

WinTR-55 for Plan Reviews

Small Watershed Hydrology
Overview

Course Outline

Overview

- Historical Background
- Program Description
- Model Capabilities and Limitations



WinTR-55 Overview

This is the Overview portion of the training. Here we'll take a brief look at how WinTR-55 evolved into what it is today, describe what the program is all about, and review the capabilities and limitations of WinTR-55.

Lesson Objectives

The objectives of this lesson are to:

- Review the background of WinTR-55
- Provide a brief description of the Program
- Give an overview of WinTR-55 capabilities and limitations



WinTR-55 Overview

The objectives for this first lesson are:

To review the background of WinTR-55;

To provide a brief description of the program;

And finally, to give an overview of the WinTR-55 capabilities and limitations.



Let's start of with a little discussion about the background of WinTR-55. In other words, where did it come from?

Background

- First issued in January 1975
 - Manual Method
 - Simplified method for estimating Q and q_{peak} , and developing partial hydrographs
 - Collection of hydrology tools
 - *RCN method to determine Q*
 - *Velocity based T_c method*
 - *Utilization of unit hydrograph theory to determine partial hydrographs and q_{peak}*
 - *Generalized stream channel routing*
 - *Simplified storage routing method*



WinTR-55 Overview

TR-55 was first issued by the Soil Conservation Service in January of 1975

☞ as a manual method. Manual in this case meaning a method for hand computations.

☞ It was developed as a simplified method for estimating runoff volumes, peak discharges, and partial hydrographs for small watershed areas.

☞ TR-55 is a suite of hydrology tools or method developed by NRCS.

☞ Specifically, the Runoff Curve Number method to determine storm runoff volumes;

☞ a velocity based Time of Concentration method;

☞ utilization of a unit hydrograph to determine partial hydrographs and peak discharges;

☞ stream channel routing methods to determine effects of routing on peak discharge estimates;

☞ and a very simplified storage routing method to determine stormwater detention basin sizes and outflows. The collection of these standard methods make up what is called TR-55.

Background

- **First issued in January 1975**
 - Generalized tables and graphs developed from TR-20
 - *Allowed rapid hand computations*
 - Type II rainfall distribution only
- **Major revision in June 1986**
 - Types I, IA and III rainfall distributions added
 - First version of DOS computer program
 - Methods/procedures identical to the manual



WinTR-55 Overview

The 1975 TR-55 was based upon generalized tables and graphs which were developed from multiple runs of the TR-20 computer program. The advantage of TR-55 was that computations could be done by hand very rapidly and estimations were reasonably close to more detailed procedures.

☞ At first release, TR-55 only contained tables and graphs for the Type II rainfall distribution.

☞ Over time, TR-20 runs were made for the types I, IA and III rainfall distributions, and in 1986 a major revision was released which included tables and graphs for the Type I, IA and III rainfall distributions.

☞ In June 1986 the first version of a TR-55 computer program was released. This DOS program utilized the same tables and graphs which were developed for the hand computations.

☞ Therefore, this version of the computer program is computationally identical to the TR-55 manual. The major advantage of this DOS computer program was that the modeler no longer had to work through the computations by hand.

Background

- **Spring 1998**
 - Team formed to upgrade the computer program from DOS to Windows
- **August 2003**
 - First version of Windows based TR-55 (WinTR-55 version 1.0) is released



WinTR-55 Overview

In Spring of 1998, a team was formed to upgrade the computer program from DOS to the Windows Operating System. This team was charged with modernizing and revising the technical release (the manual) and the computer software, changing the philosophy of the input data, developing a Windows interface and output post-processor, and enhancing the hydrograph generation capability.

📅 Finally, in August 2003 the first version of a Windows based TR-55 computer program was released. Titled WinTR-55, this computer program incorporates all of the philosophical changes envisioned.



So, what is WinTR-55?

Program Description

- Single event model
- Generates hydrographs
- Routes hydrographs through channels and/or reservoirs
- Models sub-areas



WinTR-55 Overview

WinTR-55, like its predecessor TR-55 and like the TR-20 computer model, is a single event model. This means that it processes a single storm event at one time. Multiple storms may be combined into a single run, however, the program actually processes only one storm at a time and then moves on to the next one.

Using WinTR-55, the modeler can generate complete hydrographs for various locations throughout a watershed since hydrographs may be routed through channels and/or reservoirs and the model allows multiple sub-areas.

