

HY-8 Quick Start Guide

This Quick Start guide is intended to provide essential information for installing and running the updated version 7.2 of the HY-8 culvert hydraulic analysis and design program (HY-8 7.2).

HY-8 is a computerized implementation of FHWA culvert hydraulic approaches and protocols. The HY-8 program is available at no charge to the hydraulic and transportation communities.

The FHWA has been producing computerized culvert hydraulic software since the early 1960's (with the HY-1 program). The FHWA released the initial version of the HY-8 program in the early 1980's. FHWA released the original Windows version (7.0) in March 2007 and the second phase update (7.1) in July 2008). The HY-8 program has successfully operated on all current "flavors" of the Windows operating system.

HY-8 7.2 represents a "maintenance phase" of the FHWA's multi-phase culvert hydraulic software upgrade plan. In the future, the plan calls for using a pooled fund effort¹ to fund and support incremental upgrades and additions of features, based on available time, budget, and adoption of new hydraulic practices and techniques.

What's in this Quick Start Document

This document includes information about:

- Technical Methods
- Downloading Software
- Installing the program
- What's New
- Way to report bugs or other problems.

Technical Methods

The technical methods applied in the updated HY-8 program are based on the FHWA publications:

- "Hydraulic Design Series 5: Hydraulic Design of Highway Culverts" (HDS-5) [publication FHWA-NHI-01-020, May 2005 revision]
- "Hydraulic Engineering Circular 14: Hydraulic Design of Energy Dissipaters for Culverts and Channels" (HEC-14) [publication FHWA-NHI-06-086, Third Edition, July 2006]

These documents should be considered the primary technical reference for the software.

NOTE: To save download time, the HY-8 installation file DOES NOT include the HDS-5 and HEC-14 documents as a portable document format (PDF) file.

¹ For details or to participate in the pooled fund effort (State DOTs or governmental entities), please go to <http://www.pooledfund.org/projectdetails.asp?id=428&status=4>.

However, both documents can be downloaded from the FHWA website² and placed onto the HY8 folder. Once there they are accessible from the HY-8 program Help menu. Hard copies of HDS-5 and HEC-14 can be created by printing the PDF files.

HY-8 and FEMA NFIP analyses

FHWA certifies that this version of HY-8 7.2 continues to represent reviewed, tested, and accepted software for the purposes of performing FHWA culvert analyses regulated under FHWA's 23 CFR 650 Subpart A and meeting 44 CFR 65.6(a)(6) in the FEMA NFIP regulations.

Downloading

The installation package zip file ("HY8_7_2_0.zip") can be obtained by downloading from the FHWA Hydraulic website³: www.fhwa.dot.gov/engineering/hydraulics/software/hy8.

Disclaimer & Terms of Use

As stated in the FHWA Hydraulics website, by downloading the software, the user is agreeing that they accept responsibility for understanding the following conditions and limitations, and agrees to them:

- FHWA does not provide user assistance or support for this software.
- The application of this software is the responsibility of the user. It is imperative that the responsible engineer understands the potential accuracy limitations of the program results, independently cross checks those results with other methods, and examines the reasonableness of the results with engineering knowledge and experience.
- There are no expressed or implied warranties.

File Size Contents & Download Location

The download file is relatively large: 33 megabytes (MB). This is a result of adopting a different installation program, and more significantly, including Microsoft's .NET 2.0 redistributable package (.NET) as a part of the installation. HY-8 depends on having this package installed for some of the features such as the virtual earth map locator tool. The installation program checks whether .NET is installed on the computer, and if not, it is automatically installed.

The installation package can be downloaded to any location (for example, folder "C:\Temp") on the user's computer.

Prior to Installation

The development team modified this release so that older versions of HY-8 can remain on the user's system. In doing so, the user may end up with multiple versions (DOS, version 7.0, etc) on their computer.

