Stormwater Concept Plan

Bonterra Subdivision

Chatham County, NC

Prepared by:

Pennoni

PENNONI ASSOCIATES INC.

CONSULTING ENGINEERS

February 16, 2018

Project Description

The existing site consists of two (2) parcels (AKPAR 2532 & 2533) totaling 31.495 ac +/-. There are two (2) residential dwellings and associated structures and improvements presently on the site; all existing improvements shall be removed with this project. The proposed development will consist of a maximum of twenty-two (22) single-family residential lots with a minimum lot size of 40,000 sf. To access these lots, a proposed roadway will be constructed off Mann's Chapel Road. The proposed roadway will be paved (18' wide with shoulder section) and constructed to NCDOT standards. There is a natural stream crossing the site from west to east. In order to construct the proposed roadway, a stream crossing will be required. At the easterly end of the on-site stream there is an existing small pocket of wetlands; this area will not be disturbed. Stormwater will be designed in accordance with the Chatham County Stormwater Ordinance and NCDWQ standards.

Existing site conditions

The existing site is located near the top of a drainage shed. There is a stream running from west to east across the site, with a small pocket of wetlands near the eastern property line. The stream begins just below a farm pond to the west of the site that has a drainage area of approximately 20.22 acres. This pond is not engineered and does not have a control structure or weir. Approximately 60% of the site drains to the stream, as well as approximately 7.65 acres from the north of Mann's Chapel Road that enter the site through 15" RCP and 18" RCP pipe culverts running under the road. The southern portion of the site drains to a swale near the southeast corner, with a small percentage of the site draining to the eastern boundary by sheet flow. See SWM-1 for the existing drainage plan. Computations are located in Appendix A.

The site is primarily wooded, with small cleared areas around the existing buildings and improvements. The northern portion of the site from Mann's Chapel Road to the stream consists of Helena (HeB) and Vance (VaB) soils, which are both hydrologic group C. The site to the south of the stream consists of Wedowee (WdC, WdE and WeB) soils which are hydrologic group B.

Proposed Water Quality Devices

This proposed site is a relatively low-density development, with the total impervious area limited to approximately 9,000 sf per lot, plus 0.76 acres of impervious pavement of the road. The site is generally divided into two drainage areas, with the high point of the road being the main divide. It is the intention of this design that the majority of impervious site area will be captured by a water quality device, and the untreated area will be undisturbed forest or graded pervious area which will maintain existing drainage patterns. See SWM-2 for proposed drainage divides and water quality treatment locations.

The water quality treatment to the north of the high point will consist of treatment swales along the ditch section of the road. Check dams will be provided at a maximum spacing of 200 feet along the road. This maximum spacing allows the velocity within the channel to remain below erosive velocities and the swale will drain within 72 hours of a rain event. The swales will treat the water draining from the road and from at least the front 40 feet of the lots. Additional area captured by the swale will depend on the natural topography of the area. The lots to the west of the proposed road generally drain toward the road, and lots to the east generally drain to the rear of the lot and to the stream. The final location of the check dams will be determined based on final site plan design. See Appendix B for typical drainage swale computations.

The water quality treatment for the southern drainage area will consist of a bioretention basin that will treat 0.27 acres of road plus the impervious area of five (5) lots. The basin will be located within a 50' stormwater management easement along the southern property line. The runoff from the road will be collected in an inlet at the end of the cul-de-sac and directed to the bioretention cell either by pipe flow or a swale along the western property line of lot 12. Offsite area to the west of lot 12 will be directed around the basin. The basin was sized per NCDWQ standards to treat an area of 4.60 acres, of which approximately 30% is impervious area. See Appendix C for bioretention basin computations.

Downstream impacts from the proposed development will be analyzed using the Ten Percent Rule. This is shown on SWM-3 attached to the back of the report.

Stream Crossing

The proposed road design will require a stream crossing. This crossing will consist of a box culvert installed in accordance with NCDOT standards. The box culvert is sized to pass the 1-, 2-, 5-, 10- and 25-year, 24-hour design storm events, as well as provide at least two (2) feet of freeboard to the shoulder of the road for the 100-year, 24-hour storm event. The drainage area to the culvert includes the 20.22 acres to the pond at the top of the stream. Since the pond is not an engineered pond, the Tc was computed as if any water that enters the pond leaves immediately. It was determined that a 4'x3' box culvert is adequate for this stream crossing. See Appendix D for culvert design computations.

