401 NARRATIVE & SUPPORTING CALCULATIONS

Briar Chapel Development
Great Ridge Parkway Extension

Chatham County, North Carolina
December 14, 2012

Prepared for:

BRIAR CHAPEL™
by
Newland COMMUNITIES

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M&C Project No. 02735-0080

PROJECT DESCRIPITON

The purpose of the project is to facilitate future residential areas by providing access and roadway connectivity within the development. Great Ridge Parkway Extension will provide a connection from Phase 4 to Granite Mill Boulevard and will provide the thoroughfare around which Briar Chapel South (Phases 7, 8 and 9) will be centered.

Great Ridge Parkway will be comprised of three primary roadway sections as well as the transition zones between each section. These sections will be

- 38' B-B undivided
- 35' B-B undivided
- 2 - 16.5' B-B sections divided.

Based on the conditions of the approved 401 Water Quality Certification, NCDENR-DWQ will require runoff from the roads to be captured and treated for 85% TSS removal before being discharged into the existing stream buffer. To meet this requirement, two BMPs have been designed: a wet detention pond and a level spreader/vegetative filter strip.

Upon completion of the project's construction, the proposed public roads will be turned over to and maintained by NCDOT.

SITE DESCRIPTION

The project area is approximately 14.5 acres of disturbed area located between the terminus of the existing Great Ridge Parkway within Briar Chapel and at a point along Granite Mill Boulevard near the Margaret B. Pollard Middle School.

The proposed roadway extension will cross a stream that is a direct tributary to Pokeberry Creek (WS-IV; NSW) which is saddled with 100' riparian buffers measured from the top of bank on each side as required by Chatham County. The stream is within the Cape Fear River Basi

The site generally slopes away from a ridge located near the midpoint of the project area, and drains to the north and south accordingly. The slopes in the site range from 5-20% in localized areas.

SOILS

According to the Chatham County Generalized Soil Survey, the soils located on the site are classified as Wedowee sandy loam, 2% to 15% slopes (WeC, WeD).

The following soil descriptions are associated with the soils found on the site:

> We(X) – Wedowee sandy loam soils are often found in piedmont uplands, along ridges and side slopes. Permeability is moderate and the soils are well drained. Soils have a low shrink/swell potential. The seasonal high water is generally more than 6.0 feet below the surface.

WET DETENTION DESIGN

The wet detention pond on this site has been designed to remove 90% of the total suspended solids entering from the surrounding impervious drainage areas before discharging into the adjacent stream. The calculations provided with this package include all projected future drainage areas that might be captured by the pond. Areas downstream of the ponds exceeded the new slope limitations required by the BMP Manual for level spreaders and vegetated filter strips. Treated runoff will be dissipated by a riprap outlet protection device before entering any stream buffers.

Design parameters were taken from the BMP manual and from DWQ's design supplement forms.

LEVEL SPREADER/VEGETATIVE FILTER STRIP DESIGN

Water quality flows were calculated using methods provided in the NC BMP Manual. For the proposed engineered level spreader/vegetated filter strip devices, the runoff was determined using a 1 in/hr rainfall. The outlet pipe to the level spreader was sized using the runoff. The overflow pipe for events larger than 1 in/hr was set at a higher outlet elevation to ensure that the flows are kept separate.

The LS/VFS system proposed is intended only to be a temporary measure. Upon future buildout, a wet detention pond will be designed to treat runoff from the larger drainage basin and will be designed per the precedence set in other phases of this project.

MAINTENANCE CONSIDERATIONS

The property owner shall be responsible for periodic inspection and maintenance of all temporary erosion control measures devices. Any measure that fails to function as intended shall be repaired immediately.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

CHAPEL HILL 2 W, NORTH CAROLINA (31-1677) 35.9086 N 79.0794 W 462 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004

Extracted: Wed Jan 20 2010

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Docs | Return to State Map

Precipitation Intensity Estimates (in/hr)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	4.93	3.94	3.28	2.25	1.40	0.84	0.60	0.36	0.21	0.12	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01
2	5.81	4.64	3.89	2.69	1.69	1.01	0.72	0.43	0.25	0.15	0.09	0.05	0.03	0.03	0.02	0.01	0.01	0.01
5	6.70	5.36	4.52	3.21	2.06	1.25	0.89	0.53	0.32	0.19	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01
10	7.38	5.90	4.98	3.61	2.35	1.43	1.03	0.62	0.37	0.22	0.12	0.07	0.04	0.03	0.02	0.02	0.01	0.01
25	8.11	6.46	5.46	4.04	2.69	1.66	1.20	0.73	0.44	0.25	0.15	0.08	0.05	0.04	0.03	0.02	0.02	0.01
50	8.62	6.86	5.79	4.36	2.95	1.85	1.34	0.82	0.50	0.29	0.16	0.09	0.06	0.04	0.03	0.02	0.02	0.02
100	9.07	7.21	6.07	4.65	3.20	2.02	1.48	0.91	0.56	0.32	0.18	0.10	0.06	0.05	0.03	0.02	0.02	0.02
200	9.44	7.49	6.30	4.90	3.44	2.20	1.63	1.01	0.62	0.35	0.20	0.11	0.07	0.05	0.03	0.03	0.02	0.02
500	9.85	7.79	6.54	5.21	3.73	2.43	1.82	1.14	0.71	0.40	0.22	0.12	0.08	0.06	0.04	0.03	0.02	0.02
1000	10.19	8.02	6.71	5.43	3.96	2.62	1.98	1.24	0.78	0.43	0.24	0.13	0.08	0.06	0.04	0.03	0.02	0.02

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

* Upper bound of the 90% confidence interval Precipitation Intensity Estimates (in/hr)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	5.39	4.31	3.59	2.46	1.53	0.92	0.65	0.39	0.23	0.13	0.08	0.04	0.03	0.02	0.01	0.01	0.01	0.01
2	6.36	5.08	4.26	2.94	1.85	1.11	0.79	0.47	0.28	0.16	0.09	0.05	0.03	0.03	0.02	0.01	0.01	0.01
5	7.31	5.86	4.94	3.51	2.25	1.37	0.97	0.58	0.34	0.20	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01
10	8.06	6.44	5.43	3.94	2.56	1.57	1.12	0.68	0.40	0.23	0.13	0.07	0.05	0.04	0.02	0.02	0.02	0.01
25	8.83	7.04	5.95	4.41	2.93	1.82	1.31	0.79	0.48	0.27	0.16	0.09	0.05	0.04	0.03	0.02	0.02	0.01
50	9.38	7.48	6.31	4.75	3.22	2.02	1.47	0.89	0.54	0.31	0.17	0.10	0.06	0.05	0.03	0.02	0.02	0.02
100	9.89	7.85	6.62	5.07	3.49	2.22	1.62	0.99	0.60	0.34	0.19	0.11	0.07	0.05	0.03	0.02	0.02	0.02
200	10.32	8.18	6.88	5.35	3.75	2.41	1.78	1.09	0.67	0.38	0.21	0.12	0.07	0.06	0.04	0.03	0.02	0.02
500	10.78	8.52	7.15	5.69	4.08	2.66	1.99	1.23	0.76	0.43	0.24	0.13	0.08	0.06	0.04	0.03	0.02	0.02
1000	11.14	8.77	7.34	5.94	4.34	2.87	2.16	1.36	0.85	0.46	0.26	0.14	0.09	0.07	0.04	0.03	0.02	0.02

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
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* Lower bound of the 90% confidence interval Precipitation Intensity Estimates (in/hr)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day

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NOAA, National Weather Service, Silver Spring, Maryland, 2004

Extracted: Tue Jan 19 2010

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Docs | Return to State Map

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.41	0.66	0.82	1.12	1.40	1.68	1.79	2.15	2.54	2.96	3.46	3.87	4.44	5.05	6.76	8.39	10.69	12.84
2	0.48	0.77	0.97	1.34	1.69	2.02	2.16	2.59	3.06	3.58	4.17	4.64	5.30	6.00	7.97	9.88	12.52	14.97
5	0.56	0.89	1.13	1.60	2.06	2.49	2.66	3.20	3.80	4.47	5.17	5.71	6.44	7.21	9.41	11.47	14.32	16.89
10	0.61	0.98	1.25	1.80	2.35	2.87	3.08	3.71	4.44	5.17	5.95	6.54	7.34	8.15	10.56	12.72	15.72	18.37
25	0.68	1.08	1.36	2.02	2.69	3.33	3.61	4.37	5.28	6.11	6.99	7.68	8.57	9.42	12.11	14.36	17.55	20.28
50	0.72	1.14	1.45	2.18	2.95	3.70	4.04	4.92	5.99	6.86	7.81	8.57	9.54	10.43	13.34	15.62	18.95	21.72
100	0.76	1.20	1.52	2.33	3.20	4.05	4.46	5.47	6.71	7.62	8.64	9.49	10.53	11.44	14.57	16.87	20.31	23.11
200	0.79	1.25	1.57	2.45	3.44	4.40	4.89	6.03	7.47	8.41	9.49	10.44	11.56	12.47	15.83	18.12	21.67	24.46
500	0.82	1.30	1.64	2.60	3.73	4.86	5.46	6.80	8.53	9.50	10.66	11.73	12.96	13.87	17.55	19.80	23.46	26.21
1000	0.85	1.34	1.68	2.72	3.96	5.23	5.93	7.44	9.43	10.35	11.58	12.76	14.06	14.97	18.89	21.09	24.83	27.53

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*** Upper bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

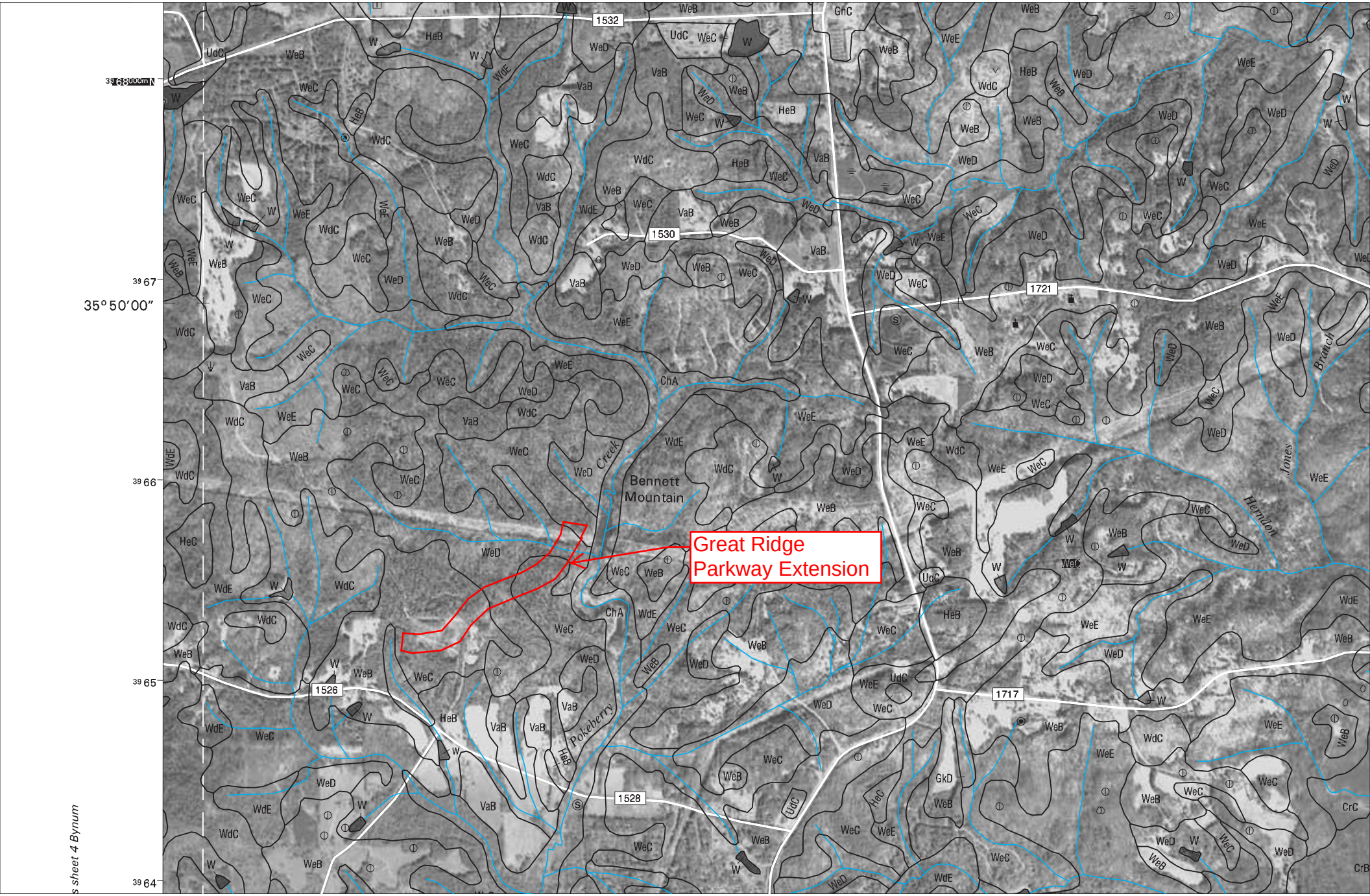
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.45	0.72	0.90	1.23	1.53	1.84	1.96	2.35	2.77	3.16	3.70	4.14	4.73	5.37	7.14	8.87	11.24	13.44
2	0.53	0.85	1.06	1.47	1.85	2.22	2.37	2.83	3.34	3.82	4.46	4.96	5.64	6.38	8.43	10.42	13.15	15.68
5	0.61	0.98	1.23	1.75	2.25	2.73	2.92	3.50	4.15	4.77	5.53	6.09	6.86	7.66	9.95	12.10	15.04	17.69
10	0.67	1.07	1.36	1.97	2.56	3.14	3.37	4.05	4.83	5.51	6.36	6.99	7.82	8.66	11.17	13.41	16.51	19.25
25	0.74	1.17	1.49	2.20	2.93	3.64	3.94	4.76	5.73	6.54	7.47	8.22	9.14	10.02	12.82	15.15	18.44	21.26
50	0.78	1.25	1.58	2.38	3.22	4.04	4.41	5.35	6.47	7.34	8.35	9.19	10.19	11.11	14.14	16.50	19.92	22.80
100	0.82	1.31	1.66	2.53	3.49	4.43	4.87	5.94	7.25	8.17	9.27	10.19	11.26	12.21	15.48	17.85	21.39	24.28
200	0.86	1.36	1.72	2.68	3.75	4.82	5.34	6.56	8.06	9.03	10.19	11.22	12.38	13.33	16.86	19.21	22.85	25.73
500	0.90	1.42	1.79	2.84	4.08	5.32	5.96	7.39	9.20	10.21	11.47	12.65	13.91	14.86	18.72	21.04	24.81	27.63
1000	0.93	1.46	1.83	2.97	4.34	5.74	6.50	8.11	10.19	11.15	12.49	13.79	15.14	16.07	20.20	22.46	26.31	29.07