² FHWA hydraulic publications located at: http://www.fhwa.dot.gov/engineering/hydraulics/library_listing.cfm

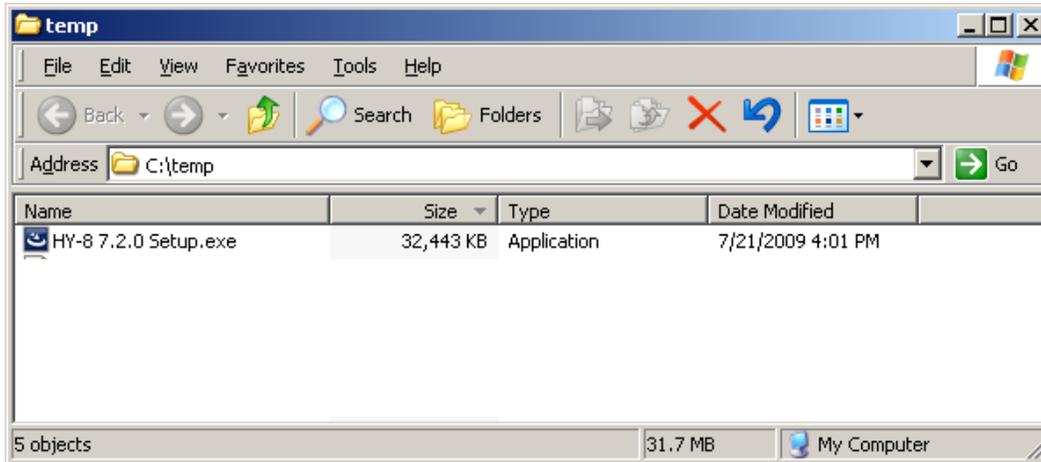
³ Note: some users have reported issues with downloading the complete file (zip file should be 32,109 kb). In these cases, the download process is interrupted, resulting in a partial file. Usually this manifests itself in an error message "corrupt file encountered" when trying to unzip the setup file. The solution appears to be to repeat the download process as needed.

If a user wishes to remove the older Windows versions, they can go to the Windows Control Panel and use the Add/Remove programs command. When doing so, project files you have created will not be deleted, but will remain in the program folder.

Installation⁴

Once downloading “HY8_7_2_0.zip” to your computer, extract the installation package setup file “HY-8 7.2.0 Setup.exe” to the desired location (i.e., “C:\temp”).

Begin the installation by going to the folder where the installation package setup file is located and double-clicking (opening) the file “HY-8 7.2.0.exe”.



Once double-clicking (opening), you may get a screen such as:



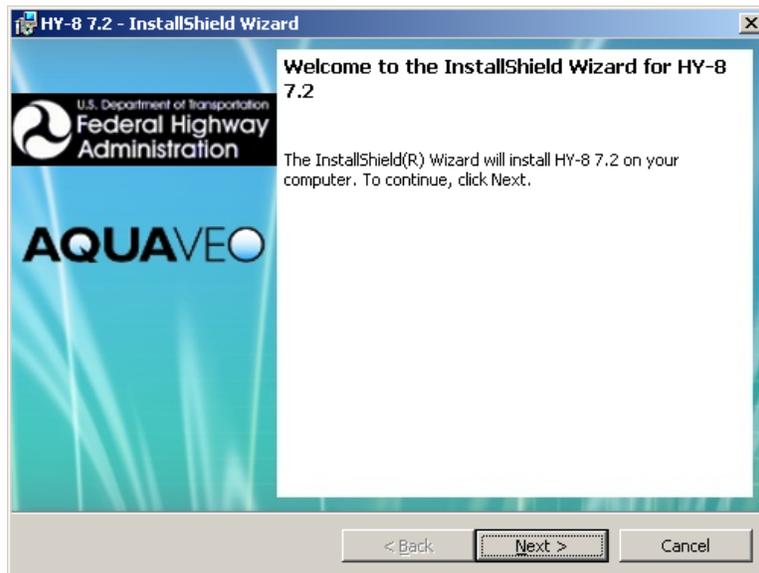
FHWA is the Publisher of HY-8. Click “Run” to continue installation.

⁴ Depending on the operating system, HY8 installation may require access to Administrator rights. Should this be the case, contact your system or network administrator for assistance.

