INITIAL RUN-ON AND RUN-OFF CONTROL PLAN
40 C.F.R. PART 257.81
PLANT WANSLEY COAL COMBUSTION BY-PRODUCT PRIVATE INDUSTRY SOLID WASTE DISPOSAL FACILITY (PLANT WANSLEY GYPSUM LANDFILL)
GEORGIA POWER COMPANY

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities" Final Rule (40 C.F.R. Part 257 and Part 261), §257.81, requires the owner or operator of an existing or new CCR landfill, or any lateral expansion of a CCR landfill, to prepare a run-on and run-off control system plan. The purpose of the plan is to demonstrate that the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section of the rule. Each plan is to be supported by appropriate engineering calculations.

The CCR landfill known as the Plant Wansley Gypsum Landfill is located on Plant Wansley property in Heard and Carroll Counties, Carrollton, Georgia. The landfill consists of three constructed cells (numbered 1 thru 3), two constructed sedimentation ponds, and a constructed clean water (return) pond. Each cell is lined with a composite liner system consisting of a 60-mil HDPE liner underlain with a geosynthetic clay liner, and a minimum 24-inch thick compacted clay liner with a maximum hydraulic conductivity of 1×10^{-5} cm/sec. Cells 1 and 2 are currently being utilized for CCR storage, while Cell 3 has been constructed but has not yet been put in service.

Storm water flows used for development of the run-on and run-off control plan were calculated using the Natural Resources Conservation Service (NRCS) method (also known as the Soil Conservation Service (SCS) method) for a 25-yr 24-hr storm event. The stormwater detention system has been designed in accordance with the Georgia Soil and Water Conservation Commission requirements as well as other local, city, and government codes. The post developed storm water discharge was designed to be less than the pre-developed storm water discharge in accordance with the requirements of the State of Georgia.

Runoff curve number data was determined using Table 2-2A from the Urban Hydrology for Small Watersheds (TR-55). Appendix A and B from the TR-55 were used to determine the rainfall distribution methodology. Precipitation values were determined from Technical Paper No. 40*, Rainfall Frequency Atlas of the United States*.

The NRCS provided information on the soil characteristics and hydrologic groups present at the site. It was determined that hydrological group "B" best reflects the characteristics of the soils on site and was used to generate inputs for the calculations. This information was placed into Hydraflow Hydrographs and used to generate appropriate precipitation curves, runoff curve numbers and storm basin runoff values.

Cells 1-3 of the Plant Wansley Gypsum Landfill were designed and constructed with perimeter berms and drainage ditches around the cells that prevent stormwater run-on during the peak discharge of a 24-hr, 25-yr storm from flowing onto the active portion of the landfill. The perimeter berms and drainage ditches also route the stormwater run-off from the cells through the system of sedimentation/clarifying ponds designed to handle the run-off from a 24-hr, 25-yr storm.

Cell 3 of the Plant Wansley Gypsum Landfill has not yet accepted any CCR material; therefore, rainfall that lands within the limits of Cell 3 is routed out of the cell and directly into normal discharge channels. When Cell 3 becomes active, stormwater runoff from Cell 3 will be directed to the North Sedimentation Pond. Stormwater runoff from Cell 1 is directed to and decanted in the South Sedimentation Pond, while stormwater runoff from Cell 2 is directed to and decanted in the North Sedimentation Pond. Decanted water from the two sedimentation ponds is then routed to the return water pond via two 36-inch HDPE pipes. Pumps located in the return water pond are utilized to send water either back to the Plant for use as process water, or to the existing Plant Wansley Ash Pond. Calculations indicate that rainfall occurring during a 24-hr, 25-yr storm is safely stored and passed. This plan is supported by appropriate engineering calculations which are attached.

The facility is operated subject to and in accordance with § 257.3-3 of EPA's regulations.

I hereby certify that the run-on and run-off control system plan meets the requirements of 40 C.F.R. Part 257.81.

10/12/16

James C. Pegues, P.E.

Licensed State of Georgia, PE No. 17419

Run-on and Run-off Control System Plan for Landfills:
Calculation Summary

for

Plant Wansley Gypsum Landfill

Prepared by:

Southern Company Services
Technical Services

Originator: _____ 9/30/2016
Wayne Wang Date

Reviewer: _____ 10/11/16
Jason S. Wilson Date

Approval: _____ 10/12/16
James C. Pegues Date

1.0 Purpose of Calculation

Georgia Power Company's Plant Wansley operates a flue gas desulfurization scrubber which produces gypsum as a byproduct. This gypsum is stored in a stacking disposal area which is comprised of three HDPE lined cells, 2 of which are being currently used. Cell 3 is future capacity and is not currently being used. The calculations attached (August 2009) show that the 100-year, 24-hour storm event is safely passed through the system. The 25-year, 24-hour run-on, run-off event is less than 78% in rain depth of the 100-year event studied in 2009 (6.35 inches/8.15 inches), and thus the 25-year event will be detained and passed safely through the system with more than adequate freeboard.

The purpose of this report is to demonstrate the run-on and run-off controls of the Plant Wansley Gypsum landfill in order to prepare a run-on and run-off control system plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (EPA 40 CFR 257).

Cell 3 has not been used, and stormwater which falls into this open pond area is directly routed out to normal discharge channels. This cell has never held ash, and is currently considered a clean area with no storm detention.

2.0 Summary of Conclusions

2.1 Site Overview/Narrative

Plant Wansley is a coal fired steam generating power plant located in Carrollton, GA . The site of interest is located within the confines of the plant property (Latitude: 33.4151°, Longitude: -85.0424°) and is occupied by three storage cells , sedimentation ponds, a clear pool, multiple outlet control structures, pump houses, and emergency overflow spillway.

The gypsum cells (1-3) were constructed such that surrounding roads and diversion berms and ditches divert stormwater away from these cells, so that only rain which falls directly onto the cells, sedimentation ponds, clean water pond and associated infrastructure is incorporated into the system (no outside drainage).

The calculations indicate that the Plant Wansley gypsum cells 1-3 are capable of storing and then passing a 100-year, 24-hour storm event, which event is more intense and larger in volume than the required 25-year, 24-hour event. The calculations performed for the 100-year storm in 2009 were based upon rain depth data taken from Technical Paper 40, which data has been superseded by data from NOAA Atlas 14 (Precipitation Frequency Data Server, Volume 9, Version 2, Franklin, GA, US; National Oceanic and Atmospheric Administration, National Weather Server). The current NOAA 14 values for rainfall events are less than those from TP40 which were used in these calculations, with the exception of the 2-year storm event . Thus, the calculations attached for the 100-year storm event and runoff reflect events which are more intense and larger in scope than would now be currently calculated, passing the 100-year, 24-hour storm and 25-year, 24-hour storm successfully. A new calculation of the 25-year, 24-hour storm is attached for the system of two cells, connecting ditches, two sedimentation ponds, and the return water pond. This storm event is contained within the sediment pond/return water system below the berm and spillways.

An overview of Plant Wansley Gypsum Landfill Cells 1 and 2 and the sediment ponds is provided in Table 1 below.

Table 1—Landfill Site Characteristics

Pond Description	Storage Cells (Cells 1 and 2)	Sedimentation Pond North	Sedimentation Pond South	Clear Pool
Size (Acres)	71.39	6.53	4.05	1.66
Outlet Type	36 inch HPDE	60” Riser connected to36” pipe	60” Riser connected to 36” pipe	
Outlets To	Cell 1 to South Sed Pond	Clear Pool	Clear Pool	Plant or existing ash pond
	Cell 2 to North Sed Pond			

2.2 Run-on Control System Plan

There is no stormwater run-on into Cells 1-3 because the surrounding roads and perimeter ditches and site grading were all designed to intercept and pass the 100-year, 24-hour storm event run-off away from the cells. For further information on this hydraulic design, see SCS Calculation No. DC-WN-3068DE-001-C01NH, Plant Wansley Gypsum Storage Area, Stormwater Management Calculations, August, 2009.

2.3 Run-off Control System Plan

A hydrologic and hydraulic model was developed for the Plant Wansley Gypsum cells 1 and 2 (cell 3 is not in use, has not been used and is open to freely drain as a clean area) to determine the hydraulic capacity of the cells. The minimum design storm for the purposes of run-off control system plans is the 24-hour, 25-year rainfall event, the calculations performed for design are 100-year, 24-hour, with a rain depth in excess of the 25-year event. New calculations (software run) are attached for the current 25-year, 24-hour storm event also.

The results of routing this design storm event through the landfill system are presented in Table 2 below:

Table 2-Flood Routing (25-year) Results for Plant Wansley Gypsum Landfill

Plant Wansley	Normal Pool El (ft)	Top of embankment El (ft)	Peak Water Surface Elevation (ft	Freeboard* (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
Sed Ponds North and South	Varies	741.1	734.29	6.81	985.91	0 (contained, recycled)

*Freeboard is measured from the top of embankment to the peak water surface elevation

3.0 Assumptions

1. Refer to Title 40 CFR Part 257.81 Hydrologic and hydraulic capacity requirements for CCR surface impoundments.
2. Pond volumetric calculations were determined using design documents and stack storage estimates for the ultimate cell volumes.
3. Other assumptions listed on attached calculation sheets.
4. From August 2009 calculations:

- North and South Sedimentation Ponds and the Return Water Pond are designed to contain a combination of the 100 year-24 hour storm event, 72-hours of plant process flow (in the case of return water pump failure), and the necessary sediment storage.
- Cell #1 decant flows and stormwater runoff will be directed to the South Sedimentation Pond.
- Cell #2 and Cell #3 decant flows and stormwater runoff will be directed to the North Sedimentation Pond.
- North and South Sedimentation Ponds will be connected to the Return Water Pond via 2-36" hdpe corrugated pipes. Pumps at the Return Water Pond will be used to return decanted process water and additional stormwater back to the plant or the existing ash pond and will thereby control the water levels in the ponds.
- All pipes, ditches associated with the "closed system" (gypsum process) shall be designed to convey the 100 year 24-hour storm event.
- All culverts not associated with the "closed system" are designed to convey a minimum 25 year peak flow rate as calculated by the rational method with the 50 year and 100 year flow rates analyzed for overtopping as well.

4.0 Methodology

4.1 HYDROLOGIC ANALYSES

The minimum design storm for all run-on/run-off analyses is a 24-hour, 25-year rainfall event. In August 2009 the pond storm water flows were calculated using the National Resources Conservation Service method (also known as the Soil Conservation Service (SCS) method) using a 100-year, 24-hour design storm. A September, 2016 storm event analysis for the 25 year, 24-hour storm is also attached.

Storm basin calculation information was gathered from a number of sources including the Georgia Stormwater Management Manual and Technical Release 55.

Run-off curve number data was determined using Table 2-2A from the Urban Hydrology for Small Watersheds (TR-55). Curve numbers for the cells and ponds varied from 93 to 95.5.

Appendix B from the TR-55 was used to determine the following:

- Rainfall distribution – Type II

NOAA Atlas 14 was used to determine 24-hour precipitation for the Franklin, GA area (Latitude: 33.4151°, Longitude: -85.0424°)

- Precipitation values (SCS 24-hr precipitation)
  (Attached 2009 calculations show higher values based on using TP-40)
  Based on NOAA Atlas 14:
  - 2-yr – 24-hr = 3.91 in
  - 5-yr – 24-hr = 4.70 in
  - 10-yr – 24-hr = 5.38 in
  - 25-yr – 24-hr = 6.35 in
  - 50-yr – 24-hr = 7.13 in
  - 100-yr – 24-hr = 7.93 in

For the purpose of this evaluation, only the 25-year, 24-hour storm event is being considered. The attached calculations from August 2009 indicate that the cells (1 – 3) are capable of handling the 100-year storm (at that time 8.15 inches).

The National Resources Conservation Service web soil survey was used originally to determine the soil characteristics and hydrologic groups. The map is attached for reference only, since the ponds are constructed such that outside flows do not enter the cells, the surrounding soil types are moot. Soil types in the areas of the cells at the time of construction were:

Cell #1: - AmC Appling sandy loam (6% to 10% slopes), CfC2 Cecil sandy loam (6% to 10% slopes), CfD2 Cecil sandy loam (10% to 15% slopes) and AkB Altivista fine sandy loam (2% to 6% slopes).

Cell #2: - MdE Madison gravelly sandy loam (15% to 25% slopes) and MfD2 Madison gravelly sandy clay loam (10% to 15% slopes).

Cell #3: - MdE Madison gravelly sandy loam (15% to 25% slopes), AmB Appling sandy loam (2% to 6% slopes), AmC Appling sandy loam (6% to 10% slopes), MfD2 Madison gravelly sandy clay loam (10% to 15% slopes), and PUF Pacolet soils (15% to 40% slopes).

Sediment and Return Water Ponds: - CfC2 Cecil sandy loam (6% to 10% slopes) and MdE Madison gravelly sandy loam (15% to 25% slopes).

A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 3.

Table 3. Plant Wansley Gypsum Landfill Design Storm Distribution

Return Frequency (years)	Storm Duration (hours)	Rainfall Total (Inches)	Rainfall Source	Storm Distribution
25	24	6.35	NOAA Atlas 14	SCS Type II
100	24	8.15 (2009) 7.93 (2016)	NOAA Atlas 14	SCS Type II

The drainage area for the Plant Wansley Gypsum Landfill was delineated based on LiDAR data acquired for the Plant in 2016. Run-off characteristics were developed based on the Soil Conservation Service (SCS) methodologies as outlined in TR-55. An overall SCS curve number for the drainage area was developed based on methods prescribed in TR-55. Soil types were obtained from the Natural Resources Conservation Service. Land use areas were delineated based on aerial photography. Time of Concentration and Lag Time calculations were also developed based on methodologies prescribed in TR-55.

A table of the pertinent basin characteristics of the Gypsum Landfill is provided below in Table 4(a):

Table 4—Landfill Hydrologic Information

Drainage Basin Area (acres)	83.63 overall
Hydrologic Curve Number, CN	95.3 overall
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	5 minutes used
Lag Time (minutes)	3
Hydrologic Software	Hydraflow Hydrographs

4.2 HYDRAULIC ANALYSES

Storage values for the landfill were determined by developing a stage-storage relationship utilizing contour data. The spillway system at the Plant Wansley Gypsum Landfill consists of a primary spillway and an auxiliary spillway. The primary spillway acts as a broad crested weir 20 feet in length. The top of the primary spillway is elevation 739.36 (top of berm is 741.1). The spillway is 2 feet deep and 20 feet in width. The top of the secondary spillway is elevation 739.40. The spillway is 2 feet deep and 15 feet in width.

Table 5—Spillway Attribute Table

Spillway Component	US Invert El (feet)	DS Invert El (feet)	Dimension (ft)	Slope (ft/ft)	Length (ft)	Spillway Capacity (cfs)
Primary	739.36	700.0	20	31.7%	140	1,880
Secondary	739.4	700	15	31.8%	140	1450

Based on the spillway attributes listed above, a rating curve was developed to determine the pond performance during the design storm. Results are shown in Table 2. The 100-year routing results are shown in the calculations below.

5.0 SUPPORTING INFORMATION

25 YEAR

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	373.68	1	717	876,334	------	------	------	Cell #2
2	SCS Runoff	76.16	1	719	192,219	------	------	------	Cell#2 Perimeter Ditch
3	SCS Runoff	60.09	1	717	138,800	------	------	------	North Sed. Pond Area
4	SCS Runoff	15.10	1	717	34,353	------	------	------	Return Pond Area
5	SCS Runoff	289.26	1	717	678,375	------	------	------	Cell #1
6	SCS Runoff	37.61	1	717	88,200	------	------	------	South Sed. Pond Area
7	Combine	326.87	1	717	766,574	5, 6	------	------	Combine Cell#1 & S. Sed. Pond
8	Combine	445.98	1	717	1,068,553	1, 2,	------	------	Combine Cell 2 & Perim. Ditch
9	Combine	506.07	1	717	1,207,353	3, 8	------	------	Combine Cell#2 & N. Sed. Pond
10	Combine	848.04	1	717	2,008,281	4, 7, 9	------	------	Comb Sed. Ponds & Ret Wtr
11	Reservoir	0.000	1	n/a	0	10	733.57	2,008,282	Comb Sed Ponds & Ret W

WANSLEY

Hydrograph Report

2.5 YEAR

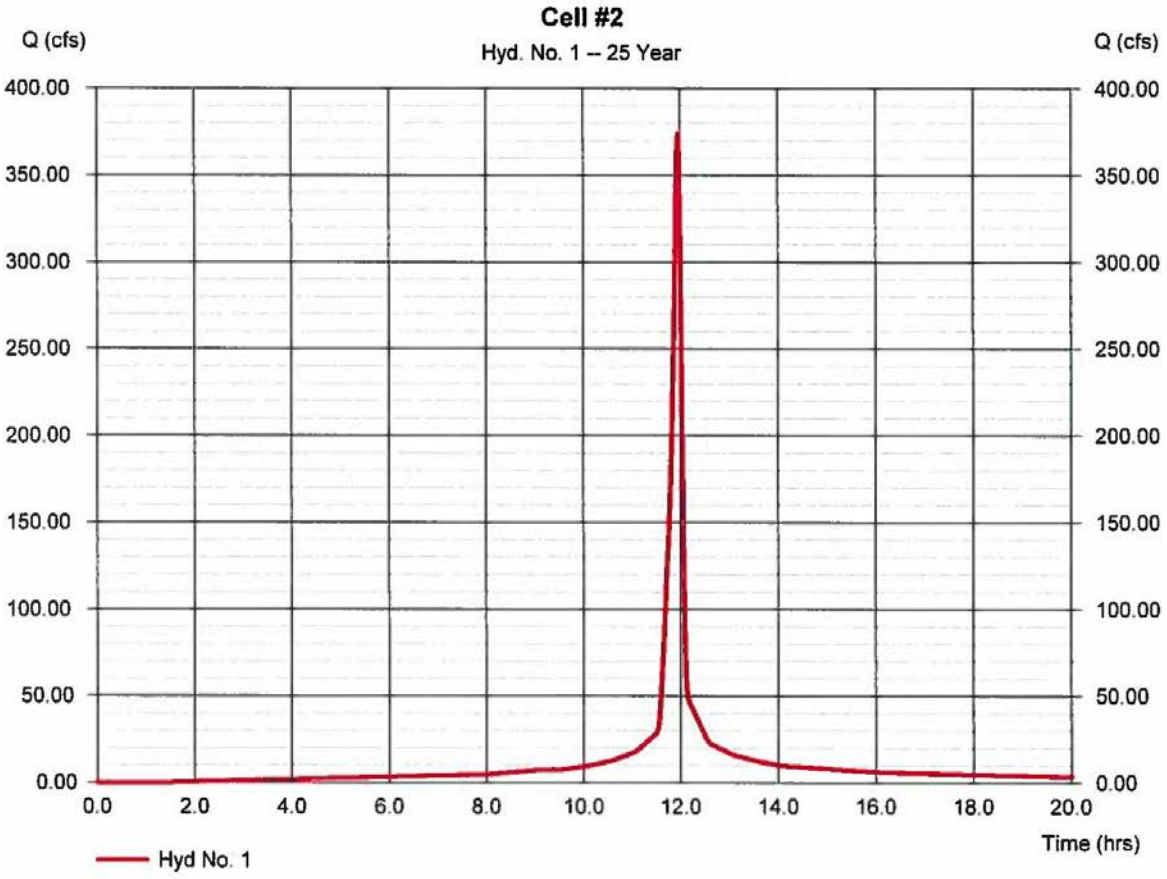
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Friday, 09 / 30 / 2016

