Ballentine Associates, P.A.

Storm Water Impact Analysis

For

Chartwell

850 N. Estes Drive
Chapel Hill, North Carolina

PIN: 9789-35-9617 (Orange County)

Prepared by:

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BA Project # 111015.00 Vol. II "K"
Hanging File

Project Overview

Chartwell is a proposed hotel and multi-family residential site located at the northeast corner of the intersection of Estes Drive and Martin Luther King Jr Blvd. The project includes associated parking, recreation areas, utilities, and stormwater facilities.

Town of Chapel Hill Stormwater Requirements

Per Section 5.4.6 of the Town of Chapel Hill's Land Use Management Ordinance, this project must comply with the following criteria:

Stormwater Quality:

- 85% TSS removal through volume control of the first inch of post-developed runoff from new development.

Stormwater Runoff Volume Control:

- The post-developed stormwater volume for the 2-yr, 24-hour storm event shall match pre-developed levels. Flow shall be released over a 2 to 5 day period.

Stormwater Peak Runoff Rate:

- The post-developed peak flow for the 1-yr, 2-yr, and 25-yr, 24-hour storm events shall not exceed pre-developed levels.

Stream Disturbance:

- Land disturbance to stream channels shall be minimized.

Jordan Lake Rules:
The following rules were adopted by the Town of Chapel Hill prior to design:

- Land disturbance to riparian stream buffers shall be minimized.
- Provide diffuse flow outside of the riparian stream buffer for new points of discharge.

The following rules were not adopted by the Town of Chapel Hill at the time of design, but are anticipated in the future:

- Nitrogen Export (Upper New Hope):
  - Limit nitrogen export to below 8 lb/ac/yr. (prior to buydown).
  - Limit nitrogen export to 2.2 lb/ac/yr. This may be achieved using a combination of onsite BMPs and a buydown.
- Phosphorus Export (Upper New Hope):
  - Limit phosphorus export to 0.82 lb/ac/yr. This may be achieved using a combination of onsite BMPs and a buydown.

Existing Conditions:

Reference the Existing Conditions Drainage Area Map (DA 1):

The existing site is approximately 14.7 acres, is entirely wooded, and consists of Enon HSG "C" soil types. The property is bounded by Martin Luther King Jr. Blvd. to the west, by Estes Drive to the south, by an undeveloped tract to the east, and by multi-family and single-family residential neighborhoods to the north. There is a power easement along the east perimeter of the site. The property generally slopes at about 5% from west to east. The southeast corner of the property slopes at 10% towards the head of an intermittent stream, which exits the property to the southeast and flows under Estes Drive via an existing culvert.

The intermittent stream does have a Jordan Lake Riparian Stream Buffer, as shown on the plans. The attached FEMA maps show that there is no regulatory floodplain on the site.

Existing Total Onsite Impervious = 0 sf

Subarea Pre-A1 (Refer to map DA-1): The majority of the site (approx 13 acres) slopes from west to east at slopes ranging from 5% to 10%, where it concentrates and discharges into an existing intermittent stream. This stream exits the southeast corner of the property at "Pre-Outlet A", where it soon flows under Estes Drive via an existing culvert.

Subarea Pre-B1 (Refer to map DA-1): A small percentage of the site (less than 1/4 acre) slopes west towards Martin Luther King Jr Blvd, and flows over the curb as surface flow at "Pre-Outlet B".

Subarea Pre-C1: (Refer to map DA-1): A small percentage of the site (approx 1 acre) slopes to the north and flows over a curb as surface flow towards a parking lot in a neighboring multi-familty residential neighborhood (Shadow Wood) at "Pre-Outlet C".

Subarea Pre-D1: (Refer to map DA-1): A small percentage of the site (less than 1/2 acre) slopes to the north as surface flow towards a neighboring single-familty residential neighborhood at Woodshire Lane at "Pre-Outlet D".

Offsite Watershed: (Refer to map DA-1): There is only one offsite watershed (approx. 4 acres), which sends flows towards the Chartwell property. The offsite watershed is located to the east, and is mostly an undeveloped wooded site. Flow from the offsite watershed enters the existing intermittent stream on the Chartwell property, and soon exits the site at "Pre-Outlet A", as described above.

- Refer to the Table of Subareas, Land Uses, Curve Numbers, and Time of Concentration for additional information on the hydrology of these subareas.
- Refer to the Peak Flow and Volume Summary for additional information on the flows and volumes generated by these subareas.

Post-Developed Conditions:

Reference the Post-Developed Conditions Drainage Area Map (DA 2):

The proposed project consists of a hotel, ten student housing buildings, clubhouse and swimming pool, internal drives, parking lots, a parking deck, and associated infrastructure as shown on the Special Use Permit drawings.

Proposed Total Onsite Impervious = 388,616 sf (includes 15,000 sf impervious contingency)

No development is proposed within the Jordan Lake Riparian Stream Buffer. This project has been designed to maintain pre-existing drainage patterns, as described below:

Subarea Post-A1, A2, A3, A4, A5 (Refer to map DA-2): The majority of the site (approx 14 acres) continues to drain to the east side of the site. These subareas consist of nearly all of the project's proposed impervious surfaces. As shown on the Stormwater Management Plan (C1201), the impervious surfaces are collected in multiple stormwater Best Management Practice (BMPs) devices, including underground sand filters and surface bioretention facilities, where they are treated for the removal of 85% TSS, nitrogen, and phosphorus. Stormwater is then directed into multiple underground detention facilities, which meet the following Town of Chapel Hill LUMO requirements:

- The 2-year volume is detained and slowly released over a 2 to 5 day period.
- The peak flows from the 1-year, 2-year, and 25-year storm events are detained down to below pre-developed levels.

The reduced flow is then released in the same manner as the existing condition, which is channel flow at the head of the intermittent stream at the southeast corner of the property. This stream exits the southeast corner of the property at "Pre-Outlet A", where it soon flows under Estes Drive via an existing culvert.

Subarea Post-B1 (Refer to map DA-1): A small percentage of the site (less than 1/4 acre) slopes west towards Martin Luther King Jr Blvd, and flows over the curb as surface flow at "Pre-Outlet B". The flow from this very small watershed is less than the existing condition, and no stormwater facilities are needed at this outlet.

Subarea Post-C1: (Refer to map DA-1): A small percentage of the site (approx 1/10 acre) slopes to the north and flows over a curb as surface flow towards a parking lot in a neighboring multi-familty residential neighborhood (Shadow Wood) at "Pre-Outlet C". The flow from this very small watershed is less than the existing condition, and no stormwater facilities are needed at this outlet.

Subarea Pre-D1: (Refer to map DA-1): A small percentage of the site (less than 1/2 acre) slopes to the north as surface flow towards a neighboring single-familty residential neighborhood at Woodshire Lane at "Pre-Outlet D". The flow from this very small watershed is less than the existing condition, and no stormwater facilities are needed at this outlet.

Offsite Watershed: (Refer to map DA-1): This 4-acre offsite watershed to the east is unchanged by this project. Flows from offsite briefly enter the Chartwell property from the east, but do not pose a drainage hazard for the proposed development. The offsite flow quickly exits the site to the southeast via the intermittent stream.

- Refer to the Table of Subareas, Land Uses, Curve Numbers, and Time of Concentration for additional information on the hydrology of these subareas.

- Refer to the Peak Flow and Volume Summary for additional information on the flows and volumes generated by these subareas.

Results:

The Town of Chapel Hill's current stormwater management requirements, as listed in the Land Use Management Ordinance are satisfied as follows:

Stormwater Quality:

- ✓ **Requirement Satisfied**: 85% TSS removal and 1-inch volume control provided by underground sand filters and surface bioretention facilities.

Stormwater Runoff Volume Control:

- ✓ **Requirement Satisfied**: 2-year volume detained and released over a 2 to 5 day period by underground detention facilities.

Stormwater Peak Runoff Rate:

- ✓ **Requirement Satisfied**: The post-developed peak flow for the 1-yr, 2-yr, and 25-yr, 24-hour storm events is reduced below pre-developed levels by underground detention facilities.

Stream Disturbance:

- ✓ **Requirement Satisfied**: No disturbance to stream channels is proposed.

Jordan Lake Buffer Rules:

The following rules were adopted by the Town of Chapel Hill prior to design, and are satisfied as follows:

- ✓ **Requirement Satisfied**: No disturbance to the riparian stream buffer is proposed.
- ✓ **Requirements Satisfied**: No new points of concentrated discharge into the riparian stream buffer are proposed. Flow will be discharged in the same manner as the existing condition, which is channel flow at the head of the riparian stream buffer.

In addition to the above, this project will meet the upcoming Jordan Lake Rules for nitrogen and phosphorus export, which we anticipate will be adopted by the Town of Chapel Hill in September 2012:

Nitrogen Export:

- ✓ As shown in the attached Jordan Lake Accounting Tool calculation, the proposed underground sand filters and surface bioretention facilities significantly reduce the nitrogen export from this project.
- ✓ In addition to nitrogen removed onsite by proposed BMPs, this project can get down to a 2.2 lb/ac/yr nitrogen export through a buydown to NCEEP. Refer to the attached buydown calculation.

Phosphorus Export:

- ✓ As shown in the attached Jordan Lake Accounting Tool calculation, the proposed underground sand filters and surface bioretention facilities significantly reduce the phosphorus export from this project.
- ✓ In addition to phosphorus removed onsite by proposed BMPs, this project can get down to a 0.82 lb/ac/yr phosphorus export through a buydown to NCEEP. Refer to the attached buydown calculation.

Conclusions:

In summary, the Chartwell project will meet all of the Town of Chapel Hill's current LUMO stormwater management requirements, as well as the upcoming Jordan Lake requirements for nitrogen and phosphorus export.