You will see the InstallShield program preparing the setup (below)



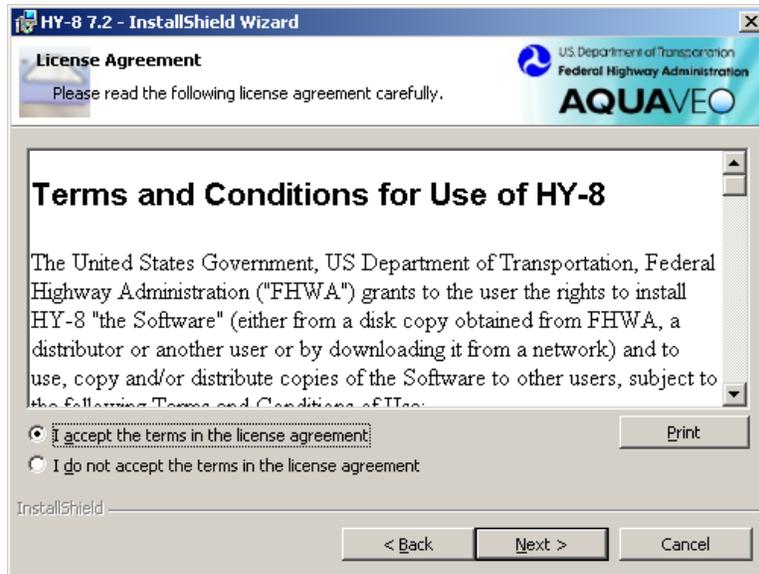
Then the first InstallShield Wizard setup screen will appear (AquaVeo is part of the HY-8 development team). Clicking “Next >” continues to the next screen.



Accepting Terms and Conditions

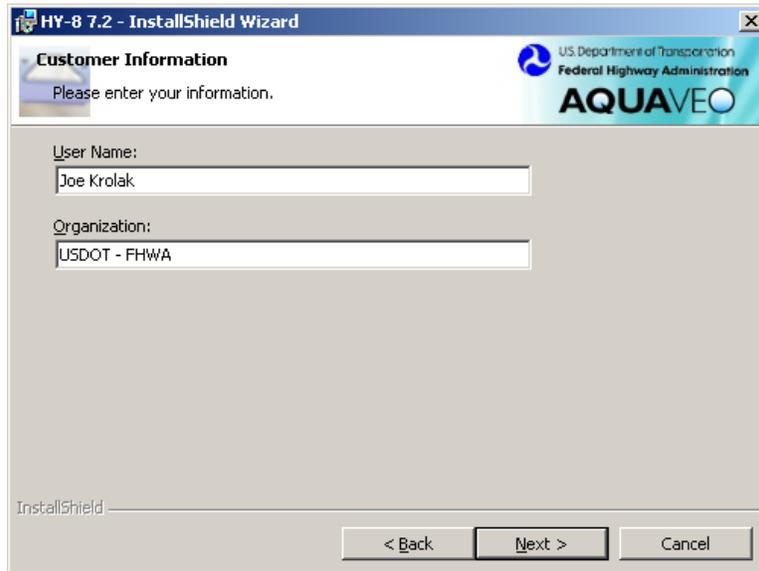
During the installation, the user is once again asked to review and accept the Terms and Conditions for using the HY-8 software.

Please read these carefully! Failure to accept these terms will result in non-installation of the program. The “Next >” option only becomes active when accepting the agreement.



Customer Information

The user will be prompted for their name and organization for which they work. The default information is taken from the user’s computer. Information needs to be placed in BOTH fields (the information is not yet used by the program, but may be used later for user support purposes).



Installation Location

The setup program will now provide a screen that depicts the default destination folder “C:\Program Files\HY-8\7.2\”

The user can choose to either use this default folder or to use (or create) a different folder location.



