	569.23	1.03	1.08	1.11	0.02	569.25	n/a	77.0	569.00	569.62i	0.44	0.39	3.13	0.15	569.77i	n/a	n/a	0.365	1.00	n/a
3	15	0.84	567.00	567.37	0.37	0.30	2.75	0.12	567.49	n/a	180	570.60	571.10i	0.37	0.30	2.79	0.12	571.22i	n/a	n/a	3.611	1.00	n/a
4	15	1.08	580.00	580.42	0.42	0.36	2.99	0.14	580.56	n/a	64.0	581.00	581.58i	0.42	0.36	3.03	0.14	581.72i	n/a	n/a	1.020	1.00	n/a

Project File: 15016 Cole Park Vet.stm | Number of lines: 4 | Run Date: 12-16-2008

NOTES: * Normal depth assumed., ** Critical depth assumed., i Under inlet control.

Storm Sewer Profile

Proj. file: 15016 Cole Park Vet.stm



Storm Sewer Profile

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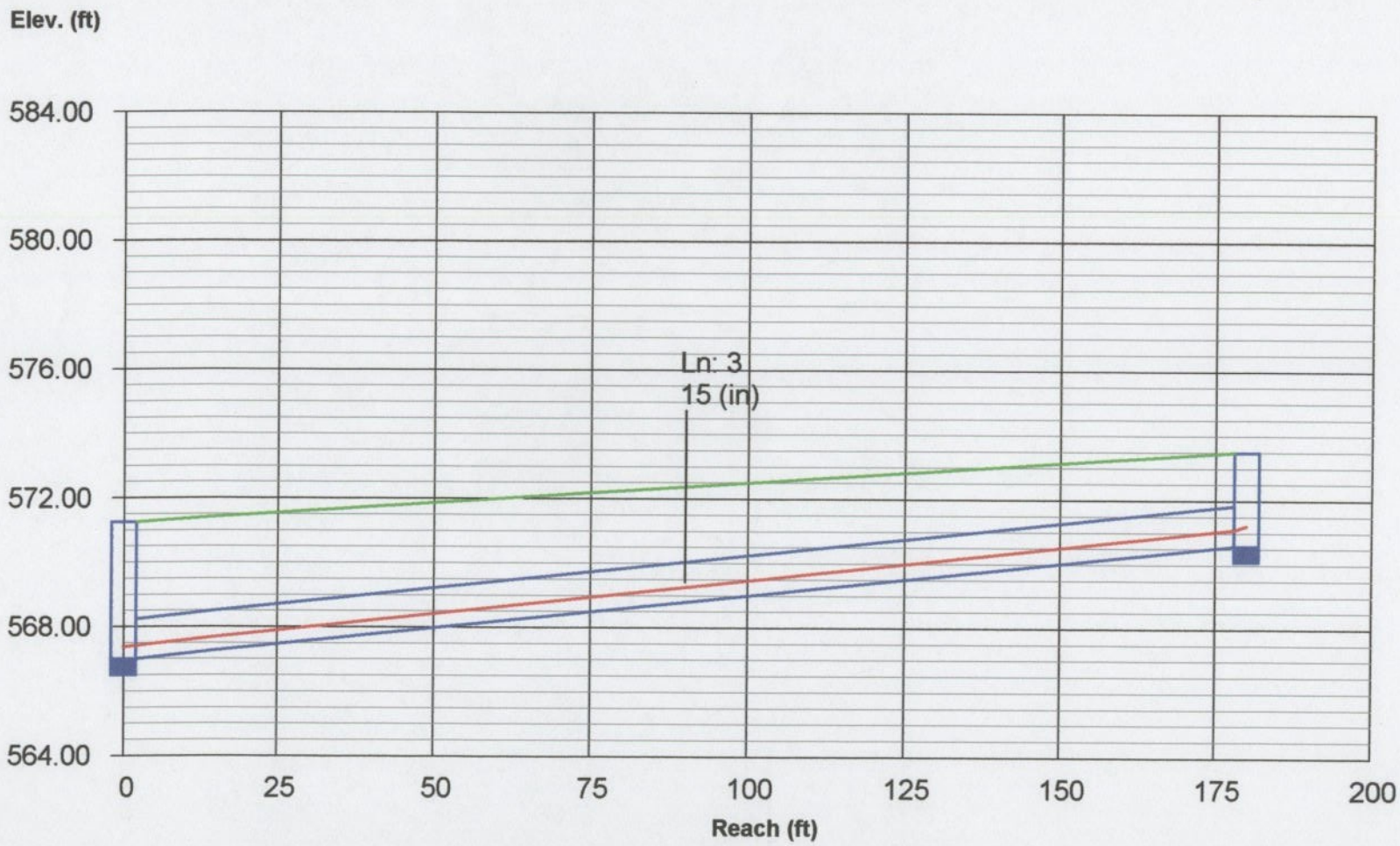
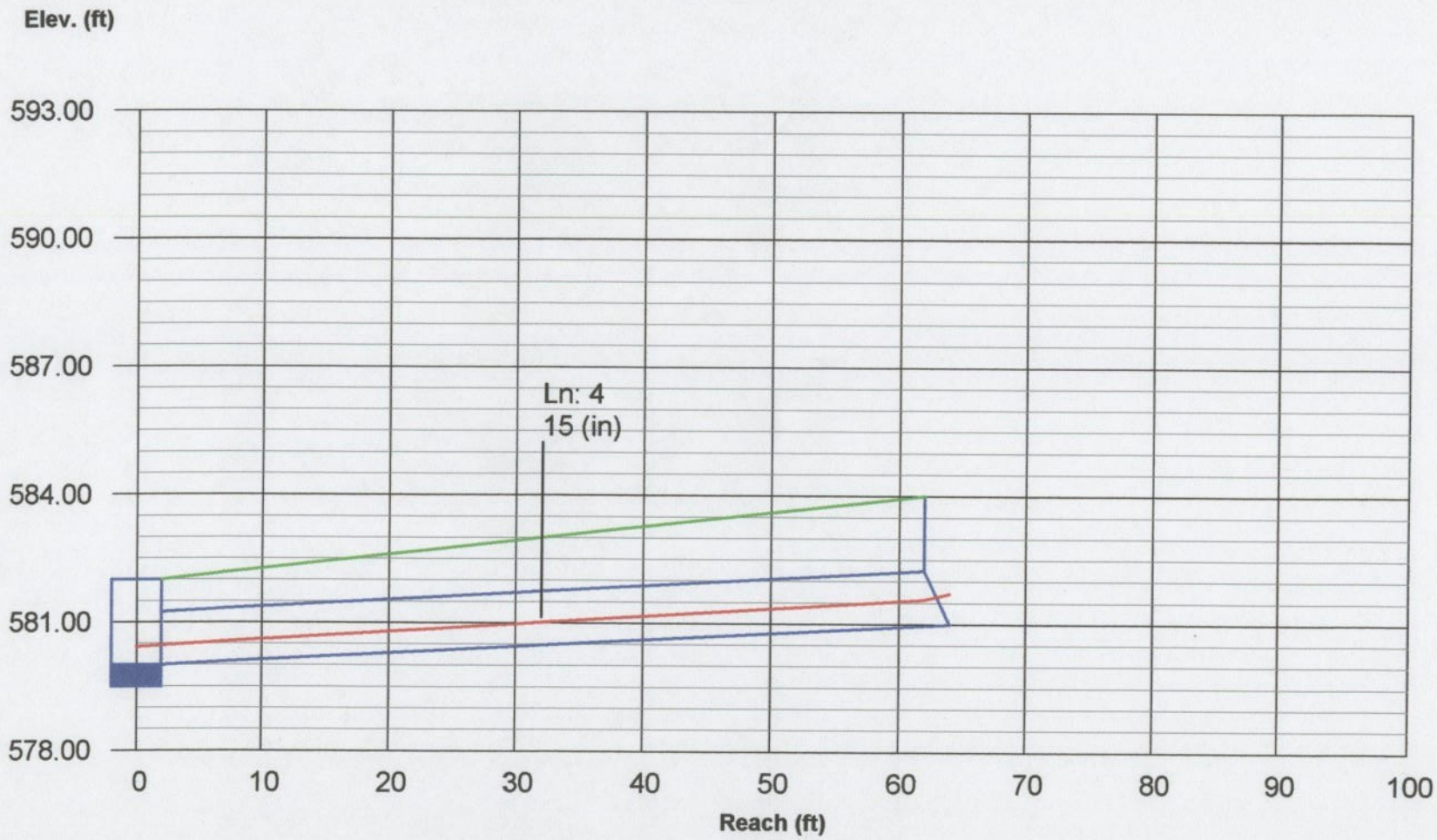


