SURFACE WATER MANAGEMENT SYSTEM
LANDFILL 3

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal #:** GR3762 **Task #:** 05

TITLE OF COMPUTATIONS Quantity Estimation Calculation Package

COMPUTATIONS BY:
Signature
Printed Name and Title Jill F. Roboski
Engineer
9 Feb 2007
DATE

ASSUMPTIONS AND PROCEDURES CHECKED BY:
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Project Engineer
9 FEB 2007
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APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal #:** GR3762 **Task #:** 05

TITLE OF COMPUTATIONS Design & Analysis Of The Surface Water Management System For Landfill No.3

COMPUTATIONS BY:
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DATE
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and Title Principal

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

TABLE OF CONTENTS

Written by: Mehmet Iscimen **Date:** 09/13/06 **Reviewed by:** Victoria Cheplak **Date:** 10/04/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

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List of Attachments

EXECUTIVE SUMMARY

In this calculation package, surface water management system design for Landfill No.3 (LF3) has been evaluated. Design criteria was established based on the “Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites”, discussions with the City of Anniston, and general practice experience related to stormwater management system designs. The criteria included the comparison of stormwater runoff from the site under pre-development and post–development conditions and the function of the stormwater management system under the 25-year, 24-hour design storm.

In order to analyze and design the stormwater management system, a variety of parameters including hydrologic soil types, rainfall distribution and depths, and topographical information such as slopes, elevations, and areas, were evaluated for the site. Using the methodology and procedures described in Soil Conservation Service’s Technical Release-55 [SCS TR-55, 1986], storm water runoff rates and volumes were calculated.

Results of this analysis indicate that the peak stormwater discharge rate from the site under post-development conditions with the stormwater management system is less than peak stormwater discharge rate under pre-development conditions. The stormwater management system consists of stormwater diversion berms and their appurtenances, as well as a new eastern perimeter channel, an existing western perimeter channel, and a downchute to convey the flow.

Written by: Mehmet Iscimen **Date:** 09/13/06 **Reviewed by:** Victoria Cheplak **Date:** 10/04/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

DESIGN & ANALYSIS OF THE SURFACE WATER MANAGEMENT SYSTEM

PURPOSE

The purpose of this calculation package is to present the analysis and design of the surface water management system for the final cover system at the Landfill 3 site (LF3) at the former Fort McClellan (McClellan) in Anniston, Alabama. The following are the specific goals of this package:

- establish the design criteria;
- calculate the pre-development peak discharges leaving the site;
- design the components of the surface water management system, including final cover system, diversion berms and appurtenances, perimeter channel and downchute;
- calculate the post-development peak discharges leaving the site; and
- compare the calculated post-development discharges with the calculated pre-development discharges.

SURFACE WATER MANAGEMENT SYSTEM - OVERVIEW

The topographic map of LF3 and the plan view of the proposed surface water management system are provided in Attachments 1 and 2, respectively. The cover system will have slopes of generally 1 to 2 percent, fitting to the existing topography and stormwater routing practices. Side slopes (perimeter slopes) of the cover system will be 33 percent (i.e., 3H:1V) until natural ground surface elevations are reached. The cover system forms a ridge between two peaks located at the southeast corner towards the center to western boundary of the landfill. The access road is generally located along the ridge. The cover system design allows storm water runoff to flow approximately equally to east and west sides of the landfill with the exception of a small area on the south side of the landfill draining to the wetlands located south of the site.

Stormwater runoff is managed by diversion berm/channel structures distributed over the cover system of LF3. These structures are formed by 1.5-foot high benches constructed on the cover system. The runoff collected in the diversion structures will be detained within the bermed channels and released over time by 6-inch diameter, horizontal, corrugated metal pipes. The number of the pipes at each structure is dependent upon the storm runoff volume, peak discharge rate, and available storage volume.

Structures located on the western side of LF3 will drain to the existing channel located adjacent to the western perimeter of the landfill. Structures located on the eastern side of LF3 will drain to a new perimeter channel to be constructed adjacent to the eastern boundary of the landfill. This channel is designed with a V-shaped cross-section, 33 percent (3H:1V) west side slopes, 50 percent (2H:1V) east side slopes, and 2-feet depth and will join the existing western perimeter channel near the northeast corner of LF3. Flow from one set of the eastern diversion structures, located near the center of LF3, is directed to a riprap downchute on the east slope, which in turn directs the flow into the new perimeter channel.

DESIGN APPROACH

The surface water management system for the LF3 is designed to meet requirements of the “Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites” (herein referred as ASWCC [2003]) [Alabama Soil and Water Conservation Committee, 2003]. ASWCC [2003] does not specifically recommend a certain storm event for design purposes, however it does state: *“In many localities, a 10-year design storm is specified to preserve the effectiveness of downstream drainage structures which were originally designed to pass a 10-year pre-development storm. Other localities require that larger storms (i.e., 50-100 year events) must be detained and released at a controlled rate to reduce the downstream effects of major storms*.” Based on this statement, discussions with the City of Anniston, and general practice experience related to stormwater management system designs, the following criteria are selected for the stormwater management system design:

- Design, construct, operate, and maintain a runoff management system to collect and control at least the peak flow volume resulting from a 25-year, 24-hour design storm event;
- Design holding facilities (e.g., detention basins) associated with run-on and runoff control systems to detain at least the water volume resulting from a 25-year, 24-hour design storm event with 0.5-feet of freeboard; and
- Design conveyance facilities (e.g., perimeter channels) to provide a minimum of 0.25 feet of freeboard for calculated peak flows from the 25-year 24-hour design storm.

ANALYSIS METHODOLOGY

Pre-development Watershed Analysis

Attachment 1 presents the topographic map for the general site vicinity and the boundary of LF3. Attachment 3 presents the delineation of the natural watersheds in the vicinity of the site on the topographic map. These drainage areas are the basis for the pre-development watershed analysis.

Post-development Analysis of Surface Water Management System

Attachment 2 presents the topographic map for the general site vicinity of LF3 for the post-development conditions. The map also identifies the locations of the diversion structures, the downchute, and the perimeter channels.

Attachment 4 presents a Schematic Plan of the surface water management system and the delineation of subareas, reaches (i.e., perimeter channels), and ponds (i.e., detention areas caused by the diversion structures) on the cover system. The post-development analysis of the surface water management system is based on the parameters calculated/estimated from this plan.

SOFTWARE

Storm water discharges are estimated using the computer program "HydroCAD^{TM}" [HydroCAD^{TM} 7.1, 2005]. The program uses hydrology procedures presented in Soil Conservation Services' TR-55 [SCS TR-55, 1986]. Hydrographs generated within the computer program are routed through a user specified network of reaches using documented hydraulic routing techniques.

MAJOR CALCULATION PARAMETERS

- **Rainfall Distribution**: Attachment 5 [SCS TR-55, 1986] shows the location of the site on the rainfall distribution map of the United States. The site is located in Calhoun County, Alabama, which is categorized by SCS Type II Rainfall Distribution.

- **Rainfall Depths:** Attachment 5 also presents the site location and the rainfall depth for the 2-year and 25-year, 24-hour design storms. The 2-year rainfall depth is used for calculating the times of concentration for hydrologic modeling. The rainfall depths are shown in the following table.

Return Period (years)	Duration (hours)	Design Rainfall Depth (inches)
2	24	3.9
25	24	6.7

- **Hydrologic Soil Groups (HSG):** Attachment 6 presents the regional soils maps for the vicinity of LF3 and Borrow Area No.2 located southeast of Reilly Airfield. Major soil units found within the areas of interest and the corresponding HSGs are listed in the Table A6-1 in Attachment 6. The LF3 vicinity is composed of HSG B, HSG C, and HSG D soils. Therefore, HSG B was conservatively used for the pre-development analyses performed in this package. For the final cover system, it is anticipated that a local area adjacent to Reilly Airfield southeast of the site will be used as a borrow source. This area consists of soils characterized as HSG B. Therefore, for the purposes of hydrologic modeling performed in this package, HSG B is assumed for the post-development analyses.

- **Curve Numbers (CN):** CNs were selected based on Table 2.2a and 2.2c of SCS TR-55, 1986. The following table summarizes the CNs chosen for the analyses performed in this package. The complete version of both tables can be found in Attachment 7.

Area Description	Condition	HSG	CN
Pre-Development Conditions of the LF3	Woods – Good Condition	B	55
LF3 Cover System	Open Space, Good Hydrologic Condition (Grass Cover>75%)	B	61

- **Nodal Network Diagram:** Attachment 8 presents a diagram of the nodal network used in HydroCAD^{TM} for the pre-development and post-development analysis.

    - <u>Pre-development Nodal Network:</u> In the pre-development scenario (identified in Attachment 3), the site is divided into four subcatchments routed to the western perimeter channel or the eastern perimeter. The two perimeter drainage paths ultimately join near the northeast corner of LF3.

- Post-development Nodal Network: Subcatchments as depicted in the Schematic Surface Water Management Plan (Attachment 4) were generally routed to diversion structures which discharge into the perimeter channels. The perimeter channels ultimately join near the northeast corner of LF3.

- **Properties of Subareas:** Attachment 9 presents roperties of the subareas used in HydroCAD^{TM} for the pre- and post-development analysis. The computed area (acres) of each subarea, curve number, and computations for times of concentration are included in Attachment 9.

  Computations for travel time for sheet flow are performed using the equation for Manning's kinematic solution [SCS TR-55, 1986]:

  $$T_t = \frac{0.007(nL)^{0.8}}{(P)^{0.5} S^{0.4}}$$

  where, T_t=travel time (hr), n=Manning's roughness coefficient, n=0.15 for short grass and n=0.80 for woods with dense underbrush, L=flow length (ft), P=2-year, 24-hour rainfall depth (inches), and S=land slope (ft/ft).

  After a maximum of 300 feet, sheet flow is assumed to become shallow concentrated flow (i.e., upland flow). Travel times for shallow concentrated flow are estimated using the methodology presented in TR-55 [SCS TR-55, 1986]:

  $$T_t = \frac{L}{K\,S^{0.5}}$$

  where, T_t = travel time (seconds), L = flow length (ft), S = land slope (ft/ft), K = 7.0 for short grass pasture and K = 2.5 for forest with heavy litter.

DESIGN OF SURFACE WATER MANAGEMENT SYSTEM COMPONENTS

Stormwater Diversion Structures and Downchute

Surface water runoff at LF3 will be controlled by storm water diversion structures located on the landfill. The diversion structures will be formed by benches constructed over the cover system. The benches will have a v-shaped cross-sectional geometry, with 1.5-feet depth, 1-foot width at the top, and 33% (3H:1V) side slopes. They will function to break the continuous slope along the cover system, dividing the cover system into distinct subcatchments, and then divert and detain the runoff from each individual subcatchment. The detained runoff will pond in the diversion structure due to 6-inch diameter corrugated metal spillway pipes serving as outlet pipes which will convey the flow to the perimeter channels.

One set of diversion structures (designated as 5P in HydroCAD^{TM}) located towards the center of the landfill, will function slightly differently, in that the flow from the spillway pipe will first drain to a downchute and then to the eastern perimeter channel. The downchute is designed with a V-shaped cross-section, 33-percent side slopes and 1.5-foot depth. It has a constant longitudinal slope of 1 percent. Velocities in the channel do not exceed 1.3 feet/second for the 25-year, 24-hour storm event.

The storage capacities of the diversion structures were designed based on the cover system grades and required storage at each subcatchment. They are designed to provide a minimum of 0.5-feet of freeboard for calculated peak flows from the 25-year, 24-hour design storm. The following table summarizes the number of the spillway pipes at each diversion structure, depth of flow and available freeboard from the 25-year, 24-hour storm as designated in the HydroCAD^{TM} model. As shown in the table, the diversion structure design meets the minimum freeboard criteria. Details of outlet structures can be seen on Attachment 10. Ponded water elevations from a 25-year 24-hour storm can be seen in Attachment 11.

Diversion Structure Designation	**Number of Spillway Pipes**	**Depth of Flow in the Diversion Structure (feet)**	**Available Freeboard (feet)**
5P	2	0.58	0.92
6P	2	0.64	0.86
7P	2	0.51	0.99
9P	2	0.55	0.95
10P	2	0.58	0.92
11P	2	0.80	0.70
12P	4	0.93	0.57
13P	2	0.40	1.10

Riprap protection is recommended at the (i) diversion structure outlets and connections to the perimeter channels and (ii) lining the downchute, since erosion control is critical to long term performance of the final cover system.

For the diversion structure outlets and connections, Figure OP-2 from ASWCC [2003] was used to estimate required riprap size and apron length. Accordingly, d_{50} is found to be 3 inches whereas the maximum apron length is found to be 10 feet.

For the lining of the downchute, the following equation was used to calculate the riprap size required (ASWCC [2003]):

$$d_{50} = [QS_0^{0.58} / (3.93*10^{-2})]^{(1/1.89)}$$

where, d_{50}=minimum median riprap diameter (in), Q=discharge through the downchute from 25-year, 24-hour storm (cfs), and S_0=longitudinal slope (ft/ft). Required d_{50} for the downchute is found to be 1.1 inches.

The riprap protection sizing calculations are presented in Attachment 10. Details of the downchute and diversion berm intersection and the diversion berm intersection and pipe outlet can be found on Drawings C-14 and C-15, Surface Water Management Details 1 and 2.

Eastern Perimeter Channel

The new eastern perimeter channel is designed with a V-shaped cross-section, 33 percent (3H:1V) west and 50 percent (2H:1V) east side slopes and 2-foot depth. It has a constant longitudinal slope of 0.5 percent. Velocities in the channel do not exceed 2.1 feet/second for the 25-year, 24-hour storm event; therefore, grass lining is appropriate. The peak depth in the channel is 0.98 feet, corresponding to 1.02 feet freeboard, satisfying the design criteria.

COMPUTATIONS USING HydroCAD^{TM}

Calculations were performed using HydroCAD^{TM} for the input parameters discussed in the previous section for the 25-year, 24-hour design storm. The computer program results for the pre-development and post-development analyses are presented in Attachments 11 and 12.

COMPARISON OF PRE- VERSUS POST-DEVELOPMENT DISCHARGES

The following table summarizes the results from Attachments 11 and 12 for pre- and post-development discharges from the site for the 25-year, 24-hour design storm. As shown in the table, the post-development discharge with the storm water management system described above is less than the pre-development discharge at the nodal point for the design storm that was considered in this analysis.

Design Rainfall Event	**Design Rainfall Depth (inch)**	**Peak Pre-Development Discharge (At Nodal Point) (cfs)**	**Peak Post-Development Discharge (At Nodal Point) (cfs)**
25-year, 24-hour	6.7	8.11	7.22

REFERENCES

Alabama Soil and Water Conservation Committee (ASWCC), "*Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites*", 2003.

Chadwick, Andrew and Morfett, John, "*Hydraulics in Civil and Environmental Engineering*", 2nd edition, E&FN Spon, 1993, London.

HydroCAD, "*HydroCAD™: Stormwater Modeling System, Version 7*", HydroCAD Software Solutions LLC., 2nd ed., Chocorua, New Hampshire, 2004.

SCS, "*TR-55 Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55)*", United States Department of Agriculture, Soil Conservation Service, 2nd ed., Washington, D.C., 1986.

ATTACHMENT 1

Topographic Map
(Pre-Development)

LEGEND

—730—	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
═	EXISTING ROAD
━━ ━━	LANDFILL/FILL AREA PERIMETER LIMIT
— – – —	INDUSTRIAL ACCESS ROAD RIGHT-OF-WAY LIMIT
— - —	INDUSTRIAL ACCESS ROAD CENTERLINE
▭	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
∿→	SURFACE WATER FLOW DIRECTION

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 200' 400'
SCALE IN FEET

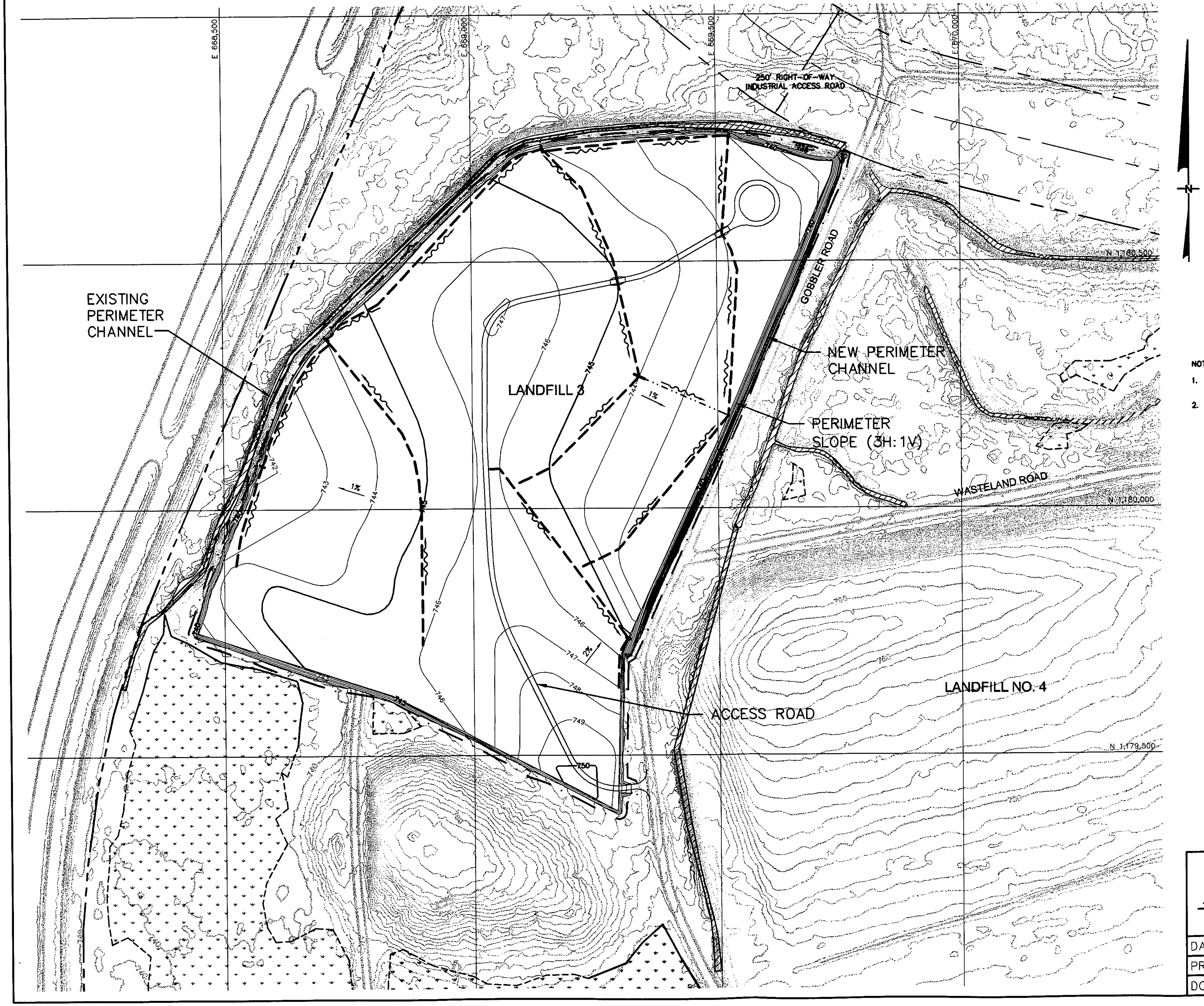
ATTACHMENT 1 - TOPOGRAPHIC MAP (PRE-DEVELOPMENT)

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	1"=200'
PROJECT NO.	GR3762	FILE NO.	3762SM05
DOCUMENT NO.		FIGURE NO.	1

ATTACHMENT 2

Surface Water Management System: Grading Plan



LEGEND

——730——	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
▒▒▒▒	EXISTING ROAD
—— · ——	LIMIT OF WORK
——750——	FINISHED GRADE ELEVATION (FEET)
—— – – ——	INDUSTRIAL ACCESS ROAD RIGHT-OF-WAY LIMIT
—— – ——	INDUSTRIAL ACCESS ROAD CENTERLINE
– · · – · · –	CENTERLINE OF DOWNCHUTE
▬ ▬ ▬ ▬	CENTERLINE OF DIVERSION BERM
⁘	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
∿→	SURFACE WATER/DIVERSION BERM FLOW DIRECTION

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 200' 400'

SCALE IN FEET

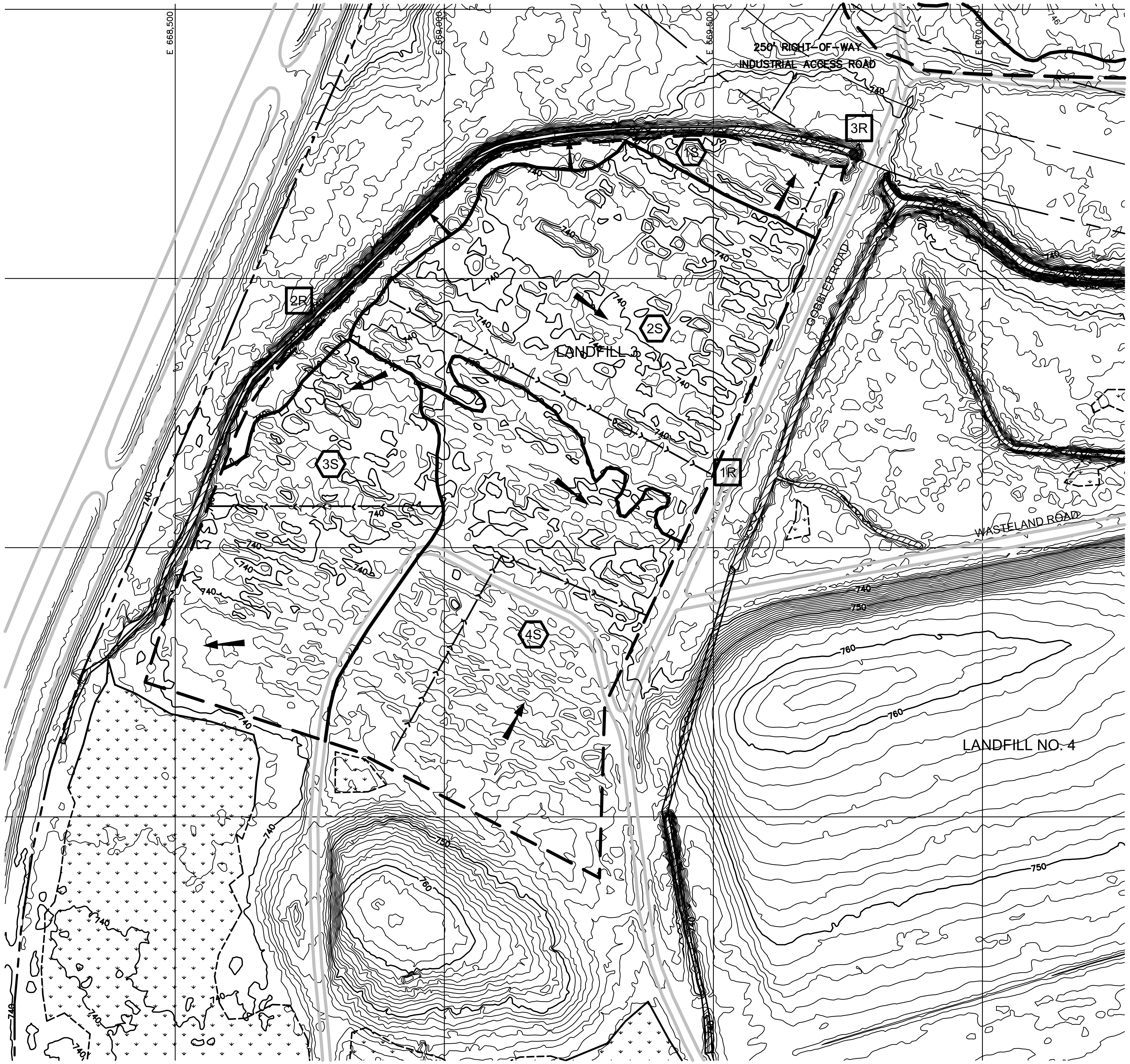
ATTACHMENT 2 - SURFACE WATER MANAGEMENT SYSTEM: GRADING PLAN

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	1"=200'
PROJECT NO.	GR3762	FILE NO.	3762SM06
DOCUMENT NO.		FIGURE NO.	2

ATTACHMENT 3

Pre-Development Watershed Delineation Map



LEGEND

730	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
═	EXISTING ROAD
━ ━	LANDFILL/FILL AREA PERIMETER LIMIT
— - - —	INDUSTRIAL ACCESS ROAD RIGHT-OF-WAY LIMIT
—— - ——	INDUSTRIAL ACCESS ROAD CENTERLINE
↓ ↓ ↓	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
━	SUBCATCHMENT BOUNDARY
—<—<—	FLOW PATH FOR T_C CALCULATION
∿→	SURFACE WATER FLOW DIRECTION
1S	SUBCATCHMENT DESIGNATION
1R	REACH DESIGNATION
➤	FLOW DIRECTION
●	NODAL POINT

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 200' 400'
SCALE IN FEET

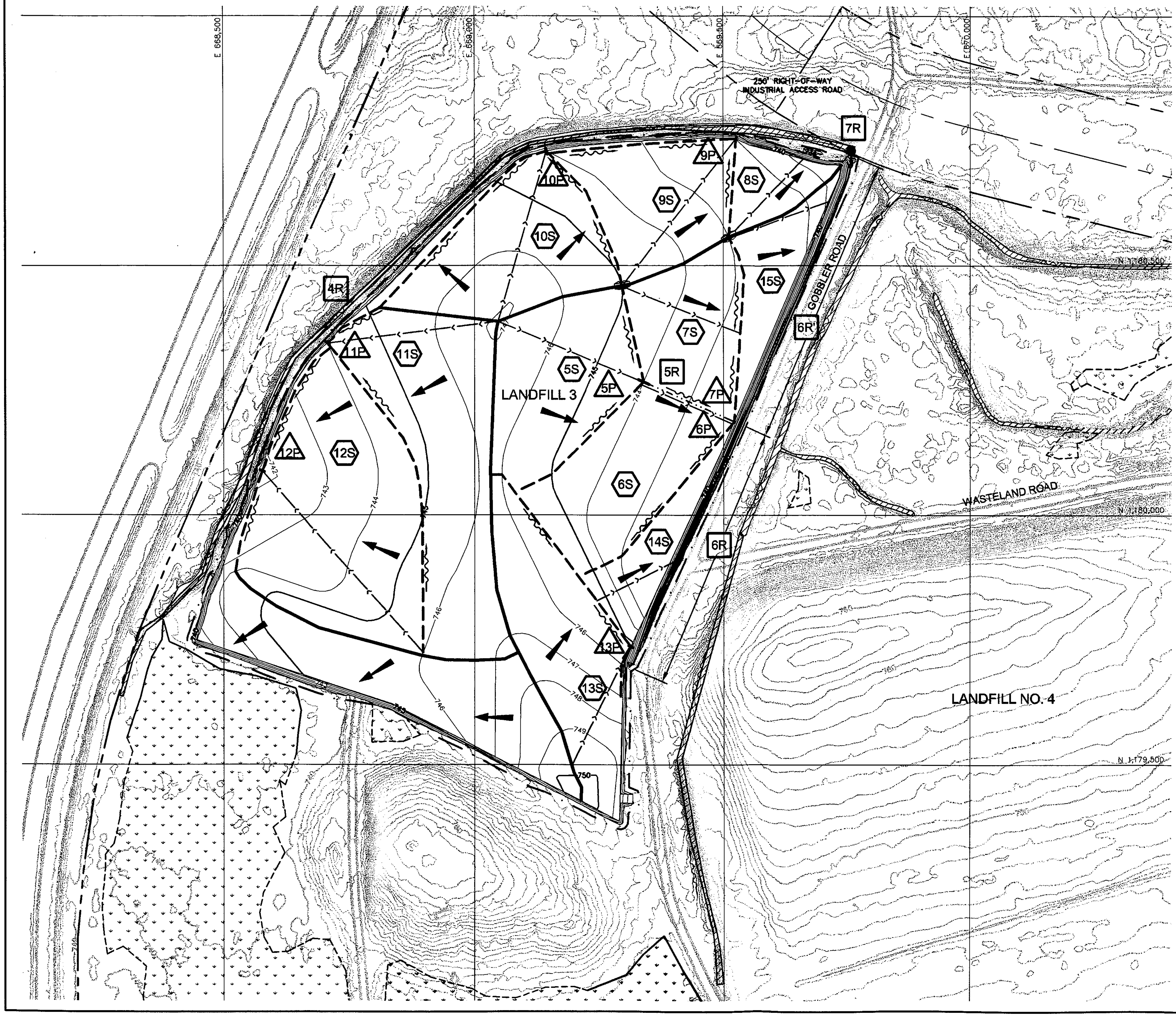
ATTACHMENT 3 - PRE-DEVELOPMENT WATERSHED DELINEATION MAP

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	1"=200'
PROJECT NO.	GR3762	FILE NO.	3762SM07
DOCUMENT NO.		FIGURE NO.	3

ATTACHMENT 4

Post-Development Watershed Delineation Map



LEGEND

- EXISTING GROUND ELEVATION (FEET) (NOTE 1)
- EXISTING ROAD
- LANDFILL/FILL AREA PERIMETER LIMIT
- 750 FINISHED GRADE ELEVATION (FEET)
- RIGHT-OF-WAY LIMIT
- INDUSTRIAL ACCESS ROAD CENTERLINE
- CENTERLINE OF DOWNCHUTE
- CENTERLINE OF DIVERSION BERM
- JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
- JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
- SURFACE WATER FLOW DIRECTION
- DIVERSION BERM FLOW DIRECTION
- SUBCATCHMENT BOUNDARY
- FLOW PATH FOR T_c CALCULATION
- 1S SUBCATCHMENT DESIGNATION
- 1R REACH DESIGNATION
- 5P POND DESIGNATION
- ➡ FLOW DIRECTION
- ● NODAL POINT

N

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 200' 400'

SCALE IN FEET

ATTACHMENT 4 - POST-DEVELOPMENT WATERSHED DELINEATION MAP

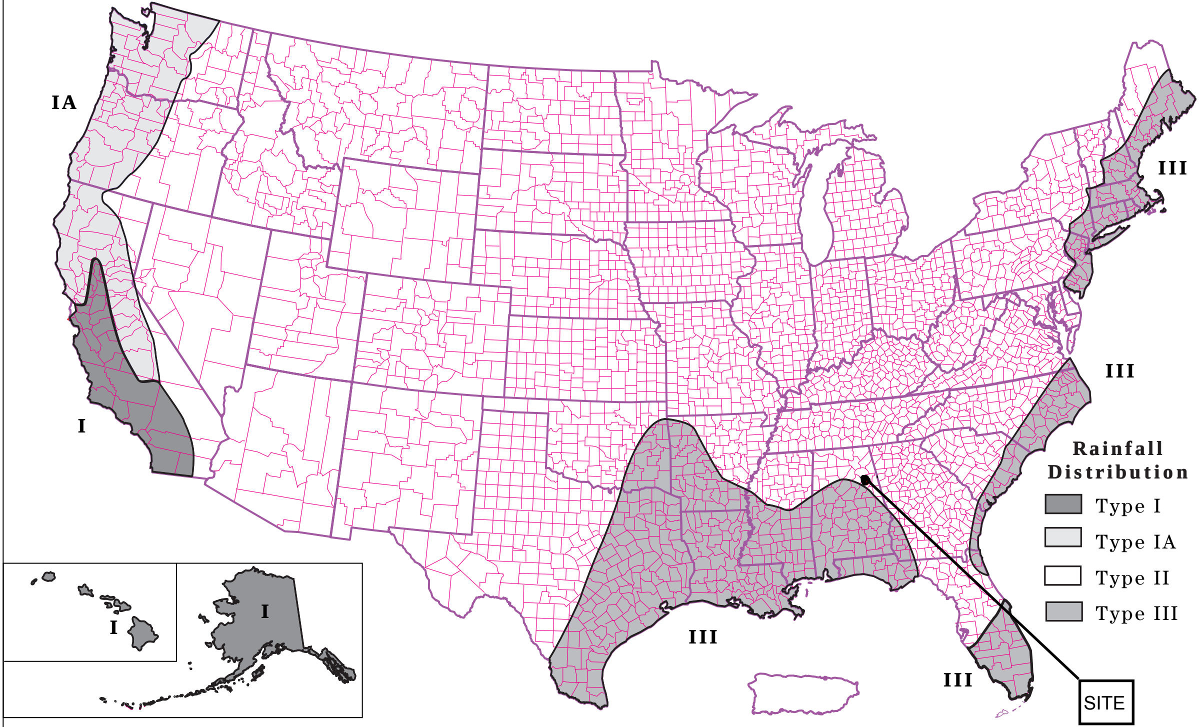
GEOSYNTEC CONSULTANTS

KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	1"=200'
PROJECT NO.	GR3762	FILE NO.	3762SM08
DOCUMENT NO.		FIGURE NO.	4

ATTACHMENT 5

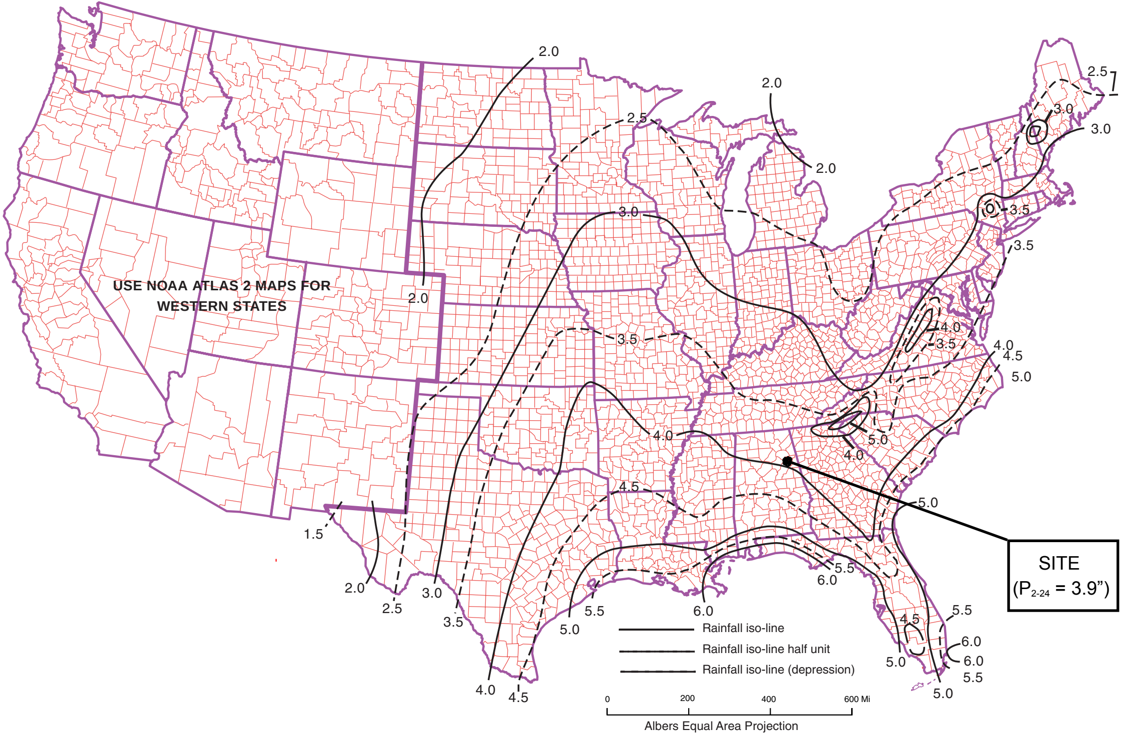
Rainfall Distribution and Rainfall Depths


IA
I
I
I
III
III
III
III
Rainfall Distribution
Type I
Type IA
Type II
Type III
SITE

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

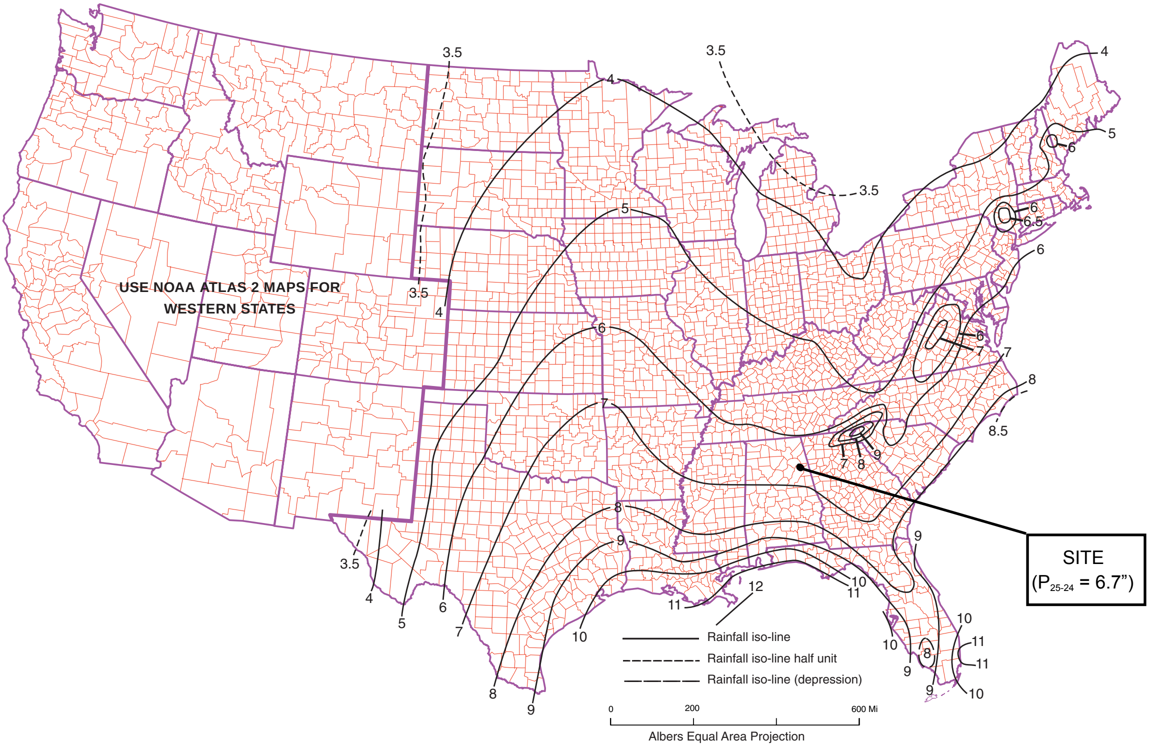
2-Year 24-Hour Rainfall (inches)



U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

25-Year 24- Hour Rainfall (inches)



USE NOAA ATLAS 2 MAPS FOR WESTERN STATES

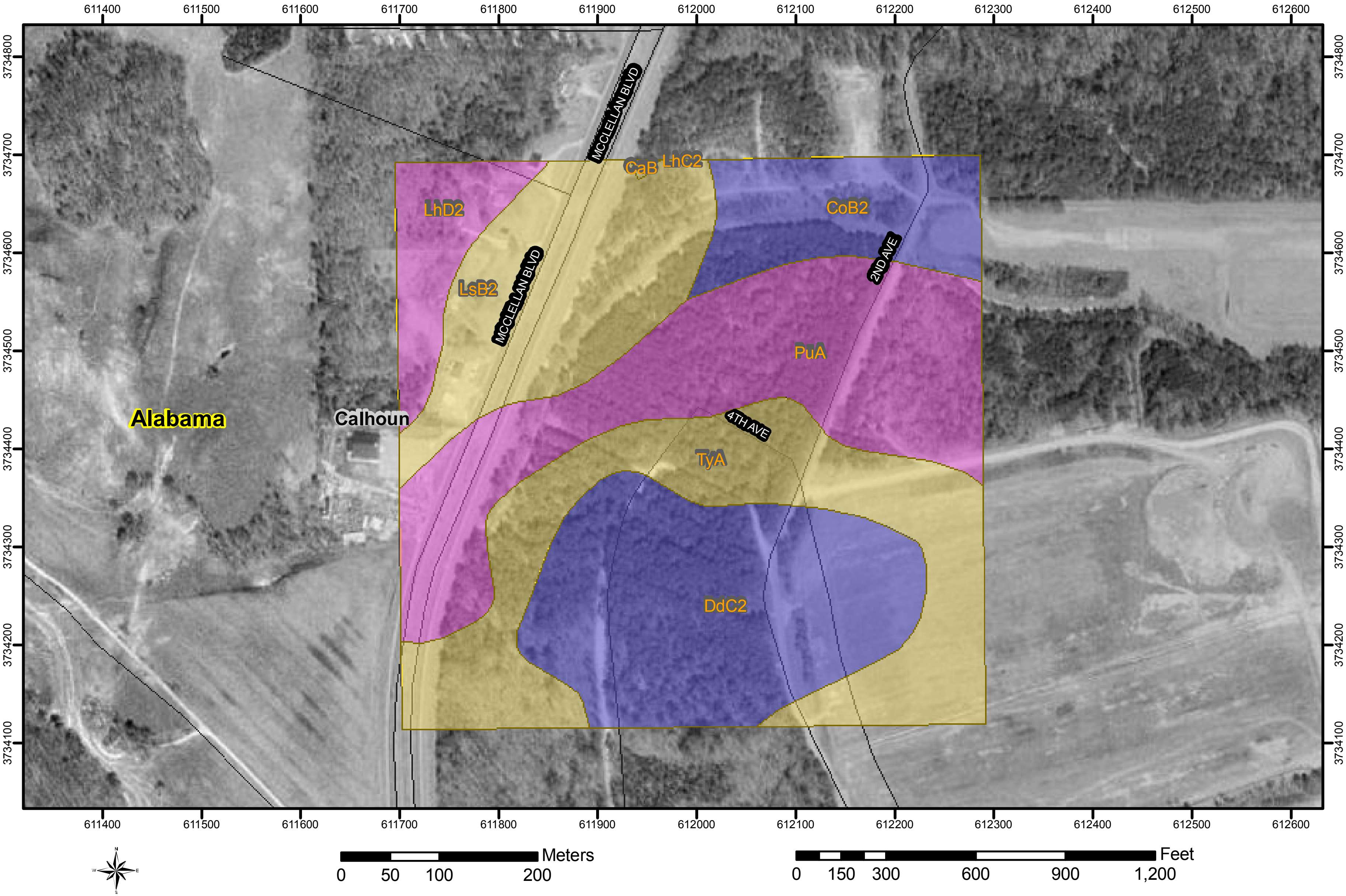
SITE
(P_{25-24} = 6.7”)

ATTACHMENT 6

Hydrologic Soil Groups

HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

Landfill No.3



HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

Landfill No.3

MAP LEGEND

Hydrologic Group

{Dominant Condition, <}

🟥	A
🟩	A/D
🟦	B
🟦	B/D
🟨	C
🟦	C/D
🟪	D
⬜	Not rated or not available
▭	Soil Map Units
●	Cities
▭	Detailed Counties
▭	Detailed States
—	Interstate Highways
—	Roads
—+—+—	Rails
🟦	Water
—	Hydrography
🟦	Oceans

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 16

Soil Survey Area: Calhoun County, Alabama
Spatial Version of Data: 3
Soil Map Compilation Scale: 1:20000

Map comprised of aerial images photographed on these dates:
1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables - Hydrologic Group

Summary by Map Unit - Calhoun County, Alabama

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
CaB	Camp silt loam, 2 to 6 percent slopes	C	0.1	0.1
CoB2	Cumberland gravelly loam, 2 to 6 percent slopes eroded	B	7.7	9.1
DdC2	Decatur and Cumberland loams 6 to 10 percent slopes, eroded	B	19.5	22.9
LhC2	Lehew-Montevallo soils, 2 to 10 percent slopes, eroded	D	0.0	0.0
LhD2	Lehew-Montevallo soils, 10 to 15 percent slopes, eroded	D	4.5	5.3
LsB2	Locust gravelly fine sandy loam, 2 to 6 percent slopes, eroded	C	13.5	15.9
PuA	Purdy silt loam, 0 to 2 percent slopes	D	20.8	24.4
TyA	Tyler silt loam, 0 to 2 percent slopes	C	19.0	22.3

Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

Parameter Summary - Hydrologic Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

Borrow Area No.2

USDA Natural Resources Conservation Service

Web Soil Survey 1.1
National Cooperative Soil Survey

9/22/2006

HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

Borrow Area No.2

MAP LEGEND

Hydrologic Group

{Dominant Condition, <}

🟥	A
🟩	A/D
🟦	B
🟦	B/D
🟨	C
🟦	C/D
🟪	D
⬜	Not rated or not available
□	Soil Map Units
●	Cities
□	Detailed Counties
□	Detailed States
—	Interstate Highways
—	Roads
┼	Rails
🟦	Water
—	Hydrography
🟦	Oceans

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 16

Soil Survey Area: Calhoun County, Alabama
Spatial Version of Data: 3
Soil Map Compilation Scale: 1:20000

Map comprised of aerial images photographed on these dates:
1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables - Hydrologic Group

Summary by Map Unit - Calhoun County, Alabama

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
AbC3	Anniston gravelly clay loam 6 to 10 percent slopes, severely eroded	B	11.4	56.1
CoB2	Cumberland gravelly loam, 2 to 6 percent slopes eroded	B	9.0	43.9

Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

Parameter Summary - Hydrologic Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

TABLE A6-1

MAJOR TYPES OF SOILS FOR RUN-ON AREAS IN THE SOIL MAP

Soil Unit (1)	**Soil Unit Description** (1)	**Location**	**Hydrologic Soil Group** (1)
CoB2	Cumberland Gravelly Loam	LF3 & Borrow Area No.2	B
PuA	Purdy Silt Loam	LF3	D
TyA	Tyler Silt Loam	LF3	C
DdC2	Decatur and Cumberland Loams	LF3	B
LsB2	Locust Gravelly Fine Sandy Loam	LF3	C
AbC3	Anniston Gravelly Clay Loam	Borrow Area No.2	B

Notes:

(1) Map symbols, map soil unit names, and hydrologic soil groups for the soil survey area obtained from Natural Resources Conservation Service (NRCS) Web Soil Survey Site with the web address http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx (accessed on 26 September 2006).