Appendix A

Existing Conditions Drainage Computations

Worksheet 2: Runoff curve number and runoff

Project	Mann's Chapel Road Subdivision	**By**	MAG	**Date**	2/8/2018
Location	Outfall #1	**Checked**	BTN	**Date**	2/8/2018

Check One: [X] **Pre-Developed** [ ] **Developed** **Pre-Developed Conditions - Outfall #1**

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN* Table 2-2	CN* Figure 2-3	CN* Figure 2-4	Area [X] acres [ ] mi^2 [ ] %	Product of CN x area
C	Residential (1 acre average lots)	79			34.97	2762.6
B	Residential (1 acre average lots)	68			15.73	1069.6
	Totals				50.70	3832.27

* Use only one CN source per line

CN (weighted) = total product / total area = 3832.27 / 50.70

Use CN **75.59**

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency.....	yr	2	10	100
Rainfall, P (24-hour).....	in	3.57	6.13	7.67
Runoff, Q.....	in	1.39	3.45	4.81

(Use P and CN with table 2-1, figure 2-1, or equation 2-3 and 2-4)

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project	Mann's Chapel Road Subdivision	**By**	MAG	**Date**	2/8/2018
Location	Outfall #1	**Checked**	BTN	**Date**	2/8/2018

Check One: [X] Pre-Developed [ ] Developed **Pre-Developed Conditions**

Check One: [X] T_c [ ] T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments

Sheet Flow (Applicable to T_c only)

Segment ID	A-B				
1. Surface description (table 3-1)……..	Grass				
2. Manning's roughness coefficient, *n* (table 3-1)……..	0.24				
3. Flow Length, L (total L<= 300 ft)……ft	200				
4. Two-Year 24-hour rainfall, p_2 ..... in	3.57				
5. Land Slope, s……ft/ft	0.0250				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t……. hr	0.36	+		=	0.36

Shallow Concentrated Flow

Segment ID	B-C				
7. Surface description (paved or unpaved)……..	Unpaved				
8. Flow length, L ……..ft	1108				
9. Watercourse slope, s ……..ft/ft	0.0397				
10. Average velocity, V (figure 3-1)……ft/s	3.21				
11 $T_t = \frac{L}{3600V}$ Compute T_t……. hr	0.10	+		=	0.10

Channel Flow

Segment ID	CD		DE		
12. Cross sectional flow area, a……ft^2	9.39		15.71		
13. Wetted perimeter, Pw……ft	11.24		12.4		
14. Hydraulic Radius, r= a/Pw Compute r……ft	0.84		1.27		
15. Channel Slope, s……ft/ft	0.0277		0.0182		
16. Manning's Roughness coefficient, n…….	0.03		0.03		
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V……ft/s	7.36		7.86		
18. Flow Length, L……ft	440		490		
19 $T_t = \frac{L}{3600V}$ Compute T_t……. hr	0.02	+	0.02	=	0.03
				Total Tc	**0.49**
				Use Tc (min.)	**29.29**

Worksheet 2: Runoff curve number and runoff

Project	Mann's Chapel Road Subdivision	**By**	MAG	**Date**	2/8/2018
Location	Outfall #2	**Checked**	BTN	**Date**	2/8/2018

Check One: [X] **Pre-Developed** [ ] **Developed** **Pre-Developed Conditions - Outfall #2**

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN* Table 2-2	CN* Figure 2-3	CN* Figure 2-4	Area [X] acres [ ] mi^2 [ ] %	Product of CN x area
B	Residential (1 acre average lots)	68			12.57	854.8
* Use only one CN source per line				Totals	12.57	854.76

CN (weighted) = total product / total area = 854.76 / 12.57

Use CN **68.00**

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency.....	yr	2	10	100
Rainfall, P (24-hour).....	in	3.57	6.13	7.67
Runoff, Q.....	in	0.94	2.72	3.96
(Use P and CN with table 2-1, figure 2-1, or equation 2-3 and 2-4)				