Storm Sewer Profile

Proj. file: 15016 Cole Park Vet.stm



Hydraflow Storm Sewers 2003

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line type	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	40.0	-160.1	DrGrt	0.00	1.14	0.61	10.0	567.60	1.00	568.00	18	Cir	0.013	0.70	571.00	A01 to A02
2	1	77.0	30.0	DrGrt	0.00	1.30	0.20	20.0	568.20	1.04	569.00	15	Cir	0.013	1.00	573.50	A02 to A03
3	End	180.0	-170.1	DrGrt	0.00	0.90	0.20	20.0	567.00	2.00	570.60	15	Cir	0.013	1.00	573.50	B01 to B02
4	End	64.0	-150.0	Hdwl	0.00	0.30	0.50	5.0	580.00	1.56	581.00	15	Cir	0.013	1.00	584.00	C01 to C02

Project File: 15016 Cole Park Vet.stm | Number of lines: 4 | Date: 12-16-2008

CHART 1: Precalculated Apron Sizes for Minimum TW Conditions

Apron Sizing Based on NCDENR Charts for Sizing - Sizes rounded up to the nearest 0.5 ft

ZONE 1 APRONS - Class A Erosion Control Stone

	Inlet			Outlet		
Pipe Diameter	L	W	T	L	W	T
inch	ft	ft	inch	ft	ft	inch
12	3	3	12	4	5	12
15	4	4	12	5	6.5	12
18	4.5	4.5	12	6	7.5	12
24	6	6	12	8	10	12
30	7.5	7.5	12	10	12.5	12
36	9	9	12	12	15	12
42	10.5	10.5	12	14	17.5	12
48	12	12	12	16	20	12
54	13.5	13.5	12	18	22.5	12
60	15	15	12	20	25	12

ZONE 3/4 APRONS - Class 1 Rip Rap

	Inlet			Outlet		
Pipe Diameter	L	W	T	L	W	T
inch	ft	ft	inch	ft	ft	inch
12	4	3	24	8	9	24
15	5	4	24	10	11.5	24
18	6	4.5	24	12	13.5	24
24	8	6	24	16	18	24
30	10	7.5	24	20	22.5	24
36	12	9	24	24	27	24
42	14	10.5	24	28	31.5	24
48	16	12	24	32	36	24
54	18	13.5	24	36	40.5	24
60	20	15	24	40	45	24

ZONE 2 APRONS - Class B Erosion Control Stone

	Inlet			Outlet		
Pipe Diameter	L	W	T	L	W	T
inch	ft	ft	inch	ft	ft	inch
12	3	3	18	6	7	18
15	4	4	18	7.5	9	18
18	4.5	4.5	18	9	10.5	18
24	6	6	18	12	14	18
30	7.5	7.5	18	15	17.5	18
36	9	9	18	18	21	18
42	10.5	10.5	18	21	24.5	18
48	12	12	18	24	28	18
54	13.5	13.5	18	27	31.5	18
60	15	15	18	30	35	18

-B,C
-A

ZONE 5 APRONS - Class 2 Rip Rap

	Inlet			Outlet		
Pipe Diameter	L	W	T	L	W	T
inch	ft	ft	inch	ft	ft	inch
12	5	3	36	10	11	36
15	6.5	4	36	12.5	14	36
18	7.5	4.5	36	15	16.5	36
24	10	6	36	20	22	36
30	12.5	7.5	36	25	27.5	36
36	15	9	36	30	33	36
42	17.5	10.5	36	35	38.5	36
48	20	12	36	40	44	36
54	22.5	13.5	36	45	49.5	36
60	25	15	36	50	55	36

Sediment and Erosion Control Calculations

COLE PARK VETERINARY HOSPITAL

Project: 15016
Date: Dec. 15, 2008

Sediment Trap:

Drainage Area	= 3.5 ac.
Disturbed Area	= 1.2 ac.
C	= 0.30 (Woods and disturbed site)
I_{10}	= 4.7 in/hr (Tc = 20 min.)

