Westwood

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June 24, 2020

County of San Diego
Planning & Development Services
5510 Overland Ave. Suite 110
San Diego, CA 92123

Re: Valley Center Storage Project – Drainage Study Certification
File: R0026751.00

Dear San Diego County:

This letter is provided to certify that the Valley Center Storage Project Drainage Study and SWQMP meet the County CEQA requirements per the design standards of the San Diego County Hydrology Manual dated June 2003 and County of San Diego BMP Design Manual effective January 1, 2019. Both the Drainage Study and SWQMP were provided as part of the latest project submittal.

The Drainage Study provides the calculations and summary of the drainage design and shows that the NRCS Hydrologic Method (Curve Number Method) provides conservative basin sizing volume when compared to the flow rates and volume that would be permitted by the Modified Rational Method, which has a higher allowable discharge rate. Based on this, it is the professional opinion of the engineer-of-record that the curve number method provides valid and conservative results for the design flow rates and volumes.

Please contact me if you have any questions.

Sincerely,

WESTWOOD PROFESSIONAL SERVICES

Christopher J. Carda
Director, Civil Engineering
California PE License No C75322
(Expires December 31, 2021)

REGISTERED PROFESSIONAL ENGINEER
CHRISTOPHER J. CARDA
C75322
EXP. 12-31-21
CIVIL
STATE OF CALIFORNIA

County of San Diego

Stormwater Quality Management Plan (SWQMP) For Priority Development Projects (PDPs)

Use for all PDPs (see Storm Water Intake Form, Part 4)

Priority Development Project

Project Information	
Project Name	Valley Center Storage Project
Project Address	29523 Valley Center Road, Valley Center, CA 92082
Assessor's Parcel # (APN)	189-013-20-00
Permit # / Record ID	Permit #/Record ID

Project Applicant / Project Proponent		
Name	Valley Center ESS, LLC	
Address	11455 El Camino Real, Suite 160, San Diego, CA 92130	
Phone	916-835-7459	**Email:** MTurner@terra-gen.com

SWQMP Preparer		
Name	Chris Carda	
Company (if applicable)	Westwood Professional Services	
Address	12701 Whitewater Drive Suite 300, Minnetonka, MN 55343	
Phone	952-937-5150	**Email:** Chris.Carda@westwoodps.com
PE Number (if applicable)	75322	

Preparer's Certification

I understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the County of San Diego BMP Design Manual. The BMP Design Manual is a design manual for compliance with local County of San Diego Watershed Protection Ordinance (Sections 67.801 et seq.) and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2013-0001, as amended by Order No. R9-2015-0001 and Order No. R9-2015-0100) requirements for storm water management.

This SWQMP is intended to comply with applicable requirements of the BMP Design Manual. I certify that it has been completed to the best of my ability and accurately reflects the project being proposed and the applicable BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this SWQMP by County staff is confined to a review and does not relieve me as the person in charge of overseeing the selection and design of storm water BMPs for this project, of my responsibilities for project design.

Signature Christopher J. Carda **Date** June 22, 2019

COUNTY ACCEPTED

SWQMP Approved By: *Approval Date*:

** Note* **Approval does not constitute compliance with regulatory requirements.***

Submittal Record: List the dates of SWQMP and plan submittals and updates. Briefly describe key changes from previous versions. If responding to plan check comments, note this in the entry and attach the responses as applicable.

No.	Date	Summary of Changes
Preliminary Design / Planning / CEQA		
1	4/30/2020	Initial Submittal
2	6/5/2020	Changes based on Attachment A issue checklist
3	Date	Summary of Change
4	Date	Summary of Change
No.	Date	Summary of Change
Final Design		
1	Date	Initial Submittal
2	Date	Summary of Change
3	Date	Summary of Change
4	Date	Summary of Change
No.	Date	Summary of Change
Plan Changes		
1	Date	Initial Submittal
2	Date	Summary of Change
3	Date	Summary of Change
4	Date	Summary of Change
No.	Date	Summary of Change

PDP SWQMP Submittal Checklist

SWQMP Tables: All of the eight tables below must be completed.

SWQMP Attachments[1]: Use the checklist below to identify which attachments will be included with this submittal. Attachments with boxes already checked (☒) are required for all projects. The applicability of other attachments will be determined upon completing this form.

☒ Attachment 1: Storm Water Intake Form

☒ Attachment 2: DMA Exhibits and Construction Plan Sheets

☐ Attachment 3: Source Control BMP Worksheet

☐ Attachment 4: Previous SWQMP Submittals

☒ Attachment 5: Existing Site and Drainage Description

☐ Attachment 6: Documentation of DMAs without Structural BMPs

☒ Attachment 7: Documentation of DMAs with Structural Pollutant Control BMPs

☒ Attachment 8: Documentation of DMAs with Structural Hydromodification Management BMPs

☒ Attachment 9: Management of Critical Coarse Sediment Yield Areas

☒ Attachment 10: Installation Verification Form

☒ Attachment 11: BMP Maintenance Agreements and Plans

☐ Attachment 12: Documentation of Alternative Compliance Projects (ACPs)

After completing the remainder of this form, check the applicable SWQMP Attachment boxes to summarize your selections.

[1] All SWQMP attachments are available at www.sandiego.gov/stormwater under the Development Resources tab. Some attachments are presented out of order because they are shared between multiple SWQMP forms.

Table 1 – Scope of SWQMP Submittal

Select one option below that describes the scope of this SWQMP Submittal. Document your selection as indicated.	
SWQMP Scope	**Required Documentation**
☒ ***a. SWQMP addresses the entire project***	No additional documentation.
☐ ***b. SWQMP implements requirements of an earlier master SWQMP submittal***	Include a copy of the previous submittal as **Attachment 4**.
☐ ***c. First of multiple SWQMP submittals***	Use the spaces below to identify the elements addressed in this submittal and in future submittals.
(1) Elements addressed in current submittal (streets, common areas, first project phase, etc.):	
(2) Elements to be addressed in future submittal(s) (individual lots, future project phases, etc.):	

Table 2 – Baseline BMPs for Existing and Proposed Site Features

Site Features Select each feature that applies.	**BMP Implementation** Describe BMP implementation for each selected site feature.					
Group 1: Existing Natural Site Features [See BMPDM Sections 4.3.1 and 4.3.2]						
	Maintain & conserve natural features		**Establish buffers for waterbodies**			
	Full	Partial	Full	Partial		
☐ **Natural waterbodies**	☐	☐	☐	☒		
☒ **Natural storage reservoirs & drainage corridors**	☐	☒				
☒ **Natural areas, soils, & vegetation (incl. trees)**	☐	☒				
Group 2: Common Impervious Outdoor Site Features [See BMPDM Sections 4.3.3 and 4.3.5]						
	Disperse impervious areas (See SD-B)		**Use permeable materials (See SD-D)**		**Minimize impervious areas**	
	Full	Partial	Full	Partial	☒ Check here to confirm that impervious surfaces have been minimized where applicable and feasible for all outdoor impervious areas. If not, explain in Table 4.	
☒ **Streets and roads**	☐	☒	☐	☒		
☐ **Sidewalks & walkways**	☐	☐	☐	☐		
☐ **Parking areas & lots**	☐	☐	☐	☐		
☐ **Driveways**	☐	☒	☐	☒		
☐ **Patios, decks, & courtyards**	☐	☐	☐	☐		
☐ **Hardcourt recreation areas**	☐	☐	☐	☐		
☐ Add impervious feature	☐	☐	☐	☐		
☐ Add impervious feature	☐	☐	☐	☐		
☐ Add impervious feature	☐	☐	☐	☐		
Group 3: Other Outdoor Site Features [See BMPDM Sections 4.2.6, 4.3.4, 4.3.5, 4.3.7, and 4.3.8]						
☒ **Rooftop areas**	**Disperse rooftop runoff (See SD-B)**		**Install green roofs (optional; See SD-C)**		**Use rain barrels to capture runoff (optional; See SD-E)**	
	Full	Partial	Full	Partial	Full	Partial
	☐	☒	☐	☐	☐	☐
☐ **Landscaped areas**	**Use water-efficient landscaping (required)**		**Install efficient irrigation systems (required)**		**Minimize erosion of slopes and surfaces (required)**	
	Full		Full		Full	
	☐		☐		☐	
☐ **Water features (pools, spas, etc.)**	**Provide a designated washing area**		**Drain feature to the sanitary sewer (if allowed)**		**Drain feature to a pervious area**	
	Full	Partial	Full	Partial	Full	Partial
	☐	☐	☐	☐	☐	☐

Note: Justification is required in Table 4 for any feature not selecting at least one BMP (either full or partial implementation). For Group 2 features this means not selecting either SD-B or SD-D. Additional justifications may be required on request by County staff. Also use Table 4 to describe sources or BMPs other than those listed.

Table 3 –Baseline BMPs for Pollutant-generating Sources (Group 4)

A. Requirements for Documentation Select either or both as applicable.	Completion of Part B is <u>not</u> required because: ☐ This is a Small Residential Project, OR ☐ None of these sources or features is proposed.	☐ ***Source Control BMP Requirements Worksheet E.1-1*** (SC in Appendix E of the BMP Design Manual) is included as **Attachment 3** (optional unless requested by County staff).

B. Sources and BMPs Select all proposed sources and features below. Then select the BMPs on the right to be implemented for each.	**Plumb to sanitary sewer**	**Drain feature to a pervious area**	**Provide containment for spills and discharges**	**Prevent contact with rainfall**	**Isolate flows from adjacent areas**	**Prevent wind dispersal**	**Label with stencils or signs**
<u>Common Source Areas</u>							
☒ **Trash & Refuse Storage**	☐	---	☐	☐	☒	☐	---
☒ **Materials & Equipment Storage**	☐	---	☐	☐	☒	☐	---
☒ **Loading & Unloading**	☐	---	☐	☐	☒	---	---
☒ **Fueling**	☐	---	☐	☐	☒	---	---
☐ **Maintenance & Repair**	☐	---	☐	☐	☐	---	---
☐ **Vehicle & Equipment Cleaning**	☐	---	☐	☐	☐	---	---
☐ **Food Preparation or Service**	☐	---	☐	☐	☐	---	---
<u>Distributed Features</u>							
☐ **Storm drain inlets & catch basins**	---	---	---	---	---	---	☐
☐ **Interior floor drains and sumps**	☐	---	---	---	---	---	---
☐ **Drain lines (air conditioning, etc.)**	☐	☐	☐	---	---	---	---
☐ **Fire test sprinkler discharges**	☐	☐	☐	---	---	---	---

Provide the following in Table 4: (1) justification of any source area or feature with NO BMPs selected, (2) justification of individual unselected BMPs *if requested by County staff*, and (3) identification of any proposed pollutant-generating sources and BMPs not listed here.

Note: Pollutant-generating sources and features may <u>not</u> discharge directly to the MS4. Discharging to any of the stormwater BMPs identified in Table 5 Part B is also discouraged. If doing so, however, the source or feature area must be included in applicable DCV calculations.

Table 4 – Explanations and Justifications for Table 2 and 3 Baseline BMPs

☐ **Check here if no explanations or justifications for Table 2 or 3 BMPs are required.**

- **Required Justifications**: If NO BMPs are selected for a source or feature, justify why all BMPs are either not applicable or are infeasible. For Group 2 features NO BMPs means not selecting either SD-B or SD-D.
- **If Requested**: Justify why individual BMPs will not be implemented or will only be partially implemented.
- **Additional Explanation**: Describe any proposed features and/or BMPs not listed in Tables 2 or 3.

BMP-Feature Combination		Explanation
Feature	1 Feature	No distributed features onsite, no food prep, no vehicle cleaning, no maintenance & repair.
BMP	Features	
Feature	Feature	Explanation
BMP	BMP	
Feature	Feature	Explanation
BMP	BMP	
Feature	Feature	Explanation
BMP	BMP	
Feature	Feature	Explanation
BMP	BMP	
Feature	Feature	Explanation
BMP	BMP	
Feature	Feature	Explanation
BMP	BMP	

Table 5: DMA Structural Compliance Strategies and Documentation

Part A – Selection and Application Structural Performance Standards

1. Selection of Standards (select one; see BMPDM Section 6.1)

☒ a. Pollutant control + hydromodification ☐ b. Pollutant control only (project is exempt from hydromodification requirements)

2. Application of Structural Performance Standards (select one; see BMPDM Section 1.7)

☒ **New Development Projects:** Standards apply to <u>all impervious surfaces</u>.

☐ **Redevelopment Projects:** Complete the calculations below. Select <u>the</u> applicable scenario based on the results.

a. Existing impervious area (ft^2)	b. Impervious area created / replaced (ft^2)	c. % Impervious created / replaced [(b/a)*100]
0	229,127	100%

☒ *Scenario 1: c is 50% or more*: Performance standards apply to all impervious surfaces (a + b).

☐ *Scenario 2: c is less than 50%*: Performance standards apply only to created or replaced impervious surfaces (b only).

Part B – Compliance Strategies and Required Attachments

1.*Complete and submit each of the applicable attachments on the right.*

Att. 1	Att. 2	Att. 3	Att. 4	Att. 5
Storm Water Intake Form	DMA Exhibits and Construction Plan Sheets	Source Control BMP Worksheet (see Table 3)	Previous SWQMP Submittals (see Table 1)	Existing Site and Drainage Description
☒	☒	☐	☐	☒

2. *Indicate each compliance strategy below that will be used for one or more DMAs on the site.*

	Att. 6	Att. 7	Att. 8	Att. 9	Att. 10	Att. 11	Att. 12
	DMAs without Structural BMPs	DMAs w/ Structural Pollutant Control BMPs	DMAs w/ Structural Hydromod. BMPs	Critical Coarse Sediment Yield Areas	Installation Verification Form	Maintenance Agreements/ Plans	Alternative Compliance Projects
☐Self-mitigating DMAs (BMPDM Section 5.2.1)	☐			☐			
☐De Minimis DMAs (BMPDM Section 5.2.2)	☐			☐			
☐Self-retaining DMAs (BMPDM Section 5.2.3)	☐			☐	☐		
<u>Structural BMPs (select all that apply)</u>							
☒Pollutant Control BMPs (BMPDM Section 5.4)		☒		☒	☒	☒	
☒Hydromodification BMPs (BMPDM Chapter 6)			☒	☒	☒	☒	
☐Alternative Compliance Project (BMPDM Section 1.8)				☐	☐	☐	☐

☒ **Please check this box after you complete this list. Corresponding attachments will be automatically selected on the right.**

- *Attachments 1, 2, and 5 are required for all projects.*

Table 6: Critical Coarse Sediment Yield Area (CCSYA) Requirements

○ Identify one applicable compliance pathway for the PDP below. ○ Document your selection in **Attachment 9**.
A. Hydromodification Management Exemption (BMPDM Sections 1.6 and 6.1)
☐ **PDP is Exempt from Hydromodification Management Requirements** Select if hydromodification management exemption was selected in Table 4 Part A.1.
B. Watershed Management Area (WMAA) Mapping (BMPDM Appendix H.1.1.2)
☐ **WMAA mapping demonstrates the following:** a. <5% of potential onsite CCYSAs will be impacted (built on or obstructed) b. All potential upstream offsite CCYSAs will be bypassed
C. Resource Protection Ordinance (RPO) Methods (BMPDM Appendix H.1.1.1)
☐ **RPO Scenario 1: PDP is subject to and in compliance with RPO requirements** a. Project requires one or more discretionary permits (RPO applicability is confirmed during discretionary review) b. Onsite AND upstream offsite CCSYAs will be avoided and/or bypassed ☐ **RPO Scenario 2: PDP is entirely exempt/not subject to RPO requirements**[2] a. Project does not require discretionary permits b. Project will bypass all upstream offsite CCSYAs (no requirements for onsite CCSYAs)
D. No Net Impact Analysis (BMPDM Appendix H.4)
☒ **Project demonstrates no net impact to receiving waters**

[2] Does not include PDPs utilizing exemption(s) via RPO Section 86.604(e)(2)(cc) or 86.604(e)(3).

Table 7 –Minimum Construction Stormwater BMPs

Minimum Required BMPs by Activity Type Select all applicable activities and at least one BMP for each	**References** **Caltrans[3]**	**County of San Diego**	
☒ **Erosion Control for Disturbed Slopes** (choose at least 1 per season)			
☒ Vegetation Stabilization Planting[4] (Summer)	SS-2, SS-4		
☒ Hydraulic Stabilization Hydroseeding[9] (Summer)	SS-4		
☐ Bonded Fiber Matrix or Stabilized Fiber Matrix[5] (Winter)	SS-3		
☐ Physical Stabilization Erosion Control Blanket[7] (Winter)	SS-7		
☒ **Erosion control for disturbed flat areas (slope < 5%)**			
☒ County Standard Lot Perimeter Protection Detail	SC-2	PDS 659[6]	
☐ Use of Item A erosion control measures on flat areas	SS-3, SS-4, SS-7		
☐ County Standard Desilting Basin (must treat all site runoff)	SC-2	PDS 660[7]	
☐ Mulch, straw, wood chips, soil application	SS-6, SS-8		
☒ **Energy dissipation (required to control velocity for concentrated runoff or dewatering discharge)**			
☒ Energy Dissipater Outlet Protection	SS-10	RSD D-40[8]	
☒ **Sediment control for all disturbed areas**			
☒ Silt Fence	SC-1		
☒ Fiber Rolls (Straw Wattles)	SC-5		
☐ Gravel & Sand Bags	SC-6, SC-8		
☐ Dewatering Filtration	NS-2		
☐ Storm Drain Inlet Protection	SC-10		
☐ Engineered Desilting Basin (sized for 10-year flow)	SC-2		
☒ **Preventing offsite tracking of sediment**			
☒ Stabilized Construction Entrance	TC-1		
☐ Construction Road Stabilization	TC-2		
☐ Entrance/Exit Tire Wash	TC-3		
☐ Entrance/Exit Inspection & Cleaning Facility	TC-1		
☐ Street Sweeping and Vacuuming	SC-7		
☒ **Materials Management**			
☒ Material Delivery & Storage	WM-1		
☐ Spill Prevention and Control	WM-4		
☒ **Waste Management[9]**			
☒ Waste Management Concrete Waste Management	WM-8		
☒ Solid Waste Management	WM-5		
☒ Sanitary Waste Management	WM-9		
☐ Hazardous Waste Management	WM-6		

[3] See Caltrans 2017 Storm Water Quality Handbooks, Construction Site BMP Manual, available at: (http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm)
[4] Planting or Hydroseeding may be installed between May 1st and August 15th. Slope irrigation must be in place and operable for slopes >3 feet. Vegetation must be watered and established prior to October 1st. A contingency physical BMP must be implemented by August 15th if vegetation is not established by that date. If landscaping is proposed, erosion control measures must also be used while landscaping is being established. Established vegetation must have a subsurface mat of intertwined mature roots with a uniform vegetative coverage of 70 percent of the natural vegetative coverage or more on all disturbed areas.
[5] All slopes over three feet must have established vegetative cover prior to final permit approval.
[6] County PDS 659. Standard Lot Perimeter Protection Design System (Bldg. Division)
[7] County PDS 660. County Standard Desilting Basin for Disturbed Areas of 1 Acre or Less Bldg. Division
[8] Regional Standard Drawing D-40 – Rip Rap Energy Dissipater (also acceptable for velocity reduction)
[9] Applicants are responsible to apply appropriate BMPs for specific wastes (e.g., BMP WM-8 for concrete).

Table 8 – Explanations and Justifications for Construction Phase BMPs

☒ **Check here if no explanations or justifications for Table 7 BMPs are required.**

Justifications for Table 7 Temporary Construction Phase BMPs

- **Required Justifications**: Justify all construction activity types for which NO BMPs were selected.
- **If Requested**: Justify why specific individual BMPs were not selected.
- **Additional Explanation**: Describe any proposed features and/or BMPs not listed in Table 7.

Activity Type / BMP		Explanation
Activity Type	Activity Type	Explanation
BMP	BMP	
Activity Type	Activity Type	Explanation
BMP	BMP	
Activity Type	Activity Type	Explanation
BMP	BMP	
Activity Type	Activity Type	Explanation
BMP	BMP	
Activity Type	Activity Type	Explanation
BMP	BMP	
Activity Type	Activity Type	Explanation
BMP	BMP	
Activity Type	Activity Type	Explanation
BMP	BMP	

This form establishes Stormwater Quality Management Plan (SWQMP) requirements for Development Projects per Sections 67.809 and 67.811 of the County of San Diego Watershed Protection Ordinance (WPO). See ***Storm Water Intake Form Instructions*** for additional guidance and explanation of terms.

Part 1. Project Information	
Project Name:	Valley Center Storage Project
Record ID (Permit) No(s):	PDS2020-IC-20-003
Assessor's Parcel No(s):	189-013-20-00
Street Address (or Intersection):	29523 Valley Center Road
City, State, Zip:	Valley Center, CA 92082

Part 2. Applicant / Project Proponent Information	
Name:	Valley Center ESS, LLC
Company:	Valley Center ESS, LLC
Street Address:	1455 El Camino Real Suite 160
City, State, Zip:	San Diego, CA 92130
Phone Number	916-835-7459
Email:	MTurner@terra-gen.com

Part 3. Required Information for All Development Projects

A	**1. Existing (pre-development) impervious surfaces (ft²)**	**2. Created or replaced impervious surfaces (ft²)**	**3. Total disturbed area (acres or ft²)**
	0	229,127	229,127

B		**WDID # (if issued)**
	☐ Check here and provide a WDID# if this project is subject to the California Construction General Permit (Order No. 2009-0009-DWQ)[1]	

For County Use Only	Reviewed By:	Review Date:
☐ Standard SWQMP	☐ PDP SWQMP	☐ Green Streets PDP Exemption SWQMP

[1] Available at: https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

Part 4. Priority Classification & SWQMP Form Selection

(A) *If your project is the following … (select one)*	(B) *You must complete …*
☐ **Standard Project** ☐ a. Project is East of the Pacific/Salton Sea Divide ☐ b. None of the PDP criteria below applies	➔ **Standard *SWQMP Form***
☐ **Priority Development Project (PDP)** ☐ 1. Project is part of an existing PDP**,** <u>OR</u> ☒ 2. Project does any of the following: ☒ a. Creates or replaces a total of 10,000 ft² or more of impervious surface ☐ b. Creates or replaces a combined total of 5,000 ft² or more of impervious surface within one or more of the following uses: (1) parking lots; (2) streets, roads, highways, freeways, and/or driveways; (3) restaurants; and (4) hillsides ☐ c. Creates or replaces a combined total of 5,000 ft² or more of impervious surface within one or more of the following uses: (1) automotive repair shops; and (2) retail gasoline outlets ☐ d. Discharges directly to an Environmentally Sensitive Area (ESA) AND creates or replaces 2,500 ft² or more of impervious surface ☐ e. Disturbs one or more acres of land (43,560 ft²) and is expected to generate pollutants post-construction ☐ f. Is a <u>redevelopment</u> project that creates or replaces 5,000 ft² or more of impervious surface on a site already having at least 10,000 ft² of impervious surface	➔ **PDP *SWQMP Form***
☐ **Green Streets PDP Exemption**[2]	➔ **Green *Streets PDP Exemption SWQMP Form***

Part 5. Applicant Signature

I have reviewed the information in this form, and it is true and correct to the best of my knowledge.

Applicant / Project Proponent Signature: Date:

- ***Upon completion*** *submit this form to the County.*
- ***If requested****, attach supporting documentation to justify selections made or exemptions claimed.*
- ***If this is a PDP that is part of a larger existing PDP****, you will be required to attach a copy of the existing SWQMP to the newer SWQMP submittal.*

[2] ***Green Streets PDP Exemption Projects*** are those claiming exemption from PDP classification per WPO Section 67.811(b)(2) because they consist exclusively of *either* 1) development of new sidewalks, bike lanes, and/or trails; *or* 2) improvements to existing roads, sidewalks, bike lanes, and/or trails.

2.0 General Requirements

- Attachment 2 consolidates exhibits and plans required for the entire project.
- Complete the table below to indicate which sub-attachments are included with the submittal. Sub-attachments that are not applicable can be excluded from the submittal.
- Unless otherwise stated, features and BMPs identified and described in each corresponding Attachment (6 through 9) must be shown on applicable DMA Exhibits and construction plans submitted for the project.

Sub-attachments	Requirement
☒ **2.1: DMA Exhibits**	All PDPs
☒ **2.2: Individual Structural BMP DMA Mapbook**	PDPs with structural BMPs
☒ **2.3: Construction Plan Sets**	All projects

2.1 DMA Exhibits

- DMA Exhibits must show all DMAs on the project site. Exhibits must include all applicable features identified in applicable SWQMP attachments.
- Exhibits may be prepared individually for the BMPs associated with each applicable SWQMP Attachment (6, 7, 8, and/or 9) or combined into one or more consolidated exhibits.
- Use this checklist to ensure required information is included on each exhibit (copy as needed).

DMA Exhibit ID #:	**1**	
A. Features required for all exhibits		
1. Existing Site Features		
☒ Underlying hydrologic soil group (A, B, C, D) ☒ Approximate depth to groundwater ☒ Natural hydrologic features	☒ Topography and impervious areas ☒ Existing drainage network, directions, and offsite connections	
2. Drainage Management Area (DMA) Information		
☒ Proposed drainage network, directions, and offsite connections	☒ DMA boundaries, ID numbers, areas, and type (structural BMP, de minimis, etc.)	
3. Proposed Site Changes, Features, and BMPs		
☒ Proposed demolition and grading ☒ Group 1, 2, and 3 Features[1] ☒ Group 4 Features	☒ Construction BMPs[2] ☒ Baseline source control BMPs ☒ Baseline source control BMPs	
B. Proposed Features and BMPs Specific to Individual SWQMP Attachments[3]		
☐ Attachment 6	☐ SSD-BMP impervious dispersion areas ☐ SSD-BMP tree wells	
☒ Attachment 7	☒ Structural pollutant control BMPs	
☒ Attachment 8	☒ Structural hydromodification management BMPs ☒ Point(s) of Compliance (POC) for hydromodification management ☒ Proposed drainage boundary and drainage area to each POC	
☒ Attachment 9	☐ Onsite CCSYAs	☐ Bypass of onsite CCSYAs ☒ Bypass of upstream offsite CCSYAs

[1] Group 1-4 features and baseline BMPs from PDP SWQMP Tables 2 and 3.
[2] Minimum Construction Stormwater BMPs from PDP SWQMP Table 7.
[3] Identify the location, ID numbers, type, and size/detail of BMPs.

2.2 Individual Structural BMP DMA Mapbook

- Use this page as a cover sheet for the Structural DMA Mapbook.
- An individual Structural DMA Mapbook must be submitted for any project site with one or more structural BMPs. One Mapbook is required for each unique subsequent owner with responsibility for maintenance of a Structural BMP. Mapbook exhibits will be incorporated as exhibits in Stormwater Maintenance Agreements (SWMAs) and Maintenance Notifications (MNs). See Attachment 11 for additional information on maintenance agreements. If the Mapbook has been provided for each subsequent owner in Attachment 11, they are not required here.
- Place each map on 8.5"x11" paper.
- Show at a minimum the DMA, Structural BMP, Assessor's parcel boundaries with parcel numbers, and any existing hydrologic features within the DMA.

☒	All Mapbooks are attached
☒	All Mapbooks are in Attachment 11

2.3 Construction Plan Sets

- DMAs, features, and BMPs identified and described in this attachment must also be shown on all applicable construction and landscape plans.
- As applicable, plan sheets must identify:
  - All features and BMPs identified in Sub-attachment 2.1 (DMA Exhibits).
  - The additional information listed below.
- Use this checklist to ensure required information is included on each plan (copy as needed).

Plan Type	**Grading Plan**
Required Information[4]	
☒ Structural BMP(s) and Significant Site Design BMPs (if applicable) with ID numbers. ☒ The grading and drainage design shown on the plans must be consistent with the delineation of DMAs shown on the DMA exhibit. ☒ Details and specifications for construction of Structural BMP(s) and Significant Site Design BMPs (if applicable). ☒ Signage indicating the location and boundary of structural BMP(s) as required by County staff. ☒ How to access the structural BMP(s) to inspect and perform maintenance. ☒ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds). ☒ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP). ☒ Recommended equipment to perform maintenance. ☒ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management. ☒ Include landscaping plan sheets (if available) showing vegetation requirements for vegetated structural BMP(s). ☒ All BMPs must be fully dimensioned on the plans. ☐ When proprietary BMPs are used, site-specific cross-section with outflow, inflow, and manufacturer model number must be provided. Photocopies of general brochures are not acceptable. ☒ Include all source control and site design measures described in the SWQMP. ☒ Include all construction BMPs described in the SWQMP.	

[4] For Building Permit Applications, refer to Form PDS 272, https://www.sandiegocounty.gov/content/dam/sdc/pds/docs/pds272.pdf

Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary
- County Boundary

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Westwood Professional Services, Inc.

Valley Center Storage Project

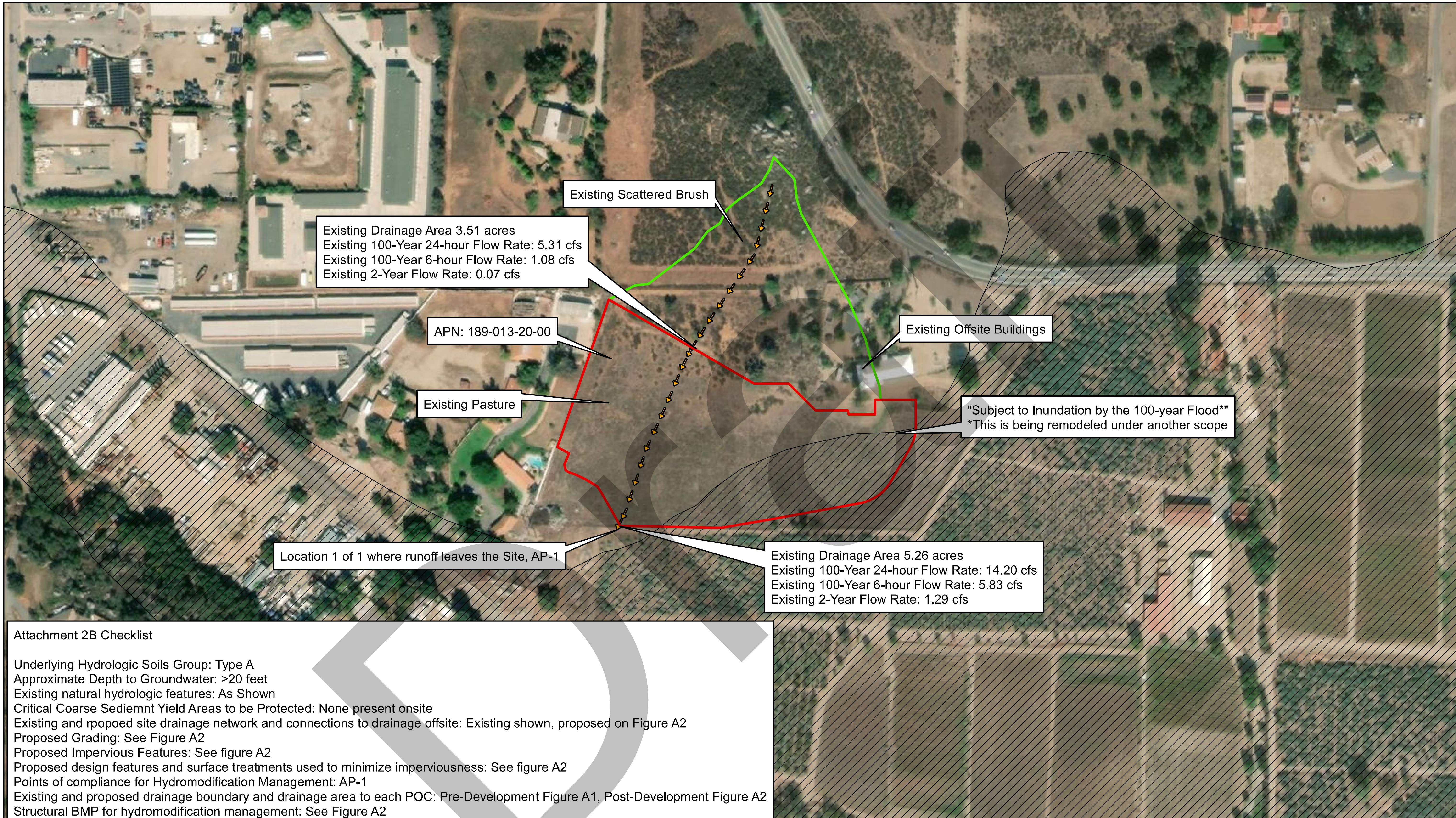
San Diego County, California

N

0 0.5 Miles

Exhibit 1: Location Map

April 28, 2020



Attachment 2B Checklist

Underlying Hydrologic Soils Group: Type A
Approximate Depth to Groundwater: >20 feet
Existing natural hydrologic features: As Shown
Critical Coarse Sediemnt Yield Areas to be Protected: None present onsite
Existing and rpopoed site drainage network and connections to drainage offsite: Existing shown, proposed on Figure A2
Proposed Grading: See Figure A2
Proposed Impervious Features: See figure A2
Proposed design features and surface treatments used to minimize imperviousness: See figure A2
Points of compliance for Hydromodification Management: AP-1
Existing and proposed drainage boundary and drainage area to each POC: Pre-Development Figure A1, Post-Development Figure A2
Structural BMP for hydromodification management: See Figure A2

Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary/Drainage Area Boundary
- Offsite Drainage Area
- County Boundary
- 1' Contours
- FEMA Zone A
- Existing Flow Path

N

Feet
0 200

Valley Center Storage Project

San Diego County, California

Figure A1

June 2, 2020

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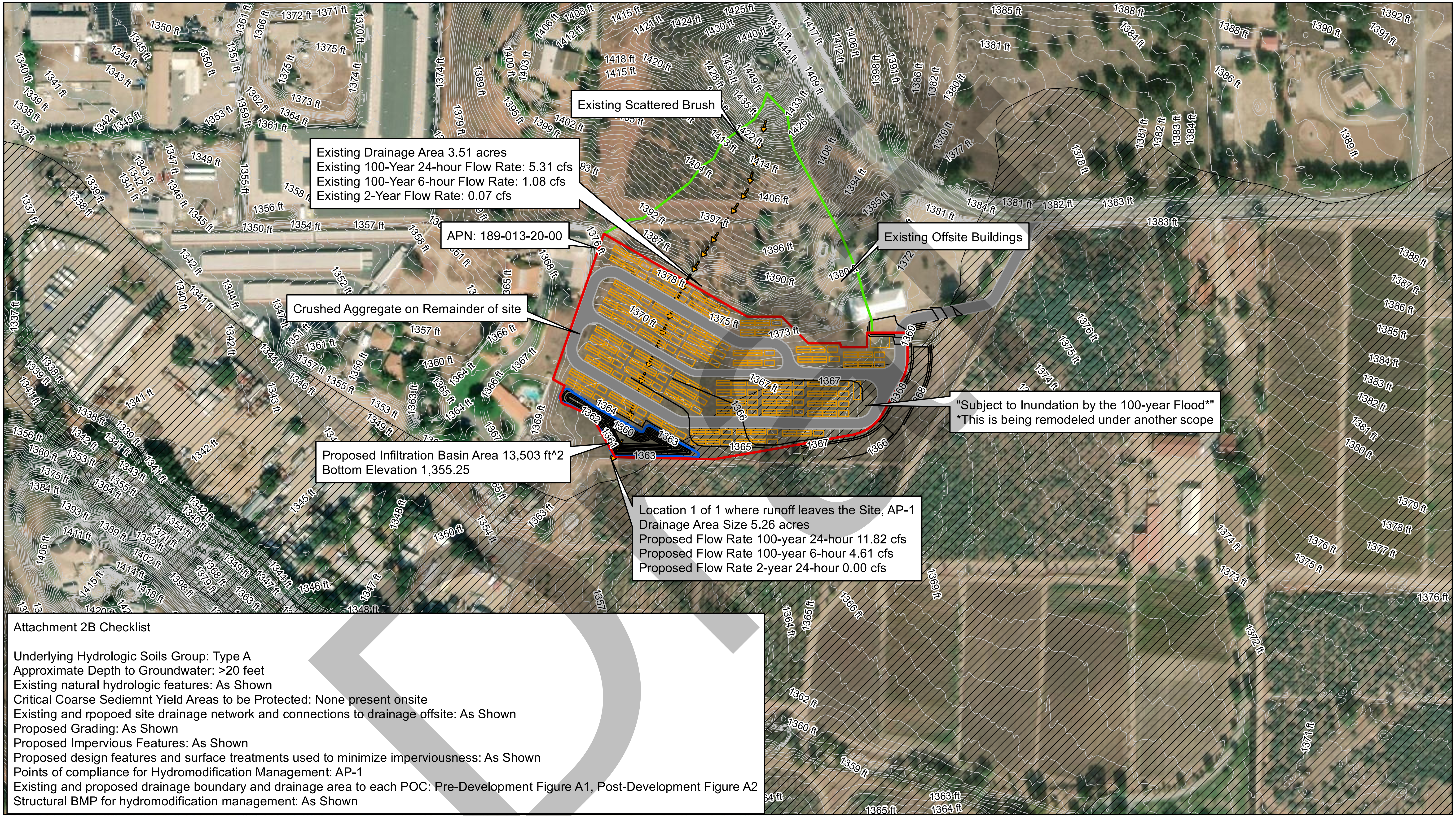
Map Document: N:\0026751.00\GIS\Hydro Exhibits\2020-04-27_ValleyCenter_FA1PreDevelopmentMap.mxd 6/2/2020 2:33:01 PM



Attachment 2B Checklist

Underlying Hydrologic Soils Group: Type A
Approximate Depth to Groundwater: >20 feet
Existing natural hydrologic features: As Shown
Critical Coarse Sediemnt Yield Areas to be Protected: None present onsite
Existing and rpopoed site drainage network and connections to drainage offsite: As Shown
Proposed Grading: As Shown
Proposed Impervious Features: As Shown
Proposed design features and surface treatments used to minimize imperviousness: As Shown
Points of compliance for Hydromodification Management: AP-1
Existing and proposed drainage boundary and drainage area to each POC: Pre-Development Figure A1, Post-Development Figure A2
Structural BMP for hydromodification management: As Shown

Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary
- County Boundary
- Offsite Drainage Area
- Proposed Infiltration Basin
- Proposed Energy Storage
- Proposed Access Road
- 1' Contours
- Proposed Grading
- Proposed Flow Path
- FEMA Zone A

N

0 200 Feet

Valley Center Storage Project

San Diego County, California

Figure A2

June 3, 2020

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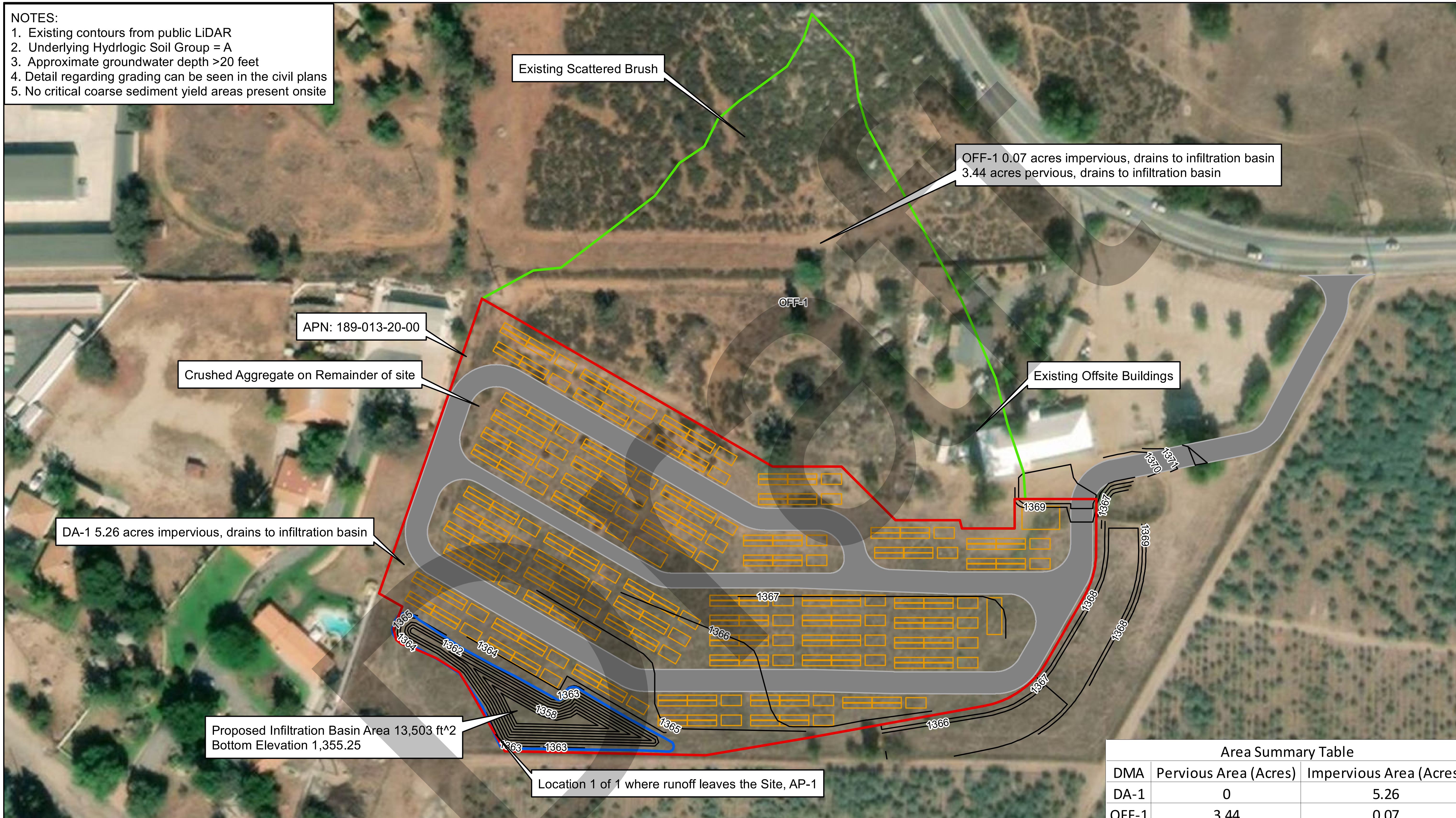
Westwood Professional Services, Inc.

Map Document: N:\0026751.00\GIS\Hydro Exhibits\2020-04-27_ValleyCenter_FA2PostDevelopmentMap.mxd 6/3/2020 7:24:04 AM

NOTES:
1. Existing contours from public LiDAR
2. Underlying Hydrlogic Soil Group = A
3. Approximate groundwater depth >20 feet
4. Detail regarding grading can be seen in the civil plans
5. No critical coarse sediment yield areas present onsite



Area Summary Table

DMA	Pervious Area (Acres)	Impervious Area (Acres)
DA-1	0	5.26
OFF-1	3.44	0.07

Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary/Onsite DMA Boundary
- County Boundary
- Offsite Drainage Area
- Proposed Infiltration Basin
- Proposed Energy Storage
- Proposed Access Road
- NWI Wetlands
- Existing 1' Contours
- Proposed Grading
- NHD Flowline

Valley Center Storage Project

San Diego County, California

DMA Exhibit

N

0 100 Feet

June 2, 2020

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5.0 General Requirements

- Each Priority Development Project (PDP) must provide a description of existing site conditions and proposed changes to them, including changes to topography and drainage.
- Has a **Drainage Report** has been prepared for the PDP?

☒ **Yes**

- Review of the Drainage Report must be concurrent with the PDP SWQMP.
- Include the summary page of the Drainage Report with this cover page, and provide the following information:

Title: CEQA Preliminary Drainage Study Valley Center Storage Project
Prepared By: Westwood Professional Services
Date: April 30, 2020

- Do not complete the rest of this attachment (also exclude these additional pages from your submittal). Additional documentation of site and drainage conditions is not required unless requested by County staff.

☐ **No** -- Complete and submit the remainder of this attachment below.

5.1 Description of Existing Site Condition

Provide the requested information below for the project site in its existing condition.

a. Current Site Status

Select all that apply to any portion of the site.

☐ Existing development
☐ Previously graded but not built out
☐ Agricultural or other non-impervious use
☐ Vacant, undeveloped/natural
☐ Demolition completed without new construction

b. Existing Land Cover

Provide the area (in acres or square feet) within all applicable categories of land cover below. The total area should equal that of the entire project site.

	Area *(acres or ft²)*
☐ Vegetative Cover	Click here to enter text.
☐ Non-Vegetated Pervious Areas	Click here to enter text.
☐ Impervious Areas	Click here to enter text.

c. Underlying Soil

Select all soil groups that are present on the site.

NRCS Hydrologic Soil Group(s)			
Type A	Type B	Type C	Type D
☐	☐	☐	☐

5.2 Description of Existing Site Drainage

Describe how storm water runoff is conveyed from the site. At a minimum, address the following:

- Is the existing drainage conveyance ☐ **natural** or ☐ **urban**?
- Is runoff from offsite conveyed through the site? ☐ **Yes** ☐ **No**
  If **yes**, quantify all offsite drainage areas, design flows, and locations where offsite flows enter the project site, and summarize how such flows are conveyed through the site.
- Describe the existing project site drainage conveyance network (including any existing storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels).
- Identify all discharge locations from the existing project site along with a summary of conveyance system size and capacity for each of the discharge locations. Summarize the pre-project drainage areas and design flows to each of the existing runoff discharge locations.
- Provide additional information as necessary or requested to describe the site drainage.

Description (add pages as necessary to provide all requested information).
Click here to enter text.

5.3 Description of Proposed Site Development

Provide a general description of the proposed site development, including at a minimum the information requested below. Add pages as necessary.

a. Project description/ Proposed land use and/or activities (project location, development type, size, numbers of units, etc.) Click here to enter text.
b. List/describe proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features). Click here to enter text.
c. List/describe proposed pervious features of the project (e.g., landscape areas): Click here to enter text.
d. Does the project include grading and changes to site topography? ☐ **Yes** ☐ **No** *If **yes**, describe below.* Click here to enter text.

5.4 Description of Proposed Site Drainage

A. Changes to Site Drainage -- Does the project include changes to site drainage (e.g., installation of new storm water conveyance systems)? ☐ **Yes** ☐ **No**

If **yes**:

- Describe (1) the proposed project site drainage conveyance network (including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels), and (2) the method for conveying offsite flows through or around the proposed project site.
- Identify all discharge locations from the proposed project site along with a summary of the conveyance system size and capacity for each of the discharge locations.
- Provide a summary of pre- and post-project drainage areas and design flows to each of the runoff discharge locations.

Description (add pages as necessary to provide all requested information).
Click here to enter text.

CEQA PRELIMINARY DRAINAGE STUDY

Valley Center Storage Project

San Diego County, California

JUNE, 2020

Valley Center ESS, LLC
11455 El Camino Real, Suite 160
San Diego, CA 92130

Westwood

CEQA Preliminary Drainage Study

Valley Center Storage Project

San Diego County, California

Prepared For:

Valley Center ESS, LLC
11455 El Camino Real, Suite 160
San Diego, CA 92130

Prepared By:

Westwood Professional Services
12701 Whitewater Drive, Suite 300
Minnetonka, MN 55343
(952) 937-5150

Project Number: R0026751.00
Date: June 22, 2020

Westwood

Declaration of Responsible Charge

I hereby declare that I am the engineer of work for this study. That I have exercised responsible charge over the work associated with this study as defined in section 6703 of the business and professions code, and that the design is consistent with current standards.

I understand that the check of this study by the county of San Diego is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

Chris Carda	P.E. 75322	Date 06/22/2020

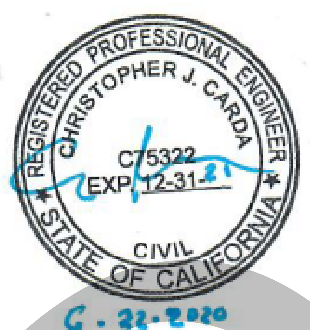
Signature Page for

Report on

CEQA Preliminary Drainage Study
Velley Center Storage Project
29523 Valley Center Road
Valley Center, CA 92082

Prepared For
Valley Center ESS, LLC
11455 El Camino Real, Suite 160
San Diego, CA 92130

Reviewed and Approved By:



Chris Carda, P.E.
Director, Civil Engineering
Westwood Professional Services

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Appendix D: Soils Information
Appendix E: Urban Hydrology for Small Watersheds
Appendix F: BMP Sizing Spreadsheets
Appendix G: Flood Study by Others

Executive Summary

This California Environmental Quality Act (CEQA) Preliminary Drainage Study has been prepared in support of CLIENT's proposed Valley Center Storage Project in Valley Center, California (site). The purpose of the project is to assist the local utility in meeting the California state energy storage mandate while providing local area capacity for electrical system reliability and flexibility. Westwood Professional Services prepared the report and performed the hydrology calculations. Westwood professional Services also prepared the site layout, grading drawings and sizing of the proposed infiltration basin.

The project site is proposed on approximately 5.3 acres and is bounded to the north by Valley Center Road. The site is located on moderately sloped land that generally slopes to the south. The site has been historically used as undeveloped pasture or grazing land. The existing conditions map can be seen on Exhibit 2.

The proposed project, which generally consists of a battery storage facility and a gravel access road, is located within one parcel being developed by Valley Center ESS, LLC: Assessor's Parcel Number (APN) 189-013-20-20 totaling 8.93 acres.

This study includes an analysis of the site drainage before and after the proposed development of the site, and includes preliminary sizing the stormwater best management practices (BMPs) to control the proposed conditions runoff rate and quality, and there ensuring that that are no adverse effects from the proposed development of the project to downstream neighboring properties.

This study follow the guidelines included in the San Diego County: Hydrology Manual; Hydraulic Design Manual; and BMP Design Manual.

This study includes the information request in Figure 1-8 of the San Diego County Hydrology Manual – "Required Report Format for Unit Hydrograph Study" of the Hydrology Manual.

The analysis that was completed and summarized in this report shows that one detention basin is to be installed that has been sized to detain the increase in runoff generated by the changed landcover and use so that the peak runoff flow to off-site properties are maintained at or below the pre development conditions along with retaining and treating the 85th percentile storm runoff volume. The existing discharge calculated at the western discharge point of the project for the 100-year 24-hour storm was calculated using the NRCS Hydrologic Method (CN Method) at 14.20 cfs. For the drainage study the existing 14.20 cfs flow rate was used which provides conservative results when compared to the Modified Rational Method (18.54 cfs – See Appendix G for results from the Kimley-Horn flood study), which provides higher flow rates in the existing condition when compared to the NRCS Hydrologic Method. For the proposed condition, the curve number method used a weighted CN of 68, time of concentration of 11.1 minutes with a time to peak of 12.01 hours and a rainfall of 8.20" per the County of San Diego Hydrology Manual. The onsite basin volume is based on the curve number method flow rates and reduces the outflow at the property line to 11.82 cfs which occurs at 12.58 hours, in proposed conditions, which is less than existing. This provides conservative basin sizing volume when compared to the flow rates and volume that would be permitted by the Modified Rational Method, which has a higher allowable discharge rate. Based on this, the curve number method provides valid and conservative results for the onsite and basin flow rates and volumes and is recommended by the engineer-of-record based on their professional opinion.

The pre-development drainage conditions can be found on Exhibit 2. In summary, the site one existing watersheds (DA-1) with one offsite watershed flowing onto the site. The proposed storage facility will be constructed entirely on DA-1. The site is also within a flood zone according to regional WMAA data. This flooding zone is being studied by another consultant and the site will be removed through a LOMR. The flow rate of this zone through the project area will be handled by a channel in proposed conditions which will remove the developed portion of the site from the flood zone. This redirection is internal to the site and the flow will be returned to near existing conditions (flow rate, velocity and spread) at the property boundary. Therefore, no housing will be placed within the 100-year flood hazard as the project will have no habitable structures and no existing offsite housing structures will be added to the 100-year flood hazard delineation as a result of this development. Additionally no structures will be placed in new delineation of the flood zone so no impediment or redirection of flows will occur.

The post-development conditions can be found on Exhibit 3. It can be seen that the general location of overland flow will be similar and all water will be discharging to the same downstream area. The onsite watersheds will be routed into one infiltration basin located in DA-1 with a discharge rate lower than DA-1 in existing conditions. As shown in the proposed conditions section of the report the site will have less runoff than in existing conditions with the addition of the infiltration basin. No substantial loss of soil or soil erosion is expected onsite. We have therefore concluded that the development of the site will not increase the risk of off-site flooding to downstream properties. A channel will constructed to handle the flows from the onsite flooding zone and this will reduce the onsite flooding risk of the project area. The detailed pre and post flow rates can be found in the proposed conditions section of this report. Please note that for layout and design purposes, the gravel roads and energy storage equipment area have conservatively been assumed to be impervious and a retention basin has been sized and included in the project to provide infiltration for this scenario. The project will explore means to minimize the imperviousness of the site and provide direct infiltration in the final design wherever feasible, and therefore the included imperviousness should be considered worst case for purposes of this submittal. Final grading, drainage and surface material design will provide calculations for any changes that are made that improve perviousness.

Data Sources

Table 1: Data Sources

Task	Format	Source	Use
Elevation	2.5-foot DEM	2015 San Diego Region QL2 Lidar	Watershed Delineation
Crop Data	Shapefile	USDA 2013 Crop Data Layer	Landcover
Soils	Shapefile	USGS SSURGO Dataset	Curve Numbers
Precipitation	PDF File	NOAA Atlas 14	Design Storms

Existing Conditions and Drainage

Existing Site Conditions

Historically the site has been used a pasture area based on both landcover data and imagery data. The topographic elevation used in this analysis is from publically available 2015 San Diego Region QL2 Lidar. These contours can be seen on Exhibit 2 & 3.

Based on the United States Department of Agriculture soil survey for the project area the onsite soils are classified mostly as Hydrologic Soils Group (HSG) A with a small amount of HSG C. Both the A and C soils area classified as a sandy loam. Additionally onsite Geotechnical work has verified the onsite soils. Based on onsite infiltration testing the A soils have an infiltration rate of 2.40 inches per hour. This infiltration rate was taken into account in both the basin sizing and the County's BMP sizing Spreadsheet V3.0. The typically recommend value is 0.30 in the spreadsheet and this value was used to determine the required BMP storage for the 85th percentile storm along with the required water quality volume. The BMP is assumed to be unlined to allow infiltration in the basin.

According to both FEMA and Regional WMAA data a portion of the site is located with a FEMA Zone A. The site is undergoing a study for a LOMR through another consultant to remove the site from the flood zone. All assumptions in this study assume the site is removed from the flood zone and removes the risk of offsite flooding. No housing is proposed on the project so no housing will be placed in a flood zone. Additionally no structures will be placed in the new delineation of the flood zone so no impediment or redirection of the flows will occur.

Existing Site Drainage

The project parcel is gently sloped to the south with all water shedding into the adjacent flood zone. A localized low point is in the southwest corner and is where the basin will be placed in proposed conditions for ease of grading and release of the water. Due to the site being undeveloped there are no existing hydraulic structures onsite.

The existing hydrology was modeled using HydroCAD which is a computer software that utilizes SCS TR-20 methodology to rough hydrographs of the selected return period through a watershed. The model is dynamic and factors in ground cover, slope, and time off concentration as well as the sequencing and combining of flow through sub-catchments that are connected to each other. In accordance with the San Diego County Manual both the 100-year return period, 24-hour duration storm and the 100-year, 6-hour duration storm were modeled using a nested Atlas 14 rainfall distribution. According the NOAA Atlas 14 (Appendix A) the 100-year, 24-hour storm rainfall is 6.60 and the 100-year, 6-hour storm is 3.45. These values from NOAA Atlas 14 were then compared to the isopluvial maps in the County of San Diego Hydrology Manual for the same return period storms. The isopluvial maps indicated that the same storm events had values of approximately 8.2" and 3.8" respectively. In order to provide the more conservative results the County of San Diego rainfall values were used. The isopluvial maps can be found in Appendix C.

The goal of the model was to assess the existing peak runoff rates at the point where runoff leaves the project. The results of the existing conditions modeling are presented below in Table 1. The details of the pre-development hydrology modeling and outputs are provided in Appendix B. The runoff rate of DA-1 assumes the onsite and offsite drainage are combined with the 24-hour storm having an approximately 41% higher peak runoff rate than the 6-hour storm event.

Table 2

100-Year Peak Runoff Flowrates – Existing Conditions

Sub-Catchment	Avg. CN (unitless)	Time of Concentration (min)	Area (Acres)	6-hour Storm (cfs)	6-hour Storm Volume (ac-ft)	24-hour Storm (cfs)	24-hour Storm Volume (ac-ft)
DA-1	68	11.1	5.26	5.83	0.474	14.20	1.93

Proposed Site Layout, Grading and Drainage

Proposed Site Layout and Grading

The proposed battery storage facility will be constructed entirely on the project parcel as seen on Exhibit 3. The battery storage units will be placed on concrete pads surrounded by gravel surfacing. The access roads to the battery storage will be in a loop format in accordance with county regulations. The road will be sloped so that no drainage is blocked onsite. The battery storage facility will receive minor grading to allow all site drainage to flow into the proposed infiltration basin in the southwest corner of the project. This basin will require selection of vegetation that can withstand inundation for greater than 24 (but less than 96) hours. The basin sizing calculations for proposed conditions can be found in Appendix B. No substantial soil erosion or loss of topsoil is expected onsite as a result of this development.

Proposed Drainage and Design of Detention Basins

For the hydrologic analysis the site was evaluated per the proposed development of the site as proposed by the client. The addition of impervious structures and gravel increases the weighted curve number of the onsite drainage area and thus increases the peak runoff flow rate at the project boundary. In order to mitigate this increase a proposed infiltration basin is proposed in the southwest corner of the project area and with the proposed site grading will capture all of the project water and release at a rate less than existing conditions.

An additional HydroCAD TR-20 model was created to represent the proposed conditions of the project. The grading from the civil design was incorporated into the model pond to represent the onsite storage. Since the basin is an infiltration basin an infiltration rate of 2.4" was assumed in accordance with the onsite percolation tests that were done in the geotechnical report. The goal of the proposed hydrologic model is to assess the potential for increased runoff with the proposed changes to ground cover associated with the development of the project area and to ensure that the infiltration basins has adequate capacity to mitigate the excess runoff created so that the proposed development would not increase the peak runoff from the site during both design storms. The basins were modeled using the initial sizing from the County BMP sizing spreadsheet and then enlarged to account for the 100-year runoff increase. The sizing of the required BMP is discussed in the next section. The storage volumes provided in the next section represent the volume below the overflow, however, there is freeboard in the basin to allow for the water level to continue rising during peak flow conditions. The hydrologic modelling peak runoff rates for the project can be seen in Table 3 below and show that the basin provides adequate detention of the additional runoff created by the project to prevent adverse effects to the neighboring properties. The details and output of the post-development model can be seen in Appendix B. The infiltration basin will take into account both onsite and offsite flows. The flow rates shown in Table 3 are slightly lower than those calculated by another consultant who is remapping the floodplain, this is due to a difference in methods used and the basin not being taken into account, their calculated 100-year flow rate is 18.5cfs. The existing discharge calculated at the western discharge point of the project for the 100-year 24-hour storm was calculated using the NRCS Hydrologic Method (CN Method) at 14.20 cfs. For the drainage study the existing 14.20 cfs flow rate was used which provides conservative results when compared to the Modified Rational Method (18.54 cfs – See Appendix G for results from the Kimley-Horn flood study), which provides higher flow rates in the existing condition when compared to the NRCS Hydrologic Method. For the proposed condition, the curve number method used a weighted CN of 68, time of concentration of 11.1 minutes with a time to peak of 12.01 hours and a rainfall of 8.20" per the County of San Diego Hydrology Manual. The onsite basin volume is based on the curve number method flow rates and reduces the outflow at the property line to 11.82 cfs which occurs at 12.58 hours, in proposed conditions, which is less than existing. This provides conservative basin sizing volume when compared to the flow rates and volume that would be permitted by the Modified Rational Method, which has a higher allowable discharge rate. Based on this, the curve number method provides valid and conservative results for the onsite and basin flow rates and volumes and is recommended by the engineer-of-record based on their professional opinion.

Table 3

100-Year Peak Runoff Flowrates – Proposed Conditions w/BMP

Sub-Catchment	Avg. CN (unitless)	Time of Concentration (min)	Area (Acres)	6-hour Storm (cfs)	6-hour Storm Volume (ac-ft)	24-hour Storm (cfs)	24-hour Storm Volume (ac-ft)	24-hour Storm Velocity (fps)
DA-1	98	3.7	5.26	4.61	0.79	11.82	2.75	4.02

Outlet flow control for the infiltration pond during peak flow conditions will be through an overflow weir. This weir will safely pass the peak from both 100-year events. The weir size limits the flow out of the basin to less than the existing conditions. The remainder of water in the basin will infiltrate in less than the required 96 hours. The velocity from the outlet will be 4fps and this will be mitigated through riprap placed on the overflow weir to mitigate erosion potential. No special surfaces will be needed due to scour. Please note that for layout and design purposes, the gravel roads and energy storage equipment area have conservatively been assumed to be impervious and a retention basin has been sized and included in the project to provide infiltration for this scenario. The project will explore means to minimize the imperviousness of the site and provide direct infiltration in the final design wherever feasible, and therefore the included imperviousness should be considered worst case for purposes of this submittal. Final grading, drainage and surface material design will provide calculations for any changes that are made that improve perviousness.

Sizing of Proposed Post-Construction BMPs

The detention basin was designed in a "unified BMP design approach" to meet the requirements for both stormwater treatment and hydromodification management using an infiltration basin for the onsite drainage area (BMP Manual). One infiltration basin is proposed to capture and treat the required Design Capture Volume as required for an 85th percentile 24-hour event.

The basins were sized using the spreadsheets from San Diego County called "BMP Sizing Spreadsheet V3.1" and "County BMPDM PC Worksheet" provided with the BMP Manual for sizing infiltration basins with an integrated stormwater flow control and pollutant control configuration. The infiltration basins are used to treat the required Design Capture Volume indicated in the BMP Manual as well as sized for flow control associated with the hydro modification plan. The full calculation sizing spreadsheet package can be found in Appendix F. The process for designing each BMP is as follows.

- Identify sub-catchment areas which require infiltration basins.
- Delineate post project surface type and area and identify the corresponding pre-project slope and soil type for each DMA.
- Using Table G.2.1 in Appendix G of the BMP Manual (to be used for only for hydromodification management flow control) identify the runoff factor for each DMA.
- Determine the Hydromodification Plan (HMP) sizing factor which is based on the project location to determine the reference rain gauge, the pre-project soil group, the pre-project slope and the channel erosion susceptibility.
- Multiply the DMA area by the area weighted runoff factor and the HMP sizing factor to determine the required basin size.
- Sum the individual DMAs into a single basin minimum size.
- Determine the drawdown time to make sure it is less than 96 hours.

The calculation for the infiltration basin are included in Appendix F and summarized below.

Table 4

Summary of Post-Construction BMPs

Sub-Catchment	BMP Type	BMP Surface Area (sf)	BMP Volume (cf)
DA-1	Infiltration	13,503	45,302

The infiltration basin will have no sub drain as the basin has a high infiltration rate (2.4 in/hr.) per onsite percolation testing. The storage capacity in the basin is greater than the required detention volume to lit post-development peak runoff to pre-development peak runoff rates. The basin will have a max outflow of 4 fps outflow during a larger storm event, riprap placed at the outlet will mitigate the velocity and prevent erosion.

Therefore, the basins performs the required treatment of the 85th percentile 24-hour storm event and also meets the requirements for hydromodification factors. Additionally the basin controls the excess volume resulting from the proposed development from the 100-year storm event.

The basin is designed in accordance with the requirements outline for water quality and hydromodification control. Additionally, as the basins are providing flood control as well, they are also subject to the requirements identified in the Hydraulic Design Manual (Section 6.2.3), which required 1-foot of freeboard when passing the 100-year storm event. The infiltration basin will have approximately 3" of freeboard during the 100-year storm event. For this project the 3-inches of freeboard is judged to be accurate for the following reasons.

- The post development 100-year, 24-hour storm runoff flows are less than the pre-development flows.
- The site is for private use with no public access.
- The basins are not to be maintained by the County.
- The overflow weir can safely pass the 100-year storm without any impact to abutters, nor any risk to public safety.

References Cited

County of San Diego Department of Public Works (CSDDPW). 2003. San Diego County Hydrology Manual Retrieved March 2020

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Exhibits

Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary
- County Boundary

Westwood

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Westwood Professional Services, Inc.

Valley Center Storage Project

San Diego County, California

N

0 0.5 Miles

Exhibit 1: Location Map

April 28, 2020

Map Document: N:\0026751.00\GIS\Hydro Exhibits\2020-04-27_ValleyCenter_EX1LocationMap.mxd 4/28/2020 3:58:23 PM

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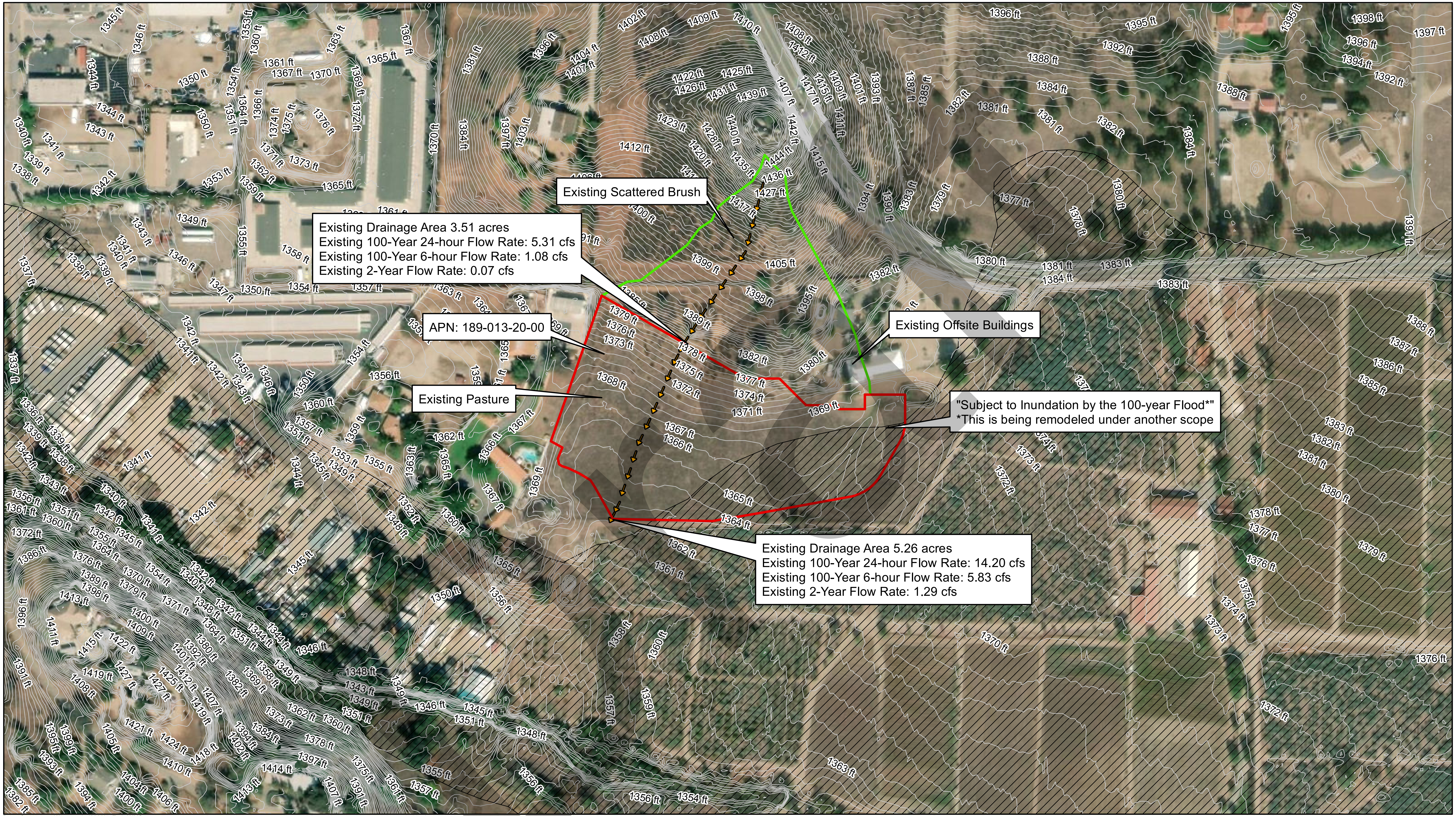

Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

Project Boundary | Offsite Drainage Area | FEMA Zone A

County Boundary | 1' Contours | Existing Flow Path

Westwood

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Westwood Professional Services, Inc.

N

Feet

0 200

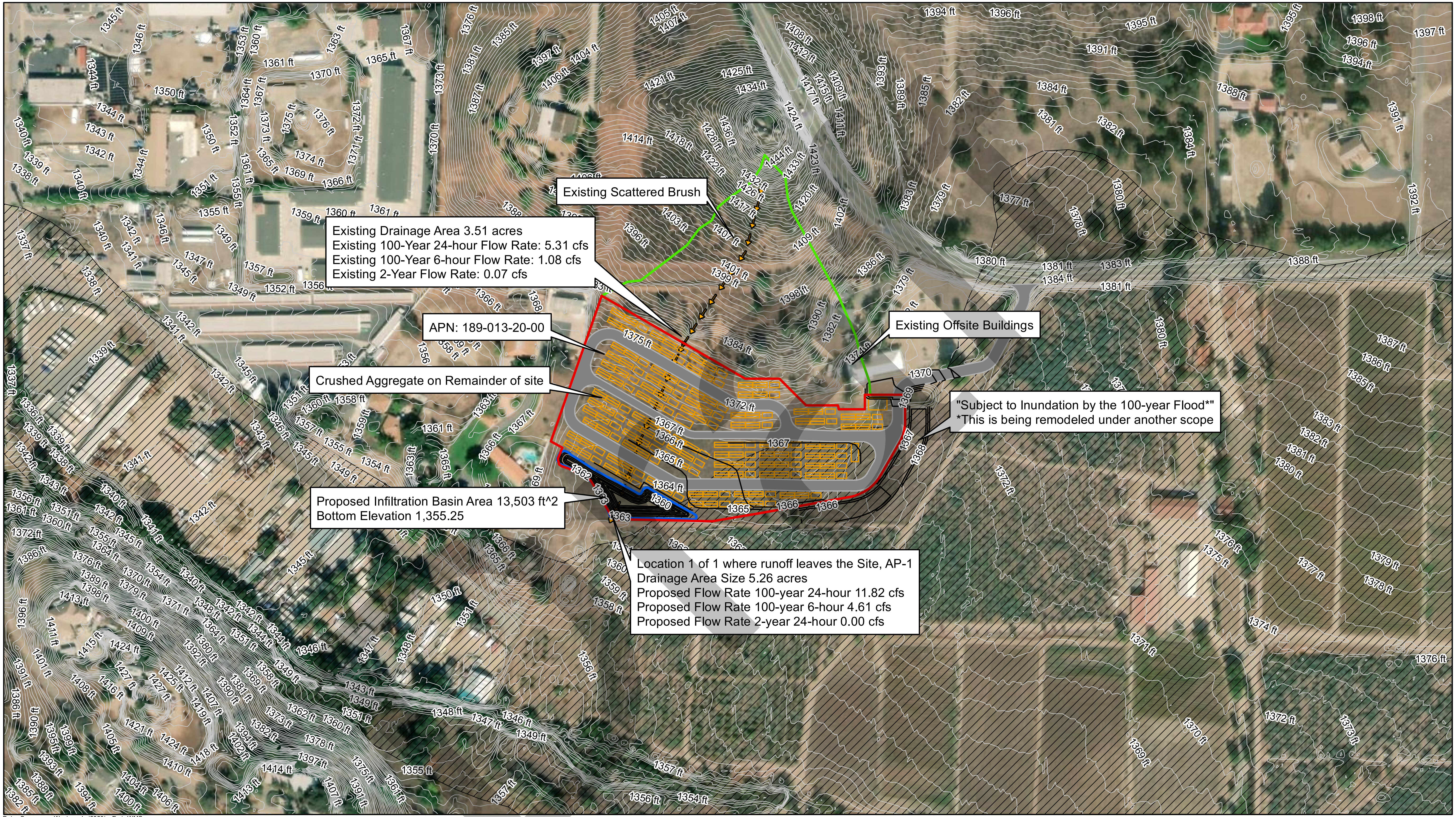
Valley Center Storage Project

San Diego County, California

Exhibit 2: Existing Conditions Map

June 3, 2020

Map Document: N:\0026751.00\GIS\Hydro Exhibits\2020-06-02_ValleyCenter_EX2PreDevelopmentMap.mxd 6/3/2020 8:07:54 AM



Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary
- County Boundary
- Offsite Drainage Area
- Proposed Infiltration Basin
- Proposed Energy Storage
- Proposed Access Road
- 1' Contours
- Proposed Grading

N

Feet 0 200

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San Diego County, California

Exhibit 3: Proposed Conditions Map

June 3, 2020

Map Document: N:\0028751.00\GIS\Hydro Exhibits\2020-06-02_ValleyCenter_EX3PostDevelopmentMap.mxd 6/3/2020 8:10:33 AM

Appendix A

NOAA Atlas 14 Rainfall Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Valley Center, California, USA*
Latitude: 33.2271°, Longitude: -117.0191°
Elevation: 1366.71 ft**
* source: ESRI Maps
** source: USGS

Note: The rainfall values in the San Diego County Hydrology Manual were higher and therefore controlling

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

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	**0.126** (0.106-0.151)	**0.158** (0.133-0.190)	**0.202** (0.169-0.243)	**0.239** (0.199-0.290)	**0.291** (0.234-0.367)	**0.333** (0.261-0.429)	**0.377** (0.288-0.499)	**0.424** (0.315-0.578)	**0.491** (0.348-0.700)	**0.545** (0.373-0.806)
10-min	**0.180** (0.152-0.216)	**0.226** (0.191-0.272)	**0.289** (0.243-0.348)	**0.343** (0.285-0.416)	**0.418** (0.335-0.526)	**0.478** (0.375-0.615)	**0.541** (0.413-0.715)	**0.608** (0.451-0.829)	**0.704** (0.499-1.00)	**0.782** (0.534-1.16)
15-min	**0.218** (0.183-0.261)	**0.274** (0.230-0.329)	**0.350** (0.294-0.421)	**0.414** (0.344-0.503)	**0.505** (0.405-0.636)	**0.578** (0.453-0.744)	**0.654** (0.500-0.865)	**0.736** (0.545-1.00)	**0.851** (0.604-1.21)	**0.945** (0.646-1.40)
30-min	**0.316** (0.267-0.379)	**0.398** (0.335-0.478)	**0.508** (0.426-0.612)	**0.602** (0.500-0.731)	**0.733** (0.588-0.924)	**0.839** (0.658-1.08)	**0.950** (0.726-1.26)	**1.07** (0.792-1.46)	**1.24** (0.877-1.76)	**1.37** (0.939-2.03)
60-min	**0.488** (0.411-0.585)	**0.613** (0.516-0.736)	**0.783** (0.657-0.943)	**0.927** (0.771-1.13)	**1.13** (0.906-1.42)	**1.29** (1.01-1.67)	**1.46** (1.12-1.94)	**1.65** (1.22-2.24)	**1.91** (1.35-2.71)	**2.12** (1.45-3.13)
2-hr	**0.700** (0.590-0.840)	**0.866** (0.728-1.04)	**1.09** (0.918-1.32)	**1.29** (1.07-1.57)	**1.57** (1.26-1.98)	**1.80** (1.41-2.31)	**2.04** (1.56-2.69)	**2.30** (1.70-3.13)	**2.67** (1.90-3.81)	**2.98** (2.04-4.41)
3-hr	**0.854** (0.719-1.02)	**1.05** (0.884-1.26)	**1.32** (1.11-1.59)	**1.56** (1.30-1.89)	**1.90** (1.52-2.39)	**2.17** (1.70-2.80)	**2.47** (1.88-3.26)	**2.79** (2.06-3.79)	**3.25** (2.30-4.63)	**3.63** (2.48-5.36)
6-hr	**1.19** (1.00-1.43)	**1.47** (1.23-1.76)	**1.85** (1.55-2.23)	**2.18** (1.81-2.64)	**2.65** (2.13-3.34)	**3.04** (2.38-3.91)	**3.45** (2.64-4.56)	**3.90** (2.89-5.32)	**4.56** (3.23-6.49)	**5.10** (3.49-7.53)
12-hr	**1.64** (1.38-1.96)	**2.04** (1.72-2.45)	**2.60** (2.18-3.13)	**3.07** (2.55-3.73)	**3.75** (3.01-4.72)	**4.29** (3.37-5.53)	**4.87** (3.72-6.44)	**5.50** (4.08-7.49)	**6.40** (4.54-9.11)	**7.13** (4.87-10.5)
24-hr	**2.12** (1.87-2.45)	**2.69** (2.38-3.12)	**3.47** (3.05-4.03)	**4.13** (3.61-4.83)	**5.07** (4.29-6.11)	**5.81** (4.82-7.15)	**6.60** (5.35-8.31)	**7.45** (5.88-9.63)	**8.64** (6.56-11.6)	**9.61** (7.06-13.4)
2-day	**2.60** (2.29-3.00)	**3.33** (2.94-3.86)	**4.34** (3.82-5.04)	**5.20** (4.54-6.08)	**6.43** (5.44-7.75)	**7.42** (6.15-9.13)	**8.47** (6.86-10.7)	**9.60** (7.57-12.4)	**11.2** (8.51-15.1)	**12.5** (9.20-17.4)
3-day	**2.87** (2.53-3.31)	**3.71** (3.27-4.29)	**4.86** (4.28-5.64)	**5.85** (5.11-6.84)	**7.27** (6.15-8.77)	**8.42** (6.99-10.4)	**9.65** (7.82-12.1)	**11.0** (8.66-14.2)	**12.9** (9.77-17.3)	**14.4** (10.6-20.1)
4-day	**3.14** (2.77-3.62)	**4.08** (3.60-4.72)	**5.37** (4.72-6.23)	**6.48** (5.65-7.57)	**8.07** (6.83-9.73)	**9.36** (7.77-11.5)	**10.7** (8.71-13.5)	**12.2** (9.66-15.8)	**14.4** (10.9-19.3)	**16.2** (11.9-22.4)
7-day	**3.68** (3.25-4.25)	**4.81** (4.25-5.57)	**6.37** (5.60-7.39)	**7.70** (6.72-9.00)	**9.59** (8.12-11.6)	**11.1** (9.23-13.7)	**12.8** (10.3-16.1)	**14.5** (11.5-18.8)	**17.1** (12.9-22.9)	**19.1** (14.1-26.6)
10-day	**4.01** (3.55-4.64)	**5.28** (4.66-6.11)	**7.02** (6.17-8.14)	**8.49** (7.41-9.92)	**10.6** (8.95-12.8)	**12.3** (10.2-15.1)	**14.1** (11.4-17.7)	**16.0** (12.6-20.7)	**18.8** (14.2-25.2)	**21.0** (15.5-29.2)
20-day	**4.86** (4.30-5.62)	**6.47** (5.71-7.49)	**8.66** (7.62-10.0)	**10.5** (9.18-12.3)	**13.1** (11.1-15.9)	**15.3** (12.7-18.8)	**17.5** (14.2-22.0)	**19.9** (15.7-25.8)	**23.4** (17.7-31.4)	**26.2** (19.2-36.4)
30-day	**5.87** (5.19-6.79)	**7.85** (6.92-9.08)	**10.5** (9.28-12.2)	**12.8** (11.2-15.0)	**16.1** (13.6-19.4)	**18.7** (15.5-23.0)	**21.4** (17.4-27.0)	**24.4** (19.3-31.5)	**28.6** (21.7-38.5)	**32.1** (23.6-44.6)
45-day	**6.98** (6.17-8.07)	**9.34** (8.24-10.8)	**12.5** (11.0-14.6)	**15.3** (13.3-17.9)	**19.1** (16.2-23.1)	**22.3** (18.5-27.4)	**25.6** (20.7-32.2)	**29.1** (23.0-37.6)	**34.2** (26.0-46.0)	**38.4** (28.2-53.4)
60-day	**8.10** (7.16-9.37)	**10.8** (9.52-12.5)	**14.5** (12.7-16.8)	**17.6** (15.4-20.6)	**22.1** (18.7-26.6)	**25.7** (21.3-31.6)	**29.5** (23.9-37.2)	**33.7** (26.6-43.6)	**39.7** (30.1-53.3)	**44.6** (32.7-61.9)

[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.

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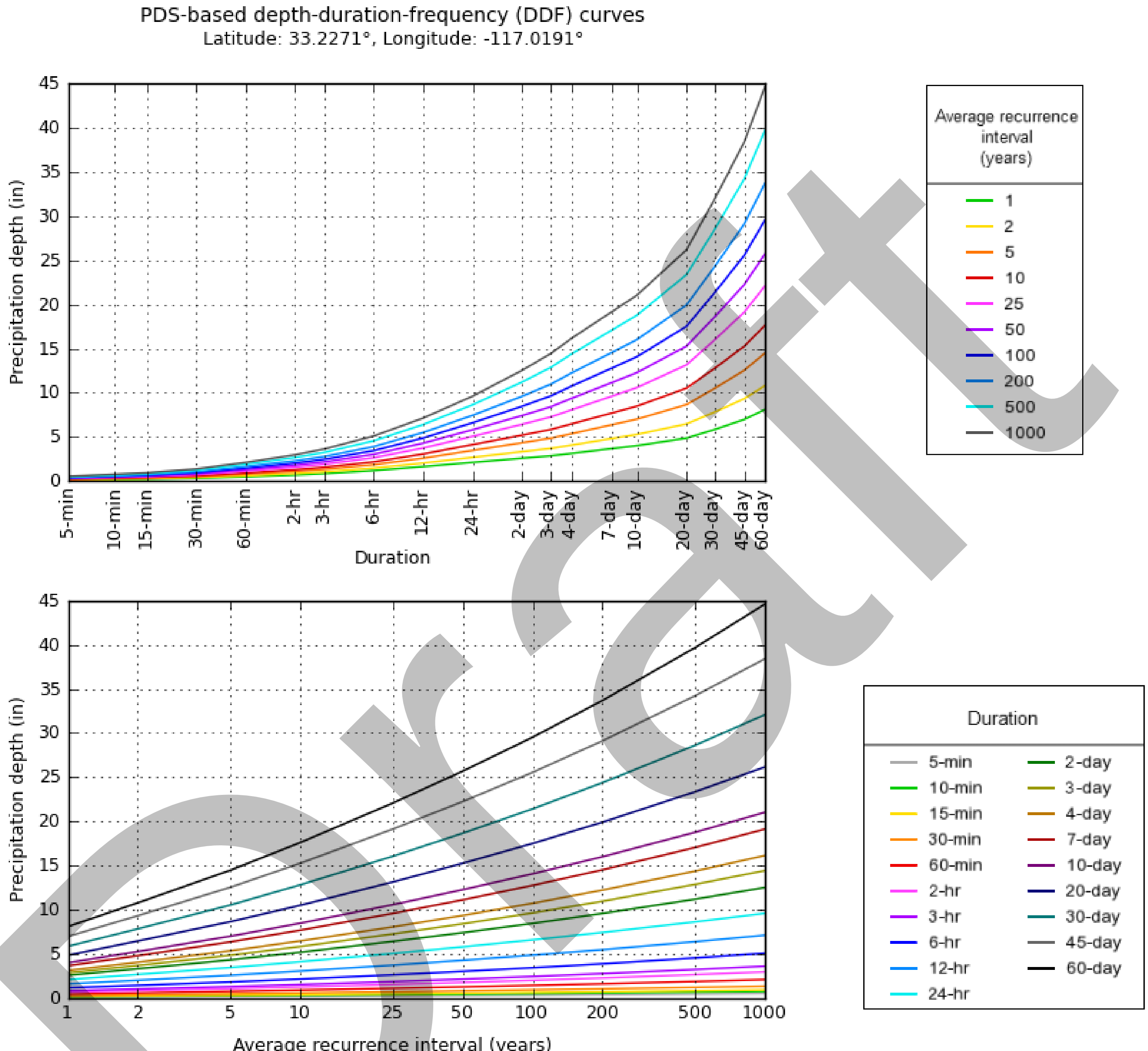
PF graphical



NOAA Atlas 14, Volume 6, Version 2

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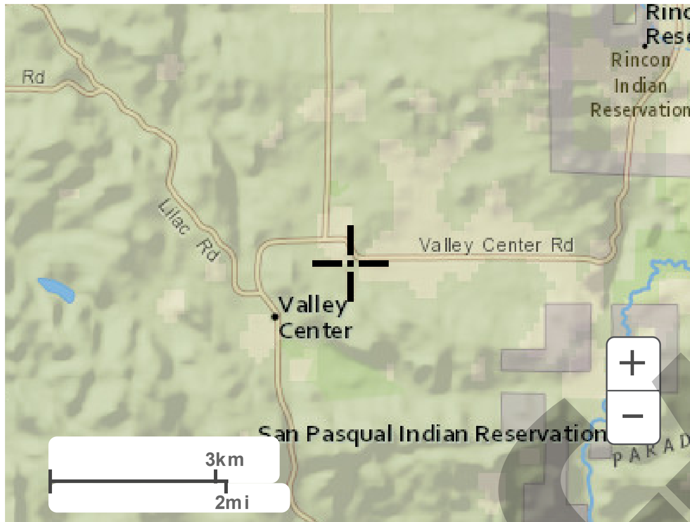
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map

Large scale aerial

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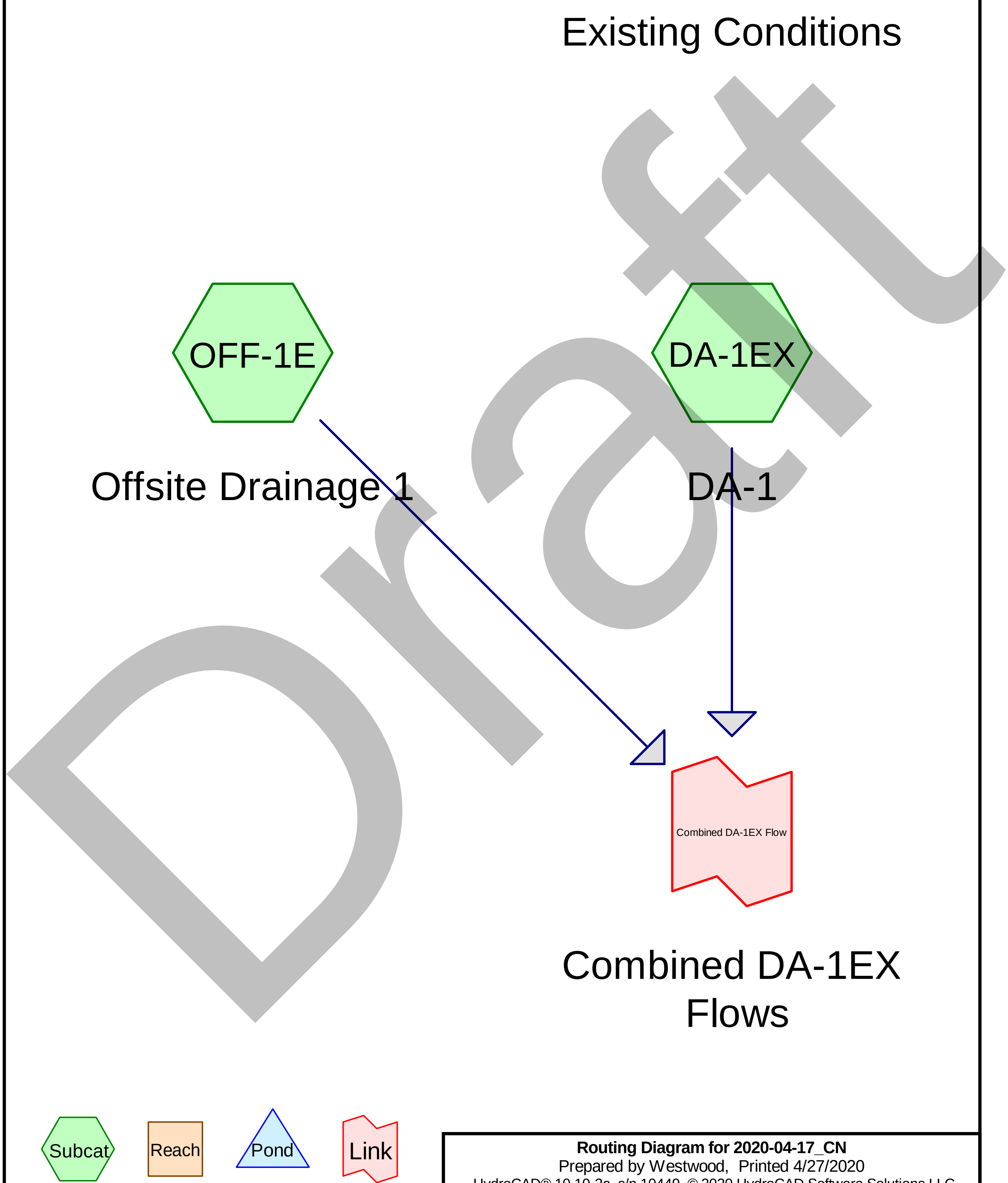
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix B

Hydrology Calculations



Routing Diagram for 2020-04-17_CN
Prepared by Westwood, Printed 4/27/2020
HydroCAD® 10.10-3a s/n 10449 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr	ValleyCenter 24-hr S1	1-yr	Default	24.00	1	2.12	2
2	2-yr	ValleyCenter 24-hr S1	2-yr	Default	24.00	1	3.00	2
3	5-yr	ValleyCenter 24-hr S1	5-yr	Default	24.00	1	4.10	2
4	10-yr	ValleyCenter 24-hr S1	10-yr	Default	24.00	1	5.10	2
5	25-yr	ValleyCenter 24-hr S1	25-yr	Default	24.00	1	6.20	2
6	50-yr	ValleyCenter 24-hr S1	50-yr	Default	24.00	1	7.20	2
7	100-yr	ValleyCenter 24-hr S1	100-yr	Default	24.00	1	8.20	2
8	100-yr-6hr	ValleyCenter 24-hr S1	100-yr	Scale	6.00	1	3.80	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.560	48	Brush, Poor, HSG A (OFF-1E)
0.880	77	Brush, Poor, HSG C (OFF-1E)
5.170	68	Pasture/grassland/range, Poor, HSG A (DA-1EX)
0.090	86	Pasture/grassland/range, Poor, HSG C (DA-1EX)
0.070	98	Paved parking, HSG C (OFF-1E)
8.770	**63**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
7.730	HSG A	DA-1EX, OFF-1E
0.000	HSG B	
1.040	HSG C	DA-1EX, OFF-1E
0.000	HSG D	
0.000	Other	
8.770		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
2.560	0.000	0.880	0.000	0.000	3.440	Brush, Poor	OFF-1E
5.170	0.000	0.090	0.000	0.000	5.260	Pasture/grassland/range, Poor	DA-1EX
0.000	0.000	0.070	0.000	0.000	0.070	Paved parking	OFF-1E
7.730	**0.000**	**1.040**	**0.000**	**0.000**	**8.770**	**TOTAL AREA**	

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA-1EX: DA-1 Runoff Area=5.260 ac 0.00% Impervious Runoff Depth=4.40"
Flow Length=420' Slope=0.0403 '/' Tc=11.1 min CN=68 Runoff=9.96 cfs 1.930 af

Subcatchment OFF-1E: Offsite Drainage 1 Runoff Area=3.510 ac 1.99% Impervious Runoff Depth=3.03"
Tc=6.0 min CN=56 Runoff=5.31 cfs 0.887 af

Link Combined DA-1EX Flow: Combined DA-1EX Flows Inflow=14.20 cfs 2.818 af
Primary=14.20 cfs 2.818 af

Total Runoff Area = 8.770 ac Runoff Volume = 2.818 af Average Runoff Depth = 3.86"
99.20% Pervious = 8.700 ac 0.80% Impervious = 0.070 ac

Summary for Subcatchment DA-1EX: DA-1

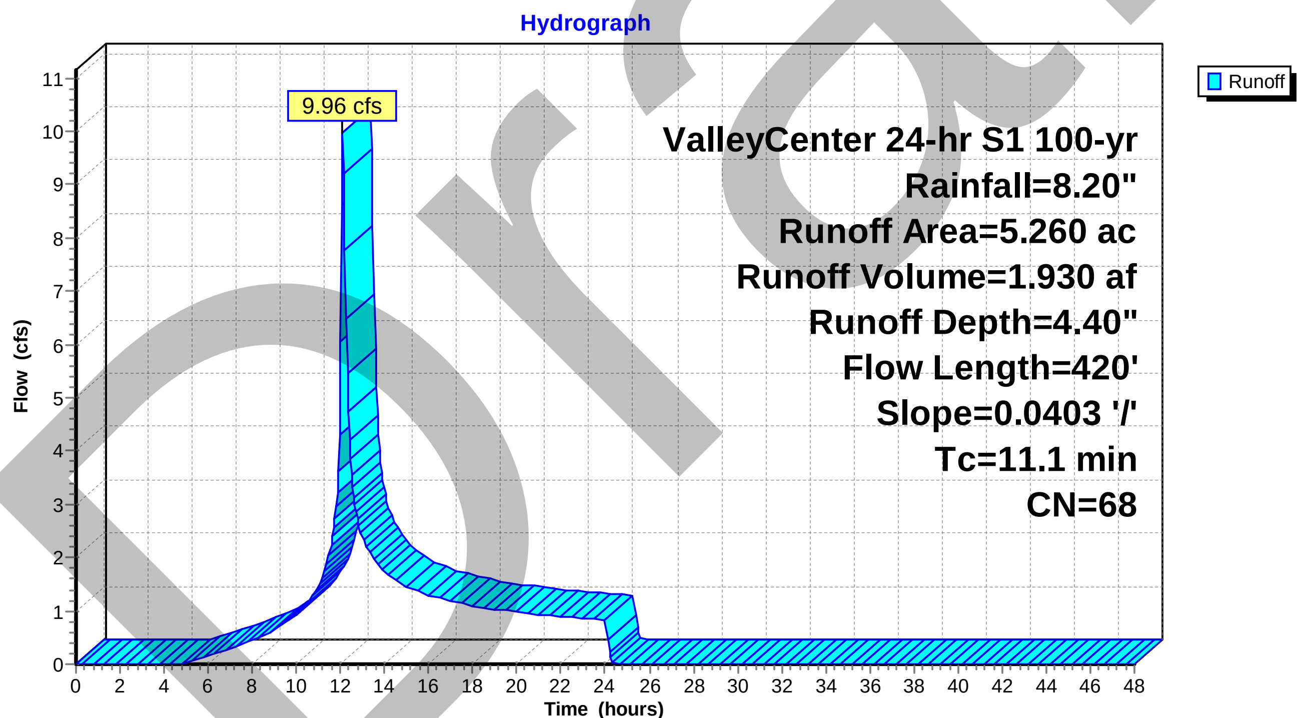
Runoff = 9.96 cfs @ 12.11 hrs, Volume= 1.930 af, Depth= 4.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr Rainfall=8.20"

Area (ac)	CN	Description
5.170	68	Pasture/grassland/range, Poor, HSG A
0.090	86	Pasture/grassland/range, Poor, HSG C
5.260	68	Weighted Average
5.260		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	420	0.0403	0.63		**Lag/CN Method,**

Subcatchment DA-1EX: DA-1



Hydrograph for Subcatchment DA-1EX: DA-1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.09	0.00	0.00
1.00	0.19	0.00	0.00
1.50	0.29	0.00	0.00
2.00	0.39	0.00	0.00
2.50	0.49	0.00	0.00
3.00	0.59	0.00	0.00
3.50	0.70	0.00	0.00
4.00	0.81	0.00	0.00
4.50	0.92	0.00	0.00
5.00	1.04	0.00	0.03
5.50	1.16	0.01	0.09
6.00	1.29	0.02	0.16
6.50	1.42	0.04	0.22
7.00	1.55	0.07	0.29
7.50	1.70	0.10	0.37
8.00	1.85	0.15	0.45
8.50	2.00	0.20	0.55
9.00	2.17	0.26	0.65
9.50	2.36	0.33	0.78
10.00	2.56	0.41	0.94
10.50	2.78	0.52	1.15
11.00	3.05	0.65	1.47
11.50	3.39	0.84	2.07
12.00	4.25	1.37	**6.04**
12.50	4.85	1.77	**3.55**
13.00	5.17	2.00	2.37
13.50	5.43	2.19	1.96
14.00	5.66	2.36	1.73
14.50	5.85	2.51	1.57
15.00	6.04	2.65	1.45
15.50	6.20	2.78	1.37
16.00	6.36	2.90	1.29
16.50	6.51	3.02	1.23
17.00	6.65	3.13	1.18
17.50	6.79	3.24	1.14
18.00	6.92	3.34	1.10
18.50	7.04	3.44	1.06
19.00	7.16	3.54	1.03
19.50	7.28	3.64	1.01
20.00	7.39	3.73	0.98
20.50	7.50	3.82	0.96
21.00	7.61	3.91	0.94
21.50	7.71	3.99	0.92
22.00	7.81	4.08	0.90
22.50	7.91	4.16	0.88
23.00	8.01	4.24	0.86
23.50	8.11	4.32	0.85
24.00	**8.20**	**4.40**	0.84
24.50	8.20	4.40	0.00
25.00	8.20	4.40	0.00
25.50	8.20	4.40	0.00
26.00	8.20	4.40	0.00
26.50	8.20	4.40	0.00
27.00	8.20	4.40	0.00
27.50	8.20	4.40	0.00
28.00	8.20	4.40	0.00
28.50	8.20	4.40	0.00
29.00	8.20	4.40	0.00
29.50	8.20	4.40	0.00
30.00	8.20	4.40	0.00
30.50	8.20	4.40	0.00
31.00	8.20	4.40	0.00
31.50	8.20	4.40	0.00
32.00	8.20	4.40	0.00
32.50	8.20	4.40	0.00
33.00	8.20	4.40	0.00
33.50	8.20	4.40	0.00
34.00	8.20	4.40	0.00
34.50	8.20	4.40	0.00
35.00	8.20	4.40	0.00
35.50	8.20	4.40	0.00
36.00	8.20	4.40	0.00
36.50	8.20	4.40	0.00
37.00	8.20	4.40	0.00
37.50	8.20	4.40	0.00
38.00	8.20	4.40	0.00
38.50	8.20	4.40	0.00
39.00	8.20	4.40	0.00
39.50	8.20	4.40	0.00
40.00	8.20	4.40	0.00
40.50	8.20	4.40	0.00
41.00	8.20	4.40	0.00
41.50	8.20	4.40	0.00
42.00	8.20	4.40	0.00
42.50	8.20	4.40	0.00
43.00	8.20	4.40	0.00
43.50	8.20	4.40	0.00
44.00	8.20	4.40	0.00
44.50	8.20	4.40	0.00
45.00	8.20	4.40	0.00
45.50	8.20	4.40	0.00
46.00	8.20	4.40	0.00
46.50	8.20	4.40	0.00
47.00	8.20	4.40	0.00
47.50	8.20	4.40	0.00
48.00	8.20	4.40	0.00

Summary for Subcatchment OFF-1E: Offsite Drainage 1

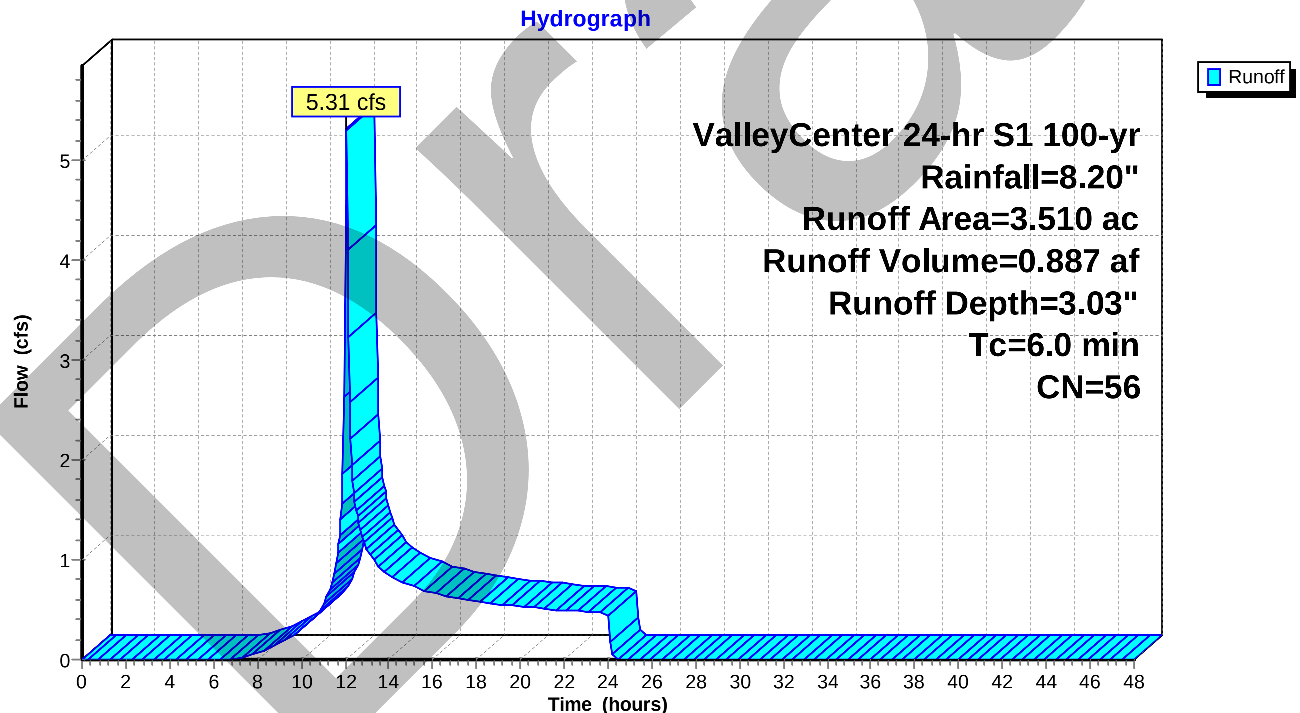
Runoff = 5.31 cfs @ 12.04 hrs, Volume= 0.887 af, Depth= 3.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr Rainfall=8.20"

Area (ac)	CN	Description
2.560	48	Brush, Poor, HSG A
0.880	77	Brush, Poor, HSG C
0.070	98	Paved parking, HSG C
3.510	56	Weighted Average
3.440		98.01% Pervious Area
0.070		1.99% Impervious Area

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

Subcatchment OFF-1E: Offsite Drainage 1



Hydrograph for Subcatchment OFF-1E: Offsite Drainage 1

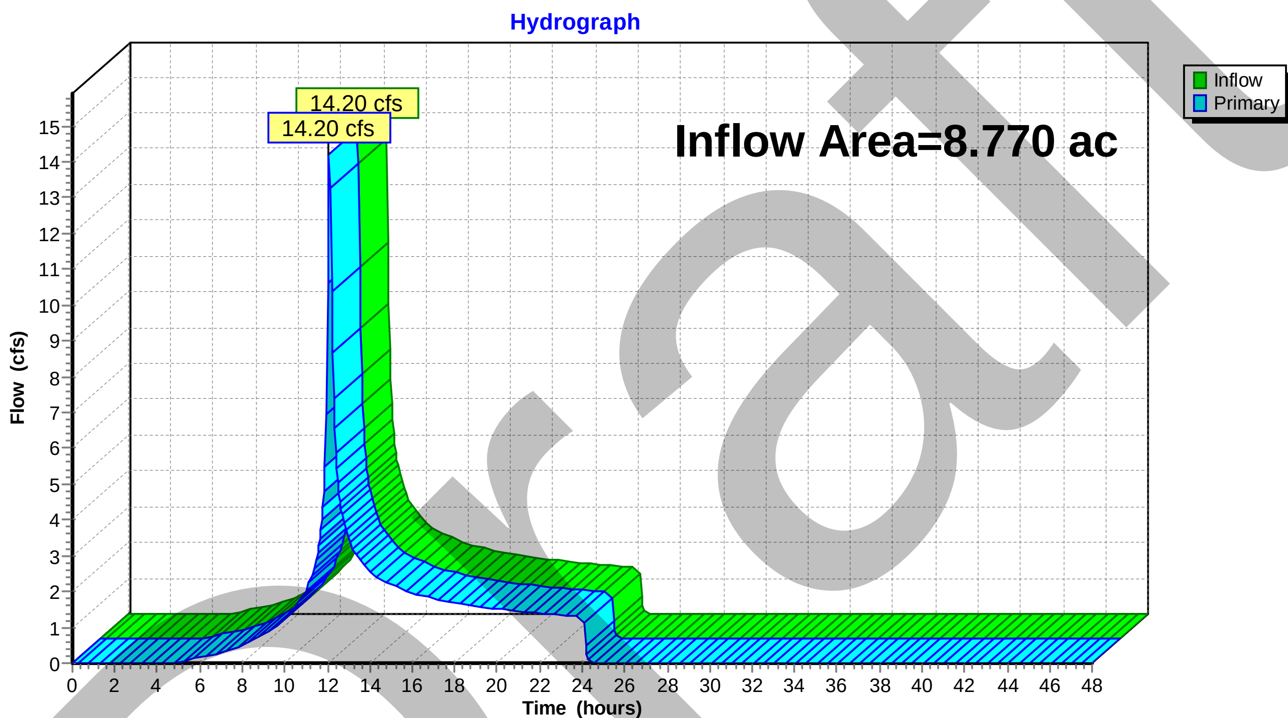
Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.09	0.00	0.00
1.00	0.19	0.00	0.00
1.50	0.29	0.00	0.00
2.00	0.39	0.00	0.00
2.50	0.49	0.00	0.00
3.00	0.59	0.00	0.00
3.50	0.70	0.00	0.00
4.00	0.81	0.00	0.00
4.50	0.92	0.00	0.00
5.00	1.04	0.00	0.00
5.50	1.16	0.00	0.00
6.00	1.29	0.00	0.00
6.50	1.42	0.00	0.00
7.00	1.55	0.00	0.00
7.50	1.70	0.00	0.02
8.00	1.85	0.01	0.06
8.50	2.00	0.02	0.11
9.00	2.17	0.04	0.16
9.50	2.36	0.07	0.22
10.00	2.56	0.11	0.30
10.50	2.78	0.16	0.40
11.00	3.05	0.23	0.56
11.50	3.39	0.34	0.88
12.00	4.25	0.68	**4.60**
12.50	4.85	0.96	**1.49**
13.00	5.17	1.13	1.11
13.50	5.43	1.27	0.95
14.00	5.66	1.40	0.85
14.50	5.85	1.51	0.79
15.00	6.04	1.62	0.74
15.50	6.20	1.72	0.70
16.00	6.36	1.81	0.67
16.50	6.51	1.91	0.64
17.00	6.65	1.99	0.62
17.50	6.79	2.08	0.60
18.00	6.92	2.16	0.58
18.50	7.04	2.24	0.57
19.00	7.16	2.32	0.55
19.50	7.28	2.40	0.54
20.00	7.39	2.48	0.53
20.50	7.50	2.55	0.52
21.00	7.61	2.62	0.51
21.50	7.71	2.69	0.50
22.00	7.81	2.76	0.49
22.50	7.91	2.83	0.49
23.00	8.01	2.90	0.48
23.50	8.11	2.97	0.47
24.00	**8.20**	**3.03**	0.46
24.50	8.20	3.03	0.00
25.00	8.20	3.03	0.00
25.50	8.20	3.03	0.00
26.00	8.20	3.03	0.00
26.50	8.20	3.03	0.00
27.00	8.20	3.03	0.00
27.50	8.20	3.03	0.00
28.00	8.20	3.03	0.00
28.50	8.20	3.03	0.00
29.00	8.20	3.03	0.00
29.50	8.20	3.03	0.00
30.00	8.20	3.03	0.00
30.50	8.20	3.03	0.00
31.00	8.20	3.03	0.00
31.50	8.20	3.03	0.00
32.00	8.20	3.03	0.00
32.50	8.20	3.03	0.00
33.00	8.20	3.03	0.00
33.50	8.20	3.03	0.00
34.00	8.20	3.03	0.00
34.50	8.20	3.03	0.00
35.00	8.20	3.03	0.00
35.50	8.20	3.03	0.00
36.00	8.20	3.03	0.00
36.50	8.20	3.03	0.00
37.00	8.20	3.03	0.00
37.50	8.20	3.03	0.00
38.00	8.20	3.03	0.00
38.50	8.20	3.03	0.00
39.00	8.20	3.03	0.00
39.50	8.20	3.03	0.00
40.00	8.20	3.03	0.00
40.50	8.20	3.03	0.00
41.00	8.20	3.03	0.00
41.50	8.20	3.03	0.00
42.00	8.20	3.03	0.00
42.50	8.20	3.03	0.00
43.00	8.20	3.03	0.00
43.50	8.20	3.03	0.00
44.00	8.20	3.03	0.00
44.50	8.20	3.03	0.00
45.00	8.20	3.03	0.00
45.50	8.20	3.03	0.00
46.00	8.20	3.03	0.00
46.50	8.20	3.03	0.00
47.00	8.20	3.03	0.00
47.50	8.20	3.03	0.00
48.00	8.20	3.03	0.00

Summary for Link Combined DA-1EX Flow: Combined DA-1EX Flows

Inflow Area = 8.770 ac, 0.80% Impervious, Inflow Depth = 3.86" for 100-yr event
Inflow = 14.20 cfs @ 12.08 hrs, Volume= 2.818 af
Primary = 14.20 cfs @ 12.08 hrs, Volume= 2.818 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link Combined DA-1EX Flow: Combined DA-1EX Flows



Hydrograph for Link Combined DA-1EX Flow: Combined DA-1EX Flows

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	**0.00**	0.00
0.50	0.00	0.00	0.00
1.00	0.00	0.00	0.00
1.50	0.00	0.00	0.00
2.00	0.00	0.00	0.00
2.50	0.00	0.00	0.00
3.00	0.00	0.00	0.00
3.50	0.00	0.00	0.00
4.00	0.00	0.00	0.00
4.50	0.00	0.00	0.00
5.00	0.03	0.00	0.03
5.50	0.09	0.00	0.09
6.00	0.16	0.00	0.16
6.50	0.22	0.00	0.22
7.00	0.29	0.00	0.29
7.50	0.39	0.00	0.39
8.00	0.52	0.00	0.52
8.50	0.65	0.00	0.65
9.00	0.81	0.00	0.81
9.50	1.00	0.00	1.00
10.00	1.24	0.00	1.24
10.50	1.55	0.00	1.55
11.00	2.03	0.00	2.03
11.50	2.95	0.00	2.95
12.00	**10.64**	0.00	**10.64**
12.50	**5.04**	0.00	**5.04**
13.00	3.48	0.00	3.48
13.50	2.91	0.00	2.91
14.00	2.58	0.00	2.58
14.50	2.36	0.00	2.36
15.00	2.19	0.00	2.19
15.50	2.07	0.00	2.07
16.00	1.96	0.00	1.96
16.50	1.88	0.00	1.88
17.00	1.80	0.00	1.80
17.50	1.74	0.00	1.74
18.00	1.68	0.00	1.68
18.50	1.63	0.00	1.63
19.00	1.59	0.00	1.59
19.50	1.55	0.00	1.55
20.00	1.51	0.00	1.51
20.50	1.48	0.00	1.48
21.00	1.45	0.00	1.45
21.50	1.42	0.00	1.42
22.00	1.39	0.00	1.39
22.50	1.37	0.00	1.37
23.00	1.34	0.00	1.34
23.50	1.32	0.00	1.32
24.00	1.30	0.00	1.30
24.50	0.00	0.00	0.00
25.00	0.00	0.00	0.00
25.50	0.00	0.00	0.00
26.00	0.00	0.00	0.00
26.50	0.00	0.00	0.00

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
27.00	0.00	0.00	0.00
27.50	0.00	0.00	0.00
28.00	0.00	0.00	0.00
28.50	0.00	0.00	0.00
29.00	0.00	0.00	0.00
29.50	0.00	0.00	0.00
30.00	0.00	0.00	0.00
30.50	0.00	0.00	0.00
31.00	0.00	0.00	0.00
31.50	0.00	0.00	0.00
32.00	0.00	0.00	0.00
32.50	0.00	0.00	0.00
33.00	0.00	0.00	0.00
33.50	0.00	0.00	0.00
34.00	0.00	0.00	0.00
34.50	0.00	0.00	0.00
35.00	0.00	0.00	0.00
35.50	0.00	0.00	0.00
36.00	0.00	0.00	0.00
36.50	0.00	0.00	0.00
37.00	0.00	0.00	0.00
37.50	0.00	0.00	0.00
38.00	0.00	0.00	0.00
38.50	0.00	0.00	0.00
39.00	0.00	0.00	0.00
39.50	0.00	0.00	0.00
40.00	0.00	0.00	0.00
40.50	0.00	0.00	0.00
41.00	0.00	0.00	0.00
41.50	0.00	0.00	0.00
42.00	0.00	0.00	0.00
42.50	0.00	0.00	0.00
43.00	0.00	0.00	0.00
43.50	0.00	0.00	0.00
44.00	0.00	0.00	0.00
44.50	0.00	0.00	0.00
45.00	0.00	0.00	0.00
45.50	0.00	0.00	0.00
46.00	0.00	0.00	0.00
46.50	0.00	0.00	0.00
47.00	0.00	0.00	0.00
47.50	0.00	0.00	0.00
48.00	0.00	0.00	0.00

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA-1EX: DA-1 Runoff Area=5.260 ac 0.00% Impervious Runoff Depth=1.08"
Flow Length=420' Slope=0.0403 '/' Tc=11.1 min CN=68 Runoff=4.89 cfs 0.474 af

Subcatchment OFF-1E: Offsite Drainage 1 Runoff Area=3.510 ac 1.99% Impervious Runoff Depth=0.49"
Tc=6.0 min CN=56 Runoff=1.08 cfs 0.144 af

Link Combined DA-1EX Flow: Combined DA-1EX Flows Inflow=5.83 cfs 0.618 af
Primary=5.83 cfs 0.618 af

Total Runoff Area = 8.770 ac Runoff Volume = 0.618 af Average Runoff Depth = 0.85"
99.20% Pervious = 8.700 ac 0.80% Impervious = 0.070 ac

Summary for Subcatchment DA-1EX: DA-1

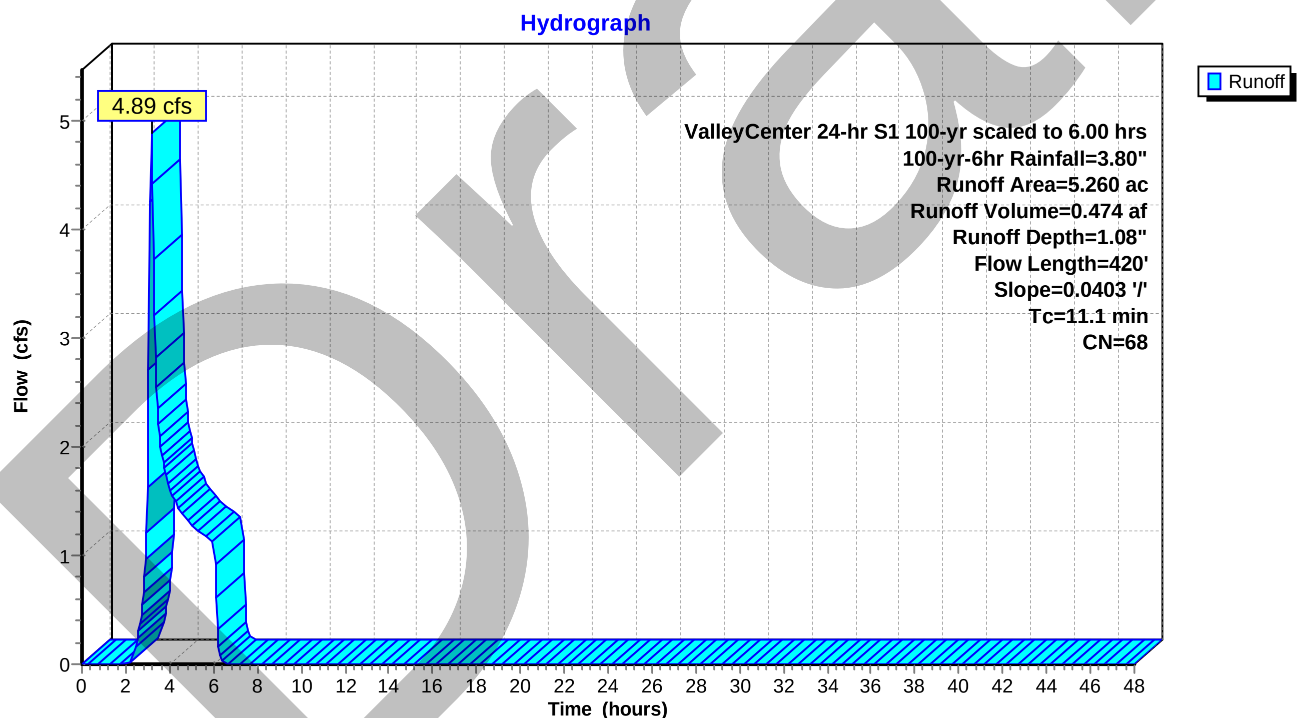
Runoff = 4.89 cfs @ 3.15 hrs, Volume= 0.474 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr scaled to 6.00 hrs 100-yr-6hr Rainfall=3.80"

Area (ac)	CN	Description
5.170	68	Pasture/grassland/range, Poor, HSG A
0.090	86	Pasture/grassland/range, Poor, HSG C
5.260	68	Weighted Average
5.260		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	420	0.0403	0.63		**Lag/CN Method,**

