

Calculation Sheet

Client: Beazer East, Inc.

Project Location: Carbondale, Illinois

Project: Soil Removal and Surface Cover Remedial Design

Project No.: B0039331.0000

Subject: Pre- and Post-Construction Stormwater Hydrologic Analysis

Prepared By: RLJ

Date: October 2017

Reviewed By: PHB

Date: October 2017

Checked By: PHB

Date: October 2017

TASK

Demonstrate that the estimated stormwater runoff volumes and peak runoff rates resulting from the 25-year, 24-hour design storm do not increase from pre-construction to post-construction conditions.

REFERENCES

1. Beazer East, Inc. Soil Removal and Surface Cover Remedial Design Drawing No. 1 titled "Existing Site Plan," Arcadis, October 2017.
2. Beazer East, Inc. Soil Removal and Surface Cover Remedial Design Drawing No. 3 titled "Soil Removal Area Plan," Arcadis, October 2017.
3. Beazer East, Inc. Soil Removal and Surface Cover Remedial Design Drawing No. 4 titled "Surface Cover Area Plan," Arcadis, October 2017.
4. Beazer East, Inc. Soil Removal and Surface Cover Remedial Design Drawing No. 6 titled "Sections and Details," Arcadis, October 2017.
5. Beazer East, Inc. Soil Removal and Surface Cover Remedial Design Drawing No. 7 titled "Sections and Details," Arcadis, October 2017.
6. Trimble Navigation Limited Computer Software (Terramodel), Version 10.52 (2007).
7. Natural Resources Conservation Service (NRCS), Web Soil Survey. Select pages provided in Attachment 2.
8. United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Urban Hydrology for Small Watersheds Technical Release 55 (TR-55), Release Date June 1986. Select pages provided in Attachment 3.
9. National Oceanic and Atmospheric Administration (NOAA) Website Atlas 14 Point Precipitation Frequency Estimates for Carbondale, Illinois. Precipitation frequency estimate output provided in Attachment 4.
10. HydroCAD Software Solutions LLC. Computer Software (HydroCAD), Version 10.0 (2015). Output provided in Attachment 5.

Calculation Sheet

ASSUMPTIONS

1. Based on the existing topography shown on Design Drawing 1 (Reference 1), stormwater runoff from the surface cover remediation areas is generally conveyed to the east and west by a series of existing drainage ditches which collect and convey the runoff off-site. The approximate watershed boundaries associated with the surface cover remediation areas are shown on the Watershed Area Map provided in Attachment 1.
2. The soil removal remediation areas shown on Design Drawing 3 (Reference 2) will be restored to pre-construction grade and surface cover conditions (i.e., surface cover types). Therefore, it is assumed that the estimated stormwater runoff volumes and peak runoff rates from these areas will not change from pre-construction to post-construction conditions. As such, the watershed areas associated with the soil removal remediation areas have been excluded from this analysis.
3. As part of the remedial design, a 12-inch-thick surface cover will be installed over existing topography in three separate areas of the site (Reference 3). The surface cover consists of the following components (listed from top to bottom):
 - 4 inches of vegetated cover soil
 - 8 inches of general fill soil
 - Non-woven geotextile (demarcation layer)

These surface cover components and associated perimeter terminations will be constructed as shown on Design Drawings 6 and 7 (References 4 and 5).

4. Based on soil survey information for the site area (Reference 7), existing soils within the remediation area are classified as hydrologic soil group (HSG) D. A portion of the watershed areas include areas of the site that were previously remediated. Soils within the previously remediated areas and soils to be used to construct the 12-inch-thick surface cover shown on Design Drawing 6 (Reference 4) are classified as HSG C.
5. Runoff curve numbers used in the analyses are determined from hydrologic information contained in TR-55 (Reference 8). The runoff curve numbers are based on surface cover conditions and the HSGs described in Assumption 4. The following runoff curve numbers are used in the hydrologic analyses:
 - Gravel Roads = 89 (HSC C)
 - Open Space/Grass Cover = 74 (Good condition, >75% aerial coverage, HSG C)
 - Open Space/Grass Cover = 84 (Fair condition, 50%-75% aerial coverage, HSG D)
 - Woods/Grass Combination = 79 (Good condition, HSG D)
 - Brush = 77 (Fair condition, HSG D)
 - Impervious Areas = 98 (used for wetland areas, HSG D)
6. The time of concentration (T_c) used for the analyses is conservatively assumed to be 0.1 hour (6 minutes) for sensitivity analysis purposes (actual T_c may be longer).
7. The 25-year, 24-hour design storm rainfall depth is 6.01 inches (Reference 9).

Calculation Sheet

CALCULATIONS

The estimated stormwater runoff volumes and estimated peak runoff rates were determined using HydroCAD version 10.0 computer software (Reference 10). HydroCAD is an integrated program for hydrologic analysis and the design of drainage systems using standard hydrograph techniques. Runoff hydrographs were developed by HydroCAD using the SCS Unit Hydrograph procedure.

The pre-construction and post-construction watershed area characteristics used for the analyses are summarized below in Table 1.

Table 1 – Watershed Area Characteristics

Watershed ID	Condition	Watershed Area ¹ (acres)	Time of Concentration ² (minutes)	Composite Curve Number ³
Area #1	Pre-Construction	11.4	6.0	79
	Post-Construction			77
Area #2	Pre-Construction	23.8	6.0	84
	Post-Construction			81

Notes:

1. The Watershed Areas are shown on the attached Watershed Area Map.
2. The Time of Concentration was defined based on Assumption 6.
3. The Composite Curve Number for each watershed area is determined by HydroCAD based on surface cover type and the conditions described in Assumption 5.

The estimate stormwater runoff volumes and estimated peak runoff rates associated with the 25-year, 24-hour design storm event for pre-construction and post-construction conditions are summarized below in Table 2.