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project	Mann's Chapel Road Subdivision	**By**	MAG	**Date**	2/8/2018
Location	Outfall #2	**Checked**	BTN	**Date**	2/8/2018

Check One: [X] Pre-Developed [ ] Developed **Pre-Developed Conditions**

Check One: [X] T_c [ ] T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments

Sheet Flow (Applicable to T_c only)

	Segment ID	A-B			
1. Surface description (table 3-1)……..		Grass			
2. Manning's roughness coefficient, *n* (table 3-1)……..		0.24			
3. Flow Length, L (total L<= 300 ft)…….ft		200			
4. Two-Year 24-hour rainfall, p_2 ..... in		3.57			
5. Land Slope, s……ft/ft		0.0700			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P2^{0.5}\,s^{0.4}}$ Compute T_t……. hr		0.24	+		=
					0.24

Shallow Concentrated Flow

	Segment ID	B-C			
7. Surface description (paved or unpaved)……..		Unpaved			
8. Flow length, L ……...ft		1141			
9. Watercourse slope, s ……...ft/ft		0.0473			
10. Average velocity, V (figure 3-1)……ft/s		3.51			
11 $T_t = \frac{L}{3600V}$ Compute T_t……. hr		0.09	+		=
					0.09

Channel Flow

	Segment ID	CD		DE	
12. Cross sectional flow area, a……ft^2					
13. Wetted perimeter, Pw……ft					
14. Hydraulic Radius, r= a/Pw Compute r……ft					
15. Channel Slope, s……ft/ft					
16. Manning's Roughness coefficient, n…….					
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V……ft/s					
18. Flow Length, L……ft					
19 $T_t = \frac{L}{3600V}$ Compute T_t……. hr			+		=
					0.00
				Total Tc	**0.33**
				Use Tc (min.)	**19.67**

Appendix B

Treatment Swale Computations

Worksheet for Treatment Swale Section

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.07000	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	1.00	ft
Discharge	2.54	ft³/s

Results

Normal Depth	0.30	ft
Flow Area	0.57	ft²
Wetted Perimeter	2.90	ft
Hydraulic Radius	0.20	ft
Top Width	2.80	ft
Critical Depth	0.40	ft
Critical Slope	0.02163	ft/ft
Velocity	4.44	ft/s
Velocity Head	0.31	ft
Specific Energy	0.61	ft
Froude Number	1.73	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.30	ft
Critical Depth	0.40	ft
Channel Slope	0.07000	ft/ft

Worksheet for Treatment Swale Section

GVF Output Data

Critical Slope	0.02163	ft/ft

Appendix C

Bioretention Basin Preliminary Sizing

Maximum Allowable Depth	
f (Infiltration rate based on underlying soil) (ft/hr)	0.0166
Ts (Maximum allowable Storage Time) (hr)	48
n (Porosity of Soil Media)	0.25
d_{max} (Maximum Allowable Depth) (ft)	3.1872

$$d_{max} = \frac{f * T_s}{n}$$

Target Treatment Volume Required	
P	1
RvI	0.95
%I	0.3195652
RvT	0.2
%T	0.4630435
RvF	0.03
%F	0.2173913
SA (acres)	4.6
Site Rv (Volumetric Runoff Coefficient)	0.40
Tv (Target Treatment Volume) (ac.-ft.)	0.154375
Tv (Target Treatment Volume) (ft^3)	6,725

$$T_v$$

Bioretention Area A

STEP 1 Surface Ponding	
Surface Ponding Depth $d_{ponding}$ (ft.)	1.00
Surface Ponding Volume (ft^3) Must be ≥50% of Design Tv	3978.00
Average Ponding Surface Area (ft^2) ($SA_{avg\text{-}ponding}$)	3978.00
Side Slopes (3:1)	3.00
Approximate surface area at the top of the ponding depth (ft^2)	4500.00
Approximate surface area at the bottom of the ponding depth (ft^2)	3456.00

STEP 2 Soil Media Surface Area and Depth	
Soil Media Surface Area (SA_{bottom}) (ft^2)	3456.00
d_{media} (ft)	2.00
d_{gravel} (ft)	1.00
n_{media}	0.25
n_{gravel}	0.4
$SA_{avg\text{-}ponding}$ (ft^2)	3,978.00
$d_{ponding}$ (ft)	1.0
$Dv_{practive}$ (ft^3)	7,088

