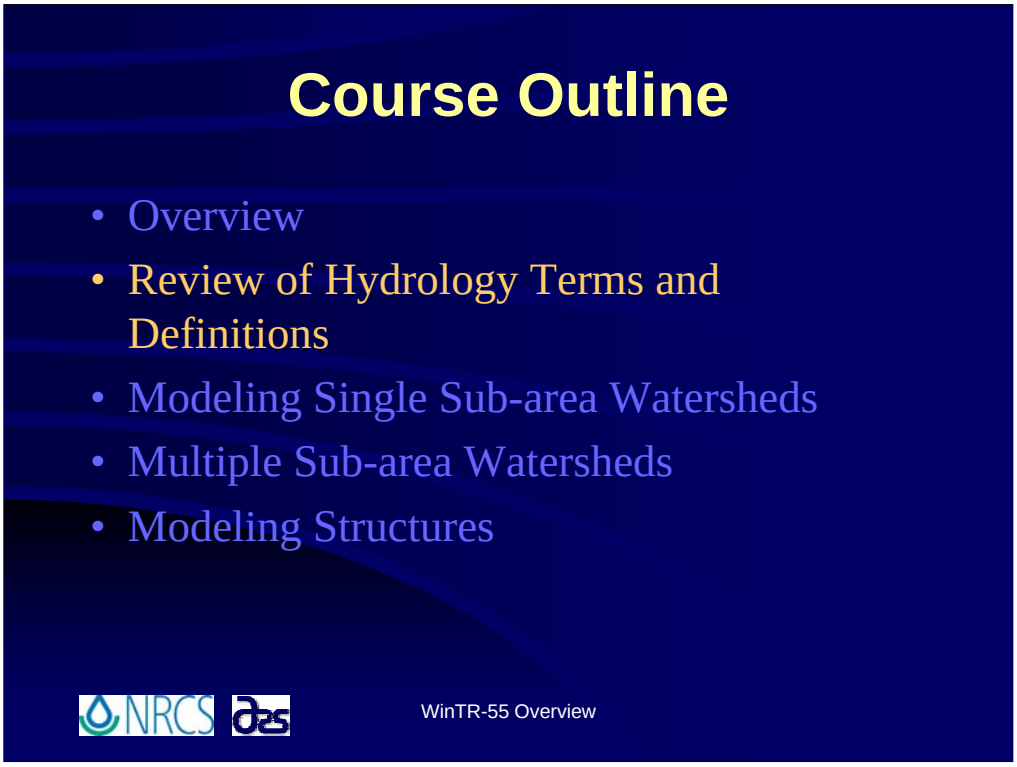
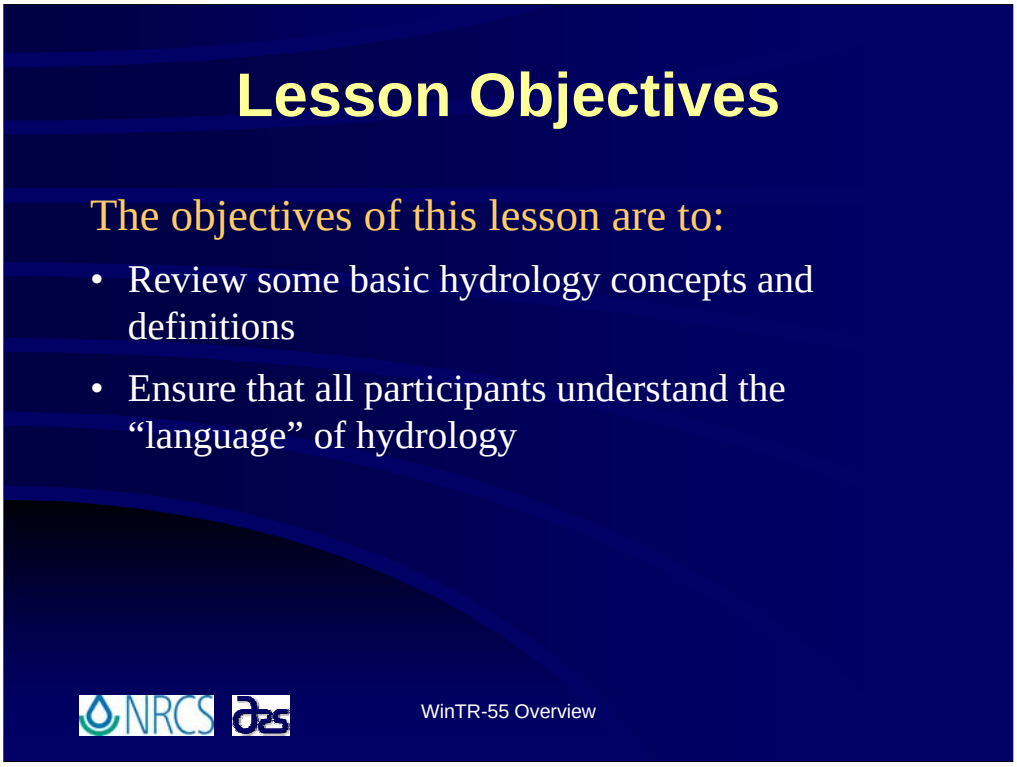
WinTR-55 for Plan Reviewers