Subcatchment DA-1EX: DA-1



Hydrograph for Subcatchment DA-1EX: DA-1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.18	0.00	0.00
1.00	0.38	0.00	0.00
1.50	0.60	0.00	0.00
2.00	0.86	0.00	0.00
2.50	1.18	0.01	0.18
3.00	1.97	0.18	**1.63**
3.50	2.62	0.44	**2.21**
4.00	2.95	0.60	1.62
4.50	3.20	0.74	1.41
5.00	3.42	0.86	1.29
5.50	3.62	0.97	1.20
6.00	**3.80**	**1.08**	1.14
6.50	3.80	1.08	0.00
7.00	3.80	1.08	0.00
7.50	3.80	1.08	0.00
8.00	3.80	1.08	0.00
8.50	3.80	1.08	0.00
9.00	3.80	1.08	0.00
9.50	3.80	1.08	0.00
10.00	3.80	1.08	0.00
10.50	3.80	1.08	0.00
11.00	3.80	1.08	0.00
11.50	3.80	1.08	0.00
12.00	3.80	1.08	0.00
12.50	3.80	1.08	0.00
13.00	3.80	1.08	0.00
13.50	3.80	1.08	0.00
14.00	3.80	1.08	0.00
14.50	3.80	1.08	0.00
15.00	3.80	1.08	0.00
15.50	3.80	1.08	0.00
16.00	3.80	1.08	0.00
16.50	3.80	1.08	0.00
17.00	3.80	1.08	0.00
17.50	3.80	1.08	0.00
18.00	3.80	1.08	0.00
18.50	3.80	1.08	0.00
19.00	3.80	1.08	0.00
19.50	3.80	1.08	0.00
20.00	3.80	1.08	0.00
20.50	3.80	1.08	0.00
21.00	3.80	1.08	0.00
21.50	3.80	1.08	0.00
22.00	3.80	1.08	0.00
22.50	3.80	1.08	0.00
23.00	3.80	1.08	0.00
23.50	3.80	1.08	0.00
24.00	3.80	1.08	0.00
24.50	3.80	1.08	0.00
25.00	3.80	1.08	0.00
25.50	3.80	1.08	0.00
26.00	3.80	1.08	0.00
26.50	3.80	1.08	0.00
27.00	3.80	1.08	0.00
27.50	3.80	1.08	0.00
28.00	3.80	1.08	0.00
28.50	3.80	1.08	0.00
29.00	3.80	1.08	0.00
29.50	3.80	1.08	0.00
30.00	3.80	1.08	0.00
30.50	3.80	1.08	0.00
31.00	3.80	1.08	0.00
31.50	3.80	1.08	0.00
32.00	3.80	1.08	0.00
32.50	3.80	1.08	0.00
33.00	3.80	1.08	0.00
33.50	3.80	1.08	0.00
34.00	3.80	1.08	0.00
34.50	3.80	1.08	0.00
35.00	3.80	1.08	0.00
35.50	3.80	1.08	0.00
36.00	3.80	1.08	0.00
36.50	3.80	1.08	0.00
37.00	3.80	1.08	0.00
37.50	3.80	1.08	0.00
38.00	3.80	1.08	0.00
38.50	3.80	1.08	0.00
39.00	3.80	1.08	0.00
39.50	3.80	1.08	0.00
40.00	3.80	1.08	0.00
40.50	3.80	1.08	0.00
41.00	3.80	1.08	0.00
41.50	3.80	1.08	0.00
42.00	3.80	1.08	0.00
42.50	3.80	1.08	0.00
43.00	3.80	1.08	0.00
43.50	3.80	1.08	0.00
44.00	3.80	1.08	0.00
44.50	3.80	1.08	0.00
45.00	3.80	1.08	0.00
45.50	3.80	1.08	0.00
46.00	3.80	1.08	0.00
46.50	3.80	1.08	0.00
47.00	3.80	1.08	0.00
47.50	3.80	1.08	0.00
48.00	3.80	1.08	0.00

Summary for Subcatchment OFF-1E: Offsite Drainage 1

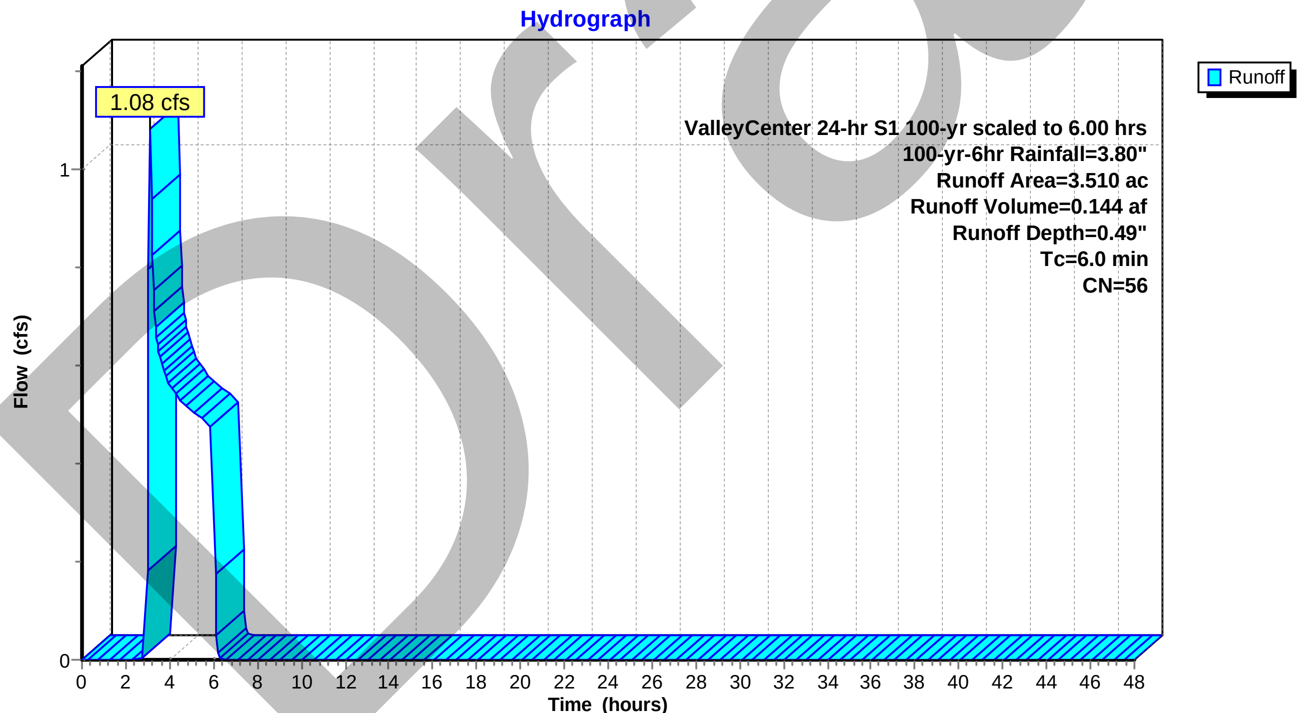
Runoff = 1.08 cfs @ 3.11 hrs, Volume= 0.144 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr scaled to 6.00 hrs 100-yr-6hr Rainfall=3.80"

Area (ac)	CN	Description
2.560	48	Brush, Poor, HSG A
0.880	77	Brush, Poor, HSG C
0.070	98	Paved parking, HSG C
3.510	56	Weighted Average
3.440		98.01% Pervious Area
0.070		1.99% Impervious Area

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

Subcatchment OFF-1E: Offsite Drainage 1



Hydrograph for Subcatchment OFF-1E: Offsite Drainage 1

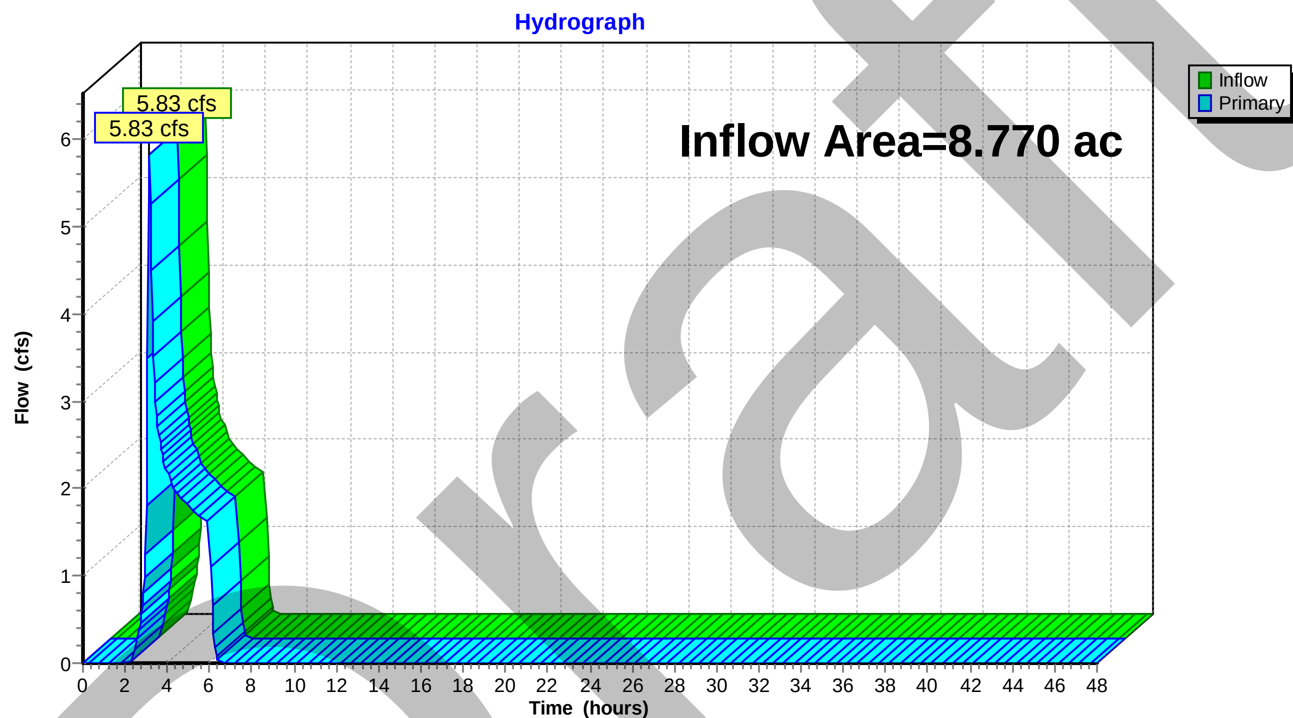
Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.18	0.00	0.00
1.00	0.38	0.00	0.00
1.50	0.60	0.00	0.00
2.00	0.86	0.00	0.00
2.50	1.18	0.00	0.00
3.00	1.97	0.02	**0.18**
3.50	2.62	0.12	**0.63**
4.00	2.95	0.21	0.56
4.50	3.20	0.28	0.53
5.00	3.42	0.35	0.51
5.50	3.62	0.42	0.49
6.00	**3.80**	**0.49**	0.48
6.50	3.80	0.49	0.00
7.00	3.80	0.49	0.00
7.50	3.80	0.49	0.00
8.00	3.80	0.49	0.00
8.50	3.80	0.49	0.00
9.00	3.80	0.49	0.00
9.50	3.80	0.49	0.00
10.00	3.80	0.49	0.00
10.50	3.80	0.49	0.00
11.00	3.80	0.49	0.00
11.50	3.80	0.49	0.00
12.00	3.80	0.49	0.00
12.50	3.80	0.49	0.00
13.00	3.80	0.49	0.00
13.50	3.80	0.49	0.00
14.00	3.80	0.49	0.00
14.50	3.80	0.49	0.00
15.00	3.80	0.49	0.00
15.50	3.80	0.49	0.00
16.00	3.80	0.49	0.00
16.50	3.80	0.49	0.00
17.00	3.80	0.49	0.00
17.50	3.80	0.49	0.00
18.00	3.80	0.49	0.00
18.50	3.80	0.49	0.00
19.00	3.80	0.49	0.00
19.50	3.80	0.49	0.00
20.00	3.80	0.49	0.00
20.50	3.80	0.49	0.00
21.00	3.80	0.49	0.00
21.50	3.80	0.49	0.00
22.00	3.80	0.49	0.00
22.50	3.80	0.49	0.00
23.00	3.80	0.49	0.00
23.50	3.80	0.49	0.00
24.00	3.80	0.49	0.00
24.50	3.80	0.49	0.00
25.00	3.80	0.49	0.00
25.50	3.80	0.49	0.00
26.00	3.80	0.49	0.00
26.50	3.80	0.49	0.00
27.00	3.80	0.49	0.00
27.50	3.80	0.49	0.00
28.00	3.80	0.49	0.00
28.50	3.80	0.49	0.00
29.00	3.80	0.49	0.00
29.50	3.80	0.49	0.00
30.00	3.80	0.49	0.00
30.50	3.80	0.49	0.00
31.00	3.80	0.49	0.00
31.50	3.80	0.49	0.00
32.00	3.80	0.49	0.00
32.50	3.80	0.49	0.00
33.00	3.80	0.49	0.00
33.50	3.80	0.49	0.00
34.00	3.80	0.49	0.00
34.50	3.80	0.49	0.00
35.00	3.80	0.49	0.00
35.50	3.80	0.49	0.00
36.00	3.80	0.49	0.00
36.50	3.80	0.49	0.00
37.00	3.80	0.49	0.00
37.50	3.80	0.49	0.00
38.00	3.80	0.49	0.00
38.50	3.80	0.49	0.00
39.00	3.80	0.49	0.00
39.50	3.80	0.49	0.00
40.00	3.80	0.49	0.00
40.50	3.80	0.49	0.00
41.00	3.80	0.49	0.00
41.50	3.80	0.49	0.00
42.00	3.80	0.49	0.00
42.50	3.80	0.49	0.00
43.00	3.80	0.49	0.00
43.50	3.80	0.49	0.00
44.00	3.80	0.49	0.00
44.50	3.80	0.49	0.00
45.00	3.80	0.49	0.00
45.50	3.80	0.49	0.00
46.00	3.80	0.49	0.00
46.50	3.80	0.49	0.00
47.00	3.80	0.49	0.00
47.50	3.80	0.49	0.00
48.00	3.80	0.49	0.00

Summary for Link Combined DA-1EX Flow: Combined DA-1EX Flows

Inflow Area = 8.770 ac, 0.80% Impervious, Inflow Depth = 0.85" for 100-yr-6hr event
Inflow = 5.83 cfs @ 3.15 hrs, Volume= 0.618 af
Primary = 5.83 cfs @ 3.15 hrs, Volume= 0.618 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link Combined DA-1EX Flow: Combined DA-1EX Flows



Hydrograph for Link Combined DA-1EX Flow: Combined DA-1EX Flows

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	**0.00**	0.00
0.50	0.00	0.00	0.00
1.00	0.00	0.00	0.00
1.50	0.00	0.00	0.00
2.00	0.00	0.00	0.00
2.50	0.18	0.00	0.18
3.00	**1.82**	0.00	**1.82**
3.50	**2.84**	0.00	**2.84**
4.00	2.18	0.00	2.18
4.50	1.94	0.00	1.94
5.00	1.79	0.00	1.79
5.50	1.69	0.00	1.69
6.00	1.62	0.00	1.62
6.50	0.00	0.00	0.00
7.00	0.00	0.00	0.00
7.50	0.00	0.00	0.00
8.00	0.00	0.00	0.00
8.50	0.00	0.00	0.00
9.00	0.00	0.00	0.00
9.50	0.00	0.00	0.00
10.00	0.00	0.00	0.00
10.50	0.00	0.00	0.00
11.00	0.00	0.00	0.00
11.50	0.00	0.00	0.00
12.00	0.00	0.00	0.00
12.50	0.00	0.00	0.00
13.00	0.00	0.00	0.00
13.50	0.00	0.00	0.00
14.00	0.00	0.00	0.00
14.50	0.00	0.00	0.00
15.00	0.00	0.00	0.00
15.50	0.00	0.00	0.00
16.00	0.00	0.00	0.00
16.50	0.00	0.00	0.00
17.00	0.00	0.00	0.00
17.50	0.00	0.00	0.00
18.00	0.00	0.00	0.00
18.50	0.00	0.00	0.00
19.00	0.00	0.00	0.00
19.50	0.00	0.00	0.00
20.00	0.00	0.00	0.00
20.50	0.00	0.00	0.00
21.00	0.00	0.00	0.00
21.50	0.00	0.00	0.00
22.00	0.00	0.00	0.00
22.50	0.00	0.00	0.00
23.00	0.00	0.00	0.00
23.50	0.00	0.00	0.00
24.00	0.00	0.00	0.00
24.50	0.00	0.00	0.00
25.00	0.00	0.00	0.00
25.50	0.00	0.00	0.00
26.00	0.00	0.00	0.00
26.50	0.00	0.00	0.00
27.00	0.00	0.00	0.00
27.50	0.00	0.00	0.00
28.00	0.00	0.00	0.00
28.50	0.00	0.00	0.00
29.00	0.00	0.00	0.00
29.50	0.00	0.00	0.00
30.00	0.00	0.00	0.00
30.50	0.00	0.00	0.00
31.00	0.00	0.00	0.00
31.50	0.00	0.00	0.00
32.00	0.00	0.00	0.00
32.50	0.00	0.00	0.00
33.00	0.00	0.00	0.00
33.50	0.00	0.00	0.00
34.00	0.00	0.00	0.00
34.50	0.00	0.00	0.00
35.00	0.00	0.00	0.00
35.50	0.00	0.00	0.00
36.00	0.00	0.00	0.00
36.50	0.00	0.00	0.00
37.00	0.00	0.00	0.00
37.50	0.00	0.00	0.00
38.00	0.00	0.00	0.00
38.50	0.00	0.00	0.00
39.00	0.00	0.00	0.00
39.50	0.00	0.00	0.00
40.00	0.00	0.00	0.00
40.50	0.00	0.00	0.00
41.00	0.00	0.00	0.00
41.50	0.00	0.00	0.00
42.00	0.00	0.00	0.00
42.50	0.00	0.00	0.00
43.00	0.00	0.00	0.00
43.50	0.00	0.00	0.00
44.00	0.00	0.00	0.00
44.50	0.00	0.00	0.00
45.00	0.00	0.00	0.00
45.50	0.00	0.00	0.00
46.00	0.00	0.00	0.00
46.50	0.00	0.00	0.00
47.00	0.00	0.00	0.00
47.50	0.00	0.00	0.00
48.00	0.00	0.00	0.00

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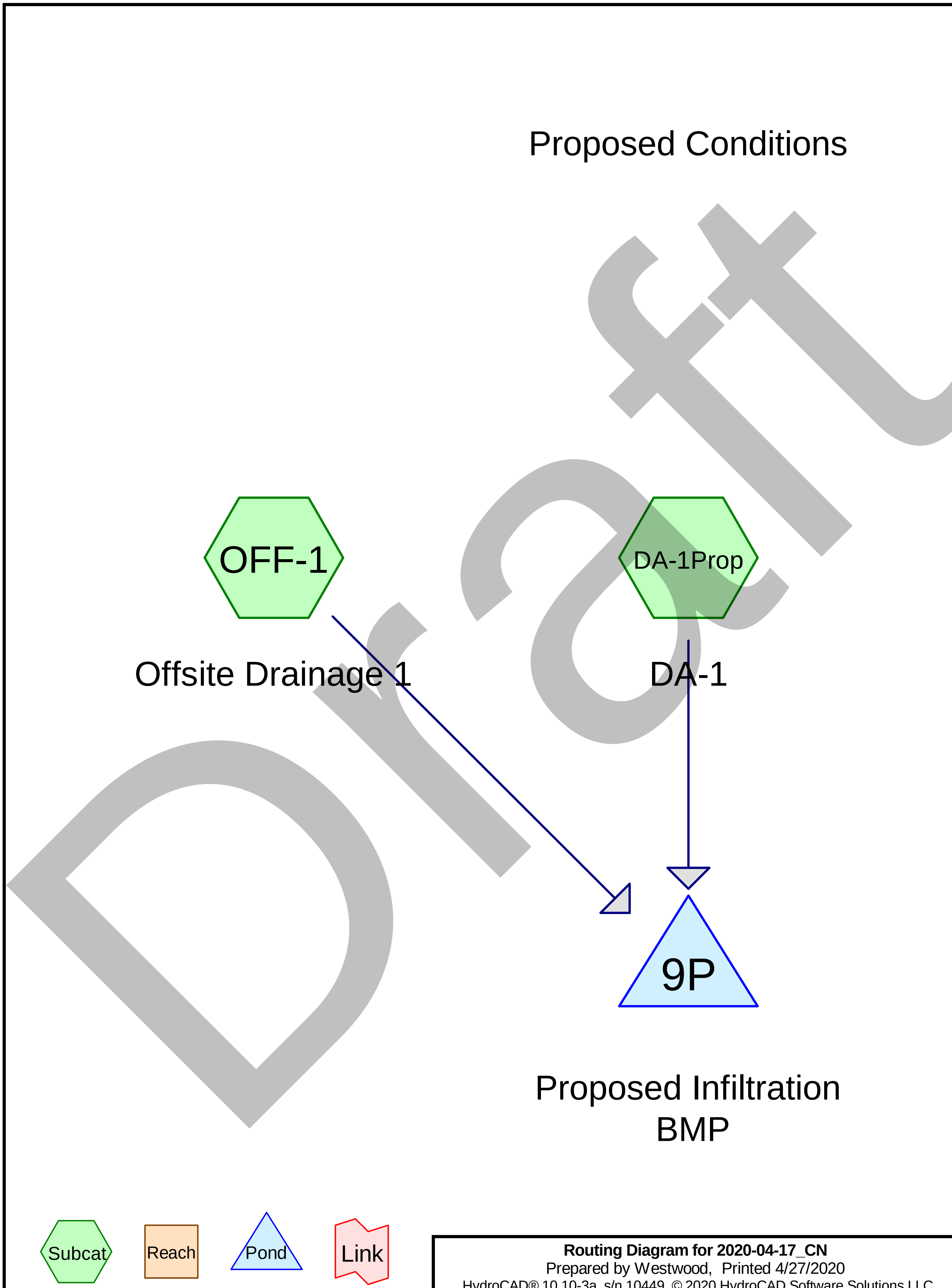


Routing Diagram for 2020-04-17_CN
Prepared by Westwood, Printed 4/27/2020

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr	ValleyCenter 24-hr S1	1-yr	Default	24.00	1	2.12	2
2	2-yr	ValleyCenter 24-hr S1	2-yr	Default	24.00	1	3.00	2
3	5-yr	ValleyCenter 24-hr S1	5-yr	Default	24.00	1	4.10	2
4	10-yr	ValleyCenter 24-hr S1	10-yr	Default	24.00	1	5.10	2
5	25-yr	ValleyCenter 24-hr S1	25-yr	Default	24.00	1	6.20	2
6	50-yr	ValleyCenter 24-hr S1	50-yr	Default	24.00	1	7.20	2
7	100-yr	ValleyCenter 24-hr S1	100-yr	Default	24.00	1	8.20	2
8	100-yr-6hr	ValleyCenter 24-hr S1	100-yr	Scale	6.00	1	3.80	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.560	48	Brush, Poor, HSG A (OFF-1)
0.880	77	Brush, Poor, HSG C (OFF-1)
0.070	98	Paved parking, HSG C (OFF-1)
5.260	98	Unconnected pavement, HSG C (DA-1Prop)
8.770	**81**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
2.560	HSG A	OFF-1
0.000	HSG B	
6.210	HSG C	DA-1Prop, OFF-1
0.000	HSG D	
0.000	Other	
8.770		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
2.560	0.000	0.880	0.000	0.000	3.440	Brush, Poor	OFF-1
0.000	0.000	0.070	0.000	0.000	0.070	Paved parking	OFF-1
0.000	0.000	5.260	0.000	0.000	5.260	Unconnected pavement	DA-1Prop
2.560	**0.000**	**6.210**	**0.000**	**0.000**	**8.770**	**TOTAL AREA**	

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA-1Prop: DA-1 Runoff Area=5.260 ac 100.00% Impervious Runoff Depth=7.96"
Flow Length=420' Slope=0.0403 '/' Tc=3.7 min CN=98 Runoff=20.74 cfs 3.489 af

Subcatchment OFF-1: Offsite Drainage 1 Runoff Area=3.510 ac 1.99% Impervious Runoff Depth=3.03"
Tc=6.0 min CN=56 Runoff=5.31 cfs 0.887 af

Pond 9P: Proposed Infiltration BMP Peak Elev=1,363.72' Storage=1.043 af Inflow=25.54 cfs 4.376 af
Discarded=0.76 cfs 1.552 af Primary=11.82 cfs 2.745 af Outflow=12.58 cfs 4.297 af

Total Runoff Area = 8.770 ac Runoff Volume = 4.376 af Average Runoff Depth = 5.99"
39.22% Pervious = 3.440 ac 60.78% Impervious = 5.330 ac

Summary for Subcatchment DA-1Prop: DA-1

[49] Hint: Tc<2dt may require smaller dt

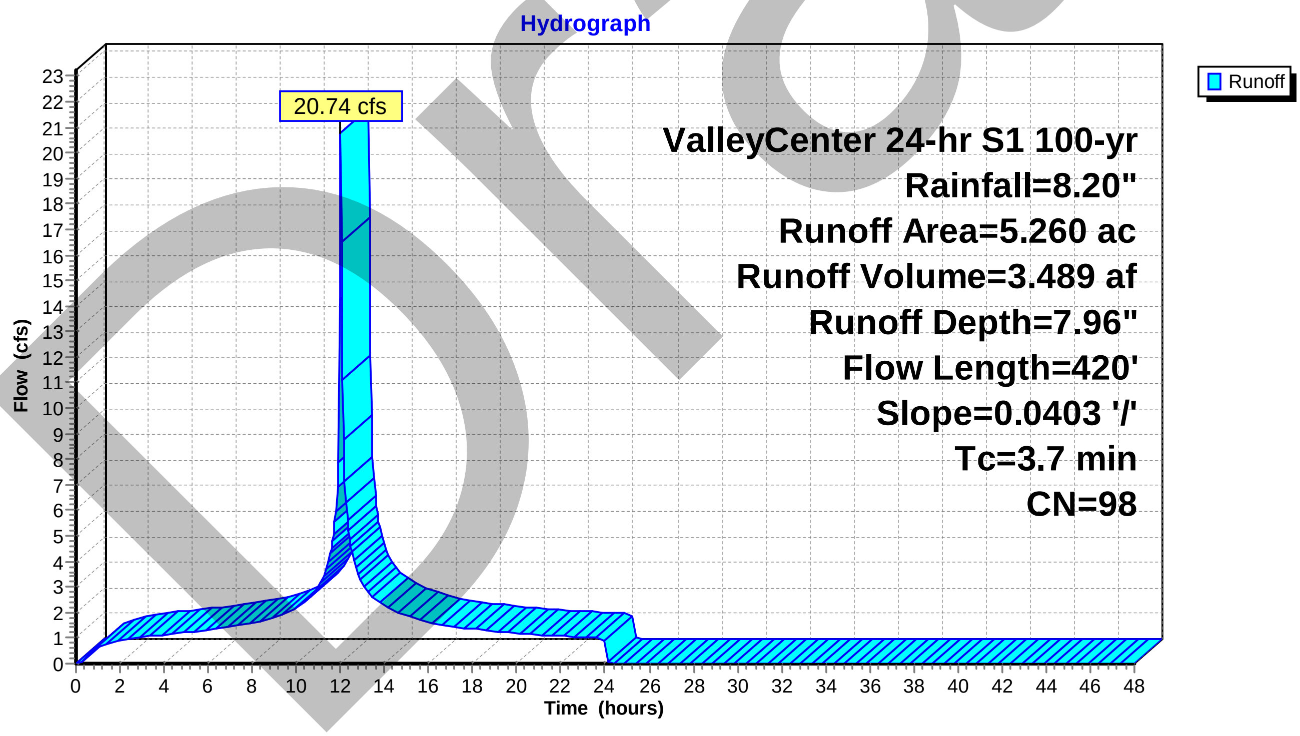
Runoff = 20.74 cfs @ 12.01 hrs, Volume= 3.489 af, Depth= 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr Rainfall=8.20"

Area (ac)	CN	Description
5.170	98	Unconnected pavement, HSG C
0.090	98	Unconnected pavement, HSG C
5.260	98	Weighted Average
5.260		100.00% Impervious Area
5.260		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	420	0.0403	1.87		**Lag/CN Method,**

Subcatchment DA-1Prop: DA-1



Hydrograph for Subcatchment DA-1Prop: DA-1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.09	0.01	0.31
1.00	0.19	0.06	0.66
1.50	0.29	0.13	0.82
2.00	0.39	0.22	0.91
2.50	0.49	0.31	0.98
3.00	0.59	0.40	1.04
3.50	0.70	0.50	1.08
4.00	0.81	0.61	1.13
4.50	0.92	0.72	1.17
5.00	1.04	0.83	1.22
5.50	1.16	0.95	1.27
6.00	1.29	1.07	1.32
6.50	1.42	1.20	1.38
7.00	1.55	1.33	1.44
7.50	1.70	1.47	1.52
8.00	1.85	1.62	1.60
8.50	2.00	1.78	1.71
9.00	2.17	1.95	1.83
9.50	2.36	2.13	1.99
10.00	2.56	2.33	2.20
10.50	2.78	2.55	2.51
11.00	3.05	2.81	3.01
11.50	3.39	3.15	4.07
12.00	4.25	4.01	**20.68**
12.50	4.85	4.61	4.35
13.00	5.17	4.94	3.11
13.50	5.43	5.20	2.57
14.00	5.66	5.42	2.25
14.50	5.85	5.62	2.03
15.00	6.04	5.80	1.86
15.50	6.20	5.97	1.73
16.00	6.36	6.12	1.63
16.50	6.51	6.27	1.54
17.00	6.65	6.41	1.47
17.50	6.79	6.55	1.41
18.00	6.92	6.68	1.35
18.50	7.04	6.80	1.30
19.00	7.16	6.92	1.26
19.50	7.28	7.04	1.22
20.00	7.39	7.15	1.19
20.50	7.50	7.26	1.15
21.00	7.61	7.37	1.12
21.50	7.71	7.47	1.10
22.00	7.81	7.57	1.07
22.50	7.91	7.67	1.05
23.00	8.01	7.77	1.02
23.50	8.11	7.87	1.00
24.00	**8.20**	**7.96**	0.98
24.50	8.20	7.96	0.00
25.00	8.20	7.96	0.00
25.50	8.20	7.96	0.00
26.00	8.20	7.96	0.00
26.50	8.20	7.96	0.00
27.00	8.20	7.96	0.00
27.50	8.20	7.96	0.00
28.00	8.20	7.96	0.00
28.50	8.20	7.96	0.00
29.00	8.20	7.96	0.00
29.50	8.20	7.96	0.00
30.00	8.20	7.96	0.00
30.50	8.20	7.96	0.00
31.00	8.20	7.96	0.00
31.50	8.20	7.96	0.00
32.00	8.20	7.96	0.00
32.50	8.20	7.96	0.00
33.00	8.20	7.96	0.00
33.50	8.20	7.96	0.00
34.00	8.20	7.96	0.00
34.50	8.20	7.96	0.00
35.00	8.20	7.96	0.00
35.50	8.20	7.96	0.00
36.00	8.20	7.96	0.00
36.50	8.20	7.96	0.00
37.00	8.20	7.96	0.00
37.50	8.20	7.96	0.00
38.00	8.20	7.96	0.00
38.50	8.20	7.96	0.00
39.00	8.20	7.96	0.00
39.50	8.20	7.96	0.00
40.00	8.20	7.96	0.00
40.50	8.20	7.96	0.00
41.00	8.20	7.96	0.00
41.50	8.20	7.96	0.00
42.00	8.20	7.96	0.00
42.50	8.20	7.96	0.00
43.00	8.20	7.96	0.00
43.50	8.20	7.96	0.00
44.00	8.20	7.96	0.00
44.50	8.20	7.96	0.00
45.00	8.20	7.96	0.00
45.50	8.20	7.96	0.00
46.00	8.20	7.96	0.00
46.50	8.20	7.96	0.00
47.00	8.20	7.96	0.00
47.50	8.20	7.96	0.00
48.00	8.20	7.96	0.00

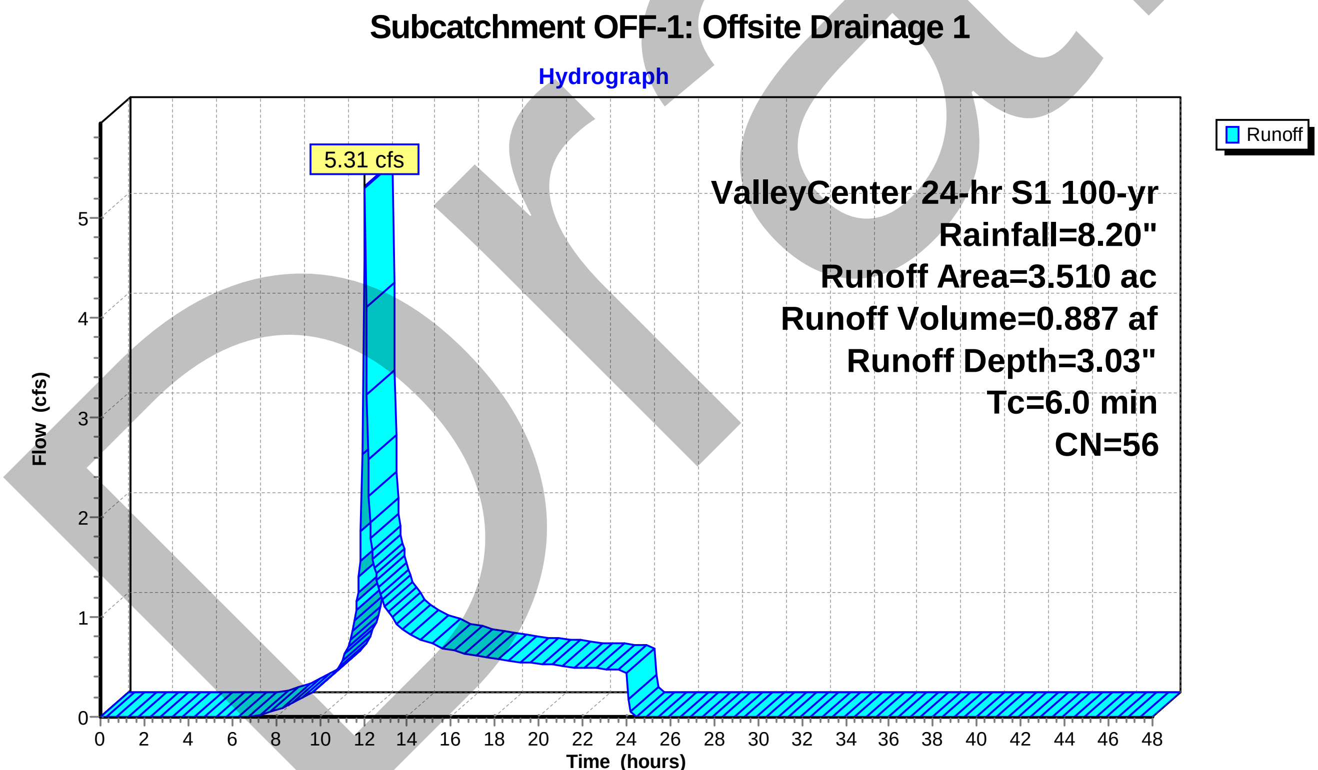
Summary for Subcatchment OFF-1: Offsite Drainage 1

Runoff = 5.31 cfs @ 12.04 hrs, Volume= 0.887 af, Depth= 3.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr Rainfall=8.20"

Area (ac)	CN	Description
2.560	48	Brush, Poor, HSG A
0.880	77	Brush, Poor, HSG C
0.070	98	Paved parking, HSG C
3.510	56	Weighted Average
3.440		98.01% Pervious Area
0.070		1.99% Impervious Area

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



Hydrograph for Subcatchment OFF-1: Offsite Drainage 1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.09	0.00	0.00
1.00	0.19	0.00	0.00
1.50	0.29	0.00	0.00
2.00	0.39	0.00	0.00
2.50	0.49	0.00	0.00
3.00	0.59	0.00	0.00
3.50	0.70	0.00	0.00
4.00	0.81	0.00	0.00
4.50	0.92	0.00	0.00
5.00	1.04	0.00	0.00
5.50	1.16	0.00	0.00
6.00	1.29	0.00	0.00
6.50	1.42	0.00	0.00
7.00	1.55	0.00	0.00
7.50	1.70	0.00	0.02
8.00	1.85	0.01	0.06
8.50	2.00	0.02	0.11
9.00	2.17	0.04	0.16
9.50	2.36	0.07	0.22
10.00	2.56	0.11	0.30
10.50	2.78	0.16	0.40
11.00	3.05	0.23	0.56
11.50	3.39	0.34	0.88
12.00	4.25	0.68	**4.60**
12.50	4.85	0.96	**1.49**
13.00	5.17	1.13	1.11
13.50	5.43	1.27	0.95
14.00	5.66	1.40	0.85
14.50	5.85	1.51	0.79
15.00	6.04	1.62	0.74
15.50	6.20	1.72	0.70
16.00	6.36	1.81	0.67
16.50	6.51	1.91	0.64
17.00	6.65	1.99	0.62
17.50	6.79	2.08	0.60
18.00	6.92	2.16	0.58
18.50	7.04	2.24	0.57
19.00	7.16	2.32	0.55
19.50	7.28	2.40	0.54
20.00	7.39	2.48	0.53
20.50	7.50	2.55	0.52
21.00	7.61	2.62	0.51
21.50	7.71	2.69	0.50
22.00	7.81	2.76	0.49
22.50	7.91	2.83	0.49
23.00	8.01	2.90	0.48
23.50	8.11	2.97	0.47
24.00	**8.20**	**3.03**	0.46
24.50	8.20	3.03	0.00
25.00	8.20	3.03	0.00
25.50	8.20	3.03	0.00
26.00	8.20	3.03	0.00
26.50	8.20	3.03	0.00
27.00	8.20	3.03	0.00
27.50	8.20	3.03	0.00
28.00	8.20	3.03	0.00
28.50	8.20	3.03	0.00
29.00	8.20	3.03	0.00
29.50	8.20	3.03	0.00
30.00	8.20	3.03	0.00
30.50	8.20	3.03	0.00
31.00	8.20	3.03	0.00
31.50	8.20	3.03	0.00
32.00	8.20	3.03	0.00
32.50	8.20	3.03	0.00
33.00	8.20	3.03	0.00
33.50	8.20	3.03	0.00
34.00	8.20	3.03	0.00
34.50	8.20	3.03	0.00
35.00	8.20	3.03	0.00
35.50	8.20	3.03	0.00
36.00	8.20	3.03	0.00
36.50	8.20	3.03	0.00
37.00	8.20	3.03	0.00
37.50	8.20	3.03	0.00
38.00	8.20	3.03	0.00
38.50	8.20	3.03	0.00
39.00	8.20	3.03	0.00
39.50	8.20	3.03	0.00
40.00	8.20	3.03	0.00
40.50	8.20	3.03	0.00
41.00	8.20	3.03	0.00
41.50	8.20	3.03	0.00
42.00	8.20	3.03	0.00
42.50	8.20	3.03	0.00
43.00	8.20	3.03	0.00
43.50	8.20	3.03	0.00
44.00	8.20	3.03	0.00
44.50	8.20	3.03	0.00
45.00	8.20	3.03	0.00
45.50	8.20	3.03	0.00
46.00	8.20	3.03	0.00
46.50	8.20	3.03	0.00
47.00	8.20	3.03	0.00
47.50	8.20	3.03	0.00
48.00	8.20	3.03	0.00

Summary for Pond 9P: Proposed Infiltration BMP

Inflow Area = 8.770 ac, 60.78% Impervious, Inflow Depth = 5.99" for 100-yr event
Inflow = 25.54 cfs @ 12.01 hrs, Volume= 4.376 af
Outflow = 12.58 cfs @ 12.15 hrs, Volume= 4.297 af, Atten= 51%, Lag= 8.1 min
Discarded = 0.76 cfs @ 12.15 hrs, Volume= 1.552 af
Primary = 11.82 cfs @ 12.15 hrs, Volume= 2.745 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,363.72' @ 12.15 hrs Surf.Area= 0.315 ac Storage= 1.043 af

Plug-Flow detention time= 278.7 min calculated for 4.297 af (98% of inflow)
Center-of-Mass det. time= 266.8 min (1,047.0 - 780.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,355.25'	1.136 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

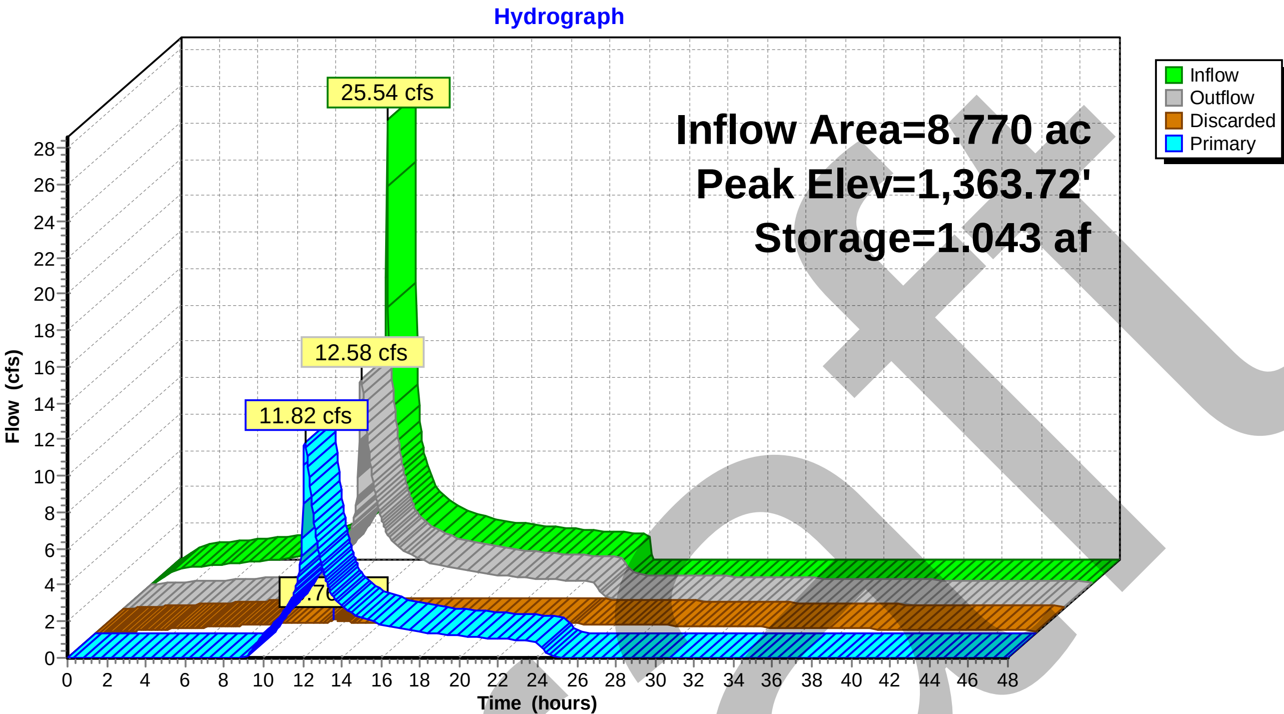
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,355.25	0.012	0.000	0.000
1,356.00	0.024	0.014	0.014
1,357.00	0.043	0.033	0.047
1,358.00	0.065	0.054	0.101
1,359.00	0.091	0.078	0.179
1,360.00	0.121	0.106	0.285
1,361.00	0.163	0.142	0.427
1,362.00	0.206	0.184	0.612
1,363.00	0.251	0.228	0.840
1,364.00	0.340	0.295	1.136

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,355.25'	**2.400 in/hr Exfiltration over Surface area**
#2	Primary	1,362.25'	**2.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

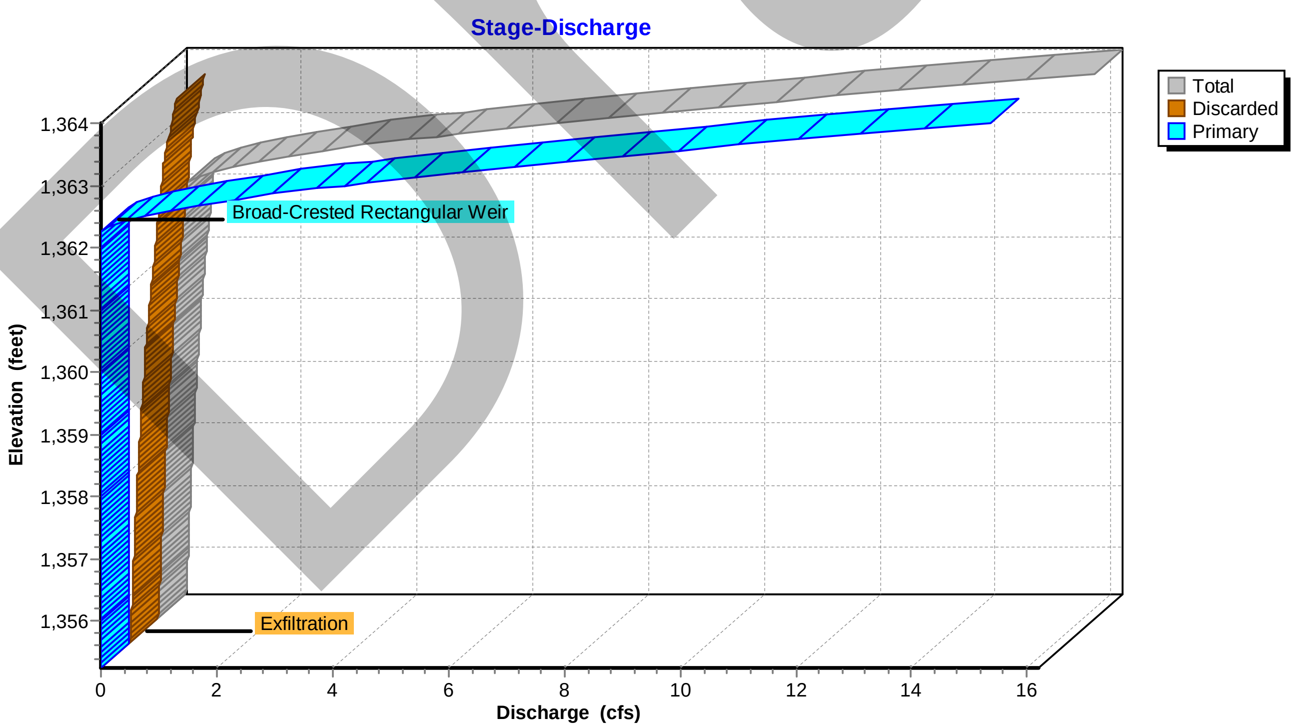
Discarded OutFlow Max=0.76 cfs @ 12.15 hrs HW=1,363.72' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.76 cfs)

Primary OutFlow Max=11.80 cfs @ 12.15 hrs HW=1,363.72' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 11.80 cfs @ 4.02 fps)

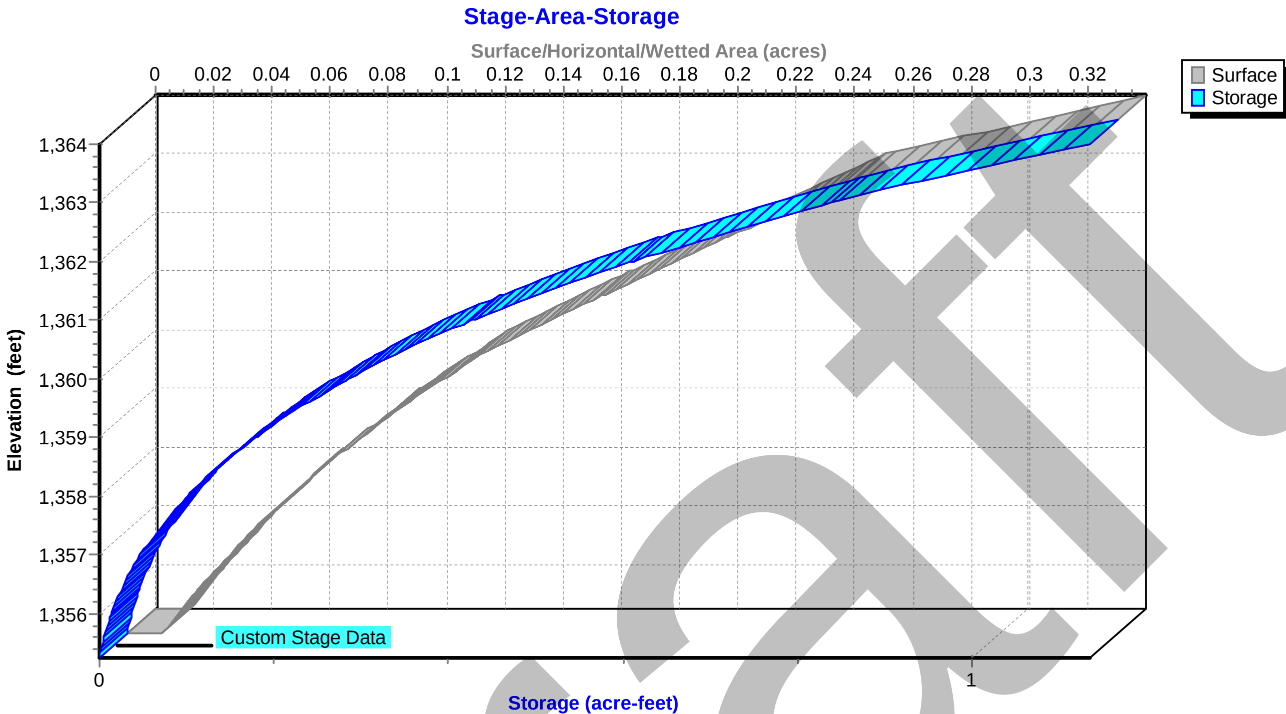
Pond 9P: Proposed Infiltration BMP



Pond 9P: Proposed Infiltration BMP



Pond 9P: Proposed Infiltration BMP



Hydrograph for Pond 9P: Proposed Infiltration BMP

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	1,355.25	0.00	0.00	0.00
1.00	0.66	0.022	1,356.30	0.07	0.07	0.00
2.00	0.91	0.080	1,357.65	0.14	0.14	0.00
3.00	1.04	0.147	1,358.63	0.20	0.20	0.00
4.00	1.13	0.218	1,359.40	0.25	0.25	0.00
5.00	1.22	0.292	1,360.06	0.30	0.30	0.00
6.00	1.32	0.370	1,360.63	0.36	0.36	0.00
7.00	1.44	0.452	1,361.15	0.41	0.41	0.00
8.00	1.67	0.544	1,361.66	0.46	0.46	0.00
9.00	1.99	0.654	1,362.20	0.52	0.52	0.00
10.00	2.50	0.746	1,362.61	1.84	0.57	1.27
11.00	3.57	0.789	1,362.79	3.03	0.59	2.45
12.00	**25.28**	**0.956**	**1,363.43**	**9.21**	**0.70**	**8.51**
13.00	4.22	**0.860**	**1,363.08**	**5.62**	**0.62**	**4.99**
14.00	3.10	0.803	1,362.85	3.46	0.59	2.86
15.00	2.60	0.782	1,362.76	2.79	0.58	2.21
16.00	2.30	0.769	1,362.71	2.42	0.58	1.85
17.00	2.09	0.760	1,362.67	2.19	0.57	1.61
18.00	1.94	0.753	1,362.64	2.01	0.57	1.44
19.00	1.82	0.748	1,362.62	1.87	0.57	1.31
20.00	1.72	0.743	1,362.60	1.76	0.56	1.20
21.00	1.63	0.739	1,362.58	1.68	0.56	1.12
22.00	1.56	0.736	1,362.57	1.60	0.56	1.04
23.00	1.50	0.733	1,362.56	1.54	0.56	0.98
24.00	1.44	0.730	1,362.54	1.48	0.56	0.92
25.00	0.00	0.665	1,362.25	0.53	0.53	0.01
26.00	0.00	0.623	1,362.05	0.50	0.50	0.00
27.00	0.00	0.582	1,361.85	0.48	0.48	0.00
28.00	0.00	0.543	1,361.65	0.46	0.46	0.00
29.00	0.00	0.506	1,361.45	0.44	0.44	0.00
30.00	0.00	0.470	1,361.25	0.42	0.42	0.00
31.00	0.00	0.436	1,361.05	0.40	0.40	0.00
32.00	0.00	0.404	1,360.85	0.38	0.38	0.00
33.00	0.00	0.373	1,360.65	0.36	0.36	0.00
34.00	0.00	0.344	1,360.45	0.34	0.34	0.00
35.00	0.00	0.317	1,360.25	0.32	0.32	0.00
36.00	0.00	0.292	1,360.05	0.30	0.30	0.00
37.00	0.00	0.268	1,359.85	0.28	0.28	0.00
38.00	0.00	0.245	1,359.65	0.27	0.27	0.00
39.00	0.00	0.224	1,359.45	0.25	0.25	0.00
40.00	0.00	0.203	1,359.25	0.24	0.24	0.00
41.00	0.00	0.184	1,359.05	0.22	0.22	0.00
42.00	0.00	0.166	1,358.85	0.21	0.21	0.00
43.00	0.00	0.149	1,358.66	0.20	0.20	0.00
44.00	0.00	0.133	1,358.45	0.19	0.19	0.00
45.00	0.00	0.118	1,358.25	0.17	0.17	0.00
46.00	0.00	0.105	1,358.06	0.16	0.16	0.00
47.00	0.00	0.092	1,357.85	0.15	0.15	0.00
48.00	0.00	0.080	1,357.65	0.14	0.14	0.00

Stage-Discharge for Pond 9P: Proposed Infiltration BMP

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
1,355.25	0.00	0.00	0.00
1,355.35	0.03	0.03	0.00
1,355.45	0.04	0.04	0.00
1,355.55	0.04	0.04	0.00
1,355.65	0.04	0.04	0.00
1,355.75	0.05	0.05	0.00
1,355.85	0.05	0.05	0.00
1,355.95	0.06	0.06	0.00
1,356.05	0.06	0.06	0.00
1,356.15	0.06	0.06	0.00
1,356.25	0.07	0.07	0.00
1,356.35	0.07	0.07	0.00
1,356.45	0.08	0.08	0.00
1,356.55	0.08	0.08	0.00
1,356.65	0.09	0.09	0.00
1,356.75	0.09	0.09	0.00
1,356.85	0.10	0.10	0.00
1,356.95	0.10	0.10	0.00
1,357.05	0.11	0.11	0.00
1,357.15	0.11	0.11	0.00
1,357.25	0.12	0.12	0.00
1,357.35	0.12	0.12	0.00
1,357.45	0.13	0.13	0.00
1,357.55	0.13	0.13	0.00
1,357.65	0.14	0.14	0.00
1,357.75	0.14	0.14	0.00
1,357.85	0.15	0.15	0.00
1,357.95	0.15	0.15	0.00
1,358.05	0.16	0.16	0.00
1,358.15	0.17	0.17	0.00
1,358.25	0.17	0.17	0.00
1,358.35	0.18	0.18	0.00
1,358.45	0.19	0.19	0.00
1,358.55	0.19	0.19	0.00
1,358.65	0.20	0.20	0.00
1,358.75	0.20	0.20	0.00
1,358.85	0.21	0.21	0.00
1,358.95	0.22	0.22	0.00
1,359.05	0.22	0.22	0.00
1,359.15	0.23	0.23	0.00
1,359.25	0.24	0.24	0.00
1,359.35	0.25	0.25	0.00
1,359.45	0.25	0.25	0.00
1,359.55	0.26	0.26	0.00
1,359.65	0.27	0.27	0.00
1,359.75	0.27	0.27	0.00
1,359.85	0.28	0.28	0.00
1,359.95	0.29	0.29	0.00
1,360.05	0.30	0.30	0.00
1,360.15	0.31	0.31	0.00
1,360.25	0.32	0.32	0.00
1,360.35	0.33	0.33	0.00
1,360.45	0.34	0.34	0.00
1,360.55	0.35	0.35	0.00
1,360.65	0.36	0.36	0.00
1,360.75	0.37	0.37	0.00
1,360.85	0.38	0.38	0.00
1,360.95	0.39	0.39	0.00
1,361.05	0.40	0.40	0.00
1,361.15	0.41	0.41	0.00
1,361.25	0.42	0.42	0.00
1,361.35	0.43	0.43	0.00
1,361.45	0.44	0.44	0.00
1,361.55	0.45	0.45	0.00
1,361.65	0.46	0.46	0.00
1,361.75	0.47	0.47	0.00
1,361.85	0.48	0.48	0.00
1,361.95	0.49	0.49	0.00
1,362.05	0.50	0.50	0.00
1,362.15	0.51	0.51	0.00
1,362.25	0.53	0.53	0.00
1,362.35	0.71	0.54	0.18
1,362.45	1.05	0.55	0.50
1,362.55	1.50	0.56	0.94
1,362.65	2.05	0.57	1.48
1,362.75	2.70	0.58	2.12
1,362.85	3.45	0.59	2.86
1,362.95	4.34	0.60	3.74
1,363.05	5.34	0.62	4.72
1,363.15	6.29	0.64	5.65
1,363.25	7.30	0.66	6.64
1,363.35	8.34	0.68	7.66
1,363.45	9.43	0.70	8.73
1,363.55	10.57	0.73	9.84
1,363.65	11.75	0.75	11.00
1,363.75	12.97	0.77	12.20
1,363.85	14.23	0.79	13.44
1,363.95	**15.53**	**0.81**	**14.72**

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA-1Prop: DA-1 Runoff Area=5.260 ac 100.00% Impervious Runoff Depth=3.57"
Flow Length=420' Slope=0.0403 '/' Tc=3.7 min CN=98 Runoff=23.33 cfs 1.563 af

Subcatchment OFF-1: Offsite Drainage 1 Runoff Area=3.510 ac 1.99% Impervious Runoff Depth=0.49"
Tc=6.0 min CN=56 Runoff=1.08 cfs 0.144 af

Pond 9P: Proposed Infiltration BMP Peak Elev=1,363.04' Storage=0.850 af Inflow=24.11 cfs 1.707 af
Discarded=0.62 cfs 0.920 af Primary=4.61 cfs 0.786 af Outflow=5.23 cfs 1.707 af

Total Runoff Area = 8.770 ac Runoff Volume = 1.707 af Average Runoff Depth = 2.34"
39.22% Pervious = 3.440 ac 60.78% Impervious = 5.330 ac

Summary for Subcatchment DA-1Prop: DA-1

[49] Hint: Tc<2dt may require smaller dt

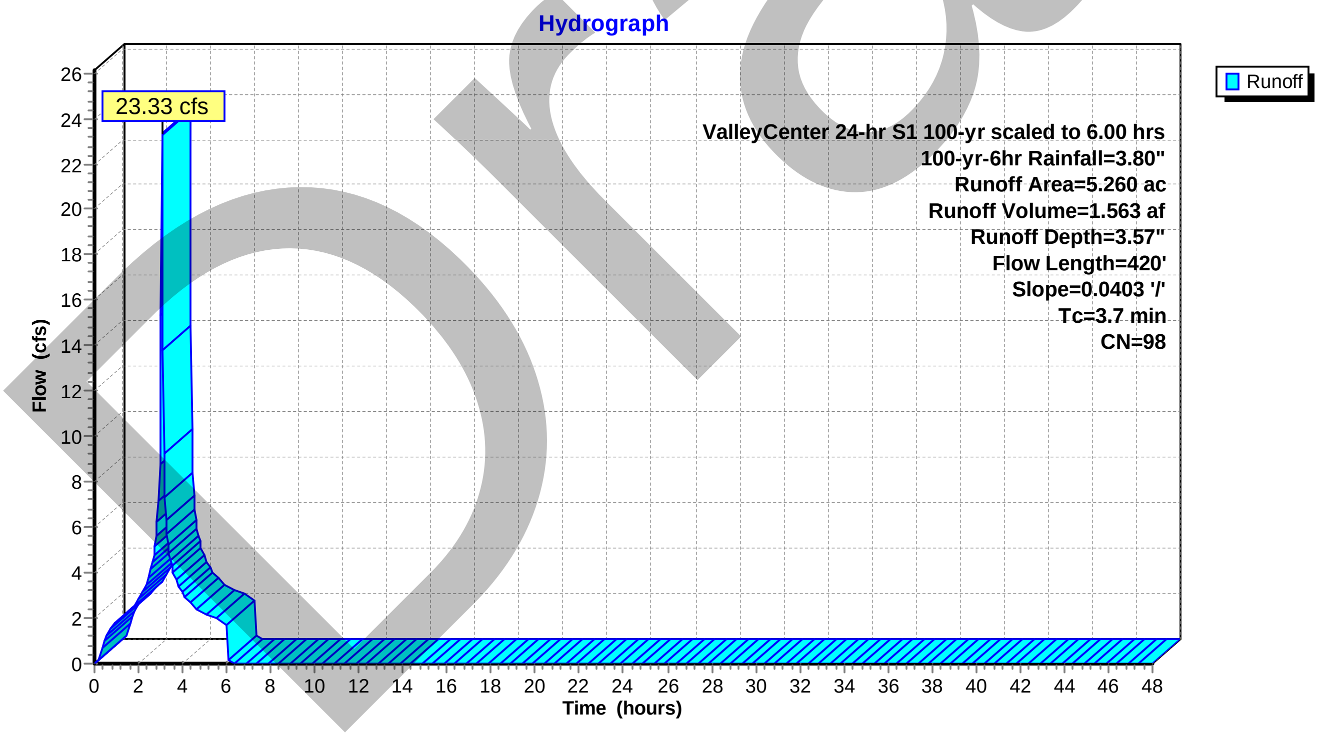
Runoff = 23.33 cfs @ 3.05 hrs, Volume= 1.563 af, Depth= 3.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr scaled to 6.00 hrs 100-yr-6hr Rainfall=3.80"

Area (ac)	CN	Description
5.170	98	Unconnected pavement, HSG C
0.090	98	Unconnected pavement, HSG C
5.260	98	Weighted Average
5.260		100.00% Impervious Area
5.260		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	420	0.0403	1.87		**Lag/CN Method,**

Subcatchment DA-1Prop: DA-1



Hydrograph for Subcatchment DA-1Prop: DA-1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.18	0.06	1.17
1.00	0.38	0.21	1.83
1.50	0.60	0.41	2.28
2.00	0.86	0.65	2.82
2.50	1.18	0.97	3.86
3.00	1.97	1.74	**15.36**
3.50	2.62	2.39	**4.33**
4.00	2.95	2.72	3.07
4.50	3.20	2.97	2.53
5.00	3.42	3.19	2.21
5.50	3.62	3.39	2.00
6.00	**3.80**	**3.57**	1.82
6.50	3.80	3.57	0.00
7.00	3.80	3.57	0.00
7.50	3.80	3.57	0.00
8.00	3.80	3.57	0.00
8.50	3.80	3.57	0.00
9.00	3.80	3.57	0.00
9.50	3.80	3.57	0.00
10.00	3.80	3.57	0.00
10.50	3.80	3.57	0.00
11.00	3.80	3.57	0.00
11.50	3.80	3.57	0.00
12.00	3.80	3.57	0.00
12.50	3.80	3.57	0.00
13.00	3.80	3.57	0.00
13.50	3.80	3.57	0.00
14.00	3.80	3.57	0.00
14.50	3.80	3.57	0.00
15.00	3.80	3.57	0.00
15.50	3.80	3.57	0.00
16.00	3.80	3.57	0.00
16.50	3.80	3.57	0.00
17.00	3.80	3.57	0.00
17.50	3.80	3.57	0.00
18.00	3.80	3.57	0.00
18.50	3.80	3.57	0.00
19.00	3.80	3.57	0.00
19.50	3.80	3.57	0.00
20.00	3.80	3.57	0.00
20.50	3.80	3.57	0.00
21.00	3.80	3.57	0.00
21.50	3.80	3.57	0.00
22.00	3.80	3.57	0.00
22.50	3.80	3.57	0.00
23.00	3.80	3.57	0.00
23.50	3.80	3.57	0.00
24.00	3.80	3.57	0.00
24.50	3.80	3.57	0.00
25.00	3.80	3.57	0.00
25.50	3.80	3.57	0.00
26.00	3.80	3.57	0.00
26.50	3.80	3.57	0.00
27.00	3.80	3.57	0.00
27.50	3.80	3.57	0.00
28.00	3.80	3.57	0.00
28.50	3.80	3.57	0.00
29.00	3.80	3.57	0.00
29.50	3.80	3.57	0.00
30.00	3.80	3.57	0.00
30.50	3.80	3.57	0.00
31.00	3.80	3.57	0.00
31.50	3.80	3.57	0.00
32.00	3.80	3.57	0.00
32.50	3.80	3.57	0.00
33.00	3.80	3.57	0.00
33.50	3.80	3.57	0.00
34.00	3.80	3.57	0.00
34.50	3.80	3.57	0.00
35.00	3.80	3.57	0.00
35.50	3.80	3.57	0.00
36.00	3.80	3.57	0.00
36.50	3.80	3.57	0.00
37.00	3.80	3.57	0.00
37.50	3.80	3.57	0.00
38.00	3.80	3.57	0.00
38.50	3.80	3.57	0.00
39.00	3.80	3.57	0.00
39.50	3.80	3.57	0.00
40.00	3.80	3.57	0.00
40.50	3.80	3.57	0.00
41.00	3.80	3.57	0.00
41.50	3.80	3.57	0.00
42.00	3.80	3.57	0.00
42.50	3.80	3.57	0.00
43.00	3.80	3.57	0.00
43.50	3.80	3.57	0.00
44.00	3.80	3.57	0.00
44.50	3.80	3.57	0.00
45.00	3.80	3.57	0.00
45.50	3.80	3.57	0.00
46.00	3.80	3.57	0.00
46.50	3.80	3.57	0.00
47.00	3.80	3.57	0.00
47.50	3.80	3.57	0.00
48.00	3.80	3.57	0.00

Summary for Subcatchment OFF-1: Offsite Drainage 1

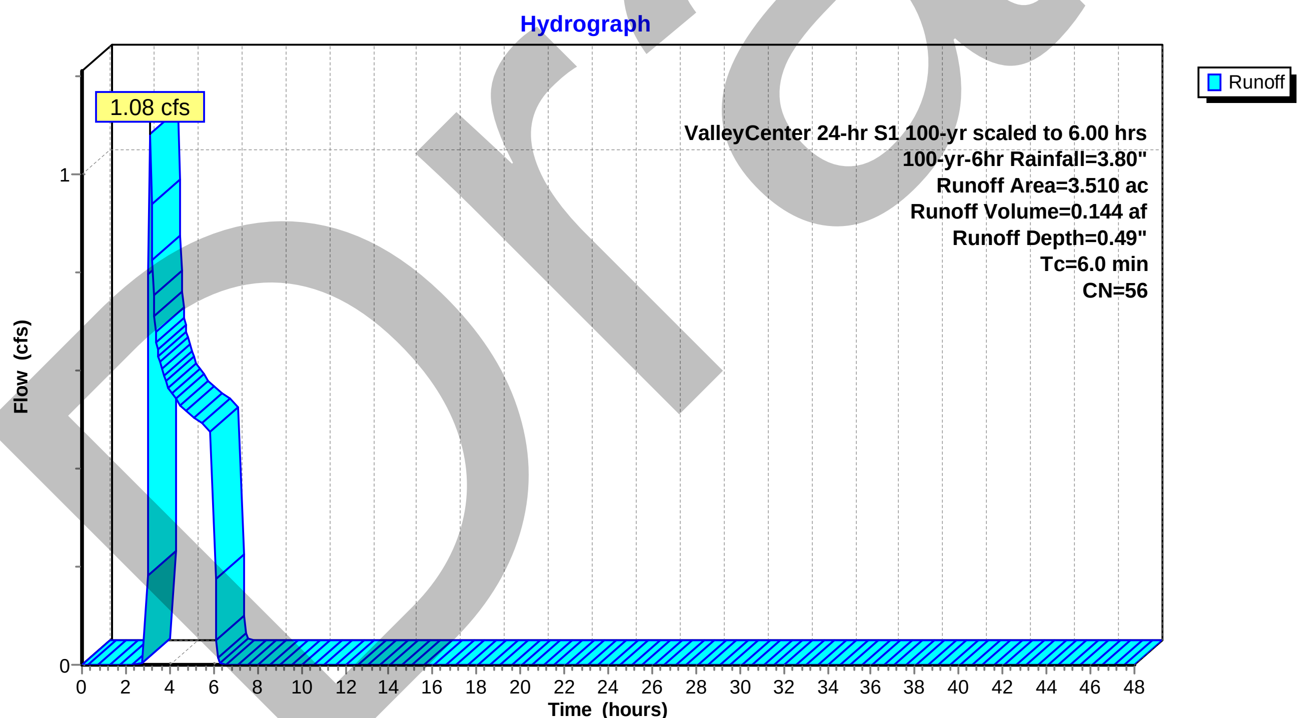
Runoff = 1.08 cfs @ 3.11 hrs, Volume= 0.144 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
ValleyCenter 24-hr S1 100-yr scaled to 6.00 hrs 100-yr-6hr Rainfall=3.80"

Area (ac)	CN	Description
2.560	48	Brush, Poor, HSG A
0.880	77	Brush, Poor, HSG C
0.070	98	Paved parking, HSG C
3.510	56	Weighted Average
3.440		98.01% Pervious Area
0.070		1.99% Impervious Area

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

Subcatchment OFF-1: Offsite Drainage 1



Hydrograph for Subcatchment OFF-1: Offsite Drainage 1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
0.50	0.18	0.00	0.00
1.00	0.38	0.00	0.00
1.50	0.60	0.00	0.00
2.00	0.86	0.00	0.00
2.50	1.18	0.00	0.00
3.00	1.97	0.02	**0.18**
3.50	2.62	0.12	**0.63**
4.00	2.95	0.21	0.56
4.50	3.20	0.28	0.53
5.00	3.42	0.35	0.51
5.50	3.62	0.42	0.49
6.00	**3.80**	**0.49**	0.48
6.50	3.80	0.49	0.00
7.00	3.80	0.49	0.00
7.50	3.80	0.49	0.00
8.00	3.80	0.49	0.00
8.50	3.80	0.49	0.00
9.00	3.80	0.49	0.00
9.50	3.80	0.49	0.00
10.00	3.80	0.49	0.00
10.50	3.80	0.49	0.00
11.00	3.80	0.49	0.00
11.50	3.80	0.49	0.00
12.00	3.80	0.49	0.00
12.50	3.80	0.49	0.00
13.00	3.80	0.49	0.00
13.50	3.80	0.49	0.00
14.00	3.80	0.49	0.00
14.50	3.80	0.49	0.00
15.00	3.80	0.49	0.00
15.50	3.80	0.49	0.00
16.00	3.80	0.49	0.00
16.50	3.80	0.49	0.00
17.00	3.80	0.49	0.00
17.50	3.80	0.49	0.00
18.00	3.80	0.49	0.00
18.50	3.80	0.49	0.00
19.00	3.80	0.49	0.00
19.50	3.80	0.49	0.00
20.00	3.80	0.49	0.00
20.50	3.80	0.49	0.00
21.00	3.80	0.49	0.00
21.50	3.80	0.49	0.00
22.00	3.80	0.49	0.00
22.50	3.80	0.49	0.00
23.00	3.80	0.49	0.00
23.50	3.80	0.49	0.00
24.00	3.80	0.49	0.00
24.50	3.80	0.49	0.00
25.00	3.80	0.49	0.00
25.50	3.80	0.49	0.00
26.00	3.80	0.49	0.00
26.50	3.80	0.49	0.00

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
27.00	3.80	0.49	0.00
27.50	3.80	0.49	0.00
28.00	3.80	0.49	0.00
28.50	3.80	0.49	0.00
29.00	3.80	0.49	0.00
29.50	3.80	0.49	0.00
30.00	3.80	0.49	0.00
30.50	3.80	0.49	0.00
31.00	3.80	0.49	0.00
31.50	3.80	0.49	0.00
32.00	3.80	0.49	0.00
32.50	3.80	0.49	0.00
33.00	3.80	0.49	0.00
33.50	3.80	0.49	0.00
34.00	3.80	0.49	0.00
34.50	3.80	0.49	0.00
35.00	3.80	0.49	0.00
35.50	3.80	0.49	0.00
36.00	3.80	0.49	0.00
36.50	3.80	0.49	0.00
37.00	3.80	0.49	0.00
37.50	3.80	0.49	0.00
38.00	3.80	0.49	0.00
38.50	3.80	0.49	0.00
39.00	3.80	0.49	0.00
39.50	3.80	0.49	0.00
40.00	3.80	0.49	0.00
40.50	3.80	0.49	0.00
41.00	3.80	0.49	0.00
41.50	3.80	0.49	0.00
42.00	3.80	0.49	0.00
42.50	3.80	0.49	0.00
43.00	3.80	0.49	0.00
43.50	3.80	0.49	0.00
44.00	3.80	0.49	0.00
44.50	3.80	0.49	0.00
45.00	3.80	0.49	0.00
45.50	3.80	0.49	0.00
46.00	3.80	0.49	0.00
46.50	3.80	0.49	0.00
47.00	3.80	0.49	0.00
47.50	3.80	0.49	0.00
48.00	3.80	0.49	0.00

Summary for Pond 9P: Proposed Infiltration BMP

Inflow Area = 8.770 ac, 60.78% Impervious, Inflow Depth = 2.34" for 100-yr-6hr event
Inflow = 24.11 cfs @ 3.05 hrs, Volume= 1.707 af
Outflow = 5.23 cfs @ 3.45 hrs, Volume= 1.707 af, Atten= 78%, Lag= 24.1 min
Discarded = 0.62 cfs @ 3.45 hrs, Volume= 0.920 af
Primary = 4.61 cfs @ 3.45 hrs, Volume= 0.786 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,363.04' @ 3.45 hrs Surf.Area= 0.255 ac Storage= 0.850 af

Plug-Flow detention time= 398.0 min calculated for 1.705 af (100% of inflow)
Center-of-Mass det. time= 399.8 min (597.7 - 197.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,355.25'	1.136 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

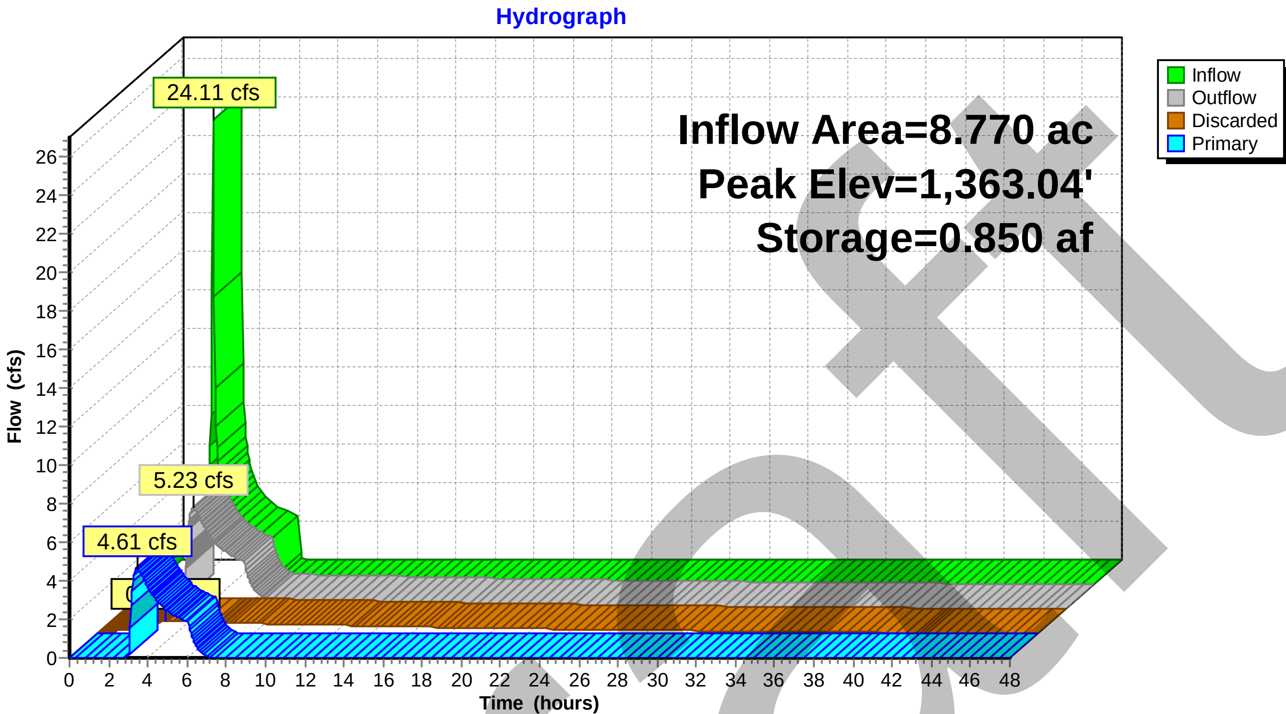
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,355.25	0.012	0.000	0.000
1,356.00	0.024	0.014	0.014
1,357.00	0.043	0.033	0.047
1,358.00	0.065	0.054	0.101
1,359.00	0.091	0.078	0.179
1,360.00	0.121	0.106	0.285
1,361.00	0.163	0.142	0.427
1,362.00	0.206	0.184	0.612
1,363.00	0.251	0.228	0.840
1,364.00	0.340	0.295	1.136

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,355.25'	**2.400 in/hr Exfiltration over Surface area**
#2	Primary	1,362.25'	**2.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

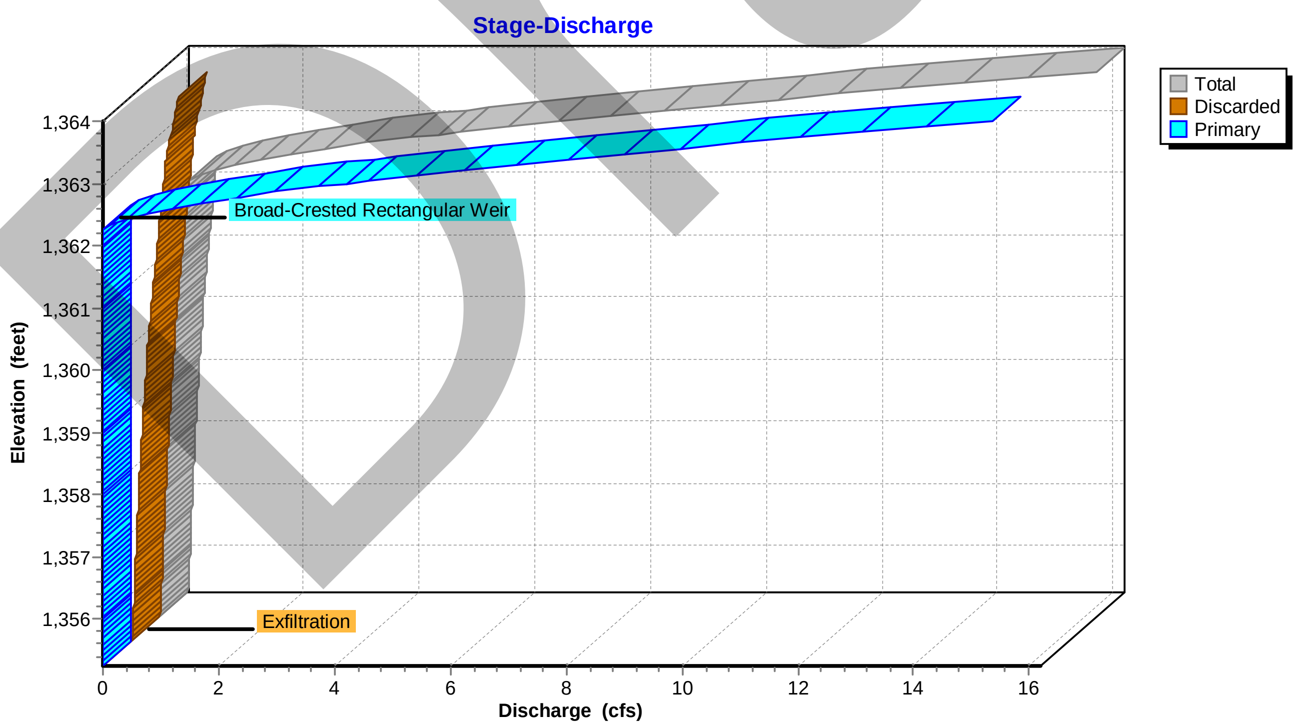
Discarded OutFlow Max=0.62 cfs @ 3.45 hrs HW=1,363.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.62 cfs)

Primary OutFlow Max=4.62 cfs @ 3.45 hrs HW=1,363.04' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 4.62 cfs @ 2.92 fps)

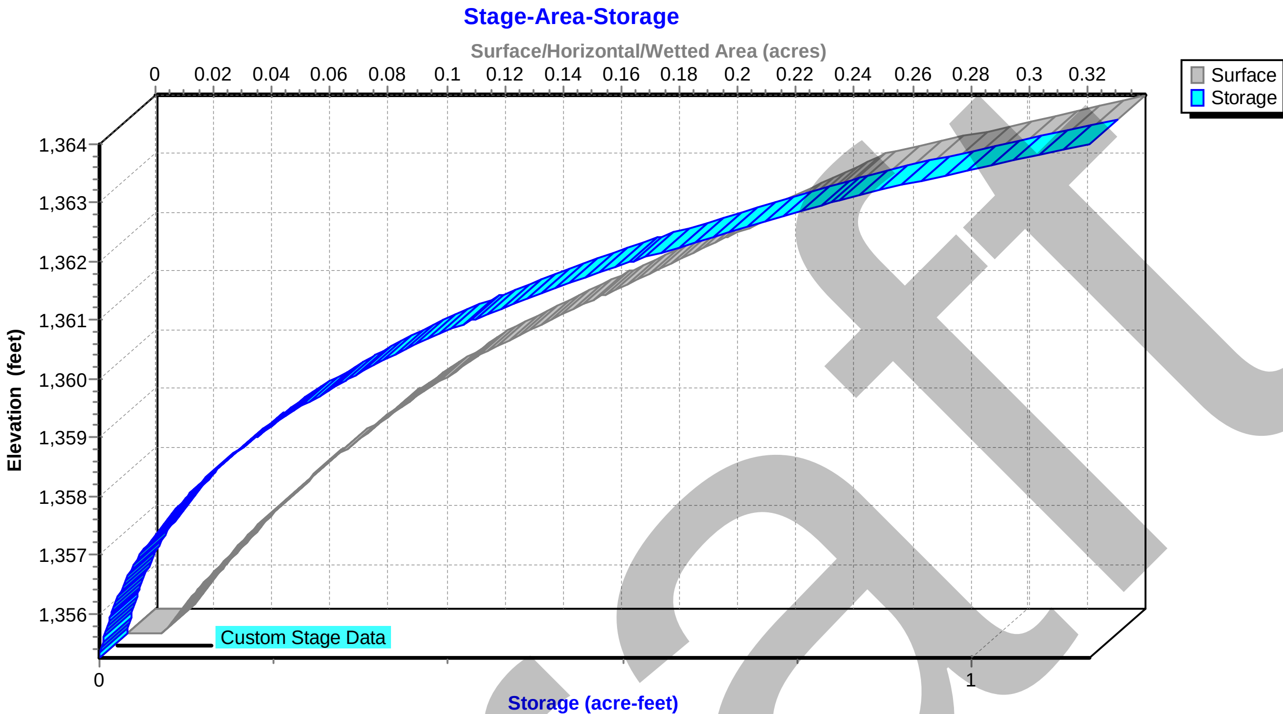
Pond 9P: Proposed Infiltration BMP



Pond 9P: Proposed Infiltration BMP



Pond 9P: Proposed Infiltration BMP



Hydrograph for Pond 9P: Proposed Infiltration BMP

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	1,355.25	0.00	0.00	0.00
1.00	1.83	0.077	1,357.61	0.14	0.14	0.00
2.00	2.82	0.250	1,359.70	0.27	0.27	0.00
3.00	**15.54**	**0.604**	**1,361.96**	**0.49**	**0.49**	**0.00**
4.00	**3.63**	**0.825**	**1,362.94**	**4.26**	**0.60**	**3.66**
5.00	2.72	0.789	1,362.79	3.02	0.58	2.43
6.00	2.30	0.771	1,362.72	2.48	0.58	1.90
7.00	0.00	0.677	1,362.31	0.63	0.53	0.10
8.00	0.00	0.633	1,362.10	0.51	0.51	0.00
9.00	0.00	0.592	1,361.90	0.49	0.49	0.00
10.00	0.00	0.553	1,361.70	0.47	0.47	0.00
11.00	0.00	0.515	1,361.50	0.45	0.45	0.00
12.00	0.00	0.479	1,361.30	0.43	0.43	0.00
13.00	0.00	0.444	1,361.10	0.41	0.41	0.00
14.00	0.00	0.412	1,360.90	0.38	0.38	0.00
15.00	0.00	0.381	1,360.70	0.36	0.36	0.00
16.00	0.00	0.351	1,360.50	0.34	0.34	0.00
17.00	0.00	0.324	1,360.30	0.32	0.32	0.00
18.00	0.00	0.298	1,360.10	0.30	0.30	0.00
19.00	0.00	0.274	1,359.90	0.29	0.29	0.00
20.00	0.00	0.251	1,359.70	0.27	0.27	0.00
21.00	0.00	0.229	1,359.50	0.26	0.26	0.00
22.00	0.00	0.208	1,359.30	0.24	0.24	0.00
23.00	0.00	0.189	1,359.10	0.23	0.23	0.00
24.00	0.00	0.170	1,358.90	0.21	0.21	0.00
25.00	0.00	0.153	1,358.70	0.20	0.20	0.00
26.00	0.00	0.137	1,358.50	0.19	0.19	0.00
27.00	0.00	0.122	1,358.30	0.18	0.18	0.00
28.00	0.00	0.108	1,358.10	0.16	0.16	0.00
29.00	0.00	0.095	1,357.90	0.15	0.15	0.00
30.00	0.00	0.083	1,357.70	0.14	0.14	0.00
31.00	0.00	0.072	1,357.50	0.13	0.13	0.00
32.00	0.00	0.061	1,357.30	0.12	0.12	0.00
33.00	0.00	0.052	1,357.10	0.11	0.11	0.00
34.00	0.00	0.043	1,356.90	0.10	0.10	0.00
35.00	0.00	0.035	1,356.70	0.09	0.09	0.00
36.00	0.00	0.028	1,356.50	0.08	0.08	0.00
37.00	0.00	0.022	1,356.30	0.07	0.07	0.00
38.00	0.00	0.016	1,356.10	0.06	0.06	0.00
39.00	0.00	0.011	1,355.90	0.05	0.05	0.00
40.00	0.00	0.007	1,355.70	0.05	0.05	0.00
41.00	0.00	0.004	1,355.51	0.04	0.04	0.00
42.00	0.00	0.001	1,355.31	0.02	0.02	0.00
43.00	0.00	0.000	1,355.26	0.00	0.00	0.00
44.00	0.00	0.000	1,355.25	0.00	0.00	0.00
45.00	0.00	0.000	1,355.25	0.00	0.00	0.00
46.00	0.00	0.000	1,355.25	0.00	0.00	0.00
47.00	0.00	0.000	1,355.25	0.00	0.00	0.00
48.00	0.00	0.000	1,355.25	0.00	0.00	0.00

Stage-Discharge for Pond 9P: Proposed Infiltration BMP

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
1,355.25	0.00	0.00	0.00
1,355.35	0.03	0.03	0.00
1,355.45	0.04	0.04	0.00
1,355.55	0.04	0.04	0.00
1,355.65	0.04	0.04	0.00
1,355.75	0.05	0.05	0.00
1,355.85	0.05	0.05	0.00
1,355.95	0.06	0.06	0.00
1,356.05	0.06	0.06	0.00
1,356.15	0.06	0.06	0.00
1,356.25	0.07	0.07	0.00
1,356.35	0.07	0.07	0.00
1,356.45	0.08	0.08	0.00
1,356.55	0.08	0.08	0.00
1,356.65	0.09	0.09	0.00
1,356.75	0.09	0.09	0.00
1,356.85	0.10	0.10	0.00
1,356.95	0.10	0.10	0.00
1,357.05	0.11	0.11	0.00
1,357.15	0.11	0.11	0.00
1,357.25	0.12	0.12	0.00
1,357.35	0.12	0.12	0.00
1,357.45	0.13	0.13	0.00
1,357.55	0.13	0.13	0.00
1,357.65	0.14	0.14	0.00
1,357.75	0.14	0.14	0.00
1,357.85	0.15	0.15	0.00
1,357.95	0.15	0.15	0.00
1,358.05	0.16	0.16	0.00
1,358.15	0.17	0.17	0.00
1,358.25	0.17	0.17	0.00
1,358.35	0.18	0.18	0.00
1,358.45	0.19	0.19	0.00
1,358.55	0.19	0.19	0.00
1,358.65	0.20	0.20	0.00
1,358.75	0.20	0.20	0.00
1,358.85	0.21	0.21	0.00
1,358.95	0.22	0.22	0.00
1,359.05	0.22	0.22	0.00
1,359.15	0.23	0.23	0.00
1,359.25	0.24	0.24	0.00
1,359.35	0.25	0.25	0.00
1,359.45	0.25	0.25	0.00
1,359.55	0.26	0.26	0.00
1,359.65	0.27	0.27	0.00
1,359.75	0.27	0.27	0.00
1,359.85	0.28	0.28	0.00
1,359.95	0.29	0.29	0.00
1,360.05	0.30	0.30	0.00
1,360.15	0.31	0.31	0.00
1,360.25	0.32	0.32	0.00
1,360.35	0.33	0.33	0.00
1,360.45	0.34	0.34	0.00
1,360.55	0.35	0.35	0.00
1,360.65	0.36	0.36	0.00
1,360.75	0.37	0.37	0.00
1,360.85	0.38	0.38	0.00
1,360.95	0.39	0.39	0.00
1,361.05	0.40	0.40	0.00
1,361.15	0.41	0.41	0.00
1,361.25	0.42	0.42	0.00
1,361.35	0.43	0.43	0.00
1,361.45	0.44	0.44	0.00
1,361.55	0.45	0.45	0.00
1,361.65	0.46	0.46	0.00
1,361.75	0.47	0.47	0.00
1,361.85	0.48	0.48	0.00
1,361.95	0.49	0.49	0.00
1,362.05	0.50	0.50	0.00
1,362.15	0.51	0.51	0.00
1,362.25	0.53	0.53	0.00
1,362.35	0.71	0.54	0.18
1,362.45	1.05	0.55	0.50
1,362.55	1.50	0.56	0.94
1,362.65	2.05	0.57	1.48
1,362.75	2.70	0.58	2.12
1,362.85	3.45	0.59	2.86
1,362.95	4.34	0.60	3.74
1,363.05	5.34	0.62	4.72
1,363.15	6.29	0.64	5.65
1,363.25	7.30	0.66	6.64
1,363.35	8.34	0.68	7.66
1,363.45	9.43	0.70	8.73
1,363.55	10.57	0.73	9.84
1,363.65	11.75	0.75	11.00
1,363.75	12.97	0.77	12.20
1,363.85	14.23	0.79	13.44
1,363.95	**15.53**	**0.81**	**14.72**

TABLE OF CONTENTS

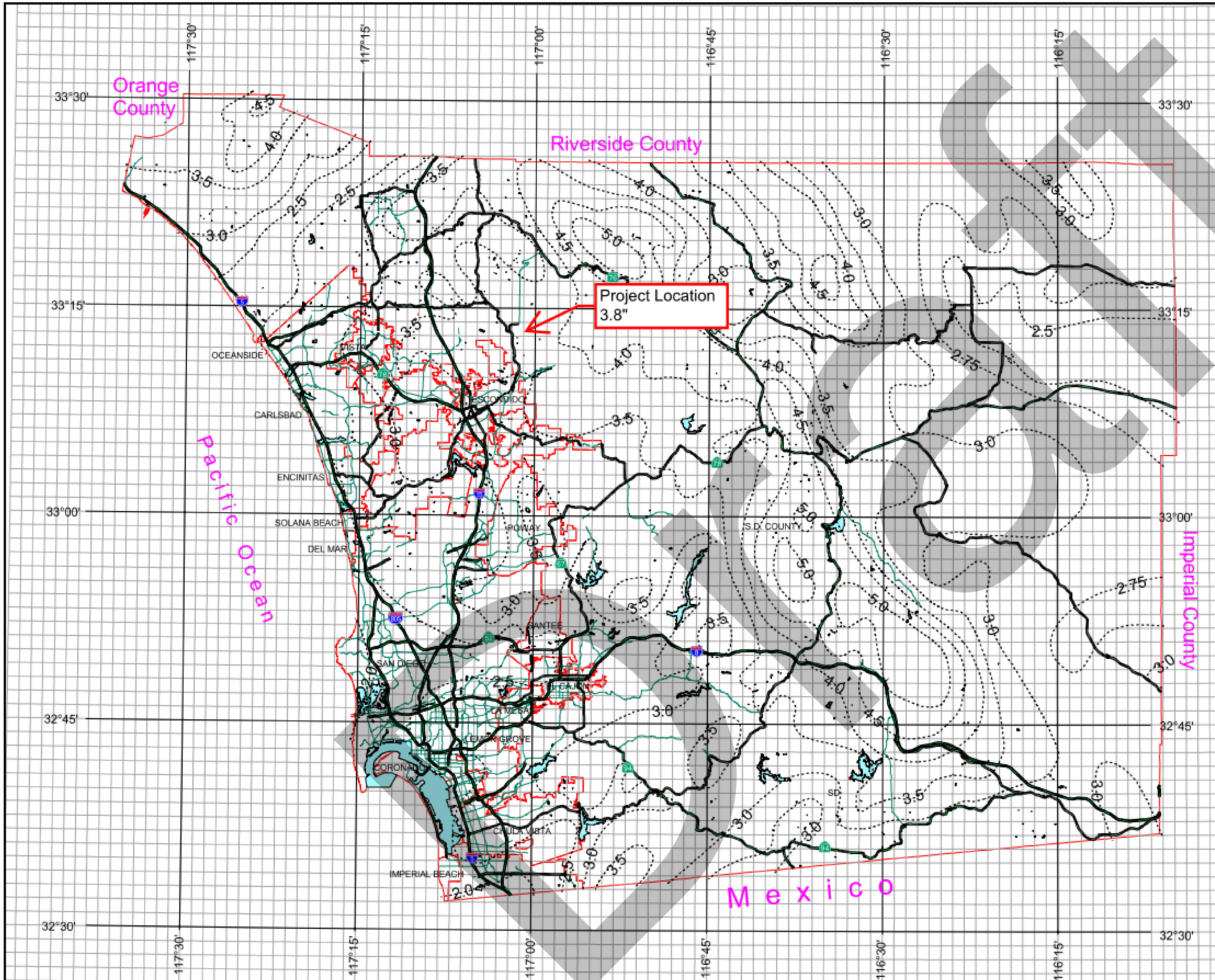
Project Reports

100-yr Event

100-yr-6hr Event

Appendix C

County of San Diego Hydrology Manual Excerpts



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

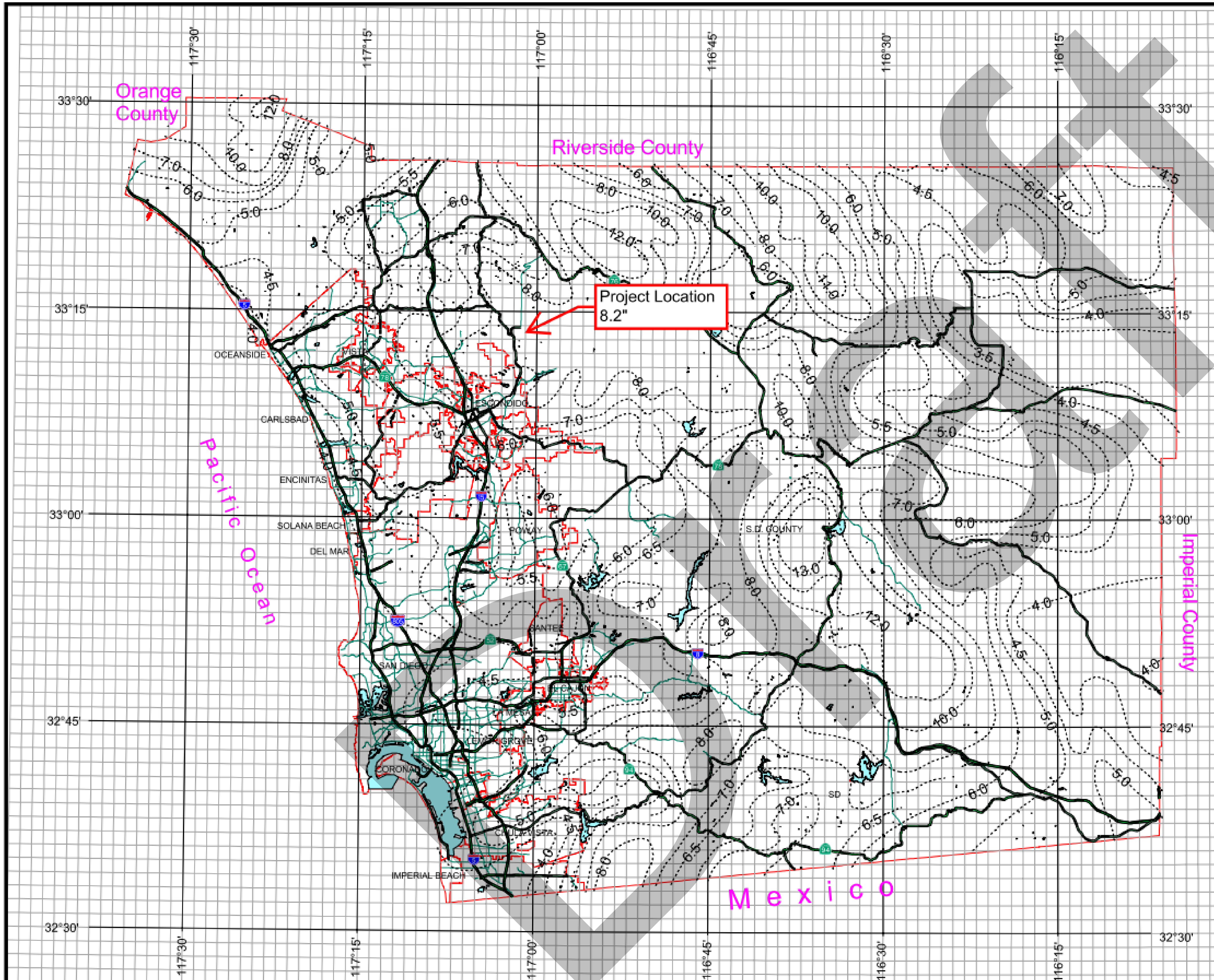
-------- Isopluvial (inches)

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

N
W E
S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

.... Isopluvial (inches)

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

N W E S

3 0 3 Miles

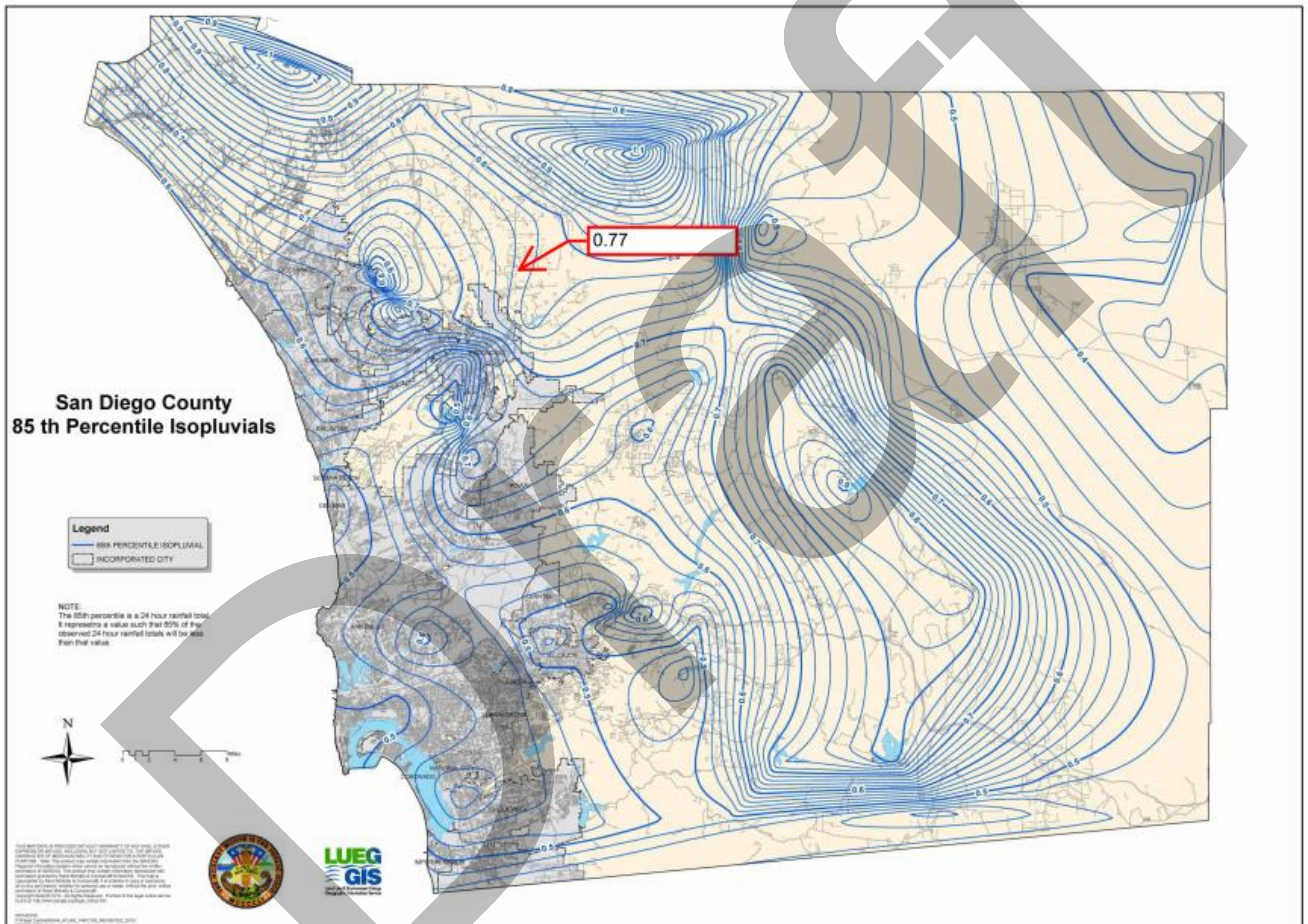
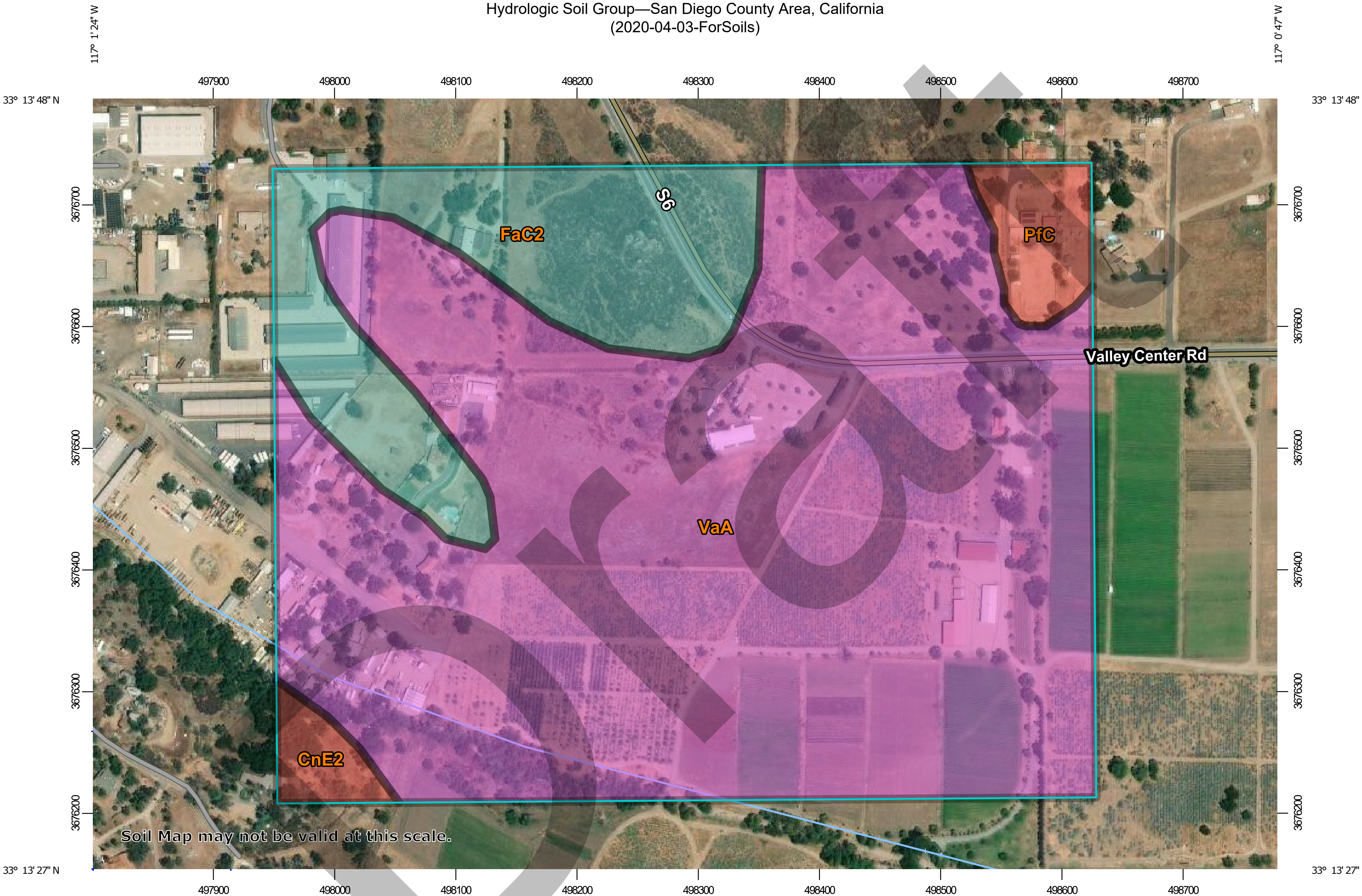


Figure B.1-1: 85th Percentile 24-hour Isopluvial Map

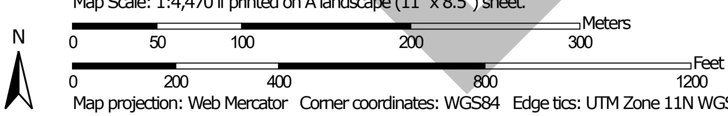
Appendix D

Soils Information

Hydrologic Soil Group—San Diego County Area, California
(2020-04-03-ForSoils)



Map Scale: 1:4,470 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

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 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: San Diego County Area, California
Survey Area Data: Version 14, Sep 16, 2019

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

Date(s) aerial images were photographed: Dec 31, 2009—Oct 22, 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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CnE2	Cieneba-Fallbrook rocky sandy loams, 9 to 30 percent slopes, eroded	D	1.5	1.7%
FaC2	Fallbrook sandy loam, 5 to 9 percent slopes, eroded	C	14.5	16.5%
PfC	Placentia sandy loam, thick surface, 2 to 9 percent slo pes	D	2.6	3.0%
VaA	Visalia sandy loam, 0 to 2 percent slopes	A	68.9	78.8%
Totals for Area of Interest			**87.5**	**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

Appendix E

Urban Hydrology Manual for Small Watersheds

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

To show bookmarks which navigate through the document.

Click the show/hide navigation pane button, and then

click the bookmarks tab. It will navigate you to the contents,

chapters, rainfall maps, and printable forms.

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

Preface

Technical Release 55 (TR-55) presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small watersheds, especially urbanizing watersheds, in the United States. First issued by the Soil Conservation Service (SCS) in January 1975, TR-55 incorporates current SCS procedures. This revision includes results of recent research and other changes based on experience with use of the original edition.

The major revisions and additions are:

- A flow chart for selecting the appropriate procedure;
- Three additional rain distributions;
- Expansion of the chapter on runoff curve numbers;
- A procedure for calculating travel times of sheet flow;
- Deletion of a chapter on peak discharges;
- Modifications to the Graphical Peak Discharge method and Tabular Hydrograph method;
- A new storage routing procedure;
- Features of the TR-55 computer program; and
- Worksheets.

This revision was prepared by Roger Cronshey, hydraulic engineer, Hydrology Unit, SCS, Washington, DC; Dr. Richard H. McCuen, professor of Civil Engineering, University of Maryland, College Park, MD; Norman Miller, head, Hydrology Unit, SCS, Washington, DC; Dr.Walter Rawls, hydrologist, Agricultural Research Service, Beltsville, MD; Sam Robbins (deceased), formerly hydraulic engineer, SCS, South National Technical Center (NTC), Fort Worth, TX; and Don Woodward, hydraulic engineer, SCS, Northeast NTC, Chester, PA. Valuable contributions were made by John Chenoweth, Stan Hamilton, William Merkel, Robert Rallison (ret.), Harvey Richardson, Wendell Styner, other SCS hydraulic engineers, and Teresa Seeman.

Revised June 1986
Update of Appendix A January 1999

Contents

Figures

Tables

Exhibits

Worksheets

Metric conversions

The English system of units is used in this TR. To convert to the International System of units (metric), use the following factors:

From English unit	To metric unit	Multiply by
Acre	Hectare	0.405
Square mile	Square kilometer	2.59
Cubic feet per second	Cubic meters per second	0.0283
Inch	Millimeter	25.4
Feet per second	Meters per second	0.3048
Acre-foot	Cubic meter	1233.489
Cubic foot	Cubic meter	0.0283

Perform rounding operations as appropriate to indicate the same level of precision as that of the original measurement. For example:

1. A stream discharge is recorded in cubic feet per second with three significant digits.
2. Convert stream discharge to cubic meters per second by multiplying by 0.0283.
3. Round to enough significant digits so that, when converting back to cubic feet per second, you obtain the original value (step 1) with three significant digits.

Definitions of symbols

Symbol	Unit	Definition
a	ft^2	Cross sectional flow area
Am	mi^2	Drainage area
CN		Runoff curve number
CN_e		Composite runoff curve number
CN_p		Pervious runoff curve number
E_{max}		Maximum stage
F_p		Pond and swamp adjustment factor
H_w	ft	Head over weir crest
I_a	in	Initial abstraction
L	ft	Flow length
L_w	ft	Weir crest length
m		Number of flow segments
n		Manning's roughness coefficient
P	in	Rainfall
P_{imp}		Percent imperviousness
P_2	in	Two-year frequency, 24-hour rainfall
p_w	ft	Wetted perimeter
q	ft^3/s (cfs)	Hydrograph coordinate
q_i	ft^3/s (cfs)	Peak inflow discharge
q_o	ft^3/s (cfs)	Peak outflow discharge
q_p	ft^3/s (cfs)	Peak discharge
q_t	csm/in	Tabular hydrograph unit discharge
q_u	csm/in	Unit peak discharge
Q	in	Runoff
r	ft	Hydraulic radius
R		Ratio of unconnected impervious area to total impervious area
s	ft/ft	Slope of hydraulic grade line
S	in	Potential maximum retention after runoff begins
t	hr	Hydrograph time
T_c	hr	Time of concentration
T_p	hr	Time to peak
T_t	hr	Travel time
V	ft/s	Average velocity
V_r	acre-ft, ft^3 or water-shed-inch	Runoff volume
V_s	acre-ft, ft^3 or water-shed-inch	Storage volume

Chapter 1 Introduction

The conversion of rural land to urban land usually increases erosion and the discharge and volume of storm runoff in a watershed. It also causes other problems that affect soil and water. As part of programs established to alleviate these problems, engineers increasingly must assess the probable effects of urban development, as well as design and implement measures that will minimize its adverse effects.

Technical Release 55 (TR-55) presents simplified procedures for estimating runoff and peak discharges in small watersheds. In selecting the appropriate procedure, consider the scope and complexity of the problem, the available data, and the acceptable level of error. While this TR gives special emphasis to urban and urbanizing watersheds, the procedures apply to any small watershed in which certain limitations are met.

Effects of urban development

An urban or urbanizing watershed is one in which impervious surfaces cover or will soon cover a considerable area. Impervious surfaces include roads, sidewalks, parking lots, and buildings. Natural flow paths in the watershed may be replaced or supplemented by paved gutters, storm sewers, or other elements of artificial drainage.

Hydrologic studies to determine runoff and peak discharge should ideally be based on long-term stationary streamflow records for the area. Such records are seldom available for small drainage areas. Even where they are available, accurate statistical analysis of them is usually impossible because of the conversion of land to urban uses during the period of record. It therefore is necessary to estimate peak discharges with hydrologic models based on measurable watershed characteristics. Only through an understanding of these characteristics and experience in using these models can we make sound judgments on how to alter model parameters to reflect changing watershed conditions.

Urbanization changes a watershed's response to precipitation. The most common effects are reduced infiltration and decreased travel time, which significantly increase peak discharges and runoff. Runoff is determined primarily by the amount of precipitation and by infiltration characteristics related to soil type, soil moisture, antecedent rainfall, cover type, impervious surfaces, and surface retention. Travel time is determined primarily by slope, length of flow path, depth of flow, and roughness of flow surfaces. Peak discharges are based on the relationship of these parameters and on the total drainage area of the watershed, the location of the development, the effect of any flood control works or other natural or manmade storage, and the time distribution of rainfall during a given storm event.

The model described in TR-55 begins with a rainfall amount uniformly imposed on the watershed over a specified time distribution. Mass rainfall is converted to mass runoff by using a runoff curve number (CN). CN is based on soils, plant cover, amount of impervious areas, interception, and surface storage. Runoff is then transformed into a hydrograph by using unit hydrograph theory and routing procedures that depend on runoff travel time through segments of the watershed.

For a description of the hydrograph development method used by SCS, see chapter 16 of the SCS National Engineering Handbook, Section 4—Hydrology (NEH-4) (SCS 1985). The routing method (Modified Att-Kin) is explained in appendixes G and H of draft Technical Release 20 (TR-20) (SCS 1983).

Rainfall

TR-55 includes four regional rainfall time distributions. See appendix B for a discussion of how these distributions were developed.

All four distributions are for a 24-hour period. This period was chosen because of the general availability of daily rainfall data that were used to estimate 24-hour rainfall amounts. The 24-hour duration spans most of the applications of TR-55.

One critical parameter in the model is time of concentration (T_c), which is the time it takes for runoff to travel to a point of interest from the hydraulically most distant point. Normally a rainfall duration equal to or greater than T_c is used. Therefore, the rainfall distributions were designed to contain the intensity of any duration of rainfall for the frequency of the event chosen. That is, if the 10-year frequency, 24-hour rainfall is used, the most intense hour will approximate the 10-year, 1-hour rainfall volume.

Runoff

To estimate runoff from storm rainfall, SCS uses the runoff curve number (CN) method (see chapters 4 through 10 of NEH-4, SCS 1985). Determination of CN depends on the watershed's soil and cover conditions, which the model represents as hydrologic soil group, cover type, treatment, and hydrologic condition. Chapter 2 of this TR discusses the effect of urban development on CN and explains how to use CN to estimate runoff.

Time parameters

Chapter 3 describes a method for estimating the parameters used to distribute the runoff into a hydrograph. The method is based on velocities of flow through segments of the watershed. Two major parameters are time of concentration (T_c) and travel time of flow through the segments (T_t). These and the other parameters used are the same as those used in accepted hydraulic analyses of open channels.

Many methods are empirically derived from actual runoff hydrographs and watershed characteristics. The method in chapter 3 was chosen because it is basic; however, other methods may be used.

Peak discharge and hydrographs

Chapter 4 describes a method for approximating peak rates of discharge, and chapter 5 describes a method for obtaining or routing hydrographs. Both methods were derived from hydrographs prepared by procedures outlined in chapter 16 of NEH-4 (SCS 1985). The computations were made with a computerized SCS hydrologic model, TR-20 (SCS 1983).

The methods in chapters 4 and 5 should be used in accordance with specific guidelines. If basic data are improperly prepared or adjustments not properly used, errors will result.

Storage effects

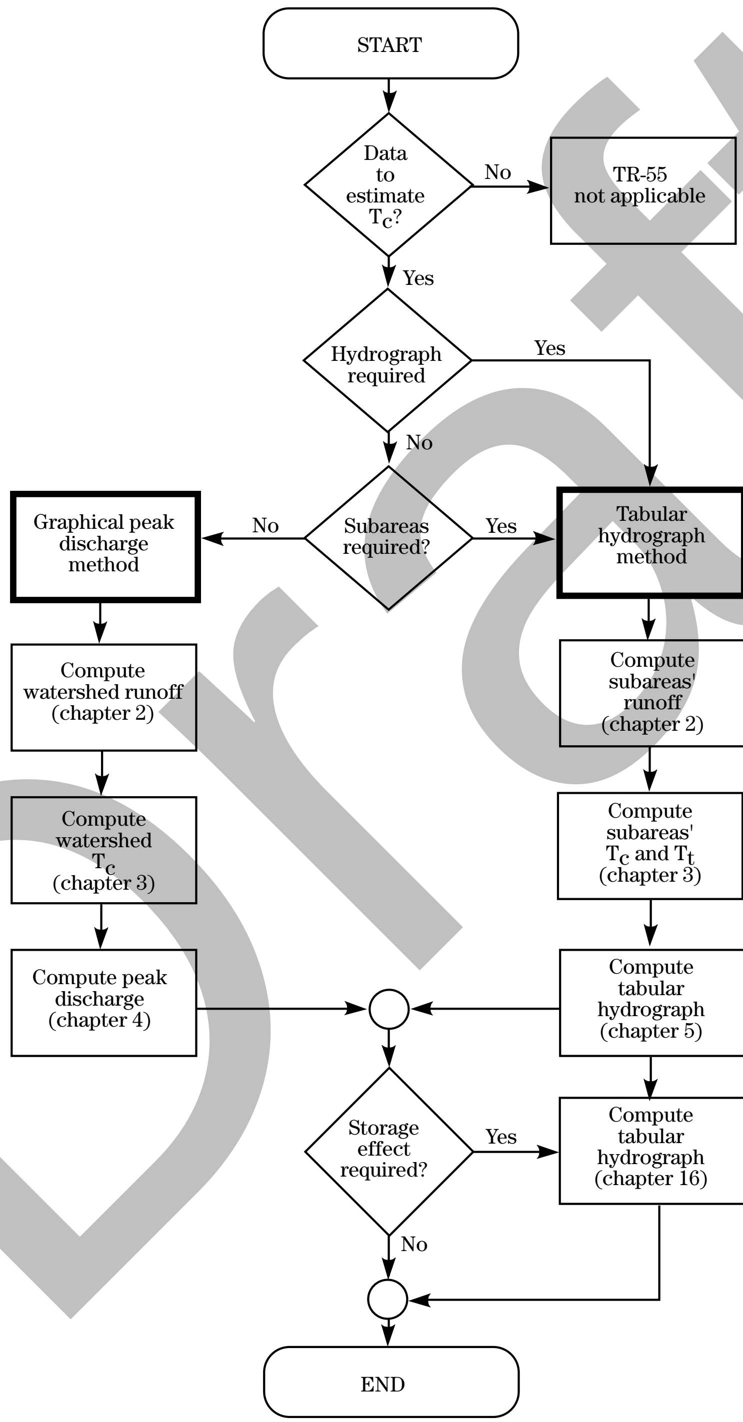
Chapter 6 outlines procedures to account for the effect of detention-type storage. It provides a shortcut method to estimate temporary flood storage based on hydrologic data developed from the Graphical Peak Discharge or Tabular Hydrograph methods.

By increasing runoff and decreasing travel times, urbanization can be expected to increase downstream peak discharges. Chapter 6 discusses how flood detention can modify the hydrograph so that, ideally, downstream peak discharge is reduced approximately to the predevelopment condition. The shortcuts in chapter 6 are useful in sizing a basin even though the final design may require a more detailed analysis.

Selecting the appropriate procedures

Figure 1-1 is a flow chart that shows how to select the appropriate procedures to use in TR-55. In the figure, the diamond-shaped box labeled "Subareas required?" directs the user to the appropriate method based on whether the watershed needs to be divided into subareas. Watershed subdivision is required when significantly different conditions affecting runoff or timing are present in the watershed—for example, if the watershed has widely differing curve numbers or nonhomogeneous slope patterns.

