



LETTER OF TRANSMITTAL

DATE: June 17, 2015	
PROJECT NO: 2735-0113	TASK NO: EXP
RE: Briar Chapel – Phase 15 North	
TRANSMITTAL NO: 1	PAGE 1 OF 1

TO: NCDENR – Division of Water Resources 401 & Buffer Permitting Unit
512 N. Salisbury St. Archdale Building - 9th floor Raleigh, NC 27604
ATTENTION: Mr. Boyd Devane

WE ARE SENDING: Originals Prints Shop Drawings Samples
 Specifications Calculations Other -

Quantity	Dwg No.	Rev.	Description	Status
1			Cover Letter Requesting Stormwater Management Plan Approval	G
2			Stormwater Design Plans	G
2			Narrative & Supporting Calculations	G
2			BMP #23 Design Supplement	G
2			BMP #23 O&M Agreement	G

Issue Status Code: A. Preliminary B. Fabrication Only C. For Information D. Bid
 E. Construction F. For Review & Comments G. For Approval H. See Remarks

REMARKS:

Boyd,

Please find the enclosed documents for your review and approval. Please let us know if you have any questions or comments. Thank you.

Cc:

McKIM & CREED, INC.

Signed *Gareth Avant*
 Gareth Avant, PE



ENGINEERS

SURVEYORS

PLANNERS

June 17, 2015

Mr. Boyd Devane
512 N. Salisbury St.
Archdale Building - 9th floor
Raleigh, NC 27604

RE: Briar Chapel Phase 15 N

Mr. Devane,

Please find enclosed the plans, calculations, supplement forms and operation and maintenance agreements for the Phase 15 North subdivision at Briar Chapel.

This letter is to formally request approval of the stormwater management plan for the enclosed plans in accordance with Water Quality Certification as issued by the Division of Water Resources on January 11, 2008.

Please let me know if you have any questions on this. Thank you for your assistance.

Sincerely,
McKIM & CREED, INC.

A handwritten signature in black ink that reads "Gareth Avant".

Gareth Avant, PE
Project Engineer

Venture IV Building

Suite 500

1730 Varsity Drive

Raleigh, NC 27606

919.233.8091

Fax 919.233.8031

www.mckimcreed.com

Red triangles at the upper right hand corner indicate design comments
Please complete the yellow shaded items.



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 - Phase 15N
Contact person	Gareth Avant, PE
Phone number	919.233.8091
Date	17-Jun-2015
Drainage area number	1 - Wet Pond #23

II. DESIGN INFORMATION

Site Characteristics

Drainage area	754,858 ft ²
Impervious area, post-development	338,602 ft ²
% impervious	44.86 %
Design rainfall depth	1.0 in

Storage Volume: Non-SA Waters

Minimum volume required	28,541 ft ³	OK
Volume provided	29,861 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	0.68 (unitless)	
Rainfall intensity: 1-yr, 24-hr storm	0.13 in/hr	OK
Pre-development 1-yr, 24-hr peak flow	12.87 ft ³ /sec	
Post-development 1-yr, 24-hr peak flow	47.65 ft ³ /sec	
Pre/Post 1-yr, 24-hr peak flow control	34.78 ft ³ /sec	

Elevations

Temporary pool elevation	449.00 fmsl	
Permanent pool elevation	447.50 fmsl	
SHWT elevation (approx. at the perm. pool elevation)	fmsl	
Top of 10ft vegetated shelf elevation	448.00 fmsl	
Bottom of 10ft vegetated shelf elevation	447.00 fmsl	Data not needed for calculation option #1, but OK if provided.
Sediment cleanout, top elevation (bottom of pond)	442.00 fmsl	
Sediment cleanout, bottom elevation	441.00 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?	Y	(Y or N)
Elevation of the top of the additional volume	449.0 fmsl	OK

II. DESIGN INFORMATION
Surface Areas

Area, temporary pool	21,437	ft ²	
Area REQUIRED, permanent pool	16,909	ft ²	
SA/DA ratio	2.24	(unitless)	
Area PROVIDED, permanent pool, A_{perm_pool}	17,183	ft ²	OK
Area, bottom of 10ft vegetated shelf, A_{bot_shelf}	14,194	ft ²	
Area, sediment cleanout, top elevation (bottom of pond), A_{bot_pond}	7,260	ft ²	

Volumes

Volume, temporary pool	29,861	ft ³	OK
Volume, permanent pool, V_{perm_pool}	67,374	ft ³	
Volume, forebay (sum of forebays if more than one forebay)	13,949	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	2.24	(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}	67,374	ft ³	
Area provided, permanent pool, A_{perm_pool}	17,183	ft ²	
Average depth calculated	3.92	ft	OK
Average depth used in SA/DA, d_{av} , (Round to nearest 0.5ft)	4.0	ft	OK

Calculation option 2 used? (See Figure 10-2b)

Area provided, permanent pool, A_{perm_pool}	17,183	ft ²	
Area, bottom of 10ft vegetated shelf, A_{bot_shelf}	14,194	ft ²	
Area, sediment cleanout, top elevation (bottom of pond), A_{bot_pond}	7,260	ft ²	

"Depth" (distance b/w bottom of 10ft shelf and top of sediment)

Average depth calculated	5.00	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)	2.75	in	
Area of orifice (if non-circular)		in ²	
Coefficient of discharge (C_D)	0.60	(unitless)	
Driving head (H_0)	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	11.52	ft ³ /sec	
Post-development 1-yr, 24-hr peak flow	38.95	ft ³ /sec	
Storage volume discharge rate (through discharge orifice or weir)	0.09	ft ³ /sec	
Storage volume drawdown time	2.47	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	1.5 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 and/or pump provided by owner	

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-C3.7	1. Plans (1" - 50' or larger) of the entire site showing: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - Side slopes, 3:1 or lower, - Pretreatment and treatment areas, and - Inlet and outlet structures.
GCA	C3.3-C3.7	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	C3.3-C3.7	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	N/A	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.

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.

Permit Number: _____
(to be provided by DWQ)

Drainage Area Number: _____

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).

Permit Number: _____
 (to be provided by DWQ)

Drainage Area Number: _____

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.

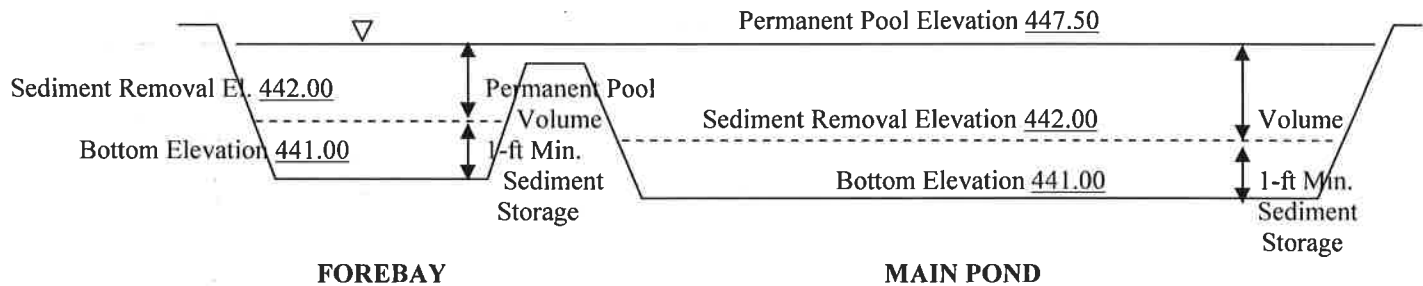
The measuring device used to determine the sediment elevation shall be such that it will give an accurate depth reading and not readily penetrate into accumulated sediments.

When the permanent pool depth reads 4.50 feet in the main pond, the sediment shall be removed.

When the permanent pool depth reads 4.50 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 - Phase 15 North

BMP drainage area number: 1 - Wet Detention Pond #23

Print name: Laurie Ford

Title: Vice President, Operations

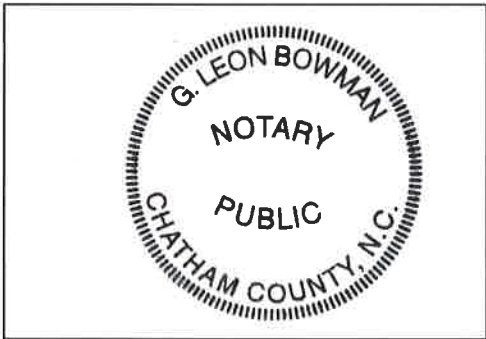
Address: 16 Windy Knoll Circle, Chapel Hill, NC 27516

Phone: (919) 951-0700

Signature: *Laurie Ford*
Date: 6-8-15

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, G. Leon Bowman, a Notary Public for the State of NC, County of Chatham, do hereby certify that Laurie Ford personally appeared before me this 8th day of June, 2015, and acknowledge the due execution of the forgoing wet detention basin maintenance requirements. Witness my hand and official seal,



SEAL

My commission expires 9/10/19

401 NARRATIVE & SUPPORTING CALCULATIONS

Briar Chapel Development Phase 15 North

Chatham County, North Carolina
June 17, 2015

Prepared for:



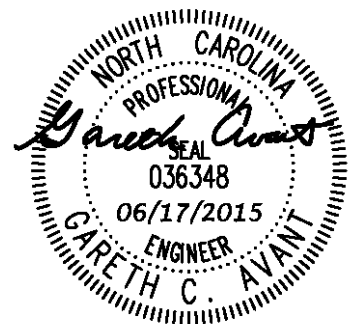
NNP Briar Chapel, LLC
16 Windy Knoll Circle
Chapel Hill, North Carolina 27516

Prepared By:



1730 Varsity Drive, Suite 500
Raleigh, North Carolina 27606
Phone: (919) 233.8091
Fax: (919) 233.8031

M&C Project No. 02735-0113



PROJECT DESCRIPTION

The purpose of the project is to construct water, sewer and roadway infrastructure to support 50 residential lots in the Phase 15 North section of the overall Briar Chapel Development.

Based on the conditions of the approved 401 Water Quality Certification, NCDENR-DWR will require runoff from the roads to be captured and treated for 85% TSS removal before being discharged into existing stream buffers. To meet this requirement, the runoff from the general area of all Phase 15 North construction will be directed to Wet Detention Pond #23. Calculations for these new facilities are included in this package.

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 20.32 acres located within the BC West development area, which is west of the intersection of Granite Mill Boulevard and Briar Chapel Parkway.

The site slopes away from a ridge located near the center of the project area, and drains to the southeast and southwest and into adjacent buffered streams. Slopes on the site range from 5 to greater than 20% in localized areas.

