

Chapter 16 – Engineering Software^{*}

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^{*} Chapter 16 added to Drainage Manual July 2012

Chapter 16 – Engineering Software

16.1 Software Utilized in the Electronic Development & Delivery of Plans

See VDOT CADD Manual For Software Requirements*

* Rev. 3/19

16.2 Hydraulic/Hydrologic Engineering Software in Use by The Department

16.2.1 Introduction and Disclaimer

The following section provides a link to the current list of all hydrologic and hydraulic engineering software generally utilized by the Department.

It should be noted that the Department does not necessarily prefer all software that is included on the list for a given application, nor does it reject software that is not included. The list is intended only to represent such hydrologic and/or hydraulic engineering software that the Department either currently uses or has at least summarily tested. It serves as a recommendation, not a requirement. If there is any question as to the application of hydrologic and/or hydraulic engineering software either on Department projects or those projects that will ultimately come under the Department's jurisdiction, an inquiry should be made to the Department's Central Office Hydraulics/Utilities Program.

16.2.2 Link to Appendix 16A-1

[Appendix 16A-1](#) Hydrologic/Hydraulic Engineering Microcomputer Software in Use by the Department (revised 2/2016*)

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16.3 VDOT Web-Based Hydrologic/Hydraulic Applications

16.3.1 Introduction and Disclaimer

The following section provides a link to a list of all the current web-based hydrologic and hydraulic applications in use by the Department. A User's Guide for all of the applications can be accessed on the Sign-In page.

VDOT assumes no responsibility for the use/misuse of these software products. The application of these software products is the sole responsibility of the user. There are no expressed or implied warranties. No user support for this software will be provided by VDOT.

Most of these web-based WINDOWS software modules were created to replace older DOS-based programs that will no longer function in the latest MICROSOFT WINDOWS environments. The Department no longer supports or distributes these DOS-based programs.

16.3.2 Link to Appendix 16A-2

[Appendix 16A-2 VDOT Web-Based Hydrologic/Hydraulic Applications \(revised 2/2016*\)](#)

16.3.3 Link to VDOT Web Applications Usage Agreement Form

The following is a link to the VDOT Web Applications Usage Agreement Form for External Customers (Consultant):

[VDOT Web Applications Usage Agreement Form](#)

External Customers will be required to complete and submit this form, before being issued a sign-in ID and Password.

16.3.4 Link to VDOT Web Applications Sign-In Page

The following is a link to the VDOT Web Applications Sign-In Page for External Customers (Consultant):

[VDOT Web Applications Sign-In Page \(External\)](#)

VDOT Internal Customers can access the applications through this link:

[VDOT Web Applications Sign-In Page \(Internal\)](#)

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Appendix 16A-1 Hydrologic/Hydraulic Engineering Software In Use By
The Department

**HYDROLOGIC/HYDRAULIC ENGINEERING SOFTWARE IN USE BY
THE DEPARTMENT**

HYDROGRAPH/FLOOD ROUTING

(1) HEC-HMS*

- U.S. Army Corps of Engineers' Hydrologic Modeling System
- Computer requirements: WINDOWS-based.

Source: U.S. Army Corps of Engineers – Hydrologic Engineering Center

<http://www.hec.usace.army.mil/software/hechms/>

(2) WIN TR-55

- An interactive package for calculating peak flows and hydrographs using the N.R.C.S. TR-55 procedures. Routing provisions are included.
- Computer requirements: WINDOWS-based.

Source: USDA - National Resource Conservation Service

<http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?cid=stelprdb1042901>

(3) WIN TR-20

- A program for performing hydrographic analyses & flood routing using N.R.C.S.' procedures described in their "NEH-4" publication.
- Computer requirements: WINDOWS-based.

