ATTACHMENT C

STORMWATER MANAGEMENT PLAN (ZACHRY)

NO	REVISIONS	DATE	DESIGNER	DM REVIEWER
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ZACHRY

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C-A013756-SRWS001 R0

GAINESVILLE RENEWABLE ENERGY CENTER
BIOMASS GENERATING FACILITY
CALCULATION PACKAGE
SITE RELATED WORK
STORMWATER PIPE

DAVID F. HOLLRAH LICENSE No PE 68723 STATE OF FLORIDA PROFESSIONAL ENGINEER 1/19/2010

DATE	DESIGNER	REVIEWER	DM REVIEWER
1/19/10	SD Read	DM ANDERSEN	M.J.PETERSON

CALCULATION NUMBER	PAGES	REV
C-A013756-SRWS001	40	0

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1.0 Purpose and Scope

The following calculations will provide the piping calculations for Gainesville project located in Gainesville, Florida.

2.0 Design Methodology

The Rational Method is used to determine flow volumes.

For calculating pipe flow Manning's equation is used. Design storms are 3-year 10-minute per EDA recommendation. The intensity for this storm is 6.2 in/hr.

Runoff coefficients are determined based off of tabulated values.

An HDPE French Drain system will drain the fuel yard. The combination of the HDPE pipe and ditch will convey the stormwater to the drain fields at the north and northeast ends of the fuel yard.

3.0 Design Inputs

Located within the calculation.

4.0 Assumptions

The runoff coefficient for the site is estimated to be 0.9 for a heavy industrial site. This is used for both construction and post construction. In areas where the runoff may be lower, a runoff coefficient value is calculated based on a weighted average.

5.0 References

1. Florida DOT Drainage Manual; http://www.dot.state.fl.us/rddesign/dr/files/May2008DrainageManual.pdf
2. Wurbs, Ralph. A (2002). Water Resources Engineering. Upper Saddle River, NJ: Prentice Hall.
3. Mecosta County Drain Commissioner; Subdivision Drainage Rules and Storm Water Design Criteria; Rational Runoff Coefficients.doc

6.0 Calculations

See following pages:

Runoff Coefficient Calculations and Determinations:

North Drainage Swale: Post-Construction		
Item	Area	c
Total		
[ac]	1.25	
Ditch		0.3
[ac]	0.75	
Road		0.95
[ac]	0.50	
composite c	0.56	

North Drainage Swale: Construction		
Item	Area	c
Total		
[ac]	1.25	
Ditch		0.6
[ac]	0.75	
Rock		0.85
[ac]	0.50	
composite c	0.70	

South Drainage Swale: Post-Construction		
Item	Area	c
Total		
[ac]	4.49	
Ditch		0.3
[ac]	3.07	
Road		0.95
[ac]	1.42	
composite c	0.51	

South Drainage Swale: Construction		
Item	Area	c
Total		
[ac]	4.49	
Ditch		0.6
[ac]	3.07	
Rock		0.85
[ac]	1.42	
composite c	0.68	

Example:

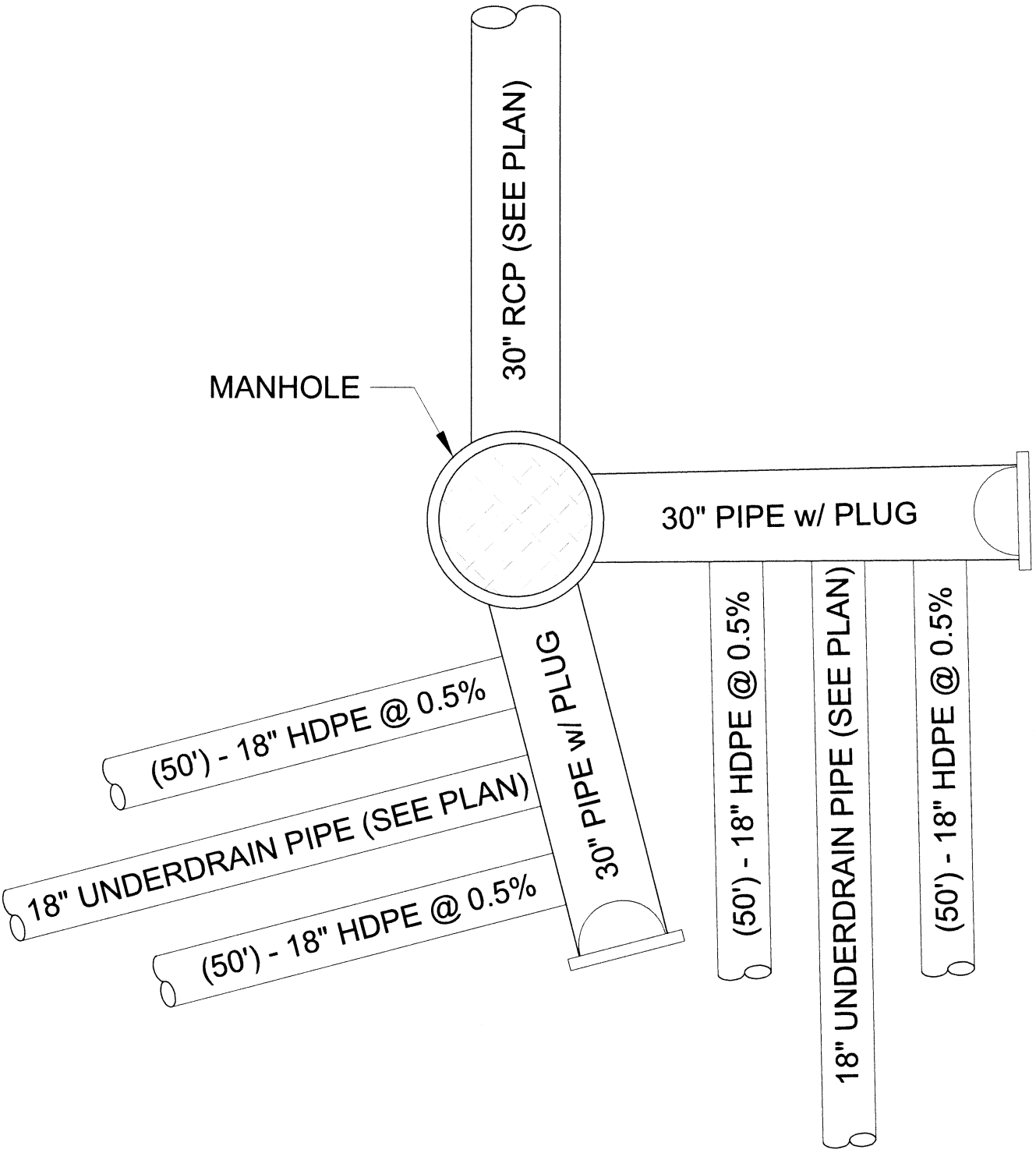
$$c_1 := \sum_{i=1}^{n} \left(\frac{A_n}{A_T} \cdot c_n \right)$$

FUEL YARD

The fuel yard utilizes a HDPE French Drain system to convey the stormwater off of the site. Manholes 5 and 9 have a “drain field” in order to collect all of the incoming french drain stormwater. The series of pipes collects the water and sends it through the outlet pipe.