Appendix D

Stream Crossing Culvert Computations

Culvert Design Report
Culvert Drainage Area - Discharge Rates

Peak Discharge Method: SCS Peak Discharge					
Design Rainfall Depth	6.13	in	Check Rainfall Depth	7.67	in
Design Peak Discharge	91.36	cfs	Check Peak Discharge	125.18	cfs
Total Area	28.26	acres	Time of Concentration	28.31	min
Weighted Curve Number	79		Rainfall Type	Type II	

Subwatershed	Area (acres)	CN
1	28.26	79

Grades Model: Inverts					
Invert Upstream	528.00	ft	Invert Downstream	526.00	ft
Length	100.00	ft	Slope	0.020000	ft/ft
Drop	2.00	ft			

Headwater Model: Allowable HW/Height	
Headwater Depth/Height	0.00

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	ft

Culvert Calculator Report
Culvert 1 - 100 yr for Culvert Size

Solve For: Section Size

Culvert Summary					
Allowable HW Elevation	538.00	ft	Headwater Depth/Height	2.34	
Computed Headwater Elevation	535.03	ft	Discharge	125.18	cfs
Inlet Control HW Elev.	535.03	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	533.87	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	528.00	ft	Downstream Invert	526.00	ft
Length	100.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.14	ft
Slope Type	Steep		Normal Depth	1.95	ft
Flow Regime	Supercritical		Critical Depth	3.00	ft
Velocity Downstream	14.60	ft/s	Critical Slope	0.010230	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	4 x 3 ft		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	533.87	ft	Upstream Velocity Head	1.69	ft
Ke	0.70		Entrance Loss	1.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	535.03	ft	Flow Control	N/A	
Inlet Type	0° wingwall flares		Area Full	12.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Calculator Report
Culvert 1 - 25 yr for Headwater

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	538.00	ft	Headwater Depth/Height	1.42	
Computed Headwater Elevation	532.25	ft	Discharge	91.36	cfs
Inlet Control HW Elev.	532.25	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	532.05	ft	Control Type	Inlet Control	