Attachments:

- **Table of Subareas, Land Uses, Curve Numbers, and Time of Concentration**
- **Peak Flow and Volume Summary**
- **2-Year Volume Calculation**
- **Sand Filter Sizing Calculations**
- **Bioretention Sizing Calculations**
- **Jordan Lake Accounting Tool Calculation**
- **Nutrient Buydown Calculation**
- **PondPack Results**
  - **Network Schematic**
  - **Detained Routing (1, 2, 25-yr)**
  - **Undetained Routing (1, 2, 25-yr)**
  - **Time of Concentration Calculations**
- **Maps**
  - **DA-1: Existing Conditions Drainage Area Map**
  - **DA-2: Post-Developed Conditions Drainage Area Map**
  - **FEMA Flood Map**
  - **USGS Map**
  - **Soils Survey Map**

Table of Subareas,
Land Uses, CN, & TC

Chartwell - 111015.00
Stormwater Summary Table
18-Jul-12

Table of Subareas, Land Uses, Curve Numbers, & Time of Concentration

Pre-Developed Subareas:

Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Pre-A1	70	571,802	13.127	Woods - Good (C)	70	571,802	13.127
				Time of Concentration =		19.44 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Pre-B1	70	8,308	0.191	Woods - Good (C)	70	8,308	0.191
				Time of Concentration =		5.00 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Pre-C1	70	43,377	0.996	Woods - Good (C)	70	43,377	0.996
				Time of Concentration =		17.88 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Pre-D1	70	17,266	0.396	Woods - Good (C)	70	17,266	0.396
				Time of Concentration =		10.56 minutes	

Post-Developed Subareas:

Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-A1	92.4	114,203	2.622	Impervious (Roof/Pvmt) (C)	98	88,889	2.041
				Lawn - Good (C)	74	17,720	0.407
				Woods - Good (C)	70	7,594	0.174
				Time of Concentration =		6.66 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-A2	89.8	390,808	8.972	Impervious (Roof/Pvmt) (C)	98	263,098	6.040
				Lawn - Good (C)	74	89,397	2.052
				Woods - Good (C)	70	38,313	0.880
				Time of Concentration =		5.94 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-A3	86.4	26,077	0.599	Impervious (Roof/Pvmt) (C)	98	14,625	0.336
				Lawn - Good (C)	74	4,765	0.109
				Woods - Good (C)	70	6,687	0.154
				Time of Concentration =		5.00 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-A4	87.9	33,749	0.774	Impervious (Roof/Pvmt) (C)	98	19,022	0.437
				Impervious (Gravel) (C)	89	1,875	0.043
				Lawn - Good (C)	74	8,997	0.206
				Woods - Good (C)	70	3,855	0.088
				Time of Concentration =		5.00 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-A5	70.2	48,929	1.123	Impervious (Gravel) (C)	89	445	0.010
				Woods - Good (C)	70	48,484	1.113
				Time of Concentration =		11.40 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-B1	74.8	5,823	0.134	Impervious (Roof/Pvmt) (C)	98	662	0.015
				Lawn - Good (C)	74	2,343	0.054
				Woods - Good (C)	70	2,818	0.065
				Time of Concentration =		5.00 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-C1	70	4,795	0.110	Woods - Good (C)	70	4,795	0.110
				Time of Concentration =		5.00 minutes	
Subarea:	Composite CN:	Total Area (sf)	Total Area (ac)	Land Use:	CN:	Area (sf)	Area (ac)
Post-D1	70	16,369	0.376	Woods - Good (C)	70	16,369	0.376
				Time of Concentration =		10.56 minutes	

Peak Flow &
Volume Summary

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Stormwater Summary Table
18-Jul-12

Peak Flow & Volume Summaries

Peak Flow Summary

Subarea:	1-Yr Flow (cfs)	2-Yr Flow (cfs)	25-Yr Flow (cfs)	Notes:
Pre-Outlet A	8.05	14.15	44.02	
Post-Outlet A (undetained)	36.86	49.14	98.69	
Post-Outlet A (detained)	3.38	4.58	39.94	Detention provided.
Pre-Outlet B	0.17	0.30	0.90	
Post-Outlet B (undetained)	0.17	0.27	0.73	No detention required.
Pre-Outlet C	0.64	1.12	3.46	
Post-Outlet C (undetained)	0.10	0.17	0.52	No detention required.
Pre-Outlet D	0.32	0.55	1.68	
Post-Outlet D (undetained)	0.30	0.52	1.59	No detention required.
Pre-Out Total	9.01	15.79	48.93	
Post-Out Total (undetained)	37.38	50.04	101.40	
Post-Out Total (detained)	3.87	5.39	41.44	

Volume Summary

2-year volume calculations were performed according to methodology listed within Town of Chapel Hill Design Manual. Refer to attached nomograph calculations.

Volume Required to Maintain Pre-Development Runoff Volume = 66,959 CF.

This volume has been provided within two underground detention systems.

Drawdown time is between 2 and 5 days. Drawdown calculations to be submitted at ZCP.

2-Year Volume

P=3.0 → 1.08 in storage
P=4.0 → 1.37 in storage
→ P=3.6 = 1.254 inches

(1.37-1.08)(0.6) + 1.08 = 1.254

Total Property = 640,753 SF

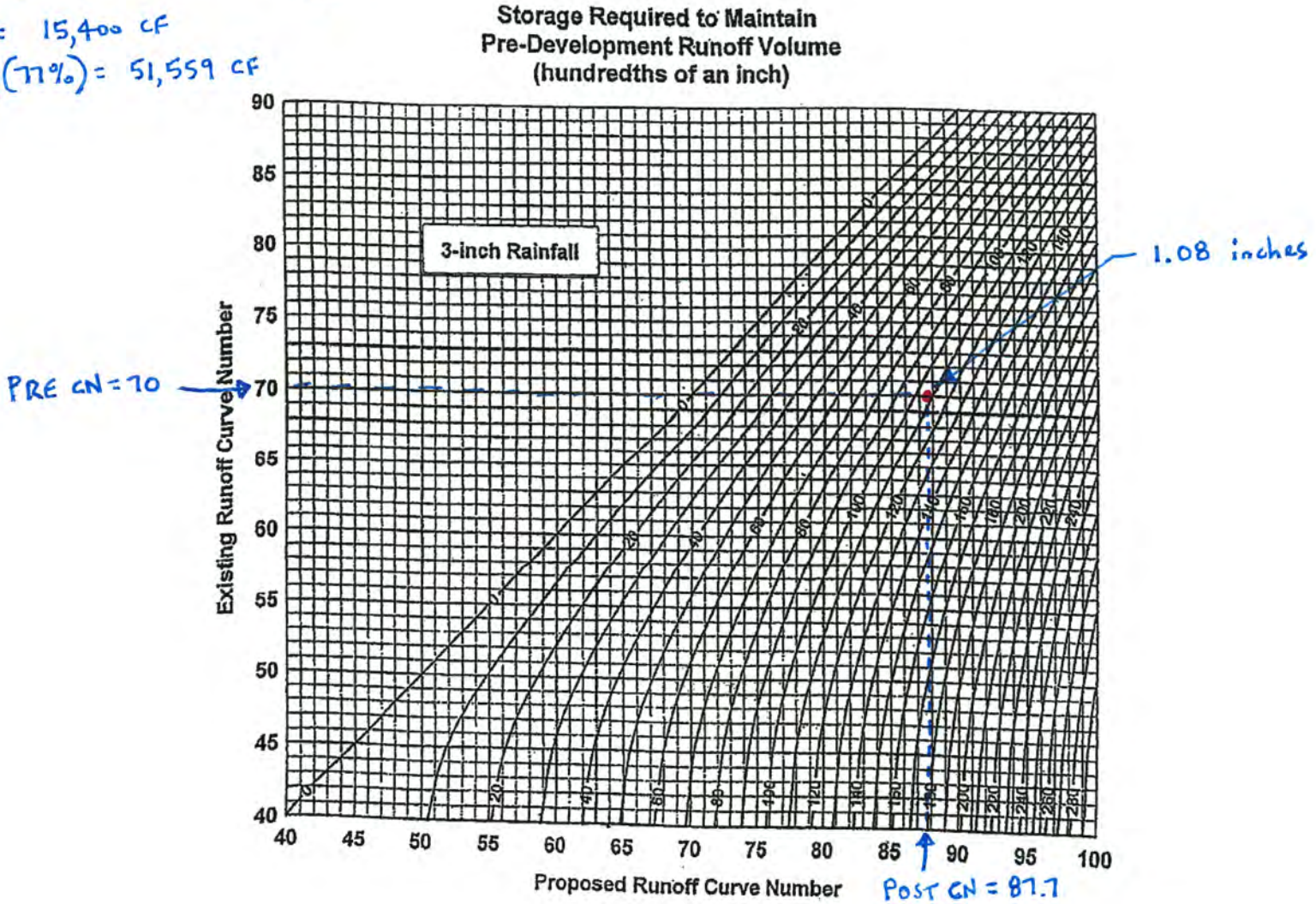
2-YEAR STORAGE VOLUME

(1.254 in)(1 ft/12 in)(640,753 SF) = 66,959 CF

Hotel (23%) = 15,400 CF

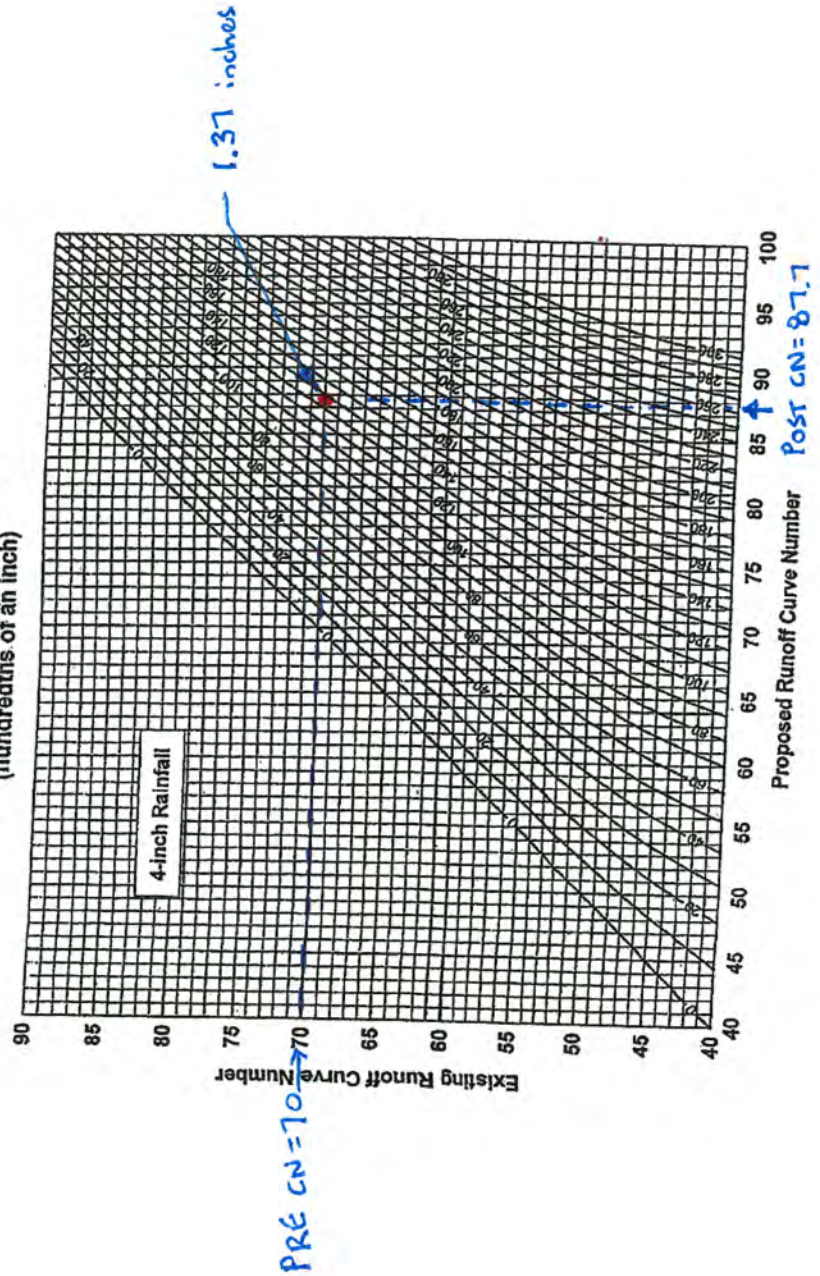
Student Housing (77%) = 51,559 CF

FIGURE 2-A-2
SCS RUNOFF EQUATION
CURVE FOR P+3.0"