The calculation assumes the drain field inlet flow as being six separate pipes with their flows being summed to obtain a total inlet flow.

Manholes SMH 01 and SMH02 are used to collect and treat oil in the stormwater from the truck dumper and scale house areas on the site.



DETAIL A S10002 01

Area 2A Outlet Pipe

Site Data		
c	0.9	
i	6.2	[in/hr]
A	10.25	[ac]
Q	57.20	[ft^3/s]

Slope	0.02	[ft/ft]
Pipe Diameter	30	[in]
	2.5	[ft]

USE MANNINGS EQUATION	
R	0.625
Cm	1.49
n	0.012

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

(RCP)

Velocity [V]	12.84	[fps]
Flow [Q]	63.01	[cfs]

OK

Area 2B Outlet Pipe

Site Data		
c	0.9	
i	6.2	[in/hr]
A	8.43	[ac]
Q	47.04	[ft^3/s]

Slope	0.015	[ft/ft]
Pipe Diameter	30	[in]
	2.5	[ft]

USE MANNINGS EQUATION	
R	0.625
Cm	1.49
n	0.012

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

(RCP)

Velocity [V]	11.12	[fps]
Flow [Q]	54.57	[cfs]

OK

Area 2A Inlet

Worst Case over 2B

Site Data		
c	0.9	
i	6.2	[in/hr]
A	10.25	[ac]
Q	57.20	[ft^3/s]

PIPE 1

Slope	0.005	[ft/ft]
Pipe Diameter	18	[in]
	1.5	[ft]

USE MANNINGS EQUATION	
R	0.375
Cm	1.49
n	0.009

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

(HDPE)

Velocity [V]	6.09	[fps]
Flow [Q]	10.76	[cfs]

TOTAL FLOW	**64.55 cfs**

OK

Pipe 1 x 3 x 2

(6 total pipes)

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in SMH 01

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.390	acres	(Approximate area draining into MH)
	2.18		
Q(storm,culvert) =	**4.46**	cfs	(add Q from MH 28)

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	4.46	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.005	decimal			
Target value =	0.508		**Iterated value =**	0.504	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.92**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.97**	sq. ft.	**Flow velocity =**	**4.61**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in SMH 02

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.250	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**1.40**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	1.40	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.003	decimal			
Target value =	0.205		**Iterated value =**	0.205	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.52**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.48**	sq. ft.	**Flow velocity =**	**2.89**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 28

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.410	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**2.29**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	2.29	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.005	decimal			
Target value =	0.261		**Iterated value =**	0.260	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.60**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.58**	sq. ft.	**Flow velocity =**	**3.96**	ft/s

POWER BLOCK

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 10

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.390	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**2.18**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking				
Q =	2.18	cfs		
n =	0.012	no units	(reinforced concrete pipe)	
d_o =	1.25	feet		
Slope =	0.005	decimal		
Target value =	0.248		**Iterated value =**	0.248

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.58**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.56**	sq. ft.	**Flow velocity =**	**3.90**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 11

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.180	acres	(Approximate area draining into MH)
	1.00		
Q(storm,culvert) =	**3.18**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking				
Q =	3.18	cfs		
n =	0.012	no units	(reinforced concrete pipe)	
d_o =	1.25	feet		
Slope =	0.005	decimal		
Target value =	0.362		**Iterated value =**	0.360

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.73**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.74**	sq. ft.	**Flow velocity =**	**4.31**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 12

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.150	acres	(Approximate area draining into MH)
	0.84		
Q(storm,culvert) =	**4.02**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking				
Q =	4.02	cfs		
n =	0.012	no units	(reinforced concrete pipe)	
d_o =	1.25	feet		
Slope =	0.018	decimal		
Target value =	0.241		**Iterated value =**	0.241

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.57**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.54**	sq. ft.	**Flow velocity =**	**7.37**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 13

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.400	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**2.23**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	2.23	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.0035	decimal			
Target value =	0.304		**Iterated value =**	0.302	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.65**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.64**	sq. ft.	**Flow velocity =**	**3.46**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 14

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.210	acres	(Approximate area draining into MH)
	1.17		
Q(storm,culvert) =	**3.40**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	3.40	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.0033	decimal			
Target value =	0.477		**Iterated value =**	0.477	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.88**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.92**	sq. ft.	**Flow velocity =**	**3.69**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 15

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.360	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**2.01**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	2.01	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.005	decimal			
Target value =	0.229		**Iterated value =**	0.226	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.55**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.52**	sq. ft.	**Flow velocity =**	**3.86**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 16

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.330	acres	(Approximate area draining into MH)
	1.84		
Q(storm,culvert) =	**7.25**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	7.25	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.5	feet			
Slope =	0.0038	decimal			
Target value =	0.948		**Iterated value =**	0.947	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.28**	feet	**Culvert cross-sectional area =**	**1.77**	sq. ft.
Water cross-sectional area =	**1.60**	sq. ft.	**Flow velocity =**	**4.53**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 17

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.600	acres	(Approximate area draining into MH)
	3.35		
Q(storm,culvert) =	**14.01**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	14.01	cfs			
n =	0.012	no units	(RCP)		
d_o =	2	feet			
Slope =	0.005	decimal			
Target value =	1.595		**Iterated value =**	1.202	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.13**	feet	**Culvert cross-sectional area =**	**3.14**	sq. ft.
Water cross-sectional area =	**1.82**	sq. ft.	**Flow velocity =**	**7.69**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 18

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.630	acres	(Approximate area draining into MH)
	3.52		
Q(storm,culvert) =	**17.52**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	17.52	cfs			
n =	0.012	no units	(RCP)		
d_o =	2	feet			
Slope =	0.005	decimal			
Target value =	1.996		**Iterated value =**	1.602	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.37**	feet	**Culvert cross-sectional area =**	**3.14**	sq. ft.
Water cross-sectional area =	**2.28**	sq. ft.	**Flow velocity =**	**7.67**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 19

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.700	acres	(Approximate area draining into MH)
	3.91		
Q(storm,culvert) =	**21.43**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	21.43	cfs			
n =	0.012	no units	(RCP)		
d_o =	2	feet			
Slope =	0.005	decimal			
Target value =	2.440		**Iterated value =**	2.052	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.72**	feet	**Culvert cross-sectional area =**	**3.14**	sq. ft.
Water cross-sectional area =	**2.87**	sq. ft.	**Flow velocity =**	**7.47**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 20

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.120	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**0.67**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	0.67	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.005	decimal			
Target value =	0.076		**Iterated value =**	0.076	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.31**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.24**	sq. ft.	**Flow velocity =**	**2.82**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 21