Hyd. No. 1

Cell #2

Hydrograph type	= SCS Runoff	Peak discharge	= 373.68 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 876,334 cuft
Drainage area	= 40.240 ac	Curve number	= 95.5
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.35 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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Hydrograph Report

25 YEAR

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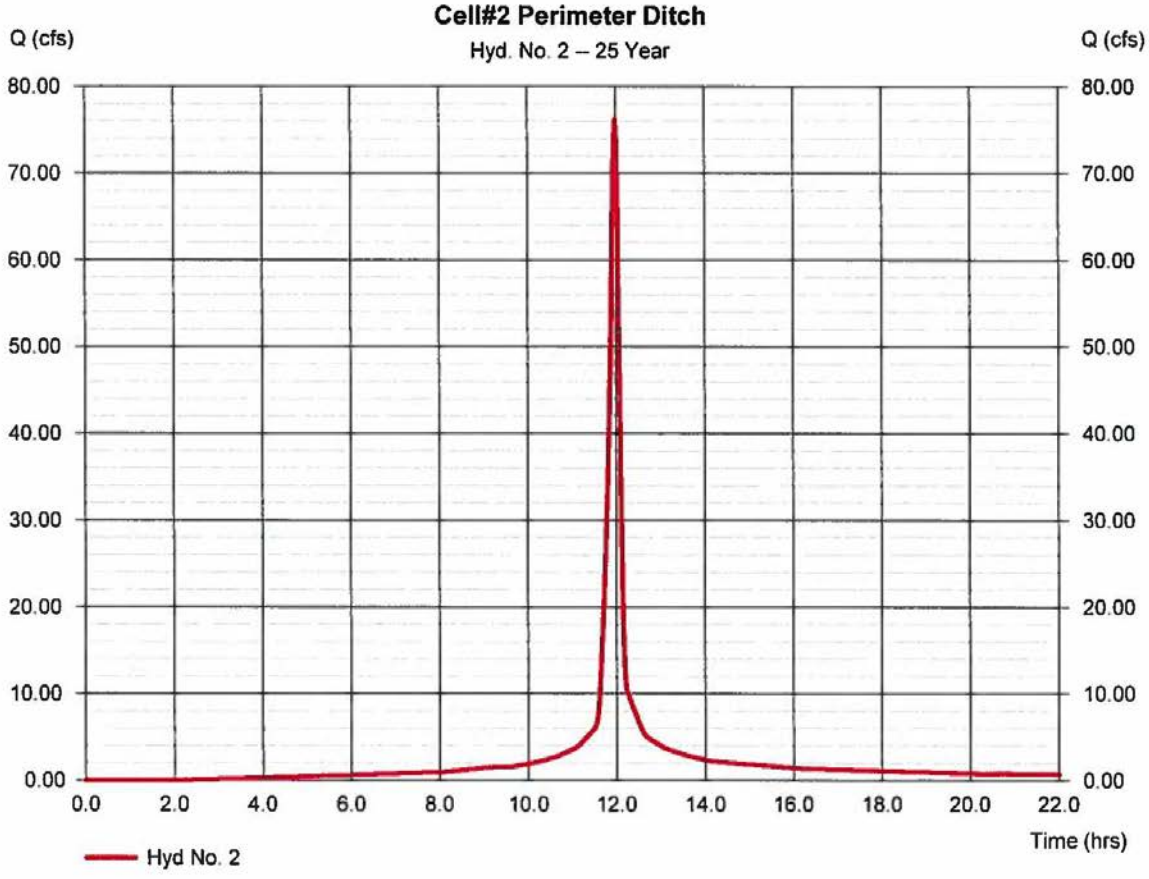
Hyd. No. 2

Cell#2 Perimeter Ditch

Hydrograph type	= SCS Runoff	Peak discharge	= 76.16 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 192,219 cuft
Drainage area	= 9.480 ac	Curve number	= 93.5
Basin Slope	= 1.6 %	Hydraulic length	= 2915 ft
Tc method	= TR55	Time of conc. (Tc)	= 9.60 min
Total precip.	= 6.35 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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25 YEAR

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Friday, 09 / 30 / 2016

Hyd. No. 3

North Sed. Pond Area

Hydrograph type	= SCS Runoff	Peak discharge	= 60.09 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 138,800 cuft
Drainage area	= 6.530 ac	Curve number	= 94.3
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
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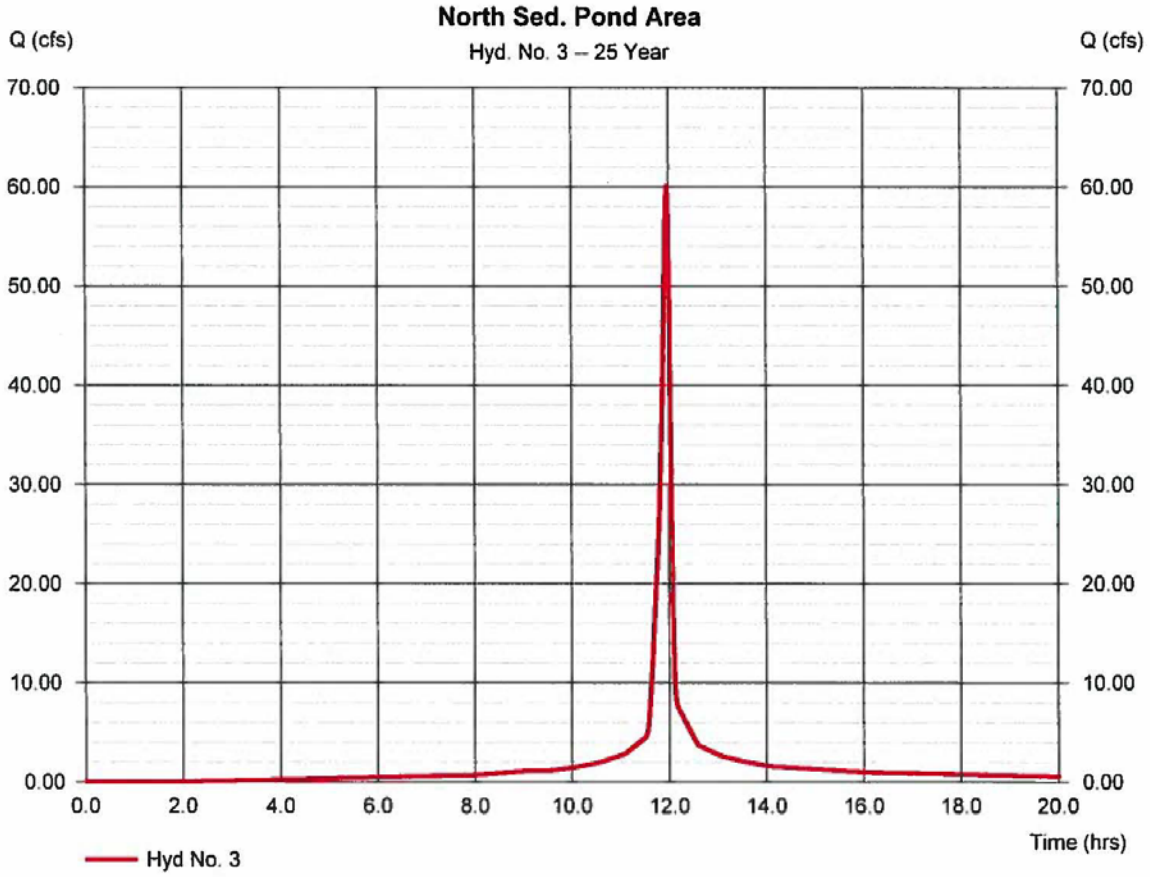
Total precip.	= 6.35 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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Hydrograph Report

25 YEAR

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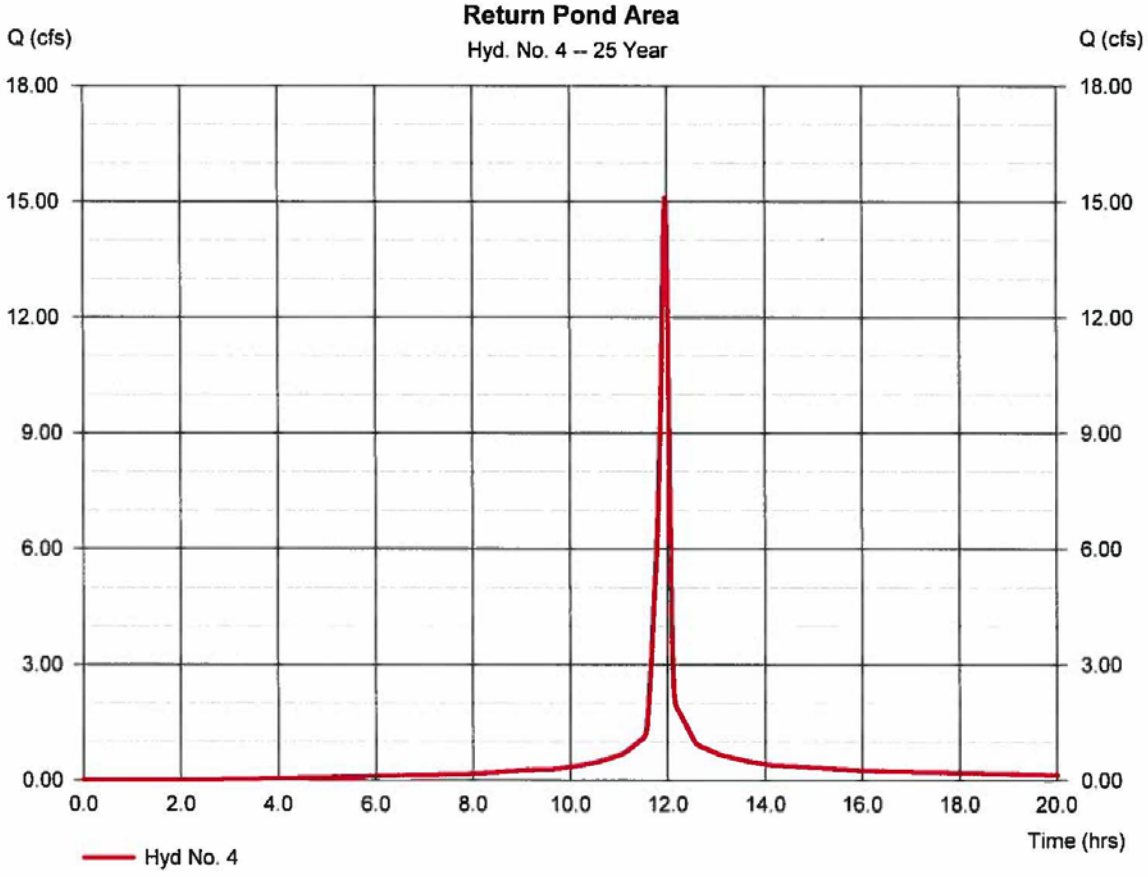
Hyd. No. 4

Return Pond Area

Hydrograph type	= SCS Runoff	Peak discharge	= 15.10 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 34,353 cuft
Drainage area	= 1.660 ac	Curve number	= 93
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	=	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.35 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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Hydrograph Report

25 YEAR

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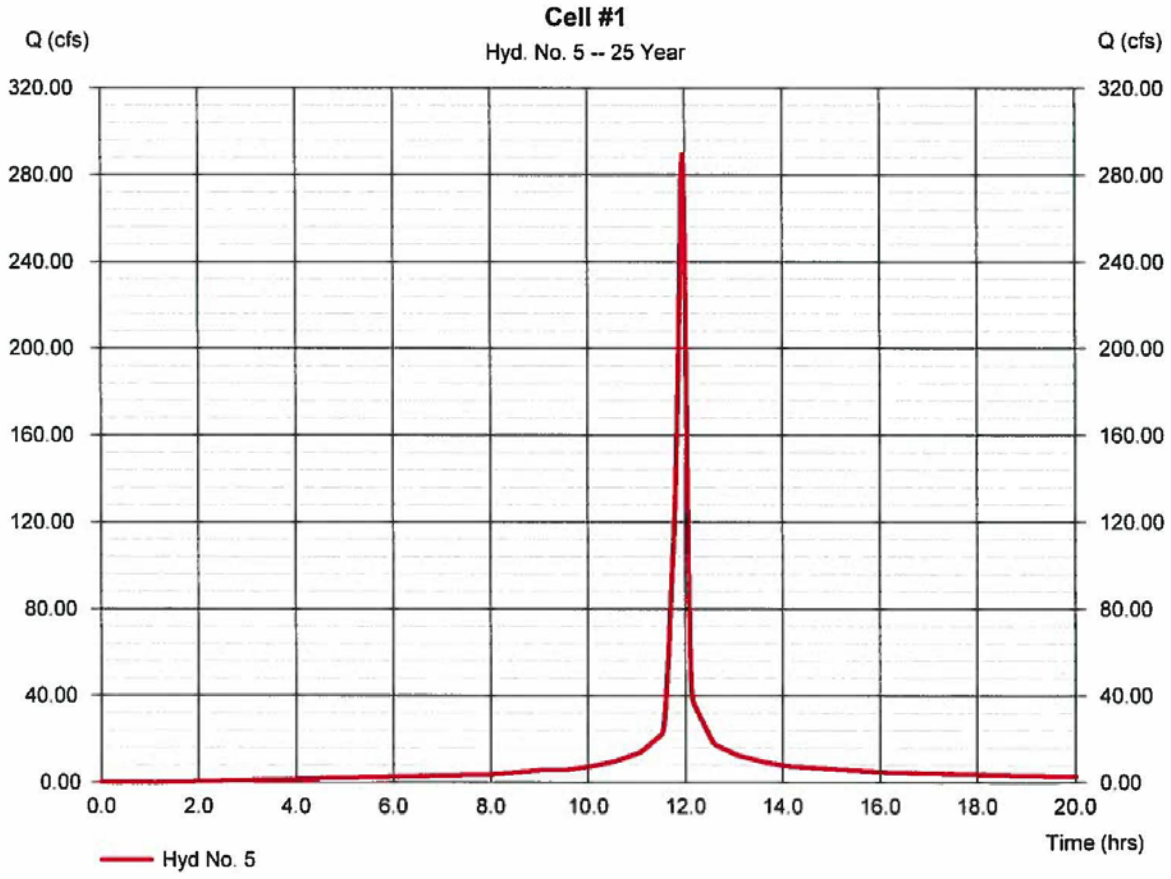
Hyd. No. 5

Cell #1

Hydrograph type	= SCS Runoff	Peak discharge	= 289.26 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 678,375 cuft
Drainage area	= 31.150 ac	Curve number	= 95.5
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.35 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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25 YEAR

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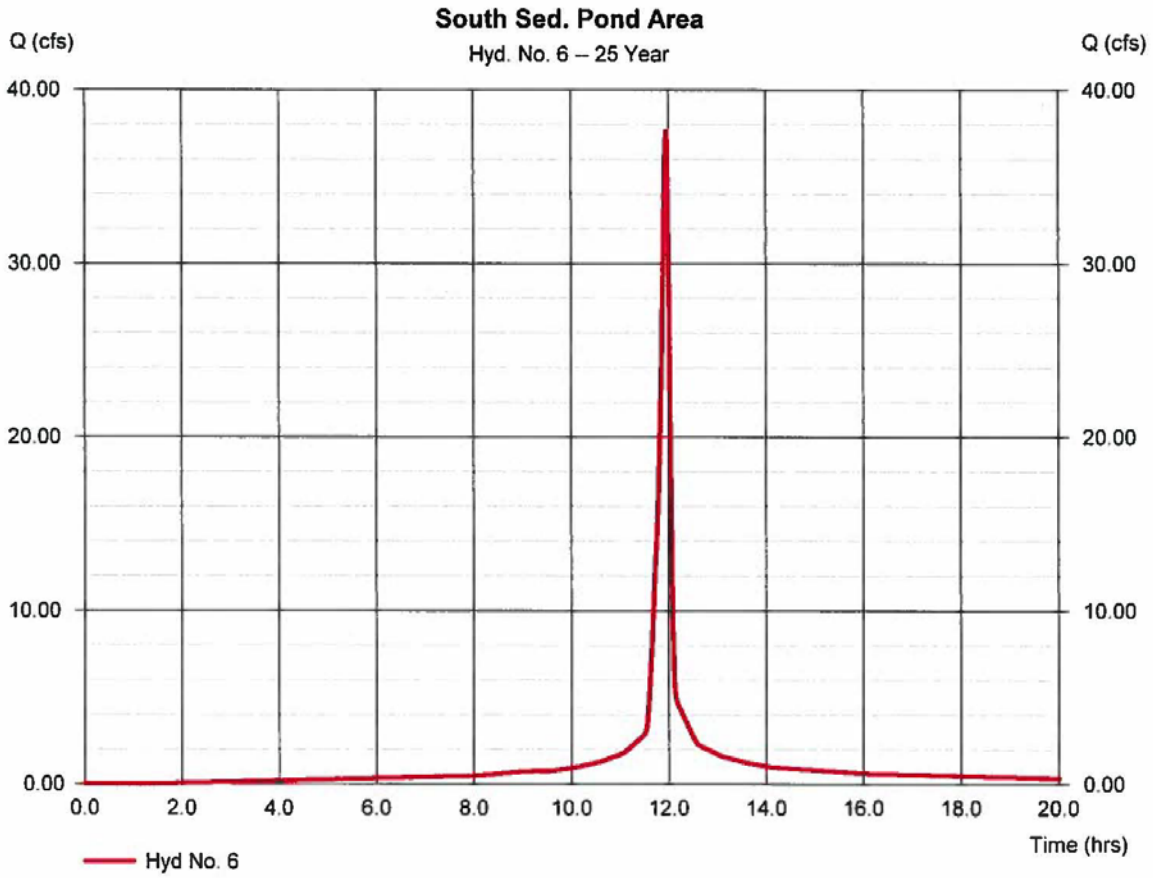
Hyd. No. 6