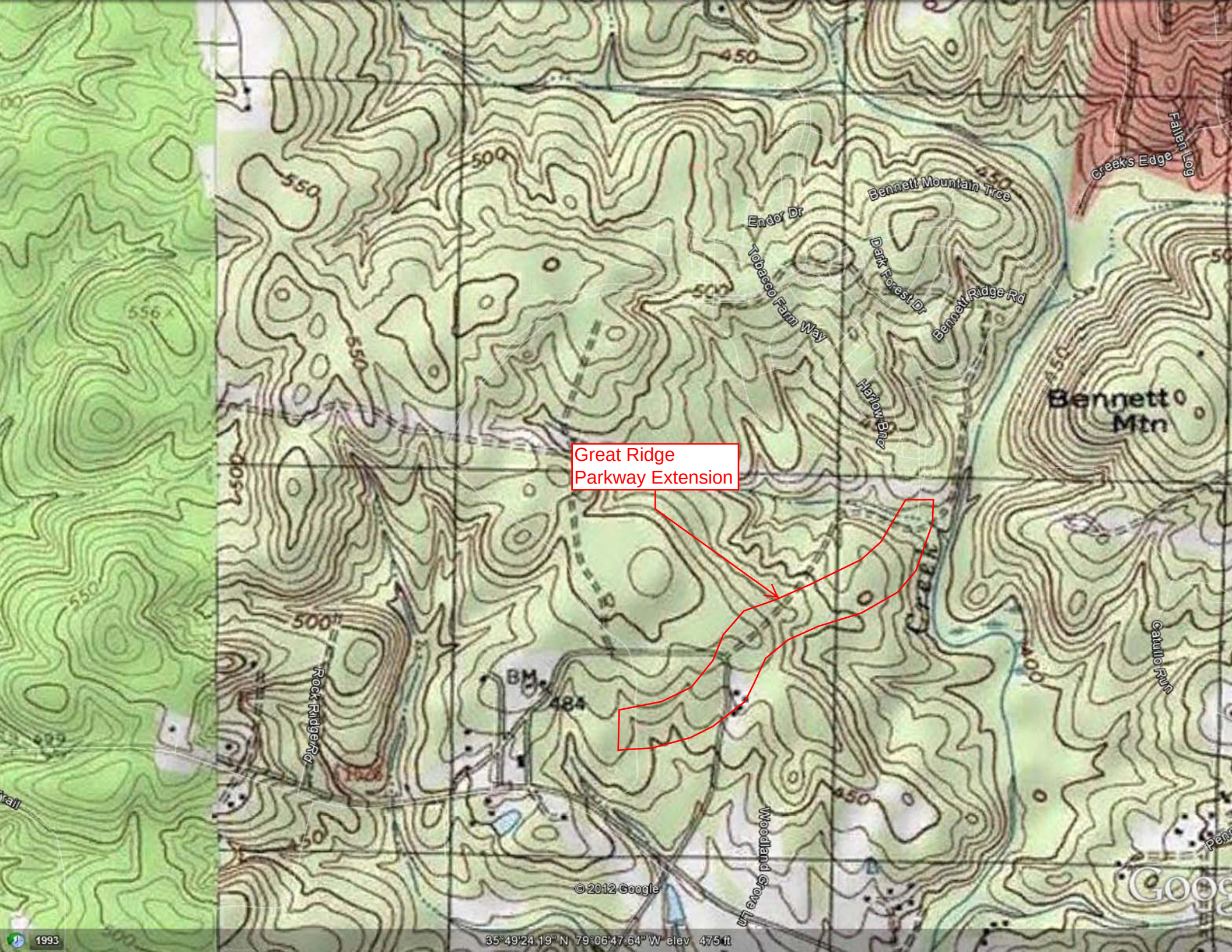
* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

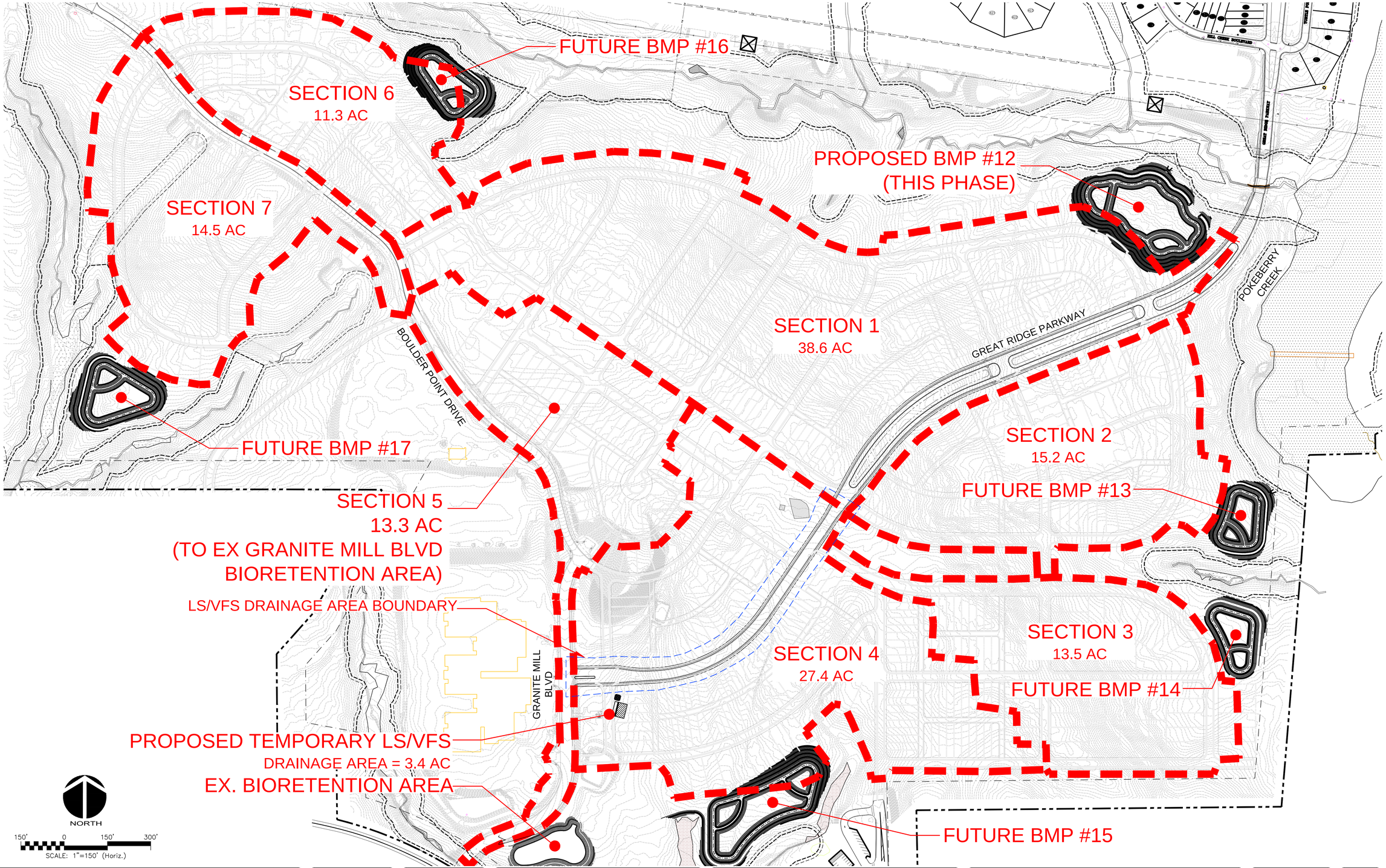
*** Lower bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day

MAPS


Great Ridge
Parkway Extension
Bennett
Mountain
Creek
Pokeberry
Jones
Branch
Herndon
1532
1530
1721
1526
1528
1717
39 68 000m N
39 67
35° 50′ 00″
39 66
39 65
39 64
s sheet 4 Bynum


Great Ridge
Parkway Extension
Bennett Mtn
Bennett Mountain Trce
Endor Dr
Tobacco Farm Way
Dark Forest Dr
Bennett Ridge Rd
Harlow Brg
Creeks Edge
Fallen Log
Rock Ridge Rd
Woodland Grove Ln
Catullo Run
BM
484
© 2012 Google
1993
35°49'24.19" N 79°06'47.64" W elev 475 ft



REV.NO.	DESCRIPTIONS	DATE
1	SUBMITTAL TO DWQ 401 UNIT	2012.12.19

REVISIONS

SEAL

SEAL

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BRIAR CHAPEL™
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BRIAR CHAPEL
GREAT RIDGE PARKWAY EXTENSION
CHATHAM COUNTY, NORTH CAROLINA

BC SOUTH DRAINAGE AREA MAP

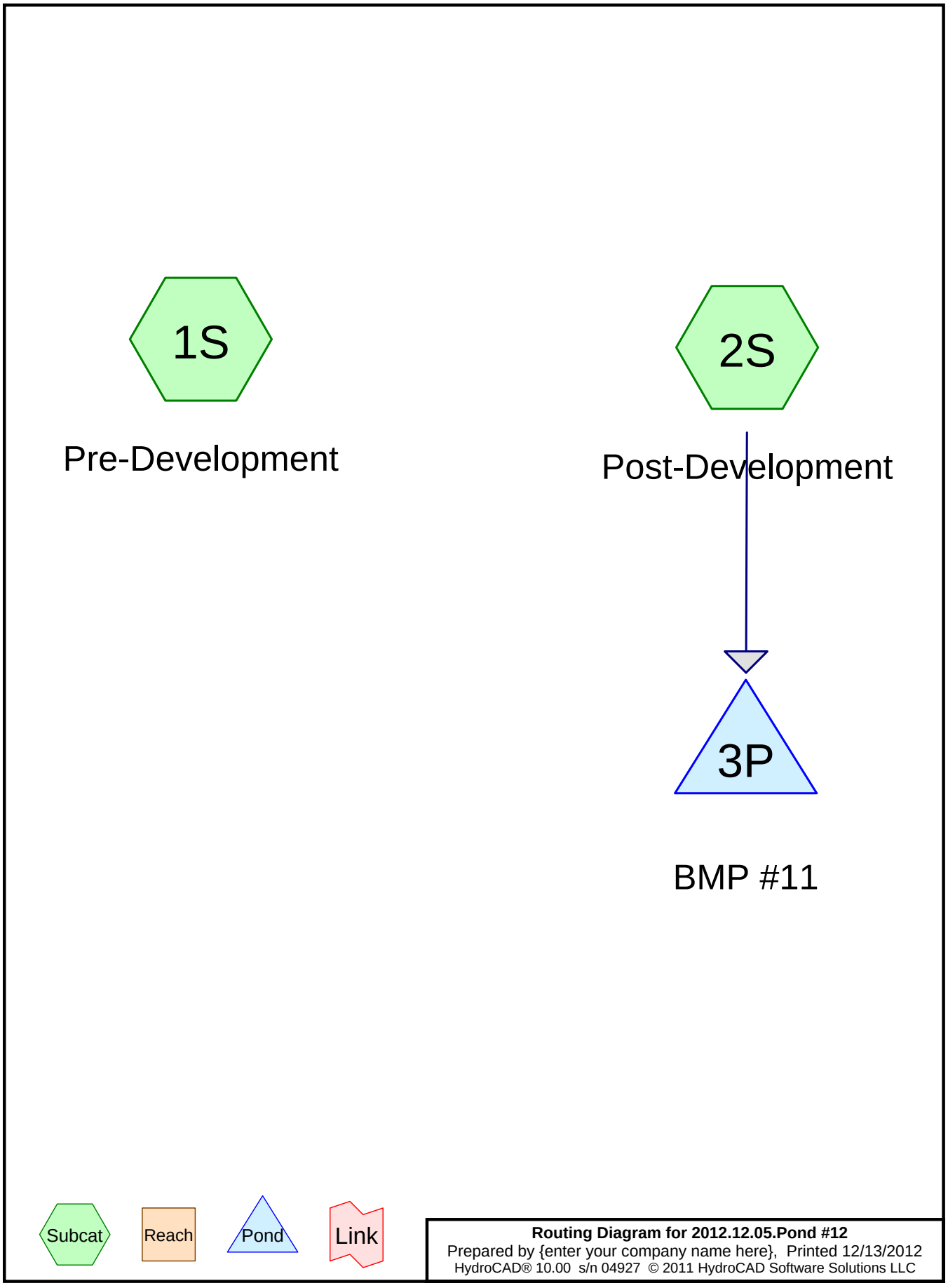
DATE:	DECEMBER 19, 2012
MCE PROJ. #	02735-0080
DRAWN	GCA
DESIGNED	GCA
CHECKED	CHS
PROJ. MGR.	CHS