Figure 1-1 Flow chart for selecting the appropriate procedures in TR-55.



Limitations

To save time, the procedures in TR-55 are simplified by assumptions about some parameters. These simplifications, however, limit the use of the procedures and can provide results that are less accurate than more detailed methods. The user should examine the sensitivity of the analysis being conducted to a variation of the peak discharge or hydrograph. To ensure that the degree of error is tolerable, specific limitations are given in chapters 2 through 6. Additional general constraints to the use of TR-55 are as follows:

- The methods in this TR are based on open and unconfined flow over land or in channels. For large events during which flow is divided between sewer and overland flow, more information about hydraulics than is presented here is needed to determine T_c. After flow enters a closed system, the discharge can be assumed constant until another flow is encountered at a junction or another inlet.

- Both the Graphical Peak Discharge and Tabular Hydrograph methods are derived from TR-20 (SCS 1983) output. Their accuracy is comparable; they differ only in their products. The use of T_c permits them to be used for any size watershed within the scope of the curves or tables. The Graphical method (chapter 4) is used only for hydrologically homogeneous watersheds because the procedure is limited to a single watershed subarea. The Tabular method (chapter 5) can be used for a heterogeneous watershed that is divided into a number of homogeneous subwatersheds. Hydrographs for the subwatersheds can be routed and added.

- The approximate storage-routing curves (chapter 6) should not be used if the adjustment for ponding (chapter 4) is used. These storage-routing curves, like the peak discharge and hydrograph procedures, are generalizations derived from TR-20 routings.

Chapter 2 Estimating Runoff

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{\left(P - I_a\right)^2}{\left(P - I_a\right) + S} \qquad \text{[eq. 2-1]}$$

where

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{\left(P - 0.2S\right)^2}{\left(P + 0.8S\right)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

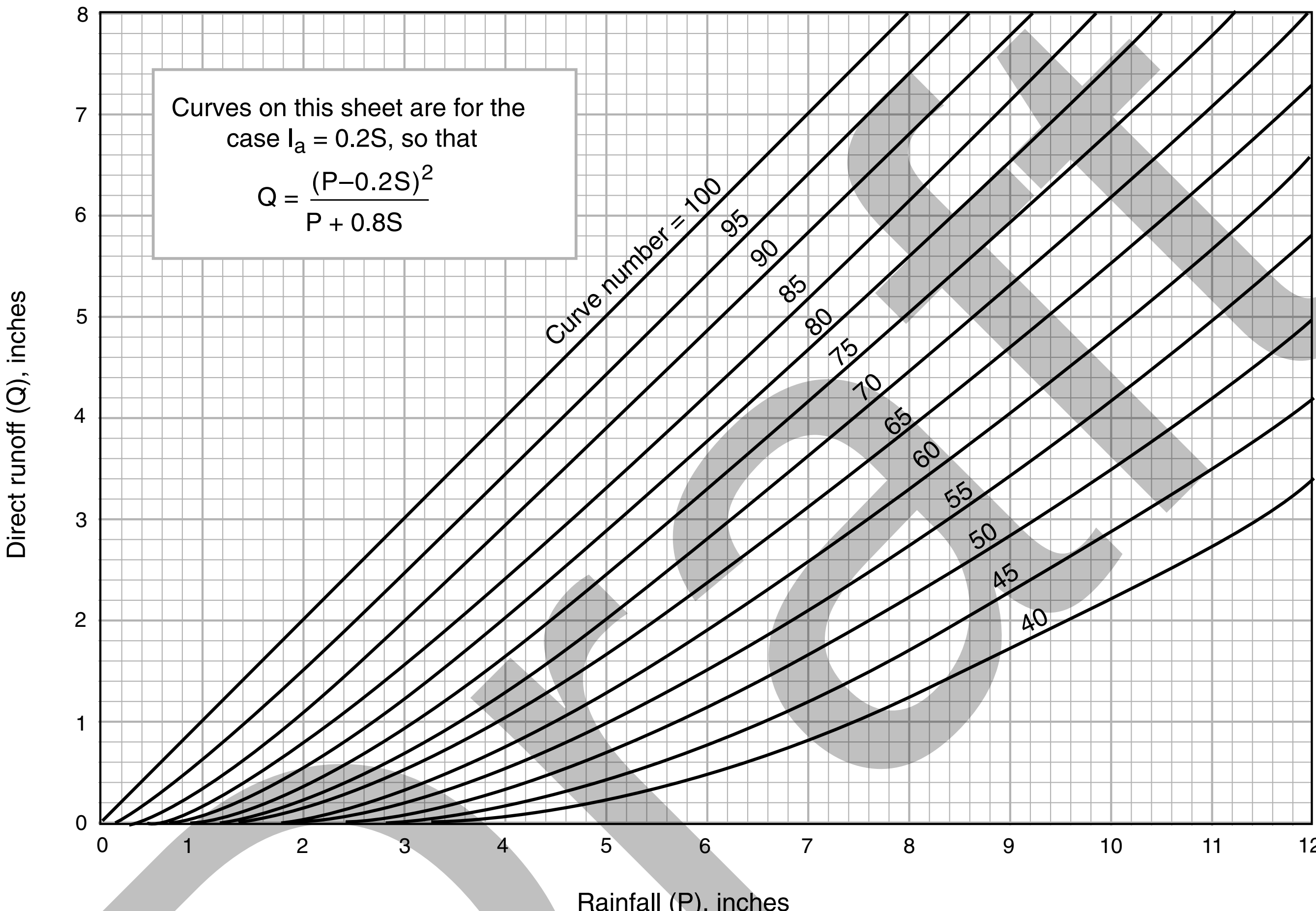
Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

Figure 2-1 Solution of runoff equation.



Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Hydrologic condition

*Hydrologic condition i*ndicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-1 Runoff depth for selected CN's and rainfall amounts [1/]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1/] Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

Figure 2-2 Flow chart for selecting the appropriate figure or table for determining runoff curve numbers.

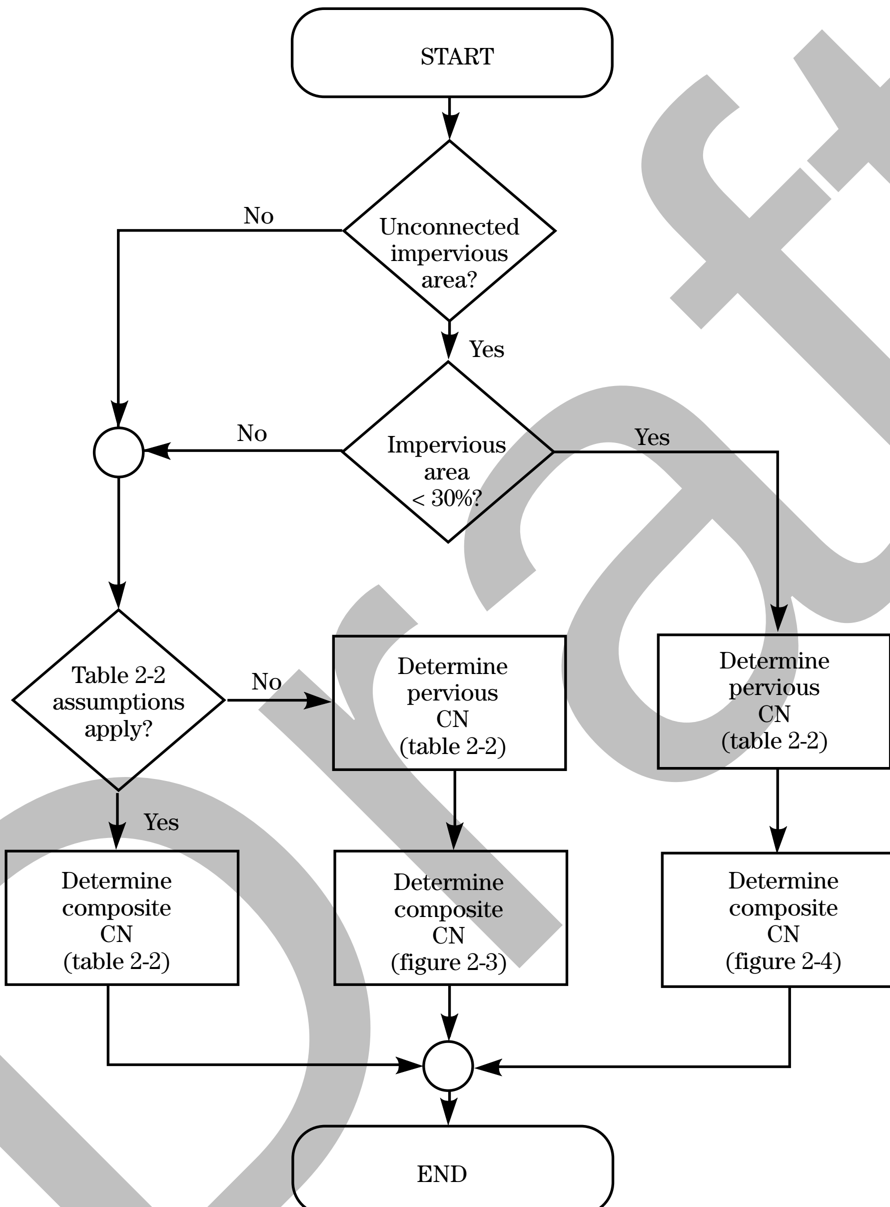


Table 2-2a Runoff curve numbers for urban areas [1/]

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	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
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 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

1 Average runoff condition, and I_a=0.2S
2 Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
3 Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

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.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands 1/

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition 2/	A 3/	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Antecedent runoff condition

The index of runoff potential before a storm event is the antecedent runoff condition (ARC). ARC is an attempt to account for the variation in CN at a site from storm to storm. CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The CN's in table 2-2 are for the average ARC, which is used primarily for design applications. See NEH-4 (SCS 1985) and Rallison and Miller (1981) for more detailed discussion of storm-to-storm variation and a demonstration of upper and lower enveloping curves.

Urban impervious area modifications

Several factors, such as the percentage of impervious area and the means of conveying runoff from impervious areas to the drainage system, should be considered in computing CN for urban areas (Rawls et al., 1981). For example, do the impervious areas connect directly to the drainage system, or do they outlet onto lawns or other pervious areas where infiltration can occur?

Connected impervious areas — An impervious area is considered connected if runoff from it flows directly into the drainage system. It is also considered connected if runoff from it occurs as concentrated shallow flow that runs over a pervious area and then into the drainage system.

Urban CN's (table 2-2a) were developed for typical land use relationships based on specific assumed percentages of impervious area. These CN vales were developed on the assumptions that (a) pervious urban areas are equivalent to pasture in good hydrologic condition and (b) impervious areas have a CN of 98 and are directly connected to the drainage system. Some assumed percentages of impervious area are shown in table 2-2a

If all of the impervious area is directly connected to the drainage system, but the impervious area percentages or the pervious land use assumptions in table 2-2a are not applicable, use figure 2-3 to compute a composite CN. For example, table 2-2a gives a CN of 70 for a 1/2-acre lot in HSG B, with assumed impervious area of 25 percent. However, if the lot has 20 percent impervious area and a pervious area CN of 61, the composite CN obtained from figure 2-3 is 68. The CN difference between 70 and 68 reflects the difference in percent impervious area.

Unconnected impervious areas — Runoff from these areas is spread over a pervious area as sheet flow. To determine CN when all or part of the impervious area is not directly connected to the drainage system, (1) use figure 2-4 if total impervious area is less than 30 percent or (2) use figure 2-3 if the total impervious area is equal to or greater than 30 percent, because the absorptive capacity of the remaining pervious areas will not significantly affect runoff.

When impervious area is less than 30 percent, obtain the composite CN by entering the right half of figure 2-4 with the percentage of total impervious area and the ratio of total unconnected impervious area to total impervious area. Then move left to the appropriate pervious CN and read down to find the composite CN. For example, for a 1/2-acre lot with 20 percent total impervious area (75 percent of which is unconnected) and pervious CN of 61, the composite CN from figure 2-4 is 66. If all of the impervious area is connected, the resulting CN (from figure 2-3) would be 68.

Figure 2-3 Composite CN with connected impervious area.

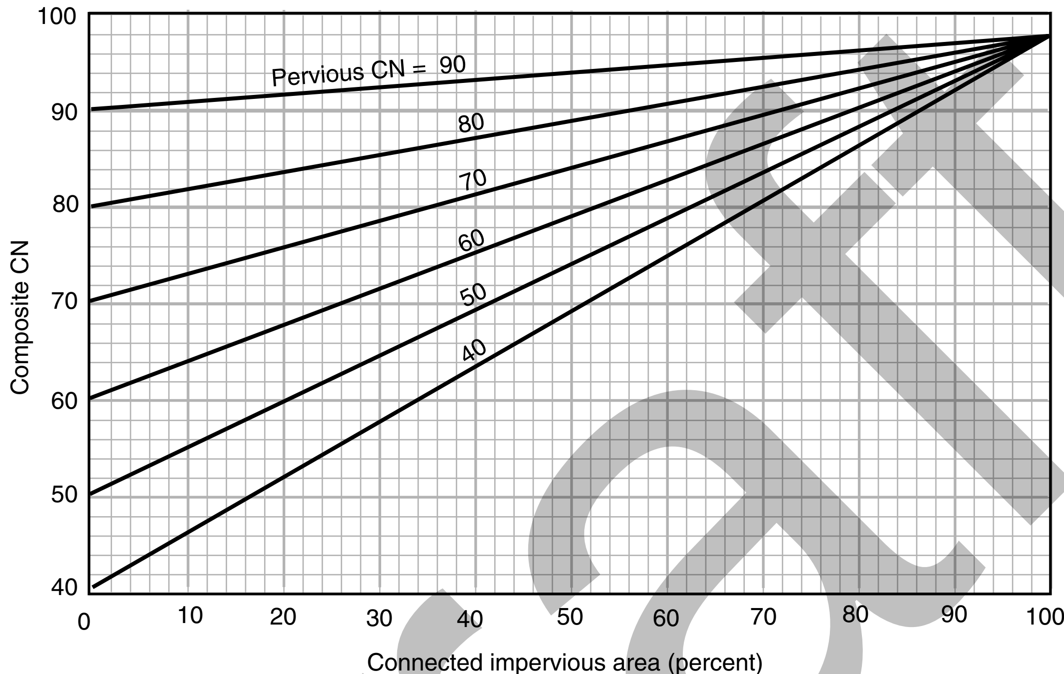
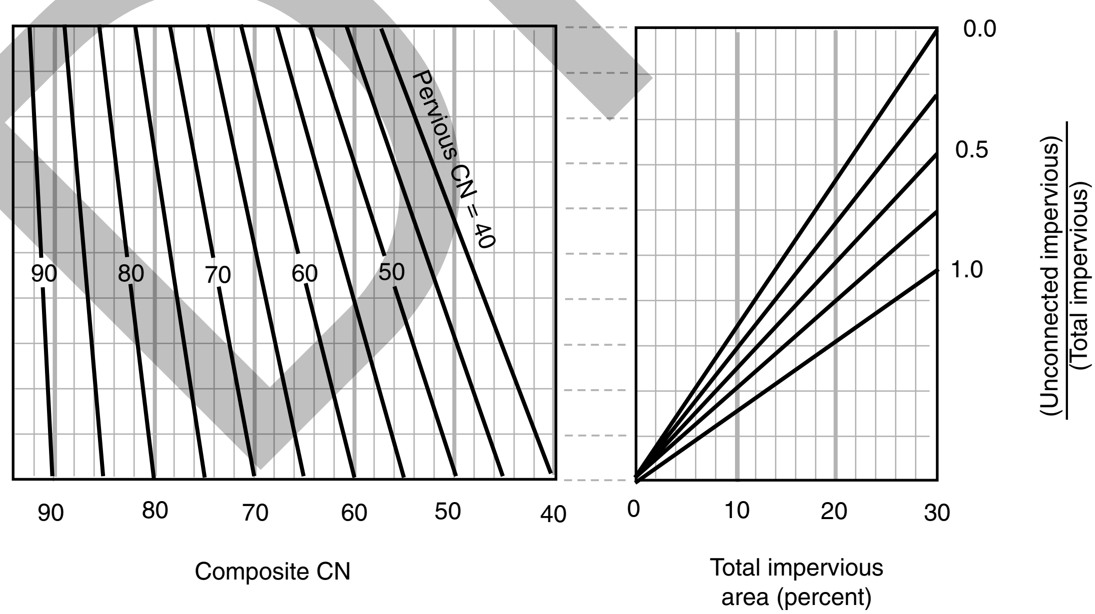


Figure 2-4 Composite CN with unconnected impervious areas and total impervious area less than 30%



Runoff

When CN and the amount of rainfall have been determined for the watershed, determine runoff by using figure 2-1, table 2-1, or equations 2-3 and 2-4. The runoff is usually rounded to the nearest hundredth of an inch.

Limitations

- Curve numbers describe average conditions that are useful for design purposes. If the rainfall event used is a historical storm, the modeling accuracy decreases.

- Use the runoff curve number equation with caution when re-creating specific features of an actual storm. The equation does not contain an expression for time and, therefore, does not account for rainfall duration or intensity.

- The user should understand the assumption reflected in the initial abstraction term (I_a) and should ascertain that the assumption applies to the situation. I_a, which consists of interception, initial infiltration, surface depression storage, evapotranspiration, and other factors, was generalized as 0.2S based on data from agricultural watersheds (S is the potential maximum retention after runoff begins). This approximation can be especially important in an urban application because the combination of impervious areas with pervious areas can imply a significant initial loss that may not take place. The opposite effect, a greater initial loss, can occur if the impervious areas have surface depressions that store some runoff. To use a relationship other than $I_a = 0.2S$, one must redevelop equation 2-3, figure 2-1, table 2-1, and table 2-2 by using the original rainfall-runoff data to establish new S or CN relationships for each cover and hydrologic soil group.

- Runoff from snowmelt or rain on frozen ground cannot be estimated using these procedures.

- The CN procedure is less accurate when runoff is less than 0.5 inch. As a check, use another procedure to determine runoff.

- The SCS runoff procedures apply only to direct surface runoff: do not overlook large sources of subsurface flow or high ground water levels that contribute to runoff. These conditions are often related to HSG A soils and forest areas that have been assigned relatively low CN's in table 2-2. Good judgment and experience based on stream gage records are needed to adjust CN's as conditions warrant.

- When the weighted CN is less than 40, use another procedure to determine runoff.

Examples

Four examples illustrate the procedure for computing runoff curve number (CN) and runoff (Q) in inches. Worksheet 2 in appendix D is provided to assist TR-55 users. Figures 2-5 to 2-8 represent the use of worksheet 2 for each example. All four examples are based on the same watershed and the same storm event.

The watershed covers 250 acres in Dyer County, northwestern Tennessee. Seventy percent (175 acres) is a Loring soil, which is in hydrologic soil group C. Thirty percent (75 acres) is a Memphis soil, which is in group B. The event is a 25-year frequency, 24-hour storm with total rainfall of 6 inches.

Cover type and conditions in the watershed are different for each example. The examples, therefore, illustrate how to compute CN and Q for various situations of proposed, planned, or present development.

Example 2-1

The present cover type is pasture in good hydrologic condition. (See figure 2-5 for worksheet 2 information.)

Example 2-2

Seventy percent (175 acres) of the watershed, consisting of all the Memphis soil and 100 acres of the Loring soil, is 1/2-acre residential lots with lawns in good hydrologic condition. The rest of the watershed is scattered open space in good hydrologic condition. (See figure 2-6.)

Example 2-3

This example is the same as example 2-2, except that the 1/2-acre lots have a total impervious area of 35 percent. For these lots, the pervious area is lawns in good hydrologic condition. Since the impervious area percentage differs from the percentage assumed in table 2-2, use figure 2-3 to compute CN. (See figure 2-7.)

Example 2-4

This example is also based on example 2-2, except that 50 percent of the impervious area associated with the 1/2-acre lots on the Loring soil is "unconnected," that is, it is not directly connected to the drainage system. For these lots, the pervious area CN (lawn, good condition) is 74 and the impervious area is 25 percent. Use figure 2-4 to compute the CN for these lots. CN's for the 1/2-acre lots on Memphis soil and the open space on Loring soil are the same as those in example 2-2. (See figure 2-8.)

Figure 2-5 Worksheet 2 for example 2-1

Worksheet 2: Runoff curve number and runoff

Project: Heavenly Acres	By: WJR	Date: 10/1/85
Location: Dyer County, Tennessee	Checked: NM	Date: 10/3/85

Check one: ☒ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☐ acres ☐ mi^2 ☒ %	Product of CN x area
Memphis, B	Pasture, good condition	61			30	1830
Loring, C	Pasture, good condition	74			70	5180
				Totals ➡	100	7010

1/ Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{7010}{100} = 70.1$; **Use CN** ➡ 70

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	25		
Rainfall, P (24-hour)	in	6.0		
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	2.81		

Figure 2-6 Worksheet 2 for example 2-2

Worksheet 2: Runoff curve number and runoff

Project Heavenly Acres	By WJR	Date 10/1/85
Location Dyer County, Tennessee	Checked NM	Date 10/3/85

Check one: ☐ Present ☒ Developed 175 Acres residential

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☒ acres ☐ mi^2 ☐ %	Product of CN x area
Memphis, B	25% impervious 1/2 acre lots, good condition	70			75	5250
Loring, C	25% impervious 1/2 acre lots, good condition	80			100	8000
Loring, C	Open space, good condition	74			75	5550
				Totals ➡	250	18,800

1/ Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{18{,}800}{250} = 75.2$; Use CN ➡ 75

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency .... yr	25		
Rainfall, P (24-hour) .... in	6.0		
Runoff, Q .... in	3.28		

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

Figure 2-7 Worksheet 2 for example 2-3

Worksheet 2: Runoff curve number and runoff

Project Heavenly Acres	By WJR	Date 10/1/85
Location Dyer County, Tennessee	Checked NM	Date 10/3/85

Check one: ☐ Present ☒ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
Memphis, B	35% impervious 1/2 acre lots, good condition		74		75	5550
Loring, C	35% impervious 1/2 acre lots, good condition		82		100	8200
Loring, C	Open space, good condition	74			75	5550
				Totals ➡	250	19,300

[1] Use only one CN source per line

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{19{,}300}{250} = 77.2 \quad ; \quad \textbf{Use CN} \Rightarrow \boxed{77}$$

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	25		
Rainfall, P (24-hour)	in	6.0		
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	3.48		

Figure 2-8 Worksheet 2 for example 2-4

Worksheet 2: Runoff curve number and runoff

Project: Heavenly Acres	By: WJR	Date: 10/1/85
Location: Dyer County, Tennessee	Checked: NM	Date: 10/3/85

Check one: ☐ Present ☒ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
Memphis,B	25% connected impervious 1/2 acre lots, good condition	70			75	5250
Loring, C	25% impervious with 50% unconnected 1/2 acre lots, good condition			78	100	7800
Loring, C	Open space, good condition	74			75	5550
					Totals 250	18,600

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{18{,}600}{250} = 74.4$; **Use CN** 74

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	25		
Rainfall, P (24-hour)	in	6.0		
Runoff, Q	in	3.19		

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

Chapter 3 Time of Concentration and Travel Time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

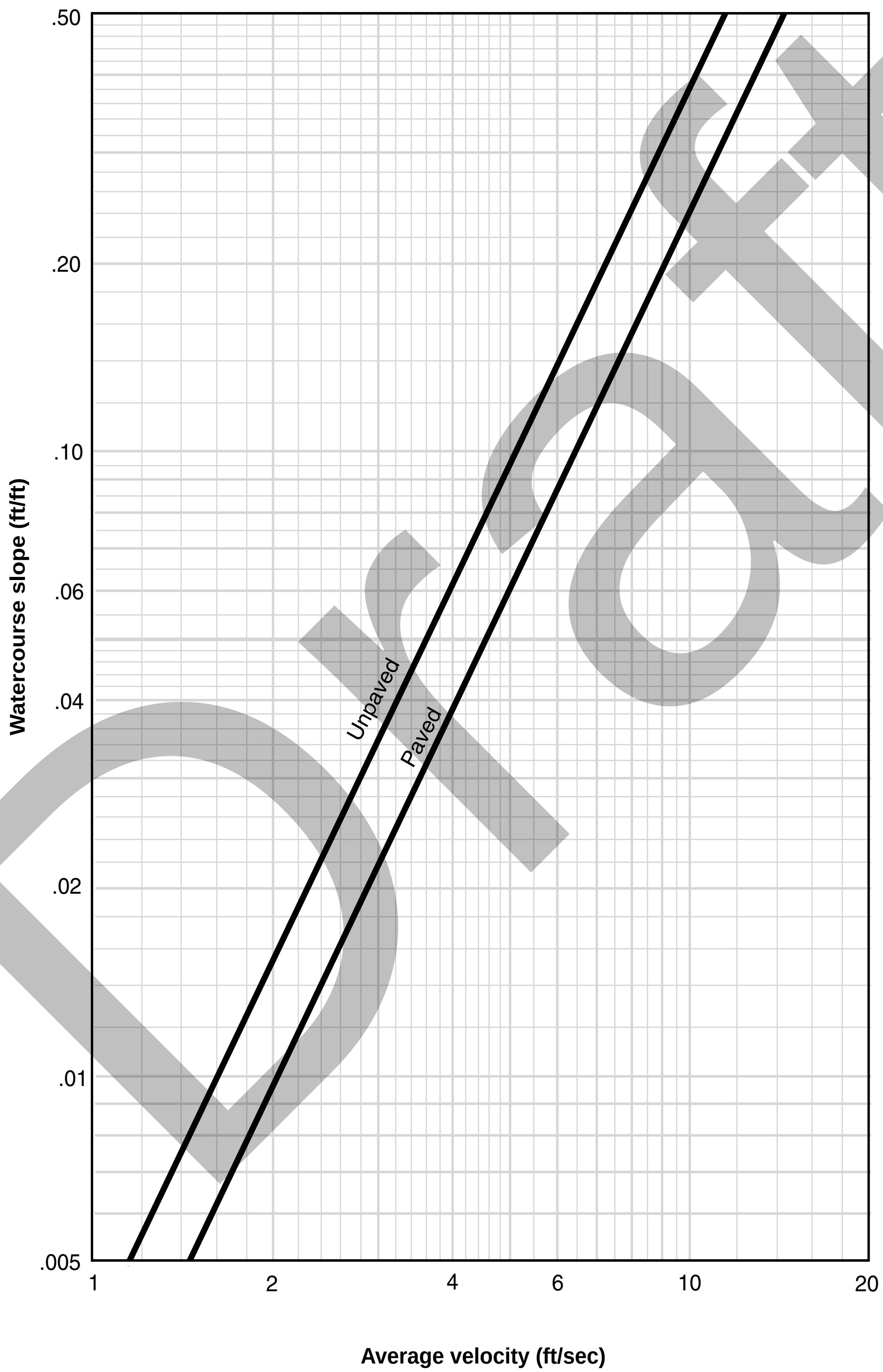
Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad \text{[eq. 3-4]}$$

where:

- V = average velocity (ft/s)
- r = hydraulic radius (ft) and is equal to a/p_w
  - a = cross sectional flow area (ft^2)
  - p_w = wetted perimeter (ft)
- s = slope of the hydraulic grade line (channel slope, ft/ft)
- n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum T_c used in TR-55 is 0.1 hour.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.

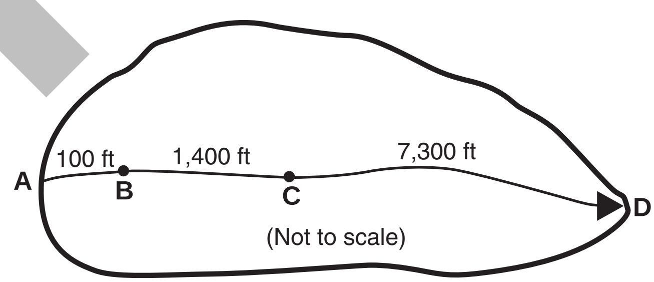


Figure 3-2 Worksheet 3 for example 3-1

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project: Heavenly Acres	By: DW	Date: 10/6/85
Location: Dyer County, Tennessee	Checked: NM	Date: 10/8/85

Check one: ☐ Present ☒ Developed

Check one: ☒ T_c ☐ T_t through subarea

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

Sheet flow (Applicable to T_c only)

	Segment ID	AB		
1.	Surface description (table 3-1)	Dense Grass		
2.	Manning's roughness coefficient, n (table 3-1)	0.24		
3.	Flow length, L (total L ≤ 300 ft) ... ft	100		
4.	Two-year 24-hour rainfall, P_2 ... in	3.6		
5.	Land slope, s ... ft/ft	0.01		
6.	$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ... hr	0.30	+	= 0.30

Shallow concentrated flow

	Segment ID	BC		
7.	Surface description (paved or unpaved)	Unpaved		
8.	Flow length, L ... ft	1400		
9.	Watercourse slope, s ... ft/ft	0.01		
10.	Average velocity, V (figure 3-1) ... ft/s	1.6		
11.	$T_t = \frac{L}{3600\ V}$ Compute T_t ... hr	0.24	+	= 0.24

Channel flow

	Segment ID	CD		
12.	Cross sectional flow area, a ... ft^2	27		
13.	Wetted perimeter, p_w ... ft	28.2		
14.	Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft	0.957		
15	Channel slope, s ... ft/ft	0.005		
16.	Manning's roughness coefficient, n ...	0.05		
17.	$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ... ft/s	2.05		
18.	Flow length, L ... ft	7300		
19.	$T_t = \frac{L}{3600\ V}$ Compute T_t ... hr	0.99	+	= 0.99
20.	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ... Hr			1.53

Chapter 4 Graphical Peak Discharge Method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, “Computer Program for Project Formulation—Hydrology” (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \qquad \text{[eq. 4-1]}$$

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi^2)
Q = runoff (in)
F_p = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi^2), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a / P is then computed.

If the computed I_a / P ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a / P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a / P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

Figure 4-1 Variation of I_a / P for P and CN

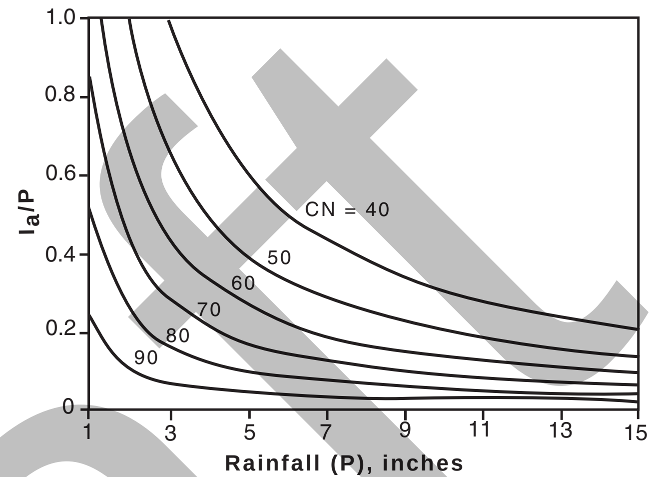


Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Table 4-2 Adjustment factor (F_p) for pond and swamp areas that are spread throughout the watershed

Percentage of pond and swamp areas	F_p
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

Limitations

The Graphical method provides a determination of peak discharge only. If a hydrograph is needed or watershed subdivision is required, use the Tabular Hydrograph method (chapter 5). Use TR-20 if the watershed is very complex or a higher degree of accuracy is required.

- The watershed must be hydrologically homogeneous, that is, describable by one CN. Land use, soils, and cover are distributed uniformly throughout the watershed.
- The watershed may have only one main stream or, if more than one, the branches must have nearly equal T_C' s.
- The method cannot perform valley or reservoir routing.
- The F_p factor can be applied only for ponds or swamps that are not in the T_c flow path.
- Accuracy of peak discharge estimated by this method will be reduced if I_a / P values are used that are outside the range given in exhibit 4. The limiting I_a / P values are recommended for use.
- This method should be used only if the weighted CN is greater than 40.
- When this method is used to develop estimates of peak discharge for both present and developed conditions of a watershed, use the same procedure for estimating T_c.
- T_c values with this method may range from 0.1 to 10 hours.

Example 4-1

Compute the 25-year peak discharge for the 250-acre watershed described in examples 2-2 and 3-1. Figure 4-2 shows how worksheet 4 is used to compute q_p as 345 cfs.

Example 4-1 Worksheet 4 for example 4-1

Worksheet 4: Graphical Peak Discharge method

Project Heavenly Acres	By RHM	Date 10/15/85
Location Dyer County, Tennessee	Checked NM	Date 10/17/85

Check one: ☐ Present ☒ Developed

1. Data

Drainage area .... A_m = 0.39 mi^2 (acres/640)

Runoff curve number ....CN = 75 (From worksheet 2), Figure 2-6

Time of concentration .... T_c = 1.53 hr (From worksheet 3), Figure 3-2

Rainfall distribution .... = II (I, IA, II III)

Pond and swamp areas sprea
throughout watershed .... = – – percent of A_m (– – acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	6.0		
4. Initial abstraction, I_a .... (Use CN with table 4-1)	in	0.667		
5. Compute I_a/P		0.11		
6. Unit peak discharge, qu .... (Use T_c and I_a/P with exhibit 4– II)	csm/in	270		
7. Runoff, Q .... (From worksheet 2). Figure 2-6	in	3.28		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		1.0		
9. Peak discharge, q_p	cfs	345		

(Where $q_p = q_u A_m Q F_p$)

Exhibit 4-I Unit peak discharge (q_u) for NRCS (SCS) type I rainfall distribution

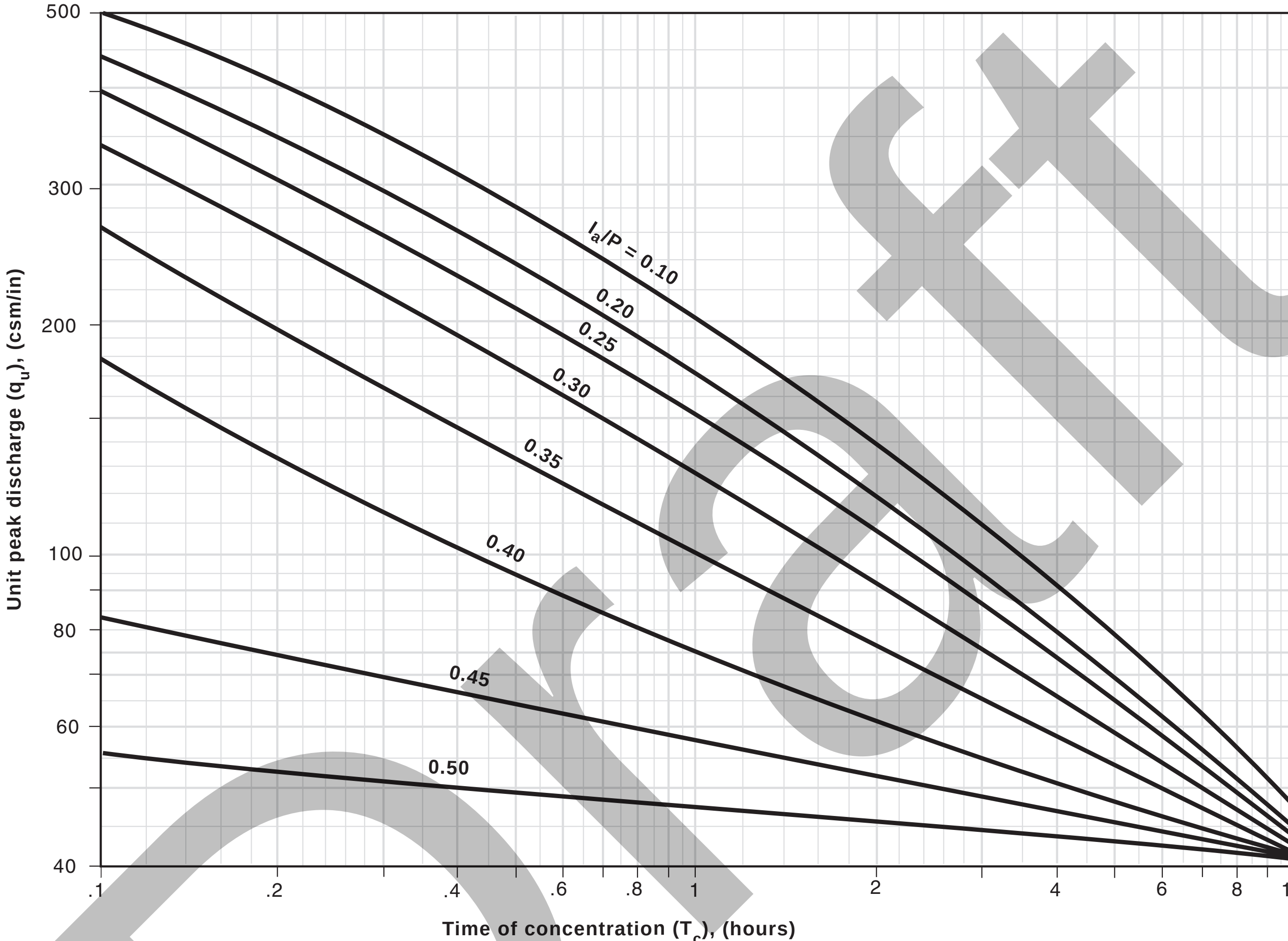


Exhibit 4-IA Unit peak discharge (q_u) for NRCS (SCS) type IA rainfall distribution

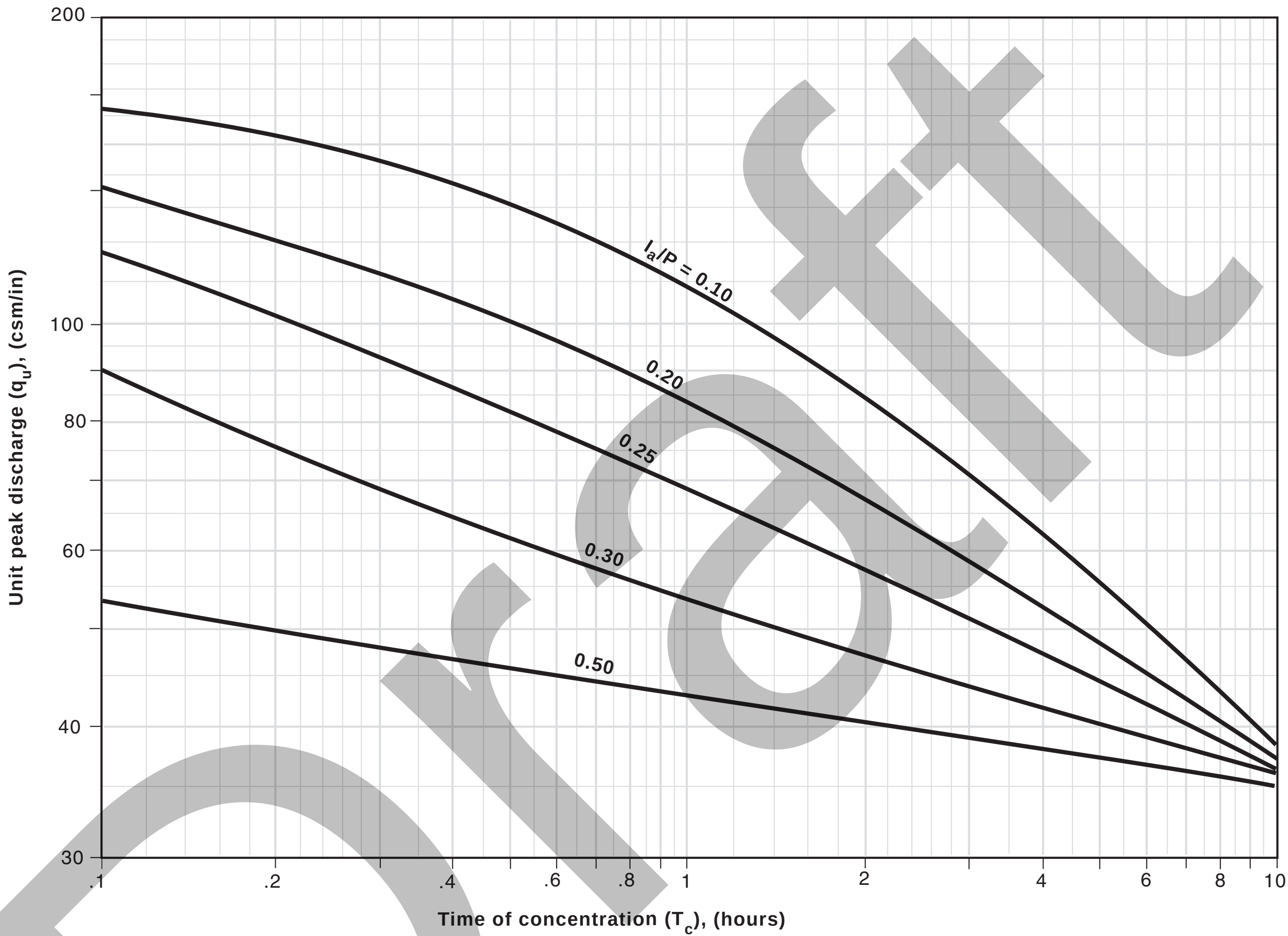


Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution

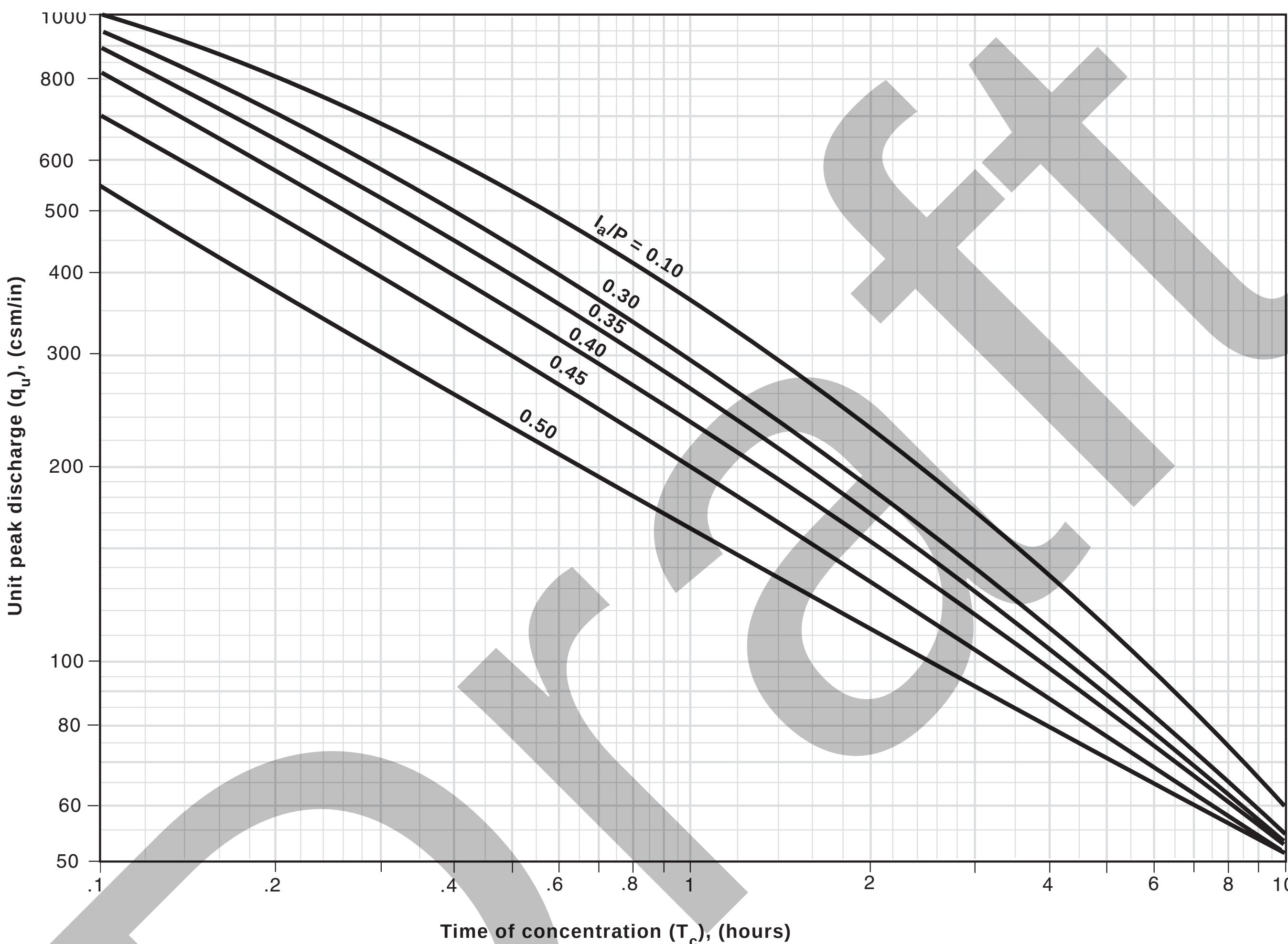
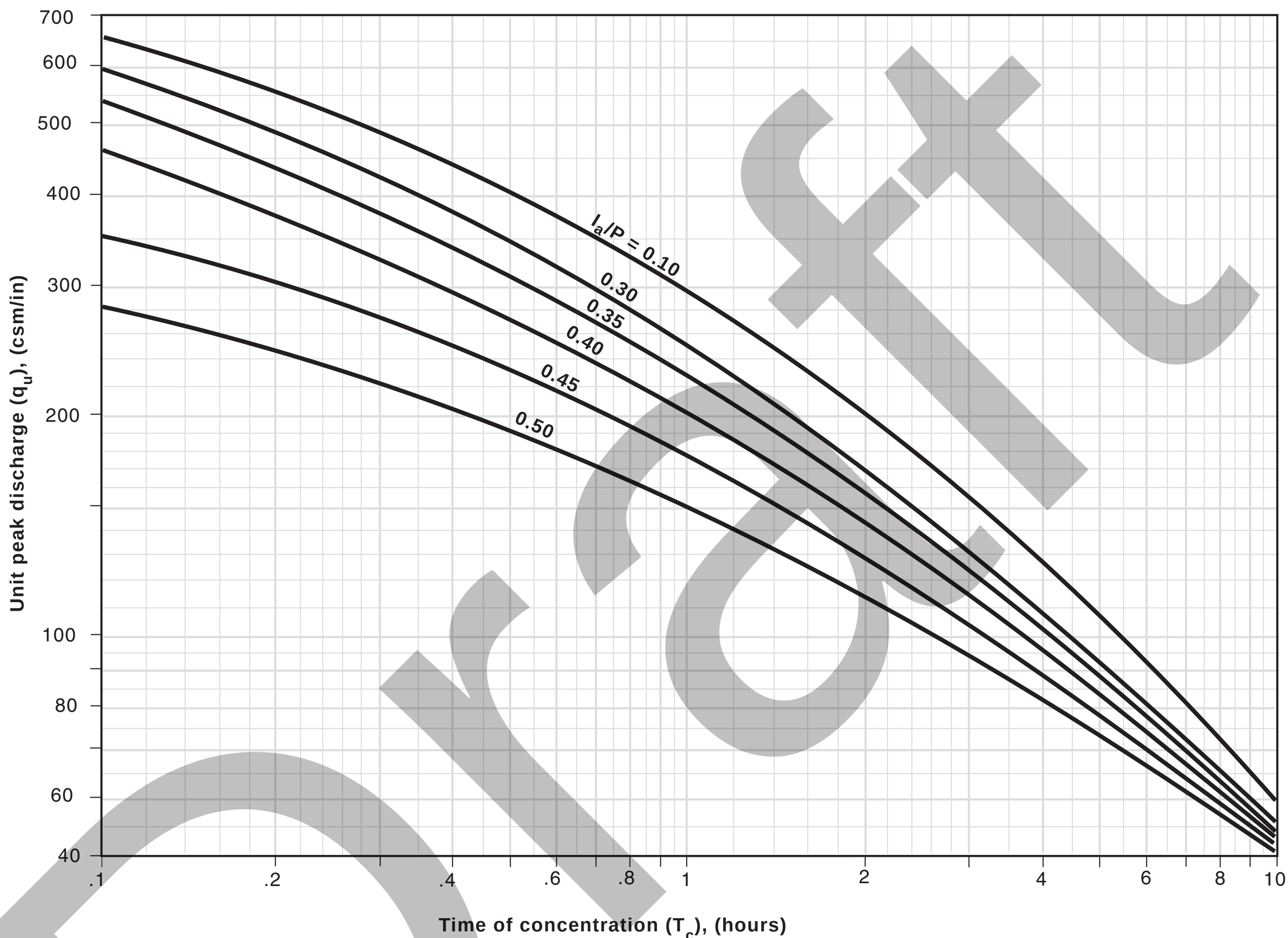


Exhibit 4-III Unit peal discharge (q_u) for NRCS (SCS) type III rainfall distribution



Chapter 5 Tabular Hydrograph Method

This chapter presents the Tabular Hydrograph method of computing peak discharges from rural and urban areas, using time of concentration (T_c) and travel time (T_t) from a subarea as inputs. This method approximates TR-20, a more detailed hydrograph procedure (SCS 1983).

The Tabular method can develop partial composite flood hydrographs at any point in a watershed by dividing the watershed into homogeneous subareas. In this manner, the method can estimate runoff from nonhomogeneous watersheds. The method is especially applicable for estimating the effects of land use change in a portion of a watershed. It can also be used to estimate the effects of proposed structures.

Input data needed to develop a partial composite flood hydrograph include (1) 24-hour rainfall (in), (2) appropriate rainfall distribution (I, IA, II, or III), (3) CN, (4) T_c (hr), (5) T_t (hr), and (6) drainage area (mi^2).

Tabular Hydrograph method exhibits

Exhibit 5 (5-I, 5-IA, 5-II, and 5-III) shows tabular discharge values for the various rainfall distributions. Tabular discharges expressed in csm/in (cubic feet of discharge per second per square mile of watershed per inch of runoff) are given for a range of subarea T_c's from 0.1 to 2 hours and reach T_t's from 0 to 3 hours.

The exhibit was developed by computing hydrographs for 1 square mile of drainage area for selected T_c's and routing them through stream reaches with the range of T_t's indicated. The Modified Att-Kin method for reach routing, formulated by SCS in the late 1970's, was used to compute the tabular hydrographs (Comer et al., 1981). A CN of 75 and rainfall amounts generating appropriate I_a/P ratios were used. The resulting runoff estimate was used to convert the hydrographs in exhibits 5-I through 5-III to cubic feet of discharge per second per square mile of watershed per inch of runoff.

An assumption in development of the tabular hydrographs is that all discharges for a stream reach flow at the same velocity. By this assumption, the subarea flood hydrographs may be routed separately and added at the reference point. The tabular hydrographs in exhibit 5 are prerouted hydrographs.

For T_t's other than zero, the tabular discharge values represent the contribution from a single subarea to the composite hydrograph at T_t downstream.

Information required for Tabular Hydrograph method

The following information is required for the Tabular method:

1. Subdivision of the watershed into areas that are relatively homogeneous and have convenient routing reaches.

2. Drainage area of each subarea in square miles.

3. T_c for each subarea in hours. The procedure for estimating T_c is outlined in chapter 3. Worksheet 3 (appendix D) can be used to calculate T_c.

4. T_t for each routing reach in hours. The procedure for estimating T_t is outlined in chapter 3. Worksheet 3 can be used to calculate T_t through a subarea for shallow concentrated and open channel flow.

5. Weighted CN for each subarea. Table 2-2 shows CN's for individual hydrologic soil cover combinations. Worksheet 2 can be used to calculate the weighted runoff curve number.

6. Appropriate rainfall distribution according to figure B-2 (appendix B).

7. The 24-hour rainfall for the selected frequency. Appendix B contains rainfall maps for various frequencies (figures B-3 to B-8).

8. Total runoff (Q) in inches computed from CN and rainfall.

9. I_a for each subarea from table 5-1, which is the same as table 4-1.

10. Ratio of I_a/P for each subarea. If the ratio for the rainfall distribution of interest is outside the range shown in exhibit 5, use the limiting value.

Development of composite flood hydrograph

This section describes the procedure for developing the peak discharge and selected discharge values of a composite flood hydrograph.

Selecting T_c and T_t

First, use worksheet 5a to develop a summary of basic watershed data by subarea. Then use worksheet 5b to develop a tabular hydrograph discharge summary; this summary displays the effect of individual subarea hydrographs as routed to the watershed point of interest. Use $\sum T_t$ for each subarea as the total reach travel time from that subarea through the watershed to the point of interest. Compute the hydrograph coordinates for selected $\sum T_t$'s using the appropriate sheets in exhibit 5. The flow at any time is:

$$q = q_t A_m Q \qquad \text{[eq. 5-1]}$$

where:

q = hydrograph coordinate (cfs) at hydrograph time t
q_t = tabular hydrograph unit discharge from exhibit 5 (csm/in)
A_m = drainage area of individual subarea (mi^2)
Q = runoff (in)

Since the timing of peak discharge changes with T_c and T_t, interpolation of peak discharge for T_c and T_t values for use in exhibit 5 is not recommended. Interpolation may result in an estimate of peak discharge that would be invalid because it would be lower than either of the hydrographs. Therefore, round the actual values of T_c and T_t to values presented in exhibit 5. Perform this rounding so that the sum of the selected table values is close to the sum of actual T_c and T_t. An acceptable procedure is to select the results of one of three rounding operations:

1. Round T_c and T_t separately to the nearest table value and sum,
2. Round T_c down and T_t up to nearest table value and sum,
3. Round T_c up and T_t down to nearest table value and sum.

From these three alternatives, choose the pair of rounded T_c and T_t values whose sum is closest to the sum of the actual T_c and T_t. If two rounding methods produce sums equally close to the actual sum, use the combination in which rounded T_c is closest to actual T_c. An illustration of the rounding procedure is as follows:

Table 5-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

	Actual values	Table values by rounding method		
		1	2	3
T_c	1.1	1.0	1.0	1.25
T_t	1.7	1.5	2.0	1.5
Sum	2.8	2.5	3.0	2.75

In this instance, the results from method 3 would be selected because the sum 2.75 is closest to the actual sum of 2.8.

Selecting I_a / P

The computed I_a / P value can be rounded to the nearest I_a / P value in exhibits 5-I through 5-III, or the hydrograph values (csm/in) can be linearly interpolated because I_a / P interpolation generally involves peaks that occur at the same time.

Summing for the composite hydrograph

The composite hydrograph is the summation of prerouted individual subarea hydrographs at each time shown on worksheet 5b. Only the times encompassing the expected maximum composite discharge are summed to define a portion of the composite hydrograph.

If desired, the entire composite hydrograph can be approximated by linear extrapolation as follows:

1. Set up a table similar to worksheet 5b. Include on this table the full range of hydrograph times displayed in exhibit 5.
2. Compute the subarea discharge values for those times and insert them in the table.
3. Sum the values to obtain the composite hydrograph.
4. Apply linear extrapolation to the first two points and the last two points of the composite hydrograph. The volume under this approximation of the entire composite hydrograph may differ from the computed runoff volume.

Limitations

The Tabular method is used to determine peak flows and hydrographs within a watershed. However, its accuracy decreases as the complexity of the watershed increases. If you want to compare present and developed conditions of a watershed, use the same procedure for estimating T_c for both conditions.

Use the TR-20 computer program (SCS 1983) instead of the Tabular method if any of the following conditions applies:

- T_t is greater than 3 hours (largest T_t in exhibit 5).
- T_c is greater than 2 hours (largest T_c in exhibit 5).
- Drainage areas of individual subareas differ by a factor of 5 or more.
- The entire composite flood hydrograph or entire runoff volume is required for detailed flood routings. The hydrograph based on extrapolation is only an approximation of the entire hydrograph.
- The time of peak discharge must be more accurate than that obtained through the Tabular method.

The composite flood hydrograph should be compared with actual stream gage data where possible. The instantaneous peak flow value from the composite flood hydrograph can be compared with data from USGS curves of peak flow versus drainage area.

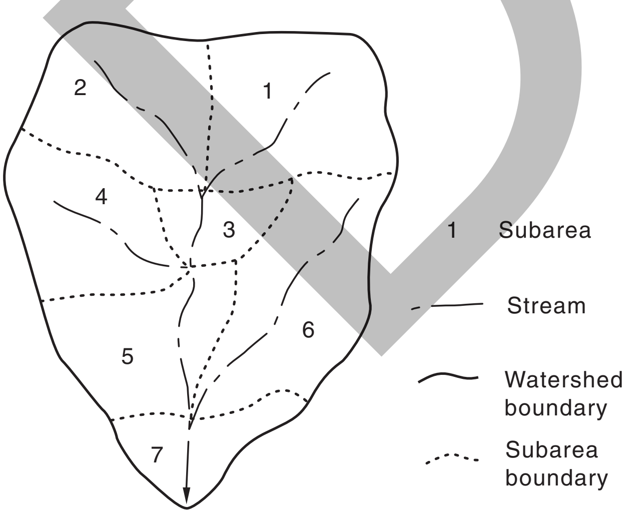
Examples

A developer proposes to put a subdivision, Fallswood, in subareas 5, 6, and 7 of a watershed in Dyer County, northwestern Tennessee (see sketch below). Before approving the developer's proposal, the planning board wants to know how the development would affect the 25-year peak discharge at the downstream end of subarea 7. The rainfall distribution is type II (figure B-2), and the 24-hour rainfall (P) is 6.0 inches (figure B-6).

Example 5-1

Compute the 25-year frequency peak discharge at the downstream end of subarea 7 for present conditions, using worksheets 5a and 5b. To do this, first calculate the present condition CN, T_c, and T_t for each subarea, using the procedures in chapters 2 and 3. Enter the values on worksheet 5a (figure 5-1).

Next, compute the prerouted hydrograph points for each subarea hydrograph over a range of time near the peak discharge using worksheet 5b (figure 5-2) and the appropriate exhibit 5. For example, for subarea 4, in which T_c= 0.75 hr, refer to sheet 6 of exhibit 5-II. With ΣT_t of 2.00 hr (the sum of downstream travel time through subareas 5 and 7 to the outlet) and Ia / P of 0.1, the routed peak discharge of subarea 4 at the outlet of subarea 7 occurs at 14.6 hr and is 274 csm/in.



Solving equation 5-1 with appropriate values provides the peak discharge (q) for subarea 4 at 14.6 hr:

$$q = qt(A_mQ) = (274)(0.70) = 192 \text{ cfs.}$$

Once all the prerouted subarea hydrographs have been tabulated on worksheet 5b, sum each of the time columns to obtain the composite hydrograph. The resulting 25-year frequency peak discharge is 720 cfs at 14.3 hr (figure 5-2).

Example 5-2

Compute the 25-year frequency peak discharge at the downstream end of subarea 7 for the developed conditions, using worksheets 5a and 5b.

First, calculate the developed condition CN, T_c, and T_t for each subarea, using the procedures in chapters 2 and 3. Enter the values on worksheet 5a (figure 5-3).

Next, compute the prerouted hydrograph points for each subarea hydrograph over a range of time near the peak discharge using worksheet 5b (figure 5-4) and the appropriate exhibit 5. For example, for subarea 6, in which T_c= 1.0 hr, refer to sheet 7 of exhibit 5-II. With ΣT_t of 0.5 hr (downstream travel time through subarea 7 to the outlet) and I_a / P of 0.1, the peak discharge of subarea 6 at the outlet of the watershed occurs at 13.2 hr and is 311 csm/in. Solving equation 5-1 provides the peak discharge (q):

$$q = q_t\,(A_mQ) = (311)(1.31) = 407 \text{ cfs}$$

Once all the prerouted subarea hydrographs have been tabulated on worksheet 5b, sum each of the time columns to obtain the composite hydrograph. The resulting 25-year frequency peak discharge is 872 cfs

Comparison

According to the results of the two examples, the proposed subdivision at the downstream end of subarea 7 is expected to increase peak discharge from 720 to 872 cfs and to decrease the time to peak from 14.3 to 13.6 hr.

Figure 5-1 Worksheet 5a for example 5-1

Worksheet 5a: Basic watershed data

Project: Fallswood	Location: Dyer County, Tennessee	By: DW	Date: 10/1/85
Check one: [X] Present [ ] Developed	Frequency (yr): 25	Checked: NM	Date: 10/3/85

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr rainfall P (in)	Runoff curve number CN	Runoff Q (in)	A_mQ (mi^2—in)	Initial abstraction I_a (in)	I_a/P
1	0.30	1.50	– –	3, 5, 7	2.50	6.0	65	2.35	0.71	1.077	0.18
2	0.20	1.25	– –	3, 5, 7	2.50	6.0	70	2.80	0.56	0.857	0.14
3	0.10	0.50	0.50	5, 7	2.00	6.0	75	3.28	0.33	0.667	0.11
4	0.25	0.75	– –	5, 7	2.00	6.0	70	2.80	0.70	0.857	0.14
5	0.20	1.50	1.25	7	0.75	6.0	75	3.28	0.66	0.667	0.11
6	0.40	1.50	– –	7	0.75	6.0	70	2.80	1.12	0.857	0.14
7	0.20	1.25	0.75	– –	0	6.0	75	3.28	0.66	0.667	0.11
		From worksheet 3					From worksheet 2			From table 5-1	

Figure 5-2 Worksheet 5b for example 5-1

Worksheet 5b: Basic watershed data

Project Fallswood	Location Dyer County, Tennessee	By DW	Date 10/1/85
Check one: [X] Present [ ] Developed	Frequency (yr) 25	Checked NM	Date 10/3/85

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi²—in)	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5
					Discharges at selected hydrograph times 3/ (cfs)											
1	1.50	2.50	0.10	0.71	4	4	5	6	6	8	10	113	24	49	100	149
2	1.25	2.50	0.10	0.56	3	4	4	6	7	8	11	16	32	64	110	127
3	0.50	2.00	0.10	0.33	5	5	6	8	12	21	41	67	98	92	60	29
4	0.75	2.00	0.10	0.70	8	9	11	14	20	34	62	106	172	192	149	81
5	1.50	0.75	0.10	0.66	21	28	50	83	118	147	158	154	127	98	67	44
6	1.50	0.75	0.10	1.12	36	47	85	140	200	249	269	261	216	166	114	75
7	1.25	0	0.10	0.66	169	187	205	176	140	108	85	69	51	40	31	24
Composite hydrograph at outlet					246	284	366	433	503	575	636	686	720	701	631	529

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Figure 5-3 Worksheet 5a for example 5-2

Worksheet 5a: Basic watershed data

Project *Fallswood*	Location *Dyer County, Tennessee*	By *DW*	Date *10/1/85*
Check one: ☐ Present ☒ Developed	Frequency (yr) *25*	Checked *NM*	Date *10/3/85*

Subarea name	Drainage area A_m (mi^2)	Time of concen-tration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr rain-fall P (in)	Runoff curve number CN	Runoff Q (in)	A_mQ (mi^2—in)	Initial abstraction I_a (in)	I_a/P
1	0.30	1.50	– –	3, 5, 7	2.00	6.0	65	2.35	0.71	1.077	0.18
2	0.20	1.25	– –	3, 5, 7	2.00	6.0	70	2.80	0.56	0.857	0.14
3	0.10	0.50	0.50	5, 7	1.50	6.0	75	3.28	0.33	0.667	0.11
4	0.25	0.75	– –	5, 7	1.50	6.0	70	2.80	0.70	0.857	0.14
5	0.20	1.50	1.00	7	0.50	6.0	85	4.31	0.86	0.353	0.06
6	0.40	1.00	– –	7	0.50	6.0	75	3.28	1.31	0.857	0.14
7	0.20	0.75	0.50	– –	0	6.0	90	4.85	0.97	0.222	0.04

From worksheet 3 — From worksheet 2 — From table 5-1

Figure 5-4 Worksheet 5b for example 5-2

Worksheet 5b: Basic watershed data

Project Fallswood	Location Dyer County, Tennessee	By DW	Date 10/1/85
Check one: ☐ Present ☒ Developed	Frequency (yr) 25	Checked NM	Date 10/3/85

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi²—in)	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5
					Discharges at selected hydrograph times 3/ (cfs)											
1	1.50	2.00	0.10	0.71	6	6	7	9	11	16	24	40	78	122	155	133
2	1.25	2.00	0.10	0.56	6	6	7	9	12	20	33	55	96	132	132	87
3	0.50	1.50	0.10	0.33	8	9	14	29	58	89	106	102	74	46	25	16
4	0.75	1.50	0.10	0.70	13	14	19	32	63	114	169	207	193	143	83	46
5	1.50	0.50	0.10	0.86	51	69	117	167	205	214	202	175	132	99	70	48
6	1.00	0.50	0.10	1.31	149	208	331	407	393	329	255	195	134	97	69	52
7	0.75	0	0.10	0.97	398	358	244	167	119	90	72	59	48	40	34	30
Composite hydrograph at outlet					631	670	739	820	861	872	861	833	755	679	568	412

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution

HYDROGRAPH TIME (HOURS)

IA/P = 0.10 — * * * TC = 0.1 HR * * *

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	30	40	56	183	337	504	326	155	122	107	93	81	73	66	60	56	54	52	49	46	44	40	36	32	30	29	28	27	26	24	20	13
.10	26	35	48	93	153	276	428	360	223	156	123	103	83	72	65	59	56	54	51	47	45	42	37	33	30	29	28	28	26	24	21	13
.20	23	30	41	60	82	129	227	361	360	269	194	147	118	85	71	63	58	55	53	49	46	43	39	35	31	29	29	28	26	24	21	14
.30	22	29	39	56	73	111	188	303	341	293	227	173	136	94	75	65	60	56	54	50	47	43	39	35	31	29	29	28	26	25	21	14
.40	18	25	34	46	53	66	96	157	255	312	300	251	199	126	90	73	64	59	56	52	48	44	40	36	32	30	29	28	26	25	21	14
.50	18	24	32	44	50	61	84	133	214	280	293	265	221	144	99	77	66	60	56	52	49	45	41	37	32	30	29	28	27	25	21	14
.75	14	19	25	34	38	43	49	62	88	134	190	234	252	221	162	115	87	71	63	56	52	47	43	39	35	31	29	29	27	25	22	15
1.0	11	14	19	26	28	31	34	38	44	52	68	98	141	222	238	191	139	101	79	63	56	51	45	41	37	33	30	29	27	26	22	15
1.5	9	10	13	17	18	20	22	25	27	30	34	38	44	74	132	191	211	190	151	101	73	58	50	45	41	37	33	30	28	27	23	16
2.0	6	7	9	11	12	13	14	15	16	18	20	22	24	29	38	58	97	148	193	193	141	89	61	51	46	41	37	33	29	27	24	17
2.5	4	5	7	8	9	9	10	11	11	12	13	14	16	19	23	29	39	58	93	154	181	147	87	61	51	45	41	37	30	28	25	18
3.0	2	3	5	6	6	7	7	8	9	9	10	10	11	13	15	19	23	28	39	72	124	170	138	86	61	50	45	40	33	29	26	19

IA/P = 0.30 — * * * TC = 0.1 HR * * *

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	61	195	343	232	129	113	103	91	81	76	71	66	64	62	61	59	56	54	51	47	43	40	40	39	39	37	36	31	21
.10	0	0	0	12	45	145	277	247	169	131	112	98	87	76	70	65	64	62	60	57	55	53	49	44	40	40	39	39	38	36	32	21
.20	0	0	0	9	33	107	220	238	192	151	125	107	94	79	71	66	64	62	61	58	56	53	49	45	41	40	40	39	38	36	32	21
.30	0	0	0	1	6	24	79	173	216	200	168	139	118	90	77	70	66	64	62	59	57	54	50	46	41	40	40	39	38	36	32	22
.40	0	0	0	1	4	17	59	135	189	196	177	152	129	97	81	72	67	64	63	60	57	54	51	46	42	40	40	39	38	36	32	22
.50	0	0	0	0	0	3	12	43	104	161	185	180	161	121	93	79	71	66	64	61	58	55	52	48	43	40	40	39	38	37	33	22
.75	0	0	0	0	0	1	5	18	49	92	130	153	159	142	114	92	79	71	66	63	60	56	53	49	44	41	40	40	38	37	33	23
1.0	0	0	0	0	0	0	0	0	2	9	27	56	92	144	152	128	103	86	75	67	63	59	55	51	47	43	40	40	39	37	34	24
1.5	0	0	0	0	0	0	0	0	0	0	0	2	6	32	79	121	136	127	109	85	72	64	58	55	51	47	43	40	39	38	34	25
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	33	70	105	126	118	97	75	63	58	54	50	46	42	40	39	35	26
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	32	63	105	118	100	75	63	58	54	50	46	40	39	36	27
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	12	43	84	112	96	74	63	58	54	50	42	40	37	28

IA/P = 0.50 — * * * TC = 0.1 HR * * *

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	3	13	28	39	44	45	46	46	48	49	51	53	54	54	55	56	55	53	50	50	49	49	49	49	48	45	32
.10	0	0	0	0	0	2	9	22	33	41	44	45	46	48	49	50	52	54	54	54	56	55	53	50	50	49	49	49	49	48	45	32
.20	0	0	0	0	0	0	1	7	17	28	36	41	44	46	48	49	51	53	54	54	56	56	54	51	50	50	49	49	49	48	45	32
.30	0	0	0	0	0	0	0	1	5	13	23	32	38	44	47	48	50	51	53	54	54	55	54	52	50	50	49	49	49	48	46	33
.40	0	0	0	0	0	0	0	0	3	10	18	27	34	43	46	48	49	51	53	54	54	55	54	52	50	50	49	49	49	48	46	33
.50	0	0	0	0	0	0	0	0	0	2	7	15	23	36	43	46	48	50	51	53	54	55	55	53	50	50	49	49	49	48	46	34
.75	0	0	0	0	0	0	0	0	0	1	3	7	13	27	37	43	46	48	50	52	54	55	55	54	51	50	50	49	49	48	46	34
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	20	32	40	45	47	50	52	54	55	54	52	50	50	49	49	49	47	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	23	33	42	47	51	54	55	54	53	50	50	49	49	48	37
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	12	25	37	46	51	54	55	54	52	50	49	49	48	39
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	15	31	45	51	53	55	54	52	50	49	48	41
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	32	45	51	53	54	54	51	49	48	42

RAINFALL TYPE = I — * * * TC = 0.1 HR * * * — SHEET 1 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

IA/P = 0.10 * * * TC = 0.2 HR * * * IA/P = 0.10

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	28	37	52	126	220	379	405	267	168	129	108	92	80	69	62	58	55	53	50	47	44	41	37	33	30	29	28	27	26	24	21	13
.10	24	32	44	71	108	182	313	375	303	213	157	124	103	78	68	61	57	55	52	49	46	42	38	34	30	29	29	28	26	24	21	14
.20	21	28	38	53	65	94	153	260	336	314	247	187	145	97	77	67	60	57	54	50	47	44	39	35	31	30	29	28	26	25	21	14
.30	20	27	36	50	60	82	129	216	296	308	267	214	168	110	82	69	62	58	55	51	47	44	40	36	32	30	29	28	26	25	21	14
.40	17	23	31	42	47	56	74	111	181	258	291	275	234	152	103	79	68	61	57	53	49	45	41	37	33	30	29	28	27	25	22	14
.50	16	22	30	40	45	52	66	96	153	223	269	273	247	171	115	86	71	63	58	54	50	46	42	37	33	30	29	28	27	25	22	14
.75	13	17	24	32	35	39	44	52	68	99	145	194	229	240	183	132	97	77	66	58	53	48	44	39	35	31	30	29	27	26	22	15
1.0	11	13	17	24	26	29	32	35	39	45	56	75	107	189	229	206	158	115	88	67	58	52	46	42	38	34	31	29	28	26	23	15
1.5	8	10	12	15	17	19	21	23	25	28	31	35	39	60	106	166	204	197	165	112	79	60	51	46	42	37	33	30	28	27	23	16
2.0	5	7	9	10	11	12	13	14	15	17	18	20	22	27	34	49	79	126	169	188	152	97	64	52	46	42	38	34	29	28	24	17
2.5	3	5	6	8	8	9	10	10	11	12	13	14	15	18	22	26	34	49	77	136	176	155	95	64	52	46	42	37	31	28	25	18
3.0	2	3	4	5	6	6	7	7	8	8	9	9	10	11	13	16	19	23	29	49	91	154	167	102	67	53	47	42	34	29	26	19

IA/P = 0.30 * * * TC = 0.2 HR * * * IA/P = 0.30

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	22	76	206	258	207	144	119	104	92	82	74	68	65	63	62	60	57	55	52	48	44	40	40	39	39	38	36	32	21
.10	0	0	0	3	16	56	156	224	213	167	135	114	99	81	73	67	65	63	61	58	56	53	50	45	41	40	40	39	38	36	32	22
.20	0	0	0	2	11	41	116	189	205	179	150	126	108	85	75	69	65	63	62	59	56	54	50	46	41	40	40	39	38	36	32	22
.30	0	0	0	0	2	8	30	58	155	188	182	161	138	103	83	74	68	65	63	60	57	55	51	47	42	40	40	39	38	36	32	22
.40	0	0	0	0	1	6	22	66	126	167	177	166	147	111	88	76	69	66	63	61	58	55	51	47	43	40	40	39	38	37	33	22
.50	0	0	0	0	0	1	4	16	50	100	145	167	166	136	105	85	75	69	65	62	59	56	53	49	44	41	40	40	38	37	33	23
.75	0	0	0	0	0	0	2	7	22	50	87	119	140	148	124	101	85	74	69	64	61	57	54	50	45	42	40	40	38	37	33	23
1.0	0	0	0	0	0	0	0	0	1	3	11	28	55	114	142	135	113	93	80	69	64	60	56	52	48	44	41	40	39	37	34	24
1.5	0	0	0	0	0	0	0	0	0	0	0	1	2	17	52	97	124	129	115	91	75	65	59	55	52	48	43	41	39	38	35	25
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	49	84	111	120	102	79	65	59	55	51	47	43	40	39	36	26
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	20	45	89	113	104	78	65	59	55	51	47	41	39	36	28
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	30	68	108	99	77	65	58	54	50	43	40	37	29

IA/P = 0.50 * * * TC = 0.2 HR * * * IA/P = 0.50

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	0	4	15	28	38	43	45	45	48	49	50	52	53	53	53	53	53	53	50	50	50	49	49	49	48	45	32
.10	0	0	0	0	0	0	3	11	22	32	40	43	45	47	48	50	52	53	53	53	53	53	53	50	50	50	49	49	49	48	45	32
.20	0	0	0	0	0	0	2	8	17	27	36	41	43	46	48	49	51	53	53	53	53	53	53	51	50	50	49	49	49	48	45	33
.30	0	0	0	0	0	0	1	6	13	23	31	38	41	45	48	49	51	52	53	53	53	53	53	51	50	50	49	49	49	48	46	33
.40	0	0	0	0	0	0	1	4	10	19	27	34	39	44	47	49	50	52	53	53	53	53	53	51	50	50	49	49	49	49	46	33
.50	0	0	0	0	0	0	1	3	8	15	23	30	36	43	46	48	50	51	53	53	53	53	53	52	50	50	49	49	49	48	46	33
.75	0	0	0	0	0	0	0	0	3	8	14	20	27	37	43	46	48	50	52	53	53	53	53	52	50	50	50	49	49	48	46	34
1.0	0	0	0	0	0	0	0	0	0	0	0	2	4	14	26	36	42	46	48	51	52	53	53	53	52	50	50	49	49	49	47	35
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	23	33	40	46	49	52	53	53	53	51	50	50	49	49	48	37
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	16	26	37	44	50	52	53	53	53	51	50	49	49	48	38
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	19	31	43	50	52	53	53	52	51	50	49	48	39
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	11	25	41	49	52	53	53	52	50	49	48	41

RAINFALL TYPE = I * * * TC = 0.2 HR * * * SHEET 2 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

HYDROGRAPH TIME (HOURS)

IA/P = 0.10 — * * * TC = 0.3 HR * * *

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	25	34	46	87	138	242	349	346	256	182	141	115	97	76	66	60	57	54	52	48	45	42	38	34	30	29	28	28	26	24	21	13
.10	24	32	44	77	118	200	299	330	281	215	166	132	109	82	69	62	58	55	52	49	46	42	38	34	30	29	29	28	26	24	21	14
.20	21	28	38	54	69	102	167	255	305	289	240	190	152	103	79	67	61	57	54	50	47	44	40	35	31	30	29	28	26	25	21	14
.30	20	27	36	51	63	89	141	217	276	285	255	212	172	115	85	71	63	58	55	51	48	44	40	36	32	30	29	28	26	25	21	14
.40	17	23	31	42	48	58	79	120	185	246	272	260	228	156	108	82	69	62	57	53	49	45	41	37	33	30	29	28	27	25	22	14
.50	16	22	30	40	45	54	70	104	158	216	253	258	238	173	120	89	72	63	58	54	50	46	42	37	33	30	29	28	27	25	22	14
.75	13	17	24	32	35	39	45	54	72	104	147	189	219	231	182	135	100	79	67	58	53	48	44	40	35	32	30	29	27	26	22	15
1.0	11	13	17	24	26	29	32	35	40	46	58	79	110	184	221	202	158	118	90	68	58	52	46	42	38	34	31	29	28	26	23	15
1.5	8	10	12	15	17	19	21	23	25	28	31	35	40	62	107	163	199	193	165	114	81	61	52	46	42	37	33	31	28	27	23	16
2.0	5	7	9	10	11	12	13	14	15	17	18	20	22	27	35	50	80	125	165	184	152	99	64	53	47	42	38	34	29	28	24	17
2.5	3	5	6	8	8	9	10	10	11	12	13	14	15	18	22	27	35	50	78	134	173	154	96	64	52	46	42	37	31	28	25	18
3.0	2	3	4	6	6	7	7	8	8	9	9	10	11	12	14	17	21	26	34	61	107	164	145	94	64	52	46	41	33	29	26	19

IA/P = 0.30 — * * * TC = 0.3 HR * * *

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	8	32	98	198	217	192	148	125	108	95	79	72	67	64	63	61	58	56	53	49	45	41	40	40	39	38	36	32	22
.10	0	0	0	1	6	23	73	156	197	194	164	138	118	91	77	70	66	64	62	59	57	54	50	46	41	40	40	39	38	36	32	22
.20	0	0	0	1	4	17	54	122	172	187	171	149	128	98	81	72	67	64	63	60	57	54	51	46	42	40	40	39	38	36	32	22
.30	0	0	0	0	0	3	12	40	95	146	173	172	157	120	34	79	71	67	64	61	58	55	52	48	43	40	40	39	38	37	33	23
.40	0	0	0	0	0	2	9	30	73	122	156	167	160	128	100	83	73	68	65	62	59	56	52	48	44	41	40	39	38	37	33	23
.50	0	0	0	0	0	1	6	22	56	100	137	157	159	135	107	87	76	69	65	62	59	56	53	49	44	41	40	40	38	37	33	23
.75	0	0	0	0	0	0	1	3	9	26	53	86	115	143	134	113	93	80	72	65	62	58	54	51	46	42	40	40	39	37	33	23
1.0	0	0	0	0	0	0	0	0	1	5	14	32	57	111	138	132	113	94	81	69	64	60	56	52	48	44	41	40	39	37	34	24
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	8	34	74	111	126	121	99	80	67	61	56	53	49	44	41	39	38	35	26
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	33	66	97	118	108	84	67	60	56	52	48	44	40	39	36	27
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	12	32	74	106	112	83	67	60	56	52	48	41	39	37	28
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	21	54	98	107	81	67	60	55	51	43	40	37	29

IA/P = 0.50 — * * * TC = 0.3 HR * * *

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	0	1	6	16	27	36	41	44	46	48	49	51	52	52	52	52	52	52	51	50	50	49	49	49	48	46	33
.10	0	0	0	0	0	0	1	4	12	22	31	38	42	45	48	49	51	52	52	52	52	52	52	51	50	50	49	49	49	48	46	33
.20	0	0	0	0	0	0	0	3	9	18	27	34	39	44	47	49	50	51	52	52	52	52	52	51	50	50	49	49	49	48	46	33
.30	0	0	0	0	0	0	0	2	7	14	23	30	36	43	46	48	50	51	52	52	52	52	52	51	50	50	49	49	49	48	46	33
.40	0	0	0	0	0	0	0	1	5	11	19	26	33	41	46	48	49	51	52	52	52	52	52	52	50	50	49	49	49	48	46	33
.50	0	0	0	0	0	0	0	1	4	9	15	23	30	39	44	47	49	50	51	52	52	52	52	52	50	50	49	49	49	48	46	33
.75	0	0	0	0	0	0	0	0	2	4	8	14	20	31	40	44	47	49	51	52	52	52	52	52	50	50	50	49	49	48	46	34
1.0	0	0	0	0	0	0	0	0	0	0	0	1	2	9	20	31	39	44	47	50	51	52	52	52	52	50	50	50	49	49	47	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9	18	28	36	44	48	51	52	52	52	51	50	50	49	49	48	37
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	12	21	33	42	48	51	52	52	52	51	50	49	49	48	38
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	15	27	40	48	51	52	52	52	51	50	49	48	40
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	11	25	41	48	51	52	52	51	50	49	48	41

RAINFALL TYPE = I   * * * TC = 0.3 HR * * *   SHEET 3 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
IA/P = 0.10														* * * TC = 0.4 HR * * *														IA/P = 0.10				
0.0	23	31	42	66	96	157	250	310	304	244	186	149	122	89	73	64	59	56	53	49	46	43	39	35	31	29	29	28	26	25	21	14
.10	22	29	40	61	84	133	211	277	295	261	211	170	138	98	78	66	60	56	54	50	47	43	39	35	31	29	29	28	26	25	21	14
.20	19	26	34	47	56	75	114	178	244	278	267	230	190	128	93	75	65	59	56	52	48	44	40	36	32	30	29	28	27	25	21	14
.30	18	24	33	45	53	67	98	152	213	257	263	241	207	143	102	80	68	61	57	52	49	45	41	37	32	30	29	28	27	25	21	14
.40	15	21	28	38	43	49	61	86	130	185	233	253	245	188	132	97	77	66	60	55	51	46	42	38	34	30	29	28	27	25	22	14
.50	15	20	27	36	41	46	56	76	112	161	209	238	243	201	146	106	82	69	61	55	51	47	42	38	34	31	29	29	27	25	22	14
.75	12	16	21	29	32	35	39	46	57	77	108	147	184	220	200	157	118	91	74	61	55	50	45	40	36	32	30	29	27	26	22	15
1.0	10	12	16	21	24	26	29	32	36	40	48	61	83	147	202	212	178	138	105	75	62	54	47	43	39	35	31	29	28	26	23	16
1.5	8	9	11	14	16	17	19	21	23	25	28	31	35	50	83	134	179	193	177	131	92	65	53	47	42	38	34	31	29	27	24	16
2.0	5	6	8	10	10	11	12	13	14	15	17	18	20	25	31	42	64	102	144	179	163	111	70	55	48	43	39	35	30	28	25	17
2.5	3	4	6	7	8	8	9	9	10	11	12	13	14	16	20	24	30	42	63	114	160	170	107	70	54	47	43	38	31	29	25	18
3.0	2	3	4	5	6	6	7	7	8	8	9	9	10	11	13	16	19	23	30	51	90	148	161	104	69	54	47	42	34	29	26	19
IA/P = 0.30														* * * TC = 0.4 HR * * *														IA/P = 0.30				
0.0	0	0	0	3	14	48	115	184	192	178	148	127	111	88	77	70	66	64	62	59	56	54	50	46	41	40	40	39	38	36	32	22
.10	0	0	0	0	2	10	35	89	152	179	178	158	137	105	85	75	69	65	63	60	58	55	51	47	42	40	40	39	38	36	32	22
.20	0	0	0	0	2	7	26	68	124	161	172	163	146	113	90	78	70	66	64	61	58	55	52	47	43	40	40	39	38	37	33	22
.30	0	0	0	0	1	5	19	52	100	140	162	162	151	120	96	81	72	67	64	61	59	55	52	48	43	41	40	39	38	37	33	23
.40	0	0	0	0	0	1	4	14	39	80	120	148	158	142	114	92	79	71	67	63	60	57	53	49	45	41	40	40	38	37	33	23
.50	0	0	0	0	0	1	3	10	29	63	101	132	152	145	120	97	82	73	68	63	60	57	53	50	45	41	40	40	38	37	33	23
.75	0	0	0	0	0	0	0	1	4	13	31	58	87	130	138	123	103	87	77	68	63	59	55	51	47	43	41	40	39	37	34	24
1.0	0	0	0	0	0	0	0	0	0	2	7	18	36	86	125	134	122	104	88	73	66	61	57	53	49	45	41	40	39	38	34	24
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	10	36	75	109	124	120	100	81	68	61	56	53	49	44	41	40	38	35	26
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	22	50	83	116	116	91	70	61	57	53	49	45	40	39	36	27
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	22	60	97	111	88	70	61	56	53	48	42	39	37	28
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	43	89	106	86	69	61	56	52	44	40	37	29
IA/P = 0.50														* * * TC = 0.4 HR * * *														IA/P = 0.50				
0.0	0	0	0	0	0	0	0	2	8	17	27	34	40	44	47	49	50	51	51	51	51	51	51	51	50	50	49	49	49	48	46	33
.10	0	0	0	0	0	0	0	0	2	6	13	22	30	40	45	47	49	50	51	51	51	51	51	51	50	50	50	49	49	48	46	34
.20	0	0	0	0	0	0	0	0	0	1	4	10	18	33	41	45	48	49	51	51	51	51	51	51	50	50	50	49	49	49	46	34
.30	0	0	0	0	0	0	0	0	0	0	1	3	8	22	35	42	46	48	50	51	51	51	51	51	51	50	50	49	49	49	47	35
.40	0	0	0	0	0	0	0	0	0	0	1	2	6	19	32	40	45	47	49	51	51	51	51	51	51	50	50	49	49	49	47	35
.50	0	0	0	0	0	0	0	0	0	0	0	0	2	9	23	34	41	45	48	50	51	51	51	51	51	50	50	49	49	49	47	35
.75	0	0	0	0	0	0	0	0	0	0	0	0	1	5	14	26	35	42	46	49	50	51	51	51	51	50	50	50	49	49	47	36
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	14	25	35	44	48	50	51	51	51	51	50	50	49	49	48	37
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	13	27	39	47	50	51	51	51	51	50	49	49	48	39
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	21	36	47	50	51	51	51	51	50	49	48	40
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	19	37	47	50	51	51	51	50	40	48	42
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	25	40	48	50	51	51	50	50	49	43

RAINFALL TYPE = I * * * TC = 0.4 HR * * * SHEET 4 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

TRVL TIME (hr) — HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 0.5 HR * * * IA/P = 0.10

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	21	23	38	56	73	111	175	247	282	271	229	186	152	108	84	71	63	58	55	51	47	44	40	35	31	30	29	28	26	25	21	14
.10	20	27	36	52	66	96	149	214	259	267	242	204	169	119	90	74	65	59	55	51	48	44	40	36	32	30	29	28	26	25	21	14
.20	17	23	31	42	49	60	84	127	185	234	256	247	219	156	112	86	72	63	58	53	49	45	41	37	33	30	29	28	27	25	22	14
.30	16	22	30	40	46	55	74	110	160	210	241	245	227	171	123	93	76	66	59	54	50	46	42	38	33	30	29	28	27	25	22	14
.40	14	19	26	35	38	43	51	67	95	138	186	222	237	210	157	115	89	73	64	57	52	47	43	39	35	31	29	29	27	25	22	15
.50	14	18	25	33	37	41	48	61	84	120	164	203	229	216	170	126	96	77	66	58	53	48	43	39	35	31	30	29	27	25	22	15
.75	11	14	19	26	29	32	35	40	48	61	83	114	148	202	210	176	137	106	84	66	57	51	46	41	37	33	30	29	28	26	22	15
1.0	10	11	15	19	21	24	26	29	32	36	41	50	65	116	176	203	190	156	122	85	67	56	49	44	40	35	32	30	28	26	23	16
1.5	7	9	11	13	14	16	17	19	21	23	25	28	31	42	67	110	157	187	183	146	104	72	55	48	43	39	35	32	29	27	24	17
2.0	4	6	7	9	10	10	11	12	13	14	15	17	18	22	27	36	53	83	123	175	175	124	77	57	49	44	40	35	30	28	25	18
2.5	3	4	5	7	7	8	8	9	9	10	11	12	13	15	18	22	27	36	53	97	146	166	119	76	57	49	44	39	32	29	25	18
3.0	1	2	3	5	5	6	6	6	7	8	8	9	9	11	12	15	17	21	27	43	76	135	158	114	75	57	48	43	35	30	26	19

IA/P = 0.30 * * * TC = 0.5 HR * * * IA/P = 0.30

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	1	6	22	64	123	168	174	165	143	126	100	84	74	68	65	63	60	57	54	51	47	42	40	40	39	38	36	32	22
.10	0	0	0	1	5	16	48	98	144	164	165	150	134	106	87	77	70	66	63	60	58	55	51	47	42	40	40	39	38	36	32	22
.20	0	0	0	0	1	3	12	36	77	122	150	160	154	126	101	85	75	69	65	62	59	56	52	48	44	41	40	39	38	37	33	23
.30	0	0	0	0	0	2	9	27	60	101	134	151	153	132	107	89	77	70	66	63	60	56	53	49	44	41	40	40	38	37	33	23
.40	0	0	0	0	0	0	2	6	20	47	83	117	140	148	125	102	86	76	69	64	61	57	54	50	46	42	40	40	39	37	33	23
.50	0	0	0	0	0	0	1	5	15	36	68	101	127	144	130	108	90	78	71	65	62	58	54	50	46	42	40	40	39	37	33	23
.75	0	0	0	0	0	0	0	2	6	17	36	60	87	125	133	121	103	88	78	68	63	59	55	52	47	43	41	40	39	37	34	24
1.0	0	0	0	0	0	0	0	0	0	1	3	9	21	62	106	130	126	112	96	78	69	62	57	54	50	46	42	40	39	38	34	25
1,5	0	0	0	0	0	0	0	0	0	0	0	0	1	6	23	56	92	115	120	106	87	71	62	57	53	49	45	42	40	38	35	26
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	36	67	104	113	96	74	63	58	54	50	46	40	39	36	27
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	15	47	85	109	93	73	63	57	53	49	42	40	37	28
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	32	77	105	90	72	62	57	53	45	40	38	30

IA/P = 0.50 * * * TC = 0.5 HR * * * IA/P = 0.50

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	0	0	1	4	10	18	26	33	41	45	47	49	50	50	50	50	50	50	50	50	50	50	49	49	48	46	33
.10	0	0	0	0	0	0	0	1	3	8	15	22	30	39	44	47	49	50	50	50	50	50	50	50	50	50	50	49	49	48	46	34
.20	0	0	0	0	0	0	0	0	2	6	12	19	26	37	43	46	48	50	50	50	50	50	50	50	50	50	50	49	49	48	46	34
.30	0	0	0	0	0	0	0	0	1	4	9	16	23	34	41	45	48	49	50	50	50	50	50	50	50	50	50	49	49	49	46	34
.40	0	0	0	0	0	0	0	0	1	3	7	13	19	31	39	44	47	49	50	50	50	50	50	50	50	50	50	49	49	49	46	34
.50	0	0	0	0	0	0	0	0	1	2	6	10	16	28	37	43	46	48	50	50	50	50	50	50	50	50	50	49	49	49	46	34
.75	0	0	0	0	0	0	0	0	0	1	3	6	10	20	30	38	43	46	48	50	50	50	50	50	50	50	50	49	49	49	47	35
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	20	30	38	43	47	49	50	50	50	50	50	50	50	49	49	47	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	14	23	31	41	46	49	50	50	50	50	50	50	49	49	48	38
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	13	25	36	45	49	50	50	50	50	50	49	49	48	39
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	12	23	37	46	49	50	50	50	50	50	49	48	40
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	21	37	46	49	50	50	50	50	49	48	42

RAINFALL TYPE = I * * * TC = 0.5 HR * * * SHEET 5 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
IA/P = 0.10												* * * TC = 0.75 HR * * *																	IA/P = 0.10			
0.0	16	22	30	41	47	59	82	119	167	209	229	233	212	161	122	97	80	69	62	56	51	46	42	38	33	31	29	28	27	25	22	14
.10	14	19	26	35	39	44	54	72	104	146	188	215	227	197	150	116	93	77	68	59	53	48	43	39	35	31	30	29	27	25	22	15
.20	13	16	22	30	33	37	42	50	65	91	128	168	200	218	183	142	110	89	75	63	56	49	44	40	36	32	30	29	27	26	22	15
.30	12	16	21	28	31	35	39	46	59	80	112	149	183	214	191	151	118	94	79	65	57	50	45	41	36	32	30	29	27	26	22	15
.40	12	15	20	27	30	33	37	43	54	71	98	132	166	207	197	161	126	100	83	67	58	51	45	41	37	33	30	29	27	26	22	15
.50	11	13	18	24	26	29	32	36	41	49	64	87	117	178	204	186	152	120	96	74	62	53	47	42	38	34	31	29	28	26	23	15
.75	10	12	15	21	23	25	28	31	35	40	49	63	83	136	180	190	171	142	115	85	69	57	49	44	39	35	32	30	28	26	23	16
1.0	8	10	12	16	17	19	21	23	25	28	31	35	42	66	110	158	186	180	157	116	86	65	53	46	42	38	34	31	28	27	23	16
1.5	5	7	8	10	11	12	13	14	15	17	18	20	22	27	35	52	83	124	159	174	147	102	69	54	47	42	38	34	30	28	24	17
2.0	3	5	6	8	8	9	9	10	11	12	13	14	15	18	22	27	36	52	80	131	165	148	99	68	54	47	42	38	31	28	25	18
2.5	2	3	4	5	6	6	7	7	8	9	9	10	11	12	14	17	21	26	35	63	107	157	141	96	67	54	46	42	34	29	26	19
3.0	1	1	2	3	4	4	4	5	5	6	6	7	7	8	10	11	13	15	19	26	42	86	151	141	101	71	55	47	38	31	27	20
IA/P = 0.30												* * * TC = 0.75 HR * * *																	IA/P = 0.30			
0.0	0	0	0	0	1	4	14	35	69	105	131	143	146	124	104	89	79	72	68	64	60	56	53	49	44	41	40	40	38	37	33	23
.10	0	0	0	0	0	1	3	10	27	55	88	117	134	142	118	100	87	77	71	66	62	58	54	50	46	42	40	40	39	37	33	23
.20	0	0	0	0	0	0	2	7	20	43	73	102	123	137	123	105	90	80	73	66	62	58	54	50	46	42	40	40	39	37	33	23
.30	0	0	0	0	0	0	0	1	5	15	34	60	88	128	134	118	101	88	78	69	64	60	55	52	48	43	41	40	39	37	34	24
.40	0	0	0	0	0	0	0	1	4	12	27	49	75	118	131	121	105	91	80	71	65	60	56	52	48	44	41	40	39	37	34	24
.50	0	0	0	0	0	0	0	0	1	3	9	21	39	87	122	128	116	101	88	75	68	62	57	53	49	45	42	40	39	38	34	24
.75	0	0	0	0	0	0	0	0	0	1	4	10	21	56	95	118	121	110	98	82	72	64	58	54	50	46	42	41	39	38	34	25
1.0	0	0	0	0	0	0	0	0	0	0	0	1	2	12	39	76	106	119	115	98	82	69	61	57	53	49	44	42	40	38	35	26
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	37	67	95	112	105	85	69	61	56	52	48	44	40	39	36	27
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	15	35	74	102	107	84	69	61	56	52	48	41	39	37	28
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	23	55	94	103	82	68	60	56	52	44	40	37	29
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	15	50	93	100	81	68	60	55	47	41	38	30
IA/P = 0.50												* * * TC = 0.75 HR * * *																	IA/P = 0.50			
0.0	0	0	0	0	0	0	0	0	1	2	5	10	17	29	37	42	45	48	49	49	49	49	49	49	49	49	49	49	49	49	47	34
.10	0	0	0	0	0	0	0	0	0	2	4	8	14	26	35	41	45	47	49	49	49	49	49	49	49	49	49	49	49	49	47	35
.20	0	0	0	0	0	0	0	0	0	1	3	7	11	23	33	39	44	47	48	49	49	49	49	49	49	49	49	49	49	49	47	35
.30	0	0	0	0	0	0	0	0	0	1	2	5	9	20	30	38	43	46	48	49	49	49	49	49	49	49	49	49	49	49	47	35
.40	0	0	0	0	0	0	0	0	0	1	2	4	8	17	28	36	41	45	47	49	49	49	49	49	49	49	49	49	49	49	47	35
.50	0	0	0	0	0	0	0	0	0	0	1	3	6	15	25	34	40	44	47	48	49	49	49	49	49	49	49	49	49	49	47	35
.75	o	0	0	0	0	0	0	0	0	0	1	1	3	9	18	27	35	40	44	47	48	49	49	49	49	49	49	49	49	49	47	36
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	18	27	35	40	45	48	49	49	49	49	49	49	49	49	49	48	37
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	13	21	29	38	44	48	49	49	49	49	49	49	49	49	48	38
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	15	26	36	44	48	49	49	49	49	49	49	49	48	39
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	21	34	44	48	48	48	48	48	48	48	48	40
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	19	35	44	48	48	48	48	48	48	48	42

RAINFALL TYPE = I * * * TC = 0.75 HR * * * SHEET 6 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

TRVL TIME (hr) — HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 1.0 HR * * * IA/P = 0.10

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	14	19	25	34	38	46	58	79	106	136	165	186	202	185	153	122	101	85	74	63	56	50	44	40	35	32	30	29	27	26	22	15
.10	13	18	24	32	36	42	53	70	94	122	151	174	194	188	160	130	106	89	77	65	57	50	44	40	36	32	30	29	27	26	22	15
.20	12	15	21	28	31	34	40	49	63	83	109	137	162	190	180	152	124	102	86	70	61	53	46	41	37	33	31	29	27	26	22	15
.30	12	15	20	26	29	33	37	45	57	75	98	124	149	187	183	159	131	107	90	73	62	53	47	42	37	33	31	29	28	26	23	15
.40	10	13	17	23	25	28	31	35	42	52	67	88	112	160	183	176	151	125	103	81	67	56	48	43	39	35	31	30	28	26	23	15
.50	10	13	16	22	24	27	30	33	39	48	61	79	101	148	181	181	157	131	108	84	69	58	49	43	39	35	32	30	28	26	23	16
.75	9	11	14	19	21	23	26	29	33	38	47	59	75	115	153	172	167	148	125	96	77	62	51	45	40	36	33	30	28	27	23	16
1.0	8	9	11	15	16	17	19	21	23	26	29	33	40	61	95	134	162	169	157	126	97	72	57	49	43	39	35	32	29	27	24	16
1.5	5	6	8	10	10	11	12	13	14	16	17	19	21	25	33	48	74	107	138	160	148	111	76	59	50	44	39	35	30	28	25	17
2.0	3	4	6	7	8	8	9	9	10	11	12	13	14	17	20	25	33	48	71	115	153	153	108	75	58	49	43	39	32	29	25	18
2.5	2	3	4	5	5	6	6	7	7	8	9	9	10	12	14	16	20	25	33	56	94	139	147	104	74	58	49	43	34	30	26	19
3.0	1	1	2	3	3	4	4	4	5	5	6	6	7	8	9	10	12	14	17	24	38	76	131	143	108	78	60	50	39	32	27	20

IA/P = 0.30 * * * TC = 1.0 HR * * * IA/P = 0.30

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	1	2	7	17	34	55	79	99	114	128	114	100	89	80	74	68	63	59	54	51	46	43	41	40	39	37	33	23
.10	0	0	0	0	0	0	2	5	13	27	46	68	89	116	124	110	98	87	79	71	65	60	56	52	48	43	41	40	39	37	34	24
.20	0	0	0	0	0	0	1	4	10	21	37	58	78	109	121	113	101	90	81	72	66	61	56	52	48	44	41	40	39	37	34	24
.30	0	0	0	0	0	0	0	1	3	8	17	31	49	87	113	118	109	98	87	76	69	63	57	53	49	45	42	40	39	38	34	24
.40	0	0	0	0	0	0	0	1	2	6	13	25	41	78	107	117	111	101	90	78	70	63	58	54	50	45	42	41	39	38	34	25
.50	0	0	0	0	0	0	0	0	2	5	10	20	34	69	100	115	113	103	93	80	71	64	58	54	50	46	42	41	39	38	34	25
.75	0	0	0	0	0	0	0	0	0	1	2	5	10	31	61	90	107	110	104	90	79	69	61	56	52	48	44	41	40	38	35	25
1.0	0	0	0	0	0	0	0	0	0	0	0	1	3	12	33	61	89	105	109	99	86	73	64	58	54	50	45	42	40	38	35	26
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	13	31	55	80	104	104	88	73	63	58	53	49	45	41	39	36	27
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	20	51	82	100	90	74	64	58	54	50	42	40	37	28
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	13	37	76	98	88	73	64	58	53	45	41	38	30
3,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	34	77	95	86	73	63	58	49	42	38	31

IA/P = 0.50 * * * TC = 1.0 HR * * * IA/P = 0.50

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	0	0	0	0	1	3	5	9	18	28	35	40	44	47	48	48	48	48	48	48	48	48	48	48	48	47	35
.10	0	0	0	0	0	0	0	0	0	1	2	4	7	16	25	33	39	43	46	48	48	48	48	48	48	48	48	48	48	48	47	35
.20	0	0	0	0	0	0	0	0	0	1	2	3	6	14	23	31	38	42	45	47	48	48	48	48	48	48	48	48	48	48	47	36
.30	0	0	0	0	0	0	0	0	0	0	1	3	5	12	21	29	36	41	44	47	48	48	48	48	48	48	48	48	48	48	47	36
.40	0	0	0	0	0	0	0	0	0	0	1	2	4	10	19	27	34	40	44	47	48	48	48	48	48	48	48	48	48	48	47	36
.50	0	0	0	0	0	0	0	0	0	0	1	2	3	8	16	25	33	38	43	46	48	48	48	48	4&	48	48	48	48	48	47	36
.75	0	0	0	0	0	0	0	0	0	0	1	2	3	8	15	23	30	36	41	45	47	48	48	48	48	48	48	48	48	48	47	36
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	19	27	33	41	45	47	48	48	48	48	48	48	48	48	48	37
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	11	17	28	37	44	47	48	48	48	48	48	48	48	48	39
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	16	26	38	45	47	48	48	48	48	48	48	48	40
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	12	24	38	45	47	47	47	47	47	47	47	41
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	14	29	40	46	47	47	47	47	47	47	42

RAINFALL TYPE = I * * * TC = 1.0 HR * * * SHEET 7 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
IA/P = 0.10												* * * TC = 1.25 HR * * *																	IA/P = 0.10			
0.0	12	16	22	29	33	38	47	61	80	103	127	149	164	180	163	138	115	98	85	71	62	53	47	41	37	33	31	29	27	26	22	15
.10	11	14	19	25	28	31	36	44	55	72	92	116	138	167	175	156	132	111	95	77	66	56	48	43	38	34	31	30	28	26	23	15
.20	11	14	18	24	27	30	34	40	50	65	83	105	127	160	172	160	138	116	99	80	68	57	49	43	39	34	31	30	28	26	23	15
.30	10	12	16	21	23	25	28	32	38	46	58	75	95	136	164	169	154	132	112	89	74	61	51	45	40	36	32	30	28	26	23	16
.40	9	12	15	20	22	24	27	30	35	42	53	68	86	126	157	167	157	137	117	92	76	62	52	46	40	36	33	30	28	26	23	16
.50	9	11	13	17	19	21	23	26	29	33	39	49	61	97	134	160	165	152	132	104	84	67	55	47	42	37	33	31	28	27	23	16
.75	7	9	11	14	15	17	18	20	22	25	28	32	38	59	90	124	150	159	152	126	101	77	60	51	45	40	35	32	29	27	24	17
1.0	6	8	10	12	13	14	15	17	19	20	23	25	29	40	60	91	123	148	157	144	118	88	66	54	47	41	37	33	29	27	24	17
1.5	4	6	7	9	9	10	11	12	13	14	15	16	18	22	28	40	59	85	114	145	150	121	86	65	54	46	41	37	31	28	25	13
2.0	2	3	5	6	6	7	7	8	9	9	10	11	11	13	16	19	24	33	47	80	119	144	124	90	68	55	47	42	33	29	26	19
2.5	1	2	3	4	4	5	5	6	6	7	7	8	8	10	11	13	16	19	24	38	65	111	140	120	88	67	54	47	37	31	27	20
3.0	1	1	2	2	3	3	3	4	4	5	5	5	6	7	8	9	11	13	15	21	32	62	114	136	116	86	66	54	41	33	27	20
IA/P = 0.30												* * * TC = 1.25 HR * * *																	IA/P = 0.30			
0.0	0	0	0	0	0	1	4	10	21	35	53	71	86	106	115	104	94	86	79	72	66	61	56	52	48	44	41	40	39	37	34	24
.10	0	0	0	0	0	0	1	3	8	16	29	45	62	92	107	113	101	92	84	75	69	63	58	53	49	45	42	41	39	38	34	24
.20	0	0	0	0	0	0	1	2	6	13	23	37	54	84	104	110	104	94	86	77	70	64	58	54	49	45	42	41	39	38	34	24
.30	0	0	0	0	0	0	0	0	2	4	10	19	31	62	90	106	109	101	92	81	73	66	60	55	51	46	43	41	39	38	34	25
.40	0	0	0	0	0	0	0	0	1	3	8	15	26	55	83	102	107	103	94	83	74	67	60	56	51	47	43	41	39	38	35	25
.50	0	0	0	0	0	0	0	0	0	1	3	6	12	33	62	38	103	106	100	88	78	69	62	57	53	48	44	42	40	38	35	25
.75	0	0	0	0	0	0	0	0	0	0	0	1	3	12	31	56	80	97	103	97	87	75	65	59	55	50	46	43	40	39	35	26
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	13	32	56	79	95	101	94	80	69	61	56	52	48	44	40	39	36	27
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	13	30	51	81	98	94	79	68	61	56	52	47	42	39	36	28
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	37	66	95	95	78	68	61	56	51	44	40	37	29
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	26	61	93	89	77	67	60	55	47	41	38	30
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	24	64	91	87	76	66	60	50	43	39	31
IA/P = 0.50												* * * TC = 1.25 HR * * *																	IA/P = 0.50			
0.0	0	0	0	0	0	0	0	0	0	1	2	3	6	13	21	29	35	40	43	47	47	47	47	47	47	47	47	47	47	47	47	36
.10	0	0	0	0	0	0	0	0	0	0	1	3	5	11	19	27	34	39	42	47	47	47	47	47	47	47	47	47	47	47	47	36
.20	0	0	0	0	0	0	0	0	0	0	1	2	4	9	17	25	32	37	41	46	47	47	47	47	47	47	47	47	47	47	47	36
.30	0	0	0	0	0	0	0	0	0	0	1	2	3	8	15	23	30	36	40	45	47	47	47	47	47	47	47	47	47	47	47	36
.40	0	0	0	0	0	0	0	0	0	0	0	1	2	7	13	21	28	35	39	45	47	47	47	47	47	47	47	47	47	47	47	37
.50	0	0	0	0	0	0	0	0	0	0	0	1	2	6	12	19	27	33	38	44	46	47	47	47	47	47	47	47	47	47	47	37
.75	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	14	21	28	34	41	45	47	47	47	47	47	47	47	47	47	47	37
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	11	17	24	34	41	46	47	47	47	47	47	47	47	47	47	38
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	19	29	39	45	47	47	47	47	47	47	47	47	40
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	9	18	30	41	46	47	47	47	47	47	47	47	41
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	17	31	41	46	47	47	47	47	47	47	42
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	18	32	42	46	47	47	47	47	47	43

RAINFALL TYPE = I * * * TC = 1.25 HR * * * SHEET 8 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
IA/P = 0.10														* * * TC = 1.5 HR * * *															IA/P = 0.10			
0.0	11	14	19	25	28	32	39	48	60	76	94	112	129	151	163	147	130	112	97	81	69	59	50	44	39	35	32	30	28	26	23	15
.10	10	12	16	22	24	27	30	36	44	55	69	86	103	135	152	159	143	125	108	88	75	62	52	46	41	36	32	30	28	26	23	16
.20	9	11	14	19	21	23	25	29	34	41	50	63	78	112	140	155	152	138	121	98	81	67	55	43	42	37	33	31	28	27	23	16
.30	9	11	14	18	20	22	24	27	31	38	46	57	71	104	133	151	154	141	125	101	84	68	56	48	43	38	34	31	29	27	23	16
.40	8	10	13	17	19	21	23	26	30	35	42	52	65	96	126	147	152	144	129	105	87	70	57	49	43	38	34	31	29	27	23	16
.50	8	9	12	15	17	18	20	22	25	28	33	39	48	73	104	131	148	151	140	117	95	75	60	51	45	40	35	32	29	27	24	17
.75	7	8	11	13	15	16	18	19	21	24	27	32	38	56	82	110	133	146	144	127	106	83	65	54	47	41	36	33	29	27	24	17
1.0	5	7	9	11	11	12	13	15	16	18	19	22	24	32	47	69	96	122	139	145	127	99	74	60	51	44	39	35	30	28	24	17
1.5	4	5	6	8	8	9	10	10	11	12	13	14	16	19	24	32	46	66	90	124	139	128	97	73	59	50	44	39	32	29	25	18
2.0	2	3	4	5	5	6	6	7	7	8	9	9	10	12	14	17	21	27	38	63	96	135	129	100	76	61	51	44	35	30	26	19
2.5	1	2	2	3	4	4	4	5	5	6	6	7	7	8	10	11	14	16	20	31	51	91	132	124	98	75	60	51	39	32	27	20
3.0	0	1	1	2	2	2	2	3	3	3	4	4	5	6	7	8	9	10	12	16	23	42	86	123	128	101	77	62	45	35	28	21
IA/P = 0.30														* * * TC = 1.5 HR * * *															IA/P = 0.30			
0.0	0	0	0	0	0	1	3	7	13	21	33	46	60	83	97	106	97	90	84	76	70	64	59	54	50	45	43	41	39	38	34	25
.10	0	0	0	0	0	0	1	2	5	10	18	28	40	66	86	98	103	95	88	80	73	66	60	55	51	47	43	41	39	38	35	25
.20	0	0	0	0	0	0	0	1	4	8	14	23	34	60	81	95	101	97	90	81	74	67	61	56	52	47	44	41	40	38	35	25
.30	0	0	0	0	0	0	0	0	1	3	6	12	19	41	65	85	98	100	95	85	77	69	62	57	53	48	44	42	40	38	35	25
.40	0	0	0	0	0	0	0	0	1	2	5	9	16	36	59	80	94	99	96	87	79	70	63	58	53	49	45	42	40	38	35	26
.50	0	0	0	0	0	0	0	0	1	2	4	8	13	31	54	75	91	98	97	88	80	71	64	58	54	49	45	42	40	38	35	26
.75	0	0	0	0	0	0	0	0	0	0	1	2	4	13	28	49	69	85	95	95	87	76	67	61	56	51	47	44	40	39	36	26
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	29	49	69	84	95	92	81	71	63	58	53	49	45	41	39	36	27
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	9	20	35	63	84	92	83	72	64	58	54	49	43	40	37	28
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	9	25	50	79	90	81	71	63	58	53	45	41	38	29
2.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	18	46	79	88	80	70	63	57	49	42	38	31
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	17	50	79	87	79	70	62	52	45	39	32
IA/P = 0.50														* * * TC = 1.5 HR * * *															IA/P = 0.50			
0.0	0	0	0	0	0	0	0	0	0	0	1	2	3	8	15	22	29	34	39	44	46	46	46	46	46	46	46	46	46	46	46	37
.10	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	17	24	30	35	41	46	46	46	46	46	46	46	46	46	46	46	37
.20	0	0	0	0	0	0	0	0	0	0	0	1	1	4	9	15	22	28	34	40	45	46	46	46	46	46	46	46	46	46	46	37
.30	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	13	20	27	33	39	44	46	46	46	46	46	46	46	46	46	46	38
.40	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	12	18	25	31	38	44	46	46	46	46	46	46	46	46	46	46	38
.50	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	17	23	30	37	43	46	46	46	46	46	46	46	46	46	46	38
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	12	19	25	33	40	45	46	46	46	46	46	46	46	46	46	38
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	15	25	33	42	46	46	46	46	46	46	46	46	46	39
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	14	23	34	43	46	46	46	46	46	46	46	46	40
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	11	22	35	43	46	46	46	46	46	46	46	42
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	23	36	43	46	46	46	46	46	46	43
3.0	0	n	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	14	27	38	44	46	46	46	46	46	44

RAINFALL TYPE = I * * * TC = 1.5 HR * * * SHEET 9 OF 10

Exhibit 5-I: Tabular hydrograph unit discharges (csm/in) for type I rainfall distribution—continued

IA/P = 0.10 * * * TC = 2.0 HR * * * IA/P = 0.10

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	9	11	14	19	21	24	28	33	40	49	59	70	82	106	123	138	138	125	115	97	83	70	59	50	44	39	35	32	29	27	23	16
.10	8	10	13	17	18	20	23	26	31	37	45	54	65	89	110	125	135	130	123	106	90	75	62	53	46	40	36	33	29	27	24	16
.20	8	10	12	16	17	19	22	25	29	34	41	50	60	83	105	121	132	131	125	109	92	77	63	53	46	41	36	33	29	27	24	17
.30	7	9	11	14	15	17	18	21	23	27	32	38	46	66	89	109	123	131	129	117	100	82	66	56	48	42	38	34	30	28	24	17
.40	7	8	10	13	15	16	18	20	22	25	30	35	43	61	83	104	120	131	131	119	103	84	68	57	49	43	38	34	30	28	24	17
.50	6	8	10	13	14	15	17	19	21	24	28	33	39	56	78	99	116	127	130	121	106	86	69	58	50	44	39	35	30	28	24	17
.75	5	7	8	11	12	13	14	15	16	18	20	23	27	38	53	73	93	111	123	127	118	98	77	63	54	47	41	37	31	28	25	17
1.0	4	5	7	8	9	10	11	12	13	14	15	17	18	24	32	45	63	83	102	122	126	113	89	71	59	51	44	39	32	29	25	18
1.5	3	4	5	6	7	7	8	8	9	10	10	11	12	15	18	23	32	44	60	88	111	123	110	87	70	58	50	44	35	30	26	19
2.0	1	2	3	4	5	5	5	6	6	7	7	8	9	10	12	14	18	23	31	49	74	106	121	107	86	69	58	49	38	32	27	20
2.5	1	1	2	2	3	3	3	4	4	4	5	5	6	7	8	9	11	13	16	22	35	62	101	118	108	88	71	59	44	35	28	21
3.0	0	0	1	1	1	2	2	2	3	3	3	3	4	5	5	6	8	9	10	14	19	34	67	103	116	105	86	70	50	39	29	21

IA/P = 0.30 * * * TC = 2.0 HR * * * IA/P = 0.30

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	0	1	3	6	10	16	23	31	49	65	77	84	92	86	80	75	69	63	58	53	49	45	43	40	38	35	26
.10	0	0	0	0	0	0	0	1	2	5	9	13	19	35	53	68	79	85	90	83	77	71	64	59	55	50	46	43	40	39	35	26
.20	0	0	0	0	0	0	0	0	1	2	4	7	11	24	40	57	71	81	89	89	80	73	66	61	56	51	47	44	41	39	35	26
.30	0	0	0	0	0	0	0	0	1	1	3	6	9	20	36	53	68	78	84	88	81	74	67	61	56	52	48	44	41	39	36	26
.40	0	0	0	0	0	0	0	0	0	0	1	2	5	12	24	40	57	70	80	87	84	76	69	63	58	53	49	45	41	39	36	27
.50	0	0	0	0	0	0	0	0	0	0	1	2	4	10	21	36	53	67	77	87	85	77	69	63	58	54	49	46	41	39	36	27
,75	0	0	0	0	0	0	0	0	0	0	0	1	2	6	14	26	41	56	69	82	85	80	72	65	60	55	51	47	42	40	36	27
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	20	34	49	68	81	85	77	69	63	58	53	49	43	40	37	28
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	19	38	58	78	83	76	68	62	57	53	45	41	37	29
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	13	29	55	77	82	75	68	62	57	48	43	38	30
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	22	51	75	81	75	68	62	53	45	39	32
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	25	54	75	80	75	68	57	48	43	33

IA/P = 0.50 * * * TC = 2.0 HR * * * IA/P = 0.50

TRVL TIME (hr)	9.0	9.3	9.6	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.3	12.6	13.0	13.5	14.0	14.5	15.0	15.5	16.0	17.0	18.0	20.0	24.0
0.0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	13	18	24	29	36	41	46	46	46	46	46	46	46	46	46	46	38
.10	0	0	0	0	0	0	0	0	0	0	0	1	1	3	7	12	17	22	28	35	40	45	46	46	46	46	46	46	46	46	46	38
.20	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	13	18	24	31	38	44	46	46	46	46	46	46	46	46	46	39
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	7	12	17	22	30	37	43	45	46	46	46	46	46	46	46	46	39
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	11	16	21	29	36	42	45	46	46	46	46	46	46	46	46	39
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	9	14	20	28	35	42	45	45	45	45	45	45	45	45	45	39
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	9	13	18	26	33	41	45	45	45	45	45	45	45	45	45	39
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	9	16	24	33	42	45	45	45	45	45	45	45	45	40
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	15	25	36	43	45	45	45	45	45	45	45	42
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	14	26	37	43	45	45	45	45	45	45	43
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	15	27	37	43	45	45	45	45	45	44
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	19	30	39	44	45	45	45	45	45