SOILS

According to the Chatham County Generalized Soil Survey, the soils located on the site are classified as Helena sandy loam, 6 to 10 percent slopes (HeC); Wedowee sandy loam, 2 to 15 percent slopes (WeB, WeD); and Wedowee sandy loam, 15 to 35 percent slopes, bouldery (WdC, WdE)

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

HeC - Helena sandy loam soils are often found in piedmont uplands, along ridges and drainageways. Permeability is slow and the soils are moderately well drained. Soils have a high shrink/swell potential. The seasonal high water is perched at a depth of 1.5 to 2.5 feet.

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.

Wd(X) – Wedowee sandy loam, bouldery soils carry the same characteristics of Wedowee We(X) soils, listed above, with the exception that large boulders are more commonly found.

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 buffer. The calculations provided with this package include all projected future drainage areas that might be captured by the pond. 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.

MAINTENANCE CONSIDERATIONS

The property owner shall be responsible for periodic inspection and maintenance of all permanent stormwater management devices and shall adhere to conditions agreed upon by the executed Operation and Maintenance agreements included with this submittal. Any measure that fails to function as intended shall be repaired immediately.



NOAA Atlas 14, Volume 2, Version 3
 Location name: Chapel Hill, North Carolina, US*
 Latitude: 35.8280°, Longitude: -79.1077°
 Elevation: 505ft*
 * source: Google Maps



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.98 (4.55-5.45)	5.87 (5.38-6.43)	6.77 (6.20-7.40)	7.45 (6.82-8.15)	8.18 (7.44-8.93)	8.69 (7.87-9.48)	9.16 (8.24-9.98)	9.53 (8.54-10.4)	9.95 (8.83-10.9)	10.3 (9.04-11.2)
10-min	3.98 (3.64-4.35)	4.69 (4.30-5.14)	5.42 (4.96-5.93)	5.96 (5.45-6.52)	6.52 (5.93-7.12)	6.92 (6.27-7.55)	7.27 (6.55-7.93)	7.55 (6.77-8.26)	7.87 (6.98-8.60)	8.09 (7.12-8.85)
15-min	3.31 (3.03-3.62)	3.93 (3.60-4.31)	4.57 (4.18-5.00)	5.03 (4.60-5.49)	5.51 (5.01-6.02)	5.84 (5.29-6.37)	6.12 (5.52-6.68)	6.35 (5.69-6.94)	6.60 (5.86-7.22)	6.77 (5.96-7.40)
30-min	2.27 (2.08-2.48)	2.72 (2.49-2.97)	3.25 (2.97-3.55)	3.64 (3.33-3.98)	4.08 (3.71-4.45)	4.40 (3.99-4.80)	4.69 (4.23-5.12)	4.95 (4.43-5.40)	5.25 (4.66-5.74)	5.48 (4.82-6.00)
60-min	1.42 (1.30-1.55)	1.70 (1.56-1.87)	2.08 (1.91-2.28)	2.37 (2.17-2.59)	2.72 (2.47-2.97)	2.98 (2.70-3.25)	3.23 (2.91-3.53)	3.47 (3.11-3.79)	3.77 (3.35-4.12)	4.00 (3.52-4.38)
2-hr	0.840 (0.766-0.925)	1.02 (0.928-1.12)	1.25 (1.14-1.38)	1.44 (1.31-1.58)	1.67 (1.51-1.83)	1.85 (1.67-2.03)	2.03 (1.81-2.23)	2.20 (1.96-2.42)	2.43 (2.14-2.67)	2.61 (2.27-2.87)
3-hr	0.595 (0.544-0.655)	0.720 (0.660-0.792)	0.891 (0.814-0.979)	1.03 (0.938-1.13)	1.21 (1.09-1.32)	1.35 (1.21-1.48)	1.49 (1.33-1.63)	1.63 (1.45-1.78)	1.82 (1.60-2.00)	1.98 (1.71-2.17)
6-hr	0.358 (0.329-0.392)	0.433 (0.398-0.474)	0.536 (0.491-0.587)	0.620 (0.567-0.678)	0.731 (0.663-0.797)	0.822 (0.740-0.895)	0.913 (0.815-0.994)	1.01 (0.890-1.10)	1.13 (0.988-1.23)	1.24 (1.07-1.35)
12-hr	0.210 (0.194-0.230)	0.254 (0.234-0.278)	0.316 (0.290-0.345)	0.368 (0.336-0.402)	0.438 (0.397-0.476)	0.496 (0.446-0.537)	0.555 (0.495-0.601)	0.618 (0.544-0.668)	0.704 (0.609-0.762)	0.778 (0.662-0.841)
24-hr	0.123 (0.115-0.131)	0.148 (0.139-0.159)	0.186 (0.174-0.198)	0.215 (0.201-0.229)	0.254 (0.237-0.272)	0.285 (0.265-0.305)	0.317 (0.294-0.340)	0.350 (0.323-0.376)	0.395 (0.363-0.425)	0.431 (0.394-0.464)
2-day	0.072 (0.067-0.077)	0.086 (0.081-0.093)	0.107 (0.100-0.115)	0.123 (0.115-0.132)	0.145 (0.135-0.155)	0.162 (0.151-0.174)	0.180 (0.166-0.193)	0.198 (0.182-0.212)	0.222 (0.204-0.239)	0.241 (0.221-0.260)
3-day	0.051 (0.047-0.054)	0.061 (0.057-0.065)	0.075 (0.070-0.080)	0.086 (0.081-0.092)	0.102 (0.095-0.109)	0.114 (0.105-0.122)	0.126 (0.116-0.135)	0.138 (0.127-0.149)	0.155 (0.142-0.167)	0.169 (0.154-0.182)
4-day	0.040 (0.038-0.043)	0.048 (0.045-0.051)	0.059 (0.055-0.063)	0.068 (0.063-0.073)	0.080 (0.074-0.085)	0.089 (0.083-0.096)	0.099 (0.091-0.106)	0.109 (0.100-0.117)	0.122 (0.112-0.132)	0.133 (0.121-0.144)
7-day	0.026 (0.025-0.028)	0.031 (0.030-0.034)	0.038 (0.036-0.041)	0.044 (0.041-0.046)	0.051 (0.048-0.054)	0.057 (0.053-0.061)	0.063 (0.058-0.067)	0.069 (0.064-0.074)	0.077 (0.071-0.083)	0.084 (0.077-0.090)
10-day	0.021 (0.020-0.022)	0.025 (0.024-0.027)	0.030 (0.028-0.032)	0.034 (0.032-0.036)	0.039 (0.037-0.042)	0.043 (0.041-0.046)	0.048 (0.044-0.051)	0.052 (0.048-0.055)	0.058 (0.053-0.062)	0.062 (0.057-0.067)
20-day	0.014 (0.013-0.015)	0.017 (0.016-0.018)	0.020 (0.019-0.021)	0.022 (0.021-0.023)	0.025 (0.024-0.027)	0.028 (0.026-0.029)	0.030 (0.028-0.032)	0.033 (0.031-0.035)	0.036 (0.034-0.039)	0.039 (0.036-0.042)
30-day	0.012 (0.011-0.012)	0.014 (0.013-0.014)	0.016 (0.015-0.017)	0.018 (0.017-0.019)	0.020 (0.019-0.021)	0.022 (0.020-0.023)	0.023 (0.022-0.025)	0.025 (0.023-0.027)	0.027 (0.026-0.029)	0.029 (0.027-0.031)
45-day	0.010 (0.009-0.010)	0.012 (0.011-0.012)	0.013 (0.013-0.014)	0.015 (0.014-0.015)	0.016 (0.015-0.017)	0.018 (0.017-0.018)	0.019 (0.018-0.020)	0.020 (0.019-0.021)	0.022 (0.020-0.023)	0.023 (0.021-0.024)
60-day	0.009 (0.008-0.009)	0.010 (0.010-0.011)	0.012 (0.011-0.012)	0.013 (0.012-0.013)	0.014 (0.013-0.015)	0.015 (0.014-0.016)	0.016 (0.015-0.017)	0.017 (0.016-0.018)	0.018 (0.017-0.019)	0.019 (0.018-0.020)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical



NOAA Atlas 14, Volume 2, Version 3
 Location name: Chapel Hill, North Carolina, US*
 Latitude: 35.8282°, Longitude: -79.1072°
 Elevation: 508ft*
 * source: Google Maps



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnín, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