Selecting the Default Destination Folder

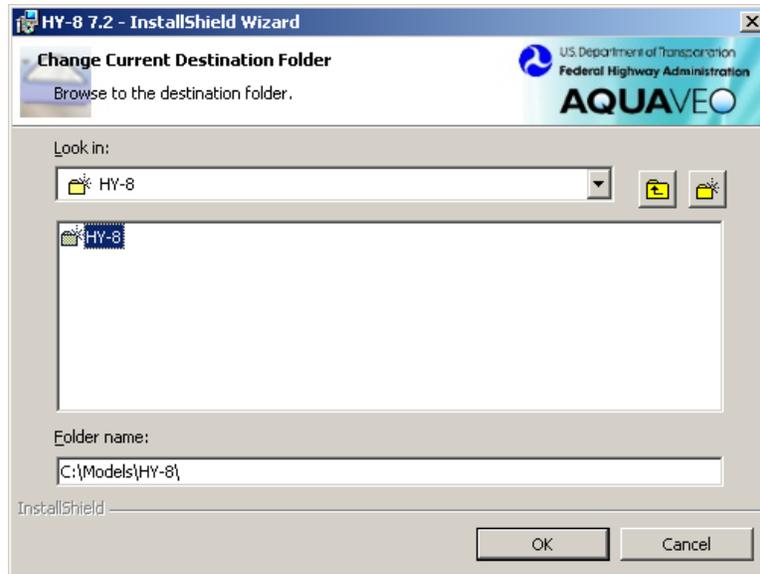
Clicking on “Next >” installs the program in the default location for program installation folder: “C:\Program Files\HY-8\7.2.0\”. This scheme allows the user to keep both version 7.2.0 and older versions on their system.

As well as installing Program Files, the setup program also adds a tutorial (“QuickTutorial.pdf”) and sample input files to the system. Altogether, these Program, Tutorial, and Sample files require about 31 MB of free storage space.

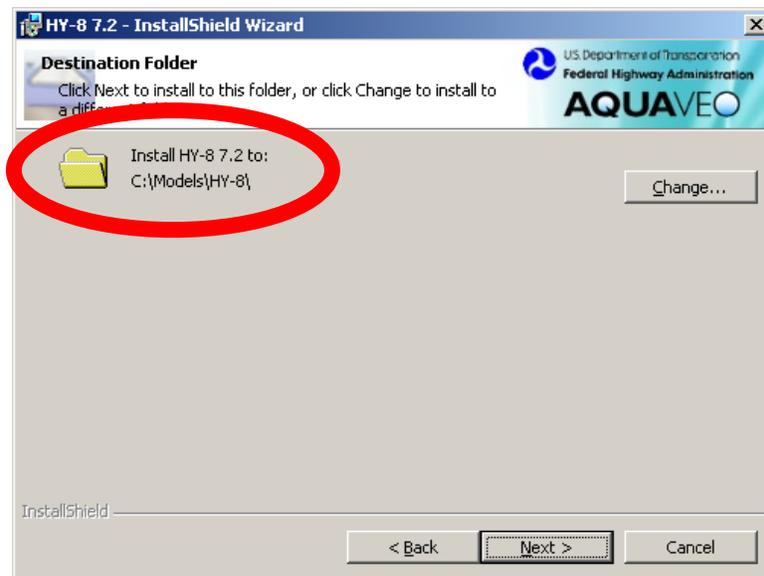
Changing the Destination Folder

(Suggested for Advanced Users Only). The setup program allows a user to change the location to any directory without affecting the performance of the program.