South Sed. Pond Area

Hydrograph type	= SCS Runoff	Peak discharge	= 37.61 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 88,200 cuft
Drainage area	= 4.050 ac	Curve number	= 95.5
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	=	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.35 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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Hydrograph Report

25 YEAR

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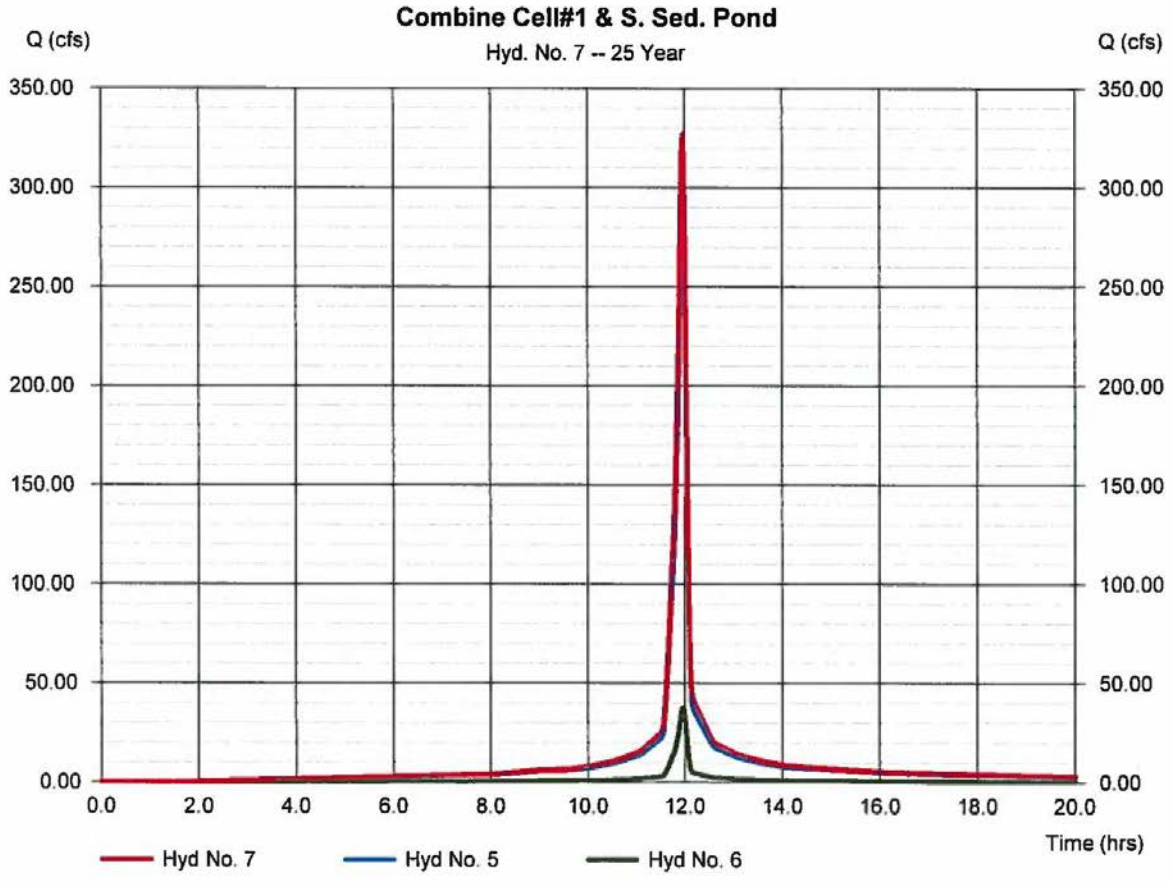
Friday, 09 / 30 / 2016

Hyd. No. 7

Combine Cell#1 & S. Sed. Pond

Hydrograph type	= Combine	Peak discharge	= 326.87 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 766,574 cuft
Inflow hyds.	= 5, 6	Contrib. drain. area	= 35.200 ac



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25 YEAR

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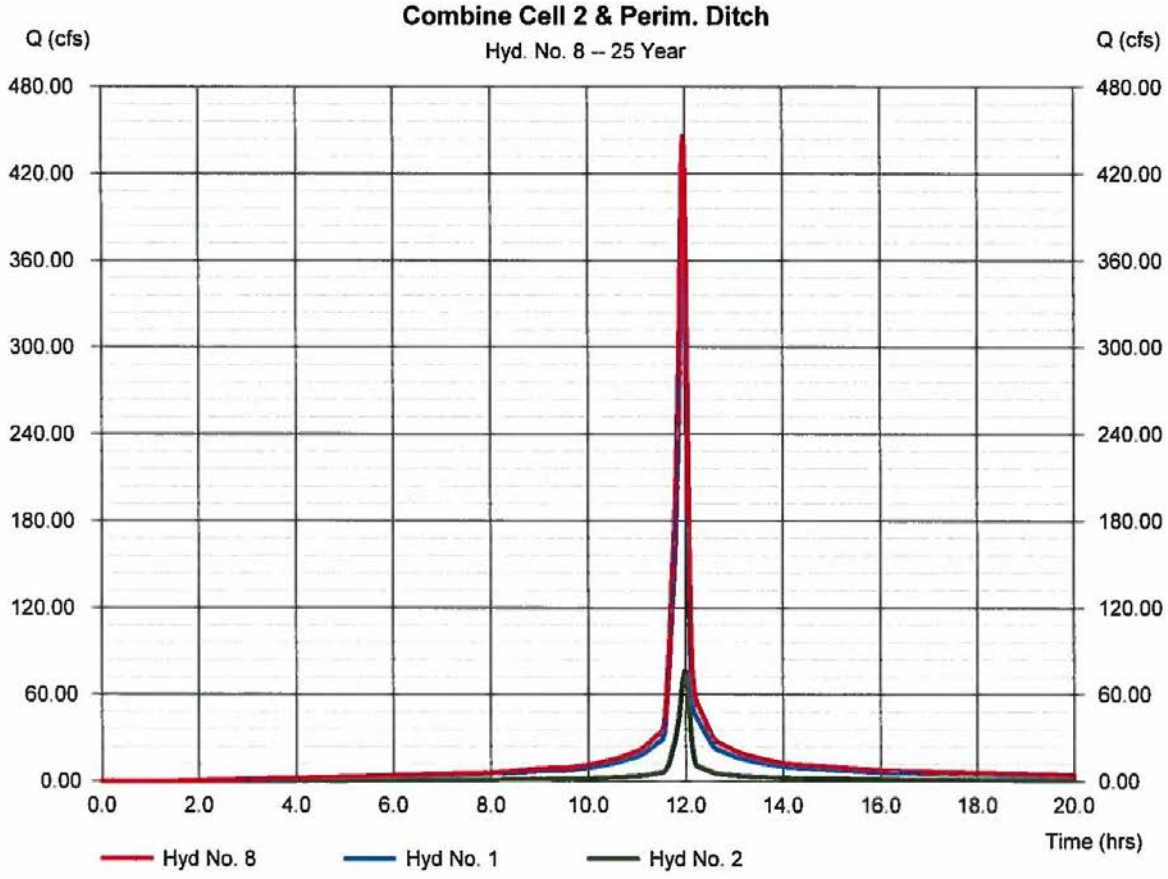
Friday, 09 / 30 / 2016

Hyd. No. 8

Combine Cell 2 & Perim. Ditch

Hydrograph type	= Combine	Peak discharge	= 445.98 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 1,068,553 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 49.720 ac



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25 YEAR

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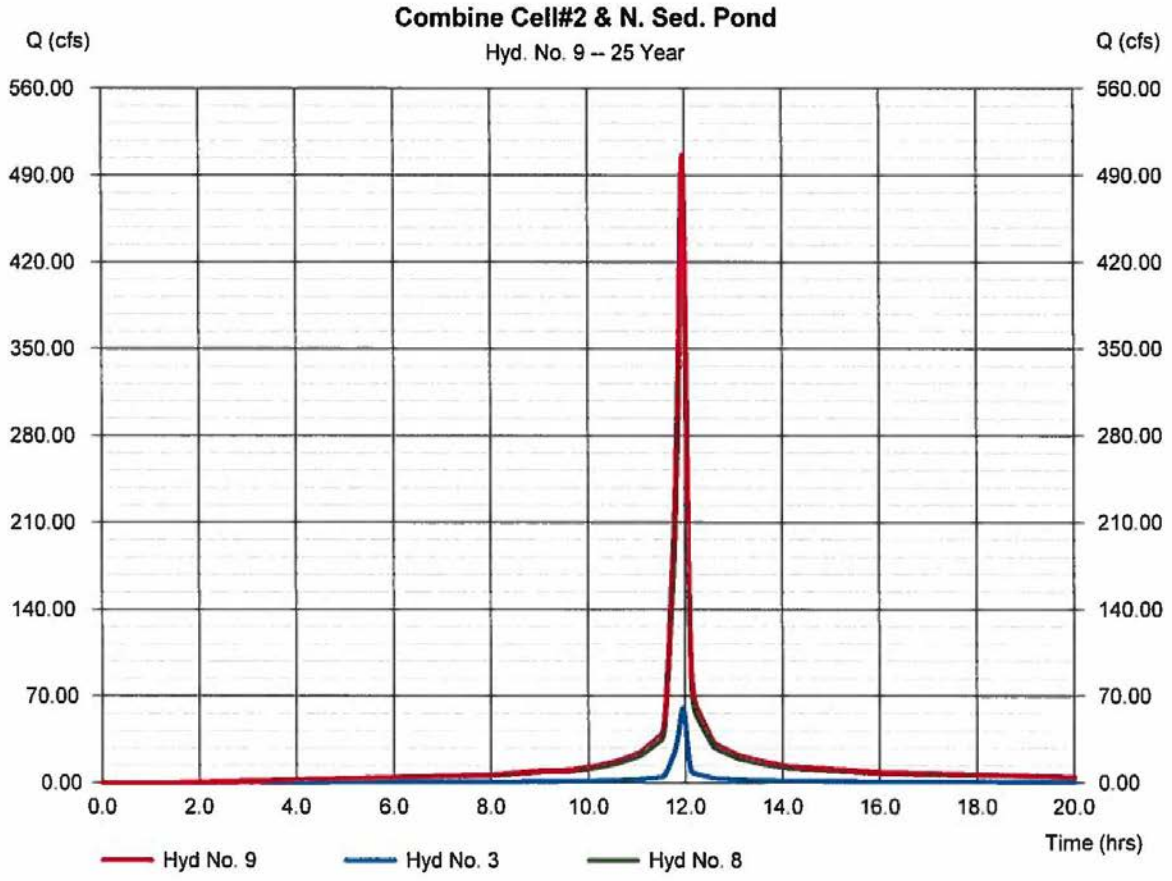
Friday, 09 / 30 / 2016

Hyd. No. 9

Combine Cell#2 & N. Sed. Pond

Hydrograph type	= Combine	Peak discharge	= 506.07 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 1,207,353 cuft
Inflow hyds.	= 3, 8	Contrib. drain. area	= 6.530 ac



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Hydrograph Report

25 YEAR

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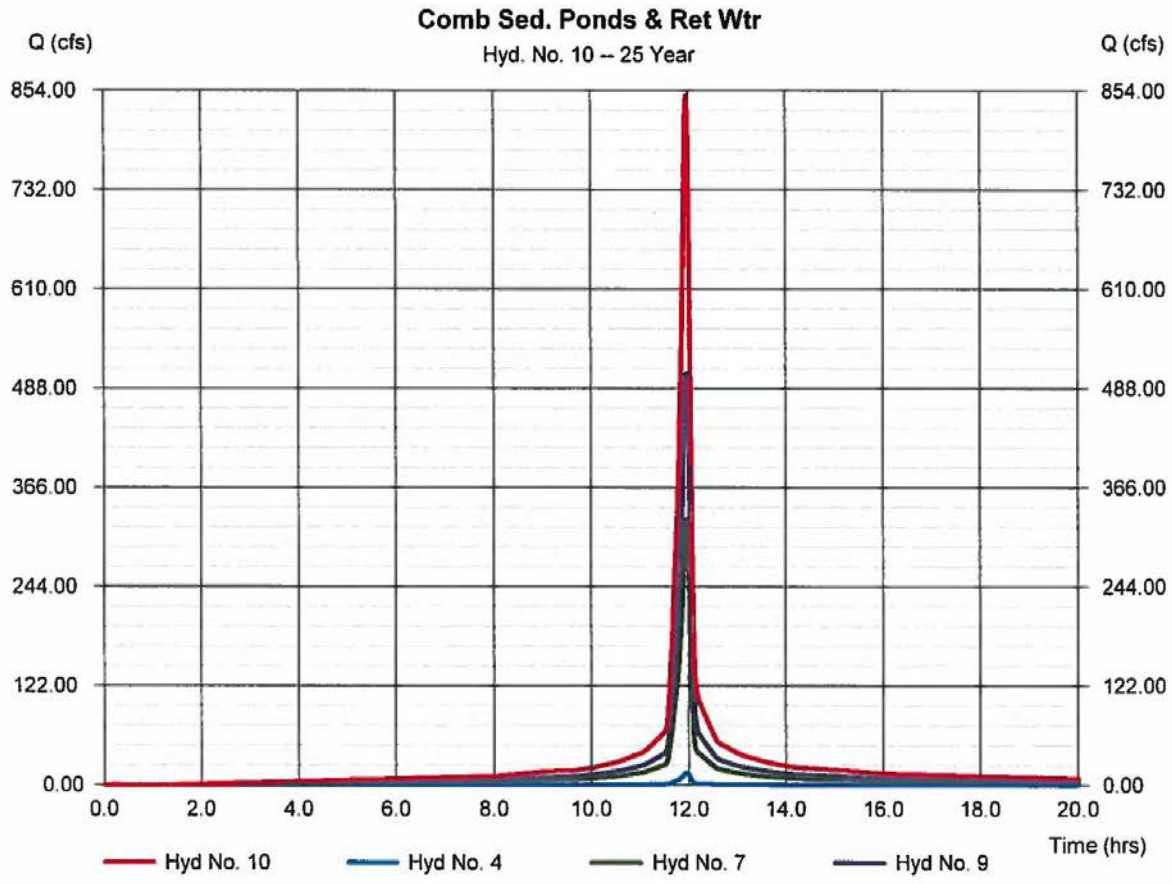
Friday, 09 / 30 / 2016

Hyd. No. 10

Comb Sed. Ponds & Ret Wtr

Hydrograph type	= Combine	Peak discharge	= 848.04 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 2,008,281 cuft
Inflow hyds.	= 4, 7, 9	Contrib. drain. area	= 1.660 ac



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Hydrograph Report

25 YEAR

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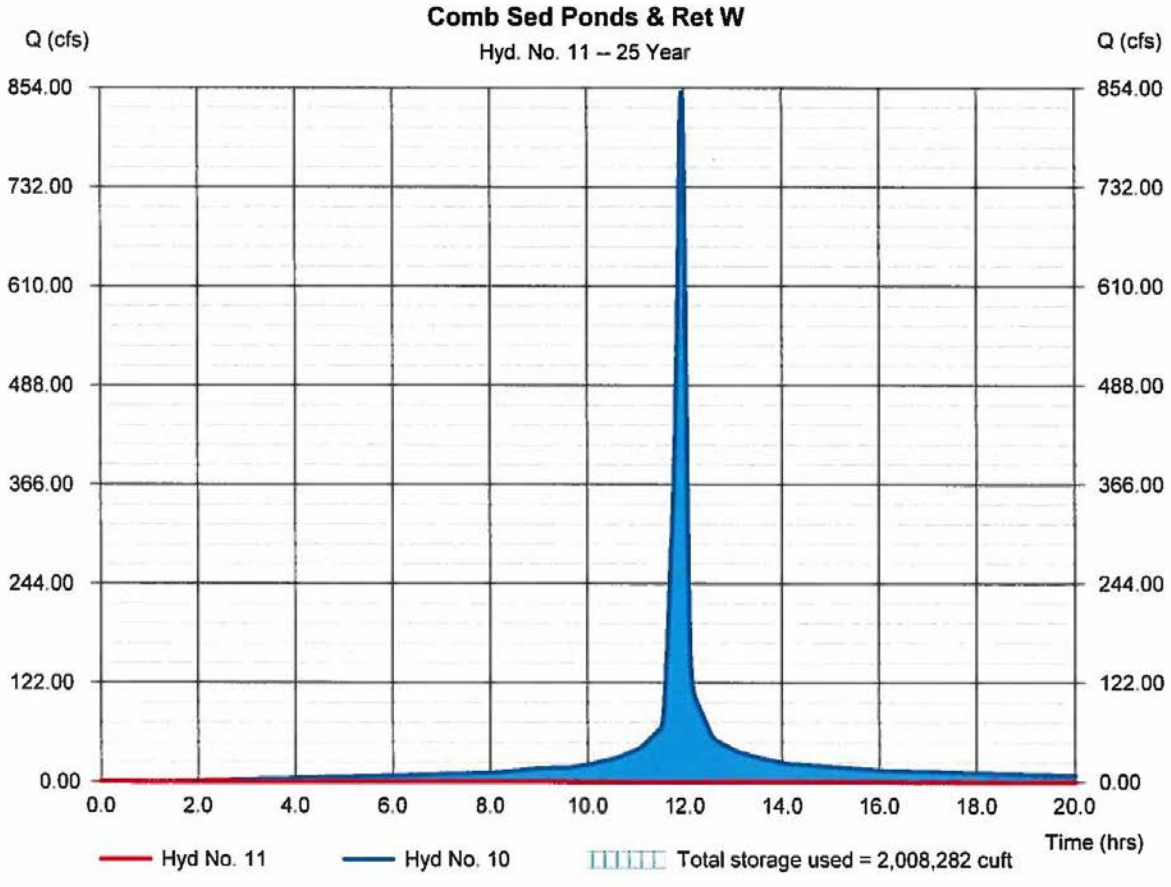
Friday, 09 / 30 / 2016

Hyd. No. 11

Comb Sed Ponds & Ret W

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 10 - Comb Sed. Ponds & Ret W	Max. Elevation	= 733.57 ft <
Reservoir name	= Sed. & Ret. Wtr. Ponds	Max. Storage	= 2,008,282 cuft

Storage Indication method used.