Q_{10} = CIA	= 3.5 x 4.7 x 0.30	= 4.9cfs
Surface Area (ac)	= 435 x Q_{10}	
	= 435 x 4.9	= 2130 sf
	Use a 105' x 23' trap SA	= 2415 sf
Volume (cu ft)	= 3600 x Disturbed Area	
	= 3600 x 1.1	= 3960 cu. ft.
	Volume provided at 3' depth	= 4028 cu. ft.
	Use 3' depth	
Wier Length	10' minimum (Table 6.60a)	

Calculate Skimmer Size

Basin Volume in Cubic Feet	4,028	Cu.Ft	**Skimmer Size**	**1.5**	Inch
Days to Drain*	3	Days	Orifice Radius	**0.7**	Inch[es]
			Orifice Diameter	**1.3**	Inch[es]

*In NC assume 3 days to drain

Estimate Volume of Basin

	Length	Width				
Top of water surface in feet	115	21	Feet	**VOLUME**	**4027.5**	**Cu. Ft.**
Bottom dimensions in feet	90	3	Feet			
Depth in feet	3		Feet			

DRAINAGE SWALE SCHEDULE

							Stability		Capacity (10-yr)		Temporary Protection (2-yr)					
														Temporary Liner		
Swale Number	Length (ft)	Area (ac)	C	I_{10} (in/hr)	Q_{10} (CFS)	Slope (%)	V_{10} (fps)	Is Grass Acceptable?	Flow Depth (ft)	Ditch Depth (ft)	Q_2	Flow Depth (ft)	Shear Stress T_2	Type	Installed Width (ft)	Comments
A	100	1.3	0.20	7.22	1.9	1.5%	2.37	Y	0.52	1.5	1.5	0.47	0.44	S75	4	
B	100	0.9	0.20	7.22	1.3	1.5%	2.16	Y	0.45	1.5	1.0	0.41	0.38	S75	4	
C	60	0.3	0.50	7.22	1.1	6.0%	3.48	Y	0.32	2.0	0.9	0.30	1.12	S75	4	

Notes:

1. Q = CIA; I_2 = 5.76 in/hr; I_{10} = 7.22 in/hr
2. S75 refers to single net straw blanket, as manufactured by North American Green, or approved equal.
3. TRM 450 refers to Landlok TRM 450 and is permanent reinforcement matting, manufactured by SI Geosolutions, or approved equal.

Swale A, 10-year Flow
Worksheet for Triangular Channel

Project Description	
Project File	p:\haestad\academic\fmw\cole par.fm2
Worksheet	Swale A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.015000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.90	cfs

Results		
Depth	0.52	ft
Flow Area	0.80	ft^2
Wetted Perimeter	3.27	ft
Top Width	3.10	ft
Critical Depth	0.48	ft
Critical Slope	0.022672	ft/ft
Velocity	2.37	ft/s
Velocity Head	0.09	ft
Specific Energy	0.60	ft
Froude Number	0.82	
Flow is subcritical.		

Swale A, 2-year Flow
Worksheet for Triangular Channel

Project Description	
Project File	p:\haestad\academic\fmw\cole par.fm2
Worksheet	Swale A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.015000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.50	cfs

Results		
Depth	0.47	ft
Flow Area	0.67	ft^2
Wetted Perimeter	2.99	ft
Top Width	2.84	ft
Critical Depth	0.43	ft
Critical Slope	0.023396	ft/ft
Velocity	2.24	ft/s
Velocity Head	0.08	ft
Specific Energy	0.55	ft
Froude Number	0.81	
Flow is subcritical.		