Source: USDA - National Resource Conservation Service

<http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/null/?cid=stelprdb1042793>

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(4) CRITSTRM

- Actually "Critical Storm Duration", the program will determine the ordinates of a hydrograph for the storm even that will produce the largest volume of water for a given frequency using the Rational Formula as a basis for the calculation. This is a module of the Department's "Web-Based Hydraulics Applications".*
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

(5) PONDPACK

- WINDOWS based hydrologic modeling/routing program.
- Analyzes pre and post-developed watershed conditions and pond sizes
- Computes outlet rating curves with tailwater effects, pond infiltration, pond detention times, and analyzes channels
- Computes interconnected pond routing with divergent (multiple) outfalls
- Can use any rainfall duration or distribution to compute hydrographs
- Computes hydrographs for multiple events, adds them at junctions, and routes them through multiple reaches and ponds
- Computer requirements: WINDOWS-based.

Source: Bentley <http://www.bentley.com/en-US/Products/PondPack/>

(6) SWMSOFTVA

- WINDOWS based hydrologic modeling/routing/analysis program.
- Computes Water Quality and Water Quantity requirements in accordance with the VSMP Part IIB and Part IIC regulations.
- Analyzes pre and post-developed watershed conditions
- Designs BMP's in accordance with the VDOT BMP Manual and DEQ BMP Clearinghouse
- Computes hydrographs for multiple drainage areas and combines them at defined outfalls
- Computer requirements: WINDOWS-based.

Source: ENSOFTEC, INC.

P.O. Box 3009

Gaithersburg, MD 20885-3009

www.ensoftec.com

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PEAK DISCHARGE HYDROLOGY

(1) NSS (National Streamflow Statistics Program)

- NSS is a Windows program for estimating the magnitude and probability of peak discharges for unregulated rural and urban watersheds and for estimating other streamflow statistics for unregulated rural watersheds. NSS replaced NFF (National Flood Frequency Program) in 2004.
- Computer requirements: WINDOWS- based.

Source: U.S. Geological Survey

<http://water.usgs.gov/software/NSS/>*

(2) PEAKFQWIN

- A program for determining design peak discharges from stream gaging records (downloadable from USGS' Internet site) using the Log-Pearson Type III frequency distribution method in accordance with WRC Bulletin 17-B guidelines.
- Computer requirements: WINDOWS- based.

Source: U.S. Geological Survey

<http://water.usgs.gov/software/peakfq.html>

(3) EPSON

- A program that projects design peak flows based on analysis of annual gaged peak flows. Gage records are available on for most all gaging stations in Va. This is a module of the Department's "Web-Based Hydraulics Applications."
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

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(4) DISCHARGE*

- A program for estimating the 2, 5, 10, 25, 50, 100 and 500-yr peak flows using the Daniel G. Anderson Method ("MAGNITUDE AND FREQUENCY OF FLOODS IN NORTHERN VIRGINIA") and the Franklin Snyder Method (A.S.C.E. Journal – Hydraulics Division - October, 1958. One hundred point rainfall curves, in the form of external data files, are supplied with the program for use with the Franklin Snyder Method. This is a module of the Department's "Web-Based Hydraulics Applications".
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

(5) PQTRANS

- A program for estimating the peak discharges at an ungaged location from a nearby gaging station using both the U.S.G.S. and N.R.C.S. peak discharge transfer formulae. This is a module of the Department's "Web-Based Hydraulics Applications".
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

(6) HydrologyVA

- HydrologyVA is an engineering tool which provides computations for the different hydrologic methods used in Virginia.
- The program will calculate the following methods: Ration Method, NRCS TR-55, Anderson Method, Snyder Method, USGS Rural and Urban Regression Method, Log Pearson III
- Computer requirements: WINDOWS-based.

Source: ENSOFTEC, INC.