SCALE
HORIZONTAL: 1" = 150'
VERTICAL: N/A

M&C FILE NUMBER
DA MAP
DRAWING NUMBER
MAP 1

STATUS: FOR PERMIT ONLY
REVISION 1

WET DETENTION POND
#12 DESIGN



Routing Diagram for 2012.12.05.Pond #12
Prepared by {enter your company name here}, Printed 12/13/2012

Summary for Pond 3P: BMP #11

Inflow Area = 39.152 ac, 66.12% Impervious, Inflow Depth = 0.32" for 1-inch event
Inflow = 15.42 cfs @ 12.08 hrs, Volume= 1.045 af
Outflow = 0.45 cfs @ 18.08 hrs, Volume= 0.742 af, Atten= 97%, Lag= 360.0 min
Primary = 0.45 cfs @ 18.08 hrs, Volume= 0.742 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 414.98' @ 18.08 hrs Surf.Area= 64,092 sf Storage= 29,379 cf

Plug-Flow detention time= 662.2 min calculated for 0.742 af (71% of inflow)
Center-of-Mass det. time= 551.2 min (1,419.0 - 867.8)

Volume	Invert	Avail.Storage	Storage Description
#1	414.50'	332,222 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

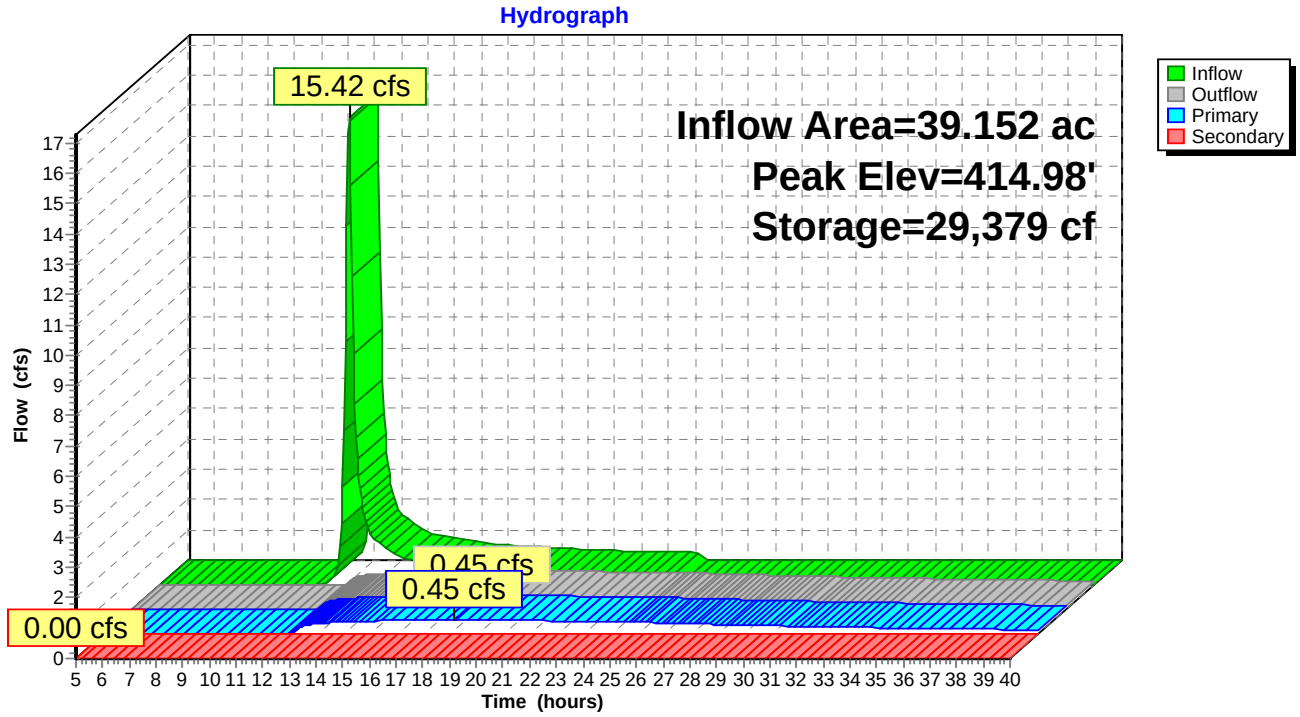
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
414.50	59,103	0	0
415.00	64,333	30,859	30,859
416.00	67,546	65,940	96,799
417.00	54,030	60,788	157,587
418.00	56,787	55,409	212,995
419.00	59,599	58,193	271,188
420.00	62,468	61,034	332,222

Device	Routing	Invert	Outlet Devices
#1	Primary	411.00'	**30.0" Round Culvert** L= 55.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 411.00' / 410.00' S= 0.0182 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	414.50'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	416.00'	**30.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	416.33'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	419.00'	**50.0' long x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.45 cfs @ 18.08 hrs HW=414.98' (Free Discharge)
└**1=Culvert** (Passes 0.45 cfs of 39.03 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.45 cfs @ 2.35 fps)
  ├**3=Orifice/Grate** (Controls 0.00 cfs)
  └**4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=414.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: BMP #11



Summary for Subcatchment 1S: Pre-Development

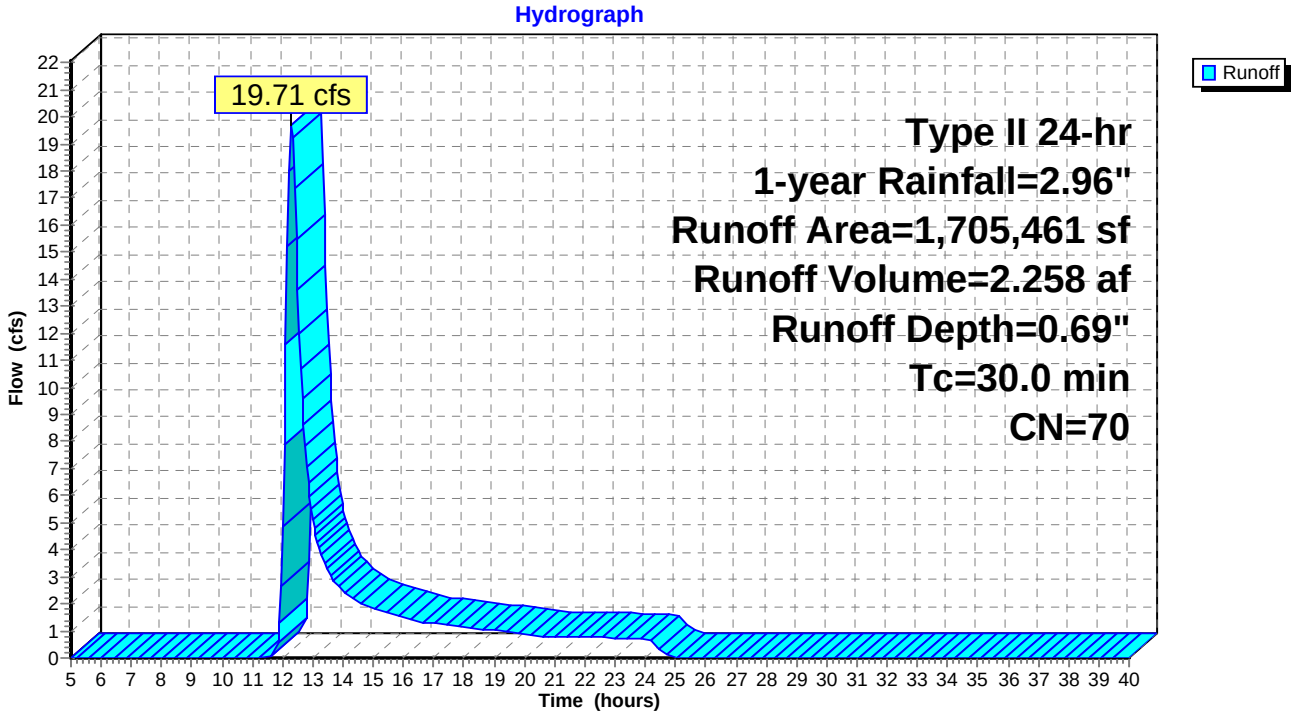
Runoff = 19.71 cfs @ 12.28 hrs, Volume= 2.258 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-year Rainfall=2.96"

Area (sf)	CN	Description
1,705,461	70	Woods, Good, HSG C
1,705,461		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry,**

Subcatchment 1S: Pre-Development



Summary for Pond 3P: BMP #11

Inflow Area = 39.152 ac, 66.12% Impervious, Inflow Depth = 1.95" for 1-year event
Inflow = 96.85 cfs @ 12.07 hrs, Volume= 6.354 af
Outflow = 19.59 cfs @ 12.44 hrs, Volume= 5.149 af, Atten= 80%, Lag= 22.1 min
Primary = 19.59 cfs @ 12.44 hrs, Volume= 5.149 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 416.77' @ 12.44 hrs Surf.Area= 57,174 sf Storage= 144,654 cf

Plug-Flow detention time= 428.6 min calculated for 5.149 af (81% of inflow)
Center-of-Mass det. time= 349.5 min (1,164.8 - 815.2)

Volume	Invert	Avail.Storage	Storage Description
#1	414.50'	332,222 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

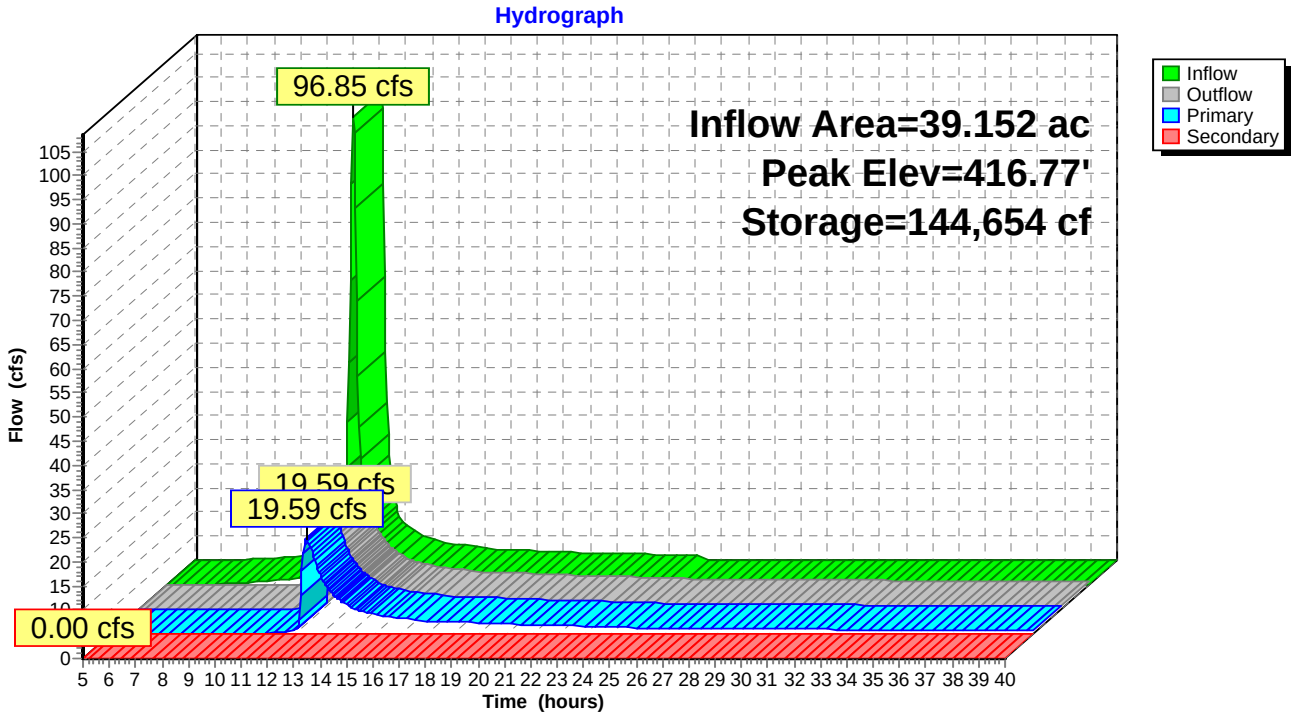
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
414.50	59,103	0	0
415.00	64,333	30,859	30,859
416.00	67,546	65,940	96,799
417.00	54,030	60,788	157,587
418.00	56,787	55,409	212,995
419.00	59,599	58,193	271,188
420.00	62,468	61,034	332,222