Table 2 – Summary of Pre-Construction and Post-Construction Hydrologic Analyses

Watershed ID	Condition	Estimated Stormwater Runoff Volume ¹ (acre-ft.)	Change Between Pre- and Post-Construction Conditions ³ (%)	Estimated Peak Runoff Rate ² (cfs)	Change Between Pre- and Post-Construction Conditions ³ (%)
Area #1	Pre-Construction	3.3	-6.1%	71.3	-4.9%
	Post-Construction	3.1		67.8	
Area #2	Pre-Construction	7.8	-7.7%	166.0	-6.1%
	Post-Construction	7.2		155.9	

Notes:

1. The Estimated Stormwater Runoff Volume is based on a minimum Tc of 6.0 minutes (Assumption 6). Actual Tc may be longer.
2. The Estimated Peak Runoff Rate is based on a minimum Tc of 6.0 minutes (Assumption 6). Actual Tc may be longer.
3. The Change Between Pre- and Post- Construction is calculated by subtracting the post-construction estimated volume/rate from the pre-construction estimated volume/rate, dividing the result by the pre-construction estimated volume/rate and multiplying the result by 100. (For example, $3.3 - 3.1 = 0.2$ divided by $3.3 = 0.061 \times 100 = 6.1\%$). A negative change represents a decrease in the estimated volume/rate from pre-construction to post-construction conditions.

Calculation Sheet

Supporting output from Reference 10 is provided in Attachment 5.

SUMMARY:

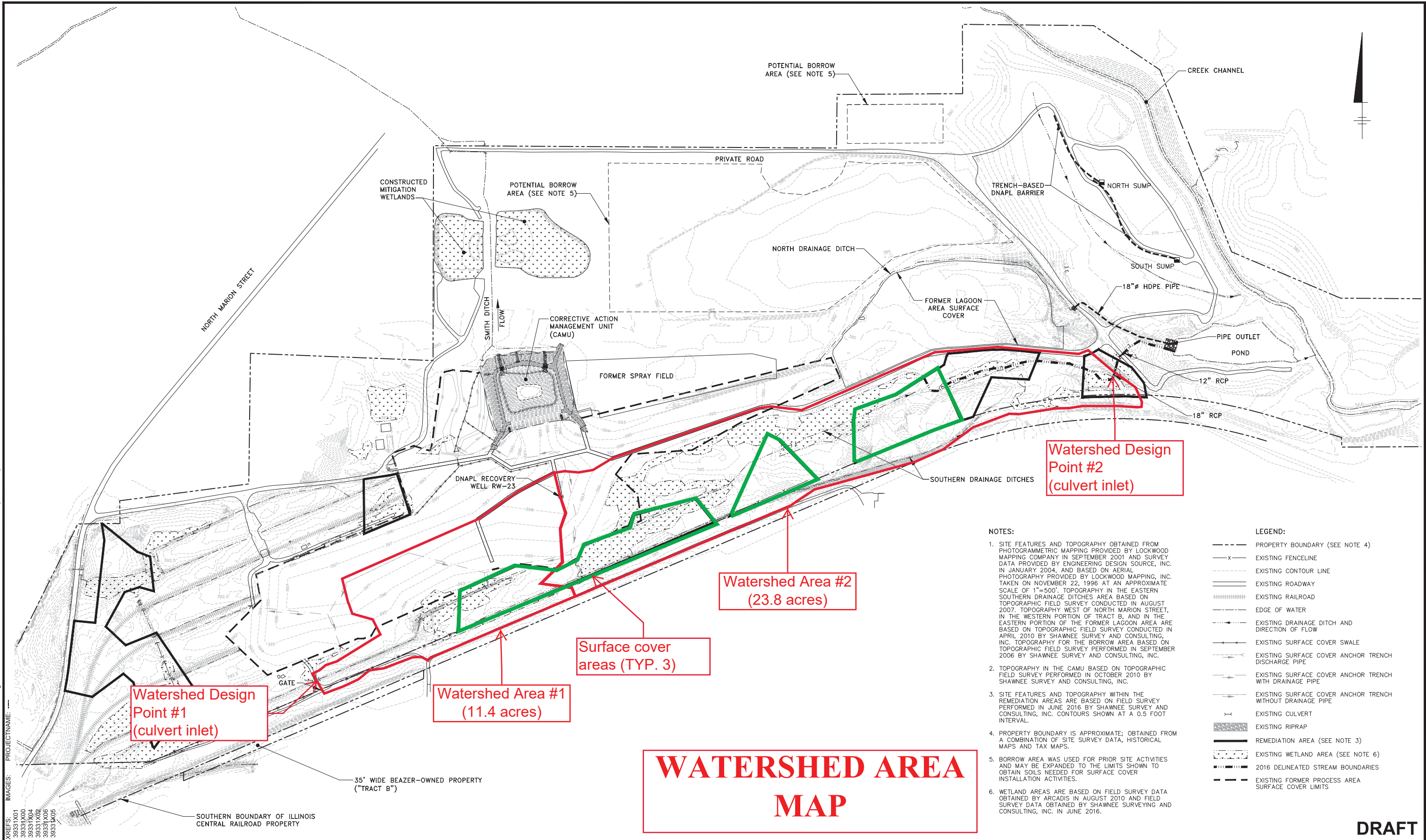
The results of this hydrologic analyses show that the estimated stormwater runoff volumes and estimated peak runoff rates resulting from the 25-year, 24-hour storm event decrease slightly from pre-construction to post-construction conditions.