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(7) VIRTOC*

- A program for determining peak discharges using the Rational Formula. Program has several options for calculating both overland and channel flow time. The program uses rainfall data based on “B, D, & E” factors derived from the NOAA’s “Atlas-14” publication. This is a module of the Department’s “Web-Based Hydraulics Applications.”
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft “Internet Explorer” (or fully compatible web browser), and “Adobe Reader” for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

OPEN CHANNEL FLOW

(1) HY-15

- A program for use in designing stable linings for open channels in accordance with the FHWA “HEC-15” publication. The program was originally developed by the FHWA but the Department has re-written as a WINDOWS application and is a module of the Departments “Web-Based Hydraulics Applications”.
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft “Internet Explorer” (or fully compatible web browser), and “Adobe Reader” for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

(2) RDDITCH

- A program for use in determining depth and velocity for the 2-yr and 10-yr peak flows in roadside and median ditches. Flow characteristics are calculated for Manning’s “n” values of 0.03, 0.05 and 0.015. The program uses rainfall data based on “B, D, & E” factors derived from the NOAA’s “Atlas-14” publication. This is a module of the Department’s “Web-Based Hydraulics Applications.”
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft “Internet Explorer” (or fully compatible web browser), and “Adobe Reader” for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

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(3) RIPRAP*

- A program for designing riprap slope protection in accordance with the FHWA's "HEC-11" publication. It considers channel side slopes, bottoms, slope stability by tractive force procedures and riprap slope protection for wave action. This is a module of the Department's "Web-Based Hydraulics Applications."
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

(4) DitchSoftVA

- A WINDOWS-based application for use in designing, analyzing, and checking allowable flow velocities and depths of roadside and median ditches in accordance with Chapter 7 of the VDOT DRAINAGE MANUAL. Also allows the user to determine to test different flexible and concrete linings in accordance with the latest version of the FHWA's "HEC-25" publication. Works either as a stand-alone application or, as appropriate, in conjunction with the other modules of Ensoftec's "ENSOFT HYDRO" software suite.
- Computer requirements: Microsoft's EXCEL spreadsheet (required only to generate output using the Department's standard LD-268 form).

Source: ENSOFTEC, INC.

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Gaithersburg, MD 20885-3009

www.ensoftec.com

PIPE FLOW/CULVERT HYDRAULICS

(1) HY-8

- A program for designing and/or analyzing round culvert pipes and box culverts. HY-8 automates culvert hydraulic computations utilizing a number of essential features that make culvert analysis and design easier.
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: FHWA <https://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/>

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(2) CulvertSoftVA

- A WINDOWS-based application for use in designing/analyzing culverts using the FHWA's "HDS-5" procedures. The software also includes provisions for designing outlet protection/energy dissipators using VDOT, FHWA, & DEQ* procedures.
- Computer requirements: Microsoft's EXCEL spreadsheet (Required only to generate the Department's Standard LD-269 form and other basic reports associated with the program).

Source: ENSOFTEC, INC.
P.O. Box 3009
Gaithersburg, MD 20885-3009
www.ensoftec.com

(3) CulvertMaster

- CulvertMaster is an easy-to-use calculator product that designs new culverts and analyze existing culvert hydraulics. It can also be used to analyze: single-barrel crossings, complex embankment cross-drain systems, different shapes and sized culverts, special tailwater considerations, roadway overtopping considering watershed data, culvert characteristics, and weir geometry.
- Computer requirements: WINDOWS-based.

Source: Bentley <http://www.bentley.com/en-US/Products/CulvertMaster/>

DROP INLET/STORM SEWER DESIGN

(1) InletSoftVA

A WINDOWS-based application for use in designing/analyzing all types of drop inlets in accordance procedures presented in the VDOT DRAINAGE MANUAL and the FHWA's HEC-22 publication. Works either as a stand-alone application or in conjunction with the PipeSoftVA software package shown below.

- Computer requirements: Microsoft's EXCEL spreadsheet (Required only to generate the Department's Standard LD-204 form).

Source: ENSOFTEC, INC.
P.O. Box 3009
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(2) PipeSoftVA

- A WINDOWS-based application for use in designing/analyzing storm sewers in accordance with procedures described in the VDOT DRAINAGE MANUAL. The software will also generate a hydraulic grade line utilizing the VDOT method. Works either as a stand-alone application or in conjunction with Inletsoft software package described above.
- Computer requirements: Microsoft's EXCEL spreadsheet (Required only to generate the Department's Standard LD-229 form and other basic reports associated with the program).