PF tabular

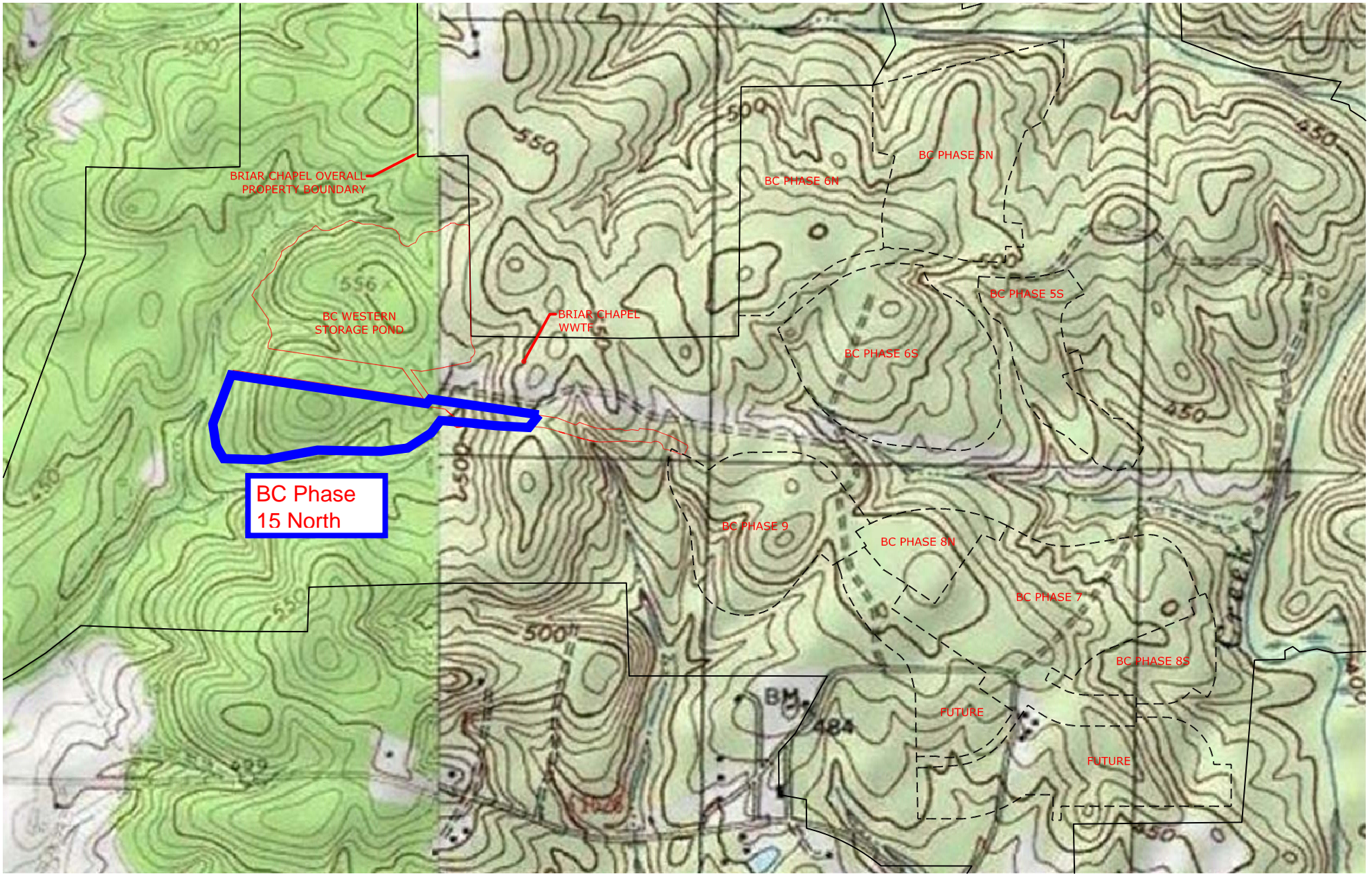
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.415 (0.379-0.454)	0.489 (0.448-0.536)	0.564 (0.517-0.617)	0.621 (0.568-0.679)	0.682 (0.620-0.744)	0.724 (0.656-0.790)	0.763 (0.687-0.832)	0.794 (0.712-0.868)	0.829 (0.736-0.906)	0.856 (0.753-0.936)
10-min	0.663 (0.606-0.725)	0.782 (0.717-0.856)	0.904 (0.827-0.989)	0.994 (0.908-1.09)	1.09 (0.989-1.19)	1.15 (1.05-1.26)	1.21 (1.09-1.32)	1.26 (1.13-1.38)	1.31 (1.16-1.43)	1.35 (1.19-1.48)
15-min	0.828 (0.758-0.906)	0.983 (0.901-1.08)	1.14 (1.05-1.25)	1.26 (1.15-1.37)	1.38 (1.25-1.50)	1.46 (1.32-1.59)	1.53 (1.38-1.67)	1.59 (1.42-1.74)	1.65 (1.47-1.80)	1.69 (1.49-1.85)
30-min	1.14 (1.04-1.24)	1.36 (1.25-1.49)	1.62 (1.49-1.78)	1.82 (1.67-1.99)	2.04 (1.86-2.23)	2.20 (1.99-2.40)	2.35 (2.11-2.56)	2.47 (2.22-2.70)	2.63 (2.33-2.87)	2.74 (2.41-3.00)
60-min	1.42 (1.30-1.55)	1.70 (1.56-1.87)	2.08 (1.91-2.28)	2.37 (2.17-2.59)	2.72 (2.47-2.97)	2.98 (2.70-3.25)	3.23 (2.91-3.53)	3.47 (3.11-3.79)	3.77 (3.35-4.12)	4.00 (3.52-4.38)
2-hr	1.68 (1.53-1.85)	2.03 (1.86-2.23)	2.51 (2.29-2.76)	2.88 (2.61-3.16)	3.34 (3.02-3.67)	3.71 (3.33-4.07)	4.06 (3.62-4.45)	4.41 (3.91-4.84)	4.86 (4.27-5.34)	5.23 (4.55-5.75)
3-hr	1.79 (1.64-1.97)	2.16 (1.98-2.38)	2.68 (2.45-2.94)	3.09 (2.82-3.39)	3.62 (3.28-3.96)	4.05 (3.64-4.43)	4.47 (3.99-4.89)	4.90 (4.34-5.36)	5.47 (4.79-5.99)	5.94 (5.15-6.52)
6-hr	2.15 (1.97-2.35)	2.59 (2.38-2.84)	3.21 (2.94-3.51)	3.72 (3.40-4.06)	4.38 (3.97-4.77)	4.92 (4.43-5.36)	5.47 (4.88-5.95)	6.03 (5.33-6.56)	6.79 (5.92-7.39)	7.42 (6.39-8.10)
12-hr	2.54 (2.33-2.77)	3.06 (2.82-3.35)	3.81 (3.49-4.16)	4.44 (4.05-4.84)	5.28 (4.78-5.73)	5.97 (5.38-6.47)	6.69 (5.96-7.24)	7.44 (6.55-8.05)	8.49 (7.34-9.18)	9.37 (7.98-10.1)
24-hr	2.95 (2.76-3.15)	3.56 (3.34-3.81)	4.45 (4.17-4.76)	5.15 (4.82-5.50)	6.10 (5.68-6.52)	6.85 (6.37-7.33)	7.61 (7.06-8.16)	8.40 (7.76-9.02)	9.49 (8.72-10.2)	10.3 (9.46-11.1)
2-day	3.44 (3.23-3.69)	4.15 (3.89-4.44)	5.15 (4.82-5.51)	5.92 (5.53-6.34)	6.97 (6.49-7.46)	7.79 (7.23-8.34)	8.63 (7.98-9.26)	9.48 (8.74-10.2)	10.7 (9.78-11.5)	11.6 (10.6-12.5)
3-day	3.65 (3.42-3.90)	4.38 (4.11-4.69)	5.42 (5.07-5.79)	6.22 (5.81-6.66)	7.31 (6.81-7.83)	8.17 (7.58-8.76)	9.05 (8.37-9.71)	9.95 (9.17-10.7)	11.2 (10.3-12.1)	12.2 (11.1-13.1)
4-day	3.85 (3.61-4.12)	4.62 (4.33-4.94)	5.69 (5.32-6.08)	6.52 (6.09-6.98)	7.66 (7.13-8.20)	8.56 (7.93-9.17)	9.48 (8.76-10.2)	10.4 (9.60-11.2)	11.7 (10.7-12.6)	12.8 (11.6-13.8)
7-day	4.43 (4.18-4.72)	5.29 (4.98-5.63)	6.42 (6.05-6.84)	7.33 (6.89-7.81)	8.56 (8.02-9.12)	9.53 (8.90-10.2)	10.5 (9.80-11.2)	11.6 (10.7-12.4)	13.0 (11.9-13.9)	14.1 (12.9-15.1)
10-day	5.04 (4.76-5.36)	5.99 (5.65-6.37)	7.19 (6.78-7.65)	8.13 (7.65-8.65)	9.41 (8.82-10.0)	10.4 (9.73-11.1)	11.4 (10.6-12.2)	12.4 (11.6-13.3)	13.8 (12.8-14.8)	14.9 (13.8-16.0)
20-day	6.75 (6.38-7.14)	7.96 (7.53-8.42)	9.40 (8.88-9.94)	10.5 (9.95-11.2)	12.1 (11.4-12.8)	13.3 (12.5-14.1)	14.5 (13.6-15.4)	15.8 (14.7-16.8)	17.5 (16.2-18.7)	18.8 (17.4-20.1)
30-day	8.37 (7.94-8.85)	9.86 (9.33-10.4)	11.4 (10.8-12.1)	12.7 (12.0-13.4)	14.3 (13.5-15.1)	15.6 (14.7-16.5)	16.8 (15.8-17.8)	18.1 (16.9-19.2)	19.7 (18.4-21.0)	21.0 (19.5-22.4)
45-day	10.7 (10.2-11.2)	12.5 (11.9-13.1)	14.3 (13.6-15.0)	15.7 (14.9-16.5)	17.5 (16.6-18.4)	18.9 (17.9-19.9)	20.3 (19.1-21.3)	21.6 (20.3-22.8)	23.4 (21.9-24.7)	24.7 (23.1-26.2)
60-day	12.8 (12.2-13.4)	14.9 (14.2-15.6)	16.8 (16.1-17.6)	18.3 (17.5-19.2)	20.2 (19.3-21.2)	21.7 (20.6-22.7)	23.0 (21.9-24.2)	24.4 (23.1-25.7)	26.1 (24.7-27.6)	27.5 (25.9-29.0)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical

Maps





BC Phase 15 North

39 67

35° 50' 00"

39 66

39 65

Wet Detention Pond #23 Design

WATER QUALITY POND #23 CALCULATIONS

Project Name

Briar Chapel - Phase 15 North

Project Number

02735-0113

Date

June 17, 2015

3rd revision _____
2nd revision _____
1st revision _____

Water Quality Pond Drainage Area Data

Project Briar Chapel - Phase 15 North

Project No. 02735-0113

Date June 17, 2015

Total site area 754,858 square feet = 17.33 acres

	Drainage area to pond			Other Drainage Area	
	Existing [sf]	Proposed [sf]	Change [sf]	Existing [sf]	Proposed [sf]
Impervious areas					
On-site buildings (BUA)	0	183,700	183,700	0	0
On-site streets	0	103,720	103,720	0	0
On-site alleys	0	0	0	0	0
On-site sidewalks	0	20,400	20,400	0	0
On-site future (open space)	0	0	0	0	0
On-site future (Amenity)	0	0	0	0	0
Off-site future development	0	0	0	0	0
10% Contingency	0	30,782	30,782	0	0
Total Impervious	0	338,602	338,602	0	0

	Drainage area to pond			Other Drainage Area	
	Existing [sf]	Proposed [sf]	Change [sf]	Existing [sf]	Proposed [sf]
Non-impervious areas					
On-site grass/landscape	0	298,394	298,394	0	0
On-site woods	754,858	117,862	-636,996	0	0
Other undeveloped	0	0	0	0	0
Total off-site non-impervious	0	0	0	0	0
Total non-impervious	754,858	416,256	-338,602	0	0

Total Drainage Area	754,858	754,858	0	0	0
Percent Impervious	0.0	44.9	44.9	n/a	n/a

Notes:

Water Quality Pond Surface Area Calculations

Project Briar Chapel - Phase 15 North
 Project No. 02735-0113

Date June 17, 2015

Total on-site drainage area to pond 754,858 square feet
 Total impervious area in drainage area 338,602 square feet

Average water depth of basin at normal pool 4.0 feet

Location of site Chatham County
 Site region Piedmont

% Impervious cover 44.9 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%) 1.58 percent
 For a site in the Piedmont (90%) 2.24 percent
 For a site in a Coastal County w/ Vegetative Filter 2.94 percent
 For a site in a Coastal County w/out Vegetative Filter 3.89 percent

Required surface area of pond:

For a site in the Piedmont (85%) 11,900.0 square feet
 For a site in the Piedmont (90%) 16,940.0 square feet
 For a site in a Coastal County w/ Vegetative Filter 22,200.0 square feet
 For a site in a Coastal County w/out Vegetative Filter 29,360.0 square feet

Notes:

Water Quality Pond Stormwater Runoff Volume Calculations

Project Briar Chapel - Phase 15 North
Project No. 02735-0113

Date June 17, 2015

Drainage area 754,858 square feet
Impervious area 338,602 square feet
Rainfall depth 1.00 inches

Percent Impervious 44.9 percent

$R(v) = 0.05 + 0.009 * (\text{Percent impervious})$

Runoff coefficient - R(v) 0.45 in/in

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

Runoff volume 28,540.4 cubic feet

Notes:

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

Project Briar Chapel - Phase 15 North

Project No. 02735-0113

Date June 17, 2015

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]
447.5	0	17,183.0	0.394	17,183.0	0.4	0.0	0.0	0.0	0.0
448	0.5	19,795.0	0.454	19,795.0	0.1	9,244.5	0.2	9,244.5	0.2
449	1.5	21,437.0	0.492	21,437.0	0.0	20,616.0	0.5	29,860.5	0.7
450	2.5	23,136.0	0.531	23,136.0	0.0	22,286.5	0.5	52,147.0	1.0
451	3.5	24,892.0	0.571	24,892.0	0.0	24,014.0	0.6	76,161.0	1.1
452	4.5	26,704.0	0.613	26,704.0	0.0	25,798.0	0.6	101,959.0	1.1
453	5.5	28,573.0	0.656	28,573.0	0.0	27,638.5	0.6	129,597.5	1.2
454	6.5	30,498.0	0.700	30,498.0	0.0	29,535.5	0.7	159,133.0	1.3

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

Project Briar Chapel - Phase 15 North

Project No. 02735-0113

Date June 17, 2015

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]
441	0	6,124.0	0.141	6,124.0	0.1	0.0	0.0	0.0	0.0
442	1	7,260.0	0.167	1,136.0	0.0	6,692.0	0.2	6,692.0	0.2
443	2	8,481.0	0.195	1,221.0	0.0	7,870.5	0.2	14,562.5	0.3
444	3	9,793.0	0.225	1,312.0	0.0	9,137.0	0.2	23,699.5	0.4
445	4	11,186.0	0.257	1,393.0	0.0	10,489.5	0.2	34,189.0	0.5
446	5	12,651.0	0.290	1,465.0	0.0	11,918.5	0.3	46,107.5	0.5
447	6	14,194.0	0.326	1,543.0	0.0	13,422.5	0.3	59,530.0	0.6
447.5	6.5	17,183.0	0.394	2,989.0	0.1	7,844.3	0.2	67,374.3	0.5

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

Project Briar Chapel - Phase 15 North

Project No. 02735-0113

Date June 17, 2015

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]
441	0	854.0	0.020	854.0	0.0	0.0	0.0	0.0	0.0
442	1	1,169.0	0.027	315.0	0.0	1,011.5	0.0	1,011.5	0.0
443	2	1,528.0	0.035	359.0	0.0	1,348.5	0.0	2,360.0	0.1
444	3	1,935.0	0.044	407.0	0.0	1,731.5	0.0	4,091.5	0.1
445	4	2,383.0	0.055	448.0	0.0	2,159.0	0.0	6,250.5	0.1
446	5	2,866.0	0.066	483.0	0.0	2,624.5	0.1	8,875.0	0.1
447	6	3,388.0	0.078	522.0	0.0	3,127.0	0.1	12,002.0	0.1
447.5	6.5	4,398.0	0.101	1,010.0	0.0	1,946.5	0.0	13,948.5	0.1

Water Quality Basin Dewatering Time Calculations

Project Briar Chapel - Phase 15 North
 Project No. 02735-0113

Date June 17, 2015

Water quality treatment volume	<u>28,540</u>	cubic feet
Total treatment volume	<u>29,861</u>	cubic feet
Maximum head of water above dewatering hole	<u>1.50</u>	feet
Driving head	<u>0.50</u>	feet
Orifice coefficient	<u>0.60</u>	
Diameter of each hole	<u>2.75</u>	inches
Number of holes	<u>1</u>	
Cross sectional area of each hole =	<u>0.041</u>	square feet
Cross sectional area of each hole =	<u>5.9</u>	square inches
Cross sectional area of dewatering hole(s) =	<u>0.041</u>	square feet
Cross sectional area of dewatering hole(s) =	<u>5.9</u>	square inches
Dewatering time for water quality volume =	<u>2.36</u>	days
	<u>56.7</u>	hours
Dewatering time for total volume =	<u>2.47</u>	days
	<u>59.4</u>	hours

Notes:

Dewatering time formula: $t \text{ (days)} = V / (Cd * A * \text{Sqrt} (2 * 32.2 * H) * 86,400)$

- t = drawdown time
- V = treatment volume
- Cd = orifice coefficient
- A = cross sectional area of orifice
- H = driving head (1/3 max. head)

Water Quality Pond Summary Information

Project Briar Chapel - Phase 15 North
Project No. 02735-0113

Date June 17, 2015

Drainage area to pond 754,858 square feet = 17.33 acres
Impervious area in drainage area 338,602 square feet = 7.77 acres

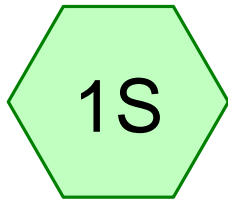
Bottom of pond elevation 441.00 feet
Normal pool elevation 447.50 feet
Pond volume at normal pool 67,374 cubic feet
Forebay volume at normal pool 13,949 cubic feet
Forebay % of total volume 20.7%

Required volume for design rainfall 28,540 cubic feet
Required surface area for pond 16,940 square feet

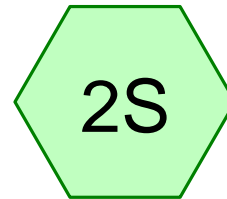
Volume provided for storage of design rainfall = 29,861 cubic feet at elevation 449

Surface area provided at normal pool 17,183 square feet

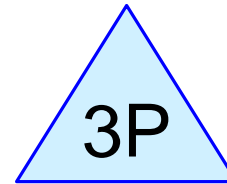
Average Depth 3.92 feet



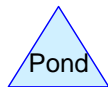
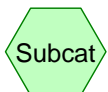
Pre-Development



Post-Development



BMP #23



Summary for Pond 3P: BMP #23

Inflow Area = 17.330 ac, 44.84% Impervious, Inflow Depth > 0.13" for 1-Inch event
 Inflow = 3.11 cfs @ 12.05 hrs, Volume= 0.189 af
 Outflow = 0.09 cfs @ 20.00 hrs, Volume= 0.051 af, Atten= 97%, Lag= 477.2 min
 Primary = 0.09 cfs @ 20.00 hrs, Volume= 0.051 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 447.83' @ 20.00 hrs Surf.Area= 18,920 sf Storage= 6,001 cf

Plug-Flow detention time= 261.0 min calculated for 0.051 af (27% of inflow)
 Center-of-Mass det. time= 138.4 min (983.7 - 845.3)

Volume	Invert	Avail.Storage	Storage Description
#1	447.50'	159,133 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
447.50	17,183	0	0
448.00	19,795	9,245	9,245
449.00	21,437	20,616	29,861
450.00	23,136	22,287	52,147
451.00	24,892	24,014	76,161
452.00	26,704	25,798	101,959
453.00	28,573	27,639	129,598
454.00	30,498	29,536	159,133

Device	Routing	Invert	Outlet Devices
#1	Primary	444.25'	30.0" Round Culvert L= 53.8' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 444.25' / 444.00' S= 0.0046 1/ S Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 4.91 sf
#2	Device 1	447.50'	2.7" Vert. Orifice/Grate C= 0.600
#3	Device 1	449.00'	36.0" W x 9.0" H Vert. Orifice/Grate X 2.00 C= 0.600
#4	Device 1	451.00'	48.0" x 48.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	452.00'	40.0' long x 22.0' 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=0.09 cfs @ 20.00 hrs HW=447.83' (Free Discharge)

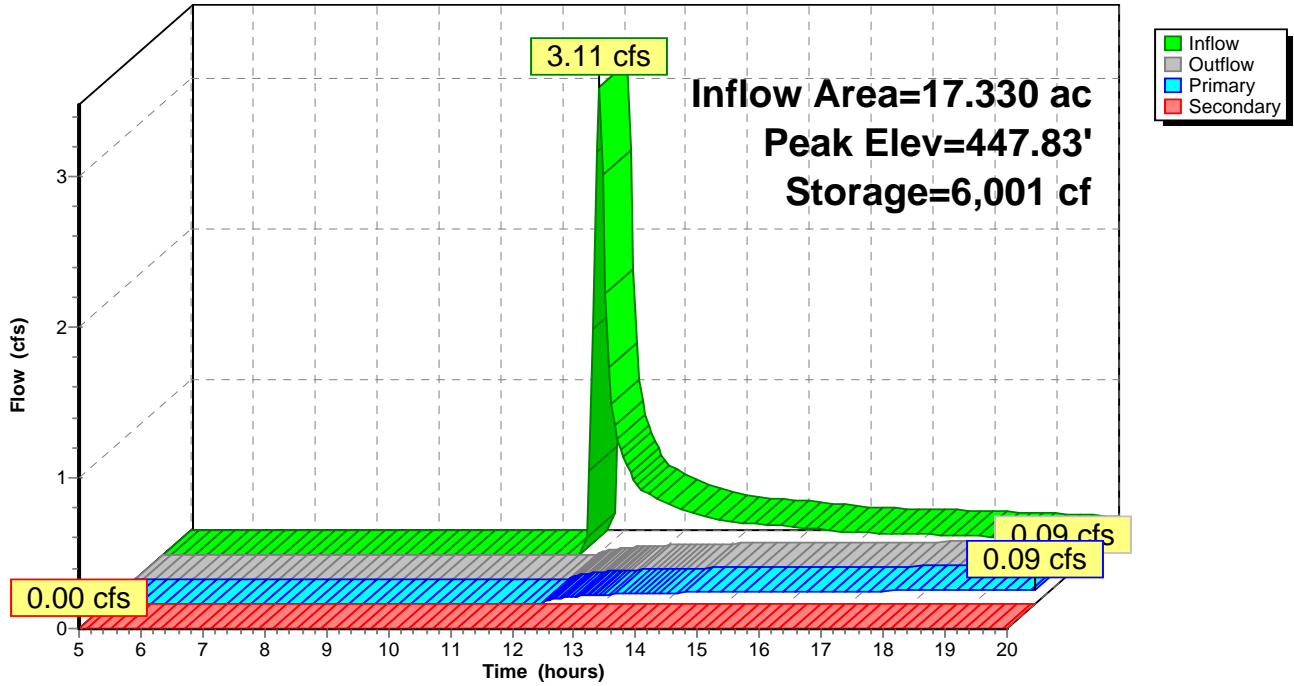
- ↑ 1=Culvert (Passes 0.09 cfs of 32.17 cfs potential flow)
- ↑ 2=Orifice/Grate (Orifice Controls 0.09 cfs @ 2.26 fps)
- ↑ 3=Orifice/Grate (Controls 0.00 cfs)
- ↑ 4=Orifice/Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=447.50' (Free Discharge)