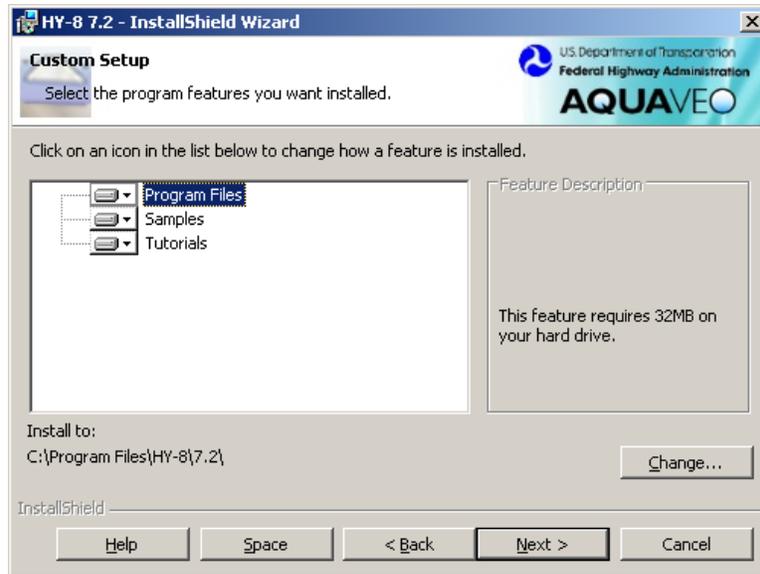
Use the “Change” option to select an alternative (or new) folder. (As depicted in the example below, the user decided to install HY-8 7.2.0 into a folder “C:\Models\HY8” ...)



Selecting “OK” returns the user to the previous screen, but with the selected folder name.



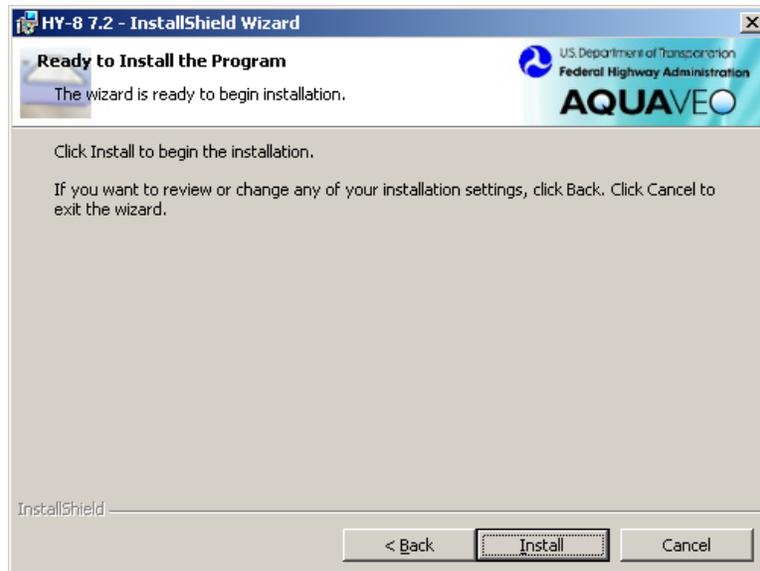
Once clicking on “Next”, the installation option allows the user to specify which features they wish to install. (Note: the Program Files MUST be installed for HY-8 to work. The Samples and Tutorial files only consist of approximately 1 to 2 MB of space).

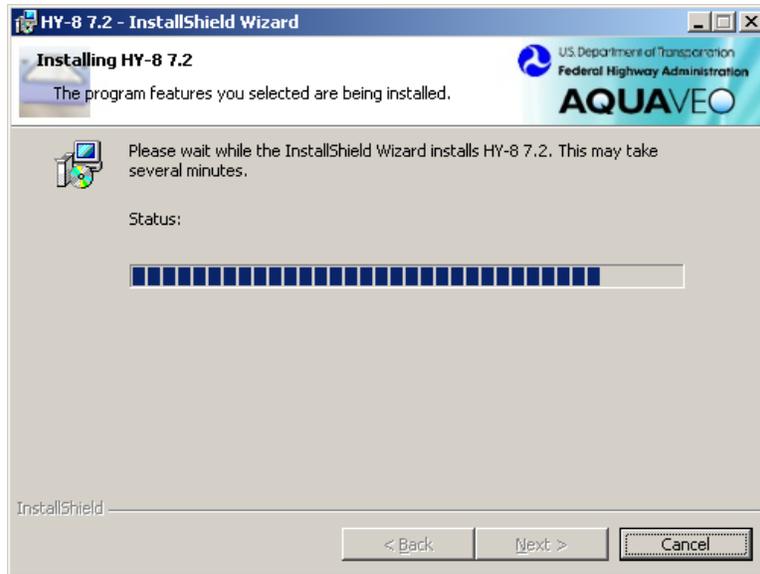


Clicking “Next >” leads the user to the Installation screen.