Source: ENSOFTEC, INC.*
P.O. Box 3009
Gaithersburg, MD 20885-3009
www.ensoftec.com

(3) PipeProfilerVA

- A WINDOWS-based application that plots and/or displays storm sewer pipes and appurtenances (in plan profile view) using data files created by the "InletSoftVA" and "PipeSoftVA" program modules from the "Ensoft Hydro" hydraulic design software suite. Calculated hydraulic grade lines may be plotted and/or displayed. The program can also optionally generate separate storm sewer pipe and appurtenance summaries using the same data. The plots and summaries may be viewed and/or printed from with "PipeProfilerVA" but, to be included as part of an electronic plan assembly, must be used in conjunction with CADD software such as "AUTOCAD", "MICROSTATION", etc. Pipe and structure summaries may also be exported to an "EXCEL" spreadsheet.
- Computer requirements: CADD software such as "AUTOCAD", "MICROSTATION", etc. is required in order to import the program's output into a standard CADD file format. Microsoft "EXCEL" is also required if it is desired to export the summaries to a spreadsheet.

Source: ENSOFTEC, INC.
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Gaithersburg, MD 20885-3009
www.ensoftec.com

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(4) PFLOW*

- A WINDOWS-based application for use in determining flow characteristics in round pipe based on Manning's equation. This is a module of the Department's "Web-Based Hydraulics Applications.
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: ENSOFTEC, INC.
P.O. Box 3009
Gaithersburg, MD 20885-3009
www.ensoftec.com

(5) GEOPAK Drainage

- A module within the GEOPAK Design Software Package used primarily for the design of roadway drainage systems and the production of storm sewer profiles.
- Computer requirements: MICROSTATION CADD software. Program operates within the MICROSTATION environment.

Source: Bentley
<http://www.bentley.com/en-US/Products/GEOPAK+Civil+Engineering+Suite/>

(6) StormCAD

- StormCAD provides comprehensive modeling for the design and analysis of storm sewer systems. StormCAD also provides calculations for catchment runoff, gutters, inlets, junctions, pipe networks, and outfalls, and its intuitive interface makes the design and analysis of storm sewer systems.
- StormCAD includes automated constraint-based design, scenario and data management, and reporting capabilities.
- StormCAD provides comprehensive modeling for the design and analysis of storm sewer systems using a peak flow (Rational Method) approach.
- Computer requirements: WINDOWS-based

Source: Bentley <http://www.bentley.com/en-US/Products/StormCAD/>

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WATER SURFACE PROFILES / BRIDGE HYDRAULICS

(1) HEC-RAS*

- (Hydrologic Engineering Center - River Analysis System) - The U.S. Army Corps of Engineers new software package for the analysis of floodplains and bridged waterways. Full graphics package for viewing x-sections, profiles, rating curves, and 3-D floodplain views.
- Computer requirements: WINDOWS-based.

Source: U.S. Army Corps of Engineers – Hydrologic Engineering Center
<http://www.hec.usace.army.mil/software/hec-ras/downloads.aspx>

(2) FESWMS-2DH

- (Finite Element Surface Water Modeling System) is a two dimensional stream flow model which employs finite element analysis techniques.
- Computer requirements: MS-DOS 3.1 or greater operating system, 640K RAM (minimum), a 10-MEGABYTE hard disk (minimum), a math coprocessor.

Source: USGS <http://water.usgs.gov/software/FESWMS-2DH/>

(3) BRRIPRAP

- A program that calculates the size of riprap necessary to protect bridge abutments based on the FHWA's "HEC-23" publication (2009). This is a module of the Department's "Web-Based Hydraulics Applications".
- Computer requirements: Internet access, Microsoft WINDOWS, Microsoft "Internet Explorer" (or fully compatible web browser), and "Adobe Reader" for viewing, saving, and/or generating hardcopy printouts

Source: VDOT – Location & Design Web Section
<http://www.virginiadot.org/business/locdes/notification.asp>

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(4) CHECKRAS*

- A software package developed by the Federal Emergency Management Agency (FEMA) specifically for checking HEC-RAS data sets for compliance with FEMA modeling practices. Note: this software works in conjunction with HEC-RAS so it must be installed on the user's computer.
- Computer requirements: WINDOWS-based.