RAINFALL TYPE = I * * * TC = 2.0 HR * * * SHEET 10 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
IA/P = 0.10														* * * TC = 0.1 HR * * *														IA/P = 0.10				
0.0	28	36	50	143	154	163	140	103	87	76	68	67	65	61	54	49	45	44	44	41	40	39	36	33	32	32	31	30	30	29	26	21
.10	27	32	43	104	130	146	157	145	117	97	83	73	69	65	59	53	48	45	45	42	40	39	37	34	33	32	32	31	30	29	27	22
.20	26	29	37	59	89	116	136	150	147	127	107	91	79	68	63	57	52	47	45	44	41	39	37	35	33	32	32	31	30	29	27	22
.30	25	28	35	53	77	103	125	142	145	133	116	99	86	71	65	59	53	48	46	44	41	39	38	35	33	32	32	31	30	29	27	22
.40	24	26	31	41	49	68	91	114	132	141	136	122	107	82	70	63	57	52	48	45	43	40	38	36	33	32	32	31	30	29	27	22
.50	24	26	30	39	46	60	81	103	123	135	135	127	114	88	73	65	59	53	49	45	43	40	39	36	33	33	32	31	30	29	27	22
.75	20	24	27	32	35	39	47	60	76	94	111	122	125	114	94	79	68	61	55	48	45	42	39	37	35	33	32	32	30	30	27	22
1.0	16	20	24	27	28	30	32	36	41	49	62	77	94	118	122	104	86	74	65	55	49	44	41	39	36	34	33	32	31	30	28	23
1.5	12	15	18	22	23	24	25	27	28	30	32	36	42	61	86	107	112	104	91	73	60	50	44	41	38	36	34	33	31	30	28	23
2.0	7	10	12	15	16	18	19	20	21	22	24	25	26	30	36	50	69	90	106	103	87	67	52	45	41	39	36	34	32	31	29	24
2.5	4	6	8	11	12	13	14	15	16	17	18	19	21	23	26	30	36	49	66	91	101	89	66	51	44	41	38	36	33	31	29	25
3.0	2	3	5	7	8	9	10	11	11	12	13	14	16	18	20	23	25	29	36	55	79	98	86	65	51	44	41	38	34	32	30	25
IA/P = 0.30														* * * TC = 0.1 HR * * *														IA/P = 0.30				
0.0	0	0	1	45	65	89	78	64	59	54	54	53	51	50	48	45	44	43	43	43	42	42	41	40	40	40	40	40	39	39	38	33
.10	0	0	0	18	36	55	78	78	69	62	57	55	53	51	50	47	44	44	43	43	42	42	41	40	40	40	40	40	39	39	38	34
.20	0	0	0	13	29	46	67	74	71	65	60	56	54	52	50	48	45	44	43	43	43	42	41	41	40	40	40	40	39	39	38	34
.30	0	0	0	10	22	38	58	69	70	67	62	58	56	52	51	48	46	44	44	43	43	42	41	41	40	40	40	40	39	39	38	34
,40	0	0	0	2	7	17	31	49	62	67	67	64	60	55	52	50	48	45	44	43	43	42	42	41	40	40	40	40	39	39	38	34
,50	0	0	0	1	5	13	25	41	55	63	66	64	61	56	53	51	48	46	44	43	43	42	42	41	40	40	40	40	39	39	38	34
.75	0	0	0	0	0	2	6	13	24	36	47	55	61	61	57	54	51	49	47	44	43	43	42	41	41	40	40	40	40	39	38	34
1.0	0	0	0	0	0	1	3	8	15	25	36	46	53	60	59	55	53	50	48	45	44	43	42	42	41	40	40	40	40	39	38	35
1.5	0	0	0	0	0	0	0	0	1	2	5	9	15	31	47	55	57	56	53	50	46	44	43	42	41	41	40	40	40	39	39	35
2.0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	15	28	42	51	55	54	51	47	44	43	42	41	41	40	40	39	39	36
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	14	26	38	50	54	52	47	44	43	42	41	40	40	40	39	36
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	13	29	43	53	51	47	44	43	42	41	40	40	39	37
IA/P = 0.50														* * * TC = 0.1 HR * * *														IA/P = 0.50				
0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	12	14	18	21	23	26	30	32	33	37	38	41	42	46	48	53	49
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9	12	15	19	22	25	29	32	32	35	39	41	42	45	48	53	49
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	7	11	14	18	22	24	28	32	32	35	39	41	42	45	48	53	49
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	8	12	15	20	23	27	31	31	34	39	40	41	45	48	53	49
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	13	18	22	25	30	31	33	37	39	41	44	47	53	49
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	10	tS	20	24	29	31	32	36	39	41	44	47	53	53
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	16	21	26	30	31	34	38	40	43	46	53	53
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	11	17	23	28	31	32	35	39	42	45	53	53
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	17	23	28	31	32	35	40	43	49	52
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	17	23	28	31	32	38	42	48	52
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	18	24	28	31	36	40	47	52
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	11	18	24	28	33	39	45	52

RAINFALL TYPE = IA * * * TC = 0.1 HR * * * SHEET 1 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 0.2 HR * * * IA/P = 0.10

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	27	34	46	124	143	153	153	127	103	87	76	68	67	63	57	51	47	45	44	42	40	39	36	33	33	32	32	31	30	29	27	21
.10	27	33	44	108	131	146	151	135	113	96	83	73	69	65	59	53	48	45	45	42	40	39	37	33	33	32	32	31	30	29	27	22
.20	26	29	38	67	95	119	137	146	139	122	105	90	79	69	63	57	52	47	45	44	41	39	37	34	33	32	32	31	30	29	27	22
.30	25	27	33	45	60	83	107	127	140	139	128	112	97	76	68	62	56	50	47	45	42	40	38	35	33	33	32	31	30	29	27	22
.40	24	27	32	43	54	73	96	117	132	137	131	118	104	81	70	63	57	52	48	45	43	40	38	36	33	33	32	32	30	29	27	22
.50	23	25	29	37	41	50	65	86	106	124	132	131	123	98	79	69	62	56	51	46	44	41	39	37	34	33	32	32	30	29	27	22
.75	20	24	27	33	36	41	50	63	80	97	112	121	123	111	93	78	68	61	55	48	45	42	39	37	34	33	32	32	30	30	27	22
1.0	16	20	24	27	29	31	33	37	43	52	65	81	96	120	120	102	85	73	64	55	49	44	41	39	36	34	33	32	31	30	28	23
1.5	12	15	19	22	23	24	26	27	28	30	33	37	44	63	88	107	111	102	89	72	60	50	44	41	38	36	34	33	32	30	28	23
2.0	7	10	12	16	17	18	19	20	22	23	24	25	27	30	38	52	71	91	105	101	86	66	52	45	41	39	36	34	32	31	29	24
2.5	4	6	9	11	12	13	14	15	16	17	19	20	21	23	26	30	38	50	68	92	101	88	65	51	44	41	38	36	33	31	29	25
3.0	2	3	5	7	7	8	9	10	11	12	13	14	15	17	19	22	24	28	33	49	72	97	89	68	53	45	41	39	34	32	30	25

IA/P = 0.30 * * * TC = 0.2 HR * * * IA/P = 0.30

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	26	45	64	76	74	65	59	55	53	52	51	49	46	44	44	43	43	42	42	41	40	40	40	40	40	39	39	38	33
.10	0	0	0	20	37	55	69	72	67	62	57	54	53	52	50	47	44	44	43	43	42	42	41	40	40	40	40	40	39	39	38	34
.20	0	0	0	5	15	30	47	61	68	68	64	59	56	53	52	49	46	44	44	43	43	42	42	41	40	40	40	40	39	39	38	34
.30	0	0	0	4	11	23	39	54	64	66	65	61	58	54	52	50	47	45	44	43	43	42	42	41	40	40	40	40	39	39	38	34
.40	0	0	0	3	8	18	32	47	58	64	64	62	59	55	52	50	48	45	44	43	43	42	42	41	40	40	40	40	40	39	38	34
.50	0	0	0	0	2	6	14	26	40	52	60	63	62	58	54	52	50	47	45	44	43	42	42	41	40	40	40	40	40	39	38	34
.75	0	0	0	0	1	3	7	14	24	35	45	53	57	59	56	54	51	49	47	44	43	43	42	41	41	40	40	40	40	39	38	34
1.0	0	0	0	0	0	0	1	4	8	15	25	35	44	56	58	56	54	51	49	46	44	43	42	42	41	40	40	40	40	39	39	35
1.5	0	0	0	0	0	0	0	0	0	1	2	5	9	23	38	50	55	56	54	51	47	44	43	42	42	41	40	40	40	39	39	35
2.0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	15	27	40	49	54	54	51	47	44	43	42	41	41	40	40	40	39	36
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	14	25	36	49	53	51	47	44	43	42	41	41	40	40	39	36
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	13	28	42	52	51	47	44	43	42	41	40	40	39	37

IA/P = 0.50 * * * TC = 0.2 HR * * * IA/P = 0.50

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	13	16	19	23	25	29	32	33	36	39	41	42	46	48	50	49
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	10	14	17	21	24	28	31	32	35	40	41	42	45	48	50	49
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	7	11	15	19	23	26	31	31	34	39	40	41	45	48	50	49
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	8	12	17	21	25	30	31	33	37	39	41	44	47	50	50
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	9	15	19	23	28	31	32	35	39	41	44	47	50	50
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	12	17	22	27	31	32	34	39	40	43	46	50	50
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	14	20	25	30	31	33	37	39	42	46	50	50
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	16	22	27	31	32	35	38	42	45	49	50
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	17	23	28	31	32	35	40	43	49	50
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	17	23	28	31	32	38	42	48	50
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	16	22	27	30	35	40	46	50
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9	17	23	27	33	38	45	50

RAINFALL TYPE = IA * * * TC = 0.2 HR * * * SHEET 2 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

TRVL TIME (hr) / HYDROGRAPH TIME (HOURS)

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
IA/P = 0.10														* * * TC = 0.3 HR * * *															IA/P = 0.10			
0.0	26	31	41	92	120	138	145	144	125	105	90	78	71	66	60	54	49	46	45	43	40	39	37	34	33	32	32	31	30	29	27	22
.10	26	30	39	80	106	128	139	142	131	113	98	85	76	68	62	56	51	47	45	43	41	39	37	34	33	32	32	31	30	29	27	22
.20	25	28	34	51	70	94	117	131	139	133	120	105	92	74	67	60	54	49	46	44	42	40	38	35	33	33	32	31	30	29	27	22
.30	24	26	31	40	47	62	84	106	123	133	133	124	112	87	73	65	59	53	49	45	43	40	39	36	33	33	32	32	30	29	27	22
.40	23	26	30	38	44	56	75	95	114	127	131	127	117	93	76	67	60	55	50	46	43	40	39	36	34	33	32	32	30	29	27	22
.50	21	25	28	34	37	42	51	67	86	104	119	127	127	110	88	74	66	59	53	47	45	41	39	37	34	33	32	32	30	30	27	22
.75	19	23	26	31	33	36	42	51	64	80	96	109	119	116	102	85	73	65	58	50	46	43	40	38	35	33	33	32	31	30	28	23
1.0	15	19	23	26	27	29	31	33	37	44	53	66	80	106	116	109	93	79	69	58	51	45	41	39	37	34	33	32	31	30	28	23
1.5	11	14	17	21	22	23	24	26	27	29	31	34	38	53	75	97	109	106	96	78	64	52	45	41	39	36	34	33	32	30	28	24
2.0	6	9	11	14	16	17	18	19	20	21	23	24	25	28	34	44	61	81	97	103	91	71	54	46	42	39	37	34	32	31	29	24
2.5	4	5	8	10	11	12	13	14	15	16	17	19	20	22	25	28	34	44	58	84	59	92	70	54	46	41	39	36	33	32	29	25
3.0	2	3	5	7	7	8	9	10	11	12	13	14	15	17	19	22	24	28	33	49	71	96	89	68	53	45	41	39	34	32	30	25
IA/P = 0.30														* * * TC = 0.3 HR * * *															IA/P = 0.30			
0.0	0	0	0	13	28	45	63	69	69	65	60	55	53	53	51	48	45	44	43	43	42	42	42	40	40	40	40	40	39	39	38	34
.10	0	0	0	9	21	37	54	64	67	65	62	57	54	53	51	49	46	44	43	43	42	42	42	41	40	40	40	40	40	39	38	34
.20	0	0	0	7	17	30	46	58	64	65	63	59	56	53	52	49	46	44	44	43	42	42	42	41	40	40	40	40	40	39	38	34
.30	0	0	0	1	5	13	25	39	52	60	63	63	60	55	53	51	49	46	44	43	43	42	42	41	40	40	40	40	40	39	38	34
.40	0	0	0	1	4	10	20	33	45	55	61	62	61	56	54	52	49	46	45	43	43	42	42	41	40	40	40	40	40	39	38	34
.50	0	0	0	1	3	7	15	27	39	50	57	60	61	57	54	52	50	47	45	44	43	42	42	41	40	40	40	40	40	39	38	34
.75	0	0	0	0	1	3	8	15	24	34	43	51	55	58	56	54	52	49	47	44	43	43	42	41	41	40	40	40	40	39	38	34
1.0	0	0	0	0	0	0	0	2	4	9	16	25	34	49	56	57	55	53	50	47	44	43	42	42	41	40	40	40	40	39	39	35
1.5	0	0	0	0	0	0	0	0	0	1	3	5	10	23	37	49	54	55	54	51	47	44	43	42	42	41	40	40	40	39	39	35
2.0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	21	33	44	51	54	52	48	44	43	42	41	41	40	40	40	39	36
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	19	30	45	53	53	48	44	43	42	41	41	40	40	39	37
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	23	37	50	52	47	44	43	42	41	40	40	39	37
IA/P = 0.50														* * * TC = 0.3 HR * * *															IA/P = 0.50			
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	7	11	14	18	22	24	28	32	32	35	40	41	42	45	48	48	48
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	8	12	15	20	23	27	31	31	34	39	40	41	45	48	48	48
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	13	18	21	25	30	31	33	37	39	41	44	47	48	48
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	8	12	17	21	25	30	31	33	37	39	41	44	47	48	48
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	9	14	19	23	28	31	32	35	39	41	44	47	48	48
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	15	21	26	30	31	33	38	40	43	46	48	48
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	13	19	24	29	31	33	36	39	42	46	48	48
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	16	22	27	31	32	35	38	42	45	48	48
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	16	23	27	31	32	35	40	43	48	48
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	16	22	27	30	32	38	42	47	48
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	16	22	27	30	35	40	46	48
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9	17	23	27	33	38	45	48

RAINFALL TYPE = IA * * * TC = 0.3 HR * * * SHEET 3 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

IA/P = 0.10 * * * TC = 0.4 HR * * * IA/P = 0.10

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	26	29	37	67	93	117	134	137	136	121	105	91	81	70	64	58	52	48	46	44	41	40	37	34	33	33	32	31	30	29	27	22
.10	25	29	36	60	82	105	124	133	135	126	112	98	87	73	66	59	53	49	46	44	41	40	38	34	33	33	32	31	30	29	27	22
.20	24	27	32	43	55	73	94	114	127	132	128	117	104	83	71	64	58	52	48	45	43	40	38	35	33	33	32	32	30	29	27	22
.30	24	26	31	41	50	65	85	104	119	128	128	121	110	88	74	66	59	54	49	46	43	40	39	35	34	33	32	32	30	29	27	22
.40	22	25	28	35	39	46	59	76	95	111	122	126	122	104	85	72	64	58	52	47	44	41	39	37	34	33	32	32	30	29	27	22
.50	20	23	26	31	34	37	43	54	69	86	103	116	123	117	98	82	71	63	56	49	46	42	40	38	34	33	33	32	30	30	27	22
.75	16	20	24	27	29	31	33	37	43	53	65	80	94	116	116	101	86	74	65	56	49	44	41	39	36	34	33	32	31	30	28	23
1.0	14	18	22	25	26	27	29	31	34	38	45	54	67	93	111	113	101	87	75	62	53	47	42	40	37	34	33	33	31	30	28	23
1.5	10	13	16	20	21	22	23	24	26	27	29	31	34	45	64	86	102	107	101	84	69	55	46	42	39	37	34	33	32	30	28	24
2.0	6	8	11	13	14	16	17	18	19	20	21	23	24	27	31	39	52	71	88	102	96	76	57	47	42	40	37	35	33	31	29	24
2.5	3	5	7	9	10	11	12	13	14	15	16	17	18	21	23	26	31	38	51	75	94	98	74	57	47	42	39	37	33	32	30	25
3.0	1	2	4	6	7	7	8	9	10	11	12	13	14	16	18	20	23	26	30	43	64	89	95	72	56	47	42	39	34	33	30	25

IA/P = 0.30 * * * TC = 0.4 HR * * * IA/P = 0.30

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	6	15	29	46	60	65	65	63	59	56	53	52	49	47	44	44	43	42	42	42	41	40	40	40	40	40	39	38	34
.10	0	0	0	4	12	23	38	53	61	63	63	60	57	54	53	50	47	45	44	43	42	42	42	41	40	40	40	40	40	39	38	34
.20	0	0	0	3	9	19	32	46	56	61	62	61	59	55	53	51	48	45	44	43	43	42	42	41	40	40	40	40	40	39	38	34
.30	0	0	0	2	7	15	26	39	50	57	61	61	59	56	53	51	49	46	44	44	43	42	42	41	40	40	40	40	40	39	38	34
.40	0	0	0	0	2	5	11	21	33	44	53	58	60	58	55	53	51	48	45	44	43	42	42	41	40	40	40	40	40	39	38	34
.50	0	0	0	0	1	4	9	17	28	39	48	55	59	59	56	53	51	49	46	44	43	42	42	41	40	40	40	40	40	39	38	34
.75	0	0	0	0	0	2	4	9	16	25	34	43	49	57	57	55	53	50	48	45	44	43	42	41	41	40	40	40	40	39	39	35
1.0	0	0	0	0	0	0	1	2	5	10	17	25	34	48	55	56	55	53	50	47	45	43	42	42	41	40	40	40	40	39	39	35
1.5	0	0	0	0	0	0	0	0	0	0	1	3	6	16	30	43	51	55	55	52	49	45	43	42	42	41	40	40	40	40	39	36
2.0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	6	15	27	39	47	53	53	49	45	43	42	42	41	40	40	40	39	36
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	14	25	40	50	52	49	45	43	42	41	41	40	40	39	37
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	18	32	47	52	48	45	43	42	41	40	40	39	37

IA/P = 0.50 * * * TC = 0.4 HR * * * IA/P = 0.50

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	13	16	20	23	27	31	32	34	39	40	42	45	47	47	47
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	10	13	18	22	26	30	31	33	38	39	41	45	47	47	47
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	11	16	20	24	29	31	33	36	39	41	44	47	47	47
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	8	13	18	23	28	31	32	35	39	41	43	47	47	47
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	16	21	26	30	32	34	38	40	43	46	47	47
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	13	19	25	29	31	33	37	39	42	46	47	47
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	17	23	28	31	32	35	39	42	45	47	47
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	12	20	25	29	31	33	37	41	44	47	47
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	20	26	30	31	34	40	43	47	47
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	14	21	26	30	32	37	41	47	47
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	15	21	26	30	34	40	46	47
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	15	22	27	32	38	45	47

RAINFALL TYPE = IA * * * TC = 0.4 HR * * * SHEET 4 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

*** TC = 0.5 HR ***

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
IA/P = 0.10																																
0.0	25	28	34	53	72	94	115	129	130	129	117	104	92	76	68	61	55	50	47	44	42	40	38	34	33	33	32	31	30	29	27	22
.10	24	27	33	49	64	84	105	121	127	128	121	109	98	80	70	63	57	51	48	45	42	40	38	34	33	33	32	32	30	29	27	22
.20	23	26	30	39	46	58	75	95	112	122	126	123	114	93	78	69	61	55	50	46	44	41	39	36	34	33	32	32	30	29	27	22
.30	21	24	27	34	37	43	53	68	86	103	116	123	123	108	89	76	67	60	54	48	45	42	39	37	34	33	33	32	30	30	27	22
.40	20	24	27	32	35	40	49	61	78	95	109	118	121	111	93	79	69	62	55	49	45	42	40	37	34	33	33	32	30	30	27	22
.50	18	22	25	29	31	34	38	45	56	70	87	101	113	118	106	89	77	67	60	52	47	43	40	38	35	33	33	32	31	30	28	23
.75	15	19	23	26	27	29	31	34	38	45	54	67	80	104	112	106	93	80	70	59	51	46	41	39	36	34	33	33	31	30	28	23
1.0	13	16	20	24	25	26	27	29	31	34	39	46	56	80	102	110	105	93	81	66	56	48	43	40	38	35	33	33	31	30	28	23
1.5	9	12	15	18	20	21	22	23	24	26	27	29	31	39	55	75	94	104	103	89	74	58	48	43	40	37	35	33	32	31	29	24
2.0	5	7	10	12	13	14	15	17	18	19	20	21	23	25	29	35	45	62	79	100	100	81	61	49	43	40	38	35	33	31	29	25
2.5	3	4	6	8	9	10	11	12	13	14	15	16	17	20	22	25	28	34	45	67	88	96	79	60	49	43	40	37	33	32	30	25
3.0	1	2	3	5	6	7	7	8	9	10	11	12	13	15	17	19	21	24	28	38	56	83	93	77	59	48	43	40	35	33	30	26
IA/P = 0.30																																
0.0	0	0	0	2	8	18	31	46	57	61	61	61	58	54	53	51	48	45	44	44	43	42	42	41	40	40	40	40	40	39	38	34
.10	0	0	0	2	6	14	25	39	51	58	60	61	59	55	53	51	49	46	44	44	43	42	42	41	40	40	40	40	40	39	38	34
.20	0	0	0	0	1	4	11	21	33	45	54	58	60	58	55	53	51	48	46	44	43	42	42	41	40	40	40	40	40	39	38	34
.30	0	0	0	0	1	3	8	16	27	39	49	55	59	59	55	53	51	49	46	44	43	42	42	41	40	40	40	40	40	39	39	34
.40	0	0	0	0	1	2	6	13	23	34	44	51	56	58	56	54	52	49	47	44	43	42	42	41	40	40	40	40	40	39	39	34
.50	0	0	0	0	0	0	2	5	10	18	29	39	47	56	57	55	53	51	49	45	44	43	42	41	41	40	40	40	40	39	39	35
.75	0	0	0	0	0	0	1	2	5	10	17	25	34	48	54	56	55	53	50	47	45	43	42	42	41	40	40	40	40	39	39	35
1.0	0	0	0	0	0	0	0	0	0	1	3	6	11	26	41	51	55	55	54	50	47	44	43	42	41	41	40	40	40	40	39	35
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	23	36	47	52	54	52	48	44	43	42	41	40	40	40	40	39	36
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	16	27	38	49	53	51	47	44	42	42	41	40	40	40	39	36
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	15	30	43	52	50	46	44	42	42	41	40	40	39	37
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	23	40	51	50	46	44	42	42	40	40	39	37
IA/P = 0.50																																
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	11	14	19	22	26	30	31	34	38	40	41	45	46	46	46
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	8	12	17	21	25	29	31	33	37	39	41	44	46	46	46
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	9	14	19	23	28	31	32	35	39	41	43	46	46	46
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	12	17	22	27	31	32	34	38	40	43	46	46	46
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	16	21	26	30	32	34	38	40	43	46	46	46
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	13	19	25	29	31	33	37	39	42	46	46	46
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	17	23	28	31	32	35	39	42	45	46	46
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	18	24	29	31	33	36	41	44	46	46
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	19	24	29	31	33	39	42	46	46
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	12	19	25	29	31	37	41	46	46
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	13	20	25	29	34	39	45	46
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	14	20	26	32	37	44	46

RAINFALL TYPE = IA *** TC = 0.5 HR *** SHEET 5 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

IA/P = 0.10 * * * TC = 0.75 HR * * * IA/P = 0.10

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	22	25	29	38	45	56	71	87	103	114	117	117	111	95	81	72	65	58	53	48	45	41	39	36	33	33	33	32	30	29	27	22
.10	21	25	28	36	42	51	64	79	95	108	114	116	113	99	85	74	66	60	54	48	45	42	39	37	34	33	33	32	30	30	27	22
.20	19	23	26	32	35	39	47	58	72	87	101	110	114	109	95	82	72	65	58	51	47	43	40	38	34	33	33	32	31	30	27	23
.30	19	22	26	31	33	37	44	54	66	80	94	104	112	110	98	85	75	67	60	52	47	43	40	38	34	33	33	32	31	30	28	23
.40	17	21	24	28	30	32	36	41	49	61	74	87	99	111	106	94	82	73	65	56	49	45	41	39	35	33	33	33	31	30	28	23
.50	16	20	23	27	29	31	34	39	46	56	68	81	93	109	107	97	85	75	67	57	50	45	41	39	36	33	33	33	31	30	28	23
.75	15	18	22	25	27	28	31	34	38	45	54	64	75	95	104	102	93	83	74	62	54	47	42	40	37	34	33	33	31	30	28	23
1.0	12	15	18	22	23	24	25	27	29	31	34	39	46	65	85	100	103	98	88	74	62	52	45	41	39	35	33	33	32	30	28	23
1.5	7	10	12	15	17	18	19	20	21	22	24	25	26	31	39	53	71	87	99	99	85	68	53	46	41	39	36	34	33	31	29	24
2.0	4	6	8	11	12	13	14	15	16	17	18	19	21	23	26	31	39	51	67	88	95	86	67	53	45	41	38	36	33	32	29	25
2.5	2	3	5	7	8	9	10	11	11	12	13	14	16	18	20	23	26	30	38	56	77	93	84	66	52	45	41	38	34	33	30	25
3.0	0	1	2	4	4	5	6	6	7	8	8	9	10	12	14	16	18	21	24	30	42	67	90	84	68	54	46	42	36	33	30	26

IA/P = 0.30 * * * TC = 0.75 HR * * * IA/P = 0.30

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	2	4	10	19	29	39	48	53	56	56	54	53	51	49	46	44	44	42	42	40	40	40	40	40	40	39	39	34
.10	0	0	0	0	1	3	8	15	24	34	43	50	54	56	54	53	52	49	47	45	44	42	42	41	40	40	40	40	40	39	39	34
.20	0	0	0	0	0	1	2	6	12	20	30	39	46	54	55	54	53	51	49	46	44	43	42	41	40	40	40	40	40	39	39	35
.30	0	0	0	0	0	1	2	5	10	17	25	34	42	52	55	54	53	51	49	46	44	43	42	42	40	40	40	40	40	39	39	35
.40	0	0	0	0	0	0	1	4	8	14	21	30	38	50	55	55	53	52	50	47	45	43	42	42	40	40	40	40	40	39	39	35
.50	0	0	0	0	0	0	1	3	6	11	18	26	34	47	53	54	54	52	50	47	45	43	42	42	40	40	40	40	40	39	39	35
.75	0	0	0	0	0	0	0	1	3	6	10	16	23	37	47	52	53	53	52	49	46	44	42	42	41	40	40	40	40	40	39	35
1.0	0	0	0	0	0	0	0	0	0	1	2	4	7	17	30	42	50	53	53	51	49	45	43	42	41	40	40	40	40	40	39	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	21	33	43	49	52	51	48	45	43	42	41	40	40	40	40	39	36
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	20	30	43	50	51	48	45	43	42	41	40	40	40	39	37
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	10	23	36	48	51	47	44	43	42	41	40	40	39	37
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	17	34	48	50	47	44	43	42	40	40	39	38

IA/P = 0.50 * * * TC = 0.75 HR * * * IA/P = 0.50

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	10	15	19	23	28	31	32	36	39	41	44	44	44	44
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	7	12	17	22	27	30	32	34	38	40	43	44	44	44
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	15	20	25	30	31	33	37	39	43	44	44	44
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	12	18	24	29	31	33	36	39	42	44	44	44
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	10	16	22	27	30	32	35	38	42	44	44	44
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	14	21	26	30	31	34	38	41	44	44	44
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	19	24	29	31	33	36	41	44	44	44
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	16	22	27	30	32	35	40	43	44	44
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9	16	23	27	30	32	38	42	44	44
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	17	23	28	30	36	40	44	44
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	18	23	28	33	39	44	44
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	17	23	30	36	43	44

RAINFALL TYPE = IA * * * TC = 0.75 HR * * * SHEET 6 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

IA/P = 0.10 * * * TC = 1.0 HR * * * IA/P = 0.10

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	19	23	26	33	37	43	52	63	76	88	97	104	108	102	91	81	72	65	59	52	48	43	40	38	34	33	33	32	31	30	28	23
.10	19	22	26	32	35	41	48	58	70	82	92	100	105	103	94	83	75	67	61	53	48	44	40	38	35	33	33	32	31	30	28	23
.20	17	21	24	28	30	34	38	45	54	65	76	87	96	104	100	91	81	73	66	57	51	45	41	39	36	33	33	33	31	30	28	23
.30	16	20	23	27	29	32	36	42	50	60	71	81	91	103	101	93	84	75	67	58	52	46	42	39	36	34	33	33	31	30	28	23
.40	15	18	22	25	27	29	31	35	40	46	55	65	76	94	102	99	91	81	73	63	55	48	43	40	37	34	33	33	31	30	28	23
.50	14	18	21	25	26	28	30	33	37	43	51	61	71	90	101	101	93	84	75	64	56	49	43	40	37	34	33	33	31	30	28	23
.75	13	16	19	23	24	25	27	29	32	37	42	49	58	76	91	98	96	89	81	70	60	51	45	41	38	35	34	33	32	30	28	23
1.0	10	13	16	19	20	22	23	24	26	27	30	33	37	50	67	83	94	97	93	81	70	58	48	43	40	37	34	33	32	31	29	24
1.5	6	8	10	13	14	15	16	18	19	20	21	22	24	27	33	42	56	71	84	93	89	75	59	49	44	40	37	35	33	31	29	24
2.0	3	5	7	9	10	11	12	13	14	15	16	17	18	21	23	27	32	41	53	74	88	91	74	59	49	43	40	37	34	32	30	25
2.5	1	2	4	6	7	7	8	9	10	11	11	12	13	16	18	20	23	26	32	45	64	84	89	72	58	48	43	40	34	33	30	26
3.0	0	1	2	3	3	4	4	5	6	6	7	8	9	10	12	14	16	18	21	26	35	55	81	87	73	59	50	44	37	34	31	26

IA/P = 0.30 * * * TC = 1.0 HR * * * IA/P = 0.30

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	1	2	5	10	16	23	31	38	44	51	53	52	52	50	48	46	44	43	42	41	40	40	40	40	40	40	39	35
.10	0	0	0	0	0	1	2	4	8	13	20	27	35	46	51	53	52	51	50	47	45	44	42	42	40	40	40	40	40	40	39	35
.20	0	0	0	0	0	0	1	3	6	11	17	24	31	43	50	52	52	51	50	47	45	44	42	42	40	40	40	40	40	40	39	35
.30	0	0	0	0	0	0	1	2	5	9	14	21	28	40	48	52	52	52	50	48	46	44	43	42	40	40	40	40	40	40	39	35
.40	0	0	0	0	0	0	0	1	2	4	7	12	18	31	42	49	52	52	51	49	47	45	43	42	41	40	40	40	40	40	39	35
.50	0	0	0	0	0	0	0	1	1	3	6	10	15	28	39	47	51	52	51	49	47	45	43	42	41	40	40	40	40	40	39	35
.75	0	0	0	0	0	0	0	0	1	1	3	6	9	19	31	41	47	50	51	50	48	46	43	42	41	40	40	40	40	40	39	36
1.0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	14	25	36	44	49	51	50	47	45	43	42	41	40	40	40	40	39	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	13	23	33	44	49	50	47	44	43	42	41	40	40	40	39	37
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	13	25	38	48	50	47	44	43	42	41	40	40	39	37
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	9	19	36	48	49	47	44	43	42	40	40	39	38
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	18	37	47	49	46	44	43	41	40	40	38

IA/P = 0.50 * * * TC = 1.0 HR * * * IA/P = 0.50

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	7	11	16	21	26	30	32	34	38	40	43	43	43	43
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	9	14	19	25	29	31	33	37	39	42	43	43	43
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	11	17	23	28	30	32	36	39	42	43	43	43
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	15	21	27	30	32	35	38	41	43	43	43
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	13	20	25	29	31	34	37	41	43	43	43
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	18	24	28	31	33	36	41	43	43	43
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	16	22	27	30	32	35	40	43	43	43
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	13	20	25	29	31	34	39	42	43	43
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	14	20	25	29	31	37	41	43	43
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	14	20	26	29	34	39	43	43
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	15	21	26	32	37	43	43
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	14	20	29	34	42	43

RAINFALL TYPE = IA * * * TC = 1.0 HR * * * SHEET 7 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
IA/P = 0.10														* * * TC = 1.25 HR * * *															IA/P = 0.10			
0.0	17	21	24	29	33	37	43	52	61	71	81	89	95	100	94	86	78	71	64	57	51	46	42	39	35	34	33	33	31	30	28	23
.10	16	19	23	27	29	31	35	41	48	57	66	76	85	96	99	92	84	76	69	60	54	47	43	40	36	34	34	33	31	30	28	23
.20	15	19	22	26	28	30	33	38	45	53	62	71	80	93	97	93	86	78	71	62	55	48	43	40	37	34	34	33	31	30	28	23
.30	14	17	20	24	25	27	29	32	36	42	49	58	67	84	95	96	91	84	76	66	58	50	44	41	38	35	34	33	31	30	28	23
.40	13	16	20	23	25	26	28	31	34	39	46	54	62	80	92	96	93	86	78	68	59	51	45	41	38	35	34	33	31	30	28	23
.50	12	15	18	21	23	24	25	27	29	33	37	43	50	67	83	93	95	91	84	73	63	54	46	42	39	36	34	33	32	30	28	23
.75	10	13	16	20	21	22	23	25	27	29	32	36	42	55	71	84	93	93	88	78	68	57	49	43	40	37	34	34	32	31	28	24
1.0	8	10	13	16	17	19	20	21	22	23	25	27	29	37	49	63	78	88	92	88	78	65	53	46	42	39	36	34	33	31	29	24
1.5	5	7	9	12	13	14	15	16	17	18	19	20	22	25	29	36	47	60	73	87	89	79	64	53	46	42	38	36	33	32	29	25
2.0	2	4	6	8	9	10	10	11	12	13	14	15	16	19	21	24	29	36	45	64	80	87	77	63	52	46	41	38	34	32	30	25
2.5	1	2	3	4	5	6	6	7	8	8	9	10	11	13	15	17	19	22	26	35	49	72	85	78	65	53	46	42	36	33	30	26
3.0	0	1	1	2	3	3	4	4	5	5	6	7	7	9	11	12	14	17	19	23	31	47	73	84	76	63	53	46	38	34	31	26
IA/P = 0.30														* * * TC = 1.25 HR * * *															IA/P = 0.30			
0.0	0	0	0	0	0	1	3	6	10	15	22	28	34	43	48	51	51	51	49	47	45	44	43	42	40	40	40	40	40	40	39	35
.10	0	0	0	0	0	0	1	2	5	8	13	19	25	36	45	49	51	50	50	48	46	44	43	42	40	40	40	40	40	40	39	35
.20	0	0	0	0	0	0	1	2	4	7	11	16	22	34	43	48	50	50	50	48	46	44	43	42	41	40	40	40	40	40	39	35
.30	0	0	0	0	0	0	1	1	3	5	9	14	19	31	40	46	49	50	50	48	46	45	43	42	41	40	40	40	40	40	39	35
.40	0	0	0	0	0	0	0	1	2	4	8	12	17	28	38	45	49	50	50	49	47	45	43	42	41	40	40	40	40	40	39	35
.50	0	0	0	0	0	0	0	1	2	4	6	10	14	25	36	43	48	50	50	49	47	45	43	42	41	40	40	40	40	40	39	35
.75	0	0	0	0	0	0	0	0	0	1	2	3	6	13	23	33	41	46	49	50	48	46	44	43	42	40	40	40	40	40	39	36
1.0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	14	23	32	40	46	49	49	47	45	43	42	41	40	40	40	40	39	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	13	21	30	41	47	49	47	45	43	42	41	40	40	40	39	37
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	12	23	35	45	48	47	45	43	42	41	40	40	40	37
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	18	33	45	48	46	44	43	42	40	40	40	38
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	17	34	45	48	46	44	43	41	40	40	38
IA/P = 0.50														* * * TC = 1.25 HR * * *															IA/P = 0.50			
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	9	14	19	24	28	31	33	37	39	42	42	42	42
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	11	17	23	27	30	32	36	38	42	42	42	42
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	9	15	21	26	29	32	35	38	41	42	42	42
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	13	19	25	29	31	34	37	41	42	42	42
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	17	23	28	30	33	36	40	42	42	42
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	15	22	26	30	32	35	40	42	42	42
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	13	20	25	29	31	34	39	42	42	42
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	17	23	27	30	33	38	42	42	42
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	11	18	23	28	30	36	40	42	42
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	12	18	24	28	33	39	42	42
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	13	19	24	31	37	42	42
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	12	18	28	33	42	42

RAINFALL TYPE = IA * * * TC = 1.25 HR * * * SHEET 8 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

IA/P = 0.10 * * * TC = 1.5 HR * * * IA/P = 0.10

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	15	19	22	27	29	32	37	42	49	57	65	73	80	89	94	89	83	76	70	62	55	49	44	40	37	35	34	33	31	30	28	23
.10	14	17	20	24	26	28	31	35	40	46	53	61	69	82	90	92	87	81	74	65	58	51	45	41	38	35	34	33	31	30	28	23
.20	13	16	20	23	25	27	29	33	37	43	50	57	65	79	88	91	88	82	76	67	59	52	46	42	38	35	34	33	32	30	28	23
.30	12	15	18	22	23	24	26	28	31	35	41	47	54	69	81	89	90	86	81	71	63	54	47	43	39	36	34	34	32	30	28	24
.40	11	14	18	21	22	24	25	27	30	34	38	44	51	65	78	87	90	87	82	73	64	55	48	43	40	36	34	34	32	30	28	24
.50	10	13	16	19	20	22	23	24	26	29	32	36	41	54	69	81	88	89	86	77	68	58	50	44	41	37	35	34	32	31	29	24
.75	9	11	14	18	19	20	21	22	24	26	28	31	35	46	58	71	82	88	88	81	73	62	52	46	42	38	35	34	32	31	29	24
1.0	7	9	11	14	15	16	18	19	20	21	22	24	26	32	40	52	65	76	84	87	81	70	58	49	44	40	37	35	33	31	29	24
1.5	4	6	8	10	11	12	13	14	15	16	17	18	19	22	26	31	39	50	62	77	85	81	69	57	49	44	40	37	34	32	30	25
2.0	2	3	5	7	7	8	9	10	11	12	12	13	14	17	19	22	25	31	38	53	69	83	80	68	56	48	43	40	35	33	30	25
2.5	1	1	2	3	4	5	5	6	6	7	8	9	9	11	13	15	17	20	23	30	41	61	82	82	69	58	49	44	37	34	31	26
3.0	0	0	1	2	2	2	3	3	4	4	5	5	6	8	9	11	13	15	17	21	27	40	63	80	78	68	57	49	40	35	31	27

IA/P = 0.30 * * * TC = 1.5 HR * * * IA/P = 0.30

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	1	2	4	6	10	14	19	24	34	41	46	48	49	48	47	46	44	43	42	41	40	40	40	40	40	39	35
.10	0	0	0	0	0	0	1	1	3	5	8	12	17	27	36	42	46	48	49	48	46	45	43	42	41	40	40	40	40	40	39	36
.20	0	0	0	0	0	0	0	1	2	4	7	10	15	24	33	41	45	48	49	48	47	45	43	43	41	40	40	40	40	40	39	36
.30	0	0	0	0	0	0	0	1	2	3	6	9	13	22	31	39	44	47	48	48	47	45	44	43	41	40	40	40	40	40	39	36
.40	0	0	0	0	0	0	0	0	1	1	3	5	7	15	24	33	40	45	47	48	47	46	44	43	42	40	40	40	40	40	39	36
.50	0	0	0	0	0	0	0	0	0	1	2	4	6	13	22	31	38	44	47	48	48	46	44	43	42	40	40	40	40	40	39	36
.75	0	0	0	0	0	0	0	0	0	1	1	2	4	9	16	24	33	39	44	47	48	47	45	43	42	41	40	40	40	40	39	36
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	12	20	29	36	44	47	48	46	44	43	42	40	40	40	40	40	36
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	12	19	30	39	46	47	46	44	43	42	40	40	40	40	37
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	17	28	40	46	47	45	44	42	41	40	40	40	37
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	13	26	40	47	47	45	43	42	40	40	40	38
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	12	28	41	46	46	45	43	41	40	40	38

IA/P = 0.50 * * * TC = 1.5 HR * * * IA/P = 0.50

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	7	11	16	22	27	30	32	35	38	42	42	42	42
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	7	13	19	24	28	31	34	37	41	42	42	42
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	12	19	24	28	31	33	36	41	42	42	42
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	12	18	23	28	30	33	36	40	42	42	42
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	11	17	23	27	30	33	36	40	42	42	42
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	17	22	27	30	32	36	40	41	41	41
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	10	16	22	26	29	32	35	40	41	41	41
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	17	23	27	30	33	38	41	41	41
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	12	18	23	27	30	36	40	41	41
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	12	18	24	28	33	39	41	41
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	13	19	24	31	36	41	41
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	13	19	28	34	41	41

RAINFALL TYPE = IA * * * TC = 1.5 HR * * * SHEET 9 OF 10

Exhibit 5-IA: Tabular hydrograph unit discharges (csm/in) for type IA rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

IA/P = 0.10   * * * TC = 2.0 HR * * *

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	12	15	18	22	24	26	28	32	36	41	46	52	58	68	76	80	84	79	76	68	62	55	48	44	40	37	35	34	32	31	28	24
.10	11	13	16	20	21	23	25	27	30	34	38	43	49	60	70	77	83	83	78	72	65	57	50	45	41	38	36	34	32	31	29	24
.20	9	12	15	18	19	21	22	24	26	29	32	36	41	52	63	72	78	82	81	75	68	60	52	46	42	39	36	35	32	31	29	24
.30	9	12	14	18	19	20	21	23	25	28	31	34	39	49	60	70	77	81	81	76	70	61	53	47	43	39	36	35	33	31	29	24
.40	9	11	14	17	18	19	21	22	24	26	29	33	37	47	57	67	75	80	81	77	71	62	53	47	43	39	37	35	33	31	29	24
.50	7	10	12	15	17	18	19	20	21	23	25	28	31	39	49	60	69	76	81	79	74	65	56	49	44	40	37	35	33	31	29	24
.75	6	9	11	14	15	16	17	18	20	21	23	25	27	34	42	52	62	70	76	79	76	68	59	51	46	41	38	36	33	31	29	24
1.0	5	6	9	11	12	13	14	15	16	17	18	20	21	25	30	38	47	57	66	76	79	75	64	55	49	44	40	37	34	32	29	25
1.5	3	4	6	8	8	9	10	11	12	13	14	15	16	18	21	24	30	37	45	59	71	78	73	63	55	48	43	40	35	33	30	25
2.0	1	2	3	4	5	5	6	7	7	8	9	10	10	12	14	16	19	22	26	36	48	65	77	73	64	56	49	44	37	34	31	26
2.5	0	1	1	2	3	3	4	4	5	5	6	6	7	8	10	12	14	16	18	23	31	46	66	76	72	63	55	48	40	35	31	27
3.0	0	0	1	1	1	2	2	2	3	3	3	4	4	5	7	8	10	11	13	17	21	30	49	67	75	71	63	54	43	37	32	27

IA/P = 0.30   * * * TC = 2.0 HR * * *

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	1	2	3	5	7	10	13	20	27	34	39	42	44	47	45	45	44	43	42	40	40	40	40	40	39	36
.10	0	0	0	0	0	0	0	1	1	2	4	6	8	15	22	29	35	40	43	45	46	45	44	43	42	41	40	40	40	40	40	36
.20	0	0	0	0	0	0	0	0	1	1	2	3	5	10	17	24	31	36	41	44	46	45	44	43	42	41	40	40	40	40	40	36
.30	0	0	0	0	0	0	0	0	0	1	2	3	4	9	15	22	29	35	39	44	46	45	44	43	42	41	40	40	40	40	40	36
.40	0	0	0	0	0	0	0	0	0	1	1	2	4	8	14	20	27	33	38	43	46	46	44	43	42	41	40	40	40	40	40	36
.50	0	0	0	0	0	0	0	0	0	0	1	1	2	5	9	15	22	29	35	41	44	45	45	44	43	42	40	40	40	40	40	36
.75	0	0	0	0	0	0	0	0	0	0	0	1	1	3	6	11	17	24	30	38	42	45	45	44	43	42	41	40	40	40	40	37
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	9	14	21	30	38	43	45	44	44	43	41	40	40	40	40	37
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	16	25	36	43	45	44	43	42	41	40	40	40	38
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	12	24	36	43	45	44	43	42	40	40	40	38
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	12	25	37	43	45	44	43	41	40	40	38
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	13	26	37	43	44	44	42	40	40	39

IA/P = 0.50   * * * TC = 2.0 HR * * *

TRVL TIME (hr)	7.0	7.3	7.6	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.3	10.6	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0	18.0	22.0
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	7	12	18	23	27	30	33	36	40	40	40	40
.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	10	16	21	26	29	32	35	40	40	40	40
.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	14	20	25	28	31	34	39	40	40	40
.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	12	18	23	27	30	33	38	40	40	40
.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	11	16	22	26	29	32	38	40	40	40
.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	15	20	25	28	31	37	40	40	40
.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	13	19	24	27	30	36	40	40	40
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	14	20	24	28	34	39	40	40
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	10	16	21	25	32	37	40	40
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	11	16	21	29	35	40	40
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	17	26	32	40	40
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	21	29	39	40

RAINFALL TYPE = IA   * * * TC = 2.0 HR * * *   SHEET 10 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution

IA/P = 0.10 * * * TC = 0.1 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	24	34	53	334	647	1010	623	217	147	123	104	86	76	66	57	51	46	42	38	34	32	29	26	23	21	20	19	18	15	13	12	0
.10	21	29	43	134	267	520	847	701	378	224	157	122	98	75	64	56	50	45	41	36	33	30	27	24	21	20	19	18	16	13	12	0
.20	18	25	35	61	110	215	418	704	702	486	312	209	151	94	73	62	54	49	44	38	34	31	28	25	22	21	19	18	16	14	12	0
.30	17	23	33	56	92	174	337	582	662	545	389	269	190	109	79	65	56	50	45	39	35	32	29	25	22	21	20	18	16	14	12	0
.40	15	20	28	41	51	78	142	272	478	601	563	447	328	172	104	76	63	55	49	42	37	33	29	26	23	21	20	19	17	14	12	0
.50	14	19	26	39	47	68	117	220	392	531	553	482	380	209	121	84	67	57	51	43	38	33	30	27	23	21	20	19	17	14	12	0
.75	12	15	21	29	33	38	49	73	126	224	343	432	464	385	252	156	103	76	62	50	43	36	31	28	25	22	21	19	17	15	12	0
1.0	9	12	15	21	23	26	29	33	40	55	86	148	238	406	434	317	205	130	89	62	50	41	34	30	27	24	22	20	18	16	12	0
1.5	7	8	10	14	15	16	18	20	22	25	29	34	45	101	220	339	373	320	234	131	80	53	40	34	30	27	24	21	19	17	12	2
2.0	4	6	7	9	9	10	11	12	13	15	16	18	20	25	37	72	150	252	336	312	216	109	58	42	34	30	27	24	20	18	13	8
2.5	3	4	5	6	7	7	8	8	9	10	11	12	13	16	19	25	39	75	142	262	308	229	108	58	41	34	30	27	22	19	14	11
3.0	1	2	3	4	4	5	5	6	6	7	7	8	8	10	12	14	17	22	31	76	169	288	236	122	64	43	35	30	24	20	16	11

IA/P = 0.30 * * * TC = 0.1 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	154	568	936	524	217	172	149	126	107	97	86	76	69	63	58	53	48	46	42	38	34	31	30	28	27	24	20	19	0
.10	0	0	0	19	109	415	762	603	346	230	176	143	119	96	84	74	68	62	57	50	47	44	40	35	32	30	29	27	24	21	19	0
.20	0	0	0	0	13	77	302	609	605	432	297	217	167	115	94	81	73	66	60	53	48	45	41	37	33	31	29	28	25	21	19	0
.30	0	0	0	0	9	54	219	479	563	476	357	263	199	129	99	85	75	68	62	54	49	45	41	37	33	31	29	28	25	21	19	0
.40	0	0	0	0	0	6	38	159	372	500	484	399	309	183	123	96	82	73	66	58	51	46	42	38	34	31	30	28	25	22	19	0
.50	0	0	0	0	0	4	27	115	287	429	465	421	346	213	138	103	86	76	68	59	52	47	43	39	34	32	30	29	25	22	19	0
.75	0	0	0	0	0	0	1	10	46	132	246	338	381	341	243	165	119	94	80	67	58	50	45	41	37	33	31	29	26	23	19	0
1.0	0	0	0	0	0	0	0	1	4	22	69	149	241	357	331	246	170	122	96	76	64	54	47	42	38	34	32	30	27	24	19	0
1.5	0	0	0	0	0	0	0	0	0	0	0	1	4	41	142	258	310	285	224	142	97	71	55	47	43	39	35	32	29	25	20	4
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	49	130	221	279	255	182	108	70	55	47	42	38	34	30	27	20	11
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	52	119	224	256	193	107	70	55	47	42	38	32	28	22	17
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	52	141	240	199	117	74	56	48	43	35	30	24	18

IA/P = 0.50 * * * TC = 0.1 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	70	539	377	196	171	154	134	117	108	99	89	83	77	72	67	61	59	56	51	46	43	42	40	38	34	30	28	0
.10	0	0	0	0	47	375	376	256	199	169	146	126	114	102	92	85	79	73	68	62	59	56	52	47	43	42	40	38	34	30	28	0
.20	0	0	0	0	0	31	260	338	283	227	189	160	138	112	99	90	83	77	72	64	60	57	53	48	44	42	41	39	35	30	28	0
.30	0	0	0	0	0	0	21	180	285	284	246	208	176	131	110	97	88	82	76	68	62	59	54	50	45	43	41	39	36	31	28	0
.40	0	0	0	0	0	0	14	125	232	266	253	223	192	142	115	100	91	83	77	69	63	59	55	50	45	43	41	40	36	31	28	0
.50	0	0	0	0	0	0	9	86	183	239	248	231	205	154	122	104	93	85	79	71	64	59	55	51	46	43	41	40	36	32	28	0
.75	0	0	0	0	0	0	3	31	87	147	190	211	213	184	147	121	103	92	84	75	67	61	57	52	47	44	42	40	37	32	28	0
1.0	0	0	0	0	0	0	0	0	1	13	45	92	141	205	197	165	134	112	98	84	75	65	59	55	50	46	43	41	38	34	28	0
1.5	0	0	0	0	0	0	0	0	0	0	0	2	9	51	118	170	183	167	143	111	92	77	65	59	54	50	45	43	39	35	28	2
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	15	51	103	148	168	156	127	96	76	65	58	54	49	45	41	37	29	12
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	31	69	131	159	140	101	78	66	59	54	50	43	39	31	24
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	46	101	151	134	99	77	65	59	54	45	41	33	26

RAINFALL TYPE = II * * * TC = 0.1 HR * * * SHEET 1 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

IA/P = 0.10 * * * TC = 0.2 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	23	31	47	209	403	739	800	481	250	166	128	102	86	70	61	54	49	44	40	35	33	30	27	24	21	20	19	18	16	13	12	0
.10	19	26	39	86	168	325	601	733	565	355	229	161	122	83	69	59	53	47	43	37	34	31	28	25	22	21	19	18	16	14	12	0
.20	17	23	32	49	74	136	262	488	652	594	435	298	207	115	81	67	58	51	46	40	35	32	29	26	23	21	20	19	16	14	12	0
.30	16	22	30	46	64	112	212	396	566	585	485	360	258	139	90	71	60	53	48	41	36	32	29	26	23	21	20	19	16	14	12	0
.40	14	19	25	37	43	57	94	173	322	485	551	507	409	227	129	87	68	58	52	44	38	33	30	27	24	21	20	19	17	14	12	0
.50	13	18	24	35	40	52	80	142	262	410	504	506	441	269	153	98	73	61	53	45	39	34	30	27	24	22	20	19	17	15	12	0
.75	10	13	17	23	26	30	34	40	55	86	150	247	349	438	360	240	151	101	75	57	47	39	33	29	26	23	21	20	18	15	12	0
1.0	9	11	14	19	21	24	26	30	35	44	62	101	167	337	413	353	245	157	104	68	53	42	35	31	28	24	22	20	18	16	12	0
1.5	6	8	10	13	14	15	17	19	21	23	26	30	37	73	166	288	356	337	264	154	91	57	42	35	30	27	24	22	19	17	13	3
2.0	4	5	7	8	9	10	10	11	12	14	15	16	18	23	31	55	114	206	291	324	239	125	63	44	35	31	28	24	20	18	14	9
2.5	3	4	5	6	6	7	7	8	9	9	10	11	12	15	18	22	32	58	111	227	298	246	122	63	43	35	31	27	22	19	15	11
3.0	1	2	3	4	4	4	5	5	6	6	7	7	8	9	11	13	16	19	27	59	138	280	248	137	70	46	36	31	25	21	16	11

IA/P = 0.30 * * * TC = 0.2 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	39	180	545	697	497	276	198	158	130	110	93	81	73	67	61	56	49	46	43	39	35	32	30	29	27	24	21	19	0
.10	0	0	0	2	27	129	407	600	532	361	252	190	150	108	90	79	71	65	59	52	48	44	41	36	32	31	29	28	25	21	19	0
.20	0	0	0	2	19	92	302	501	521	415	306	228	176	119	95	82	73	67	61	53	48	45	41	37	33	31	29	28	25	21	19	0
.30	0	0	0	0	1	13	66	223	408	484	438	350	269	163	114	93	80	72	65	57	51	46	42	38	34	31	30	28	25	22	19	0
.40	0	0	0	0	1	9	47	164	327	431	436	379	306	189	127	98	83	74	67	58	52	47	43	38	34	31	30	28	25	22	19	0
.50	0	0	0	0	0	0	6	33	120	258	374	415	391	271	173	121	95	81	72	62	55	48	44	40	35	32	30	29	26	22	19	0
.75	0	0	0	0	0	0	2	13	50	126	221	302	348	323	240	167	121	96	81	68	59	50	45	41	37	33	31	29	26	23	19	0
1.0	0	0	0	0	0	0	0	0	1	6	24	69	139	285	331	280	204	145	109	82	68	56	48	43	39	35	32	30	27	24	19	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	16	79	186	271	288	247	165	110	76	58	49	44	40	35	32	29	26	20	5
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	24	80	163	235	262	202	123	76	58	49	43	39	35	30	27	21	13
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	28	77	179	242	207	120	75	57	48	43	39	32	29	22	17
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	30	101	207	227	130	80	59	49	44	35	30	24	18

IA/P = 0.50 * * * TC = 0.2 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	7	98	371	322	221	182	158	137	120	104	94	86	80	74	69	62	60	57	52	47	44	42	40	39	35	30	28	0
.10	0	0	0	0	4	67	270	305	249	204	174	149	130	108	97	88	82	76	71	64	60	57	53	48	44	42	41	39	35	30	28	0
.20	0	0	0	0	0	3	45	195	268	255	221	189	163	125	106	95	87	80	75	67	62	58	54	49	45	43	41	39	35	31	28	0
.30	0	0	0	0	0	2	31	140	226	245	229	203	176	134	111	98	89	82	76	68	62	59	55	50	45	43	41	39	36	31	28	0
.40	0	0	0	0	0	1	21	101	184	225	228	211	188	144	117	101	91	84	78	69	63	59	55	50	45	43	41	40	36	31	28	0
.50	0	0	0	0	0	0	1	14	72	146	199	218	213	175	137	113	99	89	82	73	66	60	56	52	47	43	42	40	36	32	28	0
.75	0	0	0	0	0	0	0	5	28	71	121	162	186	193	161	133	112	98	88	78	70	62	57	53	48	44	42	41	37	33	28	0
1.0	0	0	0	0	0	0	0	0	0	2	13	38	77	154	186	174	147	122	105	89	78	68	60	56	51	46	43	42	38	34	28	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	22	71	129	163	168	150	120	98	80	67	60	55	51	46	43	40	36	28	4
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	25	65	112	146	157	134	103	79	67	60	55	50	46	41	38	29	14
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	26	60	117	148	136	101	79	66	59	54	50	43	39	31	24
3,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	40	90	142	130	99	78	66	59	54	45	41	33	26

RAINFALL TYPE = II * * * TC = 0.2 HR * * * SHEET 2 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

IA/P = 0.10 * * * TC = 0.3 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	20	28	41	118	235	447	676	676	459	283	196	146	114	80	66	57	51	46	42	37	33	31	28	24	22	20	19	18	16	13	12	0
.10	19	26	39	99	189	361	571	641	520	362	251	181	136	89	70	60	53	48	43	37	34	31	28	25	22	21	19	18	16	14	12	0
.20	17	23	32	53	83	154	292	478	587	542	422	308	223	127	86	68	58	52	46	40	35	32	29	26	23	21	20	19	16	14	12	0
.30	16	22	30	49	72	127	237	398	524	536	460	359	268	151	97	73	61	53	48	41	36	32	29	26	23	21	20	19	16	14	12	0
.40	14	19	25	37	45	63	105	193	330	459	510	477	398	237	139	92	70	59	52	44	38	34	30	27	24	21	20	19	17	14	12	0
.50	13	18	24	35	42	56	89	158	272	397	472	475	424	274	163	104	76	62	54	46	39	34	30	27	24	22	20	19	17	15	12	0
.75	11	14	19	26	30	34	42	59	95	160	250	339	417	398	299	196	128	89	69	54	45	37	32	29	26	23	21	20	17	15	12	0
1.0	9	11	14	19	21	24	27	30	36	46	68	109	174	328	396	346	248	163	109	70	54	43	35	31	28	24	22	20	18	16	12	0
1.5	6	8	10	13	14	15	17	19	21	23	26	31	38	77	169	282	347	330	264	158	94	58	42	35	31	27	24	22	19	17	13	3
2.0	4	5	7	8	9	10	10	11	12	14	15	16	18	23	32	57	116	205	285	317	239	128	64	44	36	31	28	25	20	18	14	9
2.5	2	4	5	6	6	7	7	8	9	9	10	11	12	15	18	23	33	60	113	223	293	245	125	65	44	35	31	27	22	19	15	11
3.0	1	2	3	4	4	4	5	5	6	6	7	7	8	9	11	13	16	20	27	61	138	275	246	139	72	46	36	31	25	21	16	11

IA/P = 0.30 * * * TC = 0.3 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	11	64	251	525	574	454	303	221	173	140	104	88	77	70	64	58	51	47	44	40	36	32	31	29	28	24	21	19	0
.10	0	0	0	0	7	45	183	411	520	476	360	268	205	133	101	85	76	69	62	55	49	45	41	37	33	31	30	28	25	21	19	0
.20	0	0	0	0	5	32	132	318	452	468	396	310	240	151	109	90	78	70	64	56	50	46	42	38	33	31	30	28	25	22	19	0
.30	0	0	0	0	0	3	22	96	244	383	440	411	344	217	142	105	87	76	69	60	53	47	43	39	35	32	30	29	26	22	19	0
.40	0	0	0	0	0	2	16	69	186	317	399	407	365	246	160	115	92	79	71	61	54	48	43	39	35	32	30	29	26	22	19	0
,50	0	0	0	0	0	0	2	11	50	140	258	352	389	327	223	149	110	89	77	66	57	50	45	41	36	33	31	29	26	23	19	0
.75	0	0	0	0	0	0	1	4	20	63	135	219	290	335	281	205	146	110	89	72	62	52	46	42	38	34	31	30	27	23	19	0
1.0	0	0	0	0	0	0	0	0	0	2	9	32	78	216	320	306	243	176	128	90	72	59	49	44	40	36	33	31	28	24	19	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	20	84	185	264	281	246	168	112	77	58	49	44	40	36	32	29	26	20	5
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	50	121	200	257	224	141	83	61	50	44	40	36	31	28	21	14
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	51	145	239	223	137	82	60	50	44	40	33	29	22	17
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	19	74	184	224	146	89	63	51	45	36	31	24	18

IA/P = 0.50 * * * TC = 0.3 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	1	25	151	299	277	219	187	162	141	113	100	90	84	78	72	65	61	58	53	48	44	42	41	39	35	31	28	0
.10	0	0	0	0	1	17	106	235	263	234	202	175	152	120	104	93	85	79	73	66	61	58	54	49	44	42	41	39	35	31	28	0
.20	0	0	0	0	0	0	12	75	182	236	234	213	188	144	116	101	91	84	78	70	63	59	55	50	45	43	41	40	36	31	28	0
.30	0	0	0	0	0	0	8	52	138	203	224	217	197	154	123	105	94	86	79	71	64	59	55	51	46	43	42	40	36	32	28	0
.40	0	0	0	0	0	0	5	37	105	170	206	213	203	164	131	110	97	88	81	72	65	60	56	51	46	43	42	40	36	32	28	0
.50	0	0	0	0	0	0	0	4	26	78	140	184	203	191	155	126	107	95	86	76	69	62	57	53	48	44	42	41	37	33	28	0
.75	0	0	0	0	0	0	0	1	10	34	73	117	153	184	173	146	122	105	94	82	73	64	58	54	49	45	43	41	37	33	28	0
1.0	0	0	0	0	0	0	0	0	0	0	4	17	42	114	168	178	159	134	114	94	82	70	61	57	52	47	44	42	39	35	28	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	10	44	98	144	163	157	130	105	84	69	61	56	52	47	44	40	36	29	6
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	44	87	127	153	141	110	83	69	61	56	51	47	42	38	30	17
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	16	42	97	138	145	107	82	68	60	55	51	43	40	32	25
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	27	71	127	139	105	81	68	60	55	46	41	33	27

RAINFALL TYPE = II * * * TC = 0.3 HR * * * SHEET 3 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

TRVL TIME (hr) — HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 0.4 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	18	25	36	77	141	271	468	592	574	431	298	216	163	104	77	63	55	49	44	38	34	31	28	25	22	21	20	18	16	14	12	0
.10	18	24	34	67	116	219	385	523	557	473	357	263	196	119	84	67	57	51	46	39	35	32	29	25	22	21	20	19	16	14	12	0
.20	15	20	28	44	59	97	179	316	454	523	489	401	309	178	112	81	65	56	49	42	37	33	30	26	23	21	20	19	17	14	12	0
.30	15	20	27	41	53	82	147	260	389	478	486	429	349	210	129	89	69	58	51	43	38	33	30	27	24	21	20	19	17	14	12	0
.40	13	17	23	33	38	48	71	121	214	331	429	467	442	308	189	120	85	66	56	47	41	35	31	28	24	22	20	19	17	15	12	0
.50	12	16	22	31	36	44	62	102	176	279	379	438	440	339	218	137	94	71	59	49	42	35	31	28	25	22	21	19	17	15	12	0
.75	10	13	17	24	26	30	35	45	65	106	170	251	326	393	341	245	164	112	81	59	48	39	33	30	26	23	21	20	18	15	12	0
1.0	8	10	13	17	19	21	24	27	31	37	50	75	118	251	360	376	292	205	138	83	60	45	36	32	28	25	22	21	18	16	12	1
1.5	6	7	9	12	13	14	15	17	19	21	23	26	31	56	121	224	311	333	293	192	115	66	45	36	31	28	25	22	19	17	13	4
2.0	4	5	6	8	8	9	10	10	11	12	14	15	16	20	27	43	85	159	243	306	264	154	74	47	37	32	28	25	21	18	14	9
2.5	2	3	4	5	6	6	7	7	8	9	9	10	11	13	16	20	27	46	85	184	285	262	147	74	47	37	32	28	22	19	15	11
3.0	1	2	2	3	4	4	4	5	5	6	6	7	7	8	10	12	14	17	23	47	109	227	268	160	83	50	38	32	25	21	16	11

IA/P = 0.30 * * * TC = 0.4 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	4	26	113	296	480	495	413	306	234	186	127	100	84	74	67	61	54	49	45	41	37	33	31	29	28	25	21	19	0
.10	0	0	0	0	2	18	81	224	395	462	430	347	272	172	121	96	82	73	66	57	51	46	42	38	34	31	30	28	25	22	19	0
.20	0	0	0	0	2	13	59	169	320	414	424	373	305	196	134	103	85	75	67	59	52	47	43	39	34	32	30	29	25	22	19	0
.30	0	0	0	0	0	1	9	42	127	255	361	403	383	274	181	127	99	83	73	63	55	48	44	40	36	32	30	29	26	23	19	0
.40	0	0	0	0	0	1	6	30	94	202	308	372	379	298	203	141	106	87	76	65	56	49	44	40	36	32	31	29	26	23	19	0
.50	0	0	0	0	0	0	0	4	21	70	158	258	334	364	270	187	133	102	85	70	60	51	46	41	37	33	31	30	26	23	19	0
.75	0	0	0	0	0	0	0	2	8	30	76	145	219	321	305	241	177	130	102	78	65	55	47	43	38	34	32	30	27	24	19	0
1.0	0	0	0	0	0	0	0	0	0	1	4	15	42	150	267	308	272	209	154	103	79	62	51	45	41	37	33	31	28	25	19	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	10	51	136	226	274	263	195	131	85	62	51	45	41	36	33	29	26	20	6
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	31	86	162	252	239	162	93	64	52	45	41	37	31	28	21	15
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	33	112	202	235	155	92	64	52	45	41	33	29	23	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	21	76	182	221	148	90	63	51	45	36	31	24	18

IA/P = 0.50 * * * TC = 0.4 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	7	59	168	245	257	213	186	163	128	109	96	88	81	75	67	62	58	54	50	45	43	41	39	35	31	28	0
.10	0	0	0	0	0	0	5	41	125	205	240	222	198	154	123	106	94	86	79	71	64	60	56	51	46	43	42	40	36	32	28	0
.20	0	0	0	0	0	0	3	28	93	168	216	220	205	164	131	110	97	88	81	72	65	60	56	51	46	43	42	40	36	32	28	0
.30	0	0	0	0	0	0	0	2	20	69	135	189	209	192	155	126	107	95	86	77	69	62	57	53	48	44	42	41	37	33	28	0
.40	0	0	0	0	0	0	0	1	14	50	106	161	193	202	163	133	112	98	89	78	70	62	58	53	48	44	42	41	37	33	28	0
.50	0	0	0	0	0	0	0	1	9	37	83	135	174	194	171	140	117	102	91	80	71	63	58	54	49	45	43	41	37	33	28	0
.75	0	0	0	0	0	0	0	0	0	3	15	40	76	147	177	169	146	124	107	90	79	68	60	56	51	47	43	42	38	34	28	0
1.0	0	0	0	0	0	0	0	0	0	0	1	7	21	78	141	173	167	146	125	101	86	73	63	58	53	48	45	42	39	35	28	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	26	71	121	153	159	139	113	89	72	63	57	53	48	44	40	37	29	7
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	45	86	138	150	125	93	74	64	58	53	48	42	39	31	20
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	17	59	112	143	121	91	73	63	57	53	45	40	32	26
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	40	101	138	117	90	73	63	57	48	42	34	27

RAINFALL TYPE = II * * * TC = 0.4 HR * * * SHEET 4 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10														* * * TC = 0.5 HR * * *														IA/P = 0.10				
0.0	17	23	32	57	94	170	308	467	529	507	402	297	226	140	96	74	61	53	47	41	36	32	29	26	23	21	20	19	16	14	12	0
.10	16	22	30	51	80	140	252	395	484	499	434	343	265	162	108	80	65	55	49	42	36	33	29	26	23	21	20	19	16	14	12	0
.20	14	19	25	38	47	69	116	207	332	434	477	449	378	238	149	101	77	62	53	45	39	34	30	27	24	22	20	19	17	14	12	0
.30	13	18	24	35	43	60	97	170	278	382	446	448	401	270	171	114	83	66	56	46	40	34	31	27	24	22	20	19	17	15	12	0
.40	12	15	21	29	33	40	53	83	141	233	332	408	434	361	243	157	107	79	64	51	43	36	32	28	25	22	21	20	17	15	12	0
.50	11	15	20	28	31	37	48	71	118	194	286	367	412	378	271	178	119	86	68	53	44	37	32	29	25	23	21	20	17	15	12	0
.75	9	11	14	19	21	24	27	31	37	49	74	118	182	319	374	328	244	169	117	76	56	43	35	31	28	25	22	21	18	16	12	1
1.0	7	9	12	16	17	19	21	24	27	32	40	55	83	188	309	359	322	245	172	102	68	49	38	32	29	26	23	21	19	16	12	1
1.5	5	7	8	11	12	13	14	15	17	19	21	23	27	43	89	175	269	322	309	225	140	77	49	38	32	29	25	23	20	17	13	5
2.0	3	4	6	7	8	8	9	10	10	11	12	14	15	18	23	35	65	123	202	297	280	181	88	52	39	33	29	26	21	19	14	10
2.5	2	3	4	5	5	6	6	7	7	8	9	9	10	12	15	18	24	36	66	150	244	278	171	87	52	39	33	29	23	20	15	11
3.0	1	1	2	3	3	4	4	4	5	5	6	6	7	8	9	11	13	16	20	37	86	198	263	182	96	56	40	33	26	21	16	11
IA/P = 0.30														* * * TC = 0.5 HR * * *														IA/P = 0.30				
0.0	0	0	0	1	9	53	157	314	433	439	379	299	237	159	118	95	81	71	65	56	50	46	42	38	34	31	30	28	25	22	19	0
.10	0	0	0	0	1	6	37	117	248	372	416	391	330	218	150	113	92	79	70	60	53	47	43	39	35	32	30	29	26	22	19	0
.20	0	0	0	0	1	4	26	87	194	313	382	388	349	244	167	122	97	82	72	62	54	48	43	39	35	32	30	29	26	22	19	0
.30	0	0	0	0	0	0	3	19	64	151	259	341	372	316	223	156	117	94	80	67	58	50	45	41	36	33	31	29	26	23	19	0
.40	0	0	0	0	0	0	2	13	47	116	211	298	354	328	245	172	127	100	83	69	59	51	45	41	37	33	31	29	26	23	19	0
.50	0	0	0	0	0	0	0	1	9	34	89	170	255	341	303	225	161	120	96	76	64	54	47	42	38	34	31	30	27	24	19	0
.75	0	0	0	0	0	0	0	1	4	14	41	89	152	270	305	268	207	155	118	87	70	57	48	44	39	35	32	30	27	24	19	0
1.0	0	0	0	0	0	0	0	0	0	0	2	7	22	98	212	295	285	237	181	120	88	67	53	46	42	38	34	31	28	25	19	2
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	30	95	183	249	265	217	152	96	66	53	46	41	37	34	30	26	20	8
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	18	59	125	221	245	182	105	69	54	47	42	38	32	28	22	16
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	21	84	174	230	172	103	69	54	46	42	34	30	23	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	56	157	217	163	101	68	53	46	37	31	25	18
IA/P = 0.50														* * * TC = 0.5 HR * * *														IA/P = 0.50				
0.0	0	0	0	0	0	2	26	89	170	217	229	200	179	144	119	104	93	85	78	70	64	59	55	51	46	43	41	40	36	32	28	0
.10	0	0	0	0	0	0	1	18	65	135	190	216	205	170	137	115	101	91	83	74	67	61	56	52	47	44	42	40	36	32	28	0
.20	0	0	0	0	0	0	1	12	47	106	162	198	203	178	145	121	105	94	85	76	68	61	57	52	48	44	42	40	37	32	28	0
.30	0	0	0	0	0	0	0	1	8	34	82	135	177	194	168	139	117	102	92	80	71	63	58	54	49	45	43	41	37	33	28	0
.40	0	0	0	0	0	0	0	0	6	25	63	111	155	189	174	146	122	106	94	82	73	64	58	54	50	45	43	41	37	33	28	0
.50	0	0	0	0	0	0	0	0	4	18	48	90	133	184	177	152	128	110	97	84	74	65	59	55	50	45	43	41	38	33	28	0
.75	0	0	0	0	0	0	0	0	1	7	22	47	80	142	169	164	144	124	108	91	79	68	61	56	51	47	44	42	38	34	28	0
1.0	0	0	0	0	0	0	0	0	0	0	1	3	11	51	112	155	166	154	134	109	91	76	65	59	54	49	45	43	39	35	28	2
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	50	97	136	154	145	121	95	75	64	58	54	49	45	41	37	29	10
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	18	47	86	134	146	125	94	75	64	58	53	49	42	39	31	21
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	11	44	95	140	127	97	77	65	58	54	45	41	33	26
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	29	86	135	122	95	76	65	58	49	43	35	27

RAINFALL TYPE = II * * * TC = 0.5 HR * * * SHEET 5 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 0.75 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	13	18	24	36	46	68	115	194	294	380	424	410	369	252	172	123	93	74	61	49	41	35	31	27	24	22	20	19	17	15	12	0
.10	13	17	23	34	42	59	97	162	250	337	395	405	381	279	191	135	100	79	65	51	42	36	31	28	25	22	21	19	17	15	12	0
.20	11	15	20	28	32	39	52	82	135	211	295	362	391	351	255	178	127	95	75	57	46	38	32	29	26	23	21	20	17	15	12	0
.30	11	14	19	26	30	36	47	70	113	179	256	326	379	360	277	196	140	103	80	60	48	38	33	29	26	23	21	20	18	15	12	0
.40	10	12	16	22	25	28	33	42	61	96	151	221	291	367	336	255	182	131	98	69	54	42	34	30	27	24	22	20	18	16	12	0
.50	9	12	16	21	24	27	31	39	53	82	128	190	258	358	343	274	200	144	106	74	56	43	35	30	27	24	22	20	18	16	12	0
.75	8	10	13	17	18	21	23	26	31	39	55	82	122	230	314	329	281	217	161	104	72	51	38	33	29	26	23	21	19	16	12	1
1.0	6	8	10	13	14	15	17	19	21	23	27	32	42	89	177	272	319	303	249	163	105	66	45	36	31	27	24	22	19	17	13	3
1.5	4	6	7	9	10	10	11	12	14	15	16	18	20	27	46	90	163	241	295	275	204	119	66	45	35	31	27	24	20	18	13	7
2.0	3	4	5	6	7	7	8	9	9	10	11	12	13	16	20	28	48	89	151	245	274	213	115	65	44	35	30	27	22	19	14	10
2.5	1	2	3	4	4	5	5	6	6	7	7	8	8	10	12	14	17	24	37	86	170	260	219	127	71	47	36	31	24	20	16	11
3.0	1	1	2	3	3	3	4	4	4	5	5	5	6	7	8	10	11	14	17	30	64	157	247	205	122	70	46	36	27	22	17	12

IA/P = 0.30 * * * TC = 0.75 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	1	6	30	86	174	266	326	348	328	246	181	138	110	92	79	66	57	49	44	40	36	32	31	29	26	23	19	0
.10	0	0	0	0	0	1	4	22	65	137	223	292	329	303	228	170	131	106	89	73	61	52	46	41	37	33	31	29	26	23	19	0
.20	0	0	0	0	0	0	3	15	48	108	185	256	305	321	245	184	141	112	93	75	63	53	46	42	37	34	31	30	27	23	19	0
.30	0	0	0	0	0	0	2	11	36	84	151	221	277	308	260	199	152	120	98	78	65	54	47	42	38	34	31	30	27	23	19	0
.40	0	0	0	0	0	0	0	1	8	27	65	122	188	286	301	243	187	144	114	87	71	57	48	43	39	35	32	30	27	24	19	1
.50	0	0	0	0	0	0	0	1	6	20	50	98	158	263	292	254	200	155	122	91	74	59	49	44	40	35	32	30	27	24	19	1
.75	0	0	0	0	0	0	0	0	0	2	8	23	51	140	231	269	253	211	167	119	90	68	53	46	42	37	34	31	28	25	19	2
1.0	0	0	0	0	0	0	0	0	0	0	0	1	4	29	96	186	249	261	231	169	120	84	61	50	44	40	36	33	29	26	20	5
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	34	91	163	220	241	197	131	83	61	50	44	40	35	31	27	21	12
2.0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	2	11	36	85	174	226	200	127	82	60	49	44	39	32	29	22	17
2.5	o	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	37	105	196	214	135	87	62	51	44	36	31	24	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	24	96	205	189	130	85	62	50	39	32	26	18

IA/P = 0.50 * * * TC = 0.75 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	0	2	16	45	92	137	166	185	170	146	125	110	98	89	79	70	63	58	53	48	44	42	41	37	33	28	0
.10	0	0	0	0	0	0	0	1	11	34	73	115	149	180	163	141	122	107	96	84	74	65	59	54	50	45	43	41	38	33	28	0
.20	0	0	0	0	0	0	0	1	8	25	57	96	131	173	166	146	126	111	99	86	76	66	59	55	50	46	43	41	38	34	28	0
.30	0	0	0	0	0	0	0	0	1	5	18	44	79	143	170	160	141	122	108	92	81	69	61	56	52	47	44	42	38	34	28	1
.40	0	0	0	0	0	0	0	0	0	4	14	34	64	127	166	162	145	127	111	95	82	70	62	57	52	47	44	42	38	34	28	1
.50	0	0	0	0	0	0	0	0	0	0	2	10	26	82	138	162	157	140	123	103	88	75	64	58	53	49	45	43	39	35	28	2
.75	0	0	0	0	0	0	0	0	0	0	1	4	12	47	98	139	154	148	135	113	96	80	67	60	55	50	46	43	39	36	29	3
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	30	73	119	146	151	134	113	91	74	63	58	53	48	45	41	37	29	7
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	30	66	105	143	143	117	90	73	63	57	52	48	42	39	30	18
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	30	77	121	137	114	88	72	63	57	52	44	40	32	25
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	19	55	111	132	111	87	71	62	56	47	42	34	27
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12	51	112	128	108	86	71	62	51	44	36	27

RAINFALL TYPE = II * * * TC = 0.75 HR * * * SHEET 6 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 1.0 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	11	15	20	29	35	47	72	112	168	231	289	329	357	313	239	175	133	103	83	63	50	40	33	29	26	23	21	20	17	15	12	0
.10	10	13	17	24	27	33	42	62	95	144	202	260	306	340	293	222	165	126	98	72	56	43	35	30	27	24	22	20	18	15	12	0
.20	10	13	17	23	26	30	38	54	82	123	176	232	281	332	303	238	179	136	105	76	59	45	35	30	27	24	22	20	18	16	12	1
.30	9	12	16	22	24	28	35	48	70	105	152	205	256	323	310	254	193	146	113	81	61	46	36	31	27	24	22	20	18	16	12	1
.40	8	11	14	19	21	23	27	32	42	61	91	132	181	276	318	294	237	181	138	95	70	51	39	32	28	25	23	21	18	16	12	1
.50	8	10	13	18	20	22	25	30	38	53	78	114	159	253	311	300	251	195	149	102	74	53	40	33	29	25	23	21	18	16	12	1
.75	7	8	11	14	16	17	19	21	25	30	38	53	76	146	228	284	293	256	208	143	99	66	46	36	31	27	24	22	19	17	13	2
1.0	5	7	8	11	12	13	14	16	17	19	22	25	31	57	111	188	256	286	272	208	144	90	56	41	33	29	26	23	20	17	13	4
1.5	4	5	6	8	8	9	10	11	12	13	14	15	17	22	33	59	107	171	231	268	235	157	88	56	41	33	29	25	21	18	14	8
2.0	2	3	4	5	5	6	6	7	7	8	9	9	10	12	15	19	27	44	78	157	231	252	167	96	59	42	34	29	23	20	15	11
2.5	1	2	2	3	4	4	4	5	5	6	6	7	7	8	10	12	15	19	27	58	120	214	241	159	94	59	42	34	26	21	16	11
3.0	0	1	1	2	2	3	3	3	4	4	4	5	5	6	7	8	10	12	14	22	44	113	214	231	152	91	58	42	29	23	17	12

IA/P = 0.30 * * * TC = 1.0 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	1	4	16	42	83	137	195	243	271	292	227	178	143	117	98	79	66	55	47	42	38	34	31	30	27	23	19	0
.10	0	0	0	0	0	0	3	12	32	66	113	168	218	279	260	213	169	136	113	88	72	59	49	43	39	35	32	30	27	24	19	1
.20	0	0	0	0	0	0	2	9	24	52	93	143	193	271	271	225	180	145	119	92	75	60	50	44	39	35	32	30	27	24	19	1
.30	0	0	0	0	0	0	1	6	18	41	75	120	169	246	264	234	191	153	125	96	78	62	51	44	40	36	33	31	27	24	19	1
.40	0	0	0	0	0	0	0	1	4	14	32	61	100	190	251	259	222	181	146	109	86	67	53	46	41	37	33	31	28	25	19	2
,50	0	0	0	0	0	0	0	1	3	10	24	49	83	168	237	254	230	191	155	115	90	69	54	47	42	37	34	31	28	25	19	2
,75	0	0	0	0	0	0	0	0	0	1	4	12	25	76	150	213	239	228	198	149	112	82	61	50	44	39	35	32	29	26	20	4
1.0	0	0	0	0	0	0	0	0	0	0	0	1	2	15	51	113	182	226	234	197	150	104	72	56	47	42	38	34	30	27	20	7
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	18	51	104	162	220	210	158	102	71	56	47	42	37	31	28	22	13
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	20	49	121	187	209	152	100	70	55	47	41	34	29	23	17
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	32	87	171	199	146	98	69	54	46	37	31	24	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	62	158	192	151	103	73	56	41	34	26	18

IA/P = 0.50 * * * TC = 1.0 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	0	1	7	21	42	71	101	126	160	154	138	123	110	100	87	77	67	60	55	50	46	43	41	38	34	28	1
.10	0	0	0	0	0	0	0	1	5	15	33	58	87	134	156	149	134	120	108	93	82	71	62	57	52	47	44	42	38	34	28	1
.20	0	0	0	0	0	0	0	1	4	12	26	48	74	123	153	153	137	123	111	95	84	72	63	57	52	47	44	42	38	34	28	1
.30	0	0	0	0	0	0	0	0	3	9	20	38	62	111	143	150	140	127	114	98	86	73	63	58	53	48	45	42	39	35	28	1
.40	0	0	0	0	0	0	0	0	0	2	6	16	31	75	120	145	148	137	123	106	91	77	66	59	54	49	45	43	39	35	29	2
.50	0	0	0	0	0	0	0	0	0	1	5	12	25	64	109	139	146	139	127	108	94	79	67	60	55	50	46	43	39	36	29	3
.75	0	0	0	0	0	0	0	0	0	0	2	5	12	39	78	115	136	140	134	117	101	84	70	62	56	51	47	44	40	36	29	4
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	26	59	96	125	139	133	117	97	78	66	59	54	49	46	41	37	29	8
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	26	54	86	123	133	119	95	77	66	59	54	49	43	39	31	17
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	25	64	104	129	116	93	76	65	58	53	45	41	33	24
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	34	84	125	117	96	78	66	59	49	43	35	27
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	32	89	122	114	94	77	66	53	45	37	27

RAINFALL TYPE = II * * * TC = 1.0 HR * * * SHEET 7 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution —continued

HYDROGRAPH TIME(HOURS)

IA/P = 0.10 * * * TC = 1.25 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	10	13	18	25	29	38	54	81	118	163	213	256	284	311	266	212	163	129	104	78	61	47	37	31	27	24	22	20	18	16	12	1
.10	10	13	17	23	27	34	47	69	102	143	189	234	267	297	274	226	175	138	111	82	64	48	38	31	27	24	22	20	18	16	12	1
.20	9	11	15	20	22	26	31	42	60	88	124	168	212	280	292	261	212	166	131	95	72	53	40	33	28	25	23	21	18	16	12	1
.30	8	11	14	19	21	24	29	38	53	76	108	148	190	263	288	268	224	177	140	101	76	55	41	34	29	25	23	21	18	16	12	2
.40	8	10	13	18	20	23	27	34	46	66	94	130	170	245	282	273	235	188	149	107	80	58	42	34	29	26	23	21	19	16	12	2
.50	7	9	12	16	17	19	22	25	31	41	58	82	114	190	256	279	262	222	178	127	93	65	46	36	31	27	24	22	19	17	13	2
.75	6	8	10	14	15	17	19	21	25	31	41	56	78	139	207	254	265	245	208	152	110	75	51	39	32	28	25	22	19	17	13	3
1.0	5	6	8	10	11	13	14	15	17	19	22	26	33	60	109	173	230	261	255	208	153	100	64	46	36	30	26	24	20	18	13	5
1.5	3	4	5	7	7	8	9	9	10	11	12	13	15	19	27	45	79	130	186	247	239	180	108	68	48	37	31	27	22	19	14	10
2.0	2	3	4	5	6	6	7	7	8	8	9	10	11	13	16	22	35	59	98	171	236	236	156	95	62	44	35	30	23	20	15	11
2.5	1	2	2	3	4	4	4	5	5	5	6	6	7	8	10	12	14	19	28	58	114	197	226	163	102	65	46	36	26	21	16	11
3.0	0	1	1	2	2	2	2	3	3	3	4	4	4	5	6	7	9	10	13	19	35	88	184	218	169	109	70	49	31	24	18	12

IA/P = 0.30 * * * TC = 1.25 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	2	9	25	50	86	130	174	208	253	235	201	164	136	115	92	76	61	51	44	39	35	32	30	27	24	19	1
.10	0	0	0	0	0	0	1	6	19	40	71	110	153	217	247	227	191	157	131	103	84	66	53	46	41	36	33	31	28	24	19	2
.20	0	0	0	0	0	0	1	4	14	31	58	93	133	202	239	231	199	165	138	108	87	68	55	47	41	37	33	31	28	25	19	2
.30	0	0	0	0	0	0	0	1	3	10	24	46	77	152	210	236	222	190	158	122	97	74	58	49	43	38	34	32	28	25	20	3
.40	0	0	0	0	0	0	0	0	2	8	19	37	64	134	196	232	225	198	166	127	101	77	59	50	43	38	35	32	28	25	20	3
.50	0	0	0	0	0	0	0	0	0	2	6	14	30	82	151	206	228	217	189	146	113	85	64	52	45	40	36	33	29	26	20	5
.75	0	0	0	0	0	0	0	0	0	1	2	7	15	49	105	164	205	218	205	166	129	95	69	55	47	41	37	33	29	26	20	6
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	32	77	134	185	214	203	166	120	83	63	52	45	39	35	30	27	21	10
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	33	72	121	184	203	171	117	82	62	51	44	39	32	29	22	15
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	21	67	132	194	174	123	86	64	52	45	35	31	24	18
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	46	121	187	166	119	84	63	52	39	32	25	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	44	129	180	160	116	83	63	44	35	27	18

IA/P = 0.50 * * * TC = 1.25 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	0	1	5	13	26	44	68	91	125	142	142	128	117	107	94	83	72	63	57	52	47	44	42	38	34	28	2
.10	0	0	0	0	0	0	0	0	3	10	20	36	57	100	129	140	136	125	114	100	88	76	65	59	54	49	45	43	39	35	29	3
.20	0	0	0	0	0	0	0	0	2	7	16	30	48	90	122	139	139	127	117	102	90	77	66	60	54	49	45	43	39	35	29	3
.30	0	0	0	0	0	0	0	0	0	2	5	12	24	59	98	126	137	134	125	109	96	82	69	61	56	51	46	44	40	36	29	4
.40	0	0	0	0	0	0	0	0	0	1	4	10	19	51	89	119	134	136	127	112	98	83	70	62	56	51	47	44	40	36	29	5
.50	0	0	0	0	0	0	0	0	0	1	3	7	15	43	79	112	131	135	129	114	100	85	71	63	57	52	47	44	40	36	29	6
.75	0	0	0	0	0	0	0	0	0	0	0	1	3	15	39	71	102	123	130	125	112	94	78	67	60	54	49	46	41	37	29	9
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	17	40	71	101	121	129	121	103	84	71	62	56	51	47	42	38	30	13
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	26	51	92	119	125	105	86	72	63	57	52	44	40	32	23
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	11	35	72	112	122	103	85	71	63	56	47	42	34	26
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	24	66	111	119	101	83	71	62	51	44	36	27
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	23	71	110	116	99	82	70	55	46	37	27

RAINFALL TYPE = II * * * TC = 1.25 HR * * * SHEET 8 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

IA/P = 0.10 * * * TC = 1.5 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	9	11	15	21	25	31	41	58	82	112	147	184	216	255	275	236	198	159	129	98	76	57	43	35	30	25	23	21	18	16	12	1
.10	8	10	13	18	20	23	28	37	51	72	98	131	166	226	265	254	226	187	151	113	86	63	46	37	31	26	23	21	19	16	13	2
.20	8	10	13	17	19	22	26	33	45	63	87	116	149	212	259	259	233	197	160	119	90	66	48	38	32	27	24	22	19	16	13	2
.30	7	9	12	16	18	21	24	30	40	55	76	103	134	197	244	255	238	206	169	125	95	68	49	38	32	27	24	22	19	17	13	2
.40	7	8	11	14	15	17	19	23	28	36	49	67	91	151	208	247	252	230	196	146	109	77	54	41	34	29	25	22	19	17	13	3
.50	6	8	10	13	15	16	18	21	26	33	43	59	80	136	194	238	249	235	204	154	115	81	56	42	34	29	25	23	20	17	13	3
.75	5	7	8	11	12	13	14	16	18	21	25	32	42	76	125	179	222	240	233	193	148	102	67	48	38	32	27	24	20	18	13	5
1.0	4	5	7	8	9	10	11	12	13	14	16	18	22	34	59	101	152	201	236	230	193	135	86	59	44	35	30	26	21	18	14	7
1.5	3	4	5	6	6	7	8	8	9	10	11	12	13	16	22	34	58	95	141	203	226	197	131	84	58	43	35	29	23	20	15	10
2.0	1	2	3	4	4	5	5	6	6	7	7	8	9	10	12	16	22	34	56	110	172	218	187	126	82	57	43	34	25	21	16	11
2.5	1	1	2	2	3	3	3	4	4	4	5	5	6	7	8	9	11	14	18	34	69	141	210	190	133	87	60	44	30	23	17	12
3.0	0	0	1	1	2	2	2	2	3	3	3	3	4	5	5	6	8	9	11	16	27	66	149	204	181	128	85	58	35	25	18	12

IA/P = 0.30 * * * TC = 1.5 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	1	6	15	31	53	80	112	144	193	225	208	186	157	134	108	89	70	56	48	42	37	34	31	28	25	20	2
.10	0	0	0	0	0	0	1	4	12	25	43	68	97	157	198	219	203	178	151	120	98	77	60	50	44	38	35	32	28	25	20	3
.20	0	0	0	0	0	0	0	1	3	9	19	35	57	114	168	201	213	196	171	135	108	84	64	53	46	40	36	33	29	26	20	4
.30	0	0	0	0	0	0	0	1	2	7	15	29	48	100	155	193	210	200	177	140	113	87	66	54	46	41	36	33	29	26	20	5
.40	0	0	0	0	0	0	0	0	2	5	12	23	39	87	141	184	207	202	182	146	117	89	68	55	47	41	36	33	29	26	20	5
,50	0	0	0	0	0	0	0	0	0	1	4	9	18	51	101	153	190	205	197	164	131	99	73	58	49	43	38	34	30	26	20	7
.75	0	0	0	0	0	0	0	0	0	0	2	4	9	30	68	116	160	189	197	179	147	110	80	62	52	45	39	35	30	27	21	8
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	20	49	92	138	175	195	178	137	97	72	57	48	42	37	31	28	21	12
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	21	47	85	145	187	178	133	95	71	57	48	42	34	29	23	16
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	13	45	97	162	180	138	99	74	58	49	38	32	25	18
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	31	89	161	174	133	97	72	58	42	34	26	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	29	98	160	169	129	95	71	48	37	28	19

IA/P = 0.50 * * * TC = 1.5 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
.0	0	0	0	0	0	0	0	3	8	16	27	42	59	92	116	128	130	121	112	100	90	78	67	60	55	50	46	43	39	35	29	4
.10	0	0	0	0	0	0	0	2	6	12	22	35	51	84	110	125	128	123	114	102	91	79	68	61	55	50	46	43	39	35	29	4
.20	0	0	0	0	0	0	0	0	1	4	10	18	29	60	91	114	126	128	120	108	97	83	71	63	57	52	47	44	40	36	29	5
.30	0	0	0	0	0	0	0	0	1	3	8	14	24	52	83	108	123	126	122	110	98	85	72	63	57	52	48	44	40	36	29	6
.40	0	0	0	0	0	0	0	0	0	1	2	6	12	31	60	90	112	124	126	116	104	90	75	66	59	54	49	45	41	37	29	8
.50	0	0	0	0	0	0	0	0	0	0	2	4	9	26	53	83	106	121	125	118	106	91	77	67	60	54	49	46	41	37	29	8
.75	0	0	0	0	0	0	0	0	0	0	1	2	5	16	36	62	88	108	119	122	112	97	81	69	62	56	51	47	42	38	30	11
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	26	49	75	98	118	121	108	90	76	66	59	54	49	43	39	31	16
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	11	25	45	80	107	118	106	89	75	65	59	53	45	41	32	23
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	32	63	100	115	104	87	74	65	58	48	42	34	26
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	16	48	94	113	105	89	76	66	53	45	36	27
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	15	54	96	111	103	88	75	58	48	38	28

RAINFALL TYPE = II * * * TC = 1.5 HR * * * SHEET 9 OF 10

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution—continued

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10														* * * TC = 2.0 HR * * *														IA/P = 0.10				
0.0	7	9	12	16	18	21	27	36	49	64	82	104	127	171	201	226	208	193	171	132	105	79	58	45	36	30	26	23	20	17	13	3
.10	6	8	10	14	15	17	20	25	33	43	57	74	94	139	179	204	218	205	188	150	118	88	63	48	38	32	27	24	20	17	13	4
.20	6	8	10	13	14	16	19	23	29	39	51	66	84	128	169	198	213	207	192	157	123	91	65	49	39	33	28	24	20	17	13	4
.30	6	7	9	12	14	15	18	21	27	35	45	59	76	117	159	191	211	208	196	163	128	95	68	51	40	33	28	25	20	18	13	4
.40	5	6	8	11	12	13	15	17	20	24	31	41	53	87	128	167	197	209	205	180	145	106	75	55	43	35	30	26	21	18	14	5
.50	5	6	8	10	11	13	14	16	18	22	28	37	48	78	118	158	190	208	208	185	151	111	77	57	44	36	30	26	21	18	14	5
.75	4	6	7	9	10	11	12	13	15	18	22	27	35	58	91	129	164	191	202	194	167	125	87	63	48	38	32	27	22	18	14	6
1.0	3	4	6	7	8	8	9	10	11	12	14	16	18	28	46	74	110	147	178	201	193	156	108	76	56	43	35	30	23	19	14	8
1.5	2	3	3	5	5	5	6	6	7	8	8	9	10	12	16	23	36	57	86	137	178	195	160	113	79	58	45	36	26	21	16	11
2.0	1	2	2	3	3	4	4	4	5	5	6	6	7	8	10	12	16	23	35	67	112	169	190	154	110	78	57	44	30	23	17	11
2.5	0	1	1	2	2	2	3	3	3	4	4	4	5	6	7	8	9	12	16	28	52	105	170	185	149	107	76	56	35	26	18	12
3.0	0	0	1	1	1	1	1	2	2	2	2	3	3	3	4	5	6	7	8	12	18	41	99	161	180	152	112	80	45	30	19	12
IA/P = 0.30														* * * TC = 2.0 HR * * *														IA/P = 0.30				
0.0	0	0	0	0	0	1	3	8	15	25	38	54	74	115	148	168	185	170	159	131	110	89	70	57	49	42	38	34	29	26	20	5
.10	0	0	0	0	0	0	0	2	6	12	21	32	47	85	124	153	169	180	168	145	120	96	75	60	51	44	39	35	30	26	20	6
.20	0	0	0	0	0	0	0	2	4	10	17	27	41	75	114	146	165	175	170	149	124	99	76	62	52	45	39	35	30	27	21	6
.30	0	0	0	0	0	0	0	0	1	3	7	14	23	49	86	122	151	170	174	160	136	107	82	66	54	47	41	37	31	27	21	8
.40	0	0	0	0	0	0	0	0	1	2	6	11	19	43	77	113	144	165	173	163	140	111	85	67	55	47	41	37	31	27	21	8
.50	0	0	0	0	0	0	0	0	1	2	4	9	16	37	68	104	136	160	171	165	144	114	87	69	56	48	42	37	31	27	21	9
.75	0	0	0	0	0	0	0	0	0	0	1	2	5	15	34	62	96	127	152	167	160	132	100	77	62	52	45	40	32	28	22	11
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	24	48	79	111	150	166	153	118	90	71	58	49	43	34	29	23	14
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	24	45	88	130	161	148	115	88	70	57	48	37	31	24	17
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	32	68	122	157	143	113	87	68	56	42	34	26	18
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	16	51	114	153	144	116	89	70	49	38	27	19
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	15	59	118	150	140	113	88	57	42	29	19
IA/P = 0.50														* * * TC = 2.0 HR * * *														IA/P = 0.50				
0.0	0	0	0	0	0	0	0	1	4	8	13	20	28	51	73	92	104	111	112	106	97	86	75	66	60	54	49	46	41	37	30	7
.10	0	0	0	0	0	0	0	1	3	6	11	17	24	45	68	87	101	109	112	107	98	88	76	67	60	55	50	46	41	37	30	8
.20	0	0	0	0	0	0	0	1	2	5	9	14	21	40	62	82	98	107	111	108	100	89	77	68	61	55	50	47	41	37	30	8
.30	0	0	0	0	0	0	0	0	0	2	4	7	12	26	46	67	86	100	108	111	104	93	80	70	63	57	52	48	42	38	30	10
.40	0	0	0	0	0	0	0	0	0	1	3	6	10	22	41	62	81	96	106	110	105	94	81	71	63	57	52	48	42	38	30	11
.50	0	0	0	0	0	0	0	0	0	0	1	2	4	13	27	46	67	85	99	110	108	98	85	74	66	59	54	49	43	39	31	13
.75	0	0	0	0	0	0	0	0	0	0	0	1	2	7	18	33	52	71	88	104	108	102	89	77	68	61	55	50	44	39	31	15
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	25	43	62	87	103	108	97	84	73	65	59	53	45	41	32	20
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	12	24	48	74	99	106	95	83	72	64	58	48	43	34	25
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	17	37	69	99	104	94	82	72	64	52	45	36	27
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	27	65	95	102	95	83	73	58	49	38	28
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	32	68	95	101	93	82	64	52	40	28

RAINFALL TYPE = II * * * TC = 2.0 HR * * * SHEET 10 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution

HYDROGRAPH TIME (HOURS)

IA/P = 0.10 * * * TC = 0.1 HR * * *

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	29	38	57	172	241	425	662	531	345	265	191	130	101	83	68	62	58	54	50	44	41	37	32	27	23	21	19	16	14	13	11	0
.10	26	32	47	98	147	210	353	559	540	410	313	231	164	101	80	67	61	57	53	47	43	39	34	28	24	22	19	17	14	13	11	0
.20	25	31	44	86	127	182	296	471	517	446	357	273	200	117	86	70	63	58	54	48	44	39	34	29	24	22	20	17	14	13	11	0
.30	22	28	37	57	76	110	158	250	398	477	457	390	312	178	111	83	69	62	57	51	45	41	36	31	25	23	20	18	15	13	11	0
.40	21	27	35	53	68	96	137	213	336	430	448	410	345	210	128	90	72	64	58	52	46	41	36	31	26	23	20	18	15	13	11	0
.50	19	24	30	43	49	62	85	120	182	284	382	426	415	305	188	120	86	71	63	55	49	43	38	33	27	24	21	19	15	14	11	0
.75	17	22	27	37	41	49	62	84	120	181	258	327	375	353	264	177	120	88	72	59	52	45	39	34	29	25	22	20	15	14	11	0
1.0	13	17	22	27	30	33	37	43	52	66	91	131	190	315	358	307	220	149	104	72	60	50	43	37	32	27	23	21	16	14	12	0
1.5	9	11	14	18	19	21	23	25	27	29	33	37	44	70	134	229	304	318	269	172	106	68	52	44	38	33	28	24	19	15	12	2
2.0	6	8	10	13	14	15	16	17	19	20	22	24	26	32	45	73	130	207	271	292	216	121	68	51	43	37	32	27	21	16	13	6
2.5	3	4	6	8	9	10	10	11	12	13	14	16	17	20	23	29	38	57	97	189	271	244	136	75	53	44	38	33	24	19	14	9
3.0	1	2	4	5	6	6	7	8	8	9	10	11	12	14	16	19	23	28	38	74	146	256	226	131	74	53	44	37	27	21	14	10

IA/P = 0.30 * * * TC = 0.1 HR * * *

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	48	106	296	597	496	368	300	221	155	125	106	89	83	79	74	69	62	59	54	47	40	35	32	28	25	22	20	17	0
.10	0	0	0	35	82	225	473	488	408	336	260	190	147	113	94	85	80	75	70	63	59	54	48	40	35	32	29	25	22	20	17	0
.20	0	0	0	7	26	64	171	372	449	422	365	295	225	142	109	92	84	79	74	66	61	56	50	43	36	33	30	26	22	20	17	0
.30	0	0	0	5	19	49	130	291	397	414	381	323	258	161	118	96	86	80	75	68	62	57	50	43	37	33	30	27	22	20	17	0
.40	0	0	0	0	3	14	37	99	227	340	389	384	343	229	152	113	94	85	79	71	65	59	52	46	38	34	31	28	23	21	17	0
.50	0	0	0	0	2	10	28	75	177	286	355	374	354	256	170	123	99	87	80	73	66	60	53	46	39	35	31	28	23	21	18	0
.75	0	0	0	0	0	1	4	13	35	86	161	238	296	325	266	194	141	110	93	80	71	63	56	50	43	37	33	30	24	21	18	0
1.0	0	0	0	0	0	0	0	2	6	19	48	99	165	282	311	264	197	144	112	88	77	67	59	52	45	39	34	31	24	22	18	0
1.5	0	0	0	0	0	0	0	0	0	0	0	1	4	29	99	197	265	277	236	162	113	84	69	60	53	46	39	35	28	23	19	2
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	35	94	172	233	253	196	124	83	68	59	52	45	39	31	25	20	8
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	37	88	184	235	201	122	83	67	59	52	45	34	27	21	13
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	38	110	222	202	131	88	69	60	52	39	31	22	15

IA/P = 0.50 * * * TC = 0.1 HR * * *

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	107	226	282	258	209	155	130	123	107	97	95	91	87	82	78	74	69	61	52	47	43	39	35	32	29	25	0
.10	0	0	0	0	0	71	174	246	254	224	178	146	130	112	100	96	92	88	83	78	75	70	62	53	48	44	40	35	32	29	25	0
.20	0	0	0	0	0	0	48	132	208	239	229	195	162	127	109	99	95	91	87	80	77	72	65	56	49	45	41	36	32	30	25	0
.30	0	0	0	0	0	0	32	99	172	216	225	205	176	136	113	101	96	92	88	81	77	72	65	57	50	45	41	37	32	30	26	0
.40	0	0	0	0	0	0	0	21	73	139	191	213	208	164	131	111	100	95	91	85	79	74	68	60	51	47	43	38	33	30	26	0
.50	0	0	0	0	0	0	0	14	53	110	164	197	204	174	139	116	103	97	92	86	80	75	68	60	52	47	43	39	33	30	26	0
.75	0	0	0	0	0	0	0	5	22	54	96	137	166	180	159	134	115	103	96	89	83	77	70	63	54	48	44	40	33	31	26	0
1.0	0	0	0	0	0	0	0	0	0	2	10	29	60	132	175	169	146	124	109	97	89	81	74	67	59	52	47	43	34	31	27	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	17	58	112	150	159	148	122	104	91	81	74	67	59	51	46	38	32	28	1
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	20	54	98	133	149	133	108	90	80	73	66	58	51	42	34	29	7
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12	35	87	131	141	111	92	81	74	66	59	46	38	30	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	22	63	120	136	110	91	81	73	66	51	42	31	22

RAINFALL TYPE = III * * * TC = 0.1 HR * * * SHEET 1 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

HYDROGRAPH TIME (HOURS)

IA/P = 0.10   * * * TC = 0.2 HR * * *   IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	27	34	50	119	176	258	448	565	483	358	270	194	137	93	75	65	60	56	52	46	42	38	33	28	24	21	19	17	14	13	11	0
.10	24	30	42	70	103	151	222	372	501	489	402	314	234	128	91	73	64	59	55	49	44	40	35	30	25	22	20	17	15	13	11	0
.20	23	29	39	64	90	131	192	312	438	472	425	351	273	153	101	78	66	61	56	50	45	40	35	30	25	22	20	18	15	13	11	0
.30	21	26	33	48	59	79	114	166	263	380	441	431	378	238	141	96	75	65	60	53	47	42	37	32	26	23	21	18	15	13	11	0
.40	20	25	32	45	54	71	99	144	224	328	404	422	392	271	165	108	81	68	61	54	48	43	37	32	27	23	21	19	15	14	11	0
.50	18	22	28	38	43	51	64	88	125	191	282	363	402	356	241	151	102	78	66	57	51	44	39	34	28	24	22	19	15	14	11	0
.75	15	18	23	30	33	37	42	50	64	87	125	184	253	359	341	260	177	121	89	67	57	48	42	36	31	26	23	21	16	14	12	0
1.0	12	16	20	25	28	30	33	37	43	53	68	94	135	251	345	330	260	181	125	81	63	52	44	38	33	28	24	21	17	14	12	0
1.5	8	10	13	17	18	19	21	23	25	27	30	33	38	55	99	179	266	308	289	201	124	74	54	45	39	34	29	24	19	15	12	2
2.0	5	7	9	12	13	14	15	16	17	19	20	22	24	29	38	57	99	166	238	284	239	141	75	54	44	38	33	28	21	17	13	6
2.5	2	4	5	7	8	9	10	10	11	12	13	14	16	18	22	26	33	46	75	155	240	264	154	83	56	46	39	34	25	19	14	9
3.0	1	2	3	5	5	6	6	7	8	8	9	10	11	13	15	18	21	25	33	59	118	220	250	147	82	56	45	39	28	22	14	10

IA/P = 0.30   * * * TC = 0.2 HR * * *   IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	17	49	115	297	489	462	379	307	230	167	119	98	86	81	76	72	64	60	55	48	41	36	32	29	26	22	20	17	0
.10	0	0	0	12	37	89	228	402	442	400	338	266	200	131	104	89	82	78	73	65	61	56	49	42	36	33	29	26	22	20	17	0
.20	0	0	0	1	8	27	69	175	326	403	401	359	297	182	126	100	88	81	76	69	63	58	51	44	37	34	30	27	23	21	17	0
.30	0	0	0	1	6	20	52	134	262	356	386	368	321	208	140	107	91	83	78	70	64	58	52	45	38	34	31	27	23	21	17	0
.40	0	0	0	1	4	15	40	103	209	307	360	365	336	234	157	116	95	85	79	72	65	59	53	46	39	34	31	28	23	21	17	0
.50	0	0	0	0	0	3	11	30	78	165	260	327	352	305	213	147	111	93	84	75	68	61	55	48	41	35	32	29	23	21	18	0
.75	0	0	0	0	0	1	5	14	37	83	150	220	276	311	264	196	144	112	94	80	72	64	56	50	43	37	33	30	24	21	18	0
1.0	0	0	0	0	0	0	0	0	2	7	20	48	94	215	299	286	230	171	128	95	81	69	61	54	47	40	35	32	25	22	18	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	13	56	139	224	266	253	186	128	89	71	61	54	48	41	36	29	23	19	3
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	17	58	126	196	245	214	140	89	71	61	54	47	40	32	25	20	9
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	21	57	145	228	213	136	89	70	60	53	46	35	28	21	13
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	23	78	180	215	145	94	72	61	54	41	32	22	15

IA/P = 0.50   * * * TC = 0.2 HR * * *   IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	10	110	206	245	245	208	162	137	117	102	96	93	90	85	79	76	71	63	54	48	44	40	36	32	29	25	0
.10	0	0	0	0	0	7	76	163	217	235	217	181	152	122	106	98	94	90	86	80	76	71	64	55	49	45	41	36	32	29	25	0
.20	0	0	0	0	0	0	5	52	126	187	219	218	193	145	119	104	97	93	89	83	78	73	66	58	50	46	42	37	32	30	26	0
.30	0	0	0	0	0	0	3	36	96	156	198	211	199	155	125	108	99	94	90	84	79	74	67	59	51	46	42	38	32	30	26	0
.40	0	0	0	0	0	0	0	2	24	72	128	175	199	184	147	121	106	98	93	87	81	76	69	61	53	48	44	39	33	30	26	0
.50	0	0	0	0	0	0	0	1	17	54	103	151	183	194	156	127	109	100	95	88	82	76	70	62	54	48	44	40	33	30	26	0
.75	0	0	0	0	0	0	0	0	6	23	52	90	127	174	168	146	124	109	100	92	85	78	72	65	56	49	45	41	34	31	26	0
1.0	0	0	0	0	0	0	0	0	0	0	2	11	29	91	149	169	157	135	117	100	92	83	76	69	61	53	48	43	35	32	27	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	7	33	81	128	155	155	130	109	94	83	75	68	60	53	47	39	33	28	2
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	34	72	112	145	139	114	93	82	74	67	60	52	43	35	29	9
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	12	33	83	126	139	112	92	81	74	67	59	47	38	30	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	21	60	116	133	110	92	81	73	66	51	42	31	22

RAINFALL TYPE = III   * * * TC = 0.2 HR * * *   sheet 2 of 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

IA/P = 0.10 * * * TC = 0.3 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	25	31	44	84	124	181	287	441	498	451	358	276	204	118	87	70	63	58	54	48	44	39	34	29	24	22	20	17	14	13	11	0
.10	22	28	37	56	74	108	156	244	375	457	453	389	314	180	113	83	69	62	57	51	46	41	36	31	26	23	20	18	15	13	11	0
.20	21	27	35	53	67	94	136	208	319	411	439	406	345	212	130	91	73	64	59	52	46	42	36	31	26	23	21	18	15	13	11	0
.30	19	24	30	42	49	61	83	118	178	272	365	414	409	305	190	121	87	71	63	55	49	43	38	33	27	24	21	19	15	14	11	0
.40	18	23	29	40	46	56	74	103	153	232	321	383	400	329	217	138	96	75	65	57	50	44	38	33	28	24	21	19	15	14	11	0
.50	16	21	26	34	38	43	52	67	91	132	199	280	349	383	297	196	128	91	73	60	53	46	40	35	30	25	22	20	16	14	11	0
.75	14	18	23	30	33	37	43	52	66	91	131	187	251	347	331	260	182	126	92	68	57	49	42	36	31	26	23	21	16	14	12	0
1.0	11	15	18	23	25	28	30	33	38	44	54	71	98	192	296	334	294	221	154	94	69	55	45	40	34	29	25	22	17	15	12	0
1.5	7	9	12	15	17	18	19	21	23	25	27	30	33	45	75	137	222	287	300	233	149	84	57	47	40	35	30	25	20	16	13	3
2.0	4	6	8	11	12	13	14	15	16	17	19	20	22	26	33	46	76	131	201	278	258	165	85	57	46	40	34	29	22	17	13	7
2.5	2	3	5	7	7	8	9	10	10	11	12	13	14	17	20	24	29	39	60	125	213	260	177	94	60	47	40	35	25	20	14	9
3.0	1	2	3	4	5	5	6	6	7	8	8	9	10	12	14	16	19	23	29	48	95	195	247	167	93	60	47	40	29	22	15	10

IA/P = 0.30 * * * TC = 0.3 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	6	22	58	146	308	424	422	367	303	234	145	111	92	84	79	74	67	62	57	50	43	36	33	30	26	22	20	17	0
.10	0	0	0	4	16	44	112	243	364	402	379	328	266	166	120	97	86	80	75	68	62	57	51	44	37	33	30	27	22	21	17	0
.20	0	0	0	3	12	33	86	190	306	370	376	344	292	189	132	103	89	82	77	69	63	58	51	44	37	34	30	27	23	21	17	0
.30	0	0	0	0	2	8	25	65	149	254	331	361	350	261	175	126	100	88	31	73	66	60	53	46	39	35	31	28	23	21	18	0
.40	0	0	0	0	1	6	19	50	116	208	290	338	346	282	195	138	107	91	83	74	67	60	54	47	40	35	32	28	23	21	18	0
.50	0	0	0	0	0	1	4	14	38	90	168	250	308	333	256	180	131	103	89	78	71	63	56	49	42	36	33	29	23	21	18	0
.75	0	0	0	0	0	0	2	6	17	43	89	150	213	299	286	229	171	129	104	85	75	65	58	51	44	38	34	30	24	22	18	0
1.0	0	0	0	0	0	0	0	0	1	3	9	24	53	153	253	288	257	200	150	105	85	72	62	55	48	41	36	32	26	22	19	0
1.5	0	0	0	0	0	0	0	0	0	0	0	1	2	15	59	138	217	258	248	187	130	91	71	62	55	48	41	36	29	23	19	3
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	36	90	159	239	227	158	97	74	63	55	48	42	32	26	20	10
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12	37	113	194	224	151	96	73	62	55	48	36	29	21	14
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	24	78	176	211	145	95	73	62	54	41	32	22	15

IA/P = 0.50 * * * TC = 0.3 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	2	33	116	193	221	221	200	165	129	110	99	95	92	87	81	77	72	65	56	49	45	41	37	32	30	25	0
.10	0	0	0	0	0	1	23	85	157	200	214	205	178	138	115	102	96	92	88	82	77	73	66	57	50	46	42	37	32	30	26	0
.20	0	0	0	0	0	1	15	62	125	175	201	203	187	147	121	105	98	94	89	83	78	73	66	58	50	46	42	38	32	30	26	0
.30	0	0	0	0	0	0	0	10	45	99	149	184	197	174	140	117	104	97	93	86	80	75	69	61	52	47	43	39	33	30	26	0
.40	0	0	0	0	0	0	0	7	32	76	125	164	189	179	148	123	107	99	94	87	81	76	69	62	53	48	44	39	33	30	26	0
.50	0	0	0	0	0	0	0	0	5	23	59	103	144	183	169	141	119	105	98	90	84	78	71	64	55	49	45	41	33	31	26	0
.75	0	0	0	0	0	0	0	0	2	9	27	55	89	148	168	156	135	117	105	94	87	80	73	66	58	51	46	42	34	31	27	0
1.0	0	0	0	0	0	0	0	0	0	0	1	4	14	59	119	157	163	145	126	105	95	85	77	71	63	55	49	44	36	32	27	0
1,5	0	0	0	0	0	0	0	0	0	0	0	0	0	3	19	56	103	139	151	138	116	97	85	77	70	62	54	48	40	33	28	3
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	21	52	91	135	143	120	96	84	76	69	61	54	44	35	29	11
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	22	65	112	136	117	96	83	75	68	60	48	39	30	19
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	45	102	131	114	95	83	75	67	53	43	31	22

RAINFALL TYPE = III * * * TC = 0.3 HR * * * SHEET 3 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10												* * * TC = 0.4 HR * * *																IA/P = 0.10				
0.0	23	29	39	65	91	132	198	308	422	449	417	345	274	162	108	82	68	61	57	50	45	41	35	30	25	22	20	18	15	13	11	0
.10	20	26	33	48	60	80	114	170	262	368	422	418	370	242	149	102	79	67	60	53	47	42	37	32	27	23	21	18	15	13	11	0
.20	20	25	32	45	55	72	100	147	224	320	388	408	383	272	171	114	85	70	62	54	48	43	37	32	27	23	21	19	15	14	11	0
.30	17	22	28	38	43	51	65	88	127	191	277	351	389	349	244	157	108	81	68	58	51	45	39	34	29	24	22	19	15	14	11	0
.40	17	21	27	36	41	47	59	79	111	165	240	314	378	359	268	178	120	88	72	60	52	45	40	34	29	25	22	20	15	14	11	0
.50	15	19	24	31	34	38	44	54	71	98	142	207	278	364	332	243	163	113	84	65	56	48	41	36	31	26	23	20	16	14	12	0
.75	12	16	20	25	27	30	33	38	44	54	70	97	138	249	333	320	257	185	131	85	65	53	44	39	33	28	24	22	17	14	12	0
1.0	11	13	17	22	23	25	28	30	34	38	46	57	75	145	245	322	311	255	188	114	77	58	47	41	35	30	26	23	18	15	12	1
1.5	6	9	11	14	15	17	18	19	21	23	25	27	30	39	59	105	180	255	292	257	176	98	61	48	41	36	31	26	20	16	13	4
2.0	4	6	8	10	11	12	13	14	15	16	17	19	20	24	30	39	61	103	166	253	272	189	98	61	48	41	35	30	23	18	13	8
2.5	2	3	4	6	7	7	8	9	10	10	11	12	13	16	18	22	26	34	49	100	183	255	198	108	66	50	42	36	26	20	14	9
3.0	1	1	2	4	4	5	5	6	6	7	8	8	9	11	13	15	18	21	26	40	77	169	243	185	106	65	49	41	30	23	15	10
IA/P = 0.30												* * * TC = 0.4 HR * * *																IA/P = 0.30				
0.0	0	0	0	2	10	30	78	177	306	379	379	347	293	187	133	105	90	82	77	69	63	58	51	44	38	34	30	27	23	21	17	0
.10	0	0	0	2	7	22	59	138	250	336	365	353	313	212	146	112	94	84	78	71	64	59	52	45	38	34	31	27	23	21	17	0
.20	0	0	0	1	5	17	45	107	202	292	341	349	325	235	162	121	98	87	80	72	65	59	53	46	39	34	31	28	23	21	17	0
.30	0	0	0	0	1	4	12	34	83	162	249	310	336	298	215	152	116	96	85	76	68	61	55	48	41	36	32	29	23	21	18	0
.40	0	0	0	0	0	3	9	26	64	130	209	276	324	307	234	168	125	101	88	77	70	62	55	49	41	36	32	29	23	21	18	0
.50	0	0	0	0	0	0	2	7	19	49	103	173	242	313	285	216	157	119	98	82	73	65	57	51	44	37	33	30	24	22	18	0
.75	0	0	0	0	0	0	1	3	9	23	52	97	153	253	285	253	199	151	118	91	78	68	59	53	46	39	35	31	25	22	18	0
1.0	0	0	0	0	0	0	0	0	0	1	4	13	30	104	204	276	276	226	175	120	92	75	64	57	50	43	37	33	26	22	19	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	8	36	98	177	236	250	207	148	99	75	63	56	49	42	37	29	24	19	4
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	22	62	124	210	232	176	107	78	65	57	50	43	33	27	20	11
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	24	85	167	219	167	106	77	64	56	49	37	29	21	14
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	15	58	152	207	159	104	76	64	55	42	33	22	15
IA/P = 0.50												* * * TC = 0.4 HR * * *																IA/P = 0.50				
0.0	0	0	0	0	0	0	10	54	121	182	204	204	191	146	121	106	98	94	90	83	78	73	66	58	50	46	42	38	32	30	26	0
.10	0	0	0	0	0	0	7	38	94	153	187	198	193	155	128	110	100	95	91	84	79	74	67	59	51	46	42	38	32	30	26	0
.20	0	0	0	0	0	0	5	27	71	126	166	187	191	164	134	114	103	96	92	85	80	75	68	60	52	47	43	38	33	30	26	0
.30	0	0	0	0	0	0	0	3	19	54	102	145	173	185	155	129	111	101	95	88	82	76	70	62	54	48	44	40	33	31	26	0
.40	0	0	0	0	0	0	0	2	13	40	81	124	157	180	161	135	116	104	97	90	83	77	71	63	55	49	44	40	33	31	26	0
.50	0	0	0	0	0	0	0	0	1	9	30	64	104	163	174	154	130	113	102	93	86	79	73	66	57	50	46	42	34	31	27	0
.75	0	0	0	0	0	0	0	0	0	3	13	32	59	120	157	162	145	126	111	98	90	82	75	68	60	52	47	43	35	31	27	0
1.0	0	0	0	0	0	0	0	0	0	0	0	2	6	36	90	138	158	152	135	112	98	88	79	72	65	56	50	45	37	32	27	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	37	80	121	148	143	123	102	87	78	71	64	56	49	41	34	28	4
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	36	71	121	140	126	101	86	78	70	63	55	44	36	29	13
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	14	49	97	135	122	100	86	77	70	62	49	40	30	20
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	33	88	130	119	98	85	76	69	54	44	32	22

RAINFALL TYPE = III * * * TC = 0.4 HR * * * SHEET 4 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