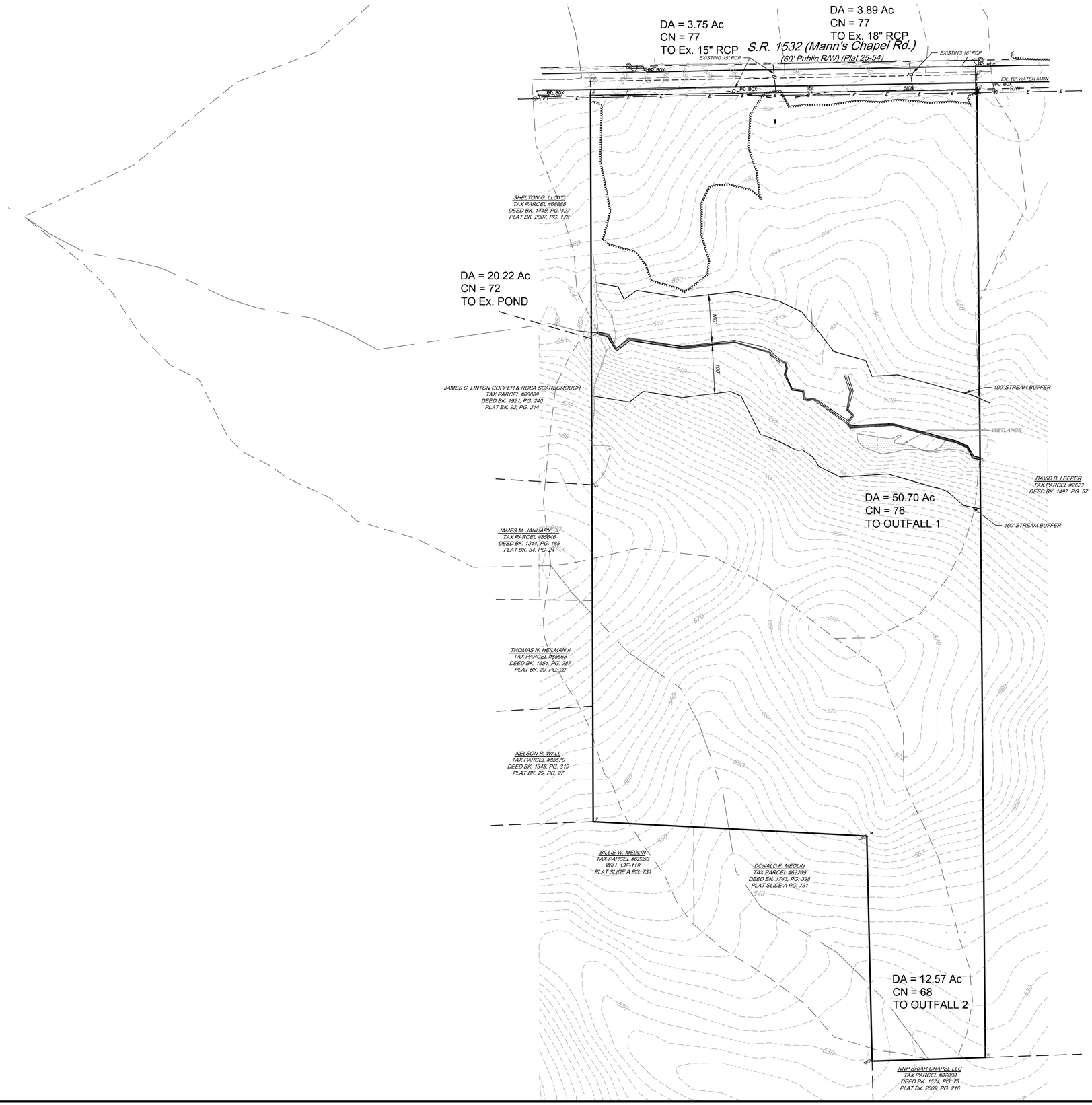
Grades					
Upstream Invert	528.00	ft	Downstream Invert	526.00	ft
Length	100.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.68	ft
Slope Type	Steep		Normal Depth	1.55	ft
Flow Regime	Supercritical		Critical Depth	2.53	ft
Velocity Downstream	13.61	ft/s	Critical Slope	0.005377	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	4 x 3 ft		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	532.05	ft	Upstream Velocity Head	1.27	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	532.25	ft	Flow Control	Submerged	
Inlet Type	90° headwall w 45° bevels		Area Full	12.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				



PRELIMINARY
NOT FOR CONSTRUCTION

ALL DIMENSIONS MUST BE VERIFIED BY CONTRACTOR AND OWNER MUST BE NOTIFIED OF ANY DISCREPANCIES BEFORE PROCEEDING WITH WORK

BONTERRA SUBDIVISION

3954 MANNS CHAPEL ROAD
CHAPEL HILL, NC 27516

PRE-DEVELOPED DRAINAGE PLAN

IDEAL CAPITAL GROUP, LLC
2100 COOK RIDGE COURT
RALEIGH, NC 27615

NO.	DATE	REVISIONS	BY
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PROJECT	DLAZ1701
DATE	2018-02-16
DRAWING SCALE	1"= 100'
DRAWN BY	DMC
APPROVED BY	PCB