ATTACHMENT 1

Watershed Area Map



CITY: MINNEAPOLIS, MN DIV: GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC: PM: TM: LYRON+OFF=REF* G:\ENV\CAD\Minneapolis\MINNEAPOLIS\DIV\GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC: PM: TM: LYRON+OFF=REF* PLOTTED: 9/18/2017 4:58 PM BY: OBERLANDER, ROSEANNE



NOTES:

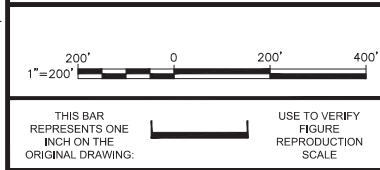
1. SITE FEATURES AND TOPOGRAPHY OBTAINED FROM PHOTOGRAMMETRIC MAPPING PROVIDED BY LOCKWOOD MAPPING COMPANY IN SEPTEMBER 2001 AND SURVEY DATA PROVIDED BY ENGINEERING DESIGN SOURCE, INC. IN JANUARY 2004, AND BASED ON AERIAL PHOTOGRAPHY PROVIDED BY LOCKWOOD MAPPING, INC. TAKEN ON NOVEMBER 22, 1996 AT AN APPROXIMATE SCALE OF 1"=500'. TOPOGRAPHY IN THE EASTERN SOUTHERN DRAINAGE DITCHES AREA BASED ON TOPOGRAPHIC FIELD SURVEY CONDUCTED IN AUGUST 2007. TOPOGRAPHY WEST OF NORTH MARION STREET, IN THE WESTERN PORTION OF TRACT B, AND IN THE EASTERN PORTION OF THE FORMER LAGOON AREA ARE BASED ON TOPOGRAPHIC FIELD SURVEY CONDUCTED IN APRIL 2010 BY SHAWNEE SURVEY AND CONSULTING, INC. TOPOGRAPHY FOR THE BORROW AREA BASED ON TOPOGRAPHIC FIELD SURVEY PERFORMED IN SEPTEMBER 2006 BY SHAWNEE SURVEY AND CONSULTING, INC.
2. TOPOGRAPHY IN THE CAMU BASED ON TOPOGRAPHIC FIELD SURVEY PERFORMED IN OCTOBER 2010 BY SHAWNEE SURVEY AND CONSULTING, INC.
3. SITE FEATURES AND TOPOGRAPHY WITHIN THE REMEDIATION AREAS ARE BASED ON FIELD SURVEY PERFORMED IN JUNE 2016 BY SHAWNEE SURVEY AND CONSULTING, INC. CONTOURS SHOWN AT A 0.5 FOOT INTERVAL.
4. PROPERTY BOUNDARY IS APPROXIMATE; OBTAINED FROM A COMBINATION OF SITE SURVEY DATA, HISTORICAL MAPS AND TAX MAPS.
5. BORROW AREA WAS USED FOR PRIOR SITE ACTIVITIES AND MAY BE EXPANDED TO THE LIMITS SHOWN TO OBTAIN SOILS NEEDED FOR SURFACE COVER INSTALLATION ACTIVITIES.
6. WETLAND AREAS ARE BASED ON FIELD SURVEY DATA OBTAINED BY ARCADIS IN AUGUST 2010 AND FIELD SURVEY DATA OBTAINED BY SHAWNEE SURVEYING AND CONSULTING, INC. IN JUNE 2016.

LEGEND:

- PROPERTY BOUNDARY (SEE NOTE 4)
- x- EXISTING FENCELINE
- - - EXISTING CONTOUR LINE
- == EXISTING ROADWAY
- ===== EXISTING RAILROAD
- - - - - EDGE OF WATER
- - - - - EXISTING DRAINAGE DITCH AND DIRECTION OF FLOW
- - - - - EXISTING SURFACE COVER SWALE
- - - - - EXISTING SURFACE COVER ANCHOR TRENCH DISCHARGE PIPE
- - - - - EXISTING SURFACE COVER ANCHOR TRENCH WITH DRAINAGE PIPE
- - - - - EXISTING SURFACE COVER ANCHOR TRENCH WITHOUT DRAINAGE PIPE
- x- EXISTING CULVERT
- ===== EXISTING RIPRAP
- REMEDIATION AREA (SEE NOTE 3)
- - - - - EXISTING WETLAND AREA (SEE NOTE 6)
- - - - - 2016 DELINEATED STREAM BOUNDARIES
- - - - - EXISTING FORMER PROCESS AREA SURFACE COVER LIMITS

WATERSHED AREA MAP

DRAFT



No.	Date	Revisions	By	Ckd

Professional Engineer's Name MARK GRAVELDING		
Professional Engineer's No. 062059378		
State ILLINOIS	Date Signed	Project Mgr. DGB
Designed by RLJ	Drawn by RMO	Checked by PHB



Design & Consultancy
for natural and built assets

ARCADIS U.S., INC.

FORMER KOPPERS WOOD-TREATING SITE • CARBONDALE, ILLINOIS
FORMER PROCESS AREA REMEDIAL DESIGN

EXISTING SITE PLAN

ARCADIS Project No. 80039331.0000.00001
Date SEPTEMBER 2017
ARCADIS 110 WEST FAYETTE STREET SUITE 300 SYRACUSE, NY 13202 TEL. 315.446.9120