IA/P = 0.10 * * * TC = 0.5 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	21	27	35	54	70	97	144	217	316	397	411	388	330	214	139	99	78	67	60	52	47	42	36	31	26	23	21	18	15	13	11	0
.10	19	24	30	43	50	64	86	125	186	273	355	392	390	296	194	129	94	75	65	56	49	43	38	33	28	24	21	19	15	14	11	0
.20	18	23	29	40	47	58	77	109	161	235	315	367	382	318	218	145	103	80	68	57	50	44	39	33	28	24	22	19	15	14	11	0
.30	16	21	26	34	38	44	53	69	95	139	203	278	337	367	289	199	135	98	77	62	54	46	40	35	30	25	22	20	16	14	11	0
.40	16	20	25	33	36	41	49	62	84	121	176	244	306	358	306	220	151	107	83	64	55	47	41	35	30	25	23	20	16	14	12	0
.50	14	18	22	28	31	35	39	46	57	75	106	152	213	323	346	282	202	140	102	73	59	50	42	37	32	27	23	21	16	14	12	0
.75	12	16	20	25	28	30	34	38	45	56	75	104	145	246	319	308	252	187	135	89	67	53	44	39	33	28	24	22	17	14	12	0
1.0	10	12	16	20	22	23	25	28	31	34	39	47	60	110	197	280	309	279	220	138	90	63	49	42	37	31	26	23	18	15	12	1
1.5	6	8	10	13	14	15	17	18	19	21	23	25	27	34	49	82	143	218	283	271	203	116	68	51	43	37	32	27	21	16	13	4
2.0	3	5	7	9	10	11	12	13	14	15	16	17	19	22	27	34	50	82	135	226	265	211	114	67	50	42	37	31	23	18	13	8
2.5	2	3	4	6	7	7	8	9	10	10	11	12	13	16	18	22	26	34	50	102	182	249	197	111	67	50	42	36	26	20	14	9
3.0	1	1	2	3	4	4	5	5	6	6	7	8	8	10	12	14	16	19	23	34	63	144	238	201	121	72	52	43	31	23	15	10

IA/P = 0.30 * * * TC = 0.5 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	1	4	15	40	101	198	295	345	345	325	232	161	122	100	88	80	72	65	59	53	46	39	34	31	28	23	21	18	0
.10	0	0	0	1	3	11	30	77	158	249	313	335	329	253	178	132	106	91	82	73	66	60	53	47	40	35	31	28	23	21	18	0
.20	0	0	0	0	2	8	23	59	125	208	278	316	324	271	196	144	112	95	85	75	67	61	54	47	40	35	32	28	23	21	18	0
.30	0	0	0	0	0	2	6	17	45	98	171	242	291	313	249	182	136	108	92	80	71	63	56	49	42	36	33	29	24	21	18	0
.40	0	0	0	0	0	1	4	13	34	77	140	208	264	304	263	198	148	115	97	81	72	64	57	50	43	37	33	30	24	21	18	0
.50	0	0	0	0	0	0	1	3	10	26	60	113	177	276	295	244	185	140	111	88	77	67	59	52	45	39	34	31	24	22	18	0
.75	0	0	0	0	0	0	0	1	4	12	29	60	104	204	271	263	222	174	136	101	83	70	61	54	47	40	35	32	25	22	18	0
1.0	0	0	0	0	0	0	0	0	0	1	2	6	16	67	155	235	263	242	198	138	102	80	66	58	51	44	38	34	27	23	19	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	67	138	205	241	221	167	110	79	66	58	51	44	38	30	24	20	5
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	13	42	93	182	225	191	119	83	67	58	51	44	34	27	21	12
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	15	62	139	213	180	117	82	67	58	51	38	30	22	15
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	41	127	203	171	114	81	66	57	43	33	23	16

IA/P = 0.50 * * * TC = 0.5 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	0	3	24	68	124	174	190	190	162	133	114	103	97	92	85	80	75	68	60	52	47	43	39	33	30	26	0
.10	0	0	0	0	0	0	2	17	51	100	149	177	186	169	140	119	106	99	93	86	81	75	69	61	52	47	43	39	33	30	26	0
.20	0	0	0	0	0	0	1	12	38	79	126	160	181	173	147	124	109	101	95	88	81	76	69	62	53	48	44	39	33	30	26	0
.30	0	0	0	0	0	0	0	1	8	28	62	105	141	176	165	141	120	107	99	91	84	78	71	64	56	49	45	41	33	31	26	0
.40	0	0	0	0	0	0	0	1	6	20	48	86	123	172	172	146	125	111	101	92	85	79	72	65	56	50	45	41	34	31	26	0
.50	0	0	0	0	0	0	0	0	4	15	37	70	105	157	167	151	130	114	104	94	87	79	73	66	57	50	46	42	34	31	27	0
.75	0	0	0	0	0	0	0	0	0	1	6	17	37	91	139	157	150	134	119	103	93	84	76	69	62	54	48	44	35	32	27	0
1.0	0	0	0	0	0	0	0	0	0	0	1	3	9	40	91	135	153	149	135	113	99	88	79	72	65	57	50	45	37	32	27	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	24	59	101	132	144	130	107	90	80	73	65	57	51	41	34	29	6
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	25	55	106	138	130	105	89	79	72	65	57	45	37	30	15
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	36	81	133	133	104	88	79	71	64	50	41	31	21
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	24	74	128	122	103	88	78	70	55	45	32	23

RAINFALL TYPE = III * * * TC = 0.5 HR * * * SHEET 5 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

TC = 0.75 HR

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10																																
0.0	17	22	28	39	45	56	73	104	151	215	281	328	343	310	228	163	121	94	77	63	53	45	39	34	29	25	22	20	15	14	11	0
.10	17	21	27	37	42	51	66	91	131	187	250	302	336	319	247	179	131	101	82	65	55	46	40	35	29	25	22	20	16	14	11	0
.20	15	19	24	31	35	40	48	60	81	114	163	221	275	328	298	229	167	124	96	73	60	49	42	36	31	26	23	20	16	14	12	0
.30	14	18	23	30	33	38	44	55	72	100	142	194	248	320	305	245	182	135	103	76	62	50	42	37	31	27	23	21	16	14	12	0
.40	13	16	21	26	29	32	36	41	50	65	88	124	171	268	313	288	228	170	127	88	68	54	44	38	33	28	24	21	17	14	12	0
.50	12	16	20	25	28	30	34	39	46	59	78	109	150	244	306	294	242	184	138	94	71	56	45	39	34	28	24	22	17	14	12	0
.75	10	13	16	21	23	25	27	30	33	38	46	58	77	140	221	277	287	248	197	133	92	66	50	42	36	31	26	23	18	15	12	1
1.0	8	10	13	16	18	19	21	23	25	27	30	34	39	61	109	181	249	280	265	198	134	85	58	46	40	34	29	25	20	16	12	2
1.5	5	7	9	12	13	14	15	16	17	19	20	22	24	30	40	63	106	167	225	261	226	147	84	58	46	39	34	29	22	17	13	5
2.0	2	4	5	7	8	9	9	10	11	12	13	14	16	18	22	26	34	50	80	155	226	246	158	91	61	47	40	34	25	20	14	9
2.5	1	2	3	5	5	6	6	7	8	8	9	10	11	13	15	18	21	26	34	62	120	209	234	151	90	60	47	39	29	22	15	10
3.0	0	1	2	3	3	3	4	4	5	5	6	7	7	9	10	12	15	17	21	29	50	113	209	224	144	88	59	46	33	25	16	10
IA/P = 0.30																																
0.0	0	0	0	0	1	3	8	24	58	113	182	243	283	287	233	178	139	114	98	83	73	64	56	50	43	37	33	30	24	21	18	0
.10	0	0	0	0	0	2	6	18	45	91	151	212	259	284	245	191	149	120	102	85	75	65	57	50	43	37	33	30	24	21	18	0
.20	0	0	0	0	0	0	1	5	14	35	72	125	183	263	277	230	180	142	116	93	80	68	59	52	45	39	34	31	25	22	18	0
.30	0	0	0	0	0	0	1	3	10	26	57	102	156	245	270	240	192	151	122	96	82	69	60	53	46	39	35	31	25	22	18	0
.40	0	0	0	0	0	0	0	1	2	8	20	45	83	182	252	264	226	181	144	108	89	73	62	55	48	41	36	32	26	22	19	0
.50	0	0	0	0	0	0	0	0	2	6	15	35	67	158	235	259	235	192	153	113	92	75	63	56	49	42	36	33	26	22	19	1
.75	0	0	0	0	0	0	0	0	0	0	1	2	7	35	100	178	232	242	217	163	121	90	71	61	54	47	40	35	28	23	19	2
1.0	0	0	0	0	0	0	0	0	0	0	0	1	4	21	68	140	205	236	229	181	135	97	74	63	55	48	41	36	29	24	19	3
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	42	94	155	221	212	158	103	77	64	56	49	42	33	26	20	10
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	15	42	113	184	209	151	101	76	63	55	48	36	29	21	14
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	27	80	168	199	146	100	75	63	55	41	32	22	15
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	56	154	191	151	105	78	64	48	37	24	16
IA/P = 0.50																																
0.0	0	0	0	0	0	0	0	3	13	37	71	108	140	167	156	136	120	108	101	92	85	78	72	64	56	50	45	41	34	31	26	0
.10	0	0	0	0	0	0	0	2	10	28	57	91	124	163	158	140	124	111	103	94	86	79	72	65	57	50	46	41	34	31	27	0
.20	0	0	0	0	0	0	0	0	1	7	21	45	76	135	159	153	136	120	109	98	90	82	74	67	59	52	47	43	35	31	27	0
.30	0	0	0.	0	0	0	0	0	1	5	15	35	62	121	157	157	140	124	112	100	91	83	75	68	60	52	47	43	35	31	27	0
.40	0	0	0	0	0	0	0	0	1	3	11	27	50	107	146	154	143	128	115	102	93	84	76	69	61	53	48	43	35	32	27	0
.50	0	0	0	0	0	0	0	0	0	0	2	8	21	66	118	148	152	139	125	108	97	87	78	71	63	55	49	45	36	32	27	1
.75	0	0	0	0	0	0	0	0	0	0	1	4	10	38	82	122	142	144	133	116	103	91	80	73	66	58	51	46	37	32	28	1
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	24	60	102	132	142	133	116	99	86	77	70	62	55	49	40	33	28	3
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	25	55	91	128	136	119	98	85	77	69	62	54	44	36	29	11
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	25	66	109	131	116	97	85	76	69	61	48	39	30	18
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	47	100	127	114	96	84	75	68	53	43	31	22
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	44	102	124	112	95	83	75	59	47	33	23

RAINFALL TYPE = III * * * TC = 0.75 HR * * * SHEET 6 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10													* * * TC = 1.0 HR * * *															IA/P = 0.10				
0.0	15	19	24	32	37	44	54	71	98	136	181	227	264	297	270	215	164	128	103	78	64	52	43	36	31	26	23	21	16	14	12	0
.10	13	17	22	28	31	35	41	49	64	87	120	161	205	273	289	254	201	155	122	90	71	56	45	38	33	28	24	21	17	14	12	0
.20	13	16	21	27	29	33	38	46	58	77	105	142	184	257	285	263	214	167	130	95	74	57	46	39	33	28	24	22	17	14	12	0
.30	12	16	20	26	28	31	36	42	53	69	93	126	165	240	279	268	225	178	139	100	77	59	47	39	34	29	25	22	17	15	12	1
.40	11	14	18	23	25	27	30	34	40	48	62	83	112	185	251	276	256	213	168	118	87	65	50	41	35	30	26	23	18	15	12	1
.50	11	13	17	22	24	26	29	32	37	45	56	74	99	167	235	270	261	223	179	126	92	67	51	42	36	31	26	23	18	15	12	1
.75	8	10	13	17	18	19	21	23	25	28	31	36	44	72	122	186	239	258	243	189	136	90	62	48	40	34	29	25	20	16	12	2
1.0	6	9	11	14	15	17	18	20	21	23	25	28	32	46	75	124	185	234	253	226	170	110	71	53	43	37	31	27	21	16	13	4
1.5	4	6	8	10	11	12	13	14	15	16	17	19	21	25	32	46	74	118	170	230	239	179	108	70	52	43	36	31	23	18	13	7
2.0	2	3	4	6	7	7	8	9	10	10	11	12	13	16	18	22	28	38	58	111	179	228	185	116	75	54	44	37	27	21	14	9
2.5	1	1	2	4	4	5	5	6	6	7	8	8	9	11	13	15	18	22	28	46	87	167	219	176	113	73	54	43	31	23	15	10
3.0	0	0	1	2	2	2	3	3	3	4	4	5	5	7	8	10	12	14	16	21	32	68	156	210	179	120	78	56	37	27	16	11
IA/P = 0.30													* * * TC = 1.0 HR * * *															IA/P = 0.30				
0.0	0	0	0	0	0	1	5	13	30	57	95	141	186	243	249	213	174	142	119	97	83	70	60	53	46	39	35	31	25	22	18	0
.10	0	0	0	0	0	1	3	10	23	46	79	120	164	230	245	221	183	150	125	101	85	72	61	53	46	40	35	31	25	22	18	0
.20	0	0	0	0	0	0	1	3	7	18	36	65	102	183	233	241	210	174	144	112	92	76	64	56	48	42	36	33	26	22	19	1
.30	0	0	0	0	0	0	1	2	6	14	29	53	86	163	221	237	217	183	151	117	95	78	65	56	49	42	37	33	26	22	19	1
.40	0	0	0	0	0	0	0	0	1	4	11	23	43	107	180	225	233	207	175	133	105	84	68	59	51	44	38	34	27	23	19	1
.50	0	0	0	0	0	0	0	0	1	3	8	18	34	91	162	214	230	213	183	139	109	86	70	60	52	45	39	34	27	23	19	1
.75	0	0	0	0	0	0	0	0	0	0	1	4	9	33	82	145	196	218	211	174	135	101	77	64	56	48	42	37	29	24	19	3
1.0	0	0	0	0	0	0	0	0	0	0	0	1	2	11	37	85	144	192	214	199	160	116	85	69	59	51	44	38	30	25	20	5
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	23	56	104	174	203	177	123	89	71	60	52	45	35	27	21	11
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	24	73	139	194	169	120	87	70	59	51	39	30	22	14
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	15	51	127	186	162	117	86	69	59	44	34	23	16
3,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	35	117	180	164	122	90	71	51	39	25	16
IA/P = 0.50													* * * TC = 1.0 HR * * *															IA/P = 0.50				
0.0	0	0	0	0	0	0	0	2	6	17	34	57	83	127	151	142	130	118	109	99	91	83	75	68	59	52	47	43	35	31	27	1
.10	0	0	0	0	0	0	0	1	5	13	27	47	71	117	146	144	133	121	112	101	92	84	76	68	60	53	48	43	35	32	27	1
.20	0	0	0	0	0	0	0	1	3	10	21	38	60	106	138	143	135	124	114	102	94	85	76	69	61	54	48	44	35	32	27	1
.30	0	0	0	0	0	0	0	0	0	2	7	16	31	73	114	139	142	132	121	108	98	88	79	71	64	56	50	45	36	32	27	1
.40	0	0	0	0	0	0	0	0	0	2	5	13	25	62	104	133	140	134	124	110	99	89	80	72	64	56	50	45	37	32	27	1
.50	0	0	0	0	0	0	0	0	0	0	1	4	10	35	74	112	134	138	131	117	104	93	82	74	67	59	52	47	38	33	28	2
.75	0	0	0	0	0	0	0	0	0	0	0	2	5	19	43	84	115	131	134	123	110	97	85	77	69	61	54	48	39	33	28	3
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	21	49	84	113	129	132	119	103	89	80	72	64	56	50	41	34	28	5
1.5	0	0	0	0	0	0	0	0	o	0	0	0	0	0	1	7	21	46	75	113	128	120	102	88	79	71	63	56	45	37	29	12
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	14	42	82	119	124	104	90	80	72	64	50	41	31	20
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	29	75	117	121	102	89	79	71	56	45	32	23
3,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	28	80	118	118	101	88	79	63	49	34	24

RAINFALL TYPE = III   * * * TC = 1.0 HR * * *   SHEET 7 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

HYDROGRAPH TIME(HOURS)

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10 — * * * TC = 1.25 HR * * * — IA/P = 0.10																																
0.0	13	17	22	28	32	37	44	56	75	100	133	170	206	255	264	236	194	155	125	95	75	59	47	39	33	28	24	22	17	14	12	1
.10	13	16	21	27	30	34	41	51	67	89	118	152	188	243	261	243	204	164	133	100	79	61	48	40	34	29	25	22	17	15	12	1
.20	11	15	18	24	26	29	33	38	47	60	79	105	137	203	248	256	232	193	156	115	88	67	51	42	35	30	26	23	18	15	12	1
.30	11	14	18	23	25	27	31	36	43	54	71	94	122	187	237	254	238	203	165	121	92	69	53	43	36	30	26	23	18	15	12	1
.40	10	12	16	20	22	24	26	29	34	40	49	64	84	140	201	242	250	228	193	142	106	77	57	46	38	32	27	24	19	15	12	1
.50	9	12	15	19	21	23	25	28	32	37	45	58	75	126	186	232	248	233	201	150	111	80	58	47	39	33	28	24	19	15	12	2
.75	8	11	14	17	19	20	22	24	27	31	36	44	56	93	144	196	230	237	220	174	131	91	64	50	41	34	29	25	20	16	12	2
1.0	6	8	11	14	15	16	17	19	20	22	25	28	32	46	74	119	170	213	234	218	174	120	79	58	46	38	32	27	21	17	13	4
1.5	3	5	7	9	9	10	11	12	13	14	16	17	18	22	27	38	58	91	134	197	223	194	128	83	60	47	39	33	24	19	14	7
2.0	2	3	4	6	6	7	8	8	9	10	11	12	13	15	18	22	27	38	57	106	166	214	184	124	82	59	47	39	28	21	14	9
2.5	1	1	2	3	3	4	4	5	5	6	7	7	8	10	11	13	16	19	24	38	68	137	206	186	130	87	62	48	33	24	15	10
3.0	0	0	1	2	2	2	2	3	3	4	4	5	5	6	8	9	11	13	16	21	31	66	145	200	178	126	85	61	39	28	17	11
IA/P = 0.30 — * * * TC = 1.25 HR * * * — IA/P = 0.30																																
0.0	0	0	0	0	0	1	2	7	18	35	61	94	130	192	222	218	191	161	136	110	93	77	65	56	48	41	36	32	26	22	19	1
.10	0	0	0	0	0	1	2	5	14	28	50	79	113	177	214	219	197	168	142	115	96	79	66	57	49	42	37	33	26	22	19	1
.20	0	0	0	0	0	0	1	4	10	22	41	66	97	162	205	217	202	175	149	119	99	81	67	58	50	43	37	33	26	23	19	1
.30	0	0	0	0	0	0	0	1	3	8	17	33	55	115	174	208	214	195	168	133	108	87	70	60	52	45	39	34	27	23	19	2
.40	0	0	0	0	0	0	0	1	2	6	14	26	45	100	159	200	212	199	174	138	112	89	72	61	53	45	39	35	28	23	19	2
.50	0	0	0	0	0	0	0	0	1	2	5	11	21	60	116	170	203	209	192	156	124	97	76	64	55	47	41	36	29	24	19	3
.75	0	0	0	0	0	0	0	0	0	1	2	5	11	35	79	131	175	201	201	172	140	107	82	67	58	50	43	37	30	24	20	4
1.0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	23	57	105	153	186	198	172	131	95	75	63	54	47	41	32	25	20	7
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	24	54	96	157	189	174	127	94	74	63	54	46	35	28	21	12
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	24	69	127	182	167	124	93	74	62	53	40	31	22	15
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	35	99	176	167	129	96	76	63	46	35	23	16
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	34	107	171	161	125	94	75	53	40	25	17
IA/P = 0.50 — * * * TC = 1.25 HR * * * — IA/P = 0.50																																
0.0	0	0	0	0	0	0	0	1	4	10	21	36	55	95	123	138	131	122	114	104	95	86	78	70	62	55	49	44	36	32	27	1
.10	0	0	0	0	0	0	0	0	1	3	8	16	30	66	102	125	134	128	120	108	99	89	80	73	65	57	51	46	37	32	28	2
.20	0	0	0	0	0	0	0	0	0	2	6	13	24	57	94	120	132	130	122	110	101	91	81	73	66	58	51	46	37	33	28	2
.30	0	0	0	0	0	0	0	0	0	1	4	10	19	49	85	113	131	131	124	112	102	92	82	74	66	58	52	47	38	33	28	2
.40	0	0	0	0	0	0	0	0	0	1	3	8	16	42	76	106	126	130	125	114	104	93	83	75	67	59	52	47	38	33	28	3
.50	0	0	0	0	0	0	0	0	0	0	1	2	6	22	51	84	112	127	129	120	109	97	86	77	70	61	54	49	40	33	28	4
.75	0	0	0	0	0	0	0	0	0	0	0	1	3	12	32	61	91	113	125	123	114	101	89	80	72	64	56	50	41	34	28	5
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	22	47	76	102	122	124	111	96	85	76	69	61	54	43	36	29	9
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	22	43	82	111	121	109	95	84	76	68	60	48	39	30	16
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	9	30	63	104	118	107	94	83	75	67	53	43	31	21
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	20	58	104	116	106	93	83	74	59	47	33	23
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	19	64	104	114	104	92	82	65	52	35	24

RAINFALL TYPE = III * * * TC = 1.25 HR * * * SHEET 8 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

IA/P = 0.10 * * * TC = 1.5 HR * * * IA/P = 0.10

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	12	15	19	25	27	31	37	45	57	75	97	122	151	203	231	238	213	182	150	115	91	70	54	44	37	30	26	23	18	15	12	1
.10	10	13	17	21	23	26	29	34	41	52	67	87	111	165	210	233	227	205	173	131	102	77	58	46	39	32	27	24	19	15	12	1
.20	10	13	16	21	23	25	28	32	38	47	61	78	100	152	199	228	231	210	181	138	107	80	59	47	39	33	28	24	19	15	12	2
.30	9	12	15	20	22	24	27	30	36	44	55	70	90	139	188	221	228	215	188	145	112	83	61	48	40	33	28	24	19	15	12	2
.40	8	11	14	18	19	21	23	25	29	33	40	50	64	103	152	196	223	226	208	166	127	92	66	52	42	35	30	25	20	16	13	2
.50	8	10	13	17	18	20	22	24	27	31	37	46	58	93	140	186	216	224	212	173	133	96	69	53	43	36	30	26	20	16	13	3
.75	6	8	11	14	15	16	18	19	21	23	26	31	36	55	87	130	173	205	217	202	165	119	81	60	48	39	33	28	21	17	13	4
1.0	5	6	8	11	12	13	14	15	16	18	19	21	24	31	46	71	109	151	189	214	200	153	102	72	55	44	37	31	23	18	13	6
1.5	3	4	5	7	8	9	10	11	11	12	14	15	16	19	24	31	45	69	103	159	207	207	147	99	71	54	44	36	26	20	14	8
2.0	1	2	3	5	5	6	6	7	8	9	9	10	11	13	16	19	23	31	45	81	132	189	199	142	97	69	53	43	30	22	15	10
2.5	0	1	1	2	3	3	4	4	4	5	6	6	7	8	10	12	14	17	20	31	53	107	179	194	147	102	73	55	36	26	16	10
3.0	0	0	1	1	1	2	2	2	3	3	3	4	4	5	7	8	10	11	13	18	26	51	116	178	188	142	100	71	43	30	18	11

IA/P = 0.30 * * * TC = 1.5 HR * * * IA/P = 0.30

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	0	1	2	5	11	22	38	59	84	138	180	200	195	176	154	125	105	86	71	60	52	44	39	34	27	23	19	2
.10	0	0	0	0	0	0	0	1	4	9	18	31	50	99	149	184	198	190	170	139	115	93	75	63	55	47	40	35	28	23	19	3
.20	0	0	0	0	0	0	0	1	3	7	14	25	41	86	137	176	195	192	175	144	119	95	76	64	55	47	41	36	28	24	19	3
.30	0	0	0	0	0	0	0	0	1	2	5	11	21	53	100	147	181	194	187	159	130	103	81	68	58	50	43	37	29	24	19	4
.40	0	0	0	0	0	0	0	0	0	2	4	9	17	45	88	136	172	192	189	164	135	106	83	69	59	51	43	38	30	24	20	4
,50	0	0	0	0	0	0	0	0	0	0	1	3	7	23	56	101	145	177	190	177	149	116	89	73	62	53	45	39	31	25	20	6
.75	0	0	0	0	0	0	0	0	0	0	0	1	3	13	35	71	113	151	176	184	162	128	97	77	65	55	48	41	32	26	20	7
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	24	53	92	132	174	182	153	114	88	72	61	52	45	34	27	21	10
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9	24	50	103	152	175	148	112	87	71	60	51	38	30	22	14
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	24	62	127	170	151	116	89	73	61	45	34	23	16
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	16	58	131	165	146	113	88	72	52	39	25	16
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	67	134	161	142	111	87	60	44	27	17

IA/P = 0.50 * * * TC = 1.5 HR * * * IA/P = 0.50

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0,0	0	0	0	0	0	0	0	1	2	6	13	22	34	65	94	114	129	122	117	108	100	91	81	74	66	58	52	46	38	33	28	2
.10	0	0	0	0	0	0	0	0	0	2	5	10	18	42	73	99	116	126	121	112	104	94	84	76	68	60	53	48	39	33	28	3
.20	0	0	0	0	0	0	0	0	0	1	4	8	15	36	65	93	112	123	122	113	105	95	85	77	69	61	54	48	39	34	28	4
.30	0	0	0	0	0	0	0	0	0	0	1	3	6	20	44	72	97	114	122	118	109	99	88	79	71	63	56	50	41	34	28	5
.40	0	0	0	0	0	0	0	0	0	0	1	2	5	16	38	65	91	110	121	119	110	100	89	80	72	64	57	51	41	34	29	5
.50	0	0	0	0	0	0	0	0	0	0	0	1	4	13	33	59	85	105	118	120	112	101	90	81	73	65	57	51	41	35	29	6
.75	0	0	0	0	0	0	0	0	0	0	0	1	2	7	20	41	66	89	107	118	115	105	93	83	75	67	60	53	43	35	29	8
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	14	31	53	78	106	117	113	100	89	80	72	64	57	46	37	30	12
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	14	29	60	91	115	111	99	88	79	71	63	50	41	31	18
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	20	45	85	113	109	98	87	78	70	56	45	32	22
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	13	42	87	111	107	97	86	78	62	49	34	24
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	39	82	109	109	98	87	70	56	37	25

RAINFALL TYPE = III * * * TC = 1.5 HR * * * SHEET 9 OF 10

Exhibit 5-III: Tabular hydrograph unit discharges (csm/in) for type III rainfall distribution—continued

TRVL TIME (hr)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10														* * * TC = 2.0 HR * * *														IA/P = 0.10				
0.0	9	11	15	19	21	23	27	31	39	48	60	75	91	129	164	187	200	191	178	147	119	92	69	55	45	37	31	26	20	16	13	3
.10	8	10	13	17	18	20	22	25	29	36	44	55	68	101	139	170	189	197	188	163	132	101	75	59	47	39	33	28	21	17	13	3
.20	7	10	13	16	18	19	21	24	28	33	40	50	62	93	129	162	185	195	190	168	137	104	77	60	48	40	33	28	21	17	13	4
.30	7	9	12	15	17	18	20	23	26	31	37	46	56	85	120	154	179	193	191	172	142	108	80	62	49	41	34	29	21	17	13	4
.40	6	8	11	14	15	16	18	19	22	25	29	34	42	64	94	129	161	183	192	183	157	120	87	66	53	43	36	30	22	17	13	5
.50	6	8	10	13	14	16	17	19	21	23	27	32	38	58	87	121	153	177	191	185	162	124	90	68	54	44	36	31	22	18	13	5
.75	5	6	8	11	12	13	14	15	16	18	20	23	26	37	55	81	113	144	169	186	179	147	106	78	61	49	40	33	24	19	14	6
1.0	4	5	7	9	10	11	12	13	14	15	17	18	20	27	38	56	82	113	143	176	185	164	121	88	67	53	43	36	26	20	14	7
1.5	2	3	4	5	6	7	7	8	9	10	10	11	12	15	18	23	31	45	65	106	148	180	166	126	92	69	55	44	31	23	15	9
2.0	1	1	2	3	4	4	5	5	6	6	7	8	8	10	12	14	18	23	31	52	87	139	176	160	122	90	68	54	36	26	16	10
2.5	0	0	1	2	2	2	2	3	3	4	4	5	5	6	7	9	11	13	16	22	36	71	132	172	161	126	94	71	45	31	18	11
3.0	0	0	0	1	1	1	1	1	2	2	2	3	3	4	5	6	7	9	10	14	19	35	78	136	168	156	123	92	54	36	20	11
IA/P = 0.30														* * * TC = 2.0 HR * * *														IA/P = 0.30				
0.0	0	0	0	0	0	0	1	2	6	11	18	29	41	75	111	140	159	170	163	145	124	103	84	70	60	51	44	39	30	25	20	4
.10	0	0	0	0	0	0	0	1	2	4	9	15	24	50	84	118	145	160	167	155	134	110	89	74	63	54	46	40	31	25	20	5
.20	0	0	0	0	0	0	0	0	1	3	7	12	20	43	76	110	138	157	165	157	138	113	91	75	64	55	47	41	32	26	20	5
.30	0	0	0	0	0	0	0	0	1	3	5	10	17	38	68	101	131	152	164	159	141	116	93	77	65	56	48	41	32	26	20	6
.40	0	0	0	0	0	0	0	0	0	1	2	4	8	22	45	76	109	137	155	163	151	125	99	81	68	58	50	43	33	26	20	7
.50	0	0	0	0	0	0	0	0	0	1	1	3	7	18	39	69	101	130	151	162	153	128	101	83	69	59	51	44	34	27	20	7
.75	0	0	0	0	0	0	0	0	0	0	0	1	2	6	17	36	63	93	122	151	158	143	114	92	76	64	55	47	36	28	21	9
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	18	37	63	93	132	157	153	125	100	82	68	58	50	38	29	21	11
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	12	26	59	100	142	154	128	102	83	70	59	44	34	23	15
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	18	43	93	142	150	125	101	82	69	50	38	24	16
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	12	41	98	141	147	122	99	81	58	43	26	17
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	38	92	135	144	124	102	69	50	30	18
IA/P = 0.50														* * * TC = 2.0 HR * * *														IA/P = 0.50				
0.0	0	0	0	0	0	0	0	0	1	3	6	11	16	33	54	75	91	102	114	114	103	96	87	79	72	64	57	51	41	35	29	6
.10	0	0	0	0	0	0	0	0	1	2	5	9	14	29	49	70	87	99	106	113	104	97	88	80	72	65	58	52	42	35	29	6
.20	0	0	0	0	0	0	0	0	0	1	2	4	7	18	34	54	74	90	101	112	107	99	90	82	75	67	60	53	43	36	29	8
.30	0	0	0	0	0	0	0	0	0	0	1	3	6	15	30	49	69	86	98	111	108	100	91	83	75	68	60	54	43	36	29	8
.40	0	0	0	0	0	0	0	0	0	0	0	1	2	8	19	35	55	73	89	105	110	103	94	86	78	70	62	56	45	37	30	10
.50	0	0	0	0	0	0	0	0	0	0	0	1	2	6	16	31	50	69	85	102	109	104	95	86	78	71	63	56	45	37	30	11
.75	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	21	37	55	73	93	107	107	97	89	81	73	65	58	47	38	30	13
1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	15	29	46	72	93	107	103	94	86	78	70	62	50	40	31	16
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	15	34	59	89	105	101	93	85	77	69	55	44	32	21
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	25	55	90	104	100	92	84	76	61	49	34	23
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	24	59	91	103	99	91	83	68	54	36	25
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	28	62	91	101	98	90	75	60	39	26

RAINFALL TYPE = III * * * TC = 2.0 HR * * * SHEET 10 OF 10

Chapter 6 Storage Volume for Detention Basins

As rural areas become urbanized, the resulting increases in peak discharges can adversely affect downstream flood plains. Increasingly, planners, developers, and the public want these downstream areas to be protected. Many local governments are adopting ordinances to control the type of development and its allowable impacts on the watershed. One of the most common controls requires that postdevelopment discharges do not exceed present-condition discharges for one or more storm frequencies at specified points along a channel.

This chapter discusses ways to manage peak discharges by delaying runoff. It also presents a procedure for estimating the storage capacity required to maintain the peaks within a specified level.

Efforts to reduce the effects of increased runoff from urban areas have been innovative and diverse. Many methods have been used effectively, such as infiltration trenches, porous pavement, rooftop storage, and cisterns. But these solutions can be expensive or require site conditions that cannot be provided.

The detention basin is the most widely used measure for controlling peak discharge. It is generally the least expensive and most reliable of the measures that have been considered. It can be designed to fit a wide variety of sites and can accommodate multiple-outlet spillways to meet requirements for multifrequency control of outflow. Measures other than a detention basin may be preferred in some locations; their omission here is not intended to discourage their use. Any device selected, however, should be assessed as to its function, maintenance needs, and impart.

Estimating the effect of storage

When a detention basin is installed, hydrologic routing procedures can be used to estimate the effect on hydrographs. Both the TR-20 (SCS 1983) and DAMS2 (SCS 1982) computer programs provide accurate methods of analysis. Programmable calculator and computer programs are available for routing hydrographs through dams.

This chapter contains a manual method for quick estimates if the effects of temporary detention on peak discharges. The method is based on average storage and routing effects for many structures.

Figure 6-1 relates two ratios: peak outflow to peak inflow discharge (q_o/q_i) and storage volume runoff volume (V_s/V_r) for all rainfall distributions.

The relationships in figure 6-1 were determined on the basis of single stage outflow devices. Some were controlled by pipe flow, others by weir flow. Verification runs were made using multiple stage outflow devices, and the variance was similar to that in the base data. The method can therefore be used for both single- and multiple-stage outflow devices. The only constraints are that (1) each stage requires a design storm and a computation of the storage required for it and (2) the discharge if the upper stage(s) includes the discharge of the lower stage(s).

The brevity of the procedure allows the planner to examine many combinations of detention basins. When combined with the Tabular Hydrograph method, the procedure's usefulness is increased. Its principal use is to develop preliminary indications of storage adequacy and to allocate control to a group of detention basins. It is also adequate, however, for final design of small detention basins.

Input requirements and procedures

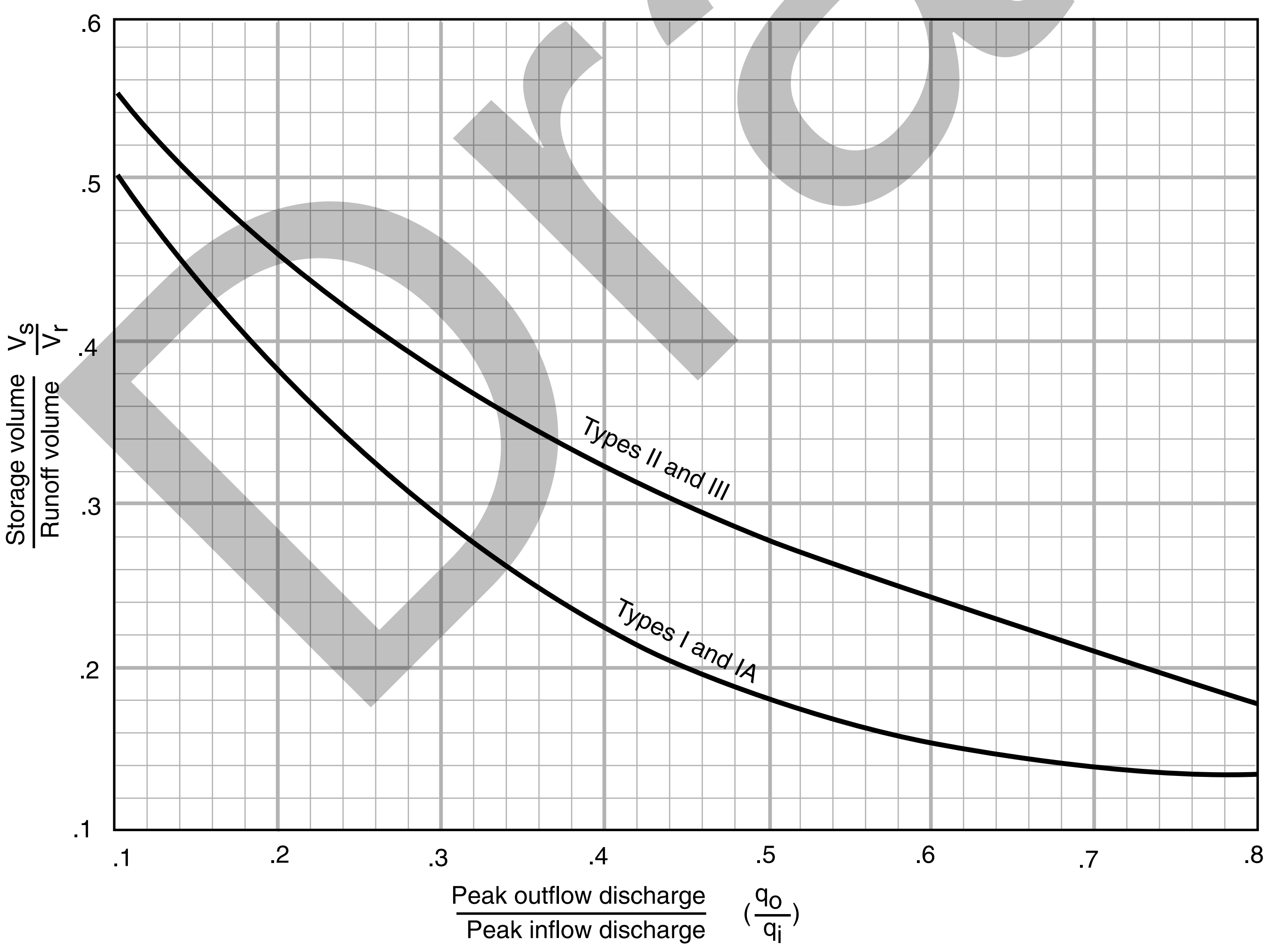
Use figure 6-1 estimate storage volume (V_s) required or peak outflow discharge (q_o). The most frequent application is to estimate V_s, for which the required inputs are runoff volume (V_r), q_o, and peak inflow discharge (q_i). To estimate q_o, the required inputs are V_r, V_s, and q_i.

Estimating V_s

Use worksheet 6a to estimate V_s, storage volume required, by the following procedure.

1. Determine q_o. Many factors may dictate the selection of peak outflow discharge. The most common is to limit downstream discharges to a desired level, such as predevelopment discharge. Another factor may be that the outflow device has already been selected.
2. Estimate q_i by procedures in chapters 4 or 5. Do not use peak discharges developed by other procedure. When using the Tabular Hydrograph method to estimate q_i for a subarea, only use peak discharge associated with $T_t = 0$.

Figure 6-1 Approximate detention basin routing for rainfall types I, IA, II, and III



3. Compute q_o/q_i and determine V_s/V_r from figure 6-1.
4. Q (in inches) was determined when computing q_i in step 2, but now it must be converted to the units in which V_s is to be expressed—most likely, acre-feet or cubic feet. The most common conversion of Q to V_r is expressed in acre-feet:

$$V_r = 53.33Q(A_m) \qquad \text{[eq. 6-1]}$$

where
V_r = runoff volume (acre-ft)
Q = runoff (in)
A_m = drainage area (mi^2), and
53.33 = conversion factor from in-mi^2 to acre-ft.

5. Use the results of steps 3 to 4 to compute V_s:

$$V_s = V_r \left(\frac{V_s}{V_i} \right) \qquad \text{[eq. 6-2]}$$

where
V_s = storage volume required (acre-ft).

6. The stage in the detention basin corresponding to V_s must be equal to the stage used to generate q_o. In most situations a minor modification of the outflow device can be made. If the device has been preselected. repeat the calculations with a modified q_o value.

Estimating q_o

Use worksheet 6b to estimate q_o, required peak outflow discharge, by the following procedure.

1. Determine V_s. If the maximum stage in the detention basin is constrained, set V_s by the maximum permissible stage.
2. Compute Q (in inches) by the procedures in chapter 2, and convert it to the same units as V_s (see step 4 in "estimating V_s").
3. Compute V_s/V_r and determine q_o/q_i from figure 6-1.
4. Estimate q_i by the procedures in chapters 4 or 5. Do not use discharges developed by any other method. When using Tabular method to estimate q_i for a subarea, use only the peak discharge associated with $T_t = 0$.
5. From steps 3 to 4, compute q_o:

$$q_o = q_i \left(\frac{q_o}{q_i} \right) \qquad \text{[eq. 6-3]}$$

6. Proportion the outflow device so that the stage at q_o is equal to the stage corresponding to V_s. If q_o cannot be calibrated except in discrete steps (i.e., pipe sizes), repeat the procedure until the stages for q_o and V_s are approximately equal.

Limitations

- This routing method is less accurate as the q_o/q_i ratio approaches the limits shown in figure 6-1. The curves in figure 6-1 depend on the relationship between available storage, outflow device, inflow volume, and shape of the inflow hydrograph. When storage volume (V_s) required is small, the shape of the outflow hydrograph is sensitive to the rate of the inflow hydrograph. Conversely, when V_s is large, the inflow hydrograph shape has little effect on the outflow hydrograph. In such instances, the outflow hydrograph is controlled by the hydraulics of the outflow device and the procedure therefore yields consistent results. When the peak outflow discharge (q_o) approaches the peak flow discharge (q_i) parameters that affect the rate of rise of a hydrograph, such as rainfall volume, curve number, and time of concentration, become especially significant.
- The procedure should not be used to perform final design if an error in storage of 25 percent cannot be tolerated. Figure 6-1 is biased to prevent undersizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and routing will often pay for itself through reduced construction costs.

Examples

Four examples illustrate the use of figure 6-1. Examples 6-1 through 6-4, respectively, show estimation of V_s of a two-stage structure, estimation of q_o, and use the Tabular Hydrograph method.

Example 6-1: Estimating V_s, single-stage structure

A development is being planned in a 75-acre (0.1170 mi^2) watershed that outlets into an existing concrete-lined channel designed for present conditions. If the channel capacity is exceeded, damages will be substantial. The watershed is in the type II storm distribution region. The present channel capacity, 180 cfs, was established by computing discharge for the 25-year-frequency storm by the Graphical Peak Discharge method (chapter 4).

The developed-condition peak discharge (q_i) computed by the same method is 360 cfs, and runoff (Q) is 3.4 inches. Since outflow must be held to 180 cfs, a detention basin having that maximum outflow discharge (q_o) will be built at the watershed outlet.

How much storage (V_s) will be required to meet the maximum outflow discharge (q_o) of 180 cfs, and what will be the approximate dimensions of a rectangular weir outflow structure? Figure 6-2 shows how worksheet 6a is used to estimate required storage (V_s = 5.9 acre-ft) and maximum stage (E_{max} = 105.7 ft).

The rectangular weir was chosen for its simplicity; however, several types of outlets can meet the outflow device proportion requirement. Most hydraulic references, along with considerable research data that are available, provide more guidance on variations of outlet devices that can be summarized here.

An outlet device should be proportioned to meet specific objectives. A single-stage device was specified in this example because only one storm was considered. A weir is suitable here because of the low head. The weir crest elevation is 100.00 ft.

Using V_s = 5.9 acre-ft (figure 6-2, step 9) and the elevation-storage curve, the maximum stage (E_{max}) is 105.7 ft.

The rectangular weir equation is

$$q_o = 3.2 L_w H_w^{1.5} \qquad \text{[eq. 6-4]}$$

where

q_o = peak outflow discharge (cfs)
L_w = weir crest length (ft)
H_w = head over weir crest (ft)

H_w and q_o are computed as follows:

H_w = E_{max} – weir crest elevation
= 105.7 - 100.0 = 5.7 ft.

Since q_o is known to be 180 cfs, solving equation 6-4 for L_w yields

$$L_w = \frac{q_o}{3.2 H_w^{1.5}} = \frac{180}{3.2(5.7)^{1.5}} = 4.1 \text{ ft} \qquad \text{[eq. 6-5]}$$

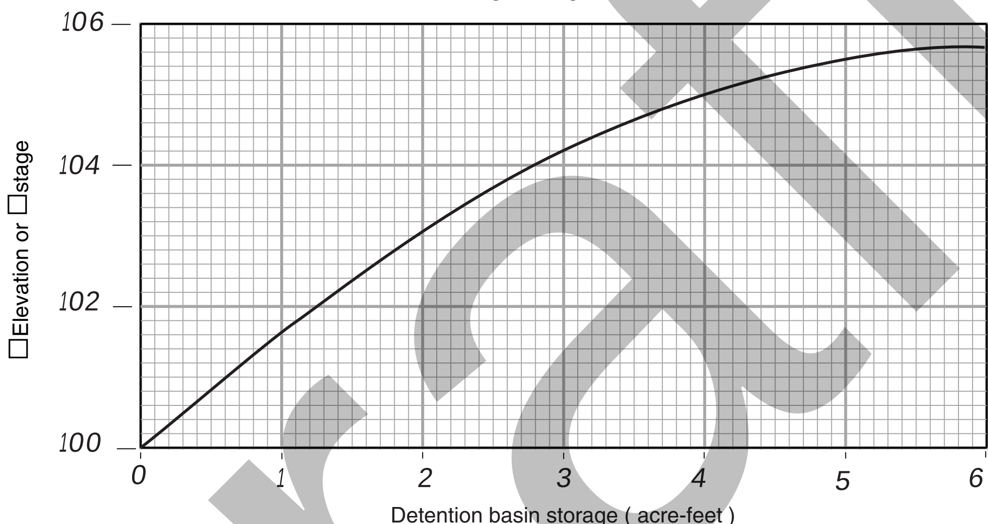
In summary, the outlet structure is a rectangular weir with crest length of 4.1 ft, H_w = 5.7 ft, and q_o = 180 cfs corresponding to a V_s = 5.9 acre-ft.

Figure 6-2 Worksheet 6a for example 6-1

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project *Robbinsville*	By *SWR*	Date *11/5/85*
Location *Dyer County, Tennessee*	Checked *RGC*	Date *11/8/85*

Check one: ☐ Present ☒ Developed *Single stage structure*



1. Data:
   Drainage area .... A_m = *0.117* mi²
   Rainfall distribution type (I, IA, II, III) = *II*

	1st Stage	2nd Stage
2. Frequency .... yr	*25*	
3. Peak inflow discharge q_i ....cfs (from worksheet 4 or 5b)	*360*	
4. Peak outflow discharge q_u .... cfs	*180*	1/
5. Compute $\frac{q_o}{q_i}$	*0.50*	
6. $\frac{V_s}{V_r}$ .... (Use $\frac{q_o}{q_i}$ with figure 6-1)	*0.28*	
7. Runoff, Q .... in (From worksheet 2)	*3.4*	
8. Runoff volume V_r .... ac-ft ($V_r = QA_m$ 53.33)	*21.2*	
9. Storage volume, V_s .... ac-ft ($V_s = V_r$ ($\frac{V_s}{V_r}$))	*5.9*	
10. Maximum storage E_{max} (from plot)	*105.7*	

1/ 2nd stage q_o includes 1st stage q_o.

Example 6-2 Estimating V_s, Two-stage structure

In addition to the requirements for a 25-year peak outflow discharge of 180 cfs stated in example 6-1, a decision was made to limit the 2-year outflow discharge to 50 cfs because of potential damages to agricultural property below the lined channel. by the method in chapter 4, the estimated 2-year peak discharge for developed conditions will be 91 cfs and runoff (Q) will be 1.5 inches.

Again, a rectangular concrete weir outlaw device was selected; the device could have been another type, but it is important to remember that the flows through the first stage are part of the total discharge of the higher stage.

Figure 6-3 shows how worksheet 6a is used to compute the V_s of 2.4 acre-ft and E_{max} of 103.6 for the stage. E_{max} of 103.6 is the weir crest elevation for the second stage.

Equation 6-5 is again used to compute L_w for the first stage. The weir crest elevation for the first stage is 100.00 ft and q_o = 50 cfs. The first-stage computations for H_w and L_w are

$$\begin{aligned} H_w &= E_{max} \text{ - weir crest elevation} \\ &= 103.6 - 100.0 = 3.6 \text{ ft;} \end{aligned}$$

and, from equation 6-5,

$$\begin{aligned} L_w &= \frac{50}{3.2(3.6)^{1.5}} \\ &= 2.3 \text{ ft} \end{aligned}$$

The second stage is then proportioned to discharge the correct amount at 105.7 feet (fig. 6-2, step 10). Compute the discharge through the first stage for elevation 105.7 feet using

$$L_w = 2.3 \text{ ft (first stage)}$$

and

$$H_w = 105.7 - 100.0 = 5.7 \text{ ft}$$

By substituting these values in equation 6-4, discharge (q_o) through the first stage at 105.7 feet is calculated:

$$\begin{aligned} q_o &= 3.2(2.3)(5.7)^{1.5} \\ &= 100 \text{ ft}^3/\text{s} \end{aligned}$$

Now compute the required weir crest length (L_w) for the second stage, using equation 6-5. Since the second stage crest elevation is 103.6 feet,

$$\begin{aligned} H_w &= 105.7 - 103.6 \\ &= 2.1 \text{ ft} \end{aligned}$$

and, since q_o for the second stage equals the total discharge from example 6-1 minus discharge through the first stage,

$$\begin{aligned} q_o &= 180 - 100 \\ &= 80 \text{ ft}^3/\text{s} \end{aligned}$$

Finally, substituting these H_w and q_o values in equation 6-5 results in

$$\begin{aligned} L_w &= \frac{80}{3.2(2.1)^{1.5}} \\ &= 8.2 \text{ ft} \end{aligned}$$

In summary, the outlet structure is a two-stage rectangular weir with first stage crest length of 2.3 feet at elevation 100.0, and second stage crest length of 8.2 feet at elevation 103.6 feet.

The weir equation used is probably less accurate for the two-stage example than for the single-stage example. The actual second-stage discharge will be slightly more that the one computed. but a discussion of hydraulics of outflow devices is outside the scope of this technical release. Example 6-2 is presented only to illustrate the interrelationship of outflow discharges and storage volume and to show how to develop preliminary estimates of storage requirements for two-stage outlet structures.

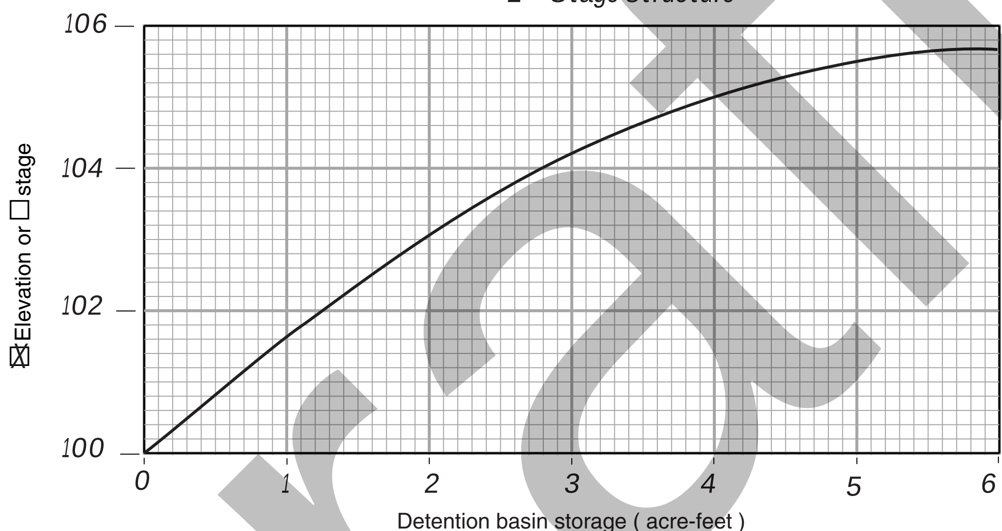
Figure 6-3 Worksheet 6a for example 6-2

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project *Robbinsville*	By *SWR*	Date *11/6/85*
Location *Dyer County, Tennessee*	Checked *RGC*	Date *11/9/85*

Check one: ☐ Present ☒ Developed

2 – Stage structure



1. Data:
   Drainage area .... A_m = *0.117* mi²
   Rainfall distribution type (I, IA, II, III) = *II*

	1st Stage	2nd Stage
2. Frequency .... yr	*2*	*25*
3. Peak inflow discharge q_i ....cfs (from worksheet 4 or 5b)	*91*	*360*
4. Peak outflow discharge q_o .... cfs	*50*	*180* [1]
5. Compute $\frac{q_o}{q_i}$	*0.55*	*0.50*
6. $\frac{V_s}{V_r}$ .... (Use $\frac{q_o}{q_i}$ with figure 6-1)	*0.26*	*0.28*
7. Runoff, Q .... in (From worksheet 2)	*1.5*	*3.4*
8. Runoff volume V_r .... ac-ft ($V_r = QA_m$ 53.33)	*9.4*	*21.2*
9. Storage volume, V_s .... ac-ft ($V_s = V_r (\frac{V_s}{V_r})$)	*2.4*	*5.9*
10. Maximum storage E_{max} (from plot)	*103.6*	*105.7*

[1] 2nd stage q_o includes 1st stage q_o

Example 6-3 Estimating q_o

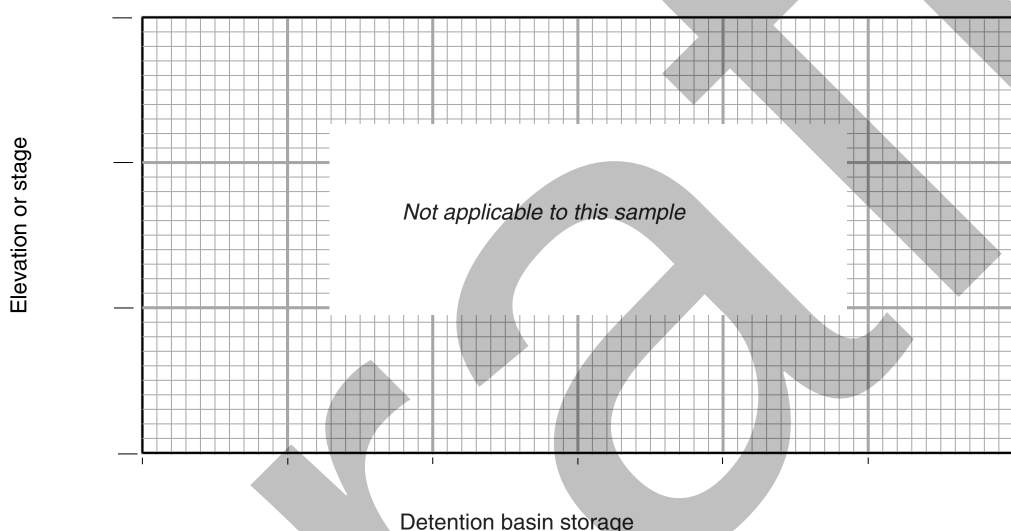
A development is being planned for a 10-acre watershed (0.0156 mi^2). A county ordinance requires that the developed-condition outflow from the watershed for 24-hr, 100-year frequency storm does not exceed the outflow for present conditions. The peak discharge from the watershed for present conditions, 35 cfs, is calculated from procedures in chapter 4. For developed conditions, runoff (Q) is 5.4 inches, peak discharge from the watershed is 42 cfs from procedures in chapter 4, and rainfall distribution is type II.
What will be the peak outflow discharge (q_o) from a detention basin that is located at the outlet and has maximum allowable storage volume (V_s) of 35,000 ft^3 and peak inflow discharge (q_i) of 42 cfs? Figure 6-4 shows how worksheet 6b is used to estimate qo as 33 cfs, which is within the 35 cfs limit. An outflow device will be selected to discharge 33 cfs at a stage corresponding to a V_s of 35,000 ft^3.

Figure 6-4 Worksheet 6b for example 6-3

Worksheet 6b: Detention basin storage, storage volume (V_s) known

Project *Woods Acres*	By *SWR*	Date *11/8/85*
Location *Dyer county, Tennessee*	Checked *RGC*	Date *11/11/85*

Check one: ☐ Present ☒ Developed



1. Data:
   Drainage area .... A_m = *0.0156* mi^2
   Rainfall distribution type (I, IA, II, III) = *II*

	1st Stage	2nd Stage
2. Frequency .... yr	*100*	
3. Storage volume V_s .... ac-ft	*0.8*	
4. Runoff, Q .... in (from worksheet 2)	*5.4*	
5. Runoff volume ..... ac-ft ($V_r = QA_m$ 53.33)	*4.5*	
6. Compute $\frac{V_s}{V_r}$	*0.18*	
7. $\frac{q_o}{q_i}$ .... in (Use $\frac{V_s}{V_r}$ with figure 6-1)	*0.78*	
8. Peak inflow discharge q_i .... in (From worksheet 4 or 5b)	*42*	
9. Peak outflow discharge q_o .... cfs 1/ ($q_o = q_i \left(\frac{q_o}{q_i}\right)$)	*33*	
10. Maximum storage E_{max} (from plot)	*N/A*	

1/ 2nd stage q_o includes 1st stage q_o

Example 6-4 Estimating V_S, Tabular Hydrograph method

This example builds on examples 5-1 and 5-2. If peak outflow discharge from subarea 7 must not exceed the discharge for present conditions, what will be the storage volume (V_s) required in a detention basin at the outlet of subarea 6?

First, compute the outflow hydrograph without subarea 6 as shown in the table below, which presents developed-condition discharges for example 5-2. (The information in the table is from figure 5-4.)

	Discharge (cfs) at time (hr)								
Sub area	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0
	cfs								
1	7	9	11	16	24	40	78	122	155
2	7	9	12	20	33	55	96	132	132
3	14	29	58	89	106	102	74	46	25
4	19	32	63	114	169	207	193	143	83
5	117	167	205	214	202	175	132	99	70
6 omitted	—	—	—	—	—	—	—		
7	244	167	119	90	72	59	48	40	34
Total without subarea 6	408	413	468	543	606	638	621	582	499

After computing the outflow hydrograph, determine the maximum permissible outflow discharge from subarea 6. The present condition peak discharge at the outlet of subarea 7 is 750 cfs at 14.3 hr (figure 5-2), and the developed condition peak discharge at the outlet of subarea 7 minus subarea 6 is 638 cfs (table above). The difference between these two discharges, 82 cfs, is the maximum outflow discharge (q_o) for the detention basin.

Next, determine the peak discharge for subarea 6 for developed conditions by substituting values in equation 5-1:

$$q = q_t A_m Q \qquad \text{[eq 5-1]}$$

From exhibit 5-II, the largest q_t value is 357 csm/in (exhibit 5-II, sheet 7: $T_c = 1.0$ hr, $T_t = 0$, and $I_a / P = 0.10$ at 12.8 hr). From figure 5-4, $A_m Q$ for subarea 6 is 1.31. Therefore,

$$q = (357)\,(1.31) = 468 \text{ cfs}$$

This q value is, of course, the same as the peak inflow discharge (q_i) into the detention basin.

Finally, use worksheet 6a (fig. 6-5) to compute Vs as 33.2 acre-feet.

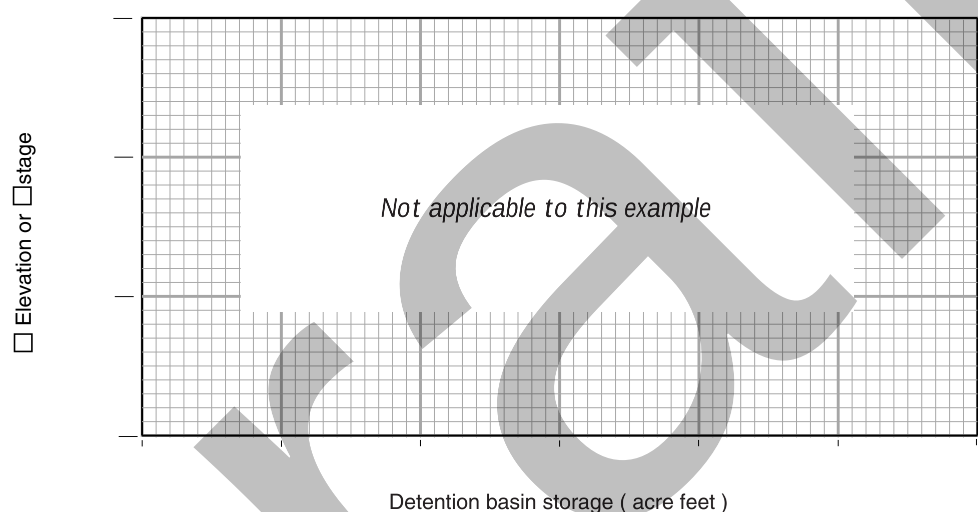
The required storage volume of 33.2 acre-feet is the basis for determining the required stage in the detention basin. This stage is a guide proportioning a spillway that will discharge 82 cfs or less at that storage. The timing or routing effect is not considered because the outflow hydrograph will discharge at near q_o for a significant period.

Figure 6-5 Worksheet 6a for example 6-4

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project *Fallswood*	By *SWR*	Date *11/8/85*
Location *Dyer county, Tennessee*	Checked *RGC*	Date *11/10/85*

Check one: ☐ Present ☒ Developed



1. Data:
   Drainage area .... A_m = *0.40* mi²
   Rainfall distribution type (I, IA, II, III) = *II*

	1st Stage	2nd Stage
2. Frequency .... yr	*25*	
3. Peak inflow discharge q_i .... cfs (from worksheet 4 or 5b)	*468*	
4. Peak outflow discharge q_u .... cfs	*82*	1/
5. Compute $\frac{q_o}{q_i}$	*0.175*	
6. $\frac{V_s}{V_r}$ .... (Use $\frac{q_o}{q_i}$ with figure 6-1)	*0.475*	
7. Runoff, Q .... in (From worksheet 2)	*3.28*	
8. Runoff volume V_r.................. ac-ft ($V_r = QA_m$ 53.33)	*69.9*	
9. Storage volume, V_s .... ac-ft ($V_s = V_r$ ($\frac{V_s}{V_r}$))	*33.2*	
10. Maximum storage E_{max} (from plot)	*N/A*	

1/ 2nd stage q_o includes 1st stage q_o.

Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred (Brakensiek and Rawls 1983).

HSG	*Soil textures*
A	Sand, loamy sand, or sandy loam
B	Silt loam or loam
C	Sandy clay loam
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay

Drainage and group D soils

Some soils in the list are in group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in a different group. For example, Ackerman soil is classified as A/D. This indicates that the drained Ackerman soil is in group A and the undrained soil is in group D.

Exhibit A: Hydrologic Soil Groups for the United States

AABAB	D
AABERG	D
AARON	C
AARUP	D
AASTAD	B
AAZDAHL	B
ABAC	D
ABAJO	C
ABALAN	D
ABALOBADIAH	B
ABARCA	B
ABBAYE	B
ABBEYLAKE	A
ABBIE	B
ABBOTT	D
ABBOTTSPRING	B
ABBOTTSTOWN	C
ABEGG	B
ABELA	B
ABELL	B
ABENAKI	B
ABERDEEN	C
ABERONE	B
ABERSITO	C
ABERT	B
ABES	D
ABGESE	B
ABILENE	C
ABIN	B
ABIQUA	B
ABIQUA, Flooded	C
ABIQUIU	C
ABITA	C
ABO	C
ABOR	D
ABORIGINE	D
ABOTEN	D
ABRA	B
ABRACON	B
ABRAM	D
ABRAZO, Gravelly	C
ABRAZO	D
ABREU	B
ABRIGO	B
ABSAQUIL	B
ABSAROKEE	C
ABSAROOK Cool	B
ABSAROOK	C
ABSAY	D
ABSCO	A
ABSCOTA	A
ABSHER	D
ABSTON	C
ACACIO	B
ACADEMY	C
ACADIA	D
ACADIANA	D
ACAMPO	C
ACANA	D
ACANOD	C
ACASCO	D
ACCELERATOR	B
ACCOLA	B
ACEITUNAS	B
ACEL	C
ACHELAKE	B
ACHIMIN	C
ACKELTON	B
ACKER	B
ACKERMAN	A/D
ACKETT	D
ACKLEY	B
ACKMEN	B
ACKMEN, Wet	C
ACKMORE, Poorly Drained	B
ACKNA	B
ACKWATER	D
ACME	C
ACO	B
ACOMA	C
ACORD	C
ACOVE	C
ACREE	C
ACRELANE	C
ACTEM	D
ACTI	D
ACTON	B
ACUFF	B
ACUNA	C
ACY	C
ADA	C
ADABOI	C
ADAIR	C
ADAMANT	B
ADAMS	A
ADAMSLAKE	B
ADAMSON	B
ADAMSVILLE	C
ADATON	D
ADAVEN	C
ADCO	D
ADDER	A/D
ADDERTON	B
ADDICKS	D
ADDIELOU	B
ADE	A
ADEK	B
ADEL	B
ADEL, Wet	D
ADELAIDE	D
ADELANTO	B
ADELINO	B
ADELINO, Saline-Alkali	C
ADELMANN	C
ADELPHIA	B/D
ADEN	C
ADENA	C
ADGER	D
ADIEUX	B
ADILIS	B
ADINOT	D
ADIOS	D
ADIRONDACK	D
ADJIDAUMO	D
ADJUNTAS	C
ADKINS	B
ADLER	C
ADMAN	D
ADOBE	D
ADOLPH	B/D
ADOS	C
ADRIAN	A/D
ADVOKAY	D
ADWELL	C
ADY	B
ADYEVILLE	C
AECET	C
AENEAS	B
AETNA	C
AFFEY	C
AFLEY	B
AFLEY, Extremely Stony	C
AFTAD	B
AFTADEN	D
AFTON	C/D
AGA	C
AGAN	D
AGAR	B
AGASSIZ	D
AGATE	D
AGATHA	B
AGAWAM	B
AGEE	D
AGENCY	B
AGENCY, Stony	C
AGERDELLY	D
AGFAYAN	D
AGNAL	D
AGNESS	B
AGNEW	C
AGNOS	D
AGON	C
AGORT	C
AGRA	D
AGUA	B
AGUA DULCE	B
AGUA FRIA	C
AGUADILLA	A
AGUALT	B
AGUEDA	B
AGUILARES	B
AGUILITA	B
AGUIRRE	D
AGUSTIN	B
AHART	B
AHCHEW	D
AHL	C
AHLSTROM	D
AHMEEK	C
AHOLT	D
AHPAH	C
AHREN	B
AHRNKLIN	C
AHRS	B
AHSAHKA	C
AHTANUM	C/D
AHWAHNEE	B
AIBONITO	D
AIDO	D
AIKEN	B
AIKMAN	D
AILEY	B
AIMELIIK	B
AINAKEA	B
AINSLEY	B
AINSWORTH	B
AIRMONT	C
AIRPORT, Wet	C
AIRPORT	D
AITS	B
AJAX	D
AJO	C
AJOLITO	D
AKAD	C
AKAKA	A
AKAN	B/D
AKASKA	B
AKBASH	B
AKELA	D
AKELEY	A
AKERCAN	B
AKERITE	B
AKERS	B
AKERUE	D
AKHONI	D
AKINA	B
AKINVILLE	B
AKLER	D
AKSARBEN	B
ALABASTER	D
ALADDIN	B
ALADSHI	B
ALAE	A
ALAELOA	B
ALAGA	A
ALAKAI	D
PARANAT	C
ALAMA	B
ALAMADITAS	C
ALAMANCE	B
ALAMBIQUE	B
ALAMEDAWELL	B
ALAMO	D
ALAMOGORDO	B
ALAMUCHEE	B
ALANGO	D
ALANOS	B
ALANOS, Cool	D
ALAPAHA	B/D
ALAPAI	A
ALAZAN	C
ALBAN	B
ALBANO	D
ALBANY	C
ALBATON	D
ALBEE	C
ALBEMARLE	B
ALBERS	D
ALBERTI	C
ALBERTON	B
ALBERTVILLE	C
ALBICALIS	D
ALBINAS	B
ALBION	B
ALBRIGHTS	C
ALBURZ	B/C
ALBUS	B
ALCALDE	D
ALCAN	D
ALCESTER	B
ALCOA	B
ALCONA	B
ALCOT	A
ALCOVA	B
ALCOVY	C
ALDA, Saline	B/D
ALDA	C
ALDAPE	D
ALDAX	D
ALDEN	D
ALDENLAKE	B
ALDER	C
ALDERDALE	C
ALDERFLATS	D
ALDERMAND	B
ALDERON	B
ALDERWOOD	C
ALDI	D
ALDINE	D
ALDING	D
ALDINO	C
ALDO	A
ALDRICH	C
ALEDO	C
ALEGROS	C
ALEKNAGIK	C
ALEMEDA	C
ALESNA	C
ALEX	B
ALEX, Wet Substratum	C
ALEXANDER	C
ALEXANDRIA	C
ALFLACK	C
ALFORD	B
ALGARROBO	A
ALGIERS	C/D
ALGOA	C
ALGOMA	D
ALIBATES	B
ALIBI	C
ALICEL	B
ALICIA	B
ALIDA	B
ALIKCHI	B
ALINE	A
ALIRE	B
ALIVAR	B
ALKABO	C
ALKIRIDGE	C
ALLAGASH	B
ALLAMORE	D
ALLANTON	B/D
ALLARD	B
ALLDOWN	C
ALLEN	B
ALLENDALE	C
ALLENS PARK	B
ALLENS PARK, Stony	C
ALLENTINE	D
ALLENWOOD	B
ALLHANDS	D
ALLINGHAM	B
ALLIS	D
ALLIVAR	B
ALLKER	B
ALLOUEZ	B
ALLOWAY	B
ALLUVIAL LAND	A
ALLWIT	D
ALMAC	B
ALMAVILLE	D
ALMIRANTE	B
ALMO	D
ALMOND	C
ALMONT	D
ALMORA	B
ALNITE	D
ALNULT	B
ALOGIA	C
ALOHA	C
ALOMAX	D

Exhibit A: Hydrologic Soil Groups for the United States

ALONA	B
ALONEMILL	B
ALONSO	B
ALONZEVILLE	B
ALOVAR	C
ALPENA	A
ALPHA	B
ALPIN	A
ALPINEPEAK	C
ALPON	B
ALPOWA	B
ALRED	B
ALROS	C
ALS	A
ALSASH	B
ALSCO	B
ALSEA	B
ALSPAUGH	C
ALSTAD	C
ALSTONY	B
ALSTOWN	B
ALSUP	C
ALTA	B
ALTAMONT	D
ALTAPEAK	B
ALTAR	B
ALTASLOUGH	C
ALTAVISTA	C
ALTDORF	D
ALTHOUSE	B
ALTICREST	C
ALTITA	C
ALTMAR	B
ALTO	C
ALTOGA	C
ALTON	A
ALTUDA	D
ALTURAS	C
ALTUS	B
ALTVAN	B
ALUF	A
ALUM	B
ALUSA	D
ALVADA	B/D
ALVARADO	B
ALVIN	B
ALVISO	D
ALVODEST	D
ALVOR	D
ALWILDA	B
ALZADA	D
ALZOLA	C
AMABILIS	C
AMADON	D
AMADOR	D
AMAGON	D
AMAL	B
AMALIA	B
AMALU	D
AMANA	B
AMANDA	C
AMARILLO	B
AMASA	B
AMBER	B
AMBIA	D
AMBOAT	D
AMBOY	C
AMBRANT	B
AMBRAW	B/D
AMBROSIA	A
AMCEC	B
AMELAR	B
AMELIA	C
AMENE	D
AMENIA	B
AMENSON	D
AMERICANOS	B
AMERICUS	A
AMERIMINE	B
AMERY	B
AMES	C/D
AMESHA	B
AMHERST	D
AMIRET	B
AMISTAD	D
AMITY	D
AMMON	B
AMNICON	D
AMODAC	C
AMOLE	C
AMOR	B
AMORUS	D
AMOS	C
AMOSTOWN	C
AMPAD	C
AMPHION	C
AMSDEN	B
AMSTERDAM	B
AMTOFT	D
AMUZET	A
AMUZET, Gravelly	B
AMWELL	C
AMY	D
ANACAPA	B
ANACOCO	D
ANACONDA	B
ANAHEIM	C
ANAHUAC	D
ANALULU	B
ANAMAC	B
ANAMITE	D
ANAN	D
ANAPRA	B
ANASAZI	C
ANATOLIAN	C
ANATONE	D
ANAUD	D
ANAVERDE	B
ANAWALT	D
ANCENY	B
ANCHO	B
ANCHO, Saline	C
ANCHOR POINT	D
ANCHORAGE	A
ANCHUSTEQUI	D
ANCHUTZ	B
ANCLOTE	B/D
ANCO	C
ANDERGEORGE	B
ANDERLY	C
ANDERSON	B
ANDERSON, Hard Substratum	C
ANDOK	B
ANDOVER	D
ANDRADA	D
ANDREGG	B
ANDRES	C
ANDREWS	C
ANDRUSIA	A
ANDRY	D
ANDYS	B
ANED	D
ANELA	B
ANGELICA	B/D
ANGELINA	D
ANGELPEAK	B
ANGELUS	B
ANGIE	D
ANGLE	A
ANGLEN	C
ANGOLA	C
ANGORA	B
ANGUS	B
ANHALT	D
ANIAK	D
ANIGON	B
ANIMAS	C
ANNABERG	D
ANNAHOOTZ	A
ANNALAKE	B
ANNAROSE	B
ANNAW	B
ANNEMAINE	C
ANNISQUAM	C
ANNISTON	B
ANNLAKE	B/D
ANNONA	D
ANNROMA	D
ANNUM	B
ANOCON	C
ANOKA	B
ANONES	C
ANOWELL	D
ANSGAR	B/D
ANSPING	B
ANT FLAT	D
ANTARES	A
ANTARES	C
ANTELOPE SPRINGS	D
ANTERO	D
ANTHOLOP	D
ANTIGO	B
ANTILON	C
ANTIOCH	D
ANTOINE	B
ANTOKEN	C
ANTON	D
ANTONITO	C
ANTOSA	B
ANTWERP	C
ANUNDE	B
ANVIL	C
APALACHEE	D
APALO	B
APELDORN	D
APEX	B
APISON	B
APMAT	B
APMAY	B
APOLLO	B
APOPKA	A
APPAM	B
APPANOOSE	D
APPERSON	C
APPLEDELLIA	C
APPLEGATE	C
APPLERIVER	B
APPLESEED	D
APPLESHALL	D
APPLING	B
APPOMATTOX	B
APPOQUINMINK	D
APRON	B
APT	B
APTAKISIC	B
APTOS	C
AQUANDIC HUMAQUEPTS	C
AQUARIUS	C
AQUATNA	D
AQUILLA	A
AQUIMA	B
AQUINAS	C
ARADA	B
ARADARAN	C
ARAGON	C
ARAMBURU	C
ARAPAHOE	B/D
ARARAT	B
ARAT	D
ARAVAIPA	C
ARAWAK	B
ARBELA	C
ARBOLES	C
ARBOR	B
ARBUCKLE	C
ARBUS	B
ARBUTUS	A
ARCADIAN	D
ARCATA	B
ARCHABAL	B
ARCHBOLD	A
ARCHER	C
ARCHIN, Cool	C
ARCHIN	D
ARCO	B/C
ARD	C
ARDENING	B
ARDENMONT	B
ARDEP	C
ARDILLA	C
ARDTOO	B
ARECIBO	A
ARENA	C/D
ARENALES	A
ARENOSA	A
ARGALT	D
ARGEE	C
ARGENTA	C
ARGONNE	B
ARGORA	B
ARGOVAR	D
ARGYLE	B
ARIDIC USTIFLUVENTS	B
ARIEL	C
ARIMO	B
ARISTINE	C
ARIVACA	C
ARIVACA, Very Cobbly	D
ARIZER	B
ARKABUTLA	C
ARKAQUA	C
ARKONA	B
ARKPORT	B
ARKRIGHT	B
ARKSON	B
ARKTON	C
ARLAND	B
ARLE	C
ARLEN	B
ARLINGTON, Thick Solum	B
ARLINGTON	C
ARLOVAL	A
ARLYNDA	D
ARMENDARIS	C
ARMENIA	D
ARMESA	B
ARMESPAN	B
ARMINGTON	D
ARMISTEAD	C
ARMITAGE	C
ARMO	B
ARMOINE	D
ARMPUP	C
ARNESS	D
ARNEY	B
ARNHEIM	D
ARNO	D
ARNOLD	A
ARNTZ	C
AROL	D
AROSA	C
ARP	C
ARRADA	D
ARRASTRE	B
ARRIBA	C
ARRINGTON	B
ARRIOLA	D
ARRITOLA	D
ARROD	D
ARROLIME	C
ARRON	D
ARROWHEAD	C
ARROYADA	D
ARROYO SECO	B
ARSITE	D
ARTA	C
ARTIL	A
ARTNOC	B
ARTRAY	D
ARUJO	B
ARUNDEL	C
ARVA	D
ARVADA	C
ARVANA	C
ARVILLA	B
ARWITE	B
ARZO	C
ASAAYI	D
ASABEAN	B
ASBILL	D
ASCAR	C
ASHART	D
ASHBURN	B
ASHCAMP	C
ASHCROFT	B
ASHDALE	B
ASHDOS	C
ASHERTON	B
ASHFORD	D
ASHFORK	D

Exhibit A: Hydrologic Soil Groups for the United States

ASHIPPUN	C
ASHKUM	B/D
ASHLEY	B
ASHLO	B
ASHMED	B
ASHMUN	D
ASHNOLA	B
ASHOLLOW	B
ASHONE	C
ASHPORT	B
ASHTRE	C
ASHUE	B
ASHUELOT	D
ASHVILLE	D
ASHWOOD	C
ASHWORTH	B
ASKECKSY	A/D
ASLINGER	C
ASOLT	D
ASOTIN	C
ASPARAS	B
ASPEN	B
ASPENLAKE	C
ASPERMONT	B
ASPERSON	C
ASSATEAGUE	A
ASSININS	B
ASTATULA	A
ASTOR	B/D
ASTOR, Flooded	D
ASTRAG	A
ATASCO	C
ATATE	B
ATCHISON	B
ATCO	B
ATESH	C
ATLANTIS	C
ATLAS	D
ATLATL	C
ATLEE	C
ATMORE	B/D
ATOKA	C
ATOM	B
ATRAVESADA	D
ATRYPA	D
ATSION	C/D
ATSION, Tide Flooded	D
ATTELLA	D
ATTEWAN, Wet	D
ATTICA	B
ATTOYAC	B
ATWELL	D
ATWOOD	B
AU GRES	C
AUA	B
AUBARQUE	D
AUBERRY	B
AUCHARD	C
AUDUBON	C
AUFCO	D
AUGANAUSH	C
AUGGIE	B
AUGUSTA	C
AUGUSTINE	B
AUGWOOD	B
AURA	B
AURAND	C
AURORA	C
AUSABLE	D
AUSTIN	C
AUSTINVILLE	B
AUSTONIO	B
AUSTWELL	D
AUT	C
AUTOMBA	B
AUTRYVILLE	A
AUXVASSE	D
AUZQUI	B
AVA	C
AVAL	D
AVANT	B
AVAR	D
AVAWATZ	A
AVENAL	B
AVERLANDE	D
AVERY	C
AVIS	A
AVISTON	B
AVOCA	B
AVON	C
AVONDA	B
AVONVILLE	B
AVTABLE	D
AWBRIG	D
AWET	B
AXFORD	B
AXIS	D
AXTELL	D
AYCOCK	B
AYDELOTTE	D
AYERSVILLE	B
AYLMER	A
AYMATE	C
AYOCK	B
AYOUB	C
AYR	B
AYRMOUNT	B
AZAAR	C
AZABACHE	D
AZELTINE	B
AZTALAN	C
AZTEC	B
AZTEC, High Rainfall	C
AZURE	D
AZWELL	C
BAAHISH	B
BABBINGTON	B
BABCO	C
BABELTHUAP	B
BABERWIT	C
BABOON	C
BABOQUIVARI	B
BABOQUIVARI, Sandy Substratum	C
BACBUSTER	C
BACH	B/D
BACHELOR	B
BACHO	D
BACHUS	C
BACID	B
BACKBAY	D
BACKCANYON	D
BACKROAD	B
BACLIFF	D
BACONA	B
BADAXE	B
BADEN	C/D
BADGER	C
BADGERCAMP	D
BADGERMONT	C
BADITO	C
BADRIVER	D
BADUS	C/D
BADWATER	B
BAGGER	B
BAGGOTT	D
BAGGS	B
BAGLEY	B
BAGMONT	B
BAGNESS	B
BAHIA	A
BAHIAHONDA	B
BAHNER	C
BAILE	D
BAILING	C
BAINES	D
BAINTER	B
BAINVILLE	C
BAIRD HOLLOW	D
BAKERSFIELD, Drained	B
BAKERSFIELD, Saline-Sodic	C
BAKERSVILLE	D
BAKSCRATCH	D
BALAKE	B
BALATON	B
BALCHER	C
BALD	C
BALDEAGLE	B
BALDER	D
BALDHILL	B
BALDKNOB	D
BALDMOUNTAIN	B
BALDRIDGE	B
BALDWIN	D
BALE	B
BALE, Wet	D
BALHUD LOAM	B
BALLAHACK	D
BALLARD	B
BALLINGER	D
BALLTOWN	D
BALLVAR	B
BALM	D
BALMAN	C
BALMLAKE	B
BALON	B
BALSORA	B
BALTIMORE	B
BAMA	B
BAMBER	B
BAMFIELD	C
BANADERU	D
BANAT	B
BANBURY	D
BANCAS	B
BANCKER	D
BANDANA	B
BANDON	C
BANE	A
BANGTAIL	C
BANIDA	D
BANKER	D
BANKHEAD	B
BANLIC	C
BANNEL	B
BANNER	C
BANNING	C
BANQUITO	B
BANTRY	A/D
BARANA	B
BARANOF	C
BARASCO	C
BARATARI	A/D
BARBARELA	B
BARBAROSA	D
BARBARY	D
BARBERMILL	C
BARBERT	D
BARBOUR	B
BARBOURVILLE	B
BARCE	B
BARCELONA	C
BARCLAY	C
BARCUS	A
BARDEN	C
BARDWELL	B
BARFAN	D
BARFUSS	B
BARGAMIN	B
BARGE	C
BARGER	C
BARHISKEY	A
BARIO	B
BARISHMAN	C
BARKEY	B
BARKSHANTY	B
BARLING	C
BARLOW	B
BARNABE	D
BARNELLCREEK	B
BARNESTON	A
BARNHARDT	B
BARNMOT	D
BARNSDALL	B
BARNWELL	C
BARODA	D
BAROID	D
BARPEAK	B
BARRADA	D
BARRE	D
BARRETT	D
BARRON	B
BARRYMORE	C
BARSAC	C
BARSHAAD	D
BART	B
BARTHOLF	B
BARTINE	C
BARTMUS	D
BARTO	D
BARTOME	D
BARTON	B
BARTONFLAT	B
BARTONHILL	B
BARZEE	D
BASCAL	B
BASCOM	B
BASCOVY	D
BASH	C
BASHER	B
BASILE	D
BASIN	C
BASINGER	B/D
BASINPEAK	B
BASKET	B
BASNOB	A
BASSEL	B
BASSFIELD	B
BASTIAN	C
BASTON	C
BASTROP	B
BASTSIL	B
BATA	B
BATEMAN	B
BATES	B
BATESVILLE	C
BATHEL	C
BATTEAU	C
BATTLE CREEK	C
BATTLEBUTTE	D
BATTLEFIELD	A/D
BATTLEGROUND	B
BATTYDOE	B
BATZA	D
BAUDETTE	B
BAUGO	C
BAUMAN	C
BAUX	B
BAUXSON	B
BAVARIA	C
BAVDARK	B
BAXTERVILLE	B
BAYAMON	B
BAYFIELD	D
BAYHOOK	B
BAYHORSE	D
BAYLIS	B
BAYLOR	A
BAYMEADE	A
BAYOU	D
BAYOUDAN	D
BAYS	C
BAYSHORE, Moderately Wet	B
BAYSHORE	D
BAYTOWN	B
BAYUCOS	D
BAYVIEW	D
BAYWOOD	A
BAZETTE	C
BEACH	D
BEAD	C
BEAL	C
BEALAND	B
BEALES	B
BEAMTON	C
BEANBLOSSUM	B
BEANFLAT	C
BEANO	D
BEAR BASIN	B
BEAR CREEK	C
BEARCAMP	B
BEARDALL	C
BEARDSLEY	C
BEARDSTOWN	C
BEARGULCH	B
BEARHEAD	B
BEARPEN	C
BEARRUN	C
BEARTOOTH	B
BEARTRAP	B

Exhibit A: Hydrologic Soil Groups for the United States

BEARVILLE	C
BEARWALLOW	C
BEASLEY	C
BEASON	C
BEATRICE	D
BEAUCOUP	B/D
BEAUFORD	D
BEAUGHTON	D
BEAUREGARD	C
BEAUSITE	C
BEAUVAIS	B
BEAVERCREEK	B
BEAVERDAM	C
BEAVERDUMP	B
BEAVERFLAT	B
BEAVERTAIL	D
BEBEEVAR	B
BECA	C
BECHTEL	B
BECHYN	D
BECKER	B
BECKHAM	B
BECKMAN	D
BECKS	C
BECKSTRAND	C
BECKVILLE	B
BECKWITH	D
BECRAFT	B
BEDEN	D
BEDFORD	C
BEDKE	B
BEDNER	C
BEDSTEAD	C
BEDWYR	D
BEDZEE	D
BEECH	C
BEECH GROVE	C
BEECHER	C
BEECHWOOD	C
BEELEM	D
BEENO	C
BEERBO	D
BEERSHEBA	B
BEESKOVE	B
BEEWON	D
BEEZEE	B
BEHEMOTOSH	C
BEHRING	D
BEIGLE	B
BEIRMAN	D
BEJUCOS	B
BELAIN	C
BELATE	B
BELCHER	D
BELDEN	C
BELDING	B
BELFON	B
BELGARRA	C
BELGRADE	B
BELINDA	D
BELK	D
BELKNAP	C
BELLA	D
BELLAMY	C
BELLAVISTA	C
BELLE	B
BELLECHESTER	A
BELLEHELEN	D
BELLENMINE	D
BELLEVILLE	B/D
BELLEVILLE, Ponded	D
BELLEVUE	B
BELLICUM	B
BELLINGHAM	C/D
BELLOTA	D
BELLPASS	D
BELLPINE	C
BELLSLAKE	D
BELLTOWER	B
BELLWOOD	D
BELMILL	B
BELPRE	C
BELRICK	B
BELROSE	B
BELSAC	B
BELTAVA	B
BELTON	C
BELTSVILLE	C
BELUGA	C/D
BELVOIR	C
BELZAR	C
BEMIDJI	B
BEMIS	C
BEMISHAVE	C
BEN LOMOND	B
BENADUM	C/D
BENCHLEY	D
BEND	B
BENDAHL	B
BENDAVIS	C
BENDER	B
BENDERLY	A
BENDOH	B
BENEMES	A
BENEVOLA	C
BENEWAH	D
BENFIELD	C
BENITO	D
BENKA	B
BENKELMAN	B
BENKLIN	C
BENMAN	C
BENNDALE	B
BENNING	B
BENRIDGE	B
BENSLEY	B
BENSON	D
BENSTOT	C
BENTAXLE	D
BENTEEN	C
BENTILLA	C
BENTONSPORT	B
BENZ	D
BEOR	D
BEOWAWE	B
BEQUINN	B
BERDA	B
BERDUGO	C
BEREA	C
BERGQUIST	B
BERGSTROM	B
BERGSVIK	D
BERLAND	D
BERLIN	C
BERMUDIAN	B
BERN	B
BERNALDO	B
BERNARD	D
BERNICE	A
BERNOW	B
BERON	D
BERRAY	B
BERRYHILL	D
BERRYMAN	C
BERTHAHILL	B
BERTHOUD	B
BERTOLOTTI	B
BERTRAND	B
BERVILLE	B/D
BERWOLF	B
BERZATIC	D
BESHERM	C
BESNER	B
BESS	C
BESSIE	D
BESSLEN	D
BESTPITCH	D
BESTROM	C
BETHALTO	B
BETHANY	C
BETHUNE	C
BETIS	A
BETRA	C
BETTERAVIA	C
BEULAH	B
BEVERIDGE	D
BEVERLY	A
BEVIER	C
BEVIL	D
BEVINGTON	B
BEW	C
BEWEARZE	B
BEWLEYVILLE	B
BEXAR	D
BEZO	D
BIAGGI	B
BICKERDYKE	D
BICKETT	D
BICKFORD	D
BICKLETON	B
BICONDOA	C/D
BIDDLE	C/D
BIDONIA	D
BIDRIM	D
BIEDELL	D
BIEDSAW	D
BIFFLE	B
BIG TIMBER	D
BIGA	C
BIGBEAVER	C
BIGBEE	A
BIGBOW	B
BIGBROWN	C
BIGCREEK	B
BIGDRAW	C
BIGDUTCH	B
BIGELOW	B
BIGFOOT	C
BIGFROG	D
BIGGSVILLE	B
BIGHAT	D
BIGHILL	B
BIGLAKE	A
BIGLICK	D
BIGLOST	B
BIGLOST, Wet	C
BIGPAW	B
BIGPOOL	C
BIGRIVER	B
BIGSAG	D
BIGSHEEP	B
BIGWIN	C
BIJORJA	C
BIKEN	D
BIKEYAH	C
BILGER	D
BILGRAY	C
BILHAUL	D
BILHIL	C
BILLMAN	C
BILLYBOY	B
BILLYCREEK	C
BILLYHAW	D
BILLYRIDGE	B
BILMOD	B
BILSON	B
BILTMORE	A
BIMINI	C
BIMMER	D
BINDLE	B
BINFORD	B
BINGER	B
BINGHAMPTON	B
BINGHAMVILLE	D
BINNSVILLE	D
BINS	B
BINTON, Reclaimed	B
BINTON	C
BINVAR	C
BIPLANE	D
BIPPUS	B
BIRCHBAY	C
BIRCHFIELD	D
BIRCHLAKE	C
BIRDSALL	D
BIRDSBEAK	D
BIRDSVIEW	A
BIRKBECK	B
BIRMINGHAM	B
BISBEE	A
BISCAY	D
BISCAYNE	B/D
BISCHOFF	B
BISCUIT	B/D
BISGANI	B
BISHOP	C
BISON	B
BISPING	B
BISSETT	D
BISSONNET	D
BIT	C
BITCREEK	B
BITCREEK LOAM	B
BITNER	C
BITTER	B
BITTERCREEK	D
BITTERROOT	C
BIVANS	D
BIWABIK	A
BIXBY	B
BJORKLAND	B/D
BLACK CANYON	C/D
BLACKBURN	B
BLACKCREEK	C
BLACKDOG	B
BLACKFOOT	B/C
BLACKHAMMER	B
BLACKHOOF	D
BLACKHORSE	D
BLACKLAKE	D
BLACKLEG	D
BLACKMORE	B
BLACKMOUNT	B
BLACKNEST	B
BLACKOAR	B/D
BLACKPIPE	C
BLACKRIVER	B
BLACKSAN	B
BLACKSPAR	D
BLACKSPOT	D
BLACKTOP	D
BLACKWATER	D
BLACKWOOD	B
BLAG	D
BLAGO	D
BLAINEGATE	D
BLAIR	C
BLAKABIN	C
BLAKENEY	D
BLALOCK	D
BLAMER	C
BLANCA	B
BLANCHE	B
BLANCHESTER	B/D
BLANCOVERDE	C
BLAND	C
BLANEY	B
BLANKET	C
BLANKOUT	A
BLANTON	B
BLAPPERT	D
BLAQUIRRE	C
BLASE	C
BLASHKE	A
BLAYDEN	D
BLAZEFORK	D
BLEAKHILL	C
BLEAKWOOD	C
BLEIBLERVILLE	D
BLEUMONT	C
BLEVINS	B
BLEVINTON	B
BLEWETT	D
BLICHTON	D
BLIMO	B
BLIND	B
BLINDSPRING	A
BLINN	C
BLINT	B
BLISSHILL	C
BLITZEN	C
BLIZZARD	D
BLOCKER	D
BLOCKHOUSE	D
BLOCKTOWN	C/D
BLOOMFIELD	A
BLOOMING	B
BLOOMINGDALE	D
BLOOR	D
BLOSSBERG	C

Exhibit A: Hydrologic Soil Groups for the United States

BLUCHER	C
BLUE EARTH	D
BLUE LAKE	A
BLUEAGLE	B
BLUEBIRD	C
BLUECANYON	D
BLUECREEK	D
BLUEDOME	C
BLUEGULCH	B
BLUEHILL	C
BLUEMASS	D
BLUENOSE	B
BLUERIM	C
BLUESKY	D
BLUESLIDE	D
BLUESTOCKING	C
BLUESTONE	D
BLUEWATER	D
BLUEWING	B
BLUEYE	C
BLUFF	D
BLUFFCREEK	B
BLUFFTON	C/D
BLUFORD	C
BLUHOL	D
BLULA	A
BLUM	C
BLY	B
BLYBURG	B
BLYTHE	D
BOARDBURN	B
BOARDFLOWER	C
BOARDMAN	D
BOARDTREE	C
BOASH	D
BOAZ	C
BOBERT	B/C
BOBILLO	B
BOBKITTY	C
BOBS	D
BOBSGARDEN	B
BOBTAIL	C
BOBTOWN	B
BOCK	B
BOCOX	D
BODECKER	B
BODIFORD	D
BODORUMPE	C
BOEL	A
BOEL, Overwash	C
BOERNE	B
BOESEL, Protected	B
BOESEL	C
BOGA	B
BOGACHIEL	A
BOGAN	C
BOGGIANO	B
BOGGS	C
BOGGY	C
BOGUE	D
BOGUSCREEK	B
BOHICA	B
BOHICKET	D
BOHNA	B
BOHNLY	D
BOHNSACK	B
BOILER	C
BOISE	B
BOISTFORT	B
BOLACK	D
BOLD	B
BOLENT	A
BOLES	C
BOLES Loam Substratum	D
BOLEY	D
BOLFAR	B/C
BOLICKER	B
BOLIO	D
BOLLIBOKKA	D
BOLLING	C
BOLTON	B
BOLTZ	C
BOLUDO	D
BOMAR	C
BOMBAY	B
BONA	B
BONAIR	D
BONANZA	B
BONAPARTE	A
BONDMAN	D
BONDOE	B
BONDUEL	C
BONE	D
BONFIELD	B
BONFRI	C
BONG	A
BONHAM	D
BONIDU	C
BONIFAY	A
BONJEA	D
BONJON	B
BONN	D
BONNASH	B
BONNEAU	A
BONNEFEMME	C
BONNERDALE	B
BONNET	B
BONNEVILLE	A
BONNICK	A
BONOLDEN	B
BONSAI	D
BONSALL	D
BONWIER	C
BONWIER	D
BOOFUSS	C/D
BOOKOUT	C
BOOKWOOD	B
BOOMSTICK	D
BOOMTOWN	D
BOONDOCK	D
BOONE	A
BOONESBORO	B
BOONTLING	C
BOONVILLE	D
BOOTEN	B
BOOTLAKE	B
BOOTS	A/D
BOPLAIN	A
BOQUILLAS	C
BORACHO	D
BORAH	A
BORCO	A
BORDA	D
BORDENGULCH	B
BORDERLINE	B
BOREA	D
BOREALIS	D
BOREHAM	B/C
BORFIN	C
BORGEAU	B
BORGES	D
BORGSTROM	B
BORIANA	D
BORID	D
BORKY	C
BORLAND	D
BORNSTEDT	C
BORO	D
BOROSAPRISTS	D
BORPARK	B
BORREGO	D
BORREGUERO	C
BORSKI	B
BORUNDA	C
BOSA	D
BOSCO	B
BOSKET	B
BOSLAND	C
BOSLER	C
BOSO	D
BOSONOAK	C
BOSQUE	B
BOSQUEJO, Overwash	C
BOSQUEJO	D
BOSSBURG	C/D
BOSTON	C
BOSTRUM	D
BOSTWICK	B
BOSVILLE	D
BOSWELL	D
BOTETOURT	C
BOTHOMPEEK	D
BOTHWELL	B
BOTLEG	C
BOTT	B
BOTTINEAU	B
BOTTLE	C
BOTTLEROCK	C
BOULDER POINT	B
BOULDIN	B
BOULOGNE	B/D
BOUNCER	D
BOUNDARY	B
BOURBON	B
BOURNE	C
BOUSIC	D
BOWBAC	B
BOWERS	C
BOWERY	B
BOWES	B
BOWIE	B
BOWLAKE	C
BOWLUS	B
BOWMAN	C
BOWMANSVILLE	B/D
BOWNS	C
BOWSTRING	A/D
BOX	A
BOXELDER	C
BOXFORD	C
BOXIRON	D
BOXJOE	A
BOXSPRING	D
BOXVILLE	C
BOXWELL	B
BOY	B
BOYD	D
BOYERLAKE	C
BOYKIN	B
BOYLESTON	B
BOYLESTON, Gravelly Subsoil	C
BOYSEN	D
BOZE	B
BOZEMAN	B
BRABAS	D
BRABBLE	C
BRACKETT	C
BRACOS	B
BRADBOLDT	B
BRADCO	C
BRADDALE	B
BRADEN	B
BRADENTON	D
BRADER	D
BRADFIELD	C
BRADGATE	B
BRADSON	B
BRADWAY, Thawed	C
BRADWAY	D
BRADY	B
BRADYVILLE	C
BRAGG	C
BRAGTON	D
BRAILSFORD	C
BRAM	C
BRAMAN	B
BRAMARD	B
BRAMLETT	D
BRANCHVILLE	A
BRANCROFT	C
BRAND	D
BRANDENBERRY	B
BRANDENBURG	A
BRANDER	B
BRANDON	B
BRANDT	B
BRANDYPEAK	B
BRANDYWINE	A
BRANFORD	B
BRANNAN	B
BRANSCOMB	B
BRANSON	B
BRANSTAD	B
BRANTLEY	C
BRANYON	D
BRASHEAR	C
BRASSFIELD	B
BRASSTOWN	B
BRATTON	B
BRAUN	C
BRAVO	B
BRAWLEY	D
BRAY	D
BRAYS	C
BRAZILTON	D
BRAZITO, Thck Surface	B
BRAZITO, Saline-Alkali	C
BREADLOAF	D
BRECKEN	B
BRECKENRIDGE	B/D
BRECKSVILLE	C
BREEDS	B
BREHM	C
BREIEN	B
BREMER, Sandy Substratum	B
BREMER	C
BREMOND	D
BREMS	A
BRENDA	C
BRENHAM	C
BRENNAN	B
BRENNER	D
BRENNYVILLE	C
BRENT, Dry	A
BRENT	D
BRENTWOOD	B
BREQUITO	B
BRESSA	C
BREVATOR	C
BREVCO	B
BREW	C
BREWER	C
BREWLESS	C
BREWTON	C
BREZNIAK	D
BRIABBIT	B
BRICKHAVEN	C
BRICKMILL	C
BRICKTON	C
BRICKYARD	D
BRICO	C
BRIDGECREEK	C
BRIDGER	C
BRIDGESON	C/D
BRIERY	C
BRIFOX	C
BRIGGS	A
BRIGHTON	B/D
BRIGHTWOOD	B
BRILEY	B
BRILL	B
BRILLIANT	B
BRIMHALL	B
BRIMLEY	C
BRIMSON	C
BRINGMEE	B
BRINKERHOFF	D
BRINKLOW	B
BRINNUM	C/D
BRIONES	B
BRISBANE	B
BRISCOT	C/D
BRISKY	D
BRISTOL	A
BRISTOW	D
BRITTON	D
BRITWATER	B
BROADHEAD	D
BROADHURST	D
BROADKILL	D
BROADLAND	C
BROADUS	B
BROADWATER	A
BROADWAY	B
BROADWELL	B
BROBETT	C
BROCKATONORTON	D
BROCKET	C
BROCKGULCH	B
BROCKLISS	B

Exhibit A: Hydrologic Soil Groups for the United States

BROCKMAN	C
BROCKO	B
BROCKPORT	D
BROCKROAD	C
BROCKSBURG	B
BROCKWAY	B
BROCKWELL	B
BRODALE	C
BRODEER	B
BRODY	C
BRODYK	B
BROE	B
BROGAN	B
BROGDON	B
BROKENFINGER	B
BROKENHORN	D
BROKIT	C
BROLAND	D
BROMAGLIN	B
BROMER	C
BROMIDE	B
BROMO	B
BRONELL	B
BRONSON	B
BRONTE	C
BROOKE	D
BROOKLINE	B
BROOKSHIRE	C
BROOKSVILLE	D
BROOME	B
BROPHY	A/D
BROSE	D
BROSELEY	B
BROUGHTON	D
BROUILLETT	C
BROWARD	C
BROWER	B
BROWNBEAR	B
BROWNDELL	D
BROWNELL	B
BROWNFIELD	A
BROWNSBURG	B
BROWNSCOMBE	C
BROWNSCREEK	B
BROWNSDALE	C
BROWNSTONE	B
BROWNSTOWN	B
BROWNSVILLE	C
BROWNTON	C/D
BROXON	B
BRUBECK	D
BRUCE	B.D
BRUELLA	B
BRUELLA, Hard Substratum	C
BRUFFY	B
BRUHEL	B
BRUJA	B
BRULE	C
BRUNEEL	D
BRUNELDA	D
BRUNSWICK	B
BRUSHCREEK	C
BRUSHER	B
BRUSHTON	B
BRUSHY	B
BRUSSELS	C
BRYARLY	D
BRYDE	C
BRYDEN	C
BRYSTAL	B
BRYWAY	C
BTREE	C
BUB	D
BUCAN	D
BUCCANEER	D
BUCHEL	D
BUCHENAU	B
BUCKBAY	C
BUCKBERT	B
BUCKBOARD	B
BUCKCREEK	C
BUCKEAR	D
BUCKETLAKE	B
BUCKEYE	C
BUCKHALL	B
BUCKHILL	B
BUCKHOUSE	B
BUCKING	A
BUCKINGHAM	C
BUCKLAKE	D
BUCKLE	B
BUCKLICK	B
BUCKMAN	D
BUCKMEN	B
BUCKNDOE	B
BUCKNEY	B
BUCKROCK	D
BUCKSHOT	B
BUCKSKIN	C
BUCKTON	B
BUCKWILDER	D
BUCYRUS	C
BUDE	C
BUENA VISTA	B
BUFALO	B
BUFFCREEK	B
BUFFMEYER	B
BUFFSTAT, Channery	B
BUFFSTAT	C
BUFORD	B
BUGCREEK	D
BUGLEY	C/D
BUHL	C
BUHLER	D
BUHRIG	B
BUICK	C
BUKO	B
BUKO, Wet	C
BUKREEK	B
BULADEAN	B
BULGRAN	D
BULL RUN	B
BULL RUN, Hardpan	C
BULLARDS	B
BULLFLAT	B
BULLFOR	C
BULLGULCH	C
BULLIS	D
BULLOCK	C
BULLTOWN	B
BULLVARO	B
BULLVILLE	B
BULLWINKLE	D
BULLY	B
BULOW	A
BUMBOB	C
BUNANCH	C
BUNCELVOIR	D
BUNCETON	C
BUNCHPOINT	C
BUNCOMBE	A
BUNDORA	B
BUNDORF	D
BUNDY	C
BUNDYMAN	C
BUNGALOW	D
BUNKER	B
BUNKERHILL	D
BUNKUM	C
BUNKY	C
BUNNELL	B
BUNSELMEIER	B
BUNTING	A
BUNTINGVILLE	C
BUNTLINE	D
BUNYAN	B
BURCHAM	B
BURCO	D
BUREN	C
BURFORD	C
BURGET	D
BURGRAFF	B
BURKEMONT	C
BURKETOWN	C
BURKEVILLE	D
BURLESON	D
BURLINGTON	A
BURMAN	C
BURNBOROUGH	B
BURNEL	C
BURNEY	B
BURNSCREEK	B
BURNSIDE	B
BURNSVILLE	B
BURNSWICK	B
BURNT LAKE	A
BURNTCREEK	D
BURNTHILL	B
BURNTRIVER	B
BURPEAK	B
BURR	D
BURRANT	B
BURRFOOT	B
BURROWSVILLE	C
BURSLEY	D
BURSON	C
BURSTEADT	B
BURWELL	C
BURWILL	C
BUSACCA	C
BUSHMAN	B
BUSHNELL	C
BUSHONG	C
BUSHVILLE	C
BUSSY	C
BUSTER	B
BUSTERBACK	B
BUSTI	C
BUSYWILD	B
BUTANO	C
BUTCHERKNIFE	C
BUTLER	D
BUTLERTOWN	C
BUTTECREEK	B
BUTTERMILK	B
BUTTERS	B
BUTTONCREEK	B
BUXIN	D
BUZZTAIL	D
BYBEE	D
BYGLAND	C
BYINGTON	C
BYLER	C
BYRAM	C
BYWELL	D
CABINET	C
CABLON	B
CABO ROJO	C
CABOOL	B
CABOOSE	B
CABRILLO	C
CABSTON	B
CACHEBUTTE	B
CACHECAN	C
CACHECREEK	B
CACIQUE	D
CACTUSFLAT	C
CADDO	D
CADELAKE	D
CADELL	D
CADEVILLE	D
CADILLAC	A
CADIZ	B
CADMUS	B
CADOMA	C
CADOTTE	B
CAESAR	A
CAFETAL	B
CAFFEY	C
CAGAS	C
CAGEY	C
CAHABA	B
CAHONA	B
CAID	B
CAINHOY	A
CAIRN	B
CAJALCO	C
CAJON	B
CALABAR	D
CALABASAS	B
CALAMINE	D
CALAMITY	D
CALAMUS	A
CALAWAH	B
CALCIO	A
CALD	C
CALDER	D
CALDERWOOD	D
CALDWELL	B/C
CALEAST	C
CALEDONIA	B
CALENDAR	C
CALERA	C
CALFRANCH	B
CALHI	B
CALICOTT	A
CALICREEK	B
CALKINS	C
CALLA	B
CALLABO	C
CALLADITO	A
CALLAN	C
CALLEGUAS	D
CALLISBURG	C
CALLISON	C
CALNAT	C
CALNEVA	C
CALODO	C
CALOOSA	C
CALPEAK	D
CALROY	B
CALVERTON	C
CALVISTA	D
CALWOODS	D
CALZACORTA	D
CAMAC	C
CAMAGUEY	D
CAMARGO	B
CAMARILLO	B/C
CAMASCREEK	D
CAMATTA	D
CAMBARGE	B
CAMBERN	C
CAMILLUS	B
CAMMASPATCH	D
CAMOCCA	A/D
CAMPAIR	C
CAMPANA	B
CAMPANILE	C
CAMPBELL	B/C
CAMPBELLTON	C
CAMPCREEK	C
CAMPFOUR	B
CAMPIA	B
CAMPONE	C
CAMPRA	B
CAMPSPASS	B
CAMPSPASS, Deep	C
CAMPTOWN	D
CAMPUS	B
CAMPWOOD	D
CAMRODEN	C
CANA	C
CANADIAN	B
CANAL	C
CANALOU	B
CANASERAGA	C
CANCIENNE	C
CANDELERO	C
CANDERLY	B
CANDLESTICK	C
CANE	C
CANEADEA	D
CANEEK	B
CANELO	D
CANEST	D
CANEYHEAD	C
CANEZ	B
CANISTEO	D
CANIWE	B
CANLON	D
CANMER	B
CANNELL	B
CANNING	B
CANNON	B
CANONEROS	D
CANOSIA	C
CANOVA	B/D
CANQUYA	D
CANTALA	B

Exhibit A: Hydrologic Soil Groups for the United States

CANTEEN	B
CANTINA	C
CANTLIN	A
CANTON BEND	C
CANTRIL	B
CANTUA	B
CANTUCHE	D
CANWALL	C
CANYADA	D
CANYONCREEK	B
CANYOUNG	B
CAPA	D
CAPAC	C
CAPE	D
CAPE FEAR	D
CAPEBLANCO	B
CAPEHORN	D
CAPERS	D
CAPERTON	D
CAPHEALY	B
CAPISTRANO	B
CAPITAN	D
CAPLEN	D
CAPLES	C/D
CAPOOSE	C
CAPPS	B
CAPSHAW	C
CAPSUS	D
CAPTIVA	B/D
CAPTOM	B
CARACARA	C
CARACOLES	D
CARADAN	D
CARALAMPI	C
CARAMON	C
CARBENGLE	B
CARBERRY	B
CARBIKA	D
CARBINE	D
CARBONDALE	A/D
CARBONTON	C
CARDENAS	D
CARDIFF	B
CARDINAL	B
CARDINGTON	C
CARDON	D
CARDSOUND	D
CAREFREE	D
CARETT	B
CAREY LAKE	B
CARFALL	B
CARGENT	B
CARGILL	C
CARIB	D
CARIBEL	B
CARIBOU	B
CARIBOURIDGE	B
CARIOCA	B
CARIS, High Rainfall	B
CARIS	C
CARLAIN	B
CARLIN	D
CARLITO	D
CARLOS	A/D
CARLOTTA	B
CARLSBAD	C
CARLSBORG	A
CARLSON	B
CARLSTROM	C
CARLTON	C
CARMAN	B
CARMEL	C
CARMI	B
CARMINE	C
CARMODY	C
CARNEGIE	C
CARNERO	C
CAROLINE	C
CAROLLO	D
CARON	A/D
CARPENTERVILLE	D
CARRACAS	D
CARRCREEK	B
CARRI	B
CARRICK	C
CARRIZALES	A
CARROLLTON	C
CARRWASH	A
CARSITAS	B
CARSTAIRS	A
CART	B
CARTAGENA	D
CARTER	D
CARTERET	D
CARTERSVILLE	D
CARTHAGE	B
CARTWRIGHT	B
CARVER	A
CARVIX	B
CARWALKER	C
CARWAY	D
CARWILE	D
CARYTOWN	D
CASABONNE	B
CASAMERO	D
CASCILLA	B
CASE	B
CASEY	D
CASEYLAKE	B
CASEYVILLE	B/C
CASHEL	C
CASHIERS	B
CASHNER	C
CASITO	D
CASLO	C/D
CASPIANA	B
CASSAL	B
CASSIA	B/C
CASSIDAY	C
CASSOLARY	C
CASSOPOLIS	B
CASTAIC	C
CASTAN	A
CASTANA	B
CASTANEDA	C
CASTEE	B
CASTELL	C
CASTELLEIA	B
CASTEPHEN	C
CASTILE	B
CASTLE	D
CASTLEPEAK	A
CASTLEROCK	B
CASTLEROCK	D
CASTLEWOOD	C/D
CASTO	C
CASTROVILLE	B
CASVARE	D
CASWELL	B
CATALINA	B
CATALPA	C
CATANO	A
CATARACT	B
CATAULA	B
CATELLI	B
CATH	C
CATHARPIN	C
CATHEEN	B
CATHERINE	C
CATHLAMET	B
CATILLA	B
CATLA	D
CATNIP	D
CATPOINT	A
CATTCREEK	A
CATTO	D
CAULEY	B
CAUSEWA	C
CAVANAUGH	C
CAVENDISH	B
CAVERNS	B
CAVINESS	B
CAVO	D
CAX	B
CAYAGUA	C
CAYO	B
CAYUGA	C
CAYUSE	B
CAZADERO	C
CEBOLIA	C
CEBONE	C
CEBOYA	C
CEDAR BUTTE	D
CEDARAN	D
CEDARBLUFF	C
CEDARCREEK	C
CEDARFALLS	A
CEDARGROVE	B
CEDARLAKE	D
CEDARPASS	B
CEDARROCK	D
CEDARTOWN	A
CEDONIA	B
CEDRIC	D
CEDVAR	B
CEEBEE	B
CEEJAY	D
CEEK	C
CELACY	C
CELAVAR	B
CELAVAR, Loamy Surface	C
CELESTE	D
CELETON	D
CELINA	C
CELIO	C
CELT	C
CENCOVE	B
CENIZA	B
CENTENARY	A
CENTENNIAL	C
CENTER	C
CENTER CREEK	A
CENTERBURG	C
CENTERVILLE, Gravelly Substratum	B
CENTERVILLE	D
CENTISSIMA	B
CENTRALIA	B
CENTRALPEAK	C
CERBAT	D
CERP	B
CERROCOSO	B
CESARIO	C
CESSNA	B
CESTNIK	C
CETRACK	B
CETREPAS	D
CEWAT	C
CHABENEAU	B
CHACON	D
CHACUACO	C
CHAD	C
CHAFFEE	D
CHAGRIN	B
CHAIN	C
CHAINLINK	D
CHAIRES	D
CHALKCREEK	B
CHALKFORD	B
CHALKHILL	C
CHALKVILLE	D
CHALLENGER	B
CHALLENGER, Alkali	D
CHALLIS	C
CHALMERS	B/D
CHAMA	C
CHAMATE	B
CHAMBEAM	B
CHAMBERLAIN	B
CHAMITA	C
CHAMOKANE	C
CHAMPLAIN	A
CHANAC	B
CHANCELLOR	C
CHANNAHON	D
CHANTIER	D
CHANYBUCK	D
CHAPANOKE	C
CHAPARRAL	B
CHAPEL	D
CHAPETT	B
CHAPPELL	A
CHAPPUIS	C
CHARBONO	B
CHARCO	C
CHARDOTON	C
CHARDOTON, Hardpan	D
CHARETTE	C
CHARGO	D
CHARITON	C
CHARITY	D
CHARLEBOIS	B/C
CHARLESTON	C
CHARLOS	B/D
CHARLOTTE	B/D
CHARNOCK, Moderately Wet	B
CHARNOCK	C
CHARTERS	B
CHARWELL	D
CHATBURN	B
CHATCOLET	B
CHATHAM	B
CHATT	C
CHATTERDOWN	B
CHATTERTON	A
CHATTICUP	D
CHATUGE	D
CHAUMONT	D
CHAUNCEY	C
CHAUTAUQUA	C
CHAVIES	B
CHAWANAKEE	C
CHAZNER	C
CHAZOS	C
CHAZY	C
CHEAHA	D
CHECKER	C
CHEDATNA	B
CHEDESKI	B
CHEDSEY	C
CHEEKTOWAGA	D
CHEESEMAN	B
CHEESEMAN, Loamy Surface	C
CHEETHAM	B
CHEHALEM	C
CHEHULPUM	D
CHEKIKA	D
CHELINA	B
CHELMO	D
CHEMAWA	B
CHEME	D
CHENA	A
CHENAULT	B
CHENEGA	A
CHENOA	B
CHENOWETH	B
CHEOAH	B
CHEOSA	D
CHEQUEST	C
CHEROKEE	D
CHERRYCREEK	B
CHERRYHILL	B
CHESANING	B
CHESBROOK	D
CHESNIMNUS	B
CHESTATEE	B
CHESTERTON	D
CHESTOA	B
CHESTONIA	D
CHETASLINA	B
CHETCO	D
CHETEK	B
CHETOMBA	B/D
CHEVAL	C
CHEW	B
CHEWACK	B
CHEWAUCAN	C
CHEWELAH	C
CHEYENNE	B
CHIA	D
CHIC	B
CHICANE	C
CHICHAGOF	D
CHICHANTNA	D
CHICKAMAN	B
CHICKASAW	C
CHICKASHA	B
CHICO	B
CHICOLETE	C
CHICONE	D

CHICOTE	D
CHIDAGO	A
CHIEFLAND	B
CHIGLEY	C
CHILAO	C
CHILCOTT	C
CHILDS	B
CHILGREN	C
CHILHOWEE	B
CHILICOTAL	B
CHILLICOTHE	B
CHILLIGAN	B
CHILLUM	B
CHILLYBU	D
CHILOQUIN	D
CHILSON	D
CHIMAY	D
CHIME	C
CHIMINET	D
CHIMNEY	A
CHIMNEYROCK	B
CHINA	D
CHINABUTTE	D
CHINAHAT	B
CHINCAP	B
CHINCOTEAGUE	D
CHINDE	C
CHINHILL	B
CHINIAK	A
CHINKLE	D
CHINLINI	B
CHINO	B/C
CHINVAR	C
CHINWHISKER	A
CHIPENDALE	D
CHIPENHILL	D
CHIPLEY	C
CHIPOLA	A
CHIPPENY	D
CHIRENO	D
CHISMORE	D
CHISOLM	A
CHISPA	B
CHISTNA	B
CHISTOCHINA	B
CHITA	B
CHITINA	B
CHITTUM	C
CHITWOOD	D
CHIVATO	C
CHIVATO, Elevation>8000	D
CHIWAUKUM	B
CHIWAWA	B
CHO	C
CHOATES	C
CHOCCOLOCCO	B
CHOCK	D
CHOCKTOOT	B
CHOCORUA	D
CHOICE	D
CHOKE	B
CHOOP	D
CHORALMONT	A
CHOSKA	B
CHOTEAU	C
CHOWAN	D
CHRIS	C
CHRISHALL	B
CHRISMAN	D
CHRISTIANA	C
CHRISTIANBURG	C
CHRISTINE	D
CHRISTOFF	C
CHRISTY	C
CHROME	C
CHRYSLER	C
CHUBBFLAT	C
CHUCKANUT	B
CHUCKRIDGE	D
CHUCKRIVER	D
CHUFFA	B
CHUGCREEK	C
CHUGTER	B
CHUICHU	D
CHUIT	B
CHUMMY	D
CHUNILNA	D
CHUNKMONK	C
CHUPE	A
CHURCH	D
CHURCH SPRINGS	B
CHURCHVILLE	D
CHURUBUSCO	D
CHUTE	A
CHUTUM	B
CIALES	D
CIBEQUE	B
CID	C
CIDERMILL	B
CIDRAL	C
CIENEGA	B
CIENO	D
CIERVO	C
CIFIC	C
CINCO	A
CINDERHURST	D
CINNAMON BAY	B
CINTRONA	D
CIRCLE	B
CIRCLEBACK	A
CIRCLEBAR	C
CIRCLEVALLEY	B
CIRCULAR	B
CISCO	B
CISPUS	B
CITICO	B
CITRONELLE	D
CITYPOINT	A/D
CLACKAMAS	D
CLAMP	D
CLANA	A
CLANALPINE	C
CLAPHAM	C
CLARA	B/D
CLARA	D
CLARENA	B
CLARENCE	D
CLARENDON	C
CLARESON	C
CLAREVILLE	C
CLARITA	D
CLARK	B
CLARKIA	C
CLARKRANGE	C
CLARKSDALE	C
CLARKSTONE	B
CLAUNCH	B
CLAVERACK	C
CLAYBANKS	C/D
CLAYCREEK	C
CLAYHAM	B
CLAYHOLE	B
CLAYSVILLE	C
CLAYTON	B
CLE ELUM	C
CLEARCREEK	D
CLEARFORK	D
CLEARLINE	B
CLEARRIVER	B
CLEARVIEW	B
CLEAVMOR	D
CLEGHORN	C
CLEMENTINE	B/C
CLEMVILLE	B
CLENAGE	C
CLENDENEN	D
CLEONE	B
CLEORA	B
CLERGERN	B
CLERMONT	D
CLEVELAND	C
CLEVESCOVE	B
CLEYMOR	B
CLICK	A
CLIFF	B
CLIFFDELL	B
CLIFFIELD	B
CLIFFORD	C
CLIFFSIDE	B
CLIFTY	B
CLIMAX	D
CLINE	D
CLINEFALLS	A
CLINETOP	D
CLINGMAN	D
CLINKENBEARD	D
CLIPPER	C/D
CLIQUOT	C
CLITHERALL	B
CLODINE	D
CLOQUALLUM	C
CLOQUET	B
CLOSKEY	C
CLOTHO	C/D
CLOUD PEAK	B
CLOUDCROFT	D
CLOUDLAND	C
CLOUDLESS	C
CLOUGH	D
CLOVELLY	D
CLOVER SPRINGS	B
CLOVERCREEK	C
CLOWERS	B
CLOWERS	B/C
CLOWFIN	B
CLOYD	D
CLUBCAF	D
CLUNIE	D
CLUNTON	D
COACHELLA	B/C
COAHUILA	B
COALDALE	D
COALDRAW	D
COALGATE	D
COAMO	C
COARSEGOLD	C
COARSEWOOD	B
COATSBURG	D
COBATUS	C
COBB	B
COBBLANK	D
COBEN	D
COBERLY	B
COBERLY, Low Rainfall	C
COBEY	B
COBLENTZ	C
COBLYNN	B
COBOC	C
COBRE	C
COBSTONE	B
COCHINA	D
COCHRAN	C
COCKSCOMB	C
COCOA	A
COCODRIE	C
COCOLALLA	C/D
COCONINO	B
COD	B
CODORUS	C
CODQUIN	D
CODYLAKE	B
COE	A
COESSE	C/D
COFF	C
COFFEE	B
COFFEEN	B
COFFEEPOT	B
COFFTON	B
COGHILL	C
COGLIN	C
COHAGEN	C
COHAGEN, Cool	D
COHAS	C
COHOE	B
COILE	D
COILS	C
COIT	D
COKATO	B
COKEDALE	C/D
COKER	D
COKEVILLE	B
COLBE	D
COLBERT	D
COLBURN	C
COLDENT	C
COLDSPRING	B
COLEMAN	C
COLEMANTOWN	C/D
COLEPOINT	B
COLERIDGE	C
COLFAX	C
COLFER	A
COLHILL	B
COLIBRO	B
COLINAS	B
COLLEGECREEK	B
COLLETT	C/D
COLLIER	A
COLLINGTON	B
COLLINS	C
COLLISTER	B
COLMA	B
COLNEVEE	B
COLOMEX	B
COLONVILLE	C
COLORADO	B
COLOROCK	D
COLOROW	B
COLPIEN	B
COLSAVAGE	C
COLUMBINE	A
COLUMBUS	C
COLUSA	C
COLVARD	B
COLVILLE	C/D
COLY	B
COLYELL	C
COLYER	D
COMAR	C
COMBE	B
COMBEST	B
COMBS	B
COMER	B
COMETCRIK	D
COMFORT	D
COMFREY	D
COMITAS	A
COMO	A
COMPASS	B
COMSTOCK	C
COMUS	B
CONA	C
CONABY	B/D
CONALB	B
CONANT	C
CONATA	D
CONBOY	D
CONCEPCION	D
CONCHAS	C
CONCHOVAR	C
CONCORD	D
CONCORDIA	D
CONDA	D
CONDIDO	D
CONDIT	D
CONDON	C
CONECUH	D
CONETOE	A
CONEWARD	A
CONGAREE	B
CONGLE	B
CONICAL	B
CONLEN	B
CONLEY	C
CONNAH	D
CONNERIDGE	C
CONNET	D
CONOSTA	C
CONOTTON	B
CONOVER	C
CONOWINGO	C
CONPEAK	D
CONQUISTA	D
CONRAD	A/D
CONSEJO	C
CONSER	D
CONSTABLE	A
CONSTANCE	D
CONSTANCIA	D
CONSUMO	B