Note: 1. Interpolate P=3.6" using 3" and 4" rainfall depth curves

FIGURE 2-A-3
SCS RUNOFF EQUATION
CURVE FOR P=4.0"



Note: 1. Interpolate P=3.6" using 3" and 4" rainfall depth curves

CN Area Collection - Post-Total (Catchment)

Description	CN	Area (ft^2)	Percent Connected Impervious Area (%)	Percent Unconnected Impervious Area (%)
Imp-Roof/Pvmt	98.000	386,296	0.0	0.0
Imp-Gravel (C)	89.000	2,320	0.0	0.0
Lawn-Good (C)	74.000	123,222	0.0	0.0
Woods-Good (C)	70.000	128,915	0.0	0.0

Post Total Composite CN = 87.7

CN Area Collection - Pre-Total (Catchment)

Description	CN	Area (ft^2)	Percent Connected Impervious Area (%)	Percent Unconnected Impervious Area (%)
Woods Good C	70.000	640,753	0.0	0.0

PRE TOTAL Composite CN = 70

Sand Filter Sizing

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Project #: 111015.00

Underground Sand Filter #1 - Hotel

1) Calculate percent impervious draining to sand filter.

Drainage Area = 2.62 acres

Impervious Area = 2.04 acres

% Imperv. = 77.84 %

2) Find the volume of the 1" storm using the "Simple Method" (Shueler 1987):

The volume of the 1" storm must be detained in the sand filter.

Rv = 0.05 + 0.009 (I)

Rv = runoff coefficient (ratio of runoff to rainfall in inches)
I = percent impervious

Rv = 0.05 + 0.009 (77.84) = 0.750572 in/in

Volume Required (1" Storm):

WQV (ft^3) = Rv x design rainfall x drainage area
= 0.7505721 x 1" x 1/12 ft/in x 2.62 = 0.164 acre feet
= 7144 cubic feet

WQV (adjusted) = (0.75) * WQV

= 5358 cubic feet

3) Set Sand Filter Bed Area, Sediment Basin Area, & Max. Head

$h_{MaxFilter}$(ft)	Maximum Head:	3.7 feet		
A_s(sf)	Surface Area of Sediment Basin:	750 sf	(measured)	
A_f(sf)	Surface Area of Sand Filter Bed:	750 sf	(measured)	

Check: $h_{MaxFilter}$(ft) = WQV(adj)(cf) / A_s(sf) + A_f(sf)

5358 cf / (750 sf + 750 sf) ≤ 3.7 ft — TRUE — Water Quality Volume is contained.

3.57 ≤ 3.7 feet

4) Check to ensure the minimum Sand Filter Area is attained via Darcy's Law.

Minimum Sand Filter Surface Area

$$\text{Minimum } A_f(sf) = \frac{(WQV) * (d_f)}{(k)*(t)*(h_A+d_f)}$$

d_f= Depth of sand filter bed (ft). Minimum should be 1.5 ft.
k = Coefficient of permeability for the sand filter bed = 3.5 (ft/day).
t = Time required to drain the WQV through the sand filter bed (day). This time should be 40 hours (1.66 days). (Center for Watershed Protection, 1996).
h_A = Average head (ft) = 1.85 ft. Determine the average head of water above the sand filter. The average head above the sand filter is half of the maximum head on the filter (Center for Watershed Protection, 1996).

Minimum Design:

Choose d_f = 1.5
t = 1.66 days
h_A = 1.85 ft
k = 3.5 ft/day

Minimum A_f = 551 sf

Actual A_f = 750 > Minimum A_f = 551 TRUE

5) Check to see if the Minimum Sediment Basin Area is attained via the Camp Hazen Equation.

Minimum Sediment Basin Surface Area

Minimum A_S = 240*R_v(unitless)*A_D(acres)

Minimum A_S = 472 sf

Actual A_s = 750 > Minimum A_s = 472 TRUE

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Underground Sand Filter #2 - Student Housing

1) Calculate percent impervious draining to sand filter.

Drainage Area = 8.97 acres

Impervious Area = 6.04 acres

% Imperv. = 67.32 %

2) Find the volume of the 1" storm using the "Simple Method" (Shueler 1987):

The volume of the 1" storm must be detained in the sand filter.

Rv = 0.05 + 0.009 (I)

Rv = runoff coefficient (ratio of runoff to rainfall in inches)
I = percent impervious

Rv = 0.05 + 0.009 (67.32) = 0.655885 in/in

Volume Required (1" Storm):

WQV (ft^3) = Rv x design rainfall x drainage area
= 0.655885 x 1" x 1/12 ft/in x 8.97 = 0.490 acre feet
= 21361 cubic feet

WQV (adjusted) = (0.75) * WQV

= 16021 cubic feet

3) Set Sand Filter Bed Area, Sediment Basin Area, & Max. Head

$h_{MaxFilter}$(ft)	Maximum Head:	3.7 feet	
A_s(sf)	Surface Area of Sediment Basin:	2175 sf	(measured)
A_f(sf)	Surface Area of Sand Filter Bed:	2175 sf	(measured)

Check: $h_{MaxFilter}$(ft) = WQV(adj)(cf) / A_s(sf) + A_f(sf)

16021 cf / (2,175 sf + 2,175 sf) ≤ 3.7 ft TRUE Water Quality Volume is contained.

3.68 ≤ 3.7 feet

4) Check to ensure the minimum Sand Filter Area is attained via Darcy's Law.

Minimum Sand Filter Surface Area

$$\text{Minimum } A_f \text{ (sf)} = \frac{(WQV) * (d_f)}{(k)*(t)*(h_A+d_f)}$$

d_f= Depth of sand filter bed (ft). Minimum should be 1.5 ft.
k = Coefficient of permeability for the sand filter bed = 3.5 (ft/day).
t = Time required to drain the WQV through the sand filter bed (day). This time should be 40 hours (1.66 days). (Center for Watershed Protection, 1996).
h_A = Average head (ft) = 1.85 ft. Determine the average head of water above the sand filter. The average head above the sand filter is half of the maximum head on the filter (Center for Watershed Protection, 1996).

Minimum Design:

Choose d_f = 1.5
t = 1.66 days
h_A = 1.85 ft
k = 3.5 ft/day

Minimum A_f = 1646 sf

Actual A_f = 2175 > Minimum A_f = 1646 TRUE

Bioretention Sizing

Bioretention #1 Sizing Calculation

PROJECT: Chartwell
PROJECT NO.: 111015.00
DATE: 17-Jul-12
LATEST PRINT DATE: 17-Jul-12

Ballentine Associates, P.A.

Design Requirements: (Reference: Town of Chapel Hill LUMO, Sec. 5.4.6)

"Stormwater treatment shall be designed to achieve average annual eighty-five (85) per cent total suspended solids (TSS) removal and must apply to the volume of post-development runoff resulting from the first one-inch of precipitation. Alternative treatment methods to achieve eighty-five (85) per cent average annual TSS removal may be acceptable. ***The eighty-five (85) per cent requirement applies to eighty-five (85) per cent of the additional suspended solids that are the result of the new development.***
(Ord. No. 2004-02-23/O-2)"
- Town of CHapel Hill LUMO

Conclusions:

Additional suspended solids from this project are generated solely from increased impervious surfaces.
At a minimum, the bioretention shall capture and treat the net increase of impervious surfaces for this project.

BMP: Bioretention Cell #1

The following calculations are based on Section 3.3.1 of the July 2007 NCDENR "Stormwater Best Management Practices Manual" (with 6/16/09 revs.)

1) Calculate Ia, the impervious fraction of area draining to BMP:

Drainage Area = 0.68767218 acres or 29,955 SF

Impervious Area = 0.47972911 acres or 20,897 SF

Ia = 0.70

2) Find the volume of the 1" storm using the "Simple Method" (Shueler 1987):

Rv = 0.05 + 0.9 (Ia)

Rv = runoff coefficient (ratio of runoff to rainfall in inches)
Ia = percent impervious

Rv = 0.05 + 0.9(0.69761309) = 0.67785178 in/in

Volume of 1" storm:

volume = Rv x design rainfall(inches) x drainage area(acres)
= 0.67785178 x 1" x 1/12 ft/in x 0.68767218 = 0.03884498 acre feet
= 1692.08750000 cubic feet

3) Depth of 1" storm:
Design BMP Ponding Depth = 0.75 ft.
or 9 in.

Planting Soils Surface Area (elev.439.5)= 2,258 s.f.

BMP Storage Volume Provided = 1694 c.f.

Bioretention #2 Sizing Calculation

PROJECT: Chartwell
PROJECT NO.: 111015.00
DATE: 17-Jul-12
LATEST PRINT DATE: 17-Jul-12

Ballentine Associates, P.A.

Design Requirements: (Reference: Town of Chapel Hill LUMO, Sec. 5.4.6)

"Stormwater treatment shall be designed to achieve average annual eighty-five (85) per cent total suspended solids (TSS) removal and must apply to the volume of post-development runoff resulting from the first one-inch of precipitation. Alternative treatment methods to achieve eighty-five (85) per cent average annual TSS removal may be acceptable. ***The eighty-five (85) per cent requirement applies to eighty-five (85) per cent of the additional suspended solids that are the result of the new development.***

(Ord. No. 2004-02-23/O-2)"

- Town of CHapel Hill LUMO

Conclusions:

Additional suspended solids from this project are generated solely from increased impervious surfaces. At a minimum, the bioretention shall capture and treat the net increase of impervious surfaces for this project.

BMP: Bioretention Cell #2

The following calculations are based on Section 3.3.1 of the July 2007 NCDENR "Stormwater Best Management Practices Manual" (with 6/16/09 revs.)