Small Watershed Hydrology

Hydrology Terms and Definitions



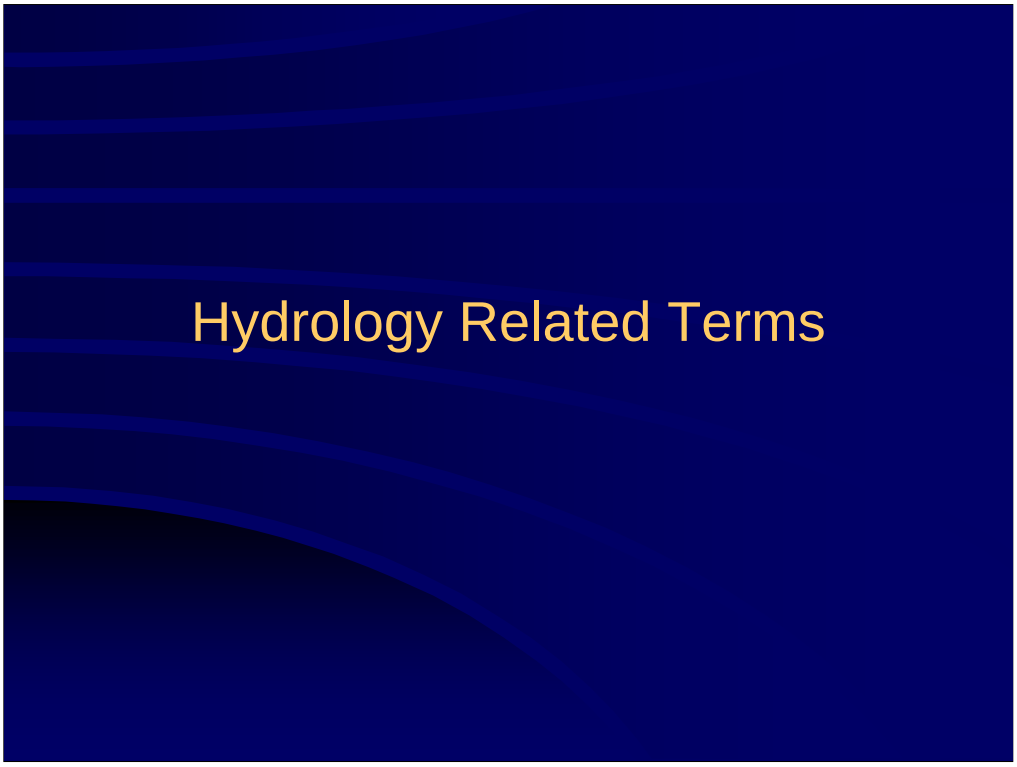
This (optional) lesson is intended to provide students with a review of the common hydrology related terms and definitions they will encounter throughout the remainder of the WinTR-55 training. This lesson is optional for those classes consisting of participants experienced in hydrology. For classes consisting of participants without an extensive background in hydrology review of these terms and definitions is encouraged.



The objectives for this first lesson are:

To review some basic hydrology concepts and definitions;

And to ensure that all participants understand the "language" of hydrology.



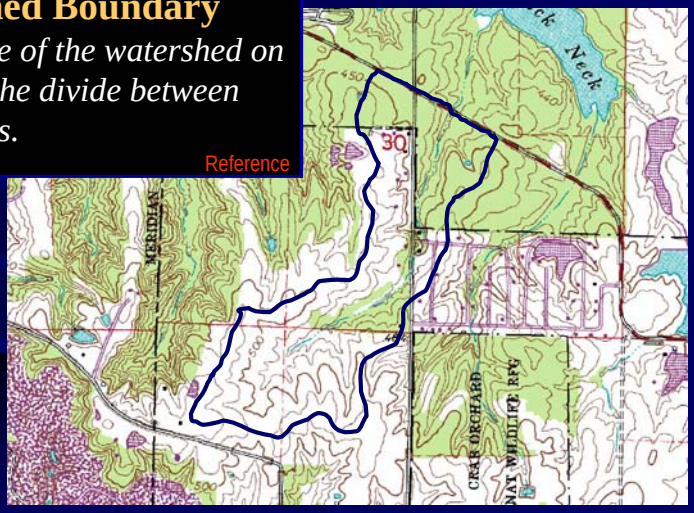
Before moving on we want to quickly review some basic hydrology terms and concepts. The purpose of this is to make sure we all have a common understanding of what is meant by some of these terms, as some have varying definitions.