ATTACHMENT 7

Curve Numbers

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
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	$\boxed{61}$	74	80
Impervious areas:			FINAL COVER		
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (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
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
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					
Newly graded areas (pervious areas only, no vegetation) [5]	77	86	91	94	
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

---

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

[2] The average percent impervious area shown was used to develop the composite CN's. 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. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

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

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	$\boxed{55}$ PRE-DEVELOPMENT	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

---

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

[2] *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

[3] *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

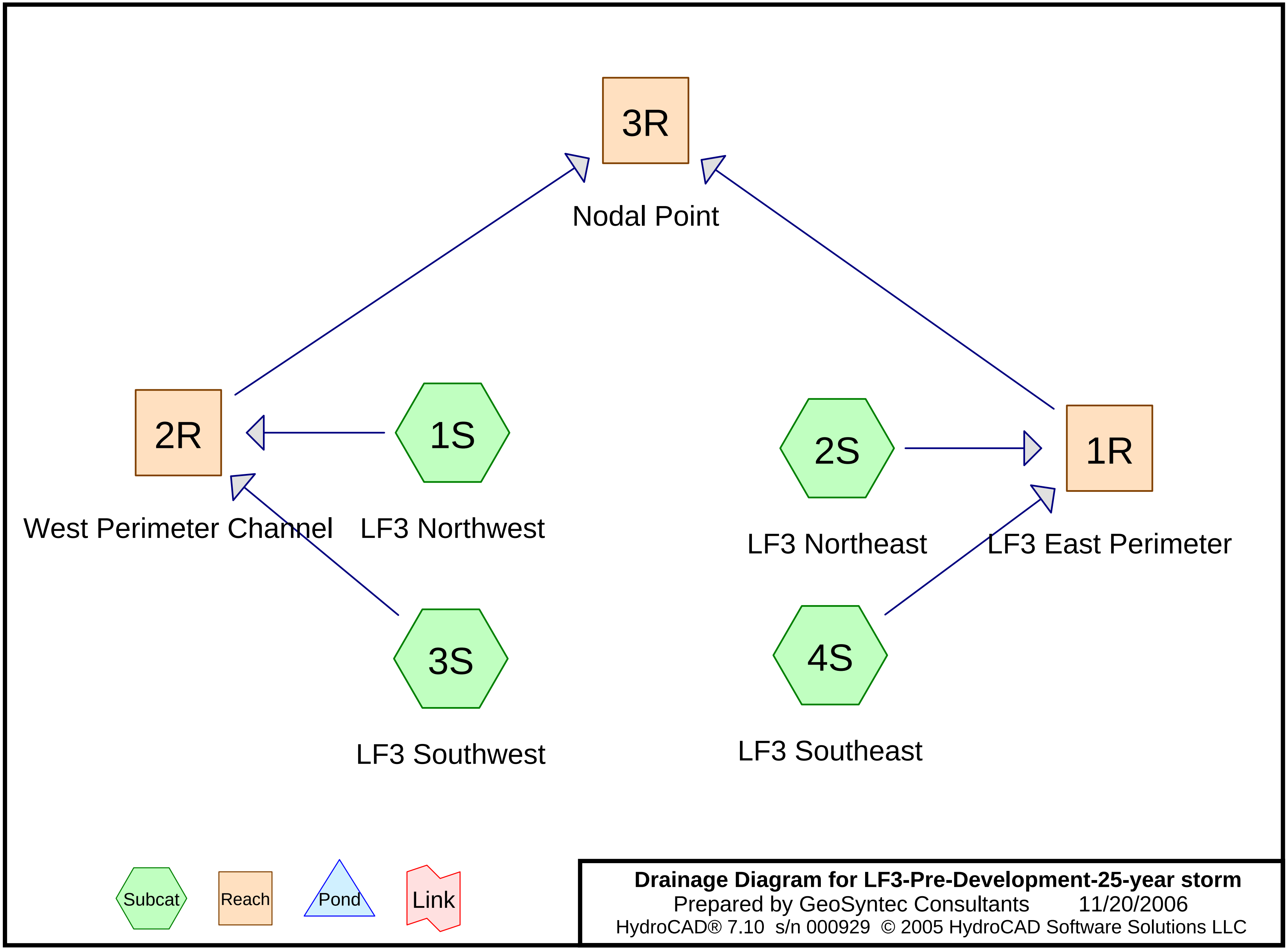
[4] Actual curve number is less than 30; use CN = 30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

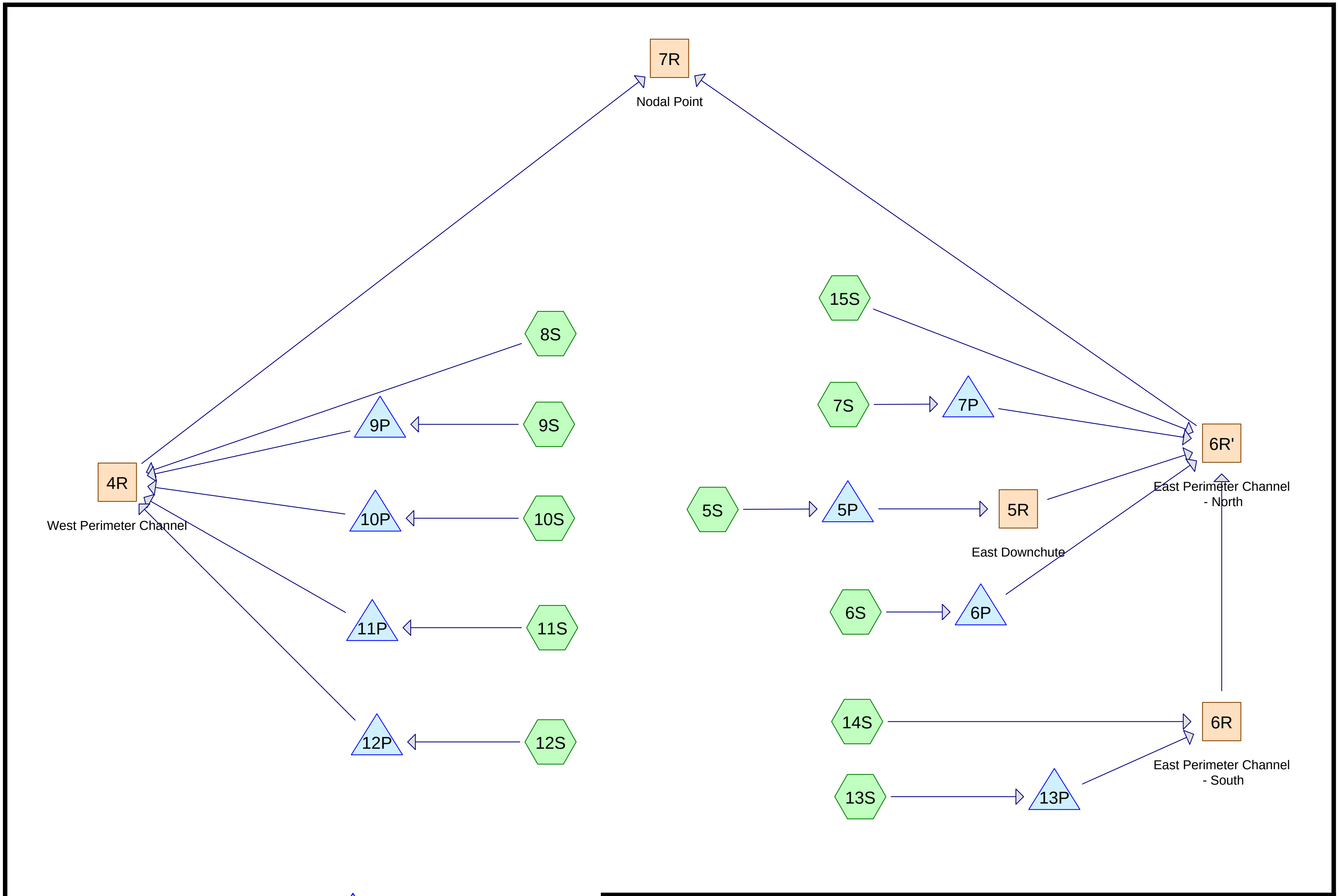
[6] *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

ATTACHMENT 8

HydroCAD^{TM} Nodal Network Diagrams



Drainage Diagram for LF3-Pre-Development-25-year storm
Prepared by GeoSyntec Consultants 11/20/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC



Drainage Diagram for LF3-Post-Development-25-year storm
Prepared by GeoSyntec Consultants 11/20/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

ATTACHMENT 9

Properties of Subareas

LANDFILL COVER SYSTEM
LANDFILL NO.3
SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS
AREAS, AND TIMES OF CONCENTRATION (Tc) CALCULATIONS FOR PRE- AND POST-DEVELOPMENT CONDITIONS

2-year, 24-hr Design Rainfall Depth, P_{2-24} = 3.90 inches

SUBAREA DESIGNATION in HydroCAD		**AREA (acres)**	**CURVE NUMBER**															
No.	Description																	
1S	LF3 Northwest (Pre-development)	1.71	55	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				150	Woods: Dense underbrush	0.800	0.001	--	--	--	--	--	--	--	--	139.8	--	**139.8**
2S	LF3 Northeast (Pre-development)	7.80	55	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Woods: Dense underbrush	0.800	0.003	400	Forrest w/Heavy litter	0.003	0.14	--	--	--	--	174.2	48.7	**222.9**
3S	LF3 Southwest (Pre-development)	5.60	55	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Woods: Dense underbrush	0.800	0.003	120	Forrest w/Heavy litter	0.008	0.22	--	--	--	--	174.2	8.9	**183.1**
4S	LF3 Southeast (Pre-development)	7.68	55	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Woods: Dense underbrush	0.800	0.003	120	Forrest w/Heavy litter	0.008	0.22	300	Forrest w/Heavy litter	0.003	0.14	174.2	45.5	**219.7**
5S	-- (Post-development)	1.95	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Grass: Short	0.150	0.010	--	--	--	--	--	--	--	--	28.2	--	**28.2**
6S	-- (Post-development)	1.90	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				200	Grass: Short	0.150	0.010	--	--	--	--	--	--	--	--	20.4	--	**20.4**
7S	-- (Post-development)	1.39	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				250	Grass: Short	0.150	0.010	--	--	--	--	--	--	--	--	24.4	--	**24.4**
8S	-- (Post-development)	0.52	61	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHALLOW CONCENTRATED FLOW 1**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				150	Grass: Short	0.150	0.007	50	Grass: Short	0.150	0.020	--	--	--	--	24.2	--	**24.2**

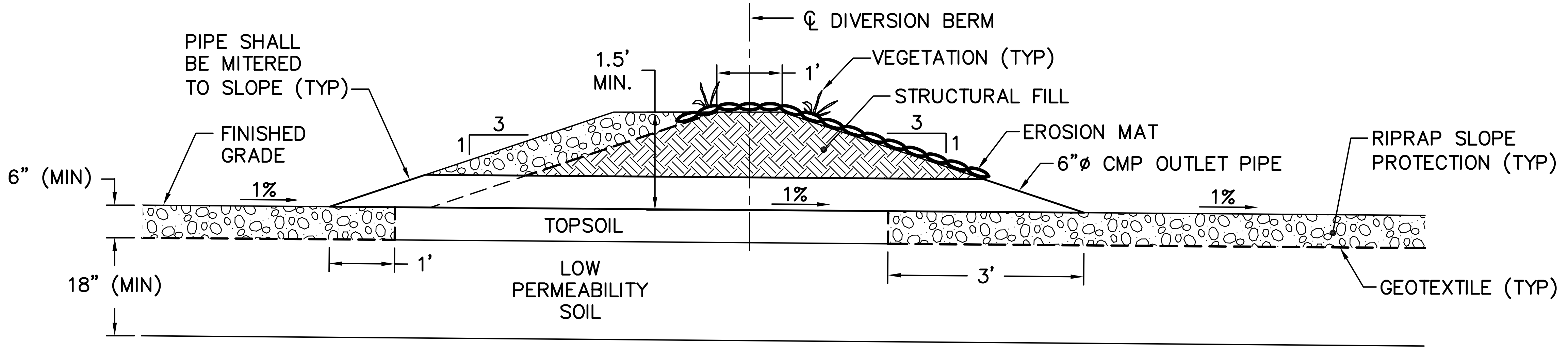
LANDFILL COVER SYSTEM
LANDFILL NO.3
SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS
AREAS, AND TIMES OF CONCENTRATION (Tc) CALCULATIONS FOR PRE- AND POST-DEVELOPMENT CONDITIONS

2-year, 24-hr Design Rainfall Depth, P_{2-24} = 3.90 inches

SUBAREA DESIGNATION in HydroCAD		**AREA (acres)**	**CURVE NUMBER**															
No.	Description																	
9S	-- (Post-development)	1.66	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Grass: Short	0.150	0.008	70	Short Grass Pasture	0.008	0.63	--	--	--	--	30.8	1.9	**32.7**
10S	-- (Post-development)	1.95	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Grass: Short	0.150	0.009	40	Short Grass Pasture	0.009	0.66	--	--	--	--	29.7	1.0	**30.7**
11S	-- (Post-development)	2.90	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Grass: Short	0.150	0.009	30	Short Grass Pasture	0.009	0.67	--	--	--	--	29.3	0.7	**30.0**
12S	-- (Post-development)	3.48	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				300	Grass: Short	0.150	0.009	170	Short Grass Pasture	0.009	0.65	--	--	--	--	30.1	4.4	**34.5**
13S	-- (Post-development)	2.00	61	**SHEET FLOW 1**				**SHALLOW CONCENTRATED FLOW 1**				**SHALLOW CONCENTRATED FLOW 2**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				250	Grass: Short	0.150	0.018	--	--	--	--	--	--	--	--	19.3	--	**19.3**
14S	-- (Post-development)	0.69	61	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHALLOW CONCENTRATED FLOW 1**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				60	Grass: Short	0.150	0.035	120	Grass: Short	0.150	0.008	--	--	--	--	19.3	--	**19.3**
15S	-- (Post-development)	1.08	61	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHALLOW CONCENTRATED FLOW 1**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				175	Grass: Short	0.150	0.006	50	Grass: Short	0.150	0.020	--	--	--	--	28.0	--	**28.0**

ATTACHMENT 10

Stormwater Diversion Berm Outlet Structures



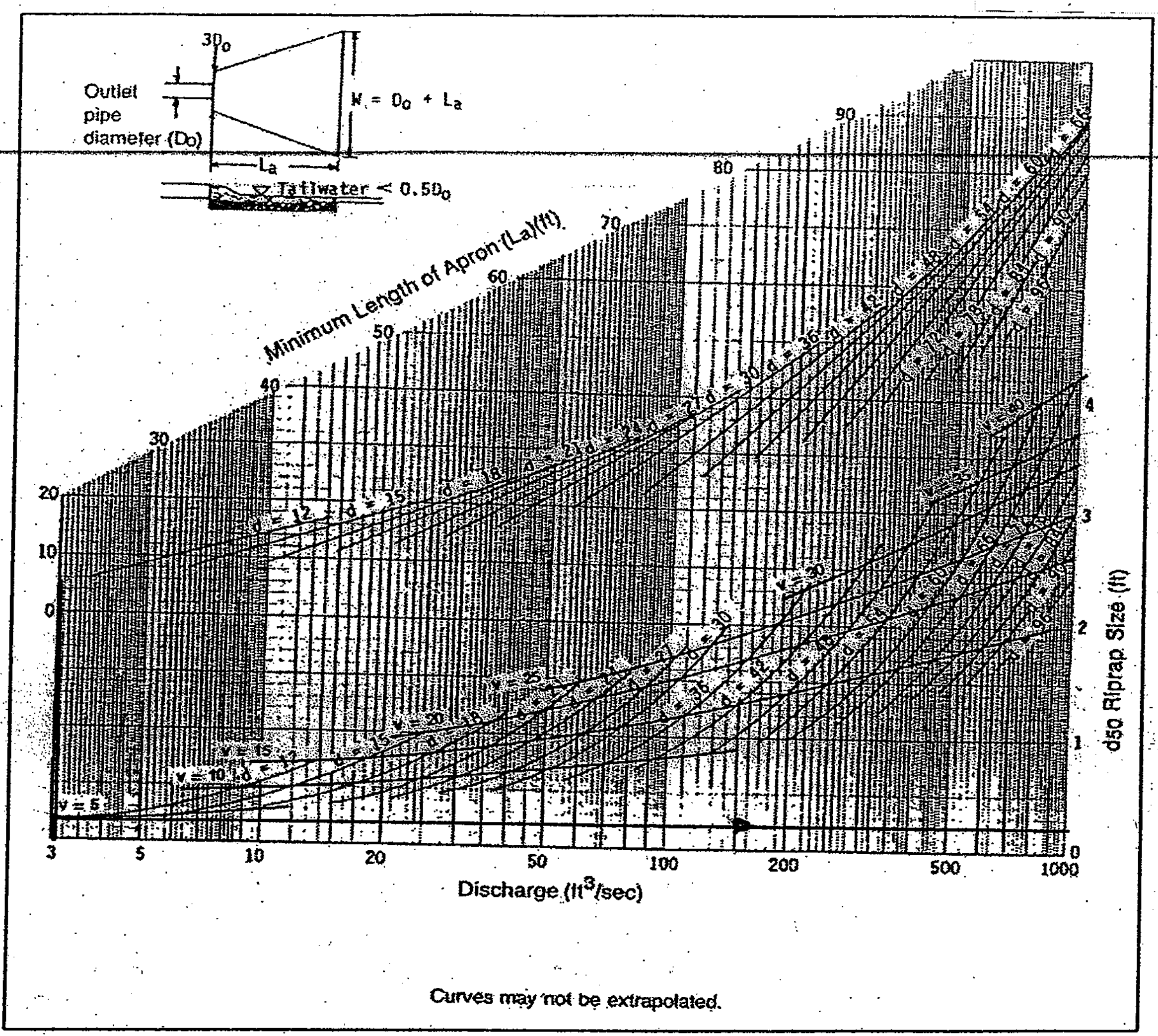
RIPRAP SIZE CALCULATION FOR THE DOWNCHUTE

$$D_{50} = [QS_0{}^{0.58} / (3.93*10^{-2})]^{(1/1.89)}$$
$$D_{50} = [0.72 \text{ cfs} * 0.01^{0.58} / 3.93*10^{-2})]^{(1/1.89)}$$
$$D_{50} = 1.1 \text{ inch}$$

ATTACHMENT 10 - DIVERSION BERM OUTLET STRUCTURES

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	N.T.S.
PROJECT NO.	GR3762	FILE NO.	3762SM11
DOCUMENT NO.		FIGURE NO.	10



Curves may not be extrapolated.

Figure OP-2 Outlet Protection Design for Tailwater < 0.5 Diameter

Maximum Discharge scenario – 12P

$Q = 2.08$ cfs

$d = 6$ inches × 4 pipes

$\therefore d_{50} = 3$ inches

$L_a = 6$ feet

Apron width at culvert = $3D_o$

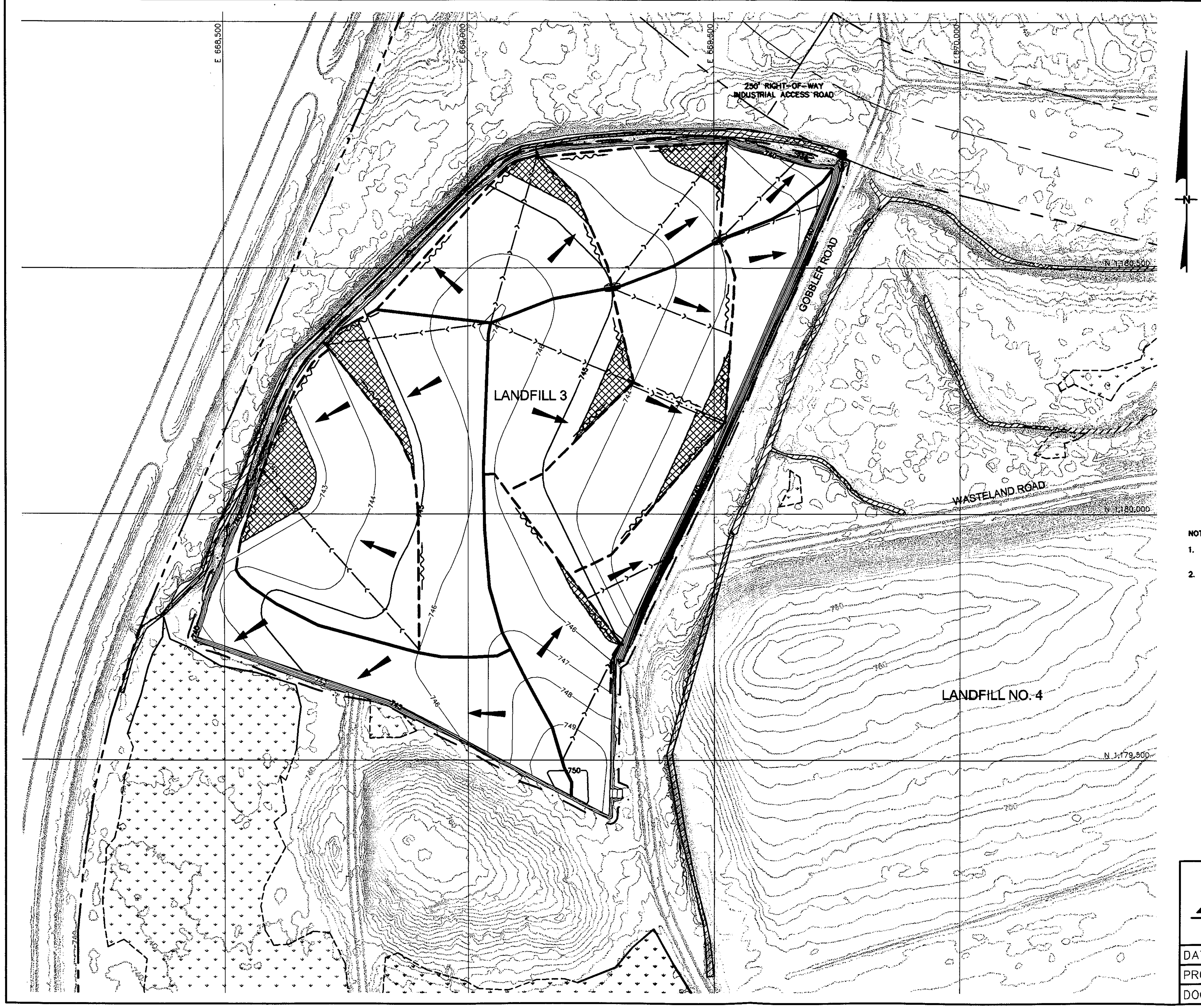
$= 3\times[(4\times0.5') + (3\times0.5')] = 10.5'$

Apron width at End = $D_o + L_a$

$= [(4\times0.5') + (3\times05')] + 6' = 9.5'$

ATTACHMENT 11

Ponded Water Elevations During 25-Year, 24-Hour Storm



LEGEND

- 730 EXISTING GROUND ELEVATION (FEET) (NOTE 1)
- EXISTING ROAD
- LANDFILL/FILL AREA PERIMETER LIMIT
- 750 FINISHED GRADE ELEVATION (FEET)
- RIGHT-OF-WAY LIMIT
- INDUSTRIAL ACCESS ROAD CENTERLINE
- CENTERLINE OF DOWNCHUTE
- CENTERLINE OF DIVERSION BERM
- JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
- ▨ JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
- SURFACE WATER FLOW DIRECTION
- DIVERSION BERM FLOW DIRECTION
- SUBCATCHMENT BOUNDARY
- ➡ FLOW DIRECTION
- ▩ PONDED WATER LIMIT

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 200' 400'
SCALE IN FEET

ATTACHMENT 11 - PONDED WATER ELEVATIONS DURING 25-YEAR 24-HOUR STORM

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	1"=200'
PROJECT NO.	GR3762	FILE NO.	3762SM12
DOCUMENT NO.		FIGURE NO.	11

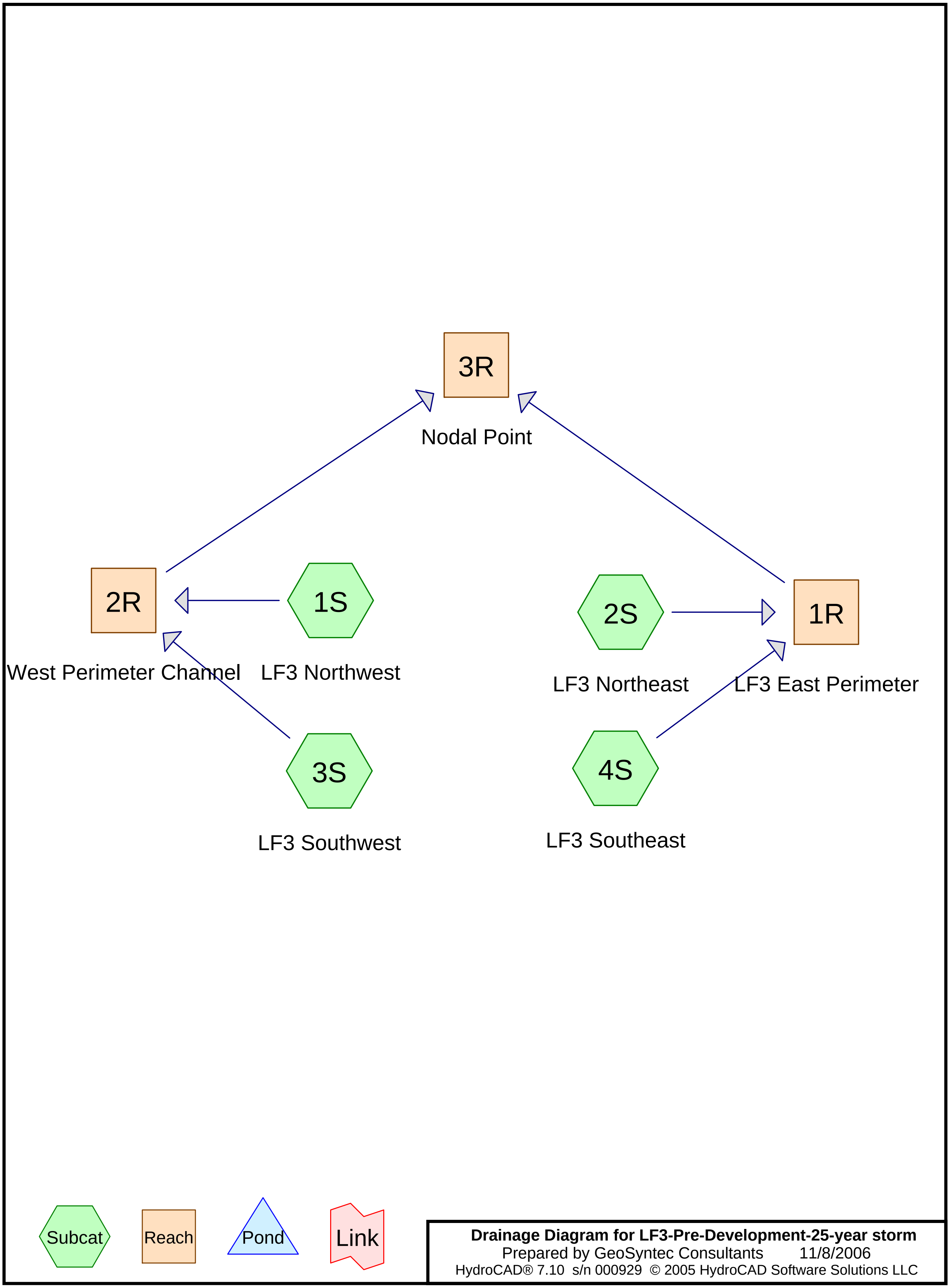
ATTACHMENT 12

Computations Using HydroCAD^{TM}: Pre-Development

25 Year – 24 Hour Storm

SCS Distribution

(Pre-Development)



Drainage Diagram for LF3-Pre-Development-25-year storm
Prepared by GeoSyntec Consultants 11/8/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

Time span=5.00-50.00 hrs, dt=0.05 hrs, 901 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: LF3 Northwest Runoff Area=1.710 ac Runoff Depth=1.94"
Flow Length=150' Tc=139.8 min CN=55 Runoff=0.83 cfs 0.276 af

Subcatchment 2S: LF3 Northeast Runoff Area=7.800 ac Runoff Depth=1.94"
Flow Length=700' Tc=222.9 min CN=55 Runoff=2.64 cfs 1.258 af

Subcatchment 3S: LF3 Southwest Runoff Area=5.600 ac Runoff Depth=1.94"
Flow Length=420' Tc=183.1 min CN=55 Runoff=2.23 cfs 0.903 af

Subcatchment 4S: LF3 Southeast Runoff Area=7.680 ac Runoff Depth=1.94"
Flow Length=720' Tc=219.6 min CN=55 Runoff=2.66 cfs 1.239 af

Reach 1R: LF3 East Perimeter Inflow=5.28 cfs 2.497 af
Outflow=5.28 cfs 2.497 af

Reach 2R: West Perimeter Channel Peak Depth=0.30' Max Vel=1.2 fps Inflow=2.95 cfs 1.179 af
n=0.030 L=2,080.0' S=0.0034 '/' Capacity=172.53 cfs Outflow=2.83 cfs 1.179 af

Reach 3R: Nodal Point Inflow=8.11 cfs 3.676 af
Outflow=8.11 cfs 3.676 af

Total Runoff Area = 22.790 ac Runoff Volume = 3.676 af Average Runoff Depth = 1.94"

Subcatchment 1S: LF3 Northwest

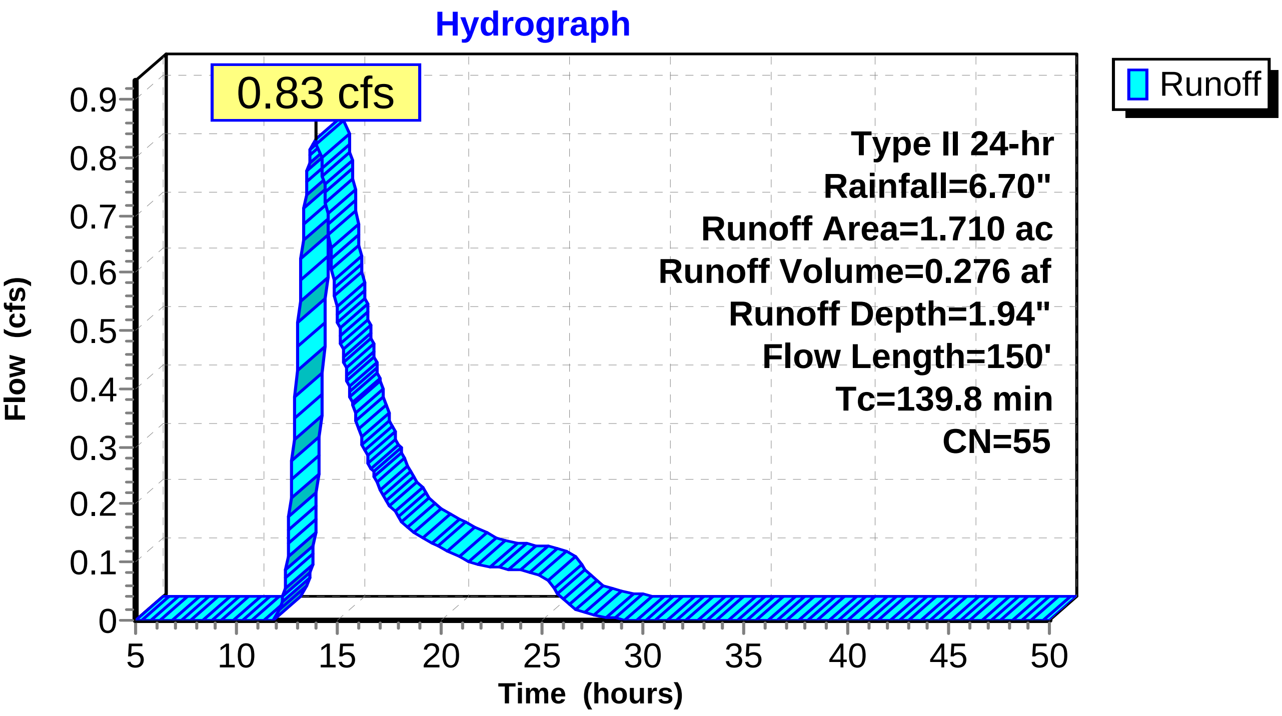
Runoff = 0.83 cfs @ 13.83 hrs, Volume= 0.276 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.710	55	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
139.8	150	0.0013	0.0		**Sheet Flow, FANWR** Woods: Dense underbrush n= 0.800 P2= 3.90"

Subcatchment 1S: LF3 Northwest



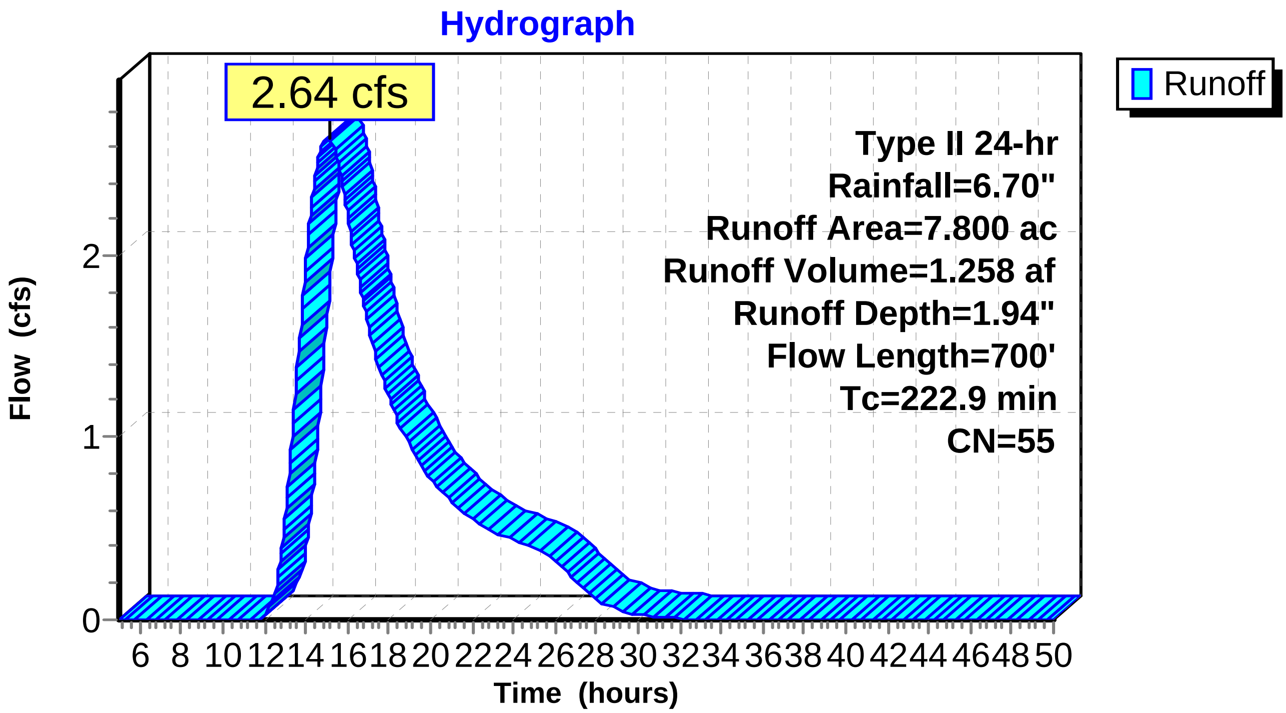
Subcatchment 2S: LF3 Northeast

Runoff = 2.64 cfs @ 15.09 hrs, Volume= 1.258 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
7.800	55	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
174.2	300	0.0030	0.0		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"
48.7	400	0.0030	0.1		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
222.9	700	Total			



Subcatchment 3S: LF3 Southwest

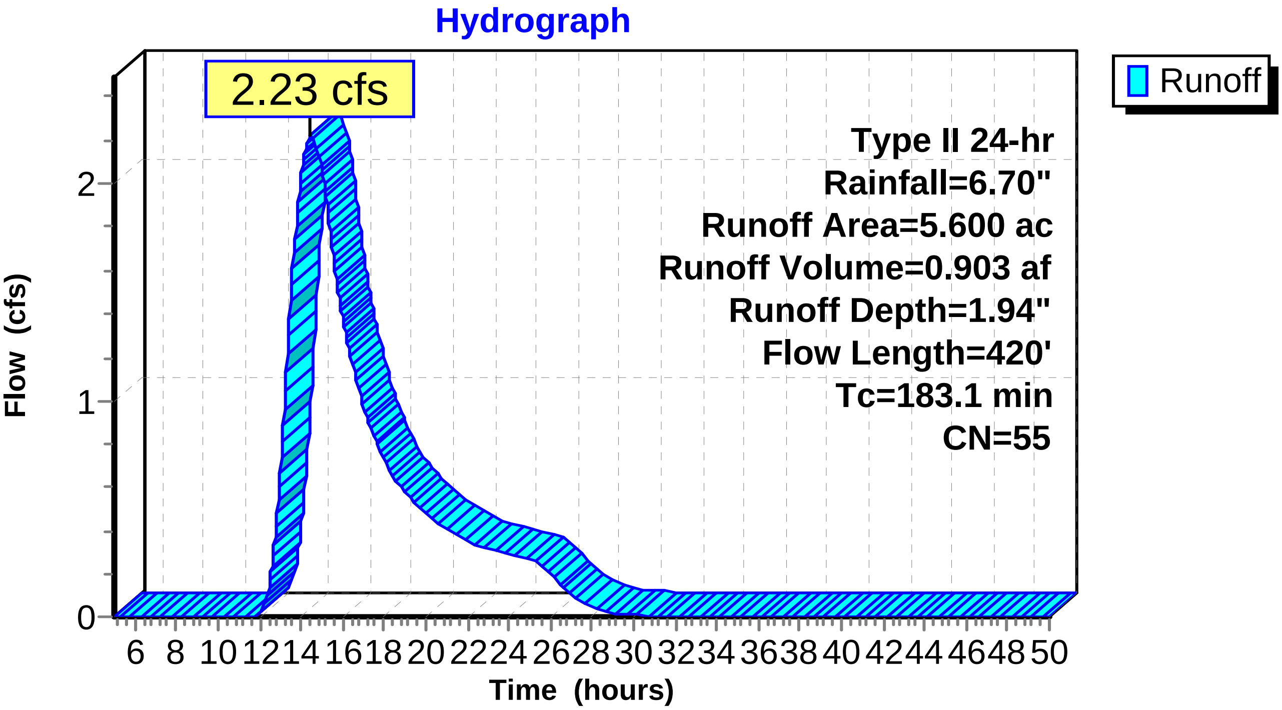
Runoff = 2.23 cfs @ 14.46 hrs, Volume= 0.903 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
5.600	55	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
174.2	300	0.0030	0.0		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"
8.9	120	0.0080	0.2		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
183.1	420	Total			

Subcatchment 3S: LF3 Southwest



Subcatchment 4S: LF3 Southeast

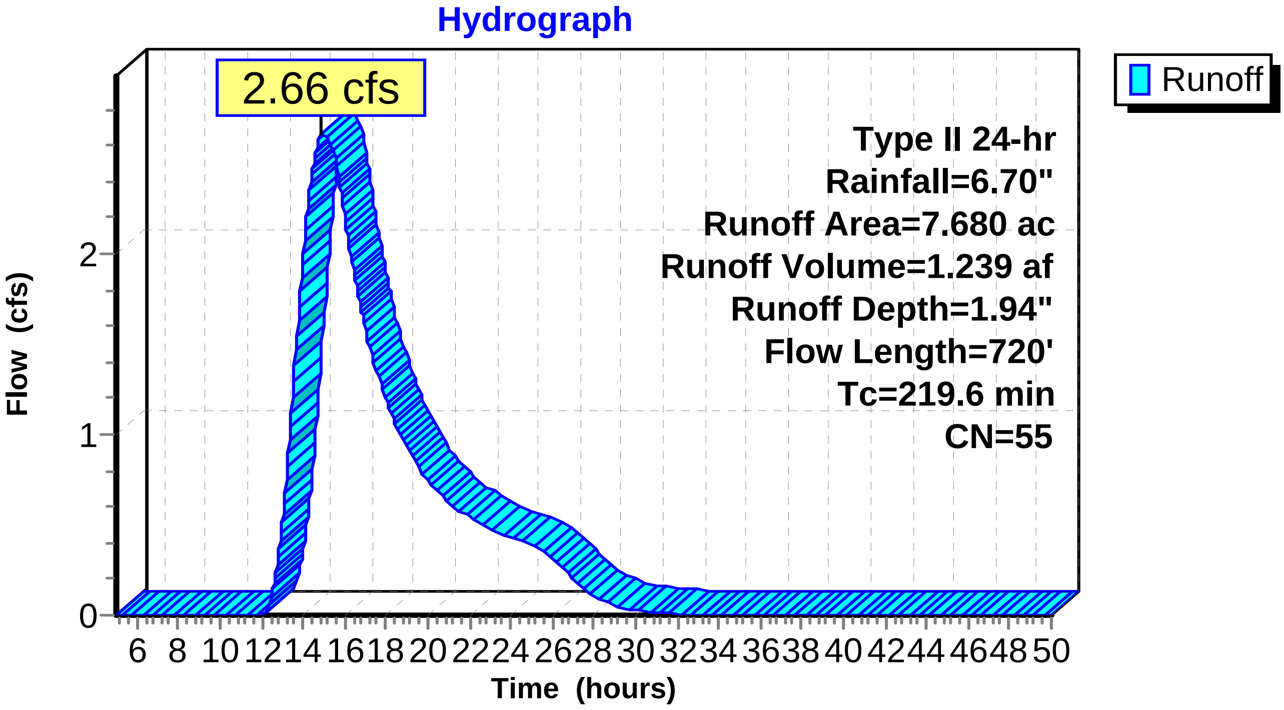
Runoff = 2.66 cfs @ 14.91 hrs, Volume= 1.239 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
7.680	55	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
174.2	300	0.0030	0.0		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"
8.9	120	0.0080	0.2		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
36.5	300	0.0030	0.1		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
219.6	720	Total			

Subcatchment 4S: LF3 Southeast



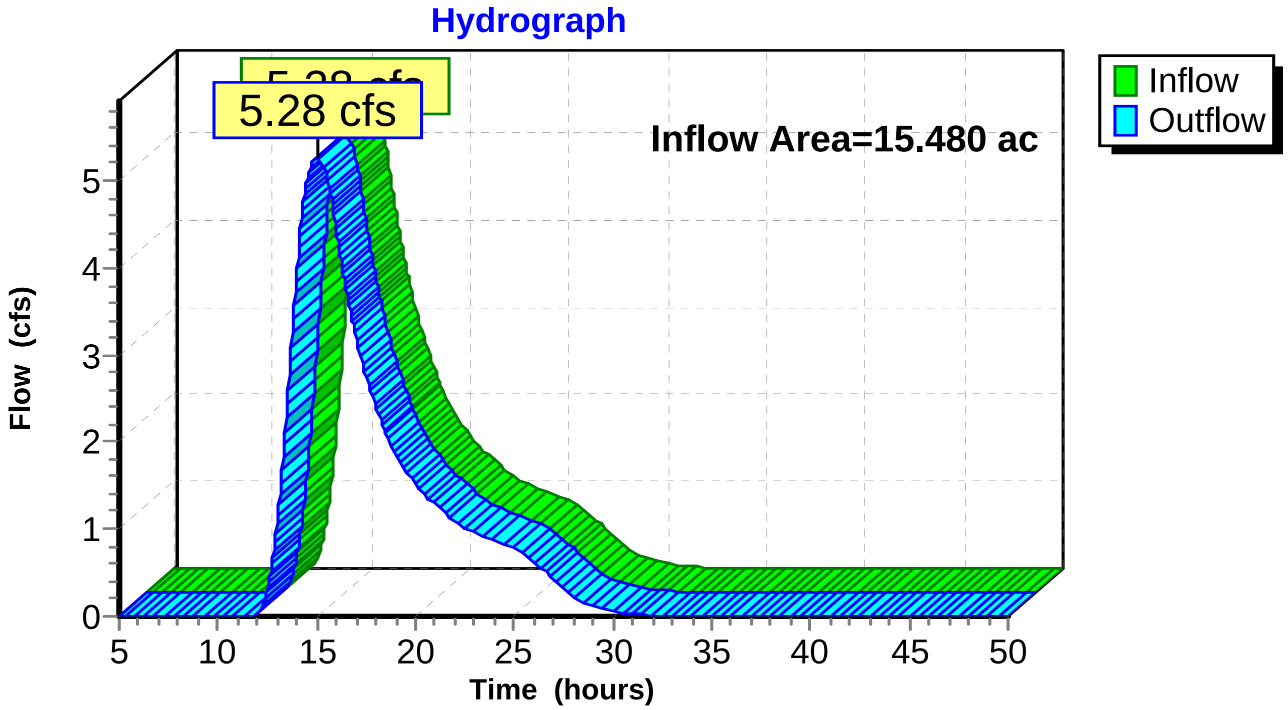
Reach 1R: LF3 East Perimeter

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 15.480 ac, Inflow Depth = 1.94"
Inflow = 5.28 cfs @ 15.07 hrs, Volume= 2.497 af
Outflow = 5.28 cfs @ 15.07 hrs, Volume= 2.497 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs

Reach 1R: LF3 East Perimeter



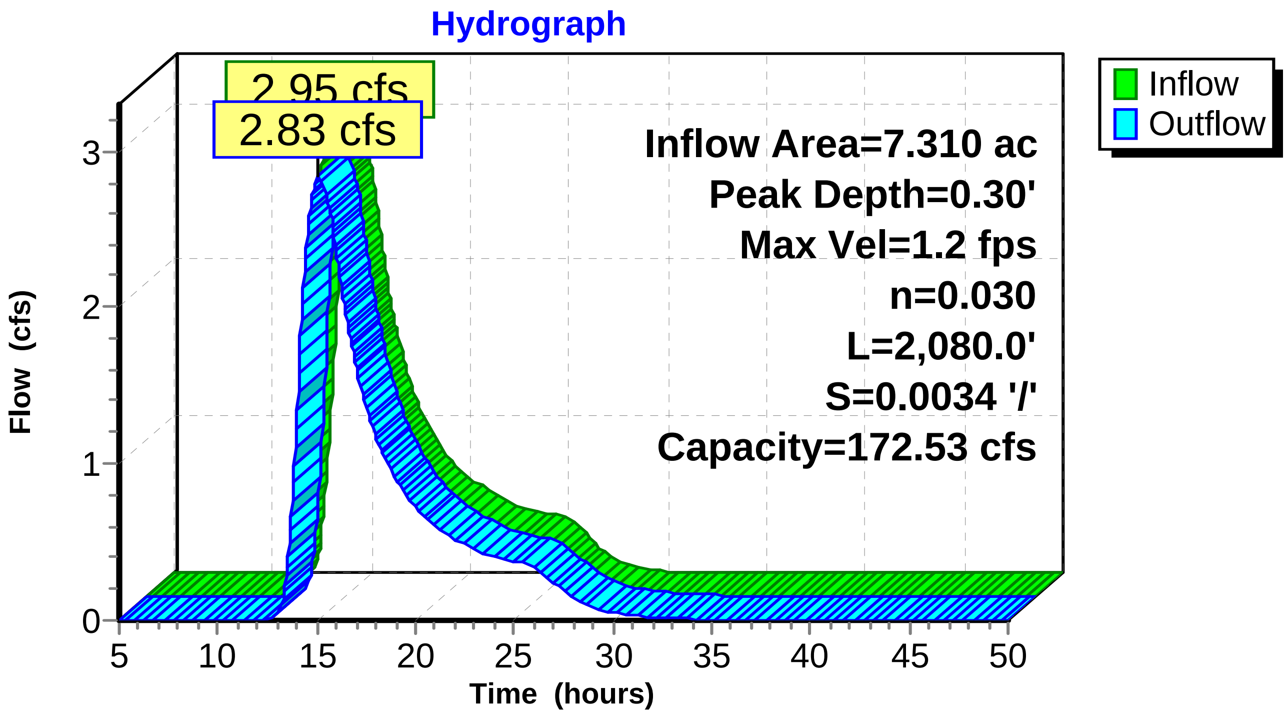
Reach 2R: West Perimeter Channel

Inflow Area = 7.310 ac, Inflow Depth = 1.94"
Inflow = 2.95 cfs @ 14.27 hrs, Volume= 1.179 af
Outflow = 2.83 cfs @ 15.11 hrs, Volume= 1.179 af, Atten= 4%, Lag= 49.8 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.2 fps, Min. Travel Time= 28.4 min
Avg. Velocity = 0.5 fps, Avg. Travel Time= 71.2 min

Peak Depth= 0.30' @ 14.63 hrs
Capacity at bank full= 172.53 cfs
Inlet Invert= 738.00', Outlet Invert= 731.00'
7.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 19.00'
Length= 2,080.0' Slope= 0.0034 '/'

Reach 2R: West Perimeter Channel



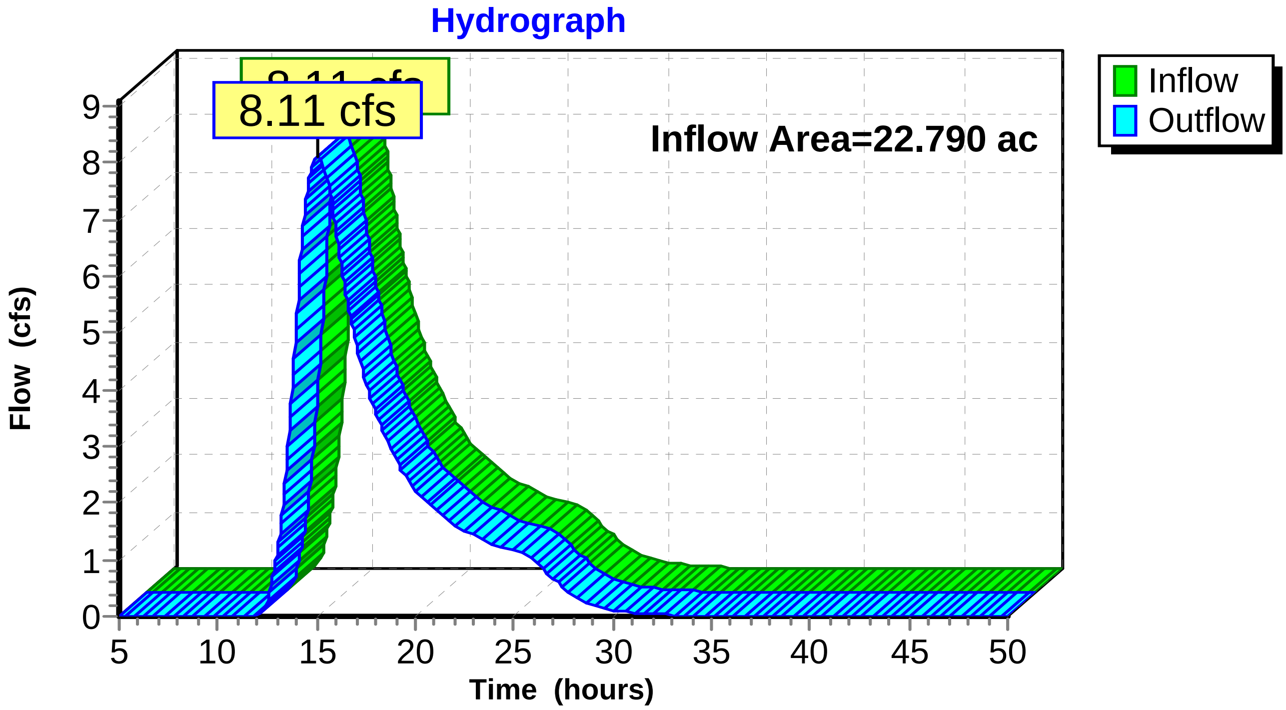
Reach 3R: Nodal Point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	22.790 ac,	Inflow Depth = 1.94"			
Inflow =	8.11 cfs @	15.08 hrs,	Volume=	3.676 af	
Outflow =	8.11 cfs @	15.08 hrs,	Volume=	3.676 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-50.00 hrs, dt= 0.05 hrs

Reach 3R: Nodal Point



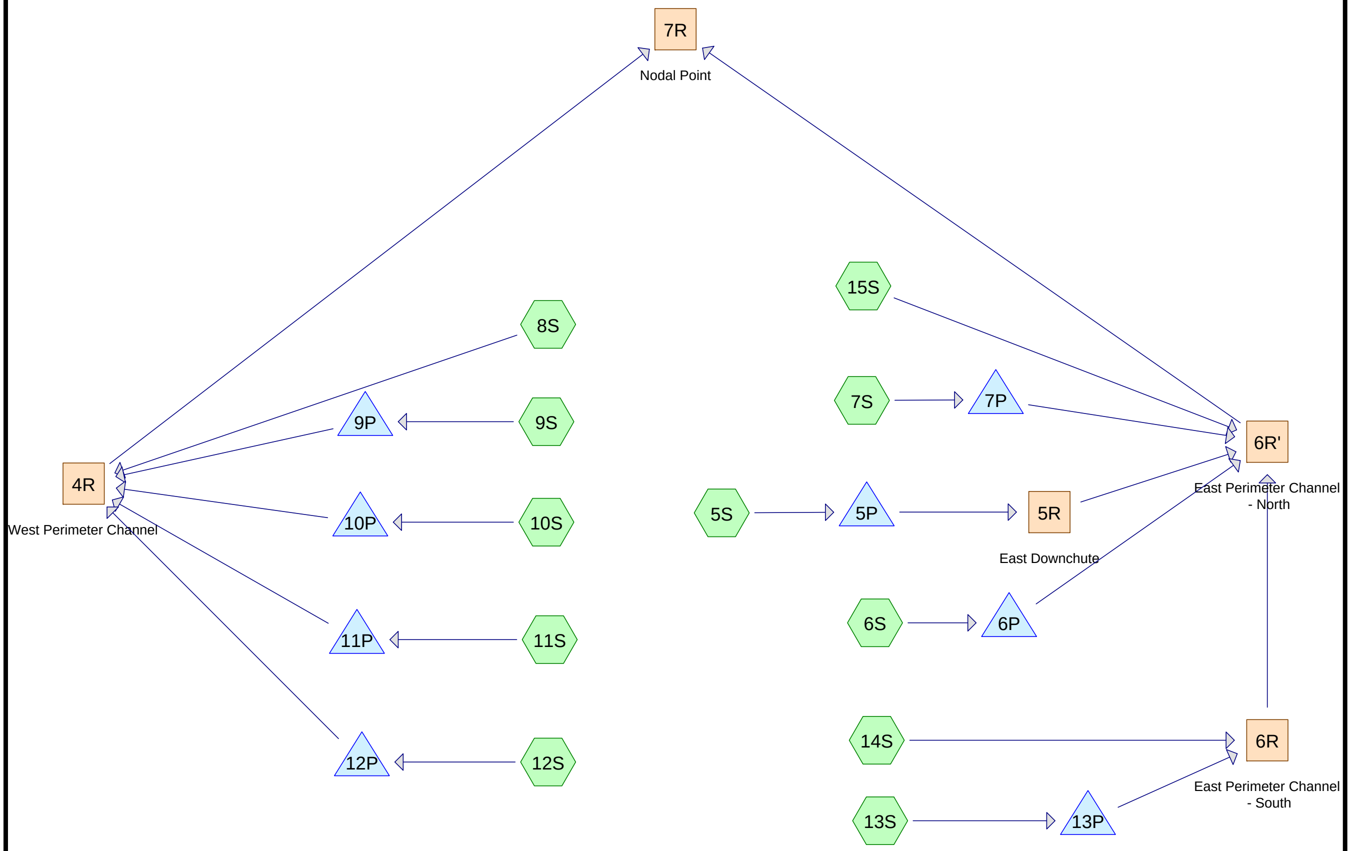
ATTACHMENT 13

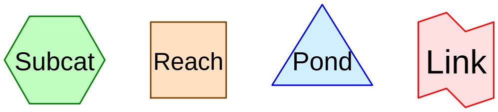
Computations Using HydroCAD^{TM}: Post-Development

25 Year – 24 Hour Storm

SCS Distribution

(Post-Development)





Drainage Diagram for LF3-Post-Development-25-year storm
Prepared by GeoSyntec Consultants 11/8/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

Time span=5.00-60.00 hrs, dt=0.05 hrs, 1101 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 5S: Runoff Area=1.950 ac Runoff Depth=2.49"
Flow Length=300' Tc=28.2 min CN=61 Runoff=4.19 cfs 0.404 af

Subcatchment 6S: Runoff Area=1.900 ac Runoff Depth=2.49"
Flow Length=200' Tc=20.4 min CN=61 Runoff=5.01 cfs 0.394 af

Subcatchment 7S: Runoff Area=1.390 ac Runoff Depth=2.49"
Flow Length=250' Tc=24.4 min CN=61 Runoff=3.28 cfs 0.288 af

Subcatchment 8S: Runoff Area=0.520 ac Runoff Depth=2.49"
Flow Length=200' Tc=24.1 min CN=61 Runoff=1.24 cfs 0.108 af

Subcatchment 9S: Runoff Area=1.660 ac Runoff Depth=2.49"
Flow Length=370' Tc=32.7 min CN=61 Runoff=3.23 cfs 0.344 af

Subcatchment 10S: Runoff Area=1.950 ac Runoff Depth=2.49"
Flow Length=340' Tc=30.7 min CN=61 Runoff=3.96 cfs 0.404 af

Subcatchment 11S: Runoff Area=2.900 ac Runoff Depth=2.49"
Flow Length=330' Tc=30.0 min CN=61 Runoff=5.98 cfs 0.601 af