1) Calculate Ia, the impervious fraction of area draining to BMP:

Drainage Area = 0.51845730 acres or 22,584 SF

Impervious Area = 0.33574380 acres or 14,625 SF

Ia = 0.65

2) Find the volume of the 1" storm using the "Simple Method" (Shueler 1987):

Rv = 0.05 + 0.9 (Ia)

Rv = runoff coefficient (ratio of runoff to rainfall in inches)
Ia = percent impervious

Rv = 0.05 + 0.9(0.64758236) = 0.63282412 in/in

Volume of 1" storm:

volume = Rv x design rainfall(inches) x drainage area(acres)
= 0.63282412 x 1" x 1/12 ft/in x 0.51845730 = 0.02734102 acre feet
= 1190.97500000 cubic feet

3) Depth of 1" storm:
Design BMP Ponding Depth = 0.75 ft.
or 9 in.

Planting Soils Surface Area = 1,588 s.f.

BMP Storage Volume Provided = 1191 c.f.

Jordan Lake
Accounting Tool

JORDAN LAKE ACCOUNTING TOOL

Development:	**Chartwell**
Prepared By:	Seth Dean
Date:	July 18, 2012

WATERSHED SUMMARY

REGION:	Piedmont
TOTAL DEVELOPMENT AREA (ft^2):	640,753

	Pre-Development Conditions	Post-Development Conditions	Post-Development w/ BMPs
Percent Impervious (%)	0.0%	61.6%	61.6%
Annual Runoff Volume (c.f.)	121,251	1,464,692	1,353,606
Total Nitrogen EMC (mg/L)	1.47	1.28	0.97
Total Nitrogen Loading (lb/ac/yr)	0.77	8.12	5.67
Total Phosphorus EMC (mg/L)	0.25	0.25	0.15
Total Phosphorus Loading (lb/ac/yr)	0.13	1.58	0.90

Percent Difference Between:

	Pre-Dev. & Post-Dev. without BMPs	Pre-Development & Post-Development with BMPs	Post-Dev without BMPs & Post-Dev with BMPs
Percent Impervious (%)	62%	62%	0%
Annual Runoff Volume (c.f.)	1108%	1016%	-8%
Total Nitrogen EMC (mg/L)	-13%	-34%	-24%
Total Nitrogen Loading (lb/ac/yr)	951%	634%	-30%
Total Phosphorus EMC (mg/L)	-1%	-39%	-38%
Total Phosphorus Loading (lb/ac/yr)	1100%	583%	-43%

*Negative percent difference values indicate a decrease in runoff volume, pollutant concentration or pollutant loading. Positive values indicate an increase.

BMP VOLUME REDUCTIONS/EFFLUENT CONCENTRATIONS

	Volume Reduction (%)	TN Effluent Concen. (mg/L)	TP Effluent Concen. (mg/L)
Bioretention with IWS	50%	0.95	0.12
Bioretention without IWS	35%	1.00	0.12
Dry Detention Pond	0%	1.20	0.20
Grassed Swale	0%	1.21	0.26
Green Roof	50%	1.08	0.15
Level Spdr, Filter Strip	40%	1.20	0.15
Permeable Pavement*	0%	1.44	0.39
Sand Filter	5%	0.92	0.14
Water Harvesting	user defined	1.08	0.15
Wet Detention Pond	10%	1.01	0.11
Wetland	20%	1.08	0.12

*if treating commercial parking lot, TP effluent concentration = 0.16 mg/L

Return to Instructions

Return to Watershed Characteristics

Return to BMP Characteristics

Print Summary

BMP SUMMARY

	CATCHMENT 1			CATCHMENT 2			CATCHMENT 3			CATCHMENT 4			CATCHMENT 5			CATCHMENT 6		
	BMP 1	BMP 2	BMP 3	BMP 1	BMP 2	BMP 3	BMP 1	BMP 2	BMP 3	BMP 1	BMP 2	BMP 3	BMP 1	BMP 2	BMP 3	BMP 1	BMP 2	BMP 3
	Sand Filter	--	--	Sand Filter	--	--	Bioretention without IWS	--	--	Bioretention without IWS	--	--	--	--	--	--	--	--
Total Area Treated (ac)	2.62	--	--	8.97	--	--	0.77	--	--	0.60	--	--	--	--	--	--	--	--
Total Inflow Volume (c.f.)	331,199	--	--	990,496	--	--	72,674	--	--	55,900	--	--	--	--	--	--	--	--
Percent Volume Reduced (%)	5%	--	--	5%	--	--	35%	--	--	35%	--	--	--	--	--	--	--	--
Inflow Nitrogen EMC (mg/L)	1.27	--	--	1.28	--	--	1.29	--	--	1.28	--	--	--	--	--	--	--	--
Total Inflow Nitrogen (lb/ac/yr)	10.03	--	--	8.81	--	--	7.54	--	--	7.47	--	--	--	--	--	--	--	--
Inflow Phosphorus EMC (mg/L)	0.158	--	--	0.273	--	--	0.274	--	--	0.272	--	--	--	--	--	--	--	--
Total Inflow Phosphorus (lb/ac/yr)	1.25	--	--	1.88	--	--	1.61	--	--	1.59	--	--	--	--	--	--	--	--
BMP Outflow Nitrogen (lbs/ac/yr)	7.15	--	--	6.26	--	--	3.97	--	--	3.94	--	--	--	--	--	--	--	--
BMP Outflow Phosphorus (lbs/ac/yr)	1.06	--	--	1.01	--	--	0.55	--	--	0.54	--	--	--	--	--	--	--	--

Catchment Outflow Nitrogen EMC (mg/L)	0.96	0.96	1.04	1.04	--	--
Catchment Outflow Total Nitrogen (lb/ac/yr)	7.15	6.26	3.97	3.94	--	--
Percent Reduction in Nitrogen Load (%)	29%	30%	45%	45%	--	--
Catchment Outflow Phosphorus EMC (mg/L)	0.142	0.154	0.144	0.143	--	--
Catchment Outflow Total Phosphorus (lb/ac/yr)	1.061	1.006	0.546	0.542	--	--
Percent Reduction in Phosphorus Load (%)	15%	10%	66%	32%	--	--

Nutrient Buydown

Chartwell
Jordan Lake Nutrient Buydown Calculation

Date: 27-Jun-12

Small Watershed #: 60100
TN: 69%
TP: 63%

Subwatershed: Upper New Hope (N:2.2 P:0.82)

Maximum (Post-Treatment) Nitrogen Load Allowed prior to buydown:
4 lb/ac/yr (SF & Duplex Residential)
8 lb/ac/yr (All other developments)

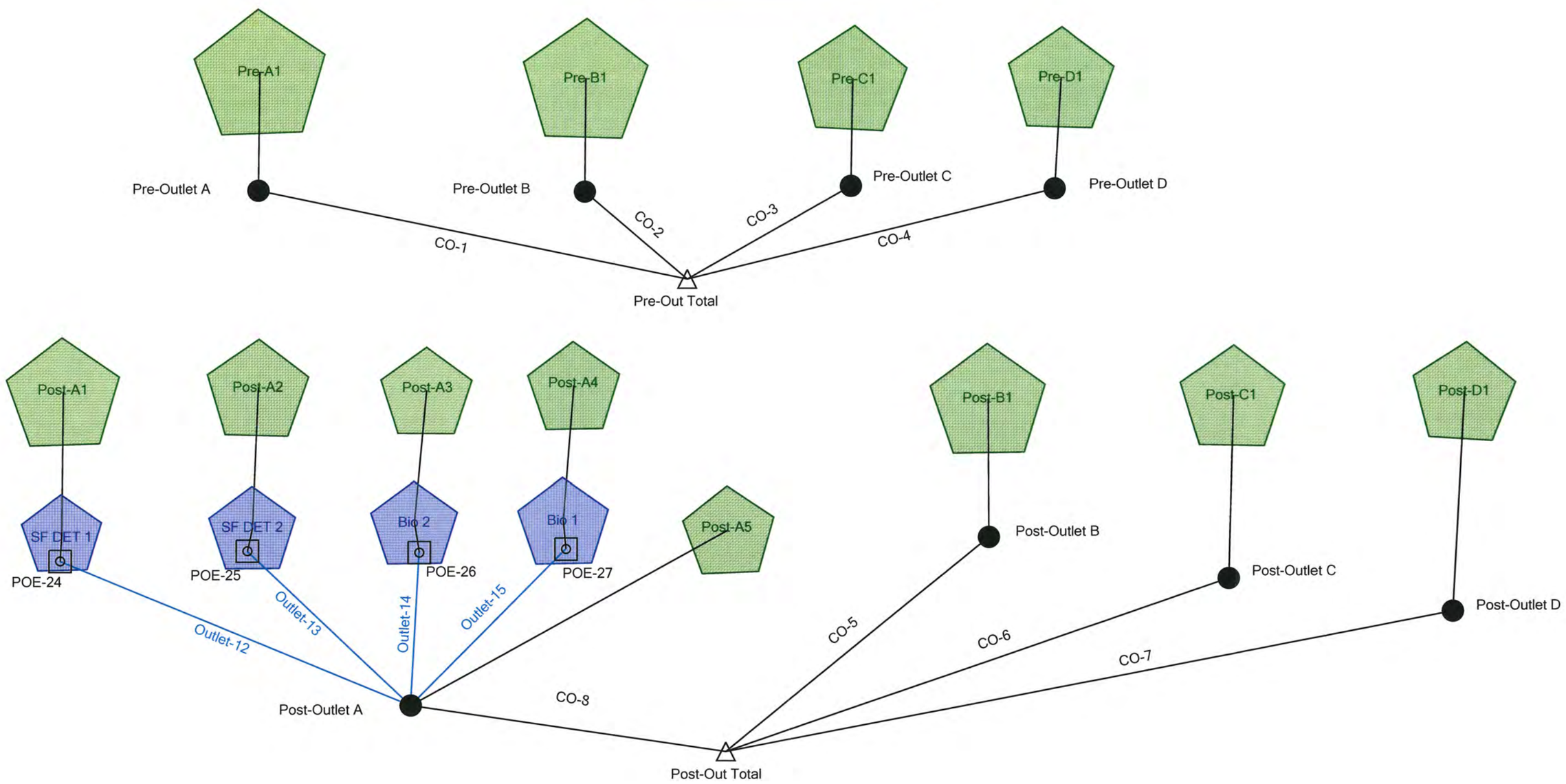
Nutient Buydown Calculation:

Post-Treatment N Load:		**5.67** lb/ac/yr		
N Limit:		2.2 lb/ac/yr		
Property Size:		14.71 acres		
Total Actual Nitrogen Export:		83.4057 lb/yr	x 30 yrs =	2502.171 lbs
Nitrogen Export Limit:		32.362 lb/yr	x 30 yrs =	970.86 lbs
N Buydown:				1531.311 lbs
N Buydown Adjusted:	(at 69%)			1056.605 lbs
NCEEP N Buydown Rate:				$21.64 per lb
Estimated NCEEP N Buydown Cost:				**$22,864.92**
Post-Treatment P Load:		**0.90** lb/ac/yr		
P Limit:		0.82 lb/ac/yr		
Property Size:		14.71 acres		
Total Actual Phosphorus Export:		13.239 lb/yr	x 30 yrs =	397.17 lbs
Phosphorus Export Limit:		12.0622 lb/yr	x 30 yrs =	361.866 lbs
P Buydown:				35.304 lbs
P Buydown Adjusted:	(at 63%)			22.242 lbs
NCEEP P Buydown Rate:				$134.23 per lb
Estimated NCEEP P Buydown Cost:				**$2,985.48**
Hotel + Housing Total Nutrient Buydown:				**$25,850.40**

Pondpack Network
Schematic

~~Scenario: 25-Year Storm~~

NETWORK SCHEMATIC



Pondpack
DETAINED Routing

DETAINED ROUTING 1-YEAR

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-A1	1-Year Storm	1	20,002	11.950	7.94
Post-A2	1-Year Storm	1	60,916	11.950	24.82
Post-A3	1-Year Storm	1	3,493	11.900	1.46
Post-A4	1-Year Storm	1	4,837	11.900	2.02
Post-A5	1-Year Storm	1	2,709	12.050	0.89
Post-B1	1-Year Storm	1	429	11.950	0.17
Post-C1	1-Year Storm	1	263	11.950	0.10
Post-D1	1-Year Storm	1	897	12.050	0.30
Pre-A1	1-Year Storm	1	31,197	12.100	8.05
Pre-B1	1-Year Storm	1	456	11.950	0.17
Pre-C1	1-Year Storm	1	2,369	12.100	0.64
Pre-D1	1-Year Storm	1	946	12.050	0.32

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-Out Total	1-Year Storm	1	47,341	12.050	3.87
Post-Outlet A	1-Year Storm	1	45,753	12.050	3.38
Post-Outlet B	1-Year Storm	1	429	11.950	0.17
Post-Outlet C	1-Year Storm	1	263	11.950	0.10
Post-Outlet D	1-Year Storm	1	897	12.050	0.30
Pre-Out Total	1-Year Storm	1	34,967	12.100	9.01
Pre-Outlet A	1-Year Storm	1	31,197	12.100	8.05
Pre-Outlet B	1-Year Storm	1	456	11.950	0.17
Pre-Outlet C	1-Year Storm	1	2,369	12.100	0.64
Pre-Outlet D	1-Year Storm	1	946	12.050	0.32

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
Bio 1 (IN)	1-Year Storm	1	4,837	11.900	2.02	(N/A)	(N/A)
Bio 1 (OUT)	1-Year Storm	1	4,814	12.050	0.94	433.25	1,253
Bio 2 (IN)	1-Year Storm	1	3,493	11.900	1.46	(N/A)	(N/A)
Bio 2 (OUT)	1-Year Storm	1	3,482	12.050	0.89	436.66	693
SF DET 1 (IN)	1-Year Storm	1	20,002	11.950	7.94	(N/A)	(N/A)
SF DET 1 (OUT)	1-Year Storm	1	7,757	15.950	0.17	461.79	13,947
SF DET 2 (IN)	1-Year Storm	1	60,916	11.950	24.82	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft^3)
SF DET 2 (OUT)	1-Year Storm	1	26,991	15.650	0.61	442.76	40,554

DETAINED ROUTING 2-YEAR

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-A1	2-Year Storm	2	26,361	11.950	10.31
Post-A2	2-Year Storm	2	81,970	11.950	32.93
Post-A3	2-Year Storm	2	4,827	11.900	2.01
Post-A4	2-Year Storm	2	6,606	11.900	2.75
Post-A5	2-Year Storm	2	4,389	12.050	1.51
Post-B1	2-Year Storm	2	659	11.950	0.27
Post-C1	2-Year Storm	2	427	11.950	0.17
Post-D1	2-Year Storm	2	1,456	12.000	0.52
Pre-A1	2-Year Storm	2	50,679	12.100	14.15
Pre-B1	2-Year Storm	2	740	11.950	0.30
Pre-C1	2-Year Storm	2	3,848	12.100	1.12
Pre-D1	2-Year Storm	2	1,536	12.000	0.55

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-Out Total	2-Year Storm	2	64,834	12.050	5.39
Post-Outlet A	2-Year Storm	2	62,292	12.050	4.58
Post-Outlet B	2-Year Storm	2	659	11.950	0.27
Post-Outlet C	2-Year Storm	2	427	11.950	0.17
Post-Outlet D	2-Year Storm	2	1,456	12.000	0.52
Pre-Out Total	2-Year Storm	2	56,802	12.100	15.79
Pre-Outlet A	2-Year Storm	2	50,679	12.100	14.15
Pre-Outlet B	2-Year Storm	2	740	11.950	0.30
Pre-Outlet C	2-Year Storm	2	3,848	12.100	1.12
Pre-Outlet D	2-Year Storm	2	1,536	12.000	0.55

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
Bio 1 (IN)	2-Year Storm	2	6,606	11.900	2.75	(N/A)	(N/A)
Bio 1 (OUT)	2-Year Storm	2	6,576	12.050	1.16	433.78	1,780
Bio 2 (IN)	2-Year Storm	2	4,827	11.900	2.01	(N/A)	(N/A)
Bio 2 (OUT)	2-Year Storm	2	4,814	12.050	1.13	437.19	1,016
SF DET 1 (IN)	2-Year Storm	2	26,361	11.950	10.31	(N/A)	(N/A)
SF DET 1 (OUT)	2-Year Storm	2	11,968	13.500	0.44	462.42	17,084
SF DET 2 (IN)	2-Year Storm	2	81,970	11.950	32.93	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft^3)
SF DET 2 (OUT)	2-Year Storm	2	34,546	14.050	1.13	445.07	54,421

DETAINED ROUTING 25-YEAR

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-A1	25-Year Storm	25	52,479	11.950	19.68
Post-A2	25-Year Storm	25	169,805	11.950	65.29
Post-A3	25-Year Storm	25	10,525	11.900	4.30
Post-A4	25-Year Storm	25	14,079	11.900	5.71
Post-A5	25-Year Storm	25	12,812	12.000	4.66
Post-B1	25-Year Storm	25	1,751	11.900	0.73
Post-C1	25-Year Storm	25	1,251	11.950	0.52
Post-D1	25-Year Storm	25	4,266	12.000	1.59
Pre-A1	25-Year Storm	25	148,588	12.100	44.02
Pre-B1	25-Year Storm	25	2,167	11.950	0.90
Pre-C1	25-Year Storm	25	11,279	12.050	3.46
Pre-D1	25-Year Storm	25	4,500	12.000	1.68

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-Out Total	25-Year Storm	25	197,621	12.100	41.44
Post-Outlet A	25-Year Storm	25	190,354	12.100	39.94
Post-Outlet B	25-Year Storm	25	1,751	11.900	0.73
Post-Outlet C	25-Year Storm	25	1,251	11.950	0.52
Post-Outlet D	25-Year Storm	25	4,266	12.000	1.59
Pre-Out Total	25-Year Storm	25	166,534	12.100	48.93
Pre-Outlet A	25-Year Storm	25	148,588	12.100	44.02
Pre-Outlet B	25-Year Storm	25	2,167	11.950	0.90
Pre-Outlet C	25-Year Storm	25	11,279	12.050	3.46
Pre-Outlet D	25-Year Storm	25	4,500	12.000	1.68

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
Bio 1 (IN)	25-Year Storm	25	14,079	11.900	5.71	(N/A)	(N/A)
Bio 1 (OUT)	25-Year Storm	25	14,022	12.050	2.55	439.54	4,096
Bio 2 (IN)	25-Year Storm	25	10,525	11.900	4.30	(N/A)	(N/A)
Bio 2 (OUT)	25-Year Storm	25	10,499	12.050	2.56	443.06	2,511
SF DET 1 (IN)	25-Year Storm	25	52,479	11.950	19.68	(N/A)	(N/A)
SF DET 1 (OUT)	25-Year Storm	25	36,825	12.100	6.58	464.39	28,006
SF DET 2 (IN)	25-Year Storm	25	169,805	11.950	65.29	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft^3)
SF DET 2 (OUT)	25-Year Storm	25	116,196	12.100	25.04	448.02	80,866

UNDETAINED ROUTING 1-YEAR

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-A1	1-Year Storm	1	20,002	11.950	7.94
Post-A2	1-Year Storm	1	60,916	11.950	24.82
Post-A3	1-Year Storm	1	3,493	11.900	1.46
Post-A4	1-Year Storm	1	4,837	11.900	2.02
Post-A5	1-Year Storm	1	2,709	12.050	0.89
Post-B1	1-Year Storm	1	429	11.950	0.17
Post-C1	1-Year Storm	1	263	11.950	0.10
Post-D1	1-Year Storm	1	897	12.050	0.30
Pre-A1	1-Year Storm	1	31,197	12.100	8.05
Pre-B1	1-Year Storm	1	456	11.950	0.17
Pre-C1	1-Year Storm	1	2,369	12.100	0.64
Pre-D1	1-Year Storm	1	946	12.050	0.32

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
Post-Out Total	1-Year Storm	1	93,545	11.950	37.38
Post-Outlet A	1-Year Storm	1	91,957	11.950	36.86
Post-Outlet B	1-Year Storm	1	429	11.950	0.17
Post-Outlet C	1-Year Storm	1	263	11.950	0.10
Post-Outlet D	1-Year Storm	1	897	12.050	0.30
Pre-Out Total	1-Year Storm	1	34,967	12.100	9.01
Pre-Outlet A	1-Year Storm	1	31,197	12.100	8.05
Pre-Outlet B	1-Year Storm	1	456	11.950	0.17
Pre-Outlet C	1-Year Storm	1	2,369	12.100	0.64
Pre-Outlet D	1-Year Storm	1	946	12.050	0.32

UNDETAINED ROUTING 2-YEAR

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)
Post-A1	2-Year Storm	2	26,361	11.950	10.31
Post-A2	2-Year Storm	2	81,970	11.950	32.93
Post-A3	2-Year Storm	2	4,827	11.900	2.01
Post-A4	2-Year Storm	2	6,606	11.900	2.75
Post-A5	2-Year Storm	2	4,389	12.050	1.51
Post-B1	2-Year Storm	2	659	11.950	0.27
Post-C1	2-Year Storm	2	427	11.950	0.17
Post-D1	2-Year Storm	2	1,456	12.000	0.52
Pre-A1	2-Year Storm	2	50,679	12.100	14.15
Pre-B1	2-Year Storm	2	740	11.950	0.30
Pre-C1	2-Year Storm	2	3,848	12.100	1.12
Pre-D1	2-Year Storm	2	1,536	12.000	0.55