- ↑ 5=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 3P: BMP #23

Hydrograph



2015.06.17.BMP #23.GCA

Prepared by McKim & Creed

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Type II 24-hr 1-Yr Rainfall=2.96"

Printed 6/23/2015

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points

Runoff by SCS TR-20 method, UH=SCS

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre-Development

Runoff Area=17.330 ac 0.00% Impervious Runoff Depth>0.61"
Tc=20.0 min CN=70 Runoff=11.52 cfs 0.880 af

Subcatchment 2S: Post-Development

Runoff Area=17.330 ac 44.84% Impervious Runoff Depth>1.36"
Tc=10.0 min CN=84 Runoff=38.95 cfs 1.969 af

Pond 3P: BMP #23

Peak Elev=449.56' Storage=42,198 cf Inflow=38.95 cfs 1.969 af
Primary=8.41 cfs 1.248 af Secondary=0.00 cfs 0.000 af Outflow=8.41 cfs 1.248 af

Total Runoff Area = 34.660 ac Runoff Volume = 2.850 af Average Runoff Depth = 0.99"
77.58% Pervious = 26.890 ac 22.42% Impervious = 7.770 ac

Summary for Subcatchment 1S: Pre-Development

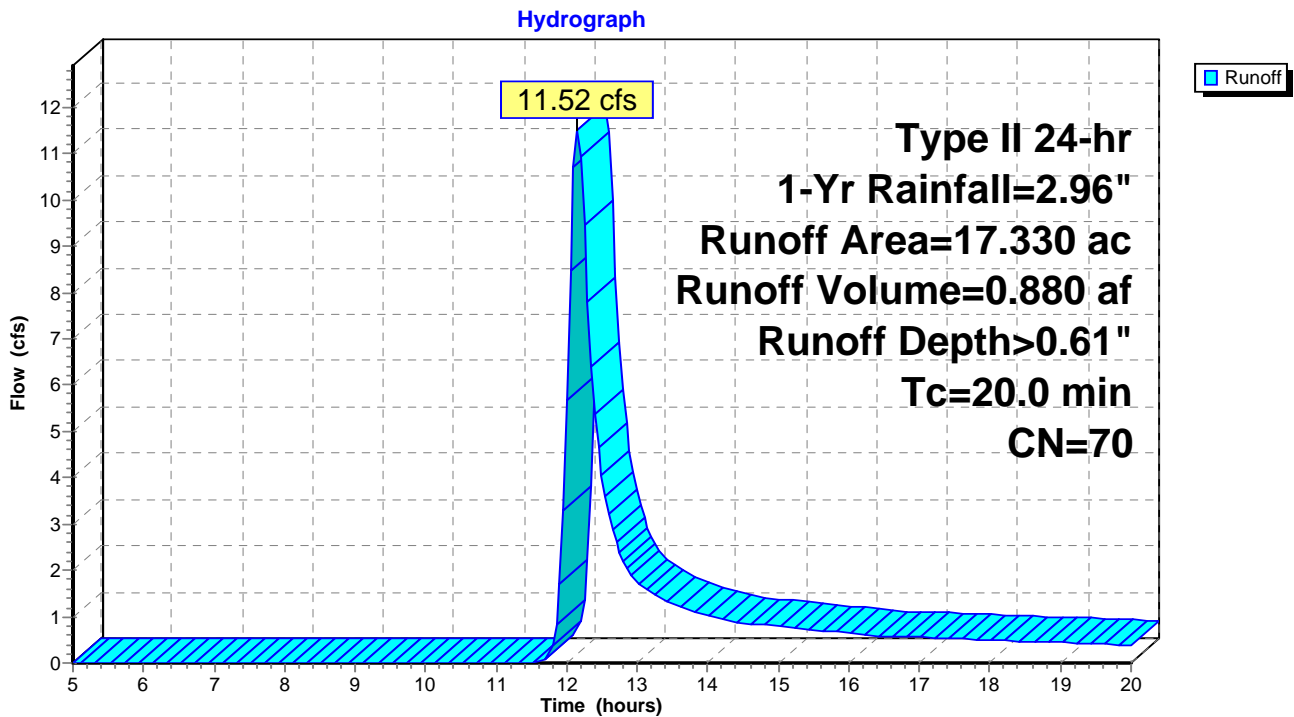
Runoff = 11.52 cfs @ 12.15 hrs, Volume= 0.880 af, Depth> 0.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type II 24-hr 1-Yr Rainfall=2.96"

Area (ac)	CN	Description
17.330	70	Woods, Good, HSG C
17.330		100.00% Pervious Area

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

Subcatchment 1S: Pre-Development



Summary for Subcatchment 2S: Post-Development

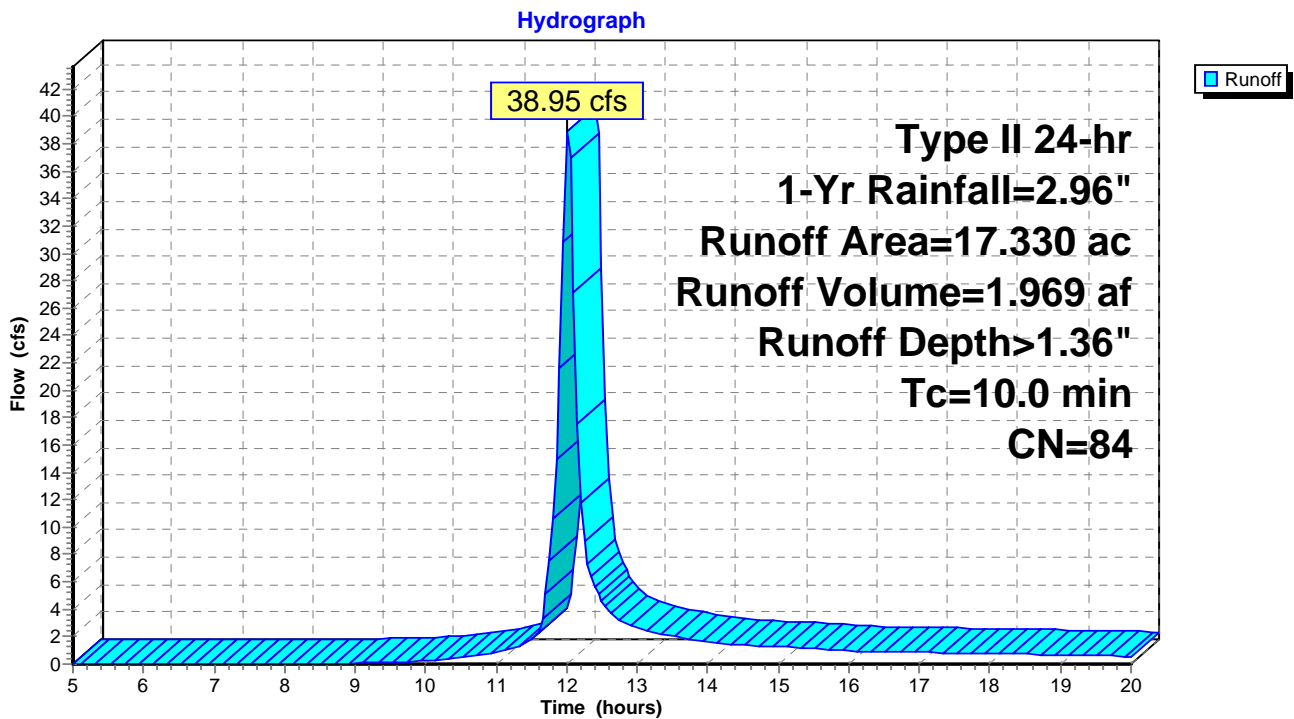
Runoff = 38.95 cfs @ 12.02 hrs, Volume= 1.969 af, Depth> 1.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type II 24-hr 1-Yr Rainfall=2.96"

Area (ac)	CN	Description
6.850	74	>75% Grass cover, Good, HSG C
7.770	98	Paved parking, HSG C
2.710	70	Woods, Good, HSG C
17.330	84	Weighted Average
9.560		55.16% Pervious Area
7.770		44.84% Impervious Area

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

Subcatchment 2S: Post-Development



Summary for Pond 3P: BMP #23

Inflow Area = 17.330 ac, 44.84% Impervious, Inflow Depth > 1.36" for 1-Yr event
 Inflow = 38.95 cfs @ 12.02 hrs, Volume= 1.969 af
 Outflow = 8.41 cfs @ 12.27 hrs, Volume= 1.248 af, Atten= 78%, Lag= 15.2 min
 Primary = 8.41 cfs @ 12.27 hrs, Volume= 1.248 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 449.56' @ 12.27 hrs Surf.Area= 22,393 sf Storage= 42,198 cf

Plug-Flow detention time= 143.3 min calculated for 1.248 af (63% of inflow)
 Center-of-Mass det. time= 69.2 min (860.0 - 790.8)

Volume	Invert	Avail.Storage	Storage Description
#1	447.50'	159,133 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
447.50	17,183	0	0
448.00	19,795	9,245	9,245
449.00	21,437	20,616	29,861
450.00	23,136	22,287	52,147
451.00	24,892	24,014	76,161
452.00	26,704	25,798	101,959
453.00	28,573	27,639	129,598
454.00	30,498	29,536	159,133

Device	Routing	Invert	Outlet Devices
#1	Primary	444.25'	30.0" Round Culvert L= 53.8' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 444.25' / 444.00' S= 0.0046 1' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 4.91 sf
#2	Device 1	447.50'	2.7" Vert. Orifice/Grate C= 0.600
#3	Device 1	449.00'	36.0" W x 9.0" H Vert. Orifice/Grate X 2.00 C= 0.600
#4	Device 1	451.00'	48.0" x 48.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	452.00'	40.0' long x 22.0' 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=8.35 cfs @ 12.27 hrs HW=449.56' (Free Discharge)