SWM-1

SHEET 1 OF 1

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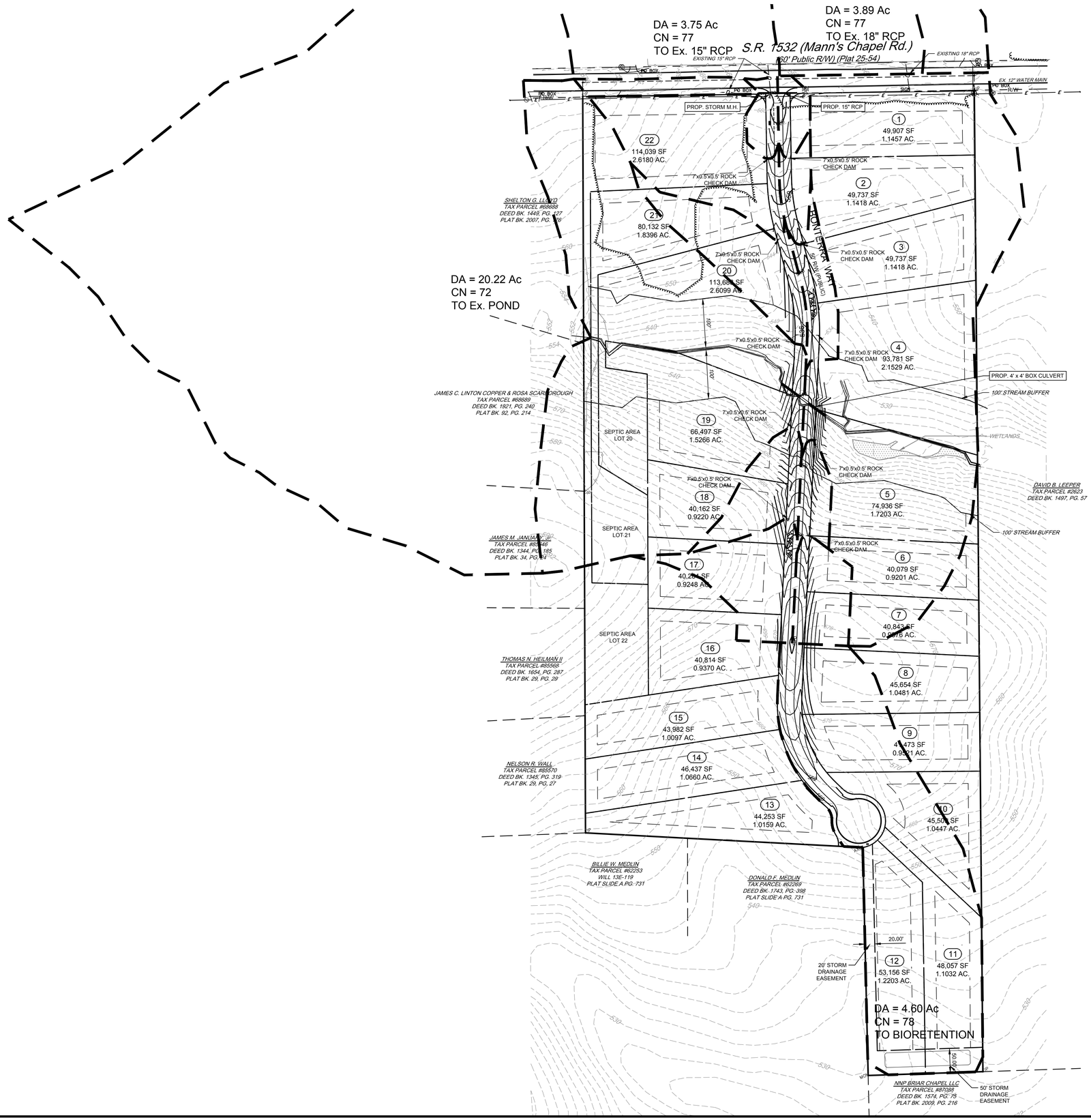

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ALL DIMENSIONS MUST BE VERIFIED BY CONTRACTOR AND OWNER MUST BE NOTIFIED OF ANY DISCREPANCIES BEFORE PROCEEDING WITH WORK

BONTERRA SUBDIVISION
3954 MANNS CHAPEL ROAD
CHAPEL HILL, NC 27516

POST-DEVELOPED DRAINAGE PLAN

IDEAL CAPITAL GROUP, LLC
2100 COOK RIDGE COURT
RALEIGH, NC 27615

NO.	DATE	REVISIONS	BY
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PROJECT	DLAZ1701
DATE	2018-02-16
DRAWING SCALE	1"= 100'
DRAWN BY	DMC
APPROVED BY	PCB