ATTACHMENT 2

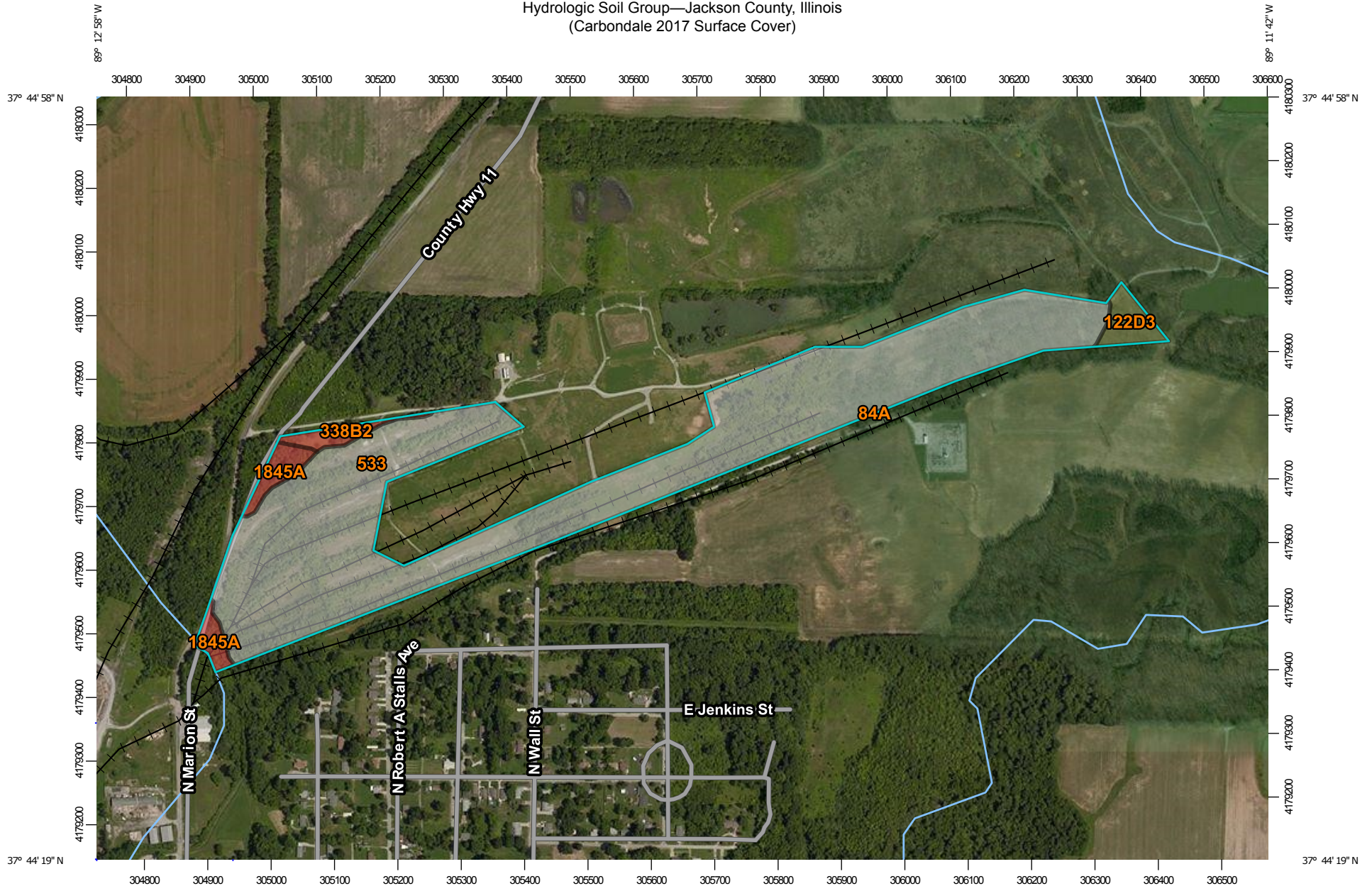
Natural Resources Conservation Service

Web Soil Survey Information

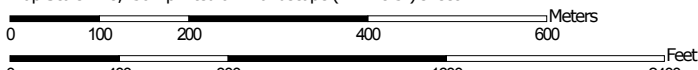
(select pages)



Hydrologic Soil Group—Jackson County, Illinois (Carbondale 2017 Surface Cover)



Map Scale: 1:8,450 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

9/12/2017
Page 1 of 4

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Illinois
 Survey Area Data: Version 16, Sep 16, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 13, 2011—Mar 14, 2017

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Jackson County, Illinois (IL077)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
84A	Okaw silt loam, 0 to 2 percent slopes	D	0.0	0.0%
122D3	Colp silty clay loam, 10 to 18 percent slopes, severely eroded	C/D	1.4	2.8%
338B2	Hurst silt loam, 2 to 5 percent slopes, eroded	D	1.0	1.9%
533	Urban land		46.2	91.5%
1845A	Darwin and Jacob silty clays, undrained, 0 to 2 percent slopes, frequently flooded	D	1.9	3.7%
Totals for Area of Interest			50.5	100.0%

Description

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 assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

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 the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

ATTACHMENT 3

Natural Resources Conservation Service

Urban Hydrology for Small Watersheds Technical Release 55

(select pages)



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
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ^{3/} :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm 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
<i>Developing urban areas</i>					
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	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 4