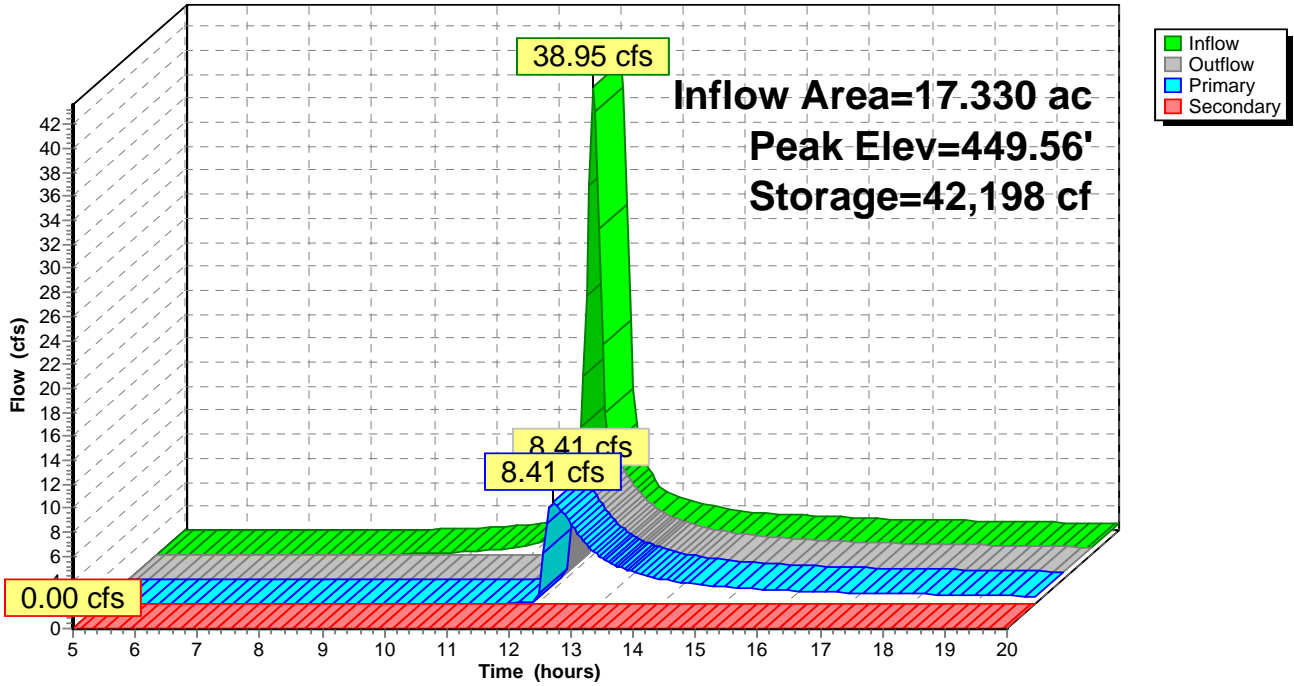
- 1=Culvert (Passes 8.35 cfs of 47.63 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.27 cfs @ 6.72 fps)
- 3=Orifice/Grate (Orifice Controls 8.08 cfs @ 2.40 fps)
- 4=Orifice/Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=447.50' (Free Discharge)

- 5=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 3P: BMP #23

Hydrograph



2015.06.17.BMP #23.GCA

Prepared by McKim & Creed

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Type II 24-hr 10-Yr Rainfall=5.17"

Printed 6/23/2015

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points

Runoff by SCS TR-20 method, UH=SCS

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre-Development

Runoff Area=17.330 ac 0.00% Impervious Runoff Depth>1.96"
Tc=20.0 min CN=70 Runoff=40.81 cfs 2.836 af

Subcatchment 2S: Post-Development

Runoff Area=17.330 ac 44.84% Impervious Runoff Depth>3.19"
Tc=10.0 min CN=84 Runoff=88.25 cfs 4.608 af

Pond 3P: BMP #23

Peak Elev=451.33' Storage=84,373 cf Inflow=88.25 cfs 4.608 af
Primary=40.34 cfs 3.856 af Secondary=0.00 cfs 0.000 af Outflow=40.34 cfs 3.856 af

Total Runoff Area = 34.660 ac Runoff Volume = 7.445 af Average Runoff Depth = 2.58"
77.58% Pervious = 26.890 ac 22.42% Impervious = 7.770 ac

Summary for Subcatchment 1S: Pre-Development

Runoff = 40.81 cfs @ 12.14 hrs, Volume= 2.836 af, Depth> 1.96"

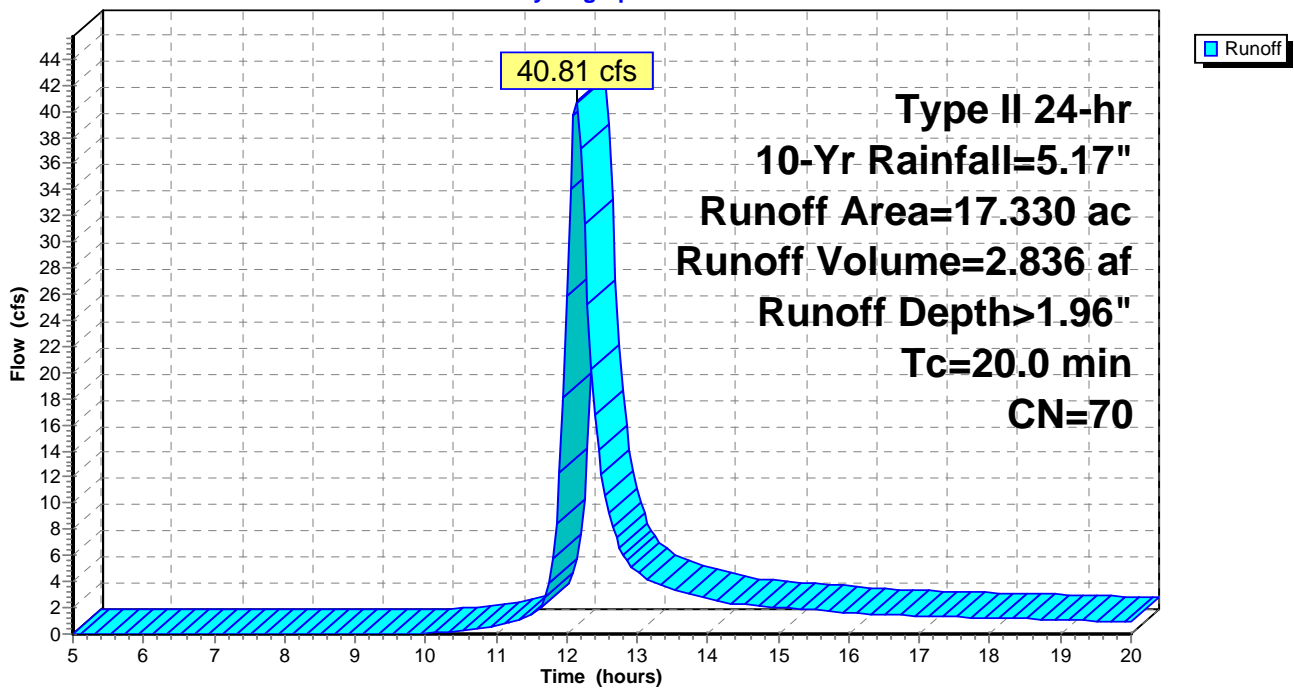
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type II 24-hr 10-Yr Rainfall=5.17"

Area (ac)	CN	Description
17.330	70	Woods, Good, HSG C
17.330		100.00% Pervious Area

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

Subcatchment 1S: Pre-Development

Hydrograph



Summary for Subcatchment 2S: Post-Development

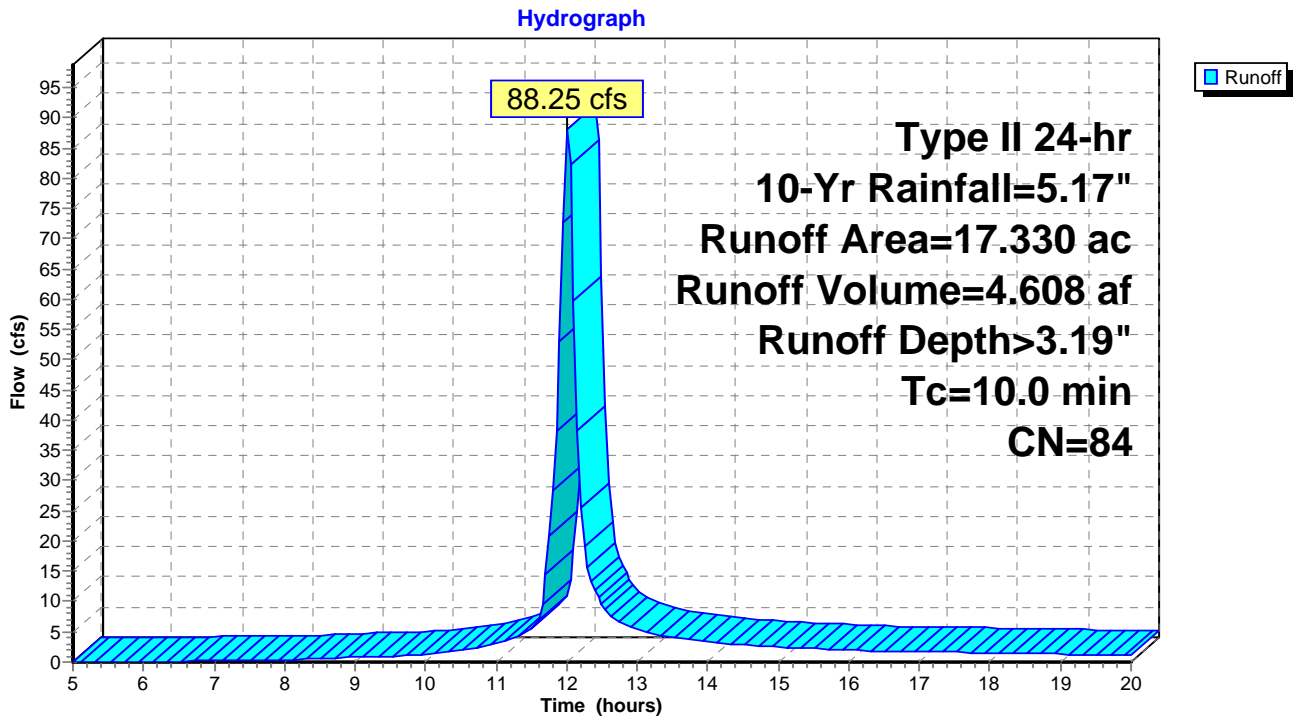
Runoff = 88.25 cfs @ 12.01 hrs, Volume= 4.608 af, Depth> 3.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type II 24-hr 10-Yr Rainfall=5.17"

Area (ac)	CN	Description
6.850	74	>75% Grass cover, Good, HSG C
7.770	98	Paved parking, HSG C
2.710	70	Woods, Good, HSG C
17.330	84	Weighted Average
9.560		55.16% Pervious Area
7.770		44.84% Impervious Area

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

Subcatchment 2S: Post-Development



Summary for Pond 3P: BMP #23

Inflow Area = 17.330 ac, 44.84% Impervious, Inflow Depth > 3.19" for 10-Yr event
 Inflow = 88.25 cfs @ 12.01 hrs, Volume= 4.608 af
 Outflow = 40.34 cfs @ 12.15 hrs, Volume= 3.856 af, Atten= 54%, Lag= 8.5 min
 Primary = 40.34 cfs @ 12.15 hrs, Volume= 3.856 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 451.33' @ 12.15 hrs Surf.Area= 25,483 sf Storage= 84,373 cf