WAWSLEY

Pond Report

25 YEAR

Pond No. 3 - Sed. & Ret. Wtr. Ponds

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	725.50	n/a	0	0
0.50	726.00	n/a	97,602	97,602
2.50	728.00	n/a	427,884	525,486
3.50	729.00	n/a	235,740	761,226
4.50	730.00	n/a	248,349	1,009,575
9.50	735.00	n/a	1,397,925	2,407,500
13.50	739.00	n/a	1,311,056	3,718,556
13.86	739.36	n/a	126,645	3,845,201
14.50	740.00	n/a	228,764	4,073,965
15.50	741.00	n/a	366,780	4,440,745
15.86	741.36	n/a	134,838	4,575,583

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 20.00	15.00	0.00	0.00
Crest El. (ft)	= 739.36	739.40	0.00	0.00
Weir Coeff.	= 2.60	2.60	3.33	3.33
Weir Type	= Broad	Broad	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	725.50	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.50	97,602	726.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
2.50	525,486	728.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
3.50	761,226	729.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
4.50	1,009,575	730.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
9.50	2,407,500	735.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
13.50	3,718,556	739.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
13.86	3,845,201	739.36	---	---	---	---	0.00	0.00	---	---	---	---	0.000
14.50	4,073,965	740.00	---	---	---	---	26.62	18.12	---	---	---	---	44.75
15.50	4,440,745	741.00	---	---	---	---	109.21	78.93	---	---	---	---	188.14
15.86	4,575,583	741.36	---	---	---	---	147.08	107.01	---	---	---	---	254.09

WANSLEY

Hydrograph Summary Report

25 YEAR

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	434.16	1	717	1,026,326	------	------	------	Cell #2
2	SCS Runoff	88.81	1	719	226,327	------	------	------	Cell#2 Perimeter Ditch
3	SCS Runoff	69.96	1	717	163,078	------	------	------	North Sed. Pond Area
4	SCS Runoff	17.62	1	717	40,504	------	------	------	Return Pond Area
5	SCS Runoff	336.08	1	717	794,485	------	------	------	Cell #1
6	SCS Runoff	43.70	1	717	103,296	------	------	------	South Sed. Pond Area
7	Combine	379.78	1	717	897,781	5, 6	------	------	Combine Cell#1 & S. Sed. Pond
8	Combine	518.55	1	717	1,252,647	1, 2,	------	------	Combine Cell 2 & Perim. Ditch
9	Combine	588.51	1	717	1,415,731	3, 8	------	------	Combine Cell#2 & N. Sed. Pond
10	Combine	985.91	1	717	2,354,018	4, 7, 9	------	------	Comb Sed. Ponds & Ret Wtr
11	Reservoir	0.000	1	n/a	0	10	734.81	2,354,015	Comb Sed Ponds & Ret W

WANSLEY

2009 CALCS

Body of Calculation

(See attached calculations with software input/output.)

Rainfall Runoff Coefficients, Curve No.'s, Etc..
Soils/Geotech Data
Process System - Sedimentation & Return Water Pond Design
Process System – Culvert/Pipe Design
Perimeter Ditch Design (Includes Concrete Drop Structures)
Decant Siphon Design
Leachate Collection & Remove System
Final Cap Drainage and Concrete Flume Design
Stormwater Culvert Design (Non-Process Flows)
Temporary Sediment Basins (Non-Process Flows)

Attachments

- Runoff Curve No.'s & Coefficient Values, Georgia Stormwater Manage Manual
- Runoff Coefficient Values, Southern Company Services, Engineering Standards and Guidelines
- TP-40 24 hr. Rainfall Maps, Georgia Stormwater Management Manual
- Hydro 35 Precipitation Maps, Intellisolve, AutoDesk
- USDA NRCS Soil Maps & Data
- Case 1 Drainage Map
- Case 2 Drainage Map
- Cell #3 Perimeter Pipes Drainage Map
- Sedimentation & Erosion Control Drainage Map, (SK-Phase1)
- Sedimentation & Erosion Control Drainage Map, (SK-Phase1A)
- Sedimentation & Erosion Control Drainage Map, (SK-Phase3)
- Erosion Control Sections & Details, Sheet 2, (H1C11150)
- Culverts C-1 Thru C-11 Drainage Map
- Culvert C-12 Drainage Map

2009 CALCS

Manning's n-Values

Previous Top

Description	Manning's "n"
Pipes	
Reinforced concrete	0.013
Vitrified clay pipe	0.013
Smooth welded pipe	0.011
Corrugated metal pipe	0.023
Polyvinyl chloride (PVC)	0.010
Natural Channels	
Gravel beds, Straight	0.025
Gravel beds, large boulders	0.040
Earth, straight, some grass	0.026
Earth, winding, no vegetation	0.030
Earth, winding	0.050
Miscellaneous	
Smooth surfaces (concrete, asphalt, bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils	0.06-0.17
Short grass	0.15
Dense grass	0.24 ← TOP OF GYPSUM STACKS
Bermuda grass	0.41
Light underbrush woods	0.40
Dense underbrush woods	0.80

Table 2.1.5-1 Runoff Curve Numbers[1]

Cover description *Cover type and hydrologic condition*	*Average percent impervious area*[2]	Curve numbers for hydrologic soil groups A	B	C	D
Cultivated land: without conservation treatment		72	81	88	91
with conservation treatment		62	71	78	81
Pasture or range land: poor condition		68	79	86	89
good condition		39	61	74	80
Meadow: good condition		30	58	71	78
Wood or forest land: thin stand, poor cover		45	66	77	83
good cover		25	55	70	77
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]					
Poor condition (grass cover <50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm drains (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85%	89	92	94	95
Industrial	72%	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65%	77	85	90	92
1/4 acre	38%	61	75	83	87
1/3 acre	30%	57	72	81	86
1/2 acre	25%	54	70	80	85
1 acre	20%	51	68	79	84
2 acres	12%	46	65	77	82
Developing urban areas and Newly graded areas (pervious areas only, no vegetation)		77	86	91	94

GYPSUM

86

[1] Average runoff condition, and $I_a = 0.2S$

[2] The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. If the impervious area is not connected, the SCS method has an adjustment to reduce the effect.

[3] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

Table 2.1.4-2 Recommended Runoff Coefficient Values

Description of Area	Runoff Coefficients (C)
Lawns:	
Sandy soil, flat, 2%	0.10
Sandy soil, average, 2 - 7%	0.15
Sandy soil, steep, > 7%	0.20
Clay soil, flat, 2%	0.17
Clay soil, average, 2 - 7%	0.22
Clay soil, steep, > 7%	0.35
Unimproved areas (forest)	0.15
Business:	
Downtown areas	0.95
Neighborhood areas	0.70
Residential:	
Single-family areas	0.50
Multi-units, detached	0.60
Multi-units, attached	0.70
Suburban	0.40
Apartment dwelling areas	0.70
Industrial:	
Light areas	0.70
Heavy areas	0.80
Parks, cemeteries	0.25
Playgrounds	0.35
Railroad yard areas	0.40
Streets:	
Asphalt and Concrete	0.95
Brick	0.85
Drives, walks, and roofs	0.95
Gravel areas	0.50
Graded or no plant cover	
Sandy soil, flat, 0 - 5%	0.30
Sandy soil, flat, 5 - 10%	0.40
Clayey soil, flat, 0 - 5%	0.50
Clayey soil, average, 5 - 10%	0.60

2009 CALCS

Pg 4 of 561

TABLE 1
RUNOFF COEFFICIENTS, C

Description of Area	Runoff Coefficients
Business	
Downtown	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single-family	0.30 to 0.50
Multi-units, detached	0.40 to 0.60
Multi-units, attached	0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yard	0.20 to 0.35
Unimproved	0.10 to 0.30

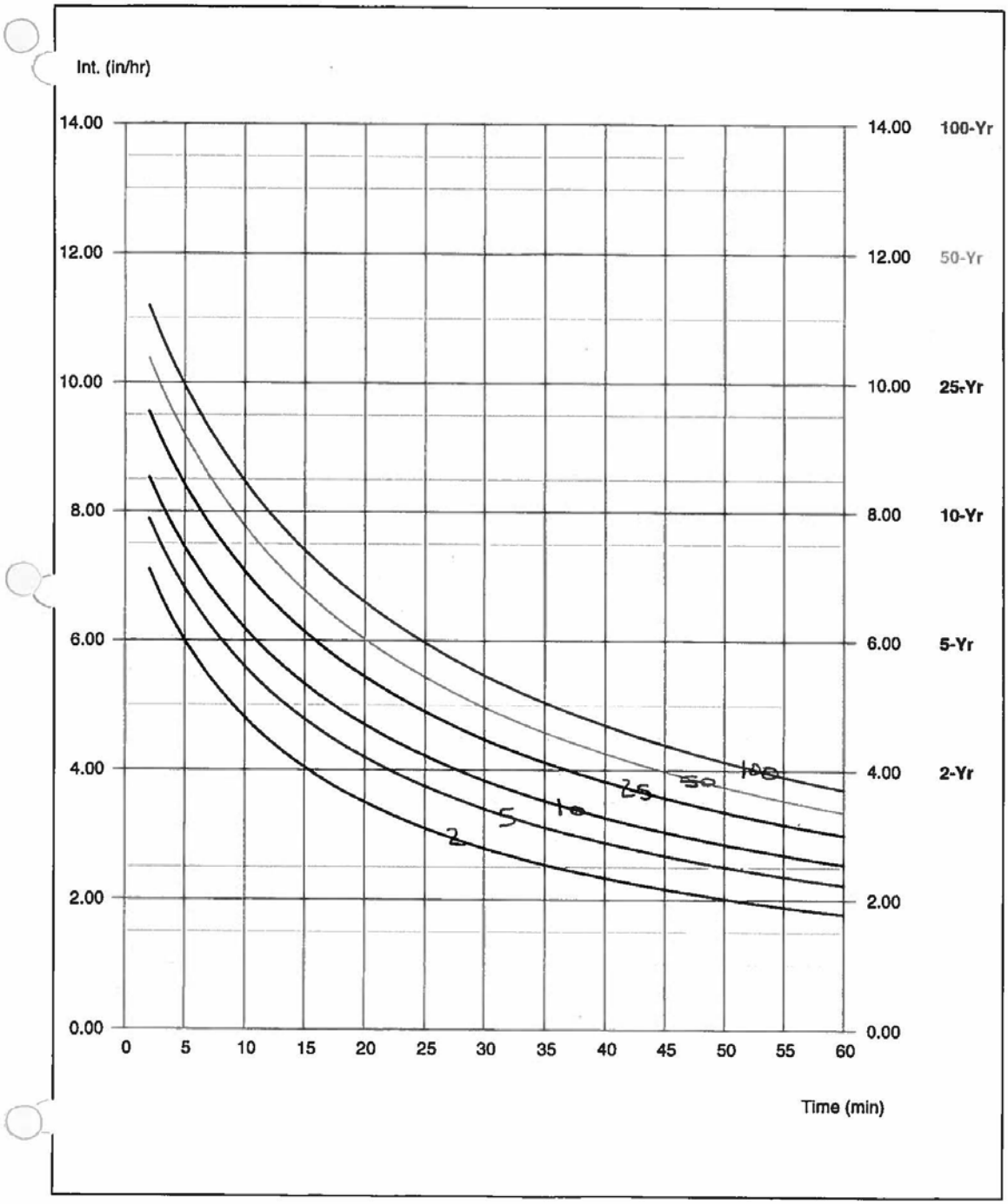
(0.27 WOODED)

Character of Surface	Runoff Coefficients
Pavement	
Asphaltic and Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, sandy soil	
Flat, 2 percent	0.05 to 0.10
Average, 2 to 7 percent	0.10 to 0.15
Steep, 7 percent	0.15 to 0.20
Lawns, heavy soil	
Flat, 2 percent	0.13 to 0.17
Average, 2 to 7 percent	0.18 to 0.22
Steep, 7 percent	0.25 to 0.35

2009 CALCS

Hydraflow IDF Curves

IDF file: wansley.IDF



HydraflowExpressExtension

2009 CALCS

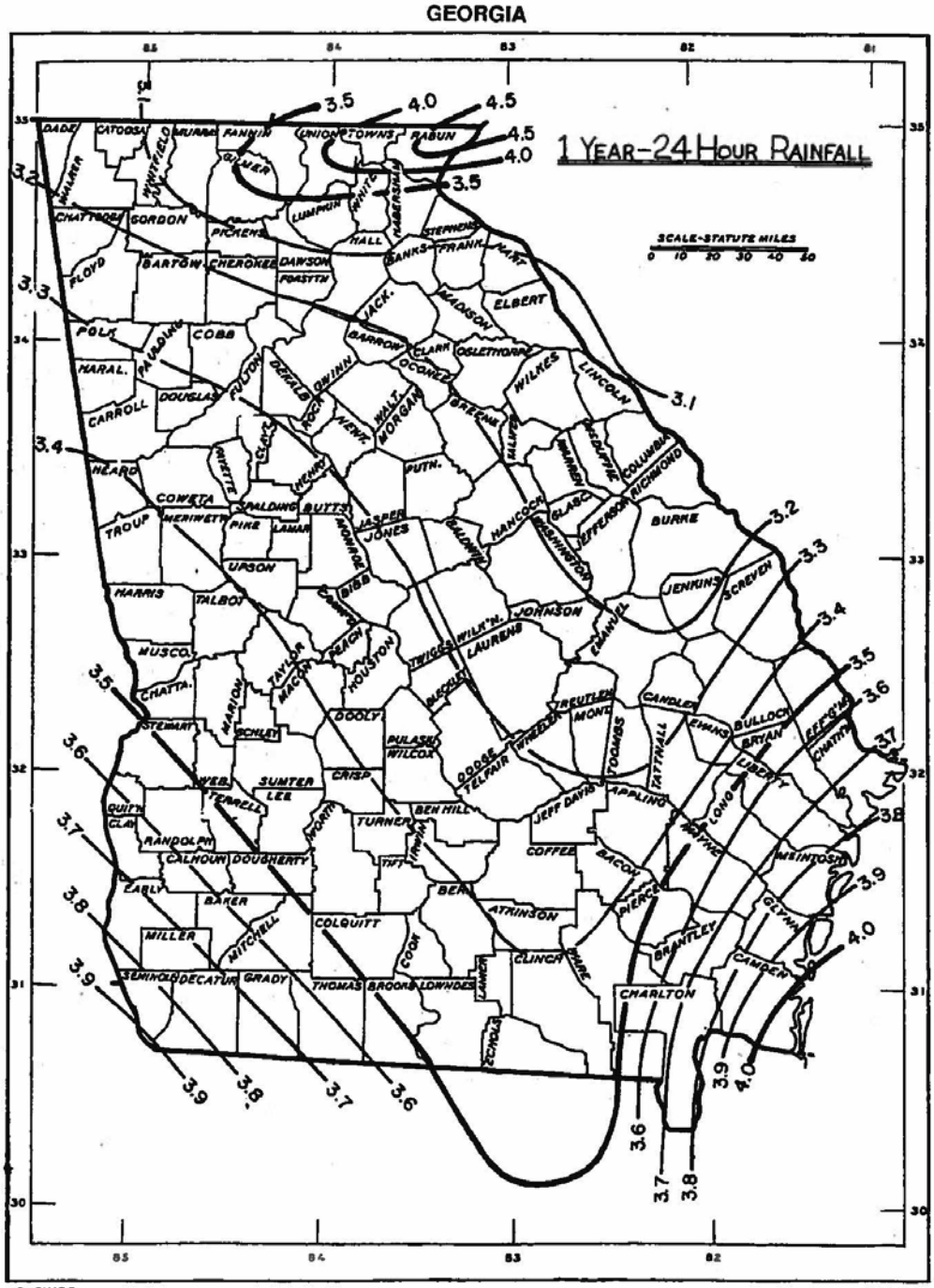
Hydraflow IDF Report

Return Period (Yrs)	Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-------
2	57.4553	11.0000	0.8151	-------
3	0.0000	0.0000	0.0000	-------
5	66.7518	12.8000	0.7929	-------
10	75.2873	13.9000	0.7873	-------
25	89.1942	15.2000	0.7854	-------
50	100.2970	16.0000	0.7849	-------
100	112.3838	16.8000	0.7863	-------