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)
Post-Out Total	2-Year Storm	2	126,695	11.950	50.04
Post-Outlet A	2-Year Storm	2	124,153	11.950	49.14
Post-Outlet B	2-Year Storm	2	659	11.950	0.27
Post-Outlet C	2-Year Storm	2	427	11.950	0.17
Post-Outlet D	2-Year Storm	2	1,456	12.000	0.52
Pre-Out Total	2-Year Storm	2	56,802	12.100	15.79
Pre-Outlet A	2-Year Storm	2	50,679	12.100	14.15
Pre-Outlet B	2-Year Storm	2	740	11.950	0.30
Pre-Outlet C	2-Year Storm	2	3,848	12.100	1.12
Pre-Outlet D	2-Year Storm	2	1,536	12.000	0.55

UNDETAINED ROUTING 25-YEAR

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)
Post-A1	25-Year Storm	25	52,479	11.950	19.68
Post-A2	25-Year Storm	25	169,805	11.950	65.29
Post-A3	25-Year Storm	25	10,525	11.900	4.30
Post-A4	25-Year Storm	25	14,079	11.900	5.71
Post-A5	25-Year Storm	25	12,812	12.000	4.66
Post-B1	25-Year Storm	25	1,751	11.900	0.73
Post-C1	25-Year Storm	25	1,251	11.950	0.52
Post-D1	25-Year Storm	25	4,266	12.000	1.59
Pre-A1	25-Year Storm	25	148,588	12.100	44.02
Pre-B1	25-Year Storm	25	2,167	11.950	0.90
Pre-C1	25-Year Storm	25	11,279	12.050	3.46
Pre-D1	25-Year Storm	25	4,500	12.000	1.68

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)
Post-Out Total	25-Year Storm	25	266,967	11.950	101.40
Post-Outlet A	25-Year Storm	25	259,700	11.950	98.69
Post-Outlet B	25-Year Storm	25	1,751	11.900	0.73
Post-Outlet C	25-Year Storm	25	1,251	11.950	0.52
Post-Outlet D	25-Year Storm	25	4,266	12.000	1.59
Pre-Out Total	25-Year Storm	25	166,534	12.100	48.93
Pre-Outlet A	25-Year Storm	25	148,588	12.100	44.02
Pre-Outlet B	25-Year Storm	25	2,167	11.950	0.90
Pre-Outlet C	25-Year Storm	25	11,279	12.050	3.46
Pre-Outlet D	25-Year Storm	25	4,500	12.000	1.68

Pondpack Time of Concentration

Subsection: Time of Concentration Calculations
Label: Post-A1

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	40.00 ft
Manning's n	0.240
Slope	0.050 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.15 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Channel Flow	
Flow Area	3.1 ft²
Hydraulic Length	1,200.00 ft
Manning's n	0.013
Slope	0.025 ft/ft
Wetted Perimeter	6.28 ft
Average Velocity	11.42 ft/s
Segment Time of Concentration	0.029 hours

Segment #3: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	165.00 ft
Manning's n	0.045
Slope	0.035 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	6.03 ft/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.111 hours

Subsection: Time of Concentration Calculations
Label: Post-A2

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	50.00 ft
Manning's n	0.240
Slope	0.100 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.21 ft/s
Segment Time of Concentration	0.068 hours

Segment #2: TR-55 Channel Flow	
Flow Area	3.1 ft²
Hydraulic Length	875.00 ft
Manning's n	0.013
Slope	0.020 ft/ft
Wetted Perimeter	6.28 ft
Average Velocity	10.21 ft/s
Segment Time of Concentration	0.024 hours

Segment #3: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	165.00 ft
Manning's n	0.045
Slope	0.035 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	6.03 ft/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.099 hours

Subsection: Time of Concentration Calculations
Label: Post-A3

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.011
Slope	0.020 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	1.46 ft/s
Segment Time of Concentration	0.019 hours

Segment #2: TR-55 Channel Flow	
Flow Area	1.2 ft²
Hydraulic Length	50.00 ft
Manning's n	0.013
Slope	0.020 ft/ft
Wetted Perimeter	3.93 ft
Average Velocity	7.43 ft/s
Segment Time of Concentration	0.002 hours

Segment #3: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	165.00 ft
Manning's n	0.045
Slope	0.035 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	6.03 ft/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

Subsection: Time of Concentration Calculations
Label: Post-A4

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	50.00 ft
Manning's n	0.011
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	1.49 ft/s
Segment Time of Concentration	0.009 hours

Segment #2: TR-55 Channel Flow	
Flow Area	1.2 ft²
Hydraulic Length	150.00 ft
Manning's n	0.013
Slope	0.020 ft/ft
Wetted Perimeter	3.92 ft
Average Velocity	7.44 ft/s
Segment Time of Concentration	0.006 hours

Segment #3: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	75.00 ft
Manning's n	0.045
Slope	0.035 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	6.03 ft/s
Segment Time of Concentration	0.003 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	110.00 ft
Manning's n	0.400
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.17 ft/s
Segment Time of Concentration	0.178 hours

Segment #2: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	140.00 ft
Manning's n	0.045
Slope	0.080 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	9.12 ft/s
Segment Time of Concentration	0.004 hours

Segment #3: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	165.00 ft
Manning's n	0.045
Slope	0.035 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	6.03 ft/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.190 hours

Subsection: Time of Concentration Calculations
Label: Post-B1

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	25.00 ft
Manning's n	0.240
Slope	0.300 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.28 ft/s
Segment Time of Concentration	0.025 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	18.00 ft
Manning's n	0.400
Slope	0.040 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.08 ft/s
Segment Time of Concentration	0.065 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	70.00 ft
Manning's n	0.400
Slope	0.050 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.11 ft/s
Segment Time of Concentration	0.176 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.176 hours

Subsection: Time of Concentration Calculations
Label: Pre-A1

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.400
Slope	0.040 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.11 ft/s
Segment Time of Concentration	0.256 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	650.00 ft
Is Paved?	False
Slope	0.040 ft/ft
Average Velocity	3.23 ft/s
Segment Time of Concentration	0.056 hours

Segment #3: TR-55 Channel Flow	
Flow Area	10.0 ft²
Hydraulic Length	310.00 ft
Manning's n	0.045
Slope	0.050 ft/ft
Wetted Perimeter	10.40 ft
Average Velocity	7.21 ft/s
Segment Time of Concentration	0.012 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.324 hours

Subsection: Time of Concentration Calculations
Label: Pre-B1

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	25.00 ft
Manning's n	0.400
Slope	0.250 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.17 ft/s
Segment Time of Concentration	0.041 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

Subsection: Time of Concentration Calculations
Label: Pre-C1

Return Event: 1 years
Storm Event: 1 Year Storm

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.400
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.10 ft/s
Segment Time of Concentration	0.287 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	130.00 ft
Is Paved?	False
Slope	0.040 ft/ft
Average Velocity	3.23 ft/s
Segment Time of Concentration	0.011 hours

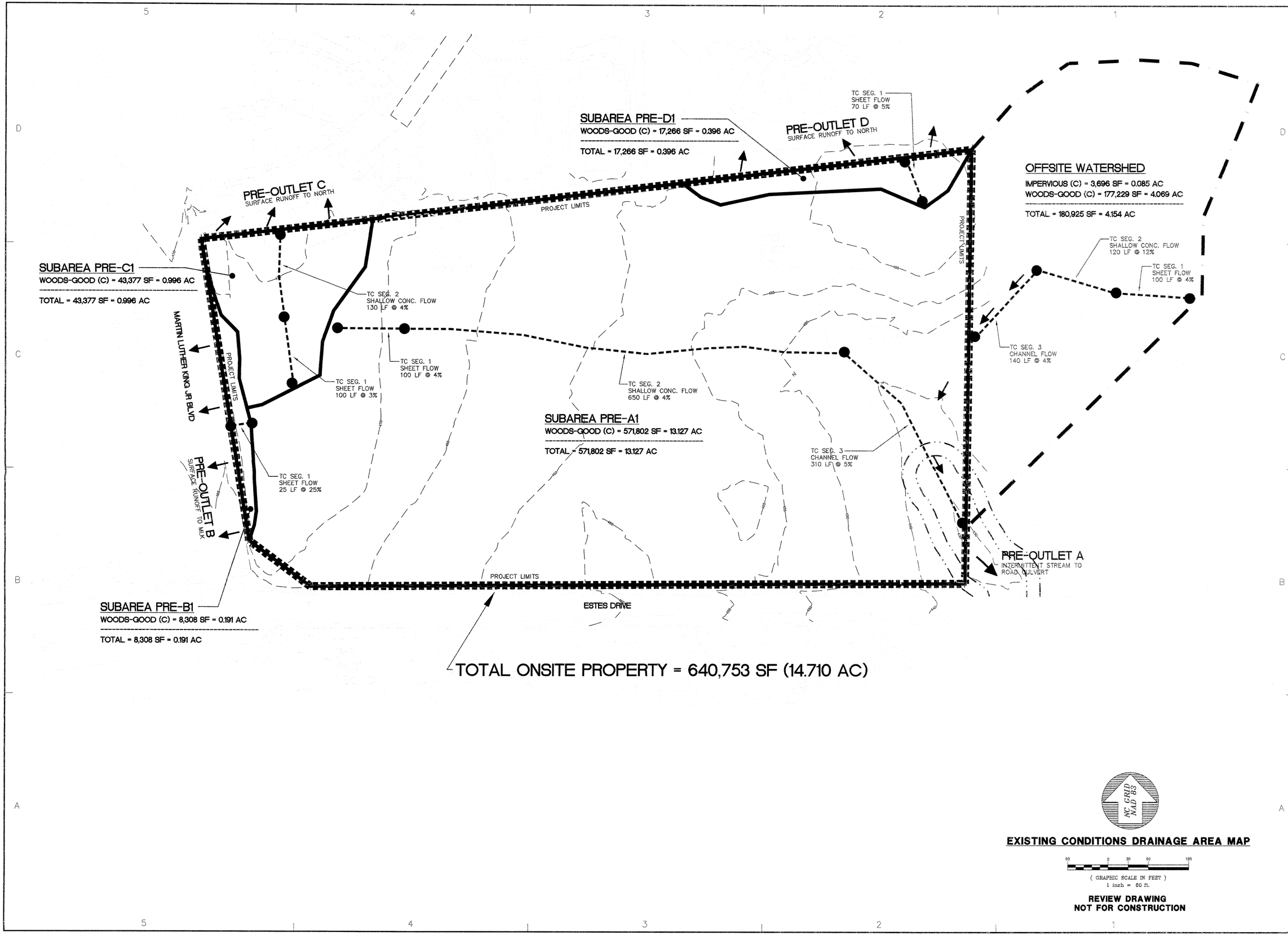
Time of Concentration (Composite)	
Time of Concentration (Composite)	0.298 hours

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	70.00 ft
Manning's n	0.400
Slope	0.050 ft/ft
2 Year 24 Hour Depth	3.60 in
Average Velocity	0.11 ft/s
Segment Time of Concentration	0.176 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.176 hours

DA-1: EX-Cond. DA Map
DA-2: Post-Dev. DA Map



NC GRID NAD 83

EXISTING CONDITIONS DRAINAGE AREA MAP

60 0 30 60 120

(GRAPHIC SCALE IN FEET)
1 inch = 60 ft.