Exhibit A: Hydrologic Soil Groups for the United States

CONTACT	A
CONTEE	D
CONTENTION	D
CONTIDE	B
CONTO	B
CONVENT	C
COOERS	B
COOKCAN	D
COOLBRITH	C
COOLVILLE	C
COOMBS	B
COONSKIN	C
COOPER	B
COOPMONT	B
COOSAW	B
COOSCANYON	B
COOT	B
COOTER	C
COPALIS	C
COPANO	D
COPASTON	D
COPEAK	C
COPELAND	B/D
COPELAND, Depressional	D
COPENHAGEN	D
COPITA	B
COPPER RIVER	D
COPPERBASIN	D
COPPERCAN	D
COPPERCREEK	B
COPPEREID	D
COPPERFIELD	B
COPPLER	A
COPUS	C
COQUAT	D
CORA	D
CORAL	C
CORAZONES	A
CORBIN	B
CORBLY	A
CORCEGA	C
CORDALE	B
CORDELL	D
CORDES	B
CORDOVA	C/D
CORDY	B
CORIFF	B/D
CORINTH	C
CORKSTONE	D
CORLENA	A
CORLETT	A
CORLEY	B/D
CORLISS	A
CORNELIA	A
CORNELIUS	C
CORNHILL	B
CORNICK	D
CORNVILLE	B
CORNWALL	C
COROLLA	D
CORONA	B
CORONACA	B
COROZAL	C
COROZO	A
CORRALCREEK	C
CORRALITOS, Silty Substratum	B
CORRALITOS, Clayey Substratum	C
CORRALRIDGE	B
CORRIGAN	D
CORSAIR	A
CORSICA	C/D
CORTA	D
CORTADA	B
CORTARO	D
CORTELYOU	D
CORTINA	A
CORUM	C
CORVUSO	C/D
CORWITH	B
CORY	C
CORZUNI	B
COSAD	C
COSH	C
COSLAW	D
COSMOS	C/D
COSPERVILLE	C
COST	D
COSTAVAR	D
COTEAU	C
COTHA	C
COTITO	B
COTO	B
COTT	B
COTTER	B
COTTON	C
COTTONBEND	B
COTTONEVA	C
COTTONTHOMAS	B
COTTONWOOD	C
COTTREE	B
COTTRELL	C
COTULLA	D
COUGARBAY	D
COUGHANOUR	C
COULTERVILLE	D
COUNTRYMAN	C
COUNTS	D
COUPEE	B
COUPEVILLE	C/D
COURSEY	C
COURT	B
COURTNEY	D
COURTOIS	B
COURVASH	B
COUSE	C
COVEDALE	B
COVEGAP	B
COVELAND	C/D
COVERTFALLS	C
COVILLE	B
COVING	C
COVINGTON	D
COWAN	A
COWBONE	D
COWCREEK	B
COWCREEK, Protected	C
COWDEN	D
COWEEMAN	D
COWHORN	B
COWSPRING	B
COWTRACK	A
COX	D
COXIT	B
COXLAKE	D
COXRANCH	C
COXVILLE	D
COXWELL	C
COY	D
COYANOSA	D
COYATA	C
COYNE	B
COYOTE	A
COZETICA	A
COZY	C
CRABCREEK	B
CRABTREE	C
CRACKER	D
CRACKERCREEK	B
CRACKLER	B
CRADLEBAUGH	D
CRAFTON	C
CRAGGEY, Organic Surface	A
CRAGGEY	D
CRAIG	B
CRAIGEN	B
CRAMER	C
CRAMONT	C
CRANECREEK	C
CRANFILL	B
CRANNLER	B
CRANSTON	B
CRASH	B
CRATER LAKE	B
CRATERMO	C
CRAVEN	C
CRAWFISH	D
CRAWFORD	D
CRAWLEY	D
CRAWLEYVILLE	B
CREASEY	C/D
CREDO	B
CREEDMOOR	C
CREEL	C
CREFORK	C
CREOLE	D
CRESAL	B
CRESKEN	B
CRESPIN	C
CRESS	A
CRESSLER	D
CREST	C
CRESTMEADE	D
CRESTVALE	C
CRESTWAY	B
CREVA	D
CREVISCREEK	C
CREX	B
CRIMS	D
CRINKER	C
CRISFIELD	B
CRISPIN	C
CRITCHELL	B
CRITTENDEN	B
CROCAMP	B
CROCAN	D
CROCKETT	D
CROFLAND	C
CROFTSHAW	B
CROGHAN	B
CROKE	B
CRONESE	A
CRONKHITE	C
CRONKS	C
CROOKED	D
CROOKSFORD	B
CROOKSTON	B
CROOM	C
CROPLEY	D
CROQUIB	D
CROSIER	C
CROSSCREEK	B
CROSSEN	D
CROSSETT	C
CROSSNORE	B
CROSSPLAIN	C
CROSSTELL	D
CROSSVILLE	B
CROSWOOD	A
CROT	D
CROW	C
CROW CREEK	B
CROW HILL	C
CROWELL	A
CROWERS	B
CROWFORK	A
CROWHEART	C
CROWLEY	D
CROWRIVER	B/D
CROWSHAW	B
CROZIER	C
CRUBAS	D
CRUCES	D
CRUCKTON	B
CRUICKSHANK	C
CRUMARINE	B
CRUMLEY	B
CRUNKER	B
CRUNKVAR	A
CRUSTOWN	C
CRUTCH	C
CRUTCHFIELD	B
CRUZE	C
CRYLUHA	C
CRYSTAL LAKE	B
CRYSTALCREEK	B
CRYSTALEX	B
CRYSTALGYP	C
CRYUMBREPTS	B
CUATE	C
CUBA	B
CUBCREEK	C
CUBDEN	C
CUBERANT	B
CUBHILL	C
CUBLAKE	A
CUCAMUNGO	D
CUCHARAS	C
CUCHILLAS	C
CUDEI	B
CUDJOE	D
CUERBIO	B
CUERO	B
CUESTA	C
CUEVA	D
CUEVITAS	D
CUEVOLAND	B
CUJOB	D
CULBERTSON	B
CULDECOLE	B
CULDESAC	B
CULITAS	C
CULLIUS	D
CULLOWHEE	B/D
CULP	C
CULPEPER	C
CULTUS	B
CULVING	C
CULVOP	B
CUMBERLAND	B
CUMBRES	C
CUMLEY	C
CUMMINGS	D
CUMMISKEY	B
CUNDICK	D
CUNIFF	D
CUNNIFF	C
CUNNINGHAM	C
CUPCO	C
CUPEL	D
CUPINE	C
CUPOLA	B
CUPPER	B
CUPPLES	C
CUPPY	D
CUPVAR	D
CURABITH	A
CURANT	B
CURDLI	B
CURRAN	C
CURRENT SPRING	C
CURRIER	A
CURRITUCK	D
CURRY	C
CURTIN	D
CURTIS CREEK	D
CURTIS SIDING	A
CURTISTOWN	B
CURTISVILLE	D
CUSHENBURY	B
CUSHING	B
CUSHMAN	B
CUSHOOL	B
CUSICK	D
CUSTCO	B
CUSTER	C/D
CUTCOMB	D
CUTHAND	B
CUTHBERT	D
CUTSHIN	B
CUTTOR	D
CUTZ	D
CUYAMA	B
CUYAMUNGUE	A
CUYON	A
CYAN	B
CYCLONE	B/D
CYCLOPIC	C
CYGNET	B
CYMRIC	D
CYNTHIANA	D
CYPRESS	D
CYRIL	B
CYVAR	D
CZAR	B
DAB	B
DABNEY	A
DABOB	C
DACKEY	C
DACRON	B
DADE	A

Exhibit A: Hydrologic Soil Groups for the United States

DADINA	D
DAGUAO	C
DAGUEY	C
DAHAR	C
DAHL	D
DAILEY	B
DAINT	B
DAISY	B
DAISYBAY	A
DALBY	D
DALCO	D
DALECREEK	B
DALEROSE	D
DALESBURG	B
DALEVILLE	D
DALHART	B
DALIG	B
DALKENA	C
DALLAM	B
DALLARDSVILLE	C
DALTON	C
DALUPE	B
DALVORD	D
DAMASCUS	B/D
DAMEWOOD	C
DAMON	D
DAMORE	C
DANABROOK	B
DANAVORE	B
DANCY	B/D
DANDAN	C
DANDREA	C
DANGULCH	D
DANHUNT	B
DANIA	B/D
DANIELSON	C/D
DANIELVIL	B
DANJER	D
DANKO	D
DANKWORTH	A
DANSKIN	B
DANT	D
DANUBE	B/D
DAPOIN	C
DARAS	B
DARBONNE	B
DARBY	C
DARCO	A
DARDANELLE	B
DARDEN	A
DARDOOW	B
DARE	D
DARFUR	B/D
DARKCANYON	C
DARL	C
DARLAND	B
DARLEY	C
DARLINGTON	A
DARLOW	C
DAROW	C
DARR	B
DARRAH	C
DARROCH	C
DARROUZETT	D
DARSIL	C
DART	A
DARTMOUTH	B
DARVEY	B
DARWASH	B
DASHER	D
DASHIKI	A
DASSEL	B/D
DATINO	B
DATINO	D
DATOM	D
DATWYLER	C
DAVEGGIO	B
DAVIDELL	B
DAVIDSON	B
DAVILLA	D
DAWHOO	B/D
DAWN	B
DAWNY	B
DAWSIL	A/D
DAWTONIA	B
DAXTY	C
DAYBROOK	C
DAYCREEK	A
DAYSCHOOL	B
DAYTONA	B
DAYVILLE	C
DAZE	D
DEACON	B
DEADFALL	C
DEADFOOT	B
DEADHORSE	C
DEADLINE	B
DEADWOOD	D
DEADYON	B
DEAM	C
DEANBURG	B
DEANRAN	D
DEARYTON	C
DEATMAN	C
DEAVER	C
DEBENGER	C
DEBEQUE	B
DEBOOK	B
DEBORAH	D
DEBS	B
DEBUTE	C
DECAN	C
DECANTEL	D
DECATHON	C
DECATUR	B
DECEPTION	B
DECHEL	D
DECKERVILLE	C/D
DECORDOVA	B
DECRAM	C
DECY	B
DEDAS	D
DEDMOUNT	C
DEDMOUNT, Lacustrine Substratum	D
DEDRICK	D
DEE	C
DEECREE	B
DEEFAN	D
DEEMER	B
DEEPCUT	D
DEEPEEK	D
DEEPWATER	B
DEEPWOOD	B
DEER PARK	A
DEERCUT	C
DEERFIELD	B
DEERHEART	C
DEERHORN	C
DEERRUN	C
DEERWOOD	B/D
DEFENBAUGH	B
DEFIANCE	D
DEGATER	D
DEGNER	B
DEGOLA	B
DEGRAND	B
DEGREY	D
DEHAVEN	B
DEHILL	B
DEHLINGER	B
DEIGHT	B
DEINACHE	A/D
DEKALB, Stony	A
DEKALB	B
DEKAPEN	C
DEKKAS	A
DEKOOM	B
DEKOVEN	D
DELA	B
DELACIT	D
DELAMAR	B
DELAMETER	A
DELAND	A
DELANO	B
DELANO, Sandy	C
DELAWARE	B
DELCOMB	D
DELENA	D
DELENBAW	D
DELEON	C
DELEPLAIN	D
DELETTE	C
DELHEW	B
DELICIAS	B
DELISH	C
DELKS	C/D
DELL	C
DELLO	D
DELLS	C
DELLWOOD	A
DELMITA	C
DELMO	B
DELNORTE	C
DELOSS	B/D
DELP	A
DELPHI	B
DELPLAIN	D
DELRAY	D
DELRIDGE	B
DELRIO	B
DELTAJO	C
DELUGE	C
DELVALLE	B
DELVAR	C
DELWAY	D
DELWIN	A
DELYNDIA	A
DEMAYO	D
DEMENT	B
DEMILL	B
DEMING	B
DEMKY	D
DEMOGUL	B
DEMONA	C
DEMONTREVILLE	B
DEMOPOLIS	D
DEMOPOLIS, cobbly	D
DEMORY	D
DEMOSS	D
DEMOX	B
DEMPSEY	B
DEMPSTER	B
DENAUD	B/D
DENBAR	C
DENBY	C
DENCO	C
DENEKA	D
DENIO	B
DENNIS	C
DENNISVILLE	B
DENOMIE	C
DENROCK	D
DENT	B
DENTDRAW	D
DENTON	D
DENURE	A
DENVACA	D
DEPALT	D
DEPCOR	B
DEPEYSTER	C
DEPNER	B
DEPOE	D
DEPORT	D
DERAPTER	B
DERB	C
DERBY	A
DERECHO	B
DERMALA	B
DEROIN	B
DEROUX	C
DERR	C
DERRINGER	C
DERRYNANE	C
DERWELL	B
DES MOINES, Dry	B
DES MOINES, Cobbly	C
DESAN	A
DESATOYA	C
DESCALABRADO	D
DESCHUTES	B
DESERTLAKE	D
DESFIREX	B
DESHA	D
DESHASER	B
DESKAMP	B
DESKER	A
DESMET	B
DESOLATION	B
DESONS	C
DESTER	C
DETERSON	C
DETOUR	B
DETRITAL	B
DETROIT	C
DEUCE	D
DEUCHARS	C
DEV	A
DEVARGAS	B
DEVILFENCE	D
DEVILS	D
DEVILSCREEK	C
DEVINE	C
DEVISADERO	C
DEVNOT	D
DEVOE	D
DEVOIGNES	D
DEVRIES	C
DEWBERRY	B
DEWEY	B
DEWEYVILLE	D
DEWITT	C
DEWMINE	D
DEWRUST	C
DEWVILLE	B
DEXTER	B
DEZELLEM	B
DIAFLATS	B
DIAGULCH	B
DIAMOND	D
DIAMONDHIL	C
DIAMONKIT	C
DIANEV	D
DIANOLA	D
DIATEE	B
DIAWELL	D
DIBOLL	D
DICECREEK	C
DICK	A
DICKERSON	D
DICKEYPEAK	C
DICKLE	D
DICKSON	C
DIEBERT	B
DIEHLSTADT	C
DIERSSEN	D
DIGBY	B
DIGHTON	B
DIGIORGIO	B
DILLARD	C
DILLCOURT	B
DILLEY	C
DILLINGHAM	A
DILLWYN	A
DILMAN	C
DILTON	D
DILWORTH	D
DIMAL	C
DIME	B
DIMEBOX	D
DIMO	B
DINA	C
DINCO	B
DINES	B
DINEVO	B
DINGLE	C
DINGLISHNA	D
DINGMAN	C
DINKEY	A
DINZER	B
DIOBSUD	C
DIPCREEK	D
DIPMAN	D
DIPSEA	B
DIQUE	B
DIREGO	D
DIRTYHEAD	C
DISAGE	D
DISAPPOINT	D
DISCO	B

Exhibit A: Hydrologic Soil Groups for the United States

DISCOVERY	D
DISHNER	D
DISHNO	C
DISHPAN	C
DISTELL	C
DISWOOD	D
DITCHCAMP	C
DITHOD	B
DITNEY	C
DIVIDE	C
DIVISION	D
DIVOT	C
DIXALETA	D
DIXBORO	B
DIXIEJETT	B
DIXON	B
DIXONVILLE	C
DOANE	B
DOBALT	B
DOBBINS	C
DOBEL	D
DOBENT	C/D
DOBIE	B
DOBSON	D
DOCAS	B
DOCENA	C
DOCKLAKE	B
DOCPAR	B
DODD	D
DODES	B
DODGE	B
DODGECREEK	B
DODGEVILLE	C
DODSON	C
DODY	C/D
DOE	B
DOEL	C
DOGIECREEK	B
DOGLAKE	A
DOGMOUNTAIN	C
DOGTOOTH	D
DOGUE	C
DOKER	C
DOLBEE, Sandy Substratum	B
DOLBEE	C
DOLEKEI	B
DOLEN	B
DOLES	C
DOLLAR	C
DOLLARD	C
DOLLARHIDE	D
DOLLYCLARK	C
DOLMAN	C
DOLUS	C
DOME	B
DOMENGINE	C
DOMERIE	B
DOMEZ	B
DOMINGUEZ	C
DOMINSON	A
DOMKEY	B
DOMO	B
DOMPIER	C
DONA ANA	C
DONAHUE	C
DONALD	C
DONALDSON	C
DONEGAN	C
DONERAIL	C
DONICA	B
DONKEHILL	D
DONLONTON	C
DONNEL	B
DONNELSVILLE	B
DONNING	D
DONNYBROOK	D
DOOH	B
DOOLIN	D
DOONE	B
DORA	B/D
DORERTON	B
DORITTY	B
DORNA	B
DORNA, Thin	C
DOROSHIN	D
DOROTHEA	C
DOROVAN	D
DORRANCE	A
DORS	B
DORSET	B
DORVAL	A/D
DOSA	D
DOSAMIGOS	D
DOSEWALLIPS	D
DOSIE	C
DOSLOMAS	C
DOSS	D
DOSSMAN	B
DOTLAKE	D
DOTSERO	B
DOTSOLOT	D
DOTY	B
DOUBLEDIA	D
DOUBLEO	D
DOUCETTE	B
DOUDLE	B
DOUGAL	D
DOUGAN	C
DOUGCITY	B
DOUGCLIFF	D
DOUGHBOY	B
DOUGHERTY	A
DOUGHSPON	C
DOUGHTY	B
DOUGLAS	B
DOUHIDE	D
DOURO	B
DOUTHIT	B
DOWAGIAC	B
DOWDE	B
DOWELLTON	D
DOWNER	B
DOWNEY	B
DOWNEYGULCH	C
DOWNSOUTH	B
DOWNSVILLE	B
DOWPER	B
DOYLESTOWN	D
DOYN	D
DRAGSTON	C
DRAKE	B
DRAKESFLAT	B
DRAKESPEAK	B
DRAMMEN	A
DRANBURN	B
DRASCO	C
DRAX	B/C
DREKA	D
DRESDEN	B
DREWING	D
DREWSEY	B
DREWSGAP	C
DREXEL	B
DRIFTWOOD	C/D
DRIGGS	B
DRINO	C
DRIVER	C
DROEM	C
DROVAL	D
DRUM	B
DRURY	B
DRY LAKE	C
DRYADINE	C
DRYBED	B
DRYBUCK	B
DRYBURG	B
DRYCK	A
DRYDEN	B
DRYFALLS	B
DRYHOLLOW	B
DRYN	C
DUART	C
DUBACH	B
DUBAY	B
DUBBS	B
DUBBS, Flooded	C
DUBINA	C
DUBLON	B
DUCKABUSH	B
DUCKCLUB	C
DUCKHILL	D
DUCKSTON	A/D
DUELM	A
DUETTE	A
DUFFAU	B
DUFFERN	A
DUFFYMONT	C
DUFFYMONT, Dry	D
DUFUR	B
DUGGINS	D
DUGUESCLIN	D
DUGWAY	C
DUKES	A
DULA	D
DULAC	C
DULANDY	B
DULCE	D
DULEYLAKE	C
DULLAXE	B
DULLES	D
DUMAS	B
DUMFRIES	B
DUMONT	D
DUMPS, Tailings	B
DUNBAR	D
DUNBRIDGE	B
DUNC	C
DUNCANNON	B
DUNFORD	C
DUNGAN	B
DUNGENESS	B
DUNKIRK	B
DUNKLEBER	D
DUNLATOP	B
DUNMORE	B
DUNNBOT	B
DUNSMUIR	B
DUNSMUIR, Nongravelly	C
DUNTON	C
DUPLIN	C
DUPO	C
DUPREE	D
DURADOS	A
DURALDE	C
DURAND	B
DURANGO	B
DURANT	D
DURAZO	A
DURBIN	D
DURELLE	B
DURKEE	C
DURRSTEIN	D
DURSTON	C
DUSEN	B
DUSKPOINT	A
DUSLER	C
DUSON	C
DUSTON	A
DUSTY	B
DUTCHATT	B
DUTCHCANYON	B
DUTCHENRY	C
DUTCHFLAT	C
DUTCHJOHN	B
DUTEK	A
DUTTON	C
DUVAL	B
DUZEL	C
DWARF	D
DWORSHAK	B
DYE	D
DYERHILL	B
DYLAN	D
DYNAL	A
EACHUS	B
EAD	C
EAGAR	B
EAGLECAP	B
EAGLECONE	B
EAGLECREEK	B
EAGLELAKE	B
EAGLEPOINT	D
EAGLEROCK	C
EAGLESNEST	C
EAGLESON	C
EAGLESPRING	B
EAGLETON	D
EAGLEVIEW	A
EAGLEVILLE	D
EAGLEWING	B
EAGLEYE	D
EAGREEK	B
EAKIN	B
EALY	B
EAPA	B
EARLE	D
EARLMONT	C/D
EARP	B
EASBY	C
EASLEY	C
EASPUR	B
EAST LAKE	A
EASTABLE	B
EASTCHOP	A
EASTHAM	D
EASTPARK	D
EASTPINE	B
EASTWOOD	D
EASYCHAIR	B
EATONCREEK	D
EAUCLAIRE	A
EAUGALLIE	D
EBADLOW	B
EBAL	B
EBBERT	C/D
EBBING	C
EBBS	B
EBIC	D
EBODA	B
EBODA, Stony	C
EBRO	D
ECHAW	A
ECHETA	C
ECKERT	D
ECKHART	B
ECKLUND	B
ECKMAN	B
ECKRANT	D
ECKVOLL	B
ECLETO	D
ECLIPSE	B
ECOLA	C
ECON	B
ECONFINA	A
ECUR	B
EDA	A
EDALFRED	A
EDALGO	C
EDDINGS	B
EDDS	B
EDDY	C
EDEMAPS	C
EDENBOWER	D
EDENTON	C
EDENVALLEY	B
EDGAR	B
EDGEHILL	C
EDGELEY	C
EDGEMERE	D
EDGEWATER	C
EDGEWICK	C
EDGINGTON	C/D
EDINBURG	C/D
EDISTO	C
EDJOBE	C
EDMINSTER	D
EDMORE	D
EDMUNDSTON	B
EDOM	C
EDROY	D
EDSON	C
EDWARDS	B/D
EDWARDSVILLE	B/D
EDWIN	B
EELCOVE	D
EELWEIR	C
EENREED	B
EEP	C
EFFIE	C
EFFINGTON	C

Exhibit A: Hydrologic Soil Groups for the United States

EGAM	C
EGAN	B
EGANROC	C
EGGLAKE	C/D
EGGLESON	B
EGHELM	C
EGLIN	A
EGLIRIM	C
EGUAJE	B
EGYPT	D
EGYPTCREEK	C
EICKS	C
EIGHTLAR	C
EIGHTMILE	D
EILERTSEN	B
EINE	D
EITZEN	B
EKAH	C
EKAL	D
EKIM	C
EKOMS	B
EKRUB	D
EL PECO	C
ELAM	A
ELAM, Hard Substratum	B
ELANDCO	B
ELBA	C
ELBAVILLE	B
ELBERT	D
ELBON	B
ELBOW	C
ELBOWLAKE	B
ELBUCK	B
ELBUTTE	D
ELCANEJO	B
ELCAPITAN	B
ELD	B
ELDADO	B
ELDER HOLLOW	D
ELDERON, Stony	A
ELDERON	B
ELDRIDGE	C
ELEMENTS	B
ELENORE	D
ELEROY	B
ELEVASIL	B
ELEVATOR	C
ELFCREEK	C
ELFLINT	B
ELGEE	A
ELGIN	C
ELIAS	C
ELIZABETH	B
ELK HOLLOW	B
ELKADER	B
ELKHEIGHT	C
ELKHEIGHTS	B
ELKHORN	B
ELKINSVILLE	B
ELKINTON	B
ELKMOUND	D
ELKPRAIRIE	B
ELKRIDGE	B
ELKTON	C/D
ELKWALOW	D
ELLA	B
ELLEN	B
ELLENA	C
ELLETT	D
ELLICOTT	A
ELLIJAY	B
ELLINGTON	B
ELLINOR	C
ELLIOTT	C
ELLIS	D
ELLISTON	C
ELLISVILLE	B
ELLOREE	D
ELLSBURG	C/D
ELLUM	C
ELLWOOD	C
ELLZEY	B/D
ELM LAKE	A/D
ELMDALE	B
ELMENWOOD	D
ELMER	C
ELMINA	C
ELMONT	B
ELMRIDGE	C
ELMVILLE	B
ELMWOOD	C
ELNORA	B
ELOCHOMAN	B
ELOCIN	D
ELON	B
ELOSO	D
ELPAM	D
ELPASO	B/D
ELRED	B/D
ELRIN	B
ELROSE	B
ELSIE	B
ELSINBORO	B
ELTOPIA	C
ELTSAC	D
ELVERS	B/D
ELVIRA	B/D
ELWELL	C
ELWHA	C
ELWOP	B
ELY	B
ELYSIAN	B
EMACHAYA	D
EMAGERT	B
EMBAL	B
EMBERTON	C
EMELINE	D
EMERALDA	D
EMERSON	B
EMERY	B
EMIGHA	B
EMIGHA, Alkaline	C
EMILY	B
EMMA	C
EMMERT	A
EMOT	B
EMPIRE	B
EMYD	B
ENBAR	B
ENBAR, Stony	C
ENBAR, Wet	D
ENCANTADO	A
ENCHANTED	B
ENCICADO	C
ENCINA	B
ENCROW	D
ENDERSBY	B
ENERGY	B
ENFIELD	B
ENGADINE	B/D
ENGLE	B
ENKO	A
ENKO, Overblown	B
ENLOE	D
ENNING	D
ENOCHVILLE	C/D
ENOLA	B
ENOREE	D
ENOS	C
ENOSBURG	C
ENSENADA	B
ENSTROM	B
ENTENTE	B
ENTERO	D
ENTERPRISE	B
ENVILLE	C
ENVOL	D
ENZIAN	D
EODY	C
EOJ	D
EOLA	D
EPHRATA, Cool	A
EPHRATA	B
EPITAPH	D
EPLEY	C
EPOT	B
EPSOM	B/D
EPVIP	D
ERAM	C
ERD	D
EREMIS	B
ERICSON	B
ERIG	B
ERIN	B
ERMABELL	A
ERMATINGER	B/D
ERNBET	C
ERNO	B
ERRAMOUSPE	C
ERVIDE	C
ESAU	A
ESCAMBIA	C
ESCANABA	A
ESCANO	C
ESCARLO	B
ESCONDIDO/ Thick Solum	B
ESCONDIDO	C
ESEL	B
ESHA	B
ESHAMY	B
ESKA	B
ESMERALDA	B
ESMOD	D
ESPARTO	B
ESPELIE	B/D
ESPERANZA	C
ESPIL	D
ESPINAL	A
ESPINOSA	B
ESPINT	D
ESPY	D
ESRO	D
ESSEN	C
ESTACION	B
ESTATE	C
ESTELLE	B
ESTELLINE	B
ESTER, Thawed	C
ESTER	D
ESTERO	D
ESTESLAKE	D
ESTO	B
ETACH	C
ETHEL	C
ETHELMAN	B
ETHETE	B
ETHETE, Saline	C
ETIL	A
ETOILE	D
ETOWAH	B
ETOWN	B
ETTER	B
ETTRICK	B/D
EUCHRAND	D
EUCHRE	C
EUCLID	C
EUDY	C
EUER	B
EUFAULA	A
EUHARLEE	C
EULONIA	C
EUNOLA	C
EUREKA	D
EUSBIO	C
EUSTIS	A
EUTAW	D
EUTROBORALFS	B
EVA	B
EVADALE	D
EVANGELINE	C
EVANOT	B
EVANSHAM	D
EVANT	D
EVART	D
EVELETH	C
EVENDALE	C
EVERETT	B
EVERGLADES	B/D
EVERGREEN	D
EVERMAN	C
EVERRY	B
EVICK	A
EWAN	D
EXCLOSE	B
EXEL	C
EXETER	B
EXTEND	C
EXUM	C
EXWAY	B
EYAK	C
EYERBOW	C
EYLAU	C
EYOTA	A
EZEL	B
EZELL	C
FABIUS	B
FACEVILLE	B
FACEY	B
FACTORY	B
FADDIN	D
FADOLL	B
FAGAN	C
FAGASA	C
FAGES	D
FAHNESTOCK	B
FAIM	B
FAIRANGEL	B
FAIRBERG	C
FAIRBIRCH	C
FAIRBURN	D
FAIRCHILD	C
FAIRFAX	B
FAIRHAVEN	B
FAIRLESS	B
FAIRLIE	D
FAIRLO	B
FAIRMOUNT	D
FAIRPLAY	D
FAIRSMITH	B
FAIRYDELL	C
FAIRYLAWN	D
FAJADA	C
FAJARDO	C
FALAYA	D
FALBA	D
FALERIA	B
FALFA	C
FALFURRIAS	A
FALK	C
FALKIRK	B
FALKNER	C
FALLBROOK	B
FALLCREEK	C
FALLERT	B
FALLON	B
FALLSINGTON	B/D
FALSEN	A
FANAL	C
FANCHER	C
FANDOW	D
FANNO	C
FANSHAW	B
FANTZ, High Rainfall	B
FANTZ	C
FANU	B
FARBER	B
FARDRAW	B
FARDRAW, Dark Surface	C
FARISITA	D
FARLOW	C
FARMERSTOWN	C
FARMINGTON	C
FARMTON	D
FARNHAMTON	C
FARNUF	C
FARQUAR	B
FARRAGUT	C
FARRENBURG	B
FARRINGTON	B
FARROT	C
FARRY	B
FARSIDE	B
FARSON	C
FARVA	C
FARVANT	D
FARVIEW	D
FARWAY	B
FASHING	D
FASKIN	B
FATIMA	B

Exhibit A: Hydrologic Soil Groups for the United States

FATTIG	C
FAUNCE	A
FAUNSDALE	D
FAVORETTA	D
FAVRET	C
FAWCETT	B
FAWIN	B
FAWNSPRING	C
FAYETTEVILLE	B
FE	D
FEAGINRANCH	D
FEARS	B
FEATHER	B
FEATHERSTONE	D
FEDJI	A
FEDORA	B/D
FELDA	D
FELDHAUSER	B
FELDTMAN	A
FELICIANA	B
FELICITY	A
FELIPE	D
FELIX	D
FELKER	C
FELLA	B/D
FELOR	B
FELT	B
FELTA	C
FELTNER	D
FENELON	C
FEPS	D
FERA	C
FERBALL	C
FERD	C
FERDELFORD	C
FEREBEE	D
FERGIE	C
FERGUS	B
FERGUSON	B
FERN	B
FERN CLIFF	B
FERNCREEK	D
FERNDALE	B
FERNHAVEN	B
FERNOW	B
FERNPOINT	B
FERNWOOD	B
FERRELO	B
FERROBURRO	D
FERTEG	C
FESSLER	B
FESTINA	B
FETCH	D
FETERITA	D
FETT	D
FETZER	C
FEZ	C
FEZIP	D
FIANDER	C/D
FIAT	C
FIBRE	B/D
FICO	B
FIDALGO	C
FIDDLETOWN	B
FIDDYMENT	D
FIDISIX	B
FIELDCREEK	B
FIELDING	B
FIELDON	B/D
FIFESRIDGE	B
FIFIELD	C
FIG	B
FIGARO	C
FIKEL	C
FILBERT	D
FILION	D
FILIRAN	D
FINAL	D
FINCHFORD	A
FINDOUT	D
FINLAND	C
FINN	D
FINNEY	B
FINOL	C
FINROD	C
FIRCREEK	C
FIREBALL	B
FIREBAUGH	C
FIRESTEEL	B
FIRESTONE	C
FIRETOWER	B
FIRMAGE	C
FIROKE	B
FIRTH	B/C
FISHAVEN	C
FISHBERRY	D
FISHERHILL	B
FISHERMAN	D
FISHHOOK	D
FISHLAKE	D
FISHPOT	C
FISHROCK	D
FISHWAY	B
FISK	B
FITZHUGH	B
FITZWIL	B
FIVEBLOCK	C
FIVEMILE	B
FIVEMILE, Saline	C
FIVES	B
FIVESPRINGS	C
FLACKVILLE	C
FLAGG	B
FLAGSTAFF	D
FLAMBEAU	B
FLAMEN	C
FLAMING	A
FLANAGAN	B
FLANDREAU	B
FLANE	C
FLANK	D
FLANLY	B
FLANNERY	B
FLARM	C
FLAT HORN	B
FLATCREEK	D
FLATHEAD	B
FLATIRONS	C
FLATONIA	D
FLATSTONE	C
FLATTOP	D
FLATWOODS	C
FLAXTON	B
FLEAK	C
FLEAK, cool	D
FLEENER	B
FLEER	D
FLEISCHMANN	D
FLEMING	C
FLEMINGTON	D
FLETCHER	B
FLEWSIE	B
FLINK	B
FLINTCREEK	D
FLO	A
FLOER	D
FLOKE	C
FLOMATON	A
FLOMOT	B
FLOODWOOD	B
FLORAHOME	A
FLORALA	C
FLORAS	C
FLORAVILLE	D
FLORENCE	C
FLORESVILLE	C
FLORIDANA	B/D
FLORIN	C
FLORIS	B
FLOTAG	B
FLOTT	B
FLOUTIER	B
FLOYD	B
FLUE	C
FLUE, Gravelly	D
FLUETSCH	B
FLUKER	C
FLUMECREEK	B
FLUMEVILLE	D
FLUVAQUENTS	D
FLYCREEK	C
FLYNN	B
FLYVALLEY	C
FOAD	C
FOARD	D
FOGGYFLAT	B
FOGLAKE	C
FOLAVAR, Elevation 6000-7400	A
FOLAVAR	B
FOLDAHL	B
FOLEY	D
FOLLET	D
FOMSENG	C
FONDA	D
FONDILLAS	D
FONNER	B
FONS	B
FONTAFLORA	A
FONTAINE	B
FONTANA	B
FOOLHEN, Stony, Cool	B
FOOLHEN	D
FOOTHILL	C
FOPIANO	D
FORAKER	D
FORBAR	D
FORBES	C
FORBESVILLE	C
FORBING	D
FORDBUTTE	B
FORDCREEK	B
FORDICE	B
FORDNEY	A/C
FORDSTERROR	C
FORDTOWN	B
FORDTRAN	C
FORELAND	D
FORELEFT	B
FORESTBURG	A
FORESTCITY	B/D
FORESTDALE	D
FORESTER	C
FORESTON	C
FORK	C
FORKHORN	B
FORLORN	B
FORMADER	C
FORMDALE	B
FORNOR	B
FORSEER	C
FORSGREN	B
FORSGREN	C
FORT MEADE	A
FORT MOTT	A
FORT ROCK	A
FORTBENTON	C
FORTBOIS	A
FORTESCUE	C/D
FORTRAN	B
FORTSAGE	B
FORTUNA	D
FORTYONE	B
FOSS	B
FOSSILON	D
FOSTERBURG	D
FOSTORIA	B
FOUNTAIN	D
FOUNTAINVILLE	C
FOUR STAR	B/C
FOURCHE	B
FOURCORNERS	D
FOURLOG	D
FOURME	B
FOURSIXES	C
FOURWHEEL	D
FOXCAN	D
FOXCREEK	C/D
FOXHOME	B
FOXLAKE	C
FOXMOUNT	C
FOXVILLE	D
FOXVIRE	B
FOXWORTH	A
FRADDLE	B
FRAGUNI	B
FRAILEY	B
FRAILTON	D
FRANCIS	A
FRANCISQUITO	C
FRANCITAS	D
FRANCONIA	B
FRANEAU	D
FRANKCREEK	B
FRANKENMUTH	C
FRANKENSTEIN	C
FRANKFORT	C
FRANKIRK	C
FRANKLIN	B
FRANKTOWN	D
FRAVAL, Gravelly	B
FRAVAL	C
FRAZERTON	B
FRED	C
FREDA	D
FREDENSBORG	C
FREDERICKTOWN	B
FREDONYER	C
FREDRIKSDAL	D
FREE	B/D
FREEBURG	C
FREECE	D
FREEHOLD	B
FREELAND	C
FREELS	B
FREEMAN	C
FREEMANVILLE	B
FREEON	B
FREER	C
FREESOIL	B
FREEST	C
FREESTONE	C
FREETPEAK	B
FREEWATER	B
FREEZENER	B
FREEZEOUT	B
FRELSBURG	D
FREMKLE	C
FRENCH	C
FRENCHJOHN	C
FRENCHMAN	B
FRENCHMILL	B
FRENCHOLLOW, Moist	C
FRENCHOLLOW	D
FRESHWATER	D
FRESNO, Thick Solum	C
FRESNO, Saline Alkali	D
FREWA	B
FREWSBURG	C
FREYA	A/D
FRIANA	D
FRIBERG	B/D
FRICABA	B
FRIEDLANDER	C
FRIENDLY	D
FRIENDS	C
FRIES	D
FRINDLE	C
FRINES	C
FRINT	C
FRIO	B
FRIONA	C
FRIOTON	C
FRIPP	A
FRISITE	B
FRITSLAND	B
FRIZZELL	C
FRODO	D
FROHMAN	C
FROLIC	B
FRONDORF	B
FRONTENAC	B
FRONTIER	C
FRONTON	D
FROZARD	C
FRUITA	B
FRUITFIELD	A
FRUITLAND	B/C
FRUITVALE	C
FRYINGPAN	D
FRYMIRE	C

Exhibit A: Hydrologic Soil Groups for the United States

FRYREAR	B
FT. DRUM	C
FUEGO	C
FUEGOSTA	D
FUGAWEE	B
FULCHER	C
FULCRUM	C
FULDA	D
FULLER	D
FULMER	C.D
FULSHEAR	C
FULTS	D
FUNMAR	C
FUNTER	D
FURLONG	A
FURNISS	D
FURSHUR	D
FURY	C/D
FUSULINA	D
FUSUVAR	D
GABBS	C
GABEL	C
GABINO	D
GABRIEL	C
GACIBA	D
GADDES	C
GADONA	B
GADWELL	C
GAGEBY	B
GAGETOWN	B
GAHEE	B
GAIA	B
GAIBSON	D
GAILA	B
GAINESVILLE	A
GAKONA	B
GALATA	D
GALBRETH	D
GALCHUTT	C
GALESTINA	C
GALEY	B
GALIENTE	C
GALILEE	C
GALLEGOS	B
GALLEN	B
GALLIA	B
GALLIME	B
GALLIMORE	B
GALLION	B
GALLIPOLIS	C
GALLUP	B
GALTSMILL	B
GALVESTON	A
GALVEZ	C
GALVIN	D
GALZUNI	C
GAMBOA	B
GAMBOGY	B
GAMELAKE	B
GAMM	D
GANADO	D
GANAFLAN	C
GANHONA	C
GANIS	D
GANO	B/D
GANSNER	C
GANY	B
GAP	B
GAPBUTTE	B
GAPCOT	D
GAPHILL	B
GAPO	C/D
GARCENO	C
GARCIA	C
GARCITAS	C
GARDELLA	D
GARDENCAN	B
GARDENCREEK	D
GARDENISLE	B
GARDENS	D
GARDENVALE	B
GARDINER	A
GARDNER'S FORK	B
GARECK	B
GAREY	B
GARFAN	D
GARHILL	D
GARIPER	D
GARLAND	B
GARLIC	A
GARLIN	D
GARLOCK	C
GARMON	C
GARMORE	B
GARNE	B
GARNEL	D
GARNER	D
GARNES	B
GARO	D
GARR	D
GARRETT	B
GARROCHALES	D
GARSID	C
GARTON	C
GARVIN	D
GARWOOD	D
GASPER	B
GASQUET	B
GASSAWAY	D
GASSVILLE	C
GASTON	C
GASTROW	C
GASUP	D
GAT	B
GATCHEL	B
GATERIDGE	C
GATESON	C
GATEWALL	B
GATLIN	B
GATTON	B
GAULD	B/D
GAULDY	B
GAUSE	C
GAVEL	B
GAVERS	C
GAVILAN	C
GAVINS	D
GAY	B/D
GAYHART	C
GAYLORD	C
GAYVILLE	D
GAZELLE	D
GAZWELL	D
GEARHART	A
GED	D
GEE	C
GEEBURG	C
GEEMORE	C
GEERTSEN	B
GEISEL	B
GEISERCREEK	B
GELSINGER	C
GEM	C
GEM, Stony	D
GEMELO	B
GEMSON	B
GENATS	D
GENEVA	B
GENTILLY	D
GENTRY	D
GEOCONDA	C
GEORGECANYON	B
GEORGECREEK	B
GERBANA	D
GERBER	D
GERLACH	D
GERLANE	B
GERMANO	B
GERMANTOWN	B
GERMER	C
GERRARD	B
GERSTLE	B
GESSNER	B/D
GESTRIN	B
GETA	B
GETCHELL	C
GETRAIL	D
GETZVILLE	D
GEWTER	C
GEYSEN	C
GHOLSON	B
GHORMLEY	C
GIANELLA	B
GIARCH	D
GIBBONSCREEK	C
GIBNEY	C
GIBRALTAR	C
GIBSONVILLE	D
GIBWELL	C
GICHIGAMI	C
GIDEON	C
GIDWIN	D
GIELOW	C
GIESE	D
GIGGER	C
GILBERT	D
GILBOA	B
GILEAD	C
GILES	B
GILFORD	D
GILLAND	C
GILLENDER	D
GILLIAM	C
GILLIGAN	B
GILLS	C
GILLSBURG	D
GILMAN	D
GILMORE	D
GILROY	C
GILT EDGE	D
GILWOOD	B
GIMLETT	B
GINAT	D
GINEX	D
GINGER	D
GINI	B
GINSBERG	B
GIRARD	D
GIRARDOT	D
GIST	D
GITABYTE	C
GITAKUP	C
GITAM	D
GIVEOUT	C
GIVIN	C
GLADDICE	C
GLADEVILLE	D
GLANCE	B
GLASGOW	C
GLASSNER	D
GLAWE	B/D
GLAZE	B
GLEN	B
GLENBLAIR	C
GLENCARB	C
GLENCOE	C/D
GLENDENNING	C
GLENDERSON	B
GLENDIVE	C
GLENDO	B
GLENEDEN	D
GLENEYRE	D
GLENHAM	B
GLENMEN	B
GLENMORA	C
GLENOMA	B
GLENPOOL	A
GLENRIO	D
GLENROSS	D
GLENSTED	D
GLENTON	C
GLENTOSH	A
GLENVIEW	B
GLENWOOD	B
GLENYON	B
GLIDE	B
GLOHM	C
GLOIN	C
GLORIA	D
GLYNN	C
GLYPHS	B
GNAWBONE	B
GNOJEK	D
GOATBUTTE	B
GOATJOE	A
GOATROCK	B
GOATROCKS	B
GOBAR	B
GOBBLER	B
GOBERNADOR	D
GODDE	D
GODECKE	C
GODECKE, Clay Substratum	D
GODWIN	D
GOEMMER	C
GOESSEL	D
GOFFPEAK	B
GOGOMAIN	B/D
GOL	C
GOLD CREEK	D
GOLDAHO	D
GOLDBEACH	C
GOLDCORD	D
GOLDEAGEL	C
GOLDEN	D
GOLDFINCH	C
GOLDHEAD	B/D
GOLDHILL, Loamy Substratum	C
GOLDHILL	D
GOLDIVIDE	B
GOLDLAKE	B
GOLDMAN	C
GOLDMIRE	C
GOLDSBORO	B
GOLDSMITH	B
GOLDSTON	C
GOLDSTREAM, Thawed	B
GOLDSTREAM	D
GOLDVALE	C
GOLDVEIN	C
GOLDYKE	D
GOLETA	B
GOLIAD	C
GOLIME	C
GOLLAHER	D
GOLONDRINA	B
GOLTRY	A
GOLVA	B
GOMERY	B
GOMEZ	B
GOMINE	D
GONZALES	D
GOODINGTON	D
GOODLAND	B
GOODLOW	B
GOODNESS	B
GOODPASTER	D
GOODRICH	B
GOODSON	C
GOODVIEW	D
GOODWILL	B
GOODWIN	B
GOOLAWAY	C
GOOSE CREEK	C
GOOSEBURY	B
GOOSENAWT	B
GOOVAL	D
GORDONPOINT	B
GORE	D
GOREEN	D
GORESVILLE	B
GORGONIO	B
GORHAM	B/D
GORIN	C
GORMAN	C
GORUS	B
GOSHAWK	B
GOSIL	A
GOSINTA	C
GOSNEY	C
GOSPER	B
GOTCHELL	D
GOTEBO	B
GOUGEVILLE	A/D
GOULDER	B
GOULDSBORO	D
GOURDIN	C
GOURLEY	C
GOUVERNEUR	D
GOVE	B

GOVEY	C
GOWDY	B
GOWEN	B
GOWKER	C
GOWTON	B
GOZEM	D
GRACOT	A
GRADCO	C
GRADON	C
GRAFF	D
GRALIC	B
GRAN	D
GRANATH	B
GRANBUL	D
GRAND	C
GRANDAD	B
GRANDBEND	B
GRANDFIELD	B
GRANDJEAN	D
GRANDMESA	C
GRANDMORE	B
GRANDPON	B
GRANDVIEW	B/C
GRANDWASH	D
GRANER	B
GRANFLAT	A
GRANGE	C
GRANGEMONT	C
GRANGEVILLE	C
GRANIPEAK	B
GRANITEPASS	B
GRANMOUNT	C
GRANSHAW	B
GRANTCENTER	B
GRANTFORK	D
GRANTHAM	D
GRANTSBURG	C
GRANTSDALE	B
GRANTURK	D
GRANVILLE	B
GRANYON	B
GRANZAN	B
GRAPELAND	A
GRASMERE	B
GRASSHOPPER	B
GRASSTON	B
GRASSVAL	D
GRASSVALLEY	D
GRASSYCAN	D
GRASSYCONE	A
GRASSYKNOB	B
GRASSYLAKE	C
GRASSYTRAIL	B
GRAUFELS	C
GRAVELTON	B/D
GRAVES	D
GRAVEYA	B
GRAVEYARD	B
GRAYBERT	B
GRAYFORD	B
GRAYLOCK	B
GRAYMONT	B
GRAYPOINT	B
GRAYROCK	C
GRAYSILL	C
GRAYSTONE	B
GRAYWOLF	B
GRAZANE	C
GRAZER	C
GREANEY	C
GREDGE	D
GREEN BLUFF	B
GREEN CANYON	B
GREENBRIAR	B
GREENCREEK	B
GREENDALE	B
GREENE	C
GREENFIELD	C
GREENGULCH	C
GREENHORN	D
GREENLEE	B
GREENMAN	C
GREENOUGH	B
GREENSCOMBE	B
GREENTIMBER	C
GREENVILLE	B
GREENVINE	D
GREENWAY	B
GREENWICH	B
GREGGO	D
GREGORY	D
GREGSON	C
GRELL	D
GREMMERS	D
GRENET	A
GRENNAN	B
GRENOBLE	D
GRESHAM	C
GRETDIVID	B
GRETOR	C
GRETTUM	A
GREWINGK	C
GREYBEAR	C
GREYBO	B
GREYBROOK	B
GREYCLIFF	C
GREYLOCK	B
GREYS	B
GREYSTOKE	B
GRIBBLE	D
GRIDELL	D
GRIDLEY	C
GRIER	D
GRIFFITH	D
GRIFTON	D
GRIMM	B
GRINDALL	D
GRINDSTONE	C
GRINK	D
GRISDALE	B
GRISMAR	A
GRISWOLD	B
GRITNEY	C
GRIVER	B/D
GRIZZLE	D
GRIZZLY	B
GRIZZLYBLUFF	B
GROESBECK	B
GROMES	B
GROOM	C
GROSS	C
GROSSCHAT	D
GROTON	A
GROTTO	A
GROUNDHOUSE	B
GROUSECREEK	B
GROUSEHAVEN	D
GROUSEVILLE	C
GROUSLOUS	D
GROVE	A
GROVENA	B
GROVETON	B
GROWDEN, Shaly Substratum	B
GROWDEN	C
GROWLER	B
GROWLER, Sandy Substratum	C
GROWSET	D
GRUBBS	D
GRUBE	B
GRUBROB	B
GRUBSTAKE	B
GRUENE	D
GRULLA	D
GRUMBLEN	D
GRUNDELEIN	B
GRUVER	C
GRYTAL	B
GSCHWEND	B
GUADALUPE	B
GUAM	D
GUAMANI	B
GUANABANO	C
GUANAJIBO	C
GUANICA	D
GUANO	D
GUARDLAKE	A
GUAYABO	A
GUAYABOTA	D
GUAYAMA	D
GUAYNAKA	D
GUBE	C
GUDGEL	C
GUDGREY	B
GUERIN	D
GUERO	C
GUERRERO	A
GUEST	C
GUEYDAN	D
GUFFIN	D
GUGUAK	D
GUIJARRAL	B
GUISER	B
GULCH	B
GULF	B/D
GULKANA	B
GULLIED LAND	D
GULLION	C
GULLROCK	B/D
GULNARE	D
GUMBOOT	C/D
GUNCLUB	C/D
GUNDY	C
GUNNEL	D
GUNNINGS	B
GUNNUK	C
GUNSONE	D
GUNSTOCK	C
GUNTER	B
GURDANE	C
GURDON	C
GURLEY	C
GURNEY	B
GUSTIN	D
GUSTSPRING	B
GUTPORT	D
GUVO	D
GUYAN	C
GUYANDOTTE	B
GWENA	D
GWINNER	C
GWINNETT	B
GYBERG	C
GYPLA	C
HAAR	D
HAARVAR	D
HACCKE	C
HACHITA	C
HACKBERRY	B
HACKERS	B
HACKNEY	D
HACREEK	B
HADAR	B
HADENCREEK	C
HADLEY	B
HADSELVILLE	D
HAFLINGER	A
HAGATA	D
HAGEN	B
HAGENSVILLE	C
HAGER	B
HAGERMAN	B
HAGGA	C
HAGGARD	D
HAGSTADT	C
HAGUE	A
HAIG	C/D
HAIGHT	C
HAIGHTS	B
HAIGLER	C
HAIKU	B
HAILESBORO	C
HAINES	C
HAIRE	D
HAKKER	C
HAL	B
HALACAN	D
HALAWA	B
HALBERT	D
HALDER	C
HALE	C/D
HALEY	B
HALF MOON	B
HALFADAY	A
HALFCIRCLE	B
HALFOSS	B
HALFWAY	D
HALII	B
HALIIMAILE	B
HALLCREEK	A
HALLECK	B
HALLENTON	D
HALLETTSVILLE	D
HALLIHAN	B
HALLISON	C
HALLORAN	C
HALLSBLUFF	D
HALSO	D
HALVERSON	B
HALVERT	D
HAMACER	A
HAMAKUAPOKO	B
HAMBLEN	C
HAMBONE	B
HAMBROOK	B
HAMBURG	B
HAMBURN	B
HAMBY	C
HAMDEN	B
HAMEL	B/D
HAMILTON	B
HAMLET	B
HAMMACK	B
HAMMAHAMMA	C
HAMMERSLEY	C
HAMMOND	C
HAMPLAIN	B
HAMPSHIRE	C
HAMPSON	C
HAMRE	C/D
HAMRUB	B
HANA	A
HANAGITA	D
HANAKER	C
HANAMAULU	B
HANCEVILLE	B
HAND	B
HANDKE	A
HANDOFF	B
HANDSBORO	D
HANEY	B
HANGAARD	A/D
HANGDO	B
HANGROCK	D
HANGTOWN	B
HANIPOE	C
HANIS	C
HANKS	B
HANKSVILLE	C
HANLON	B
HANN	B
HANNA	B
HANNAHATCHEE	B
HANNAWA	D
HANNEGAN	D
HANNON	D
HANS	B
HANTHO	B
HAOZOUS	B
HAPJACK	D
HAPNEY	D
HAPPLE	B
HAPPUS	A
HAPPYHOME	C
HAPUR	D
HARAHILL	C
HARBESON	D
HARBOR	C
HARBORD	B
HARCO	B
HARCOT	B/D
HARDEMAN	B
HARDESTY	B
HARDHART	B
HARDISTER	B
HARDOL	B
HARDSCRABBLE	D
HARDTRIGGER	B
HARDWICK	C
HARDY	C
HARDZEM	C

HARECREEK	B
HARGILL	B
HARGREAVE	B
HARJO	D
HARKEN	C
HARL	B
HARLAKE	D
HARLESTON	C
HARM	D
HARMILLER	B
HARNEY	B
HARPER	D
HARPERSVILLE	D
HARPETH	B
HARPOLE	A
HARPOLE	B
HARPS	C
HARPT	B
HARRAH	B
HARREL	B
HARRIMAN	C
HARRINGTON	C
HARRIS	D
HARRISBURG	D
HARRISON	B
HARROD	B
HARSLOW	C
HARSTINE	C
HART	C
HARTER	C
HARTFORD	A
HARTLAND	B
HARTLESS	B
HARTNIT	C
HARTOP	B
HARTSELLS	B
HARTSHORN	B
HARTWELL	D
HARTWICK	A
HARTZ	B
HARVESTER	B
HARVEY	C
HASKILL	B
HASLIE	A/D
HASSEE	D
HASSELL	C
HASSLER	C
HASSMAN	D
HASTEE	B
HAT	C
HATBORO	D
HATCH	D
HATCHERY	C
HATCHET	B
HATCHIE	C
HATERMUS	D
HATERTON	C
HATFIELD	C
HATHAWAY	B
HATKNOLL	B
HATLIFF	C
HATMAKER	C
HATRANCH	D
HATSPRING	C
HATTON	C
HATU	D
HATUR	C
HATWAI	C
HAUBSTADT	C
HAUG	B/D
HAUGAN	B
HAUGEN	B
HAULINGS	D
HAUZ	C
HAVA	C
HAVANA	B
HAVELOCK	B/D
HAVEN	B
HAVENSNECK	B
HAVERDAD	C
HAVERHILL	D
HAVERMOM	B
HAVERSID	B
HAVERTEL	B
HAVILAND	B
HAWICK	A
HAWKEYE	A
HAWKSNEST	C/D
HAWKSPRINGS	B
HAWKSTONE	B
HAWLEY	B
HAWTHORNE	B
HAXBY	C
HAYCRIK	C
HAYES	B
HAYESTON	B
HAYESVILLE	B
HAYESVILLE, Stony	C
HAYFORD	C
HAYLAND	C
HAYNAP	A
HAYNER	C
HAYNESS	B
HAYRACK	C
HAYRIVER	B
HAYSPUR	D
HAYSTACK	B
HAYSTORE	C
HAYSUM	B
HAYTI	D
HAYWIRE	C
HAZELAIR	D
HAZELCAMP	B
HAZEN	B
HAZLEHURST	C
HAZTON	D
HEADLEY	B
HEADQUARTERS	B
HEAKE	D
HEALDTON	D
HEALING	B
HEAPO	B
HEAPO	C
HEARNE	D
HEATH	D
HEATHCOAT	D
HEATLY	A
HEATON	A
HEBBRONVILLE	B
HEBER	A
HEBO	D
HECETA	D
HECHTMAN	D
HECKER	B
HECKISON	D
HECKLY	C
HEDGE	D
HEDSTROM	B
HEDVILLE	D
HEELAND	D
HEELY	B
HEESER	B
HEFED	B
HEFLIN	B
HEGGE	D
HEGLAR	B
HEIDEL	B
HEIGHTS	B/D
HEIL	D
HEINSAW	C
HEINZ	B
HEISLER	B
HEISSPITZ	D
HEITT	C
HEIZER	D
HELEMANO	B
HELLGATE	B
HELLMAN	C
HELLWIG	C/D
HELM	D
HELMER	C
HELMET	C
HELMICK	D
HELVETIA	C
HELY	C
HEMAN	D
HEMCROSS	B
HEMINGFORD	B
HEMPHILL	D
HEMPSTEAD	B
HENCO	B/D
HENDAP	D
HENDERSON	B
HENDON	C
HENDRICKS	B
HENDY	C
HENKIN	B
HENKLE, Extremely Cobby	B
HENKLE	C
HENLEY	C
HENLINE	C
HENMEL	C
HENNEWAY	B
HENNINGS	B
HENRIETTA	B/D
HENRY	D
HENRYSFORK	C
HENRYSLAKE	D
HEPPSIE	D
HERAKLE	D
HERBEL	A
HERBERT	B
HERBMAN	A
HERBOLD	C
HERCULES	C
HERDCAMP	D
HERITO	C
HERJUN	B
HERLONG	D
HERMANTOWN	C
HERMERING	B
HERMIT	B
HERMSHALE	C
HERNANDEZ	B
HERNDON	B
HERO	B
HEROD	D
HERRICK	B
HERSEY	B
HERSH	B
HERTY	D
HESHOTAUTHLA	D
HESPER	B
HESS	B
HESSELBERG	D
HESSING	B
HESSLAN	C
HETLAND	C
HETTINGER	C/D
HEUSSER	C
HEUVELTON	C
HEVERLO	B
HEWITT	D
HEWOLF	B
HEXT	B
HEYDER	B
HEYDLAUFF	D
HEYTOU	B
HEYTO, Stony, Cool	C
HIARC	C
HIATHA	D
HIBAR	C
HIBBARD	C
HIBBING	C
HIBLER	C
HIBRITEN	B
HIBSAW	D
HICKEY	B
HICKIWAN	D
HICKS	B
HICKSVILLE	C
HICORIA	B/D
HICOTA	B
HIDATSA	B
HIDEAWAY	D
HIDEWOOD	B/D
HIDVALLE	B
HIGGINS	D
HIGGINSVILLE	C
HIGH GAP	C
HIGHBANK	C
HIGHCAMP	B
HIGHCREEK	B
HIGHHORN	B
HIGHLAND	B
HIGHLAND	C
HIGHPOINT	D
HIGHSPLINT	B
HIGHTOWER	C
HIGHUP	C
HIGHVALLEY	B
HIHIMANU	B
HILAIRE	B
HILDEBRECHT	C
HILDRETH	D
HILEA	D
HILES	B
HILGRAVE	B
HILINE	D
HILKEN	C
HILLBRICK	D
HILLCITY	B
HILLCO	B
HILLCREEK	B
HILLEMANN	C
HILLIARD	B
HILLIARD, Moderatelly Well Drained	C
HILLSDALE	B
HILLTISH	B
HILLTO	C
HILLTOPPE	C
HILLVIEW	B/D
HILLWOOD	B
HILMAR	B/D
HILO	A
HILTABIDEL	D
HINDES	C
HINDMAN	B
HINESBURG	C
HINGHAM	B
HINKER	C
HINKLE	D
HINMAN	C
HINSDALE	D
HINTERLAND	D
HINTON	B
HIRAMSBURG	C
HIRSCHDALE	C
HISEGA	C
HISNA	D
HISTOSOLS	D
HITCHCOCK	B
HITILO	A
HITT	B
HIWOOD	A
HOADLY	C
HOBAN	B
HOBBS	B
HOBBY	C
HOBE	A
HOBIT	C
HOBONNY	D
HOBSON	C
HOBUCKEN	D
HOCAR	D
HOCKINSON	B/D
HOCKINSO, Moderately Wet	C
HOCKLEY	C
HOCKLE, Graded	D
HODEDO	C
HODENPYL	B
HODGSON	C
HOEHNE	A
HOFFMAN	B
HOFFMANVILLE	C
HOFSTAD	D
HOGADERO	B
HOGAN	C
HOGCREEK	C
HOGENSBORG	D
HOGHEAVEN	B
HOGMALAT	D
HOGRANCH	B
HOGRIS	B
HOGRIS, Extremely Cobbly	D
HOH	B
HOHMANN	C
HOKO	C
HOLBORN	C

Exhibit A: Hydrologic Soil Groups for the United States

HOLCOMB	D
HOLDEN	B
HOLDERMAN	C
HOLDERTON	B
HOLDINGFORD	C
HOLINROCK	C
HOLKAT	B
HOLLACE	D
HOLLANDLAKE	B
HOLLISTER	D
HOLLOMEX	B
HOLLOW	C
HOLLOWTREE	C
HOLLY	B/D
HOLLYBROOK	C
HOLLYWOOD	D
HOLMAN	A
HOLMDEL	C
HOLMQUIST	D
HOLMZIE	C
HOLOHAN	B
HOLOMUA	B
HOLSINE	B
HOLSTEIN	B
HOLSTON	B
HOLT	B
HOLTER	B
HOLTVILLE	D
HOMA	C
HOMELAKE	B
HOMELAND	C
HOMEN	B
HOMESTEAD	B
HOMEWOOD	C
HOMME, Moderately Wet	B
HOMME	C
HOMOSASSA	D
HONAUNAU	C
HONDEE	B
HONEYCREEK	B
HONEYDEW	C
HONEYVILLE	C
HONGA	D
HONLAK	C
HONOBIA	C
HONOKAA	A
HONOLUA	B
HONOMANU	A
HONONEGAH	A
HONOULIULI	D
HONTAS	B
HONTOON	B/D
HONUAULU	A
HOOD	B
HOOD CANAL	C
HOODVIEW	B
HOOGDAL	C
HOOKSAN	A
HOOKTON	C
HOOLEHUA	B
HOOLY	C
HOOP	B
HOOPAL	D
HOOPPOLE	B/D
HOOSAN	B
HOOSEGOW	B
HOOSIERVILLE	C
HOOSKANADEN	D
HOOTEN	D
HOOTENTOWN	B
HOOTER	C
HOOVERS	D
HOOVERTON	C
HOPBURN	B
HOPCO	C
HOPDRAW	A
HOPKINS	B
HOPLAND	B
HOPLEY	B
HOPPERS	C
HOPPS	D
HOPPSWELL	B
HOQUIAM	B
HORCADO	A
HOREB, Gravelly Substratum	B
HOREB	C
HORNBECK	D
HORNELL	D
HORNELLSVILLE	D
HORNER	A
HORNER, Graavelly Substratum	B
HORNEYBUCK	C
HORNICK	C
HORNING	A
HORNITOS	D
HORNSBORO	D
HORNSBY	C
HORNSVILLE	C
HORROCKS	C
HORSECAMP	D
HORSEHEAD	A
HORSEPRAIRIE	B
HORSLEY	D
HORTONVILLE, Limestone Substratum	B
HORTONVILLE	C
HOSFORD	D
HOSKAY	C
HOSLEY	D
HOSMER	C
HOSPAH	D
HOSSICK	B
HOSTA, Loamy Surface	C
HOSTA	D
HOSTAGE	B
HOT LAKE	C
HOTAW	B
HOTCREEK	D
HOTEL	C
HOTSPOT	D
HOTSPRINGS	B
HOTTIS	D
HOUCKTOWN	B
HOUGHTON	D
HOUK	C
HOULA	B
HOULKA	D
HOURGLASS	C
HOUSEROCK	D
HOUSTENADER	C
HOUSTON	D
HOUSTON BLACK	D
HOVDE	D
HOVEN	D
HOVERT	D
HOWARD	A
HOWARDSVILLE	A
HOWCREE	C
HOWE	C
HOWELL	C
HOWMEADOWS	D
HOWSON	C
HOXIE	D
HOYLETON	C
HOYLETON, Mines Sinks	D
HOZHO	D
HOZOMEEN	D
HUACHUCA	D
HUALAPAI	C
HUB	B
HUBBELL	B
HUBERLY	D
HUBERT	B
HUBLERSBURG	B
HUCKLEBERRY, High Rainfall	B
HUCKLEBERRY	C
HUCKRIDGE	B
HUDDLE	B
HUDNUT	B
HUDSPETH	C
HUECO	C
HUEL	A
HUEY	D
HUFFLING	D
HUFFMAN	B
HUFFTON	B
HUFMAN	D
HUGGINS	C
HUGHES	B
HUGHESVILLE	C
HUGUSTON	D
HUICHICA	C/D
HUILEPASS	B
HULDA	D
HULDERMAN	D
HULETT	B
HULLIGAN	B/D
HULLS	C
HULLSGULCH	B
HULLT	B
HULUA	D
HUMACAO	B
HUMATAS	C
HUMBARGER	B
HUMBARSPRINGS	B
HUMBUG	B
HUME	C
HUMMINGTON	C
HUMSKEL	C
HUNCHBACK	D
HUNDRAW	D
HUNGRY	C
HUNGRYGULCH	B
HUNSINGER	B
HUNTDALE	B
HUNTERS	B
HUNTERSCOVE	C
HUNTIMER	C
HUNTLEY	D
HUNTMOUNT	B
HUNTROCK	B
HUNTSBURG	D
HUOT	B
HURDS	B
HURLBUT	C
HURLOCK	B/D
HURRYBACK	B
HUSE	D
HUSKA	D
HUSSA	B/C
HUSSELL	B
HUSSEY	B
HUSTONTOWN	C
HUSUM	B
HUTCHINSON	C
HUTSON	B
HUTT	D
HUXLEY	C
HUYSINK	B
HYALL	C
HYANNIS	B
HYAS	B
HYATTS	C
HYATTSTOWN	D
HYATTVILLE	C
HYDABURG	D
HYDE	B/D
HYDELAND	B/D
HYDRO	C
HYE	B
HYLOC	D
HYNES	B
HYPRAIRIE	C
HYSHAM	D
HYSHOT	D
HYZEN	D
IAO	B
IARGO	C
IBERIA	D
IBEX	B
IBOLA	C
ICACOS	D
ICARIA	D
ICEBERG	D
ICESLEW, Cool	C
ICESLEW	D
ICHBOD	D
ICHETUCKNEE	D
IDABEL	B
IDAHOME	B
IDAMONT	B
IDEE	C
IDLEWILD	C/D
IDMON	B
IDMONTON	C
IDWAY	B
IFFGULCH	D
IFTEEN	B
IGERT	C
IGNORD	C
IGUALDAD	D
IHLEN	B
IJAM	D
IKE	D
IKIT	D
IKSGIZA	D
ILACHETOMEL	D
ILDECARB	B
ILIILI	D
ILLABOT	C
ILLAHEE	B
ILLER	B
ILLIANO	D
ILLITO	D
ILTON	C
ILWACO	B
IMBLER	B
IMLAY	D
IMMANUEL	C
IMMIANT	C
IMMOKALEE	D
IMNAHA	C
INCELL	D
INCHELIUM	B
INCY	A
INDART	C
INDEX	A
INDIAHOMA	D
INDIANOLA	A
INDIANPASS	B
INDIANTOWN	D
INDLETON	B
INEL	D
INEZ	D
INFERNO	C
INGALLS	B
INGENIO	B
INGERSOLL	B
INGLEDOVE	B
INGLESIDE	B
INKOM	C/D
INKOSR	D
INLOW	C
INMACHUK	D
INPENDENCE	B
INSAK	D
INSIDERT	D
INSKIP	C
INVERNESS	B
INVERSHIEL	C
IO	B
IOGOON	B
IOLEAU	C
ION	B
IONA	B
IONIA	B
IOTA	D
IOTLA	B
IPANO	C
IPAVA	B
IPISH	C
IPSOOT	A
IRAAN	B
IRAK	D
IRASBURG	C
IRENE	B
IRIS	B
IRMA	B
IROCK	C
IRON BLOSSOM	C
IRONA	D
IRONBRIDGE	D
IRONCITY	B
IRONDALE	C
IRONDYKE	B
IRONGATE	B
IRONGOLD	D
IRONRUN	B
IRONSPRINGS	B
IROQUOIS	B/D

Exhibit A: Hydrologic Soil Groups for the United States

IRRAWADDY	C
IRRIGON	C
IRVINE	D
IRVINGTON	C
ISAAC	C
ISCHUA	B
ISELLA	B
ISHI PISHI	C
ISHMAEL	A
ISIDOR	D
ISKNAT	D
ISLAMORADA	D
ISLAND	B
ISLANDLAKE	A
ISLANDPARK	B
ISLES	A/D
ISLOTE	B
ISMAY	B
ISTOKPOGA	B/D
ITANO	C
ITASCA	B
ITAT	B
ITHACA	C
ITMANN	C
ITSWOOT	B
IUKA	C
IULUS	B
IVA	C
IVAN	B
IVANELL	C
IVANHOE	D
IVANPATCH	B
IVER	B
IVERSEN	C
IVES	D
IVIE	A
IVORY	C
IWAIT	B
IWELA	B
IWICA	C
IXIAN	C
IZAGORA	C
IZEE	C
JABU	B/C
JACAGUAS	B
JACANA	D
JACEE	C
JACINTO	B
JACK CREEK	A
JACKLAND	D
JACKMAN	B
JACKPORT	D
JACKPOT	C
JACKSBACK	C
JACKSBORO	D
JACKSON	B
JACOBSEN	D
JACOBY	C
JACONITA	A
JACQUITH	C
JACRATZ	D
JADIS	B
JADPOR	B
JAFA	C
JAGERSON	C
JAGON	D
JAGUEYES	B
JAHANT	D
JAHJO	D
JALMAR	A
JAM	B
JAMES CANYON	B/D
JAMESTON	C/D
JAMESTOWN	C
JANELEW	C
JANESBURG	D
JANILE, Bouldery	C
JANISE, Overblown, Drained	B
JANKOSH	C
JANNEY	C/D
JANSITE	B
JANUDE	C
JARAB	D
JARBIDGE	D
JARBOE	D
JARDAL	C
JARDIN	D
JAREALES	D
JARITA	C
JAROSO	B
JARRE	B
JARRON	D
JASCO	D
JASSEEK	C
JAUCAS	C
JAURIGA	B
JAWBONE	D
JAY	C
JAYAR	C
JAYEL	D
JAYHAWKER	D
JAYNES	D
JAYPE	C
JAYPEAK	B
JAYWI	B
JEAGER	C
JEALOUSY	C
JEAN LAKE	B
JEANERETTE	D
JEBE	B
JEBO	A
JEBO	B
JEDBURG	C
JEDDO	C/D
JEFFERS	B/D
JEFFLAKE	C
JEKLEY	C
JELLICO	C
JEMERSON	B
JENA	B
JENERA	B
JENEVA	B
JENKINS	A
JENKINSON	D
JENKS	B
JENOR	C
JERAG	D
JERKTAIL	C
JEROME	D
JERUSALEM	A
JESBEL	D
JESKE	C
JESSIETOWN	B
JESSUP	C
JESTER	A
JETCOP	D
JETMINE	D
JETSTER	C
JEVETS	C
JEVNE	C
JIGSAW	B
JILSON	D
JIM	C
JIMBEE	D
JIMBLUFF	B
JIMCOMLATE	B
JIMCREEK	C
JIMEK	C
JIMENEZ	C
JIMGREEN	D
JIMLAKE	B
JIMSAGE	B
JIMTOWN	C
JIVAS	B
JOBOS	C
JOBPEAK	D
JOEBALDY	B
JOEBAS	D
JOEMRE	B
JOENEY	D
JOEVAR	B
JOHNS	C
JOHNSBURG	C/D
JOHNSBUTTE	C
JOHNSTON	D
JOHNSTOWN	B
JOHNTOM	D
JOICE	D
JOINER	A
JOKODOWSKI	D
JOLAN	C
JOLIET	D
JOLLIES	B
JONATHAN	B
JONCA	C
JONDA	B
JONES	B
JONESBORO	C
JONESVILLE	B
JONLAKE	D
JONNIC	C
JONPOL	C
JOPPA	B
JORDY	C
JORGE	B
JORGENSEN	B
JORN	C
JORNAHAM	B
JORSTED	C
JOSHUA	C
JOSIE	B
JOSLIN	B
JOSSET	C
JOTAVA	C
JOURDANTON	B
JOVEATCH	D
JOVINE	B
JOWEC	D
JOYCE	B
JUANA DIAZ	B
JUANDEFUCA	B
JUBILEE	B/D
JUBIN	A
JUDA	B
JUDD	C
JUDGETOWN	B
JUDICE	D
JUG	B
JUGHANDLE	B
JUGSON	C
JUGTOWN	C
JULIN	D
JUMBLE	B
JUMBO	B
JUMPCREEK	C
JUMPER	C
JUMPMORE	B
JUMPOFF	C
JUNALUSKA	B
JUNCAL	C
JUNCOS	D
JUNEBEE	B
JUNGO	B
JUNIPERO	B
JUNIUS	C
JUNQUITOS	C
JUNTURA	D
JURVANNAH	C
JUSTIN	B
KAALUALU	A
KAB	D
KABEAR	B
KABOOM	D
KACHEMAK	B
KACHESS	B
KACKLEY	C
KADLETZ	B
KADOKA	C
KAENA	D
KAFFUR	D
KAFING	B
KAHALUU	D
KAHANA	B
KAHANUI	C
KAHLOTUS	B
KAHMAH	B
KAHN	B
KAHNEETA	C
KAHOLA	B
KAHOOLAWE	B
KAHUA	D
KAI	C
KAIDERS	B
KAIKLI	D
KAILUA	A
KAIMU	A
KAINALIU	A
KAINTUCK	B
KAIPOIOI	B
KAITO	B
KAIWIKI	A
KALAE	B
KALALOCH	B
KALAMA	C
KALAMAZOO	B
KALAMBACH	B
KALAPA	B
KALAUPAPA	D
KALEETAN	B
KALEETAN, Till Substratum	C
KALIFONSKY	D
KALIGA	B/D
KALIHI	D
KALLIO	C
KALMARVILLE	B/D
KALO	C
KALOKO	D
KALONA	C
KALSIN	C
KAMAKOA	B
KAMAOLE	B
KAMAY	D
KAMELA	C
KAMIE	B
KAMM	B
KAMPVILLE	C
KANACKEY	D
KANAKA	B
KANARANZI	B
KANASKAT	B
KANCAN	B
KANDALY	A
KANDIK	B
KANDIYOHI	C/D
KANEBREAK	C
KANELOA	B
KANEOHE	B
KANEPUU	B
KANER	A
KANESPRINGS	D
KANG	C
KANGAS	A
KANIKSU	B
KANKAKEE	B
KANORADO	C
KANOTIN	A/D
KANTISHNA	D
KANUTCHAN	D
KANZA	D
KAPAA	B
KAPAPALA	B
KAPAPALA, Bedrook Substratum	C
KAPLAN	D
KAPPES	B
KAPUHIKANI	D
KARAMIN	A
KARANKAWA	D
KARBANA	C
KARHEEN	D
KARLAN	C
KARLO	D
KARLOFF	B
KARLSBORG	C
KARLSRUHE	A
KARLSTAD	A
KARLUK	D
KARMA	B
KARNES	B
KARNEY	D
KAROC	B
KARPP	D
KARS	A
KARS/ Loamy Substratum	B
KARSHNER	D
KARTA	C
KASEBERG	D
KASHWITNA	B
KASIANA	D
KASKELA	D
KASOTA	C

Exhibit A: Hydrologic Soil Groups for the United States

KASPAL	C
KASSON	C
KATAMA	B
KATELANA	B
KATEMCY	C
KATHER	C
KATKA	B
KATLON	C
KATPA	B
KATSEANES	D
KATULA	C
KATY	D
KATYBLAY	B
KAUDER	D
KAUKAUNA	C
KAUPO	A
KAUPPI	B
KAVON	B
KAWAH	A
KAWAIHAE	C
KAWEETA	B
KAWKAWLIN	C
KAYMINE	C
KAYO	B
KEALIA	D
KEANSBURG	D
KEARL	C
KEARNSAR	B
KEATING	C
KEAUALALO	B
KEAUKAHA	D
KEAWAKAPU	B
KEBA	B
KEBLER	B
KECKSROAD	C
KEDA	B
KEECHI	C
KEEFA	B
KEEI	D
KEEKEE	B
KEEL	C
KEELDAR	B
KEELE	B
KEENE	C
KEENER	B
KEESE	D
KEETER	C
KEEWATIN	C
KEG	B
KEGEL	C/D
KEGLER	C
KEGONSA	B
KEHAR	D
KEHENA	C
KEHOE	B
KEIFFER	C
KEISER	B
KEITHVILLE	C
KEKAKE	D
KELL	B
KELLER	C
KELLERBUTTE	B
KELLISON	D
KELLOGG	A
KELLOGGS	C
KELLY	D
KELSEY	B
KELSO	C
KELSTRUP	B
KELTYS	B
KELVIN	C
KEMAH	D
KEMAN	B
KEMMERER	D
KEMOO	B
KEMP	C
KENAI	C
KENDRICK	A
KENEFICK	B
KENESAW	B
KENILWORTH	C
KENMOOR	B
KENNEY	A
KENNY LAKE	B
KENO	D
KENOTRAIL	C
KENRAY	A
KENRIDGE	C
KENSAL	B
KENSINGTON	C
KENSPUR	B
KENTLAND	A/D
KENTUCK	B/D
KENUSKY	D
KEO	B
KEOKUK	B
KEOSAUQUA	B
KEOTA	B
KEOWNS	B/D
KEPHART	B
KERBER	B
KERBY	B/C
KERHAYDEN	B
KERMIT	A
KERNAN	C
KERR	B
KERRDAM, Moderate Perm	B
KERRDAM	C
KERRFIELD	C
KERRICK	B
KERRVILLE	C
KERSHAW	A
KERSTON	A/D
KERT	C
KESHENA	B
KESSON	D
KETCHLY	B
KETLAND	C
KETTLEBELLY	B
KETTLEMAN, Gravelly	B
KETTLEMAN	C
KETTNER	D
KEUTERVILLE	B
KEVANTON	C
KEVILAR	B
KEWACH	C
KEWAKE	A
KEYLARGO	D
KEYNER	B
KEYOLE	B
KEYPORT	C
KEYSTONE	A
KEYVACA	D
KEYWEST	D
KEZAR	B
KIAN	C
KIAWAH	B/D
KIBESILLAH	C
KICHATNA	A
KICKERVILLE	B
KICKINGHORSE	B
KIDAMI	B
KIDWELL	B
KIESEL	C
KIETZKE	D
KILAUEA	B
KILDOR	C
KILGORE	C
KILLARNEY	C
KILLBUCK	C/D
KILLET	B
KILLEY	C
KILLINGTON	D
KILLMASTER	C
KILMANAGH	C
KILMER	C
KILMERQUE	C
KILOA	A
KILOHANA	A
KILOWAN	C
KILTABAR	C
KILWINNING	D
KIM	C
KIMBLE	B
KIMBLES	D
KIMMELL	C
KIMPTON	C
KIMROSE	D
KINA	D
KINCHELOE	D
KINCO	A
KINDANINA	D
KINDER	C
KINDIG	B
KINDY	C
KINESAVA	C
KINGCO	D
KINGDON	B
KINGFISHER	B
KINGILE	C
KINGINGHAM	C
KINGMAN	D
KINGMONT	B
KINGS	D
KINGSBURY	D
KINGSDOWN	B
KINGSFERRY	B/D
KINGSLAND	A/D
KINGSLEY	B
KINGSPOINT	B
KINGSRIVER	B/D
KINGSTON	B
KINGTUT	D
KINKEAD	C
KINKEL, Gravelly	B
KINKEL	C
KINKORA	D
KINLEY	B
KINMAN	C
KINNEAR	B
KINNICK	B
KINNICK	C
KINOCKITY	D
KINSMAN	C
KINSTON	B/D
KINTA	D
KINTON	C
KINUSTA	D
KINZEL	B
KINZUA	B
KIOMATIA	A
KIOTE	B
KIOUS	D
KIPER	B
KIPLING	D
KIPSON	D
KIRBYVILLE	B
KIRKENDALL	C
KIRKLAND	D
KIRKSEY	C
KIRKVILLE	C
KIRLEY	C
KIRVIN	C
KIRVIN, Graded	D
KISATCHIE	D
KISCOVE	D
KISHWALK	D
KISHWAUKEE	B
KISRING	C/D
KISSICK	C
KISTIRN	B
KITCARSON	B
KITCHEN CREEK	B
KITI	D
KITKUN	D
KITSAP	C
KITSILI	B
KITTERLL	D
KITTERMAN	C
KITTITAS	C/D
KITTLESON	B
KITTSON	C
KIYI	C
KIZHUYAK, Modeately Wet	B
KIZHUYAK	D
KLABER	C/D
KLACKING	A
KLADNICK	A
KLADNICK, Stony	B
KLAHOWYA	C
KLAMATH	D
KLANELNEECHENA	D
KLAPOT	B
KLASI	D
KLAUS	C
KLAWATTI	C
KLAYENT	C
KLICKIMA	D
KLICKO	B
KLIENPETER	B
KLINE, Cobbly	B
KLINE, Protected	C
KLINGER	B
KLIPSTEIN	B
KLISKON	C
KLONDIKE	D
KLOOQUEH	B
KLOOTCH	C
KLOSSNER	D
KLOTEN	D
KLUG	B
KLUMP	B
KLUNA DEEP	B
KNAPPA	B
KNAPPTON	B
KNEELAND	C
KNEFF	C
KNEP	C
KNICKERBOCKER	A
KNIFEHILL	C
KNIFFIN	C
KNIGHT	B/D
KNIK	B
KNIKLIK	B
KNIPPA	C
KNOB HILL	B
KNOBBY	D
KNOLLE	B
KNOSS	D
KNOWLES	B
KNOWLTON	C
KNOX	B
KNOXDALE	B
KNULL	B
KOBARTER	C
KOCH	C/D
KODAK	B
KODAK, Nonflooded	C
KODIAK	B
KODRA	C
KOEHLER	C
KOELE	B
KOERLING	C
KOETHER	D
KOFFGO	C
KOGISH	D
KOHALA	B
KOHATK	D
KOKEE	B
KOKERNOT	C
KOKO	B
KOKORUDA	B
KOKOSING	C
KOLAR	D
KOLBERG	C
KOLEKOLE	C
KOLIN	C
KOLLUTUK	D
KOLOA	C
KOLOB	C
KOLOMOKI	B
KOMONDOR	B
KOMRO	A
KONA	D
KONAWA	B
KONERT	C/D
KONNAROCK	C
KONNER	C/D
KONOCTI, Stony	B
KONOCTI	C
KONSIL	B
KONZA	D
KOOCH	C
KOOLAU	C
KOONICH	A
KOOSKIA	C
KOOTENAI	B
KOPIE	D
KOPPERL	B
KOPPES	A

KORNMAN	C
KOROBAGO	C
KORONIS	B
KORTTY	B
KOSETH	B
KOSMOS	D
KOSSE	B
KOSSUTH	B/D
KOST	A
KOTO	D
KOTZMAN	B
KOUNTER	D
KOURY	B
KOYNIK	D
KOYOKEE	C
KOYUKTOLIK	D
KRACKLE	B
KRADE	B
KRAKON	D
KRAKOW	B
KRAM	D
KRANSKI	B
KRANZBURG	B
KRAUSE	B
KREAMER	C
KREBS	B
KREFT	C
KREM	A
KRENKA	B
KRESSON	C
KREYENHAGEN	B
KREZA	D
KRIER	D
KRIEST	B
KROME	A
KRON	D
KROTO	B
KRUBATE	B
KRUEGER	C
KRUM	D
KRUTAR	B
KUBE	B
KUBLER	C
KUBLI	D
KUCKUP	A
KUDLAC	C
KUKAIAU	A
KUKAIAU, Bedrock Substratum	B
KUKVEY	A
KULA	B
KULLIT	B
KULSHAN	C
KUNAYOSH	A
KUNCEIDER	A
KUNIA	B
KUNUWEIA	C
KUPREANOF	B
KUPREANOF, Moderately Wet	C
KUREB	A
KURK	C
KURO	D
KURSTAN	B
KURTEN	D
KURTH	C
KURTZ	C
KUSAL	C
KUSDRY	C
KUSHNEAHIN	D
KUSKOKWIM	D
KUSLINA	D
KUSLINAD	D
KUSSHI	B
KUTLER	C
KUVASZ	C
KUY	A
KVICHAK	B
KWAKINA	B
KWATAHEIN	B
KWEO	A
KYBURZ	B
KYDAKA	D
KYGER	B
KYLE	D
KZIN	D
LA FARGE	B
LA GRANDE	C
LA POSTA	B
LA ROSE	B
LABELLE	D
LABETTE	C
LABKEY	B
LABLUE	D
LABORCITA	B
LABOU	D
LABRE	B
LABSHAFT	D
LABU	D
LABYRINTH	A
LACERDA	D
LACEYCREEK	B
LACKSCREEK	C
LACLEDE	B
LACONNER	C
LACOOCHEE	D
LACOSTE	C
LACOTA	B/D
LACRESCENT	B
LACROL	D
LADERLY	C
LADNER	D
LADO	B
LADRON	B
LADUE	B
LADYBIRD	B
LADYCOMB	D
LADYSMITH	D
LAFAYETTE	B
LAFE	D
LAFOLLETTE	B
LAGITOS	C
LAGLORIA	B
LAGO	C
LAGONOT	C
LAGRANGE	D
LAGROSS	A
LAGUNITA	C
LAHAINA	B
LAHOGUESS	B
LAHOOD	B
LAHRITY	C
LAHTIDA	C
LAINAND	B
LAIRDSVILLE	D
LAKASH	B
LAKASKIA	D
LAKE	A
LAKE, Clayey Surface	C
LAKE CHARLES	D
LAKEBEDDER	B
LAKEFIELD	B
LAKELAND	A
LAKEPARK	B/D
LAKESHORE	B
LAKESHORE	D
LAKESOL	B
LAKETON	C
LAKEWOOD	A
LAKIN	A
LAKOMA	D
LAKOTA	D
LAKRIDGE	C
LALAAU	A
LALINDA	B
LALOS	B
LAM	D
LAMA	C
LAMADRE	B
LAMANGA	C
LAMAR	B
LAMARSH	C
LAMARTINE	C
LAMATH	D
LAMAWA	B
LAMBERJACK	B
LAMBMAN	C
LAMBRANCH	D
LAMBUTTE	B
LAMEDEER	B
LAMESA	D
LAMESHUR	A
LAMINE	D
LAMINGTON	D
LAMKIN	B
LAMOILLE	B
LAMOTTE	B
LAMPASAS	D
LANARK	B
LANCASTER	B
LANCE	B
LAND	B/C
LANDAVASO	B
LANDCO	C
LANDINGHAM	B
LANDMAN	B
LANDO	C
LANDUSKY	A
LANEVILLE	B
LANEXA	D
LANEY	B
LANFAIR	B
LANGDON	A
LANGELLAIN	D
LANGER	A
LANGLADE	B
LANGLESS	C
LANGLOIS	D
LANGOLA	C
LANGSPRING	B
LANGSTON	B
LANGWELL	D
LANIER	A
LANIP	B
LANKBUSH	B
LANOAK	B
LANONA	B
LANSDOWNE	C
LANTERN	B
LANTIS	B
LANTON, Low Rainfall	C
LANTON	D
LANTONIA	B
LANTRY	B
LANTZ	D
LANYON	C/D
LAOLAO	B
LAONA	B
LAPARITA	C
LAPHAM	A
LAPLATTA	C
LAPOINTE	C
LAPON	D
LAPPANS	A
LAPWAI	B
LARA	C
LARCHMOUNT	B
LARCHPOINT	C
LARES	C
LARIAT	B
LARIC	D
LARIM	B
LARIMER	B
LARIOSCAMP	D
LARMINE	D
LAROQUE	B
LAROSE	D
LAROSS	B
LARPENTEUR	B
LARRY	C/D
LARTON	A
LARUE	A
LARUSH	B
LARVIE	D
LARWOOD	C
LAS FLORES	D
LAS LUCAS	B
LAS VEGAS	D
LASAC	A
LASALLE	D
LASAUSES	D
LASERE	C
LASH	B
LASKA	B
LASSEL	C
LASSITER	B
LASTANCE	B
LASVAR	C
LATAH	D
LATAHCO	D
LATANIER	D
LATCH	A
LATES	C
LATEX	C
LATHER	D
LATIERRA	B
LATIGO	B
LATIMER	D
LATINA	D
LATIUM	D
LATONIA	B
LATOUCHE	D
LATOUR	B
LATOURELL	B
LATRASS	D
LATTAS	D
LAUBY	B
LAUDERDALE	D
LAUDERHILL	B/D
LAUER	C/D
LAUGENOUR	C
LAURAMIE	B
LAUREL	D
LAURELWOOD	B
LAUREN	B
LAVALLEE	B
LAVEAGA	C
LAVELLGA	B
LAVENDER	B
LAVENTANA	C
LAVEY	D
LAVINA	D
LAVODNAS	C
LAWAI	B
LAWEN	B
LAWNDALE	B
LAWNES	D
LAWNWOOD	B/D
LAWRENCE	C
LAWRENCEVILLE	C
LAWSON	C
LAWVER	B
LAX	C
LAXTON	C
LAYCOCK	B
LAYTON	B
LAZAN	D
LAZBUDDIE	D
LE BAR	B
LEA	C
LEADER	B
LEADORE	B
LEADPOINT	C
LEADVALE	C
LEAF	D
LEAFLAKE	B
LEAGUE	D
LEAGUEVILLE	B/D
LEAKEY	D
LEAKSVILLE	D
LEANDER	B
LEANNA	D
LEATHAM	C
LEATHERBARK	C
LEATHERS	B
LEATHERWOOD	B
LEAVENWORTH	C
LEBAM	B
LEBEAU	D
LEBEC	B
LEBRON	D
LECKMAN	B
LECOMA	B
LECRAG	D
LEDFORD	B
LEDGER	D
LEDOW	B
LEDRU	D
LEDWITH	B/D
LEECREEK	D
LEEDSVILLE	B
LEEFIELD	C

Exhibit A: Hydrologic Soil Groups for the United States

LEELANAU	A
LEEMONT	D
LEEMORRIS	C
LEEN	B/D
LEEPER	D
LEERAY	D
LEERCO	D
LEESVILLE	B
LEGALL	B
LEGAULT	A
LEGGETT	C
LEIDIG	B
LEILEHUA	B
LEISY	B
LEITER	C
LEMAH	A
LEMBOS	C
LEMCAVE	B
LEMCO	C
LEMETA	D
LEMHI	D
LEMING	C
LEMM	B
LEMMON	C
LEMOLO	D
LEMONEX	C
LEMOORE	C
LEMOYNE	B
LEMPIRA	B
LEMROI	D
LENA	A/D
LENACREEK	B
LENAPAH	D
LENAPE	D
LENAWEE	D
LENBERG	C
LENGBY	B
LENNEP	C
LENOIR	D
LENORAH	C
LENZLO	B
LENZWHEEL	B
LEOLA	B
LEONARD	D
LEONARDO	B
LEONARDTOWN	D
LEOPOLD	C
LEPNER	C
LEQUIEU	D
LEQUIRE	D
LEROUX	C
LEROY	B
LESBUT	A
LESIER	B
LESON	D
LESPATE	C
LESWILL	B
LETAVARIA	D
LETHENT	C
LETNEY	A
LETON	D
LETORT	B
LETRI	B/D
LETTIA	B
LEVAC	D
LEVASSEUR	A
LEVELTON	C/D
LEVENGOOD	B
LEVENMILE	B
LEVERETT	C
LEVNIK	D
LEVY	D
LEVYVILLE	B
LEWDLAC	D
LEWELLEN	B
LEWHAND	D
LEWIS	D
LEWISBURG	C
LEWISVILLE	B
LEWKALB	B
LEWNOT	C
LEXINGTON	B
LEXTON	B
LEYBA	B
LIART	D
LIBERAL	D
LIBERTY	B
LIBRARY	D
LIBUSE	C
LICK	B
LICKCREEK	B
LICKING	C
LICKSKILLET	C
LIDA	B
LIDAN	C
LIDDELL	B/D
LIDDIEVILLE	B
LIDOS	B
LIEBER	C
LIEBERMAN	B
LIESNOI	D
LIGAI	C
LIGHTNING	D
LIGNUM	C
LIGNUMVITAE	D
LIGOCKI	C
LIGURTA	B
LIHUE	B
LILAH	A
LILBERT	B
LILBOURN	B
LILLE	B
LILLINGS	B
LILLINGTON	B
LILLIS	D
LILLIWAUP	B
LILLYLANDS	C
LILSHEEP	B
LILSNAKE	C
LILTEN	C
LILYLAKE	D
LIM	C
LIMBERJIM	B
LIMECREEK	B
LIMINGA	A
LIMKING	B
LIMON	D
LIMONES	B
LIMPY	D
LINCO	B
LINDALE	C
LINDELL	C
LINDEN	B
LINDER	B
LINDQUIST	A
LINDSTROM	B
LINDY	C
LINGANORE	B
LINGUA	D
LINHART	A
LININGER	B
LINKLETTER	C
LINKSTERLY	B
LINLITHGO	B
LINNE	C
LINNEUS	B
LINO	A
LINPEAK	B
LINSLAW	D
LINTON	B
LINVELDT	B
LIONHEAD	B
LIONWOOD	B
LIPKE	D
LIPPITT	C
LIRIOS	B
LISBON	B
LISBON, Silty Clay Loam Substratum	C
LISCUM	D
LISK	B
LITAG	B
LITCHY	C
LITEN	A
LITEN, Till Substratum	B
LITHEE	C
LITHGOW	C
LITHIC HAPLUSTALFS, L,M,M	D
LITIMBER	B
LITLE	D
LITRO	D
LITTLE HORN	C
LITTLEAXE	B
LITTLEBALD	B
LITTLEFAWN	C
LITTLEFIR	C
LITTLEHAT	B
LITTLEJOHN	C
LITTLEMO	B
LITTLEMUD	C
LITTLERED	B
LITTLESALMON	A
LITTLESAND	B
LITTSAN	C
LIVAN	A
LIVCO	D
LIVENGOOD	B
LIVERMORE	B
LIVIA	D
LIVONA	B
LIZARDHEAD	B
LIZARDLAKE	D
LIZE	B
LIZZIE	B
LIZZYSPRINGS	C
LLANOS	C
LOARC	B
LOBAT	B
LOBEISNER	B
LOBERT	B
LOBO	D
LOBURN	D
LOCEY	C
LOCHLOOSA	C
LOCHSA	B
LOCKDOWN	D
LOCKE	B
LOCKERBY	D
LOCKHART	B
LOCKNEY	D
LOCKPORT	D
LOCKSPRINGS	C
LOCKTON	B
LOCO	C
LOCOBILL	B
LOCUST	C
LODALLEY	D
LODE	B
LODICO	D
LOEB	C
LOEMSTONE	C
LOFFTUS	C
LOFTON	D
LOGDELL	B
LOGGERT	B
LOGHILL	B
LOGHILL, Very Deep	C
LOGHILL, Thick Solum	D
LOGSDEN	B
LOGSPRINGS	C
LOHSMAN	D
LOIRE	B
LOKEN	C
LOKERN	C
LOKOSEE	B/D
LOLALITA	B
LOLEKAA	B
LOLETA	C
LOLITE	D
LOLON	B
LOLOPEAK	A
LOMAKI	B
LOMALTA	D
LOMART	B
LOMAX	B
LOMBARD	C
LOMETA	C
LOMILL	D
LOMIRA	B
LOMOND	B
LOMPICO	B
LONCAN	C
LONDO	C
LONEBEAR	D
LONECONE	B
LONELY	C
LONEMAN	B
LONEOAK	C
LONEPINE	B
LONERANCH	B
LONESOME	B
LONEWOOD	B
LONGBAR	B
LONGBELL	A
LONGBILLY	D
LONGBRANCH	C
LONGHIKE	C
LONGHOPE, Ponded	D
LONGJOHN	B
LONGLOIS	B
LONGMARE	C
LONGMARSH	D
LONGMONT	C
LONGORT	B
LONGPEN	B
LONGPINE	D
LONGS	B
LONGSHOAL	D
LONGSIDING	B
LONGVAL	B
LONGVIEW	C
LONIGAN, Cobbly Substratum	C
LONJON	B
LONNIEBEE	B
LONOKE	B
LONON	B
LONTI	D
LOONLAKE	B
LOONY	C
LOPENO	A
LOPER	B
LOPEZ	D
LOPWASH	B
LORACK	B
LORADALE	C
LORAY	A
LOREAUVILLE	C
LORENZO	B
LORHUNT	D
LORING	C
LORMAN	D
LORRAINE	B
LOS ALAMOS	C
LOS OSOS	C
LOS TANOS	C
LOSANTVILLE	C
LOSEGATE	C
LOSLOBOS	B
LOSMARIOS	C
LOSTBASIN	C
LOSTCOVE	B
LOSTCREEK	B
LOSTHORSE	D
LOSTINE	B
LOSTPOINT	D
LOSTSPRING	B
LOSTVALLEY	D
LOSTWELLS	B/C
LOTEX	D
LOTHAIR	C
LOTT	C
LOTUS	C
LOU	B
LOUDON	C
LOUDONVILLE	C
LOUELLA	B
LOUGHBORO	C
LOUIECREEK	B
LOUIN	D
LOUISA	B
LOURIS	B
LOUSCOT	C
LOVEDALE	B
LOVEJOY	C
LOVELACE	B
LOVELADY	B
LOVELAND	D
LOVELL	D
LOVELOCK	D
LOVENESS	B

LOVETT	B
LOVLINE	C
LOWASSIE	D
LOWDER	C
LOWE	B/D
LOWERBLUFF	D
LOWERCREEK	A
LOWLEIN	B
LOWNDES	A
LOWRY	B
LOWS	B/D
LOWVILLE	B
LOX	C
LOYAL	C
LOYALTON	D
LOYPLACE	D
LOYSVILLE	D
LOZANO	B
LOZEAU	C
LUANA	B
LUBBOCK	B
LUBKIN	B
LUBRECHT	C
LUCE	C
LUCEDALE	B
LUCILE	B/C
LUCKENBACH	C
LUCKETTS	C
LUCKIAMUTE	D
LUCKYFUSE	B
LUCKYRICH	B
LUCY	A
LUDINGTON	B
LUFKIN	D
LUGERT	B
LUGOFF	B
LUKE	C
LUKIN	C
LULA	B
LULUDE, High Rainfall	B
LULUDE, Short FFS	C
LUMAN	B
LUMBEE	B/D
LUMMI	C/D
LUMMUS	C
LUNCH	C
LUNDER	D
LUNDGREN	A
LUNDLAKE	B/D
LUNSFORD	D
LUNT	C
LUPCHO	B
LUPE	B
LUPINE	B
LUPINTO	C
LUPOYOMA	B
LUPPINO	D
LUPTON	D
LURAY	C/D
LURNICK	C
LUSETTI	B
LUSK	C
LUTA	D
LUTAK	B
LUTHER	B
LUTIE	B
LUTZCAN	D
LUTZKE	B
LUVAR	B
LYBRAND	C
LYCURGUS	B
LYDICK	B
LYERLY	D
LYFORD	C
LYKAL	C
LYKENS	C
LYKORLY	C
LYMANSON	B
LYNCH	D
LYNDEN	B
LYNN HAVEN	B/D
LYNNBOW	D
LYNNE	B/D
LYNNVILLE	C
LYNNWOOD	A
LYNXCREEK	B
LYONMAN	B
LYRA	D
LYSTAIR	B
LYTELL	B
LYTLE	B
LYX	B
MABANK	D
MABEN	C
MABI	D
MACAREENO	C
MACE	B
MACEDONIA	B
MACHETE	C
MACHIAS	B
MACHONE	B
MACHUELO	D
MACIVER	B
MACKERRICHER	A
MACKINAC	B
MACKLYN	C
MACKSBURG	B
MACLAREN	B
MACOMB	B
MACON	B
MACREEING	B
MACYFLET	D
MADAWASKA	B
MADDEN	C
MADELIA	B/D
MADERBAK	C
MADGE	B
MADILL	B
MADONNA	C
MADRAK	C
MADUREZ	B
MAES	B
MAGDALENA	D
MAGENS	B
MAGGIE	D
MAGGIN	C
MAGIC	D
MAGNET	C
MAGNETIC	D
MAGOTHA	D
MAGROC	C
MAGUAYO	C
MAHAFFEY	C
MAHAN	C
MAHANA	B
MAHASKA	B
MAHKONCE	C
MAHO BAY	D
MAHOGAN	C
MAHOOSUC	A
MAHTOWA	C/D
MAIDENPEAK	A
MAILE	A
MAILTRAIL	C
MAJIK	B
MAJUBA	C
MAJURO	A
MAKAH	B
MAKALAPA	D
MAKAPILI	B
MAKAWAO	B
MAKAWELI	B
MAKENA	B
MAKI	C
MAKIKI	B
MAKLAK	A
MAL	C
MALA	B
MALACHY	B
MALAMA	A
MALARDI	B
MALARGO	B
MALAYA	D
MALBIS	B
MALCOLM	B
MALDEN	A
MALEZA	B
MALHEUR	C
MALIBU	D
MALJAMAR	B
MALLOPASS	B
MALMESA	D
MALMESBURY	C
MALMO	D
MALO	B
MALONEY	C
MALOTERRE	D
MALSTROM	B
MALTESE	D
MAMALA	D
MANADA	C
MANAHAWKIN	D
MANANA	C
MANARD	C
MANARY	C
MANASHTASH	C
MANASSAS	B
MANATEE	B/D
MANAWA	C
MANBURN	D
MANCHESTER	A
MANCO	C
MANCOS	C
MANDARIN, Flooded	B/D
MANDARIN	C
MANDERSON	C
MANGUM	D
MANHATTAN	A
MANI	C
MANIKAN	B
MANILA	D
MANITA	C
MANITOWISH	B
MANKOMEN	D
MANN	B/D
MANNINGTON	D
MANNIXLEE	D
MANSIC	B
MANSKER	B
MANSON	B
MANTECA	C
MANTON	B
MANU	C
MANVEL	C
MANZANITA, Gravelly	B
MANZANITA	C
MANZANST	D
MAPLE HOLLOW	C
MAPLECREEK	C
MAPLECREST	B
MAPLEHILL	C
MAPLEHURST	C
MAPLEWOOD	C
MARA	B
MARACK	C
MARAGUEZ	B
MARANA	B
MARBIE	C
MARBLECREEK	B
MARBLEHEAD	C
MARBLEMOUNT	B
MARBLEMOUNT, Channery	C
MARBLETOWN	B
MARCADO	D
MARCEL	C
MARCELINAS	D
MARCELLON	C
MARCETTA	B
MARCLAY	D
MARCOLA	C
MARCONI	C
MARCOU	B
MARCUS	B/D
MAREMMA	B
MARENGO	C/D
MARESUA	B
MARGERUM	B
MARGIE	C
MARGO	B
MARIANA	C
MARIAVILLE	D
MARICAO	B
MARIEL	D
MARIETTA	C
MARILLA	C
MARIMEL	B/D
MARINA	B
MARINE	C
MARION	D
MARIOSA	D
MARISCAL	D
MARJANE	C
MARKER	B
MARKES	D
MARKESAN	B
MARKEY	D
MARKLAKE	C
MARKLEPASS	D
MARKSBUTTE	B/D
MARKTON	C
MARLA	D
MARLEY	C
MARLTON	C
MARMARTH	C
MARNA	C/D
MAROTZ	C
MARPA	C
MARPLEEN	D
MARQUAND	C
MARQUETTE	A
MARQUEZ	C
MARR	B
MARRIOTT	B
MARSDEN	B
MARSH	B
MARSHDALE	C/D
MARSHFIELD	B/D
MARSHILL	B
MARSING	B
MARSITE	D
MART	B
MARTEE	D
MARTEL	D
MARTELLA	C
MARTILLO	D
MARTIN PENA	D
MARTINEZ	D
MARTINSBURG	B
MARTINSON	C
MARTINTON	C
MARTIS	B
MARTY	B
MARUMSCO	C
MARVELL	B
MARVYN	B
MARYSTOWN	C
MARYSVILLE	B
MASARYK	A
MASCARENAS	C
MASCHETAH	B
MASCOTTE	B/D
MASCOUTAH	B/D
MASEEYA	B
MASET	B
MASHAM	D
MASHEL	B
MASHULAVILLE	B/D
MASKELL	B
MASON	B
MASONFORT	D
MASONTOWN	D
MASSACK	B/C
MASSADONA	C
MASSADONA	D
MASSANETTA	B
MASSBACH	B
MASSIE	D
MASTERSON	B
MASTLY	B
MATA	C
MATAGORDA	D
MATAMOROS	C
MATANUSKA	B
MATANZAS	B
MATAWAN	C
MATCHER	A
MATECUMBE	D
MATFIELD	C
MATHERS	B
MATHERTON	B

Exhibit A: Hydrologic Soil Groups for the United States

MATHERTON, Clay Substratum	C
MATHIAS	B
MATHISTON	C
MATHON	B
MATILO	B
MATMON	D
MATOON	D
MATOY	C
MATQUAW, Dry	B
MATQUAW	C
MATTAMUSKEET	D
MATTAN	D
MATTAPEX	C
MATTERHORN	A
MATTEX	C
MATTIX	B
MATUNUCK	D
MAU	C
MAUDE	B
MAUKEY	C
MAUMEE	D
MAUNABO	D
MAUPIN	C
MAURY	B
MAVCO	C
MAVERICK	C
MAVIE	B/D
MAVREESO	B
MAWAE	A
MAWER	B
MAXEY	C
MAXTON	B
MAY	B
MAYBELL	A
MAYBESO	D
MAYBID	D
MAYDOL	B
MAYES	D
MAYFLOWER	C
MAYGAL	D
MAYGER	C
MAYHEW	D
MAYMEAD	B
MAYNARD LAKE	A
MAYO	B
MAYQUEEN	B
MAYSPRINGS	B
MAYSWELL	D
MAYTAG	D
MAYTOWN	C
MAYVILLE	B
MAZARN	C
MAZASKA	C/D
MAZDALE	B
MAZIE	D
MAZUMA	C
MCADOO	B
MCAFEE	C
MCALLEN	B
MCALLISTER	B
MCARTHUR	B
MCBAIN	B
MCBIGGAM	C
MCCAFFERY	A
MCCALEB	B
MCCALLY	D
MCCAMMON	C
MCCANN	B
MCCASH	B
MCCAY	B
MCCLANAHAN	D
MCCLAVE	C
MCCLELLAN	B
MCCLOUD	C
MCCLUNG	B
MCCLURE	C
MCCOIN	D
MCCOLL	D
MCCOMAS	C
MCCONAUGHY	B
MCCORNICK	C
MCCOY	C
MCCREE	B
MCCRORY	D
MCCROSKET	B
MCCUE	C
MCCULIGAN	D
MCCULLAN	B
MCCUMBER	B
MCCUNE	D
MCCURDY	C
MCCUTCHEN	D
MCDANIELAKE	B
MCDERMOTT	B
MCDOLE	B
MCDONALDSVILLE	C/D
MCDOUG	B
MCDUFF	C
MCELMO	D
MCEWEN	B
MCFAIN	C
MCFARLAND	B
MCFAUL	C
MCGAFFEY	B
MCGARVEY	C
MCGEHEE	C
MCGILVERY	D
MCGINN	B
MCGINNIS	C
MCGIRK	C
MCGIRK, Low Rainfall	D
MCGOWAN	B
MCGRATH	B
MCGRAVEY	B
MCGUFFEY	D
MCGUIRE	B
MCHANDY	D
MCINTOSH	C
MCIVOR	D
MCKAMIE	D
MCKAY	C
MCKEE	D
MCKEETH	B
MCKENNA	C/D
MCKENTON	D
MCKINLEY	B
MCKINNEY	C
MCKNIGHT	B
MCLAIN	C
MCLANGOR	D
MCLAURIN	B
MCLEAN	D
MCLENNAN	C
MCLEOD	B
MCLOUGHLIN	B
MCMANUS	C
MCMEEN	C
MCMILLAN	A
MCMILLE	B
MCMURDIE	B
MCMURRAY	C/D
MCNAB	C
MCNARY	D
MCNEELY	A
MCNULTY	B
MCNYE	B
MCPAN	C
MCQUEEN	C
MCRAE	B
MCRAVEN	C
MCTAGGART	B
MCVAR	A
MCVICKERS	C
MCWATT	B
MEAD	D
MEADOWBANK	B
MEADOWLAKE	C
MEADOWPASS	C
MEADOWPEAK	C
MEADOWPORT	C
MEADOWS	D
MEADOWVILLE	B
MEANS	C
MEARES	D
MEATON	C
MECAN	B
MECHANICSBURG	C
MECKLENBURG	C
MECKLING	B
MECLO	D
MECOSTA	A
MEDFRA	D
MEDICI	A
MEDICINE	B
MEDLAKE	A
MEDLAVAL	D
MEDLEY	B
MEDO	A/D
MEDOC	C
MEDRICK	B
MEEGERNOT	B
MEENON	C
MEGONOT	C
MEGUIN	B
MEHURIN	C
MEIKLE	D
MEISS	D
MEKINOCK	D
MELAKWA	C
MELBOURNE	B
MELBY	B
MELD	C
MELDER	B
MELFA	D
MELGA	D
MELHOMES	D
MELHORN	B
MELLING	D
MELLOTT	B
MELLOWMOON	B
MELOCHE	D
MELOZA	C
MELROSE	C
MELRUDE	C/D
MELTON	D
MELVINA	C
MEMALOOSE	C
MEMMOTT	B
MENA	C
MENAN	B
MENARD	B
MENBAR	C
MENDEBOURE	C
MENDELTNA	D
MENDENHALL	D
MENDI	B
MENDNA	D
MENDON	B
MENDOTA	B
MENFRO	B
MENINIK	D
MENO	C
MENOKEN	C
MENOMIN	B
MENTO	C
MENTONE	C
MENTZ	D
MENZEL	B
MEQUITHY	B
MEQUON	C
MER ROUGE	B
MERCER	C
MERCEY	C
MEREDITH	B
MERIMOD	B
MERINO	D
MERIT	B
MERKLEY	B
MERMENTAU	D
MERNA	B
MEROS	A
MERRILL	C
MERRILLAN	C
MERRIMAC	A
MERRYVILLE	D
MERSHON	C
MERTON	B
MERWIN	A/D
MESABA	C
MESCAL	C
MESCALERO	C
MESEI	D
MESSER	C
MET	B
METALLAK	B
METANOB	B
METCALF	D
METH	C
METIGOSHE	B
METOLIUS	B
METONGA	B
METRE	D
METSER	C
MEXICO	D
MEXISPRING	D
MEXTANK	B
MEYSTRE	B
MEZZER	B
MICANOPY	C
MICAVILLE	B
MICCO	B/D
MICCOSUKEE	C
MICKEY	D
MICROSPEECH	D
MICROY	C
MIDAS	C
MIDCO	A
MIDDLEBOX	B
MIDDLEBROOK	C
MIDDLEBURG	B
MIDDLEBURY	B
MIDDLEHILL	C
MIDDLEWOOD	B
MIDELIGHT	B
MIDESSA	B
MIDFORK	B
MIDO	B
MIDPEAK	B
MIDVALE	C
MIERHILL	C
MIERUF	B
MIFFLIN	B
MIGERN	B
MIGUEL	D
MIJAY	C
MIKADO	C
MIKIM, Wet Substratum	C
MIKIM, Saline-Alkali, Wet	D
MILAN	B
MILBY	B
MILCAN	C
MILDRED	D
MILES	B
MILITARY	B
MILKWEED	C
MILL	D
MILLADORE	C
MILLAN	B
MILLBORO	D
MILLBURNE	B
MILLDAM	C
MILLECOQUINS	C
MILLERDITCH	C
MILLERFLAT	B
MILLERPOINT	B
MILLERSBURG	B
MILLERTON	D
MILLERVILLE	A/D
MILLHEIM	C
MILLHI	D
MILLICH	D
MILLIGAN	C
MILLING	D
MILLOX, Nonsaline	C
MILLOX, Saline-Sodic	D
MILLPAW	C
MILLPAW, Sandy Subsoil	D
MILLPOCKET	D
MILLPOND	B
MILLPOND	C
MILLPOT	B
MILLRACE	B
MILLROCK	A
MILLSAP	D
MILLSDALE	C/D
MILLSITE	B
MILLSITE, Stony	C
MILLSTADT, Drained	C
MILLSTONE	B
MILLSTREAM	B

Exhibit A: Hydrologic Soil Groups for the United States

MILLWARD	B
MILLWOOD	D
MILNER	B
MILTON	C
MILVAR	C
MINA	B
MINALOOSA	B
MINCHUMINA	D
MINCO	B
MINDEN	B
MINEOLA	A
MINERAL, Dry	B
MINERAL	C
MINERAL MOUNTAIN	D
MINERSVILLE	B
MINERVA	B
MINESINGER	C
MINGO	C
MINGPOINT	B
MINKLER	D
MINKWELL	B
MINLITH	D
MINNEHA	C
MINNEHAHA	B
MINNEISKA	B
MINNETONKA	C/D
MINNIEPEAK	A
MINNIEVILLE	C
MINNIMAUD	C
MINNYE	B
MINO	C
MINOA	C
MINOCQUA	B/D
MINONG	D
MINWELLS	C
MIPPON	B
MIRABAL	B
MIRACLE	B
MIRAGE	C
MIRAMAR	B
MIRASOL	B
MIREROCK	D
MIRES	A
MIRES, Stony	B
MISENHEIMER	C
MISERY	C
MISFIRE	B
MISHAK	C/D
MISHAKAL	C
MISHAWAKA	A
MISKOAKI	D
MISLATNAH	B
MISPILLION	D
MISSION	D
MISSISQUOI	A
MISSISSINEWA	C
MISSLER	B
MISSOULA	D
MISTEGUAY	D
MITCH	C
MITCHELLPOINT	B
MITIWANGA	C
MITKOF	C
MITRE	C
MITRING	C
MITTEN	B
MIZEL	D
MIZPAH	D
MOANO	D
MOAPA	C
MOAULA	A
MOBATE	D
MOBEETIE	B
MOBERG	B
MOBL	B
MOCA	D
MOCAREY	D
MOCKLEY	C
MOCKSVILLE	B
MOCO	B
MOCTILEME	C
MODALE	C
MODESTY	C
MODJESKA	B
MODOC	B
MODYON	C
MOE	B
MOENKOPIC	B
MOENTRIA	D
MOFFSPRING	C
MOGG	D
MOGLIA	C
MOGOLLON	B
MOGOTE	C
MOHAT	B
MOHLER	B
MOHOCKEN	C
MOHON	C
MOIESE	B
MOINES	C
MOINGONA	B
MOJO	C
MOKAAC	A
MOKENA	C
MOKIAK	C
MOKINS	D
MOKULEIA	B
MOLALLA	B
MOLAND	B
MOLAS	D
MOLENA	A
MOLION	D
MOLLCO	D
MOLLICY	C
MOLOKAI	B
MOLTKE	B
MOLTONER	C
MOLTONER, Silty Clay Loam Substratum	D
MONA	B
MONACAN	C
MONACHE	B
MONAHANS	B
MONARCH	D
MONASTERIO	C
MONAVILLE	B
MONBUTTE	C
MONCHA	B
MONCISCO	A
MONEE	D
MONGLE	C
MONGO	D
MONIDA	B
MONIDA	C
MONITOR	C
MONJEAU	D
MONORIDGE	C
MONOX	B
MONPARK	D
MONSE	C
MONSERATE	C
MONSERATE, Thin Surface	D
MONTBORNE	C
MONTCALM	A
MONTCAN	B
MONTE CRISTO	D
MONTEAGLE	B
MONTEGRANDE	D
MONTELLO	C
MONTEOCHA	D
MONTEROSA	C
MONTESA	C
MONTEVALLO	D
MONTEZ	B
MONTEZUMA	A
MONTIETH	B
MONTONIA	B
MONTOSO	B
MONTOUR	D
MONTROSS	C
MONTVERDE	B/D
MONTWEL	B
MONVERO	A
MONZA	C
MONZINGO	B
MOOERS	B
MOOHOO	B
MOOLACK	A
MOONLIGHT	B
MOONSHINE	D
MOONSTONE	C
MOONVILLE	B
MOORETOWN	C/D
MOORHEAD	C
MOOSE RIVER, Moderately Wet	C
MOOSE RIVER	D
MOOSECREEK	B
MOOSED	C
MOOSED, Sandy	D
MOOSEFLAT	D
MOOSEHEAD	B
MOOSELAKE	A/D
MOOSHAUNEE	C
MOPANA	D
MOPANG	B
MOPPET	B
MOQUAH	B
MORADO	C
MORALES	C
MORANCH	B
MORANVILLE	B
MORBENCH	B
MORCLAY	D
MORCOM	C
MORCONICK	B
MOREGLADE	B
MOREHEAD	C
MORET	D
MOREY	D
MORGAMINE	C
MORGANFIELD	B
MORGANHILLS	D
MORIAH	B
MORIAH, Clayey Subsoil	C
MORICAL	C
MORIMOUNT	D
MORITZ	C
MORLING	D
MORMON MESA	D
MORMOUNT	D
MORNINGSTAR	B
MOROCCO	B
MORPH	B/D
MORPHEY	D
MORRISVILLE	C
MORSE	D
MORTENSON	D
MORTIMER	D
MORVEN	C
MOSBY	C
MOSEL	C
MOSHANNON	B
MOSHEIM	D
MOSHUP	C
MOSLANDER, Elevation 7000-9000	B
MOSLANDER	D
MOSMAN	D
MOSO	B
MOSQUITO	D
MOSROC	D
MOSSBACK	B
MOSSCREEK	B
MOSSYROCK	B
MOSWELL	D
MOTARK	B
MOTEN	C
MOTLEY	B
MOTT	B
MOTTO	D
MOULTRIE	D
MOUNDHAVEN	A
MOUNDPRAIRIE	B/D
MOUNDVILLE	A
MOUNTADAMS	B
MOUNTAINBOY	D
MOUNTAINEER	C
MOUNTAINVILLE	C
MOUNTEMILY	B
MOUNTHAT	B
MOUNTMCULL	D
MOUNTMED	C
MOUNTOM	D
MOUNTPLEASANT	B
MOUNTPOOR	C
MOUNTZION	B
MOUZON	D
MOVIEFLAT	C
MOVILLE	C
MOWAKO	B
MOWATA	D
MOWBRAY	B
MOWICH	D
MOYERS	C
MOYINA	D
MT. AIRY	A
MT. HOOD	B
MT. OLIVE	C
MT. VERNON	C
MT.ZION	C
MTSTERLING	B
MUCKALEE	D
MUDBUZ	B
MUDCO	D
MUDCREE	C
MUDLAKE	C
MUDLAVIA	B
MUDPOT	D
MUELLER	B
MUES	C
MUGATU	C
MUGGINS	B
MUGHUT	C
MUIRKIRK	B
MUKILTEO	C/D
MULA	B
MULAT	D
MULDOON	B
MULDROW	D
MULE	B
MULETT	D
MULHALL	B
MULHOLLAND	B
MULKEY	C
MULLERS	D
MULLICA	C
MULLIG	B
MULLINS	D
MULLYON	D
MULSTAY	C
MULT	C
MULTEY	B
MULTORPOR	A
MULVEY	C
MUMFORD	D
MUNCIE	C
MUNDALITE	C
MUNDELEIN	B
MUNDEN	B
MUNDOS	B
MUNDT	C
MUNI	D
MUNSET	D
MUNSON	D
MUNUSCONG	B/D
MURAD	B
MURANCH	C
MURDO	B
MUREN	B
MURHUT	B
MURKEN	C
MUROC	D
MURPHILL	D
MURPHY	C
MURRAY	B
MURRIETA	D
MURRSTEAD	D
MURVILLE	A/D
MUSCATUNE	B
MUSE	C
MUSGRAVE	D
MUSGROVE	B
MUSHEL	B
MUSKELLUNGE	D
MUSKOGEE	C
MUSOFARE	C
MUSQUIZ	C
MUSSENTUCHIT	B
MUSSENTUCHIT, Dry	C
MUSSERHILL	C