Intensity = B / (Tc + D)^E

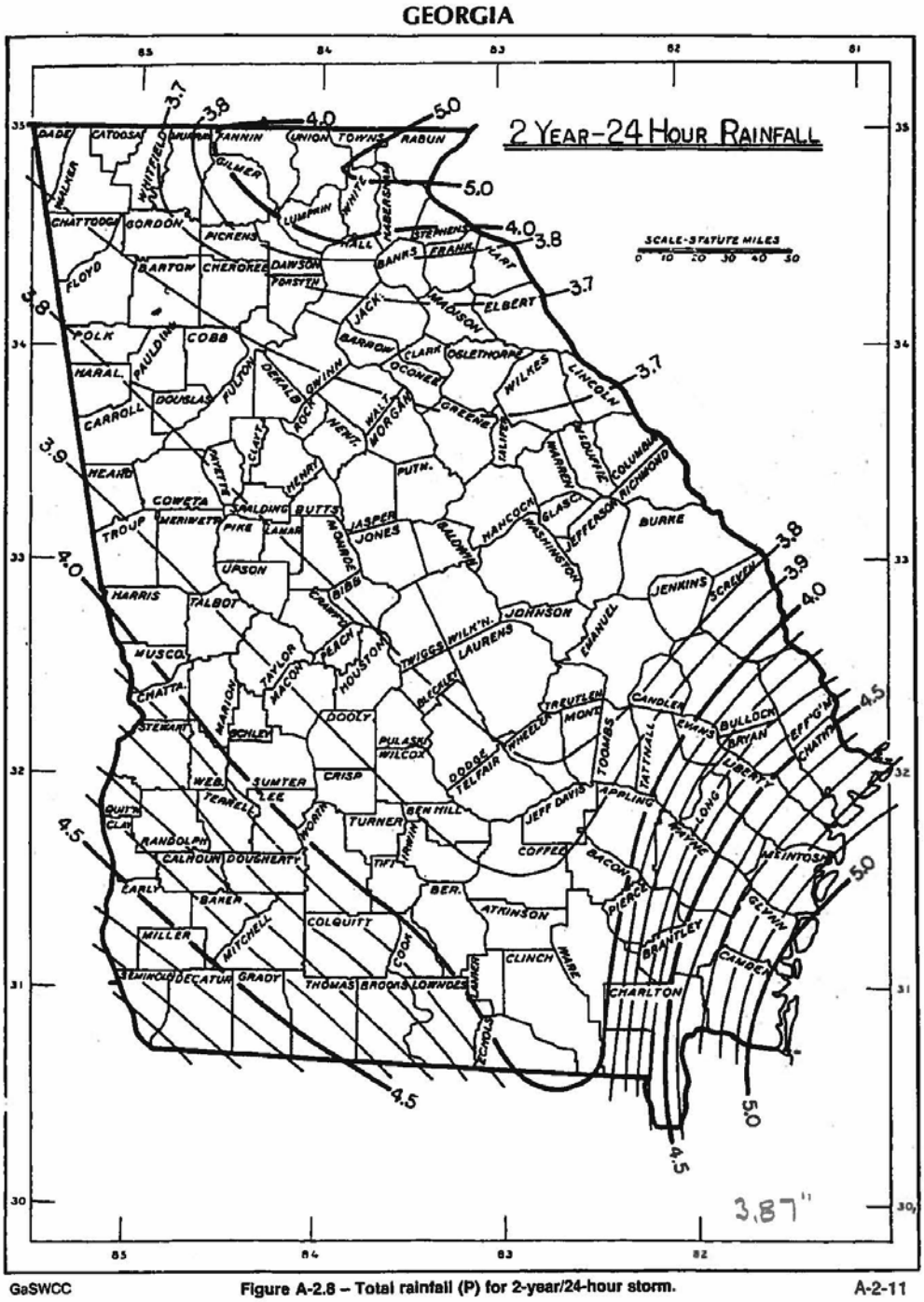
Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6.00	4.80	4.04	3.50	3.10	2.78	2.54	2.33	2.16	2.01	1.89	1.78
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.81	5.59	4.78	4.19	3.75	3.40	3.11	2.87	2.68	2.51	2.36	2.23
10	7.44	6.19	5.33	4.70	4.22	3.83	3.52	3.26	3.04	2.85	2.69	2.54
25	8.41	7.07	6.14	5.44	4.90	4.47	4.12	3.82	3.57	3.35	3.16	3.00
50	9.19	7.77	6.77	6.02	5.44	4.97	4.58	4.26	3.98	3.74	3.53	3.35
100	9.96	8.47	7.40	6.60	5.97	5.46	5.04	4.69	4.39	4.13	3.90	3.70

Tc = time in minutes. Min Tc =



GaSWCC

Figure A-2.7 – Total rainfall (P) for 1-year/24-hour storm.



GaSWCC

Figure A-2.8 – Total rainfall (P) for 2-year/24-hour storm.

A-2-11

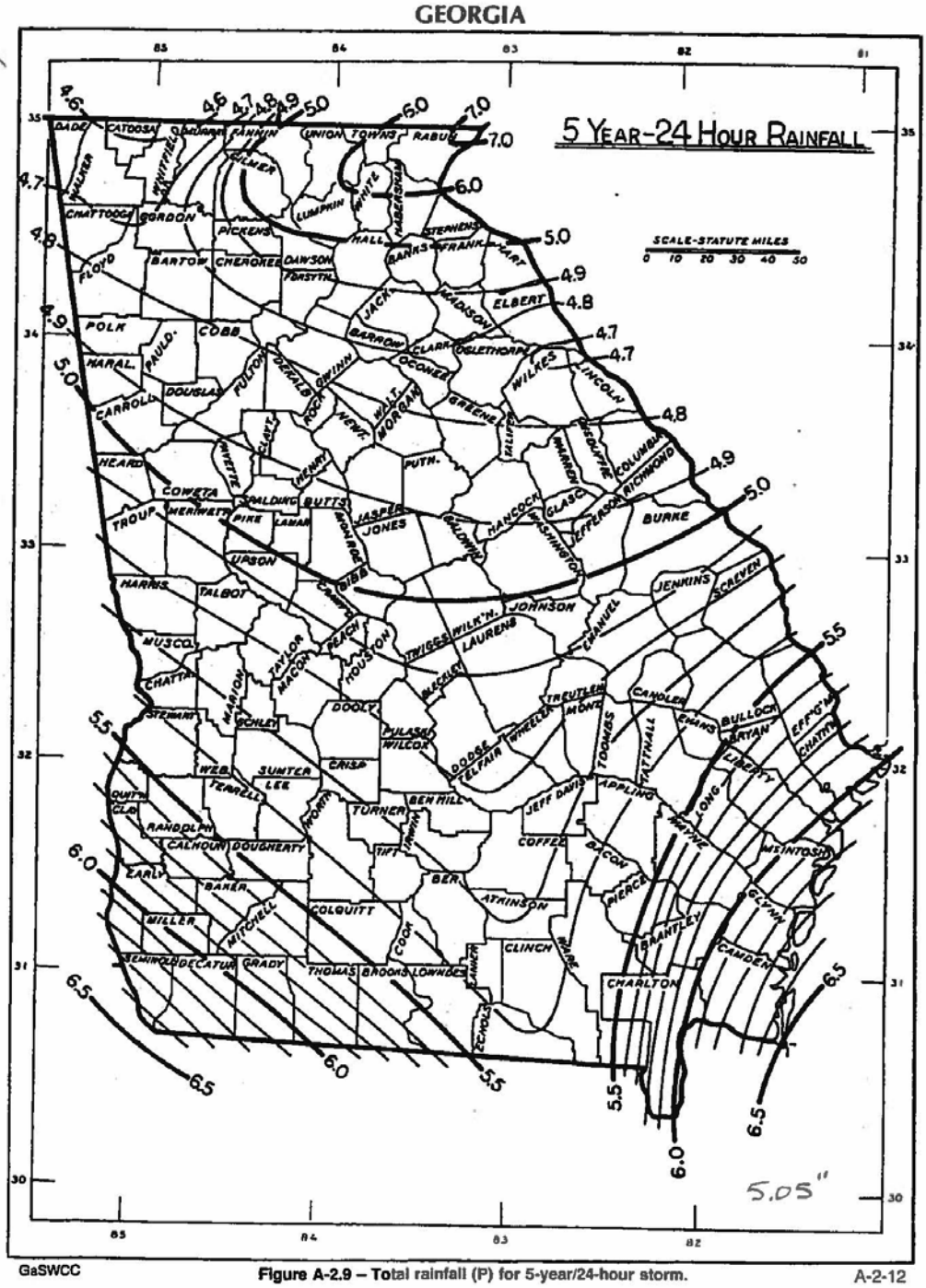


Figure A-2.9 – Total rainfall (P) for 5-year/24-hour storm.

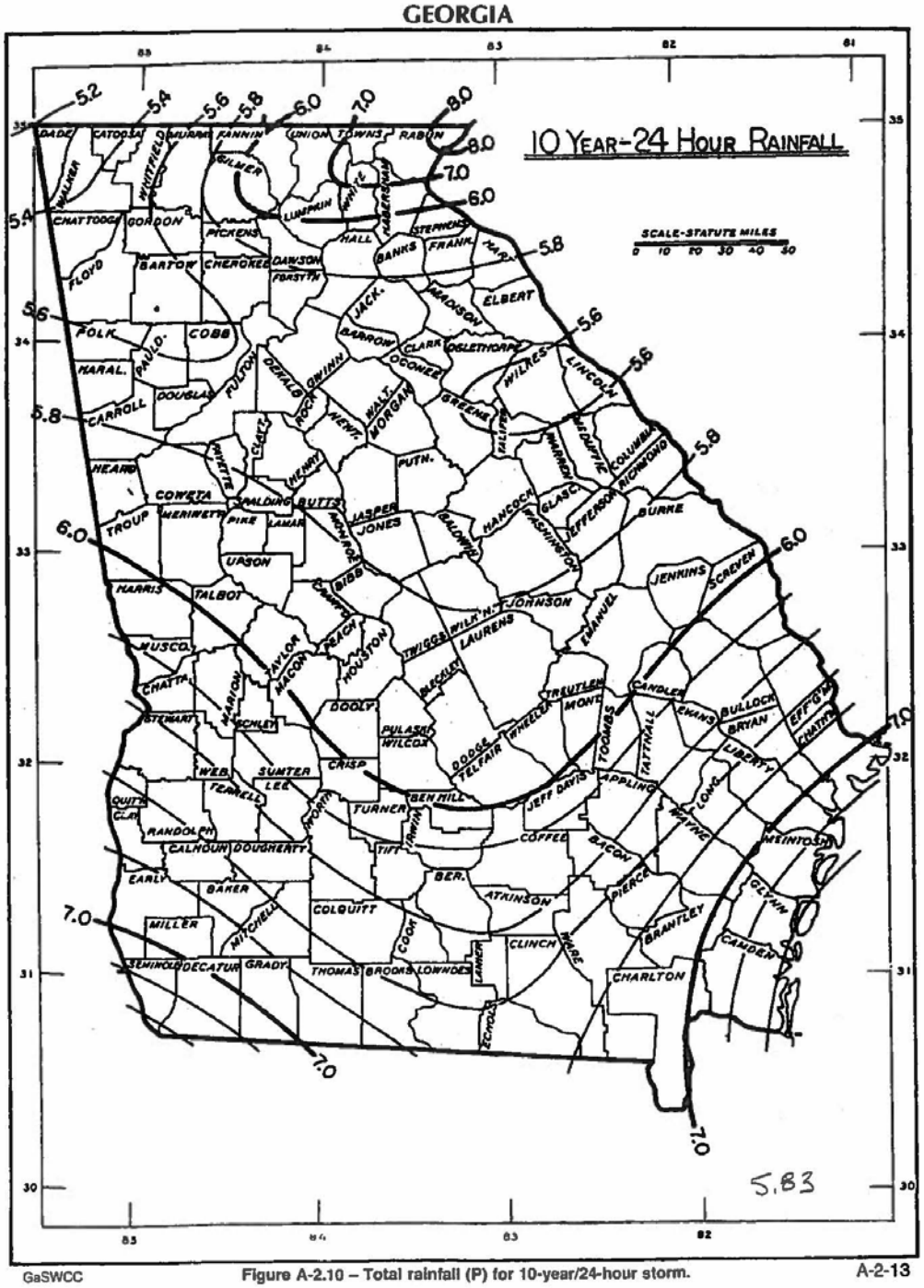
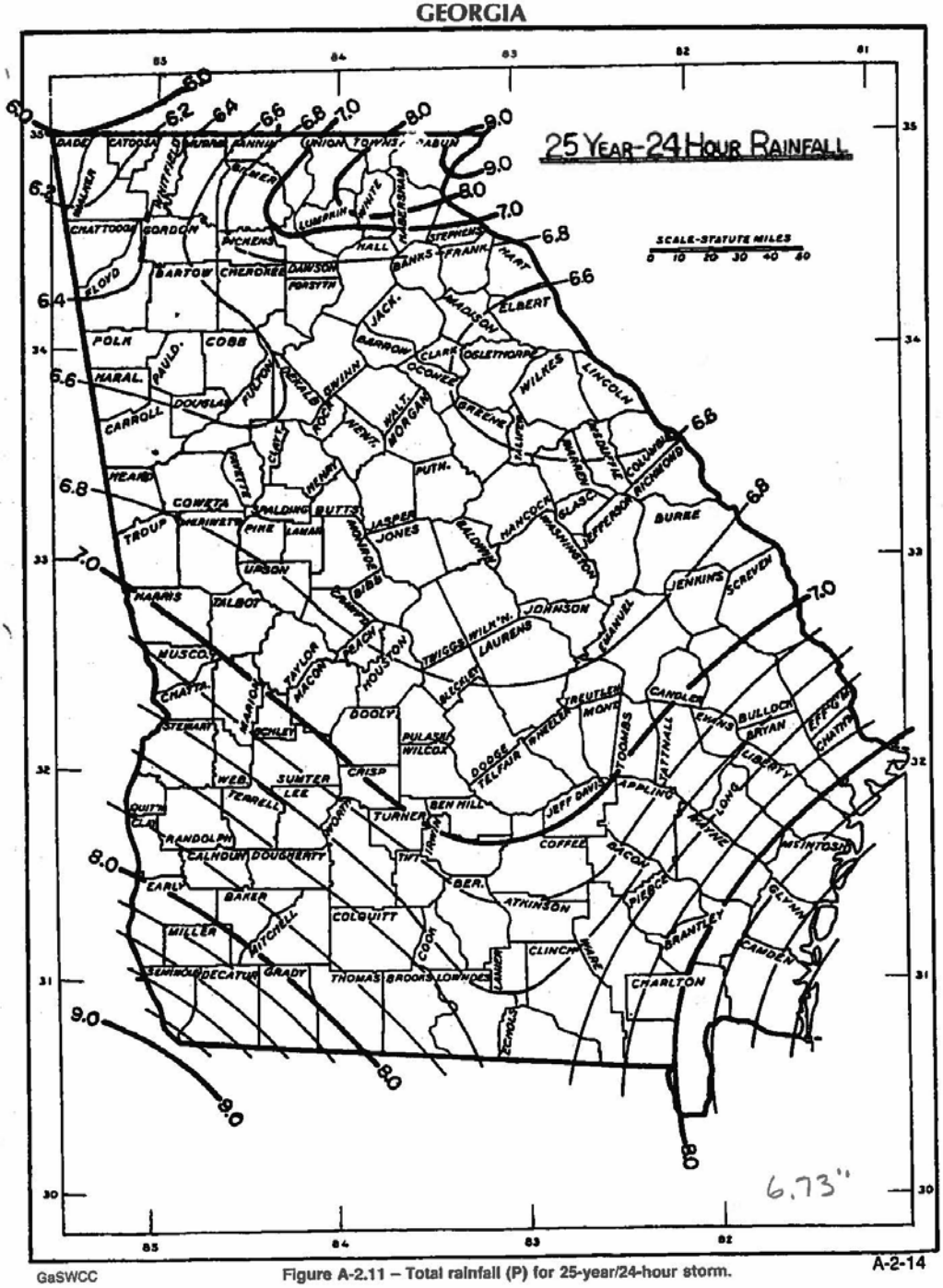


Figure A-2.10 – Total rainfall (P) for 10-year/24-hour storm.

2009 CALCS

GEORGIA

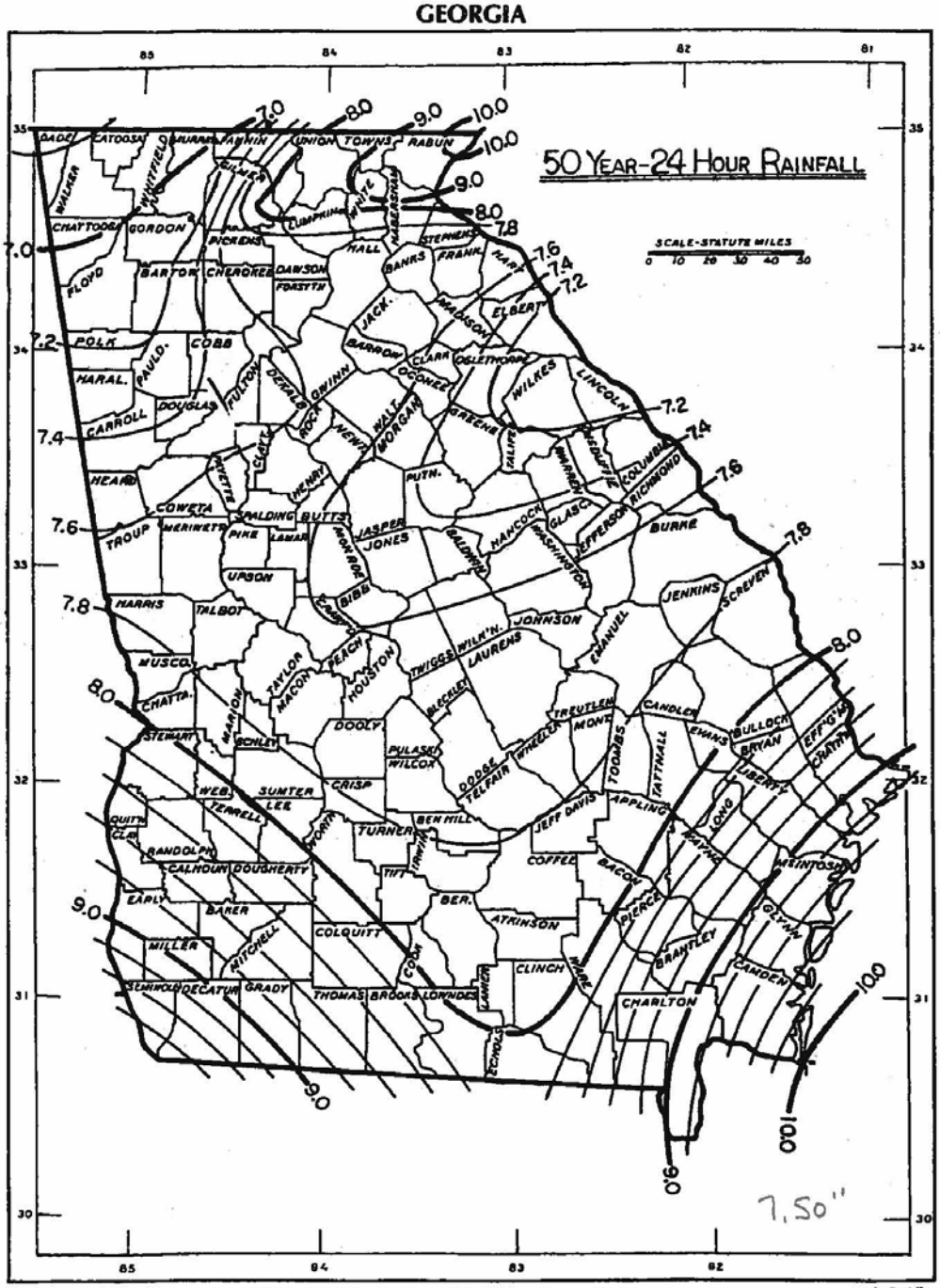


GaSWCC

Figure A-2.11 – Total rainfall (P) for 25-year/24-hour storm.