Subcatchment 12S: Runoff Area=3.480 ac Runoff Depth=2.49"
Flow Length=470' Tc=34.5 min CN=61 Runoff=6.52 cfs 0.721 af

Subcatchment 13S: Runoff Area=2.000 ac Runoff Depth=2.49"
Flow Length=250' Tc=19.3 min CN=61 Runoff=5.44 cfs 0.415 af

Subcatchment 14S: Runoff Area=0.690 ac Runoff Depth=2.49"
Flow Length=180' Tc=19.3 min CN=61 Runoff=1.88 cfs 0.143 af

Subcatchment 15S: Runoff Area=1.080 ac Runoff Depth=2.49"
Flow Length=225' Tc=28.0 min CN=61 Runoff=2.33 cfs 0.224 af

Reach 4R: West Perimeter Channel Peak Depth=0.39' Max Vel=1.4 fps Inflow=4.59 cfs 2.147 af
n=0.030 L=2,080.0' S=0.0034 '/' Capacity=172.53 cfs Outflow=4.37 cfs 2.145 af

Reach 5R: East Downchute Peak Depth=0.43' Max Vel=1.3 fps Inflow=0.72 cfs 0.395 af
n=0.040 L=200.0' S=0.0100 '/' Capacity=19.99 cfs Outflow=0.72 cfs 0.395 af

Reach 6R: East Perimeter Channel - South Peak Depth=0.67' Max Vel=1.6 fps Inflow=1.97 cfs 0.532 af
n=0.030 L=528.0' S=0.0051 '/' Capacity=33.66 cfs Outflow=1.79 cfs 0.532 af

Reach 6R': East Perimeter Channel - North Peak Depth=0.98' Max Vel=2.1 fps Inflow=5.16 cfs 1.819 af
n=0.030 L=560.0' S=0.0050 '/' Capacity=33.28 cfs Outflow=4.96 cfs 1.819 af

Reach 7R: Nodal Point Inflow=7.22 cfs 3.963 af
Outflow=7.22 cfs 3.963 af

Pond 5P: Peak Elev=744.58' Storage=0.177 af Inflow=4.19 cfs 0.404 af
6.0" x 11.5' Culvert Outflow=0.72 cfs 0.395 af

Pond 6P: Peak Elev=742.64' Storage=0.168 af Inflow=5.01 cfs 0.394 af
6.0" x 11.5' Culvert Outflow=0.77 cfs 0.387 af

Pond 7P: Peak Elev=742.51' Storage=0.121 af Inflow=3.28 cfs 0.288 af
6.0" x 11.5' Culvert Outflow=0.62 cfs 0.282 af

Pond 9P: Peak Elev=742.55' Storage=0.145 af Inflow=3.23 cfs 0.344 af
6.0" x 11.5' Culvert Outflow=0.69 cfs 0.337 af

Pond 10P: Peak Elev=744.58' Storage=0.175 af Inflow=3.96 cfs 0.404 af
6.0" x 11.5' Culvert Outflow=0.74 cfs 0.395 af

Pond 11P: Peak Elev=744.80' Storage=0.271 af Inflow=5.98 cfs 0.601 af
6.0" x 11.5' Culvert Outflow=0.91 cfs 0.590 af

Pond 12P: Peak Elev=742.73' Storage=0.250 af Inflow=6.52 cfs 0.721 af
6.0" x 11.5' Culvert Outflow=2.08 cfs 0.717 af

Pond 13P: Peak Elev=745.40' Storage=0.213 af Inflow=5.44 cfs 0.415 af
6.0" x 11.5' Culvert Outflow=0.43 cfs 0.389 af

Total Runoff Area = 19.520 ac Runoff Volume = 4.047 af Average Runoff Depth = 2.49"

Subcatchment 5S:

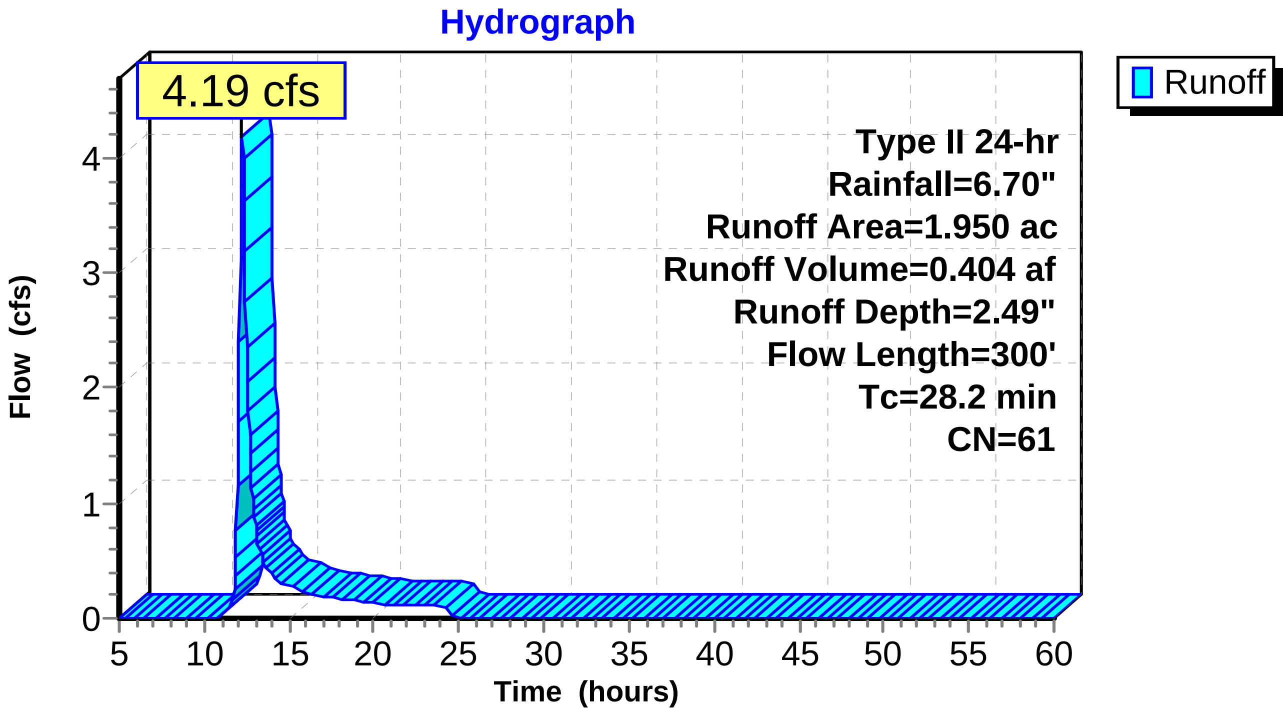
Runoff = 4.19 cfs @ 12.24 hrs, Volume= 0.404 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.950	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.2	300	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"

Subcatchment 5S:



Subcatchment 6S:

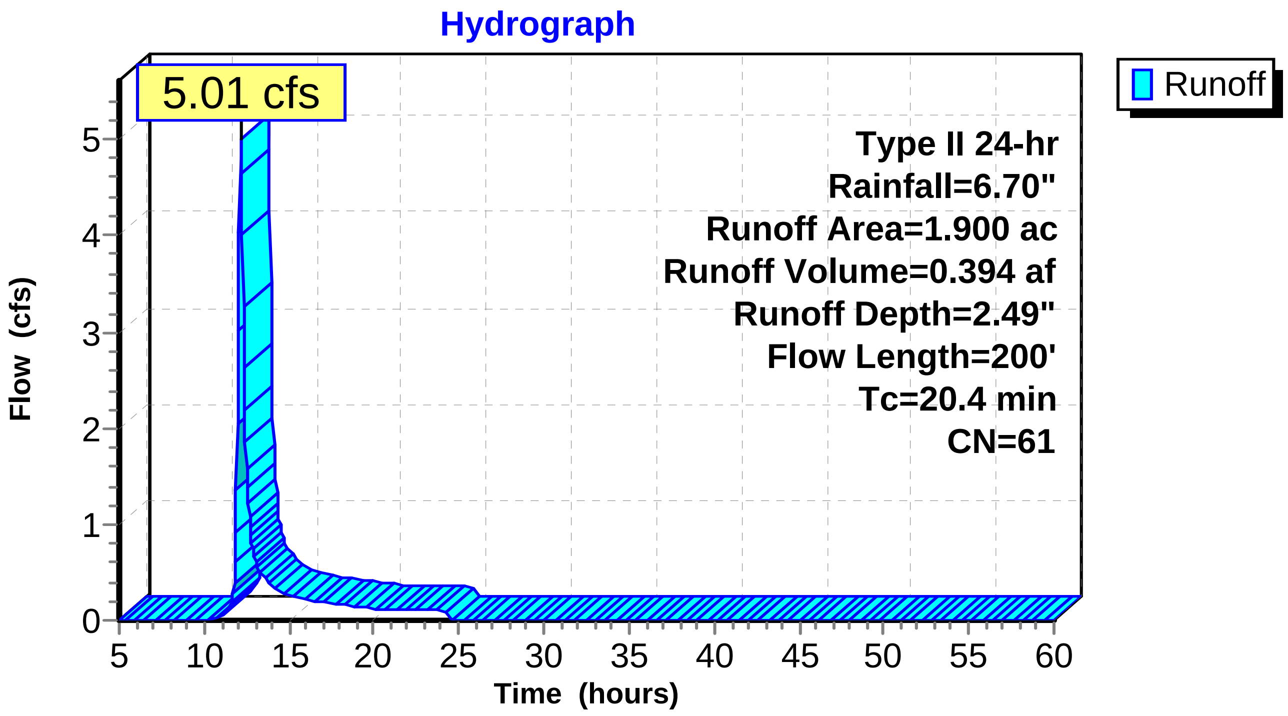
Runoff = 5.01 cfs @ 12.14 hrs, Volume= 0.394 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.900	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.4	200	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"

Subcatchment 6S:



Subcatchment 7S:

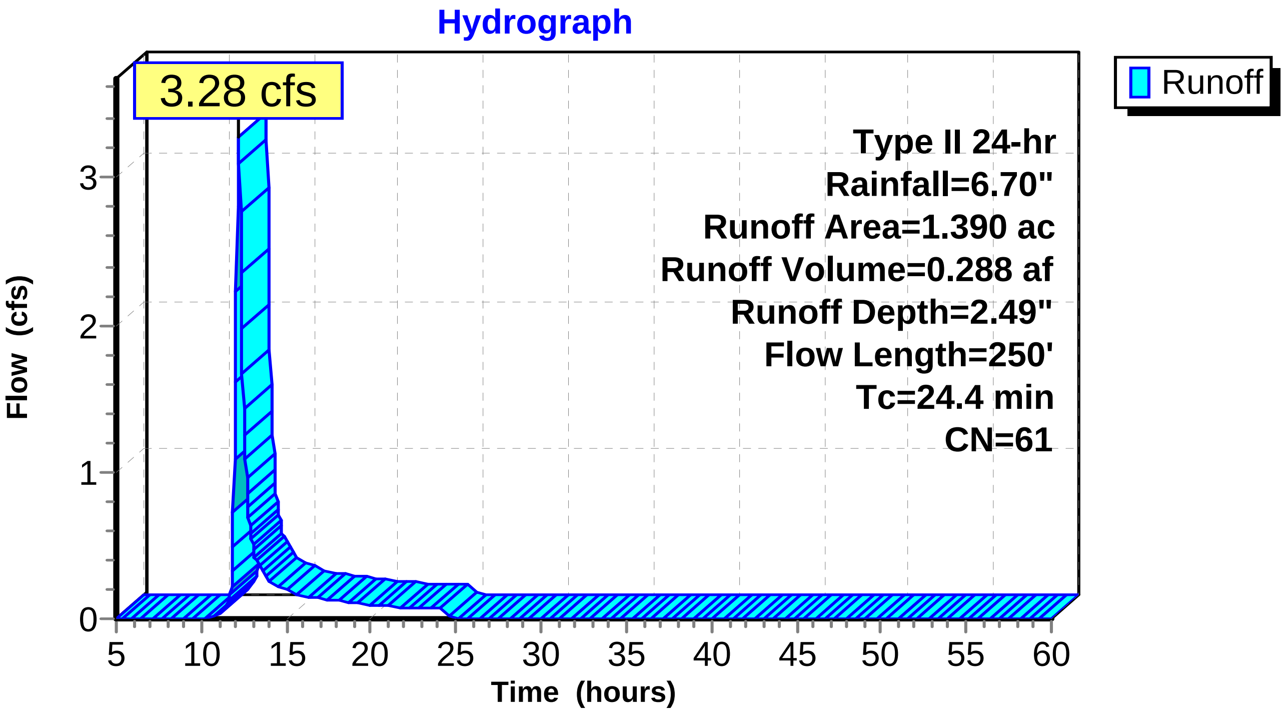
Runoff = 3.28 cfs @ 12.19 hrs, Volume= 0.288 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.390	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.4	250	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"

Subcatchment 7S:



Subcatchment 8S:

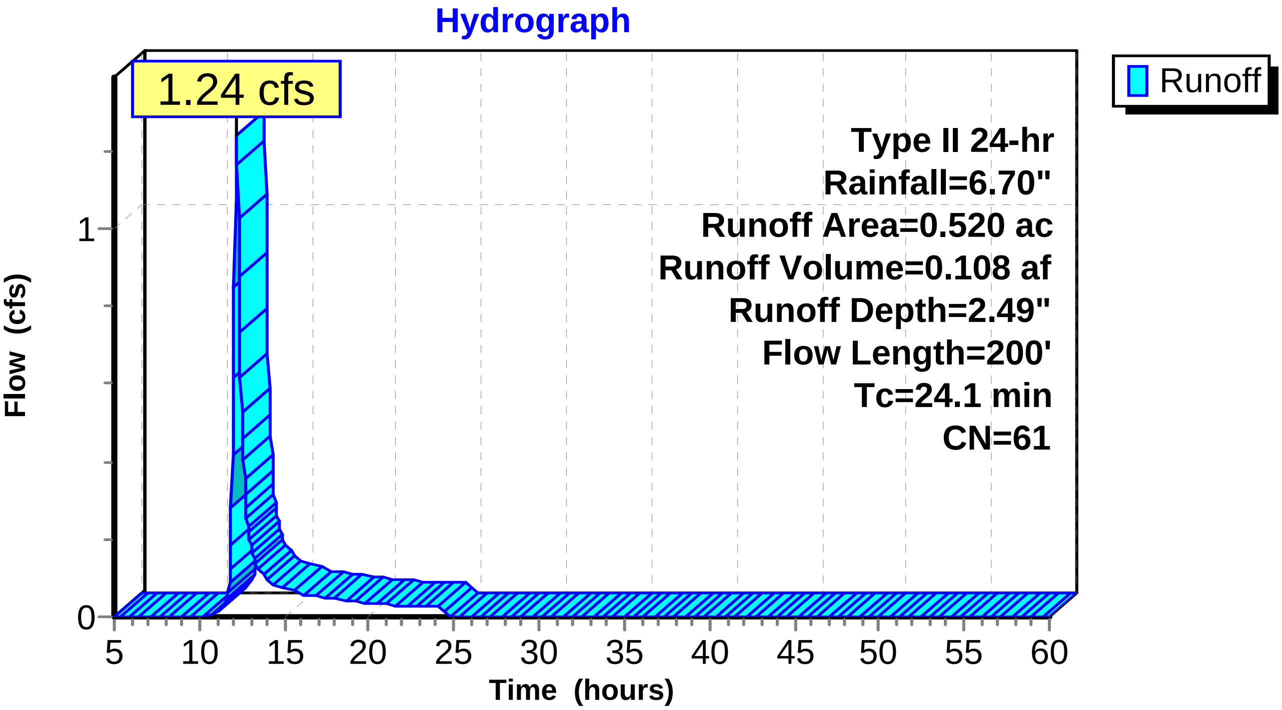
Runoff = 1.24 cfs @ 12.19 hrs, Volume= 0.108 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
0.520	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	150	0.0067	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
5.1	50	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
24.1	200	Total			

Subcatchment 8S:



Subcatchment 9S:

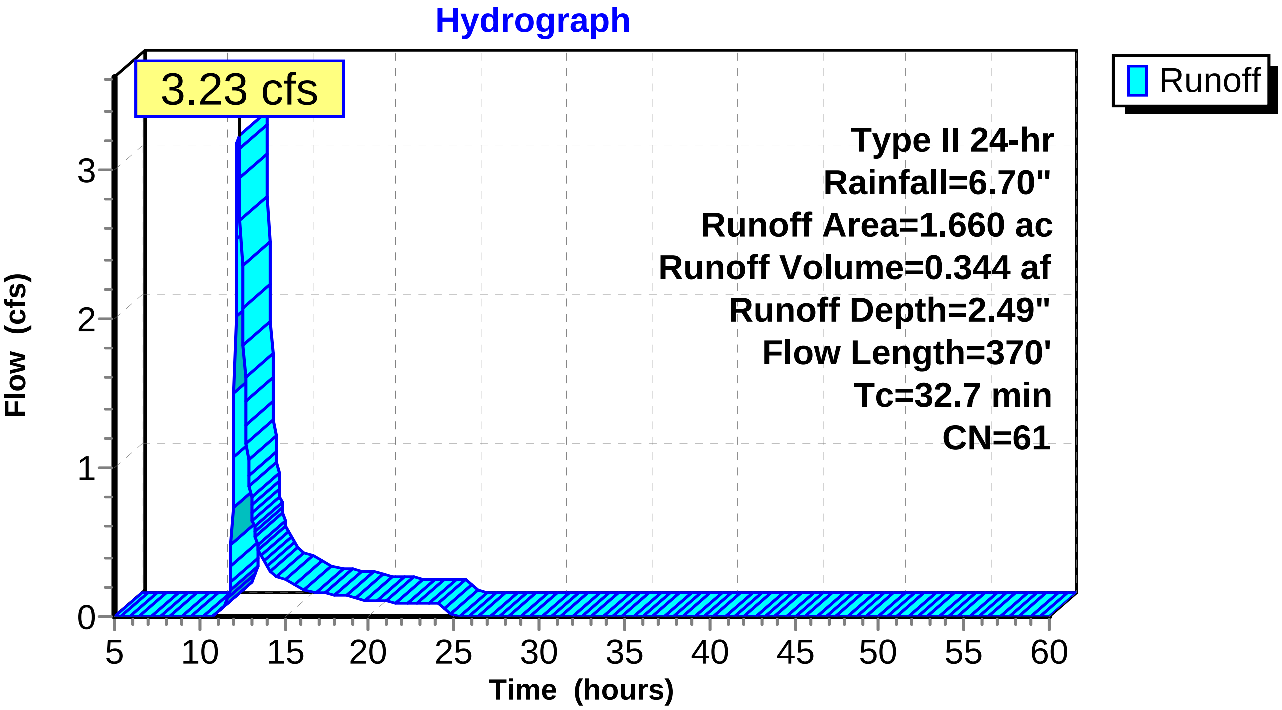
Runoff = 3.23 cfs @ 12.29 hrs, Volume= 0.344 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.660	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.8	300	0.0080	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
1.9	70	0.0080	0.6		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
32.7	370	Total			

Subcatchment 9S:



Subcatchment 10S:

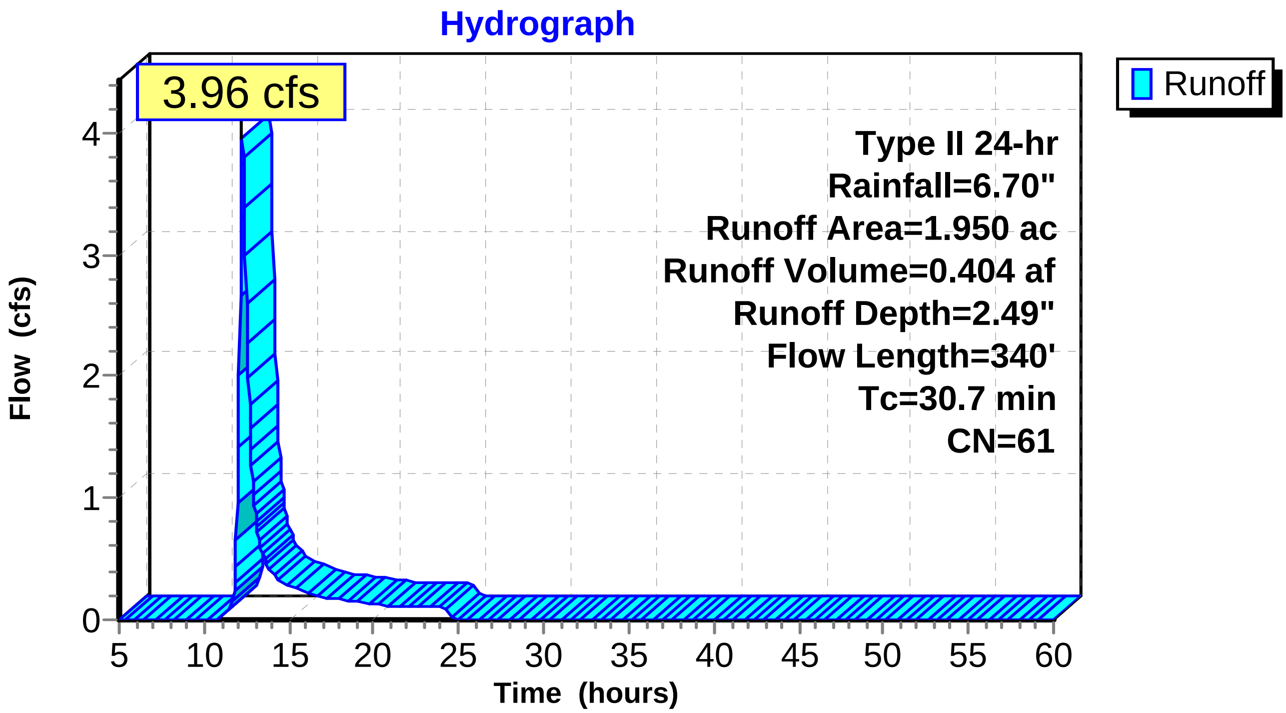
Runoff = 3.96 cfs @ 12.27 hrs, Volume= 0.404 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.950	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.7	300	0.0088	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
1.0	40	0.0088	0.7		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
30.7	340	Total			

Subcatchment 10S:



Subcatchment 11S:

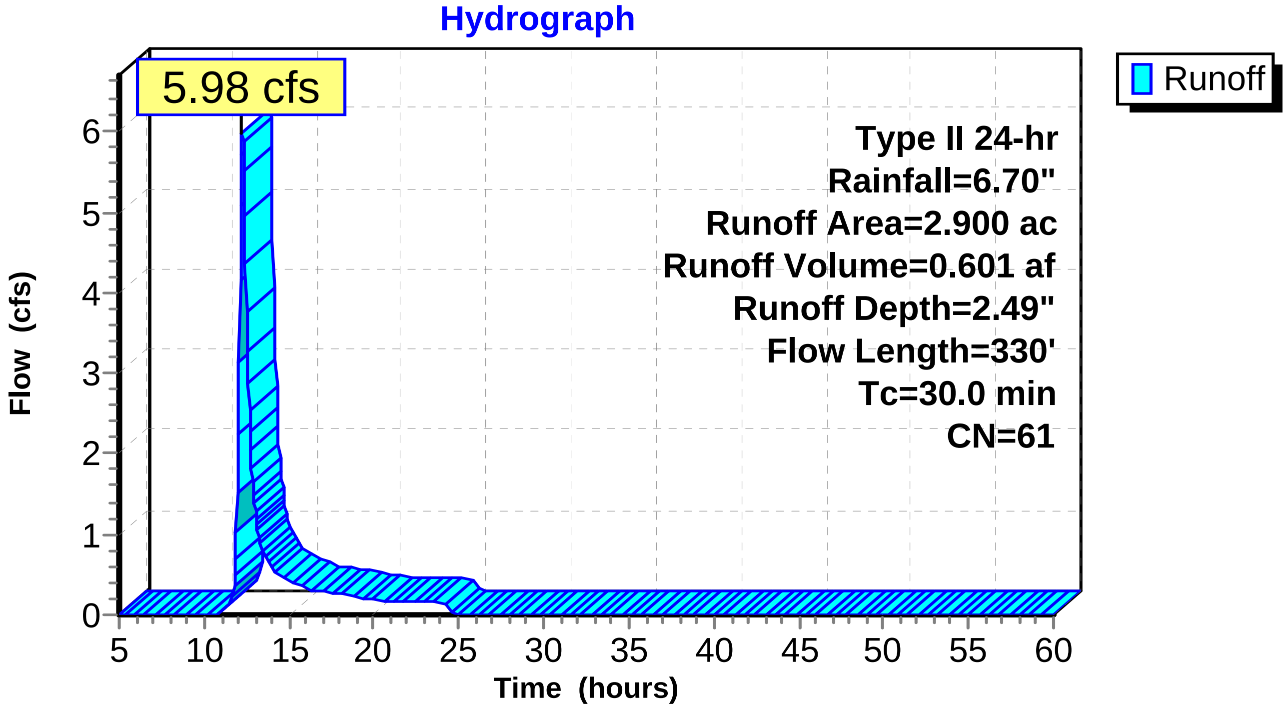
Runoff = 5.98 cfs @ 12.26 hrs, Volume= 0.601 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
2.900	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.3	300	0.0091	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
0.7	30	0.0091	0.7		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
30.0	330	Total			

Subcatchment 11S:



Subcatchment 12S:

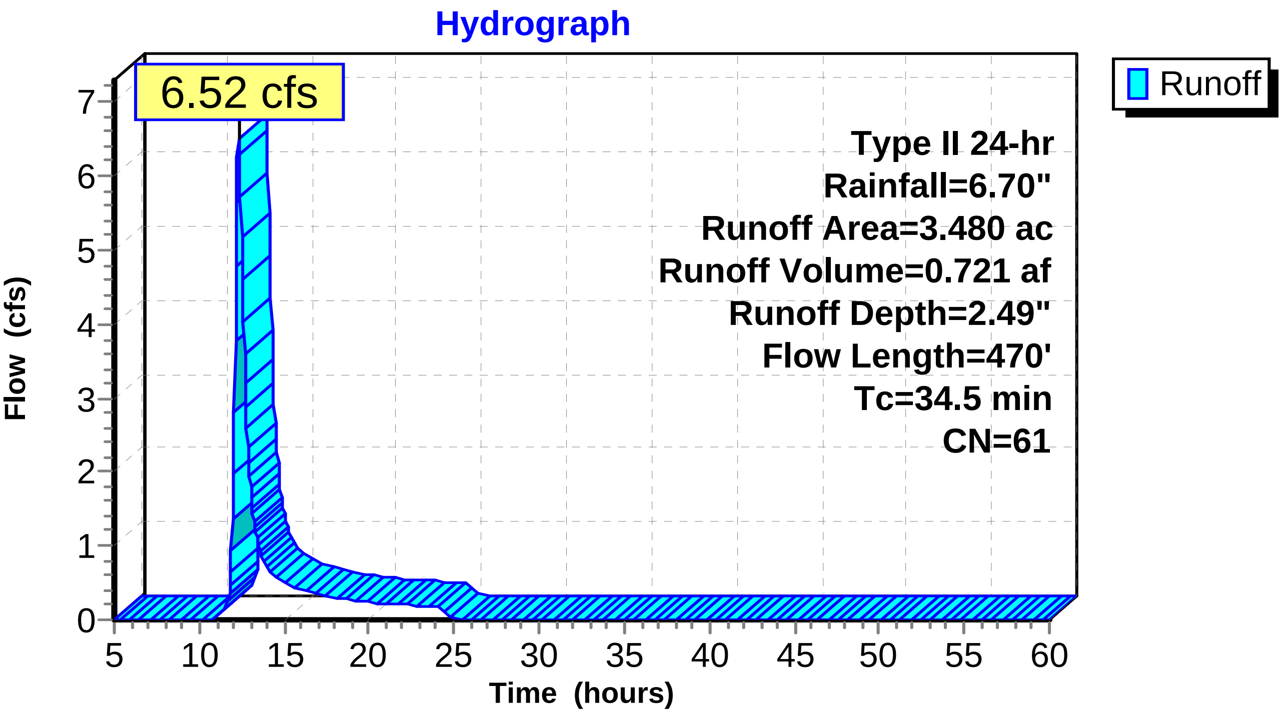
Runoff = 6.52 cfs @ 12.32 hrs, Volume= 0.721 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
3.480	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.1	300	0.0085	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
4.4	170	0.0085	0.6		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
34.5	470	Total			

Subcatchment 12S:



Subcatchment 13S:

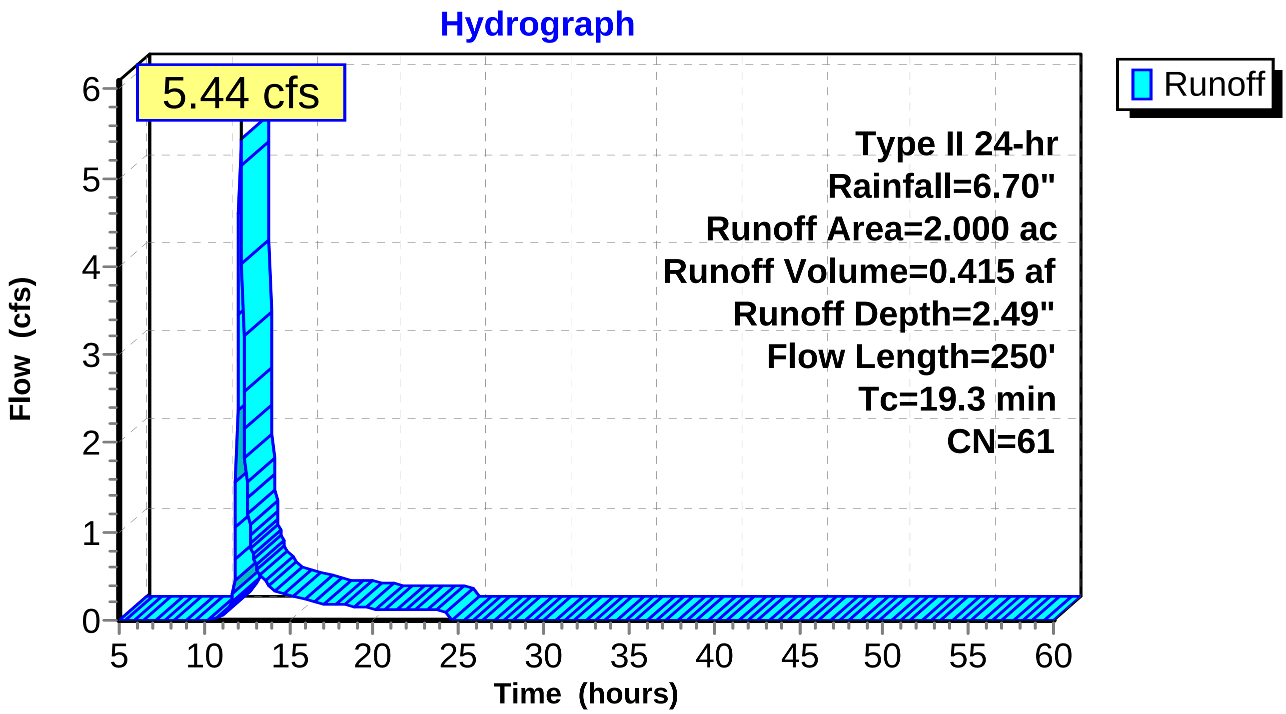
Runoff = 5.44 cfs @ 12.13 hrs, Volume= 0.415 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
2.000	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.3	250	0.0180	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"

Subcatchment 13S:



Subcatchment 14S:

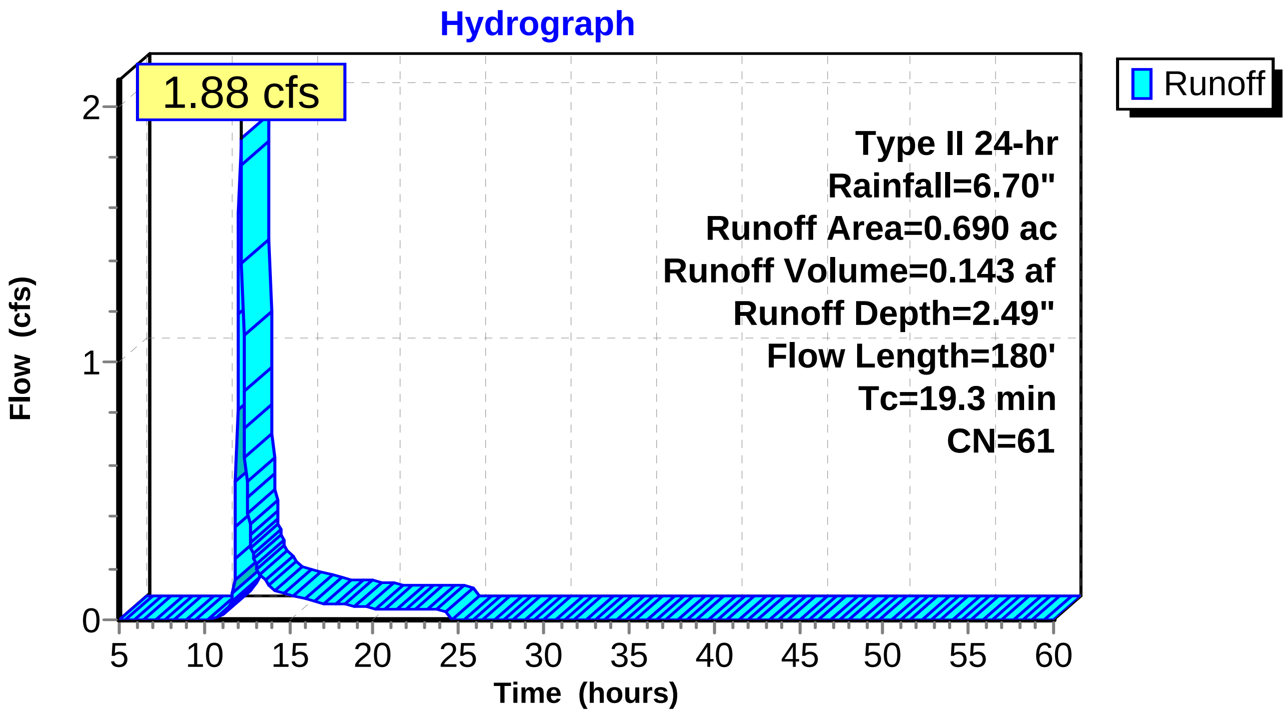
Runoff = 1.88 cfs @ 12.13 hrs, Volume= 0.143 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
0.690	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	60	0.0350	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
14.6	120	0.0083	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
19.3	180	Total			

Subcatchment 14S:



Subcatchment 15S:

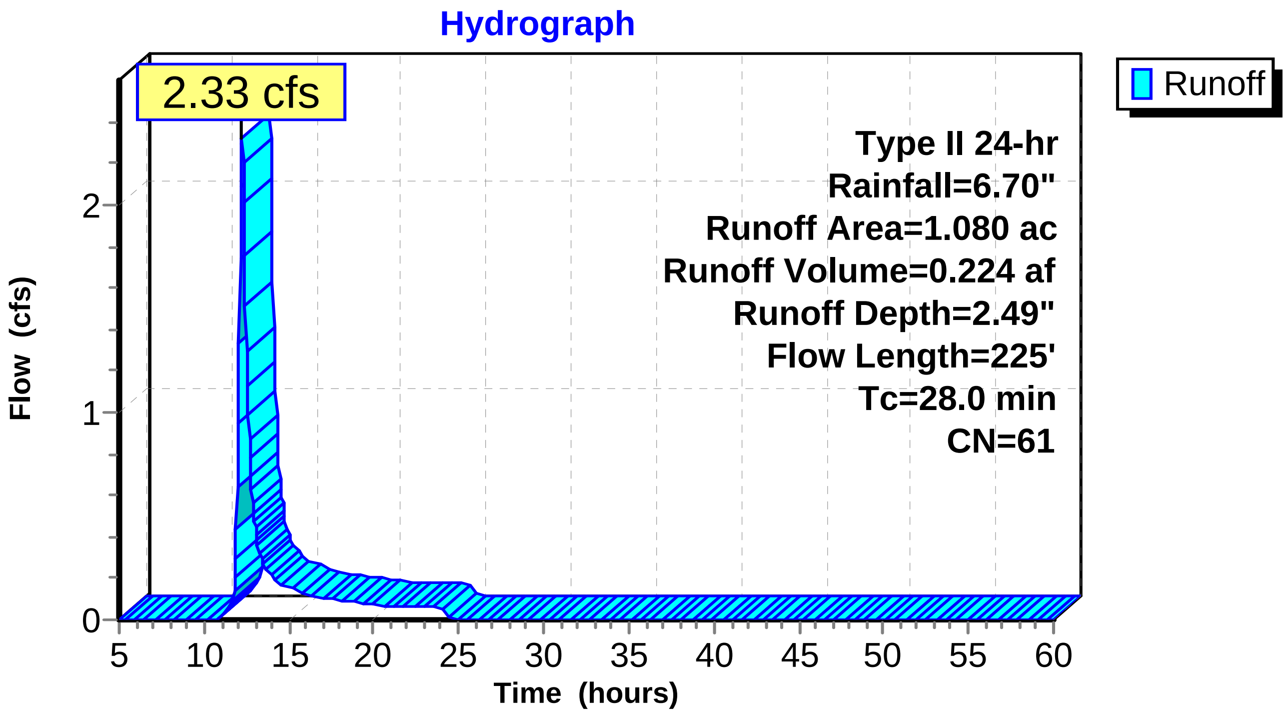
Runoff = 2.33 cfs @ 12.24 hrs, Volume= 0.224 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
1.080	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.9	175	0.0057	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
5.1	50	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
28.0	225	Total			

Subcatchment 15S:



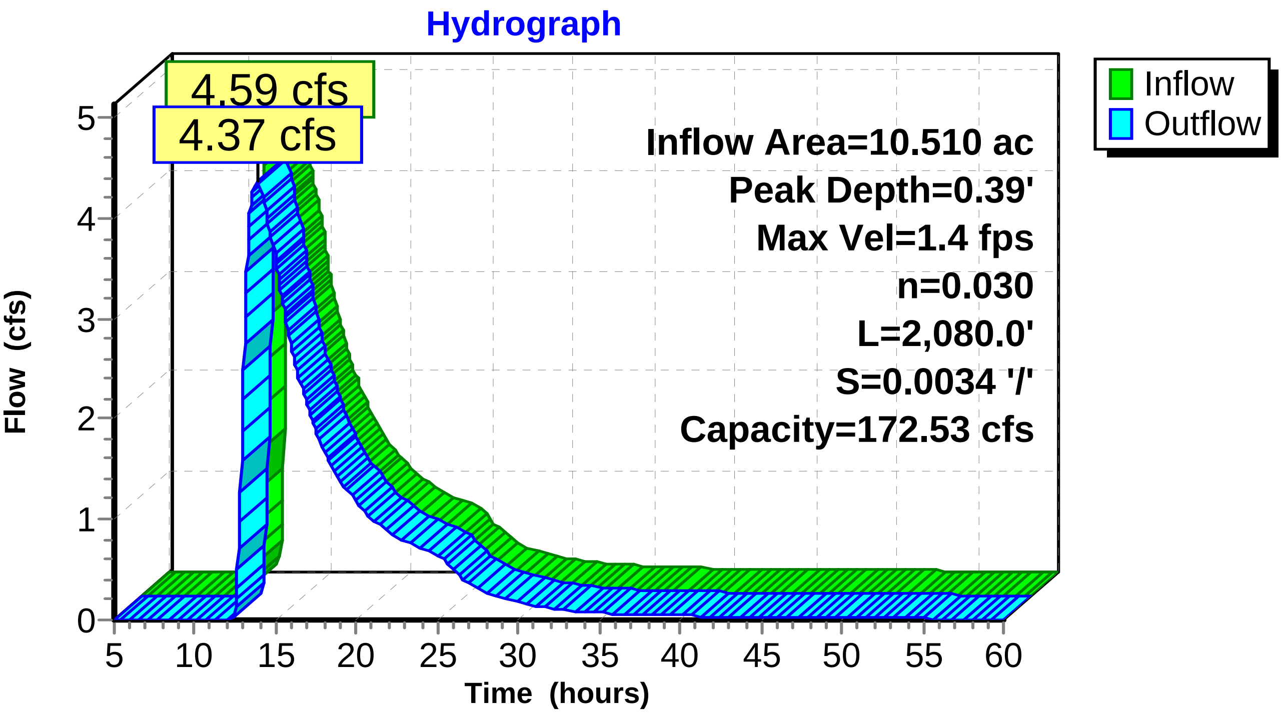
Reach 4R: West Perimeter Channel

Inflow Area =	10.510 ac,	Inflow Depth > 2.45"		
Inflow =	4.59 cfs @	12.93 hrs,	Volume=	2.147 af
Outflow =	4.37 cfs @	13.80 hrs,	Volume=	2.145 af, Atten= 5%, Lag= 51.7 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.4 fps, Min. Travel Time= 24.3 min
Avg. Velocity = 0.5 fps, Avg. Travel Time= 70.1 min

Peak Depth= 0.39' @ 13.39 hrs
Capacity at bank full= 172.53 cfs
Inlet Invert= 738.00', Outlet Invert= 731.00'
7.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 19.00'
Length= 2,080.0' Slope= 0.0034 '/'

Reach 4R: West Perimeter Channel



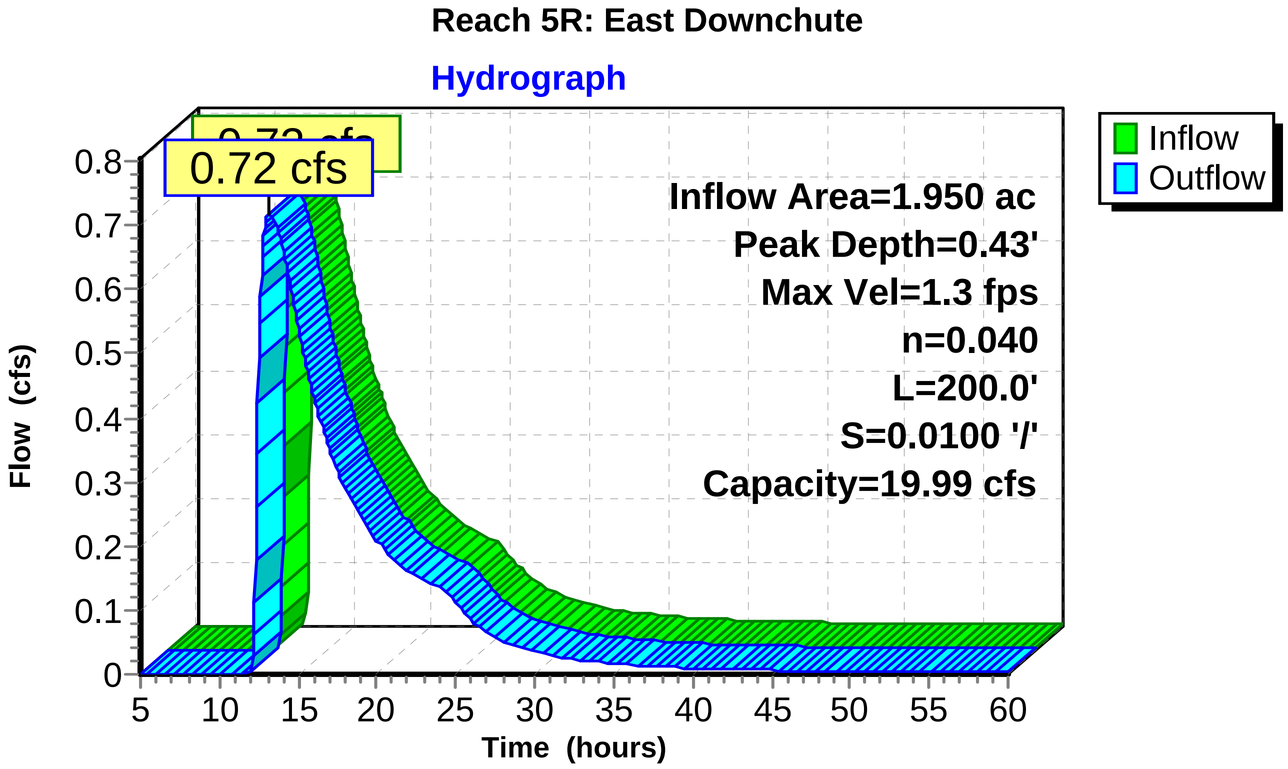
Reach 5R: East Downchute

[79] Warning: Submerged Pond 5P Primary device # 1 INLET by 0.33'

```
Inflow Area =      1.950 ac,  Inflow Depth >   2.43"
Inflow      =      0.72 cfs @   13.09 hrs,  Volume=        0.395 af
Outflow     =      0.72 cfs @   13.17 hrs,  Volume=        0.395 af,  Atten= 0%,  Lag= 4.7 min
```

Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.3 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.6 fps, Avg. Travel Time= 5.6 min

Peak Depth= 0.43' @ 13.12 hrs
Capacity at bank full= 19.99 cfs
Inlet Invert= 743.90', Outlet Invert= 741.90'
0.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 200.0' Slope= 0.0100 '/'



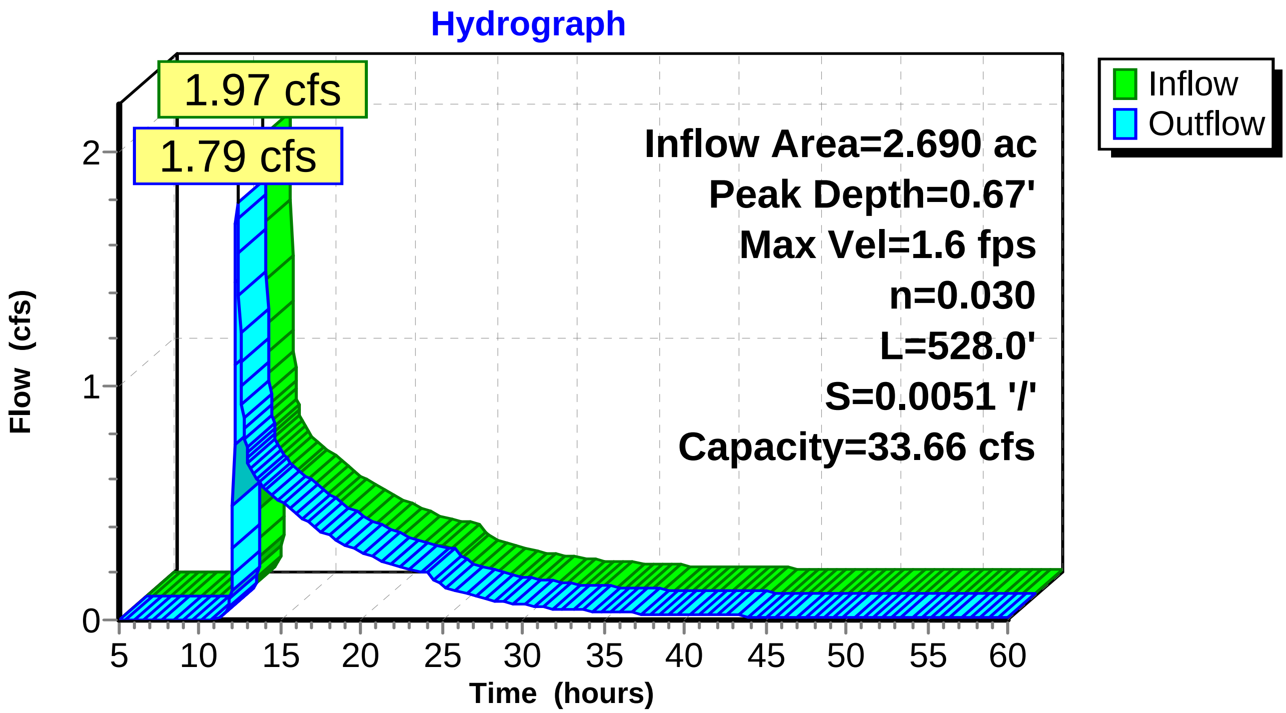
Reach 6R: East Perimeter Channel - South

```
Inflow Area =        2.690 ac,  Inflow Depth >   2.37"
Inflow       =       1.97 cfs @   12.14 hrs,  Volume=          0.532 af
Outflow      =       1.79 cfs @   12.30 hrs,  Volume=          0.532 af,  Atten= 9%,  Lag= 9.8 min
```

Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.6 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.7 fps, Avg. Travel Time= 12.8 min

Peak Depth= 0.67' @ 12.21 hrs
Capacity at bank full= 33.66 cfs
Inlet Invert= 741.00', Outlet Invert= 738.30'
0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 528.0' Slope= 0.0051 '/'

Reach 6R: East Perimeter Channel - South



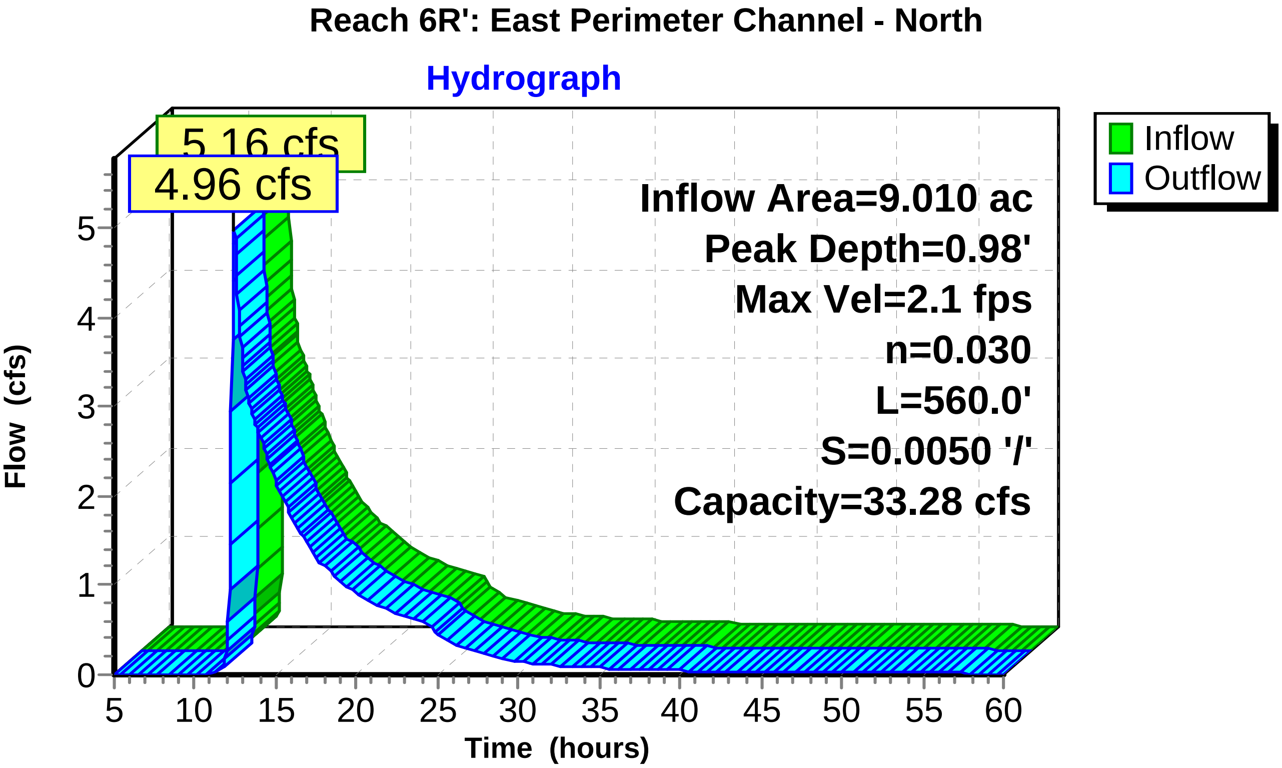
Reach 6R': East Perimeter Channel - North