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.300	acres	(Approximate area draining into MH)
	1.67		
Q(storm,culvert) =	**23.77**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	23.77	cfs			
n =	0.012	no units	(RCP)		
d_o =	2.5	feet			
Slope =	0.005	decimal			
Target value =	2.707		**Iterated value =**	2.324	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.47**	feet	**Culvert cross-sectional area =**	**4.91**	sq. ft.
Water cross-sectional area =	**2.99**	sq. ft.	**Flow velocity =**	**7.95**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 22

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.950	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**5.30**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	5.30	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.005	decimal			
Target value =	0.604		**Iterated value =**	0.605	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.14**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**1.17**	sq. ft.	**Flow velocity =**	**4.51**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 23

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	1.010	acres	(Approximate area draining into MH)
	5.64		
Q(storm,culvert) =	**10.94**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	10.94	cfs			
n =	0.012	no units	(RCP)		
d_o =	2	feet			
Slope =	0.005	decimal			
Target value =	1.246			**Iterated value =**	1.245

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.15**	feet		**Culvert cross-sectional area =**	**3.14**	sq. ft.
Water cross-sectional area =	**1.87**	sq. ft.		**Flow velocity =**	**5.85**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 24

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.460	acres	(Approximate area draining into MH)
	2.57		
Q(storm,culvert) =	**13.50**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	13.50	cfs			
n =	0.012	no units	(RCP)		
d_o =	2	feet			
Slope =	0.005	decimal			
Target value =	1.538		**Iterated value =**	1.538	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.33**	feet	**Culvert cross-sectional area =**	**3.14**	sq. ft.
Water cross-sectional area =	**2.21**	sq. ft.	**Flow velocity =**	**6.11**	ft/s

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 25

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.9	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	0.530	acres	(Approximate area draining into MH)
	2.96		
Q(storm,culvert) =	**40.23**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	40.23	cfs			
n =	0.012	no units	(RCP)		
d_o =	3	feet			
Slope =	0.005	decimal			
Target value =	4.582		**Iterated value =**	4.195	

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.88**	feet	**Culvert cross-sectional area =**	**7.07**	sq. ft.
Water cross-sectional area =	**4.67**	sq. ft.	**Flow velocity =**	**8.61**	ft/s

SOUTH DITCH
MH 26

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 26

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.68	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	2.530	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**10.67**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	10.67	cfs			
n =	0.012	no units	(RCP)		
d_o =	2	feet			
Slope =	0.005	decimal			
Target value =	1.215			**Iterated value =**	1.216

Channel Characteristics Output					
Calculated normal depth inside culvert =	**1.13**	feet		**Culvert cross-sectional area =**	**3.14**	sq. ft.
Water cross-sectional area =	**1.84**	sq. ft.		**Flow velocity =**	**5.81**	ft/s

NORTH DITCH
MH 27

Gainesville
Open Channel Flow w/ Manning's Equation, Calculation of Depth for Water in Outlet Pipe in MH 27

***Yellow cells are for input**
****Green cell requires goal seek w/ the calculated target value (purple cell) by changing the channel depth (blue cell)**

Q =ciA

Developed Site Input			
c =	0.7	no units	(calculated composite c value)
i =	6.2	in/hr	(3 yr - 10 min Event)
A =	1.470	acres	(Approximate area draining into MH)
Q(storm,culvert) =	**6.38**	cfs	

$Q = (1.49/n)*A*R_h^{2/3}*S_e^{1/2}$

Q = Flow rate (cfs)
n = Manning's coefficient
d_o = Culvert inside diameter (ft)
Slope = Culvert longitudinal slope
d = culvert normal depth (ft)

Manning's Input & Microsoft Excel Goal Seeking					
Q =	6.38	cfs			
n =	0.012	no units	(RCP)		
d_o =	1.25	feet			
Slope =	0.02	decimal			
Target value =	0.363		**Iterated value =**	0.364	

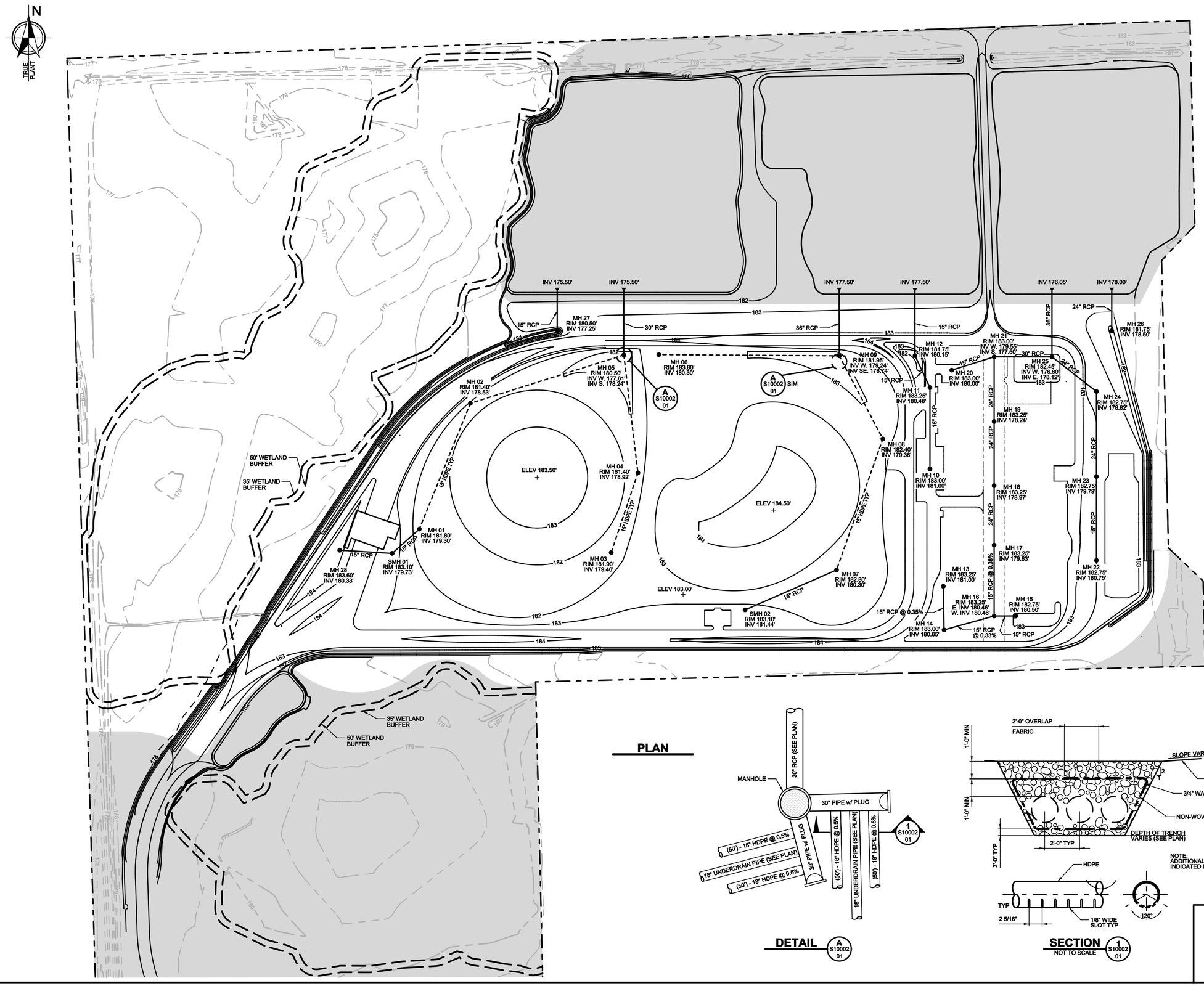
Channel Characteristics Output					
Calculated normal depth inside culvert =	**0.73**	feet	**Culvert cross-sectional area =**	**1.23**	sq. ft.
Water cross-sectional area =	**0.74**	sq. ft.	**Flow velocity =**	**8.57**	ft/s