$T = yds$

$= 62.4 \times 0.47 \times 0.015$

$= 0.44$

Swale B, 10-year Flow
Worksheet for Triangular Channel

Project Description	
Project File	p:\haestad\academic\fmw\cole par.fm2
Worksheet	Swale A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.015000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.30	cfs

Results		
Depth	0.45	ft
Flow Area	0.60	ft^2
Wetted Perimeter	2.83	ft
Top Width	2.69	ft
Critical Depth	0.41	ft
Critical Slope	0.023847	ft/ft
Velocity	2.16	ft/s
Velocity Head	0.07	ft
Specific Energy	0.52	ft
Froude Number	0.80	
Flow is subcritical.		

Swale B, 2-year Flow
Worksheet for Triangular Channel

Project Description	
Project File	p:\haestad\academic\fmw\cole par.fm2
Worksheet	Swale A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.015000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.00	cfs

Results		
Depth	0.41	ft
Flow Area	0.49	ft^2
Wetted Perimeter	2.57	ft
Top Width	2.44	ft
Critical Depth	0.37	ft
Critical Slope	0.024696	ft/ft
Velocity	2.02	ft/s
Velocity Head	0.06	ft
Specific Energy	0.47	ft
Froude Number	0.79	
Flow is subcritical.		

$T = yds$

$= 62.4 \times 0.41 \times 0.015$

$= 0.38$

Swale C, 10-year Flow
Worksheet for Triangular Channel

Project Description	
Project File	p:\haestad\academic\fmw\cole par.fm2
Worksheet	Swale A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.10	cfs

Results		
Depth	0.32	ft
Flow Area	0.32	ft^2
Wetted Perimeter	2.05	ft
Top Width	1.95	ft
Critical Depth	0.38	ft
Critical Slope	0.024386	ft/ft
Velocity	3.48	ft/s
Velocity Head	0.19	ft
Specific Energy	0.51	ft
Froude Number	1.53	
Flow is supercritical.		

Swale C, 2-year Flow
Worksheet for Triangular Channel

Project Description	
Project File	p:\haestad\academic\fmw\cole par.fm2
Worksheet	Swale A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	0.90	cfs

Results		
Depth	0.30	ft
Flow Area	0.27	ft^2
Wetted Perimeter	1.90	ft
Top Width	1.81	ft
Critical Depth	0.35	ft
Critical Slope	0.025045	ft/ft
Velocity	3.31	ft/s
Velocity Head	0.17	ft
Specific Energy	0.47	ft
Froude Number	1.51	
Flow is supercritical.		

$T = yds$

$= 62.4 \times 0.3 \times 0.06$

$= 1.12$

Stormwater Management Analysis

civil consultants
LAND DEVELOPMENT CONSULTANTS

STORMWATER MANAGEMENT ANALYSIS

FOR

COLE PARK VETERINARY HOSPITAL
CHATHAM COUNTY, NC

DECEMBER 11, 2008

Project # 15016

Prepared for:
Cole Park Veterinary Hospital, LLC
Chatham County, NC

NORTH CAROLINA PROFESSIONAL SEAL 10437 ENGINEER WILLIAM C. MILLS

12-11-08

LAND PLANNERS + CIVIL ENGINEERS
3206 HERITAGE TRADE DR, SUITE 100, WAKE FOREST, NC 27587, 919.453.2386 PHONE 919.403.0336 FAX
WWW.CIVIL-CONSULTANTS.COM

STORMWATER MANAGEMENT ANALYSIS

Project Name:	**Cole Park Veterinary Hospital**
Project Number:	15016
Report Date:	December 11, 2008
Purpose:	To determine stormwater management plans

SITE DESCRIPTION:

Project Location:	U.S. Hwy 15-501 and Woodbridge Dr, Chatham County
Site Size:	Approximately 1.83 Acres
Watershed:	Wilson Creek Drainage Area (Unnamed tributary to Wilson Creek)
River Basin:	Cape Fear River Basin
Site Characteristics:	The proposed development site is approximately 1.83 acres in size and is located on the southwest corner of the intersection of U.S. Hwy 15-501 and Woodbridge Drive, Chatham County. The site is currently wooded.
Drainage Characteristics:	The site slopes to the east. The site drainage flows under Hwy 15-501 and is eventually flowing into a tributary of Wilson Creek. Wilson Creek and its tributaries are classified by the NC Division of Water Quality as "Class IV, Nutrient Sensitive Waters" and are in the Cape Fear River Basin.