REVIEW DRAWING
NOT FOR CONSTRUCTION

BALLENTINE ASSOCIATES, P.A.
221 PROVIDENCE ROAD, CHAPEL HILL, N.C. 27514
(919) 489 - 7414 FAX (919) 489 - 7789
CORPORATE SEAL C328 NORTH CAROLINA Chapel Hill
NORTH CAROLINA PROFESSIONAL SEAL 026493 ENGINEER STEPHEN J. BALLENTINE

DATE | REVISIONS | NUM

OWNER INFORMATION
XYZ PROPERTIES

OWNERS REPRESENTATIVE:

PH.
FAX
EMAIL

DATE | ISSUED

CAROLINA FLATS
CHAPEL HILL, NORTH CAROLINA
DRAINAGE AREA MAPPING

JOB NUMBER: 111015.00
DATE: 23 MAY 12
SCALE: AS NOTED
DRAWN BY: SJB
REVIEWED BY: SJB

SHEET
DA-1

SUBAREA POST-A1
IMP. (PVMT/ROOF) = 88,889 SF = 2.041 AC
LAWN-GOOD (C) = 17,720 SF = 0.407 AC
WOODS-GOOD (C) = 7,594 SF = 0.174 AC

TOTAL = 114,203 SF = 2.622 AC

SUBAREA POST-D1
WOODS-GOOD (C) = 16,369 SF = 0.376 AC

TOTAL = 16,369 SF = 0.376 AC

TC PATH
SHEET FLOW
70 LF @ 5%

POST-OUTLET D
SURFACE RUNOFF TO NORTH

OFFSITE WATERSHED
IMPERVIOUS (C) = 3,696 SF = 0.085 AC
WOODS-GOOD (C) = 177,229 SF = 4.069 AC

TOTAL = 180,925 SF = 4.154 AC

TC PATH
SHEET FLOW
18 LF @ 4%

POST-OUTLET C
SURFACE RUNOFF TO NORTH

PROJECT LIMITS

SUBAREA POST-C1
WOODS-GOOD (C) = 4,795 SF = 0.110 AC

TOTAL = 4,795 SF = 0.110 AC

TC PATH
SHEET FLOW
110 LF @ 12%

TC PATH
SHALLOW CONC. FLOW
120 LF @ 12%

TC PATH
SHEET FLOW
100 LF @ 4%

MARTIN LUTHER KING JR BLVD

PROJECT LIMITS

TC PATH
SHEET FLOW
100 LF @ 2%

TC PATH
CHANNEL FLOW
140 LF @ 4%

TC PATH
CHANNEL FLOW
140 LF @ 8%

TC PATH
PIPE FLOW
1,200 LF
@ 2.5%

SUBAREA POST-A2
IMP. (PVMT/ROOF) = 263,098 SF = 6.040 AC
LAWN-GOOD (C) = 89,397 SF = 2.052 AC
WOODS-GOOD (C) = 38,313 SF = 0.880 AC

TOTAL = 390,808 SF = 8.972 AC

TC PATH
PIPE FLOW
50 LF @ 2%

SUBAREA POST-A3
IMP. (PVMT/ROOF) = 14,625 SF = 0.336 AC
LAWN-GOOD (C) = 4,765 SF = 0.109 AC
WOODS-GOOD (C) = 6,687 SF = 0.154 AC

TOTAL = 26,077 SF = 0.599 AC

TC PATH
SHEET FLOW
25 LF @ 30%

TC PATH
SHEET FLOW
40 LF @ 5%

TC PATH
CHANNEL FLOW
165 LF @ 3.5%

SUBAREA POST-A5
IMP (GRAVEL) (C) = 445 SF = 0.010 AC
WOODS-GOOD (C) = 48,484 SF = 1.113 AC

TOTAL = 48,929 SF = 1.123 AC

POST-OUTLET B
SURFACE RUNOFF TO MLK

TC PATH
PIPE FLOW
875 LF @ 2%

POST-OUTLET A
INTERMITTENT STREAM TO
ROAD CULVERT

TC PATH
SHEET FLOW
50 LF @ 10%

PROJECT LIMITS

N. Estes Drive

ESTES DRIVE

SUBAREA POST-B1
IMPERVIOUS (PAVED) = 662 SF = 0.015 AC
LAWN-GOOD (C) = 2,343 SF = 0.054 AC
WOODS-GOOD (C) = 2,818 SF = 0.065 AC

TOTAL = 5,823 SF = 0.134 AC

SUBAREA POST-A4
IMP. (PVMT/ROOF) = 19,022 SF = 0.437 AC
IMP. (GRAVEL) (C) = 1,875 SF = 0.043 AC
LAWN-GOOD (C) = 8,997 SF = 0.206 AC
WOODS-GOOD (C) = 3,855 SF = 0.088 AC

TOTAL = 33,749 SF = 0.774 AC

TOTAL ONSITE PROPERTY = 640,753 SF (14.710 AC)

TOTAL OFFICIAL ONSITE IMPERVIOUS = 388,616 SF
(INCLUDES 15,000 SF IMP. CONTINGENCY)

NC GRID
NAD 83

POST-DEVELOPED DRAINAGE AREA MAP

60 0 30 60 120
(GRAPHIC SCALE IN FEET)
1 inch = 60 ft.

REVIEW DRAWING
NOT FOR CONSTRUCTION

BALLENTINE ASSOCIATES, P.A.
221 PROVIDENCE ROAD, CHAPEL HILL, NC. 27514
(919) 942-4142 FAX 942-4789

Ballentine Associates P.A. CORPORATE SEAL C328 NORTH CAROLINA Chapel Hill

NORTH CAROLINA PROFESSIONAL SEAL 026493 ENGINEER STEPHEN J. BALLENTINE

NUM	REVISIONS	DATE

OWNER INFORMATION
XYZ PROPERTIES

OWNERS REPRESENTATIVE:

PH.
FAX
EMAIL

DATE

ISSUED

CHARTWELL
CHAPEL HILL, NORTH CAROLINA

DRAINAGE AREA MAPPING

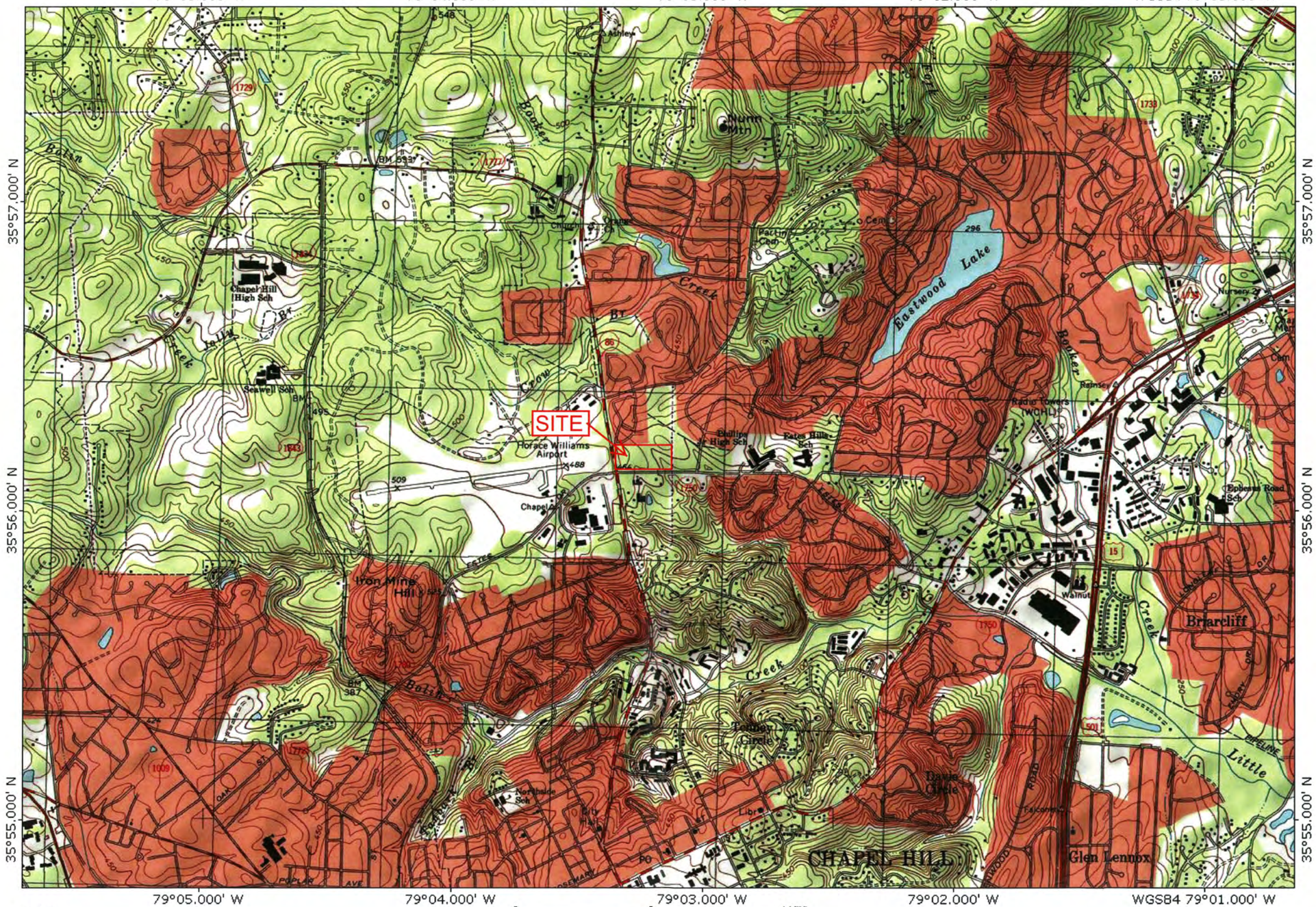
JOB NUMBER: 111015.00
DATE: 23 MAY 12
SCALE: AS NOTED
DRAWN BY: SJB
REVIEWED BY: SJB