[61] Hint: Submerged 36% of Reach 6R bottom

Inflow Area = 9.010 ac, Inflow Depth > 2.42"
Inflow = 5.16 cfs @ 12.31 hrs, Volume= 1.819 af
Outflow = 4.96 cfs @ 12.46 hrs, Volume= 1.819 af, Atten= 4%, Lag= 8.7 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.1 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 10.7 min

Peak Depth= 0.98' @ 12.38 hrs
Capacity at bank full= 33.28 cfs
Inlet Invert= 738.30', Outlet Invert= 735.50'
0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 560.0' Slope= 0.0050 '/'

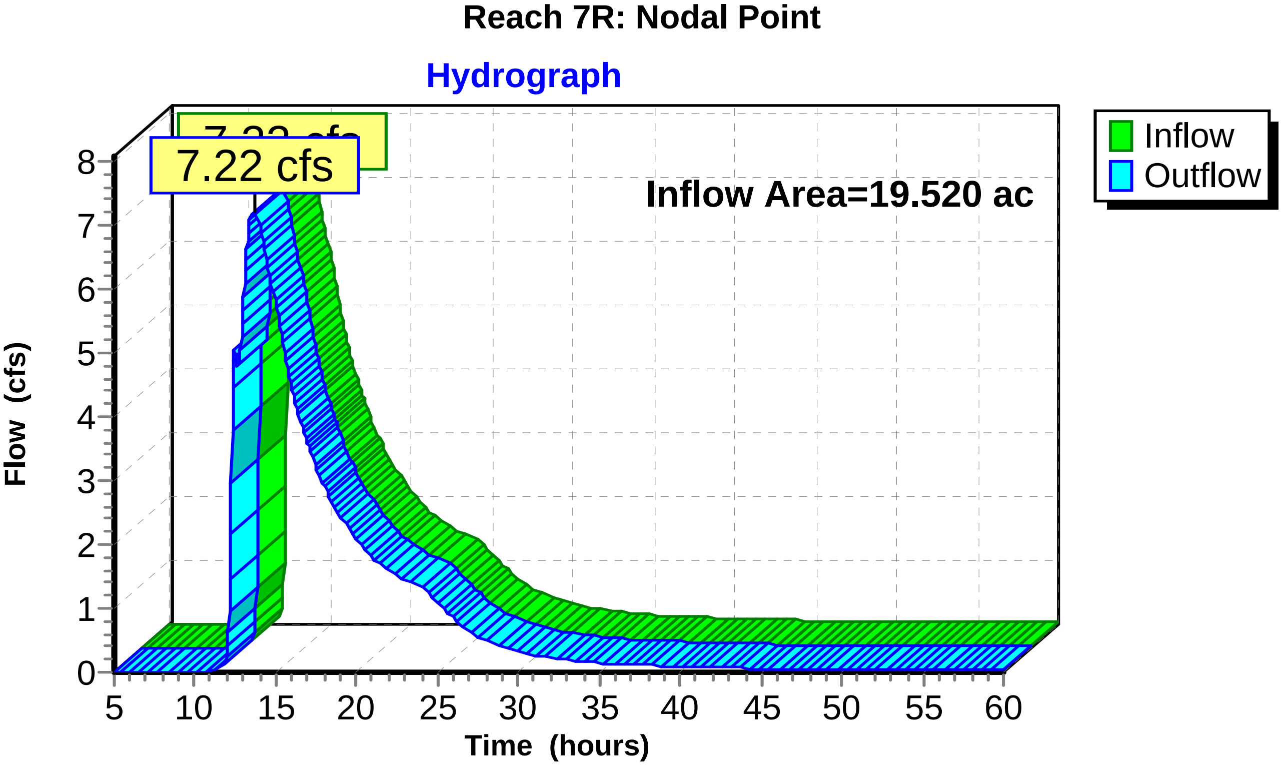


Reach 7R: Nodal Point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	19.520 ac, Inflow Depth > 2.44"			
Inflow =	7.22 cfs @	13.65 hrs, Volume=	3.963 af	
Outflow =	7.22 cfs @	13.65 hrs, Volume=	3.963 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs



Pond 5P:

Inflow Area = 1.950 ac, Inflow Depth = 2.49"
Inflow = 4.19 cfs @ 12.24 hrs, Volume= 0.404 af
Outflow = 0.72 cfs @ 13.09 hrs, Volume= 0.395 af, Atten= 83%, Lag= 51.2 min
Primary = 0.72 cfs @ 13.09 hrs, Volume= 0.395 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 744.58' @ 13.09 hrs Surf.Area= 0.000 ac Storage= 0.177 af
Plug-Flow detention time= 254.8 min calculated for 0.394 af (98% of inflow)
Center-of-Mass det. time= 243.0 min (1,113.8 - 870.9)

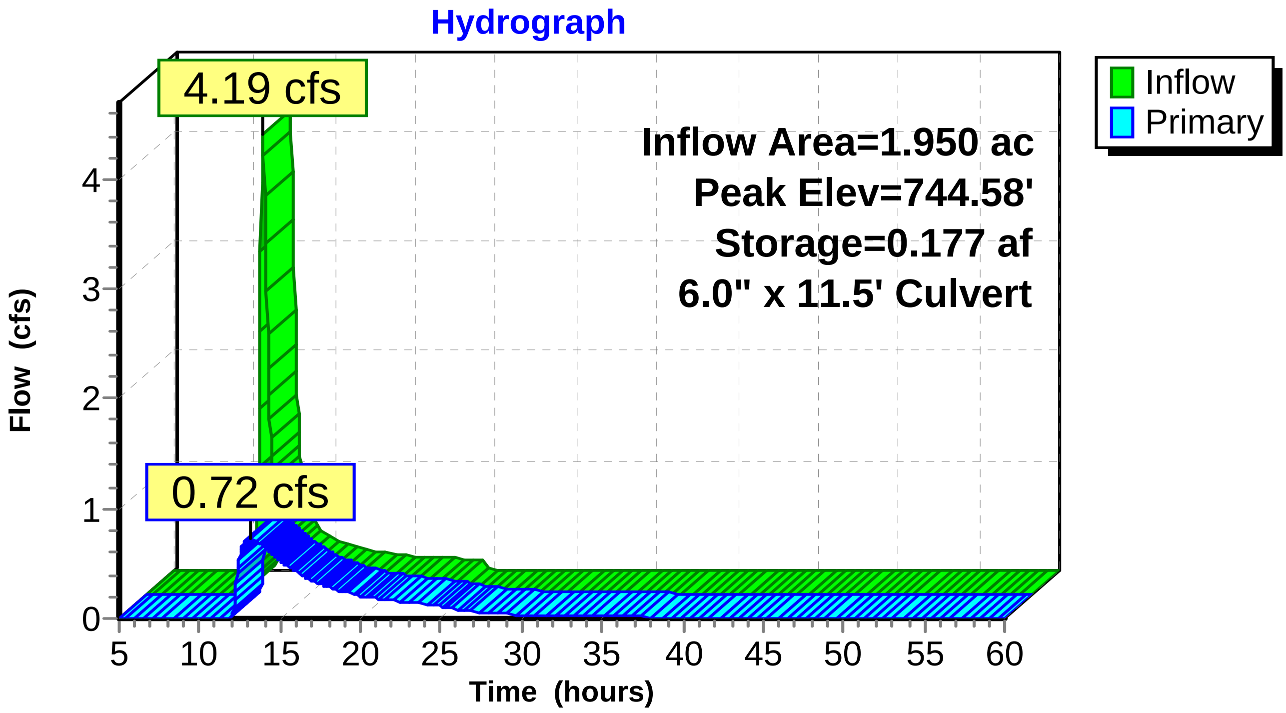
Volume	Invert	Avail.Storage	Storage Description
#1	744.00'	0.460 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
744.00	0.000
745.50	0.460

Device	Routing	Invert	Outlet Devices
#1	Primary	744.00'	**6.0" x 11.5' long Culvert X 2.00** CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 743.88' S= 0.0104 '/' Cc= 0.900 n= 0.025 Corrugated metal

Primary OutFlow Max=0.72 cfs @ 13.09 hrs HW=744.58' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 0.72 cfs @ 2.0 fps)

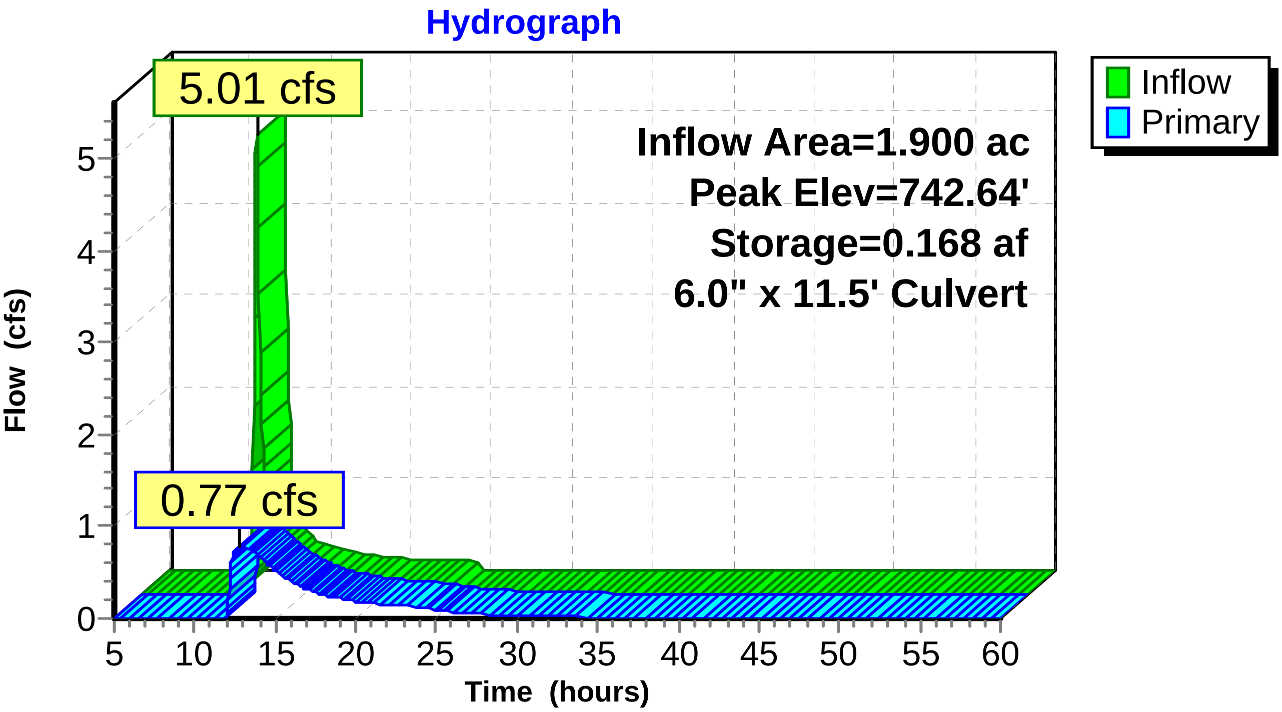
Pond 5P:


Hydrograph
4.19 cfs
0.72 cfs
Inflow Area=1.950 ac
Peak Elev=744.58'
Storage=0.177 af
6.0" x 11.5' Culvert
🟩 Inflow
🟦 Primary
Flow (cfs)
0
1
2
3
4
Time (hours)
5
10
15
20
25
30
35
40
45
50
55
60

Pond 6P:

```
Inflow Area =        1.900 ac,  Inflow Depth =   2.49"
Inflow      =       5.01 cfs @   12.14 hrs,  Volume=          0.394 af
Outflow     =       0.77 cfs @   12.83 hrs,  Volume=          0.387 af,  Atten= 85%,  Lag= 41.0 min
Primary     =       0.77 cfs @   12.83 hrs,  Volume=          0.387 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 742.64' @ 12.83 hrs   Surf.Area= 0.000 ac   Storage= 0.168 af
Plug-Flow detention time= 221.9 min calculated for 0.387 af (98% of inflow)
Center-of-Mass det. time= 211.4 min ( 1,075.0 - 863.6 )

Volume        Invert     Avail.Storage    Storage Description
    #1       742.00'          0.395 af    Custom Stage Data Listed below

 Elevation        Cum.Store
    (feet)       (acre-feet)
    742.00            0.000
    743.50            0.395

Device    Routing          Invert    Outlet Devices
    #1    Primary         742.00'    6.0"  x 11.5' long Culvert X 2.00
                                     CMP, mitered to conform to fill,  Ke= 0.700
                                     Outlet Invert= 741.88'   S= 0.0104 '/'   Cc= 0.900
                                     n= 0.025  Corrugated metal

Primary OutFlow  Max=0.77 cfs @ 12.83 hrs  HW=742.64'   (Free Discharge)
└─1=Culvert  (Barrel Controls 0.77 cfs @ 2.0 fps)
```

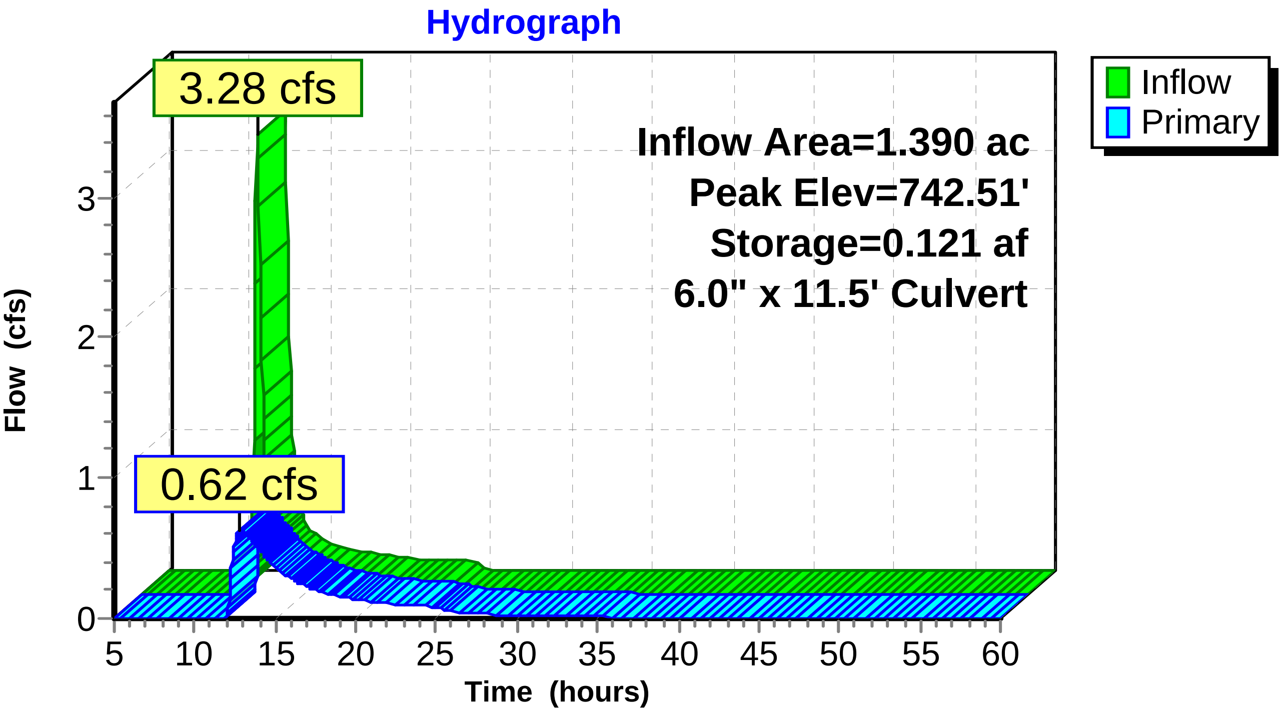
Pond 6P:


Hydrograph
5.01 cfs
0.77 cfs
Inflow Area=1.900 ac
Peak Elev=742.64'
Storage=0.168 af
6.0" x 11.5' Culvert
Inflow
Primary
Flow (cfs)
0
1
2
3
4
5
Time (hours)
5
10
15
20
25
30
35
40
45
50
55
60

Pond 7P:

```
Inflow Area =          1.390 ac,  Inflow Depth =   2.49"
Inflow       =        3.28 cfs @   12.19 hrs,  Volume=          0.288 af
Outflow      =        0.62 cfs @   12.86 hrs,  Volume=          0.282 af,  Atten= 81%,  Lag= 40.3 min
Primary      =        0.62 cfs @   12.86 hrs,  Volume=          0.282 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 742.51' @ 12.86 hrs   Surf.Area= 0.000 ac   Storage= 0.121 af
Plug-Flow detention time= 225.6 min calculated for 0.282 af (98% of inflow)
Center-of-Mass det. time= 215.7 min ( 1,083.0 - 867.3 )

Volume       Invert    Avail.Storage   Storage Description
   #1       742.00'         0.356 af   Custom Stage Data Listed below

 Elevation       Cum.Store
    (feet)     (acre-feet)
    742.00           0.000
    743.50           0.356

Device   Routing        Invert   Outlet Devices
   #1    Primary       742.00'   6.0"  x 11.5' long Culvert X 2.00
                                 CMP, mitered to conform to fill,  Ke= 0.700
                                 Outlet Invert= 741.88'   S= 0.0104 '/'   Cc= 0.900
                                 n= 0.025  Corrugated metal

Primary OutFlow  Max=0.62 cfs @ 12.86 hrs  HW=742.51'   (Free Discharge)
└─1=Culvert  (Barrel Controls 0.62 cfs @ 1.9 fps)
```

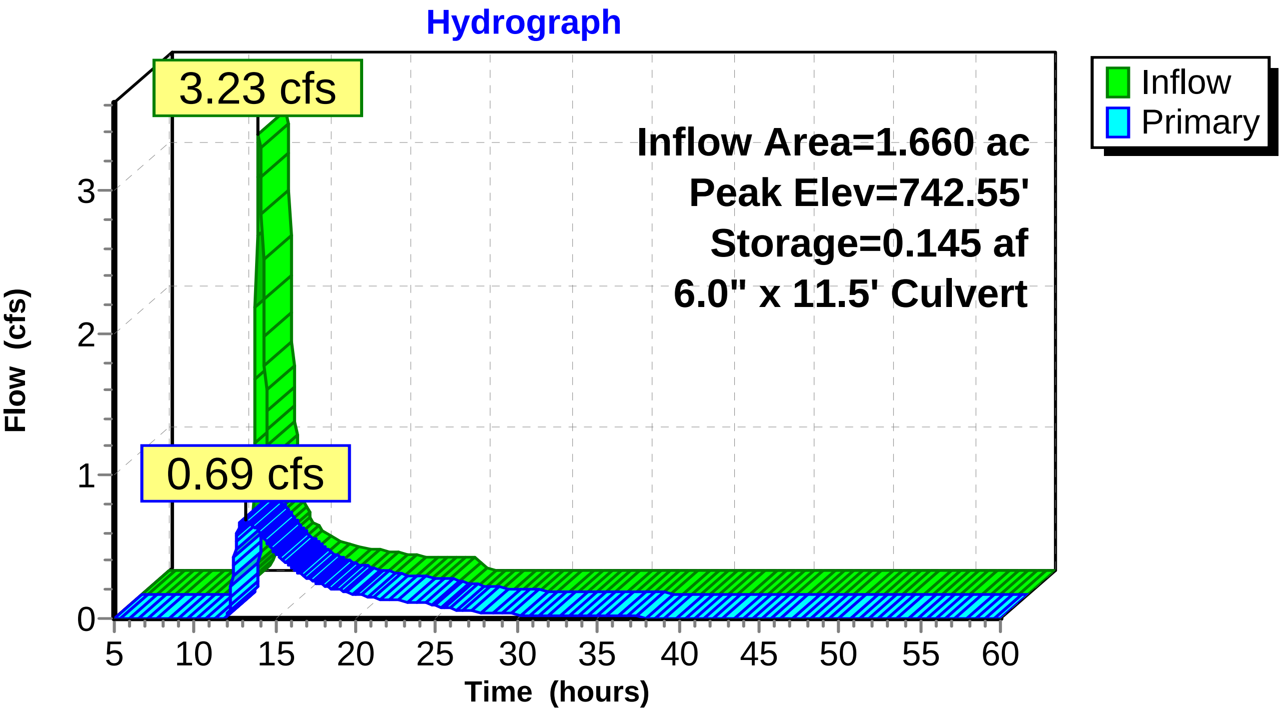
Pond 7P:


Hydrograph
3.28 cfs
0.62 cfs
Inflow Area=1.390 ac
Peak Elev=742.51'
Storage=0.121 af
6.0" x 11.5' Culvert
Inflow
Primary
Flow (cfs)
0
1
2
3
Time (hours)
5
10
15
20
25
30
35
40
45
50
55
60

Pond 9P:

```
Inflow Area =      1.660 ac,  Inflow Depth =  2.49"
Inflow      =     3.23 cfs @  12.29 hrs,  Volume=        0.344 af
Outflow     =     0.69 cfs @  13.10 hrs,  Volume=        0.337 af,  Atten= 79%,  Lag= 48.6 min
Primary     =     0.69 cfs @  13.10 hrs,  Volume=        0.337 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 742.55' @ 13.10 hrs   Surf.Area= 0.000 ac   Storage= 0.145 af
Plug-Flow detention time= 232.4 min calculated for 0.337 af (98% of inflow)
Center-of-Mass det. time= 220.5 min ( 1,095.5 - 875.0 )

Volume      Invert    Avail.Storage   Storage Description
   #1      742.00'         0.392 af   Custom Stage DataListed below

 Elevation      Cum.Store
    (feet)    (acre-feet)
    742.00          0.000
    743.50          0.392

Device   Routing        Invert   Outlet Devices
   #1    Primary       742.00'   6.0"  x 11.5' long Culvert X 2.00
                                 CMP, mitered to conform to fill,  Ke= 0.700
                                 Outlet Invert= 741.88'   S= 0.0104 '/'   Cc= 0.900
                                 n= 0.025  Corrugated metal

Primary OutFlow  Max=0.69 cfs @ 13.10 hrs  HW=742.55'   (Free Discharge)
└─1=Culvert  (Barrel Controls 0.69 cfs @ 2.0 fps)
```

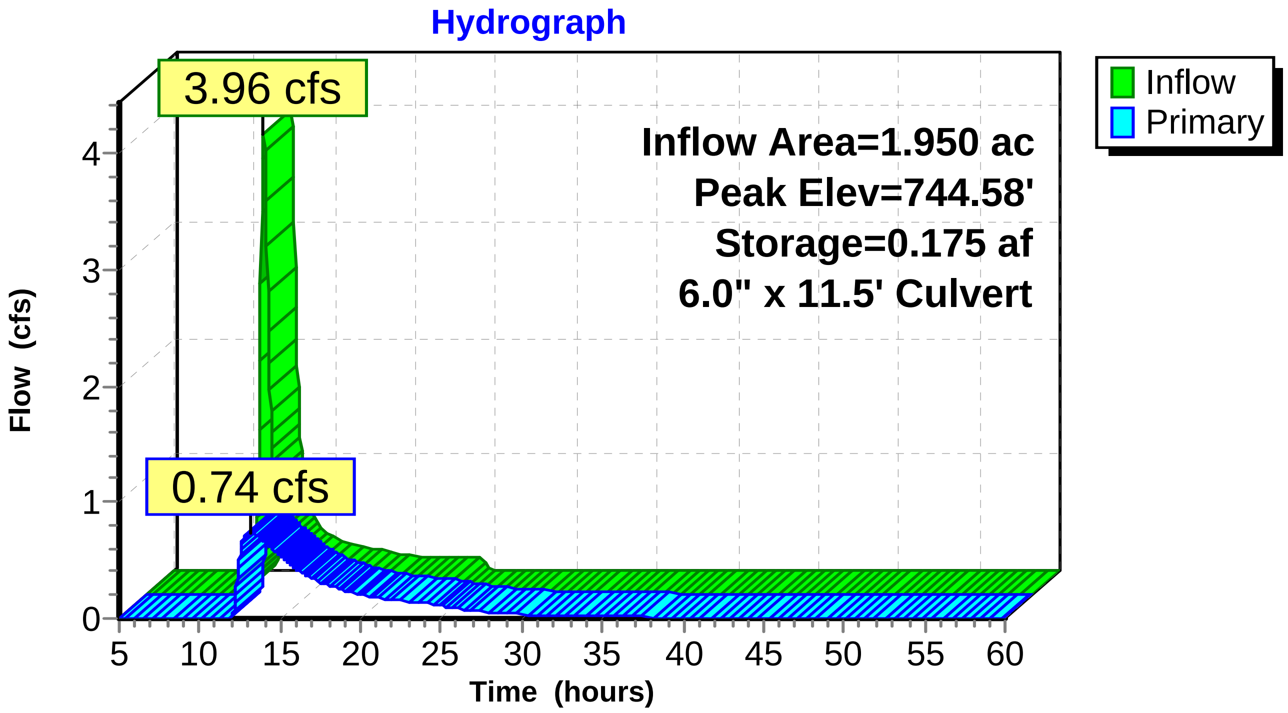
Pond 9P:


Hydrograph
3.23 cfs
0.69 cfs
Inflow Area=1.660 ac
Peak Elev=742.55'
Storage=0.145 af
6.0" x 11.5' Culvert
Inflow
Primary
Flow (cfs)
0
1
2
3
Time (hours)
5
10
15
20
25
30
35
40
45
50
55
60

Pond 10P:

```
Inflow Area =      1.950 ac,  Inflow Depth =  2.49"
Inflow      =      3.96 cfs @  12.27 hrs,  Volume=        0.404 af
Outflow     =      0.74 cfs @  13.13 hrs,  Volume=        0.395 af,  Atten= 81%,  Lag= 51.6 min
Primary     =      0.74 cfs @  13.13 hrs,  Volume=        0.395 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 744.58' @ 13.13 hrs   Surf.Area= 0.000 ac   Storage= 0.175 af
Plug-Flow detention time= 248.9 min calculated for 0.395 af (98% of inflow)
Center-of-Mass det. time= 237.4 min ( 1,110.5 - 873.2 )

Volume      Invert    Avail.Storage   Storage Description
   #1      744.00'         0.455 af   Custom Stage DataListed below

 Elevation      Cum.Store
    (feet)    (acre-feet)
    744.00          0.000
    745.50          0.455

Device   Routing        Invert   Outlet Devices
   #1    Primary       744.00'   6.0"  x 11.5' long Culvert X 2.00
                                 CMP, end-section conforming to fill,  Ke= 0.500
                                 Outlet Invert= 743.88'   S= 0.0104 '/'   Cc= 0.900
                                 n= 0.025  Corrugated metal

Primary OutFlow  Max=0.74 cfs @ 13.13 hrs  HW=744.58'   (Free Discharge)
└─1=Culvert  (Barrel Controls 0.74 cfs @ 2.0 fps)
```

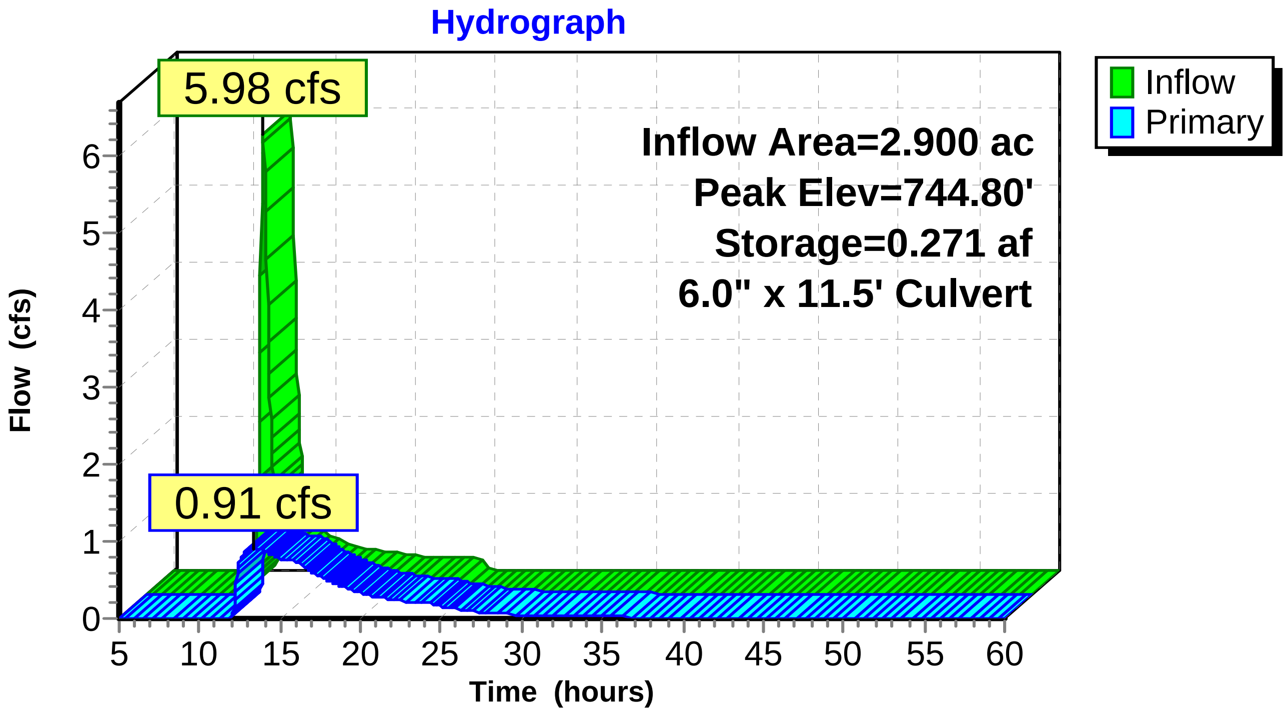
Pond 10P:


Hydrograph
3.96 cfs
0.74 cfs
Inflow Area=1.950 ac
Peak Elev=744.58'
Storage=0.175 af
6.0" x 11.5' Culvert
Inflow
Primary
Flow (cfs)
0
1
2
3
4
Time (hours)
5
10
15
20
25
30
35
40
45
50
55
60

Pond 11P:

```
Inflow Area =       2.900 ac,  Inflow Depth =   2.49"
Inflow      =      5.98 cfs @   12.26 hrs,  Volume=           0.601 af
Outflow     =      0.91 cfs @   13.28 hrs,  Volume=           0.590 af,  Atten= 85%,  Lag= 61.4 min
Primary     =      0.91 cfs @   13.28 hrs,  Volume=           0.590 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 744.80' @ 13.28 hrs   Surf.Area= 0.000 ac   Storage= 0.271 af
Plug-Flow detention time= 252.4 min calculated for 0.590 af (98% of inflow)
Center-of-Mass det. time= 241.2 min ( 1,113.7 - 872.5 )

Volume        Invert    Avail.Storage   Storage Description
   #1        744.00'         0.506 af   Custom Stage DataListed below

 Elevation      Cum.Store
    (feet)     (acre-feet)
    744.00          0.000
    745.50          0.506

Device   Routing        Invert   Outlet Devices
   #1    Primary       744.00'   6.0"  x 11.5' long Culvert X 2.00
                                 CMP, mitered to conform to fill,  Ke= 0.700
                                 Outlet Invert= 743.88'   S= 0.0104 '/'   Cc= 0.900
                                 n= 0.025  Corrugated metal

Primary OutFlow  Max=0.91 cfs @ 13.28 hrs  HW=744.80'   (Free Discharge)
└─1=Culvert  (Barrel Controls 0.91 cfs @ 2.3 fps)
```

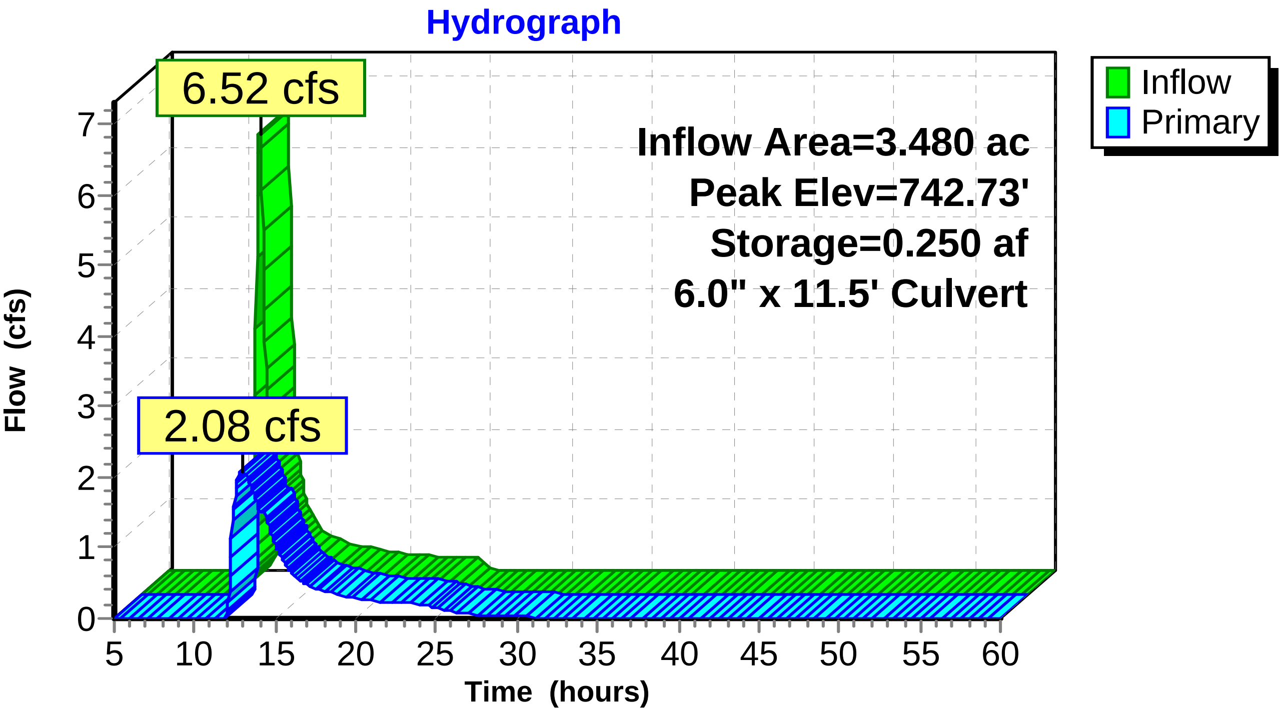
Pond 11P:


Hydrograph
5.98 cfs
0.91 cfs
Inflow Area=2.900 ac
Peak Elev=744.80'
Storage=0.271 af
6.0" x 11.5' Culvert
Inflow
Primary
Flow (cfs)
0
1
2
3
4
5
6
Time (hours)
5
10
15
20
25
30
35
40
45
50
55
60

Pond 12P:

```
Inflow Area =       3.480 ac,  Inflow Depth =   2.49"
Inflow      =      6.52 cfs @   12.32 hrs,  Volume=          0.721 af
Outflow     =      2.08 cfs @   12.91 hrs,  Volume=          0.717 af,  Atten= 68%,  Lag= 35.9 min
Primary     =      2.08 cfs @   12.91 hrs,  Volume=          0.717 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 742.73' @ 12.91 hrs   Surf.Area= 0.000 ac   Storage= 0.250 af
Plug-Flow detention time= 117.8 min calculated for 0.717 af (99% of inflow)
Center-of-Mass det. time= 114.4 min ( 991.1 - 876.7 )

Volume         Invert     Avail.Storage    Storage Description
    #1        741.80'          0.403 af    Custom Stage Data Listed below

 Elevation        Cum.Store
    (feet)       (acre-feet)
    741.80           0.000
    743.30           0.403

Device   Routing         Invert   Outlet Devices
   #1    Primary        741.80'   6.0"  x 11.5' long Culvert X 4.00
                                  CMP, mitered to conform to fill,  Ke= 0.700
                                  Outlet Invert= 741.68'   S= 0.0104 '/'   Cc= 0.900
                                  n= 0.025  Corrugated metal

Primary OutFlow  Max=2.08 cfs @ 12.91 hrs  HW=742.73'   (Free Discharge)
└─1=Culvert  (Barrel Controls 2.08 cfs @ 2.6 fps)
```

Pond 12P:


Hydrograph
6.52 cfs
2.08 cfs
Inflow Area=3.480 ac
Peak Elev=742.73'
Storage=0.250 af
6.0" x 11.5' Culvert
🟩 Inflow
🟦 Primary
Flow (cfs)
0
1
2
3
4
5
6
7
5
10
15
20
25
30
35
40
45
50
55
60
Time (hours)

Pond 13P:

Inflow Area = 2.000 ac, Inflow Depth = 2.49"
Inflow = 5.44 cfs @ 12.13 hrs, Volume= 0.415 af
Outflow = 0.43 cfs @ 13.66 hrs, Volume= 0.389 af, Atten= 92%, Lag= 92.1 min
Primary = 0.43 cfs @ 13.66 hrs, Volume= 0.389 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 745.40' @ 13.66 hrs Surf.Area= 0.000 ac Storage= 0.213 af
Plug-Flow detention time= 448.2 min calculated for 0.389 af (94% of inflow)
Center-of-Mass det. time= 414.4 min (1,277.0 - 862.6)

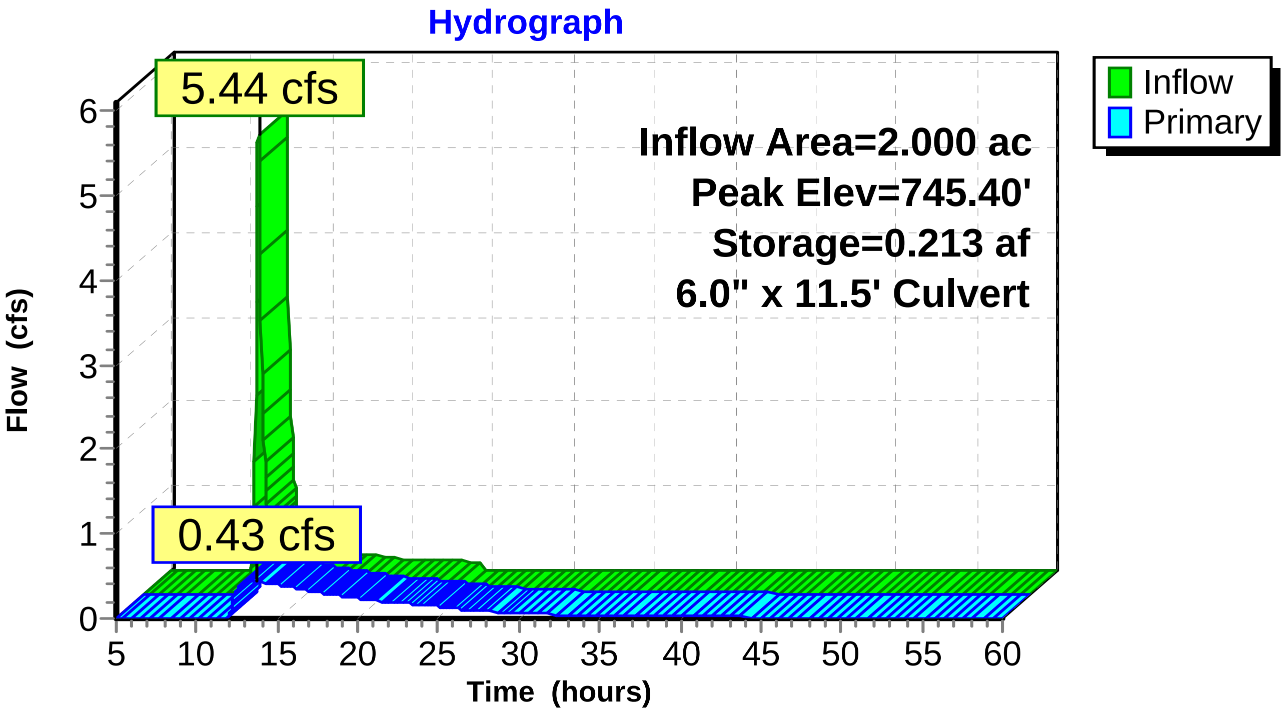
Volume	Invert	Avail.Storage	Storage Description
#1	745.00'	0.800 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
745.00	0.000
746.50	0.800

Device	Routing	Invert	Outlet Devices
#1	Primary	745.00'	**6.0" x 11.5' long Culvert X 2.00** CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 744.88' S= 0.0104 '/' Cc= 0.900 n= 0.025 Corrugated metal

Primary OutFlow Max=0.43 cfs @ 13.66 hrs HW=745.40' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.43 cfs @ 1.7 fps)

Pond 13P:


Hydrograph
5.44 cfs
0.43 cfs
Inflow Area=2.000 ac
Peak Elev=745.40'
Storage=0.213 af
6.0" x 11.5' Culvert
🟩 Inflow
🟦 Primary
Flow (cfs)
0
1
2
3
4
5
6
5
10
15
20
25
30
35
40
45
50
55
60
Time (hours)

SURFACE WATER MANAGEMENT SYSTEM
FILL AREA NORTHWEST OF REILLY AIRFIELD

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal #:** GR3762 **Task #:** 05

TITLE OF COMPUTATIONS Design & Analysis Of The Surface Water Management System For Fill Area Northwest Of Reilly Airfield

COMPUTATIONS BY:
Signature
Printed Name and Title: Mehmet Iscimen, Senior Staff Engineer
DATE: 09/15/2006

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature: Victoria S Cheplak
Printed Name and Title: Victoria Cheplak, Engineer
DATE: 09/21/2006

COMPUTATIONS CHECKED BY:
Signature: Victoria S. Cheplak
Printed Name and Title: Victoria Cheplak, Engineer
DATE: 09/21/2006

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature
Printed Name and Title: Mehmet Iscimen, Senior Staff Engineer
DATE: 09/25/2006

APPROVED BY:
(PM or Designate)
Signature
Printed Name and Title: Michael J. Monteleone, Principal
DATE: 09/25/2006

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by: Mehmet Iscimen **Date:** 09/15/06 **Reviewed by:** Victoria Cheplak **Date:** 09/21/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

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Written by: Mehmet Iscimen **Date:** 09/15/06 **Reviewed by:** Victoria Cheplak **Date:** 09/21/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

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List of Attachments

Written by: Mehmet Iscimen **Date:** 09/15/06 **Reviewed by:** Victoria Cheplak **Date:** 09/21/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

EXECUTIVE SUMMARY

In this calculation package, surface water management system design for Fill Area North West of Reilly Airfield (FANWR) has been evaluated. Design criteria was established based on the "Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites", discussions with the City of Anniston, and general practice experience related to stormwater management system designs. The criteria included the comparison of stormwater runoff from the site under pre-development and post–development conditions and the function of the stormwater management system under the 25-year and 100-year, 24-hour design storms.

In order to analyze and design the stormwater management system, a variety of parameters including hydrologic soil types, rainfall distribution and depths, and topographical information such as slopes, elevations, and areas, were evaluated for the site. Using the methodology and procedures described in Soil Conservation Service's Technical Release-55 [SCS TR-55, 1986], storm water runoff rates and volumes were calculated.

Results of this analysis indicate that the peak stormwater discharge rate from the site under post-development conditions with the stormwater management system is less than peak stormwater discharge rate under pre-development conditions. The stormwater management system consists of a stormwater detention pond at the northeast corner of the site to provide stormwater detention and sediment storage, as well as two perimeter channels to convey flow to the pond.

Written by: Mehmet Iscimen **Date:** 09/15/06 **Reviewed by:** Victoria Cheplak **Date:** 09/21/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

DESIGN & ANALYSIS OF THE SURFACE WATER MANAGEMENT SYSTEM

PURPOSE

The purpose of this calculation package is to present the analysis and design of the surface water management system for the site of the Fill Area Northwest of Reilly Airfield (FANWR). The following are the specific goals of this package:

- establish the design criteria;
- calculate the pre-development peak discharges leaving the site;
- design the components of the surface water management system, including final cover system, perimeter channels, and the sedimentation basin and appurtenances;
- calculate the post-development peak discharges leaving the site; and
- compare the calculated post-development discharges with the calculated pre-development discharges.

SURFACE WATER MANAGEMENT SYSTEM - OVERVIEW

The topographic map of FANWR and the plan view of the proposed surface water management system are provided in Attachments 1 and 2, respectively. The topographic map indicates the existing fill area perimeter limit, while the proposed surface water management system indicates a modified fill area perimeter limit as well as a limit of work. The fill area perimeter limit is modified to reflect the portion of the existing fill area that encroaches into the footprint of the right-of-way of the proposed industrial access road. The waste located at this area will be removed and re-located to other sections of the landfill. As a result, the southern perimeter limit (waste limit) of FANWR at the post-development condition will be different than the limit at the pre-development condition.

The cover system will have varying slopes depending on the existing fill topography and stormwater routing practices. Side slopes (perimeter slopes) of the cover system will be 33 percent (i.e., 3H:1V) until natural ground surface elevations are reached with the exception of the area south west of the landfill (i.e., where the waste will be relocated) that has side slopes of 8 percent. The cover system of the FANWR generally slopes to the north side of the Fill Area and ultimately directed to the proposed stormwater detention pond.

However, runoff from two small areas is not directed to the stormwater management system. A small area on the south side of the landfill crest slopes to the south. A preliminary analysis demonstrates that the stormwater runoff from this area is relatively small compared to the runoff from the rest of the landfill. Furthermore, the majority of the southern grading is located within the foot-print of industrial access road and is temporary. As a result, this area will be allowed to discharge freely in the interim condition. Additionally, an area at the northwest corner flows to the northwest, away from the stormwater detention pond, under both current and proposed conditions. The stormwater runoff from the northwest slope is comparable at pre- and post-development conditions. While the post-development slopes are steeper than pre-development slopes, the contributing area is smaller under the post development conditions, which acts to balance the runoff generated. Therefore, no further design is recommended and northwest slopes will be allowed to discharge freely, as well.

The stormwater detention pond is located northeast of the FANWR, outside of the site perimeter. It is designed as a trapezoidal channel with a constant 2 percent longitudinal slope, 3H:1V side slopes and a controlled outflow structure. Stormwater runoff from the eastern perimeter slope and a small portion of the northern perimeter slope will be collected via v-shaped channels and conveyed to the detention pond.

The runoff collected in the stormwater detention pond will be released through a principal spillway, composed of a vertical riser pipe and a horizontal barrel pipe directing flow towards the ravine located to the east of the FANWR. In addition to the principal spillway, an emergency spillway is designed to discharge stormwater runoff in excess of the capacity of the detention pond.

DESIGN APPROACH

The surface water management system for the FANWR is designed to meet requirements of the "Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites" (herein referred as ASWCC [2003]) [Alabama Soil and Water Conservation Committee, 2003]. ASWCC [2003] does not specifically recommend a certain storm event for design purposes, however it does state: "*In many localities, a 10-year design storm is specified to preserve the effectiveness of downstream drainage structures which were originally designed to pass a 10-year pre-development storm. Other localities require that larger storms (i.e., 50-100 year events) must be detained and released at a controlled rate to reduce the downstream effects of major storms*." Based on this statement, discussions with the City of Anniston, and general practice experience related to stormwater management system designs, the following criteria were selected for the stormwater management system design for the FANWR:

- Design, construct, operate, and maintain a runoff management system to collect and control at least the peak flow volume resulting from a 25-year, 24-hour design storm event; and
- Design holding facilities (e.g., detention ponds) associated with run-on and runoff control systems to detain the water volume resulting from a 25-year, 24-hour design storm event with 0.5-feet of freeboard, and to divert at least the peak flow resulting from a 100-year, 24-hour design storm event through the emergency spillway.
- Design conveyance facilities (e.g., perimeter channels) to provide a minimum of 0.25 feet of freeboard for calculated peak flows from the 25-year 24-hour design storm, and not overtop for calculated peak discharges from the 100-year 24-hour design storm.
- Design the crest elevation of the principal spillway inlet to provide the minimum storage requirement, i.e. the runoff resulting from a 2-year, 24-hour design storm event and the required sediment storage (specified below).

In addition to the specified design storm criteria discussed above, sediment storage requirements were also considered for the design of the stormwater detention pond. Specifically, ASWCC [2003] states that “*the sediment storage volume should be at least 67 cubic yards per acre of the total drainage area of the basin*”. This volume provides for sediment storage equivalent to ½-inch per acre of the total drainage area of the pond.

ANALYSIS METHODOLOGY

Pre-development Watershed Analysis

Attachment 1 presents the topographic map for the general site vicinity and the boundary of the FANWR. Attachment 3 presents the delineation of the natural watershed in the vicinity of the site on the topographic map. This drainage area is the basis for the pre-development watershed analysis.

Post-Development Analysis of Surface Water Management System

Attachment 2 presents the topographic map for the general site vicinity of the FANWR for the post-development conditions. The map also identifies the locations of the stormwater detention pond and perimeter channels.

Attachment 4 presents a Schematic Plan of the surface water management system. The plan shows the delineation of subareas on the cover system. The post-development analysis of the surface water management system is based on the parameters calculated/estimated from this plan.

SOFTWARE

Stormwater discharges are estimated using the computer program "HydroCAD^{TM}" [HydroCAD^{TM} 7.1, 2005]. The program uses hydrology procedures presented in Soil Conservation Service's TR-55 [SCS TR-55, 1986]. Hydrographs generated within the computer program are routed through a user specified network of reaches using documented hydraulic routing techniques.

MAJOR CALCULATION PARAMETERS

- **Rainfall Distribution**: Attachment 5 [SCS TR-55, 1986] shows the location of the site on the rainfall distribution map of the United States. The site is located in Calhoun County, Alabama, which is categorized by SCS Type II Rainfall Distribution.

- **Rainfall Depths:** Attachment 5 also presents the site location and the rainfall depth for the 2-year, 25-year, and 100-year, 24-hour design storms. The 2-year rainfall depth is used for calculating the times of concentration for hydrologic modeling. The rainfall depths are shown in the following table.

Return Period (years)	Duration (hours)	Design Rainfall Depth (inches)
2	24	3.9
25	24	6.7
100	24	8.0

- **Hydrologic Soil Groups (HSG):** Attachment 6 presents the regional soils maps for the vicinity of the FANWR and Borrow Area No.2 located southeast of Reilly Airfield. Major soil units found within the areas of interest and the corresponding Hydrologic Soil Groups (HSGs) are listed in the Table A6-1 in Attachment 6. HSG B was used for the pre-development analyses performed in this package. For the final cover system, it is anticipated that a local area adjacent to Reilly Airfield southeast of the site will be used as a borrow source. This area also consists of soils characterized as HSG B.

Therefore, for the purposes of hydrologic modeling performed in this package, HSG B is also assumed for the post-development analyses.

- **Curve Numbers (CN):** CNs were selected based on Table 2.2a and 2.2c of SCS TR-55, 1986. The following table summarizes the CNs chosen for the analyses performed in this package. The complete version of both tables can be found in Attachment 7.

Area Description	Condition	HSG	CN
Pre-Development Conditions of the FANWR	Woods – Good Condition	B	55
FANWR Final Cover System	Open Space, Good Hydrologic Condition (Grass Cover>75%)	B	61
Stormwater Detention Pond	Impervious Area	B	98

- **Nodal Network Diagram:** Attachment 8 presents a diagram of the nodal network used in HydroCAD™ for the pre-development and post-development analysis.
  - Pre-development Nodal Network: In the pre-development scenario, only one subcatchment is modeled (identified in Attachment 3).
  - Post-development Nodal Network: Subcatchments as depicted in the Schematic Surface Water Management Plan (Attachment 4) were generally routed to reach segments and ultimately discharge into the stormwater detention pond.

- **Properties of Subareas:** Attachment 9 presents all properties of the subareas used in HydroCAD™ for the pre- and post-development analysis. The computed area (acres) of each subarea, curve number, and computations for times of concentration are included in Attachment 9.

  Computations for travel time for sheet flow are performed using the equation for Manning's kinematic solution [SCS TR-55, 1986]:

$$T_t = \frac{0.007(nL)^{0.8}}{(P)^{0.5} S^{0.4}}$$

where, T_t=travel time (hr), n=Manning's roughness coefficient, n=0.15 for short grass and n=0.80 for woods with dense underbrush, L=flow length (ft), P=2-year, 24-hour rainfall depth (inches), and S=land slope (ft/ft).