Plug-Flow detention time= 91.2 min calculated for 3.856 af (84% of inflow)
 Center-of-Mass det. time= 43.2 min (815.3 - 772.1)

Volume	Invert	Avail.Storage	Storage Description
#1	447.50'	159,133 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
447.50	17,183	0	0
448.00	19,795	9,245	9,245
449.00	21,437	20,616	29,861
450.00	23,136	22,287	52,147
451.00	24,892	24,014	76,161
452.00	26,704	25,798	101,959
453.00	28,573	27,639	129,598
454.00	30,498	29,536	159,133

Device	Routing	Invert	Outlet Devices
#1	Primary	444.25'	30.0" Round Culvert L= 53.8' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 444.25' / 444.00' S= 0.0046 1' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 4.91 sf
#2	Device 1	447.50'	2.7" Vert. Orifice/Grate C= 0.600
#3	Device 1	449.00'	36.0" W x 9.0" H Vert. Orifice/Grate X 2.00 C= 0.600
#4	Device 1	451.00'	48.0" x 48.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	452.00'	40.0' long x 22.0' 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=40.07 cfs @ 12.15 hrs HW=451.32' (Free Discharge)

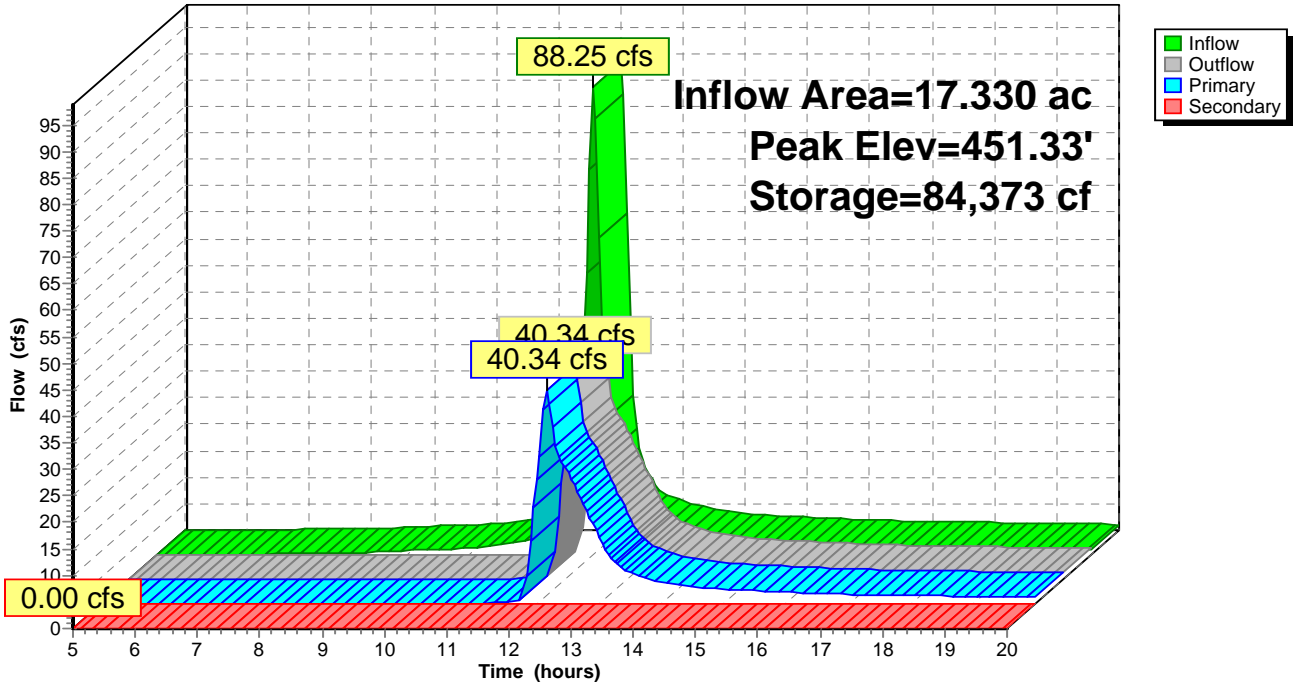
- 1=Culvert (Passes 40.07 cfs of 57.03 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.37 cfs @ 9.27 fps)
- 3=Orifice/Grate (Orifice Controls 30.18 cfs @ 6.71 fps)
- 4=Orifice/Grate (Weir Controls 9.52 cfs @ 1.85 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=447.50' (Free Discharge)

- 5=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 3P: BMP #23

Hydrograph



2015.06.17.BMP #23.GCA

Prepared by McKim & Creed

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Type II 24-hr 100-Yr Rainfall=7.62"

Printed 6/23/2015

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points

Runoff by SCS TR-20 method, UH=SCS

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre-Development

Runoff Area=17.330 ac 0.00% Impervious Runoff Depth>3.81"
Tc=20.0 min CN=70 Runoff=79.29 cfs 5.497 af

Subcatchment 2S: Post-Development

Runoff Area=17.330 ac 44.84% Impervious Runoff Depth>5.37"
Tc=10.0 min CN=84 Runoff=143.98 cfs 7.750 af

Pond 3P: BMP #23

Peak Elev=452.48' Storage=114,982 cf Inflow=143.98 cfs 7.750 af
Primary=62.44 cfs 6.602 af Secondary=35.87 cfs 0.369 af Outflow=98.31 cfs 6.970 af

Total Runoff Area = 34.660 ac Runoff Volume = 13.247 af Average Runoff Depth = 4.59"
77.58% Pervious = 26.890 ac 22.42% Impervious = 7.770 ac

Summary for Subcatchment 1S: Pre-Development

Runoff = 79.29 cfs @ 12.13 hrs, Volume= 5.497 af, Depth> 3.81"

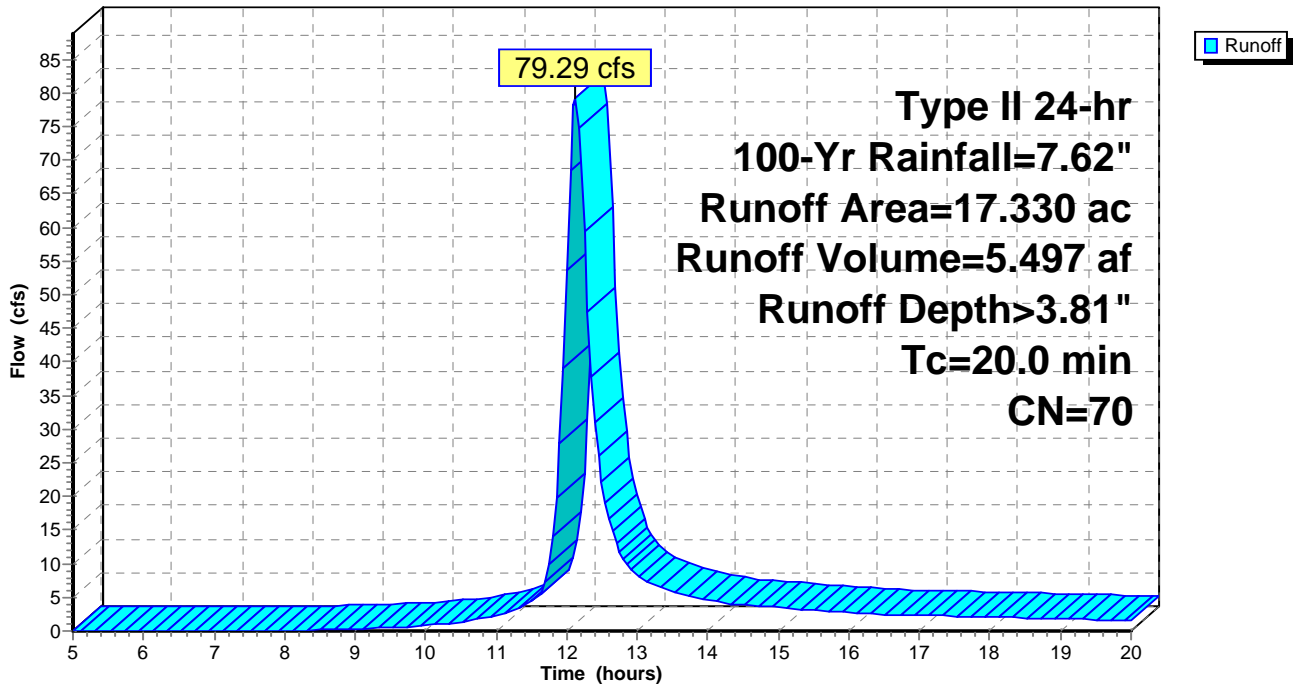
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type II 24-hr 100-Yr Rainfall=7.62"

Area (ac)	CN	Description
17.330	70	Woods, Good, HSG C
17.330		100.00% Pervious Area

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

Subcatchment 1S: Pre-Development

Hydrograph



Summary for Subcatchment 2S: Post-Development

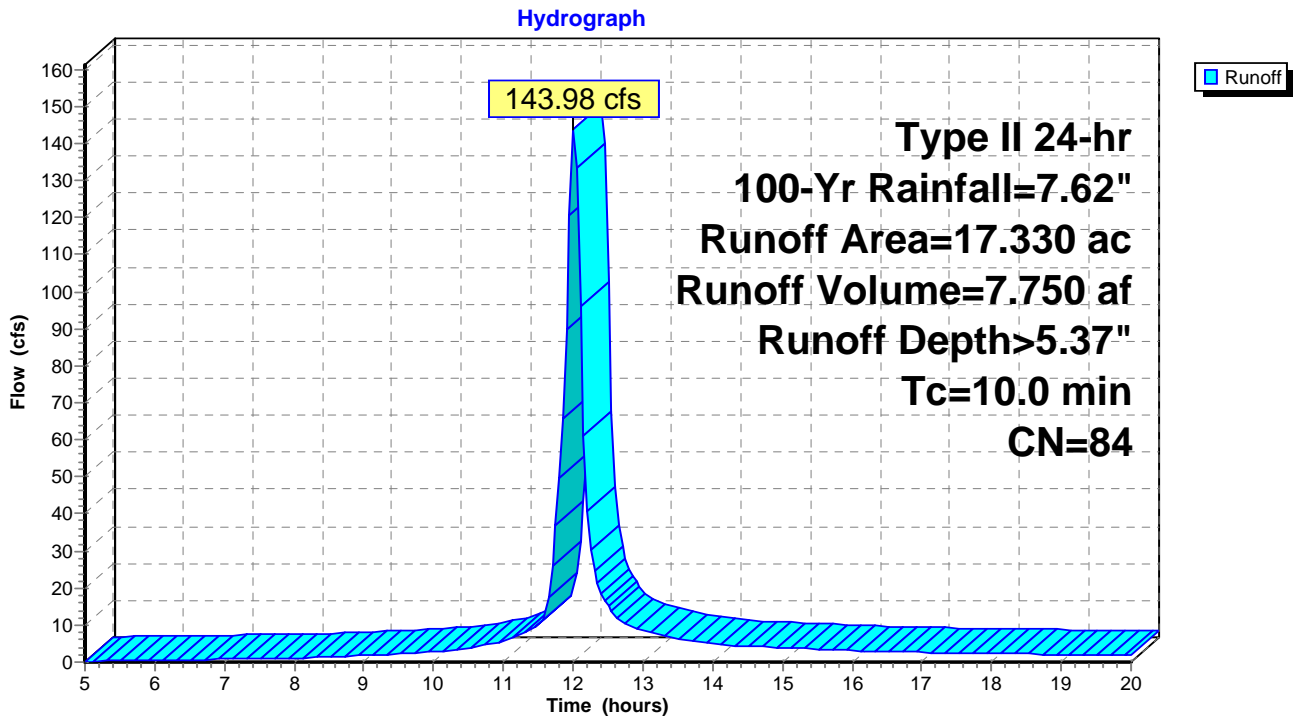
Runoff = 143.98 cfs @ 12.01 hrs, Volume= 7.750 af, Depth> 5.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type II 24-hr 100-Yr Rainfall=7.62"