Installation Screen

Whether selecting the “Complete” or “Custom” installation type, the next screen prompts the user to install the program. Clicking on “Install” begins actual installation ...





After installing all required files, the final screen in the setup Wizard will prompt the user to “Finish”. Clicking “Finish” returns the user to their desktop.



Accessing the HY-8 program file

The installation program will place a shortcut to the HY-8 program on the desktop.



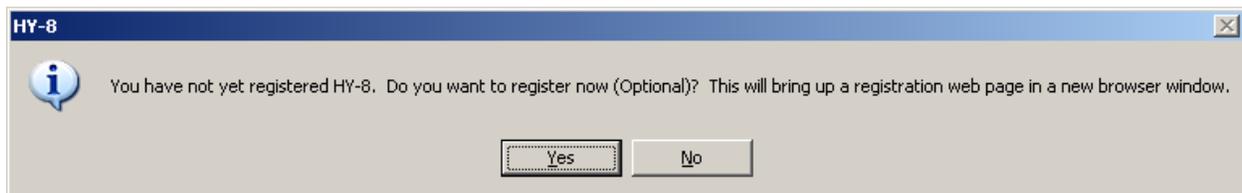
The Setup program will also automatically add a link to the HY-8 program that can be accessed by clicking on *Start*, selecting *Programs*, and looking under the *HY-8* folder until encountering the *HY8* program icon.

Users with some experience with Windows may create additional shortcuts from here or by selecting the HY8.exe file found within the (default) C:\Program Files\HY-8\7.2\ folder.

After Installation, a user is ready to run the HY-8 program (there should be no need to Restart the computer).

Registration Option

When running HY-8 the first time, the user is prompted as whether they wish to register the program.



This registration is totally optional. The only use of this information is to allow the development team to contact registrants about HY-8 program upgrades. FHWA does not allow any release of this information to any other groups or parties.

Windows & DOS Versions: Changes and Additions

An important objective of the conversion of the HY-8 program to a Windows platform was maintaining the basic philosophy and simplicity of model input and operation. Additionally, a project development goal was to provide some backward compatibility in reading the existing input files (.INP).

While FHWA and the development team feels these goals and objectives have been largely achieved, there were obviously some things that FHWA wanted to change and add in order to take advantage of the more modern Windows operating system. This section outlines these changes and new features and will serve as a road map to users who have long used the DOS version of HY-8.

The Project File Approach

The new version of HY-8 differs from earlier DOS based version in adopting a *Project File* approach. These project files are implemented into the *Project Explorer* – allowing quick

selection and application of a specific culvert system⁵. As described below, the addition of this approach adds utility in (1) organizing and applying culvert systems within multiple drainage crossings and (2) during analyses of different design configurations and materials.

Multiple Drainage Crossings

The DOS version of HY-8 only allowed analysis or design of a single drainage crossing. While the user could define multiple culverts and barrels (systems) at this crossing, if an overall roadway project included many such crossing sites, each would need to be separated into a different input file.

This led to the proliferation of many separate culvert input files associated with a single roadway project. Some practitioners described their confusion in distinguishing which culvert file was associated with which drainage crossing within a project.

In the new version of HY-8, any number of crossings can be defined within the *project file*. Users now have the option of performing an analysis on several crossings and grouping them together. A new mapping feature (described below) helps the user to create a map identifying each crossing that can be included in their report.

Of course, the Windows version retains the older version's ability to consider only a single drainage crossing. This single crossing can also still consist of multiple culvert systems (e.g., three circular barrels at one invert [system 1] and a box culvert at another invert [system 2] at the same roadway crossing).

Design Alternatives

The new version of HY-8 also provides an improved means to consider separate design alternatives of the same crossing within the same project file. In the DOS version of HY-8, a user would either have to load them as separate files, or make the incremental changes and reevaluate a single file.