Device	Routing	Invert	Outlet Devices
#1	Primary	411.00'	**30.0" Round Culvert** L= 55.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 411.00' / 410.00' S= 0.0182 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	414.50'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	416.00'	**30.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	416.33'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	419.00'	**50.0' long x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=19.53 cfs @ 12.44 hrs HW=416.77' (Free Discharge)
└**1=Culvert** (Passes 19.53 cfs of 50.23 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 1.34 cfs @ 6.84 fps)
  ├**3=Orifice/Grate** (Orifice Controls 3.10 cfs @ 3.72 fps)
  └**4=Orifice/Grate** (Weir Controls 15.09 cfs @ 2.16 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=414.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: BMP #11



Summary for Subcatchment 1S: Pre-Development

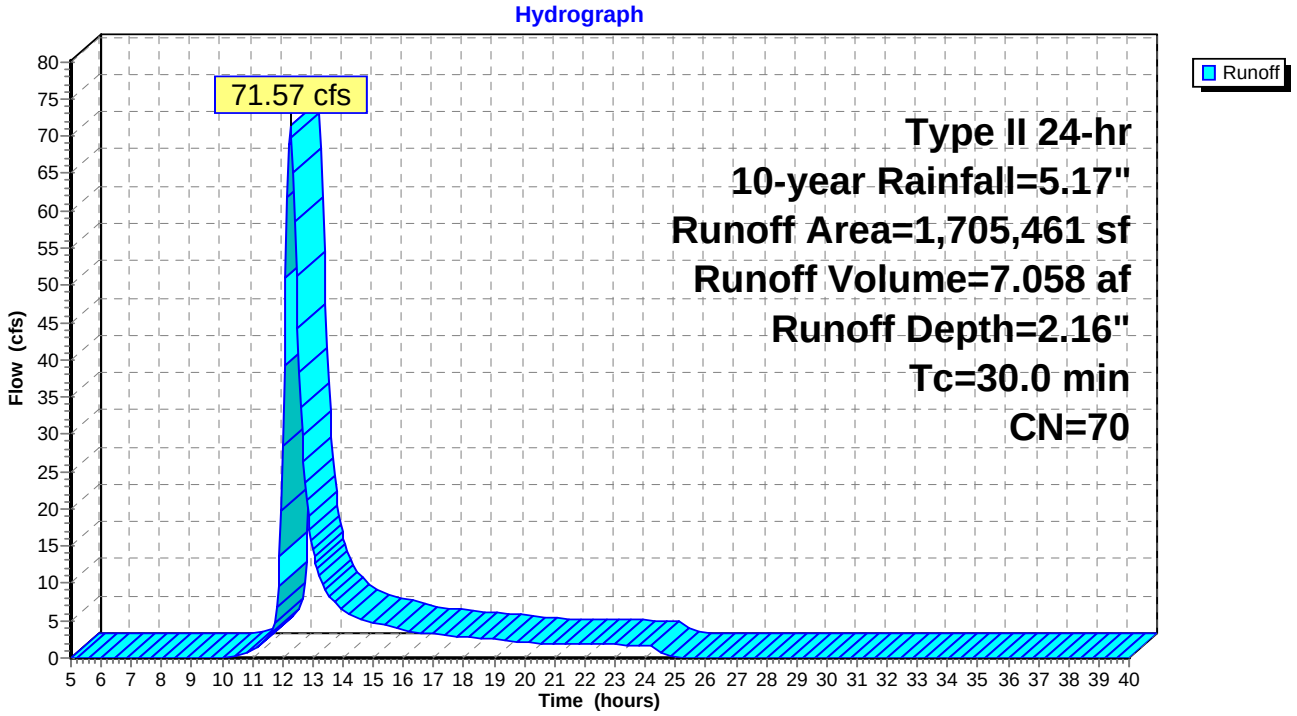
Runoff = 71.57 cfs @ 12.26 hrs, Volume= 7.058 af, Depth= 2.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.17"

Area (sf)	CN	Description
1,705,461	70	Woods, Good, HSG C
1,705,461		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry,**

Subcatchment 1S: Pre-Development



Summary for Pond 3P: BMP #11

[82] Warning: Early inflow requires earlier time span

Inflow Area = 39.152 ac, 66.12% Impervious, Inflow Depth > 4.03" for 10-year event
Inflow = 194.70 cfs @ 12.06 hrs, Volume= 13.164 af
Outflow = 60.36 cfs @ 12.32 hrs, Volume= 11.867 af, Atten= 69%, Lag= 15.2 min
Primary = 60.36 cfs @ 12.32 hrs, Volume= 11.867 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 418.77' @ 12.32 hrs Surf.Area= 58,957 sf Storage= 257,653 cf

Plug-Flow detention time= 234.1 min calculated for 11.866 af (90% of inflow)
Center-of-Mass det. time= 183.4 min (978.9 - 795.4)

Volume	Invert	Avail.Storage	Storage Description
#1	414.50'	332,222 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

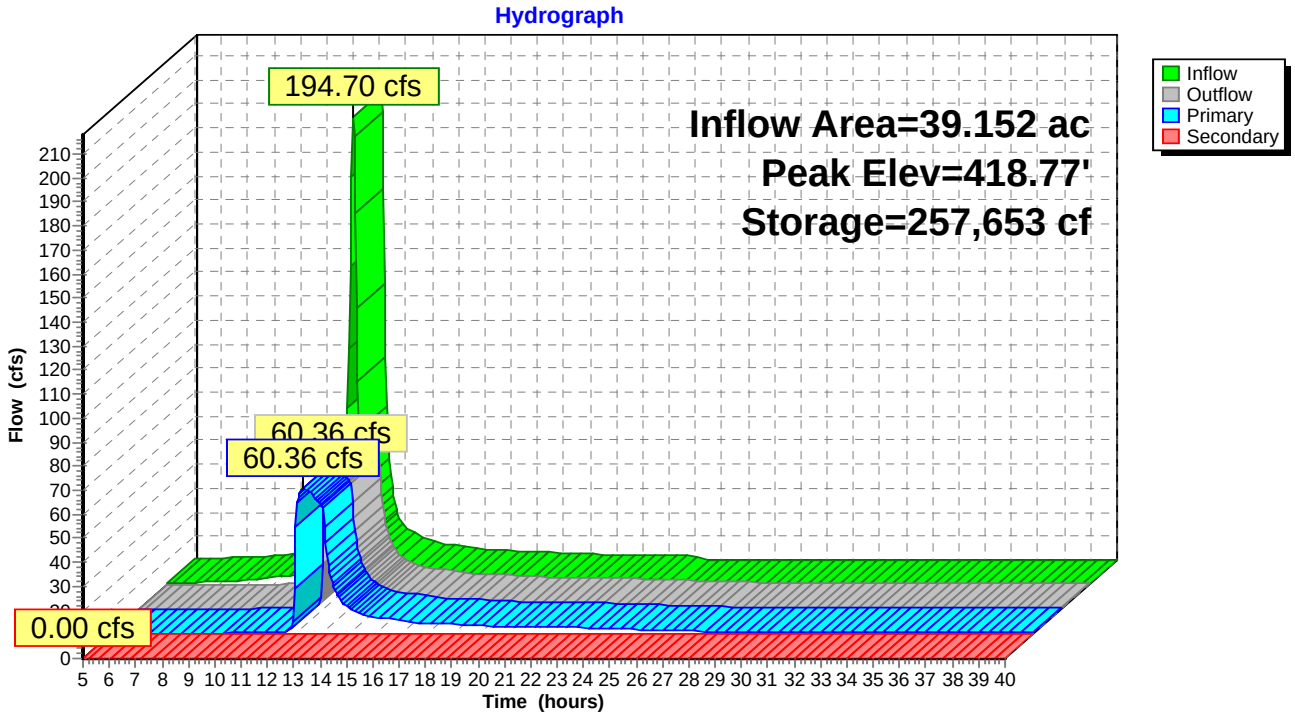
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
414.50	59,103	0	0
415.00	64,333	30,859	30,859
416.00	67,546	65,940	96,799
417.00	54,030	60,788	157,587
418.00	56,787	55,409	212,995
419.00	59,599	58,193	271,188
420.00	62,468	61,034	332,222

Device	Routing	Invert	Outlet Devices
#1	Primary	411.00'	**30.0" Round Culvert** L= 55.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 411.00' / 410.00' S= 0.0182 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	414.50'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	416.00'	**30.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	416.33'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	419.00'	**50.0' long x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=60.33 cfs @ 12.32 hrs HW=418.77' (Free Discharge)
└**1=Culvert** (Inlet Controls 60.33 cfs @ 12.29 fps)
  ├**2=Orifice/Grate** (Passes < 1.89 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 6.47 cfs potential flow)
  └**4=Orifice/Grate** (Passes < 120.24 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=414.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: BMP #11



Summary for Subcatchment 1S: Pre-Development

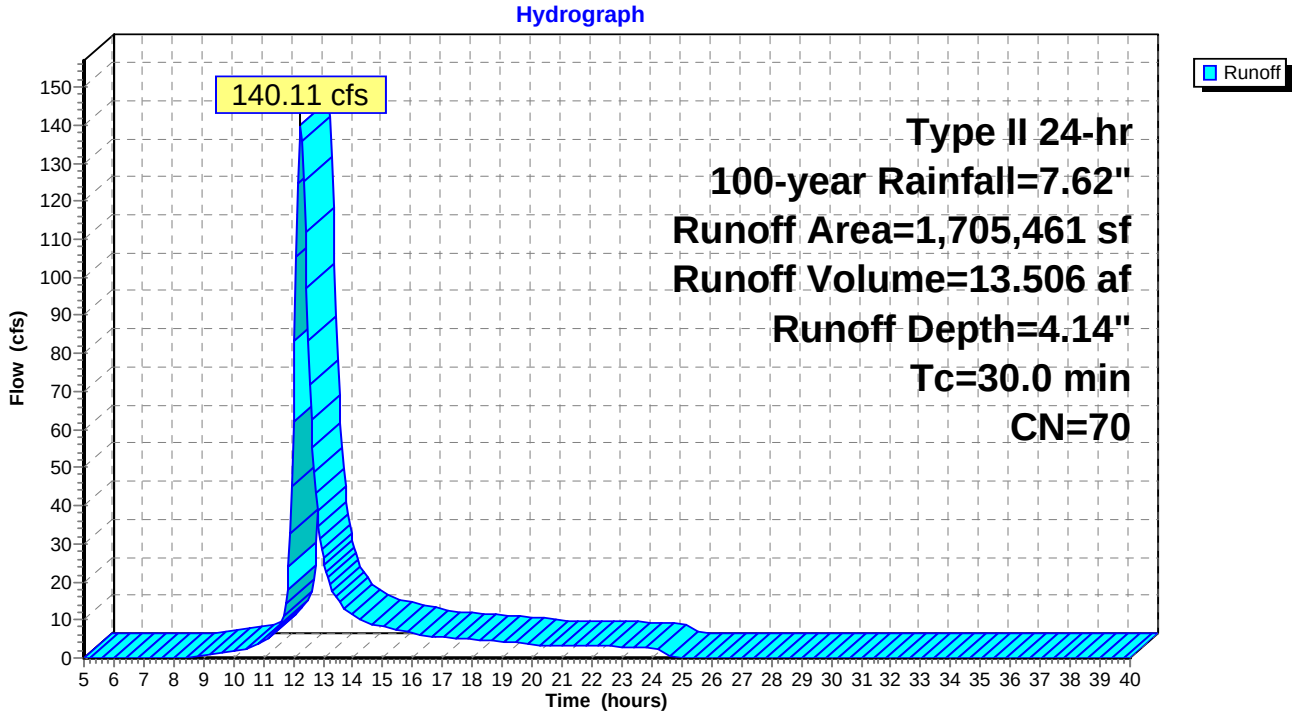
Runoff = 140.11 cfs @ 12.25 hrs, Volume= 13.506 af, Depth= 4.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=7.62"