7.0 Summary of Results

Manhole	Pipe Size [in]	Pipe Material
MH 1	18	HDPE
MH 2	18	HDPE
MH 3	18	HDPE
MH 4	18	HDPE
MH 5	30	RCP
MH 6	18	HDPE
MH 7	18	HDPE
MH 8	18	HDPE
MH 9	30	RCP
MH 10	15	RCP
MH 11	15	RCP
MH 12	15	RCP
MH 13	15	RCP
MH 14	15	RCP
MH 15	15	RCP
MH 16	15	RCP
MH 17	24	RCP
MH 18	24	RCP
MH 19	24	RCP
MH 20	15	RCP
MH 21	30	RCP
MH 22	15	RCP
MH 23	24	RCP
MH 24	24	RCP
MH 25	30	RCP
MH 26	24	RCP
MH 27	18	RCP
MH 28	15	RCP
SMH 01	15	RCP
SMH 02	15	RCP

8.0 Conclusions

The results of these calculations show that the stormwater piping is sufficient.



LEGEND

- UNDERDRAIN (HDPE)
- STORMWATER PIPE REINFORCED CONCRETE PIPE (RCP)
- OUTLET PIPE APRON
- MANHOLE (MH) OR SKIMMER MANHOLE (SMH)
- FLOW ARROW
- EXISTING CONTOUR
- FINAL CONTOUR
- PLANT BOUNDARY
- COVERED BY ENG, DENMAN & ASSOCIATES SCOPE (FOR REFERENCE ONLY)
- STORMWATER BASIN
- WETLAND BUFFER

GENERAL NOTES

1. ALL RCP PIPES ARE AT 0.5% GRADE SLOPE MINIMUM UNO.
2. ALL HPDE PIPES ARE AT 0.25% GRADE SLOPE MINIMUM UNO.
3. TOC FOR FOUNDATIONS ARE 185.00'.
3. EXISTING CONTOURS ARE BASED UPON EXISTING GENESIS CERTIFIED SURVEY FILE GREC.DWG POSTED 9/14/09.
4. SKIMMER MANHOLES WILL LOCALLY TREAT STORMWATER WHEN OIL IS PRESENT

REFERENCE DRAWINGS

1. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; EXISITING CONTOURS AND DRAINAGE AREAS PLAN; D013756-SRWS10001 SHT 01
2. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; FINAL & CONSTRUCTION DRAINAGE AREAS PLAN; D013756-SRWS10001 SHT 02
3. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; CONSTRUCTION GRADING PLAN AND DETAILS; D013756-SRWS10002 SHT 01

PRELIMINARY
AS OF 1/19/2010
NOT FOR CONSTRUCTION

PLAN

DETAIL A S10002 01

SECTION NOT TO SCALE 1 S10002 01

NO	REVISIONS	DATE	DRWN	DSND	CHKD	CHKD
C	–					

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An American Renewables Company

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GAINESVILLE RENEWABLE ENERGY CENTER
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CONSTRUCTION GRADING PLAN & DETAILS

DRAWN	DESIGNED	CHECKED	CHECKED
APPROVED	DRAWING NUMBER		SHEET	REV
APPROVED	D013756-SRWS10002		01	C

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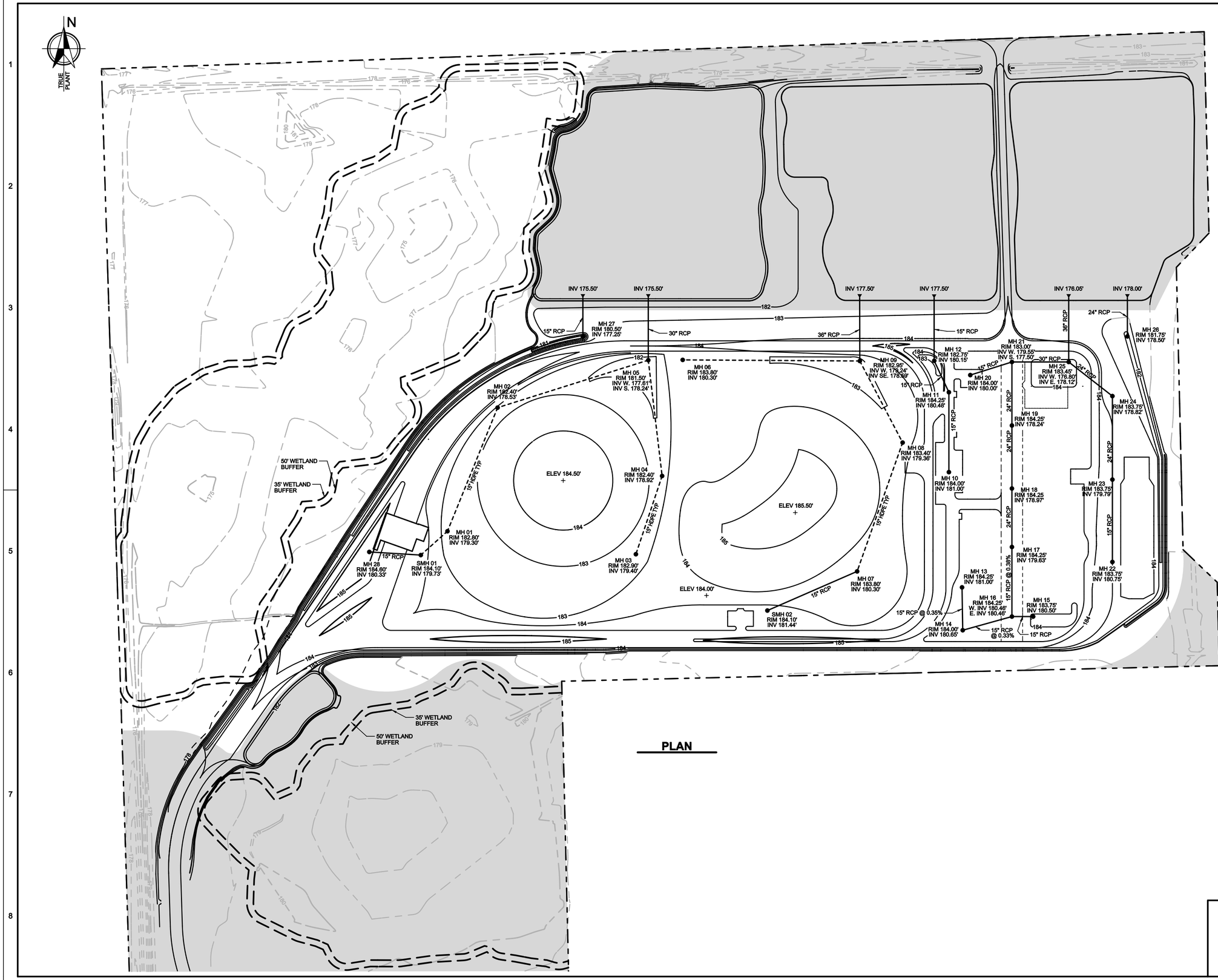