Source: VDOT – Location & Design Web Section

<http://www.virginiadot.org/business/locdes/notification.asp>

(5) RASPLOT

- A software package developed by the Federal Emergency Management Agency (FEMA) specifically generating water surface profile plots in FEMA's preferred format as extracted from HEC-RAS. Note: this software works in conjunction with HEC-RAS so it must be installed on the user's computer.
- Computer requirements: WINDOWS-based.

Source: Federal Emergency Management Agency (FEMA)

<https://www.fema.gov/rasplot-version-30>

INTERACTIVE HYDROLOGIC/HYDRAULIC ENGINEERING PACKAGE

(1) HYDRAIN

- (Also known as POOL FUND PROJECT) An interactive package of programs that perform most hydrologic/hydraulic engineering functions. A master program supervisor and data input shells are included to facilitate using the individual programs. The package currently includes HYDRO (a program to develop peak flows, inflow hydrographs, and analyze gaging data), HYCULV & HY-8 (programs for the design and analysis of culverts), HYDRA (a program for the design and analysis of storm sewers, sanitary sewers, and combination sewers), HY-7/WSPRO (water surface profiles) and HYCHANL (a program for designing channels, ditches & linings).
- Computer requirements: Developed for MS-DOS but will run under WINDOWS.

Source: The Federal Highway Administration, though it apparently is no longer available as a download option on their web site. You can contact Joe Krolak either by e-mail at joseph.krolak@fhwa.dot.gov or by phone at (202) 366-4611.

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Appendix 16A-1

MISCELLANEOUS

(1) FISHXING

- Assists in designing and analyzing highway culvert pipes to facilitate the passage of various fish species.
- Computer requirements: WINDOWS-based.

Source: <http://www.stream.fs.fed.us/fishxing/>*

(2) HYDRAULIC TOOLBOX

- The Hydraulic Toolbox is a computer program containing calculators that perform many of the routine hydrologic and hydraulic computations.

The following calculators are included: roadway hydrology, open channel flow, weir flow, pavement drainage, inlet capture/bypass, ditch inlet capture/bypass, detention basin routing, channel lining design (vegetation, rolled erosion control products, and rock), multiple riprap sizing applications (channel bank revetments; bridge piers, abutments, and guide banks; spur dikes; embankment overtopping; culvert outlets; open-bottom culverts; and wave attack), riprap filter design, gradation analyses via pebble count or digital image, ditch inlet capture/bypass calculator, culvert assessment tool, a profile system that allows a user defined riprap classification system, culvert assessment profiles, bridge scour calculator and the horizontal grade inlet analysis, and new map or plan view feature, which will allow the user to define a location for their calculators and visually represent their project.

- Computer requirements: WINDOWS-based.

Source: FHWA Hydraulics Engineering website

<https://www.fhwa.dot.gov/engineering/hydraulics/software/toolbox404.cfm>

(3) Terrain Navigator Pro

- Mapping software that contains high resolution scans of USGS topographic maps as well as current aerial photographs overlaid with a current street layer. These maps and photos can be customized with labels, marks, symbols, lines, routes, tracks, area fills, GIS data sets, and notes. Layers, maps, and photos can be exported to be used in other GIS and CAD software or image editor.
- Computer requirements: WINDOWS-based.

Source: MyTopo <https://www.terrainnavigator.com/>

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(4) Flowmaster*

- FlowMaster quickly performs hydraulic calculations for dozens of element types, from pipes and open channels to drop inlets and weirs.
- Computer requirements: WINDOWS-based.