Area (sf)	CN	Description
1,705,461	70	Woods, Good, HSG C
1,705,461		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry,**

Subcatchment 1S: Pre-Development



Summary for Pond 3P: BMP #11

[82] Warning: Early inflow requires earlier time span
[93] Warning: Storage range exceeded by 0.05'

Inflow Area = 39.152 ac, 66.12% Impervious, Inflow Depth > 6.39" for 100-year event
Inflow = 302.03 cfs @ 12.06 hrs, Volume= 20.859 af
Outflow = 207.90 cfs @ 12.19 hrs, Volume= 19.529 af, Atten= 31%, Lag= 7.7 min
Primary = 66.02 cfs @ 12.19 hrs, Volume= 16.593 af
Secondary = 141.88 cfs @ 12.19 hrs, Volume= 2.936 af

Routing by Stor-Ind method, Time Span= 5.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 420.05' @ 12.19 hrs Surf.Area= 62,468 sf Storage= 332,222 cf

Plug-Flow detention time= 167.1 min calculated for 19.526 af (94% of inflow)
Center-of-Mass det. time= 130.9 min (916.3 - 785.4)

Volume	Invert	Avail.Storage	Storage Description
#1	414.50'	332,222 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

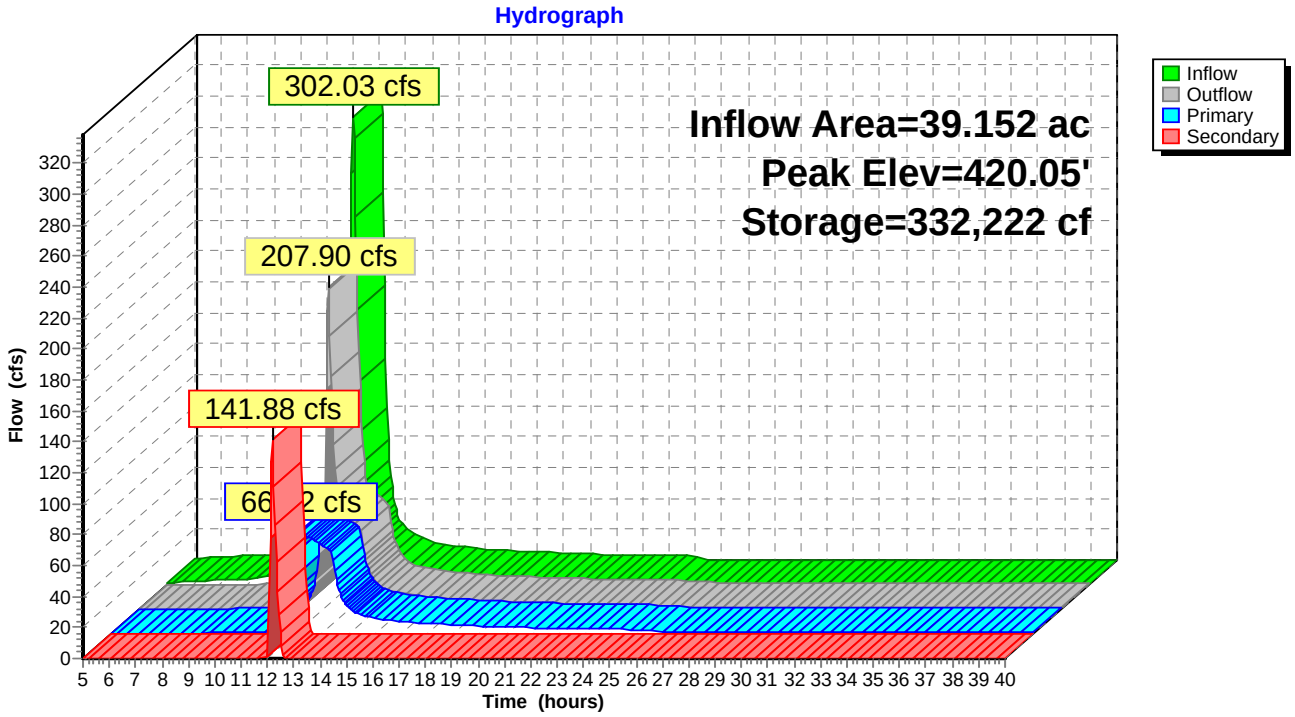
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
414.50	59,103	0	0
415.00	64,333	30,859	30,859
416.00	67,546	65,940	96,799
417.00	54,030	60,788	157,587
418.00	56,787	55,409	212,995
419.00	59,599	58,193	271,188
420.00	62,468	61,034	332,222

Device	Routing	Invert	Outlet Devices
#1	Primary	411.00'	**30.0" Round Culvert** L= 55.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 411.00' / 410.00' S= 0.0182 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	414.50'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	416.00'	**30.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	416.33'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	419.00'	**50.0' long x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=65.94 cfs @ 12.19 hrs HW=420.03' (Free Discharge)
└**1=Culvert** (Inlet Controls 65.94 cfs @ 13.43 fps)
  ├**2=Orifice/Grate** (Passes < 2.17 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 7.89 cfs potential flow)
  └**4=Orifice/Grate** (Passes < 148.27 cfs potential flow)

Secondary OutFlow Max=138.46 cfs @ 12.19 hrs HW=420.03' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Weir Controls 138.46 cfs @ 2.68 fps)

Pond 3P: BMP #11



WATER QUALITY POND #12 CALCULATIONS

Project Name

Briar Chapel - Great Ridge Parkway Extension

Project Number

02735-0080

Date
December 14, 2012

3rd revision
2nd revision
1st revision

Water Quality Pond Drainage Area Data

Project: Briar Chapel - Great Ridge Parkway Extension
Project No.: 02735-0080

Date: December 14, 2012

Total site area: 1,705,452 square feet = 39.15 acres

Impervious areas	Drainage area to pond			Other Drainage Area	
	Existing [sf]	Proposed [sf]	Change [sf]	Existing [sf]	Proposed [sf]
On-site buildings (BUA)	0	630,800	630,800	0	0
On-site streets	0	297,243	297,243	0	0
On-site alleys	0	55,676	55,676	0	0
On-site sidewalks	0	70,291	70,291	0	0
On-site future (open space)	0	10,000	10,000	0	0
Off-site streets	0	0	0	0	0
5% Contingency	0	53,201	53,201	0	0
Total Impervious	0	1,117,211	1,117,211	0	0

Non-impervious areas	Drainage area to pond			Other Drainage Area	
	Existing [sf]	Proposed [sf]	Change [sf]	Existing [sf]	Proposed [sf]
On-site grass/landscape	0	577,741	577,741	0	0
On-site woods	1,705,452	0	-1,705,452	0	0
Other undeveloped	0	0	0	0	0
Total off-site non-impervious	0	0	0	0	0
Total non-impervious	1,705,452	577,741	-1,127,711	0	0

Total Drainage Area	1,705,452	1,705,452	0	3,167,850	3,167,850
Percent Impervious	0.0	65.5	65.5	0.0	0.0

Notes:

Water Quality Pond Surface Area Calculations

Project: Briar Chapel - Great Ridge Parkway Extension
Project No.: 02735-0080

Date: December 14, 2012

Total on-site drainage area to pond	1,705,452	square feet
Total impervious area in drainage area	1,117,211	square feet

Average water depth of basin at normal pool: 3.5 feet

Location of site: Chatham County
Site region: Piedmont

% Impervious cover: 65.5 percent

If the site is in a coastal area, will a vegetative filter be used? n/a

Surface Area/Drainage Area Ratios:

For a site in the Piedmont (85%)	2.4	percent
For a site in the Piedmont (90%)	3.4	percent
For a site in a Coastal County w/ Vegetative Filter	4.9	percent
For a site in a Coastal County w/out Vegetative Filter	6.6	percent

Required surface area of pond:

For a site in the Piedmont (85%)	41,770.0	square feet
For a site in the Piedmont (90%)	58,420.0	square feet
For a site in a Coastal County w/ Vegetative Filter	83,030.0	square feet
For a site in a Coastal County w/out Vegetative Filter	113,340.0	square feet

Notes:

Water Quality Pond Stormwater Runoff Volume Calculations

Project	Briar Chapel - Great Ridge Parkway Exten	
Project No.	02735-0080	
Date	December 14, 2012	
Drainage area	1,705,452	square feet
Impervious area	1,117,211	square feet
Rainfall depth	1.00	inches
Percent Impervious	65.5	percent

R(v)=0.05+0.009*(Percent impervious)

Runoff coefficient - R(v)	0.64	in/in

Runoff volume=(Design rainfall)*(R(v))*(Drainage area)

Runoff volume	90,896.8	cubic feet

Notes:

Water Quality Pond Volume Calculations
Stage-Storage Data for Pond - Temporary Pool

Project: Briar Chapel - Great Ridge Parkway Extension
Project No.: 02735-0080

Date: December 14, 2012

Contour ID	Stage	Area [sq. ft.]	Area [acres]	Incremental Area [sq. ft.]	Incremental Area [acres]	Incremental volume [cu. ft]	Incremental volume [acre-ft]	Cumulative volume [cu. ft]	Cumulative volume [acre-ft]
414.5	0	59,103.0	1.357	59,103.0	1.4	0.0	0.0	0.0	0.0
415	0.5	64,333.0	1.477	5,230.0	0.1	30,859.0	0.7	30,859.0	0.7
416	1.5	67,546.0	1.551	3,213.0	0.1	65,939.5	1.5	96,798.5	2.2
417	2.5	70,785.0	1.625	3,239.0	0.1	69,165.5	1.6	165,964.0	3.1
418	3.5	74,142.0	1.702	3,357.0	0.1	72,463.5	1.7	238,427.5	3.3
419	4.5	77,525.0	1.780	3,383.0	0.1	75,833.5	1.7	314,261.0	3.4
420	5.5	80,965.0	1.859	3,440.0	0.1	79,245.0	1.8	393,506.0	3.6
421	6.5	84,461.0	1.939	3,496.0	0.1	82,713.0	1.9	476,219.0	3.7

Water Quality Pond Volume Calculations
Stage-Storage Data for Pond - Permanent Pool

Project: Briar Chapel - Great Ridge Parkway Extension
Project No.: 02735-0080

Date: December 14, 2012

Contour ID	Stage	Area [sq. ft.]	Area [acres]	Incremental Area [sq. ft.]	Incremental Area [acres]	Incremental volume [cu. ft]	Incremental volume [acre-ft]	Cumulative volume [cu. ft]	Cumulative volume [acre-ft]
410	0	35,993.0	0.826	35,993.0	0.8	0.0	0.0	0.0	0.0
411	1	39,840.0	0.915	3,847.0	0.1	37,916.5	0.9	37,916.5	0.9
412	2	43,903.0	1.008	4,063.0	0.1	41,871.5	1.0	79,788.0	1.8
413	3	48,095.0	1.104	4,192.0	0.1	45,999.0	1.1	125,787.0	2.0
414	4	52,458.0	1.204	4,363.0	0.1	50,276.5	1.2	176,063.5	2.2
414.5	4.5	59,103.0	1.357	6,645.0	0.2	27,890.3	0.6	203,953.8	1.8

Water Quality Pond Volume Calculations
Stage-Storage Data for Pond - Forebays

Project: Briar Chapel - Great Ridge Parkway Extension
Project No.: 02735-0080

Date: December 14, 2012

Contour ID	Stage	Area [sq. ft.]	Area [acres]	Incremental Area [sq. ft.]	Incremental Area [acres]	Incremental volume [cu. ft]	Incremental volume [acre-ft]	Cumulative volume [cu. ft]	Cumulative volume [acre-ft]
410	0	5,746.0	0.132	5,746.0	0.1	0.0	0.0	0.0	0.0
411	1	7,201.0	0.165	1,455.0	0.0	6,473.5	0.1	6,473.5	0.1
412	2	8,787.0	0.202	1,586.0	0.0	7,994.0	0.2	14,467.5	0.3
413	3	10,463.0	0.240	1,676.0	0.0	9,625.0	0.2	24,092.5	0.4
414	4	12,252.0	0.281	1,789.0	0.0	11,357.5	0.3	35,450.0	0.5
414.5	4.5	14,979.0	0.344	2,727.0	0.1	6,807.8	0.2	42,257.8	0.4