SWM-2

SHEET 1 OF 1

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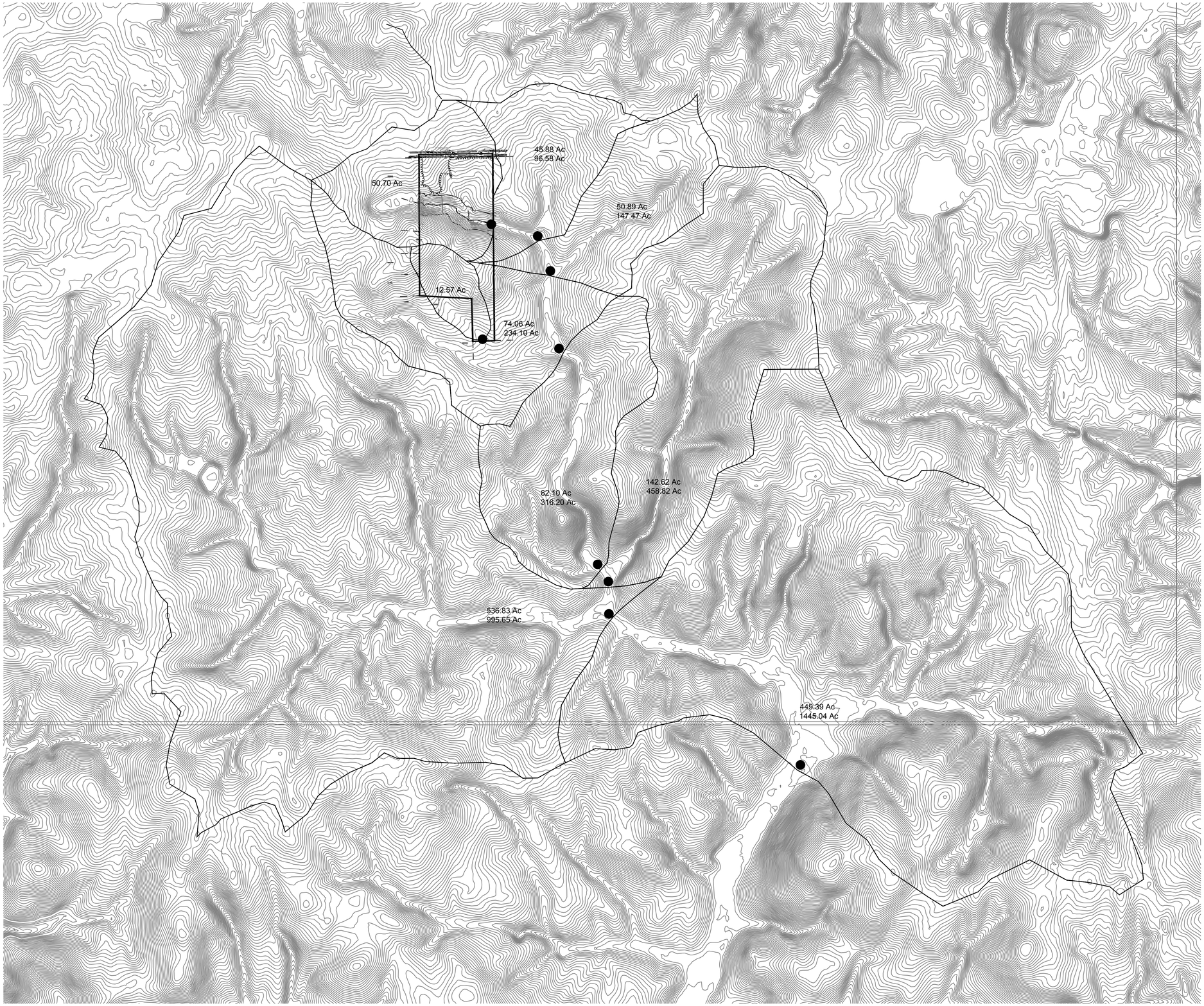

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BONTERRA SUBDIVISION

3954 MANNS CHAPEL ROAD
CHAPEL HILL, NC 27516

DOWNSTREAM DAINAGE DIVIDES

IDEAL CAPITAL GROUP, LLC
2100 COOK RIDGE COURT
RALEIGH, NC 27615

NO.	DATE	REVISIONS	BY
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PROJECT	DLAZ1701
DATE	2018-02-16
DRAWING SCALE	1"= 100'
DRAWN BY	DMC
APPROVED BY	PCB

SWM-3

SHEET 1 OF 1

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