After a maximum of 300 feet, sheet flow is assumed to become shallow concentrated flow (i.e., upland flow). Travel times for shallow concentrated flow are estimated using the methodology presented in TR-55 [SCS TR-55, 1986]:

$$T_t = \frac{L}{K\, S^{0.5}}$$

where, T_t = travel time (seconds), L = flow length (ft), S = land slope (ft/ft), K = 7.0 for short grass pasture and K = 2.5 for forest with heavy litter.

DESIGN OF SURFACE WATER MANAGEMENT SYSTEM COMPONENTS

Stormwater Detention Pond

Attachment 10 provides details of the stormwater detention pond outlet structures, including the primary spillway, emergency spillway and embankment. The principal spillway consists of a vertical, 15-inch diameter, corrugated metal riser pipe connected to a horizontal, 10-inch diameter, corrugated metal barrel pipe which discharges towards the Ravine located east of the FANWR. The vertical riser pipe components include a 15-inch diameter, horizontal orifice with trash rack and anti-vortex device at elevation 728.50 feet and 1-inch diameter vertical orifices (perforations) distributed over its height at 6-inch vertical spacing. The vertical orifices will allow the slow drainage of the runoff volume detained below the primary spillway invert. The emergency spillway is designed as a trapezoidal cross-section with 13-feet base width, 1-foot depth and 33-percent side slopes (3H:1V), at a crest elevation of 730.00 feet.

Riprap slope protection is recommended at the emergency spillway. The following equation was used to estimate the riprap size required for lining the channels (ASWCC [2003]):

$$d_{50} = [QS_0^{0.58} / (3.93*10^{-2})]^{(1/1.89)}$$

where, d_{50}=minimum median riprap diameter (in), Q=net discharge through the emergency spillway from a 100-year, 24-hour storm event (cfs), and S_0=longitudinal slope (ft/ft). Required d_{50} is found to be 14.5-inches. This calculation is presented in Attachment 10.

Attachment 11 presents the stage-storage relationship of the stormwater detention pond. Based on criteria recommended by the ASWCC [2003], a sediment storage capacity of 67 cubic yards per acre of disturbed area is provided in addition to a detention volume to accommodate the runoff from the 25-year, 24-hour design storm without overtopping the emergency spillway. The total design capacity of the stormwater detention pond is approximately 41,000 cubic-feet at the emergency spillway invert elevation of 730.00 feet. The sediment storage capacity was calculated as approximately 11,760 cubic-feet. It is recommended that the sediment be cleaned out when half (50 percent) of the required sediment storage volume has been filled with sediment. Based on a stage-storage relationship as shown in Attachment 11, a sediment cleanout elevation of 725.8 feet is recommended.

Based on estimations using HydroCAD^{TM}, the water level at the stormwater detention pond will not reach the emergency spillway crest elevation at a 100-year, 24-hour storm event.

Perimeter Channels

Perimeter channels located on both the northern and eastern perimeter are designed with a V-shaped cross-section, 33-percent side slopes (3H:1V) and 1-foot depth. The northern perimeter channel has an average longitudinal slope of 3.5 percent whereas the eastern channel has varying longitudinal slopes ranging from 2 to 14 percent. Velocities in the channels do not exceed 5.0 feet/second for the 25-year, 24-hour storm event and as a result, grass lining is appropriate.

COMPUTATIONS USING HydroCAD^{TM}

Calculations were performed using HydroCAD^{TM} for the input parameters discussed in the previous section for the 25-year, 24-hour design storm and the 100-year, 24-hour design storm. The computer program results for the pre-development and post-development analyses are presented in Attachments 12 and 13.

Written by: Mehmet Iscimen **Date:** 09/15/06 **Reviewed by:** Victoria Cheplak **Date:** 09/21/06

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

COMPARISON OF PRE- VERSUS POST-DEVELOPMENT DISCHARGES

The following table summarizes the results from Attachments 12 and 13 for pre- and post-development discharges from the site for the 25- and the 100-year, 24-hour design storms. As shown in the table, the post-development discharges with the stormwater management system described above are less than the pre-development discharges for design storms that were considered in this analysis.

Design Rainfall Event	Design Rainfall Depth (inch)	Peak Pre-Development Discharge (cfs)	Peak Post-Development Discharge (cfs)
25-year, 24-hour	6.7	3.81	3.33
100-year, 24-hour	8.0	5.75	3.58

The following table summarizes the channel and stormwater detention pond design depths, peak flow depths, and available freeboard requirements. As indicated, all peak depths meet the design requirements.

Design Rainfall Event		Stormwater Detention Pond (ft)	Northern Perimeter Channel (ft)	Eastern Perimeter Channel (ft)
25-year, 24-hour	Design Depth	9.00	1.00	1.00
	Peak Depth	6.84	0.67	0.42
	Freeboard	2.16	0.33	0.58
100-year, 24-hour	Design Depth	9.00	1.00	1.00
	Peak Depth	7.92	0.76	0.48
	Freeboard	1.08	0.24	0.52

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REFERENCES

Alabama Soil and Water Conservation Committee (ASWCC), "*Alabama Handbook for Erosion Control*, *Sediment Control, and Stormwater Management on Construction Sites*", 2003.

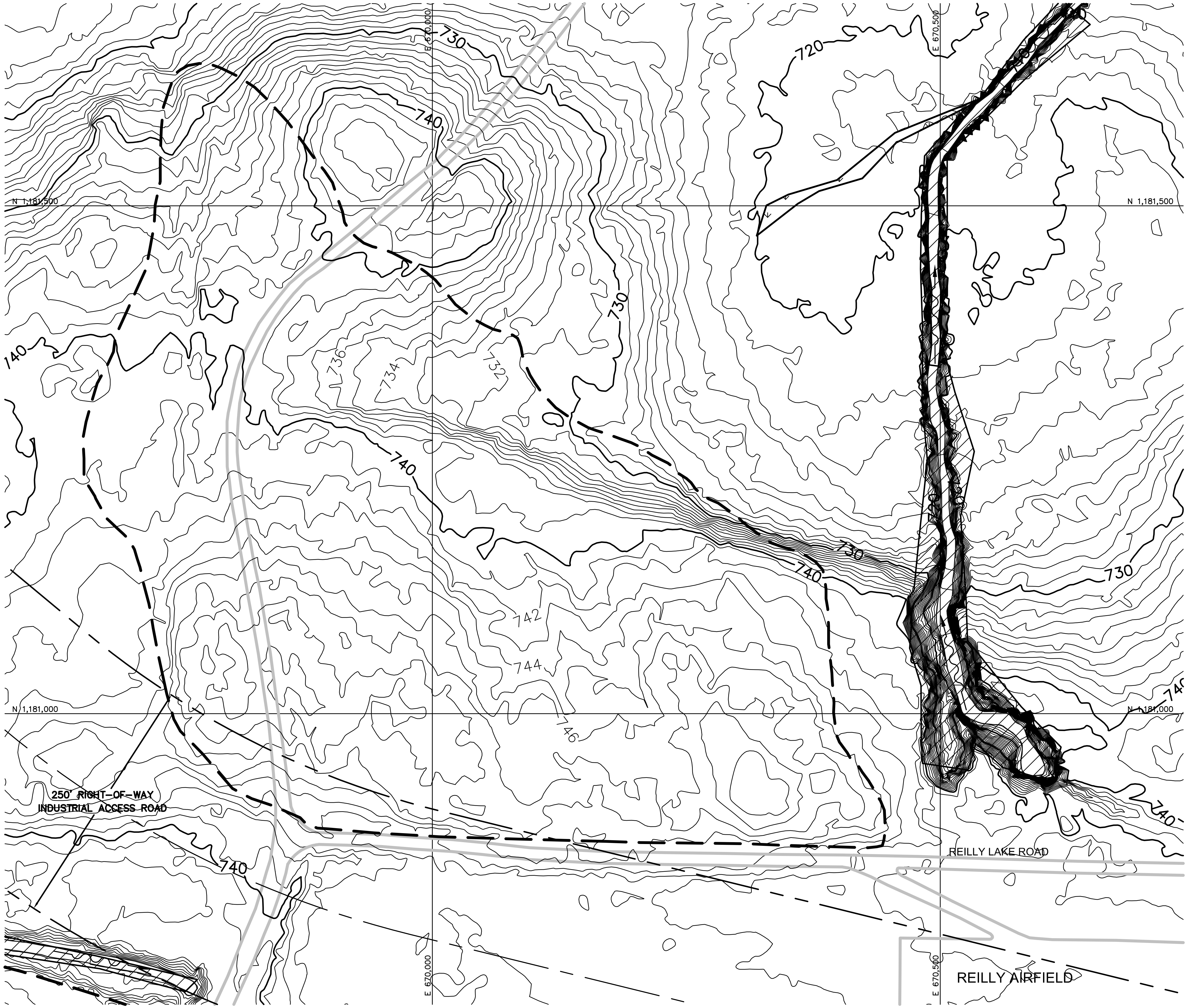
Chadwick, Andrew and Morfett, John, "*Hydraulics in Civil and Environmental Engineering*", 2nd edition, E&FN Spon, 1993, London.

HydroCAD, "*HydroCAD™: Stormwater Modeling System, Version 7*", HydroCAD Software Solutions LLC., 2nd ed., Chocorua, New Hampshire, 2004.

SCS, "*TR-55 Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55)*", United States Department of Agriculture, Soil Conservation Service, 2nd ed., Washington, D.C., 1986.

ATTACHMENT 1

Topographic Map
(Pre-Development)



LEGEND

—730—	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
═	EXISTING ROAD
— —	LANDFILL/FILL AREA PERIMETER LIMIT
— - - —	RIGHT-OF-WAY LIMIT
—— - ——	INDUSTRIAL ACCESS ROAD CENTERLINE
↓ ↓ ↓	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
∿∿→	SURFACE WATER FLOW DIRECTION

N

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 100' 200'

SCALE IN FEET

ATTACHMENT 1 - TOPOGRAPHIC MAP (PRE-DEVELOPMENT)

GEOSYNTEC CONSULTANTS

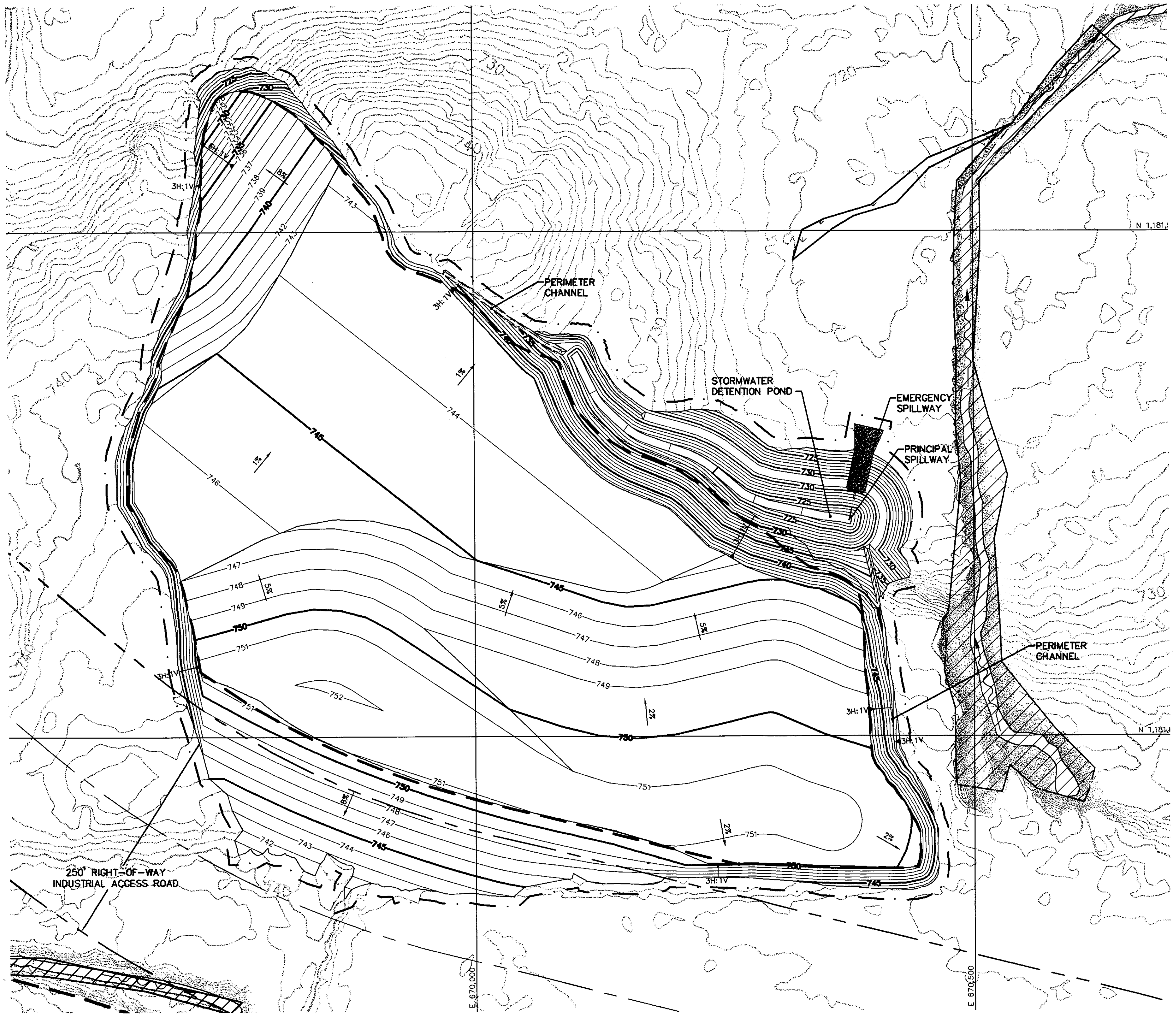
KENNESAW, GA

DATE: SEPTEMBER 2006	SCALE: 1"=100'
PROJECT NO. GR3762	FILE NO. 3762SM01
DOCUMENT NO.	FIGURE NO. 1

ATTACHMENT 2

Surface Water Management System: Grading Plan

P:\Cadd\Dwg1\CADD\GR3762-05\STORMWATER MANAGMENT\3762SM02.dwg, 11/8/2006 5:35:13 PM, jsimons, 1:1



N

LEGEND

—730—	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
▨	EXISTING ROAD
— —	LANDFILL/FILL AREA PERIMETER LIMIT
—750—	FINISHED GRADE ELEVATION (FEET)
— – – —	RIGHT-OF-WAY LIMIT
— - —	INDUSTRIAL ACCESS ROAD CENTERLINE
☐	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
∿→	SURFACE WATER FLOW DIRECTION
— · —	LIMIT OF WORK

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 100' 200'

SCALE IN FEET

ATTACHMENT 2 - SURFACE WATER MANAGEMENT SYSTEM: GRADING PLAN

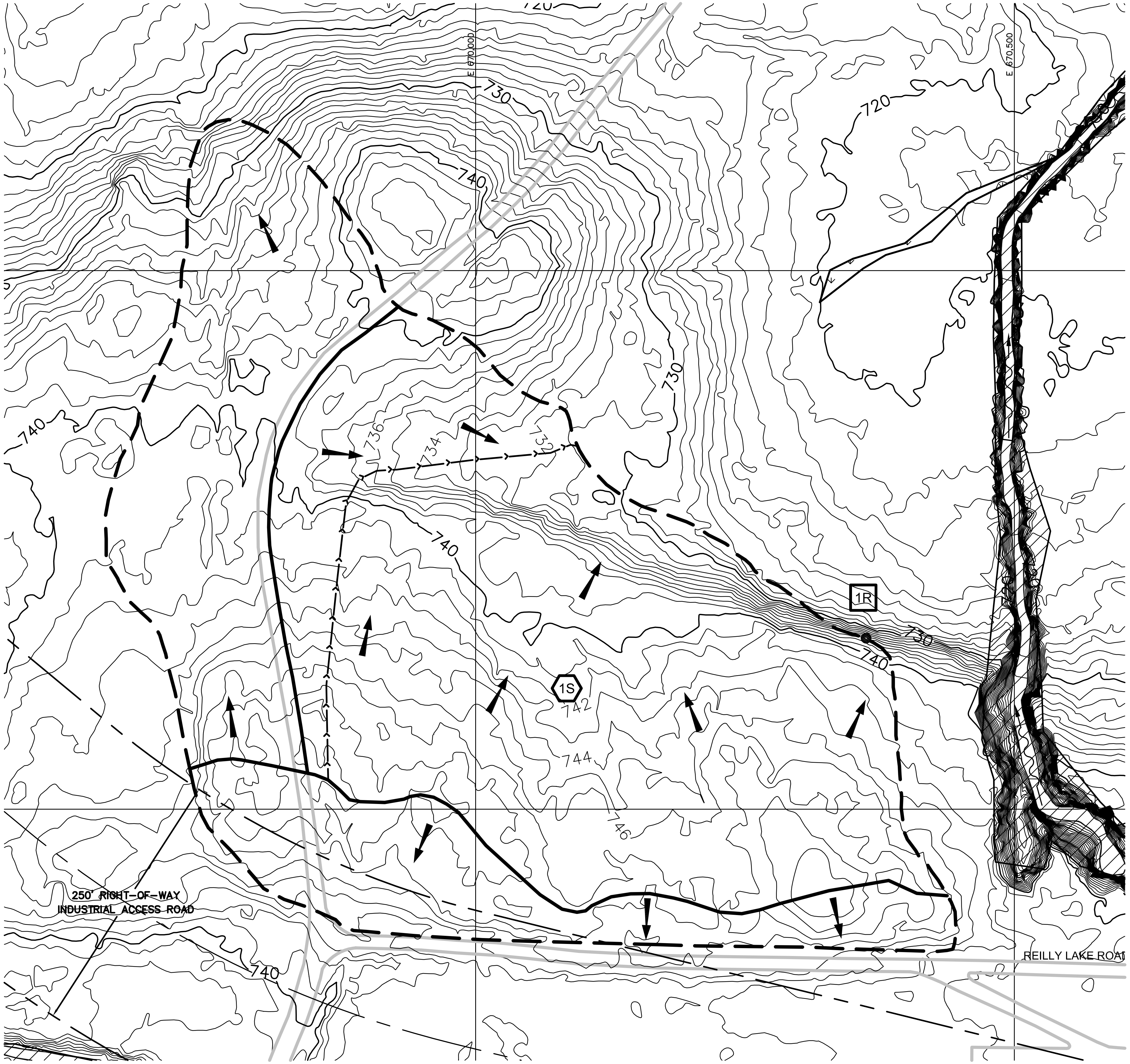
GEOSYNTEC CONSULTANTS

KENNESAW, GA

DATE:	SEPTEMBER 2006	SCALE:	1"=100'
PROJECT NO.	GR3762	FILE NO.	3762SM02
DOCUMENT NO.		FIGURE NO.	2

ATTACHMENT 3

Pre-Development Watershed Delineation Map



LEGEND

—730—	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
═	EXISTING ROAD
— —	LANDFILL/FILL AREA PERIMETER LIMIT
- - -	RIGHT-OF-WAY LIMIT
— - —	INDUSTRIAL ACCESS ROAD CENTERLINE
↓ ↓ ↓	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
∿∿→	SURFACE WATER FLOW DIRECTION
—	SUBCATCHMENT BOUNDARY
—<—<—	FLOW PATH FOR T_c CALCULATION
1S	SUBCATCHMENT DESIGNATION
1R	REACH DESIGNATION
➡	FLOW DIRECTION (ON FANWRA)
●	POINT OF INTEREST

N

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 100' 200'

SCALE IN FEET

ATTACHMENT 3 - PRE-DEVELOPMENT WATERSHED DELINEATION MAP

GEOSYNTEC CONSULTANTS

KENNESAW, GA

DATE: SEPTEMBER 2006	SCALE: 1"=100'
PROJECT NO. GR3762	FILE NO. 3762SM03
DOCUMENT NO.	FIGURE NO. 3

ATTACHMENT 4

Post-Development Watershed Delineation Map

LEGEND

—730—	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
▒	EXISTING ROAD
— —	LANDFILL/FILL AREA PERIMETER LIMIT
—750—	FINISHED GRADE ELEVATION (FEET)
— – – —	RIGHT-OF-WAY LIMIT
— – —	INDUSTRIAL ACCESS ROAD CENTERLINE
▭	JURISDICTIONAL WETLAND (SURVEYED BOUNDARY) (NOTE 2)
▨	JURISDICTIONAL WATERS OF THE UNITED STATES (NOTE 2)
∿→	SURFACE WATER FLOW DIRECTION
━	SUBCATCHMENT BOUNDARY
—<—<—	FLOW PATH FOR T_c CALCULATION
— · —	LIMIT OF WORK
2S	SUBCATCHMENT DESIGNATION
6R	REACH DESIGNATION
5P	POND DESIGNATION

NOTES:

1. TOPOGRAPHY DEVELOPED USING LIDAR TECHNOLOGY PERFORMED BY OPTIMAL GEOMATICS OF HUNTSVILLE, ALABAMA ON 17 DECEMBER 2005.
2. LOCATIONS OF JURISDICTIONAL WETLANDS AND WATERS WERE OBTAINED FROM "FINAL WETLAND DETERMINATION, LANDFILLS AND FILL AREAS," BY SHAW ENVIRONMENTAL, INC. DATED 17 NOVEMBER 2003.

0 100' 200'

SCALE IN FEET

ATTACHMENT 4 - POST-DEVELOPMENT WATERSHED DELINEATION MAP

GEOSYNTEC CONSULTANTS

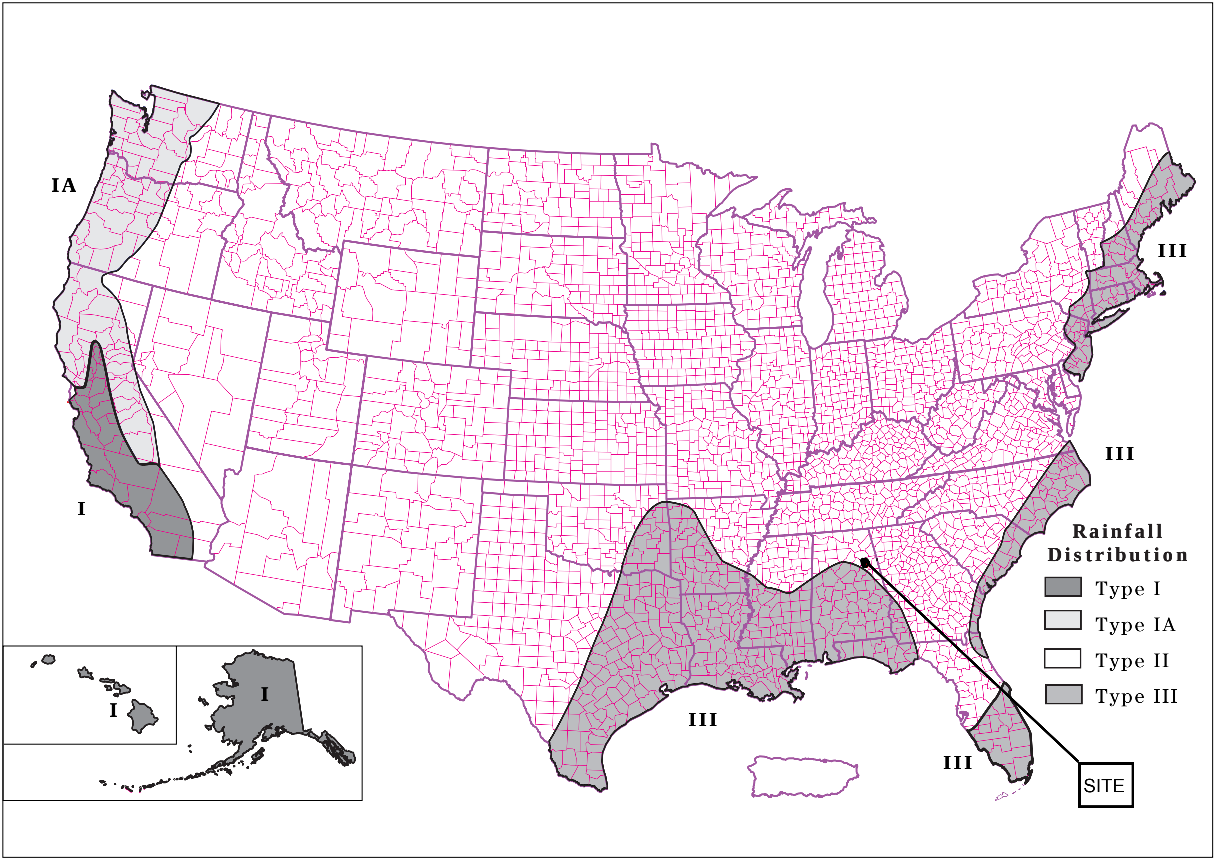
KENNESAW, GA

DATE:	SEPTEMBER 2006	SCALE:	1"=100'
PROJECT NO.	GR3762	FILE NO.	3762SM04
DOCUMENT NO.		FIGURE NO.	4

P:\Cadd\Dwg1\CADD\GR3762-05\STORMWATER MANAGMENT\3762SM04.dwg, 11/8/2006 5:33:52 PM, jsimons, 1:1

ATTACHMENT 5

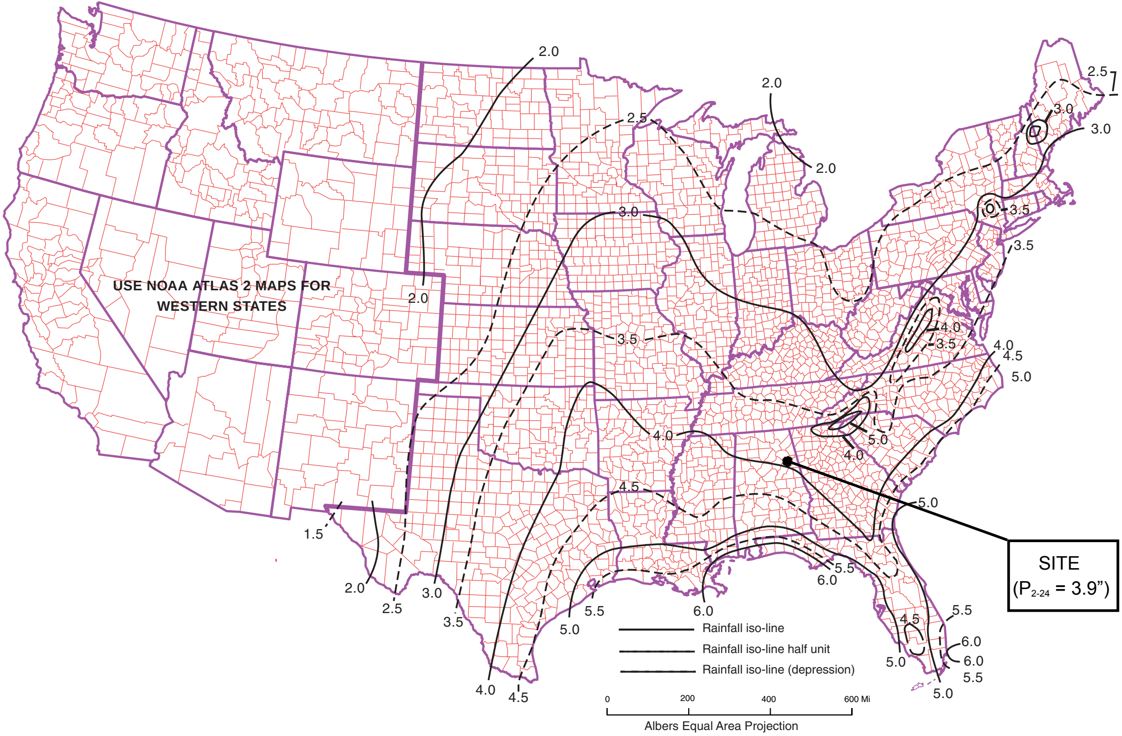
Rainfall Distribution and Rainfall Depths


IA
I
I
I
III
III
III
III
Rainfall Distribution
Type I
Type IA
Type II
Type III
SITE

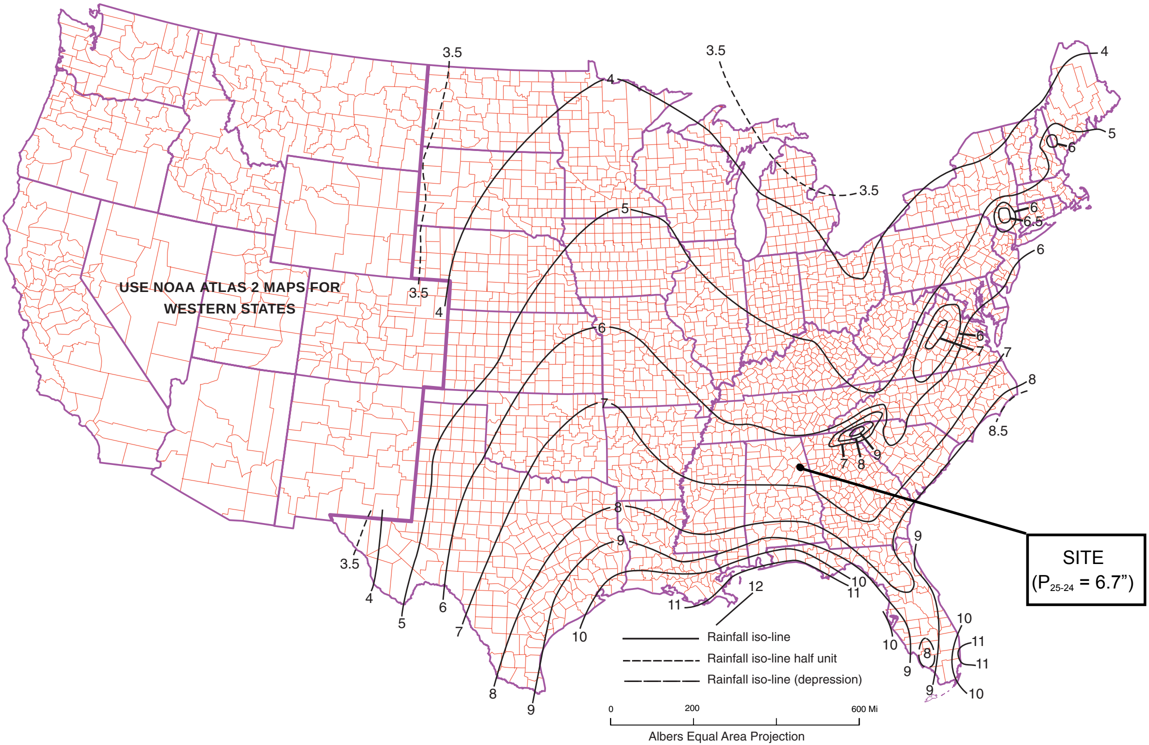
U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

2-Year 24-Hour Rainfall (inches)



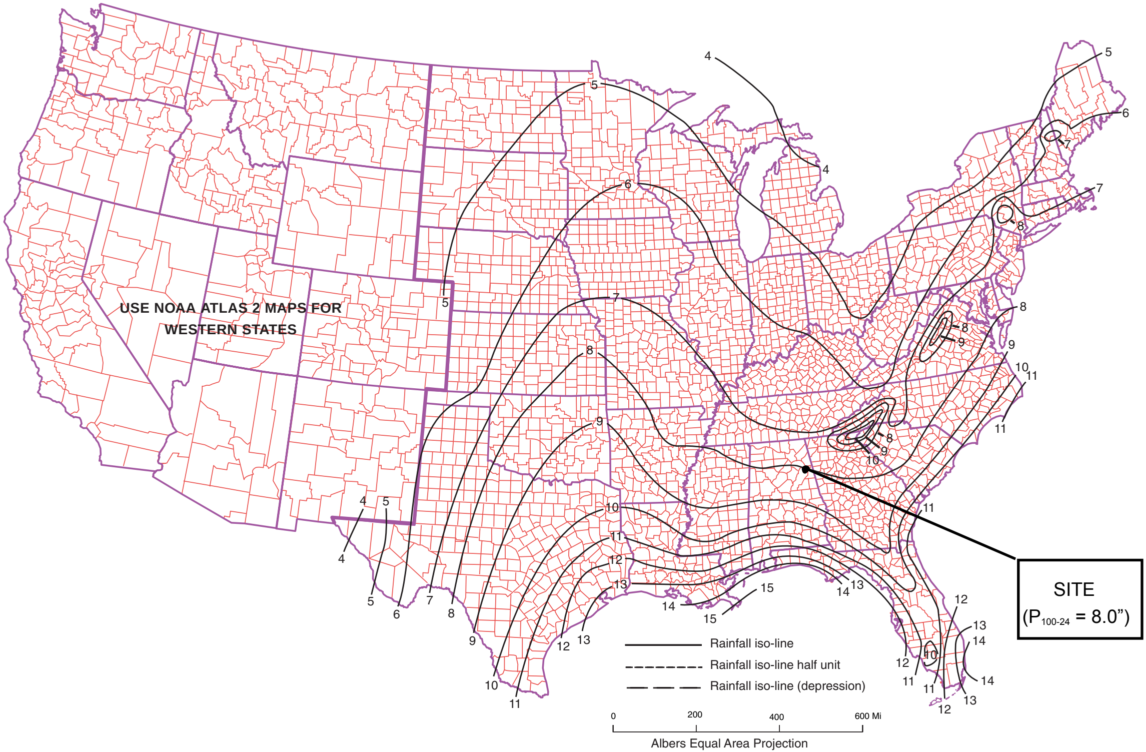
25-Year 24- Hour Rainfall (inches)



U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

100-Year 24-Hour Rainfall (inches)



SITE
(P_{100-24} = 8.0")

ATTACHMENT 6

Hydrologic Soil Groups

HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

FANWR

HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

FANWR

MAP LEGEND

Hydrologic Group

{Dominant Condition, <}

- 🟥 A
- 🟩 A/D
- 🟦 B
- 🟦 B/D
- 🟨 C
- 🟦 C/D
- 🟪 D
- ⬜ Not rated or not available
- ▭ Soil Map Units
- ● Cities
- ▭ Detailed Counties
- ▭ Detailed States
- ― Interstate Highways
- ― Roads
- ┼ Rails
- 🟦 Water
- ― Hydrography
- 🟦 Oceans

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 16

Soil Survey Area: Calhoun County, Alabama
Spatial Version of Data: 3
Soil Map Compilation Scale: 1:20000

Map comprised of aerial images photographed on these dates:
1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables - Hydrologic Group

Summary by Map Unit - Calhoun County, Alabama

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
AsA	Atkins and Stendal soils, local alluvium, 0 to 2 percent slopes	D	3.3	12.4
CoB2	Cumberland gravelly loam, 2 to 6 percent slopes eroded	B	23.0	86.0
LhC2	Lehew-Montevallo soils, 2 to 10 percent slopes, eroded	D	0.0	0.0
PuA	Purdy silt loam, 0 to 2 percent slopes	D	0.0	0.1
SeB2	Sequatchie gravelly fine sandy loam, 2 to 6 percent slopes, eroded	B	0.0	0.2
Tr	Terrace escarpments	B	0.4	1.3

Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

Parameter Summary - Hydrologic Group

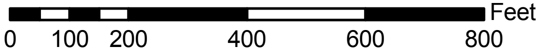
Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

Borrow Area No.2



HYDROLOGIC GROUP RATING FOR CALHOUN COUNTY, ALABAMA

Borrow Area No.2

MAP LEGEND

Hydrologic Group

{Dominant Condition, <}

- 🟥 A
- 🟩 A/D
- 🟦 B
- 🟦 B/D
- 🟨 C
- 🟦 C/D
- 🟪 D
- ⬜ Not rated or not available
- ☐ Soil Map Units
- ● Cities
- ▭ Detailed Counties
- ▭ Detailed States
- — Interstate Highways
- — Roads
- ┼ Rails
- 🟦 Water
- — Hydrography
- 🟦 Oceans

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 16

Soil Survey Area: Calhoun County, Alabama
Spatial Version of Data: 3
Soil Map Compilation Scale: 1:20000

Map comprised of aerial images photographed on these dates:
1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables - Hydrologic Group

Summary by Map Unit - Calhoun County, Alabama

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
AbC3	Anniston gravelly clay loam 6 to 10 percent slopes, severely eroded	B	11.4	56.1
CoB2	Cumberland gravelly loam, 2 to 6 percent slopes eroded	B	9.0	43.9

Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

Parameter Summary - Hydrologic Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

TABLE A6-1

MAJOR TYPES OF SOILS FOR RUN-ON AREAS IN THE SOIL MAP

Soil Unit [(1)]	**Soil Unit Description [(1)]**	**Location**	**Hydrologic Soil Group (1)**
CoB2	Cumberland Gravelly Loam	FANWR & Borrow Area No.2	B
AsA	Atkins and Stendal Soils, Local Alluvium	FANWR	D
AbC3	Anniston Gravelly Clay Loam	Borrow Area No.2	B

Notes:
(1) Map symbols, map soil unit names, and hydrologic soil groups for the soil survey area obtained from Natural Resources Conservation Service (NRCS) Web Soil Survey Site with the web address http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx (accessed on 22 September 2006).

ATTACHMENT 7

Curve Numbers

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
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	$\boxed{61}$	74	80
Impervious areas:			FINAL COVER		
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	$\boxed{98}$	98	98
Streets and roads:			DETENTION POND		
Paved; curbs and storm sewers (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
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
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					
Newly graded areas (pervious areas only, no vegetation) [5]	77	86	91	94	
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

---

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

[2] The average percent impervious area shown was used to develop the composite CN's. 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. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

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

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55 PRE-DEVELOPMENT	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

---

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

[2] *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

[3] *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

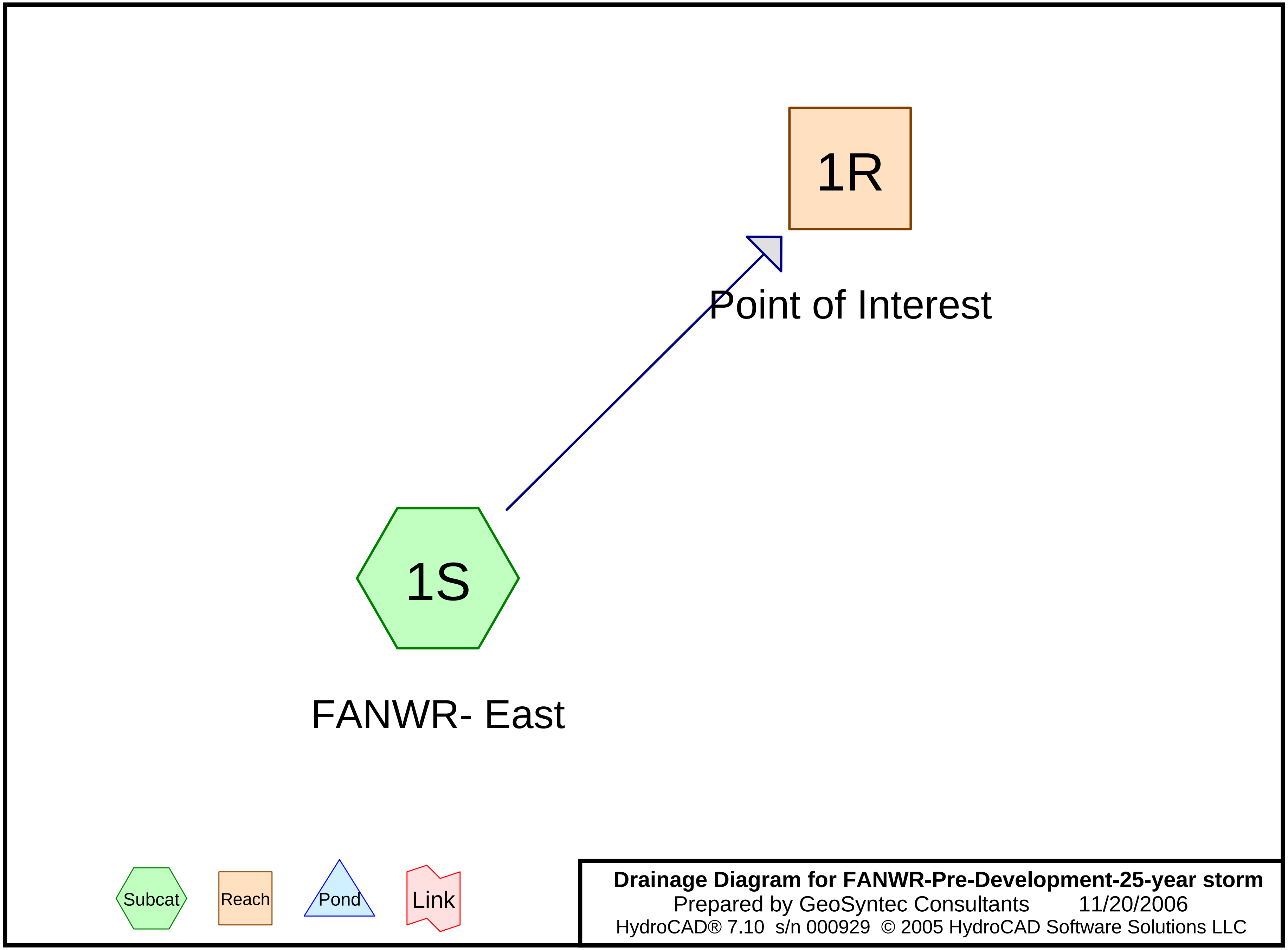
[4] Actual curve number is less than 30; use CN = 30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

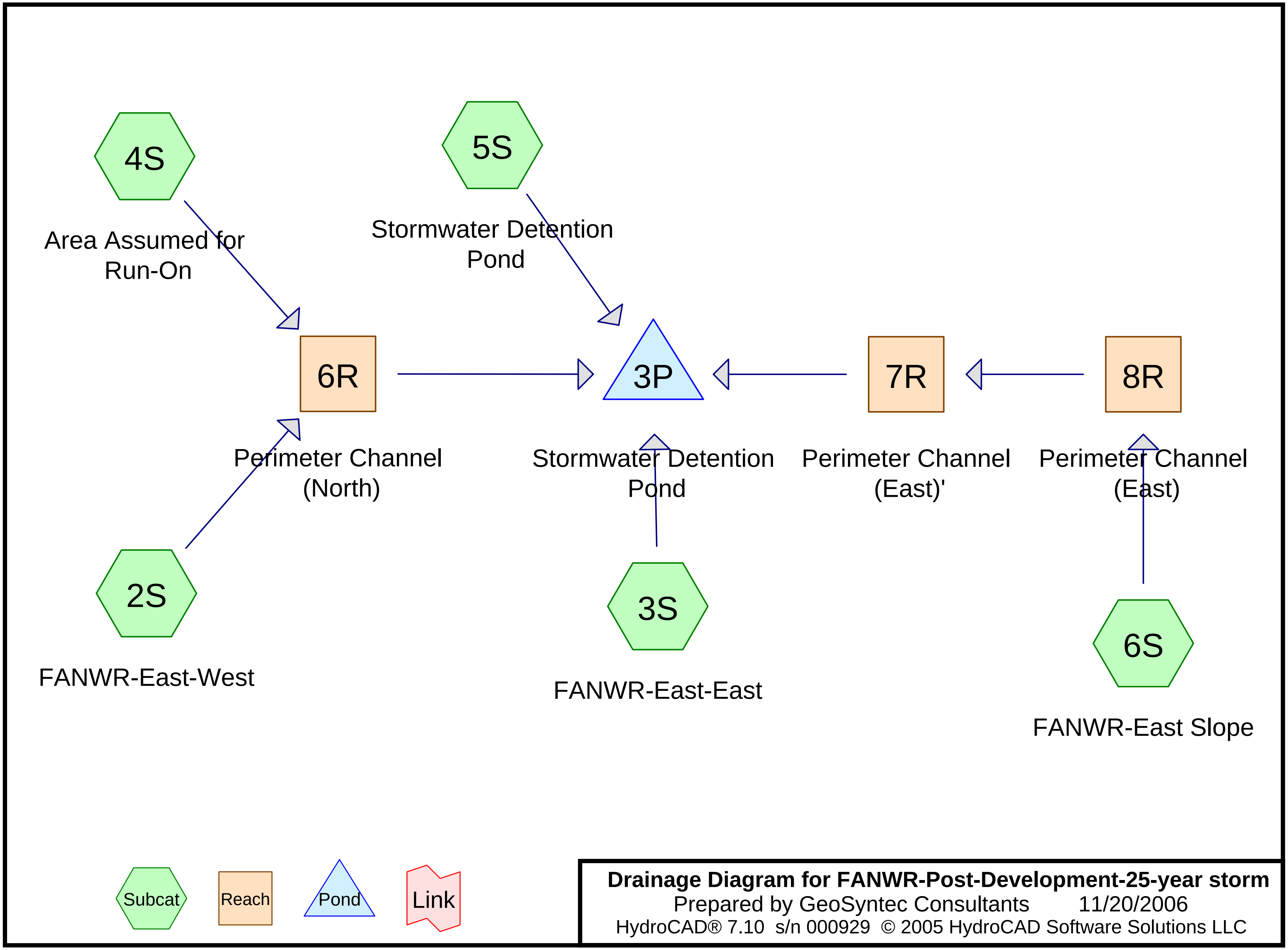
[6] *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

ATTACHMENT 8

HydroCAD^{TM} Nodal Network Diagrams



Drainage Diagram for FANWR-Pre-Development-25-year storm
Prepared by GeoSyntec Consultants 11/20/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC



Drainage Diagram for FANWR-Post-Development-25-year storm
Prepared by GeoSyntec Consultants 11/20/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

ATTACHMENT 9

Properties of Subareas

LANDFILL COVER SYSTEM
FILL AREA NORTHWEST OF REILLY AIRFIELD
SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS
AREAS, AND TIMES OF CONCENTRATION (Tc) CALCULATIONS FOR PRE- AND POST-DEVELOPMENT CONDITIONS

2-year, 24-hr Design Rainfall Depth, $P_{2\text{-}24}$ = 3.90 inches

SUBAREA DESIGNATION in HydroCAD		AREA (acres)	CURVE NUMBER															
No.	Description																	
1S	FANWR-East / Pre-Development	4.94	55	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHEET FLOW 3**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)			
				260	Woods: Dense underbrush	0.800	0.037	15	Woods: Dense underbrush	0.800	0.133	25	Woods: Dense underbrush	0.800	0.060	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				SHALLOW CONCENTRATED FLOW 1				**SHALLOW CONCENTRATED FLOW 2**				**SHALLOW CONCENTRATED FLOW 3**						
				Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft) (ft/ft)	Avg. Velocity (ft/s)	67.5	7.7	**75.2**
				200	Forrest w/Heavy litter	0.030	0.43	--	--	--	--	--	--	--	--			
2S	FANWR-East-West / Post-Development	2.69	61	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHEET FLOW 3**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)			
				100	Grass: Short	0.150	0.050	200	Grass: Short	0.150	0.010	--	--	--	--	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				SHALLOW CONCENTRATED FLOW 1				**SHALLOW CONCENTRATED FLOW 2**				**SHALLOW CONCENTRATED FLOW 3**						
				Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft) (ft/ft)	Avg. Velocity (ft/s)	26.5	4.4	**30.9**
				185	Short Grass Pasture	0.010	0.70	--	--	--	--	--	--	--	--			
3S	FANWR-East-East / Post-Development	3.06	61	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHEET FLOW 3**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)			
				50	Grass: Short	0.150	0.020	118	Grass: Short	0.150	0.050	132	Grass: Short	0.150	0.010	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				SHALLOW CONCENTRATED FLOW 1				**SHALLOW CONCENTRATED FLOW 2**				**SHALLOW CONCENTRATED FLOW 3**						
				Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft) (ft/ft)	Avg. Velocity (ft/s)	26.7	1.1	**27.8**
				40	Short Grass Pasture	0.010	0.70	37	Short Grass Pasture	0.33	4.02	--	--	--	--			
4S	Area Assumed for Run-On / Post-Development	0.23	55	**SHEET FLOW 1**				**SHEET FLOW 2**				**SHEET FLOW 3**				**Travel Times (T_t) and T_c Calculation**		
				Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)	Length (ft)	Surface Desc.	Manning Coefficient, n	Slope (ft/ft)			
				100	Woods: Dense underbrush	0.800	0.085	--	--	--	--	--	--	--	--	T_t (Sheet) (min)	T_t (Shallow Conc.) (min)	T_c (min)
				SHALLOW CONCENTRATED FLOW 1				**SHALLOW CONCENTRATED FLOW 2**				**SHALLOW CONCENTRATED FLOW 3**						
				Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Desc.	Slope (ft/ft) (ft/ft)	Avg. Velocity (ft/s)	19.0	--	**19.0**
				--	--	--	--	--	--	--	--	--	--	--	--			

LANDFILL COVER SYSTEM
FILL AREA NORTHWEST OF REILLY AIRFIELD
SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS
AREAS, AND TIMES OF CONCENTRATION (Tc) CALCULATIONS FOR PRE- AND POST-DEVELOPMENT CONDITIONS

2-year, 24-hr Design Rainfall Depth, $P_{2\text{-}24}$ = 3.90 inches

<table>
<tr><th colspan="2">SUBAREA DESIGNATION in HydroCAD</th><th rowspan="2">AREA (acres)</th><th rowspan="2">CURVE NUMBER</th></tr>
<tr><th>No.</th><th>Description</th></tr>
<tr><td rowspan="6">5S</td><td rowspan="6">Stormwater Detention Pond / Post-Development</td><td rowspan="6">0.31</td><td rowspan="6">98</td><th colspan="4">SHEET FLOW 1</th><th colspan="4">SHEET FLOW 2</th><th colspan="4">SHEET FLOW 3</th><th colspan="3" rowspan="2">Travel Times (T_t) and T_c Calculation</th></tr>
<tr><td>Length (ft)</td><td>Surface Desc.</td><td>Manning Coefficient, n</td><td>Slope (ft/ft)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Manning Coefficient, n</td><td>Slope (ft/ft)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Manning Coefficient, n</td><td>Slope (ft/ft)</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td rowspan="2">T_t (Sheet) (min)</td><td rowspan="2">T_t (Shallow Conc.) (min)</td><td rowspan="2">T_c (min)</td></tr>
<tr><th colspan="4">SHALLOW CONCENTRATED FLOW 1</th><th colspan="4">SHALLOW CONCENTRATED FLOW 2</th><th colspan="4">SHALLOW CONCENTRATED FLOW 3</th></tr>
<tr><td>Length (ft)</td><td>Surface Desc.</td><td>Slope (ft/ft)</td><td>Avg. Velocity (ft/s)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Slope (ft/ft)</td><td>Avg. Velocity (ft/s)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Slope (ft/ft) (ft/ft)</td><td>Avg. Velocity (ft/s)</td><td rowspan="2">5.0 (Direct Entry)</td><td rowspan="2">--</td><td rowspan="2">5.0</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td colspan="19"></td></tr>
<tr><td rowspan="6">6S</td><td rowspan="6">FANWR (East Slope) / Post-Development</td><td rowspan="6">0.44</td><td rowspan="6">61</td><th colspan="4">SHEET FLOW 1</th><th colspan="4">SHEET FLOW 2</th><th colspan="4">SHEET FLOW 3</th><th colspan="3" rowspan="2">Travel Times (T_t) and T_c Calculation</th></tr>
<tr><td>Length (ft)</td><td>Surface Desc.</td><td>Manning Coefficient, n</td><td>Slope (ft/ft)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Manning Coefficient, n</td><td>Slope (ft/ft)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Manning Coefficient, n</td><td>Slope (ft/ft)</td></tr>
<tr><td>131</td><td>Grass: Short</td><td>0.150</td><td>0.020</td><td>75</td><td>Grass: Short</td><td>0.150</td><td>0.050</td><td>50</td><td>Grass: Short</td><td>0.150</td><td>0.330</td><td rowspan="2">T_t (Sheet) (min)</td><td rowspan="2">T_t (Shallow Conc.) (min)</td><td rowspan="2">T_c (min)</td></tr>
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<tr><td>Length (ft)</td><td>Surface Desc.</td><td>Slope (ft/ft)</td><td>Avg. Velocity (ft/s)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Slope (ft/ft)</td><td>Avg. Velocity (ft/s)</td><td>Length (ft)</td><td>Surface Desc.</td><td>Slope (ft/ft) (ft/ft)</td><td>Avg. Velocity (ft/s)</td><td rowspan="2">17.6</td><td rowspan="2">--</td><td rowspan="2">17.6</td></tr>
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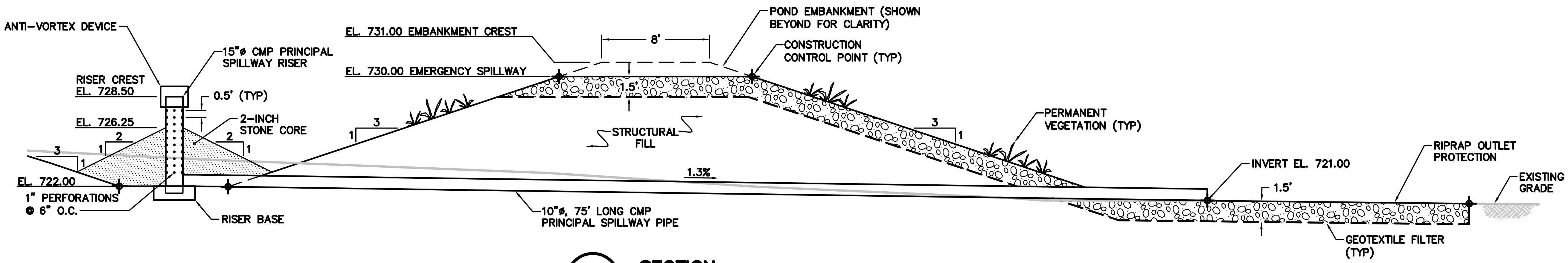
ATTACHMENT 10

Stormwater Detention Pond Outlet Structures

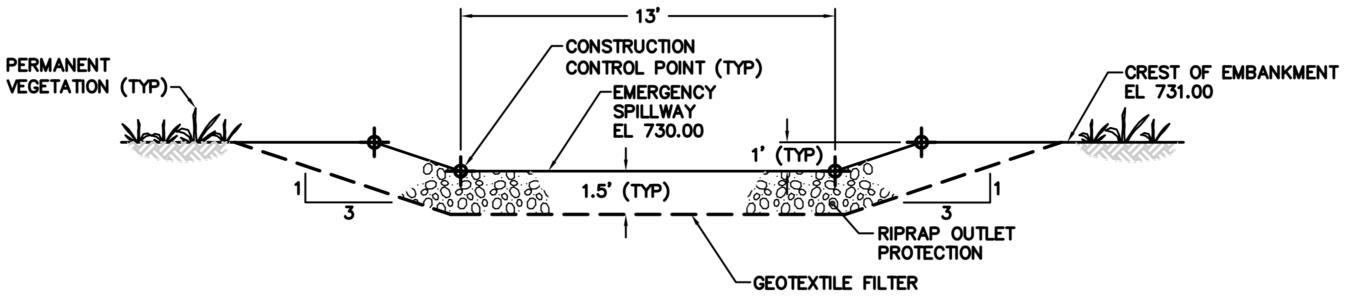


SECTION
STORMWATER/SEDIMENT DETENTION POND EMBANKMENT AND SPILLWAYS

SCALE: 1"=5'
XREF: 3762X034.DWG

RIPRAP SIZE CALCULATION FOR EMERGENCY SPILLWAY

$D_{50} = [QS_0^{0.58} / (3.93*10^{-2})]^{(1/1.89)}$
$D_{50} = [11.7 \text{ cfs} * 0.33^{0.58}/(3.93*10-2)]^{(1/1.89)}$
$D_{50} = 14.5 \text{ inch}$



SECTION
EMERGENCY SPILLWAY

SCALE: 1" = 4'
XREF: 3762X032.DWG

ATTACHMENT 10 - STORMWATER DETENTION POND OUTLET STRUCTURES

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	OCTOBER 2006	SCALE:	N.T.S.
PROJECT NO.	GR3762	FILE NO.	3762SM10
DOCUMENT NO.		FIGURE NO.	10

ATTACHMENT 11

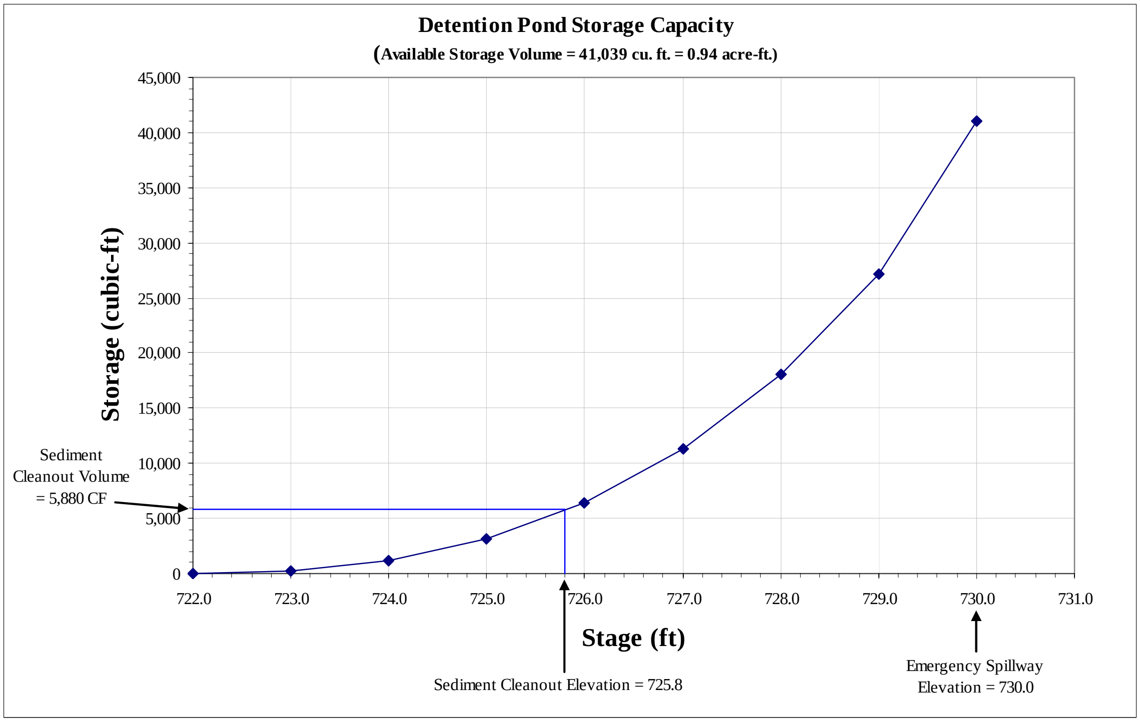
Stage-Storage Relationship

STAGE-STORAGE RELATIONSHIP

The stormwater detention pond is designed to hold 67 cubic yards per acre of drainage area (sediment storage volume) and the calculated runoff volume from a 25-year 24-hour design storm without the water elevation reaching the elevation of the emergency spillway. Available storage volume to the crest elevation of emergency spillway (730’) is approximately 41,000 cubic-feet.