Water Quality Basin Dewatering Time Calculations

Project Briar Chapel - Great Ridge Parkway Extension
Project No. 02735-0080

Date December 14, 2012

Maximum surface area of basin	67,546	square feet
Maximum head of water above dewatering hole	1.50	feet
Orifice coefficient	0.60	
Diameter of each hole	6.0	inches
Number of holes	1	
Cross sectional area of each hole =	0.196	square feet
Cross sectional area of each hole =	28.3	square inches
Cross sectional area of dewatering hole(s) =	0.196	square feet
Cross sectional area of dewatering hole(s) =	28.3	square inches
Dewatering time for basin =	48.6	hours
Dewatering time for basin =	2.03	days

Notes:

Water Quality Pond Summary Information

Project Briar Chapel - Great Ridge Parkway
Project No. 02735-0080

Date December 14, 2012

Drainage area to pond	1,705,452	square feet =	39.15	acres
Impervious area in drainage area	1,117,211	square feet =	25.65	acres

Bottom of pond elevation	410.00	feet
Normal pool elevation	414.50	feet
Pond volume at normal pool	203,954	cubic feet

Required volume for design rainfall	90,897	cubic feet
Required surface area for pond	58,420	square feet

Volume provided for storage of design rainfall = 96,799 cubic feet at elevation 416

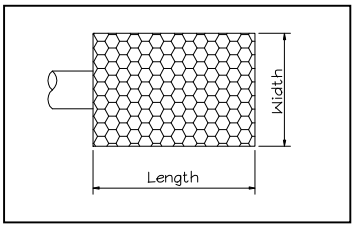
Surface area provided at normal pool 59,103 square feet

OUTLET PROTECTION DESIGN	DATE: 12/05/2012	DESIGNED BY: GCA
PROJECT NAME: Briar Chapel - GRP Extension PROJECT LOCATION: Chatham County, NC	PROJECT NO: 02735-0080	CHECKED BY GML

Storm Outlet Structure

Structure=	BMP #12 Out		Q_{10}/Qfull =	1.09	
Size=	30	in	V/Vfull =	1.112	
Q_{10} =	60.36	cfs	V =	12.5	fps
Qfull =	55.24	cfs			
Vfull =	11.25	fps			

From Fig. 8.06.b.1:



Zone	=	3	
D_{50}	=	10	in
D_{MAX}	=	15	in
Riprap Class	=	1	
Apron Thickness	=	24	in
Apron Length	=	20.0	ft
Apron Width = 3 x Dia	=	8.0	ft

ANTI-FLOATATION DESIGN	DATE: 12/05/2012	DESIGNED BY: GCA
PROJECT NAME: Briar Chapel GRP Extension PROJECT LOCATION: Chatham County, NC	PROJECT NO: 02735-0080	CHECKED BY: GML

Pond Name=	BMP #9				
Riser Outer Width =	5	ft	Riser Resisting Force =	7,871	lb
Riser Outer Length =	5	ft	Base Resisting Force =	7,350	lb
Riser Inner Width =	4	ft	Total Resisting Force =	15,221	lb
Riser Inner Length =	4	ft			
Riser Height =	5.83	ft	Riser Buoyant Force =	9,095	lb
			Base Buoyant Force =	3,058	lb
Concrete Base Length =	7	ft	Total Buoyant Force =	12,152	lb
Concrete Base Width =	7	ft			
Concrete Base Depth =	12	in	Factor of Safety	1.25	**Design Acceptable**

LS/VFS DESIGN

Pipe Flowing Full Using Manning's Equation

D(in) =	8
Slope =	0.078
Manning's n =	0.011

Q_{full} = 3.981797 > 3.02… Therefore acceptable for outlet pipe for LS/VFS

V_{full} = 11.40701

Conduit FlexTable: Combined Pipe/Node Report (GRP Storm CAD.for GRP riprap sizing.stc)

Label	Start Node	Stop Node	Length (Unified) (ft)	Upstream Inlet C	Upstream Intensity (in/h)	Upstream Inlet Area (acres)	Upstream Structure Flow (Total Surface) (ft³/s)	System CA (acres)	System Intensity (in/h)	System Rational Flow (ft³/s)
CO-52	CI-68	CI-51	48.0	0.650	1.000	0.520	0.34	0.345	1.000	0.35
CO-47	CI-63	CI-58	33.0	0.750	1.000	0.130	0.10	0.097	1.000	0.10
CO-45	CI-61	CI-60	32.0	0.750	1.000	0.150	0.11	0.111	1.000	0.11
CO-44	CI-59	CI-60	87.0	0.750	1.000	0.120	0.09	0.201	1.000	0.20
CO-46	CI-62	CI-59	34.0	0.750	1.000	0.100	0.08	0.076	1.000	0.08
CO-43	CI-58	CI-59	99.0	0.750	1.000	0.190	0.14	0.418	1.000	0.42
CO-42	CI-57	CI-58	111.0	0.750	1.000	0.170	0.13	0.643	1.000	0.65
CO-48	CI-64	CI-57	32.0	0.750	1.000	0.150	0.11	0.112	1.000	0.11
CO-41	CI-56	CI-57	129.0	0.750	1.000	0.150	0.11	0.869	1.000	0.88
CO-49	CI-65	CI-56	32.0	0.750	1.000	0.230	0.17	0.169	1.000	0.17
CO-40	CI-55	CI-56	120.0	0.750	1.000	0.290	0.22	1.246	1.000	1.26
CO-50	CI-66	CI-55	33.0	0.750	1.000	0.220	0.17	0.165	1.000	0.17
CO-39	CI-54	CI-55	120.0	0.750	1.000	0.250	0.19	1.601	1.000	1.61
CO-51	CI-67	CI-54	33.0	0.750	1.000	0.220	0.17	0.165	1.000	0.17
CO-38	CI-53	CI-54	120.0	0.750	1.000	0.270	0.20	1.967	1.000	1.98
CO-37	CI-52	CI-53	32.0	0.750	1.000	0.250	0.19	2.156	1.000	2.17
CO-36	CI-52	CI-51	123.0	0.750	1.000	0.220	0.17	2.321	1.000	2.34
CO-35	CI-51	FES-50	41.0	0.750	1.000	0.430	0.33	2.993	1.000	3.02
CO-15	CI-35	CI-34	106.0	0.750	1.000	0.080	0.06	0.908	1.000	0.91
CO-14	CI-34	CI-33	105.0	0.750	1.000	0.150	0.11	1.388	1.000	1.40
CO-13	CI-33	CI-32	108.0	0.750	1.000	0.260	0.20	1.580	1.000	1.59
CO-12	CI-32	CI-31	133.0	0.750	1.000	0.300	0.23	1.802	1.000	1.82
CO-11	CI-31	CI-30	130.0	0.750	1.000	0.260	0.20	1.999	1.000	2.02
CO-10	CI-30	CI-29	94.0	0.750	1.000	0.360	0.27	2.261	1.000	2.28
CO-9	CI-29	CI-28	166.0	0.750	1.000	0.160	0.12	2.393	1.000	2.41
CO-8	CI-28	CI-27	125.0	0.750	1.000	0.270	0.20	2.585	1.000	2.61
CO-7	CI-27	CI-26	126.0	0.750	1.000	0.260	0.20	2.778	1.000	2.80
CO-6	CI-26	CI-25	125.0	0.750	1.000	0.290	0.22	2.992	1.000	3.02
CO-5	CI-25	CI-24	131.0	0.750	1.000	0.220	0.17	3.168	1.000	3.19
CO-4	CI-24	CI-23	119.0	0.750	1.000	0.190	0.14	3.315	1.000	3.34

Permit Number:_____
(to be provided by DWQ)
Drainage Area Number:_____

Wet Detention Basin Operation and Maintenance Agreement

I will keep a maintenance record on this BMP. This maintenance record will be kept in a log in a known set location. Any deficient BMP elements noted in the inspection will be corrected, repaired or replaced immediately. These deficiencies can affect the integrity of structures, safety of the public, and the removal efficiency of the BMP.

The wet detention basin system is defined as the wet detention basin, pretreatment including forebays and the vegetated filter if one is provided.

This system (*check one*):
☐ **does** ☒ **does not** **incorporate a vegetated filter at the outlet.**

This system (*check one*):
☐ **does** ☒ **does not** **incorporate pretreatment other than a forebay.**

Important maintenance procedures:

- Immediately after the wet detention basin is established, the plants on the vegetated shelf and perimeter of the basin should be watered twice weekly if needed, until the plants become established (commonly six weeks).
- No portion of the wet detention pond should be fertilized after the first initial fertilization that is required to establish the plants on the vegetated shelf.
- Stable groundcover should be maintained in the drainage area to reduce the sediment load to the wet detention basin.
- If the basin must be drained for an emergency or to perform maintenance, the flushing of sediment through the emergency drain should be minimized to the maximum extent practical.
- Once a year, a dam safety expert should inspect the embankment.

After the wet detention pond is established, it should be inspected **once a month and within 24 hours after every storm event greater than 1.0 inches (or 1.5 inches if in a Coastal County)**. Records of operation and maintenance should be kept in a known set location and must be available upon request.

Inspection activities shall be performed as follows. Any problems that are found shall be repaired immediately.

BMP element:	Potential problem:	How I will remediate the problem:
The entire BMP	Trash/debris is present.	Remove the trash/debris.
The perimeter of the wet detention basin	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
	Vegetation is too short or too long.	Maintain vegetation at a height of approximately six inches.

BMP element:	Potential problem:	How I will remediate the problem:
The inlet device: pipe or swale	The pipe is clogged.	Unclog the pipe. Dispose of the sediment off-site.
	The pipe is cracked or otherwise damaged.	Replace the pipe.
	Erosion is occurring in the swale.	Regrade the swale if necessary to smooth it over and provide erosion control devices such as reinforced turf matting or riprap to avoid future problems with erosion.
The forebay	Sediment has accumulated to a depth greater than the original design depth for sediment storage.	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP.
	Erosion has occurred.	Provide additional erosion protection such as reinforced turf matting or riprap if needed to prevent future erosion problems.
	Weeds are present.	Remove the weeds, preferably by hand. If pesticide is used, wipe it on the plants rather than spraying.
The vegetated shelf	Best professional practices show that pruning is needed to maintain optimal plant health.	Prune according to best professional practices
	Plants are dead, diseased or dying.	Determine the source of the problem: soils, hydrology, disease, etc. Remedy the problem and replace plants. Provide a one-time fertilizer application to establish the ground cover if a soil test indicates it is necessary.
	Weeds are present.	Remove the weeds, preferably by hand. If pesticide is used, wipe it on the plants rather than spraying.
The main treatment area	Sediment has accumulated to a depth greater than the original design sediment storage depth.	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP.
	Algal growth covers over 50% of the area.	Consult a professional to remove and control the algal growth.
	Cattails, phragmites or other invasive plants cover 50% of the basin surface.	Remove the plants by wiping them with pesticide (do not spray).

BMP element:	Potential problem:	How I will remediate the problem:
The embankment	Shrubs have started to grow on the embankment.	Remove shrubs immediately.
	Evidence of muskrat or beaver activity is present.	Use traps to remove muskrats and consult a professional to remove beavers.
	A tree has started to grow on the embankment.	Consult a dam safety specialist to remove the tree.
	An annual inspection by an appropriate professional shows that the embankment needs repair. (if applicable)	Make all needed repairs.
The outlet device	Clogging has occurred.	Clean out the outlet device. Dispose of the sediment off-site.
	The outlet device is damaged	Repair or replace the outlet device.
The receiving water	Erosion or other signs of damage have occurred at the outlet.	Contact the local NC Division of Water Quality Regional Office, or the 401 Oversight Unit at 919-733-1786.

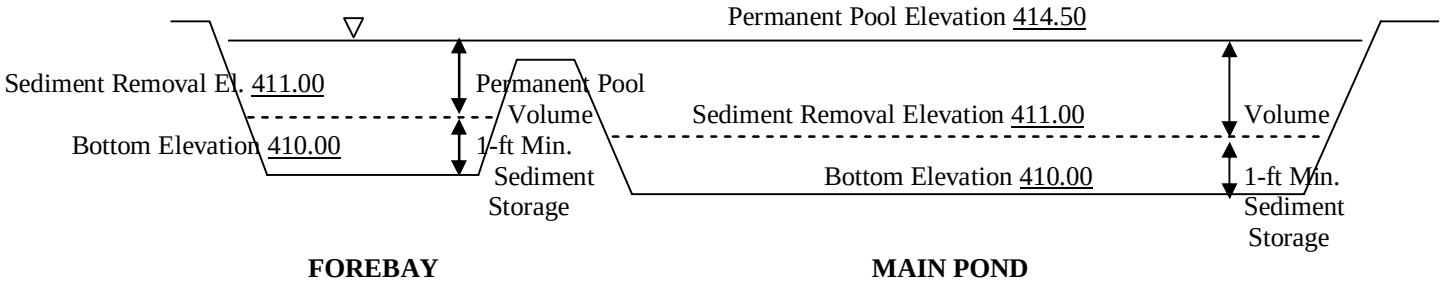
The measuring device used to determine the sediment elevation shall be such that it will give an accurate depth reading and not readily penetrate into accumulated sediments.