The new version of HY-8 provides the user the option of “copying” a culvert and associated crossing information. With this “duplicate crossing” the user can make any change(s) they wish to evaluate. The project explorer then makes it easy to toggle back and forth between the alternative crossing designs.

File Conventions

The Windows version of HY-8 saves these Project Files using a “.HY8” extension. Unlike the DOS version of HY-8, the new version allows any file name format and length allowed by Windows. While HY-8 can read in older version .INP files, to protect this new utility and format, files can only be saved using this new format (and using the new “.HY8” files extension).

⁵ As in prior versions of HY-8, a *culvert system* is considered as a collection of culverts, having the same type, material, inlet, dimension, and layout (invert elevations, length) characteristics. So a single barrel corrugated metal pipe or a box culvert with cell barrels (cells) would be considered a system, whereas, if a crossing had both a circular HDPE AND a pipe arch, these would be considered two systems. A potential reason for multiple culvert systems at a crossing would be to allow “critter crossings” in one system and normal discharge through the other system.

Order of Input

The DOS version of HY-8 presented the input as a series of linear, sequential input screens. The order always began with the discharge, followed by the culvert information, followed by the tailwater data, and ended with the roadway information.

In the Windows version of HY-8, a single input screen presents all of the input necessary to analyze a single crossing.

However, there are some important subtleties - the grouping of the information has been organized into “crossing” information and the “culvert” information. The discharge, tailwater, and roadway data are unique to the crossing while the culvert shape, inlet conditions, and site data define a culvert within the crossing.

This grouping, and therefore subsequent tabbing through the main input screen, does not follow the same linear progression of input as the DOS versions of HY-8.

What’s New in Version 7.2.0?

HY-8 version 7.2.0 primarily consists of maintenance efforts designed to address and eliminate known bugs and program foibles. Some other newer features include:

- HY-8 can plot multiple barrels in the front view. The user can specify the spacing distance between the barrels (reflecting thickness of cell wall).
- HY-8 provides a spreadsheet of the length, depth, area, velocity, energy slope, and shear of a computed profile within the barrel.

Known HY-8 Issues

A few issues continue to exist in HY-8. The intent of the FHWA is to correct these and other issues as budget and time allow. The following is a list of these issues:

1. HY-8 does not attempt to show the location of a hydraulic jump in the culvert profile.
2. If more than one flow type exists for the culvert profile, HY-8 does not attempt to show multiple profiles, but only that of the design discharge.
3. **NOTE:** The user should be aware that when the tailwater elevation exceeds the elevation of the top of the culvert outlet, HY-8 assumes that the barrel flows full at the outlet and reports an outlet velocity corresponding to full flow. A more detailed description of this limitation is given in the Help document under the limitations topic.
4. The new version of HY-8 does not support culverts with multiple slopes (broken back), hydraulic jumps, and adverse slopes. These are being added in the next phase of this effort.
5. The DOS version of HY-8 generated a comprehensive table that could be sent to a text file. However the old version lacked the ability to include graphs and take advantage of formatting in modern word processing programs. The Windows version of HY-8 includes Report Generation tools that are customizable, allow many options for plots, and are saved in rich text format (RTF) or portable document format (PDF). The primary target for the report is an MS-Word document; however, an rtf format is readable by many word processing programs. A few issues related to Report Generation remain in this version.

Each time a table or graph is written to the report, the report starts a new page. This can make reports longer (wasting paper). The HY-8 7.2 QuickTutorial document describes a workaround to this issue.

Getting Help

Beyond this and the HDS-5 document, the majority of the HY-8 documentation is self contained within the program. The functional use of the program is documented in the hyper-linked help file available from the Help menu or by selecting help buttons or icons (🔗) from the graphical user interface. While the help file is organized to provide context-sensitive help, it can be printed out and organized into a hard copy manual.

Additionally, the National Highway Institute provides courses on application of the HY-8 software (135081 – Introduction to Hydraulic Highway Software” and other courses).