Required Sediment Storage Volume = 67 cubic yards / acre of disturbed area
Total disturbed area flowing to stormwater detention pond= 6.5 acres

∴ Required Sediment Storage Volume = 435.5 cubic-yards
= 11,760 cubic-ft



Based on the stage storage relationship shown above, for the stormwater detention pond:

Sediment Cleanout Volume = 0.5 * Required Sediment Storage Vol.
= 0.5 x 11,760 cubic-ft
= 5,880 cubic-ft = 0.135 acre-ft.

Sediment Cleanout Elevation = 725.8 ft

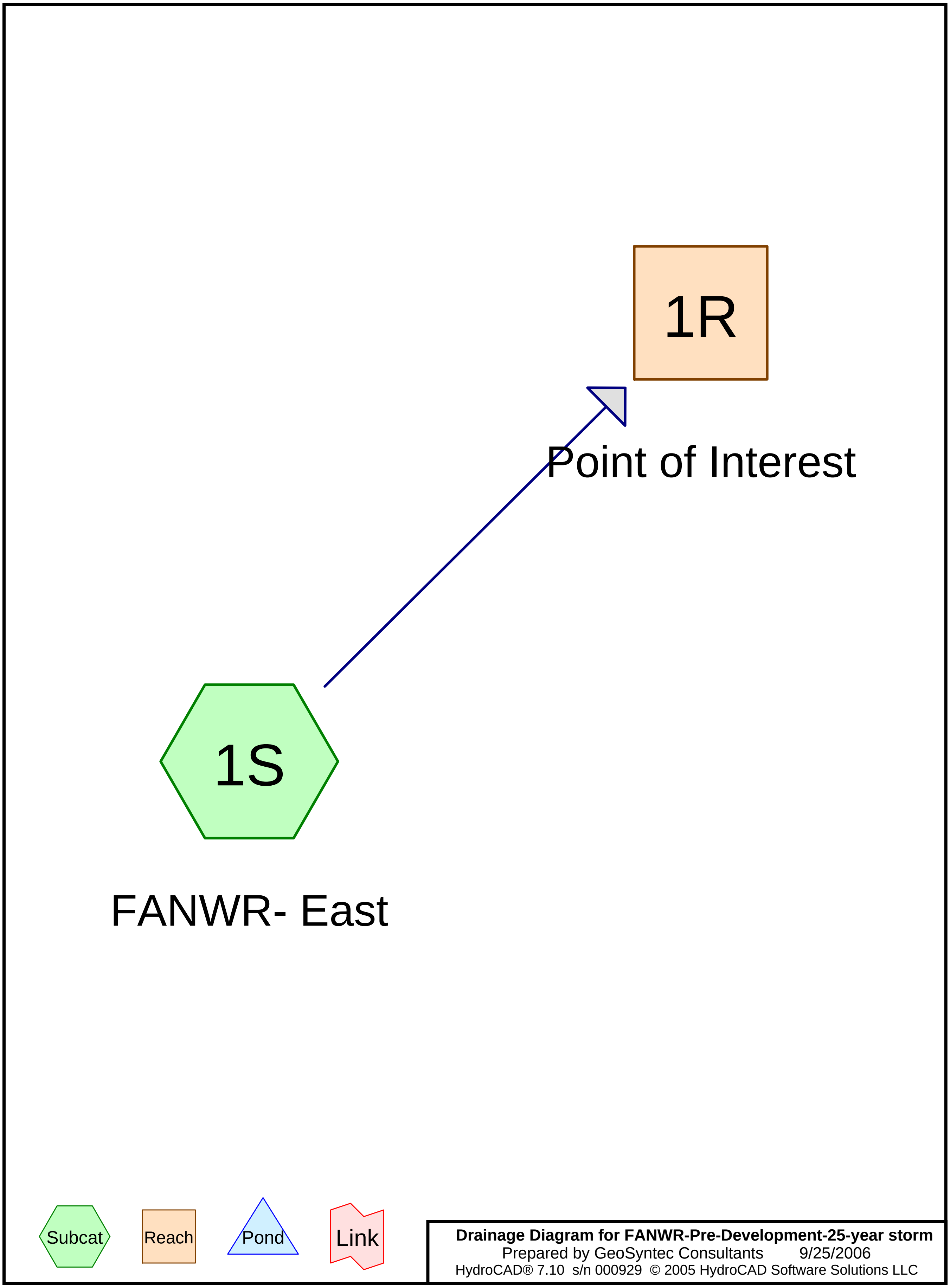
ATTACHMENT 12

Computations Using HydroCAD^{TM}: Pre-Development

25 Year – 24 Hour Storm

SCS Distribution

(Pre-Development)



Drainage Diagram for FANWR-Pre-Development-25-year storm
Prepared by GeoSyntec Consultants 9/25/2006

Time span=5.00-32.00 hrs, dt=0.05 hrs, 541 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: FANWR- East Runoff Area=4.940 ac Runoff Depth=1.94"
Flow Length=500' Tc=75.3 min CN=55 Runoff=3.81 cfs 0.797 af

Reach 1R: Point of Interest Inflow=3.81 cfs 0.797 af
Outflow=3.81 cfs 0.797 af

Total Runoff Area = 4.940 ac Runoff Volume = 0.797 af Average Runoff Depth = 1.94"

Subcatchment 1S: FANWR- East

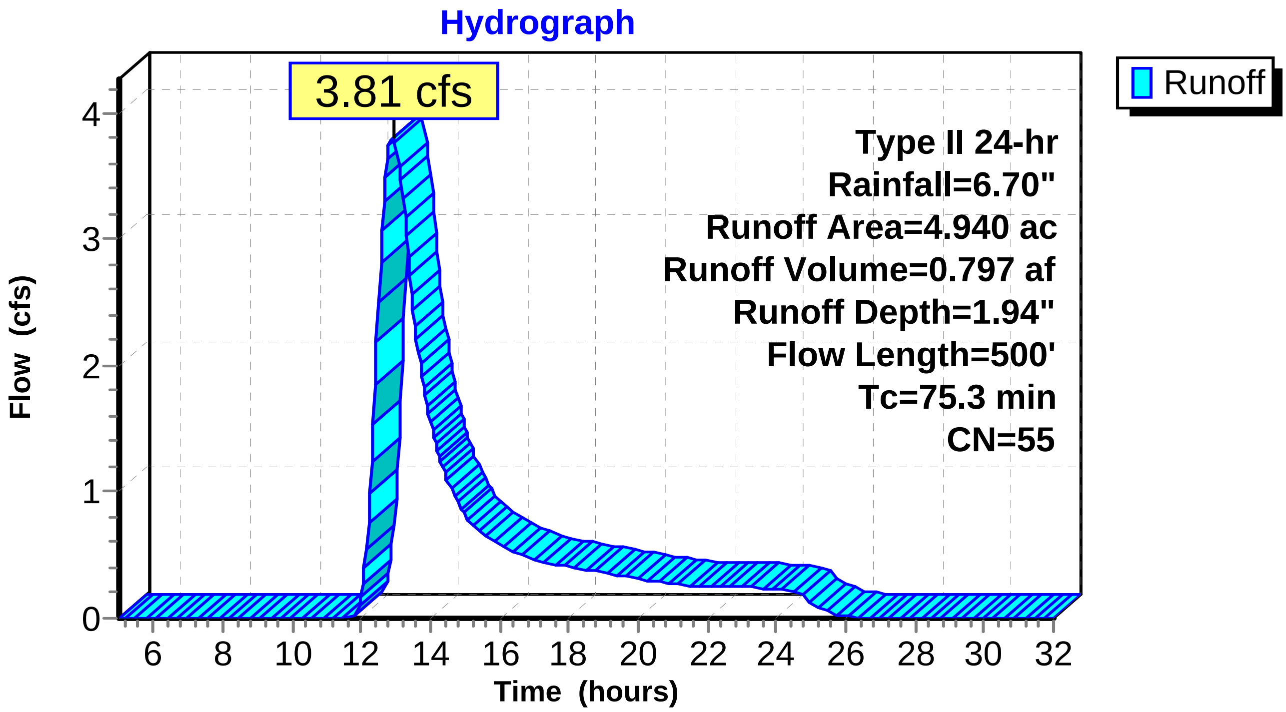
Runoff = 3.81 cfs @ 12.92 hrs, Volume= 0.797 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
4.940	55	Woods in good condition

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
56.9	260	0.0370	0.1		**Sheet Flow, FANWR** Woods: Dense underbrush n= 0.800 P2= 3.90"
3.5	15	0.1330	0.1		**Sheet Flow, FANWR** Woods: Dense underbrush n= 0.800 P2= 3.90"
7.2	25	0.0600	0.1		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"
7.7	200	0.0300	0.4		**Shallow Concentrated Flow, FANWR** Forest w/Heavy Litter Kv= 2.5 fps
75.3	500	Total			

Subcatchment 1S: FANWR- East

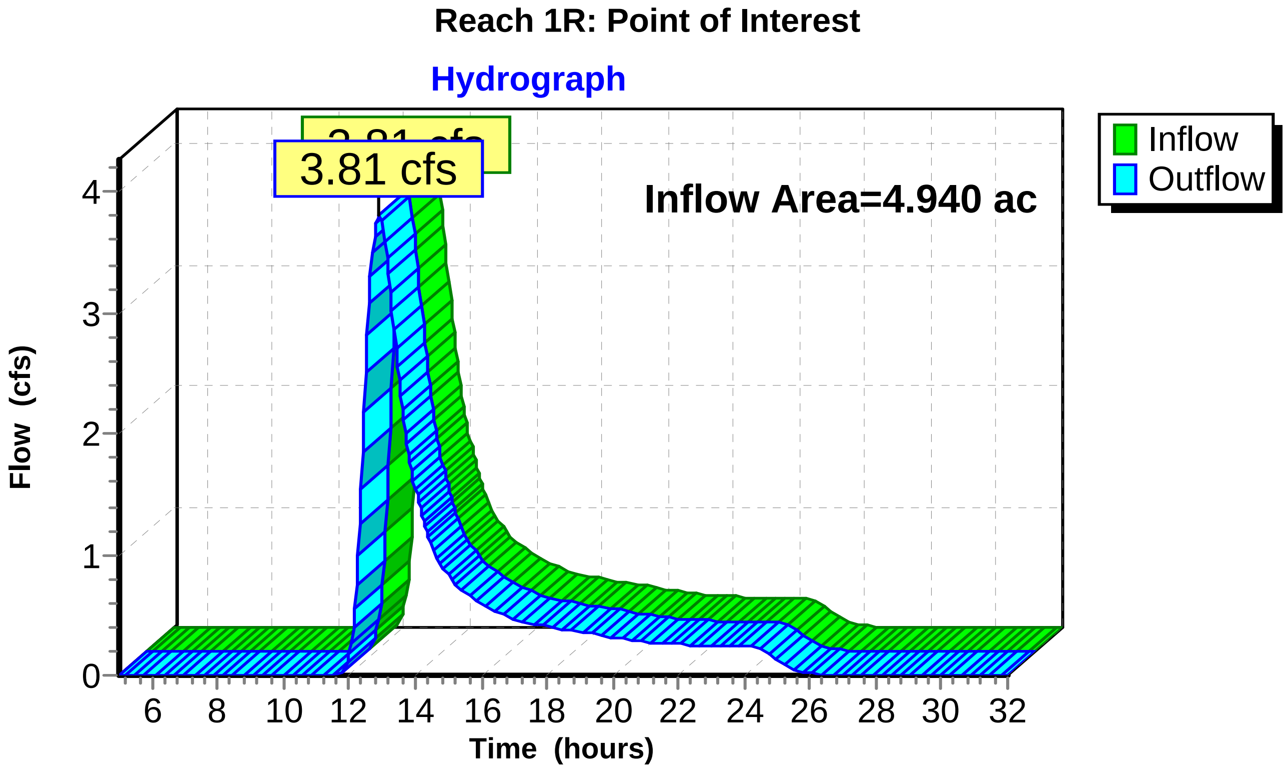


Reach 1R: Point of Interest

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.940 ac, Inflow Depth = 1.94"
Inflow = 3.81 cfs @ 12.92 hrs, Volume= 0.797 af
Outflow = 3.81 cfs @ 12.92 hrs, Volume= 0.797 af, Atten= 0%, Lag= 0.0 min

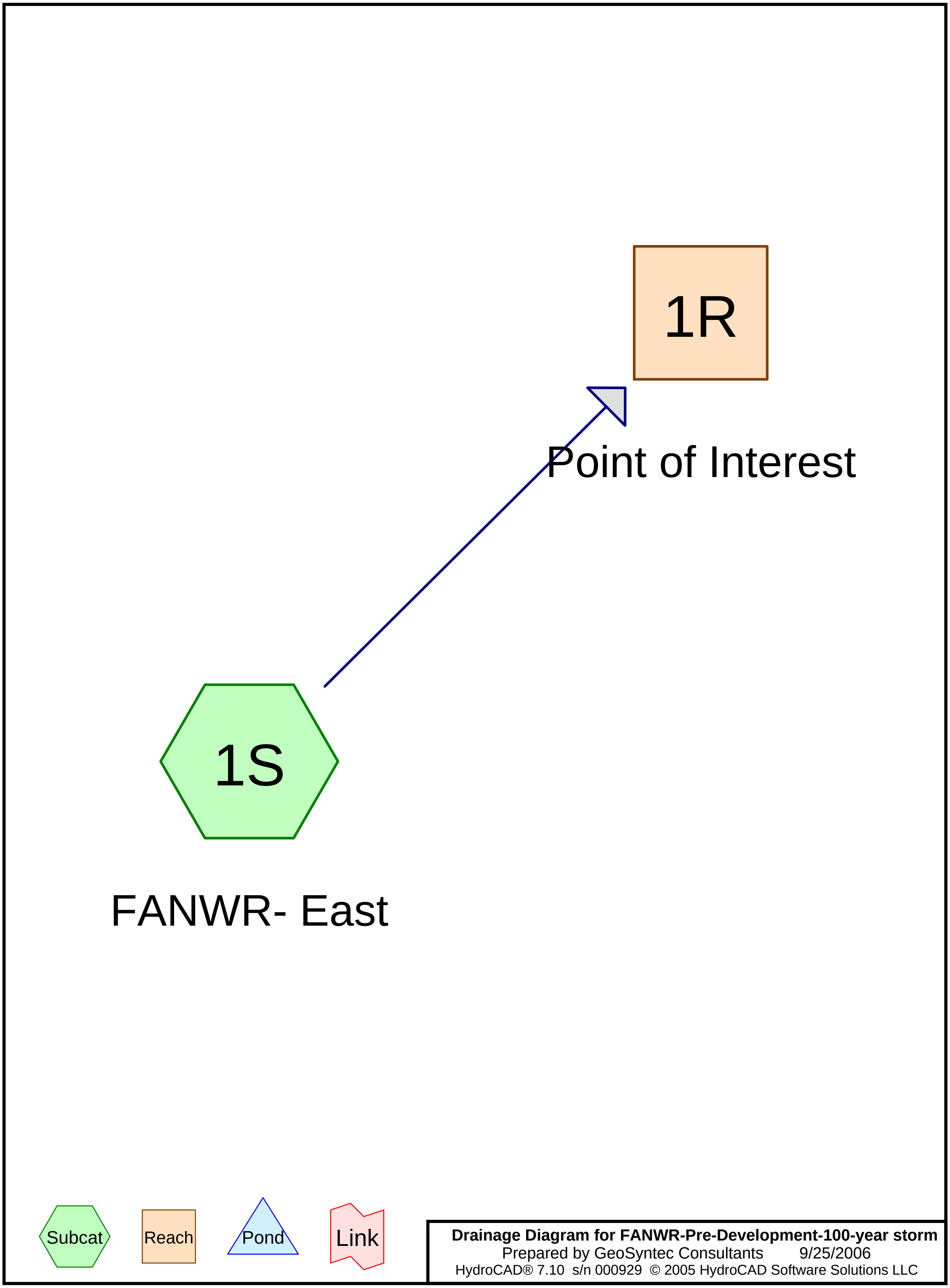
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs



100 Year – 24 Hour Storm

SCS Distribution

(Pre-Development)



Drainage Diagram for FANWR-Pre-Development-100-year storm
Prepared by GeoSyntec Consultants 9/25/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

Time span=5.00-32.00 hrs, dt=0.05 hrs, 541 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: FANWR- East Runoff Area=4.940 ac Runoff Depth=2.78"
Flow Length=500' Tc=75.3 min CN=55 Runoff=5.75 cfs 1.146 af

Reach 1R: Point of Interest Inflow=5.75 cfs 1.146 af
Outflow=5.75 cfs 1.146 af

Total Runoff Area = 4.940 ac Runoff Volume = 1.146 af Average Runoff Depth = 2.78"

Subcatchment 1S: FANWR- East

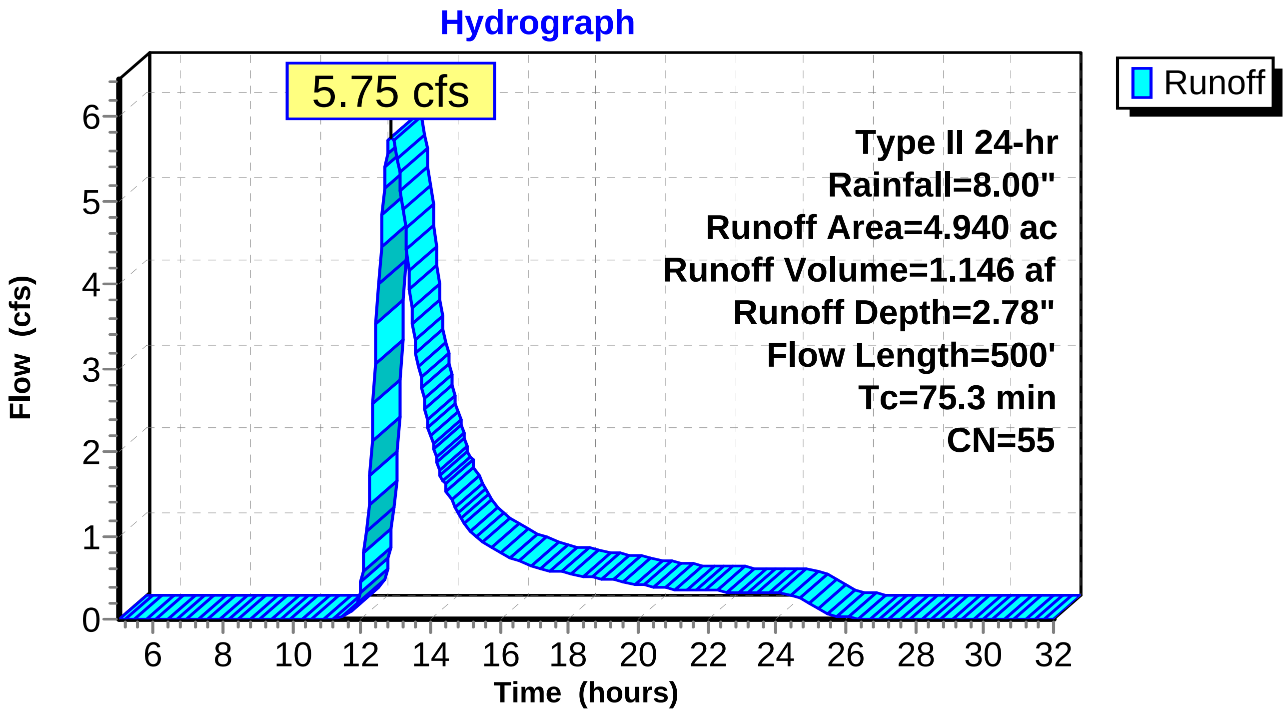
Runoff = 5.75 cfs @ 12.88 hrs, Volume= 1.146 af, Depth= 2.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=8.00"

Area (ac)	CN	Description
4.940	55	Woods in good condition

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
56.9	260	0.0370	0.1		**Sheet Flow, FANWR** Woods: Dense underbrush n= 0.800 P2= 3.90"
3.5	15	0.1330	0.1		**Sheet Flow, FANWR** Woods: Dense underbrush n= 0.800 P2= 3.90"
7.2	25	0.0600	0.1		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"
7.7	200	0.0300	0.4		**Shallow Concentrated Flow, FANWR** Forest w/Heavy Litter Kv= 2.5 fps
75.3	500	Total			

Subcatchment 1S: FANWR- East

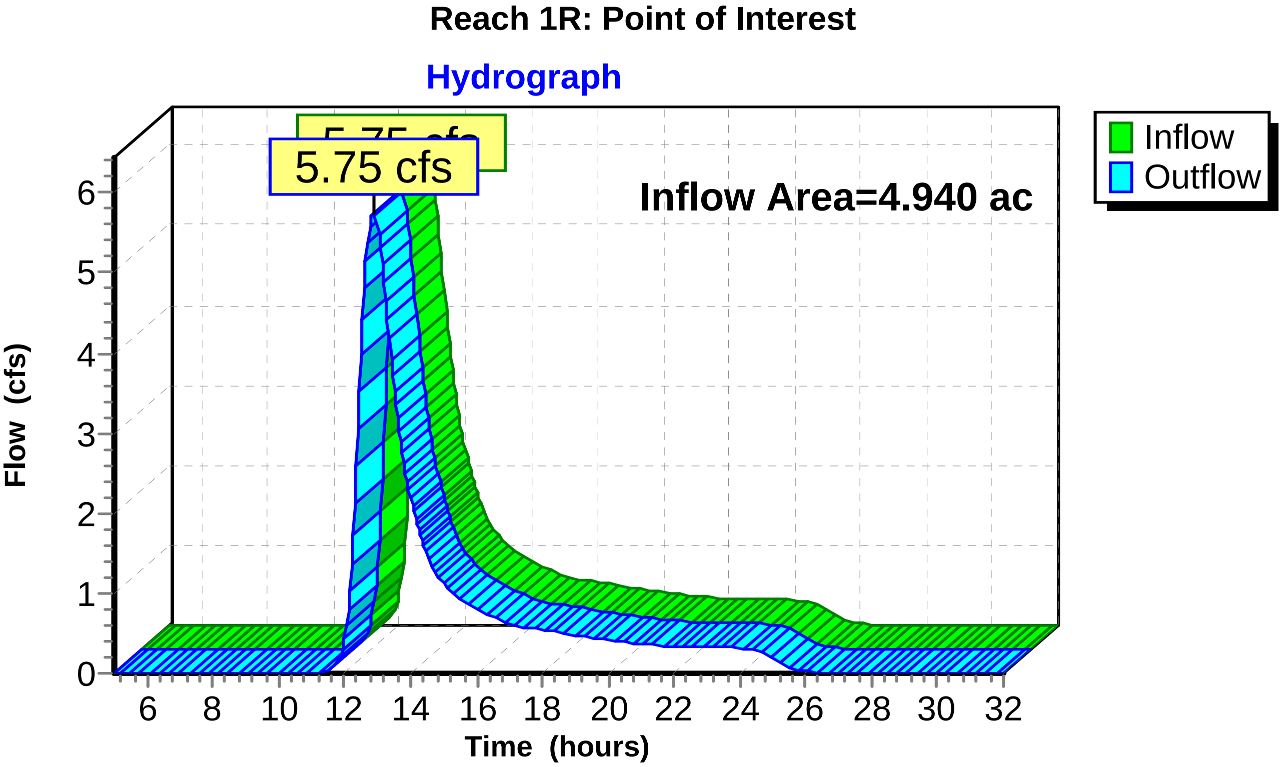


Reach 1R: Point of Interest

[40] Hint: Not Described (Outflow=Inflow)

```
Inflow Area =       4.940 ac,  Inflow Depth =   2.78"
Inflow      =      5.75 cfs @   12.88 hrs,  Volume=          1.146 af
Outflow     =      5.75 cfs @   12.88 hrs,  Volume=          1.146 af,  Atten= 0%,  Lag= 0.0 min
```

Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs



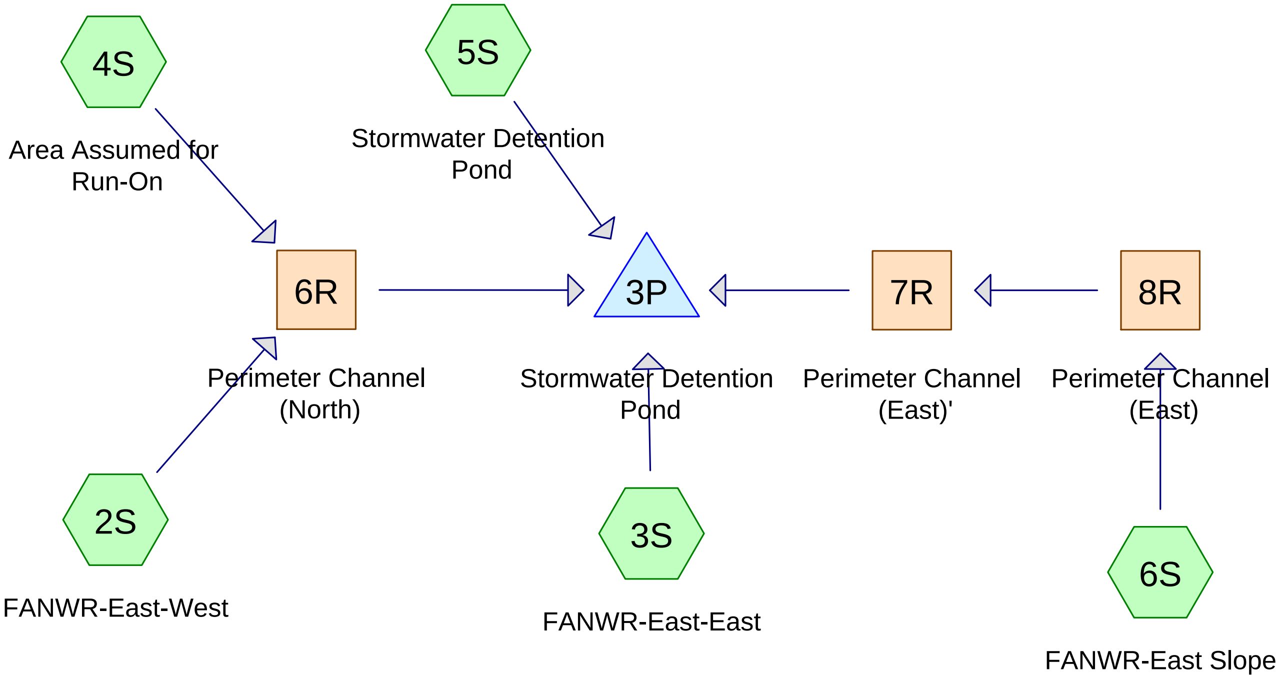
ATTACHMENT 13

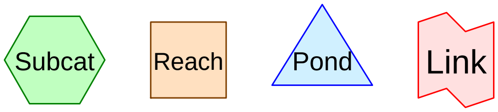
Computations Using HydroCAD^{TM}: Post-Development

25 Year – 24 Hour Storm

SCS Distribution

(Post-Development)





Drainage Diagram for FANWR-Post-Development-25-year storm
Prepared by GeoSyntec Consultants 9/25/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

```
                    Time span=0.00-60.00 hrs, dt=0.04 hrs, 1501 points
                         Runoff by SCS TR-20 method, UH=SCS
        Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment 2S: FANWR-East-West                Runoff Area=2.690 ac   Runoff Depth=2.49"
                          Flow Length=485'   Tc=31.0 min   CN=61   Runoff=5.43 cfs  0.558 af

Subcatchment 3S: FANWR-East-East                Runoff Area=3.060 ac   Runoff Depth=2.49"
                          Flow Length=377'   Tc=27.9 min   CN=61   Runoff=6.63 cfs  0.634 af

Subcatchment 4S: Area Assumed for Run-On        Runoff Area=0.230 ac   Runoff Depth=1.94"
                          Flow Length=100'   Tc=19.0 min   CN=55   Runoff=0.47 cfs  0.037 af

Subcatchment 5S: Stormwater Detention Pond      Runoff Area=0.310 ac   Runoff Depth=6.46"
                                             Tc=5.0 min   CN=98   Runoff=3.03 cfs  0.167 af

Subcatchment 6S: FANWR-East Slope               Runoff Area=0.440 ac   Runoff Depth=2.49"
                          Flow Length=256'   Tc=17.6 min   CN=61   Runoff=1.27 cfs  0.091 af

Reach 6R: Perimeter Channel (North)     Peak Depth=0.67'   Max Vel=4.3 fps   Inflow=5.77 cfs  0.595 af
                   n=0.030   L=260.0'   S=0.0346 '/'   Capacity=16.82 cfs   Outflow=5.73 cfs  0.595 af

Reach 7R: Perimeter Channel (East)'     Peak Depth=0.29'   Max Vel=5.0 fps   Inflow=1.24 cfs  0.091 af
                    n=0.030   L=63.0'   S=0.1429 '/'   Capacity=34.16 cfs   Outflow=1.24 cfs  0.091 af

Reach 8R: Perimeter Channel (East)      Peak Depth=0.42'   Max Vel=2.4 fps   Inflow=1.27 cfs  0.091 af
                   n=0.030   L=223.0'   S=0.0202 '/'   Capacity=12.84 cfs   Outflow=1.24 cfs  0.091 af

Pond 3P: Stormwater Detention Pond    Peak Elev=728.84'  Storage=25,530 cf   Inflow=13.61 cfs  1.487 af
                 Primary=3.33 cfs  1.473 af   Secondary=0.00 cfs  0.000 af   Outflow=3.33 cfs  1.473 af

         Total Runoff Area = 6.730 ac   Runoff Volume = 1.487 af   Average Runoff Depth = 2.65"
```

Subcatchment 2S: FANWR-East-West

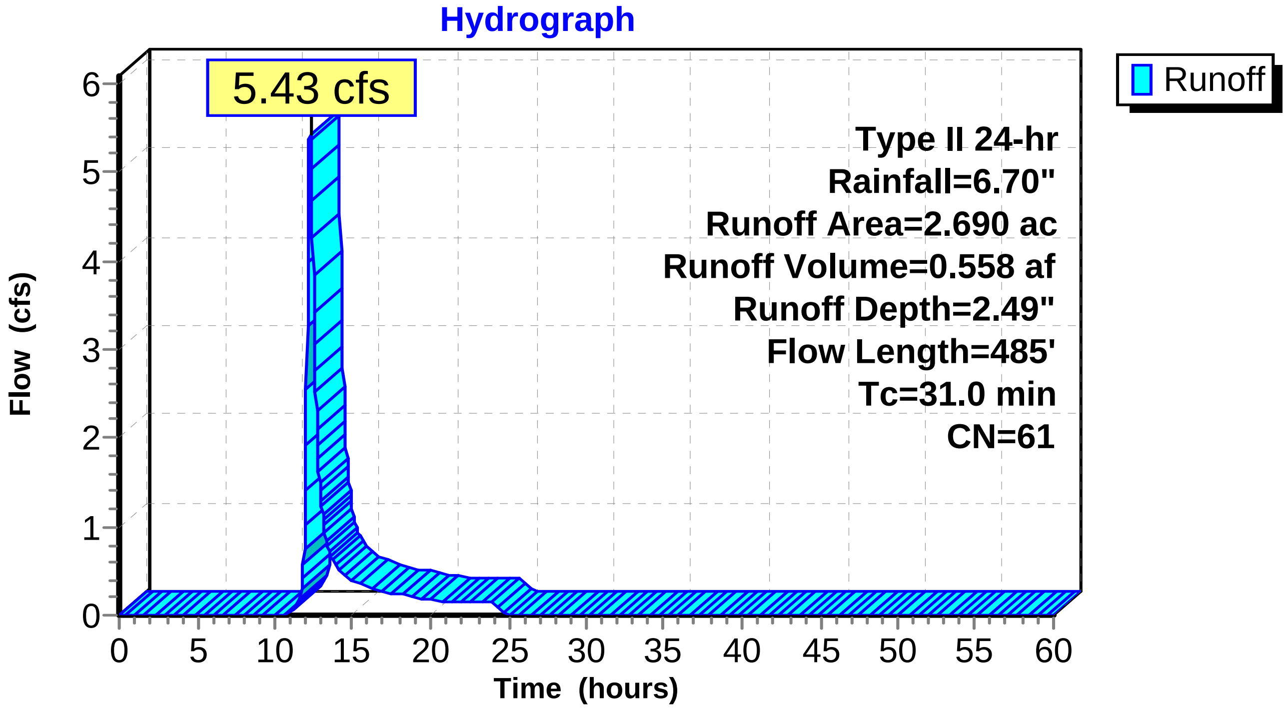
Runoff = 5.43 cfs @ 12.27 hrs, Volume= 0.558 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
2.690	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	100	0.0500	0.3		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
20.4	200	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
4.4	185	0.0100	0.7		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
31.0	485	Total			

Subcatchment 2S: FANWR-East-West



Subcatchment 3S: FANWR-East-East

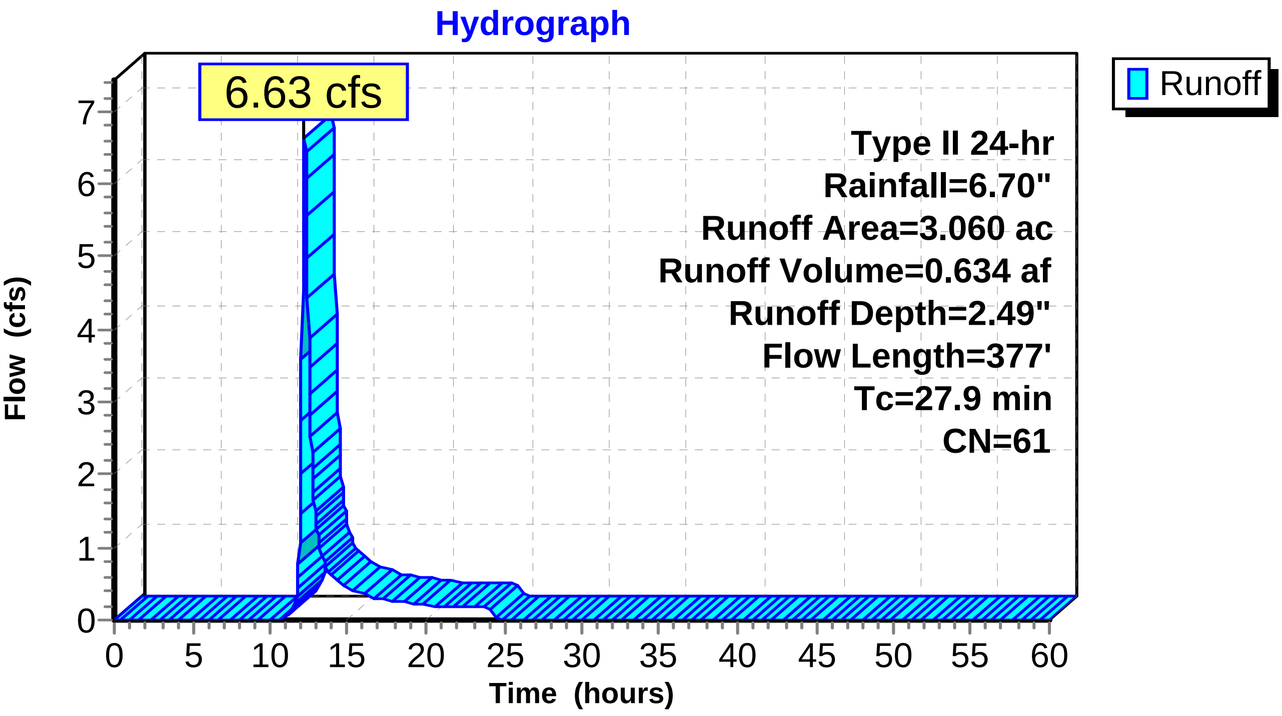
Runoff = 6.63 cfs @ 12.23 hrs, Volume= 0.634 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
3.060	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	50	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
7.0	118	0.0500	0.3		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
14.6	132	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
1.0	40	0.0100	0.7		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	37	0.3300	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
27.9	377	Total			

Subcatchment 3S: FANWR-East-East



Subcatchment 4S: Area Assumed for Run-On

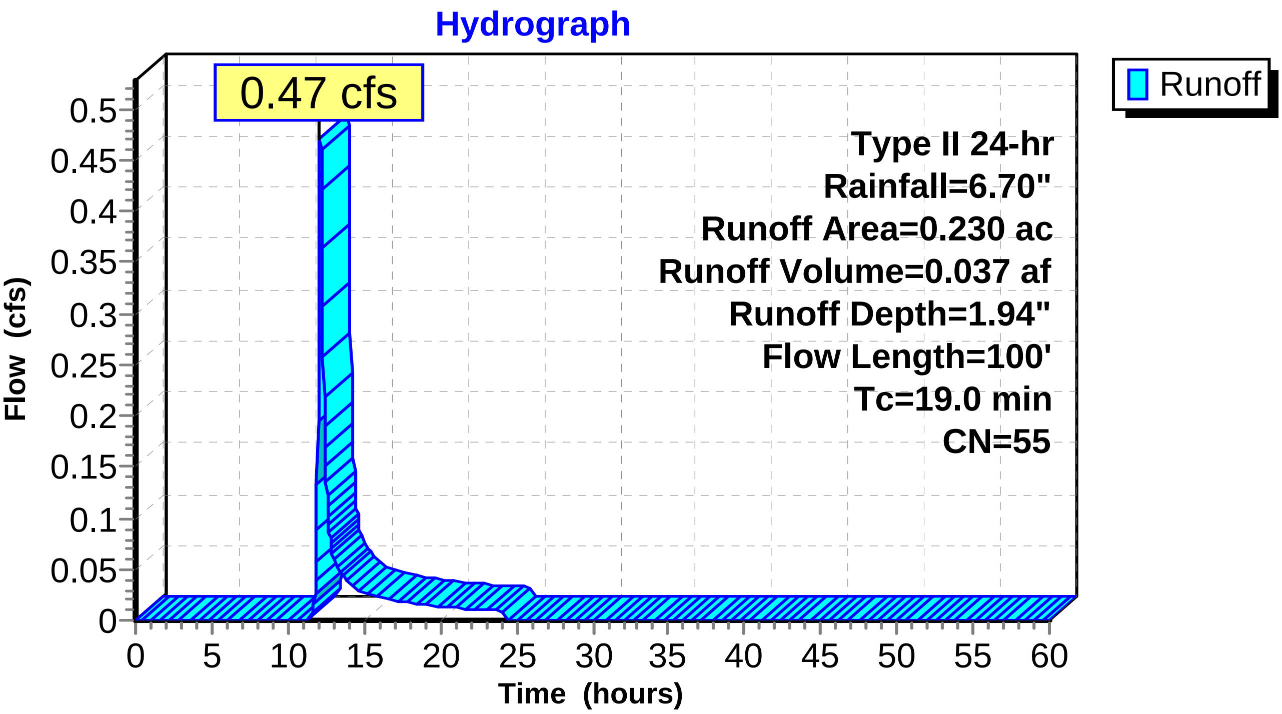
Runoff = 0.47 cfs @ 12.13 hrs, Volume= 0.037 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
0.230	55	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0850	0.1		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"

Subcatchment 4S: Area Assumed for Run-On



Subcatchment 5S: Stormwater Detention Pond

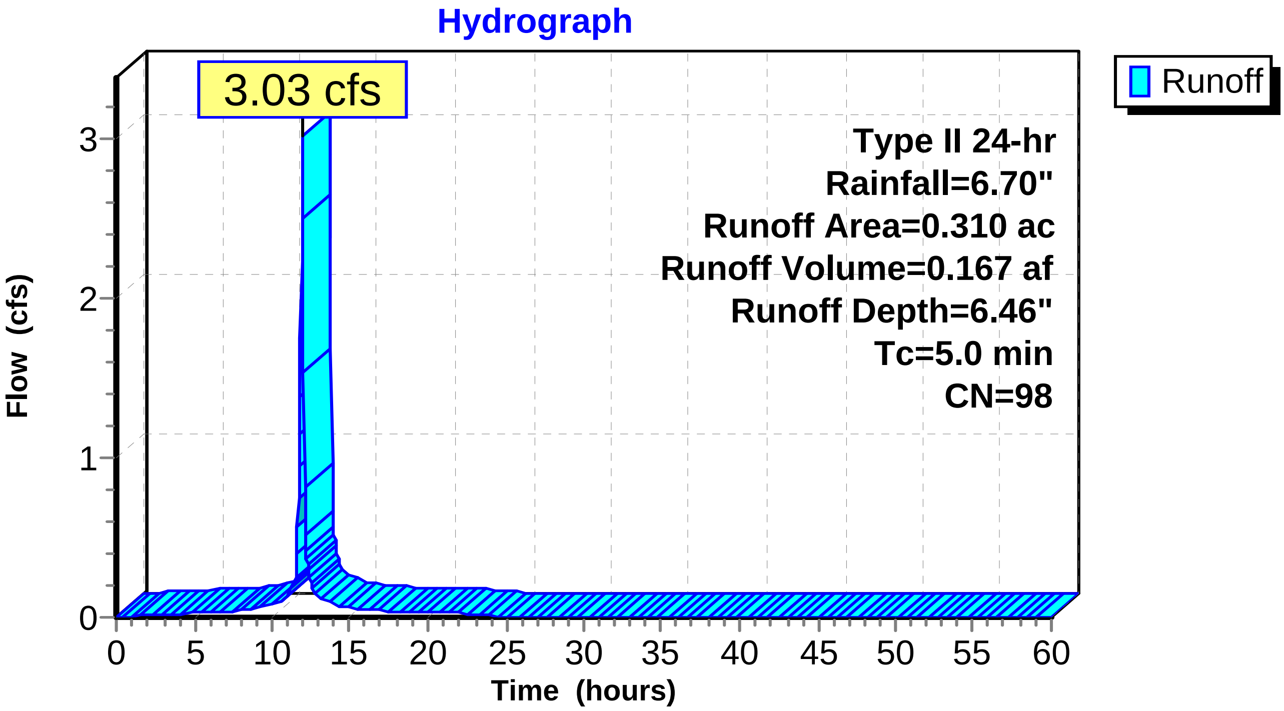
Runoff = 3.03 cfs @ 11.95 hrs, Volume= 0.167 af, Depth= 6.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
0.310	98	

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

Subcatchment 5S: Stormwater Detention Pond



Subcatchment 6S: FANWR-East Slope

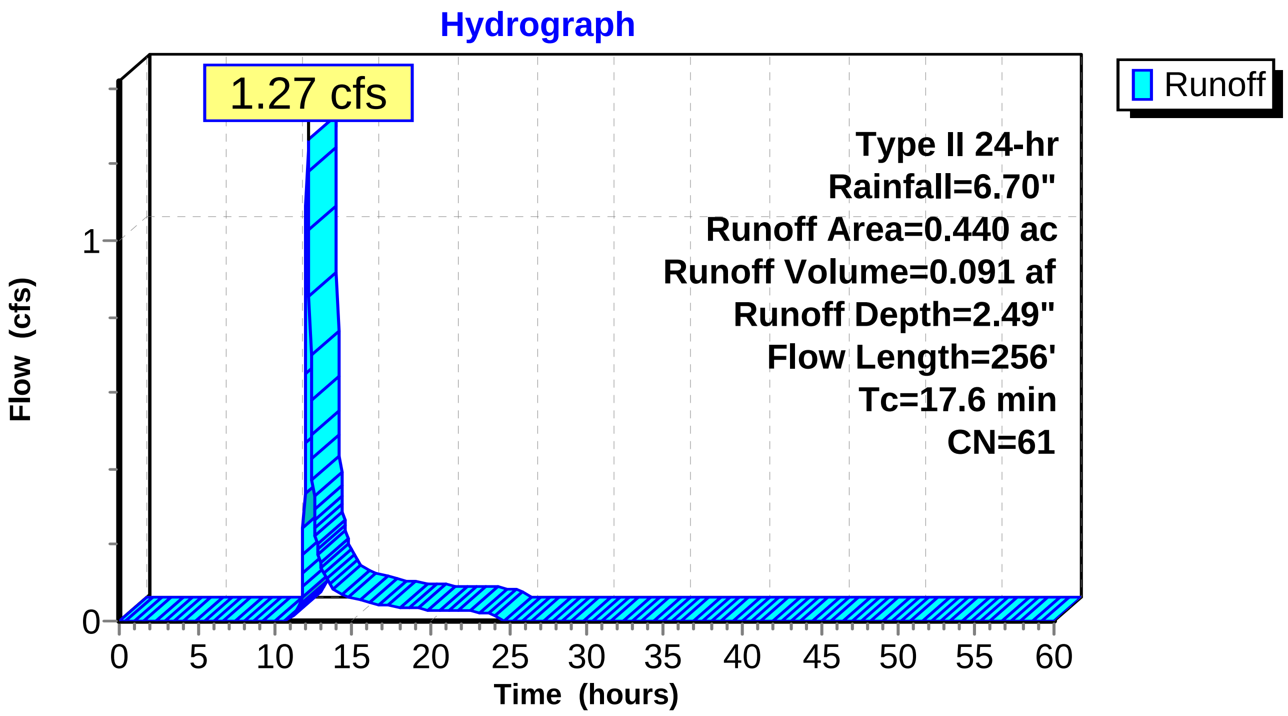
Runoff = 1.27 cfs @ 12.11 hrs, Volume= 0.091 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=6.70"