When the permanent pool depth reads _3.50_ feet in the main pond, the sediment shall be removed.

When the permanent pool depth reads _3.50_ feet in the forebay, the sediment shall be removed.

BASIN DIAGRAM

(fill in the blanks)



Permit Number: _____
(to be provided by DWQ)

I acknowledge and agree by my signature below that I am responsible for the performance of the maintenance procedures listed above. I agree to notify DWQ of any problems with the system or prior to any changes to the system or responsible party.

Project name: Briar Chapel - Great Ridge Parkway Extension

BMP drainage area number: 1 - Wet Detention Pond #12

Print name: Kevin Graham

Title: Vice President, Operations

Address: 16 Windy Knoll Circle, Chapel Hill, NC 27516

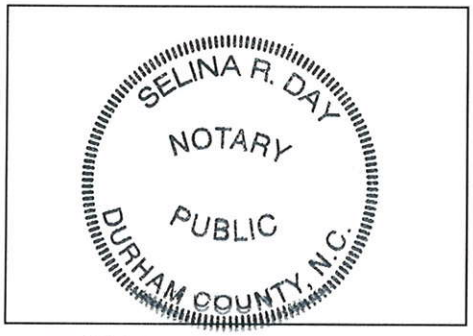
Phone: (919) 951-0709

Signature: [signature]

Date: 12/13/12

Note: The legally responsible party should not be a homeowners association unless more than 50% of the lots have been sold and a resident of the subdivision has been named the president.

I, Selina R. Day, a Notary Public for the State of North Carolina, County of Durham, do hereby certify that Kevin Graham personally appeared before me this 13 day of December, 2012, and acknowledge the due execution of the forgoing wet detention basin maintenance requirements. Witness my hand and official seal,



SEAL

My commission expires August 30, 2014

Permit Number:_____
(to be provided by DWQ)
Drainage Area Number:_____

Filter Strip, Restored Riparian Buffer and Level Spreader Operation and Maintenance Agreement

I will keep a maintenance record on this BMP. This maintenance record will be kept in a log in a known set location. Any deficient BMP elements noted in the inspection will be corrected, repaired or replaced immediately. These deficiencies can affect the integrity of structures, safety of the public, and the removal efficiency of the BMP.

Important maintenance procedures:

- Immediately after the filter strip is established, any newly planted vegetation will be watered twice weekly if needed until the plants become established (commonly six weeks).
- Once a year, the filter strip will be reseeded to maintain a dense growth of vegetation
- Stable groundcover will be maintained in the drainage area to reduce the sediment load to the vegetation.
- Two to three times a year, grass filter strips will be mowed and the clippings harvested to promote the growth of thick vegetation with optimum pollutant removal efficiency. Turf grass should not be cut shorter than 3 to 5 inches and may be allowed to grow as tall as 12 inches depending on aesthetic requirements (NIPC, 1993). Forested filter strips do not require this type of maintenance.
- Once a year, the soil will be aerated if necessary.
- Once a year, soil pH will be tested and lime will be added if necessary.

After the filter strip is established, it will be inspected **quarterly and within 24 hours after every storm event greater than 1.0 inch (or 1.5 inches if in a Coastal County)**. Records of operation and maintenance will be kept in a known set location and will be available upon request.

Inspection activities shall be performed as follows. Any problems that are found shall be repaired immediately.

BMP element:	Potential problem:	How I will remediate the problem:
The entire filter strip system	Trash/debris is present.	Remove the trash/debris.
The flow splitter device (if applicable)	The flow splitter device is clogged.	Unclog the conveyance and dispose of any sediment off-site.
	The flow splitter device is damaged.	Make any necessary repairs or replace if damage is too large for repair.

BMP element:	Potential problem:	How I will remediate the problem:
The swale and the level lip	The swale is clogged with sediment.	Remove the sediment and dispose of it off-site.
	The level lip is cracked, settled, undercut, eroded or otherwise damaged.	Repair or replace lip.
	There is erosion around the end of the level spreader that shows stormwater has bypassed it.	Regrade the soil to create a berm that is higher than the level lip, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
	Trees or shrubs have begun to grow on the swale or just downslope of the level lip.	Remove them.
The bypass channel	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully, and then reestablish proper erosion control.
	Turf reinforcement is damaged or ripap is rolling downhill.	Study the site to see if a larger bypass channel is needed (enlarge if necessary). After this, reestablish the erosion control material.
The filter strip	Grass is too short or too long (if applicable).	Maintain grass at a height of approximately three to six inches.
	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
	Sediment is building up on the filter strip.	Remove the sediment and restabilize the soil with vegetation if necessary. Provide lime and a one-time fertilizer application.
	Plants are desiccated.	Provide additional irrigation and fertilizer as needed.
	Plants are dead, diseased or dying.	Determine the source of the problem: soils, hydrology, disease, etc. Remedy the problem and replace plants. Provide a one-time fertilizer application.
	Nuisance vegetation is choking out desirable species.	Remove vegetation by hand if possible. If pesticide is used, do not allow it to get into the receiving water.
The receiving water	Erosion or other signs of damage have occurred at the outlet.	Contact the NC Division of Water Quality local Regional Office, or the 401 Oversight Unit at 919-733-1786.

Permit Number:_____
(to be provided by DWQ)

I acknowledge and agree by my signature below that I am responsible for the performance of the maintenance procedures listed above. I agree to notify DWQ of any problems with the system or prior to any changes to the system or responsible party.

Project name:Briar Chapel - Great Ridge Parkway Extension

BMP drainage area number:#2 - LS/VFS #1

Print name: Kevin Graham

Title: Vice President, Operations

Address: 16 Windy Knoll Circle, Chapel Hill, NC 27516

Phone: (919) 951-0709

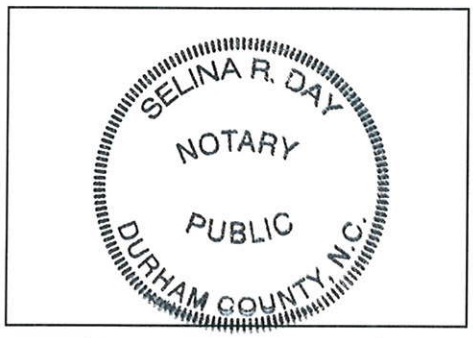
Signature: [signature]

Date: 12/13/12

Note: The legally responsible party should not be a homeowners association unless more than 50% of the lots have been sold and a resident of the subdivision has been named the president.

I, Selina R. Day, a Notary Public for the State of North Carolina, County of Durham, do hereby certify that Kevin Graham personally appeared before me this 13 day of December, 2012, and acknowledge the due execution of the forgoing filter strip, riparian buffer, and/or level spreader maintenance requirements.

Witness my hand and official seal,



SEAL

My commission expires August 30, 2014

Permit No._____
(to be provided by DWQ)

STORMWATER MANAGEMENT PERMIT APPLICATION FORM
401 CERTIFICATION APPLICATION FORM

WET DETENTION BASIN 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	Briar Chapel Development - Great Ridge Parkway Extension
Contact person	Gareth Avant, PE
Phone number	919.233.8091
Date	14-Dec-2012
Drainage area number	1 - Wet Pond #13

II. DESIGN INFORMATION

Site Characteristics

Drainage area	1,705,452	ft^2	
Impervious area, post-development	1,117,211	ft^2	
% impervious	65.51	%	
Design rainfall depth	1.0	in	

Storage Volume: Non-SA Waters

Minimum volume required	90,897	ft^3	OK
Volume provided	96,799	ft^3	OK, volume provided is equal to or in excess of volume required.

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		ft^3	
Volume provided		ft^3	

Peak Flow Calculations

Is the pre/post control of the 1yr 24hr storm peak flow required?	Y	(Y or N)	
1-yr, 24-hr rainfall depth	3.0	in	
Rational C, pre-development	0.40	(unitless)	
Rational C, post-development	0.72	(unitless)	
Rainfall intensity: 1-yr, 24-hr storm	0.12	in/hr	Insufficient. Check intensity calculation.
Pre-development 1-yr, 24-hr peak flow	19.71	ft^3/sec	
Post-development 1-yr, 24-hr peak flow	19.59	ft^3/sec	
Pre/Post 1-yr, 24-hr peak flow control	-0.12	ft^3/sec	

Elevations

Temporary pool elevation	416.00	fmsl	
Permanent pool elevation	414.50	fmsl	
SHWT elevation (approx. at the perm. pool elevation)		fmsl	
Top of 10ft vegetated shelf elevation	415.00	fmsl	
Bottom of 10ft vegetated shelf elevation	414.00	fmsl	Data not needed for calculation option #1, but OK if provided.
Sediment cleanout, top elevation (bottom of pond)	411.00	fmsl	
Sediment cleanout, bottom elevation	410.00	fmsl	Data not needed for calculation option #1, but OK if provided.
Sediment storage provided	1.00	ft	
Is there additional volume stored above the state-required temp. pool?	N	(Y or N)	
Elevation of the top of the additional volume		fmsl	

Permit No._____
(to be provided by DWQ)

II. DESIGN INFORMATION

Surface Areas			
Area, temporary pool	59,103	ft^2	
Area REQUIRED, permanent pool	51,164	ft^2	
SA/DA ratio	3.00	(unitless)	
Area PROVIDED, permanent pool, A_{perm_pool}	59,103	ft^2	OK
Area, bottom of 10ft vegetated shelf, A_{bot_shelf}	52,458	ft^2	
Area, sediment cleanout, top elevation (bottom of pond), A_{bot_pond}	35,993	ft^2	
Volumes			
Volume, temporary pool	96,799	ft^3	OK
Volume, permanent pool, V_{perm_pool}	203,954	ft^3	
Volume, forebay (sum of forebays if more than one forebay)	42,258	ft^3	
Forebay % of permanent pool volume	20.7%	%	OK
SA/DA Table Data			
Design TSS removal	90	%	
Coastal SA/DA Table Used?	N	(Y or N)	
Mountain/Piedmont SA/DA Table Used?	Y	(Y or N)	
SA/DA ratio	3.00	(unitless)	
Average depth (used in SA/DA table):			
Calculation option 1 used? (See Figure 10-2b)	Y	(Y or N)	
Volume, permanent pool, V_{perm_pool}	203,954	ft^3	
Area provided, permanent pool, A_{perm_pool}	59,103	ft^2	
Average depth calculated	3.45	ft	OK
Average depth used in SA/DA, d_{av}, (Round to nearest 0.5ft)	3.5	ft	OK
Calculation option 2 used? (See Figure 10-2b)	N	(Y or N)	
Area provided, permanent pool, A_{perm_pool}	59,103	ft^2	
Area, bottom of 10ft vegetated shelf, A_{bot_shelf}	52,458	ft^2	
Area, sediment cleanout, top elevation (bottom of pond), A_{bot_pond}	35,993	ft^2	
"Depth" (distance b/w bottom of 10ft shelf and top of sediment)	3.00	ft	
Average depth calculated		ft	
Average depth used in SA/DA, d_{av}, (Round to nearest 0.5ft)		ft	
Drawdown Calculations			
Drawdown through orifice?	Y	(Y or N)	
Diameter of orifice (if circular)	6.00	in	
Area of orifice (if-non-circular)		in^2	
Coefficient of discharge (C_D)	0.60	(unitless)	
Driving head (H_o)	0.50	ft	
Drawdown through weir?	N	(Y or N)	
Weir type		(unitless)	
Coefficient of discharge (C_w)		(unitless)	
Length of weir (L)		ft	
Driving head (H)		ft	
Pre-development 1-yr, 24-hr peak flow	19.71	ft^3/sec	
Post-development 1-yr, 24-hr peak flow	19.59	ft^3/sec	
Storage volume discharge rate (through discharge orifice or weir)	0.45	ft^3/sec	
Storage volume drawdown time	2.03	days	OK, draws down in 2-5 days.
Additional Information			
Vegetated side slopes	3	:1	OK
Vegetated shelf slope	10	:1	OK
Vegetated shelf width	10.0	ft	OK
Length of flowpath to width ratio	3	:1	OK
Length to width ratio	1.5	:1	OK
Trash rack for overflow & orifice?	Y	(Y or N)	OK
Freeboard provided	1.0	ft	OK
Vegetated filter provided?	N	(Y or N)	OK
Recorded drainage easement provided?	Y	(Y or N)	OK
Capures all runoff at ultimate build-out?	Y	(Y or N)	OK
Drain mechanism for maintenance or emergencies is:	8" DIP with gate valve		

Permit No._____
(to be provided by DWQ)

III. REQUIRED ITEMS CHECKLIST

Please indicate the page or plan sheet numbers where the supporting documentation can be found. An incomplete submittal package will result in a request for additional information. This will delay final review and approval of the project. Initial in the space provided to indicate the following design requirements have been met. If the applicant has designated an agent, the agent may initial below. If a requirement has not been met, attach justification.