NOAA Website Atlas 14 Point Precipitation Frequency Estimates





NOAA Atlas 14, Volume 2, Version 3
Location name: Carbondale, Illinois, USA*
Latitude: 37.7431°, Longitude: -89.2122°
Elevation: 391.14 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.424 (0.387 0.464)	0.503 (0.459 0.551)	0.596 (0.543 0.652)	0.668 (0.607 0.730)	0.762 (0.690 0.831)	0.836 (0.754 0.911)	0.908 (0.815 0.990)	0.984 (0.878 1.07)	1.09 (0.965 1.19)	1.17 (1.03 1.27)
10-min	0.660 (0.601 0.722)	0.785 (0.717 0.860)	0.926 (0.844 1.01)	1.03 (0.937 1.13)	1.17 (1.06 1.27)	1.27 (1.14 1.38)	1.37 (1.23 1.49)	1.47 (1.31 1.60)	1.60 (1.42 1.74)	1.70 (1.50 1.85)
15-min	0.808 (0.737 0.885)	0.960 (0.876 1.05)	1.14 (1.04 1.25)	1.27 (1.15 1.39)	1.44 (1.30 1.57)	1.57 (1.42 1.71)	1.70 (1.52 1.85)	1.83 (1.63 1.99)	2.00 (1.77 2.17)	2.12 (1.87 2.31)
30-min	1.07 (0.975 1.17)	1.29 (1.17 1.41)	1.56 (1.42 1.71)	1.76 (1.60 1.93)	2.03 (1.84 2.22)	2.24 (2.02 2.44)	2.45 (2.20 2.67)	2.67 (2.38 2.90)	2.96 (2.62 3.22)	3.18 (2.80 3.47)
60-min	1.31 (1.19 1.43)	1.58 (1.44 1.73)	1.95 (1.78 2.14)	2.24 (2.04 2.45)	2.64 (2.39 2.88)	2.95 (2.67 3.22)	3.28 (2.94 3.57)	3.62 (3.23 3.94)	4.09 (3.63 4.46)	4.47 (3.94 4.87)
2-hr	1.58 (1.43 1.74)	1.90 (1.73 2.10)	2.36 (2.15 2.60)	2.73 (2.48 3.00)	3.24 (2.92 3.56)	3.65 (3.28 4.00)	4.08 (3.66 4.47)	4.53 (4.04 4.97)	5.18 (4.58 5.67)	5.70 (5.01 6.25)
3-hr	1.71 (1.55 1.89)	2.06 (1.88 2.28)	2.56 (2.33 2.83)	2.97 (2.69 3.27)	3.54 (3.20 3.89)	4.01 (3.61 4.41)	4.51 (4.03 4.95)	5.05 (4.49 5.53)	5.81 (5.13 6.36)	6.44 (5.64 7.05)
6-hr	2.07 (1.90 2.29)	2.50 (2.29 2.76)	3.10 (2.83 3.43)	3.59 (3.27 3.96)	4.28 (3.88 4.71)	4.85 (4.38 5.33)	5.46 (4.90 5.99)	6.11 (5.45 6.70)	7.05 (6.23 7.72)	7.82 (6.86 8.57)
12-hr	2.48 (2.26 2.75)	2.99 (2.72 3.31)	3.69 (3.36 4.09)	4.26 (3.86 4.71)	5.05 (4.56 5.58)	5.71 (5.13 6.29)	6.40 (5.72 7.05)	7.14 (6.34 7.86)	8.19 (7.21 9.01)	9.05 (7.92 9.97)
24-hr	2.95 (2.75 3.18)	3.55 (3.31 3.83)	4.41 (4.10 4.74)	5.08 (4.72 5.48)	6.01 (5.58 6.47)	6.77 (6.25 7.28)	7.55 (6.94 8.12)	8.37 (7.65 9.00)	9.49 (8.61 10.2)	10.4 (9.36 11.2)
2-day	3.43 (3.19 3.70)	4.12 (3.84 4.44)	5.11 (4.76 5.50)	5.91 (5.48 6.36)	7.02 (6.49 7.56)	7.94 (7.32 8.54)	8.89 (8.15 9.57)	9.90 (9.02 10.7)	11.3 (10.2 12.2)	12.5 (11.2 13.5)
3-day	3.64 (3.40 3.91)	4.37 (4.09 4.69)	5.40 (5.05 5.80)	6.24 (5.81 6.69)	7.42 (6.88 7.95)	8.39 (7.74 8.99)	9.40 (8.64 10.1)	10.5 (9.56 11.3)	12.0 (10.8 12.9)	13.2 (11.9 14.3)
4-day	3.86 (3.61 4.12)	4.62 (4.33 4.93)	5.70 (5.34 6.09)	6.58 (6.14 7.03)	7.82 (7.26 8.35)	8.84 (8.17 9.45)	9.91 (9.12 10.6)	11.1 (10.1 11.9)	12.7 (11.5 13.6)	14.0 (12.5 15.1)
7-day	4.46 (4.19 4.75)	5.34 (5.02 5.69)	6.57 (6.17 7.00)	7.56 (7.09 8.05)	8.95 (8.36 9.53)	10.1 (9.38 10.7)	11.3 (10.4 12.0)	12.5 (11.5 13.4)	14.3 (13.0 15.4)	15.8 (14.2 17.0)
10-day	5.01 (4.71 5.33)	6.00 (5.64 6.39)	7.36 (6.92 7.84)	8.44 (7.93 8.99)	9.96 (9.31 10.6)	11.2 (10.4 11.9)	12.5 (11.6 13.3)	13.8 (12.7 14.8)	15.7 (14.3 16.9)	17.2 (15.6 18.5)
20-day	6.84 (6.49 7.24)	8.13 (7.70 8.61)	9.73 (9.21 10.3)	11.0 (10.4 11.6)	12.7 (11.9 13.4)	14.0 (13.1 14.8)	15.3 (14.3 16.2)	16.6 (15.5 17.6)	18.4 (17.0 19.6)	19.8 (18.2 21.1)
30-day	8.44 (8.01 8.90)	9.98 (9.49 10.5)	11.8 (11.2 12.4)	13.2 (12.5 13.9)	15.1 (14.2 15.9)	16.5 (15.6 17.4)	18.0 (16.9 19.0)	19.4 (18.1 20.5)	21.3 (19.7 22.6)	22.7 (21.0 24.2)
45-day	10.6 (10.1 11.1)	12.5 (11.9 13.2)	14.6 (13.9 15.4)	16.2 (15.4 17.1)	18.4 (17.4 19.3)	20.0 (18.9 21.1)	21.6 (20.4 22.8)	23.2 (21.8 24.5)	25.3 (23.6 26.8)	26.8 (24.9 28.5)
60-day	12.5 (11.9 13.2)	14.7 (14.0 15.5)	17.2 (16.3 18.1)	19.0 (18.0 20.0)	21.5 (20.3 22.6)	23.3 (22.0 24.5)	25.1 (23.6 26.4)	26.8 (25.1 28.3)	29.0 (27.1 30.8)	30.7 (28.5 32.6)