Area (ac)	CN	Description
0.440	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.0	131	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
4.9	75	0.0500	0.3		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
1.7	50	0.3300	0.5		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
17.6	256	Total			

Subcatchment 6S: FANWR-East Slope

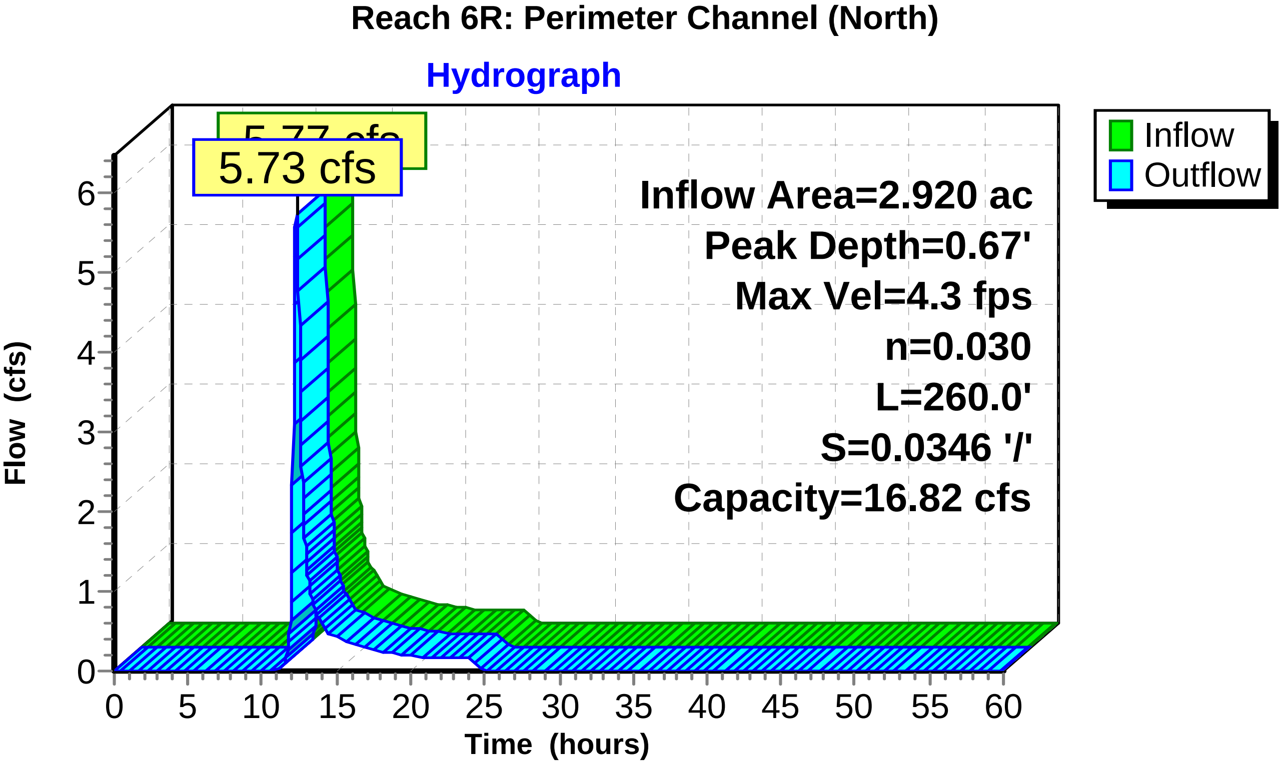


Reach 6R: Perimeter Channel (North)

Inflow Area =	2.920 ac,	Inflow Depth = 2.44"		
Inflow =	5.77 cfs @	12.26 hrs,	Volume=	0.595 af
Outflow =	5.73 cfs @	12.29 hrs,	Volume=	0.595 af, Atten= 1%, Lag= 1.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Max. Velocity= 4.3 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.9 fps, Avg. Travel Time= 2.3 min

Peak Depth= 0.67' @ 12.27 hrs
Capacity at bank full= 16.82 cfs
Inlet Invert= 741.00', Outlet Invert= 732.00'
0.00' x 1.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 260.0' Slope= 0.0346 '/'



Reach 7R: Perimeter Channel (East)'

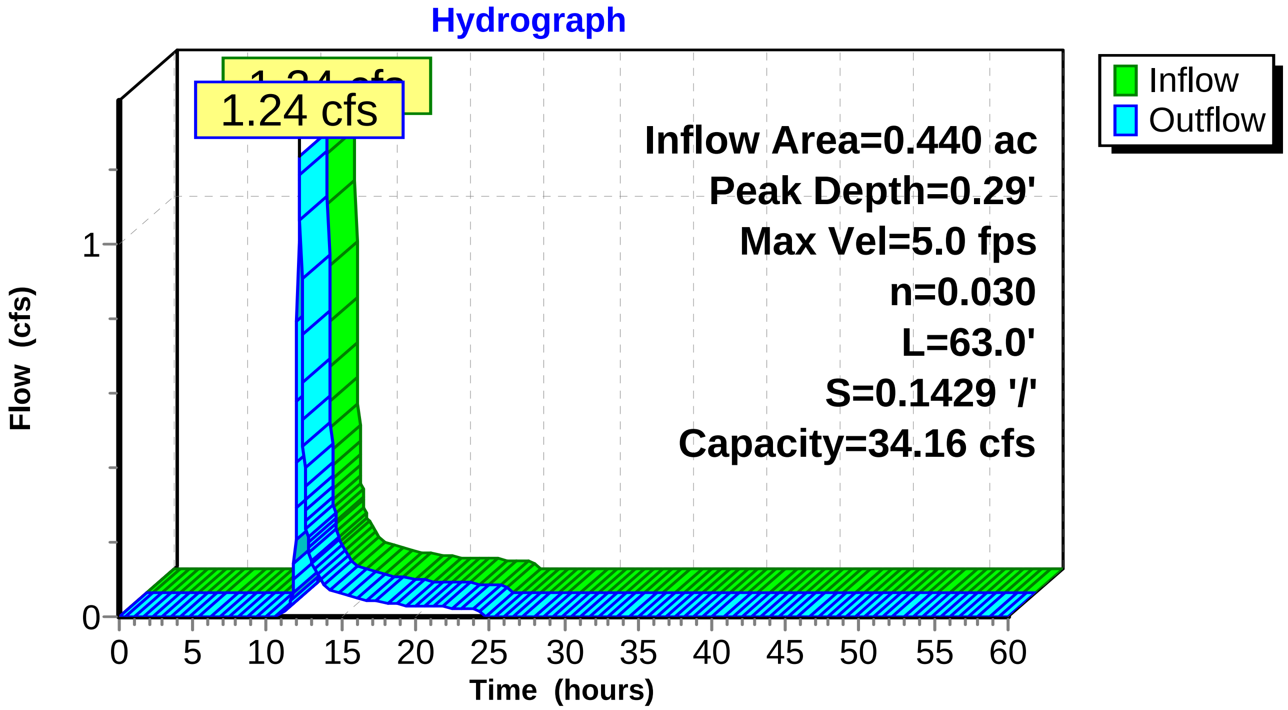
[61] Hint: Submerged 6% of Reach 8R bottom

Inflow Area =	0.440 ac,	Inflow Depth = 2.49"			
Inflow =	1.24 cfs @	12.16 hrs,	Volume=	0.091 af	
Outflow =	1.24 cfs @	12.16 hrs,	Volume=	0.091 af,	Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Max. Velocity= 5.0 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.1 fps, Avg. Travel Time= 0.5 min

Peak Depth= 0.29' @ 12.16 hrs
Capacity at bank full= 34.16 cfs
Inlet Invert= 739.50', Outlet Invert= 730.50'
0.00' x 1.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 63.0' Slope= 0.1429 '/'

Reach 7R: Perimeter Channel (East)'



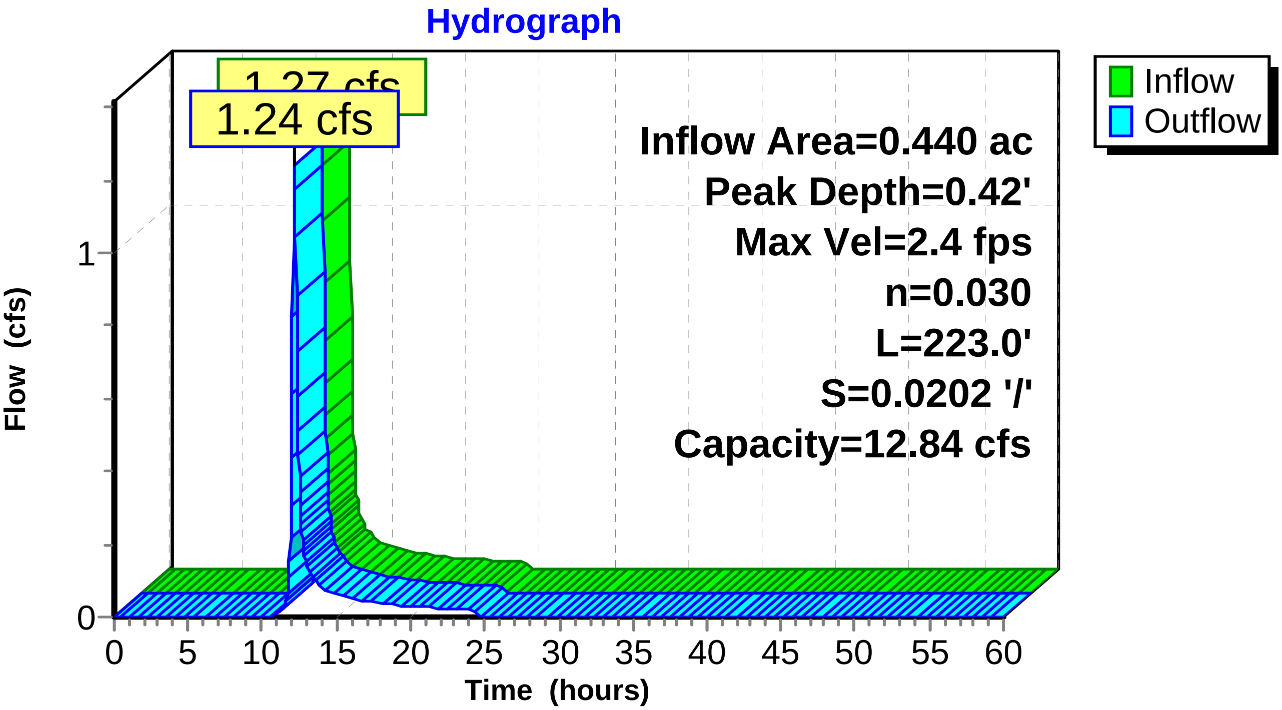
Reach 8R: Perimeter Channel (East)

Inflow Area =	0.440 ac, Inflow Depth = 2.49"			
Inflow =	1.27 cfs @	12.11 hrs, Volume=	0.091 af	
Outflow =	1.24 cfs @	12.16 hrs, Volume=	0.091 af,	Atten= 2%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Max. Velocity= 2.4 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 3.7 min

Peak Depth= 0.42' @ 12.13 hrs
Capacity at bank full= 12.84 cfs
Inlet Invert= 744.00', Outlet Invert= 739.50'
0.00' x 1.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 223.0' Slope= 0.0202 '/'

Reach 8R: Perimeter Channel (East)



Pond 3P: Stormwater Detention Pond

Inflow Area = 6.730 ac, Inflow Depth = 2.65"
Inflow = 13.61 cfs @ 12.24 hrs, Volume= 1.487 af
Outflow = 3.33 cfs @ 12.91 hrs, Volume= 1.473 af, Atten= 75%, Lag= 39.9 min
Primary = 3.33 cfs @ 12.91 hrs, Volume= 1.473 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Peak Elev= 728.84' @ 12.91 hrs Surf.Area= 9,825 sf Storage= 25,530 cf
Plug-Flow detention time= 129.0 min calculated for 1.472 af (99% of inflow)
Center-of-Mass det. time= 123.4 min (981.2 - 857.8)

Volume	Invert	Avail.Storage	Storage Description
#1	722.00'	53,188 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

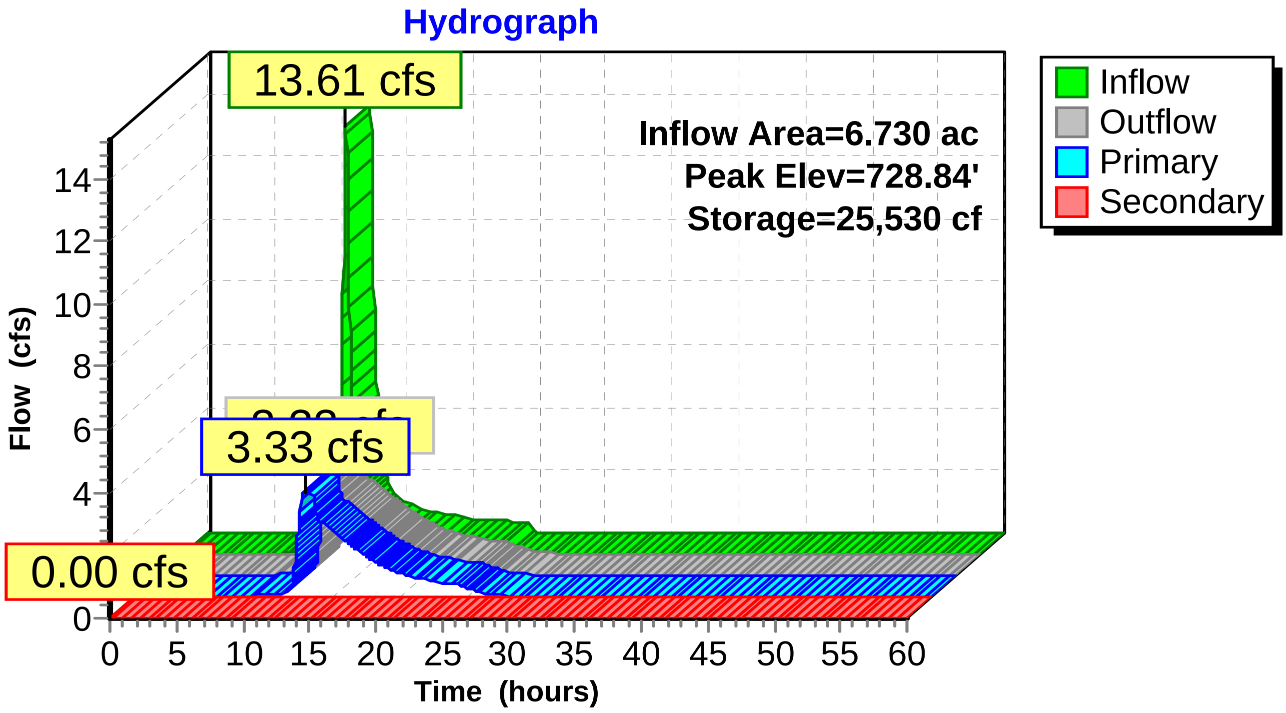
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
722.00	0	0	0
722.50	238	60	60
723.00	552	198	257
723.50	941	373	630
724.00	1,406	587	1,217
724.50	1,947	838	2,055
725.00	2,564	1,128	3,183
725.50	3,256	1,455	4,638
726.00	4,024	1,820	6,458
726.50	4,868	2,223	8,681
727.00	5,788	2,664	11,345
727.50	6,783	3,143	14,488
728.00	7,855	3,660	18,147
728.50	9,002	4,214	22,362
729.00	10,224	4,807	27,168
729.50	11,523	5,437	32,605
730.00	13,213	6,184	38,789
731.00	15,586	14,400	53,188

Device	Routing	Invert	Outlet Devices
#1	Primary	722.00'	**10.0" x 70.0' long Culvert** CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 721.00' S= 0.0143 '/' Cc= 0.900 n= 0.025 Corrugated metal
#2	Device 1	728.50'	**15.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	723.50'	**1.0" Vert. Orifice/Grate X 6.00 columns** X 10 rows with 6.0" cc spacing C= 0.600
#4	Secondary	730.00'	**13.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Primary OutFlow Max=3.33 cfs @ 12.91 hrs HW=728.84' (Free Discharge)
└─**1=Culvert** (Barrel Controls 3.33 cfs @ 6.1 fps)
  ├─**2=Orifice/Grate** (Passes < 2.50 cfs potential flow)
  └─**3=Orifice/Grate** (Passes < 2.66 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=722.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

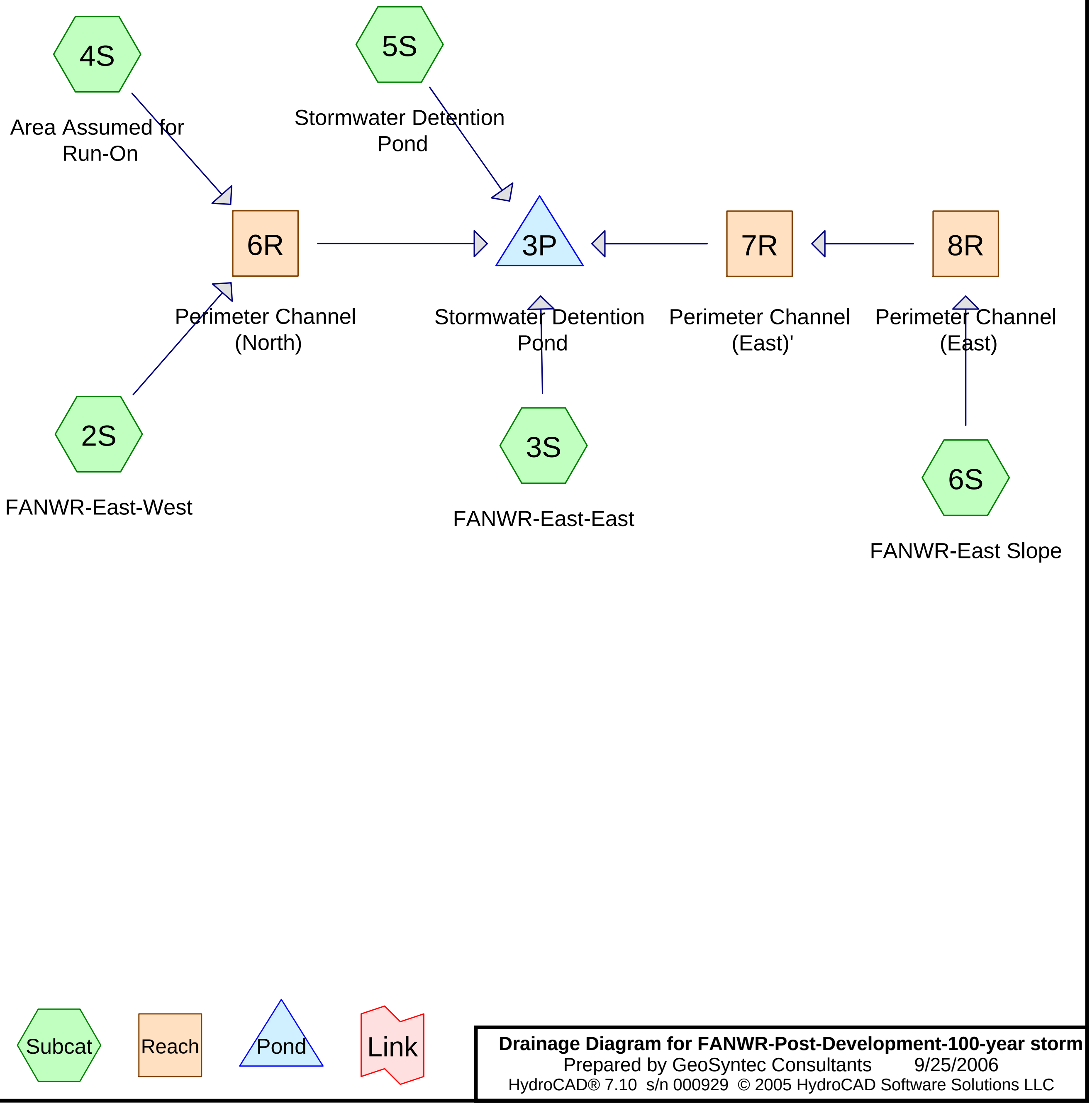
Pond 3P: Stormwater Detention Pond



100 Year – 24 Hour Storm

SCS Distribution

(Post-Development)



Drainage Diagram for FANWR-Post-Development-100-year storm
Prepared by GeoSyntec Consultants 9/25/2006
HydroCAD® 7.10 s/n 000929 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-60.00 hrs, dt=0.04 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: FANWR-East-West Runoff Area=2.690 ac Runoff Depth=3.44"
Flow Length=485' Tc=31.0 min CN=61 Runoff=7.69 cfs 0.772 af

Subcatchment 3S: FANWR-East-East Runoff Area=3.060 ac Runoff Depth=3.44"
Flow Length=377' Tc=27.9 min CN=61 Runoff=9.38 cfs 0.878 af

Subcatchment 4S: Area Assumed for Run-On Runoff Area=0.230 ac Runoff Depth=2.78"
Flow Length=100' Tc=19.0 min CN=55 Runoff=0.70 cfs 0.053 af

Subcatchment 5S: Stormwater Detention Pond Runoff Area=0.310 ac Runoff Depth=7.76"
Tc=5.0 min CN=98 Runoff=3.62 cfs 0.200 af

Subcatchment 6S: FANWR-East Slope Runoff Area=0.440 ac Runoff Depth=3.44"
Flow Length=256' Tc=17.6 min CN=61 Runoff=1.78 cfs 0.126 af

Reach 6R: Perimeter Channel (North) Peak Depth=0.76' Max Vel=4.7 fps Inflow=8.19 cfs 0.826 af
n=0.030 L=260.0' S=0.0346 '/' Capacity=16.82 cfs Outflow=8.15 cfs 0.826 af

Reach 7R: Perimeter Channel (East)' Peak Depth=0.33' Max Vel=5.4 fps Inflow=1.75 cfs 0.126 af
n=0.030 L=63.0' S=0.1429 '/' Capacity=34.16 cfs Outflow=1.74 cfs 0.126 af

Reach 8R: Perimeter Channel (East) Peak Depth=0.48' Max Vel=2.6 fps Inflow=1.78 cfs 0.126 af
n=0.030 L=223.0' S=0.0202 '/' Capacity=12.84 cfs Outflow=1.75 cfs 0.126 af

Pond 3P: Stormwater Detention Pond Peak Elev=729.92' Storage=37,708 cf Inflow=19.23 cfs 2.031 af
Primary=3.58 cfs 2.016 af Secondary=0.00 cfs 0.000 af Outflow=3.58 cfs 2.016 af

Total Runoff Area = 6.730 ac Runoff Volume = 2.031 af Average Runoff Depth = 3.62"

Subcatchment 2S: FANWR-East-West

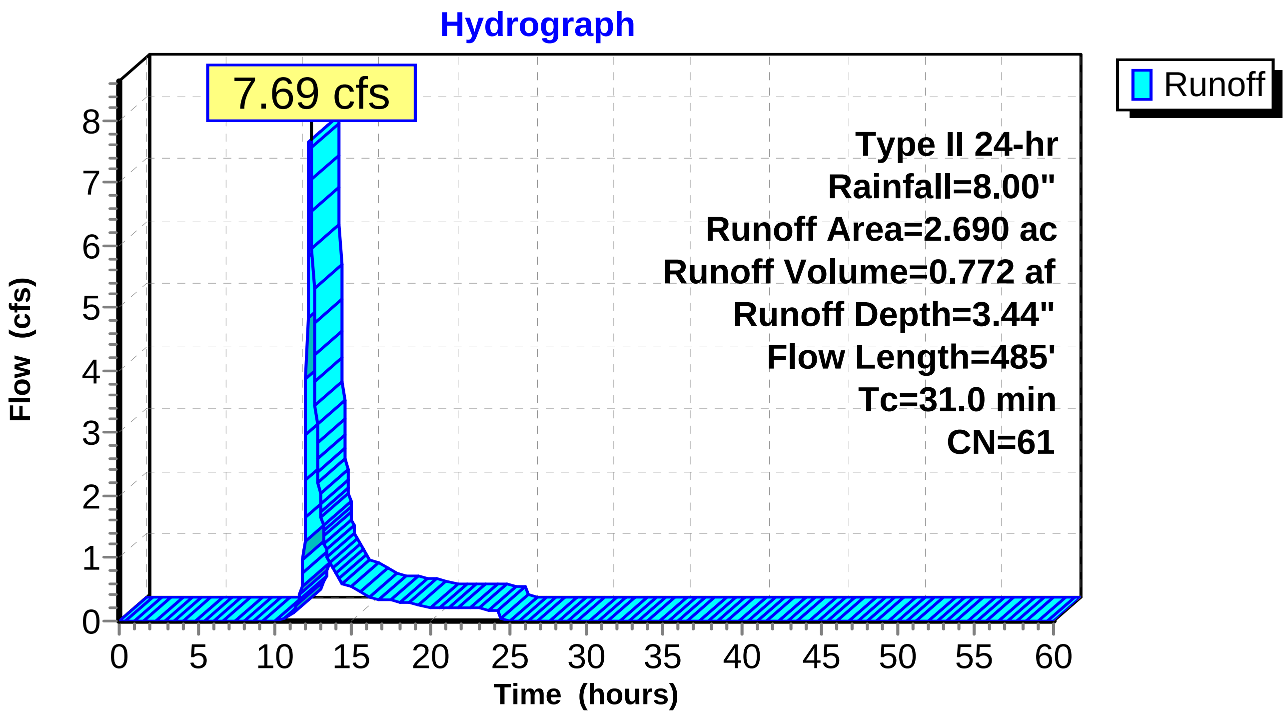
Runoff = 7.69 cfs @ 12.26 hrs, Volume= 0.772 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=8.00"

Area (ac)	CN	Description
2.690	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	100	0.0500	0.3		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
20.4	200	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
4.4	185	0.0100	0.7		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
31.0	485	Total			

Subcatchment 2S: FANWR-East-West



Subcatchment 3S: FANWR-East-East

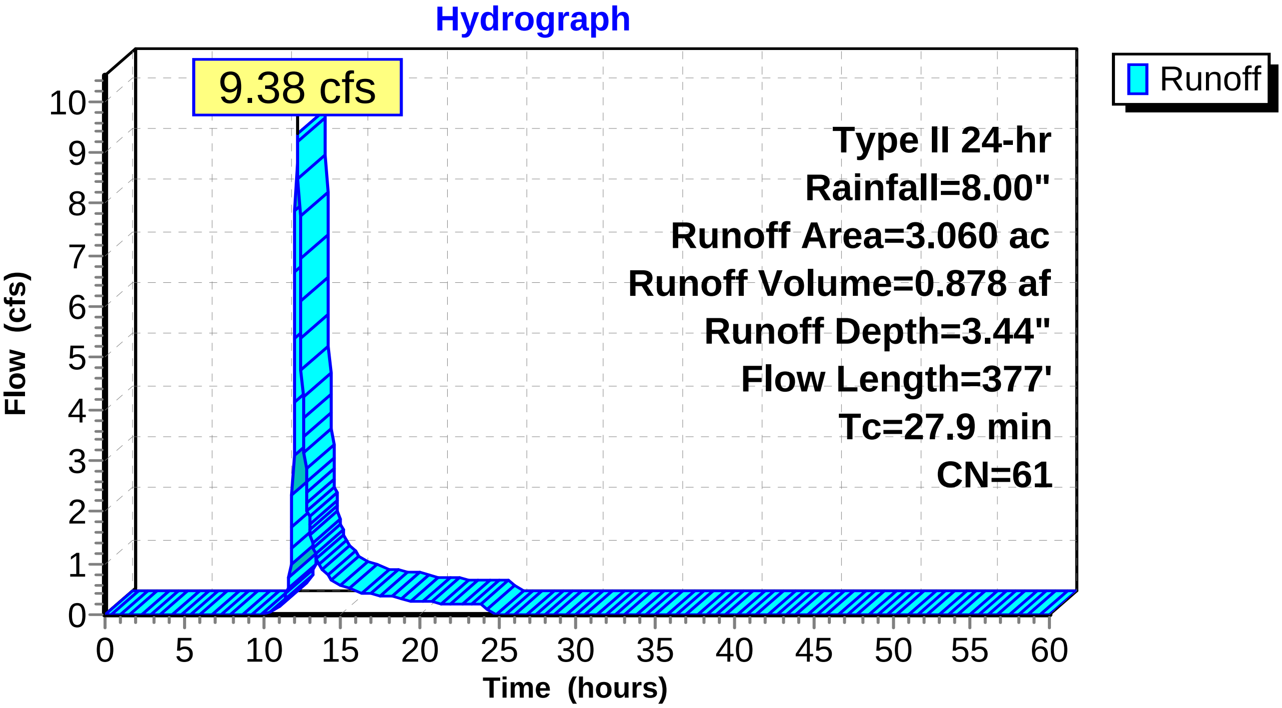
Runoff = 9.38 cfs @ 12.23 hrs, Volume= 0.878 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=8.00"

Area (ac)	CN	Description
3.060	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	50	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
7.0	118	0.0500	0.3		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
14.6	132	0.0100	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
1.0	40	0.0100	0.7		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	37	0.3300	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
27.9	377	Total			

Subcatchment 3S: FANWR-East-East



Subcatchment 4S: Area Assumed for Run-On

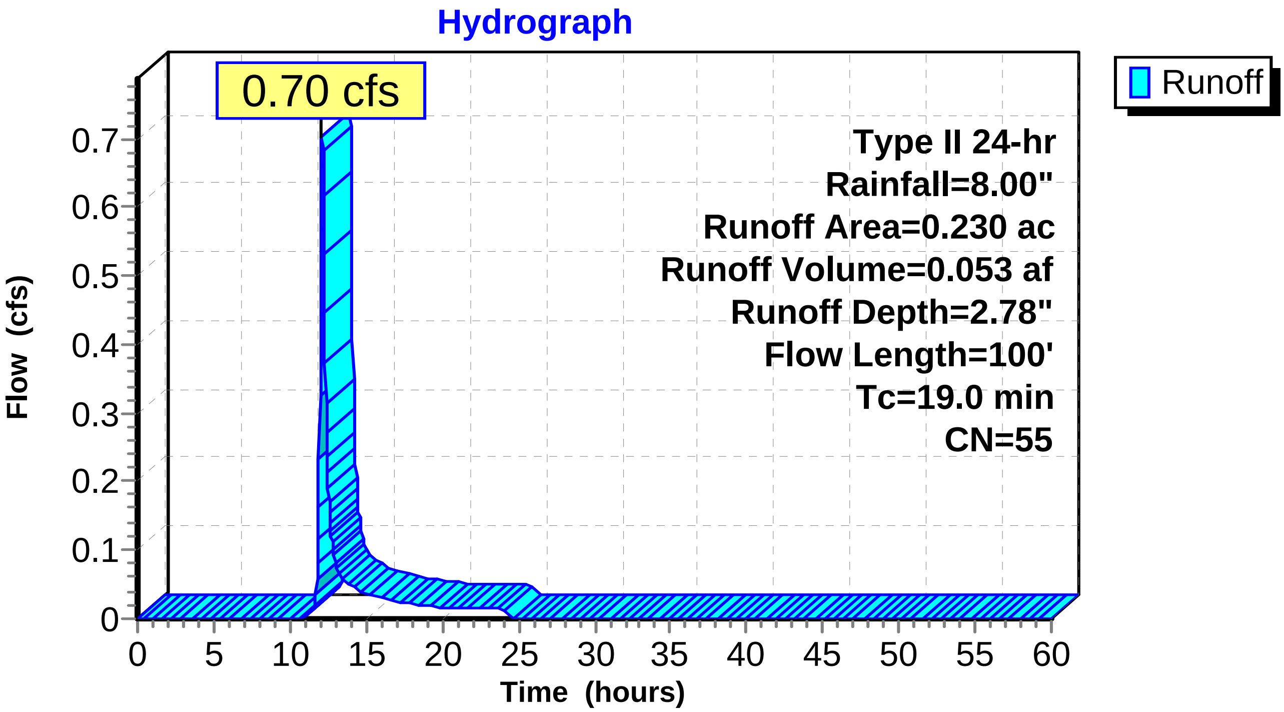
Runoff = 0.70 cfs @ 12.13 hrs, Volume= 0.053 af, Depth= 2.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.230	55	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0850	0.1		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.90"

Subcatchment 4S: Area Assumed for Run-On



Subcatchment 5S: Stormwater Detention Pond

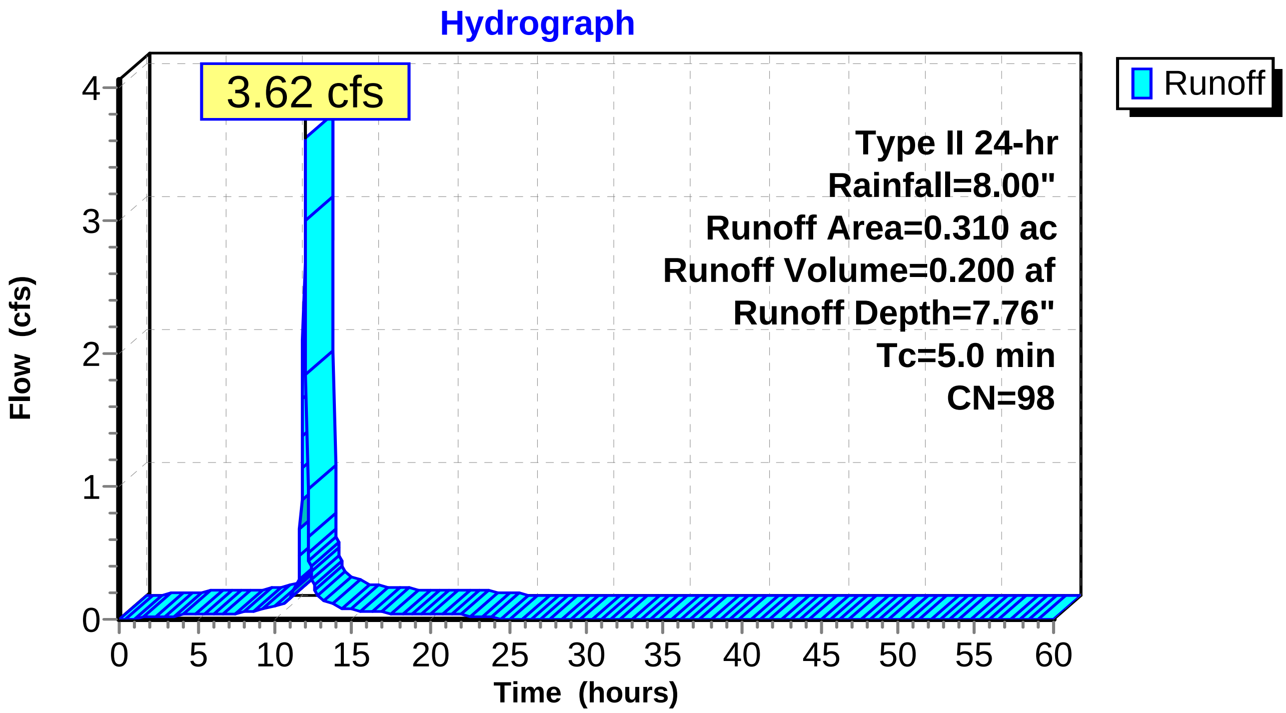
Runoff = 3.62 cfs @ 11.95 hrs, Volume= 0.200 af, Depth= 7.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.310	98	

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

Subcatchment 5S: Stormwater Detention Pond



Subcatchment 6S: FANWR-East Slope

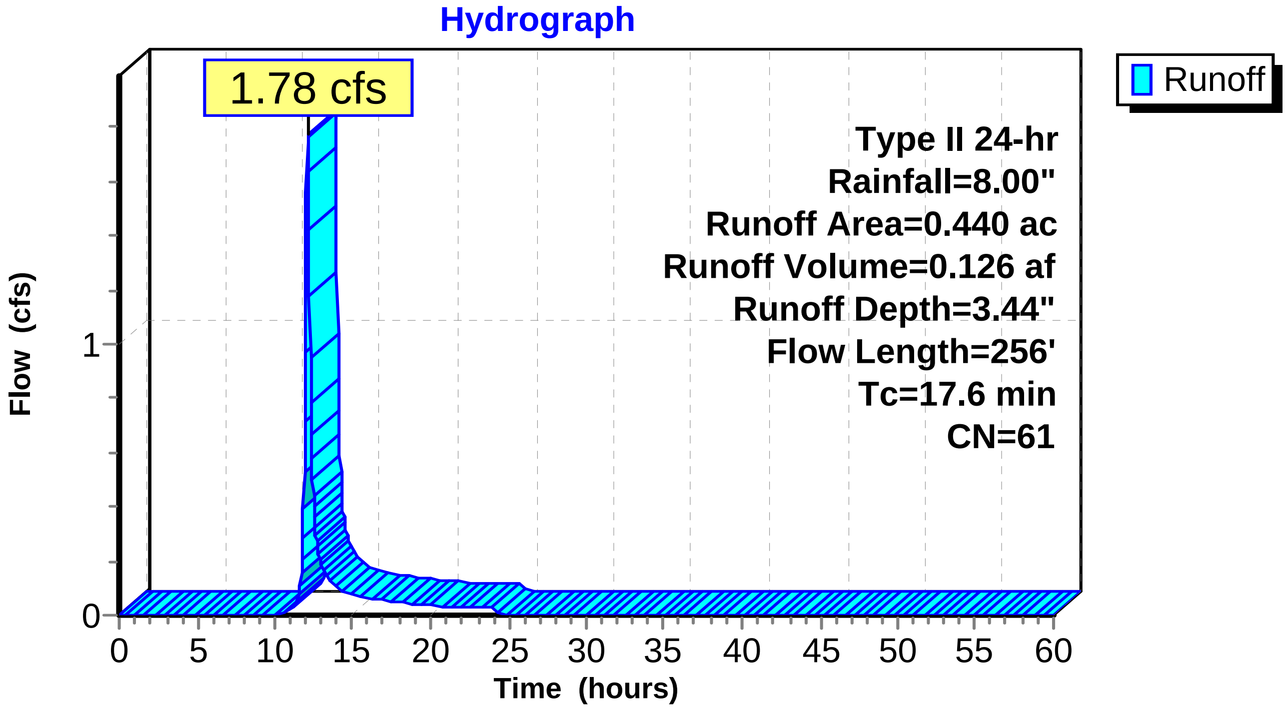
Runoff = 1.78 cfs @ 12.11 hrs, Volume= 0.126 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Type II 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.440	61	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.0	131	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
4.9	75	0.0500	0.3		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
1.7	50	0.3300	0.5		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.90"
17.6	256	Total			

Subcatchment 6S: FANWR-East Slope



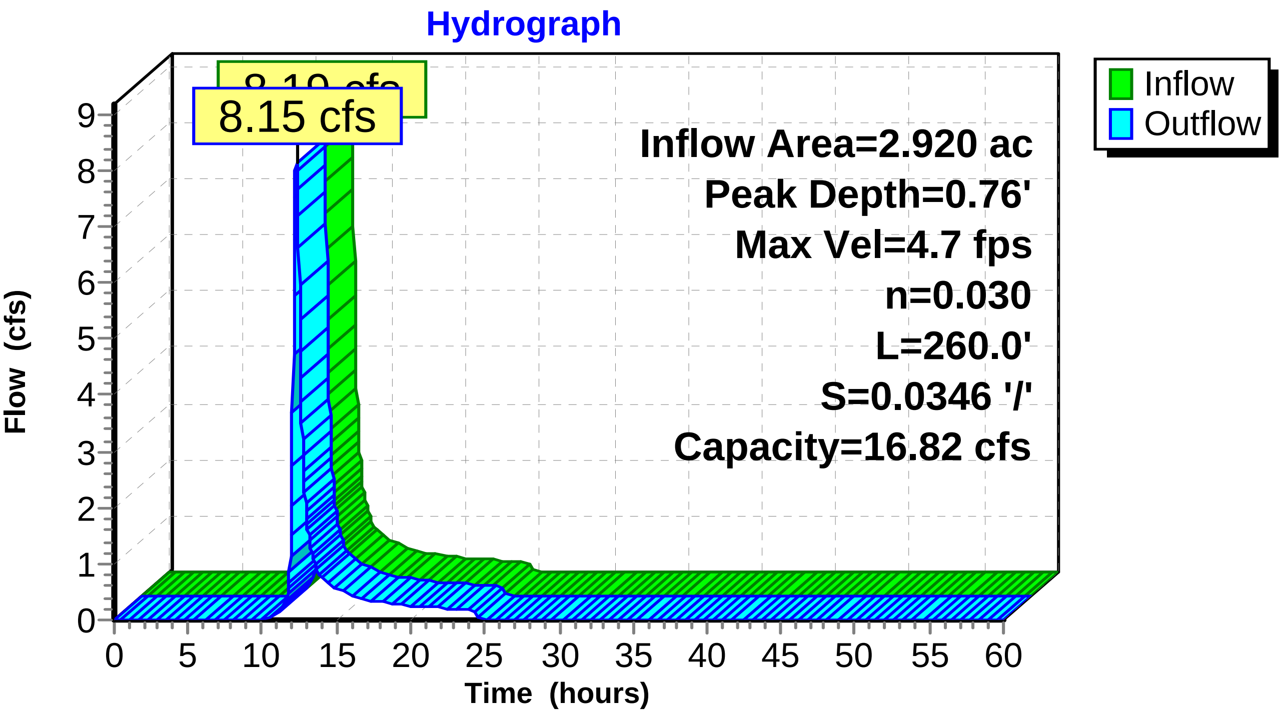
Reach 6R: Perimeter Channel (North)

Inflow Area = 2.920 ac, Inflow Depth = 3.39"
Inflow = 8.19 cfs @ 12.25 hrs, Volume= 0.826 af
Outflow = 8.15 cfs @ 12.28 hrs, Volume= 0.826 af, Atten= 1%, Lag= 1.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Max. Velocity= 4.7 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 2.2 min

Peak Depth= 0.76' @ 12.26 hrs
Capacity at bank full= 16.82 cfs
Inlet Invert= 741.00', Outlet Invert= 732.00'
0.00' x 1.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 260.0' Slope= 0.0346 '/'

Reach 6R: Perimeter Channel (North)



Reach 7R: Perimeter Channel (East)'

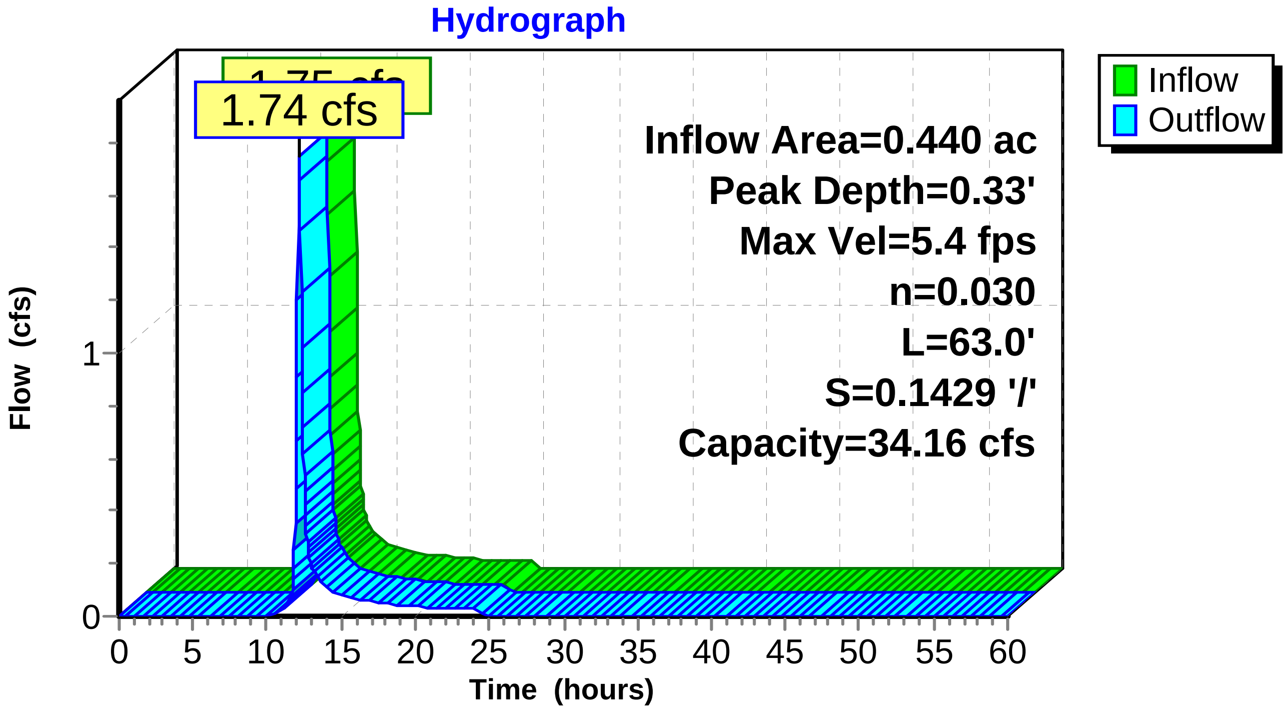
[61] Hint: Submerged 7% of Reach 8R bottom

Inflow Area = 0.440 ac, Inflow Depth = 3.44"
Inflow = 1.75 cfs @ 12.15 hrs, Volume= 0.126 af
Outflow = 1.74 cfs @ 12.16 hrs, Volume= 0.126 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Max. Velocity= 5.4 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.2 fps, Avg. Travel Time= 0.5 min

Peak Depth= 0.33' @ 12.15 hrs
Capacity at bank full= 34.16 cfs
Inlet Invert= 739.50', Outlet Invert= 730.50'
0.00' x 1.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 63.0' Slope= 0.1429 '/'

Reach 7R: Perimeter Channel (East)'



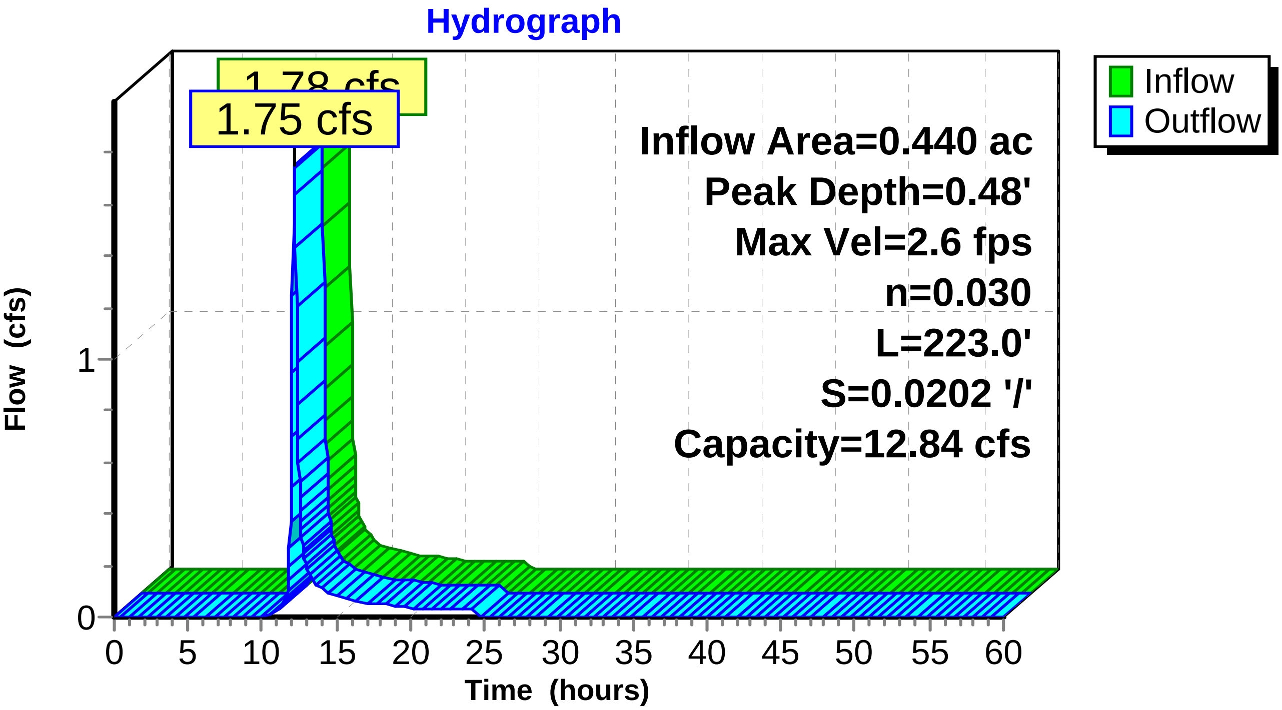
Reach 8R: Perimeter Channel (East)

Inflow Area = 0.440 ac, Inflow Depth = 3.44"
Inflow = 1.78 cfs @ 12.11 hrs, Volume= 0.126 af
Outflow = 1.75 cfs @ 12.15 hrs, Volume= 0.126 af, Atten= 2%, Lag= 2.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Max. Velocity= 2.6 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 3.5 min

Peak Depth= 0.48' @ 12.12 hrs
Capacity at bank full= 12.84 cfs
Inlet Invert= 744.00', Outlet Invert= 739.50'
0.00' x 1.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 223.0' Slope= 0.0202 '/'

Reach 8R: Perimeter Channel (East)



Pond 3P: Stormwater Detention Pond

Inflow Area = 6.730 ac, Inflow Depth = 3.62"
Inflow = 19.23 cfs @ 12.24 hrs, Volume= 2.031 af
Outflow = 3.58 cfs @ 13.05 hrs, Volume= 2.016 af, Atten= 81%, Lag= 48.9 min
Primary = 3.58 cfs @ 13.05 hrs, Volume= 2.016 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.04 hrs
Peak Elev= 729.92' @ 13.05 hrs Surf.Area= 12,933 sf Storage= 37,708 cf
Plug-Flow detention time= 141.0 min calculated for 2.016 af (99% of inflow)
Center-of-Mass det. time= 136.2 min (986.8 - 850.5)

Volume	Invert	Avail.Storage	Storage Description
#1	722.00'	53,188 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

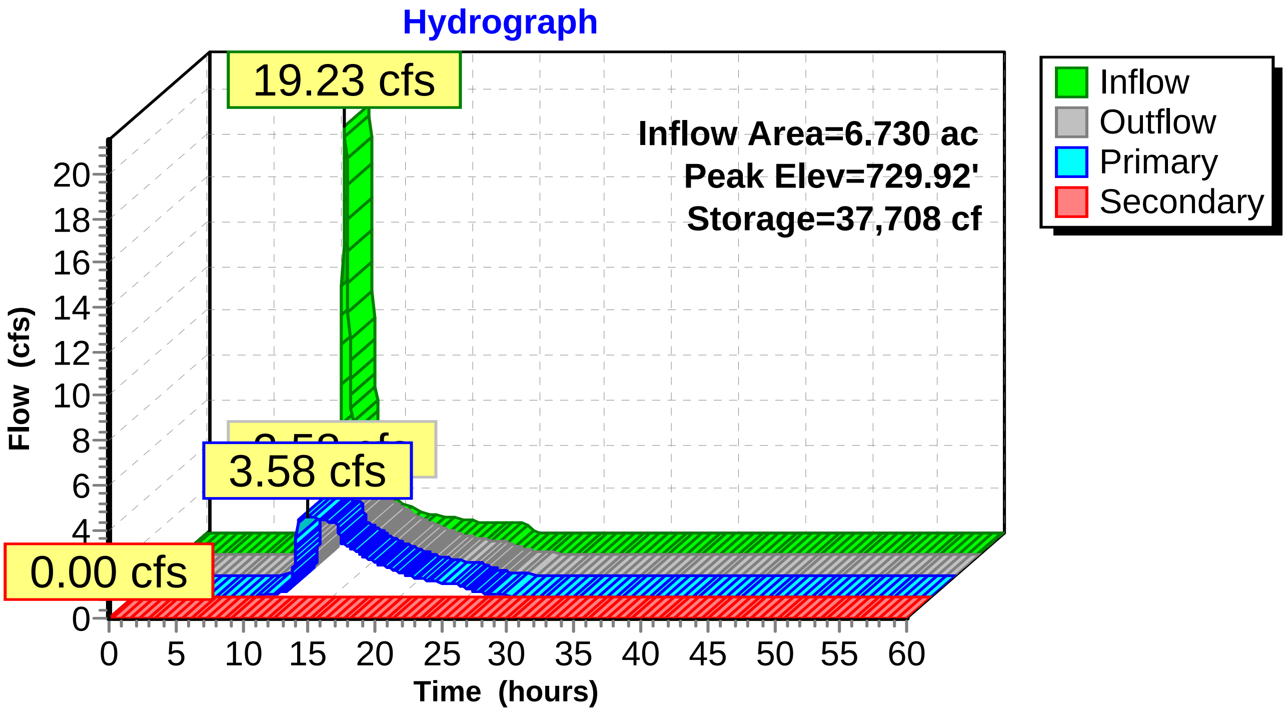
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
722.00	0	0	0
722.50	238	60	60
723.00	552	198	257
723.50	941	373	630
724.00	1,406	587	1,217
724.50	1,947	838	2,055
725.00	2,564	1,128	3,183
725.50	3,256	1,455	4,638
726.00	4,024	1,820	6,458
726.50	4,868	2,223	8,681
727.00	5,788	2,664	11,345
727.50	6,783	3,143	14,488
728.00	7,855	3,660	18,147
728.50	9,002	4,214	22,362
729.00	10,224	4,807	27,168
729.50	11,523	5,437	32,605
730.00	13,213	6,184	38,789
731.00	15,586	14,400	53,188

Device	Routing	Invert	Outlet Devices
#1	Primary	722.00'	**10.0" x 70.0' long Culvert** CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 721.00' S= 0.0143 '/' Cc= 0.900 n= 0.025 Corrugated metal
#2	Device 1	728.50'	**15.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	723.50'	**1.0" Vert. Orifice/Grate X 6.00 columns** X 10 rows with 6.0" cc spacing C= 0.600
#4	Secondary	730.00'	**13.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Primary OutFlow Max=3.58 cfs @ 13.05 hrs HW=729.92' (Free Discharge)
└─**1=Culvert** (Barrel Controls 3.58 cfs @ 6.6 fps)
  ├─**2=Orifice/Grate** (Passes < 7.03 cfs potential flow)
  └─**3=Orifice/Grate** (Passes < 3.15 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=722.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Stormwater Detention Pond



COVER SYSTEM SETTLEMENT

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal #:** GR3762 **Task #:** 05

TITLE OF COMPUTATIONS Cover System Settlement Analysis

COMPUTATIONS BY:
Signature
Printed Name Jill F. Roboski
and Title Engineer
16 Oct 2006
DATE

ASSUMPTIONS AND PROCEDURES CHECKED BY:
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and Title Project Engineer
16 OCT 2006
DATE

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16 OCT 2006
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16 Oct 2006
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APPROVED BY:
(PM or Designate)
Signature
Printed Name Michael J. Monteleone
and Title Principal
16 OCT 06
DATE

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by: JFR **Date:** 21 Sept 2006 **Reviewed by:** **Date:**

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

COVER SYSTEM SETTLEMENT ANALYSIS

Written by: JFR Date: 21 Sept 2006 Reviewed by: ________ Date: ________

Client: Matrix Project: McClellan Final Cover Systems Project/Proposal No.: GR3762 Task No.: 05

EXECUTIVE SUMMARY

In this calculation package, final cover settlements for Landfill 3 (LF3) and the Fill Area North West of Reilly Airfield (FANWR) are evaluated. The final cover settlements were calculated considering short-term primary compression and long-term secondary compression of the waste in the landfill. The effect of the settlements on the cover system final grades was also evaluated.