Initials	Page/ Plan Sheet No.	
GCA	C3.3-C3.4	1. Plans (1" - 50' or larger) of the entire site showing: - Design at ultimate build-out, - Off-site drainage (if applicable), - Delineated drainage basins (include Rational C coefficient per basin), - Basin dimensions, - Pretreatment system, - High flow bypass system, - Maintenance access, - Proposed drainage easement and public right of way (ROW), - Overflow device, and - Boundaries of drainage easement.
GCA	D4.1-D4.3	2. Partial plan (1" = 30' or larger) and details for the wet detention basin showing: - Outlet structure with trash rack or similar, - Maintenance access, - Permanent pool dimensions, - Forebay and main pond with hardened emergency spillway, - Basin cross-section, - Vegetation specification for planting shelf, and - Filter strip.
GCA	D4.1-D4.3	3. Section view of the wet detention basin (1" = 20' or larger) showing: - Side slopes, 3:1 or lower, - Pretreatment and treatment areas, and - Inlet and outlet structures.
GCA	N/A	4. If the basin is used for sediment and erosion control during construction, clean out of the basin is specified on the plans prior to use as a wet detention basin.
GCA	Calc Booklet	5. A table of elevations, areas, incremental volumes & accumulated volumes for overall pond and for forebay, to verify volume provided.
GCA	C3.1	6. A construction sequence that shows how the wet detention basin will be protected from sediment until the entire drainage area is stabilized.
GCA	Calc Booklet	7. The supporting calculations.
GCA	Included	8. A copy of the signed and notarized operation and maintenance (O&M) agreement.
GCA	Included	9. A copy of the deed restrictions (if required).
_____	N/A	10. A soils report that is based upon an actual field investigation, soil borings, and infiltration tests. County soil maps are not an acceptable source of soils information.

STORMWATER MANAGEMENT PERMIT APPLICATION FORM
401 CERTIFICATION APPLICATION FORM

LEVEL SPREADER - VEGETATED FILTER STRIP (LS-VFS) SUPPLEMENT

This form must be completely filled out, printed, initialed, and submitted.

I. PROJECT INFORMATION

Project name	Briar Chapel Development - Great Ridge Parkway Extension
Contact name	Gareth Avant
Phone number	919.233.8091
Date	December 14, 2012
Drainage area number	#2

II. DESIGN INFORMATION

The purpose of the LS-VFS	Pollutant removal: 40% TSS, 30% TN, 35% TP
Stormwater enters LS-VFS from	The drainage area
Type of VFS	Engineered filter strip (graded & sodded, slope < 8%)
Explanation of any "Other" responses above	

If Stormwater Enters the LS-VFS from the Drainage Area

Drainage area	147,452	ft^2
Impervious surface area	62,438	ft^2
Percent impervious	42.34	%
Rational C coefficient	0.75	
Peak flow from the 1 in/hr storm	2.54	cfs
Time of concentration	5.00	min
Rainfall intensity, 10-yr storm	7.38	in/hr
Peak flow from the 10-yr storm	18.74	cfs
Design storm	1 inch/hour storm	
Maximum amount of flow directed to the LS-VFS	3.02	cfs
Is a flow bypass system going to be used?	Y	(Y or N)
Explanation of any "Other" responses above		

If Stormwater Enters the LS-VFS from a BMP

Do not complete this section of the form.

Type of BMP	Pick one:		
Peak discharge from the BMP during the design storm		cfs	
Peak discharge from the BMP during the 10-year storm		cfs	Do not complete this section of the form.
Maximum capacity of a 100-foot long LS-VFS	10	cfs	
Peak flow directed to the LS-VFS		cfs	Do not complete this section of the form.
Is a flow bypass system going to be used?		(Y or N)	
Explanation of any "Other" responses above			

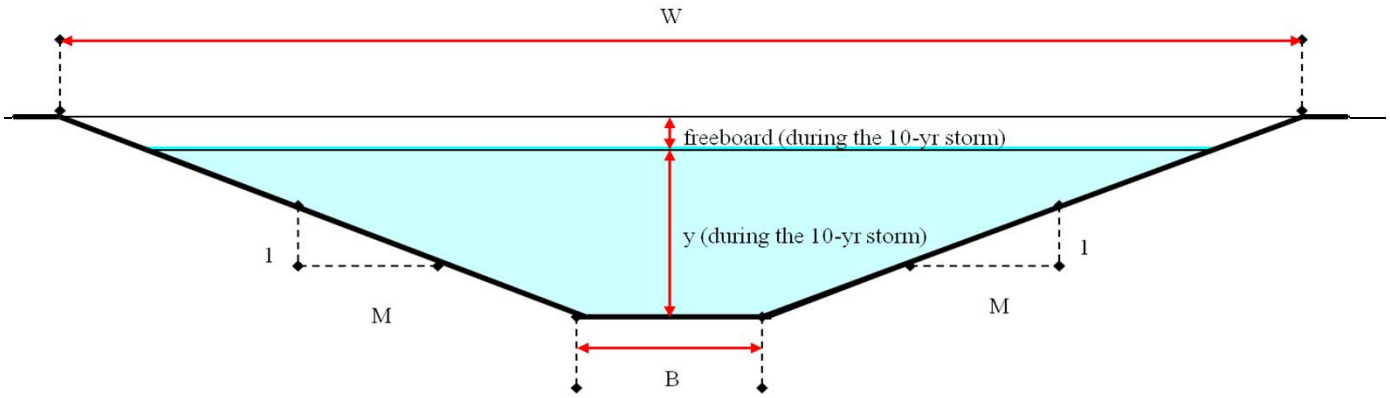
LS-VFS Design

Forebay surface area	400	sq ft	Forebay is adequately sized.
Depth of forebay at stormwater entry point	24	in	Depth is appropriate.
Depth of forebay at stormwater exit point	6	in	Depth is appropriate.
Feet of level lip needed per cfs	10	ft/cfs	
Computed minimum length of the level lip needed	30	ft	

Length of level lip provided	50	ft	
Width of VFS	30	ft	
Elevation at downslope base of level lip	446.25	fmsl	
Elevation at the end of the VFS that is farthest from the LS	444.75	fmsl	
Slope (from level lip to the end of the VFS)	5.00	%	
Are any draws present in the VFS?	N	(Y or N)	OK
Is there a collector swale at the end of the VFS?	N	(Y or N)	

Bypass System Design (if applicable)

Is a bypass system provided?	Y	(Y or N)	
Is there an engineered flow splitting device?	Y	(Y or N)	Please provide plan details of flow splitter & supporting calcs.
Dimensions of the channel (see diagram below):			
M	Existing Channel	ft	
B		ft	
W		ft	
y (flow depth for 10-year storm)		ft	
freeboard (during the 10-year storm)		ft	
Peak velocity in the channel during the 10-yr storm	9.16	ft/sec	
Channel lining material	Pick one:		
Does the bypass discharge through a wetland?	N	(Y or N)	
Does the channel enter the stream at an angle?	Y	(Y or N)	
Explanation of any "Other" responses above			



III. REQUIRED ITEMS CHECKLIST

EDIT Please indicate the page or plan sheet numbers where the supporting documentation can be found. An incomplete submittal package will result in a request for additional information. This will delay final review and approval of the project. Initial in the space provided to indicate the following design requirements have been met. If the applicant has designated an agent, the agent may initial below. If a requirement has not been met, attach justification.

Requried Item:	Initials	Page or plan sheet number and any notes:
1. Plans (1" - 50' or larger) of the entire site showing: - Design at ultimate build-out, - Off-site drainage (if applicable), - Delineated drainage basins (include Rational C coefficient per basin), - Forebay (if applicable), - High flow bypass system, - Maintenance access, - Proposed drainage easement and public right of way (ROW), and - Boundaries of drainage easement.	GCA	C3.2-C3.3

2. Plan details (1" = 30' or larger) for the level spreader showing: - Forebay (if applicable), - High flow bypass system, - One foot topo lines between the level lip and top of stream bank, - Proposed drainage easement, and - Design at ultimate build-out.	GCA	D4.4
3. Section view of the level spreader (1" = 20' or larger) showing: - Underdrain system (if applicable), - Level lip, - Upslope channel, and - Downslope filter fabric.	GCA	D4.4
4. Plan details of the flow splitting device and supporting calculations (if applicable).		D4.4
5. A construction sequence that shows how the level spreader will be protected from sediment until the entire drainage area is stabilized.	GCA	C3.2-C3.3
6. If a non-engineered VFS is being used, then provide a photograph of the VFS showing that no draws are present.		N/A
7. The supporting calculations.	GCA	Narrative & calculations booklet
8. A copy of the signed and notarized operation and maintenance (O&M) agreement.	GCA	Included

North Carolina Department of Environment and Natural Resources
Division of Water Quality
Charles Wakild, P. E.
Director

Pat McCrory
Governor

John E. Skvarla, III
Secretary

January 14, 2013

DWQ Project # 05-0732v25
Chatham County

Mr. Bill Mumford, Assistant Vice President
NNP – Briar Chapel LLC
16 Windy Knoll Circle
Chapel Hill, NC 27516

Subject Property: **Briar Chapel, Great Ridge Parkway Extension**

APPROVAL OF MODIFIED STORMWATER PLAN

Dear Mr. Mumford:

On January 11, 2008, the Division of Water Quality (DWQ) issued a revised 401 Water Quality Certification to temporarily impact 339 linear feet of stream and 0.157 acre of 404 wetlands and to permanently impact 1,666 linear feet of stream and 0.159 acre of 404 wetland in order to construct the Briar Chapel Subdivision in Chatham County.

In order to meet Condition 10 of the 401 Certification for this project, a stormwater management plan for Briar Chapel – Great Ridge Parkway Extension, dated December 18, 2012, was received on December 20, 2012.

The DWQ approves the SMP as satisfying Condition 10 of the General Water Quality Certification. This approval is for the purpose and design that you described in your application. If you change your project, you must notify us and you may be required to send us a new SMP. This approval requires to you follow the conditions listed in the General Water Quality Certification for the project and the following additional conditions listed below:

1. The SMP approved by the DWQ consists of one (1) wet detention pond and one (1) Level Spreader-Engineered Filter Strip and all associated stormwater conveyances, inlet and outlet strictures, and the grading and drainage patterns depicted on plan sheets dated December 19, 2012. The plans and specifications for the Great Ridge Parkway Extension approved by DWQ are incorporated by reference into this approval and are enforceable by DWQ provided however that any modification of the design for the stormwater management system that is accepted by DWQ shall take precedence over the original plans and specifications.

Wetlands, Buffers, Stormwater – Compliance and Permitting (Webscape) Unit
1650 Mail Service Center, Raleigh, North Carolina 27699-1650
Location: 512 N. Salisbury St. Raleigh, North Carolina 27604
Phone: 919-807-6300 \ FAX: 919-807-6494 \ Customer Service: 1-877-623-6748
Internet: www.ncwaterquality.org

2. The maximum allowable drainage area for the approved wet detention pond shall be 1,705,452 square feet and the maximum allowable built-upon area within that drainage area shall be 1,117,211 square feet. The maximum allowable drainage area for the Level Spreader-Engineered Filter Strip shall be 147,452 square feet and the maximum allowable built-upon area within that drainage area shall be 62,438 square feet. Built-upon area includes, but is not limited to, roofed structures, asphalt, concrete, gravel, brick, slate, coquina and parking areas, but does not include raised, uncovered open slat decking or the water surface of swimming pools. Any changes to these maximum areas shall require the applicant to submit and receive approval for a revised stormwater management plan by the DWQ.

3. The footprint of all stormwater management devices as well as an additional 10-foot wide area on all sides of the devices shall be located in public rights-of-way, dedicated common areas or recorded easement areas. The final plats for the project showing all such rights-of-way, common areas and easement areas shall be in accordance with the approved plans.

4. Maintenance activities for the wet detention pond shall be performed in accordance with the notarized O&M agreements signed by Kevin Graham (Vice President, Operations) on December 13, 2012. The O&M agreement must transfer with the sale of the land or transfer of ownership/responsibility for the BMP facility. DWQ must be notified promptly of every transfer.

5. The applicant and/or authorized agent shall provide a completed Certificate of Completion form to the DWQ within thirty (30) days of project completion (available at http://portal.ncdenr.org/web/wq/swp/ws/401/certsandpermits/apply/forms).

Thank you for your attention to this matter. If you have any questions or wish to discuss these matters further, please do not hesitate to contact me at (919) 807-6381.

Sincerely,

Annette Lucas, P.E.
Wetlands, Buffers and Stormwater Compliance and Permitting (Webscape) Unit

AML/aml

Cc: Becky Fox, EPA
USACE, Raleigh
DWQ Raleigh Regional Office
Chatham County Public Works Dept., P.O. Box 1550, Pittsboro, NC 27312
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