2009 CALCS

Pg 12 of 56



GaSWCC

Figure A-2.12 – Total rainfall (P) for 50-year/24-hour storm.

A-2-15

2009 CALCS

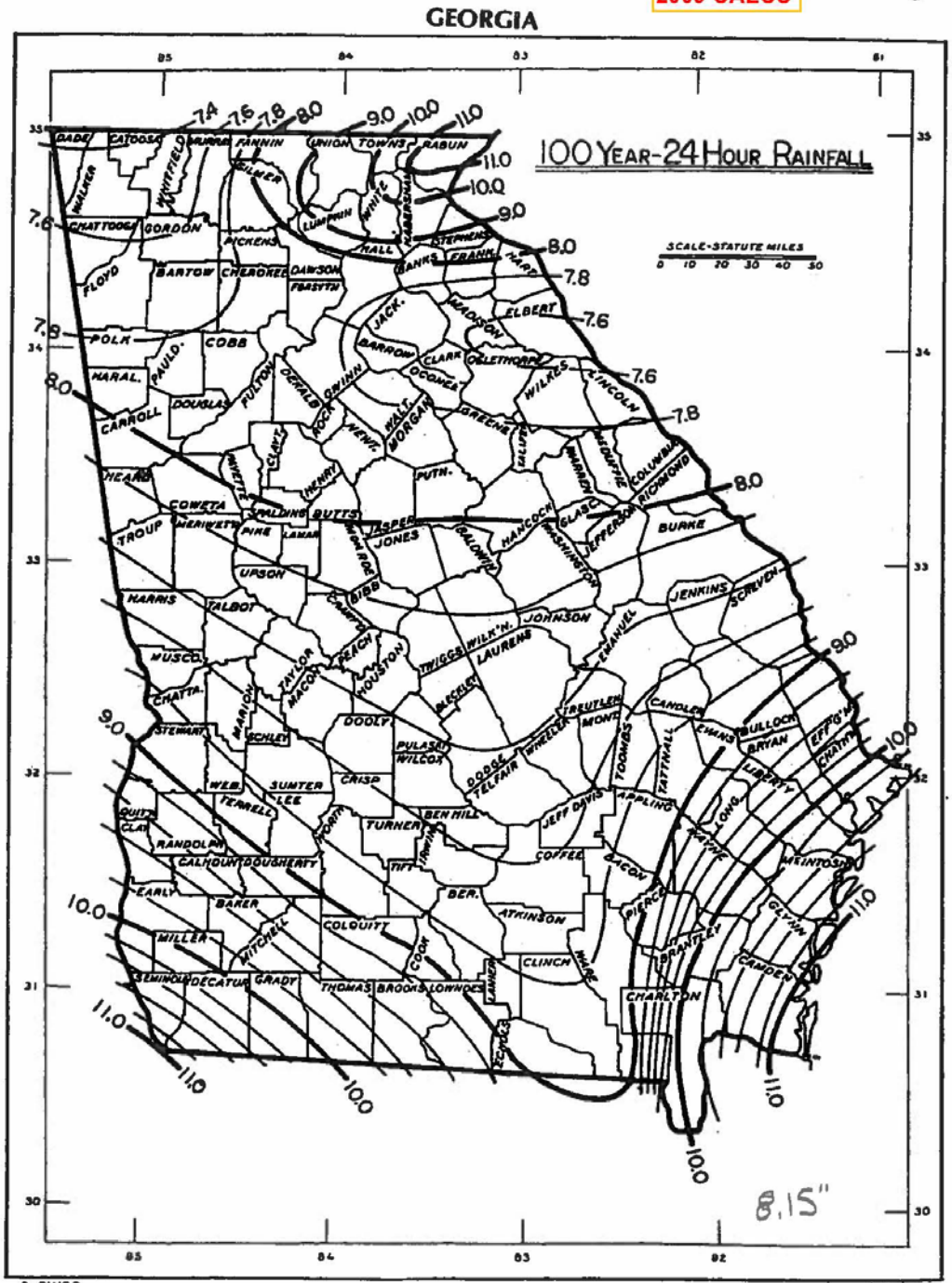


Figure A-2.13 – Total rainfall (P) for 100-year/24-hour storm.

2009 CALCS

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Energy to Serve Your World℠

Design Calculations

Project WANSLEY - FGD	Prepared By CRUMCHURCH	Date
Subject/Title GYP. STORAGE POND SIZING	Reviewed By	Date
	Calculation Number	Sheet 30 of 56

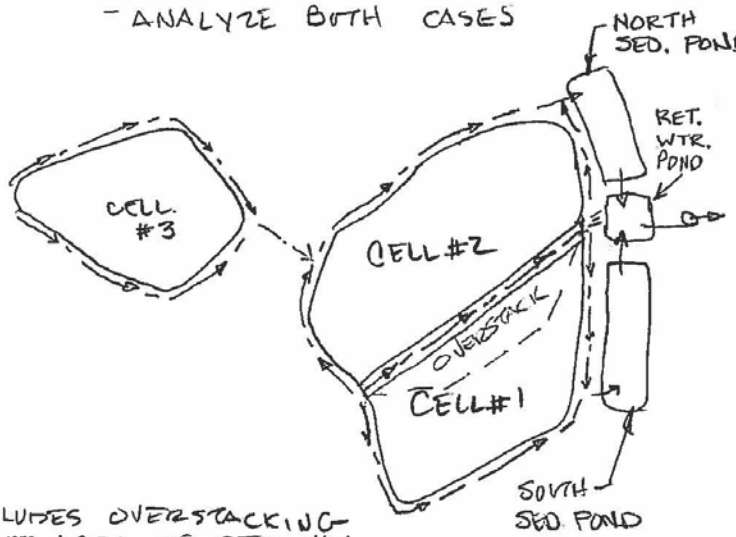
- REQ'D - CALCULATE STORM FLOWS & VOLUMES FROM CELLS #1, 2, & 3 WITH ALL DRAINING TO PONDS. DETERMINE WORST CASE FLOWS TO SIZE PERIMETER DITCHES AND PONDS.

- WORST CASE WILL BE HIGHEST FLOW/VOLUME FROM EITHER:

① CELL#1 CLOSED & NOT CAPPED (I.E. GYPSUM SURFACE EXPOSED) WITH CELL #2 HAVING BEEN CONSTRUCTED AND DECANT OPERATIONS JUST BEGINNING.

② CELL#1 CLOSED & CAPPED, CELL #2 CLOSED BUT NOT CAPPED, AND CELL #3 CONSTRUCTED WITH DECANT OPERATIONS JUST BEGINNING.

- ANALYZE BOTH CASES



AREAS

CELL #1
A = 1,838,542 ft²
= 42.21 Ac

CELL #2 *
A = 2,165,575 ft²
= 49.71 Ac

CELL #3
A = 1,406,855 ft²
= 32.30 Ac

PONDS
A = 533,018 ft²
= 12.24 Ac

*INCLUDES OVERSTACKING AREA OF CELL #1

Design Calculations 2009 CALCS SOUTHERN COMPANY *Energy to Serve Your World*

Project WANSLEY - FGD	Prepared By CRURCHURCH	Date
Subject/Title GYP. STORAGE POND SIZING	Reviewed By	Date
	Calculation Number	Sheet 30 of 561

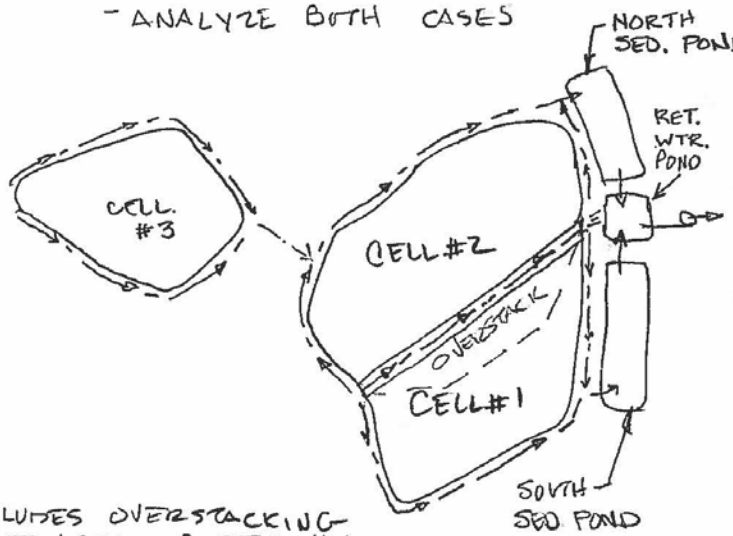
- REQ'D - CALCULATE STORM FLOWS & VOLUMES FROM CELLS #1, 2, & 3 WITH ALL DRAINING TO PONDS. DETERMINE WORST CASE FLOWS TO SIZE PERIMETER DITCHES AND PONDS.

- WORST CASE WILL BE HIGHEST FLOW/VOLUME FROM EITHER:

① CELL#1 CLOSED & NOT CAPPED (I.E. GYPSUM SURFACE EXPOSED) WITH CELL #2 HAVING BEEN CONSTRUCTED AND DECANT OPERATIONS JUST BEGINNING.

② CELL#1 CLOSED & CAPPED, CELL #2 CLOSED BUT NOT CAPPED, AND CELL #3 CONSTRUCTED WITH DECANT OPERATIONS JUST BEGINNING.

- ANALYZE BOTH CASES



AREAS

CELL #1
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A = 2,165,575 ft²
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A = 1,406,855 ft²
= 32.30 Ac

PONDS
A = 533,018 ft²
= 12.24 Ac

*INCLUDES OVERSTACKING AREA OF CELL #1

2009 CALCS

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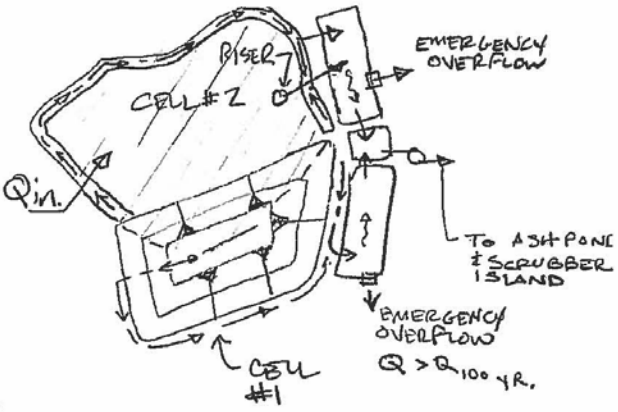
Design Calculations

Project WANSLEY - FGD	Prepared by CR UPCHURCH	Date
Subject/Title	Reviewed by	Date
	Calculation Number	Sheet 31 of 561

ANALYZE CASE (1)



-ASSUMPTIONS

- CELL #2 IS CONSTRUCTED W/ HDPE LINER & FILL TO TOP OF RISER W/ GYP. DEVANT, I.E. NO STORAGE AVAILABLE, CN = 98

- CELL #1 IS TOPPED OUT WITH EXPOSED GYP. SURFACE I.E. CN = 86

- PONDS TO BE DESIGNED TO STORE Q_{100YR} STORM AND WILL BE EVACUATED BY HORIZ. PUMPS. IN ADDITION PONDS WILL CONTAIN PROCESS FLOW RATE FOR 3 DAYS (72 HRS.)*. THESE VOLUMES SHALL BE HELD PLUS 3 FEET OF FREEBOARD.

- PERIMETER DITCH CONSTRUCTED AROUND CELL #2 BUT ONLY CONVEYS Q FROM RAINFALL RUNOFF FROM ROADS/BERMS AND DITCH ITSELF.

- CALCULATE PROCESS FLOW FOR STORAGE.
  Q_{IN} = 765 gpm/unit THIS WOULD NOT BE Q_{OUT} INTO PONDS, BUT CONSERVATIVELY USE THIS FOR VOL. TO BE STORED IN POND FOR 72 hrs.

$$Q_{2.0\%} = 765 \frac{gal}{min}\left(\frac{60\ min}{1\ hr}\right)(72\ hr.)\left(\frac{1\ ft^3}{7.4805\ gal}\right) = 441{,}789\ ft^3 \text{ SLURRY}$$

* PROCESS Q'S CAN ALSO BE HELD IN CELLS W/ STOP BLOCKS @ RISER.

2009 CALCS

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Design Calculations

Project	Prepared by	Date
WANSLEY-FGD	C.R. UPCHURCH	
Subject/Title	Reviewed by	Date
	Calculation Number	Sheet 32 of 561

WE HAVE 2 UNITS RUNNING SO.

441,789 ft³
× 2

883,577 ft³ OF SLURRY TOTAL TO BE SENT TO TEMP. GYP. CELLS. ✳

WITH 2% SULFUR COAL THE WATER CONTENT WOULD BE:

$\frac{256,827}{294,545}(100) = 87.2\%$ water

$(883,577)(.872) = 770479 ft^3$

-NOTE - USE CONC. RISER W/ 4"x4"x3' LONG STOP BLOCKS AND CAN CONTAIN THIS IN THE ACTIVE CELL IF FREEBOARD IS MAINTAINED. DON'T HAVE TO CONTAIN IN PONDS ONLY. WHEN STACK HEIGHT IS ABOVE RISER LIMITS, THE SIPHON(S) CAN BE ADJUSTED TO ALLOW CONTAINMENT.

-PER D&O DESIGN CRITERIA, THE WATER INFLOW IS 256,827 cf/day

Form No. 8.934R

2009 CALCS

Design Calculations

SOUTHERN COMPANY
Energy to Serve Your World℠

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 33 of 561

– CELL #1 DRAINING TO SOUTH SED. POND:

ASSUME CELL BUILT-UP TO FINAL STACK AND CAPPED W/ TOPSOIL & GRASSING NOT PLACED. NORTH HALF OF CELL WILL FLOW INTO CELL #2. DITCH BETWEEN CELLS HAS BEEN REMOVED AND LINERS OF CELLS #1 & #2 HAVE BEEN SEAMED THERE

D.A. CELL #1

DITCH (LINED) =	188,501 ft²
AGG SURF =	203,814 ft²
GYP. SURF =	964,369 ft²
TOTAL AREA =	1,356,684 ft²

CURVE NO.

$$CN = \frac{203{,}814\,(89) + 188{,}501\,(98) + 964{,}369\,(86)}{1{,}356{,}684}$$

$CN = 88.1$

$D.A. = 1{,}356{,}684 / 43{,}560 = 31.15\ Ac$

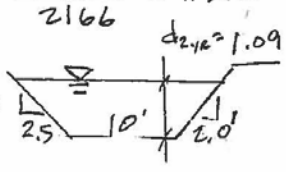
CN'S	
AGG =	89
GYP. =	86
POND/LINER =	98
GRASS =	80

USE HYDRAFLOW TO CALCULATE TIME OF CONC. & FLOWS

INPUT FOR T_c:

150 L.F. @ TOP/CAP 3% SLOPE
340 L.F. DOWNSTACK, W/ΔEL = 844 − 766 = 65'
2166 L.F. PERIMETER DITCH @ $\frac{766-736}{2166} = 1.39\%$

TO CALCULATE T_c FOR DITCH, INPUT FLOW VALUES FOR Q_{2YR} STORM (SEE NEXT PAGE) →



2009 CALCS

Design Calculations

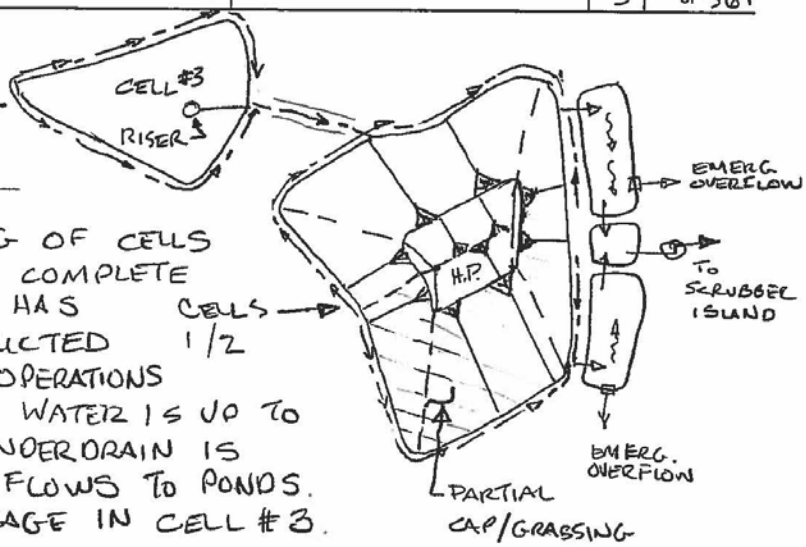
SOUTHERN COMPANY
Energy to Serve Your World

Project Wansley FGD	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 57 of 561

- ANALYZE CASE 2

- ASSUMPTIONS

- OVERSTACKING OF CELLS #1 & #2 IS COMPLETE AND CELL #3 HAS BEEN CONSTRUCTED AND DECANT OPERATIONS HAVE BEGUN. WATER IS UP TO RISER OR/ UNDERDRAIN IS CONVEYING FLOWS TO PONDS. I.E. NO STORAGE IN CELL #3.



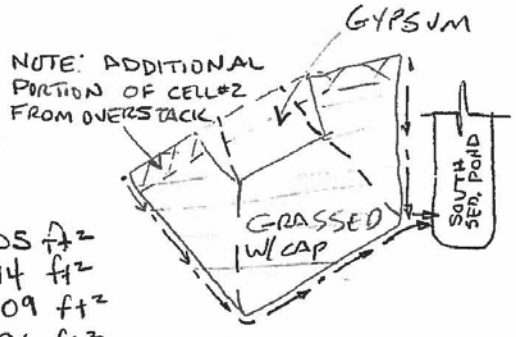
- THE OVERSTACKED CELLS 1 & 2 ARE PARTIALLY GRASSED & PARTIALLY EXPOSED GYPSUM.