MUSSEY	B/D
MUSTANG	A/D
MUSTANG	D
MUSTINKA	C/D
MUSTY	C
MUTNALA	B
MUTT	C
MUTTON	B
MYATT	D
MYERS	D
MYFORD	D
MYOMA	A
MYOMA, Wet	B
MYRA	C
MYRICK	C
MYRTLE	B
MYRTLECREEK	B
MYSOL	C
MYSTEN	A
NAALEHU	B
NAALEHU, Bedrock Substratum	C
NABB	C
NABESNA	D
NABOR	B
NACHES	B
NACHUSA	B
NACIMIENTO	C
NACLINA	D
NACO	C
NACONICHE	D
NADA	D
NADEAU	B
NADRA	D
NAEGELIN	D
NAGEEZI	B
NAGLE	B
NAHA	B
NAHA	C
NAHUNTA	C
NAILKEG	B
NAIWA	B
NAKAIBITO	B
NAKINA	B/D
NAKNEK	D
NAKOCHNA	D
NAKWASINA	D
NALAKI	C
NALDO	B
NALIVAG	B
NALL	D
NAMEOKI	D
NAMMOTH	C
NAMUR	C
NANA	D
NANAMKIN	A
NANIAK	D
NANICH	A
NANNYTON	B
NANSEMOND	C
NANSEPSEP	C
NANTAHALA	B
NANTICOKE	D
NAPIER	B
NAPOLEON	A/D
NAPOLEON	D
NAPOLI	C
NAPPANEE	D
NAPTOWNE	B
NARANJITO	C
NARANJO	C
NARBONA	B
NARCISSE	B
NARD	C
NARDINE	C
NARDMONT	B
NAREA	A
NAREL	B
NARGAR	B
NARGON	C
NARK	C
NARLON	D
NARNETT	B
NARRAGUINNEP	D
NARROWS	D
NARTA	D
NARU	C
NASH	B
NASHMEAD	B
NASHVILLE	B
NASHWAUK	C
NASKEAG	C
NASON, Gravelly	B
NASON	C
NASS	D
NASSAU	C
NASSAWANGO	B
NATAANI	B
NATAGA	A
NATAL	D
NATALBANY	D
NATAPOC	B
NATCHEZ	B
NATCHITOCHES	D
NATHALE	C
NATHROP	C
NATI	C
NATIONAL	B
NATKIM	B
NATOMAS	D
NATROY	D
NATURITA	B
NAUKATI	D
NAUMBURG	C
NAUVOO	B
NAVACA	D
NAVAN	D
NAVASAN	A
NAVIDAD	B
NAVINA	B
NAVO	D
NAWAKWA	C
NAWT	D
NAYE	C
NAYFAN	C
NAYPED	B
NAYRIB	D
NAYTAHWAUSH	B
NAZATON	B
NEABSCO	C
NEAH	B
NEALY	B
NEARL	C
NEBGEN	D
NEBISH	B
NEBONA	D
NECESSITY	C
NECHE	C
NECHES	C
NECKROCK	B
NECONDA	C
NECTAR	C
NEDA	C
NEDHILL	C
NEEDHILL	B
NEEDLE PEAK	C
NEEDMORE	C
NEEL	D
NEELEY	B
NEEN	B/C
NEEN, Wet	D
NEEPER	B
NEESES	C
NEHALEM	B
NEHALEM, Flooded	C
NEHAR	C
NEHASNE	B
NEICE	B
NEISSENBERG	C
NEKIA	B
NEKIA, Stony	C
NEKKEN	B
NEKOMA	B
NELLSPRING	D
NELSCOTT	C
NELSE	B
NELSON	C
NEMADJI	B
NEMAH	C/D
NEMICO	D
NEMOTE	A
NEMOURS	C
NENNO	C
NEOLA	D
NEOPIT	B
NEOTOMA	B
NEOTSU	C
NEPONSET	C
NEPTUNE	A
NERELNA	B
NERESON	B
NERWOODS	B
NESBITT	B
NESDA	A
NESHOBA	C
NESIKA	B
NESIUS	A
NESKOWIN	C
NESO	D
NESS	D
NESSEL	B
NESTLEY	B
NETARTS	B
NETAWAKA	B
NETOMA	B
NETRAC	A
NETTLETON	C
NEUBERT	B
NEVARC	C
NEVAT	B
NEVENS	C
NEVILLE	C
NEVO	D
NEVTAH	C
NEVU	C
NEWALBIN	B/D
NEWALLA	D
NEWANNA	C
NEWAUKUM	B
NEWAYGO	B
NEWBERN	C
NEWCO	D
NEWCOMER	B
NEWDALE	B
NEWDEAL	D
NEWFLAT	D
NEWFOLDEN	C
NEWFORK	D
NEWFOUND	C
NEWGLARUS	B
NEWGLARUS, Severely Eroded	C
NEWHAN	A
NEWHAVEN	B
NEWHORN	B
NEWHOUSE	B
NEWKIRK	D
NEWLANDS	C
NEWLANG	A/D
NEWLIN	B
NEWLONDON	C
NEWMARC	C
NEWNAN	C
NEWRY	B
NEWSKAH	B
NEWSROCK	B
NEWSTEAD	C
NEWTMAN	D
NEWTONIA	B
NEWULM	B
NEWVIENNA	B
NEWVILLE	D
NEYGAT	D
NEZ PERCE	C
NEZ PERCE, Friable Substratum	D
NGARDMAU	B
NGARDOK	B
NGERSUUL	C
NGERUNGOR	D
NIARADA	B
NIBBS	B
NIBEN	B
NIBLACK	D
NIBLEY	C
NIBSON	D
NICANOR	D
NICELY	C
NICELYTOWN	C
NICHOLFLAT	D
NICHOLIA	D
NICHOLSON	C
NICHOLVILLE	C
NICKEL	C
NICKERSON	B
NICKIN	B
NICKLUND	B
NICKOLNA	B
NICODEMUS	B
NICOLAS	A
NIDAROS	D
NIDIX	B
NIDO	C
NIELSVILLE	C/D
NIKAL	B
NIKFUL	D
NIKISHKA	B
NIKLAVAR	D
NIKWASI	B/D
NILE	B
NILER	D
NILRAP	B
NIMERICK	C
NIMMO	D
NIMROD	B
NIMS	C
NINCH	B
NINEPIPE	B
NINEVEH	B
NINIGRET	B
NINOT	B
NIOBRARA	D
NIOTA	D
NIPE	B
NIPINTUCK	D
NIPISSING	B
NIPPENO	D
NIPSUM	C
NIRAC	C
NIRE	C
NIRLING	C
NISENE	B
NISHNA	C.D
NISHNA, Ponded	D
NISHON, Warm	C/D
NISHON	D
NISQUALLY	A
NISULA	B
NITCHA	B
NITCHE	B
NITCHLY	B
NITER	C
NITPAC	D
NIU	B
NIULII	C
NIVA	D
NIWANA	B
NIXON	B
NIXONTON	B
NIZHONI	D
NOAH	B
NOBLE	B
NOBLETON	C
NOBOCO	B
NOBSCOT	A
NOBUCK	C
NOCKAMIXON	C
NOCKEN	C
NODHILL	B
NODINE	B
NODMAN	B
NODUR	D
NOELKE	D
NOHILI	D
NOKASIPPI	B/D
NOKHU	C
NOLAVA	C
NOLTEN	C
NOMARA	C
NOMBERVILLE	B
NOME	D
NOMRAH	B
NONAME	D

Exhibit A: Hydrologic Soil Groups for the United States

NONAMELAKE	C
NONAMEWASH	B
NONDALTON	B
NONOPAHU	D
NONPAREIL	D
NOOBAB	C
NOOK	C
NOOKSACK	C
NOPAH	C
NORA	B
NORA VARIANT	B
NORAD	B
NORAX	B
NORBERT	D
NORBORNE	B
NORDBY	B
NORDHOUSE	A
NORENE	C
NORFOLK	B
NORGE	B
NORGO	D
NORIA	D
NORKOOL	B
NORMA	C/D
NORMAL	B
NORMANDY	B/D
NORMANGEE	D
NORMANIA	B
NORMANNA	C
NOROD	C
NORPEL	C
NORRIS	D
NORTE	C
NORTH POWDER	C
NORTHBEND	C
NORTHCASTLE	C
NORTHCOVE	B
NORTHFIELD	D
NORTHFORK	B
NORTHMORE	C
NORTHMOUND	B
NORTHPOINT	D
NORTHRUP	C
NORTHVILLE	C
NORTHWAY	A/D
NORTON	C
NORWEST	B
NORWIDGE	B
NORWOOD	B
NOSAL	C
NOSLO	C
NOSONI	B
NOSSER	D
NOTCHER	B
NOTI	D
NOTNED	B
NOTSTEW	D
NOTTAWA	B
NOTUS	B/C
NOUQUE	D
NOVACAN	D
NOVAK	B
NOVARK	B
NOVARY	D
NOVINA	B
NOWATA	B
NOWEN	B/D
NOWOY	B
NOYES	C/D
NOYO	C
NOYSON	C
NUAHS	B
NUBY	D
NUC	C
NUCKOLLS	B
NUCLA	B
NUECES	C
NUFFEL	B
NUFFER	C
NUKA	D
NUKRUM	D
NULEY	B
NUMA	C
NUPART	D
NUPPER	D
NUSIL	A
NUSMAG	D
NUTREEAH	C
NUTTER	B
NUTVAL	B
NUTZAN	C
NUVALDE	B
NYAK	B
NYALA	B
NYE	B
NYMAN	C
NYMORE	A
NYSERVA	B
NYSSATON	B
NYSWONGER	D
NYTHAR	D
O'BRIEN	B
O'NEILL	B
OAHE	B
OAK GROVE	B
OAKALLA	B
OAKBORO	C
OAKCITY	C
OAKCREEK	B
OAKDALE	B
OAKHURST	D
OAKLAND	C
OAKLET	C
OAKLIMETER	C
OAKTON	B
OAKWOOD	B
OAKY	D
OANAPUKA	B
OATUU	D
OBAN	C
OBARO	B
OBIE	B
OBISPO	D
OBNOT	D
OBRAY	C
OBRIEN	C
OBSCURITY	B
OBURN	D
OCCIDENTAL	D
OCCUM	B
OCCUR	C
OCEANET	D
OCEANO	A
OCHLOCKONEE	B
OCHO	D
OCHOPEE	B/D
OCOEE	B/D
OCONALUFTEE	B
OCONEE	C
OCONTO	B
OCQUEOC	A
OCQUEOC, Moderately Wet	B
OCUD	D
ODANAH	D
ODAS	D
ODEM, Overwash	A
ODEM	B
ODENSON	D
ODERMOTT	B
ODESSA	D
ODIN	C
ODONNELL	C
OESTERLE	C
OFFENBACHER	C
OFU	B
OGDEN	C
OGDENSBURG	C
OGEMAW	C/D
OGILVIE	B/D
OGLE	B
OGLES	B
OGLESBY	D
OGRAL	B
OGTNA	B
OHACO	C
OHANA	C
OHMAN	A
OHOP	C
OHSCOW	B
OHTOG	B
OHTOG, Wet	C
OHTWO	C
OIDEM	A
OJATA	C
OJIBWAY	C
OJITO	C
OKAN	B
OKAY	B
OKEE	B
OKEECHOBEE	B/D
OKEELALA	B
OKEELANTA	B/D
OKEETEE	D
OKEMAH	C
OKERLAND	B
OKIOTA	D
OKLARED	B
OKLARK	B
OKLAWAHA	B/D
OKO	C
OKOBOJI	D
OKOLONA	D
OKREEK	D
OKRIST	B
OKTAHA	B
OLALLIE	D
OLANCHA	B
OLAND	B
OLANTA	B
OLASHES	B
OLATHE	D
OLATON	B
OLBUT	D
OLDBUTTE	C
OLDMAN	C
OLDS	D
OLDSMAR	D
OLDSPAN	B
OLDTRAIL	B
OLDWOLF	B
OLEAN	B
OLELO	B
OLEMAN	B
OLEMAN	D
OLENO	D
OLENTANGY	A/D
OLEO	A
OLEPHANT	B
OLEQUA	B
OLETE	C
OLETHA	D
OLEX	B
OLF	D
OLGUN	B
OLI	B
OLIAGA	C
OLIN	B
OLINDA	B
OLIVE	D
OLIVENHAIN	D
OLIVIER	C
OLLA	B
OLLEI	D
OLLIERIVAS	D
OLMITO	D
OLMITZ	B
OLMOS	C
OLOAVA	B
OLOKUI	D
OLOMOUNT	C
OLOMPALI	D
OLPE	C
OLYIC	B
OLYMPUS	A
OMAHALING	C
OMAK	C
OMENA	B
OMIO	B
OMRO	C
OMSTOTT	C
OMULGA	C
ONASON, Nongravelly	C
ONASON	D
ONATE	A
ONDAWA	B
ONECO	B
ONEIL	C
ONEONTA	B
ONKEYO	D
ONOVILLE	C
ONSLOW	B
ONSTAD	B
ONTKO	D
ONTRAIL	B
OOKALA	A
OOSEN	A
OPALOCKA	D
OPIE	D
OPIHIKAO	D
OPLIN	C
OPNISH	C
OPOLIS	C
OPPIO, Stony	C
OPPIO	D
OPTIMA	A
OQUIN	C
OQUOSSOC	D
ORA	C
ORAGRAN	D
ORAID	C
ORAMEL	C
ORAN	B
ORANGEVALE	B
ORCADIA	D
ORDNA	D
ORDNANCE	C
ORDWAY	D
OREANNA	B
ORENDA	B
OREOKE	B
ORHOOD	D
ORIF	A
ORINOCO	C
ORIO	B/D
ORION	C
ORITA	B
ORIZABA	B/C
ORLA	B
ORLANDO	A
ORLIE	B
ORMSBY	C
ORNBAUN	B
ORNEA	B
ORO FINO	B
ORONOCO	B
ORONTO	C
OROSE	C
ORPARK	C
ORR	C
ORSET	B
ORSINO	A
ORTEGA	A
ORTELLCREEK	C
ORTHENTS, Maat47-53	C
ORTING	D
ORTIZ	C
ORTON	B
ORTONVILLE	B
ORUPA	B
ORWET	A/D
ORWIG	B
OSAGE	D
OSBORN	C
OSCAR	D
OSCEOLA	B
OSCO	B
OSDITCH	B
OSGOOD	C
OSHAWA	D
OSHONE	D
OSHOTO	C
OSITO	C
OSKA	C
OSMUND	B
OSO	C
OSOLL	D
OSOLO	A
OSSIAN	B/D
OSSIPEE	D
OSSMER	C

Exhibit A: Hydrologic Soil Groups for the United States

OST	B
OSTIN	A
OSTRANDER	B
OSWALD	D
OTANYA	B
OTEEN	C
OTEGO	B
OTERODRY	B
OTHELLO	C/D
OTHELLO, Very Wet	D
OTISVILLE	A
OTOE	D
OTOMO	D
OTOOLE	C
OTTERHOLT	B
OTTERSON	A
OTTMAR	B
OTTMAR, Very Deep	C
OTTOKEE	A
OTTOSEN	B
OTTUMWA	D
OTWAY	D
OTWIN	C
OUACHITA	C
OUARD	D
OULA	D
OUPICO	C
OURAY, Cool	A
OURAY, Sandy Loam Surface	B
OUSELFAL	D
OUSLEY	C
OUTLAW	D
OUTLET	C
OUTLOOK	C/D
OUTPOST	C
OVALL	C
OVAN	D
OVERCUP	D
OVERLAKE	A
OVERLOOK	B
OVERSHUE	B/D
OVERSIGHT	B
OVIATT	B
OVIDCREEK	C
OVINA	B
OVINGTON	B
OWANKA	C
OWENTOWN	B
OWINZA	D
OWLCAN	B
OWLHOLE	D
OWLROCK	D
OWLSPRING	C
OWSEL	B
OWYHEE	B
OXBOW	C
OXFORD	D
OXHEAD	B
OXLEY	C
OXMAN	B
OXY	C
OYHUT	C
OYLEN	B
OZAN	D
OZETTE	C
OZIAS	D
PAAIKI	B
PAALOA	B
PAAUHAU	A
PABLO	D
PACER	B
PACHAPPA	D
PACHEL	B
PACHNEUM	B
PACIFICO	C
PACKARD	B
PACKMO	B
PACKSADDLE	C
PACKTRAIL	C
PACKWOOD	D
PACO	C
PACTOLUS	A
PADDY	D
PADDYKNOB, Stony	A
PADDYKNOB	C
PADEN	C
PADIGAN	D
PADINA	B
PADONIA	C
PADRES	B
PADRONES	B
PADUCAH	B
PADWET	B
PADWOOD	B
PAGARI	B
PAGELAND	C
PAGESPRINGS	D
PAGINA	C
PAHLOW	B
PAHOKEE	B/D
PAHRANGE	C
PAHROC	D
PAHRUMP	C
PAHSIMEROI	B
PAHTO	C
PAHUK	A
PAIA	B
PAIGES	C
PAILO	B
PAINESVILLE	C
PAINT	D
PAINTBRUSH	C
PAISANO	D
PAJARA	C
PAJUELA	B
PAKA	B
PAKINI	B
PALACID	B
PALACIOS	D
PALAFOX	C
PALANUSH	C
PALAPALAI	B
PALATINE	B
PALAU	B
PALAZZO	B
PALERF	C
PALINOR	D
PALISADE	B
PALISADE, wet	C
PALIX	B
PALLS	C
PALM	D
PALM BEACH	A
PALMAR	D
PALMAREJO	C
PALMER CANYON	B
PALMERDALE	B
PALMETTO	B/D
PALMICH	B
PALMONT	A
PALO	D
PALOBIA	B
PALODURO	B
PALOMARIN	B
PALOMAS	B
PALOMINO	D
PALOS VERDES	C
PALOS VERDES, Dry	D
PALSGROVE	B
PALUXY	B
PAMISON	B
PAMOA	B
PAMSDEL	C
PANA	B
PANAEWA	D
PANAK	B
PANAMAKER	A
PANAMAKER, Flooded	B
PANAMINT	B
PANDO	B
PANDOAH	C
PANDORA	B/D
PANDURA	D
PANE	B
PANHANDLE	B
PANHILL	B
PANIN	B
PANIOGUE	C
PANKY	B
PANKY, Clayey	C
PANMOD	C
PANOLA	D
PANOR	B
PANORAMA	B
PANTANO, Gravelly	C
PANTANO	D
PANTEGO	B/D
PANTERA	B
PANTEX	C
PANTON	D
PAOLA	A
PAPAA	D
PAPAC	C
PAPAGUA	C
PAPAI	A
PAPALOTE	C
PAPASPILA	C
PAPEEK	D
PAPINEAU	C
PAQUIN	A
PARA	B
PARADISE	C
PARADISE SPRING	D
PARADOX, Clayey	C
PARADOX, Wet	D
PARAGON	C
PARAGONAH	D
PARAJE	B
PARANAT, Drained, Saline	B
PARASOL	B
PARCELAS	D
PARCHIN	C
PARDEE	D
PARDEEVILLE	B
PARIATO	D
PARIDA	B
PARISIAN	D
PARKALLEY	B
PARKDALE	B
PARKFIELD	C
PARKINSON	B
PARKS	B
PARKVIEW	B
PARKVILLE	C
PARKWOOD	B/D
PARLE	C/D
PARMELE	C
PAROD	D
PARREGO	C
PARRITA	C
PARSIPPANY	C/D
PARSNIP	D
PARSONS	D
PARTLOW	D
PARTOV	D
PARTRIDGE	B
PARVIS	B
PASAGSHAK	C
PASCACK, Moderately Well Drained	B
PASCACK, Smowhat Poorly Drained	C
PASCO	C/D
PASHUA	C
PASO SECO	D
PASQUETTI	D
PASQUOTANK	B/D
PASSAIC	D
PASTIK	D
PASTORPEAK	B
PATAHA	C
PATBURN	C
PATCHIN	D
PATE	C
PATEL	C
PATELZICK	D
PATEMOS	B
PATENT	B
PATEROS	B
PATHFINDER	A
PATILLAS	B
PATILO	A
PATOS	C
PATOUTVILLE	C
PATOUZA	C
PATRICIA	B
PATRICK	B
PATRICKSBURG	D
PATROLE	C
PATTANI	D
PATTEE	B
PATTENBURG	B
PATTERSON	C
PATTIWAY	C
PAULDING	D
PAULSON	B
PAUMALU	B
PAUPACK	D
PAUSANT	B
PAUWELA	B
PAVAIAI	C
PAVELEK	D
PAVER	B
PAVER, Fan	C
PAWCATUCK	D
PAWHUSKA	D
PAWLING	B
PAWTOOT	C
PAX	B
PAXVILLE	B/D
PAYNE	C
PAYPOINT	B
PEACHSPRINGS	B
PEAHKE	B
PEARCE	D
PEARL	B
PEARL HARBOR	D
PEARLWISE	B
PEARNE	D
PEARSONCREEK	B
PEASLEY	D
PEASPEAR	D
PEAVINE	B
PEAWICK	D
PEBBLEPOINT	C
PECATONICA	B
PECKHAM	C
PECKISH	D
PEDEE	C
PEDERNALES	C
PEDIGO	B/D
PEDLEFORD	C
PEDREGAL	B
PEDRICK	B
PEDRICKTOWN	D
PEDRO	C
PEEBLES	C
PEEDEE	A
PEEKO	D
PEEL	C
PEERLESS	B
PEETZ	A
PEGLEG	C
PEJI	A
PEKAY	C
PELAHATCHIE	C
PELAN	B
PELATO	D
PELELIU	D
PELICAN	B
PELION	B/D
PELKIE	A
PELLEJAS	B
PELLICER	D
PELTON	B
PEMBERTON	B
PEMI	C
PEN ARGYL	B
PENAGUL	D
PENALOSA	C
PENASCO	D
PEND OREILLE	B
PENDARVIS	C
PENDEN	B
PENDER	C
PENDERGRASS	D
PENDOLA	B
PENELAS	D
PENEY	D
PENGILLY	B/D

PENGRA	C
PENINSULA	B
PENLAW	C
PENNARGYL	B
PENNEKAMP	D
PENNELL	B
PENNEY	A
PENNICHUCK	B
PENNING	B
PENNYCREEK	D
PENTHOUSE	C
PENWELL	A
PENWOOD	A
PENZANCE	C
PEOH	C/D
PEOLA	C
PEONE	C/D
PEORIA	D
PEOTONE	C/D
PEP	B
PEPAL	B
PEPIN	B
PEPOON	D
PEPPER	D
PEPPERBOX	B
PEPTON	D
PEQUAYWAN	B
PEQUEA	B
PERCELL	B
PERCHAS	D
PERCHE	B
PERCHLAKE	B
PERCILLA	D
PERCOUN	C
PERDIDO	B
PERECHENEY	B
PERFA	D
PERGRIN	B
PERICO	B
PERIDA	B
PERIDGE	B
PERIL	D
PERING	C
PERINOS	C
PERITSA	C
PERKINS	D
PERKS	A
PERLOR	D
PERN	B
PERNITAS	C
PERQUIMANS	D
PERREAU	B
PERRIN	B
PERRINE	B/D
PERRY	D
PERRYGULCH	D
PERSANTI	C
PERSAYO	C
PERSIS	B
PERSONVILLE	B
PERT	D
PERVINA	B
PESCADO	D
PESCAR	C
PESHTIGO	C
PESKAH	B
PESO	C
PESOWYO	C
PETACA	D
PETAL	C
PETAN	D
PETCAN	C
PETERMAN, Sandy Substratum, Alkali	C
PETERMAN	D
PETERS	D
PETERSON	B
PETESCREEK, Stony	B
PETESCREEK, Gravelly	C
PETRIE	C
PETROF	B
PETROS	D
PETSPRING	D
PETTIGREW	D
PETTIJOHN	B
PETTUS	C
PETTY	B
PETTYJON	B
PEVELY	B
PEVETO	A
PHALANX	B
PHANTOM	C
PHAROAH	D
PHEBA	C
PHELAN	D
PHERSON	B
PHIFERSON	C
PHILBON	D
PHILIPPA	C
PHILIPSBURG	B
PHILLCHER	B
PHILLIPS	C
PHILLIPSBURG	B
PHILOMATH	D
PHILOMONT	B
PHING	C
PHLISS	D
PHLYNSPA	B
PHOEBE	B
PHOENIX	D
PHYS	B
PIANKESHAW	B
PIANOHILL	C
PIAR	B
PIASA	D
PICACHO	C
PICANTE	D
PICARD	B
PICEANCE	C
PICKAWAY	C
PICKENS	D
PICKETPIN	B
PICKNEY	A/D
PICKTON	A
PICKWICK	B
PICOSA	C
PICTURE	D
PIDCOKE	D
PIDINEEN	D
PIE CREEK	D
PIEDAWN	B
PIEDMONT	D
PIEGON	B
PIERCEPARK	B
PIERIVER	C
PIERKING	D
PIERPONT	C
PIERRE	D
PIERRON	D
PIERSONTE	A
PIERZ	B
PIETOWN	B
PIEZON	B
PIGEONROOST	B
PIGTAIL	D
PIKADEN	A
PIKE	B
PIKEVILLE	B
PILABO	B
PILCHUCK	A
PILEUP	B
PILGRIMS	B
PILLERY	B
PILLIKEN	B
PILLOT	B
PILONI	A
PILOT PEAK	D
PILOT ROCK	C
PILOTWELL	B
PILTZ	C
PINAL	D
PINBIT	B
PINCHER	C
PINCHOT	B
PINE FLAT	B
PINEAL	D
PINEDA	D
PINEGAP	B
PINEGUEST	B
PINEHILL	B
PINEISLAND	C
PINELLAS	B/D
PINENUT	D
PINEOLA	B
PINERUN	B
PINESPRING	C
PINETOP	C
PINETUCKY	B
PINETUCKY,Graded	C
PINEVILLAGE	B
PINEYNECK	B
PINEYWOODS	D
PINEZ	B
PINGREE	D
PINHOOK	B/D
PINICON	B
PINKEL	C
PINKHAM	A
PINNEBOG	A/D
PINNOBIE	B
PINNTANK	C
PINONES	D
PINOTY	B
PINRIDGE	B
PINSPRING	C
PINTAS	B
PINTO	C
PINWHEEL	D
PIOCHE	D
PIONEER	D
PIPEFLAT	A
PIPELINE	D
PIPPIN	A
PIPPOD	A
PIRAPEAK	B
PIRD	B
PIRKEY	C
PIRODEL	B
PISCASAW	B
PISCOE	B
PISGAH	C
PISMO	D
PISTOL	C
PISTOLRIVER	B
PITCHER	B
PITCO	D
PITNEY	C
PITTSGROVE	B
PITTVILLE	B
PITVAR	D
PITZER	C
PIUMPSHA	B
PIVOT	A
PIXLEY	D
PIZENE	B
PLACEDO	D
PLACER	B
PLACID	B/D
PLACK	D
PLAINBO	A
PLAINS	A
PLAINTANK	C
PLAINVIEW	A
PLANK	C
PLANKINTON	D
PLANTATION	B/D
PLASKETT	D
PLATEA	C
PLATO	C
PLATSHER	C
PLATTVILLE	B
PLAYMOOR	C/D
PLAZA	C
PLEASANT	C
PLEDGER	D
PLEINE	D
PLEIOVILLE	C
PLEITO	B
PLEMONS	B
PLEV	B
PLEVNA	D
PLINCO	B
PLOVER	C
PLUCK	C
PLUMBROOK	B
PLUMCREEK	B
PLUMFIELD	C
PLUSH	B
PLUTOS	B
POACHIE	B
POALL	C
POALL, Cool	D
POARCH	B
POBER	B
POCALLA	A
POCASSET	B
POCATELLO	B
POCATY	D
POCKER	C
POCOLA	D
POCUM	D
PODEN	B
PODMOR	C
PODUNK	B
PODUS	C
POE	C
POGAL	C
POHAKUPU	B
POHOCCO	B
POINSETT	B
POINT	C
POINT ISABEL	C
POINTLA	C
POISONHOL	C
POJO	C
POKEGEMA	B
POKER	C
POKEY	C
POLALLIE	C
POLANDER	B
POLAR	B
POLAWANA	A/D
POLECAT	B
POLETA	C
POLETAD	B
POLICH	C
POLKING	D
POLLARD, High Rainfall	B
POLLARD	C
POLLASKY	B
POLLUX	C
POLO, Moderate Perm	B
POLO, Moderately Slow Perm	C
POLSON	B
POLUM	B
POLUMAR	B
POLVADERO	C
POMAN	C
POMAT, Dry	B
POMAT	C
POMERENE	C
POMERENING	A
POMME	B
POMO	B
POMONA	B/D
POMPONIO	C
PONCA	B
PONCENA	D
PONCHA	A
PONCIANO	C
POND CREEK	B
PONDER	D
PONDEROSA	B
PONE	B/D
PONINA	D
PONTOTOC	B
PONYCREEK	A/D
PONZER	D
POOBAA	C
POOCHAM	B
POOKALOO	D
POOKU	B
POOLEVILLE	C
POORCAL	B
POORHOUSE	D
POORMA	B
POORMAN	B
POORMAN	D
POOSE	D
POPASH	D

Exhibit A: Hydrologic Soil Groups for the United States

POPHERS	C
POPLE	B/D
POPSON	B
POQUITA	B
PORONTO	C
PORRETT	D
PORRONE	B
PORTAGEVILLE	D
PORTAL	B
PORTALES	B
PORTALTO	B
PORTDICK	B
PORTER	B
PORTERFIELD	D
PORTERSPRINGS	B
PORTGRAHAM	B
PORTHILL	D
PORTIA	C
PORTILLO	B
PORTINO	C
PORTLAND	D
PORTMOUNT	B
PORTSMOUTH	B/D
PORTVILLE	C
PORUM	D
POSEY	B
POSEYVILLE	C
POSKIN	C
POSO	B
POSOS	C
POSSUMTROT	B
POST	D
POTAGANNISSING	D
POTAMUS	B
POTATOLAKE	B
POTAWATOMI	C
POTCHUB	C
POTEET	C
POTELL	B
POTH	C
POTLATCH	C
POTOSI	D
POTRATZ	C
POTRERO	A/D
POTRILLO	B
POTRMOUND	C
POTTER	C
POTTERSVILLE	C
POTTINGER	B
POTTSBURG	C
POUDRE	D
POUJADE	B
POULSBO	D
POUNCEY	D
POVERTY	D
POVERTYFLAT	B
POVIRT	D
POWDERHORN	C
POWDERWASH	C
POWEEN	C
POWELL	C
POWER	B
POWLEY	D
POWLOW	D
POWMENT	C
POWVAL	B
POWWAHKEE	B
POWWATKA	C
POYGAN	D
POZEGA	C
POZO BLANCO	B
PRADE	D
PRAIRIE	A
PRAIRIECREEK	C
PRAIRIEVILLE	B
PRAMISS	C
PRATHER	D
PRATLEY	C
PRATT	A
PREAKNESS	B/D
PREATORSON	B
PREGO	A
PRELO	B
PREMIER	B
PRENTISS	C
PRESA	B
PRESHER	B
PRESNAL	B
PRESTO	B
PREUSS	C
PREUSSRANGE	C
PRICE	B
PRICECREEK	D
PRICETOWN	B
PRIDHAM	D
PRIESTLAKE	B
PRILL	D
PRIM	D
PRIMEAUX	C
PRIMGHAR	B
PRINCETON	B
PRINEVILLE	C
PRINSBURG	B/D
PRISONEAR	C
PRISSEL	A
PRITCHARD	C
PROBERT	B
PROMONTORY	D
PRONG	C
PROPER	A
PROPHETSTOWN	B/D
PROTIVIN	C
PROUT	C
PROVIDENCE	C
PROVIG	C
PROW	D
PRUCREE	C
PRUDY	B
PRUE	B
PRUITTON	B
PRUNIE	D
PRYOR	C
PSAMMAQUENTS	D
PSAMMENTS	A
PSUGA	B
PSUYAAH	C
PTARMIGAN	C
PUAPUA	D
PUAULU	A
PUCKUM	D
PUEBLO	B
PUELZMINE	D
PUERCO	D
PUGET	C
PUGSLEY, Dry	B
PUGSLEY	C
PUHI	B
PUHIMAU	D
PUICE	C
PULA	C
PULANTAT	C
PULASKI	B
PULCAN	C
PULEXAS	B
PULLMAN	D
PULLUP	A
PULPIT	C
PULSIPHER	D
PULTNEY	C
PUMEL, Nongravelly	C
PUMEL	D
PUMPHOUSE	B
PUMPHOUSE, Clayey Subsoil	C
PUMPKIN	B
PUNA	A
PUNALUU	D
PUNG	C
PUNOHU	A
PUNSIT	C
PUNTA	B/D
PUNTILLA	B
PURCELLVILLE	B
PURCHASE	C
PURCHES	C
PURDIN	C
PURETT	B
PURGATORY	C
PURGATORY, Cool Dry	D
PURNELL	D
PURNER	D
PUROB	D
PURSLEY	B
PUSHMATAHA	C
PUSTOI	B
PUTCO	B
PUTNAM	D
PUTNEY	B
PUTT	C
PUU LAI	D
PUU MOIWI	B
PUU OO	A
PUU OPAE	B
PUUKALA	D
PUUONE	C
PUYE	C
PUZZLECREEK	B
PYBURN	D
PYEATT	B
PYLE	B
PYLON	D
PYOTE	A
PYRADY	C
PYRAMID	D
PYRENEES	C
PYRMONT, Bedrock Substratum	C
PYRMONT	D
PYSHT	C
QENI	C
QUADRIA	D
QUAFENO	C
QUAGLE	B
QUAILPRAIRIE	C
QUAILRIDGE	B
QUAKERTOWN	C
QUAKING	B
QUALLA, Dry	B
QUALLA	C
QUAM	B/D
QUANAH	B
QUANTICO	B
QUARDERER	B
QUARLES	D
QUARTELES	D
QUARTERBACK	B
QUARTERMASTER	C
QUARTZVILLE	B
QUATAMA	C
QUAY	B
QUEALMAN	B/C
QUEALY	D
QUEBRADA	C
QUEENY	D
QUEETS	B
QUEMADO	C
QUENCHEROO	B
QUENZER	D
QUERC	C
QUETICO	D
QUEZCAN	C
QUIBURI	B
QUICKSELL	C
QUICKSILVER	D
QUIDEN	B
QUIENSABE	C
QUIERO	C
QUIETUS	C
QUIGG	D
QUIHI	C
QUILCENE	C
QUILLAMOOK	B
QUILLAYUTE	B
QUILLIAN	C
QUIMA	B
QUIMERA	C
QUINAULT	D
QUINBINS	C
QUINCREEK	C
QUINCY	B
QUINLIVEN	C
QUINN	B/D
QUINNEY	C
QUINTO	D
QUIRK	C
QUITERIA	B
QUITMAN	C
QUITTER	B
QUIVER	B/D
QUIVERA	C
QUOMUS	B
QUONAL	B
QUOPANT	D
QUOSATANA	D
RABBS	B
RACE	B
RACING	D
RACKER	A
RADER	D
RADFORD	B
RADIUM	A
RADLEY	B
RADNOR	C
RAFTRIVER	C
RAFTVILLE	B
RAGAMUFFIN	B
RAGGULCH	C
RAGNAR	B
RAGPIE	D
RAHAL	C
RAHM	C
RAHWORTH	B
RAIL	D
RAILCITY	A
RAILROAD	C
RAINBOLT	C
RAINEY	C
RAINIER	C
RAINO	D
RAINS	B/D
RAINS, Flooded	D
RAINSBORO	C
RAINSVILLE	B
RAINTUF	B
RAISIO	C
RAKANE	C
RALDRIDGE	B
RALORE	D
RALPH	B
RALPHSTON	B
RALSEN	D
RAMADERO	B
RAMAH	B
RAMBLA	C
RAMMEL	C
RAMONA	C
RAMOTH	B
RAMPART	B
RAMSDELL	C
RANA	D
RANACKER	D
RANCE	C
RANCHOSECO	D
RANCO	D
RANDADO	C
RANDALL	D
RANDCORE	D
RANDMAN	D
RANDOLPH	C
RANDS	C
RANDSBURG	D
RANGEE	D
RANGER	C
RANKOR	B
RANRUFF	D
RANSECT	C
RANSLO	D
RANSOM	B
RANSTEIN	B
RANTOUL	D
RAPADO	C
RAPATEE	D
RAPELJE	B
RAPH	B
RAPHO	B
RAPIDAN	B
RAPPAHANNOCK	D
RAPSON	B
RAQUETTE	B
RARICK	C
RARITAN	C
RASSER	B

Exhibit A: Hydrologic Soil Groups for the United States

RASSET	B
RASTER	A
RASTUS	C
RATIOPEAK	B
RATLAKE	D
RATLEFLAT	B
RATLIFF	B
RATROOT	D
RATSNEST	D
RATSOW	C
RATTLER	D
RATTO	C
RAUB	C
RAUS	C
RAUSTER	C
RAUZI	B
RAVALLI, Bedrock Substratum	B
RAVALLI	D
RAVEENWASH	A
RAVEN	A
RAVENELL	D
RAVENNA	C
RAVENSROOST	B
RAVIA	C
RAWAH	C
RAWLES	B
RAWSON	B
RAYBURN	D
RAYCREEK	B
RAYFORD	C
RAYLAKE	D
RAYNAL	C
RAYNOLDSON	B
RAYOHILL	C
RAYPOL	C
RAZORBA	B
RAZORBACK	D
RAZSUN	D
READLYN	B
REALLIS	B
REAM	B
REAP	D
REARDAN	C
REAVILLE	C
REAVIS	B
REBA	C
REBECCA	B
RECK	D
RECKLOR	C
RED BAY	B
RED BLUFF	B
RED HILL	B
RED HOOK	C
RED SPUR	B
REDARROW	D
REDBELL	B
REDBIRD	B
REDBOW	C
REDBUD	C
REDCAMERON	D
REDCANYON	B
REDCAP	B
REDCHIEF	C
REDCLOUD	B
REDCO	D
REDCREEK	C
REDDALE	D
REDDIES	B
REDFIELD	B
REDFIELD, Wet	C
REDFIST	C
REDFLAME	B
REDFLAT	B
REDHOOK	A
REDIG	B
REDLAKE	D
REDLEVEL	C
REDLOCK	B
REDLODGE	D
REDMANSON	B
REDMORE	C
REDMOUNT	B
REDNIK	B
REDNIK, Nonstony	C
REDNUN	C
REDO	A
REDPEAK	B
REDPEN	B
REDPORT	B
REDRIDGE	B
REDRIM	B
REDROB	C
REDSLIDE	B
REDSPEAR	D
REDSPOON	C
REDSPRINGS	B
REDSPRINGS, Graded	D
REDSTOE	B
REDSUN	D
REDTHAYNE	B
REDUN	B
REDVALE	C
REDVIEW	C
REDVINE	C
REDWASH	D
REDWATER	B
REED	D
REEDER	C
REEDPOINT	D
REEDSBURG	C
REEDSCREEK	B
REEDSLAKE	B
REEDWEST	C
REEDY	C
REEFRIDGE	D
REELFOOT	C
REEPO	C
REESE	C
REESER	C
REESVILLE	C
REEUP	C
REFLECTION	B
REGAL	B/D
REGER	B
REGGAD	A
REGNAPS	C
REGRACIC	D
REHBURG	C
REHFIELD	B
REHM	C
REHOBETH	D
REICESS	B
REILLY	A
REINACH	B
REINECKE	B
REINER	B
REINHART	D
REIS	D
REK	C
REKIMA	D
RELAN	B
RELEEP	B
RELFE	A
RELIZ	D
RELYEA	B
REMBERT	D
REMEDIOS	C
REMLAP	C
REMMEL	B
REMMIT	B
REMOUNT	A
REMSEN	D
REMUS	B
REN	D
RENCALSON	C
REND	B
RENDOVY	B
RENEGADE	D
RENFROW	D
RENHA	C
RENICK	D
RENNER	B
RENNIE	D
RENOX	B
RENSHIGH	B
RENSSELAER	C
RENTHIN	D
RENTILL	B
RENTON	C/D
RENTSAC	C
RENTZEL	C
RENVERS	D
RENWASH	B
RENWICK	B
REPARADA	D
REPKIE	B
REPMIS	C
REPP	B
REPPART	B
RESOOT	C
RESOTA	A
RESTON	D
RET, High Elevation	C
RET	D
RETAW	D
RETEP	B
RETSOVER	C
RETTIB	B
RETTIB LOAM	B
REUTER	C
REVA	D
REVEL	C
REVERE	B/D
REVIT	C
REVLING	B
REVOR	D
REWARD	B
REXFORD	C
REXOR	B
REYAB	B
REYCREEK	C
RHEA	B
RHOAMETT	D
RHYLOW	B
RHYMES	A
RIB	B/D
RIBERA	C
RIBHILL	B
RIBRIVER	B
RICCO	D
RICEBORO	B/D
RICELAKE	B
RICES	C
RICETON, Sandy Substratum	A
RICETON	B
RICEVILLE	C
RICH	C
RICH, Wet	D
RICHARDVILLE	B
RICHFIELD	C
RICHFORD	A
RICHSUM	B
RICHVIEW	C
RICHWOOD	B
RICKETTS, Nonstony	B
RICKETTS	C
RICKMAN	C
RICKMORE	C
RICKREALL	D
RICKS	A
RICOT	C
RIDENBAUGH	D
RIDGE	B
RIDGELAND	B/D
RIDGELAWN, wet	D
RIDGELITE	D
RIDGEVIEW	D
RIDGEWOOD	C
RIDIT	C
RIDLEY	C
RIEDEL	C
RIEDTOWN	C
RIESEL	C
RIFT	C
RIGA	D
RIGDON	C
RIGGSVILLE	C
RIGOLETTE	C
RILEY	B
RILLA	B
RILLOSO	A
RIMINI	A
RIMROCK	D
RIMTON	C
RIN	B
RINCON	C
RINCONFLAT	B
RINDGE, Drained	C
RINEARSON	B
RINEY	B
RINGLE	B
RINGO	D
RINGWOOD	B
RINKER	C
RINQUIN	C
RIO ARRIBA	D
RIO DIABLO	C
RIO FRIO	B
RIO GRANDE	B
RIO KING	C
RIO LAJAS	A
RIO PIEDRAS	B
RIOBLANCHO	C
RIOLINDA	C
RIOLOMAS	B
RIONUTRIA	C
RIOVISTA	A
RIPGUT	C
RIPLEY	C
RIPON	B
RIPPLE	B
RISBECK	B
RISLEY	C
RISUE	D
RISWOLD	B
RITA	D
RITCHEY	D
RITIDIAN	D
RITNER	C
RITO	B
RITTEL	C
RITTER	B
RITZ	C/D
RITZCAL	B
RIVALIER	B
RIVERBY	A
RIVERDALE	A
RIVERLOST	B
RIVEROAD	C
RIVERSIDE	A
RIVERTON	B
RIVERVIEW	B
RIVERWASH	A
RIVIERA, Limestone Substratum	B/D
RIVIERA	D
RIXON	C
RIZ	D
RIZNO	A
ROACHA	C
ROADMASTER	D
ROANE	C
ROANHIDE	C
ROARING	B
ROATCAP	B
ROBAGO	B
ROBANA	B
ROBBS	D
ROBBSCREEK	C
ROBCO	C
ROBER	C
ROBERTSDALE	C
ROBERTSVILLE	D
ROBINETTE	B
ROBINLEE	C
ROBOLATA	C
ROCHELLE	C
ROCHEPORT	B
ROCHER	B
ROCHPAH	D
ROCK OUTCROP	D
ROCKABIN	C
ROCKBLUFF	A
ROCKCASTLE	D
ROCKCUT	B
ROCKDALE	A
ROCKDAM	A
ROCKERS	C
ROCKFIELD	B
ROCKFORD	B

ROCKHILL	D
ROCKHOUSE	A
ROCKLIN	D
ROCKMILL	C/D
ROCKO	B
ROCKOA	B
ROCKPENS	B
ROCKRUN	B
ROCKSAN	C
ROCKY FORD	C
ROCKYBAR	B
ROCKYBROOK	B
RODAD	D
RODELL	D
RODEN	D
RODEO	D
RODESSA	D
RODIE	B
RODNEY	D
RODROF	D
ROELLEN	D
ROEMER	C
ROGAN	B
ROGERSON	D
ROGGER	B
ROGRUBE	B
ROHAN	D
ROHNERVILLE	B
ROHONDA	C
ROHRBECK	B
ROHRERSVILLE	D
ROJO	C
ROLETTE	C
ROLFE	C/D
ROLIE	D
ROLLA	C
ROLLAWAY	D
ROLLINGSTONE	C
ROLLINS	A
ROLO	B
ROMAN	B
ROMANOSE	D
ROMBERG	C
ROMBO	D
ROME	B
ROMEO	D
ROMGAN	C
ROMINE	B
ROMINELL	C
ROMNELL	B/D
ROMONA	D
ROMOUND	C
ROMSTOCK	B
RONAN	D
ROND	C
RONDELL	B
RONEY	C
RONNEBY	C
RONSON	B
ROOKS	B
ROONEY	D
ROOP	B
ROOSET	C
ROOSTERCOMB	C
ROOT	B/D
ROOTEL	C
ROPER	B/D
ROQUES	D
ROSALIE	B
ROSAMOND	C
ROSARIO	C
ROSCED	B
ROSCHENE	C
ROSE VALLEY	D
ROSEBERRY, Sandy Substratum	C
ROSEBERRY, Drained	D
ROSEBRIAR	D
ROSEBURG	B
ROSEDALE	A
ROSEDHU	B/D
ROSEGLEN	B
ROSEHAVEN	B
ROSEHILL	D
ROSELAND	B
ROSELLA	D
ROSELLE	C
ROSENBROCK	D
ROSENDALE	C
ROSENWALL	D
ROSESPRING	B
ROSEWOOD	D
ROSHE SPRINGS	C/D
ROSHOLT	B
ROSINE	B
ROSLYN	B
ROSMAN	B
ROSS	B
ROSSMOOR	B
ROSSMOYNE	C
ROSSPEAK	B
ROSSVILLE	B
ROSWELL	A
ROSY	B
ROTAMER	B
ROTAN	C
ROTHICAN	B
ROTHSAY	B
ROTINOM	B
ROTTULEE	C
ROTURA	B
ROUEN	B
ROUGHCREEK	D
ROUND BUTTE	D
ROUNDABOUT	C
ROUNDBARN	B
ROUNDHEAD	B/D
ROUNDOR	C
ROUNDUP	C
ROVAL	D
ROWDEN	C
ROWDY	B
ROWE	D
ROWEL	D
ROWENA	C
ROWLAND	C
ROWLEY	C
ROXAL	D
ROXANA	B
ROXER	B
ROXTON	D
ROYCE	C
ROYERTON	B
ROYSTONE	B
ROZARA	D
ROZELLVILLE	B
ROZLEE	C
RUBBLE LAND	A
RUBICITY	B
RUBIO	C/D
RUBSON	B
RUBY	B
RUBYCREEK	B
RUBYLAKE, Strongly Saline	C
RUBYLAKE	D
RUCHEZ	C
RUCKER	B
RUDDLEY	D
RUDEEN	C
RUDO	B
RUDYARD	D
RUEDLOFF	B
RUELLA	B
RUESH	B
RUGAR	C
RUGLES	B
RUINS, Thick Surface	A
RUINS	C
RUIZ	A
RUMA	B
RUMBO	C
RUMFORD	B
RUMLEY	B
RUMNEY	C
RUMPAH	D
RUMPELTEASER	D
RUMPLE	C
RUMSEY	B
RUMUNG	C
RUNCLINT	A
RUNE	C
RUNGE	B
RUNLETT	B
RUPLE	C
RUPLEY	A
RUPRECHT	D
RUSBACH	A
RUSHCREEK	B
RUSHFORD	B
RUSHLAKE	A
RUSHMORE	B/D
RUSHRIVER	B/D
RUSHTOWN	A
RUSHVILLE	D
RUSKTOWN	B
RUSO	B
RUSSLER	C
RUSTIGATE	C
RUSTLERPEAK	C
RUSTY	B
RUSTYBUTTE	B
RUTERSVILLE	C
RUTHERFORD	C
RUTLAND	C
RYALLEN	D
RYAN	D
RYARK	B
RYCO	D
RYDOLPH	C
RYEGATE	C
RYELL	D
RYER	C
RYKER	B
RYORP	C
RYUS	B
SAAR	C
SABANA	D
SABANA SECA	D
SABENYO	B
SABIES	C
SABINA	C
SABINE	A
SACATAR	B
SACH	C
SACKETT	B
SACO	D
SACTUS	D
SACVILLE	D
SADDLEBUNCH	D
SADDLEBUTTE	D
SADDLEPEAK	B
SADIE	C
SADLER	C
SADORUS	D
SAEMO	B
SAFETY	B
SAGANING	A/D
SAGASER	B
SAGE	D
SAGECREEK	B
SAGEDALE	C
SAGEHEN	D
SAGERTON	C
SAGEVALLEY	B
SAGLE	C
SAGLEY	B
SAGO	D
SAGOUSPE	B/C
SAHALIE	B
SAHAPTIN	D
SAHKAHTAY	B
SAHUARITA	B
SAID	B
SAILBOAT	B/C
SAILES	B
SAIN	B
SAKAKAWEA	B
SAL	D
SALADAR	D
SALAL	C
SALAMANCA	B
SALAMATOF	D
SALANDER	B
SALCO	B
SALCREEK	C
SALEM	B
SALERNO	B/D
SALGA	C
SALINAS	D
SALINE=SODIC	A
SALISBURY, High Elevation	D
SALIX	B
SALKUM	B
SALLYANN	C
SALMON	B
SALONIE, Moderately wet	C
SALT CHUCK	A
SALT FLAT	D
SALTCREEK	C
SALTERY	D
SALTILLO	C
SALTINE	C
SALTON	D
SALUDA	C
SALVISA	C
SALZER, Protected	C
SAMARIA	B
SAMBA	D
SAMBRITO	B
SAMINIEGO	C
SAMOIST	D
SAMOR	D
SAMSIL	D
SAN ANDREAS	B
SAN ANTON	B
SAN ANTONIO	C
SAN BENITO	B
SAN GERMAN	D
SAN ISABEL, Stony	A
SAN ISABEL,Cobbly	B
SAN MIGUEL	D
SAN RAFAEL	B
SAN SEBASTIAN	B
SAN SIMEON	D
SAN YSIDRO	D
SANBEE, Thin	A
SANBEE	B
SANBORG	D
SANBORN	C
SANBURN	B
SANCAJO	C
SANDBERG	A
SANDBRANCH	B
SANDBUR	A
SANDCREEK	D
SANDERSON	B
SANDHILL	B
SANDIA	B
SANDOSE	A
SANDOVER	A
SANDOW	C
SANDRIDGE, Alkali	A
SANDSPRING	B
SANDUN	B
SANDUSKY	D
SANDVIEW	B
SANDWASH	C
SANDWICK	B
SANDY POINT	D
SANFECO	C
SANFELIPE	B
SANGO	C
SANHEDRIN	B
SANHUD	B
SANILAC	B
SANJE	B
SANKEY	C
SANKLUNA	B
SANLOREN	B
SANOSTEE	C
SANPITCH	C
SANSARC	D
SANTA	C
SANTA CLARA	C
SANTA ISABEL	D
SANTA LUCIA	C
SANTA MARTA	C
SANTANELA, Alkali	D
SANTAQUIN	A
SANTAROSA. Flooded	B
SANTEE	D

Exhibit A: Hydrologic Soil Groups for the United States

SANTEETLAH	B
SANTIAGO, Moderate Perm	B
SANTIAM	C
SANTO	B
SANTONI	D
SANTOP	B
SANTUC	C
SANWELL	B
SANYON	D
SAPEHA	B
SAPINERO, Cool	B
SAPKIN	C
SAPPHO	B
SARA	D
SARAGOSA	B
SARAGOTE	C
SARAHSVILLE	D
SARAZAN	B
SARBO	B
SARCILLO	D
SARDINIA	C
SARDIS	C
SARGEANT	D
SARILDA	C
SARITA	A
SARKAR	D
SARNOSA	B
SARTELL	A
SARUCHE	D
SASALAGUAN	C
SASPAMCO	B
SASSER	B
SATAGO	D
SATANKA	C
SATATTON	D
SATELLITE	C
SATILLA	D
SATIN	C
SATSOP	B
SATSUMA	C
SATT	C
SATURDAY	B
SATURN	B
SAUCEL	D
SAUCIER	C
SAUCITO	D
SAUCON	B
SAUGATUCK	C
SAUGUS	B
SAUK	B
SAUM	B
SAURIN	C
SAUTER	B
SAUVIE, Protected	B
SAUVIE, Moderately Wet	C
SAUVIE	D
SAUVOLA	C
SAUXHEAD, Very Stony	D
SAUZ	B
SAVAGETON	D
SAVANNAH	C
SAVAR	B
SAVENAC	C
SAVO	C
SAVOIA	B
SAVONA	C
SAW	B
SAWABASH	B/D
SAWABE	D
SAWATCH, Gravelly	B/D
SAWBUCK, Shale Substratum	C
SAWCREEK	C
SAWDUST	B
SAWLIT	C
SAWPEAK	B
SAWTELL	C
SAWTELPEAK	D
SAWTOWN	C
SAWYER	C
SAX	D
SAXON	C
SAY	B
SAYDAB	C
SAYERS	A
SAYLES	D
SAYNER	A
SCALEROCK	C
SCALLEY	B
SCALPCREEK	B
SCAMMAN	D
SCANDARD	C
SCAPONIA	B
SCAR	B
SCAREDMAN	B
SCARFACE	B
SCARPER	C
SCARUL	B
SCATLAKE	D
SCATTERSVILLE	D
SCHAFER	D
SCHAFFER	C
SCHALLER	A
SCHALOW	B
SCHATTEL	C
SCHEINER	A
SCHERRARD	D
SCHIEFFLIN	D
SCHILLER	B
SCHISLER	C/D
SCHLOMER	C
SCHNEBLY	D
SCHNOORSON, Drained	C
SCHNORBUSH	B
SCHODSON	C
SCHOER	C
SCHOLTEN	C
SCHOODIC	D
SCHOOLCRAFT	B
SCHOOLER	D
SCHOOLEY	D
SCHOOLHOUSE	D
SCHOONER	D
SCHRIEVER	D
SCHROCK	B
SCHULENBURG	B
SCHULINE	B
SCHUTZ	B
SCHWACHEIM	D
SCHWALBE	B
SCIOTA	C
SCIOTOVILLE	C
SCIPIO	D
SCITICO	C
SCLOME	C
SCOAP	B
SCOBA	B
SCOGGIN	D
SCONSIN	B
SCOTAL	D
SCOTCH	D
SCOTCO	A
SCOTMONT	B
SCOTT LAKE	B
SCOTTCAS	B
SCOTTSBURG	C
SCOTTSVILLE	C
SCRANTON	A/D
SCRIVER	B
SCROGGIN	C
SCUFFE	C
SCUPPERNONG	D
SEABOARD	B
SEABROOK	C
SEAFIELD	B
SEAFORTH	B
SEAGATE	A/D
SEAGOVILLE	D
SEAGRAVES	B
SEALY	B
SEAQUEST	B
SEAR	B
SEARCH	B
SEARCHLIGHT	B
SEARCY	C
SEARING	B
SEARVAR	B
SEASIDE	D
SEATTLE	C/D
SEAVERSON	D
SEAWILLOW	B
SEBAGO	D
SEBASTIAN	D
SEBASTOPOL	C
SEBBO	B
SECCA	C
SECHLER	B
SECO	C
SECONDCREEK	D
SECREPASS	D
SECREST	C
SECRET CREEK	B
SECTION	B
SED	C
SEDALE	D
SEDALIA	C
SEDGEFIELD	C
SEDGWICK	D
SEDONA	D
SEDROWOOLLEY	C
SEEBURG	A
SEEDSKADEE	D
SEEG	B
SEELEZ	A
SEELOVERS	C
SEES	C
SEEWEE	B
SEFERINO	B
SEGNO	C
SEGUIN	B
SEGUNDO	B
SEHARNEY	D
SEHOME	C
SEIS	C
SEJITA	D
SEKIL	B
SEKIU	D
SELBIT	B
SELDEN	C
SELDOVIA	B
SELFRIDGE	B
SELIA	C
SELLE	B
SELLERS	B/D
SELMAN	B
SELON	B
SELOW	D
SELTI	B
SELWAY	B
SEMIAHMOO	C/D
SEMINOLE	D
SEMPER	C
SEN	B
SENACHWINE	B
SENGTOWN	B
SENLAR	C
SENTINEL	B
SEQUATCHIE	B
SEQUIM	A
SEQUITE	D
SEQUOIA	C
SERDEN	A
SEROCO	A
SERPEN	C
SERPENTANO	B
SERPOD	C
SERRANO	D
SESAME	C
SESPE	C
SESSIONS	B
SESSUM	D
SETILL	C
SETNUM	C
SETTERS	C
SETTERS	D
SETTLEMEYER	B
SEVAL	C
SEVAR	C
SEVENOAKS	A
SEVERN	B
SEWANEE	B
SEWELL	C
SEYMOUR	C
SEZNA	D
SHAAK	C
SHACK	B
SHADELEAF	C
SHADEVILLE	B
SHADILTO	D
SHADOVAL	D
SHADY	B
SHADYGROVE	C
SHADYPASS	A
SHAFFTON	B
SHAFTER	D
SHAG	D
SHAGNASTY	C
SHAKAMAK	C
SHAKAN	C
SHAKESPEARE	C
SHAKOPEE	C
SHALAKE	C
SHALBA	D
SHALCLEAV	D
SHALONA	B
SHALPER	D
SHAM	D
SHAMEL	B
SHAMIZO	A
SHAMOCK	C
SHANDEP	B/D
SHANE	D
SHANGHAI	B/C
SHANGLAND	B
SHANKBA	D
SHANKLER	A
SHANKS	C
SHANLEY	B
SHANNONDALE	C
SHANTOWN	A
SHANTY	D
SHAR	C
SHARATIN	B
SHARESNOUT	C
SHARLAND	B
SHARON	B
SHARPS	C
SHARPSHOOTER	B
SHARPTOWN	C
SHARROTT	D
SHARVANA	C
SHASER	B
SHASKIT	C
SHASTA	B
SHASTACOSTA	C
SHASTINA	B
SHATTA	C
SHATTUCK	B
SHAVASH	C
SHAVER	B
SHAWA	C
SHAWANO	A
SHAWAVE	B
SHAWMOUNT	B
SHAWTOWN	B
SHAYLA	D
SHEBANG	D
SHEBEON	C
SHEDD	C
SHEDDENBROOK	A
SHEEK	B
SHEEPCAN	B
SHEEPSKIN	B
SHEFFLEIN	B
SHELBYVILLE	B
SHELD	B
SHELLBLUFF	B
SHELLCREEK	C
SHELLDRAKE	A
SHELLROCK	A
SHELLWOOD	B
SHELTER	D
SHELTON	C
SHENA	D
SHENANDOAH	D
SHENANGO	C
SHENON	B
SHEP	B
SHEPAN	C
SHERAR	C
SHERBURNE	C

Exhibit A: Hydrologic Soil Groups for the United States

SHERLOCK	B
SHERM	D
SHERMORE	B
SHERMOUNT	D
SHEROD	C
SHERRY	B/D
SHERRY, Stony	D
SHERRYL	B
SHERVAL	C
SHERWIN	D
SHERWOOD	B
SHEVA	C
SHEZA	C
SHIAWASSEE	C
SHIELDS	C
SHIFFER	B
SHILLA	B
SHILLING	B
SHILLY	C
SHIMA	C
SHIMMON	C
SHINAKU	D
SHINANDO	D
SHINBONE	B
SHINDLER	C
SHINER	C
SHINGLEMILL	D
SHINGLETOWN	B
SHINGLETOWN	C
SHINKEE	C
SHINNPEAK	D
SHIOYA	A
SHIPLEY	C
SHIPPA	D
SHIPS	D
SHIPSHE	B
SHIRCLIFF	C
SHIRED	D
SHIRK	C
SHIRLEY	B
SHIRLEYBASIN	B
SHIRO	C
SHIRTS	C
SHIRTTAIL	B
SHIVA	B
SHIVLUM	B
SHOAT	C
SHOBA	D
SHOBAN	B
SHODDY	D
SHOEBEND	B
SHOEGAME	B
SHOEMAKER	B
SHOEPAC	C
SHOEPEG	C
SHOHOLA	C
SHOKEN	D
SHONGO	C
SHONKIN	D
SHONTIK	C
SHOOFLIN	D
SHOOFLY	D
SHOOKER	C
SHORE	B
SHOREEK	C
SHORT CREEK	C
SHORTBREAD	A
SHORTCUT	C
SHORTHAIR	D
SHORTHORN	D
SHOSHONE	C
SHOTGUN	C
SHOWALTER	B
SHOWLOW	D
SHREE	B
SHREWDER	B
SHREWSBURY	C/D
SHROE	C
SHROUTS	D
SHROYTON	A
SHRUBCREEK	B
SHUBUTA	C
SHUE	C
SHUKSAN	C
SHULE	C
SHULLSBURG	C
SHUMBEGAY	B
SHUMLA	C
SHURLEY	A
SHUSHUSKIN	C
SI	C
SIBANNAC	D
SIBELIA	B
SIBLEY	B
SIBLEYVILLE	B
SIBOLD	C
SICKLES	B/D
SICKLESTEETS	B
SIEBERELL	B
SIEBERT	A
SIECHE	C
SIEGEL	B
SIERRA	B
SIERRAVILLE	B
SIERRAVISTA	B
SIESTA	D
SIEVERS	C
SIGBIRD	D
SIKESTON	B/D
SILAWA	B
SILCAT	D
SILCOX	B
SILENT	D
SILER	B
SILERTON	B
SILESCA	C
SILETZ	B
SILEX	D
SILHOUETTE	B
SILICO	D
SILKIE	D
SILSBEE	B
SILSTID	A
SILVA	C
SILVER CREEK	D
SILVERBELL	C
SILVERCITY	B
SILVERDALE	A
SILVERHILL	B
SILVERHORN	C
SILVERKING	B
SILVERLAKE	C
SILVERN	A
SILVERSTRIKE	C
SILVERTON	C
SIMANNI	B
SIMCOE	C
SIMEON	A
SIMESCREEK	A
SIMITARQ	D
SIMMONT	C
SIMONA	D
SIMONIN	B
SIMPARK	D
SIMPATICO	B
SIMPER	C
SIMSFIELD	C
SINAMOX	B
SINBAD	D
SINCLAIR	C
SINDION	B
SINGERTON	B
SINGH	B
SINGLETON	D
SINGLETREE	C
SINKER	C
SINONA	B
SINTON	B
SINUK	D
SION	B
SIOUXCREEK	C
SIOUXON	B
SIPAPU	D
SIPHONCAN	D
SIPHONLAKE	B
SIPPLE	B
SIPSEY	B
SIRDRAK	A
SIREN	C
SIRREF	D
SIRRETTA	C
SISKIYOU	B
SISLEY	B
SISSABAGAMA	A
SISSETON	B
SITAR	B
SITKA	B
SIWASH	D
SIWELL	C
SIXES	B
SIXMILE. Loamy	B
SIXMILE, Stony	C
SKAGEN	C
SKAGIT	D
SKAGWAY	C
SKAMANIA	B
SKAMO	C
SKEEL	B
SKEIN	D
SKELIDA	B
SKELLOCK	B
SKELTER	B
SKELTON	B
SKETERVILLE	C
SKIBO	B
SKIDMORE	B
SKILAK	B
SKIME	A
SKINNER	B
SKINWOOD	B
SKIPANON	B
SKIPEAK	B
SKIPOPA	D
SKIYOU	B
SKOKOMISH	C/D
SKOLY	B
SKOOKER	B
SKOOKUM	C
SKOOKUMHOUSE	B
SKOVEN	D
SKOWHEGAN	B
SKRANKA	B
SKULL CREEK	C
SKULLGULCH	C
SKULLWAK	D
SKUNKFARM	D
SKYBERG	C
SKYHAVEN	C
SKYHAWK	C
SKYLIGHT	D
SKYLINE	D
SKYMOR	C
SKYROCK	D
SKYTOP	B
SKYUKA	B
SKYVIEW	C
SLAB	D
SLABTOWN	B
SLACREEK	B
SLACWATER	B/D
SLAPJACK	B
SLATEGOAT	B
SLATERY	C
SLATTER	D
SLAUGHTER	C
SLAUGHTERVILLE	B
SLAWHA	C
SLAYTON	D
SLEEPER	C
SLEETH	B
SLICKEAR	B
SLICKLOG	B
SLICKPOO	B
SLICKSPOTS	D
SLIDE	B
SLIDECAMP	C
SLIDECREEK	B
SLIDELL	D
SLIDYMTN	D
SLIGHTS	C
SLIMBUTTE	B
SLIMLAKE	B
SLINGER	B
SLOCAVE	D
SLOCUM	C
SLOCUM, Moist	D
SLODUC	D
SLUICE	C
SLUKA	C
SLY	B
SMACKOUT	B
SMALLCONE	D
SMEDLEY	D
SMELTER	C
SMESTAD	C
SMIDALE	B
SMILEYVILLE	D
SMINA	C
SMITH	B
SMITHBORO	D
SMITHDALE	B
SMITHLAND	B/D
SMITHNECK	B/C
SMITHTON	D
SMITHVILLE	B
SMITHWICK	D
SMOKEY	B
SMOKYHILL	C
SMOLAN	C
SMOTHERS	C
SMOUT	B
SMYRNA	B/D
SNACREEK	C
SNAG	B
SNAHOPISH	B
SNAKE	C
SNAKEJOHN	B
SNAKELUM	B
SNAKER	D
SNAPEED	C
SNAPILL	B
SNAVEE	B
SNEFFELS	C
SNELLBY	C
SNELLMAN	B
SNETTISHAM	D
SNIDER	C
SNIDERPEAK	B
SNILEC	B
SNILLOC	B
SNOOK	D
SNOPOC	B
SNOQUALMIE	C
SNOTOWN	B
SNOWBRIER	C
SNOWCREEK	B
SNOWDANCE, Moderately Wet	C
SNOWDANCE	D
SNOWDON	C
SNOWLAKE	B
SNOWPLOW	B
SNOWSHOE	B
SNOWVILLE	D
SOAKPAK	B
SOAPCREEK	C
SOBEGA	C
SOBSON	C
SOCAGEE	D
SOCO	B
SODA LAKE	C
SODABAY	B
SODACREEK	B
SODASPRING	B
SODERVILLE	A
SOELBERG	B
SOEN	C
SOFIA	C
SOFTBACK	B
SOGI	C
SOJOURN	D
SOJUR	D
SOKOLOF	A
SOLARVIEW	D
SOLDATNA	B
SOLDIER	C
SOLDIERCREEK	B
SOLDUC	B
SOLIER	D
SOLIS	C
SOLITE	B/D

Exhibit A: Hydrologic Soil Groups for the United States

SOLITUDE	D
SOLLEKS	C
SOLLER	D
SOLNESS	C
SOLO	C
SOLSBERRY	C
SOLVAY	D
SOMA	D
SOMBORDORO	D
SOMBRERO	C
SONAHNPIL	B
SONNETT	D
SONOCAN	C
SONOMA, Stratified Substratum	D
SONORA	B
SONSELA	B
SONTAG	D
SONYOK	D
SOO	C/D
SOOLAKE	B
SOONAHBE	B
SOONAKER	C
SOONER	B
SOOPER	D
SOOSAP	C
SOPELA	D
SOPER	C
SOPERTON	B
SOPHER	C
SOQUEL	B
SORENSEN	B
SORF	C
SORTER	D
SORUM	D
SOSA	C
SOSTIEN	D
SOUDAN	C
SOURDOUGH	B
SOUTHAM	D
SOUTHFORK	D
SOUTHGATE	D
SOUTHHAVEN	B
SOUTHMOUNT	B
SOUTHPAC	B
SOUTHPLAINS	D
SOUTHRIDGE	B
SOUTHWELLS	A
SOUTHWEST	C/D
SOUTIN	B
SOWARD	B
SOWCAN	C
SPADE	B
SPADRA	B
SPAINHOWER	C
SPANA	D
SPANG	B
SPANGLER	C
SPANPEAK	B
SPANTARA	B
SPARGUS	B
SPARKS	C
SPARTA	B
SPASSKI	D
SPEAKER, High Rainfall	B
SPEAKER	C
SPEAR	C
SPEARHEAD	B
SPEARMAN	B
SPEARVILLE	C
SPECTACLE	C
SPECTER	C
SPEED	C
SPEEDWELL	B
SPEELYAI	D
SPEER	B
SPEIGLE	B
SPELLACY	B
SPELVIN	B
SPERRY	C/D
SPESSARD	A
SPEXARTH	C
SPICERTON	D
SPICEWOOD	C
SPICKERT	C
SPIDERCREEK	A/D
SPIKE	B
SPILLCO	B
SPILLER	C
SPILOCK	D
SPILYAY	C
SPINDLETOP	D
SPIRES	B
SPIRES	D
SPIRO	B
SPLANOD	D
SPLAWN	C
SPLENDORA	C
SPLIT	C
SPLITBUTTE	C
SPLITROCK	B
SPLITTOP	C
SPLOTTER	D
SPOKEL	B
SPONIKER	B
SPONIKER, Warm	C
SPONSOR	B
SPOOL	C
SPOONER	C/D
SPOONERHILL	A
SPORLEY	B
SPOT	A/D
SPOTSYLVANIA	C
SPOTTEDHORSE	C
SPOTVILLE	B
SPRABAT	B
SPRAUER	C
SPRAY	B
SPRECKELS	C
SPRING	C
SPRINGCOVE	C
SPRINGCREEK	C
SPRINGERTON	B/D
SPRINGFIELD	D
SPRINGGULCH	B
SPRINGHILL	B
SPRINGHOLLOW	C
SPRINGLAKE	A
SPRINGSTEEN	C
SPRINGWARM	C
SPRINGWATER	C
SPRINGWOOD	B
SPRINKLER	C
SPRIPAR	D
SPROUL	D
SPRUCEDALE	D
SPUD	C
SPUKWUSH	B
SPUR	B
SPURGER	C
SPURLOCK	B
SQUALICUM	B
SQUALLY	B
SQUAMSCOTT	C
SQUAWCAVE	B
SQUAWCREEK	D
SQUAWTIP	C
SQUAWVAL	C
SQUIRES	C
SREDNIC	C
ST. ANDREWS	C
ST. ANTHONY	B
ST. AUGUSTINE	B
ST. ELMO	A
ST. HELENS	B
ST. IGNACE	D
ST. JOHNS	D
ST. LUCIE	A
ST. MARTIN	D
ST. NICHOLAS	D
ST. ONGE	B
ST. PAUL	B
ST.MARYS	B
STABBART	D
STABLER	B
STACHER	B
STACKER	B
STACKYARDS	B
STACY	B
STAFFORD	C
STAHL	C
STAINKY	B
STAKE	C
STALEY	B
STALLARD	D
STALLINGS	C
STAMFORD	D
STANDISH	C
STANDISH	D
STANDUP	B
STANEY	D
STANFLOW	C
STANHOPE	C
STANISLAUS	C
STANISLAUS, Wet	D
STANROD	C
STAPALOOP	B
STARGULCH	B
STARHOPE, Low Elevation	C
STARHOPE	D
STARICHKOF	D
STARKE	D
STARKEY	C
STARLAKE	D
STARLITE	B
STARR	C
STARVEOUT	B
STASER	B
STASH	D
STATE	B
STATELINE	D
STATEMEADOW	B
STATION	D
STATLER	B
STATZ	D
STAVELY	B
STAYTON	D
STEADMAN	C
STEAMBOAT	B
STEAMBURG	B
STEARNS	D
STECOAH	B
STECUM	C
STEED	B
STEEDMAN	C
STEEKEE	C
STEELE	C
STEESE	B
STEEVER	B
STEFF	C
STEGALL	C
STEILACOOM	C
STEIN	C
STEINHATCHEE	B/D
STEINSBURG	B
STEIWER	C
STELLA	C
STEMLEY	C
STENGEL	B/D
STEPHEN	C
STERLING	A
STERLINGTON	B
STERRETT	D
STETSON	B
STETTER	D
STEUBEN	B
STEVENSON	B
STEVIE	B
STEWART	D
STICES	B
STIDHAM	B
STIEN	B
STIGLER	D
STILES	C
STILGAR	B
STILLWELL	B
STILSKIN	C
STILSON	B
STIMSON	D
STINE	D
STINESVILLE	B
STINGAL	B
STINGER	B
STINKCREEK	D
STIPE	C
STIRUM	D
STIVERSVILLE	B
STOCKDRIVE	C
STOCKEL	D
STOCKHOLM	C
STOCKLAND	B
STOCKPEN	D
STOHLMAN	D
STOKES	D
STOKLY	B
STONEBERGER	D
STONEBURG	B
STONEHEAD	C
STONEHILL	C
STONELAKE	A
STONER	B
STONEVILLE	B
STONEWALL	C
STONEWELL	A
STONO	B/D
STONYBROOK	B
STOOKMOOR	C
STOPATOE	C
STORMKING	B
STORNETTA	D
STOTT	C
STOUGH	C
STOVALL	B
STOVEPIPE	D
STOVHO	C
STOWELL	D
STOY	C
STRABER	C
STRADDLEBUG	C
STRAHLE	D
STRAIGHT	C
STRANDLINE	B
STRANDQUIST	B/D
STRAWBCREK	B
STRAYHOSS	B
STREATOR	B/D
STRELL	D
STRELNA	C
STREULING	D
STRICKER	B
STRICKLAND	C
STRINGLEY	B
STRINGTOWN	B
STRINGTOWN, Graded	C
STROLE	C
STROM	C
STROMAL	B
STRONGHOLD	C
STRONGHURST	B
STROUPE	C
STROUT	C
STROZI	C
STRUGGLE	A
STRYKER	C
STU	C
STUBBS	C
STUBENVILLE	B
STUCK	C
STUDEBAKER	B
STUKEL, Cobbly	B
STUKEL, Sandy	C
STUKEL	D
STULTZ	C
STUMOUNT	D
STUMPP	D
STUNTZ	C
STURGEON	B
STURGES	D
STURGILL	D
STURKIE	B
STUTTGART	D
STUTZMAN	C
STUTZMAN, Wet	D
STYERS	D
STYLITE	C
STYX	B
SUAK	C
SUBACO	D
SUBLETTE, Elevation 7000-9000	A
SUBLETTE	B
SUBLIGNA	B

Exhibit A: Hydrologic Soil Groups for the United States

SUBRAN	C
SUBWELL	B
SUCARNOOCHEE	D
SUCCOR	D
SUCHES	B
SUCKERFLAT	B
SUDLEY	B
SUDPEAK, Nonflooded	C
SUDPEAK., Flooded	D
SUEPERT	C
SUEY	B
SUFFIELD	C
SUFFOLK	B
SUGAKOOL	B
SUGAR BEACH	D
SUGARBOWL	B
SUGARBUSH	B
SUGARCREEK	C
SUGARDEE	B
SUGARTOWN	D
SUGLO	B
SUILOTEM	C
SUISUN	D
SUKOI	D
SULA	B
SULLIVAN	B
SULOAF	B
SULPHURA	B
SULPHURA	D
SULSAVAR	B
SULTZ	A
SUMAN	B/D
SUMATRA	B
SUMAVA	B
SUMMERFIELD	D
SUMMERFORD	C
SUMMERMUTE	B
SUMMERS	B
SUMMERTON	B
SUMMIT	C
SUMMITVILLE	C
SUMPF	D
SUMPLEY	C
SUMTERVILLE	C
SUMYA	D
SUNBURG	B
SUNBURY	B
SUNCITY	D
SUNCOOK	A
SUND	C
SUNDANCE	B
SUNDAY	A
SUNEV	B
SUNKEN	D
SUNLIGHT	D
SUNNY	C
SUNNYHAY	D
SUNNYSIDE	B
SUNRAY	B
SUNRIVER	C
SUNSTROKE	D
SUNSWEET	C
SUNTRANA	D
SUP	B
SUPOSO	C
SUPPAH	A
SUR	C
SURFSIDE	D
SURGEM	C
SURPLUS	C
SURRETT	C
SURVEYORS	B
SURVYA	C
SURYON	B
SUSANNA	C/D
SUSANNABERG	D
SUSANVILLE	D
SUSIVAR	C
SUSQUEHANNA	D
SUTA	B
SUTHER	C
SUTHERLAND, Gravelly	C
SUTHERLAND	D
SUTHERLIN	C
SUTLEY	B
SUTPHEN	D
SUTRO	C
SUTTLE	A
SUVER	D
SVERDRUP	B
SWAFFORD	C
SWAGER	C
SWAHLEN	B
SWAINTON	B
SWALECREEK	B
SWAMPCREEK	D
SWAMPOODLE	C
SWAMPYDRAW	B
SWAN	D
SWANBERGER	D
SWANLAKE	B
SWANNER	D
SWANPOND	C
SWANSON	C
SWANTON	C/D
SWANTOWN	D
SWANWICK	D
SWARTZ	D
SWAYNE	C
SWEAGERT	B
SWEATBEE	B
SWEATBEE, Wet	C
SWEATMAN	C
SWEDE	B
SWEDEGROVE	B/D
SWEDEHEAVEN	B
SWEDESBORO	B
SWEDNA	D
SWEETAPPLE	B
SWEETBRIAR	B
SWEETBUTTE	B
SWEETGRASS	B
SWEETWATER	D
SWEITBERG	C
SWENSON	D
SWIFT CREEK	B
SWIFTCURRENT	B
SWIFTON	B
SWIMLEY	C
SWIMS	B
SWINK	D
SWINOMISH	C
SWINT	B
SWIPKIN	B
SWISBOB	D
SWISS	C
SWISSVALE	D
SWITCHBACK	C
SWITZERLAND	B
SWORMVILLE	C
SWYGERT	C
SYBIL	B
SYBILLE	B
SYBLON	D
SYCAN	A
SYCLE	B
SYCREEK	C
SYKES	B
SYLACAUGA	D
SYLVA	B/D
SYLVANIA	C
SYLVANIAM	C
SYLVESTER	B
SYLVIA	C
SYMCO	C
SYNAREP	B
SYRETT	B
SYRUPCREEK	C
TABECHEDING	C
TABERNASH	B
TABLER	D
TABLEROCK	D
TABOOSE	A
TABOOSE, Gravelly Substratum	B
TABOR	D
TACHI	D
TACODA	C
TACOOSH	B/D
TADLOCK	B
TAFFOM	B
TAFOYA	C
TAFT	C
TAFTOWN	B
TAFUNA	A
TAGUM	B
TAGUS	B
TAHKENITCH	B
TAHOULA	D
TAHQUATS	B
TAINE	D
TAINTOR	C/D
TAJO	C
TAKOTNA	B
TAKPOCHAO	D
TALAG	D
TALANTE	D
TALAPUS	B
TALCO	D
TALLA	C
TALLADEGA	C
TALLCREEK	B
TALLEYVILLE	B
TALLOWBOX	C
TALLULA	B
TALMAGE	B
TALMAKS	B
TALMOON	C
TALMOON, Depressional	D
TALOKA	D
TALQUIN	B/D
TALUWIK	B
TAMAHA	D
TAMALCO	D
TAMALPAIS	C
TAMARA	B
TAMARACK	B
TAMARACKCANYON	C
TAMARRON	C
TAMBA	D
TAMELY	B
TAMFLAT	D
TAMFORD	D
TAMIAMI	D
TAMMANY	B
TAMMING	B
TAMP	B
TAMRED	C
TANACROSS	D
TANAHA	C
TANAMA	D
TANANA, Thawed	B
TANANA, Moderately Wet	C
TANAZZA	B
TANDY	D
TANEUM	C
TANGI	C
TANGLE	C
TANGLENOOK	D
TANKERVILLE	C
TANNAWASHA	B
TANNER	C
TANNER, Low Rainfall	D
TANOAN	B
TANOB	B
TANSEM	B
TANTALUS	A
TANTILE	C/D
TANWAX	C/D
TANYARD	C
TAOPI	B
TAPAWINGO	C
TAPICITOES	D
TAPPAN	B/D
TARA	B
TARAL	B
TARHOLLOW	C
TARKIO	D
TARLOC	B
TARLTON	C
TARNAV	B
TARRETE	D
TARRYALL	C
TARRYTOWN	C
TASAJAL	B
TASAYA	C
TASCOSA	B
TASSELCREEK	A
TASSELMAN	D
TASSI	D
TASSO	B
TATAI	C
TATERPA	B
TATLUM	D
TATOUCHE	B
TATTON	D
TAUMSAUK	D
TAUNCAL	C
TAVER	D
TAVERNIER	D
TAWAH	B
TAWCAW	C
TAYLOR CREEK	C
TAYLORSFLAT	C
TEAGARD	D
TEAGO	A
TEAGULF	C
TEAKEAN	B
TEALSON	D
TEALWHIT	D
TEAMONT	D
TEARNEY	D
TEASDALE	B
TEBAY	B
TEBO	B
TECHICK	B
TECHICKNOT	B
TECKLA	B
TECO	B
TECOPA	D
TECTAH	B
TECUMSEH	B
TECZUNI	C
TEDDY	C
TEEBAR	D
TEEBONE	C
TEEDOWN	B
TEEGARDEN	C
TEEMAT	B
TEETERS, Protected	C
TEETERS	D
TEFTON	C
TEHRAN	A
TEIGEN	C
TEJA	D
TEJABE	D
TEJANA	B
TEKAPO	D
TEKENINK	B
TEKISON	C
TEKLANIKA	A
TEKOA	B
TELA	B
TELAQUANA	B
TELAY	B
TELCHER	B
TELECAN	B
TELEFONO	C
TELEMON	D
TELESCOPE	A
TELFAIR	C
TELFERNER	D
TELL	B
TELLER	B
TELLICO	B
TEMBLOR	D
TEMDILLE	A
TEMESCAL	D
TEMVIK	B
TENAHA	B
TENAS	C
TENDOY	D
TENEB	D
TENEX	B
TENINO	C
TENMILE	C
TENNCO	C
TENNECO	B
TENOT	C
TENPIN	D
TENRAG	B

Exhibit A: Hydrologic Soil Groups for the United States

Soil	Group
TENSAS	D
TENSED	C
TENSLEEP	B
TENVORRD	D
TENWALTER	C
TENWELL	C
TEOCULLI	B
TEQUESTA	B/D
TERADA	B
TERBIES	B
TERCA	D
TERESA	D
TERLINGUA	D
TERMO	D
TEROMOTE	B
TEROUGE	D
TERRA CEIA	B/D
TERRABELLA	D
TERRACECREEK	C
TERRAD	C
TERRAROSSA	D
TERRETON	C
TERRO	B
TERT	D
TESSFIVE	D
TETHEROW	A
TETILLA	B
TETLIN	D
TETONIA	B
TETONVILLE, Gravelly	C
TETONVILLE	D
TETOTUM	C
TEVAL	B
TEVIS	B
TEWFEL	C
TEX	B
TEXANA	D
TEXASCREEK	B
TEXLA	D
TEXLINE	B
TEXROY	B
THADER	C
THAGE	C
THATCHERFLATS	D
THAYNE	B
THEBES	B
THEBO	D
THEECAN	C
THENARROWS	D
THENAS	C
THENIPEL	B
THEODOR	D
THERESA	C
THERMO	D
THETFORD	A
THETIS	B
THIBAUT	D
THIEFRIVER	B/D
THIKE	D
THIMBLE	C
THIRST	D
THIRSTYGULCH	D
THISTLEBURN	B
THISTLEDEW	B
THOENY	D
THOMAS	B/D
THOMASFORK	C
THOMHILL	B
THOMS	D
THOR	B
THORN	D
THORNCREEK	C
THORNDALE	D
THORNOCK	D
THORNTON	D
THOUT, Gravelly Surface	B
THOUT	C
THOW	B
THRASH	B
THREADGILL	B
THREEBEAR	C
THREEBUCK	C
THREECHOP	B
THREECREEKS	C
THREEFORKS	B
THREEK	C
THREEMILE	B
THREERIV	D
THREETREES	B
THRIFTON	C
THROCKMORTON	B
THULEPAH	C
THUNDER	B
THUNDERBAY	D
THUNDEREGG	C
THURBER	D
THURLONI	C
THURLOW	B
THWOOP	C
TIAGOS	B
TIAK	C
TIBBCREEK	C
TIBBITTS	B
TIBKEY	B
TIBURONES	D
TICANOT	D
TICELL	D
TICESKA	C
TICONIC	A
TIDERISHI	C
TIDEWATER	D
TIDINGS	B
TIEFORT	B
TIERRANEGRA	B
TIESIDE	D
TIETON	B
TIEVILLE	D
TIFF	C
TIFFANY	C
TIFTON	B
TIGER CREEK	B
TIGIT	C
TIGIWON	B
TIGON	D
TILDEN	B
TILK	A
TILLEDA	B
TILLICUM	B
TILLMAN	D
TILLMONT	B
TILLOU	C
TILMA	C
TILSIT	C
TILTON	B
TILVERN	D
TIMBALIER	D
TIMBERBUTTE	B
TIMBERG	C
TIMBERHEAD	B
TIMBERLY	B
TIMBLIN	D
TIMBUCTOO	C
TIMGULCH	D
TIMHILL	D
TIMHUS	B
TIMKEN	D
TIMMERCREK	B
TIMMONS	B
TIMOR	A
TIMPAHUTE	D
TIMPER	D
TIMPIE	C
TIMULA	B
TINA	C
TINAJA	B
TINAJA, Cool	C
TINAMOU	C
TINCAN	D
TINCUP	B
TINDAHAY	A
TINE	B
TINEMAHA	B
TINEMAN	C
TINIAN	C
TINKER	C
TINN	D
TINNIN	A
TINPAN	D
TINT	A
TINTERO	B
TINTON	A
TINTSON	A
TINYTOWN	B
TIOGA	B
TIONESTA	A
TIPLER	B
TIPNAT	B
TIPPAH	C
TIPPECANOE	B
TIPPER	C
TIPPIPAH	B
TIPPO	C
TIPSAW	C
TIPTON	B
TIPTONVILLE	B
TIPTOP	B
TIRO	C
TIROD	B
TISBURY	B
TISDALE	C
TISHAR	B
TISMID	C
TISONIA	D
TITCHENAL	B
TITIACK	B
TITUSVILLE	C
TIVOLI	A
TIVY	C
TOA	B
TOADLAKE	B
TOADLENA	D
TOBA	B
TOBINSPORT	B
TOBOSA	B
TOBY	B
TOCALOMA	C
TOCAN	B
TOCCOA	B
TOCITO	B
TOCK	C
TOCOI	B/D
TODACHEENE	B
TODDSTAV	D
TODDVILLE	B
TODOS	C
TOECANE	B
TOEFOOT	B
TOGCHA	B
TOGUS	D
TOHATIN	B
TOHOBIT	C
TOIMI	C
TOINE	B
TOISNOT	B/D
TOISNOT, Ponded	D
TOKAY	B
TOKEEN	C
TOKIO	B
TOKLAT	D
TOKO	C
TOKOSITNA	B
TOKUL	C
TOLANY	B
TOLER	C
TOLFORK	B
TOLICHA	D
TOLIUS	B
TOLKE	B
TOLLGATE	B
TOLMAN	C
TOLNA	B
TOLONIER	B
TOLOVANA	B
TOLSONA	D
TOLUCA	B
TOMAHAWK	A
TOMALES	D
TOMARIZO	D
TOMASAKI	C
TOMAST	C
TOMBEALL	D
TOMEK	B
TOMERA	C
TOMERA, Cemented Substratum	D
TOMODO	B
TOMOKA	B/D
TOMOTLEY	B/D
TOMS	C
TOMSHERRY	C
TOMTY	D
TONATA	D
TONEY	D
TONIO	B
TONKAVAR	A
TONKAWA	A
TONKIN	B
TONKIN, Moderately Wet	C
TONKS	C
TONOR	B
TONOWEK	B
TONRA	B
TONSINA	B
TONUCO	D
TOOLES	B/D
TOOLESBORO	B
TOONE	B
TOOTERVILLE	D
TOPAWA	B
TOPAWA, Very Gravelly	C
TOPEMAN	D
TOPETAUL	C
TOPIA	D
TOPKNOT	D
TOPO	D
TOPOCK	D
TOPPENISH	C/D
TOPPER	B
TOPSEY	C
TOQUIMA	C
TOREX	B
TORHUNTA	C
TORNEY	D
TORNILLO	B
TORNING	B
TORODA	B
TORONTO	C
TOROX	B
TORPEDO LAKE	D
TORREON	D
TORRES	A
TORRY	B/D
TORULL	D
TOSP	B
TOTAVI	B
TOTEM	B
TOTIER	C
TOTNESS	D
TOTO	B/D
TOTTEN	C/D
TOTTLES	C
TOTZ	D
TOUCHET	C
TOULA	C
TOURN	C
TOURNQUIST	B
TOUTLE	B
TOWAVE	B
TOWERVILLE	B
TOWNSEND	C
TOWNSHIP	B
TOWOSAHGY	B
TOXAWAY	B/D
TOY	D
TOZE	B
TRACE	B
TRACK	C/D
TRACKLER	C
TRACOSA	D
TRACTUFF	D
TRACYLEE	B
TRADELAKE	C
TRAER	B/D
TRAHAM	C
TRAHERN	D
TRAIL	B
TRAILAMP	D
TRAILCREEK	C
TRAILHEAD	B
TRAINER	B
TRAITORS	D

Exhibit A: Hydrologic Soil Groups for the United States

TRALEY	B
TRAMWAY	B
TRANSFER	D
TRANSQUAKING	D
TRANSYLVANIA	B
TRAPPER	B
TRAPPERCREEK	B
TRASK	C
TRAUNIK	B
TRAVER	B
TRAVERTINE	C
TRAVILAH	C
TRAZUNI	B
TREATY	B/D
TREBLOC	D
TREBOR	C
TREEBUTTE	D
TREEKOR, nonstony	C
TREEKOR	D
TREEN	D
TREFRY	B
TREGO	C
TREGONING	C
TREHARNE	C
TRELONA, Moist	C
TRELONA	D
TREMBLES	C
TREMENTINA	B
TREMONA	C
TREMONT	B
TREMPE	A
TREMPEALEAU	B
TRENHOLM	D
TRENTON	C
TREOFF	D
TREON	D
TREP	B
TRESTLE	B
TRETTEN	B
TREVLAC	B
TREY	A
TRIANGLE	D
TRIBBEY	C
TRICART	B
TRICERA	A
TRICON	C
TRID, Nonstony	B
TRID	C
TRIGGER	D
TRIGO	D
TRIMMER	C
TRIMONT	B
TRINIDAD	D
TRIO	D
TRIOMAS	B
TRIPIT	C
TRIPLEN	B
TRIPLETT	D
TRIPOLI	B/D
TRISTAN	B
TRITON	D
TRIVAR	B
TRIX	C
TROMP	C
TRONSON	B
TROOK	C
TROSKY	B/D
TROUP	A
TROUTER	C
TROUTLAKE	B
TROUTMEADOWS	B
TROVE	B
TRUCKEE	B/C
TRUEFISSURE	B
TRUHOY	D
TRULAE	D
TRUMBULL	D
TRUMP	D
TRUSCREEK	B
TRUSSUM	C/D
TRUXTON	B
TSADAKA	B
TSALI	C
TSANA	B
TSAYA	D
TSCHAMMAN	D
TSCHICOMA	B
TSEBITAI	B
TSETTA	A
TSIRKU	C
TUCANNON	C
TUCES	D
TUCKAHOE	B
TUCKERDOWNS	B
TUCSON	B
TUCSON, saline-Alkali	C
TUCUMCARI	B
TUFFIT	C
TUFON	B
TUGAS	A
TUKEY	C
TUKUHNIK	C
TUKWILA	C/D
TULANA, Moderately Drained	C
TULANA	B/D
TULARGO	B
TULAROSA	B
TULCH	B
TULE	C
TULEBASIN	D
TULECAN	C
TULIA	B
TULIK	B
TULIP	C
TULLAHASSEE	C
TULLOCK, Dry	A
TULLOCK, Warm	B
TUMARION	D
TUMBLETON	C
TUNAWEE	C
TUNEHILL	D
TUNELCREEK	B
TUNIS	D
TUNITCHA	B
TUNKCREEK	A
TUNNEL	B
TUOMI	B
TUPELO	D
TUPPER	A
TUPUKNUK	D
TUQUE	B
TURBA	D
TURCOTTE	B
TURIST	D
TURK	C
TURKEY	A
TURKEYSPRINGS	B
TURKEYTRACK	C
TURLIN	B
TURLOCK	D
TURMOUND	D
TURNBACK	C
TURNBULL	D
TURNERCREST	B
TURON	A
TURRAH	C
TURRET	B
TURRIA	C
TURZO	C
TUSCARAWAS	C
TUSCAWILLA	D
TUSCOSSO	B
TUSCUMBIA	D
TUSIP	B
TUSLER	A
TUSLER	B
TUSSY	D
TUSTELL	C
TUSUNE	C
TUTE	B
TUTKA	D
TUTNI	B
TUTNI, Loamy Substratum	C
TUTTLE	C
TUTUILLA	C
TUTWILER	B
TUWEEP	B
TUXEKAN	B
TUZIGOOT	C
TWEBA, Modeately Wet	B
TWEBA, Drained	C
TWEEDY	C
TWELVEMILE	B
TWENTY DAY	B
TWICK	D
TWIG	D
TWINBUTTES	A
TWINING	C
TWINMOUND	A
TWISSELMAN	C
TWOBUTTE	B
TWOCABIN	B
TWOMILE	C/D
TWOTOP	D
TYBO	D
TYDEN	D
TYEE	D
TYENDE	B
TYGH	C
TYLER	D
TYLERPEAK	B
TYMOSLING	C
TYNDALL	B/C
TYNER	A
TYONEK	D
TYRE	A/D
TYSON	B
UANA	D
UBANK	D
UBAR	D
UBEHEBE	C
UCHEE	A
UCOPIA	B
UDAHO	B
UDARENTS	B
UDECIDE, Cobbly	B
UDECIDE	C
UDEL	D
UDELOPE, Bouldery	B
UDELOPE	D
UDIPSAMMENTS, Flooded	A
UGAK	D
UHL	B
UHLAND	B
UHLORN, Cool	B
UHLORN	C
ULA	C
ULANDO	B
ULHALF	B
ULLOA	B
ULMET	C
ULRANT	B
ULRIC	C
ULTO	B
ULTRA	D
ULTRAMONT	B
ULUPALAKUA	B
ULY	B
UMA	A
UMAPINE	C/D
UMATILLA	B
UMBARG	B
UMIAT	D
UMPA	B
UMPUMP	B
UMTANUM	C
UNAKA	B
UNAKWIK	D
UNCAS	D
UNCOMPAHGRE	D
UNDERWOOD	B
UNDUSK	B
UNGENE	A
UNICOI	C
UNICORN	B
UNION	C
UNIONGROVE	B/D
UNIONVILLE	B
UNIQUE	B
UNIUS	D
UNIVEGA	D
UNIVERSITY	A
UNKEE	B
UNLIC	B
UNSON	B
UPCREEK	C
UPDEGRAFF	B
UPSATA	B
UPSEL	A
UPSON	C
UPSTEER	B
URBANA	C
URBO	D
URBODEN	B
UREAL	D
URGESTEIN	B
URICH	C/D
URIPNES, Gravelly	C
URIPNES	D
URLAND	C
URMAFOT	D
URSA	C
URSINE	D
URWIL	C
USAL, Gravelly	B
USAL	C
USEFUL	C
USINE	A
USKABWANKA	A
USTARENTS, Loamy	B
USTIBUCK	D
USTIDUR	D
USTORTHENTS, Sandy	A
UTALINE	C
UTE	D
UTLEY	B
UTUADO	B
UTURIN	C/D
UVADA Loamy Surface	C
UVALDE	B
UVER	A
UWALA	B
UWELL	C
UZANEVA	D
VABBING	B
VABEM	C
VADAHO	D
VADER	B
VAEDA	D
VAIDEN	D
VAILTON	B
VALBY	C
VALCO	C
VALCREEK	B
VALCREST	C
VALDOSTA	A
VALE	B
VALENA	D
VALENCIA, Saline, Flooded	C
VALERA	C
VALHALLA	A
VALKARIA	B/D
VALKARIA, Deppressional	D
VALLAN	D
VALLE	B
VALLEONO	B
VALLERS	D
VALLETTA	B
VALLEYCITY	D
VALMAR	C
VALMONT	C
VALPAC	C
VALTON	B
VALTON, Severely Eroded	C
VALVERDE	B
VAMER	B
VAMONT	D
VAN HORN	B
VANBRUNT, Warm	B
VANBRUNT	C
VANCE	C
VANCECREEK	B/D
VANDAMINE	B
VANDAMME	B
VANDAMORE	B
VANDERBILT	B
VANDERBILT, Moderaterly Wet	C
VANDERGRIFT	C
VANDERPOOL	B
VANEPPS	C

VANGOE	C
VANGUARD	C
VANLUE	C
VANMETER	C
VANNOY	C
VANOCKER	B
VANOSS	B
VANPETTEN	B
VANSICKLE	D
VANSTEL	B
VANWYPER	D
VANZANDT	C
VANZILE	B
VAQUERO	D
VARELUM	B
VARELUM, Clay Loam Substratum	C
VARGAS	C
VARICK	D
VARRO	B
VARWASH	A
VARYSBURG	B
VASA	B
VASSETT	B
VASTINE, Map>16	B
VASTINE	D
VAUGHAN	D
VAUGHNSVILLE	C
VAYAS	D
VEAL	B
VEATCH	C
VECONT	C
VEEDUM	D
VEGA ALTA	B
VEGA BAJA	C
VELASCO	D
VELDA	B
VELDKAMP	B
VELOW	B
VENA	C
VENAGRO	B
VENAPASS	D
VENATOR, Channery	B
VENATOR	C
VENETA	D
VENEZIA	D
VENICE	C
VENLO	A/D
VENNOB	D
VENSON	B
VENSORA	C
VENUM	D
VERBOORT	D
VERCLIFF	C
VERDEL	D
VERDIGRE	C
VERDUN	D
VERENDRYE	B/D
VERGENNES	C
VERHART	B
VERICK	C
VERIDGE	B
VERJELES	D
VERLOT	D
VERMILLION	C
VERNADO	D
VERNAL	B
VERNDALE	B
VERNIA	A
VERNONIA	B
VERO	D
VERSHAL	D
VERSON	C
VERSTOVIA	D
VERTEL	D
VERTINE	D
VERTREES	B
VESEY	B
VESPER	D
VESTA	B
VETAGRANDE	B
VETEADO	C
VIA	B
VIAN	B
VIBLE	A
VIBO	B
VIBORAS	D
VICK	C
VICKSBURG	B
VICTORVILLE	B
VICTORY	B
VICU	C
VIDA	B
VIDAURI	D
VIDRINE	D
VIEJA	D
VIENNA	B
VIEQUES	B
VIEWPOINT	D
VIGAR	C
VIGIA	D
VIGILANTE	C
VIGNOLO	C
VIGO	C
VILLA	B
VILLARD	D
VILLEDRY	C
VILLEGREEN	C
VILLMEAGHER	C
VILLSPRINGS	C
VILLY	B/D
VILOT	C
VIMVILLE	D
VINCOM	C
VINDICATOR	D
VINEGARROON	C
VINELAND	A
VINELAND, Wet	B
VINGO	B
VINITA	C
VINLAND	D
VINSAD	C
VINSON	B
VINTON	A
VIOLA	D
VIPONT	C
VIRDEN	B/D
VIRGIN RIVER	C
VIRKULA	C
VIRTUE	C
VISE	B
VISTA	B
VISTULA	A
VITERBO	D
VITRINA	B
VITROFF	B
VITZTHUM	D
VIUM	D
VIVES	B
VIVI	B
VIVIAN	B
VIXEN	B
VIZCAINO	D
VIZCAPOINT	D
VIZCAYA	D
VLASATY	C
VOCA	C
VOCK	D
VODA	C
VODERMAIER	B
VOELKER	B
VOIGHT	B
VOLADORA	B
VOLASH	B
VOLCO	D
VOLENTE	C
VOLINIA	B
VOLLMER	C
VOLMONT	B
VOLNEY	B
VOLSTEAD	B
VONALF	B
VONASON	B
VONDERGREEN	C
VOORHIES	C
VOSSET	B
VOTAW	B
VOYAGER	B
VULCAN	C
VYCKYL	D
WAAS	B
WABANICA	C
WABASSO	D
WABEDO	C
WABUN	A/D
WACAHOOTA	D
WACCASASSA	D
WADDINGTON	A
WADDOUPS	B
WADECREEK	C
WADELL	B
WADENILL	B
WADESPRINGS	C
WADLEIGH	D
WADLEY	A
WADMALAW	D
WADSWORTH	C
WAELDER	B
WAFLA	B
WAGNER	D
WAGONBED	B
WAGONBOW	D
WAGONBOX	D
WAGONHOUND	B
WAGONJACKET	C
WAGONTIRE	D
WAGONTOWN	B
WAGORE	B
WAGRAM	A
WAGSTAFF	C
WAHEE	D
WAHGUYHE	D
WAHIAWA	B
WAHKEENA	B
WAHLSTEN	C
WAHLUKE	B
WAHOO	D
WAHPETON	C
WAHREKDAM	C
WAHSTAL	D
WAHTUM	D
WAHWEAP	D
WAI HONU	B
WAIALEALE	D
WAIAWA	D
WAIHUNA	D
WAIKALOA	B
WAIKANE	B
WAIKAPU	B
WAIKOMO	D
WAILUKU	B
WAINEE	B
WAINOLA	B
WAIPAHU	C
WAITS	B
WAITSFIELD	B
WAKAMO	C
WAKE	D
WAKEEN	B
WAKELEY	D
WAKEMAN	C
WAKENDA	B
WAKEPISH	B
WAKETICKEH	D
WAKEVILLE	B
WAKITA	D
WAKONDA	B
WAKONDA, Till Substratum-	C
WAKULLA	A
WALBERT	C
WALCO	B
WALCOTT	B
WALDECK	C
WALDEN	D
WALDO	D
WALDORF	C/D
WALDROUP	D
WALKERSVILLE	B
WALKINSHAW	D
WALKON	C
WALKOVER	B
WALL	B
WALLKILL	B/D
WALLOWA	C
WALLROCK	C
WALLUSKI	C
WALNETT	C
WALNUT	B
WALONG	B
WALPOLE	C
WALREES	B
WALSEY	B
WALTERS	B
WALTHAM	D
WALUM	B
WALVAN	B
WALVILLE	B
WAMBA	C/D
WAMBOLT	B
WAMEGO	C
WAMIC	B
WAMPEE	C
WAMPOO	C
WAMPSVILLE	B
WANAGAN	B
WANDO	A
WANETTA	B
WANILLA	C
WANNACOTT	B
WANOGA, Elevation>4000	A
WANOGA	B
WANOMIE	C
WANSER, Drained	B
WAPAHANI	C
WAPAL	B
WAPELLO	B
WAPI	D
WAPINITIA	B
WAPITI	A
WAPPINGER	B
WAPPO	D
WAPSHILLA	B
WAPTUS	C
WARDA	B
WARDBAY	B
WARDBORO	A
WARDELL	C
WARDWELL	C
WARE	B
WAREAGLE	B
WARHORSE	D
WARM SPRINGS	D
WARMAN	A/D
WARMINSTER	C
WARNOCK	B
WARNUT	D
WARRENTON	D
WARRIOR	B
WARROAD	C
WARSING	B
WARWICK	A
WASA	D
WASDA	B/D
WASHINGTON	C
WASHPASS	B
WASKISH	D
WASKOM	C
WASNOT	C
WASSON	D
WATAB	C
WATAHALA	A
WATAUGA	B
WATCHABOB	C
WATCHES	B
WATERFALL	D
WATERFLAT	C
WATERFORD	B
WATERGATE	B
WATERTOWN	B
WATHENA	B
WATKINS	B
WATNE	B
WATONGA	D
WATONY	A
WATOOPAH	B
WATROUS	C
WATSEKA	B
WATSONIA	D
WATTON	C
WATUSI	C

Exhibit A: Hydrologic Soil Groups for the United States

WAUBERG	D
WAUCHULA	B/D
WAUCHULA, Depressional	D
WAUCOBA	D
WAUCONDA	B
WAUKENA	D
WAUKENABO	B/D
WAULD	C
WAURIKA	D
WAUTOMA	B/D
WAVELAND	B/D
WAVELAND	D
WAWAKA	B
WAWASEE	B
WAWINA	A
WAX	C
WAXPOOL	D
WAYCUP	B
WAYLAND	C/D
WAYMET	B
WAYMOR	B
WEA	A
WEALTHWOOD	A/D
WEASH	C
WEATHERFORD	B
WEATHERWAX	D
WEAVER	C
WEAVERVILLE	B
WEBB	C
WEBBRIDGE	B
WEBBTOWN	C
WEBFOOT	C
WEBILE	C
WECHECH	D
WEDDERBURN	B
WEDGE	A
WEDGEMONT	B
WEEDING	D
WEEDMARK	B
WEEDPATCH	C
WEEDZUNIT	B
WEEKIWACHEE	D
WEEKS	C
WEENA	D
WEEPAH	C
WEESATCHE	B
WEETOWN	B
WEEZWEED	B
WEGERT	A
WEGLIKE	A
WEIDER	B
WEINBACH	C
WEIR	D
WEIRMAN	D
WEISBURG	C
WEISSENFELS	C
WEITAS	B
WEITCHPEC	C
WELAKA	A
WELCH	B
WELCHLAND	B
WELCOME	B
WELDA	C
WELEETKA	D
WELLESLEY	B
WELLIE	A
WELLINGTON	D
WELLMAN	B
WELLROCK	B
WELLS	B
WELLSBENCH	B
WELLSCREEK	B
WELLSDAM	C
WELLSED	C
WELLSFORD	D
WELOY	C
WELSUM	D
WELTER	D
WEMPLE	B
WENAS	C/D
WENATCHEE	C
WENDANE	B/C
WENDELL	C
WENGLER	A
WENONAH	B
WENOTA	D
WENZEL	B
WEOGUFKA	C
WEOTT	D
WEPO	C
WERELD	B
WERITO	C
WERNOCK	B
WESFIL	D
WESIX	D
WESKA	D
WESLEY	B
WESPAC, Sandy Substratum Alkali	C
WESPAC, Alkali	D
WESSEL	C
WESTBEND	B
WESTBORO	D
WESTBROOK	D
WESTBUTTE	B
WESTERVILLE	B
WESTFORK	D
WESTGATE	C
WESTINDIAN	C
WESTLAKE, Thin Surface	C
WESTLAKE	D
WESTMION	D
WESTMORE	C
WESTOLA	B
WESTON	D
WESTOVER	B
WESTPHALIA	B
WESTPLAIN	D
WESTPORT	A
WESTPORT, Thin Surface	B
WESTSHORE	D
WESTSIDE	C
WESTSUM	D
WESTVACO	C
WESTVIEW	B
WESTVILLE	B
WESTWEGO	D
WESWIND	C
WESWOOD	B
WETA	D
WETBETH	C
WETHEY	A/C
WETHEY	C
WETSAW	C
WETTERDON	B
WETZEL	D
WEWELA	B
WEWOKA	C
WEYANOKE	C
WEYERS	C/D
WEYMOUTH	B
WHAKANA	B
WHALESHEAD	B
WHALEY	D
WHATCOM	C
WHATELY	D
WHEATBELT	D
WHEATON	B
WHEATWOOD	B
WHEELER	B
WHEELERPEK	D
WHEELERVILLE	B
WHEELON, Cool	B
WHEELON	D
WHEELRIDGE	A
WHEELS	D
WHERRY	D
WHETSOON	C
WHETSTONE	C
WHICHMAN	B
WHIDBEY	C
WHILPHANG	D
WHIPP	D
WHIPPANY	C
WHISK	D
WHISKEY	B
WHISKEYCREEK	C
WHISKLAKE	C
WHISPERING	C
WHISTLE	B
WHITE STORE	D
WHITE SWAN	D
WHITEARTH	C
WHITEBIRD	D
WHITECAP	D
WHITECLOUD	B
WHITEDEER	B
WHITEFACE	D
WHITEFIELD	D
WHITEFORD	B
WHITEHALL	B
WHITEHORN	D
WHITEHORSE	B
WHITEKNOB	B
WHITEMARSH	C/D
WHITEOAK	B
WHITEPEAK	D
WHITEPINE	D
WHITERIVER	C
WHITEROCK	D
WHITESBORO	C
WHITESBURG	C
WHITESIDE	B
WHITESON	D
WHITETHORN	B
WHITEWATER	D
WHITEWOOD, Nonflooded	B/D
WHITEWOOD	C/D
WHITEWRIGHT	C
WHITEYE	D
WHITING	B
WHITINGER	C
WHITLEY	B
WHITNEY	C
WHITSON	D
WHITTEMORE	C/D
WHITVIN	D
WHITWELL	C
WHORLED	C
WICHITA	C
WICKAHONEY	D
WICKENBURG	D
WICKERSHAM	B
WICKETT	C
WICKIUP	C
WICKSBURG	B
WICKWARE	B
WICUP	C
WIDEN	C
WIDOWSPRING	B
WIERGATE	D
WIFFO	B
WIFTON	B
WIGTON	A
WILAHA	B
WILBANKS	D
WILBUR	B
WILCO	C
WILCOX	D
WILCOXSON	C
WILDALE	C
WILDCAT	D
WILDER	A
WILDGEN	B
WILDHILL	C
WILDHORSE	A
WILDMESA	C
WILDORS	C
WILDROSE	C
WILE	C
WILHOIT	B
WILKESON	B
WILL	B/D
WILLABY	C
WILLAKENZIE	C
WILLAMETTE	C
WILLANCH	D
WILLAPA	C
WILLARD	B
WILLETTE	A/D
WILLHILL	C
WILLHO	D
WILLIAMSBURG	B
WILLIAMSPORT	C
WILLIAMSTOWN	C
WILLIAMSVILLE	C
WILLIMAN	B/D
WILLISTON	C
WILLOSIPPI	C
WILLOW CREEK	B
WILLOWDALE	B
WILLOWFORK	D
WILLSPRINGS	C
WILLYNAT	B
WILMA	C
WILMER	C
WILMONT	B
WILMONTON	B
WILPAR	C
WILPOINT	D
WILSALL	D
WILSHIRE	A
WILSON	D
WILSONGULCH	B
WILSONVILLE	D
WILSOR	B
WILSPRING	C
WILST	C
WILT	B
WILTON	B
WIMPEY	C
WINADA	C
WINBERRY	C
WINBLOW	C
WINCHUCK	C
WIND RIVER	B
WINDCOAT	D
WINDCOMB	D
WINDEGO	B
WINDER	D
WINDERE	B
WINDERNOT	B
WINDICREEK	A
WINDLASS	C
WINDMILL	B
WINDRY	D
WINDTHORST	C
WINDWHISTLE	B
WINDYBUTTE	B
WINDYHOLLOW	C
WINDYPOINT	B
WINEDALE	D
WINEG	B
WINEGAR	C
WINEVADA	C
WINFALL	B
WINFIELD	B
WING	D
WINGATE	B
WINGDALE	D
WINGINA	B
WINGINAW	D
WINGROCK	B
WINGVILLE	D
WINKLEMAN	D
WINKLER	B
WINKLO	C
WINLER	D
WINLO	D
WINN	C
WINNEBAGO	B
WINNEMUCCA	C
WINNETT	C
WINNETT	D
WINNIPEG	B
WINNSBORO	C
WINOM	D
WINOOSKI	B
WINOPEE	B
WINRIDGE	D
WINSAND	B
WINSTON	B
WINT	D
WINTERCANYON	C
WINTERIM	C
WINTERMUTE	C
WINTERS	C
WINTERSBURG	B
WINTERSET	C
WINTLEY	B

WINTON	C
WINTONER	B
WINU	C
WINWELL	C
WISBEY	B
WISBY	B
WISCOW	D
WISCOY	C
WISE	C
WISEMAN	A
WISFLAT	D
WISHARD	C
WISHBONE	B
WISHEYLU	C
WISHKAH	C/D
WISKAN	C
WISKISPRINGS	D
WISNER	B/D
WISTER	C
WISTONA	B
WITCHER	B
WITHAM	D
WITHEE	C
WITHERBEE	A/D
WITHERELL	D
WITHERS	C
WITTEN	D
WITTENBERG	B
WIVILLE	B
WIX	C
WIXOM	B
WIZARD	C
WOCKLEY	C
WOCKUM	B
WODA	D
WODAVAR	D
WODEN	B
WODOMONT	D
WODSKOW	B/C
WOHLY	B
WOLCO	C
WOLDALE	C/D
WOLFCREEK	B
WOLFER	B
WOLFESON	C
WOLFESON, Wet	D
WOLFEY	C
WOLFPEAK	B
WOLFPEN	A
WOLFTEVER	C
WOLFVAR	B
WOLLARD	C
WOLLENT	D
WOLOT	B
WOLVERTON	B
WOMACK	C
WOODBECK	B
WOODBINE	B
WOODBURN	C
WOODBURY	D
WOODCANYON	C
WOODCHOPPER	B
WOODCUTTER	D
WOODCUTTERS, Stony	B
WOODFORD	D
WOODHURST	C
WOODIN	C
WOODINGTON	B/D
WOODINVILLE	C/D
WOODLAWN	B
WOODLEAF	C
WOODLY	B
WOODMANSIE	B
WOODMERE	B
WOODMONT	C
WOODPASS	B
WOODROCK	C
WOODS	D
WOODSFIELD	C
WOODSIDE	B
WOODSLAKE	D
WOODSON	D
WOODSPOINT	B
WOODSTOCK	D
WOODTEX	D
WOODVILLE	D
WOODWARD	B
WOODWEST	D
WOOFUS	C
WOOLLY	B
WOOLPER	C
WOOLSEY	B
WOOLSTALF	B
WOOLSTED	B
WOOLWICH	B
WOONSOCKET	B
WORCESTER	C
WORFSTONE	C
WORKMAN	C
WORLAND	C
WORLEY	D
WORMCREEK	B
WORMET	B
WORMSER	C
WORSHAM	D
WORSWICK	C
WORTHENTON	D
WORTMAN	A
WORWOOD	C
WOVOKA	D
WRANGELL	D
WRAYHA	C
WRAYS	B
WREDAH	B
WREFORD	D
WRENCOE	D
WRENGART	C
WRENMAN	C
WRENTHAM	C
WRIGHTMAN	C
WRIGHTSBORO	C
WRIGHTSVILLE	D
WRIGHTWOOD	B
WUKOKI	B
WUKSI	A
WULFERT	D
WUNABUNA	C/D
WUNJEY	B
WUPATKI	D
WURTSMITH	A
WUTCHUMNA	D
WYALUSING	D
WYANDOTTE	D
WYANT	C
WYARD	B
WYARNO	B
WYATT	C
WYCOLO	C
WYEAST	D
WYECREEK	B
WYETH	B
WYEVILLE	C
WYICK	D
WYKOFF	B
WYLO	D
WYNHOFF, Moist	B
WYNHOFF	C
WYNN	B
WYNNVILLE	C
WYNONA	C
WYNOOSE	D
WYNTOON	B
WYOMINGCREEK	C
WYOTITE	B
WYRICK	B
WYSOCKING	C/D
WYVA	D
XANA	B
XANADU	B
XANKEY	B
XAVIER	B
XERTA	C
XERXES	D
XICA	C
XINE	C
XIPE	D
XMAN	D
XOBOBO	B
YABAMAR	D
YACHATS	B
YAD	D
YAGGY, Protected	B
YAGGY	C
YAHANA	D
YAHARA	C
YAHMORE	B
YAHNE	C
YAHOO	D
YAINAX	B
YAKOBI	D
YAKUS	D
YAKUTAT	A
YALELAKE	B
YALESVILLE	C
YALLANI	B
YAMHILL	C
YAMSAY	D
YANA	B
YANCY	D
YANKEE	D
YANKEEFORK	B
YANKTON	B
YAP	B
YAPOAH	A
YAQUI	B
YAQUICAN	D
YAQUINA	C/D
YATA	C
YATAHONEY	C
YATAHONEY, Stony	D
YATAMA	B
YATES	D
YAUCO	C
YAUHANNAH	B
YAUPON	D
YAWHEE	B
YAWKEY	B
YAWKOLA	C
YAXING	B
YEAGER	A
YEARIAN	D
YEARY	C
YEATON	C
YECROSS	A
YEDLICK	B
YEGUAS	C
YELLOW HORSE	D
YELLOWBANK	D
YELLOWBAY	B
YELLOWDOG	A
YELLOWHILLS	B
YELLOWLARK	C
YELLOWMULE	C
YELLOWRIVER	B
YELLOWROCK	B
YELLOWSTONE	D
YELLOWWASH	D
YELM	C
YELTON	C
YENNICK	B
YENSUS	B
YEOPIM	B
YERBA	D
YERINGTON	A
YESUM	B
YIGO	B
YIKES	A
YLIG	C
YNOT	B
YOAKRAN	A
YOCHUM	C
YODAL	B
YODER	B
YODY	C
YOGAVILLE	D
YOHN	B
YOKAYO	D
YOKUT	B
YOLLABOLLY	D
YOLOGO	D
YOMONT	B
YONCALLA	C
YONNA	D
YORBA	D
YOREL	B
YORK	C
YORKSHIRE	C
YORKTOWN	D
YORKTREE	C
YOSEMITE	B
YOST	C/D
YOTES	B
YOUGA, Sandy Substratum	D
YOUJAY	D
YOUMAN	C
YOUNGSTON, Wet	C
YOURAME	B
YOUTLKUE	B
YOVIMPA	D
YPSI	C
YRIBARREN	D
YTURBIDE	A
YTURRIA	A
YUCCA	B
YUKON	D
YUNES	D
YURM	D
YUTAN	B
YUTRUE	D
YUZARRA	B
ZAAR	D
ZABA	B
ZABOROSKY	B
ZACA	D
ZACHARY	C
ZADE	C
ZADOG	A/D
ZADVAR	D
ZAFOD	B
ZAGG	C
ZAIDY	C
ZAKME	D
ZALCO	A
ZALEA	B
ZALESKA	D
ZALLA	A
ZALVIDEA	B
ZAMORA	B
ZANBUR	B
ZANE	B
ZANGO	D
ZAPA	C
ZAPATA	C
ZAQUA	D
ZARK	C
ZASTER	C
ZAU	C
ZAVALA	B
ZAVCO	C
ZAYANTE	A
ZBART	D
ZEALE	B
ZEB	B
ZEE	B
ZEEBAR	B
ZEEGEE	D
ZEEKA	C
ZEELAND	C
ZEELNOT	B
ZEEMAL	D
ZEGRO	C
ZEIBRIGHT	B
ZEKIAH	D
ZELA	D
ZELDA	D
ZENDA	C
ZENIFF	B
ZENITH	B
ZENOBIA	B
ZENORIA	C
ZEOMONT	A
ZEPH	D
ZEPHYR	D
ZEPOL	B
ZERKEL	B
ZERKER	B
ZEUGIRDOR	B
ZIBATE	D
ZIBETOD	D
ZIEGENFUSS	D

Exhibit A: Hydrologic Soil Groups for the United States

ZIEGLER	C
ZIGGY	B
ZILABOY	D
ZILLAH	C/D
ZILWAUKEE	D
ZIMMER	D
ZIMWALA	C
ZING	C
ZIPPEL	B/D
ZIRAM	D
ZITA	B
ZITTAU	C
ZITZIANA	B
ZOAR	C
ZOATE	D
ZODA	C
ZOE	D
ZOLFO	C
ZOMAX	B
ZONO	A
ZORRA	D
ZOZOBRA	B
ZUBER	C
ZUFELT	C
ZULCH	D
ZUMAN. Protected	C/D
ZUMAN	D
ZUMBRO	A
ZUMMO	D
ZUNALEI	B
ZUNDELL	C
ZUNHALL	C
ZUNI, Gravelly	C
ZUNI	D
ZUNIVEN	B
ZUNKER	B
ZWAGG	B
ZWICKER	C
ZWIEFEL	C
ZWINGLE	D
ZYMER	B
ZYNBAR	B
ZYNBAR Till Substratum	C
ZYPLAR	D
ZYZYL	B
ZYZZI	D
ZYZZUG	D

Appendix B Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

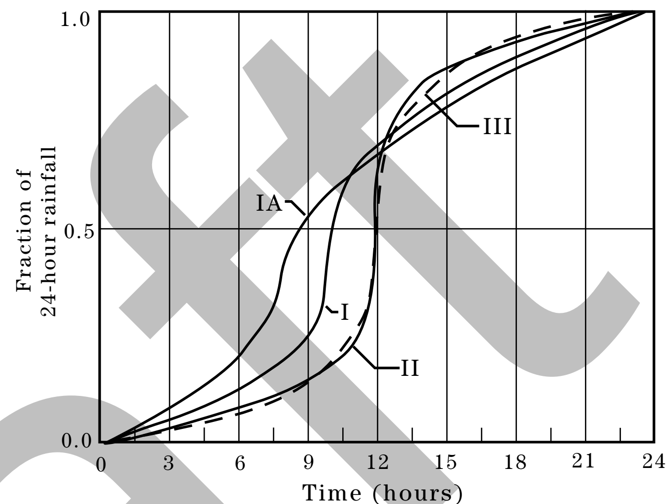
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c. For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c.