PROPOSED DEVELOPMENT:

Proposed Usage:	The proposed development consists of a building with associated parking and other amenities.
Proposed Drainage:	The drainage from the proposed building and parking lot will be collected by storm drains and discharged to a proposed biofiltration cell to be constructed on the east side of the property. The overflow and underdrain flows from the biofiltration cell will discharge to a drainage feature adjacent to the highway. This cell will also receive runoff from a offsite area which only has a small amount of impervious surface.

The biofiltration cell has been designed in accordance with DWQ BMP Manual to achieve 85% removal of Total Suspended Solids for the runoff from the first one inch of rainfall. Calculations for the sizing of the biofiltration cell are included as attachments to this report.

ANALYSIS:

The larger portion of the stormwater runoff from the 1 year, 24 hour event will be retained in the biofiltration cell. Only the water in excess of that volume will discharge over the overflow weir. The captured volume will drain down slowly over approximately 24 to 48 hours and will be out of phase with the peak discharge in this event.

CONCLUSION:

With detention the peak flows of the stormwater discharges will meet the County of Chatham's requirements for stormwater management from the 1 year storm. The biofiltration cell satisfies the County of Chatham's requirements for stormwater treatment for TSS and also serves to reduce nutrients.

ATTACHMENTS:

Calculations for Biofiltration Cell

CIVIL CONSULTANTS, INC.
3708 Lyckan Parkway Suite 201
DURHAM, NC 27707
(919) 490-1645
Fax (919) 403-0336

JOB Cole Park Veterinary Hospital - Stormwater
SHEET NO. 1 OF 1
CALCULATED BY WCM DATE 12/11/08
CHECKED BY _____ DATE _____
SCALE N.T.S.

Biofiltration Cell

D.A. to cell = 27,102 ft² impervious
+ 22,679 ft² pervious
49,700 ft² - total I = 54% imperv.
or 1.14 AC.

$R_D = 1''$
D.A. = 1.14 AC.

$R_v = 0.05 + 0.009(I)$
$R_v = 0.05 + 0.009(54)$
$R_v = 0.54$

$WQ_v = R_v \times D.A. \times R_D \times 43{,}560 \times 1/12$

$WQ_v = 0.54 \times 1.0'' \times 1.14 AC \times 43{,}560 ft^2/AC \times 1/12''$

$WQ_v = 2235 ft^3$ = required Water Quality Volume for ponding

Area provided at surface of cell (571.00' EL) = 2037 ft²
" " " top of ponding (572.00' EL) = 2807 ft²
" " " midpoint of ponding (571.50' EL) = 2415 ft²

Therefore, (for 12" ponding depth) Ponding Volume provided = 2415 ft³

2415 ft³ > 2235 ft³ OK
size of surface ponding is sufficient.

Attached DWQ, BMP Manual Worksheet. - Rev. No. 7.

24" planting media - see details for planting mix
4" of mulch on top
4" of sand on bottom
gravel beneath sand with 4" underdrains - see details

Permit Number:_____
(to be provided by DWQ)

NCDENR

DIVISION OF WATER QUALITY DWQ

STORMWATER MANAGEMENT PERMIT APPLICATION FORM
401 CERTIFICATION APPLICATION FORM

BIORETENTION CELL SUPPLEMENT

This form must be filled out, printed and submitted.
The Required Items Checklist (Part III) must be printed, filled out and submitted along with all of the required information.