Source: Bentley <http://www.bentley.com/en-US/Products/FlowMaster/>

DISCLAIMER

It should be noted that the Department does not necessarily prefer all software that is included on the above list for a given application nor does it necessarily reject software that is not included. The list is intended only to represent such hydrologic and/or hydraulic engineering software that the Department either currently uses or has at least summarily tested. It serves as a recommendation, not a requirement. If there is any question as to the application of hydrologic and/or hydraulic engineering software either on Department projects or those projects that will ultimately come under the Department's jurisdiction, an inquiry should be made to the Department's Central Office Hydraulics/Utilities Program.

As mentioned, this chapter is used to represent the most up-to-date software in use by the Department. The information shown should take precedence over older software that may be listed in previous chapters.

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Appendix 16A-2 Web-based Hydraulic/Hydrologic Applications In Use By The
Department

**WEB-BASED HYDRAULIC/HYDROLOGIC APPLICATIONS IN USE BY THE
DEPARTMENT**

PEAK DISCHARGE HYDROLOGY

DISCHAR

This module is intended for use in computing peak discharges (2, 5, 10, 25, 50, 100 and 500 yr.) for watersheds of 200 acres or more. The module uses Daniel G. Anderson's method and Franklin F. Snyder's method. Anderson's method was developed from test sites up to 570 square miles in northern Virginia. This method applies to an area of 200 acres or more. Anderson's method, entitled *Effects of Urban Development on Floods in Northern Virginia*, was published in 1968. A copy of the original study can be obtained from the U.S. Geological Survey by contacting:

U.S. Geological Survey
U.S. Books & Reports Sales
Federal Center
Box 25425
Denver, Colorado 80225
Phone: (303) 236-7476

Snyder's method was published in the October 1958 in the A.S.C.E. *Journal of the Hydraulics Division*. Refer to that publication for detailed explanation of this method. Application of the Snyder Method would be as indicated in Chapter VI of the VDOT DRAINAGE MANUAL.

EPSON - LOG PEARSON TYPE III FREQUENCY CALCULATIONS

This module is based on "Guidelines for Determining Flood Flow Frequency, Bulletin 17B" from the US Department of the Interior. It is used as an alternative Log-Pearson type III analysis to **LP3SHELL**.

This module provides a statistical analysis of stream gauge records in order to establish the discharge - frequency relationship. While this module will function with minimum of four (4) annual gauge flows, it is recognized that approximately twenty years of continuous records is required to establish a reliable gauge rating. Further, the reliability of the discharge - frequency relationship is restricted to approximately 2.5 times the length of record.

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PQTRANS – PEAK DISCHARGE TRANSFER

This module allows the user to employ peak discharges from a site, for which they are known (i.e. gauging records, etc.), and utilize them as a basis for estimating peak discharges at another site, on the same or similar nearby watershed. This is done by prorating the known discharges using two nationally recognized formulas developed for this purpose:

- 1) USGS (U.S. Geological Survey) Transfer Formula. As presented in the FHWA's publication "*User's Manual for Hydrain Integrated Drainage Design Computer System: Version 6.1*" in Volume II, "*HYDRO*."
- 2) NRCS (National Resource Conservation Service) Transfer Formula from their *NEH-4* publication

VIRTOC – VIRGINIA RATIONAL METHOD AND TIME OF CONCENTRATION

This module determines peak discharges using the Rational Formula. The program has several options for calculating both overland and channel flow time. The program utilizes NOAA ATLAS-14 Rainfall Precipitation Frequency Data for every county, and most cities, within the State.

This module was designed to be a user-friendly tool that allows the user to quickly and accurately calculate the peak flow for a given watershed. The VIRTOC module is designed to collect input and present output in English units. It allows the user to make choices in determining the variables used in the Rational formula. The user may enter all of the required variables or choose to calculate the Rational runoff coefficient, time of concentration or intensity. The format also allows the user to make changes in previous input values and recalculate the peak flow without leaving the program.

The user is advised that the use of VIRTOC is constrained by the assumptions of the Rational method and thus the program should not be used for watersheds over 200 ac in size.