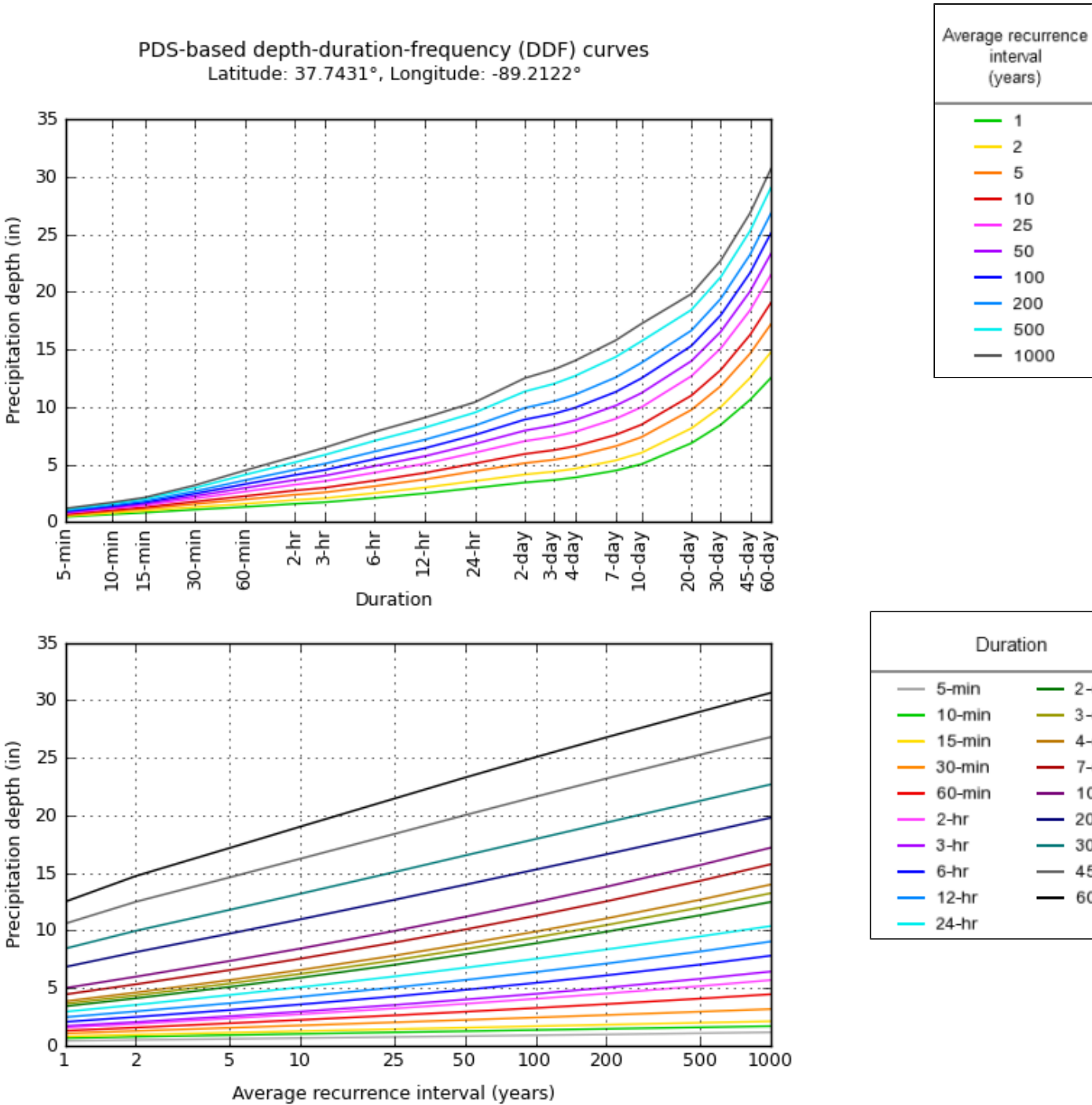
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not

checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical



[Back to Top](#)

Maps & aerials

Small scale terrain

ATTACHMENT 5

HydroCAD Output



Carbondale 2017 Surface Cover

Type II 24-hr 25-year Rainfall=6.01"

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net

Printed 9/22/2017

HydroCAD® 10.00-20 Sampler s/n S26870 © 2017 HydroCAD Software Solutions LLC

Page 1

This report was prepared with the free HydroCAD SAMPLER, which is licensed for evaluation and educational use ONLY. For actual design or modeling applications you MUST use a full version of HydroCAD which may be purchased at www.hydrocad.net. Full programs also include complete technical support, training materials, and additional features which are essential for actual design work.

Summary for Subcatchment 1S: Pre-Construction Watershed Area #1

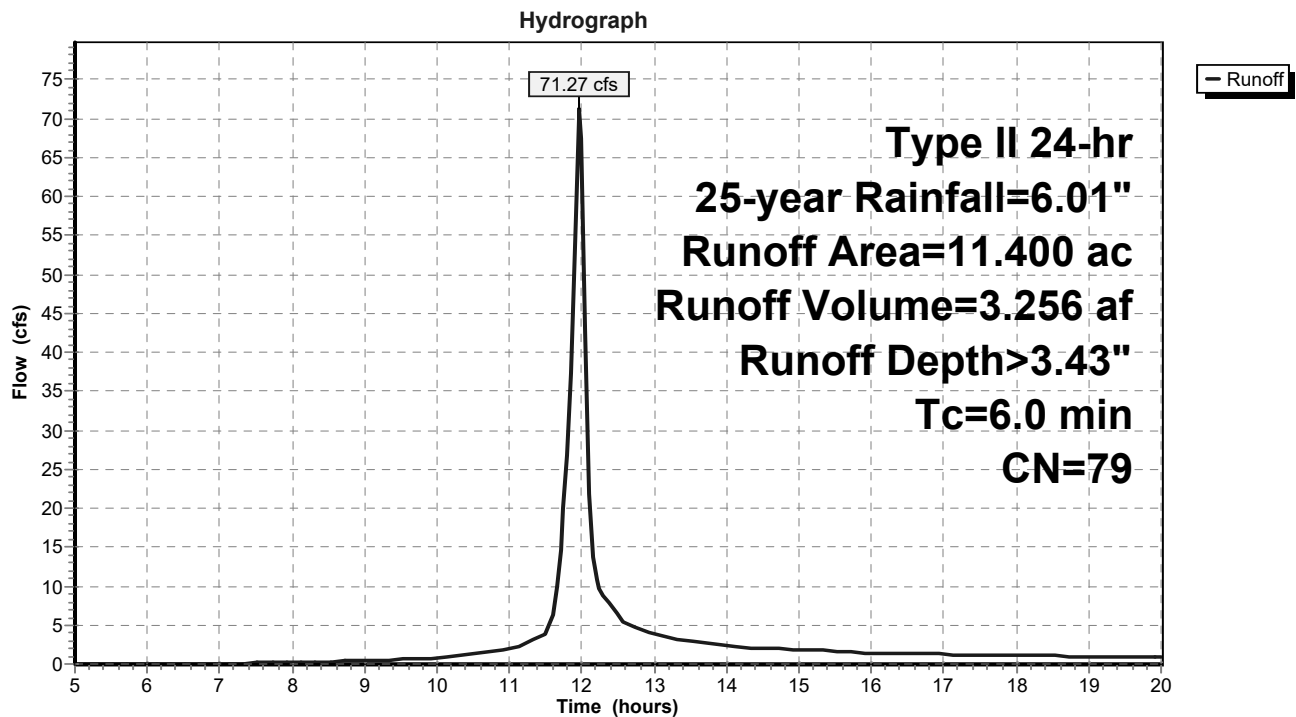
Runoff = 71.27 cfs @ 11.97 hrs, Volume= 3.256 af, Depth> 3.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.01"