I. PROJECT INFORMATION

Project name	Cole Park Veterinary Hospital
Contact name	Bill Mills, P.E. , Civil Consultants, Inc.
Phone number	919-453-2386
Date	December 12, 2008
Drainage area number	1

II. DESIGN INFORMATION

Site Characteristics			
Drainage area	49,700	ft^2	
Impervious area	27,102	ft^2	
Percent impervious	54.5%	%	
Design rainfall depth	1.0	inch	
Peak Flow Calculations			
Is pre/post control of the 1-yr, 24-hr peak flow required?	y	(Y or N)	
1-yr, 24-hr runoff depth	3	in	
1-yr, 24-hr intensity	0.28	in/hr	
Pre-development 1-yr, 24-hr peak flow		ft^3/sec	
Post-development 1-yr, 24-hr peak flow		ft^3/sec	
Pre/Post 1-yr, 24-hr peak control		ft^3/sec	
Storage Volume: Non-SA Waters			
Minimum volume required	2,235.0	ft^3	
Volume provided	2,415.0	ft^3	OK
Storage Volume: SA Waters			
1.5" runoff volume		ft^3	
Pre-development 1-yr, 24-hr runoff		ft^3	
Post-development 1-yr, 24-hr runoff		ft^3	
Minimum volume required	0	ft^3	
Volume provided		ft^3	
Cell Dimensions			
Ponding depth of water	12	inches	OK
Ponding depth of water	1.00	ft	
Surface area of the top of the bioretention cell	2,415.0	ft^2	OK
Length:	100	ft	OK
Width:	20	ft	OK
-or- Radius		ft	
Media and Soils Summary			
Drawdown time, ponded volume	12	hr	OK
Drawdown time, to 24 inches below surface	24	hr	OK
Drawdown time, total:	36	hr	
In-situ soil:			
Soil permeability	3.50	in/hr	OK
Planting media soil:			
Soil permeability	3.00	in/hr	OK
Soil composition			
% Sand (by weight)	85%		OK
% Fines (by weight)	10%		OK
% Organic (by weight)	5%		OK
Total:	100%		
Phosphorus Index (P-Index) of media		(unitless)	

Basin Elevations

Temporary pool elevation	572.00	fmsl	
Type of bioretention cell (answer "Y" to only one of the two following questions):			
Is this a grassed cell?	y	(Y or N)	OK
Is this a cell with trees/shrubs?	n	(Y or N)	
Planting elevation (top of the mulch or grass sod layer)	571	fmsl	
Depth of mulch	4	inches	OK
Bottom of the planting media soil	569	fmsl	
Planting media depth	2	ft	
Depth of washed sand below planting media soil	0.33	ft	
Are underdrains being installed?	y	(Y or N)	
How many clean out pipes are being installed?	4		OK
What factor of safety is used for sizing the underdrains? (See BMP Manual Section 12.3.6)	2		OK
Additional distance between the bottom of the planting media and the bottom of the cell to account for underdrains	1	ft	
Bottom of the cell required	567.67	fmsl	
SHWT elevation	560	fmsl	
Distance from bottom to SHWT	7.67	ft	OK

Planting Plan

Number of tree species	1		
Number of shrub species	3		
Number of herbaceous groundcover species	0		OK

Additional Information

Does volume in excess of the design volume bypass the bioretention cell?	y	(Y or N)	OK
Does volume in excess of the design volume flow evenly distributed through a vegetated filter?	y	(Y or N)	OK
What is the length of the vegetated filter?	30	ft	
Does the design use a level spreader to evenly distribute flow?	n	(Y or N)	Show how flow is evenly distributed.
Is the BMP located at least 30 feet from surface waters (50 feet if SA waters)?	y	(Y or N)	OK
Is the BMP localed at least 100 feet from water supply wells?	y	(Y or N)	OK
Are the vegetated side slopes equal to or less than 3:1?	y	(Y or N)	OK
Is the BMP located in a proposed drainage easement with access to a public Right of Way (ROW)?	y	(Y or N)	OK
Inlet velocity (from treatment system)	1	ft/sec	OK
Is the area surrounding the cell likely to undergo development in the future?	n	(Y or N)	OK
Are the slopes draining to the bioretention cell greater than 20%?	n	(Y or N)	OK
Is the drainage area permanently stabilized?	y	(Y or N)	OK

Pretreatment Used
(Indicate Type Used with an "X" in the shaded cell)

Gravel and grass (8 inches gravel followed by 3-5 ft of grass)		
Grassed swale		#VALUE!
Forebay		
Other	x	