Appendix E: COMPUTER PROGRAMS AND REFERENCE MATERIALS

E.1　Computer Programs

Numerous software packages are available which provide quick and precise hydrologic and hydraulic analysis of drainage components. This is not a comprehensive listing and other programs may be acceptable. The software summarized in this appendix are primarily public sector programs which incorporate many of the procedures discussed in this manual as well as selected commercial programs that are used within Mn/DOT. For all computer applications, the engineer and/or designer must be knowledgeable regarding the procedures and analysis in order to appropriately select, use and review the results of the application.

The Table E.1 shows the modeling packages being reviewed in this appendix as well as the capabilities of these software packages.

Table E.1 Summary of Related Computer Programs

	Hydrology	Roadside Channels	Water Surface Profiles	Culverts	Pond Routing	Water Quality	Pavement Drainage	Storm Drains
GEOPAK Drainage	•	•		•			•	•
HEC-1	•				•			
HEC-2			•					
HEC-HMS	•				•			
HEC-RAS			•	•				
HY-8				•				
HYDRAIN	•	•	•	•	•		•	•
HydroCAD	•				•			
SMS/ FESWMS-2DH			•					
TR-20	•				•			
TR-55	•							
Urban Drainage		•			•		•	•
WSPRO			•					
XP-SWMM	•				•	•		•

<u>GEOPAK Drainage</u>

GEOPAK Drainage is a commercial hydraulics design package that is integrated with the GEOPAK software that Mn/DOT uses for road design. Drainage can be used to design and analyze surface collection systems and includes functions for Rational method hydrology, inlet design and spread analysis, storm drain pipe sizing and analysis, hydraulic gradeline computation, and culvert design and analysis. GEOPAK Drainage uses MicroStation for the graphical interface. Graphics are created in the design file using MnDOT CADD standards. Options are available to produce graphics and report output.

GEOPAK Drainage is available from: GEOPAK Corporation
                                       1190 N.E. 163rd St.   www.geopak.com
                                       North Miami Beach, FL 33162   305-944-5151

<u>HEC-1</u>

HEC-1 Flood Hydrograph Package was developed by the U.S. Army Corps of Engineers to simulate the surface runoff response of a river basin to precipitation. The drainage basin can be modeled as a group of subareas for which runoff hydrographs can be simulated using options including the NRCS runoff curve number, synthetic storm, and dimensionless unit hydrograph. Computed hydrographs can be routed through stream channel reaches or reservoirs and combined to give discharge hydrographs at multiple locations within the drainage basin. The data is input via a batch file, there is an input program available to help the user assemble the correct sequence of records for the HEC-1 input file.

HEC-1 is available from: U.S. Army Corps of Engineers
                                      Hydrologic Engineering Center   www. hec.usace.army.mil/
                                      609 Second Street   530-756-1104
                                      Davis, California 95616

<u>HEC-2</u>

The U.S. Army Corps of Engineers HEC-2, Water Surface Profiles, computes water surface profiles and flood plain boundaries for steady, gradually varied flow in channels. The data is input via a batch file, there is an input program available to help the user assemble the correct sequence of records for the HEC-2 input file.

HEC-2 is available from: U.S. Army Corps of Engineers
                                      Hydrologic Engineering Center   www. hec.usace.army.mil/
                                      609 Second Street   530-756-1104
                                      Davis, California 95616

<u>HEC-HMS</u>

HEC-HMS, Hydrologic Modeling System, was developed by the U. S. Army Corps of Engineers to supercede HEC-1. HEC-HMS includes most of the capabilities of HEC-1 with additional capabilities to use a linear distributed-runoff transformation for gridded (such as radar) rainfall data and a moisture depletion option to simulate extended time periods. HEC-HMS has a graphical user interface and both graphics and reporting output options.

HEC-HMS is available from: U.S. Army Corps of Engineers
                                      Hydrologic Engineering Center   www. hec.usace.army.mil/
                                      609 Second Street   530-756-1104
                                      Davis, California 95616

<u>HEC-RAS</u>

HEC-RAS, River Analysis Software, was developed by the U. S. Army Corps of Engineers to calculate water surface profiles for steady gradually varied flow. The system can be comprised of a network of channels or a single river reach. Subcritical, supercritical, and mixed flow regime water surface profiles can be computed. HEC-RAS has a graphical user interface and both graphics and report output options.