PLAN

100 0 50 100 150 200

SCALE

SCALE IN FEET

LEGEND

- UNDERDRAIN (HDPE)
- STORMWATER PIPE REINFORCED CONCRETE PIPE (RCP)
- OUTLET PIPE APRON
- MANHOLE (MH) OR SKIMMER MANHOLE (SMH)
- FLOW ARROW
- EXISTING CONTOUR
- FINAL CONTOUR
- PLANT BOUNDARY
- COVERED BY ENG, DENMAN & ASSOCIATES SCOPE (FOR REFERENCE ONLY)
- STORMWATER BASIN
- WETLAND BUFFER

GENERAL NOTES

1. ALL RCP PIPES ARE AT 0.5% GRADE SLOPE MINIMUM UNO.
2. ALL HPDE PIPES ARE AT 0.25% GRADE SLOPE MINIMUM UNO.
3. TOC FOR FOUNDATIONS ARE 185.00'.
3. EXISTING CONTOURS ARE BASED UPON EXISTING GENESIS CERTIFIED SURVEY FILE GREC.DWG POSTED 9/14/09.
4. SKIMMER MANHOLES WILL LOCALLY TREAT STORMWATER WHEN OIL IS PRESENT

REFERENCE DRAWINGS

1. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; EXISITING CONTOURS AND DRAINAGE AREAS PLAN; D013756-SRWS10001 SHT 01
2. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; FINAL & CONSTRUCTION DRAINAGE AREAS PLAN; D013756-SRWS10001 SHT 02
3. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; CONSTRUCTION GRADING PLAN AND DETAILS; D013756-SRWS10002 SHT 01

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AS OF 1/19/2010
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NO	REVISIONS	DATE	DRWN	DSND	CHKD	CHKD
C	–					