Appendix 16A-2

OPEN CHANNEL FLOW

RDDITCH - FLOW IN MEDIAN AND SIDE DITCHES

This module was developed for use in determining the average velocity and depth of flow in highway roadside and median ditches. It is particularly useful in ascertaining locations where some sort of ditch lining (i.e. EC-2, EC-3, or paving) is needed. This module can handle multiple reaches of ditch and multiple cross sections (or stations) per reach. Either triangular or trapezoidal shapes can be considered and ditch side slopes and/or bottom width may vary from cross section to cross section. Depth and velocity of flow are calculated for the 2 yr. (50%) and 10 yr. (10%) peak flows for the following Manning's "n" values:

- 0.03 (assumed for natural, earth linings)
- 0.05 (assumed for protective linings, i.e. EC-2, EC-3, etc.)
- 0.015 (assumed for paved linings).

RIPRAP – BASED ON PROCEDURES PRESENTED IN FHWA'S "HEC-11" AND "HIGHWAYS IN THE RIVER ENVIRONMENT" PUBLICATIONS

This module is used for designing rip rap slope protection in accordance with the FHWA's *HEC-11* publication. It considers channel side slopes, bottoms, and slope stability by tractive force procedures and rip-rap slope protection for wave action.

The Rip-Rap module is really three (3) separate modules in one: Channel Rip-Rap Design, Wave Action Rip-Rap Design, and Tractive Force. These modules sections will be additionally segmented by these options.

HY-15 – DESIGN OF CHANNELS WITH FLEXIBLE LININGS

Originally developed by SIMONS, LI & ASSOCIATES, INC., this module analyzes flexible and concrete linings for trapezoidal or triangular channels in straight reaches. The module uses the design procedures of *Hydraulic Engineering Circular No. 15 (1988)*. The Manning's "n" value and normal depth calculated may be different from values obtained by use of charts and tables. Manning's "n" varies with the depth and is more accurately calculated by this process. The user has the option to have the module calculate the maximum Discharge (Q) for a given lining

IRRCHANL – IRREGULAR CHANNEL, STAGE-DISCHARGE

This module performs normal depth calculations in irregular shaped (natural) channels using the Manning's equation.

Appendix 16A-2

PIPE FLOW/CULVERT HYDRAULICS

PFLOW – PIPE FLOW (IN CIRCULAR PIPES)

This module will determine normal depth, discharge, and velocity in circular pipes. Both English and SI metric versions are available. This module function performs similar to the "Field's Wheel". It will calculate Velocity and:

- "Q" for a given Depth
- Depth for a given "Q"
- Friction Slope for a given Diameter
- Diameter for a given Friction Slope

BRIDGE HYDRAULICS

BRRIPRAP – SIZING RIPRAP FOR BRIDGE ABUTMENTS

This module is used to calculate the size of riprap necessary to protect bridge abutments. This module was developed using equations and procedures described in the Federal Highway Administration's publication entitled "*Bridge Scour and Stream Instability Countermeasures*" as revised in 2009. The publication is more popularly known as "*Hydraulic Engineering Circular (HEC) No. 23*". It is publication # FHWA NHI 01-003 and can be obtained at the following web address: <http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec/hec23.pdf>

HYDROGRAPH/FLOOD ROUTING

CRITSTRM – CRITICAL STORM DURATION (UTILIZING THE RATIONAL METHOD)

Actually "Critical Storm Duration", the module will determine the storm duration that will produce the largest volume of water for a given frequency using the Rational Formula as a basis for the calculation. The module has been modified from the original equations to incorporate the NOAA Atlas 14 rainfall data, using the B, D & E coefficients.

The need for and the process of determining the Critical Storm Duration is describe in chapter 6 (Hydrology), section 6.4.5.1.4 of the [VDOT Drainage Manual](#).

DISCLAIMER

NOTE: Most of these web-based WINDOWS software modules were created to replace older DOS-based programs that will no longer function in the latest MICROSOFT WINDOWS environments. The Department longer supports or distributes these DOS-based programs.