HEC-RAS is available from: U.S. Army Corps of Engineers
                                      Hydrologic Engineering Center   www. hec.usace.army.mil/
                                      609 Second Street   530-756-1104
                                      Davis, California 95616

HY-8
HY-8, Culvert Analysis Program, was developed by FHWA to design and analyze culvert system hydraulics. HY-8 has modules for culvert analysis and design, hydrograph generation and routing, and energy dissipation. The culvert module incorporates the HDS-5 procedures to analyze single or multiple culverts with varying geometries and overtopping flow. HY-8 has an interactive data input procedure. Output is available as reports and some graphics.

HY-8 is available online from FHWA: www.fhwa.dot.gov/bridge/hyd.htm

Or: McTrans   www.mctrans.ce.ufl.edu/
     512 Weil Hall   352-392-0378
     University of Florida
     Gainesville, FL 32611-6585

HYDRAIN
HYDRAIN is a suite of programs developed by GKY & Associates, Inc, for FHWA. The programs are embedded in a system shell to facilitate access to each module. The individual modules are:

HYDRA: Storm Drain and Sanitary Sewer Design and Analysis
HYDRA can design and analyze gravity sewer networks, using Rational Method for peak flow, or a user supplied hydrograph. Capabilities include inlet analysis, hydraulic gradeline computation, detention basin routing, and dynamic routing.

WSPRO: Open Channel Water Surface Analysis, Bridge Hydraulics, Scour (this program is also used as a stand-alone and is described below)

HYDRO: Hydrology
HYDRO has capabilities for calculating rainfall intensities, IDF curves, Rational method, log-Pearson Type III analysis, and hydrograph development using the USGS nationwide urban and semi-arid dimensionless hydrographs.

HY-8: FHWA Culvert Analysis and Design (this program is also used as a stand-alone and is discussed above)

HYCHL: Flexible and Rigid Channel Lining Design and Analysis
HYCHL can design and analyze a variety of channel lining materials using the criteria from the FHWA publications: HEC-15, "Design of Roadside Channels with Flexible Linings," and HEC-11, "Design of Riprap revetment."

NFF: USGS National Flood Frequency Program
NFF will solve the USGS Regression Equations, it includes the 1987 version of the equations for Minnesota.

HYDRA, WSPRO, and HYDRO use a batch input format. The editor provided with HYDRAIN assists the users in preparing the input files. HY-8, HYCHL, and NFF have interactive input procedures. Output is available as reports with limited graphics.

HYDRAIN is available online from FHWA: www.fhwa.dot.gov/bridge/hyd.htm

Or: McTrans   www.mctrans.ce.ufl.edu/
     512 Weil Hall   352-392-0378
     University of Florida
     Gainesville, FL 32611-6585

HydroCAD

HydroCAD is a commercial software application that generates and routes hydrographs through ponds and channels. It incorporates the NRCS runoff curve number, synthetic storm, and dimensionless unit hydrograph procedures and is considered an alternative to TR-20 (see below). HydroCAD also has capabilities to analyze the hydraulics of outlet structures. HydroCAD has an interactive data input procedure that includes a graphical interface for laying out then drainage systems components. Output options include reports and graphs.

HydroCAD is available from:

Applied Microcomputer Systems
P.O. Box 350
Chocorua, NH 03817

www.hydrocad.net
603-323-8666

SMS/FESWMS-2DH

SMS (Surface Modeling System), a commercial product of Brigham Young University, is a graphical user interface for developing and displaying the results of 2-dimensional models (including FESWMS-2DH) of river systems. FESWMS-2DH is a numerical model developed for FHWA that solves the system of equations describing two-dimensional depth-averaged flow in a horizontal plane using the finite element method. FESWMS was developed primarily to evaluate complex hydraulic conditions at highway river crossings. FESWMS is a complicated model to develop the input data for and successfully run. SMS has a graphical user interface that facilitates the development of the necessary model input, output options include a variety of graphical products and reports.