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BIOMASS GENERATING FACILITY

FINAL GRADING PLAN

DRAWN	DESIGNED	CHECKED	CHECKED
APPROVED	DRAWING NUMBER		SHEET / REV
APPROVED	D013756-SRWS10003		01 / C

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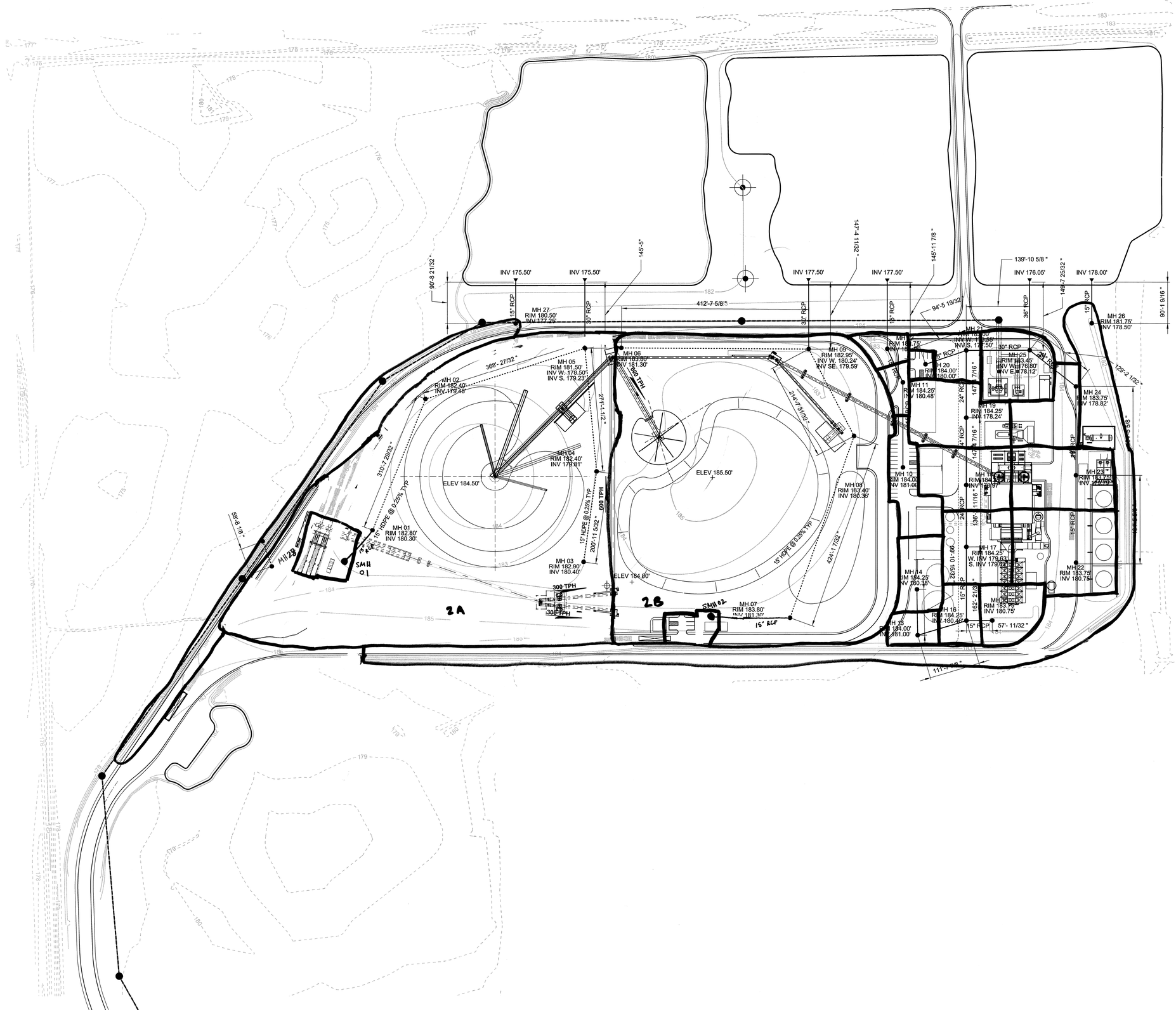
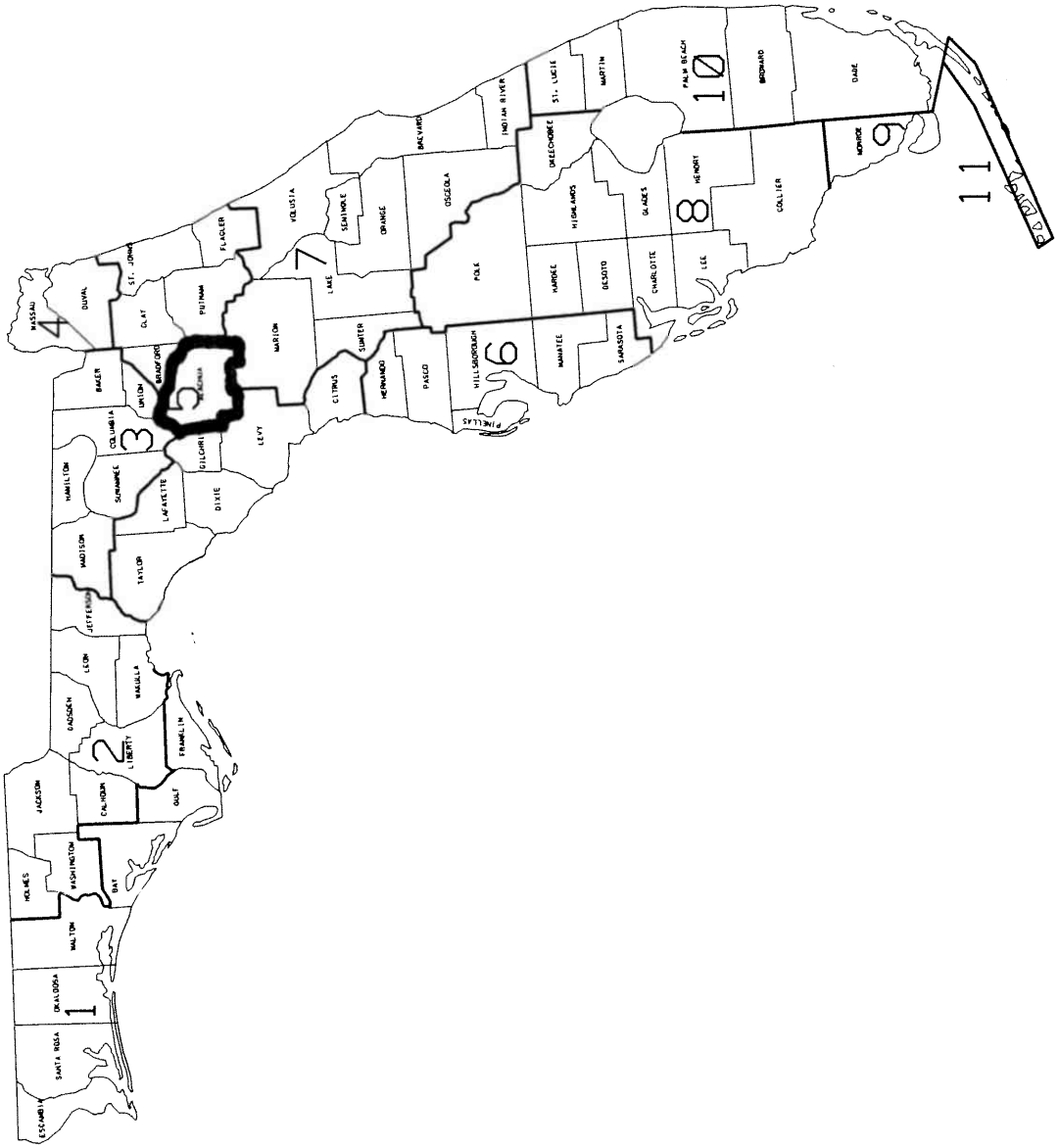
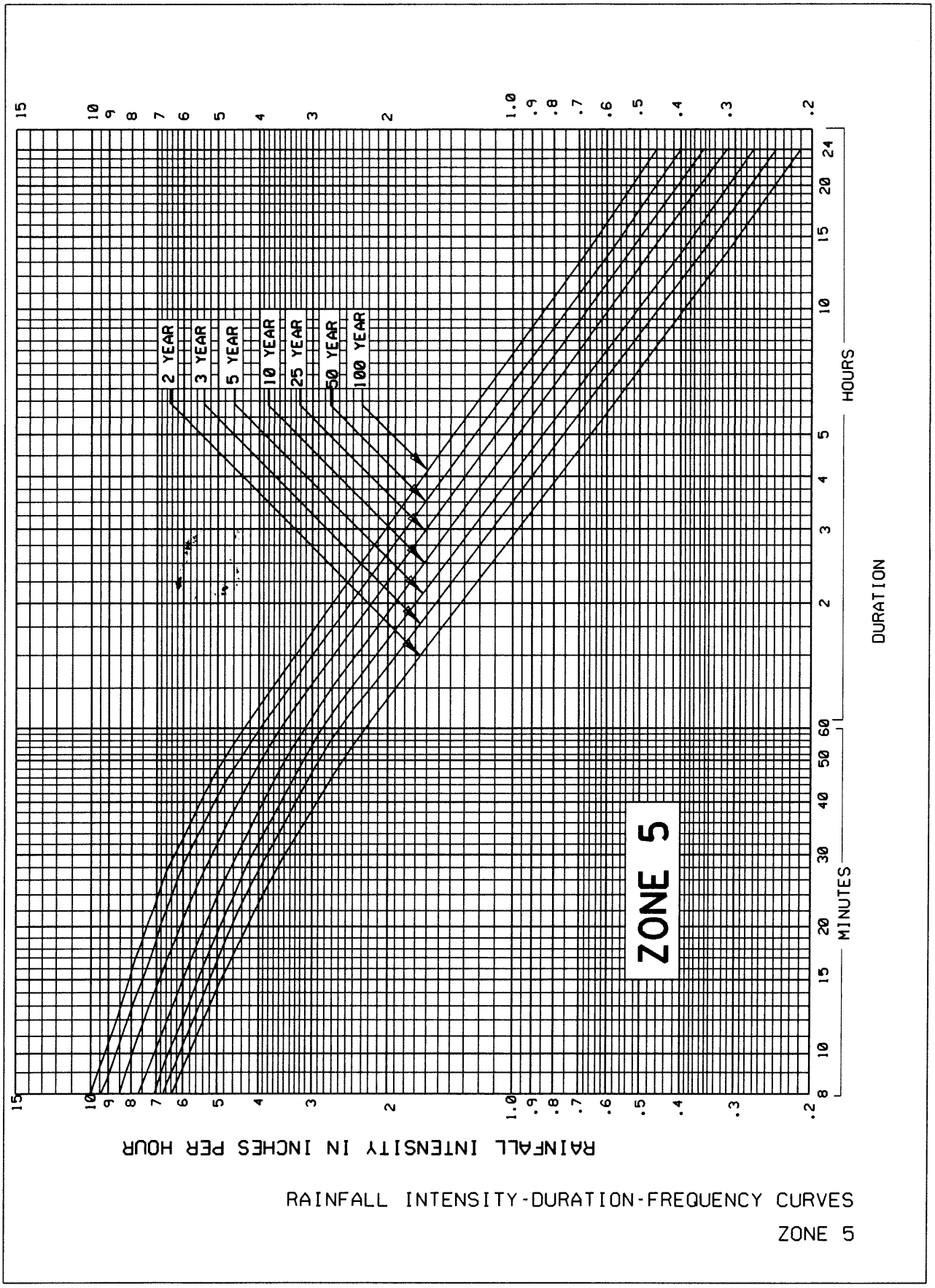