Program Description

- Program written in Visual Basic version 6.0
- WinTR-55 exists as a graphical user interface (GUI) to the WinTR-20 executable program



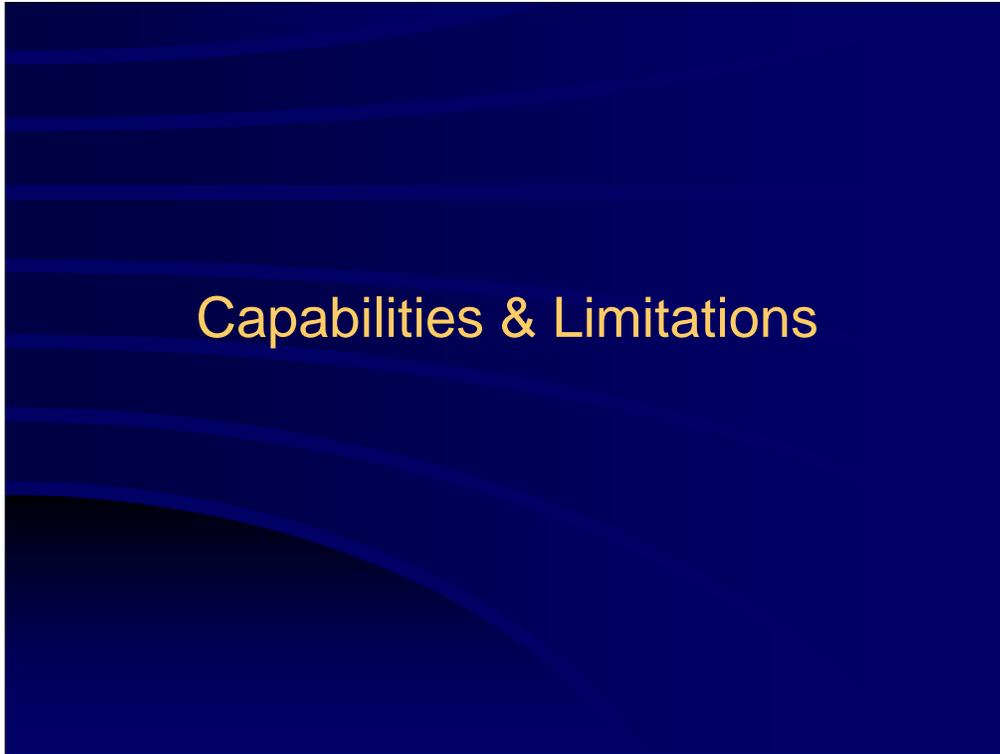
WinTR-55 Overview

The WinTR-55 computer program was written in Visual Basic 6.0.

One important thing to note is that the WinTR-55 computer program actually exists merely as a Graphical User Interface, or GUI, to the WinTR-20 executable program.

You will remember from a previous slide that the original TR-55 utilizes a set of generalized tables and graphs that were developed using TR-20. This is no longer the situation with WinTR-55. Many of the capabilities and limitations from the original TR-55 were carried over into WinTR-55 to restrict it's use to the same smaller watersheds that were being modeled with the original TR-55. However, with WinTR-55, the user is actually developing and executing a WinTR-20 run utilizing WinTR-55 as an interface. This is an important point to note since the results obtained using the original TR-55 and WinTR-55 may be different. However, results obtained from WinTR-55 and the WinTR-20 computer program will be the same.

Utilization of the WinTR-20 computational engine through the WinTR-55 interface is beneficial in that it allows the user now to develop not only peak discharges, but complete hydrographs at various points of interest throughout the watershed. The original TR-55 allowed the user to develop peak discharges and partial hydrographs, but only at the watershed outlet.



The next couple of slides are titled "Capabilities and Limitations." Represented here are the range of parameters within which WinTR-55 is useful. For example, things like, "What is the maximum drainage area size for which WinTR-55 can be used?" or "How many sub-areas can a watershed have?"

Capabilities & Limitations

• Maximum Area	25 sq. mi.
• T_c for any sub-area	$0.1 \text{ hr} < T_c < 10 \text{ hrs}$
• ARC	2 (average)
• CN for any sub-area	$40 < CN < 98$
• Number of sub-areas	1-10
• Number of reaches	0-10
• Types of reaches	Channel or Structure
• Reach Routing	Muskingum-Cunge



WinTR-55 Overview

As mentioned previously, many of the capabilities and limitations in WinTR-55 were carried over from the original TR-55. This was done to limit its use to approximately the same types of watersheds that were being modeled using the original TR-55. WinTR-20 is capable of handling extremely large and complex watersheds, but the philosophy and focus of the original TR-55 was geared towards modeling smaller, simpler watersheds. The modeling team wished to retain this focus. The result is a model that is fairly simple and straightforward to use.

• Maximum drainage area is limited to 25 square miles. This means either a single watershed of 25 square miles, or multiple sub-areas with a cumulative drainage area of 25 square miles. This is a NEW limitation as the original TR-55 had no limitation on drainage area. The true limitation for the original TR-55 lie in the time of concentration. You will also note that there is no minimum area limitation on WinTR-55. However, all users need to be highly cautious in trying to utilize this model for anything smaller than perhaps a 1 acre drainage area. The reasoning for this again lies in the T_c . The rainfall tables used within the WinTR-20 computational routine use a time increment of 0.10 hour. Therefore, for any drainage areas having times of concentration less than 0.10 hour the computations become a bit suspect.