SMS is available from:

Environmental Modeling Systems Incorporated
1890 West 719 North #38B
Provo, UT 84601

www.ems-i.com/software.html
801-373-5200

TR-20

TR-20 (Computer Program for Project Formulation Hydrology) was developed by NRCS to automate hydrographic analysis of watersheds using the runoff curve number, synthetic storm, and dimensionless unit hydrograph procedures. The program capabilities include hydrograph generation, routing through channels and reservoirs, and comparison of discharges for varying watershed parameters. TR-20 has a batch input format, there is a program that helps the user develop an input file. Output is available as text reports.

TR-20 is available online from NRCS at:

www.wcc.nrcs.usda.gov/water/quality/wst.html

TR-55

TR-55, developed by NRCS, contains simplified procedures to perform hydrologic analysis. Capabilities include peak flow using NRCS graphical procedures), time of concentration and travel time, tabular hydrograph generation, and an estimated or required detention storage volumes. TR-55 has an interactive data input procedure, output is in the form of text reports.

TR-55 is available online from the NRCS at:

www.wcc.nrcs.usda.gov/water/quality/wst.html

Or from:

PC-TRANS
2011 Learned Hall
Lawrence, KS 66045

kuhub.cc.ukans.edu/~pctrans/index.html
913-864-5655

Urban Drainage

The Urban Drainage Design Software (HY-22) is a collection of programs developed for FHWA that have capabilities for storm drain inlet analysis, channel flow hydraulics, and reservoir routing. These programs have an interactive data input procedure, and output data is available as a text report.

Urban Drainage (HY-22) is available online from FHWA: www.fhwa.dot.gov/bridge/hyd.htm

Or: McTrans   www.mctrans.ce.ufl.edu/
                     512 Weil Hall   352-392-0378
                     University of Florida
                     Gainesville, FL 32611-6585

WSPRO

WSPRO, Water Surface Profile, was developed for FHWA and is used to analyze one-dimensional, gradually-varied, steady flow in open channels. WSPRO can also be used to analyze flow through bridges and culverts, embankment overflow, and scour at bridges. WSPRO has a batch data input format, the HYDRAIN line editor (see description of HYDRAIN above) can be used to facilitate data entry. Output is available in text report files.

WSPRO (HY-7) is available online from FHWA: www.fhwa.dot.gov/bridge/hyd.htm

Or: McTrans   www.mctrans.ce.ufl.edu/
                     512 Weil Hall   352-392-0378
                     University of Florida
                     Gainesville, FL 32611-6585

XP-SWMM

XP-SWMM is a commercial application that incorporates the EPA Storm Water Management Model (SWMM) along with an enhanced user interface and additional features. SWMM is a comprehensive model for simulating runoff quantity and quality through all aspects of the hydrologic cycle. Capabilities include surface runoff, dynamic routing through the drainage system, storage, and treatment effects. SWMM is a complex model with many features. XP-Software has added the capability of using NRCS runoff and hydrograph procedures. XP-SWMM has a graphical user interface to facilitate data input, output options include text reports and a variety of graphic plots.

XP-SWMM is available from: XP-Software, Inc.   www.xpsoftware.com.au
                           2000 NE 42nd Ave, Suite 214   888-554-5022
                           Portland, Oregon, 97213-1305

E.2   Reference Material Sources

Minnesota Department of Transportation Manuals can be obtained through:

Map and Manual Sales
M.S. 260 Room G19
Transportation Building
295 John Ireland Blvd.
St. Paul, MN 55155

Phone: (651) 296-2216

This Federal Highway Administration's Hydraulic Engineering Circular (HEC) and Hydraulic Design Series (HDS) listing is based on an April 17, 2000 update. The Hydraulics publications listed in this reference list are available through either NTIS or the FHWA Report Center. The publications are not available from the Bridge Division.

Hydraulic Design Series (HDS)

		YEAR	FHWA-#	NTIS-#
HDS 1	Hydraulics of Bridge Waterways	1978	EPD-86-101	PB86-181708
HDS 2	Highway Hydrology (SI)	1996	SA-96-067	PB97-134290
HDS 3	Design Charts for Open-Channel Flow	1961	EPD-86-102	PB86-179249
HDS 4	Introduction to Highway Hydraulics (SI)	1997	HI-97-028	PB97-186761
HDS 5	Hydraulic Design of Highway Culverts *	1985	IP-85-15	PB86-196961

Hydraulic Engineering Circulars (HEC)