INV 175.50'
INV 175.50'
INV 177.50'
INV 177.50'
INV 176.05'
INV 178.00'
145'-5"
147'-4 11/32"
145'-11 7/8"
139'-10 5/8"
90°-8 21/32"
412'-7 5/8"
94'-5 19/32"
149'-7 25/32"
90°-1 9/16"
15" RCP
30" RCP
36" RCP
MH 27
RIM 180.50'
INV 177.25'
MH 26
RIM 181.75'
INV 178.50'
MH 06
RIM 182.80'
INV 181.30'
MH 09
RIM 182.95'
INV W. 180.24'
INV SE. 179.59'
MH 05
RIM 181.50'
INV W. 178.50'
INV S. 179.23'
MH 02
RIM 182.40'
INV 179.48'
368'-27/32"
600 TPH
MH 11
RIM 184.25'
INV 180.48'
MH 20
RIM 184.00'
INV 180.00'
MH 25
RIM 183.45'
INV WH 176.80'
INV E 178.12'
MH 24
RIM 183.75'
INV 178.82'
MH 19
RIM 184.25'
INV 178.24'
MH 04
RIM 182.40'
INV 179.81'
ELEV 184.50'
ELEV 185.50'
MH 08
RIM 183.40'
INV 180.36'
MH 10
RIM 184.00'
INV 181.00'
MH 23
RIM 183.75'
INV 179.25'
MH 17
RIM 184.25'
W. INV 179.63'
S. INV 179.64'
MH 22
RIM 183.75'
INV 180.75'
MH 01
RIM 182.80'
INV 180.30'
MH 03
RIM 182.90'
INV 180.40'
ELEV 184.00'
MH 14
RIM 184.25'
INV 180.36'
MH 15
RIM 184.25'
INV 180.48'
MH 18
RIM 184.00'
INV 181.00'
MH 07
RIM 183.80'
INV 181.30'
SMH 01
SMH 02
2A
2B
15" HDPE @ 0.25% TYP
15" RCP
57'- 11/32"
111'-7 1/8"