SHEET
DA-2

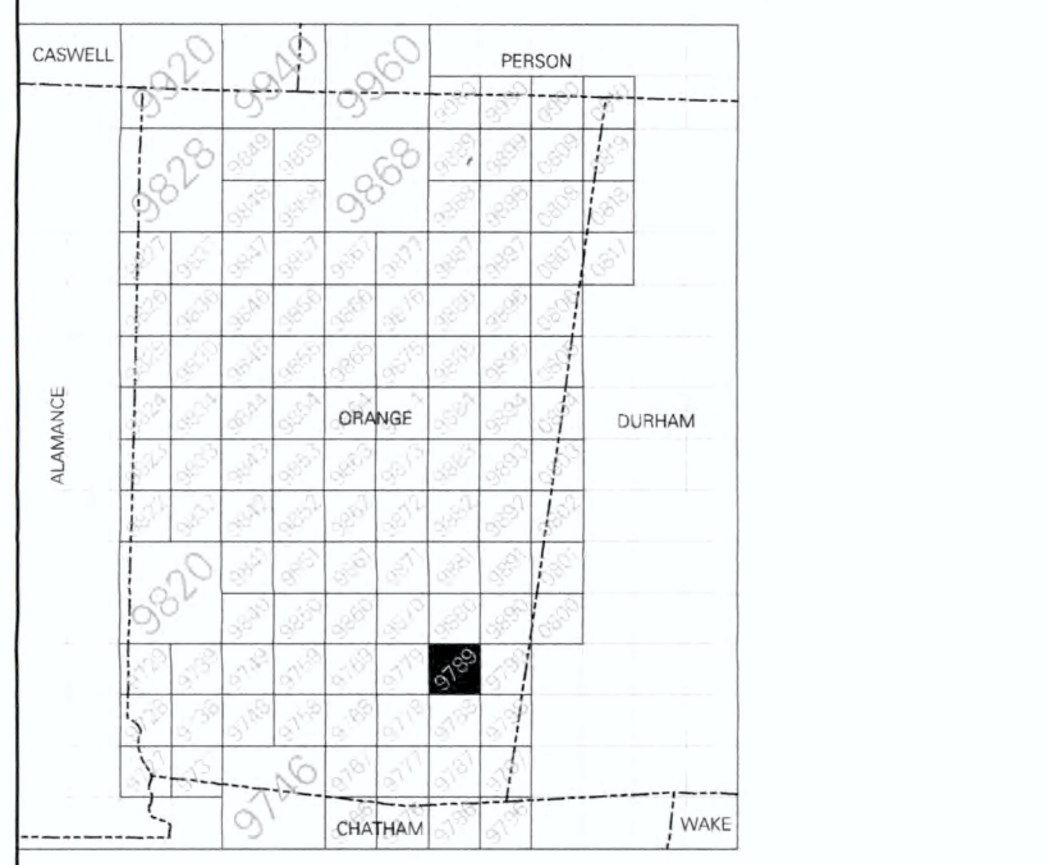
MISC MAPS

ORANGE COUNTY, NORTH CAROLINA — SHEET NUMBER 26

TOPO! map printed on 06/01/12 from "North Carolina.tpo" and "Untitled.tpg"



STATE OF NORTH CAROLINA FIRM PANEL LOCATOR DIAGRAM



DATUM INFORMATION

The **projection** used in the preparation of this map was the North Carolina State Plane (FIPSZONE 3200). The **horizontal datum** was the North American Datum of 1983, GRS80 ellipsoid. Differences in datum, ellipsoid, projection, or Universal Transverse Mercator zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdictional boundaries. These differences do not affect the accuracy of this FIRM. All coordinates on this map are in U.S. Survey Feet, where 1 U.S. Survey Foot = 1200/3937 Meters.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. An average offset between NAVD 88 and the National Geodetic Vertical Datum of 1929 (NGVD 29) has been computed for each North Carolina county. This offset was then applied to the NGVD 29 flood elevations that were not revised during the creation of this statewide format FIRM. The offsets for each county shown on this FIRM panel are shown in the vertical datum offset table below. Where a county boundary and a flooding source with unrevised NGVD 29 flood elevations are coincident, an individual offset has been calculated and applied during the creation of this statewide format FIRM. See Section 6.1 of the accompanying Flood Insurance Study report to obtain further information on the conversion of elevations between NAVD 88 and NGVD 29. To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the North Carolina Geodetic Survey at the address shown below. You may also contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at www.ngs.noaa.gov.

North Carolina Geodetic Survey
121 West Jones Street
Raleigh, NC 27601
(919) 733–3836
www.ncgs.state.nc.us

County Average Vertical Datum Offset Table

County	Vertical Datum Offset (ft)
Orange	– 0.79
Example: NAVD 88 = NGVD 29 + (–0.79)	

All streams listed in the **Flood Hazard Data Table** below were studied by detailed methods using field survey. Other flood hazard data shown on this map may have been derived using either a coastal analysis or limited detailed riverine analysis. More information on the flooding sources studied by these analyses is contained in the Flood Insurance Study report.

FLOOD HAZARD DATA TABLE				Floodway Width (feet) Left/Right Distance From the Center of Stream to Encroachment Boundary (Looking Downstream) or Total Floodway Width
Cross Section	Stream Station[1]	Flood Discharge (cfs)	1% Annual Chance (100-year) Water-Surface Elevation (feet NAVD 88)	
BOLIN CREEK				
050	5,000	6,410	266.7	110 / 113
060	6,000	6,410	273.7	205 / 105
070	7,000	6,190	274.2	40 / 262
075	7,500	6,190	274.5	70 / 140
080	8,000	6,190	275.3	44 / 264
091	9,146	5,9 0	277.9	220 / 40
095	9,500	5,980	279.8	200 / 35
100	10,000	5,980	281.6	90 / 70
105	10,500	5,980	285.0	260 / 35
115	11,500	5,530	295.3	100 / 100
120	12,000	5,530	305.0	200 / 25
136	13,602	5,530	324.5	50 / 25
142	14,152	5,530	330.8	55 / 50
150	15,000	5,530	336.2	120 / 60
165	16,500	4,540	339.4	30 / 30
173	17,324	4,410	347.2	60 / 40
BOOKER CREEK				
120	12,024	1,840	297.4	420 / 287
125	12,524	1,840	297.4	183 / 276
130	13,024	1,840	297.4	187 / 199
136	13,556	1,840	297.4	255 / 130
140	14,035	1,840	297.4	228 / 139
145	14,524	1,840	297.4	290 / 100
150	15,024	1,840	299.6	90 / 85
155	15,524	1,840	302.9	40 / 100
160	16,024	1,840	311.0	16 / 18
165	16,524	1,840	321.0	17 / 94
170	17,020	1,610	327.9	28 / 14
175	17,524	1,610	331.5	19 / 14
180	18,024	1,610	335.3	19 / 14
185	18,524	1,610	341.5	19 / 14
190	19,024	1,610	349.4	25 / 10
195	19,524	1,610	363.1	30 / 29
200	20,024	1,610	373.0	15 / 10
206	20,583	1,610	387.4	78 / 95
210	21,024	1,610	387.5	20 / 200
216	21,577	1,610	390.0	33 / 91
221	22,061	1,210	406.1	14 / 10
225	22,524	1,210	433.9	42 / 67
230	23,024	1,210	434.2	100 / 190
235	23,524	1,210	434.4	70 / 75
240	23,991	1,210	434.8	19 / 123

[1] Feet above mouth

NORTH CAROLINA Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

www.ncfloodmaps.com

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100–year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water–surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D Boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~513~~~ Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

(012) Cross section line

(23)------(23) Transect line

97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4276 000 M 1000–meter Universal Transverse Mercator grid ticks, zone 18

1 477 500 FEET 2500–foot grid values: North Carolina State Plane coordinate system (FIPSZONE 3200, State Plane NAD 83 feet)

BM5510 × North Carolina Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).

BM5510 ⊗ National Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).

● M1.5 River Mile

GRID NORTH

MAP SCALE 1" = 500' (1 : 6,000)

250 0 500 1000 FEET

150 0 150 300 METERS

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

PANEL 9789J

FIRM

FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 9789

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
CHAPEL HILL, TOWN OF	370180	9789	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE FEBRUARY 2, 2007

MAP NUMBER 3710978900J

State of North Carolina
Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data, Limited Detailed Flood Hazard Data, and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole–foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of **regulatory floodways** shown on the FIRM for flooding sources studied by detailed methods were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data for flooding sources studied by detailed methods as well as **non-encroachment widths** for flooding sources studied by limited detailed methods are provided in the FIS report for this jurisdiction. The FIS report also provides instructions for determining a floodway using non–encroachment widths for flooding sources studied by limited detailed methods.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 4.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

Base map information and geospatial data used to develop this FIRM were obtained from various organizations, including the participating local community(ies), state and federal agencies, and/or other sources. The primary base for this FIRM is aerial imagery acquired by Orange County. The time period of collection for the imagery is 2003. Information and geospatial data supplied by the local community(ies) that met FEMA base map specifications were considered the preferred source for development of the base map. See geospatial metadata for the associated digital FIRM for additional information about base map preparation.

Base map features shown on this map, such as **corporate limits**, are based on the most up–to–date data available at the time of publication. **Changes in the corporate limits may have occurred since this map was published**. Map users should consult the appropriate community official or website to verify current conditions of jurisdictional boundaries and base map features. This map may contain roads that were not considered in the hydraulic analysis of streams where no new hydraulic model was created during the production of this statewide format FIRM.

This map reflects more detailed and up–to–date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

If you have **questions about this map**, or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1–877–336–2627) or visit the FEMA website at www.fema.gov.

An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the **North Carolina Floodplain Mapping Program** website at www.ncfloodmaps.com, or contact the **FEMA Map Service Center** at 1–800–358–9616 for information on all related products associated with this FIRM. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at www.msc.fema.gov.

MAP REPOSITORY

Refer to listing of Map Repositories on Map Index or visit www.ncfloodmaps.com.

EFFECTIVE DATE OF FLOOD INSURANCE RATE MAP PANEL
FEBRUARY 2, 2007

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to statewide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent, the North Carolina Division of Emergency Management or the National Flood Insurance Program at the following phone numbers or websites:

NC Division of Emergency Management
(919) 715–8000 www.nccrimecontrol.org/nfip

National Flood Insurance Program
1–800–638–6620 www.fema.gov/nfip
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