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having “nested” rainfall intensities was developed. The set “maximizes” the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

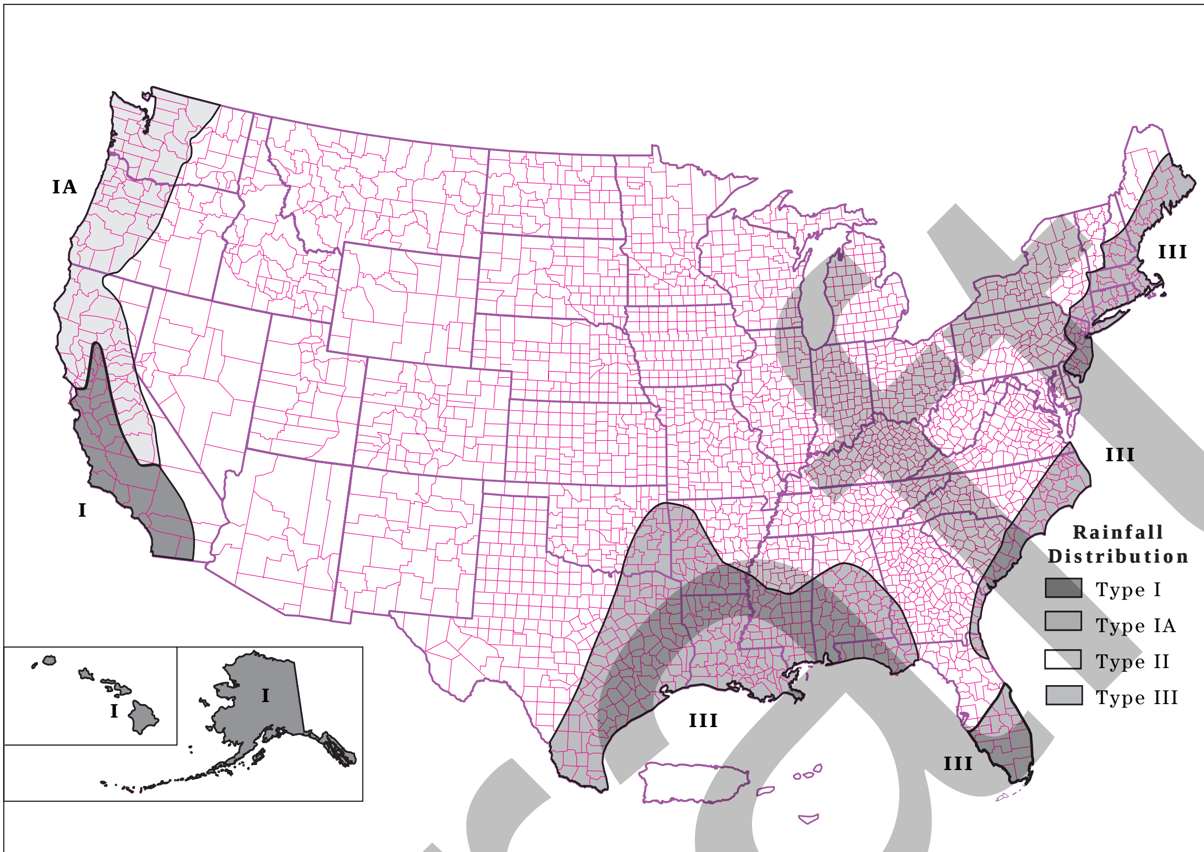
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061; Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Figure B-3 2-year, 24-hr rainfall

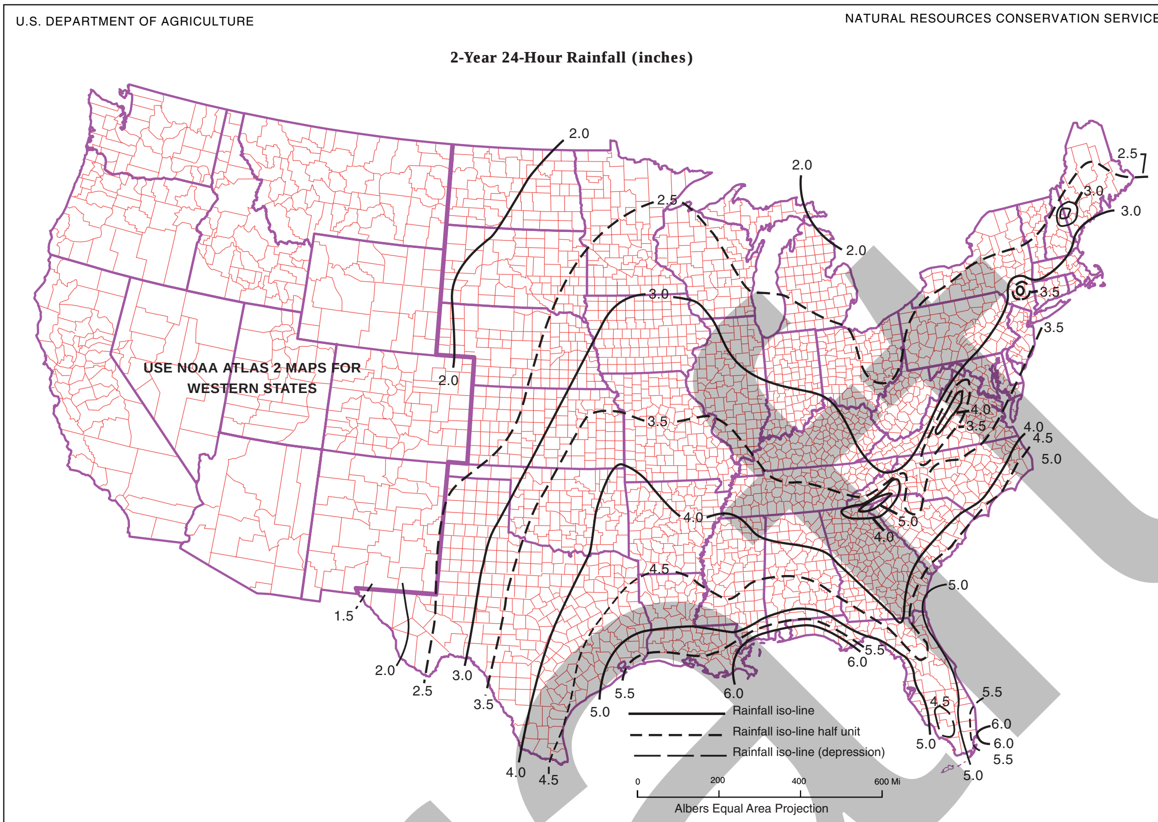


Figure B-4 5-year, 24-hour rainfall

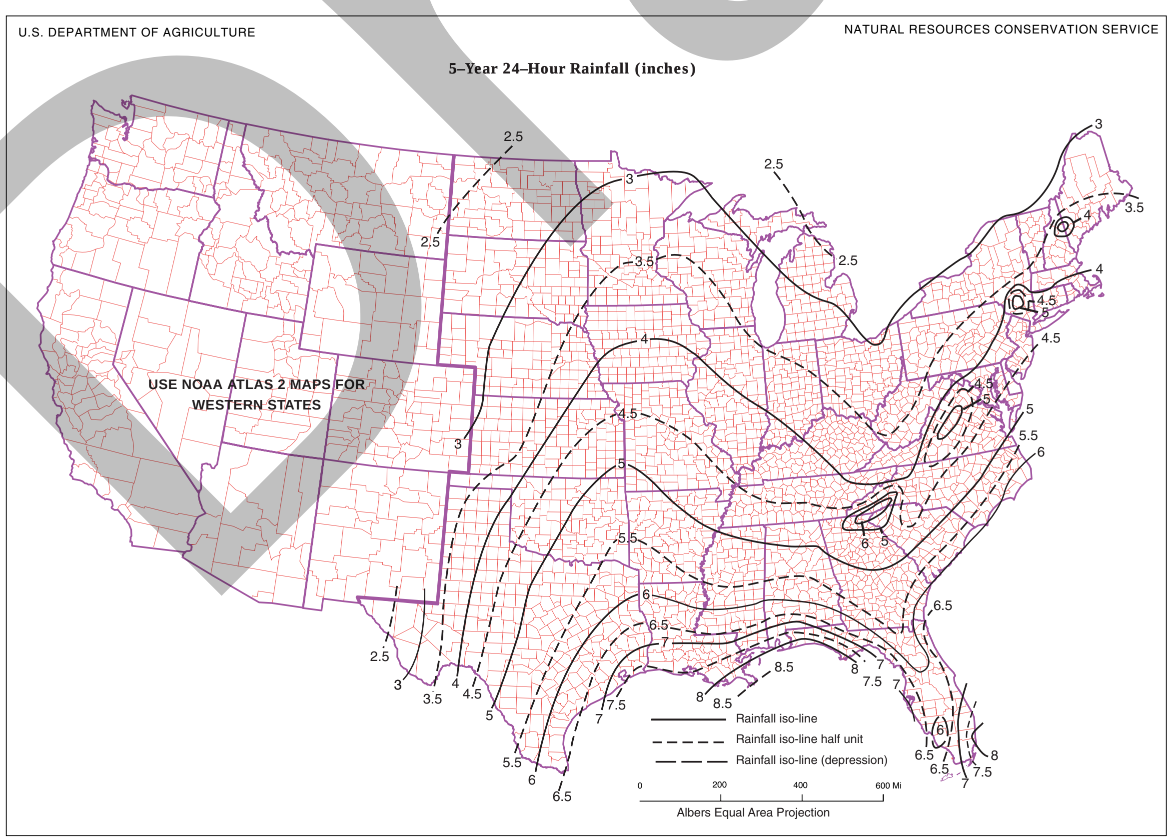


Figure B-5 10-year, 24-hour rainfall

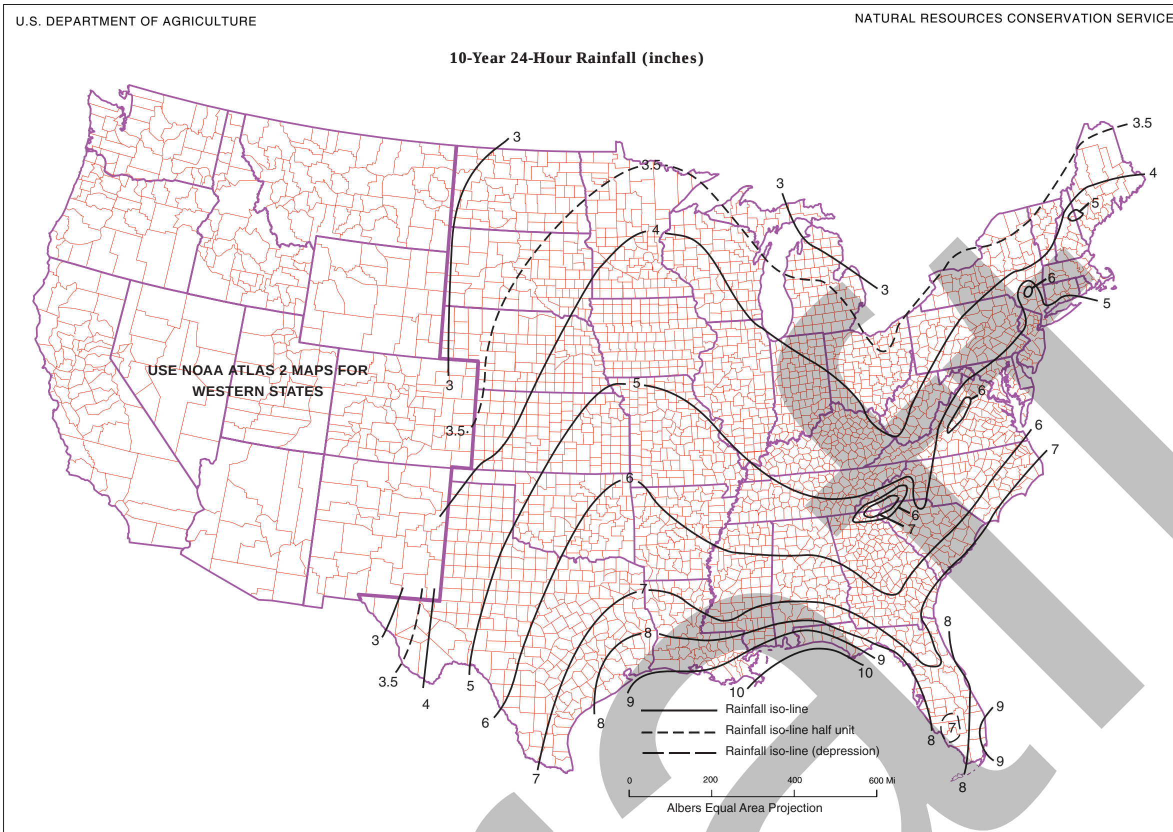


Figure B-6 25-year, 24-hour rainfall

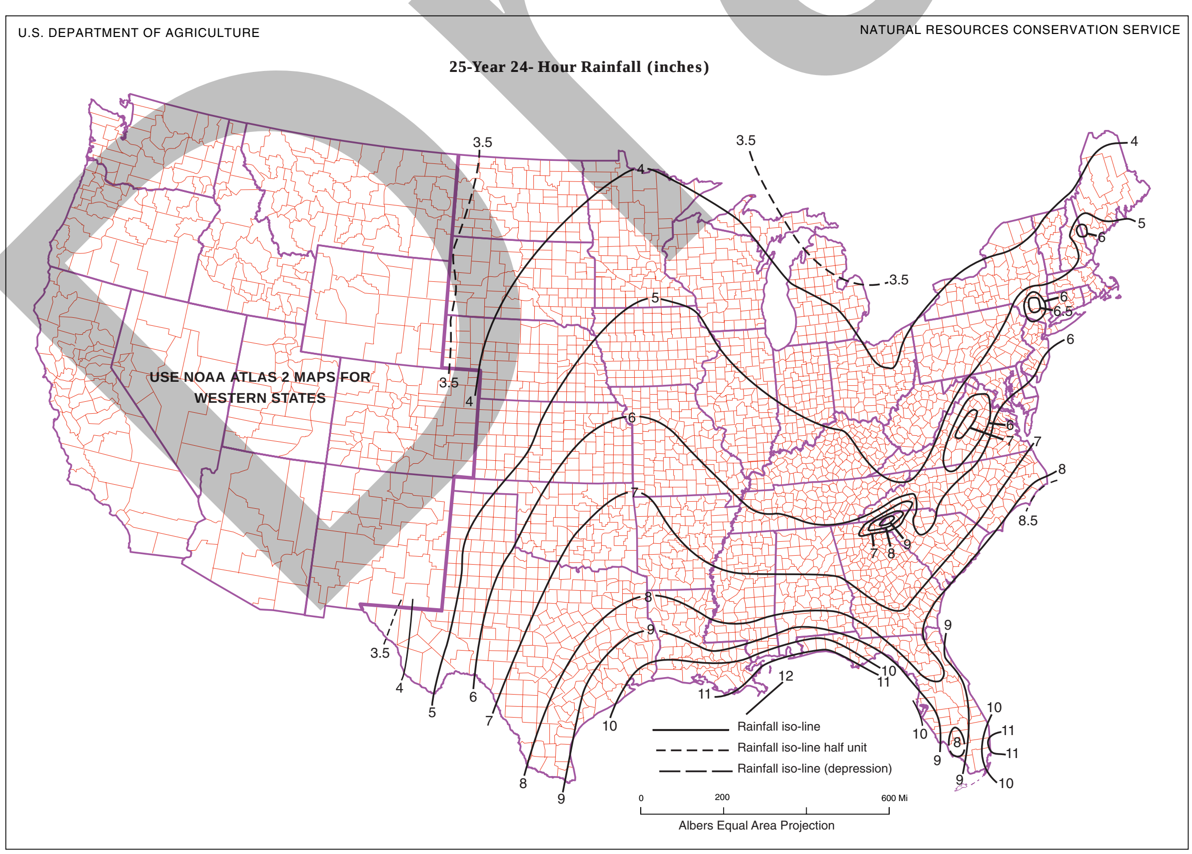


Figure B-7 50-year, 24-hour rainfall

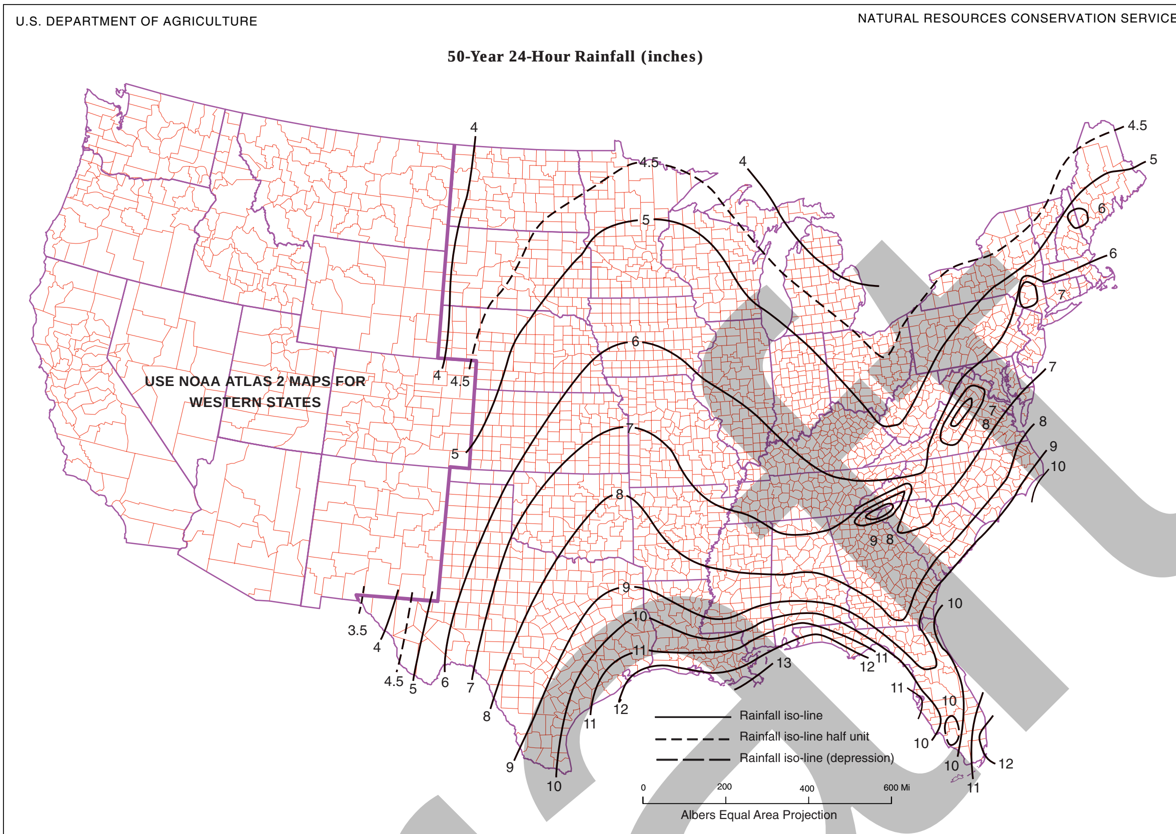
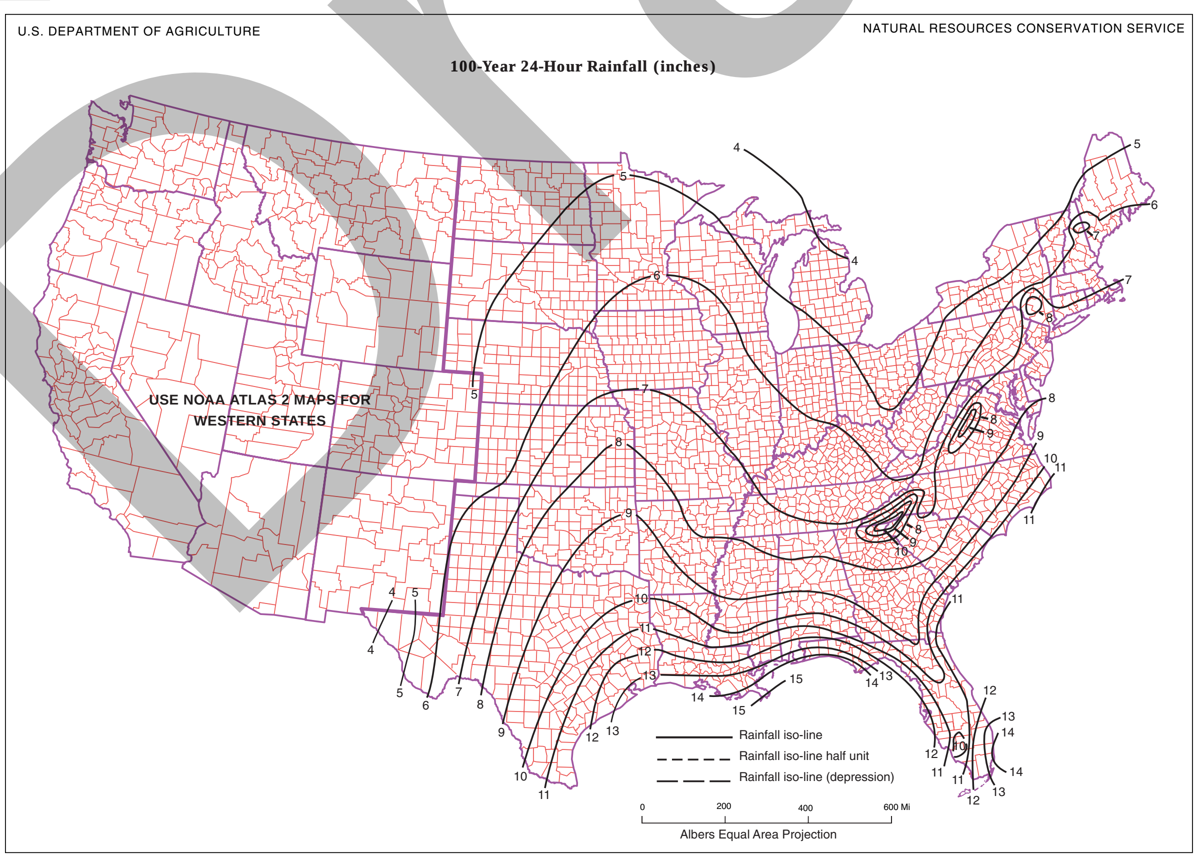


Figure B-8 100-year, 24-hour rainfall



Appendix C Computer Program

The TR-55 procedures have been incorporated in a computer program. The program, written in BASIC, requires less than 256K memory to operate and was developed for MS-DOS operating system. Users of the program, however, still need to be familiar with the procedures in this TR. Features of the program include the following:

- The full screen (24 lines, 80 columns) is used to enter data. Flexibility of coding allows movement about the screen for quick data modifications.

- Function keys provide menu power to different modules (TR-55 chapters) within the program. Some keys are permanently defined while others vary by module.

- Help screens provide pertinent information to the program. Two types of information are included: (1) define system operation and (2) describe input parameters.

- User files provide for optional entry of local data, such as rainfall-frequency. graphic peak discharge equation coefficients, and tabular hydrographs for other rainfall distributions.

Copies of the program can be obtained from—

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Telephone (703) 487-4650

Appendix D Worksheets

This appendix contains seven worksheets that can be reproduced for use with chapters 2 through 6. There is no worksheet for chapter 1.

Chapter	Worksheet
2	2
3	3
4	4
5	5a, 5b
6	6a, 6b

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☐ acres ☐ mi^2 ☐ %	Product of CN x area
				Totals ➡		

[1] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ________________ = ________ ; **Use CN ➡** ☐

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q .... (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in			

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

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

Sheet flow (Applicable to Tc only)

	Segment ID	
1. Surface description (table 3-1)		
2. Manning's roughness coefficient, n (table 3-1)		
3. Flow length, L (total L † 300 ft) .... ft		
4. Two-year 24-hour rainfall, P_2 .... in		
5. Land slope, s .... ft/ft		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{0.4}}$ Compute T_t .... hr	+	=

Shallow concentrated flow

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

Channel flow

	Segment ID	
12. Cross sectional flow area, a .... ft^2		
13. Wetted perimeter, p_w .... ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r .... ft		
15 Channel slope, s .... ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ....ft/s		
18. Flow length, L .... ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t .... hr	+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... Hr

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area .... A_m = ______________ mi^2 (acres/640)

Runoff curve number ....CN = ______________ (From worksheet 2)

Time of concentration .... T_c = ______________ hr (From worksheet 3)

Rainfall distribution .... = _______________ (I, IA, II III)

Pond and swamp areas sprea
throughout watershed .... = ____________ percent of A_m (________ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr			
3. Rainfall, P (24-hour)	in			
4. Initial abstraction, I_a (Use CN with table 4-1)	in			
5. Compute I_a / P				
6. Unit peak discharge, q_u (Use T_c and I_a / P with exhibit 4– _____)	csm/in			
7. Runoff, Q (From worksheet 2) Figure 2-6	in			
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)				
9. Peak discharge, q_p	ft^3/s			

(Where $q_p = q_u A_m Q F_p$)

Worksheet 5a: Basic watershed data

Project	Location	By	Date
Check one: ☐ Present ☐ Developed	Frequency (yr)	Checked	Date

Subarea name	Drainage area A_m (mi^2)	Time of concen-tration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr rain-fall P (in)	Runoff curve number CN	Runoff Q (in)	$A_m Q$ $(mi^2\text{—}in)$	Initial abstraction I_a (in)	I_a/P
		From worksheet 3	From worksheet 3				From worksheet 2	From worksheet 2		From table 5-1	

Worksheet 5b: Basic watershed data

Project	Location	By	Date
Check one: ☐ Present ☐ Developed	Frequency (yr)	Checked	Date

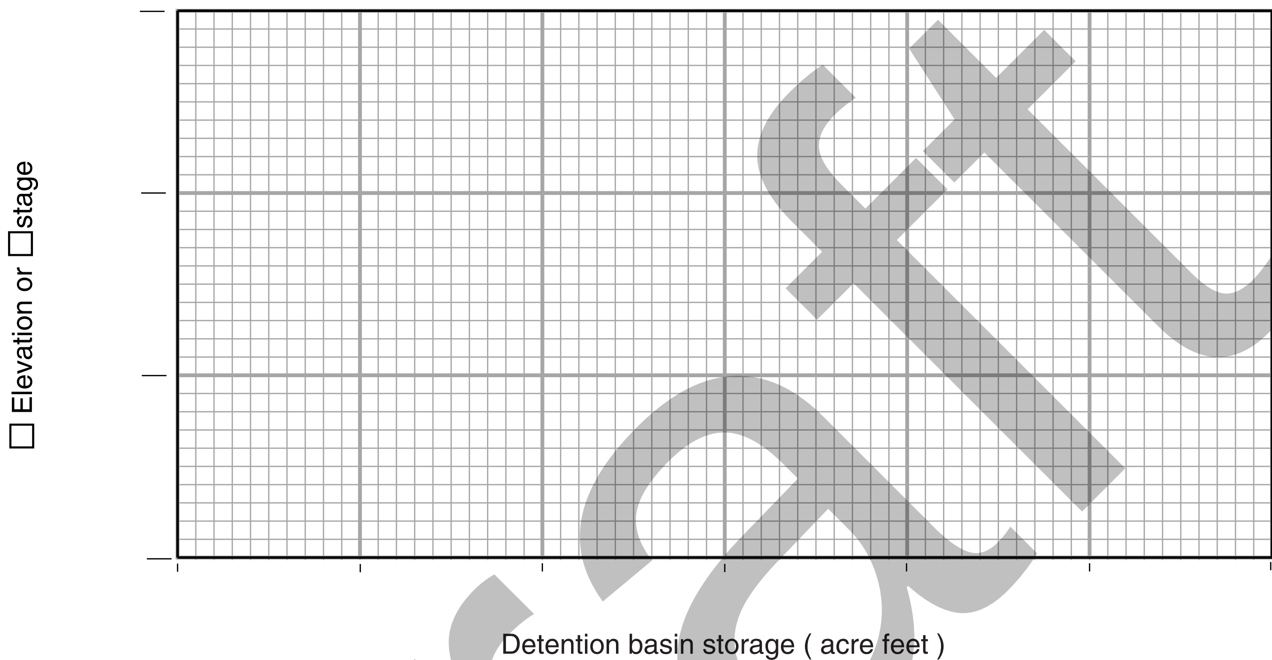
Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a / P	A_mQ (mi^2—in)												
					Discharges at selected hydrograph times 3/ (cfs)											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area .... A_m = __________ mi^2
   Rainfall distribution type (I, IA, II, III) = __________

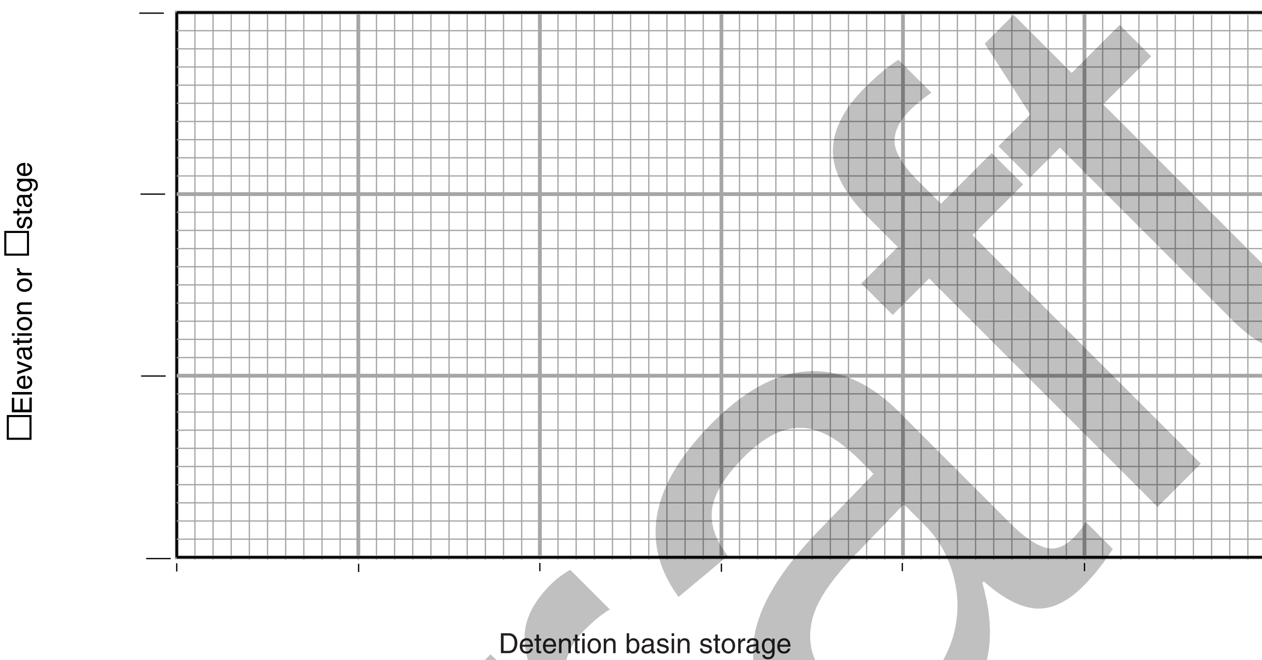
	1st Stage	2nd Stage
2. Frequency .... yr		
3. Peak inflow discharge q_i .... ft^3/s (from worksheet 4 or 5b)		
4. Peak outflow discharge q_u .... ft^3/s 1/		
5. Compute $\frac{q_o}{q_i}$		
6. $\frac{V_s}{V_r}$ .... (Use $\frac{q_o}{q_i}$ with figure 6-1)		
7. Runoff, Q .... in (From worksheet 2)		
8. Runoff volume V_r.................. ac ft ($V_r = QA_m$ 53.33)		
9. Storage volume, V_s .... ac-ft ($V_s = V_r (\frac{V_s}{V_r})$)		
10. Maximum storage E_{max} (from plot)		

1/ 2nd stage q_o includes 1st stage q_o.

Worksheet 6b: Detention basin storage, storage volume (V_s) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area .... A_m = ________ mi^2
   Rainfall distribution type (I, IA, II, III) = ________

	1st Stage	2nd Stage
2. Frequency .... yr		
3. Storage volume V_s .... ac-ft		
4. Runoff, Q .... in (from worksheet 2)		
5. Runoff volume ..... ac-ft ($V_r = QA_m$ 53.33)		
6. Compute $\frac{V_s}{V_r}$		
7. $\frac{q_o}{q_i}$ .... in (Use $\frac{V_s}{V_r}$ with figure 6-1)		
8. Peak inflow discharge q_i .... in (From worksheet 4 or 5b)		
9. Peak outflow discharge[1/] q_o .... ft^3/s ($q_o = q_i \left(\frac{q_o}{q_i} \right)$)		
10. Maximum storage E_{max} (from plot)		

1/ 2nd stage q_o includes 1st stage q_o.

Appendix E References

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Linsley, R.K., M.A. Kohier, and J.L.H. Paulhus. 1982. Hydrology for engineers. Third Edition. McGraw-Hill Book Company, Inc. New York, NY. p. 484.

Musgrave, G.W. 1955. How much of the rain enters the soil? *In* Water. The Yearbook of Agriculture 1955. U.S. Dep. Agric. U.S. Gov. Print. Off. Washington, DC. p. 151-159.

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Rawls, W.J., A. Shalaby, and R.H. McCuen. 1981. Evaluation of methods for determining urban runoff curve numbers. Transactions of the American Society of Agricultural Engineers 24 (6):1562-1566.

Soil Conservation Service. 1982 [Draft]. Structure site analysis computer program DAMS2 (interim version). SCS Technical Release 48. Washington, DC.

_.1983 [Draft]. Computer program for project formulation-hydrology. SCS Technical Release 20. Washington, DC.

_.1985. National engineering handbook. Section 4-Hydrology. Washington, DC.

Appendix F Equations for figures and exhibits

This appendix presents the equations used in procedure applications to generate figures and exhibits in TR-55.

Figure 2-1 (runoff equation):

$$Q = \frac{\left[P - .2\left(\frac{1000}{CN} - 10\right)\right]^2}{P + 0.8\left(\frac{1000}{CN} - 10\right)}$$

where
- Q = runoff (in)
- P = rainfall (in)
- CN = runoff curve number

Figure 2-3 (composite CN with connected impervious area):

$$CN_c = CN_p + \left(\frac{P_{imp}}{100}\right)\left(98 - CN_p\right)$$

where
- CN_c = composite runoff curve number
- CN_p = pervious runoff curve number
- P_{imp} = percent imperviousness.

Figure 2-4 (composite CN with unconnected impervious areas and total impervious area less than 30%):

$$CN_c = CN_p + \left(\frac{P_{imp}}{100}\right)\left(98 - CN_p\right)\left(1 - 0.5R\right)$$

where
- R = ratio of unconnected impervious area to total impervious area.

Figure 3-1 (average velocities for estimating travel time for shallow concentrated flow):

Unpaved $V = 16.1345\,(s)^{0.5}$
Paved $V = 20.3282\,(s)^{0.5}$

where

- V= average velocity (ft/s)
- s = slope of hydraulic grade line (watercourse slope, ft/ft)

These two equations are based on the solution of Manning's equation (eq. 3-4) with different assumptions for n (Manning's roughness coefficient) and r (hydraulic radius, ft). For unpaved areas, n is 0.05 and r is 0.4; for paved areas, n is 0.025 and r is 0.2.

Exhibit 4 (unit peak discharges for SCS tvpe I, IA, II, and III distributions):

$$\log\left(q_u\right) = C_o + C_1 \log\left(T_c\right) + C_2\left[\log\left(T_c\right)\right]^2$$

where
- q_u = unit peak discharge (csm/in)
- T_c = time of concentration (hr) (minimum, 0.1; maximum, 10.0)
- C_0, C_1, C_2 = coefficients from table F-1

Figure 6-1 (approximate detention basin routing through single- and multiple-stage structures for 24-hour rainfalls of the indicated type):

$$\frac{V_S}{V_r} = C_o + C_1\left(\frac{q_o}{q_1}\right) + C_2\left(\frac{q_o}{q_1}\right)^2 + C_3\left(\frac{q_o}{q_1}\right)^3$$

where
- V_s/V_r = ratio of storage volume (V_s) to runoff volume (V_r)
- q_o/q_i = ratio of peak outflow discharge (q_o) to peak inflow discharge (q_i)
- C_0, C_1, C_2, C_3 = coefficients from table F-2

Table F-1 Coefficients for the equation used to generate exhibits 4-I through 4-Ill

Rainfall type	I_a/P	C_0	C_1	C_2
I	0.10	2.30550	-0.51429	-0.11750
	0.20	2.23537	-0.50387	-0.08929
	0.25	2.18219	-0.48488	-0.06589
	0.30	2.10624	-0.45695	-0.02835
	0.35	2.00303	-0.40769	0.01983
	0.40	1.87733	-0.32274	0.05754
	0.45	1.76312	-0.15644	0.00453
	0.50	1.67889	-0.06930	0.0
IA	0.10	2.03250	-0.31583	-0.13748
	0.20	1.91978	-0.28215	-0.07020
	0.25	1.83842	-0.25543	-0.02597
	0.30	1.72657	-0.19826	0.02633
	0.50	1.63417	-0.09100	0.0
II	0.10	2.55323	-0.61512	-0.16403
	0.30	2.46532	-0.62257	-0.11657
	0.35	2.41896	-0.61594	-0.08820
	0.40	2.36409	-0.59857	-0.05621
	0.45	2.29238	-0.57005	-0.02281
	0.50	2.20282	-0.51599	-0.01259
III	0.10	2.47317	-0.51848	-0.17083
	0.30	2.39628	-0.51202	-0.13245
	0.35	2.35477	-0.49735	- 0.11985
	0.40	2.30726	-0.46541	-0.11094
	0.45	2.24876	-0.41314	-0.11508
	0.50	2.17772	- 0.36803	- 0.09525

Table F-2 Coefficients for the equation used to generate figure 6-1

Rainfall distribution (appendix B)	C_0	C_1	C_2	C_3
I, IA	0.660	-1.76	1.96	-0.730
II, III	0.682	-1.43	1.64	-0.804

Appendix F

BMP Sizing Spreadsheets

BMP Sizing Spreadsheet V3.0			
Project Name:	Valley Center Storage Project	Hydrologic Unit:	San Luis Rey
Project Applicant:	Valley Center ESS, LLC	Rain Gauge:	Lake Wohlford
Jurisdiction:	San Diego County	Total Project Area:	229,126
Parcel (APN):	189-013-20-00	Low Flow Threshold:	0.1Q2
BMP Name:	Infiltration Basin	BMP Type:	Infiltration Facilities
BMP Native Soil Type:	A	BMP Infiltration Rate (in/hr):	0.5

Areas Draining to BMP						HMP Sizing Factors	Minimum BMP Size
DMA Name	Area (sf)	Pre Project Soil Type	Pre-Project Slope	Post Project Surface Type	Area Weighted Runoff Factor (Table G.2-1)[1]	Surface Area	Surface Area (SF)
DA-1	57,935	A	Flat	Roofs	1.0	0.085	4924
DA-1	108,030	A	Flat	Crushed Aggregate	0.1	0.085	918
DA-1	63,162	A	Flat	Concrete	1.0	0.085	5369
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
BMP Tributary Area	229,127					Minimum BMP Size	11211
						Proposed BMP Size*	13503
					Surface Ponding Depth	36.00	in

* Assumes standard configuration

Notes:

1. Runoff factors which are used for hydromodification management flow control (Table G.2-1) are different from the runoff factors used for pollutant control BMP sizing (Table B.1-1). Table references are taken from the San Diego Region Model BMP Design Manual,

Describe the BMP's in sufficient detail in your PDP SWQMP to demonstrate the area, volume, and other criteria can be met within the constraints of the site.

BMP's must be adapted and applied to the conditions specific to the development project such as unstable slopes or the lack of available head.
Designated Staff have final review and approval authority over the project design.

This BMP Sizing Spreadsheet has been updated in conformance with the San Diego Region Model BMP Design Manual, April 2018. For questions or concerns please contact the jurisdiction in which your project is located.

BMP Sizing Spreadsheet V3.0			
Project Name:	Valley Center Storage Project	Hydrologic Unit:	San Luis Rey
Project Applicant:	Valley Center ESS, LLC	Rain Gauge:	Lake Wohlford
Jurisdiction:	San Diego County	Total Project Area:	229,126
Parcel (APN):	189-013-20-00	Low Flow Threshold:	0.1Q2
BMP Name	Infiltration Basin	BMP Type:	Infiltration Facilities

DMA Name	Rain Gauge	Pre-developed Condition		Unit Runoff Ratio	DMA Area (ac)	Orifice Flow - $\%Q_2$	Orifice Area
		Soil Type	Slope	(cfs/ac)		(cfs)	(in^2)
DA-1	Lake Wohlford	A	Flat	0.256	1.330	N/A	**N/A**
DA-1	Lake Wohlford	A	Flat	0.256	2.480	N/A	**N/A**
DA-1	Lake Wohlford	A	Flat	0.256	1.450	N/A	**N/A**

No Orifice Required for Infiltration Facilities

N/A	**N/A**	**N/A**	**N/A**
Max Orifice Head (feet)	**Max Tot. Allowable Orifice Flow (cfs)**	**Max Tot. Allowable Orifice Area (in^2)**	**Max Orifice Diameter (in)**

N/A	**N/A**	**0.64**	**0.900**
Average outflow during surface drawdown (cfs)	Max Orifice Outflow (cfs)	Actual Orifice Area (in^2)	Selected Orifice Diameter (in)

Drawdown (Hrs)	72.0

Automated Worksheet B.1: Calculation of Design Capture Volume (V2.0)

Category	#	Description	*i*	*ii*	*iii*	*iv*	*v*	*vi*	*vii*	*viii*	*ix*	*x*	Units
Standard Drainage Basin Inputs	1	Drainage Basin ID or Name	1										unitless
	2	85th Percentile 24-hr Storm Depth	0.77										inches
	3	Impervious Surfaces Not Directed to Dispersion Area (C=0.90)	229,126										sq-ft
	4	Semi-Pervious Surfaces Not Serving as Dispersion Area (C=0.30)											sq-ft
	5	Engineered Pervious Surfaces Not Serving as Dispersion Area (C=0.10)											sq-ft
	6	Natural Type A Soil Not Serving as Dispersion Area (C=0.10)	111,514										sq-ft
	7	Natural Type B Soil Not Serving as Dispersion Area (C=0.14)											sq-ft
	8	Natural Type C Soil Not Serving as Dispersion Area (C=0.23)	41,382										sq-ft
	9	Natural Type D Soil Not Serving as Dispersion Area (C=0.30)											sq-ft
Dispersion Area, Tree Well & Rain Barrel Inputs (Optional)	10	Does Tributary Incorporate Dispersion, Tree Wells, and/or Rain Barrels?	No	No	No	No	No	No	No	No	No	No	yes/no
	11	Impervious Surfaces **Directed to Dispersion Area** per SD-B (Ci=0.90)											sq-ft
	12	Semi-Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.30)											sq-ft
	13	Engineered Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.10)											sq-ft
	14	Natural Type A Soil **Serving as Dispersion Area** per SD-B (Ci=0.10)											sq-ft
	15	Natural Type B Soil **Serving as Dispersion Area** per SD-B (Ci=0.14)											sq-ft
	16	Natural Type C Soil **Serving as Dispersion Area** per SD-B (Ci=0.23)											sq-ft
	17	Natural Type D Soil **Serving as Dispersion Area** per SD-B (Ci=0.30)											sq-ft
	18	Number of Tree Wells Proposed per SD-A											#
	19	Average Mature Tree Canopy Diameter											ft
	20	Number of Rain Barrels Proposed per SD-E											#
	21	Average Rain Barrel Size											gal
Initial Runoff Factor Calculation	22	Total Tributary Area	382,022	0	0	0	0	0	0	0	0	0	sq-ft
	23	Initial Runoff Factor for Standard Drainage Areas	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	24	Initial Runoff Factor for Dispersed & Dispersion Areas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	25	Initial Weighted Runoff Factor	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	26	Initial Design Capture Volume	14,463	0	0	0	0	0	0	0	0	0	cubic-feet
Dispersion Area Adjustments	27	Total Impervious Area Dispersed to Pervious Surface	0	0	0	0	0	0	0	0	0	0	sq-ft
	28	Total Pervious Dispersion Area	0	0	0	0	0	0	0	0	0	0	sq-ft
	29	Ratio of Dispersed Impervious Area to Pervious Dispersion Area	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ratio
	30	Adjustment Factor for Dispersed & Dispersion Areas	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	ratio
	31	Runoff Factor After Dispersion Techniques	0.59	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	unitless
	32	Design Capture Volume After Dispersion Techniques	14,463	0	0	0	0	0	0	0	0	0	cubic-feet
Tree & Barrel Adjustments	33	Total Tree Well Volume Reduction	0	0	0	0	0	0	0	0	0	0	cubic-feet
	34	Total Rain Barrel Volume Reduction	0	0	0	0	0	0	0	0	0	0	cubic-feet
Results	35	Final Adjusted Runoff Factor	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	36	Final Effective Tributary Area	225,393	0	0	0	0	0	0	0	0	0	sq-ft
	37	Initial Design Capture Volume Retained by Site Design Elements	0	0	0	0	0	0	0	0	0	0	cubic-feet
	38	Final Design Capture Volume Tributary to BMP	14,463	0	0	0	0	0	0	0	0	0	cubic-feet

No Warning Messages

Automated Worksheet B.2: Retention Requirements (V2.0)

Category	#	Description	i	ii	iii	iv	v	vi	vii	viii	ix	x	Units
Basic Analysis	1	Drainage Basin ID or Name	1	-	-	-	-	-	-	-	-	-	unitless
	2	85th Percentile Rainfall Depth	0.77	-	-	-	-	-	-	-	-	-	inches
	3	Predominant NRCS Soil Type Within BMP Location	A										unitless
	4	Is proposed BMP location Restricted or Unrestricted for Infiltration Activities?	Unrestricted										unitless
	5	Nature of Restriction	n/a										unitless
	6	Do Minimum Retention Requirements Apply to this Project?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	yes/no
	7	Are Habitable Structures Greater than 9 Stories Proposed?	No										yes/no
Advanced Analysis	8	Has Geotechnical Engineer Performed an Infiltration Analysis?	No										yes/no
	9	Design Infiltration Rate Recommended by Geotechnical Engineer											in/hr
Result	10	Design Infiltration Rate Used To Determine Retention Requirements	0.300	-	-	-	-	-	-	-	-	-	in/hr
	11	Percent of Average Annual Runoff that Must be Retained within DMA	36.0%	-	-	-	-	-	-	-	-	-	percentage
	12	Fraction of DCV Requiring Retention	0.28	-	-	-	-	-	-	-	-	-	ratio
	13	Required Retention Volume	4050	-	-	-	-	-	-	-	-	-	cubic-feet

No Warning Messages

Automated Worksheet B.3: BMP Performance (V2.0)

Category	#	Description	i	ii	iii	iv	v	vi	vii	viii	ix	x	Units
BMP Inputs	1	Drainage Basin ID or Name	1	-	-	-	-	-	-	-	-	-	sq-ft
	2	Design Infiltration Rate Recommended	0.300	-	-	-	-	-	-	-	-	-	in/hr
	3	Design Capture Volume Tributary to BMP	14,463	-	-	-	-	-	-	-	-	-	cubic-feet
	4	Is BMP Vegetated or Unvegetated?	Unvegetated										unitless
	5	Is BMP Impermeably Lined or Unlined?	Unlined										unitless
	6	Does BMP Have an Underdrain?	No Underdrain										unitless
	7	Does BMP Utilize Standard or Specialized Media?	Standard										unitless
	8	Provided Surface Area	13,504										sq-ft
	9	Provided Surface Ponding Depth	24										inches
	10	Provided Soil Media Thickness	0										inches
	11	Provided Gravel Thickness (Total Thickness)	0										inches
	12	Underdrain Offset											inches
	13	Diameter of Underdrain or Hydromod Orifice (Select Smallest)											inches
	14	Specialized Soil Media Filtration Rate											in/hr
	15	Specialized Soil Media Pore Space for Retention											unitless
	16	Specialized Soil Media Pore Space for Biofiltration											unitless
	17	Specialized Gravel Media Pore Space											unitless
Retention Calculations	18	Volume Infiltrated Over 6 Hour Storm	2,026	0	0	0	0	0	0	0	0	0	cubic-feet
	19	Ponding Pore Space Available for Retention	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	unitless
	20	Soil Media Pore Space Available for Retention	0.40	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	unitless
	21	Gravel Pore Space Available for Retention (Above Underdrain)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	unitless
	22	Gravel Pore Space Available for Retention (Below Underdrain)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	unitless
	23	Effective Retention Depth	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	24	Fraction of DCV Retained (Independent of Drawdown Time)	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	25	Calculated Retention Storage Drawdown Time	80	0	0	0	0	0	0	0	0	0	hours
	26	Efficacy of Retention Processes	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	27	Volume Retained by BMP (Considering Drawdown Time)	14,463	0	0	0	0	0	0	0	0	0	cubic-feet
	28	Design Capture Volume Remaining for Biofiltration	0	0	0	0	0	0	0	0	0	0	cubic-feet
Biofiltration Calculations	29	Max Hydromod Flow Rate through Underdrain	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	cfs
	30	Max Soil Filtration Rate Allowed by Underdrain Orifice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	in/hr
	31	Soil Media Filtration Rate per Specifications	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	in/hr
	32	Soil Media Filtration Rate to be used for Sizing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	in/hr
	33	Depth Biofiltered Over 6 Hour Storm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	34	Ponding Pore Space Available for Biofiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	35	Soil Media Pore Space Available for Biofiltration	0.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	unitless
	36	Gravel Pore Space Available for Biofiltration (Above Underdrain)	0.00	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	unitless
	37	Effective Depth of Biofiltration Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	38	Drawdown Time for Surface Ponding	80	0	0	0	0	0	0	0	0	0	hours
	39	Drawdown Time for Effective Biofiltration Depth	0	0	0	0	0	0	0	0	0	0	hours
	40	Total Depth Biofiltered	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	41	Option 1 - Biofilter 1.50 DCV: Target Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	42	Option 1 - Provided Biofiltration Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	43	Option 2 - Store 0.75 DCV: Target Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	44	Option 2 - Provided Storage Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	45	Portion of Biofiltration Performance Standard Satisfied	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
Result	46	Do Site Design Elements and BMPs Satisfy Annual Retention Requirements?	Yes	-	-	-	-	-	-	-	-	-	yes/no
	47	Overall Portion of Performance Standard Satisfied (BMP Efficacy Factor)	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	48	**Deficit of Effectively Treated Stormwater**	**0**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	cubic-feet

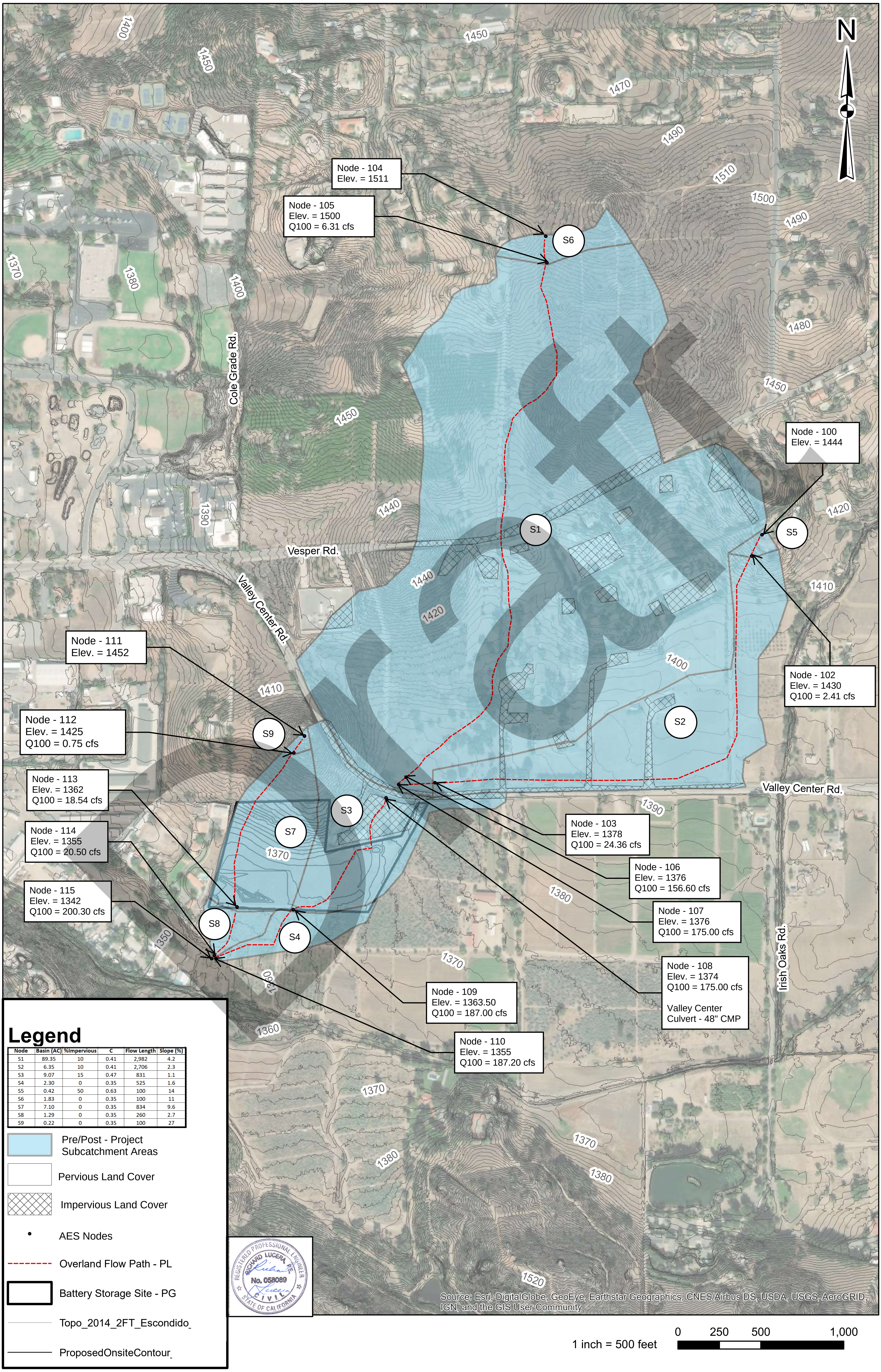
Attention!

-Vegetated BMPs with surface ponding drawdown times over 24 hours must be certified by a landscape architect or agronomist. All BMPs must have a surface ponding drawdown time of 96 hours or less.

Appendix G

Flood Study By Others

Hydrology Work Map



Node	Basin (AC)	%Impervious	C	Flow Length	Slope (%)
S1	89.35	10	0.41	2,982	4.2
S2	6.35	10	0.41	2,706	2.3
S3	9.07	15	0.47	831	1.1
S4	2.30	0	0.35	525	1.6
S5	0.42	50	0.63	100	14
S6	1.83	0	0.35	100	11
S7	7.10	0	0.35	834	9.6
S8	1.29	0	0.35	260	2.7
S9	0.22	0	0.35	100	27

```
****************************************************************************

          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                     2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2011 Advanced Engineering Software (aes)
           Ver. 18.0 Release Date: 07/01/2011  License ID 1499

                      Analysis prepared by:





 ************************** DESCRIPTION OF STUDY **************************
 * Valley Center Batter Storage Site                                      *
 * 100 Year Pre Development On and Offsite Flows                          *
 * Kimley-Horn and Associates May 31, 2020                                *
 **************************************************************************

  FILE NAME: VALLEY.DAT
  TIME/DATE OF STUDY: 14:08 05/31/2020
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =  3.460
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
    HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
    WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    102.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  USER-SPECIFIED RUNOFF COEFFICIENT = .6300
  S.C.S. CURVE NUMBER (AMC II) =  89
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =   1444.00
  DOWNSTREAM ELEVATION(FEET) =   1430.00
  ELEVATION DIFFERENCE(FEET) =     14.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    3.927
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  9.116
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      2.41
  TOTAL AREA(ACRES) =      0.42   TOTAL RUNOFF(CFS) =       2.41

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
```

```
================================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1430.00  DOWNSTREAM(FEET) =   1378.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =  2706.00   CHANNEL SLOPE =  0.0192
 CHANNEL FLOW THRU SUBAREA(CFS) =       2.41
 FLOW VELOCITY(FEET/SEC) =   2.48 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =  18.17   Tc(MIN.) =   22.10
 LONGEST FLOWPATH FROM NODE     100.00 TO NODE     103.00 =    2806.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     103.00 TO NODE     103.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
================================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.496
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.4155
 SUBAREA AREA(ACRES) =   16.35   SUBAREA RUNOFF(CFS) =   23.44
 TOTAL AREA(ACRES) =       16.8   TOTAL RUNOFF(CFS) =      24.36
 TC(MIN.) =   22.10

****************************************************************************
 FLOW PROCESS FROM NODE     103.00 TO NODE     103.00 IS CODE =  10
----------------------------------------------------------------------------
 >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
================================================================================

****************************************************************************
 FLOW PROCESS FROM NODE     103.00 TO NODE     103.00 IS CODE =  13
----------------------------------------------------------------------------
 >>>>>CLEAR THE MAIN-STREAM MEMORY<<<<<
================================================================================

****************************************************************************
 FLOW PROCESS FROM NODE     104.00 TO NODE     105.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
================================================================================
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
 UPSTREAM ELEVATION(FEET) =   1511.00
 DOWNSTREAM ELEVATION(FEET) =   1500.00
 ELEVATION DIFFERENCE(FEET) =     11.00
 SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.765
 WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.316
 SUBAREA RUNOFF(CFS) =      6.31
 TOTAL AREA(ACRES) =       1.85   TOTAL RUNOFF(CFS) =       6.31

****************************************************************************
 FLOW PROCESS FROM NODE     105.00 TO NODE     106.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
================================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1500.00  DOWNSTREAM(FEET) =   1376.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =  2982.00   CHANNEL SLOPE =  0.0416
 CHANNEL FLOW THRU SUBAREA(CFS) =       6.31
 FLOW VELOCITY(FEET/SEC) =   4.55 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =  10.93   Tc(MIN.) =   16.70
 LONGEST FLOWPATH FROM NODE     104.00 TO NODE     106.00 =    3082.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     106.00 TO NODE     106.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
================================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.189
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.4100
```

```
 SUBAREA AREA(ACRES) =   89.35   SUBAREA RUNOFF(CFS) =  153.44
 TOTAL AREA(ACRES) =      91.2   TOTAL RUNOFF(CFS) =     156.62
 TC(MIN.) =   16.70

****************************************************************************
 FLOW PROCESS FROM NODE    107.00 TO NODE    107.00 IS CODE =  11
----------------------------------------------------------------------------
 >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

 ** MAIN STREAM CONFLUENCE DATA **
 STREAM    RUNOFF      Tc      INTENSITY     AREA
 NUMBER     (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
    1      156.62    16.70       4.189       91.20
 LONGEST FLOWPATH FROM NODE    104.00 TO NODE    107.00 =    3082.00 FEET.

 ** MEMORY BANK #  1 CONFLUENCE DATA **
 STREAM    RUNOFF      Tc      INTENSITY     AREA
 NUMBER     (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
    1       24.36    22.10       3.496       16.77
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    107.00 =    2806.00 FEET.

 ** PEAK FLOW RATE TABLE **
 STREAM    RUNOFF      Tc      INTENSITY
 NUMBER     (CFS)    (MIN.)   (INCH/HOUR)
    1     175.03     16.70       4.189
    2     155.08     22.10       3.496

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =     175.03   Tc(MIN.) =   16.70
 TOTAL AREA(ACRES) =      108.0

****************************************************************************
 FLOW PROCESS FROM NODE    107.00 TO NODE    108.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =  1376.00  DOWNSTREAM(FEET) =  1374.00
 FLOW LENGTH(FEET) =    90.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  45.0 INCH PIPE IS  36.7 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  18.14
 ESTIMATED PIPE DIAMETER(INCH) =  45.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =     175.03
 PIPE TRAVEL TIME(MIN.) =   0.08    Tc(MIN.) =   16.78
 LONGEST FLOWPATH FROM NODE    104.00 TO NODE    108.00 =    3172.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    108.00 TO NODE    109.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1374.00  DOWNSTREAM(FEET) =   1363.50
 CHANNEL LENGTH THRU SUBAREA(FEET) =   831.00   CHANNEL SLOPE =  0.0126
 CHANNEL FLOW THRU SUBAREA(CFS) =     175.03
 FLOW VELOCITY(FEET/SEC) =   6.33 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   2.19   Tc(MIN.) =   18.97
 LONGEST FLOWPATH FROM NODE    104.00 TO NODE    109.00 =    4003.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    109.00 TO NODE    109.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.858
 USER-SPECIFIED RUNOFF COEFFICIENT = .4600
 S.C.S. CURVE NUMBER (AMC II) =  84
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.4147
 SUBAREA AREA(ACRES) =     9.07   SUBAREA RUNOFF(CFS) =   16.10
 TOTAL AREA(ACRES) =      117.0   TOTAL RUNOFF(CFS) =     187.23
 TC(MIN.) =   18.97
```

```
****************************************************************************
 FLOW PROCESS FROM NODE    109.00 TO NODE    110.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1363.50  DOWNSTREAM(FEET) =   1355.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   525.00   CHANNEL SLOPE =  0.0162
 CHANNEL FLOW THRU SUBAREA(CFS) =     187.23
 FLOW VELOCITY(FEET/SEC) =   7.31 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   1.20   Tc(MIN.) =   20.16
 LONGEST FLOWPATH FROM NODE    104.00 TO NODE    110.00 =    4528.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.708
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.4146
 SUBAREA AREA(ACRES) =     2.30   SUBAREA RUNOFF(CFS) =     3.50
 TOTAL AREA(ACRES) =      119.3   TOTAL RUNOFF(CFS) =     187.23
 TC(MIN.) =   20.16
 NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

****************************************************************************
 FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 IS CODE =  10
----------------------------------------------------------------------------
 >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 2 <<<<<
============================================================================

****************************************************************************
 FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 IS CODE =  13
----------------------------------------------------------------------------
 >>>>>CLEAR THE MAIN-STREAM MEMORY<<<<<
============================================================================

****************************************************************************
 FLOW PROCESS FROM NODE    111.00 TO NODE    112.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
 UPSTREAM ELEVATION(FEET) =   1452.00
 DOWNSTREAM ELEVATION(FEET) =   1425.00
 ELEVATION DIFFERENCE(FEET) =     27.00
 SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.765
 WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.316
 SUBAREA RUNOFF(CFS) =      0.75
 TOTAL AREA(ACRES) =       0.22   TOTAL RUNOFF(CFS) =       0.75

****************************************************************************
 FLOW PROCESS FROM NODE    112.00 TO NODE    113.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1425.00  DOWNSTREAM(FEET) =   1362.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   835.00   CHANNEL SLOPE =  0.0754
 NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
 CHANNEL FLOW THRU SUBAREA(CFS) =       0.75
 FLOW VELOCITY(FEET/SEC) =   4.12 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   3.38   Tc(MIN.) =    9.14
 LONGEST FLOWPATH FROM NODE    111.00 TO NODE    113.00 =     935.00 FEET.

****************************************************************************
```

```
 FLOW PROCESS FROM NODE    113.00 TO NODE    113.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.177
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.4100
 SUBAREA AREA(ACRES) =    7.10   SUBAREA RUNOFF(CFS) =   17.98
 TOTAL AREA(ACRES) =       7.3   TOTAL RUNOFF(CFS) =      18.54
 TC(MIN.) =    9.14

****************************************************************************
 FLOW PROCESS FROM NODE    113.00 TO NODE    114.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1362.00  DOWNSTREAM(FEET) =   1355.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   260.00   CHANNEL SLOPE =  0.0269
 CHANNEL FLOW THRU SUBAREA(CFS) =      18.54
 FLOW VELOCITY(FEET/SEC) =   4.82 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   0.90   Tc(MIN.) =   10.04
 LONGEST FLOWPATH FROM NODE    111.00 TO NODE    114.00 =    1195.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    114.00 TO NODE    114.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.814
 USER-SPECIFIED RUNOFF COEFFICIENT = .4100
 S.C.S. CURVE NUMBER (AMC II) =  82
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.4100
 SUBAREA AREA(ACRES) =    1.28   SUBAREA RUNOFF(CFS) =    3.05
 TOTAL AREA(ACRES) =       8.6   TOTAL RUNOFF(CFS) =      20.50
 TC(MIN.) =   10.04

****************************************************************************
 FLOW PROCESS FROM NODE    115.00 TO NODE    115.00 IS CODE =  11
----------------------------------------------------------------------------
 >>>>>CONFLUENCE MEMORY BANK # 2 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

 ** MAIN STREAM CONFLUENCE DATA **
 STREAM    RUNOFF     Tc     INTENSITY    AREA
 NUMBER    (CFS)    (MIN.)  (INCH/HOUR)  (ACRE)
    1      20.50    10.04      5.814       8.60
 LONGEST FLOWPATH FROM NODE    111.00 TO NODE    115.00 =    1195.00 FEET.

 ** MEMORY BANK #  2 CONFLUENCE DATA **
 STREAM    RUNOFF     Tc     INTENSITY    AREA
 NUMBER    (CFS)    (MIN.)  (INCH/HOUR)  (ACRE)
    1     187.23    20.16      3.708     119.34
 LONGEST FLOWPATH FROM NODE    104.00 TO NODE    115.00 =    4528.00 FEET.

 ** PEAK FLOW RATE TABLE **
 STREAM    RUNOFF     Tc     INTENSITY
 NUMBER    (CFS)    (MIN.)  (INCH/HOUR)
    1     113.74    10.04      5.814
    2     200.30    20.16      3.708

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =    200.30   Tc(MIN.) =   20.16
 TOTAL AREA(ACRES) =      127.9
============================================================================
 END OF STUDY SUMMARY:
 TOTAL AREA(ACRES)    =     127.9  TC(MIN.) =    20.16
 PEAK FLOW RATE(CFS)   =    200.30
============================================================================
============================================================================
 END OF RATIONAL METHOD ANALYSIS
```

7.0 General Requirements

- Submit this cover page and all required Sub-attachments for all structural BMPs proposed for the project.
- See the BMPDM sections and appendices listed under "BMPDM Design Resources" in the table below for additional explanation of design requirements. Constructed features must <u>fully</u> satisfy the requirements described in these resources, and any other guidance identified by the County.
- PDPs subject to hydromodification management requirements must also implement structural BMPs for flow control for hydromodification management. Completion of SWQMP Attachment 8 is also required for these BMPs.
- <u>DMA Exhibits and Construction Plans</u>: DMAs, features, and BMPs identified and described in this attachment must be shown on DMA Exhibits and all applicable construction plans submitted for the project. See Attachment 2 for additional instruction on exhibits and plans.
- <u>Structural BMP Certification</u>. All structural BMPs documented this attachment and in Attachment 8 must be certified by a registered engineer in Sub-attachment 7.1.
- <u>Structural BMP Verification</u>. Structural BMP installation must be verified by the County at the completion of construction. Applicants must complete an Installation Verification Form (Attachment 10).

Sub-attachments (check all that are completed)	**Requirement**	**BMPDM Design Resources**
☒ **7.1: Preparer's Certification**	Required	• N/A
☒ **7.2: Structural BMP Strategy**	Required	• BMPDM Sections 5.1., 5.3, 5.4, and Chapter 6 • BMPDM Appendix E (pages E-78 through E-210)
☒ **7.3: Structural BMP Checklist(s)**	Required	
☒ **7.4: Stormwater Pollutant Control Worksheet Calculations**	Required	• BMPDM Appendix B
☐ **7.5: Identification and Narrative of Receiving Water and Pollutants of Concern**	Required if flow-thru BMPs are proposed	• N/A

7.1 Engineer of Work Certification for Structural BMPs

Project Name	Valley Center Storage Project
Permit Application Number	PDS2020-IC-20-003

CERTIFICATION

I hereby declare that I am the Engineer in Responsible Charge of design of structural storm water best management practices (BMPs) for this project, and that I have exercised responsible charge over the design of the BMPs as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the PDP requirements of the County of San Diego BMP Design Manual, which is a design manual for compliance with local County of San Diego Watershed Protection Ordinance (Sections 67.801 et seq.) and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100) requirements for storm water management. I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the BMP Design Manual.

I certify that this PDP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this PDP SWQMP by County staff is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of structural storm water BMPs for this project, of my responsibilities for their design.

☒ In addition to the structural pollutant control BMPs described in this attachment, this certification applies to the Structural Hydromodification Management BMPs described in Attachment 8 (check if applicable).

PE #75322, Dec 31, 2021

Engineer of Work's Signature, PE Number & Expiration Date

Chris Carda

Print Name

Westwood Professional Services

Company

06/02/2020 Engineer's Seal:

Date

7.2 Structural BMP Strategy

7.2.1 Narrative Strategy (Continue description on subsequent pages as necessary)

Describe the general strategy for structural BMP implementation at the project site. For pollutant control BMPs, your description must address the key points outlined in Section 5.1 of the BMP Design Manual, and the type of BMPs selected. For projects requiring hydromodification flow control BMPs, indicate whether pollutant control and flow control BMPs are integrated or separate.

The general approach to the BMP selection is below. Calculations can be found in the Drainage Report.

The proposed condition was evaluated and several DMAs were identified. The proposed designed was incorporated and the DMAs we not identified as "Self-mitigating" or "De minimus" or "self retaining" and as such BMPs were required. Harvest and use was not an acceptable BMP based on the proposed site design. The proposed BMP is an infiltration basin designed to infiltrate and treat the water from the project. The majority of the soils onsite were "A" soils which have good infiltration rates per the geotechnical report. This infiltration basin will capture and treat the Design Capture Volume as required for an 85 th percentile 24-hour event.

The infiltration basin was designed in a unified BMP design approach to meet the requirements for stormwater treatment and hydromodification management for the drainage areas in accordance with the 2018 Regional Model BMP Design Manual. HMP sizing factors were used to calculate BMP sizes to meet hydromodification design requirements. Therefor the pollutant control and flow control are integrated into the BMP. No underdrains were necessary as the infiltration basin will completely drain in less than 96 hours.

The site BMP will capture both onsite and the offsite water running through the project area from the north. Please refer to the Drainage Management Area (DMA) Exhibit for more information.

The 1-foot of freeboard required by the Hydraulic Design Manual during the 100-year, 24-hour event has not been met, however, justification for the suitability relative to site conditions is provided in Section 4 of the CEQA Drainage Report.

7.2.2 Structural BMP Summary Table (Complete for all proposed structural BMPs) • List and provide the information requested below for all pollutant control and hydromodification management BMPs proposed for the project. • For each BMP listed, complete the Structural BMP Checklist on the next page. Copy the Checklist as many times as needed.										
			Structural BMP Type							
BMP ID #	**DMA #**	**DMA Area (ft²)**	Harvest and Use	Infiltration	Unlined Biofiltration	Lined Biofiltration	Flow-thru treatment	Hydromodification Management [1]	Other	**Permit # and Sheet #**
1	1	229,127	☐	☒	☐	☐	☐	☐	☐	PDS2020-IC-20-003
			☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	
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			☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	

Copy and Paste table here for additional BMPs

[1] Hydromodification Management BMPs must be accompanied by BMPs that provide pollutant control.

7.3 Structural BMP Checklist (Complete once for each proposed structural BMP)

Structural BMP ID #	**Permit # and Sheet #**
BMP Type	
Infiltration ☒ Infiltration basin (INF-1) ☐ Bioretention (INF-2) ☐ Permeable pavement (INF-3) **Unlined Biofiltration** ☐ Biofiltration with partial retention (PR-1) **Lined Biofiltration** ☐ Biofiltration (BF-1) ☐ Nutrient Sensitive Media Design (BF-2) ☐ Proprietary Biofiltration (BF-3)	**Harvest and Use** ☐ Cistern (HU-1) **Flow-thru Treatment** (describe below) ☐ With prior lawful approval to meet earlier PDP requirements ☐ Pre-treatment/forebay for an onsite retention or biofiltration BMP[2] ☐ With alternative compliance **Hydromodification Management**[3] ☐ Detention pond or vault ☐ **Other** (describe below)
BMP Purpose	
☐ Pollutant control only ☐ Hydromodification control only ☒ Combined pollutant control and hydromodification	☐ Pre-treatment/forebay for another BMP ☐ Other (describe below)
BMP Verification (See BMPDM Section 8.3)	
Provide name and contact information for the party responsible to sign BMP verification forms	Mark Turner Terra-Gen, LLC | Vice President, Energy Storage Development 11455 El Camino Real, Suite 160 | San Diego, CA 92130 916-835-8119 (mobile)

BMP Ownership and Maintenance (See BMPDM Section 7.3 and Attachment 11)				
BMP Maintenance Category	Cat. 1 ☐	Cat. 2 ☒	Cat. 3 ☐	Cat. 4 ☐
Final owner of BMP	☐ HOA ☒ Other (describe):	☐ Property Owner Developer	☐ County	
Maintenance of BMP into perpetuity	☐ HOA ☒ Other (describe):	☐ Property Owner Developer	☐ County	

Discussion (As needed; Continue on subsequent pages as necessary)

[2] Indicate which onsite retention or biofiltration BMP the pre-treatment/forebay serves.
[3] Hydromodification Management BMPs must be accompanied by BMPs that provide pollutant control.

Copy and Paste table here for additional BMPs

[2] Indicate which onsite retention or biofiltration BMP the pre-treatment/forebay serves.
[3] Hydromodification Management BMPs must be accompanied by BMPs that provide pollutant control.

7.4 Storm Water Pollutant Control Worksheet Calculations

- Use this page as a cover sheet for the submittal of any required worksheets below.
- Complete the checklist to identify which BMPDM Appendix B (Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods) worksheets are included with this attachment.
- See BMPDM Appendix B for an explanation of the applicability of individual worksheets and detailed guidance on their completion.

Worksheet	Requirement
☒ Worksheet B.1 Calculation of Design Capture Volume (DCV)	Required
☒ Worksheet B.2 Retention Requirements	Required
☒ Worksheet B.3 BMP Performance	Required
☐ Worksheet B.4 Major Maintenance Intervals for Reduced-sized BMPs	If applicable
☐ Other worksheets	As required

BMP Sizing Spreadsheet V3.0			
Project Name:	Valley Center Storage Project	Hydrologic Unit:	San Luis Rey
Project Applicant:	Valley Center ESS, LLC	Rain Gauge:	Lake Wohlford
Jurisdiction:	San Diego County	Total Project Area:	229,126
Parcel (APN):	189-013-20-00	Low Flow Threshold:	0.1Q2
BMP Name:	Infiltration Basin	BMP Type:	Infiltration Facilities
BMP Native Soil Type:	A	BMP Infiltration Rate (in/hr):	0.5

Areas Draining to BMP						HMP Sizing Factors	Minimum BMP Size
DMA Name	Area (sf)	Pre Project Soil Type	Pre-Project Slope	Post Project Surface Type	Area Weighted Runoff Factor (Table G.2-1)[1]	Surface Area	Surface Area (SF)
DA-1	57,935	A	Flat	Roofs	1.0	0.085	4924
DA-1	108,030	A	Flat	Crushed Aggregate	0.1	0.085	918
DA-1	63,162	A	Flat	Concrete	1.0	0.085	5369
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
						0	0
BMP Tributary Area	229,127					Minimum BMP Size	11211
						Proposed BMP Size*	13503
					Surface Ponding Depth	36.00	in

* Assumes standard configuration

Notes:

1. Runoff factors which are used for hydromodification management flow control (Table G.2-1) are different from the runoff factors used for pollutant control BMP sizing (Table B.1-1). Table references are taken from the San Diego Region Model BMP Design Manual,

Describe the BMP's in sufficient detail in your PDP SWQMP to demonstrate the area, volume, and other criteria can be met within the constraints of the site.

BMP's must be adapted and applied to the conditions specific to the development project such as unstable slopes or the lack of available head.
Designated Staff have final review and approval authority over the project design.

This BMP Sizing Spreadsheet has been updated in conformance with the San Diego Region Model BMP Design Manual, April 2018. For questions or concerns please contact the jurisdiction in which your project is located.

BMP Sizing Spreadsheet V3.0			
Project Name:	Valley Center Storage Project	Hydrologic Unit:	San Luis Rey
Project Applicant:	Valley Center ESS, LLC	Rain Gauge:	Lake Wohlford
Jurisdiction:	San Diego County	Total Project Area:	229,126
Parcel (APN):	189-013-20-00	Low Flow Threshold:	0.1Q2
BMP Name	Infiltration Basin	BMP Type:	Infiltration Facilities

DMA Name	Rain Gauge	Pre-developed Condition		Unit Runoff Ratio	DMA Area (ac)	Orifice Flow - $\%Q_2$	Orifice Area
		Soil Type	Slope	(cfs/ac)		(cfs)	(in^2)
DA-1	Lake Wohlford	A	Flat	0.256	1.330	N/A	**N/A**
DA-1	Lake Wohlford	A	Flat	0.256	2.480	N/A	**N/A**
DA-1	Lake Wohlford	A	Flat	0.256	1.450	N/A	**N/A**

No Orifice Required for Infiltration Facilities

N/A	**N/A**	**N/A**	**N/A**
Max Orifice Head (feet)	**Max Tot. Allowable Orifice Flow (cfs)**	**Max Tot. Allowable Orifice Area (in^2)**	**Max Orifice Diameter (in)**

N/A	**N/A**	**0.64**	**0.900**
Average outflow during surface drawdown (cfs)	Max Orifice Outflow (cfs)	Actual Orifice Area (in^2)	Selected Orifice Diameter (in)

Drawdown (Hrs)	72.0

Automated Worksheet B.1: Calculation of Design Capture Volume (V2.0)

Category	#	Description	*i*	*ii*	*iii*	*iv*	*v*	*vi*	*vii*	*viii*	*ix*	*x*	Units
Standard Drainage Basin Inputs	1	Drainage Basin ID or Name	1										unitless
	2	85th Percentile 24-hr Storm Depth	0.77										inches
	3	Impervious Surfaces Not Directed to Dispersion Area (C=0.90)	229,126										sq-ft
	4	Semi-Pervious Surfaces Not Serving as Dispersion Area (C=0.30)											sq-ft
	5	Engineered Pervious Surfaces Not Serving as Dispersion Area (C=0.10)											sq-ft
	6	Natural Type A Soil Not Serving as Dispersion Area (C=0.10)	111,514										sq-ft
	7	Natural Type B Soil Not Serving as Dispersion Area (C=0.14)											sq-ft
	8	Natural Type C Soil Not Serving as Dispersion Area (C=0.23)	41,382										sq-ft
	9	Natural Type D Soil Not Serving as Dispersion Area (C=0.30)											sq-ft
Dispersion Area, Tree Well & Rain Barrel Inputs (Optional)	10	Does Tributary Incorporate Dispersion, Tree Wells, and/or Rain Barrels?	No	No	No	No	No	No	No	No	No	No	yes/no
	11	Impervious Surfaces **Directed to Dispersion Area** per SD-B (Ci=0.90)											sq-ft
	12	Semi-Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.30)											sq-ft
	13	Engineered Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.10)											sq-ft
	14	Natural Type A Soil **Serving as Dispersion Area** per SD-B (Ci=0.10)											sq-ft
	15	Natural Type B Soil **Serving as Dispersion Area** per SD-B (Ci=0.14)											sq-ft
	16	Natural Type C Soil **Serving as Dispersion Area** per SD-B (Ci=0.23)											sq-ft
	17	Natural Type D Soil **Serving as Dispersion Area** per SD-B (Ci=0.30)											sq-ft
	18	Number of Tree Wells Proposed per SD-A											#
	19	Average Mature Tree Canopy Diameter											ft
	20	Number of Rain Barrels Proposed per SD-E											#
	21	Average Rain Barrel Size											gal
Initial Runoff Factor Calculation	22	Total Tributary Area	382,022	0	0	0	0	0	0	0	0	0	sq-ft
	23	Initial Runoff Factor for Standard Drainage Areas	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	24	Initial Runoff Factor for Dispersed & Dispersion Areas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	25	Initial Weighted Runoff Factor	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	26	Initial Design Capture Volume	14,463	0	0	0	0	0	0	0	0	0	cubic-feet
Dispersion Area Adjustments	27	Total Impervious Area Dispersed to Pervious Surface	0	0	0	0	0	0	0	0	0	0	sq-ft
	28	Total Pervious Dispersion Area	0	0	0	0	0	0	0	0	0	0	sq-ft
	29	Ratio of Dispersed Impervious Area to Pervious Dispersion Area	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ratio
	30	Adjustment Factor for Dispersed & Dispersion Areas	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	ratio
	31	Runoff Factor After Dispersion Techniques	0.59	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	unitless
	32	Design Capture Volume After Dispersion Techniques	14,463	0	0	0	0	0	0	0	0	0	cubic-feet
Tree & Barrel Adjustments	33	Total Tree Well Volume Reduction	0	0	0	0	0	0	0	0	0	0	cubic-feet
	34	Total Rain Barrel Volume Reduction	0	0	0	0	0	0	0	0	0	0	cubic-feet
Results	35	Final Adjusted Runoff Factor	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	36	Final Effective Tributary Area	225,393	0	0	0	0	0	0	0	0	0	sq-ft
	37	Initial Design Capture Volume Retained by Site Design Elements	0	0	0	0	0	0	0	0	0	0	cubic-feet
	38	Final Design Capture Volume Tributary to BMP	14,463	0	0	0	0	0	0	0	0	0	cubic-feet

No Warning Messages

Automated Worksheet B.2: Retention Requirements (V2.0)

Category	#	Description	*i*	*ii*	*iii*	*iv*	*v*	*vi*	*vii*	*viii*	*ix*	*x*	Units
Basic Analysis	1	Drainage Basin ID or Name	1	-	-	-	-	-	-	-	-	-	unitless
	2	85th Percentile Rainfall Depth	0.77	-	-	-	-	-	-	-	-	-	inches
	3	Predominant NRCS Soil Type Within BMP Location	A										unitless
	4	Is proposed BMP location Restricted or Unrestricted for Infiltration Activities?	Unrestricted										unitless
	5	Nature of Restriction	n/a										unitless
	6	Do Minimum Retention Requirements Apply to this Project?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	yes/no
	7	Are Habitable Structures Greater than 9 Stories Proposed?	No										yes/no
Advanced Analysis	8	Has Geotechnical Engineer Performed an Infiltration Analysis?	No										yes/no
	9	Design Infiltration Rate Recommended by Geotechnical Engineer											in/hr
Result	10	Design Infiltration Rate Used To Determine Retention Requirements	0.300	-	-	-	-	-	-	-	-	-	in/hr
	11	Percent of Average Annual Runoff that Must be Retained within DMA	36.0%	-	-	-	-	-	-	-	-	-	percentage
	12	Fraction of DCV Requiring Retention	0.28	-	-	-	-	-	-	-	-	-	ratio
	13	Required Retention Volume	4050	-	-	-	-	-	-	-	-	-	cubic-feet

No Warning Messages

Automated Worksheet B.3: BMP Performance (V2.0)

Category	#	Description	*i*	*ii*	*iii*	*iv*	*v*	*vi*	*vii*	*viii*	*ix*	*x*	Units
	1	Drainage Basin ID or Name	1	-	-	-	-	-	-	-	-	-	sq-ft
	2	Design Infiltration Rate Recommended	0.300	-	-	-	-	-	-	-	-	-	in/hr
	3	Design Capture Volume Tributary to BMP	14,463	-	-	-	-	-	-	-	-	-	cubic-feet
	4	Is BMP Vegetated or Unvegetated?	Unvegetated										unitless
	5	Is BMP Impermeably Lined or Unlined?	Unlined										unitless
	6	Does BMP Have an Underdrain?	No Underdrain										unitless
	7	Does BMP Utilize Standard or Specialized Media?	Standard										unitless
	8	Provided Surface Area	13,504										sq-ft
BMP Inputs	9	Provided Surface Ponding Depth	24										inches
	10	Provided Soil Media Thickness	0										inches
	11	Provided Gravel Thickness (Total Thickness)	0										inches
	12	Underdrain Offset											inches
	13	Diameter of Underdrain or Hydromod Orifice (Select Smallest)											inches
	14	Specialized Soil Media Filtration Rate											in/hr
	15	Specialized Soil Media Pore Space for Retention											unitless
	16	Specialized Soil Media Pore Space for Biofiltration											unitless
	17	Specialized Gravel Media Pore Space											unitless
	18	Volume Infiltrated Over 6 Hour Storm	2,026	0	0	0	0	0	0	0	0	0	cubic-feet
	19	Ponding Pore Space Available for Retention	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	unitless
	20	Soil Media Pore Space Available for Retention	0.40	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	unitless
	21	Gravel Pore Space Available for Retention (Above Underdrain)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	unitless
	22	Gravel Pore Space Available for Retention (Below Underdrain)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	unitless
Retention Calculations	23	Effective Retention Depth	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	24	Fraction of DCV Retained (Independent of Drawdown Time)	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	25	Calculated Retention Storage Drawdown Time	80	0	0	0	0	0	0	0	0	0	hours
	26	Efficacy of Retention Processes	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	27	Volume Retained by BMP (Considering Drawdown Time)	14,463	0	0	0	0	0	0	0	0	0	cubic-feet
	28	Design Capture Volume Remaining for Biofiltration	0	0	0	0	0	0	0	0	0	0	cubic-feet
	29	Max Hydromod Flow Rate through Underdrain	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	cfs
	30	Max Soil Filtration Rate Allowed by Underdrain Orifice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	in/hr
	31	Soil Media Filtration Rate per Specifications	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	in/hr
	32	Soil Media Filtration Rate to be used for Sizing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	in/hr
	33	Depth Biofiltered Over 6 Hour Storm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	34	Ponding Pore Space Available for Biofiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	unitless
	35	Soil Media Pore Space Available for Biofiltration	0.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	unitless
Biofiltration Calculations	36	Gravel Pore Space Available for Biofiltration (Above Underdrain)	0.00	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	unitless
	37	Effective Depth of Biofiltration Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	38	Drawdown Time for Surface Ponding	80	0	0	0	0	0	0	0	0	0	hours
	39	Drawdown Time for Effective Biofiltration Depth	0	0	0	0	0	0	0	0	0	0	hours
	40	Total Depth Biofiltered	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	inches
	41	Option 1 - Biofilter 1.50 DCV: Target Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	42	Option 1 - Provided Biofiltration Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	43	Option 2 - Store 0.75 DCV: Target Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	44	Option 2 - Provided Storage Volume	0	0	0	0	0	0	0	0	0	0	cubic-feet
	45	Portion of Biofiltration Performance Standard Satisfied	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	46	Do Site Design Elements and BMPs Satisfy Annual Retention Requirements?	Yes	-	-	-	-	-	-	-	-	-	yes/no
Result	47	Overall Portion of Performance Standard Satisfied (BMP Efficacy Factor)	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ratio
	48	**Deficit of Effectively Treated Stormwater**	**0**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	cubic-feet

Attention!

-Vegetated BMPs with surface ponding drawdown times over 24 hours must be certified by a landscape architect or agronomist. All BMPs must have a surface ponding drawdown time of 96 hours or less.

7.5 Identification and Narrative of Receiving Water and Pollutants of Concern

- Complete this sub-attachment *only if flow-thru treatment BMPs are implemented onsite* in lieu of retention or biofiltration BMPs. Unless excepted because of a Prior Lawful Approval[4], PDPs must also participate in an alternative compliance program[5].

A. General Description

Describe flow path of storm water from the project site discharge location(s), through urban storm conveyance systems as applicable, to receiving creeks, rivers, and lagoons as applicable, and ultimate discharge to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable).

B. Water Body Impairments and Priorities

List any 303(d) impaired water bodies[6] within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs and/or Highest Priority Pollutants from the WQIP for the impaired water bodies:

303(d) Impaired Water Body	Pollutant(s)/Stressor(s)	TMDLs / WQIP Highest Priority Pollutant
Keys Creek	Indicator Bacteria,	
	Nitrogen, Selenium	

C. Identification of Project Site Pollutants

Identify pollutants expected from the project site based on all proposed use(s) of the site (see BMP Design Manual Appendix B.6.

Pollutant	Not Applicable to the Project Site	Anticipated from the Project Site	Also a Receiving Water Pollutant of Concern
Sediment	☒	☐	☐
Nutrients	☒	☐	☐
Heavy Metals	☒	☐	☐
Organic Compounds	☒	☐	☐
Trash & Debris	☒	☐	☐
Oxygen Demanding Substances	☒	☐	☐
Oil & Grease	☒	☐	☐
Bacteria & Viruses	☒	☐	☐
Pesticides	☒	☐	☐

[4] See BMPDM Appendix L: Prior Lawful Approval Requirements and Guidance.
[5] See SWQMP Attachment 12 (Alternative Compliance Projects) and BMPDM Appendix J (Offsite Alternative Compliance Requirements and Guidance).
[6] The current list of Section 303(d) impaired water bodies can be found at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml

8.0 General Requirements

- Completion of this attachment is required for all PDPs subject to hydromodification management requirements (see PDP SWQMP Form Table 5). Do not submit this attachment if exempt from Hydromodification Management requirements. Document the PDP exemption in Attachment 9.
- Submit this cover page and all required Sub-attachments for all structural hydromodification management BMPs proposed for the project.
- Constructed features must fully satisfy the requirements described in applicable BMPDM sections and appendices, and any other guidance identified by the County.
- DMA Exhibits and Construction Plans: DMAs, features, and BMPs identified and described in this attachment must be shown on DMA Exhibits and all applicable construction plans submitted for the project. See Attachment 2 for additional instruction on exhibits and plans.
- Structural BMP Certification. All structural hydromodification management BMPs documented this attachment must be certified by a registered engineer in Attachment 7, Sub-attachment 7.1.
- Structural BMP Verification. BMP installation must be verified by the County at the completion of construction. Applicants must complete an Installation Verification Form (Attachment 10).

Sub-attachments (check all that are completed)
☒ **8.1: Flow Control Facility Design** (required)[1]
Submit using ☒ the Sub-attachment 8.1 cover sheet provided, or ☐ as a separate stand-alone document labeled Sub-attachment 8.1.
☒ **8.2: Hydromodification Management Points of Compliance** (required)
Complete the table provided in Sub-attachment 8.2.
8.3: Geomorphic Assessment of Receiving Channels
1. Has a geomorphic assessment been performed for the receiving channel(s)?
☒ No, the low flow threshold is 0.1Q2 (default low flow threshold)
☐ Yes (provide the information below):
Low flow threshold: ☐ 0.1Q2 ☐ 0.3Q2 ☐ 0.5Q2
Title:
Date: Preparer:
Submit using ☐ the Sub-attachment 8.3 cover sheet provided, or ☐ as a separate stand-alone document labeled Sub-attachment 8.3.
8.4: Vector Control Plan (required if BMPs will not drain in less than 96 hours)
☐ Included with this attachment ☒ Not required

[1] Including Structural BMP Drawdown Calculations and Overflow Design Summary. See BMPDM Chapter 6 and Appendix G for additional design guidance.

8.1 Flow Control Facility Design

Insert Flow Control Facility Design behind this cover page or submit as a separate stand-alone document labeled Sub-attachment 8.1.

The project is divided into three offsite watersheds and one onsite watershed. The main POC for the project area is the proposed infiltration basin. This location is in the southwest corner of the project area. Existing topography and features can be found in the CEQA Drainage Study. In the proposed post development conditions there is the one infiltration BMP designed to meet the flow and treatment requirements. The design of the BMP can be found in the DEQA drainage study along with the location and size of the BMP as well as the proposed grading, drainage features and boundaries. Due to the offsite CCSYA areas having a flow rate of <0.25 cfs for the 2–year storm, no pass through was necessary on the infiltration basin.

8.2 Hydromodification Management Points of Compliance

- List and describe all points of compliance (POCs) for flow control for hydromodification management.
- For each POC, provide a POC identification name or number, and a receiving channel identification name or number correlating to the project's HMP Exhibit (see Attachment 2).

POC name or #	Channel name or #	POC Description
Basin 1	Unnamed	Southwest exit point of project area. Infiltration basin with overflow for larger events.

8.3 Geomorphic Assessment of Receiving Water Channels

Insert Geomorphic Assessment behind this cover page or submit as a separate stand-alone document labeled Sub-attachment 8.3.

8.4 Vector Control Plan

Insert Vector Control Plan behind this cover page or submit as a separate stand-alone document labeled Sub-attachment 8.4.

9.0 General Requirements

- Complete the table below to indicate which compliance pathway was selected in PDP SWQMP Table 6. Include the corresponding sub-attachment with your SWQMP submittal. Other sub-attachments do not need to be included.
- See the BMPDM sections and appendices listed under "BMPDM Design Resources" for additional explanation of design requirements. Constructed features must fully satisfy the requirements described in these resources, and any other guidance identified by the County.
- DMA Exhibits and Construction Plans: CCSYAs and applicable BMPs identified and described in this attachment must be shown on DMA Exhibits and all applicable construction plans submitted for the project. See Attachment 2 for additional instruction on exhibits and plans.

Sub-attachments	**BMPDM Design Resources**
☐ **9.1: Documentation of Hydromodification Management Exemption**[1]	Section 1.6
☐ **9.2: Watershed Management Area Analysis (WMAA) Mapping**[1]	Appendix H.1.1.2
☐ **9.3: Resource Protection Ordinance (RPO) Methods**	Appendix H.1.1.1
☒ **9.4: No Net Impact Analysis**	Appendix H.4

[1] The San Diego County Regional comprehensive WMAA mapping data can be found on the Project Clean Water website here: http://www.projectcleanwater.org/download/wmaa_attc_data/

9.1 Documentation of Hydromodification Management Exemption (BMPDM Section 1.6)

- If the PDP is exempt from hydromodification management requirements (see Table 4 Part A.1 of the PDP SWQMP), use this Sub-attachment to document the exemption.
- Select the type of exemption below that applies and provide an explanation of the selection, including maps or other applicable documentation. Additional documentation may be requested by County staff.

Exemption Type per BMPDM Figure 1-2 (select one)
☐ a. The proposed project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean. ☐ b. The proposed project will discharge runoff directly to conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean. ☐ c. The proposed project will discharge runoff directly to an area identified by the County as appropriate for an exemption by the WMAA for the watershed in which the project resides[2].
Explanation (add or attach pages as necessary)

[2] This option must include an analysis of the project using the methodology presented in Attachment E of the Regional Watershed Management Area Analysis.

9.2 Watershed Management Area Analysis (WMAA) Mapping (BMPDM Appendix H.1.1.2)

Watershed Management Area Analysis (WMAA) mapping is a simple way to screen projects to determine the presence of onsite or offsite upstream Potential Critical Coarse Sediment Yield Areas (PCCSYAs). The San Diego County Regional WMAA mapping data can be found on the Project Clean Water website here: http://www.projectcleanwater.org/download/wmaa_attc_data/ .[3]

- Based on the WMAA map and the proposed project design, demonstrate below that both of the following conditions apply to the PDP:

  (a) Less than 5% of PCCSYAs will be impacted (built on or obstructed) by the PDP, <u>and</u>

  (b) All upstream offsite PCCYSAs will be bypassed (see BMPDM Appendix H.3).

A. Mapping Results -- At a minimum, show: (1) the project footprint, (2) areas of proposed development, (3) impacted onsite PCCSYAs, (4) offsite tributary areas[4], and (5) bypass of upstream offsite PCCSYAs.

[3] Applicants may refine initial mapping results using options identified in BMPDM Appendix H.1.2.
[4] Tributary areas must be shown to demonstrate that upstream offsite PCCSYAs do not exist. If bypassing these areas, only the bypass should be shown.

B. Explanation -- Provide documentation as needed to demonstrate that (1) impacts to PCCSYAs are below 5%, and (2) upstream offsite PCCYSAs are effectively bypassed. Add pages as necessary.

9.3 Resource Protection Ordinance (RPO) Methods (BMPDM Appendix H.1.1.1)

- Either of two Resource Protection Ordinance (RPO) methods may also be used to demonstrate compliance with CCSYA requirements. Select either option and document the selection below:

☐ **RPO Scenario 1: PDP is subject to and in compliance with RPO requirements**[5]

- **Select** if the project requires one or more discretionary permits;
- **Demonstrate** that onsite AND upstream offsite CCSYAs will be avoided and/or bypassed.

☐ **RPO Scenario 2: PDP is entirely exempt/not subject to RPO requirements**[6]

- **Select** if the project does not require discretionary permits;
- **Demonstrate** that all upstream offsite CCSYAs will be bypassed[7].

A. Mapping Results -- At a minimum, show as applicable: (1) the project footprint, (2) areas of proposed development, (3) locations of onsite and upstream offsite CCSYAs, and (4) bypass of all identified CCSYAs.

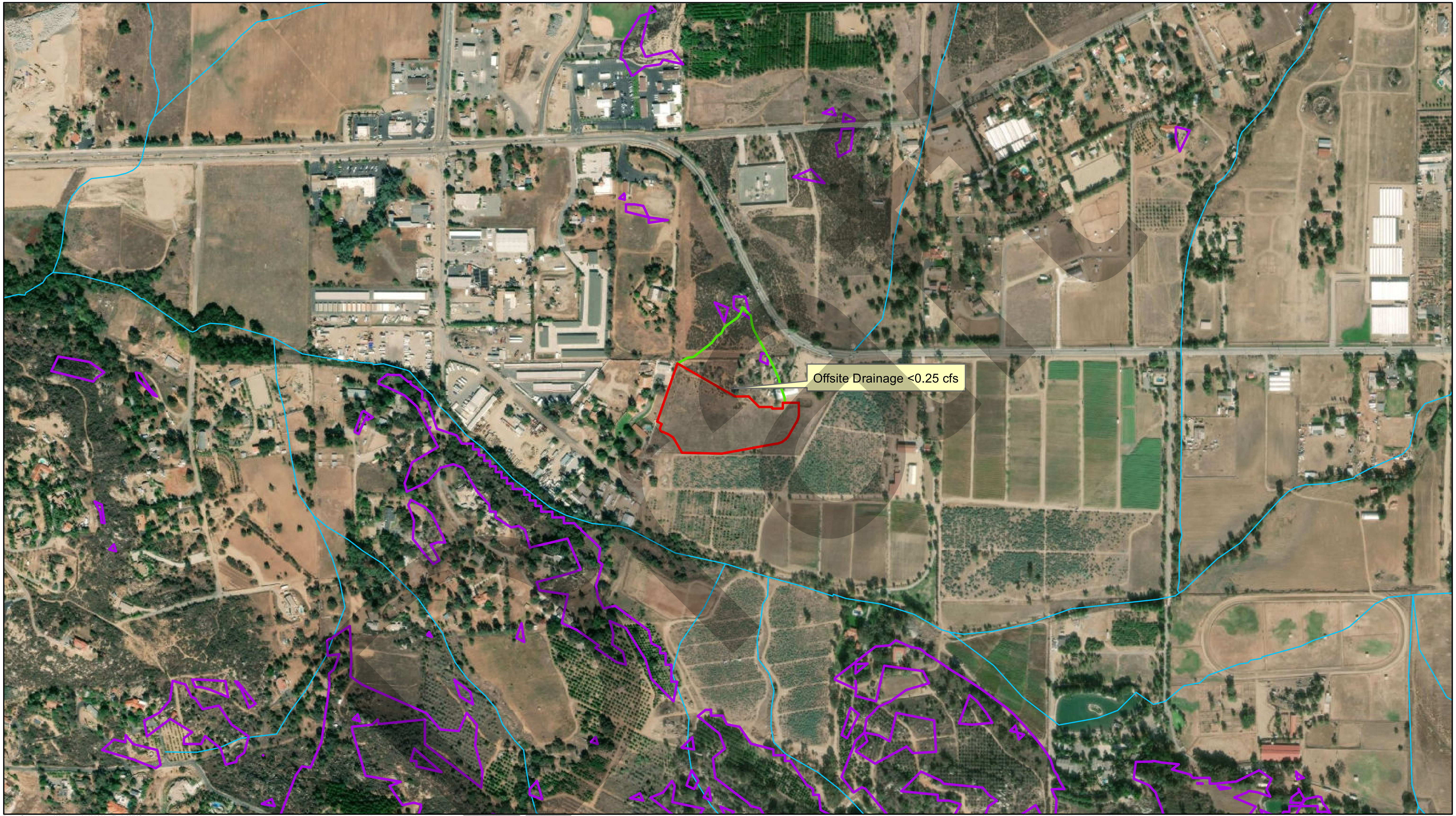
[5] RPO applicability is normally confirmed during discretionary review. Check with your project manager if you're not sure of your status.
[6] Does not include PDPs utilizing exemption(s) via RPO Section 86.604(e)(2)(cc) or 86.604(e)(3).
[7] This scenario does not impose requirements for onsite CCSYAs.

B. Explanation -- Provide documentation as needed to demonstrate that (1) onsite CCSYAs are avoided and bypassed [if applicable], and (2) upstream offsite CCYSAs are effectively bypassed. Add pages as necessary.

9.4 No Net Impact Analysis (BMPDM Appendix H.4)

- When impacts to CCSYAs cannot be avoided or effectively bypassed, applicants must demonstrate that their project generates no net impact to the receiving water per the performance metrics identified in BMPDM Appendix H.4.
- Use the space below to document that the PDP will generate no net impact to any receiving water.

No Net Impact Analysis (add or attach pages as necessary)
According to Appendix H.6 of the BMP Manual, Potential Critical Coarse Sediment Yield Areas (PCCSYAs) identified by the Regional WMAA were delineated using regional datasets for elevation, land cover, and geology. The methodology used to identify PCCSYAs from these datasets is based on the Geomorphic Landscape unit (GLU) methodology present in the Southern California Coastal Water Research Project Technical Report 605. GLUs characterize the magnitude of the sediment production from areas through three factors judged to exert the greatest influence on the variability on sediment-production rates: geology types, hillslope gradient, and land cover. The Regional WMAA document and the GIS layers for the map can be found on the Project Clean Water Website or the San Diego County Website. In the case of this project, the WMAA method was used. The attached Figure 9a was created using the GIS data available and it was determined that there are CCYSAs in the upstream watershed. The upstream watershed flow rate for the 2-year storm event was checked in order to see if the exemption of the offsite flows being less than 0.25cfs would apply. As the flows were less than 0.25cfs as seen in on Exhibit 9a it was determined that the flows did not need to be routed around the site due to the exemption and minimal potential of the CCYSAs.



Data Sources: Westwood (2020); Esri WMS Basemap Imagery (Accessed 2020); USGS (2020); FEMA (2020); USDA (2020)

Legend

- Project Boundary
- County Boundary
- Offsite Watershed
- Potential Critical Coarse Sediment Yield Areas
- NHD Flowline

N

0 500 Feet

Valley Center Storage Project

San Diego County, California

Figure 9a: CCYSA Exhibit

June 2, 2020

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Map Document: N:\0026751.00\GIS\Hydro Exhibits\2020-06-02_ValleyCenter_CCYSA -Fig9a.mxd 6/2/2020 9:36:54 AM

This form must be accepted by the County prior to the release of construction permits or granting of occupancy for applicable portions of a Priority Development Project (PDP). Its purpose is to provide documentation of the final installation of permanent Best Management Practices (BMPs) used to satisfy Structural Performance Standards for the development project. Compliance with these standards reduces the discharge of pollutants and flows from the completed project site. Applicable standards may be satisfied using Structural BMPs (S-BMPs), Significant Site Design BMPs (SSD-BMPs), or both. Applicants are responsible for providing all requested information. Do not leave any fields blank; indicate *N/A* for any requested item that is not applicable.

PART 1 General Project and Applicant Information

Table 1: Project and Applicant Information

A. Project Summary Information	**ID No. IVF-20___-____ To be assigned by DPW-WPP**
Project Name	Valley Center Storage Project
Record ID (e.g. grading/improvement plan number, building permit)	PDS2020-IC-20-003
Project Address	29523 Valley Center Road Valley Center, CA 92082
Assessor's Parcel Number(s) APN(s)	189-013-20-00
Project Watershed (complete Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)	San Luis Rey; Lower San Luis Rey 903.1
B. Owner Information	
Name	Valley Center ESS, LLC
Address	1455 El Camino Real, Suite 160 San Diego, CA 92130
Email Address	MTurner@terra-gen.com
Phone Number	916-835-7459

****THIS PAGE IS FOR PARTIAL RECORD PLAN VERIFICATIONS ONLY ****

If this is a partial Installation Verification Form submittal, list ALL DMAs and BMPs for the Priority Development Project in **Table 2**. Provide acceptance information where applicable.

Table 2: Information for Partial IVF Submittals

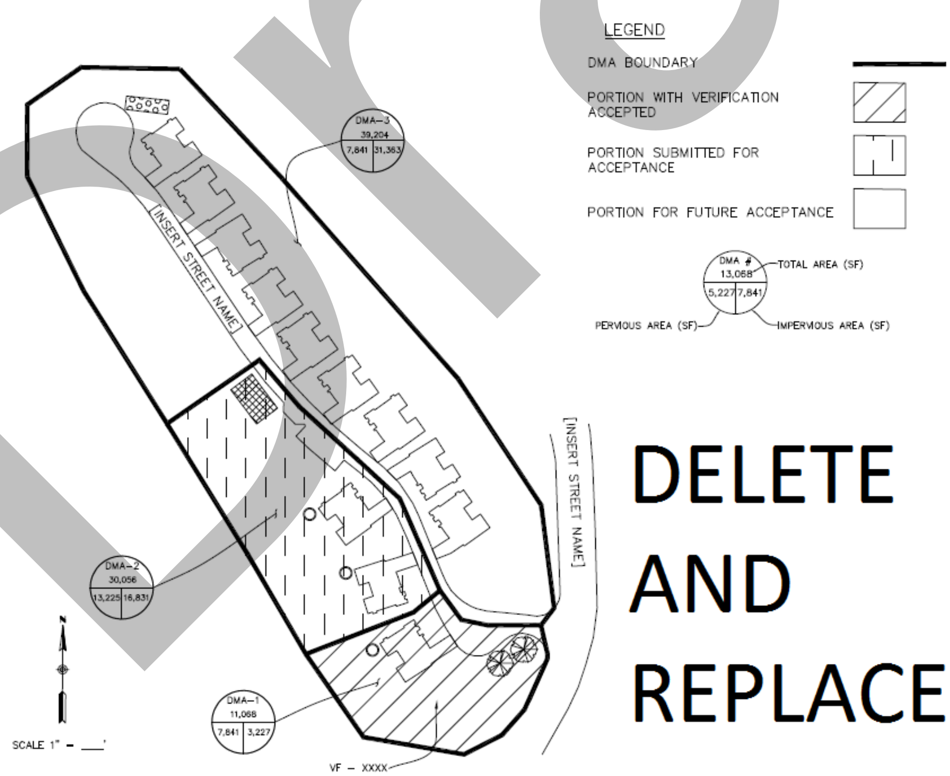
A: DMA and BMP Information

DMA #	Structural and Significant Site Design BMPs	WPP Acceptance Date	IVF ID No. (e.g. 2018-001)
1	Infiltration Basin		

B: DMA and BMP Map

Please attach a map showing (1) all DMAs for the project site, (2) the DMAs and/or lots accepted under previous Verification Forms, and (3) the locations of Structural BMPs and Significant Site Design BMPs previously accepted.

SAMPLE DMA MAP



PART 2 DMA and BMP Inventory Information

Use this table to document Structural BMPs (S-BMPs) and Significant Site Design BMPs (SSD-BMPs) for the PDP. All DMAs that are not self-mitigating or de minimis must have at least one Structural BMP or Significant Site Design BMP.

- In **Part A**, list all Structural BMPs (including both Pollutant Control and/or Hydromodification as applicable) by DMA.
- Complete **Part B** for all DMAs that contain only Significant Site Design BMPs. SSD-BMPs are Site Design BMPs (SD-BMPs) that are sized and constructed to satisfy Structural Performance Standards for a DMA.
- Documentation of SD-BMPs is not required in this table for any DMA that also contains S-BMPs.
- The information provided for each BMP in the table must match that provided in the Stormwater Quality Management Plan (SWQMP), construction plans, maintenance agreements, and other relevant project documentation.

Table 3: Required Information for Structural BMPs and Significant Site Design BMPs

DMA #	BMP Information			Maintenance Category	Maintenance Agreement or Maintenance Notification Recorded Doc. #	Construction Plan Sheet #	Landscape Plan # & Sheet # (For Vegetated BMPs Only)	FOR DPW-WPP USE ONLY *Reviewer concurs that the BMP(s) may be accepted into inventory (date and initial)*
	Quantity	Description/Type of Structural BMP	BMP ID #(s)					
Part A Structural BMPs (S-BMPs)								
1	1	Infiltration Basin	1	2	TBD	Grading Plan	TBD	
Add rows as needed								
Part B Significant Site Design BMPs (SSD-BMPs)								
		Choose an item.		---	---			
		Choose an item.		---	---			
		Choose an item.		---	---			
Add rows as needed								

PART 3 Required Attachments for All BMPs Listed in Table 3

For ALL projects, submit the following to the County inspector (check all that are attached):

☐ Photographs: Labeled photographs illustrating proper construction of each S-BMP or SSD-BMP.

☐ Maintenance Agreements: Copies of all approved and recorded Storm Water Maintenance Agreements (SWMAs) or Maintenance Notifications (MNs) for all S-BMPs.

Note: All BMPs proposed for County ownership will remain the responsibility of the owner listed on **Page 1** until a signed Letter of Acceptance of Completion is received by the DPW Watershed Protection Program.

For Grading and Improvement projects only, ALSO submit:

☒ Construction Plans: An 11" X 17" copy of the most current applicable approved Construction Plan sheets:

- ☒ Grading Plans, AND/OR
- ☐ Improvement Plans, AND/OR
- ☐ Precise Grading Plan(s) (only for residential subdivisions with tract homes), AND/OR
- ☐ Other (Please specify) Click here to enter text.

Note: For each Construction Plan, the sheets submitted must incorporate all of the following:

- ☐ A BMP Table, AND
- ☐ A plan/cross-section of each verified as-built BMP, AND
- ☐ The location of each verified as-built BMP

☐ Landscape Plans: An 11" X 17" copy of the most current applicable Landscape Plan sheets where the BMPs are required to be vegetated, including:

- ☐ The Certification of Completion (Form 407), AND
- ☐ The Certificate of Approval from PDS Landscape Architect

Note: For each Landscape Plan, the sheets submitted must show the location of each verified as-built BMP.

Required only for Verifications for Partial Record Plans

☐ If this is a partial record plan verification, please include the following:

- ☐ A list of previously submitted Verification Forms (**Table 2, A**)
- ☐ A map of DMAs and BMPs (**Table 2, B**)

PART 4 Preparer's Certification

By signing below, I certify that the BMP(s) listed in Table 3 of this Verification Form have been constructed and all are in substantial conformance with the approved plans and applicable regulations. I understand the County reserves the right to inspect the above BMPs to verify compliance with the approved plans and Watershed Protection Ordinance (WPO). Should it be determined that the BMPs were not constructed to plan or code, corrective actions may be necessary before permits can be closed.

Note: Structural BMPs (Table 3, Part A) must be certified by a licensed professional engineer.

Please sign and, if applicable, provide your seal below.

Preparer's Printed Name:

____Click here to enter text.__________________

Email: _Click here to enter text.________________

Phone Number: _Click here to enter text.________

Preparer's Signed Name:

____

Date: _Click here to enter text.__________________

[SEAL]

COUNTY - OFFICIAL USE ONLY:

For County Inspectors

County Department: ____________________

Date verification received from EOW: _____________________________

By signing below, County Inspector concurs that every noted BMP has been installed per plan.

Inspector Name: ____

Inspector's Signature: ___________________________________ Date: ________________

For Building Division Only

Inspection Supervisor Name: ____

Inspector Supervisor's Signature: ____________________________ Date: _____________

PDCI & Building, along with the rest of this package, please provide to DPW WPP:

☐ A copy of the final accepted SWQMP and any accepted addendum

For Watershed Protection Program Only

Date Received: ____

WPP Reviewer: ____

WPP Reviewer concurs that the BMPs accepted in **Part 2** above may be entered into inventory.

WPP Reviewer's Signature: __________________________________ Date: _____________

11.0 Cover Sheet and General Requirements

- All Structural BMPs must have a plan and mechanism to ensure on-going maintenance. Use the table below to document the types of agreements to be submitted for the PDP and submit them under cover of this sheet.
- See BMPDM Section 7.3 for a description of maintenance categories and responsibilities. Note that since Category 3 and 4 BMPs are County-maintained, they do not require maintenance agreements.

a. Applicability of Maintenance Agreements

Check the boxes below to indicate which types of agreements are included with this attachment.

☐ Maintenance Notification (Category 1 BMPs)

- Exhibit A: Project Site Vicinity; Project Site Map; and a map for each BMP and its Drainage Management Area
- Exhibit B: BMP Maintenance Plan (see below)

☒ Stormwater Maintenance Agreement (Category 2 BMPs)

- Exhibit A: Legal Description of Property
- Exhibit B: BMP Maintenance Plan (see below)
- Exhibit C: Project Site Vicinity Map

Maintenance agreement templates and instructions are provided on the County's website:

www.sandiegocounty.gov/stormwater under the Development Resources tab.

PDP applicants contact County staff to ensure they have the most current forms.

b. Maintenance Plan Requirements

Use this checklist to confirm that each maintenance plan includes the following that as applicable.

☐ Specific **maintenance indicators and actions** for proposed structural BMP(s). These must be based on based on maintenance indicators presented in BMP Design Fact Sheets in Appendix E and enhanced to reflect actual proposed components of the structural BMP(s).

☐ **Access** to inspect and perform maintenance on the structural BMP(s).

☐ Features to **facilitate inspection** (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds).

☐ Manufacturer and part number for **proprietary parts** of structural BMP(s) when applicable.

☐ **Maintenance thresholds** specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP).

☐ Recommended **equipment** to perform maintenance.

☐ When applicable, necessary special **training or certification** requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management.