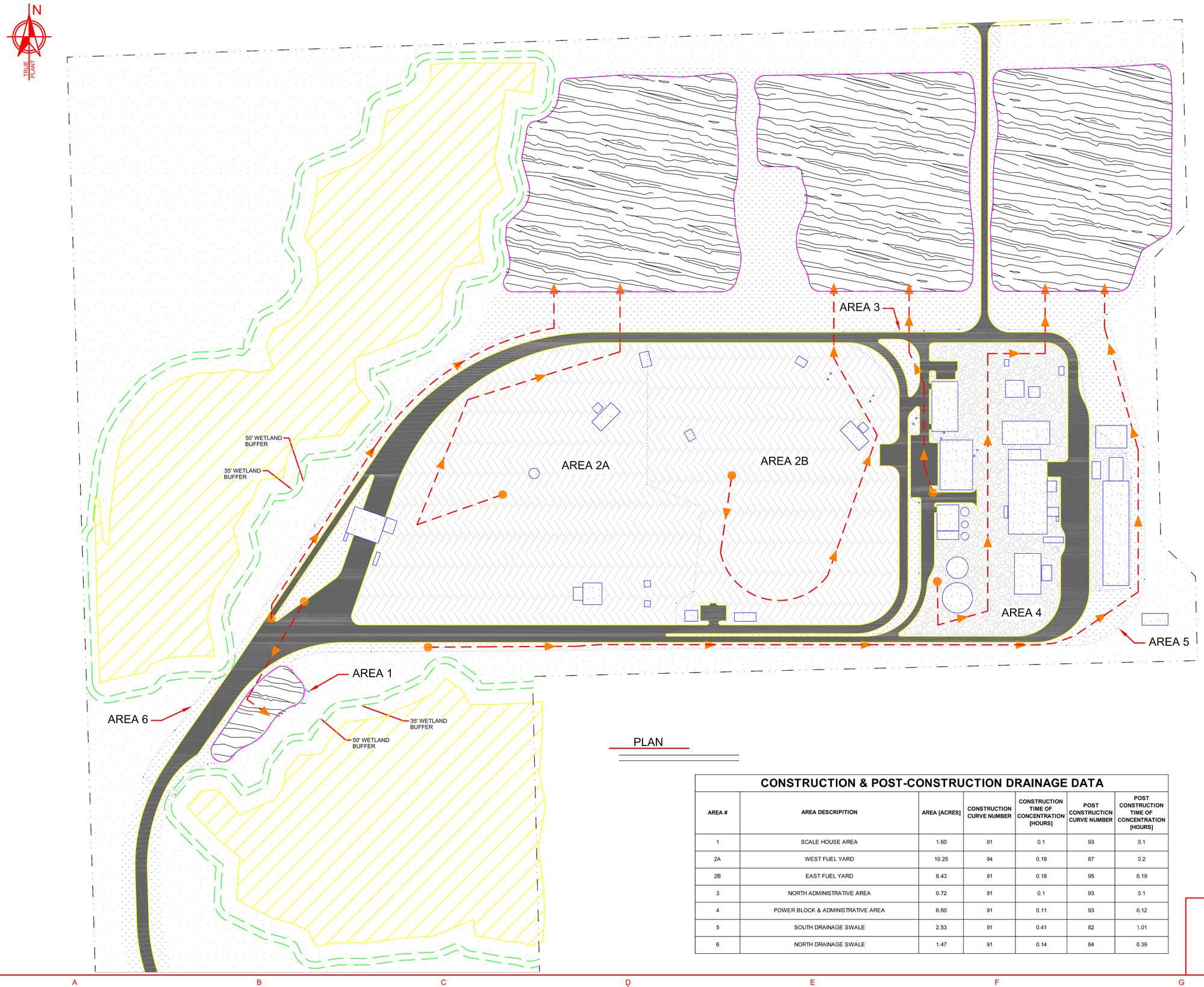
ZONES FOR PRECIPITATION IDF CURVES DEVELOPED BY THE DEPARTMENT





RAINFALL INTENSITY-DURATION-FREQUENCY CURVES

ZONE 5



PLAN

CONSTRUCTION & POST-CONSTRUCTION DRAINAGE DATA

AREA #	AREA DESCRIPTION	AREA [ACRES]	CONSTRUCTION CURVE NUMBER	CONSTRUCTION TIME OF CONCENTRATION [HOURS]	POST CONSTRUCTION CURVE NUMBER	POST CONSTRUCTION TIME OF CONCENTRATION [HOURS]
1	SCALE HOUSE AREA	1.60	91	0.1	93	0.1
2A	WEST FUEL YARD	10.25	94	0.19	87	0.2
2B	EAST FUEL YARD	8.43	91	0.18	95	0.19
3	NORTH ADMINISTRATIVE AREA	0.72	91	0.1	93	0.1
4	POWER BLOCK & ADMINISTRATIVE AREA	6.60	91	0.11	93	0.12
5	SOUTH DRAINAGE SWALE	2.53	91	0.41	82	1.01
6	NORTH DRAINAGE SWALE	1.47	91	0.14	84	0.39

100 0 50 100 150 200
SCALE
SCALE IN FEET

LEGEND

- BITUMINOUS PAVEMENT
- AGGREGATE SURFACE
- WOOD CHIPS
- DITCH / GRASSES
- CONCRETE
- STORMWATER DETENTION BASIN (BY OTHERS)
- WETLANDS
- UNDEVELOPED LAND
- AREA BOUNDARY
- PLANT BOUNDARY
- LONGEST FLOW PATH
- WETLAND BUFFER
- FLOW ARROW
- START OF FLOWLINE

GENERAL NOTES

1. LONGEST FLOW PATH DEFINES LARGEST HYDRAULIC LENGTH IN SUB-AREA

REFERENCE DRAWINGS

1. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; SITE; CONSTRUCTION GRADING; PLAN AND DETAILS; D013756-SRWS10002 SH 01
2. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; SITE; FINAL GRADING; PLAN; D013756-SRWS10003 SH 01

PRELIMINARY
AS OF $$$$$$SYDATE$$$$$$
NOT FOR CONSTRUCTION

NO.	REVISIONS	DATE	DRAWN	DSNED	CHKD	CHKP
C	ISSUED FOR COMMENTS PER CHANGE IN SITE LAYOUT					
B	ISSUED FOR COMMENTS	102609	DMA	DMA	GPL	SDR
A	ISSUED FOR COMMENTS					

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GAINESVILLE RENEWABLE ENERGY CENTER
BIOMASS GENERATING FACILITY
SITE
FINAL & CONSTRUCTION DRAINAGE AREAS
PLAN

DRAWN	DESIGNED	CHECKED	CHECKED
090909	090909	090909	090909
D M ANDERSEN	S D READ	G P LIND	M J PETERSON

APPROVED	DRAWING NUMBER	SHEET	REV
M J PETERSON	D013756-SRWS10001	02	C
APPROVED			

$$USERNAME$$ $$$$$$$$YYMMDD$$$$$$$$ $$DATE$$$$$$ $$$$$$$$$$DESIGNFILE$$$$$$$$$$

N

TRUE PLANT

100 0 50 100 150 200

SCALE

SCALE IN FEET

LEGEND

- UNDERDRAIN (HDPE)
- STORMWATER PIPE REINFORCED CONCRETE PIPE (RCP)
- OUTLET PIPE APRON
- MANHOLE (MH) OR SKIMMER MANHOLE (SMH)
- FLOW ARROW
- EXISTING CONTOUR
- FINAL CONTOUR
- PLANT BOUNDARY
- COVERED BY SCOPE (FOR REFERENCE ONLY)
- STORMWATER BASIN
- WETLAND BUFFER

GENERAL NOTES

1. ALL RCP PIPES ARE AT 0.5% GRADE SLOPE MINIMUM UNO.
2. ALL HPDE PIPES ARE AT 0.25% GRADE SLOPE MINIMUM UNO.
3. TOC FOR FOUNDATIONS ARE 185.00'.
4. EXISTING CONTOURS ARE BASED UPON GENESIS CERTIFIED SURVEY FILE GREC.DWG POSTED 11/06/09.
5. SKIMMER MANHOLES WILL CAPTURE OIL WITH STORMWATER FOR REMOVAL.
6. ALL MANHOLE OUTLET ELEVATIONS ARE AT THE LOWEST INLET ELEVATIONS.

REFERENCE DRAWINGS

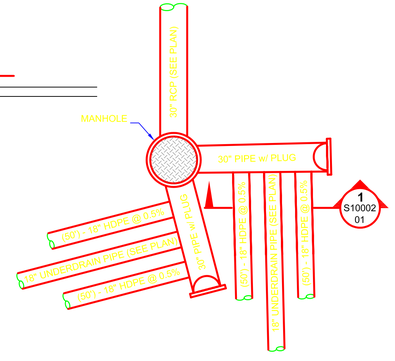
1. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; SITE; EXISTING CONTOURS AND DRAINAGE AREAS PLAN; D013756-SRWS10001 SH 01
2. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; SITE; FINAL & CONSTRUCTION DRAINAGE AREAS PLAN; D013756-SRWS10001 SH 02
3. GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY; SITE; CONSTRUCTION GRADING; PLAN AND DETAILS; D013756-SRWS10002 SH 01

PRELIMINARY

AS OF $$$$$$$SYDATE$$$$$$

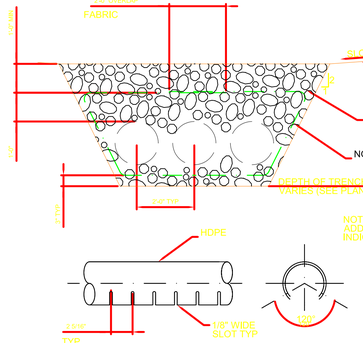
NOT FOR CONSTRUCTION

PLAN



DETAIL A S10002 01

NOT TO SCALE



SECTION 1 S10002 01

NOT TO SCALE

NO	REVISIONS	DATE	DRWN	DSNCD	CHKD	CHKD
C	ISSUED FOR COMMENTS PER CHANGE IN SITE LAYOUT	102609	DMA	DMA	GPL	SDR
B	ISSUED FOR COMMENTS					
A	ISSUED FOR COMMENTS					

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GAINESVILLE RENEWABLE ENERGY CENTER BIOMASS GENERATING FACILITY

SITE
FINAL GRADING
PLAN

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D M ANDERSEN	S D READ	G P LIND	M J PETERSON

APPROVED M J PETERSON

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DRAWING NUMBER D013756-SRWS10003

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