• Time of concentration for any single sub-area is limited to between 0.1 and 10 hours. The 0.1 hour T_c was explained previously. In the old TR-55, 10 hours was a limit strictly because the generalized tables and graphs were only extended out to include times of concentration of 10 hours. In WinTR-55, this seems a reasonable limitation in conjunction with the 25-square mile maximum drainage area size, so the limitation was carried over from the old TR-55.

• Antecedent runoff condition 2 is the assumed antecedent runoff condition. All the runoff curve number tables in WinTR-55 are for antecedent runoff condition 2.

• Curve number values for any one sub-area range from 40 to 98. If a weighted CN of less than 40 is estimated for any one sub-area, use another procedure.

• WinTR-55 allows the user to model up to 10 sub-areas. If one is doing computations by hand utilizing the original TR-55, there was no limit to the number of sub-areas, however at some point modeling increasing numbers of sub-areas by hand becomes impractical because of the volume of computations that must be done. The original DOS computer program restricted the number of sub-areas to 10 on an arbitrary basis. We have found within NRCS that this limitation serves us well, so we have carried this limitation into WinTR-55.

• Time of concentration for any one sub-area is limited to between 0.1 and 10 hours. This limitation stems from the original TR-55. When the generalized tables and graphs were developed for the original TR-55, they spanned values of T_c ranging from 0.1 to 10 hours.

• Up to 10 reaches. This is a new limitation. The philosophy on reach routing is revised in the new TR-20 computation routine. We'll talk about this later, however, the limitation of 10 reaches was intended to match up with the maximum number of sub-areas limitation.

• Reaches may be comprised of channel reaches or structure reaches. Channel reaches are those where hydrographs are routed through a length of stream channel, while structure reaches are those where hydrographs are routed through a structure. Again, we'll talk more about reaches later.

Reach routings are performed using the Muskingum-Cunge procedure. NRCS made changes in the TR-20 computation routine to now utilize Muskingum-Cunge as opposed to the previously utilized Att-Kin (Attenuation-Kinematic) Method.

Capabilities & Limitations

• Structure Routing	Storage-Indication
• Structure Types	Pipe or Weir
• Structure Trial Sizes	1-3
• Rainfall Depth	Default or user-defined (range of 0-50 inches)
• Rainfall Distributions	NRCS Type I, IA, II, III, NM distributions or user- defined
• Rainfall Duration	24-hour
• Dimensionless Unit Hydrograph	Standard peak rate factor (484) or user-defined



WinTR-55 Overview

- ☞ Structure routings are done using a storage indication method.
- ☞ Two main Structure Types may be analyzed. These are a structure with a pipe outlet or with a weir outlet. There are some limitations on the pipe and weir outlet configurations that will be discussed later when we look at modeling structures.
- ☞ If the modeler wishes to model structures, up to 3 Structure trials may be performed. Again, we'll talk more about this when we get to the portion of this course dealing with modeling structures.
- ☞ Rainfall Depths may either be specified by the user on an individual basis or retrieved from the built-in rainfall database. Up to 50 inches of rainfall may be specified for an individual storm.
- ☞ Standard NRCS Rainfall Distributions Types I, IA, II and III are built-in to the program along with several distributions developed for use in the state of New Mexico. The user may also develop and enter a custom distribution. Utilization of a custom rainfall distribution will be covered in the Advanced Modeling Features of this training.
- ☞ Rainfall duration is limited to 24 hours for any storm that is modeled using WinTR-55. Nothing less than 24-hours can be entered by the User, nor can anything greater than 24-hours be entered. We'll discuss this further in the Advanced Features portion of this training, if you are interested.
- ☞ The standard peak rate factor 484 Dimensionless Unit Hydrograph is the default built-in unit hydrograph utilized by WinTR-55. The user may develop and enter a custom unit hydrograph. The development and utilization of a custom unit hydrograph will be covered in the Advanced Modeling Features portion of this training session.

Capabilities & Limitations

- Methods based on open and unconfined flow
- Inappropriate for use in closed system pipe flows
- Composite flood hydrographs should be compared to stream gage data where possible.



WinTR-55 Overview

A few final thoughts before moving on.

☞ WinTR-55 utilizes methods based on open and unconfined flow over land and in channels. For large events during which flow is divided between sewer and overland flow, more information about hydraulics is needed than is presented here to determine T_c .

☞ Therefore, it is inappropriate for use in closed system pipe flows such as storm sewers.

☞ And finally, calibration is not something done often when making hydrologic analyses using WinTR-55. Primarily because the watersheds on which WinTR-55 analyses are performed do not have stream gages to which those comparisons can be made. It is suggested however, that at a minimum, some comparison of data against results obtained from USGS curves of peak flow be made. Even though standard errors of estimates for USGS peak discharge equations are often quite high it is a good order of magnitude check.



Note to Instructor:

Take time here to answer any questions that may have arisen and then move on to the next section.