Area (ac)	CN	Description
6.850	74	>75% Grass cover, Good, HSG C
7.770	98	Paved parking, HSG C
2.710	70	Woods, Good, HSG C
17.330	84	Weighted Average
9.560		55.16% Pervious Area
7.770		44.84% Impervious Area

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

Subcatchment 2S: Post-Development



Summary for Pond 3P: BMP #23

[82] Warning: Early inflow requires earlier time span

Inflow Area = 17.330 ac, 44.84% Impervious, Inflow Depth > 5.37" for 100-Yr event
 Inflow = 143.98 cfs @ 12.01 hrs, Volume= 7.750 af
 Outflow = 98.31 cfs @ 12.11 hrs, Volume= 6.970 af, Atten= 32%, Lag= 5.8 min
 Primary = 62.44 cfs @ 12.11 hrs, Volume= 6.602 af
 Secondary = 35.87 cfs @ 12.11 hrs, Volume= 0.369 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 452.48' @ 12.11 hrs Surf.Area= 27,600 sf Storage= 114,982 cf

Plug-Flow detention time= 72.6 min calculated for 6.970 af (90% of inflow)
 Center-of-Mass det. time= 38.2 min (798.3 - 760.1)

Volume	Invert	Avail.Storage	Storage Description
#1	447.50'	159,133 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
447.50	17,183	0	0
448.00	19,795	9,245	9,245
449.00	21,437	20,616	29,861
450.00	23,136	22,287	52,147
451.00	24,892	24,014	76,161
452.00	26,704	25,798	101,959
453.00	28,573	27,639	129,598
454.00	30,498	29,536	159,133

Device	Routing	Invert	Outlet Devices
#1	Primary	444.25'	30.0" Round Culvert L= 53.8' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 444.25' / 444.00' S= 0.0046 1' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 4.91 sf
#2	Device 1	447.50'	2.7" Vert. Orifice/Grate C= 0.600
#3	Device 1	449.00'	36.0" W x 9.0" H Vert. Orifice/Grate X 2.00 C= 0.600
#4	Device 1	451.00'	48.0" x 48.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	452.00'	40.0' long x 22.0' 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=62.37 cfs @ 12.11 hrs HW=452.46' (Free Discharge)

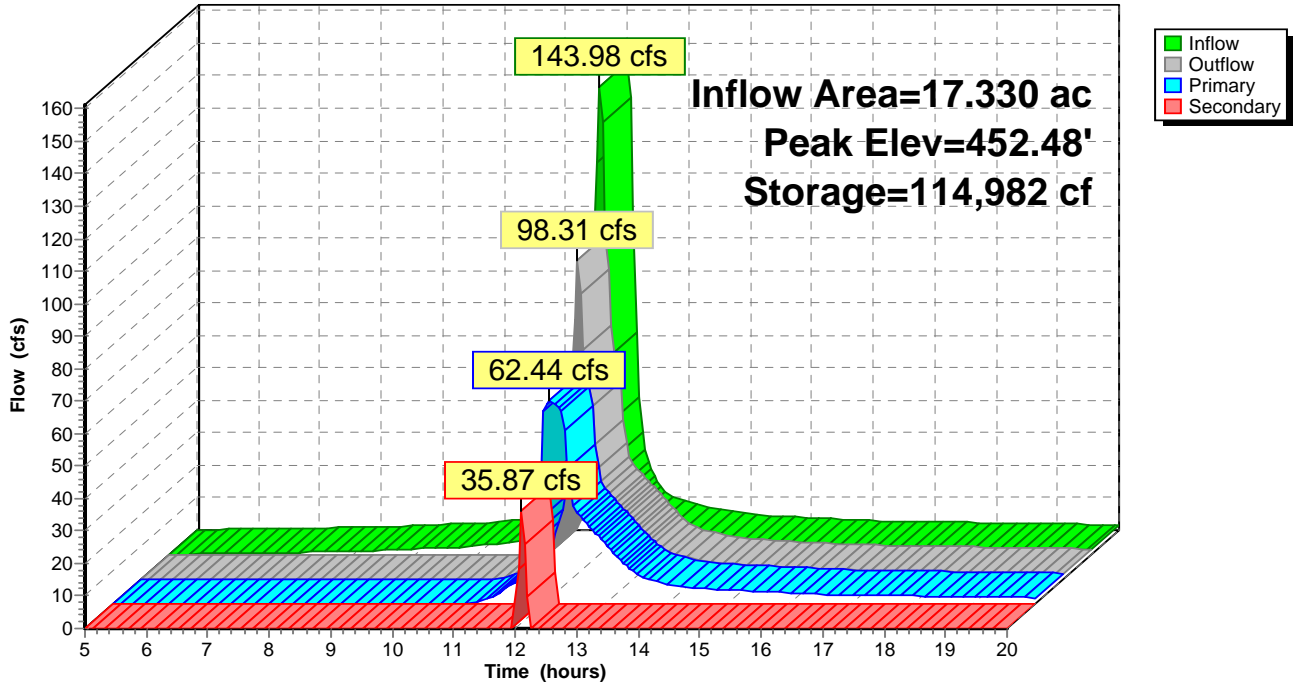
- ↑ 1=Culvert (Inlet Controls 62.37 cfs @ 12.71 fps)
- ↑ 2=Orifice/Grate (Passes < 0.42 cfs potential flow)
- ↑ 3=Orifice/Grate (Passes < 38.05 cfs potential flow)
- ↑ 4=Orifice/Grate (Passes < 92.62 cfs potential flow)

Secondary OutFlow Max=34.18 cfs @ 12.11 hrs HW=452.46' (Free Discharge)

- ↑ 5=Broad-Crested Rectangular Weir (Weir Controls 34.18 cfs @ 1.84 fps)

Pond 3P: BMP #23

Hydrograph



ANTI-FLOATATION DESIGN	DATE: 06/17/2015	DESIGNED BY: GCA																																												
PROJECT NAME: Briar Chapel - Phase 15 North PROJECT LOCATION: Chatham County, NC	PROJECT NO: 02735-0113	CHECKED BY: GML																																												
<table> <tr> <td>Pond Name=</td> <td>BMP #23</td> <td></td> <td></td> </tr> <tr> <td>Riser Outer Width =</td> <td>5 ft</td> <td>Riser Resisting Force =</td> <td>9,788 lb</td> </tr> <tr> <td>Riser Outer Length =</td> <td>5 ft</td> <td>Base Resisting Force =</td> <td>9,188 lb</td> </tr> <tr> <td>Riser Inner Width =</td> <td>4 ft</td> <td>Total Resisting Force =</td> <td>18,975 lb</td> </tr> <tr> <td>Riser Inner Length =</td> <td>4 ft</td> <td></td> <td></td> </tr> <tr> <td>Riser Height =</td> <td>7.25 ft</td> <td>Riser Buoyant Force =</td> <td>11,310 lb</td> </tr> <tr> <td></td> <td></td> <td>Base Buoyant Force =</td> <td>3,822 lb</td> </tr> <tr> <td>Concrete Base Length =</td> <td>7 ft</td> <td>Total Buoyant Force =</td> <td>15,132 lb</td> </tr> <tr> <td>Concrete Base Width =</td> <td>7 ft</td> <td></td> <td></td> </tr> <tr> <td>Concrete Base Depth =</td> <td>15 in</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>Factor of Safety</td> <td>1.25 Design Acceptable</td> </tr> </table>			Pond Name=	BMP #23			Riser Outer Width =	5 ft	Riser Resisting Force =	9,788 lb	Riser Outer Length =	5 ft	Base Resisting Force =	9,188 lb	Riser Inner Width =	4 ft	Total Resisting Force =	18,975 lb	Riser Inner Length =	4 ft			Riser Height =	7.25 ft	Riser Buoyant Force =	11,310 lb			Base Buoyant Force =	3,822 lb	Concrete Base Length =	7 ft	Total Buoyant Force =	15,132 lb	Concrete Base Width =	7 ft			Concrete Base Depth =	15 in					Factor of Safety	1.25 Design Acceptable
Pond Name=	BMP #23																																													
Riser Outer Width =	5 ft	Riser Resisting Force =	9,788 lb																																											
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Concrete Base Length =	7 ft	Total Buoyant Force =	15,132 lb																																											
Concrete Base Width =	7 ft																																													
Concrete Base Depth =	15 in																																													
		Factor of Safety	1.25 Design Acceptable																																											

OUTLET PROTECTION DESIGN	DATE: 06/12/2015	DESIGNED BY: BSS
PROJECT NAME: Briar Chapel - Phase 15N PROJECT LOCATION: Chatham County, NC	PROJECT NO: 02735-0113	CHECKED BY GCA

Storm Outlet Structure

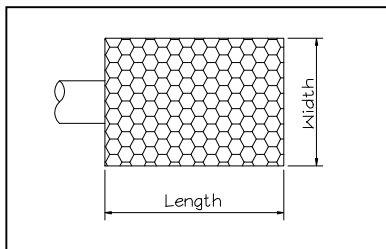
Structure= HW-BMP #23
 Size= 30 in
 Q₁₀ = 40.34 cfs
 Q_{full} = 45.16 cfs
 V_{full} = 6.39 fps

Q₁₀/Q_{full} = 0.89
 V/V_{full} = 1.29
 V = 9.03 fps

From Fig. 8.06.b.1:

Zone = 3

From Fig. 8.06.b.2:



D₅₀ = 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