		YEAR	FHWA-#	NTIS-#
HEC 9	Debris-Control Structures	1971	EPD-86-106	PB86-179801
HEC 11	Design of Riprap Revetment	1989	IP-89-016	PB89-218424
HEC 12	Drainage of Highway Pavements	1984	TS-84-202	PB84-215003
HEC 14	Hydraulic Design of Energy Dissipators for Culverts & Channels*	1983	EPD-86-110	PB86-180205
HEC 14	Hydraulic Design of Energy Diss. for Culverts & Channels (SI) (4.9 M)	1999		
HEC 15	Design of Roadside Channels with Flexible Linings *	1988	IP-87-7	PB89-122584
HEC 17	The Design of Encroachments on Flood Plains using Risk Analysis	1981	EPD-86-112	PB86-182110
HEC 18	Evaluating Scour at Bridges, Edition 3 (SI)	1995	HI-96-031	PB96-163498
HEC 20	Stream Stability at Highway Structures, Edition 2 (SI)	1995	HI-96-032	PB96-163480
HEC 21	Bridge Deck Drainage Systems	1993	SA-92-010	PB94-109584
HEC 22	Urban Drainage Design Manual (SI)	1996	SA-96-078	PB97-134308
HEC 23	Bridge Scour and Stream Instability Countermeasures (SI)	1997	HI-97-030	PB97-199491

Hydraulic Reports

		YEAR	FHWA-#	NTIS-#
HI	Highways in the River Environment	1990	HI-90-016	PB90-252479
TS	Underground Disposal of Storm Water Runoff, Design Guidelines Manual	1980	TS-80-218	PB83-180257
TS	Guide for Selecting Manning's Roughness Coefficient For Natural Channels & Flood Plains	1984	TS-84-204	PB84-242585
IP	Culvert Inspection Manual	1986	IP-86-2	PB87-151809
IP	Structural Design Manual for Improved Inlets and Culverts *	1983	IP-83-6	PB84-153485
FLP	Best management Practices for Erosion and Sediment Control	1995	FLP-94-005	
RD	Countermeasures for Hydraulic Problems at Bridges, Vol. 1 Analysis and Assessment	1978	RD-78-162	PB-297132
RD	Countermeasures for Hydraulic Problems at Bridges, Vol. 2 Case Histories	1978	RD-78-163	PB-297685

Publications on CD-ROM **

		YEAR	FHWA-#	NTIS-#
HDS-5	Hydraulic Design of Highway Culverts (CDROM), v. 1.00	1996	SA-96-080	N/A
	Installation and User's Guide	1996	SA-96-081	N/A

'*' Several manuals are also available from McTrans. These are marked with a "*".
'**' The publications on CD-ROM are only available from Pallas, Inc These are marked with a "**"

Most of the Federal Highway Administration hydraulics publications listed are available through either NTIS or the FHWA Report Center. Contact information for these offices is listed below. Contact NTIS to obtain copies of any publication that has a listed NTIS number. FHWA now has a number of manuals (including HEC-22, HDS-5, HEC-12) available electronically at http://www.fhwa.dot.gov/bridge/elibrary.htm

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Phone: (703)605-6000 or 1-800-553-NTIS
Fax: (703)605-6900
E-mail: orders@ntis.fedworld.gov
Internet: http://www.fedworld.gov/ntis

Or

Federal Highway Administration Report Center
9701 Philadelphia Court, Unit Q
Lanham, MD 20706
Phone: (301)577-0818
Fax: (301)577-1421
Email:Report Center

Software Order Information
The software and related publications listed below are available from either McTrans or PC-Trans. The user's manuals are also available through NTIS or the FHWA Report Center like other publications McTrans
512 Weil Hall
University of Florida
Gainesville, FL 32611-6585 Phone: (352)392-0378
Fax: (352)392-3224
Internet: http://www-mctrans.ce.ufl.edu/

Or

PC-TRANS
2011 Learned Hall
Lawrence, KS 66045
Phone: (913)864-5655
Fax: (913)864-3199
Internet: http://kuhub.cc.ukans.edu/~pctrans/index.html

CD ROM order information
Pallas, Inc.
8 Inverness Drive East,
Suite 245
Englewood, CO 80112
Phone: (303) 790-9001
Fax: (303) 790-9008
Email: Pallas@PallasInc.com
Internet: http://www.pallasinc.com/