Area (ac)	CN	Description
6.200	74	>75% Grass cover, Good, HSG C
0.200	89	Gravel roads, HSG C
2.600	79	Woods/grass comb., Good, HSG D
1.300	84	50-75% Grass cover, Fair, HSG D
1.100	98	Water Surface, 0% imp, HSG D
11.400	79	Weighted Average
11.400		100.00% Pervious Area

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

Subcatchment 1S: Pre-Construction Watershed Area #1



Carbondale 2017 Surface Cover

Type II 24-hr 25-year Rainfall=6.01"

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net

Printed 9/22/2017

HydroCAD® 10.00-20 Sampler s/n S26870 © 2017 HydroCAD Software Solutions LLC

Page 2

This report was prepared with the free HydroCAD SAMPLER, which is licensed for evaluation and educational use ONLY. For actual design or modeling applications you MUST use a full version of HydroCAD which may be purchased at www.hydrocad.net. Full programs also include complete technical support, training materials, and additional features which are essential for actual design work.

Summary for Subcatchment 2S: Pre-Construction Watershed Area #2

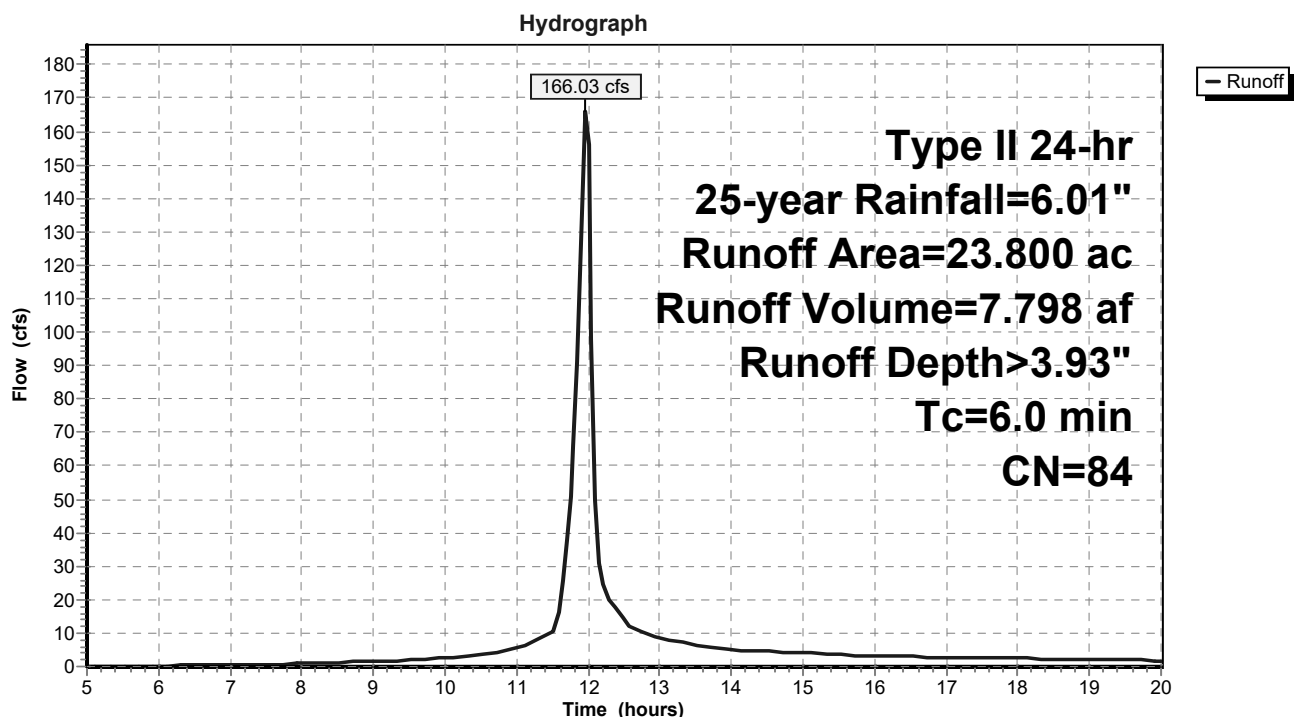
Runoff = 166.03 cfs @ 11.97 hrs, Volume= 7.798 af, Depth> 3.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.01"