LF3 was constructed using trenches; waste was placed in the trenches to a maximum depth of 22 ft and covered with soil. FANWR was not constructed in an organized manner; random fill locations were chosen for placement of waste to a maximum depth of 15 ft and then covered by soil. Given that: (i) the waste sources were similar for both LF3 and FANWR, (ii) the depth of waste is greater at LF3, and (iii) the final cover systems are similar; settlements due to final cover placement were calculated for LF3 only. For the purpose of this calculation, the foundation soils and native soils between the trenches were considered incompressible in comparison to the waste and due to the minimal load imparted on the native soils by the cover system. These calculated settlements are considered representative of the anticipated settlement at FANWR.

Settlements were evaluated along a critical cross section where the thickness of the cover system is greatest and the maximum number of assumed waste trenches is intersected. The design pre-settlement grade of the landfill cover along the selected cross section is 1 percent [100 horizontal to 1 vertical (100H:1V)]. The existing landfill waste and cover soil is at an approximate elevation of 740 ft. Results indicate that the maximum primary settlement and total settlement that will occur beneath 7 ft of final cover material are 0.81 and 1.1 ft respectively. Based on calculated post-primary and secondary settlement cover system grades, the cover system will not maintain positive drainage. However, it is anticipated that primary settlement will occur prior to final grading due to subgrade preparation and placement and compaction effort associated with the construction of the final cover system; thus, minimizing the impact of the total settlement on the final cover system performance.

Negligible tensile strains occur due to primary or secondary settlement.

COVER SETTLEMENT CALCULATIONS

PURPOSE

In this calculation package, final cover settlements for the McClellan Landfill No. 3 (LF3) and the Fill Area North West of Reilly Airfield (FANWR) are evaluated. The final cover settlements were calculated considering short-term primary compression and long-term secondary compression of waste in the landfill. The effects of these settlements on the final grades of the cover system were evaluated. Tensile strains induced in the final cover system by differential settlement are also calculated.

BACKGROUND

LF3 operated as a sanitary landfill at McClellan from 1946 to 1967. The landfill was constructed using a series of trenches that extend east-west across the 23 acre site. The waste was placed in the trenches to a maximum depth of 22 ft and subsequently covered with topsoil. A complete list of wastes disposed of at LF3 is not available. Reportedly, the waste includes triple-rinsed pesticide containers, burned ammunition pallets, paint containers, fluorescent bulbs and ballasts, waste oil, and construction debris. The landfill was not capped when it was closed in 1967 and is currently covered in vegetation. Settlement has occurred and is evident in the topographic contours developed by Optimal Geomatics of Huntsville, Alabama on 17 December 2005 (Figure 1).

The FANWR was first identified as a potential disposal area from a 1954 aerial photograph. Wastes reportedly disposed of include paint containers, fluorescent bulbs and ballasts, waste oils, and construction debris. Random fill locations were chosen for placement of waste to a maximum depth of 15 ft and were then covered by soil. The fill area was not capped upon closure circa 1970. The inactive fill area is heavily wooded and vegetated (Figure 1).

METHOD OF ANALYSIS

Given that: (i) the waste sources were similar for both LF3 and FANWR, (ii) the depth of waste is greater at LF3, and (iii) the final cover systems are similar; settlements due to final cover placement were calculated for LF3 only. These calculated settlements are considered representative of the anticipated settlement at FANWR.

Written by: JFR **Date:** 21 Sept 2006 **Reviewed by:** ____ **Date:** ____

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

Settlements

The compression settlement of municipal solid waste can be analyzed using the one-dimensional consolidation theory commonly used for cohesive soils. Based on this theory, waste settlement has two components: (i) settlement due to primary consolidation and (ii) settlement due to secondary consolidation. The primary settlement component is related to the increase in effective vertical stresses resulting from the landfill final cover system. The secondary settlement component is related to compression of the waste structure (skeleton) and is time-dependent.

Settlements resulting from primary consolidation of the waste were calculated using the general form of the 1-D consolidation theory settlement equation as given below for normally consolidated material [Holtz and Kovacs, 1981]:

$$S_p = C_{c\varepsilon} \cdot H \log\left(\frac{\sigma'_{vo} + \Delta\sigma}{\sigma'_{vo}}\right) \qquad (1)$$

where: S_p = primary settlement;

$C_{c\varepsilon}$ = modified primary compression index;

H = initial thickness of compressible layer;

σ'_{vo} = initial vertical effective stress in the waste (before installation of final cover); and

$\Delta\sigma$ = increment of vertical stress, due to installation of final cover.

The time rate of primary settlement is a function of the initial structure, compressibility, and the permeability of the waste mass. Because the permeability of the waste mass can vary by several orders of magnitude, the time rate of settlement is often controlled by the permeability. Typically, waste is not saturated. The void spaces can compress quickly and settlement occurs rapidly. GeoSyntec Consultants (GeoSyntec) demonstrated that unsaturated waste loaded with a test fill compresses rapidly (on the order of days) or as fast as the test fill can be constructed in the report entitled "*Demonstration of Technical Feasibility: Vertical and Lateral Expansion, South Shelby Landfill, Memphis, Tennessee*" [GeoSyntec, 2002]. Immediately following the rapid primary settlement response to the fill placement, the waste continues to settle but at a much slower rate. This settlement is characterized as secondary settlement.

The mechanisms for secondary settlement are mechanical creep, chemical reactions, and biodegradation. This type of compression is dependent on time, not applied loads. Settlements resulting from secondary settlement of the waste were calculated according to the following equation [Holtz and Kovacs, 1981]:

$$S_t = C_{\alpha\varepsilon} H \log\left(\frac{t_2}{t_1}\right) \tag{2}$$

where: S_t = time dependent secondary settlement;
$C_{\alpha\varepsilon}$ = modified secondary compression index;
H = initial thickness of compressible layer;
t_1 = time when secondary compression is assumed to begin (assumed to be 1 year); and,
t_2 = time for which secondary settlements are calculated (30 years, corresponding to the end of a typical post-closure period).

Total settlement is the sum of the primary and time dependent secondary settlement. To evaluate settlement of the final cover system, settlement of the native soil should also be taken into account. However, for the purposes of these calculations, the magnitude of the settlement in the native soil is considered to be negligible in comparison to the waste and therefore can be neglected herein.

Tensile Strains:

The effects of waste settlement on the final cover system were evaluated as described below.

Tensile strains in the final cover induced by differential waste settlement were estimated by the following general equation:

$$\varepsilon_{tens} = \frac{L_o - L_f}{L_o} \tag{3}$$

where ε_{tens}= strain in the cover (tension is negative);
L_o = initial length of cover between adjacent points; and
L_f = length of cover between adjacent points after settlement has occurred.

The estimated tensile strains were compared to conservative allowable tensile strains of 0.5 percent for compacted clay liner [GeoSyntec, 1995].

Grade changes induced by differential waste settlement were estimated by considering the magnitude of differential settlement and the horizontal distance between adjacent points. The estimated grade changes were then compared to the design grades of the final cover system to check that positive post-settlement surface water flow is maintained.

Written by: JFR Date: 21 Sept 2006 Reviewed by: Date:

Client: Matrix Project: McClellan Final Cover Systems Project/Proposal No.: GR3762 Task No.: 05

MATERIAL PARAMETERS

The settlement of waste can be calculated using the same one-dimensional consolidation methods that are used to calculate the settlement of soils as described previously. The modified primary compression index ($C_{c\varepsilon}$) and the modified secondary compression index ($C_{\alpha\varepsilon}$) are needed for settlement analysis of the waste.

Values of the modified primary compression index reported in technical literature range from 0.08 to 0.46 for municipal solid waste (MSW) [Sowers, 1973; Burlingame, 1985; Landva and Clark, 1990; Fassett et al., 1994]. The most recent of these references [Fassett et al., 1994] presents a compilation of data from a number of sources, reflecting a variety of types of MSW. Fassett et al. [1994] also classify this data based on its reliability and the age of the MSW. The reported modified primary compression index for “old” waste is 0.10 for an evaluation which resulted in “fair” reliability. Based on this, a modified primary compression index value of 0.10 is assumed for settlement analysis.

Values of the modified secondary compression index reported in technical literature are normally less than 0.07 [Sowers, 1973; Landva and Clark, 1990; Fassett et al., 1994]. A value of $C_{\alpha\varepsilon}$ with "good" reliability reported by Fassett et al [1994] for “old” waste is 0.01. Based on field tests, GeoSyntec [2002] found that the secondary compression index is directly dependent on the magnitude of the load. For a 10 ft thick surcharge load, the secondary compression index varied from 0.007 to 0.009. Therefore, for this settlement analysis, a $C_{\alpha\varepsilon}$ value of 0.009 was used. Tables 1a and 1b present a summary of the parameters used for the waste settlement calculation.

CROSS SECTION ANALYZED

The location of the analyzed cross section with respect to the landfill features is shown in Figure 2. Cross Section A-A’ was selected as the most critical section for analysis because it includes a representative range of waste thickness and the maximum final cover grade and thickness to be placed on LF3. Existing borings were projected to the cross section following the east-west trend of the waste trenches, and assuming the waste depth will remain constant for individual trenches. Evidence of settlement in the topographic contours along the cross section was used to define the trench width and the native soil width between waste trenches. The stratigraphy of the cross section is shown in Figure 3.

RESULTS

A graphical presentation of the pre- and post-settlement grades for the analyzed cross section is shown in Figure 4. Results of the settlement analysis are summarized in Table 2. Details of the settlement analysis are included in Attachment 1.

SUMMARY AND CONCLUSIONS

Results indicate that the maximum primary settlement and total settlement that will occur beneath 7 ft of final cover material are 0.81 and 1.1 ft respectively. Based on calculated post-primary and secondary settlement cover system grades, the cover system will not maintain positive drainage. However, as mentioned previously, GeoSyntec [2002] demonstrated that primary settlements occur rapidly for unsaturated waste. Therefore, it is anticipated that primary settlement will occur prior to final grading due to subgrade preparation and placement and compaction effort associated with the construction of the final cover system; thus, minimizing the impact of the total settlement on the final cover system performance.

Negligible tensile strains (i.e., <<0.5 percent) occur due to primary or secondary settlement.

REFERENCES

GeoSyntec Consultants, "*Final Cover System Guidance Document, Municipal Solid Waste Landfills*", prepared for the State of Maine, Department of Environmental Protection, 1995.

GeoSyntec Consultants, "*Demonstration of Technical Feasibility: Vertical and Lateral Expansion, South Shelby Landfill, Memphis, Tennessee*", prepared for BFI Waste Systems of North America, Inc., Project Number GG0904, March 2002.

Burlingame, M.J, "Construction of a Highway on a Sanitary Landfill and its Long Term Performance", *Transportation Research Record 1031*, TRB, Washington, DC, 1985, pp. 34-40.

Fasset, J., Leonards, G., and Repetto, P, "Geotechnical Properties of Municipal Solid Wastes and Their Use in Landfill Design", *Proceedings of Waste Tech 94*, Charleston, SC, 1994, pp. 1-31.

Holtz, R.D., and Kovacs, W.D, "*An Introduction to Geotechnical Engineering*", Prentice–Hall, Inc., Englewoods Cliffs, NJ, 1981.

Landva, A. and Clark, J, "Geotechnics of Waste Fill", *Geotechnics of Waste Fills – Theory and Practice*, ASTM STP 1070, A. Landva, and D. Knowles, Eds., Philadelphia, PA, 1990, pp. 86-103.

Sowers, G.F, "Settlement of Waste Disposal Fills", *Proceedings of the 8th International Conference on Soil Mechanics and Foundation Engineering*, Moscow, 1973, pp. 207-210.

Written by: JFR Date: 21 Sept 2006 Reviewed by: Date:

Client: Matrix Project: McClellan Final Cover Systems Project/Proposal No.: GR3762 Task No.: 05

TABLES

Table 1a. Waste consolidation parameters.

	$C_{c\varepsilon}$	$C_{\alpha\varepsilon}$
Waste	0.10	0.009

Table 1b. Material unit weights and thicknesses used for waste settlement calculation.

	γ (pcf)	Thickness (ft)
Final Cover	120	Varies from 2 to 7 ft
Waste	70	Varies from 0 to 22 ft

Written by: JFR **Date:** 21 Sept 2006 **Reviewed by:** **Date:**

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

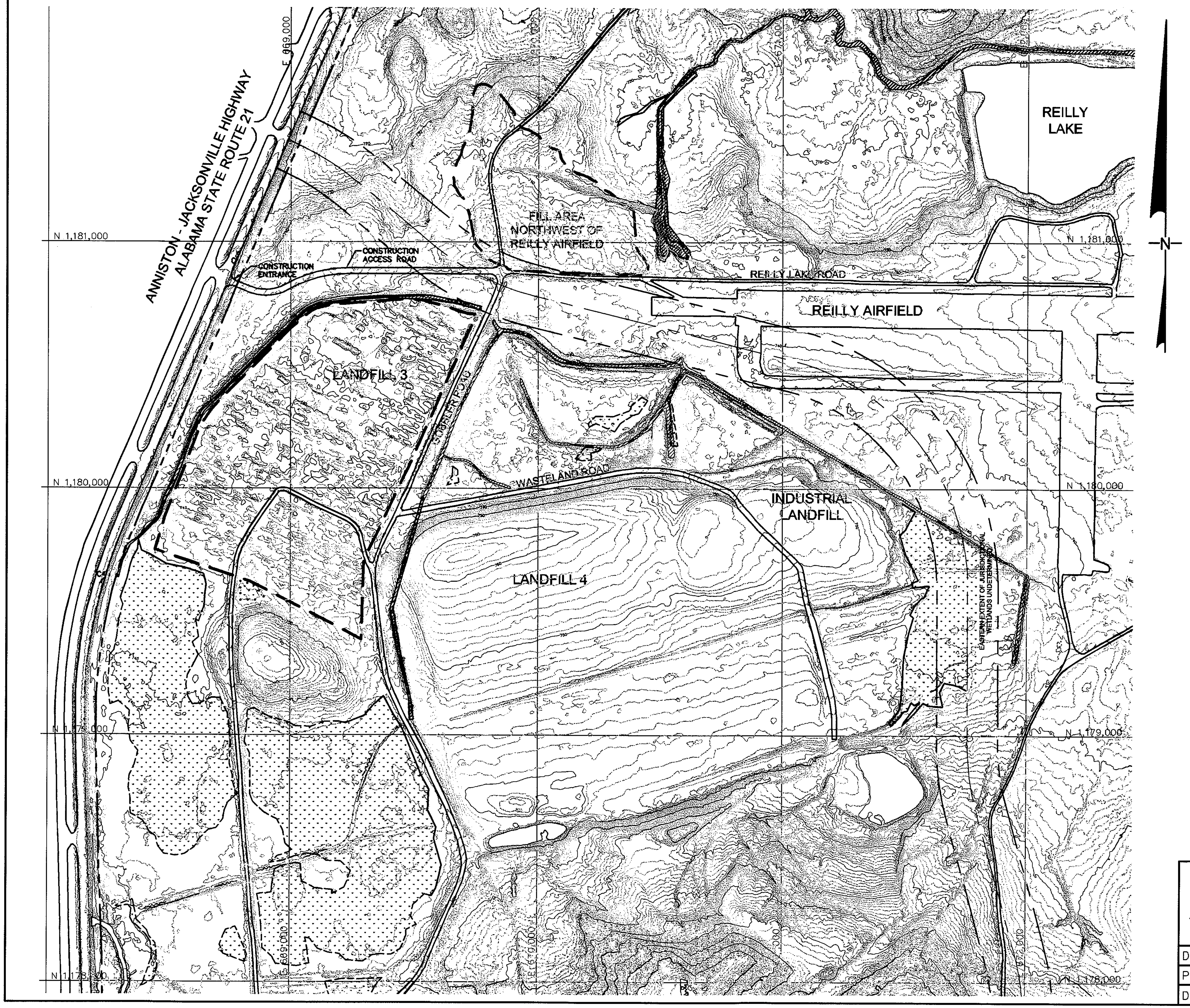
Table 2. Summary of settlement calculations.

Cross Section Analyzed	**Time Period**	**Maximum Settlement (ft)**	**Maximum Tensile Strain (%)**
A-A'	Primary Settlement	0.81	0.005
A-A'	Total Settlement	1.1	0.005

Written by: JFR Date: 21 Sept 2006 Reviewed by: Date:

Client: Matrix Project: McClellan Final Cover Systems Project/Proposal No.: GR3762 Task No.: 05

FIGURES



0 400' 800'

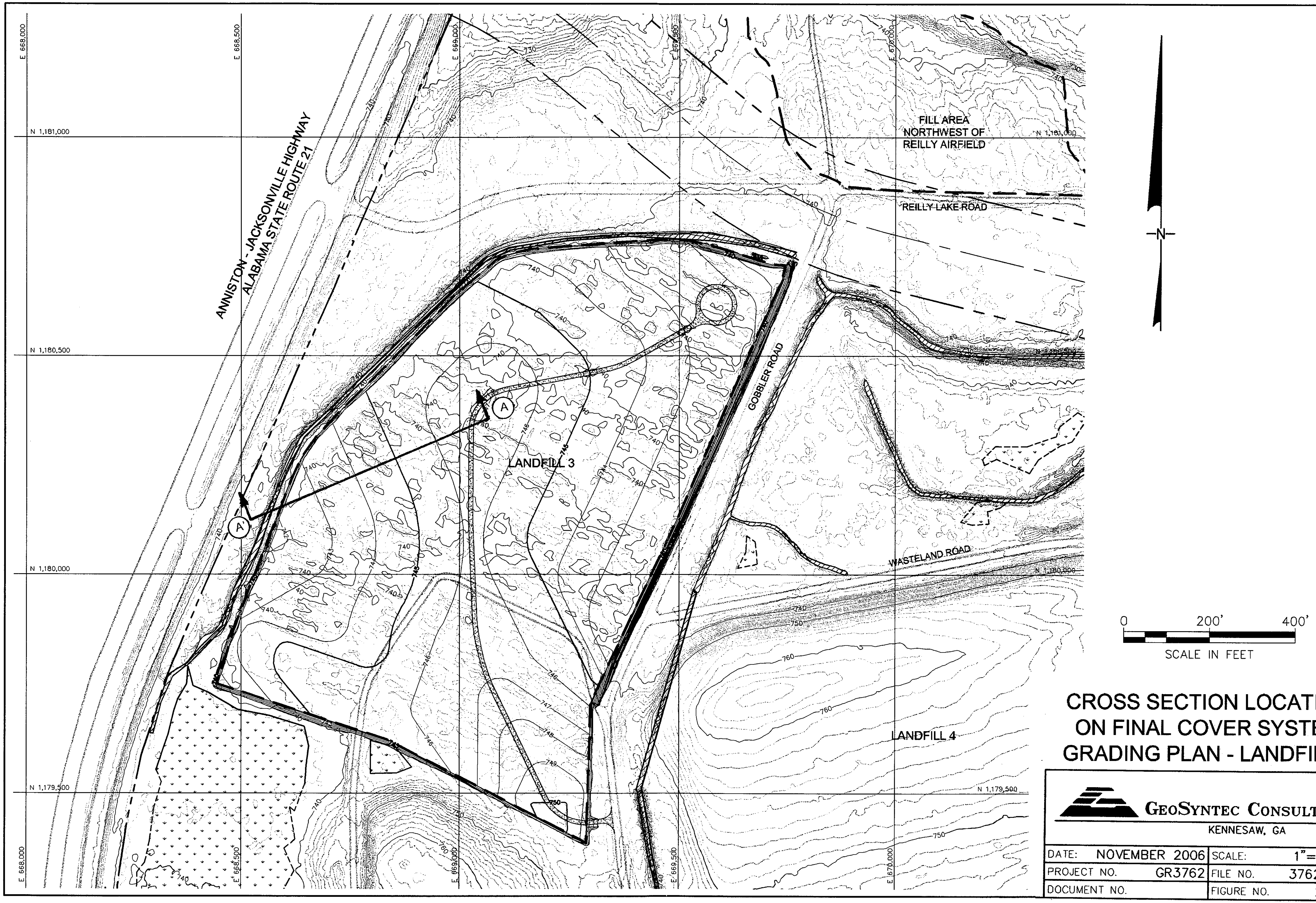
SCALE IN FEET

EXISTING SITE CONDITIONS

GEOSYNTEC CONSULTANTS

KENNESAW, GA

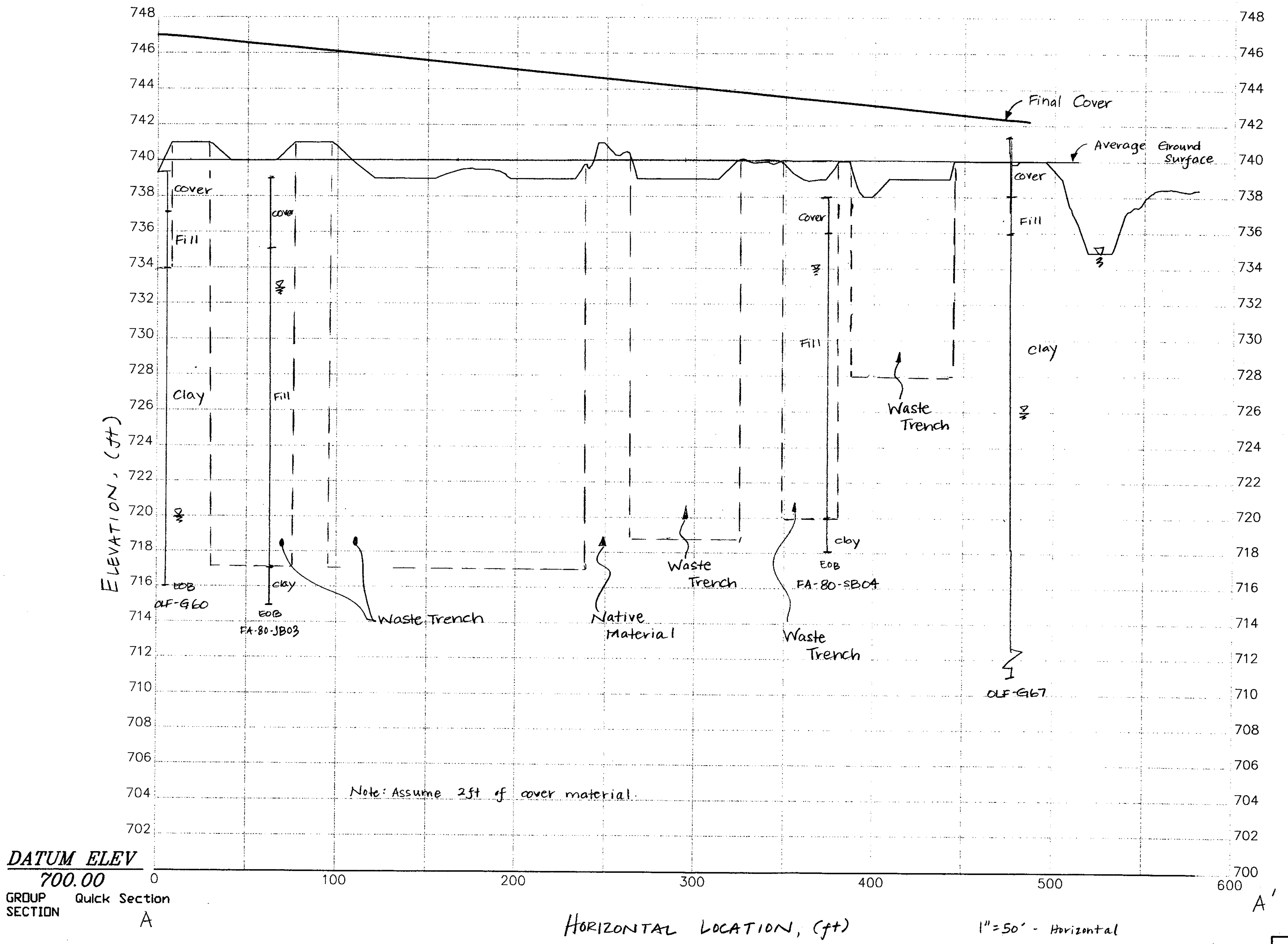
DATE:	NOVEMBER 2006	SCALE:	1"=400'
PROJECT NO.	GR3762	FILE NO.	3762F020
DOCUMENT NO.		FIGURE NO.	1



CROSS SECTION LOCATION ON FINAL COVER SYSTEM GRADING PLAN - LANDFILL 3

GEOSYNTEC CONSULTANTS
KENNESAW, GA

DATE:	NOVEMBER 2006	SCALE:	1"=200'
PROJECT NO.	GR3762	FILE NO.	3762F021
DOCUMENT NO.		FIGURE NO.	2



CROSS SECTION A-A'
STRATIGRAPHY

GeoSyntec Consultants

KENNESAW, GA

DATE:	NOVEMBER 2006	SCALE:	AS SHOWN
PROJECT NO.	GR3762	FILE NO.	3762F021
DOCUMENT NO.		FIGURE NO.	3

Written by: JFR **Date:** 21 Sept 2006 **Reviewed by:** **Date:**

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 03

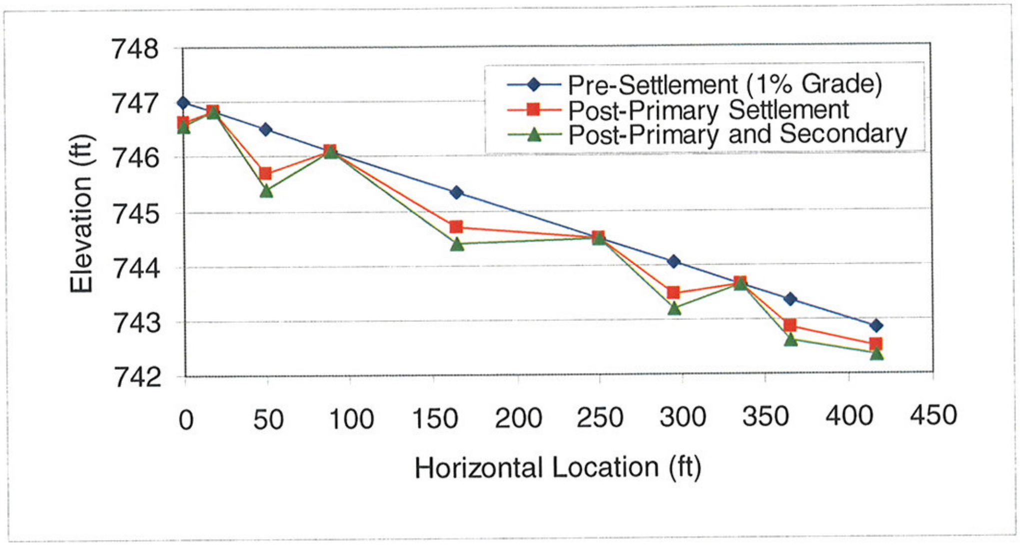


Figure 4. Summary of settlements in waste along Cross Section A-A' due to final cover loading.

ATTACHMENT 1

Written by: JFR Date: 06/09/06 (YY/MM/DD) Reviewed by: ______ Date: __/__/__ (YY/MM/DD)

Client: Matrix Project: McClellan - LF3 Project/Proposal No.: GR3762 Task No: ______

Primary Settlement Calculation LF-3 McClellan Landfill Caps

PURPOSE: The purpose of this calculation package is to calculate the magnitude of the anticipated primary settlement of the waste material at LF3.

METHOD: The primary settlement of the waste material was calculated according to the following equation:

$$S_p = C_{c\varepsilon} H_o \log\left(\frac{\sigma_{vo}' + \sigma_p'}{\sigma_{vo}'}\right)$$

[Ref. Holtz & Kovacs, 1981]

Where:

$C_{c\varepsilon}$ = modified primary compression index

H_o = initial thickness of compressible layer

σ_{vo}' = initial vertical effective stress in the waste (before installation of final cover); and

$\Delta\sigma$ = increment of vertical stress due to final cover installation

PARAMETERS: See Calculation Package "COVER SYSTEM SETTLEMENT ANALYSIS" for complete discussion of parameter selection.

$C_{c\varepsilon} = 0.1$

$\sigma_{vo}' = \sigma_p'$ ⇒ Assume waste is Normally Consolidated

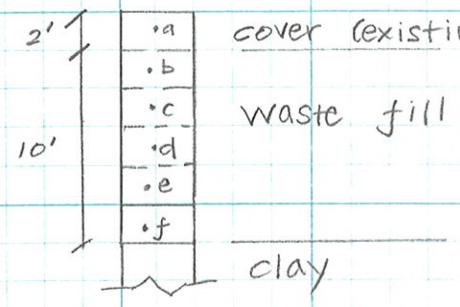
EXAMPLE CALCULATION: See the attached spreadsheet for calculation of settlement at each selected horizontal location or calculation point. Settlement is calculated for one location as follows:

Written by: JER Date: 06 / 09 / 06 (YY MM DD) Reviewed by: ______ Date: ___/___/___ (YY MM DD)

Client: Matrix Project: McClellan · LF3 Project/Proposal No.: GR3762 Task No: ______

EXAMPLE CALCULATION: (cont).

HORIZONTAL LOCATION = 416 ft



Waste Parameters:

$\gamma = 70$ pcf

$\Sigma H_{oi} = 12$ ft

$\Delta\sigma = 3ft(120\ pcf) = 360 psf$

$C_{CE} = 0.1$

$C_{RE} = 10\%(C_{CE}) = 0.01$

$C_{\alpha E} = 0.009$ (for old waste)

$\sigma_p' = \sigma_{vo}'$ (i.e., NC)

Final Cover: $\gamma = 120 pcf$

Settlement in Waste:

Point (a): $\sigma_{vo}' = 1ft(120\ pcf) = 120 psf$

$$S_{pa} = C_{CE} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma}{\sigma_{vo}'}\right) \quad (\sigma_p' = \sigma_{vo}')$$

$$= 0.1(2ft)\log\left(\frac{120 psf + 360 psf}{120 psf}\right) = 0.12\ ft$$

Point (b): $\sigma_{vo}' = 2ft(120\ pcf) + 1ft(70\ pcf) = 310 psf$

$$S_{pb} = C_{CE} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma}{\sigma_{vo}'}\right) \quad (\sigma_p' = \sigma_{vo}')$$

$$= 0.1(2ft)\log\left(\frac{310 psf + 360 psf}{310 psf}\right) = 0.067\ ft$$

Point (c): $\sigma_{vo}' = 2ft(120\ pcf) + 3ft(70\ pcf) = 450 psf$

$$S_{pc} = C_{CE} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma}{\sigma_{vo}'}\right) \quad (\sigma_p' = \sigma_{vo}')$$

$$= 0.1(2ft)\log\left(\frac{450 psf + 360 psf}{450 psf}\right) = 0.051\ ft$$

Point (d): $\sigma_{vo}' = 2ft(120\ pcf) + 5ft(70\ pcf) = 590 psf$

$$S_{pd} = C_{CE} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma}{\sigma_{vo}'}\right) \quad (\sigma_p' = \sigma_{vo}')$$

$$= 0.1(2ft)\log\left(\frac{590 + 360}{590}\right) = 0.041\ ft$$

Written by: JFR Date: 06 / 09 / 06 (YY / MM / DD) Reviewed by: ______ Date: __ / __ / __ (YY / MM / DD)

Client: Matrix Project: McClellan - LF3 Project/Proposal No.: GR3762 Task No: ______

Point (e): $\sigma_{vo}' = 2ft\ (120pcf) + 7ft\ (70pcf) = 730\ psf$

$$S_{ce} = C_{c\varepsilon} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma}{\sigma_{vo}'}\right) \qquad (\sigma_p' = \sigma_{vo}')$$

$$= 0.1\ (2ft) \log\left(\frac{730\ psf + 360 psf}{730\ psf}\right) = 0.035\ ft$$

Point (f): $\sigma_{vo}' = 2ft\ (120pcf) + 9ft\ (70pcf) = 870\ psf$

$$S_{pf} = C_{c\varepsilon} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma}{\sigma_{vo}'}\right) \qquad (\sigma_p' = \sigma_{vo}')$$

$$= 0.1\ (2ft) \log\left(\frac{870 + 360}{870}\right) = 0.03\ ft$$

$$S_p = \Sigma_i S_{pi} = 0.12 ft + 0.067 ft + 0.051 ft + 0.041 ft + 0.035ft + 0.03 ft = 0.24 ft$$

SUMMARY:

See Table A1 for a summary of primary settlements.

Table A1. Primary Settlement in Waste

Horizontal Location (ft)	Settlement (ft)
0	0.386
18	0
50	0.805
90	0
165	0.662
250	0
295	0.582
335	0
365	0.487
416	0.34
460	0.00

Written by: JFR Date: 06 / 08 / 31 (YY MM DD) Reviewed by: ____ Date: __ / __ / __ (YY MM DD)

Client: Matrix Project: McClellan Landfill Caps Project/Proposal No.: GR3762 Task No: 04

Secondary Settlement Calculation
LF3 - McClellan Landfill Caps

PURPOSE: The purpose of this calculation package is to calculate the magnitude of the anticipated secondary consolidation of the waste material at LF3.

METHOD: The secondary settlement of the waste material was calculated according to the following equation:

$$S_t = C_{\alpha\varepsilon} H \log\left(\frac{t_2}{t_1}\right)$$

[Ref. Holtz & Kovacs, 1981]

Where:

$C_{\alpha\varepsilon}$ = modified secondary compression index
H = initial thickness of compressible layer
t_1 = time when secondary compression begins
t_2 = time for which secondary compression is calculated

PARAMETERS: See Calculation Package "COVER SYSTEM SETTLEMENT ANALYSIS" for complete discussion of parameter selection.

$C_{\alpha\varepsilon}$ = 0.009
H = varies according to location
t_2 = 30 years, corresponding to the end of a typical post closure period
t_1 = 1 year

EXAMPLE CALCULATION: $S_t = C_{\alpha\varepsilon} H \log\left(\frac{t_2}{t_1}\right)$ @ Horizontal Location = 35 ft.

$$S_t = 0.009(22ft)\log\left(\frac{30}{1}\right) = 0.29ft$$

Written by: JFR Date: 06 / 08 / 31 Reviewed by: Date: / /

Client: Matrix Project: McClellan Landfill Project/Proposal No.: Task No:

Summary :

See Table A2 for a summary of secondary settlement at each calculation point.

Table A2. Secondary Settlement in Waste

Horizontal Location (ft)	Secondary Settlement (ft)
0	0.053
18	0.000
50	0.292
90	0.000
165	0.292
250	0.000
295	0.266
335	0.000
365	0.239
416	0.133
460	0.000

Written by: JFR Date: 06 / 09 / 06 (YY MM DD) Reviewed by: ________ Date: ___ / ___ / ___ (YY MM DD)

Client: Matrix Project: McClellan - LF3 Project/Proposal No.: GR3762 Task No: ________

Tensile Strain Calculation
LF3 McClellan Landfill Caps

PURPOSE: The purpose of this calculation package is to calculate the magnitude of the anticipated tensile strains in the final cover system induced by differential waste settlement.

METHOD: Tensile strains in the final cover were calculated according to the following equation:

$$\varepsilon_{tens} = \frac{L_o - L_f}{L_o}$$

Where:

ε_{tens} = strain in the cover (tension is negative)

L_o = initial length of cover between adjacent points

L_f = length of cover between adjacent points after settlement has occurred

EXAMPLE CALCULATION:

At HORIZONTAL LOCATION = 416 ft

For primary settlement only:

$$\varepsilon_{tens} = \frac{L_o - L_f}{L_o} = \frac{44.0022 - 44.0001}{44.0022} = -0.0048$$

Refer to the attached Table A3 for a summary of tensile strains after primary settlement and after primary and secondary settlement.

Table A3a. Final Cover System
Tensile Strain due to Primary Settlement

Horizontal Location (ft)	L_o (ft)	L_f (ft)	Strain, ε (%)
0	18.001	18.001	0.002
18	32.002	32.020	0.057
50	40.002	40.002	0.000
90	75.004	75.013	0.013
165	85.004	85.000	-0.005
250	45.002	45.012	0.021
295	40.002	40.000	-0.004
335	30.001	30.010	0.029
365	51.003	51.001	-0.002
416	44.002	44.000	-0.005

Table A3b. Final Cover System
Tensile Strain due to Primary and Secondary Settlement

Horizontal Location (ft)	L_o (ft)	L_f (ft)	Strain, ε (%)
0	18.001	18.002	0.005
18	32.002	32.031	0.093
50	40.002	40.006	0.010
90	75.004	75.019	0.021
165	85.004	85.000	-0.005
250	45.002	45.019	0.037
295	40.002	40.003	0.001
335	30.001	30.018	0.053
365	51.003	51.001	-0.004
416	44.002	44.000	-0.005

QUANTITY ESTIMATE

Written by: JFR **Date:** 9 Feb 2007 **Reviewed by:** LMG **Date:** 9 Feb 2007

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

McCLELLAN FINAL COVER SYSTEMS
QUANTITY ESTIMATE CALCULATION PACKAGE

Written by: JFR **Date:** 9 Feb 2007 **Reviewed by:** LMG **Date:** 9 Feb 2007

Client: Matrix **Project:** McClellan Final Cover Systems **Project/Proposal No.:** GR3762 **Task No.:** 05

EXECUTIVE SUMMARY

The purpose of this calculation package is to estimate the material quantities for the construction of the final cover systems at McClellan for Landfill 3 (LF3) and the Fill Area Northwest of Reilly Airfield (FANWR) as presented in the Final (100%) Drawings (Design Drawings) dated February 2007.

For each material, the applicable drawing details, cross-sections, and plans were used for calculating quantities. Quantities were calculated using measurements from (i) the Design Drawings, Appendix B of the Design Report, (ii) the Construction Best Management Practices Plan Drawings (ES Drawings) included in the Draft Permits, (iii) the Technical Specifications, Appendix C of the Design Report, (iv) the Borrow Area Management Plan, and (v) using the grid/prismoidal volume method within the computer program Land Development Desktop for AutoCAD.

Quantities provided in the calculation package are estimated quantities (i.e., assumed to be within ±10% of the estimated quantity based on the accuracy of the existing topographic survey). Quantities were provided for the purpose of developing the engineers cost estimate and are not provided for the purpose of ordering or procuring materials. The construction contractor will be responsible for determining material quantities for these purposes.

McCLELLAN FINAL COVER SYSTEMS
QUANTITY ESTIMATE CALCULATION PACKAGE

PURPOSE

The purpose of this calculation package is to estimate material quantities for construction of the final cover systems at McClellan for Landfill 3 (LF3) and the Fill Area Northwest of Reilly Airfield (FANWR) as presented in the Final (100%) Design Drawings (Design Drawings) dated February 2007.

METHOD

For each material, the applicable drawing details, cross-sections, and plans were used for calculating quantities. Quantities were calculated using measurements from (i) the Design Drawings, Appendix B of the Design Report, (ii) the Construction Best Management Practices Plan Drawings (ES Drawings) included in the Draft Permits, (iii) the Technical Specifications, Appendix C of the Design Report, (iv) the Borrow Area Management Plan, and (v) using the grid/prismoidal volume method within the computer program Land Development Desktop for AutoCAD.

CONCLUSIONS

Quantity estimates are provided in Table 1 for FANWR, in Table 2 for LF3, in Table 3 for general construction areas, and Table 4 for the borrow areas. Each table is organized by specification section. Each line item includes unit, quantity, and reference. The reference indicates the drawing number or figure number from which each quantity was derived. These quantity estimates are summarized for the purpose of developing a cost estimate, a schedule of estimated quantities, and confirming construction bids. These quantities are estimated quantities (i.e., assumed to be within ± 10% of the estimated quantity based on the accuracy of the existing topographic survey).

TABLES

TABLE 1. Quantity Estimate Summary
McClellan Final Cover Systems
FILL AREA NORTHWEST OF REILLY AIRFIELD

SPEC SECTION	ITEM DESCRIPTION	UNIT	Estimated Quantity	Reference$^{(1)}$
02110	**SITE PREPARATION**			
	Removal of Gobbler Road (asphalt)	LF	725	7
	Removal of Reilly Lake Road (asphalt)	LF	670	7
	Silt Fence	FT	6,662	ES-3
	Check Dam	EA	8	ES-3, ES-6
02115	**CLEARING AND GRUBBING**			
	Clear, Grub, and Strip	SF	58,567	Fig. 02115-4
	Clear and Grind	SF	30,220	Fig. 02115-4
	Select Clear and Grind	SF	27,229	Fig. 02115-4
	Stump Grinding	SF	78,201	Fig. 02115-2
02200	**EARTHWORK**			
	Structural Fill (does not include pond)	CY	28,950	8, 12
	Low Permeability Soil Fill (18 inch thickness)	CY	20,790	8, 12
	Surface Water Sediment Detention Pond		-	-
	Soil Excavation (includes northern perimeter ditch)	CY	378	7
	Soil Fill (includes northern perimeter ditch)	CY	2,241	7
	Perimeter Swale (East)	FT	174	8
	Perimeter Swale (North)	FT	145	7
02204	**TOPSOIL AND VEGETATION**			
	Topsoil	CY	6,930	8
	Specialty Landscaping		-	-
	Trees		-	-
	Red Maple	EA	19	9
	River Birch	EA	5	9
	Loblolly Pine	EA	17	9
	Sycamore	EA	2	9
	Tulip Poplar	EA	3	9
	Flowering Dogwood	EA	5	9
	Sourwood	EA	4	9
	Eastern Redbud	EA	25	9
	Shrubs		-	-
	Virginia Sweetspire	EA	30	9
	Buttonbush	EA	28	9
	Beautyberry	EA	14	9
	Oakleaf Hydrangea	EA	35	9
	Wildflowers	SF	84,175	9
	Grass (Including Erosion Mat)	SF	501,671	8
02206	**WASTE EXCAVATION AND HANDLING**			
	Waste Excavation, Placement, and Regrading	CY	19,440	7
02208	**CRUSHED STONE ROADWAY**			
	Gobbler Road Aggregate Base	CY	160	17
	Reilly Lake Road Aggregate Base	CY	150	17
	Parking Area Aggregate Base	CY	140	8
	Walking Path Crushed Stone	CY	525	8, 17
02209	**RIPRAP AND DRAINAGE AGGREGATE**			
	Spillway Riprap	CY	80	16
02720	**GEOTEXTILE SEPARATOR**			
	Excavation Area	SF	15,250	7
	Parking Area	SF	7,560	9
	Beneath Gobbler Road Replacement	SF	8,700	9, 17
	Beneath Reilly Lake Road Replacement	SF	8,040	9, 17
	Spillway Area	SF	1,419	7, 16
	Beneath Walking Path	SF	28,280	17

TABLE 1. Quantity Estimate Summary
McClellan Final Cover Systems
FILL AREA NORTHWEST OF REILLY AIRFIELD

SPEC SECTION	ITEM DESCRIPTION	UNIT	Estimated Quantity	Reference[1]
02830	**SPLIT RAIL FENCE**			
	Split Rail Fence	FT	490	9, 17
VARIOUS	**MISCELLANEOUS**			
	Well Extension	EA	1	9, 17
	PVC (2-inch and 4-inch)	EA	1	17
	Protective Casing (2-inch and 4-inch)	EA	1	17
	Grout, bentonite, sand	EA	1	17
	Concrete pad	EA	1	17
	Bollards	EA	3	17
	Spillway			
	Principal Spillway Riser w/Base and Anti Vortex Device (15 in. diameter, corrugate metal)	EA	1	16
	Stone Core (2 inch diameter)	CY	15	16
	Principal Spillway Pipe (CMP, 10 inch diameter)	FT	75	16

Note: (1) The Design Drawings referenced are included in Appendix B of the Design Report (Bid Documents, Volume II of IV). The Construction Best Management Practices Plan Drawings (ES Drawings) referenced are included in the Draft Permits (Bid Documents, Volume IV of IV). The Technical Specifications figures are included in Appendix C of the Design Report (Bid Documents, Volume II of IV).

TABLE 2. Quantity Estimate Summary
McClellan Final Cover Systems
LANDFILL 3

SPEC SECTION	ITEM DESCRIPTION	UNIT	Estimated Quantity	Reference[(1)]
2110	**SITE PREPARATION**			
	Silt Fence	FT	8,835	ES-2
	Check Dam	EA	10	ES-2, ES-6
2115	**CLEARING AND GRUBBING**			
	Clear (Cap Area)	SF	27,585	Fig. 02115-3
	Stump Grinding	SF	199,843	Fig. 02115-1
2200	**EARTHWORK**			
	Structural Fill	CY	75,282	4, 10, 11
	Low Permeability Soil Fill (18 inch thickness)	CY	53,883	4, 10, 11
	Access Road Structural Fill	CY	19	15
	Perimeter Swale (East)	FT	1,104	5
	Diversion Berm	FT	4,545	4
2204	**TOPSOIL AND VEGETATION**			
	Topsoil (6 inch)	CY	17,961	4, 10, 11
	Vegetation (Including Erosion Mat)	AC	24	4, 10, 11
2208	**CRUSHED STONE ROADWAY**			
	Access Road Aggregate Base	CY	365	4, 17
2209	**RIPRAP**			
	Riprap	CY	83	15
2720	**GEOTEXTILE**			
	Access Road	SF	19,560	4, 17
VARIOUS	**MISCELLANEOUS**			
	Well Extension	EA	5	17
	PVC (2-inch and 4-inch)	EA	5	17
	Protective Casing (2-inch and 4-inch)	EA	5	17
	Grout, bentonite, sand	EA	5	17
	Concrete pad	EA	5	17
	Bollards	EA	15	17
	Outlet Structure Pipe (6-inch diameter, CMP)	FT	270	14

Note: (1) The Design Drawings referenced are included in Appendix B of the Design Report (Bid Documents, Volume II of IV). The Construction Best Management Practices Plan Drawings (ES Drawings) referenced are included in the Draft Permits (Bid Documents, Volume IV of IV). The Technical Specifications figures are included in Appendix C of the Design Report (Bid Documents, Volume II of IV).

TABLE 3. Quantity Estimate Summary
McClellan Final Cover Systems
GENERAL CONSTRUCTION AREA

SPEC SECTION	ITEM DESCRIPTION	UNIT	Estimated Quantity	Reference(1)
2208	**CRUSHED STONE ROADWAY**			
	Construction Entrance Road (24 ft width)	FT	2,650	6
	Upgrade Gobbler Road (15 ft width/6" aggregate base)	LF	1,660	4
2720	**GEOTEXTILE**			
	Restoration of Gobbler Road	SF	24,900	17
VARIOUS	**MISCELLANEOUS**			
	Boundary Survey Permanent Monument(2)	EA	25	4, 8, 17

Note: (1) The Design Drawings referenced are included in Appendix B of the Design Report (Bid Documents, Volume II of IV).
(2) Concrete monuments to be provided by owner.

TABLE 4. Quantity Estimate Summary
McClellan Final Cover Systems
BORROW AREA No. 2 AND STOCKPILES FROM BORROW AREA No. 4

SPEC SECTION	ITEM DESCRIPTION	UNIT	Estimated Quantity	Reference[(1)]
2110	**SITE PREPARATION**			
	Silt Fence (Stockpiles from BAS-4)	FT	9,350	ES-4
	Silt Fence (BAS-2)	FT	5,350	ES-4
2115	**CLEARING AND GRUBBING**			
	Clear, Grub, and Strip (BAS-2)	AC	11	2, Fig. 02115-5
2204	**VEGETATION**			
	Vegetation/Restabilization	AC	19.5	2

Note: (1) The Design Drawings referenced are included in Appendix B of the Design Report (Bid Documents, Volume II of IV). The Construction Best Management Practices Plan Drawings (ES Drawings) referenced are included in the Draft Permits (Bid Documents, Volume IV of IV). The Technical Specifications figures are included in Appendix C of the Design Report (Bid Documents, Volume II of IV).