While FHWA does not offer any user support (as described in the Terms and Conditions for downloading and using the program), comments and bug reports may be sent to:

CommentsOnHY8@dot.gov

The Next Phase ...

The next development phase (“third phase”) uses a pooled fund effort⁶ to fund and support incremental upgrades and additions of features, based on available time, budget, and adoption of new hydraulic practices and techniques.

The project will consist of several tasks (some of which are described below. These tasks are listed in no particular order – where possible, the tasks may be developed concurrently).

Some tasks will require technical review and approval by PFP members before any programming efforts. This ensures these correspond to FHWA (or AASHTO) guidance and practices.

- **Hydrograph Routing:** Implement hydrograph routing into the HY-8 program. The routing approach will be consistent with FHWA methods and practices. The data for determining the inflow hydrograph and stage-storage curves would be supplied by the user. The task will also consider additional approaches to enter this information.
- **Hydraulic Jump Code Implementation:** The phase two HY-8 development efforts developed a theoretical framework and “pseudo-code” for computing hydraulic jumps. The FHWA reviewed the resulting product to ascertain whether they corresponded to FHWA guidance and practices. This task will implement algorithms for analyzing hydraulic jumps in available HY-8 shapes. The task will borrow logic from the BCAP program for hydraulic jumps to facilitate the necessary calculations, but will enhance the approach by computing a backwater curve upstream from the culvert outlet.
- **Broken Back Culvert Code Implementation:** Implement algorithms for analyzing broken-back culverts for all currently available HY-8 shapes. Incorporating a broken-back shape into

⁶ For details or to participate in the pooled fund effort (State DOTs or governmental entities), please go to <http://www.pooledfund.org/projectdetails.asp?id=428&status=4>.

HY-8 represents a major change in coding structure and logic because the hydraulic control for headwater calculations may occur at the culvert inlet, break in slope, or outlet.

- **Allow Modification of the Individual Analysis Discharge Values:** In the past, users have only been allowed to enter a minimum, design, and maximum value for discharge. HY-8 computes 11 discharge values based on these three values, and there is no way to edit the individual values that HY-8 computes. The task would then implement a means to allow users to modify the flow values that HY-8 uses to compute the performance table in the Culvert/Crossing input dialog.
- **Horizontal Culvert Barrels:** Implement the ability to analyze horizontally-sloped culvert barrels.
- **Adversely Sloped Barrels:** Implement the ability to analyze adversely-sloped culvert barrels.
- **Review and incorporate NCHRP 15-24 results:** NCHRP 15-24 was intended to refine existing hydraulic loss coefficients and to develop new hydraulic loss coefficients for analysis and design of culverts for conventional and nontraditional, environmentally sensitive installations. FHWA hopes to incorporate the results of this study into the HY-8 program and HDS-5 document.
- **South Dakota's Prefabricated Reinforced Concrete Box Culverts:** The FHWA completed an exhaustive set of tests on the "South Dakota prefabricated reinforced concrete box culvert." This task would incorporate separate inlet control polynomial equations and inlet loss coefficients developed for different combinations of barrel dimensions, fillets, and inlets.
- **Flared End Sections:** Inlet loss coefficients (outlet control) and headwater/depth curves (inlet control) have been developed for concrete and metal flared end sections by Dr. Bruce McEnroe at the University of Kansas. The results were published in TRR 1483.
- **Concrete Open-bottom Arches:** Concrete open-bottom arch culverts have been tested by Professor Donald Chase at the University of Dayton and reported in 1999. Dr. Chase used small scale models on the order of the same size as those used in the original NBS work upon which HDS-5 is based.
- **Maintenance Activities:** on-going maintenance phases.

To date, the States of Alabama, Iowa, Minnesota, Ohio, South Dakota, and Wisconsin have agreed to participate in this pooled fund study. (Thank You!).

Their support is enough to begin developing a formal scope of work and move forward to a contract, but not sufficient to fully fund the effort. Therefore, FHWA encourages other State DOTs to also consider making a contribution to this important project.