Area (ac)	CN	Description
2.500	74	>75% Grass cover, Good, HSG C
0.700	84	50-75% Grass cover, Fair, HSG D
0.700	77	Brush, Fair, HSG D
0.600	89	Gravel roads, HSG C
13.300	79	Woods/grass comb., Good, HSG D
6.000	98	Water Surface, 0% imp, HSG D
23.800	84	Weighted Average
23.800		100.00% Pervious Area

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

Subcatchment 2S: Pre-Construction Watershed Area #2



Carbondale 2017 Surface Cover

Type II 24-hr 25-year Rainfall=6.01"

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net

Printed 9/22/2017

HydroCAD® 10.00-20 Sampler s/n S26870 © 2017 HydroCAD Software Solutions LLC

Page 3

This report was prepared with the free HydroCAD SAMPLER, which is licensed for evaluation and educational use ONLY. For actual design or modeling applications you MUST use a full version of HydroCAD which may be purchased at www.hydrocad.net. Full programs also include complete technical support, training materials, and additional features which are essential for actual design work.

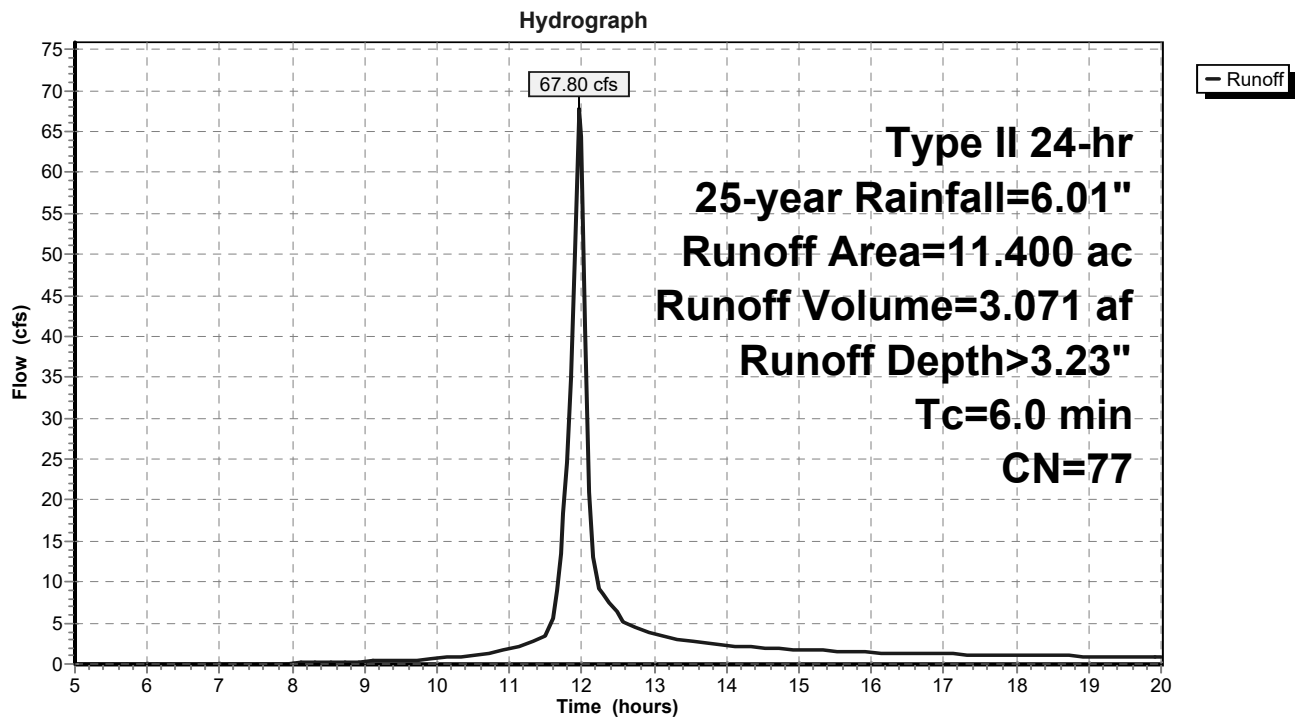
Summary for Subcatchment 5S: Post-Construction Watershed Area #1

Runoff = 67.80 cfs @ 11.97 hrs, Volume= 3.071 af, Depth> 3.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.01"

Area (ac)	CN	Description
7.900	74	>75% Grass cover, Good, HSG C
0.200	89	Gravel roads, HSG C
2.300	79	Woods/grass comb., Good, HSG D
0.300	84	50-75% Grass cover, Fair, HSG D
0.700	98	Water Surface, 0% imp, HSG D
11.400	77	Weighted Average
11.400		100.00% Pervious Area

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

Subcatchment 5S: Post-Construction Watershed Area #1

Carbondale 2017 Surface Cover

Type II 24-hr 25-year Rainfall=6.01"

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net

Printed 9/22/2017

HydroCAD® 10.00-20 Sampler s/n S26870 © 2017 HydroCAD Software Solutions LLC

Page 4

This report was prepared with the free HydroCAD SAMPLER, which is licensed for evaluation and educational use ONLY. For actual design or modeling applications you MUST use a full version of HydroCAD which may be purchased at www.hydrocad.net. Full programs also include complete technical support, training materials, and additional features which are essential for actual design work.

Summary for Subcatchment 6S: Post-Construction Watershed Area #2

Runoff = 155.86 cfs @ 11.97 hrs, Volume= 7.192 af, Depth> 3.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.01"

Area (ac)	CN	Description
8.700	74	>75% Grass cover, Good, HSG C
0.400	84	50-75% Grass cover, Fair, HSG D
0.600	77	Brush, Fair, HSG D
0.600	89	Gravel roads, HSG C
9.200	79	Woods/grass comb., Good, HSG D
4.300	98	Water Surface, 0% imp, HSG D
23.800	81	Weighted Average
23.800		100.00% Pervious Area

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

Subcatchment 6S: Post-Construction Watershed Area #2