- PROCESS FLOWS & POND STORAGE VOLUME DESIGN REQMTS SAME AS LISTED FOR CASE #1.

- CELLS 1 & 2

SOUTH D.A.

GRASSED W/CAP	=	775,105 ft²
GYP.	=	688,174 ft²
AGG SURF	=	192,809 ft²
DITCH (LINED)	=	188,496 ft²
TOTAL	=	1,844,584 ft²



SOUTH DRAINAGE AREA

- PRECIP (TP-40) $P_{2\text{-}YR} = 3.87"$

- FROM HYDRAFLOW, $Q_{2YR} = 146$ CFS

- FROM HYDRAFLOW EXPRESS: $W/Q_{2Y} = 146$ CFS
  $d = 1.10'$, $W_P = 15.42 ft$, $A = 13.72 ft^2$

CELL #2

ASSUME CELL CONSTRUCTED & DECANTING PROCESS HAS JUST BEGUN. WATER LEVEL @ TOP OF RISER, OR UNDERDRAINS ARE TAKING IN ALL Q'S ENTERING CELL, I.E. THERE IS NO LONG TERM STORAGE IN CELL, ONLY A LAG FROM PIPE CONVEYANCE SYSTEM.

- D.A. CELL #2 & PORTION OF CELL #1 SHEET DRAINING INTO CELL #2

TOTAL AREA (IN CELL)	=	1,753,062 ft^2
GYP. SURF. (@CELL #1)	=	366,407 ft^2

- D.A. @ CELL #2 PERIMETER DITCH W/SLOPES & ROAD

TOTAL AREA	=	412,877 ft^2
AGG SURF	=	209,615 ft^2
LINED DITCH	=	203,262 ft^2

- CURVE NO.'S: CELL #2 & PORTION OF CELL #1

$$CN = \frac{366,407(86) + 1,386,655(98)}{1,753,062} = 95.49 = 95.5$$

– CURVE NO.'S, CONT.

CELL #2 PERIMETER DITCHES

$$CN = \frac{203{,}262 ft^2 (98) + 209{,}615 (89)}{412{,}877} = 93.43$$

$CN = 93.5$ → $A = 412{,}877 / 43{,}560 = 9.48$ Ac

TIME OF CONC.

- FOR CELL #2 & PORTION OF CELL #1 SHEET FLOWING INTO CELL #2

  $t_c = 5$ MIN (ORLESS)

- PERIMETER DITCH

  FROM HYDRAFLOW, W/ Area = 9.48 Ac, $t_c \sim 5$ min

  $Q_{2YR} = 50.6$ cfs L = 3173', $\Delta EL = 790 - 735.5 = 54.5'$

- FROM HYDRAFLOW EXPRESS: W/ $Q_{2YR} = 50.6$ CFS

  $d = 0.56'$, $W_p = 12.76 ft^2$, & $A = 6.31 ft^2$

PONDS

SOUTH POND

TOTAL AREA =	176,404 ft^2
AGG. SURF =	32,483 ft^2
POND =	137,895 ft^2
GRASSED SLOPE =	6,026 ft^2

2009 CALCS

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2008 by Autodesk, Inc. Wednesday, Jul 29 2009

CELL #2- Q2yr. DITCH CALC FOR Tc

Trapezoidal

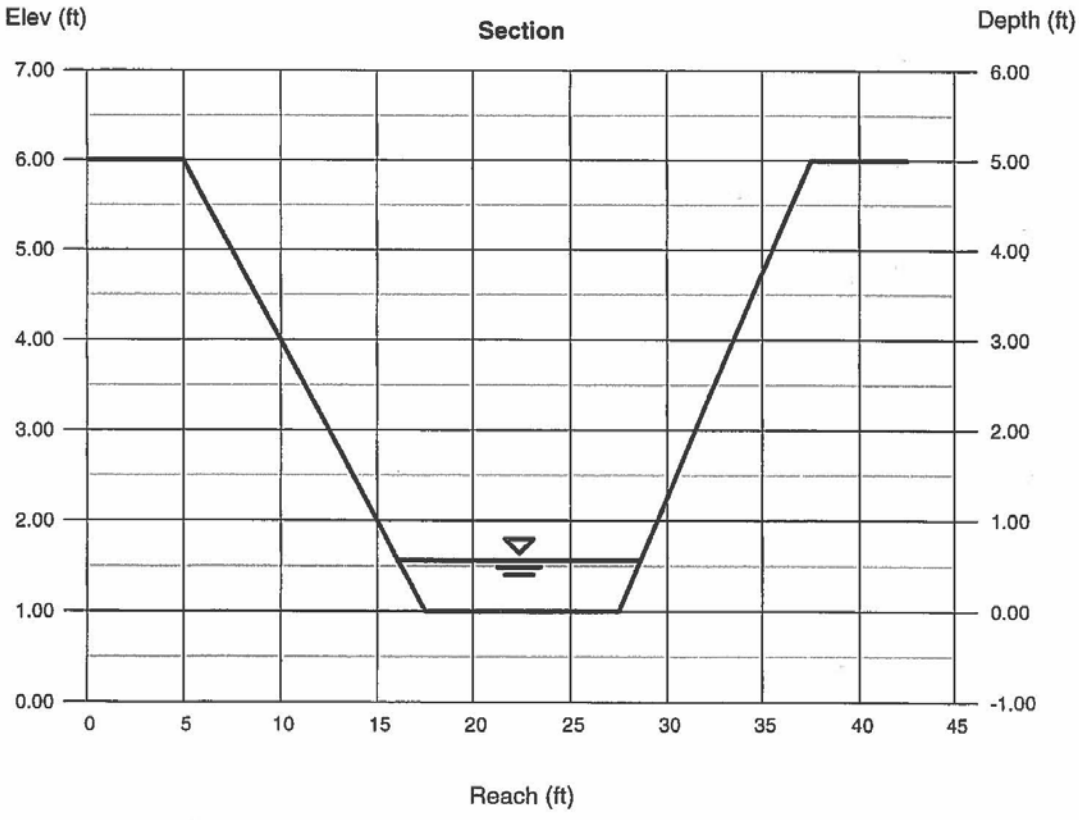
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 2.50, 2.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 1.00
Slope (%)	= 1.72
N-Value	= 0.015

Calculations

Compute by:	Known Q
Known Q (cfs)	= 50.60

Highlighted

Depth (ft)	= 0.56
Q (cfs)	= 50.60
Area (sqft)	= 6.31
Velocity (ft/s)	= 8.02
Wetted Perim (ft)	= 12.76
Crit Depth, Yc (ft)	= 0.87
Top Width (ft)	= 12.52
EGL (ft)	= 1.56



Depth	Q	Area	Veloc	Wp	Yc	TopWidth	Energy
(ft)	(cfs)	(sqft)	(ft/s)	(ft)	(ft)	(ft)	(ft)
0.56	50.60	6.306	8.02	12.76	0.87	12.52	1.56

2009 CALCS

Design Calculations

SOUTHERN COMPANY
Energy to Serve Your World℠

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 41 of 561

- PONDS CONT.

RET. WATER POND

TOTAL AREA =	72,110 ft²
AGG SURF =	16,751 ft²
POND =	41,320 ft²
GRASSED SLOPE =	14,039 ft²

NORTH SED. POND

TOTAL AREA =	284,504 ft²
AGG SURF =	38,587 ft²
POND =	196,521 ft²
GRASSED SLOPE =	49,396 ft²

CURVE NO.'S @ PONDS

$$\text{RET. WTR. POND} = \frac{16,751(89)+41,320(99)+14,039(80)}{72,110} = 92.98$$

$$\text{SOUTH POND} = \frac{32,483(89)+137,895(99)+6026(80)}{176,404} = 95.51$$

$$\text{NORTH POND} = \frac{38,587(89)+196,521(99)+49,396(80)}{284,504} = 94.34$$

RET. POND, CN = 93.0

SOUTH SED. POND, CN = 95.5

NORTH SED POND, CN = 94.3

Design Calculations

2009 CALCS

SOUTHERN COMPANY
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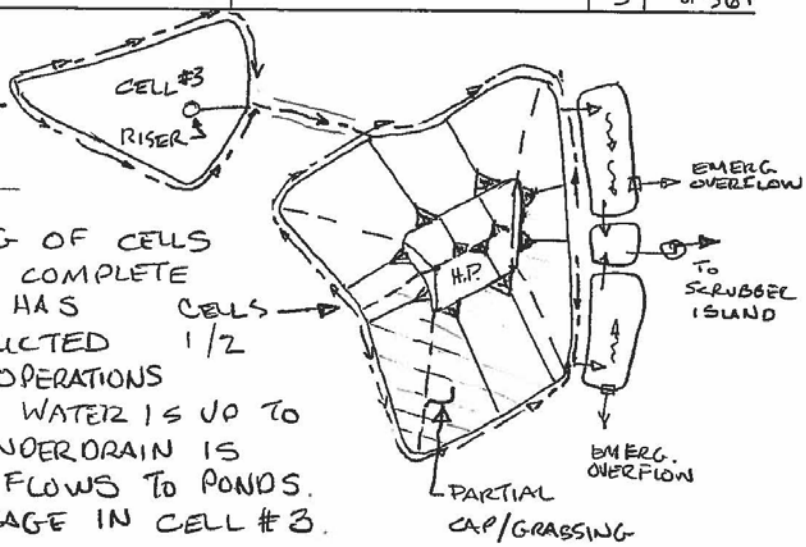
Project Wansley FGD	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 57 of 561

- ANALYZE CASE 2

- ASSUMPTIONS

- OVERSTACKING OF CELLS #1 & #2 IS COMPLETE AND CELL #3 HAS BEEN CONSTRUCTED AND DECANT OPERATIONS HAVE BEGUN. WATER IS UP TO RISER OR/ UNDERDRAIN IS CONVEYING FLOWS TO PONDS. I.E. NO STORAGE IN CELL #3.



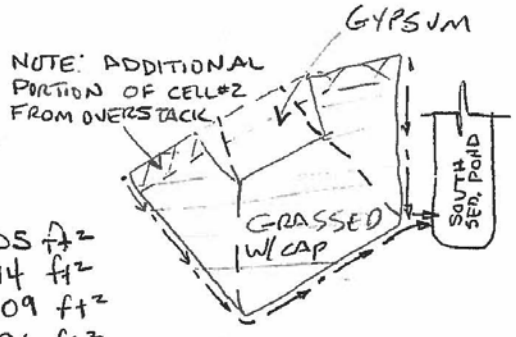
- THE OVERSTACKED CELLS 1 & 2 ARE PARTIALLY GRASSED & PARTIALLY EXPOSED GYPSUM.

- PROCESS FLOWS & POND STORAGE VOLUME DESIGN REQMTS SAME AS LISTED FOR CASE #1.

- CELLS 1 & 2

SOUTH D.A.

GRASSED W/CAP	=	775,105 ft²
GYP.	=	688,174 ft²
AGG SURF	=	192,809 ft²
DITCH (LINED)	=	188,496 ft²
TOTAL	=	1,844,584 ft²



SOUTH DRAINAGE AREA

2009 CALCS

Design Calculations

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Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 60 of 561

SOUTH D.A.

D.A. = 1,844,584 ft² / 43560 = 42.35 Ac

CURVE NO'S

$$CN = \frac{775,105(69)+688,174(86)+192,809(89)+188,496(98)}{1,844,584}$$

CN = 79.1

INPUT FOR T_c:

105 L.F. @ TOP/CAP w/ 3% SLOPE
608 L.F. DOWNSTACK, AEL = 904 - 778 = 126'
2540 L.F. PERIMETER DITCH @ $\frac{778-736(4.00)}{2540'} = 1.65'$

Q_{2YR} = 132.2 cfs (FROM HYDRAFLOW)

W/ Q = 132.2 cfs, d = 0.99', W_p = 14.88' A = 12.11 ft²
(FROM HYDROFLOW EXPRESS)

Q_{100YR} = 303.6 cfs

NORTH D.A.

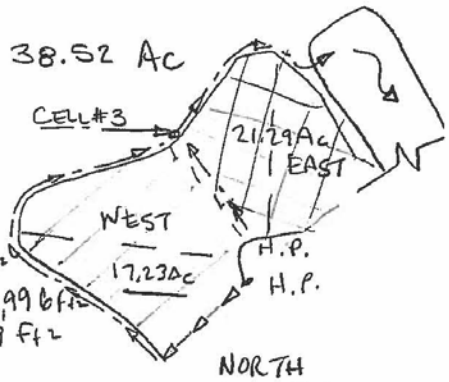
GRASSED AREA	=	-0- ft²
GYP.	=	1,183,830 ft²
AGG SURF.	=	171,820 ft²
DITCH (LINED)	=	200,450 ft²
TOTAL		1,556,100 ft²

Design Calculations 2009 CALCS SOUTHERN COMPANY

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 64 of 561

NORTH D.A.

D.A. = 927,323 ft² (EAST)
750,590 ft² (WEST)
1,677,913 ft² / 43,560 = 38.52 Ac



NORTH DRAINAGE AREA CELL #2

WEST HALF

AREA = 750,590 total
GRASSED = -0- ft²
AGG SURF = 43616 + 70,409 = 114,025 ft²
DITCH (LINED) = 208,021 - 114,025 = 93,996 ft²
GYD. = 750,590 - 208,021 = 542,569 ft²

CURVE NO'S.

$$CN = \frac{114,025(89) + 93,996(98) + 542,569(86)}{750,590}$$

CN = 87.96 → 88.0

INPUT FOR T_c:

30 L.F. @ TOP / CAP W / 3% SLOPE
598 L.F. DOWN STACK, AEL = 904.0 - 780 = 124'
1970 L.F. PERIMETER DITCH @ $\frac{780-749}{1970}(100) = 1.57\%$

Q_{2yr} = 80 CFS (FROM HYDRAFLOW - TRIAL Q)

W/ Q = 80 CFS, d = 0.75', W_p = 13.70', A = 8.11 ft² HYDRAFLOW EXPRESS

NORTH D.A., CONT.

EAST HALF

AREA = 927,323 ft² total
GRASSED = -0- ft²
AGG. SURF. = 55937 + 39431 = 95,368 ft²
DITCH (LINED) = 204296 - 95,368 = 108,928 ft²
GYP. = 927,323 - 204,296 = 723,027 ft²

CURVE NO.

$$CN = \frac{95{,}368(89) + 108{,}928(98) + 723{,}027(86)}{927{,}323} = 87.72$$

CN = 87.7

INPUT FOR T_c:

30 L.F. @ TOP/CAP w/ 3:1 SLOPE
775 L.F. DOWN STACK, AEL = 904.0 - 749.0 = 155'
1070 L.F. PERIMETER DITCH @ $\frac{749.0 - 736.0}{1070}$ = 1.21%

Q_{24HR} = 98 cfs (FROM HYDRAFLOW, TRIAL Q)

W/ Q = 98 cfs, d = 0.91, Wp = 14.49, A = 10.96 ft² HYDRAFLOW EXPRESS

- NOTE - VELOCITY MAY INCREASE SOME WITH ADDITIONAL Q OF CELL # 3 & UPPER AREA OF CELL #2, LAG IN RUNOFF FROM THOSE AREAS WILL ALLOW SOME OF THIS Q TO EXIT DITCH FIRST. O.K. TO USE PARAMETERS ABOVE, FOR CALC' VELOCITY & T_c

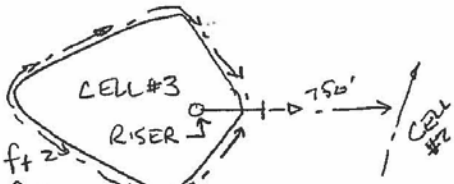
2009 CALCS

SOUTHERN COMPANY

Design Calculations

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 68 of 561

CELL #3



TOTAL AREA = 1,348,537 ft²
CELL (LINED) = 854,643 ft²
PERIM. DITCH (LINED) = 109,635 + 57,847 + 54,919 = 222,401 ft²
AGG SURF. = 1,348,537 - 854,643 - 222,401 = 271,493 ft²
GRASSED = -0-

D.A. = 1,348,537 ft² / 43,560 = 30.96 Ac

DITCH FROM CELL #3 TO CELL #2 PERIM. DITCH.

AGG. SURF. = 28,687 ft²
DITCH (LINED) = 33,226 ft²
TOTAL = 61,913 ft² / 43,560 = 1.42 Ac

CURVE NO'S.

CELL #3, $CN = \frac{854,643(98) + 222,401(98) + 271,493(89)}{1,348,537}$

CN = 96.19

CN = 96.2

CELL #3 TO CELL #2 DITCH/RD. $= \frac{28,687(89) + 33,226(98)}{61,913}$

CN = 93.83

CN = 93.8

CELL #3, CONT.

ANALYZE CELL #3 WITH PERIMETER DITCH AND CELL SEPARATE.

– PERIMETER DITCH

$$DA = (222{,}401 + 271{,}493)/43560 = 11.34\ A_c$$

CURVE NO.

$$CN = \frac{271{,}493(89) + 222{,}401(98)}{493{,}894} = 93.05$$

$CN = 93.1$

INPUT FOR T_c: 24 L.F. @ 4% SLOPE (ROAD)
60 L.F. @ SLOPE, $\Delta EL = 10'$
2115 L.F. PERIM. DT. @ $\frac{824.3 - 755}{2115}(100) = 3.28\%$

$Q_{24R} = 32.1$ CFS (FROM HYDRAFLOW)

W/Q = 32.1 CFS, $d = 0.36'$, $W_p = 11.77$, $A = 3.892\ ft^2$

– CELL #3

$$DA = 854{,}643\ ft^2/43560 = 19.62\ A_c$$

$C_n = 98$

$T_c = 5.0$ min, USE MIN.

2009 CALCS

Design Calculations

SOUTHERN COMPANY
Energy to Serve Your World®

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 71 of 561

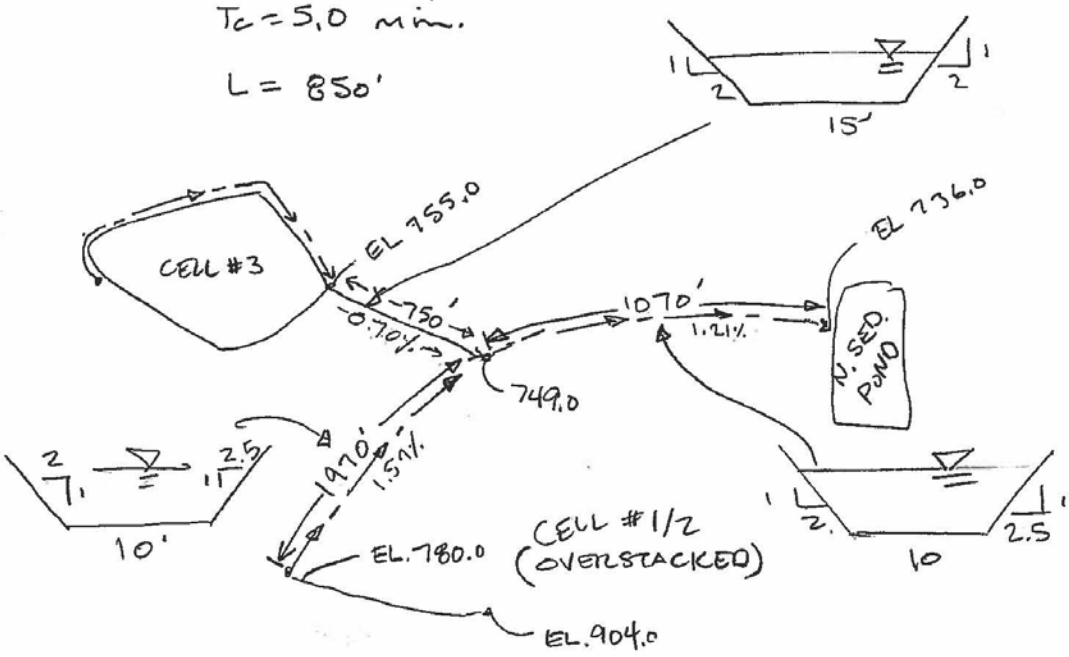
- DITCH & ROAD FROM CELL #2 TO CELL #3

$A = 316,580/43,560 = 7.27$ Ac

$CN = \frac{151,200(89) + 165,380(98)}{316,580} = 93.7$

$T_c = 5.0$ min.

$L = 850'$



2009 CALCS

Design Calculations

SOUTHERN COMPANY
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Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 94 of 561

– CASE #1

STORAGE VOL. REQ'D: 2,504,064 ft³

-CASE # 2

STORAGE VOL. REQ'D: 3,103,878 ft³

* DESIGN FOR CASE #2, W/ ADDITIONAL PROCESS FLOW & REQ'D FREEBOARD.

Form 9-0324B Rev. 10/98

Design Calculations 2009 CALCS SOUTHERN COMPANY

oject	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 95 of 561

STAGE/STORAGE SED. & RET. WTR. PONDS

RET. WTR. POND

ELEV.	AREA, FT²	ΔVOL, FT³	VOL, FT³	
720.0	7046			POND BOT. & INTAKE
722.0	8879			
724.0	10,892			
725.5	17,354			MAX. PROCESS POOL
726.0	17,966			
728.0	20,513			
729.0	21,846			
730.0	23,218			
735.0	30,665			
739.0	37,329			
739.36	37,957			
740.6	39,091			
741.0	40,895			
741.36	41,555			TOP/DIKE

SEE HYDROFLOW CALC'S

SOUTH SED. POND

ELEV.	AREA	ΔVOL, FT³	VOL, FT³	
725.5	75,720			MAX PROCESS POOL
726.0	77,541			
728.0	84,926			
729.0	88,677			
730.0	92,468			
735.0	112,009			
739.0	128,348			
739.36	129,849			SPILLWAY

SEE HYDROFLOW CALC'S

STAGE / STORAGE SED. & RET. WTR. PONDS, CONT.

SOUTH SED. POND CONT.

ELEV.	AREA, FT²	ΔVOL, FT³	VOL, FT³	
740.0	132,530			
741.0	136,753		SEE HYDRAFLOW CALC'S	
741.36	138,283			TOP / DIKE

NORTH SED. POND

	ELEV.	AREA, FT²	ΔVOL, FT³	VOL, FT³	
SHELF	725.5	97,642			MAX. PROCESS POOL
	726.0	104,186			
	728.0	122,752		SEE HYDRAFLOW CALC'S	
	729.0	132,766			
	730.0	137,722			
	735.0	163,088			
	739.0	184,089			
	739.36	186,010			SPILLWAY
	740.0	189,450			
	741.0	194,841			
	741.36	196,774			TOP / DIKE

2009 CALCS

Hydrograph Summary Report

[illegible]	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	237.15	1	717	580,968	----	------	------	Cell #3
2	SCS Runoff	122.05	1	718	293,928	----	------	------	Cell #3 Perimeter Ditch Area
3	SCS Runoff	16.87	1	717	39,311	----	------	------	Ditch Area Cell#3 to Cell#2
4	Combine	373.98	1	717	914,205	1, 2, 3	------	------	Combine Cell#3, Perim. Dit., & Ditch
5	Reach	370.41	1	719	914,207	4	------	------	Ditch Cell #3 to Cell #2
6	SCS Runoff	195.35	1	717	433,105	----	------	------	Cell#2 North (West Side)
7	SCS Runoff	240.63	1	717	532,312	----	------	------	Cell#2 North (East Side)
8	SCS Runoff	77.83	1	717	182,528	----	------	------	North Sed. Pond Area
9	SCS Runoff	19.63	1	717	45,434	----	------	------	Return Pond Area
10	SCS Runoff	303.60	1	723	880,916	----	------	------	Cell #1/2 South
11	SCS Runoff	48.56	1	717	115,384	----	------	------	South Sed. Pond Area
12	Combine	330.96	1	721	996,300	10, 11	------	------	Combine Cell#1 & S. Sed. Pond
13	Combine	559.53	1	718	1,347,310	5, 6,	------	------	Combine Upper Cell1/2 Ditch & Cell#
14	Reach	550.40	1	720	1,347,310	13	------	------	Lower N. Ditch Cell #1/2
[illegible]	Combine	843.29	1	719	2,062,149	7, 8, 14	------	------	Combine N. Ditch Cell 1/2 & N. Sed.
16	Combine	1179.18	1	719	3,103,878	9, 12, 15	------	------	Combine Sed. Ponds into Ret. Wtr.
17	Reservoir	0.00	1	0	0	16	737.12	3,103,885	Combined Ponds

2009 CALCS

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Sunday, Aug 2 2009, 9:28 AM

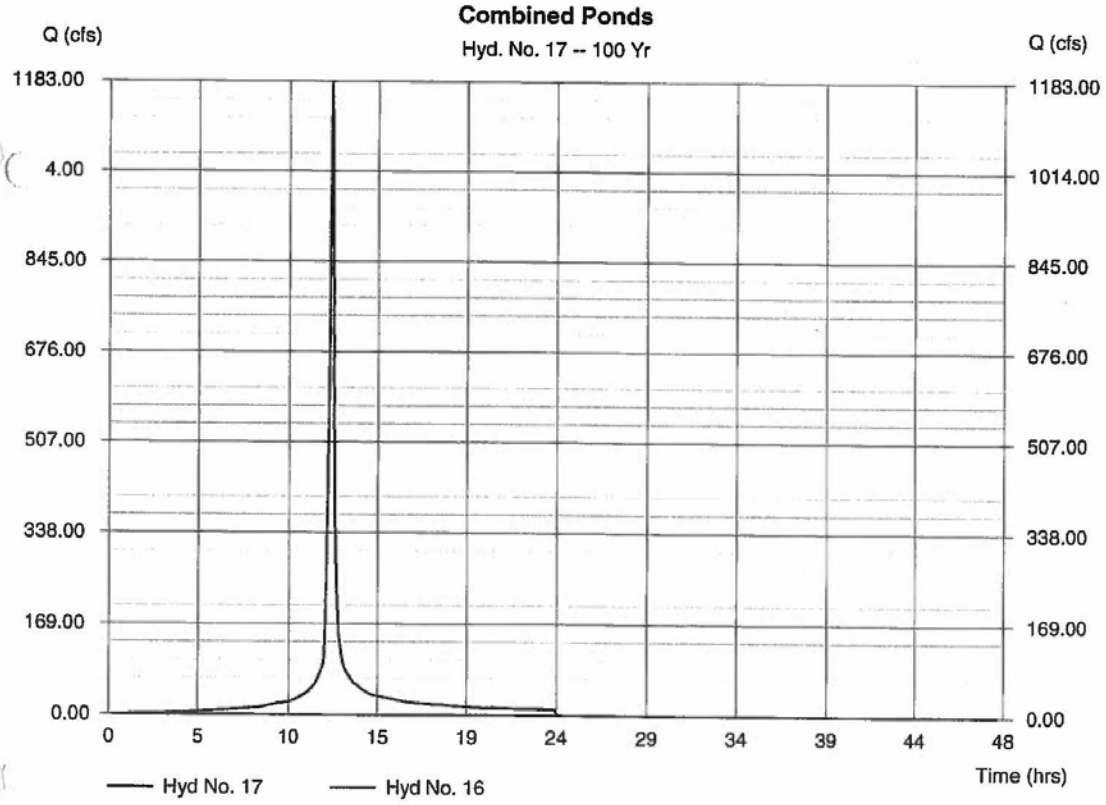
Hyd. No. 17

Combined Ponds

Hydrograph type	= Reservoir	Peak discharge	= 0.00 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 16	Max. Elevation	= 737.12 ft
Reservoir name	= Sed. & Ret. Wtr. Ponds	Max. Storage	= 3,103,885 cuft

Storage Indication method used.

Hydrograph Volume = 0 cuft



Pond Report

Hydraflow Hydrographs by Intelisolve

Sunday, Aug 2 2009, 9:28 AM

Pond No. 1 - Sed. & Ret. Wtr. Ponds

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	725.50	190,716	0	0
0.50	726.00	199,693	97,602	97,602
2.50	728.00	228,191	427,884	525,486
3.50	729.00	243,289	235,740	761,226
4.50	730.00	253,408	248,349	1,009,575
9.50	735.00	305,762	1,397,925	2,407,500
13.50	739.00	349,766	1,311,056	3,718,556
13.86	739.36	353,816	126,645	3,845,201 ← AVAILABLE STORAGE
14.50	740.00	361,071	228,764	4,073,965
15.50	741.00	372,489	366,780	4,440,745
15.86	741.36	376,612	134,838	4,575,583

Culvert / Orifice Structures

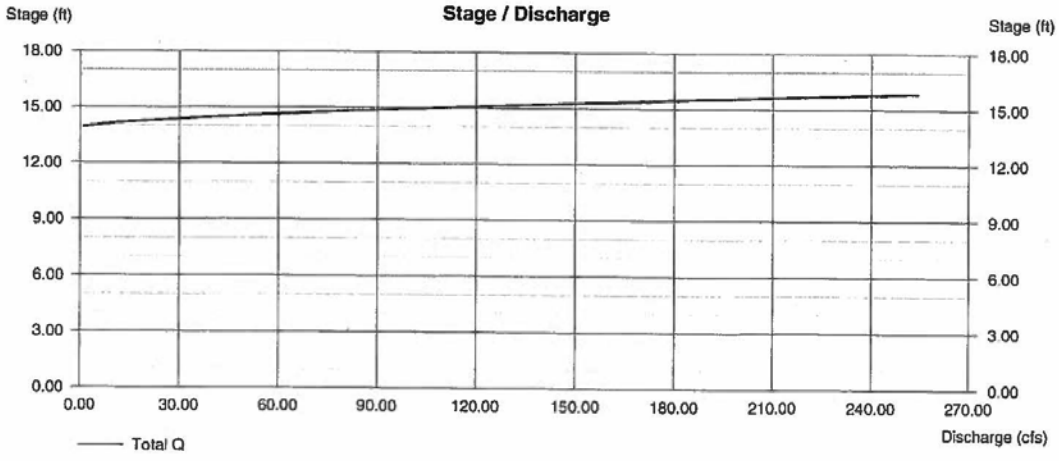
	[A]	[B]	[C]	[D]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 20.00	15.00	0.00	0.00
Crest El. (ft)	= 739.36	739.40	0.00	0.00
Weir Coeff.	= 2.60	2.60	0.00	0.00
Weir Type	= Broad	Broad	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



2009 CALCS

SOUTHERN COMPANY

Design Calculations

oject	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 100 of 561

- FROM ROUTING STORMS, WORST CASE Q_{100}'S IS CASE 2 WITH VOLUME OF

$$V_{100} = 3,103,878 \text{ ft}^3$$

- STORAGE AVAILABLE IN PONDS

$$V_{OL} = 3,845,201 \text{ ft}^3$$

- EXCESS STORAGE IN PONDS:

$$3,845,201 - 3,103,878 = 741,323 \text{ ft}^3$$

VOL. 3 DAY PROCESS STORAGE = 770,479 ft³

$$770,479 - 741,323 = 29,156 \text{ ft}^3 *$$

O.K.

*ADDITIONAL STORAGE AVAILABLE IN PERIMETER DITCH ABOVE PONDS.

2009 CALCS

SOUTHERN COMPANY

Design Calculations

Project PLANT WANSLEY - FGD	Prepared By C R UPCHURCH	Date 8/10/09
Subject/Title	Reviewed By D HALL	Date 8/13/09
	Calculation Number	Sheet 1 of 3

SEDIMENTATION POND CALCULATIONS FOR SEDIMENT STORAGE

- NEED 22 yd^3/Ac. STORAGE FOR PONDS

- SOUTH SED. POND DRAINAGE AREA:

LARGEST AREA DRAINING INTO SED. POND OCCURS DURING "CASE 2" CONDITIONS.

AREA = $1,844,584\ ft^2 / 43,560\ ft^2/Ac = 42.35\ Ac$

STORAGE REQ'D FOR SOUTH SED. POND:

$42.35\ (22\ yd^3/Ac) = 931.7\ yd^3$ OR $25,156\ ft^3$

- NORTH SED. POND DRAINAGE AREA:

AREA = $\left[1,677,913\ ft^3\ (\text{CELL \#2}) + 854,643\ ft^3\ (\text{CELL \#3})\right] / 43,560\ ft^3/Ac = 58.14\ Ac$

STORAGE REQ'D FOR NORTH SED. POND:

$58.14\ Ac\ (22\ yd^3/Ac) = 1279.1\ yd^3$ OR $34,536\ ft^3$

- CHECK STORAGE AVAILABLE IN SOUTH SED POND

- PIPE INV. @ OUTLET PIPE TO RET. WTR. POND IS SET @ EL. 725.50. CALCULATE VOL. AVAILABLE UP TO THIS ELEVATION.

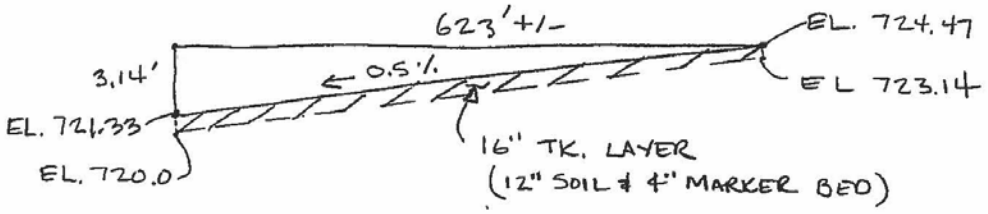
2009 CALCS

SOUTHERN COMPANY

Design Calculations

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 2 of 3

-SOUTH SED. POND, CONT.



LENGTH OF POND = 623'
WIDTH = 115.5'

$V_{OL} = \frac{1}{2}(623')(3.14')(101') = 98{,}789\ ft^3$ O.K.

O.K. WOULD HAVE ENOUGH STORAGE IN JUST THIS VOLUME OF POND. TOTAL AVAILABLE IS TO EL. 725.5 OR:

AREA @ EL. 724.47 = 71,998 ft²
AREA @ EL. 725.5 = 75,720 ft²

$$98{,}789 + \left[\frac{71{,}998\ ft^2 + 75{,}720\ ft^2}{2}\right](1.03') = 174{,}864\ ft^3$$

$VOL = 174{,}864 / 27\ ft^3/yd^3 = 6476\ yd^3$

- CHECK STORAGE AVAILABLE IN NORTH SED. POND:

- PIPE INV. @ OUTLET PIPE TO RET. WTR. POND IS SET AT EL. 725.50. CALCULATE VOL. AVAILABLE UP TO THIS ELEVATION.

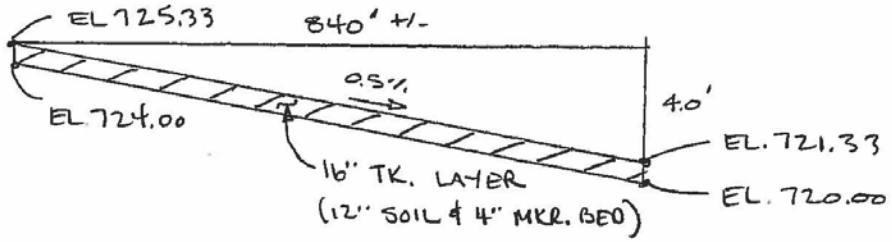
2009 CALCS

SOUTHERN COMPANY

Design Calculations

Project	Prepared By	Date
Subject/Title	Reviewed By	Date
	Calculation Number	Sheet 3 of 3

-NORTH SED. POND, CONT.



LENGTH OF POND ~840' (@EL. 725.33)
WIDTH OF POND ~98' (@EL. 725.33)

$VOL = \frac{1}{2}(845')(4.0')(98') = 165,620\ ft^3$ O.K.

O.K., WOULD HAVE ENOUGH STORAGE IN JUST THIS VOLUME OF POND. THE TOTAL AVAILABLE STORAGE IS TO EL 725.5 OR:

AREA @ 725.33 = 83,662 ft²
AREA @ 725.50 = 84,459 ft²

725.50
- 725.33
0.17'

$165,620\ ft^3 + \left[\frac{83,662\ ft^2 + 84,459\ ft^2}{2}\right](0.17') = 179,910\ ft^3$

$VOL = 179,910\ ft^3 / 27\ ft^3/yd^3 = 6663\ yd^3$