Hydrology Related Terms

Watershed Boundary

The outline of the watershed on a map or the divide between watersheds.

Reference



NRCS ars

WinTR-55 Overview

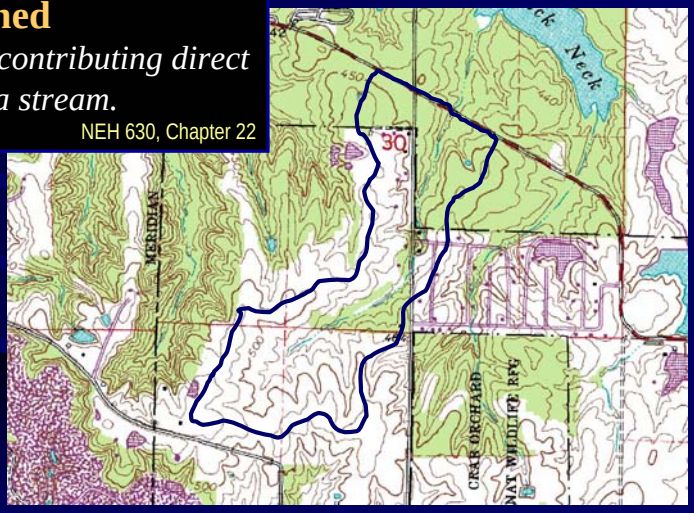
The watershed boundary is defined as the outline of the watershed on a map or the divide between watersheds. Runoff occurring as a result of rainfall over this area will make it's way to the watershed outlet.

Hydrology Related Terms

Watershed

The area contributing direct runoff to a stream.

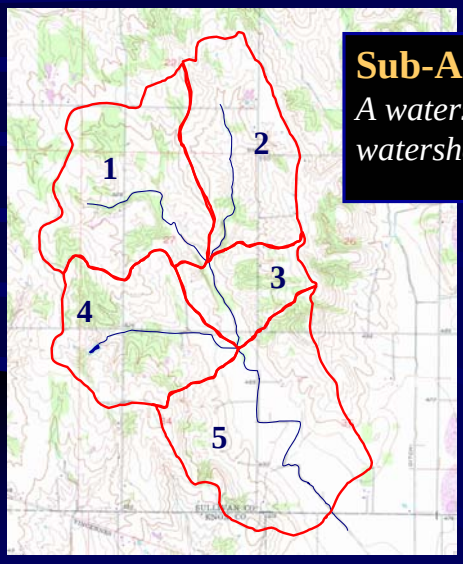
NEH 630, Chapter 22



WinTR-55 Overview

The watershed is the area defined by the watershed boundary.

Hydrology Related Terms

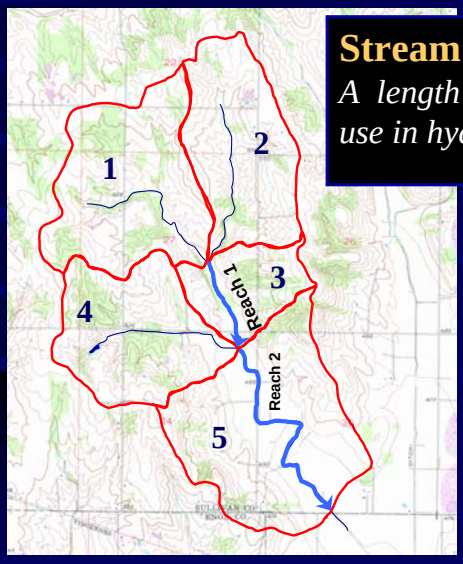


Sub-Area (or Subwatershed)
A watershed that is part of a larger watershed.
NEH 630, Chapter 22

WinTR-55 Overview

Sub-areas or subwatersheds are subdivisions of a larger watershed which themselves comprise individual smaller watersheds.

Hydrology Related Terms



Stream Channel Reach

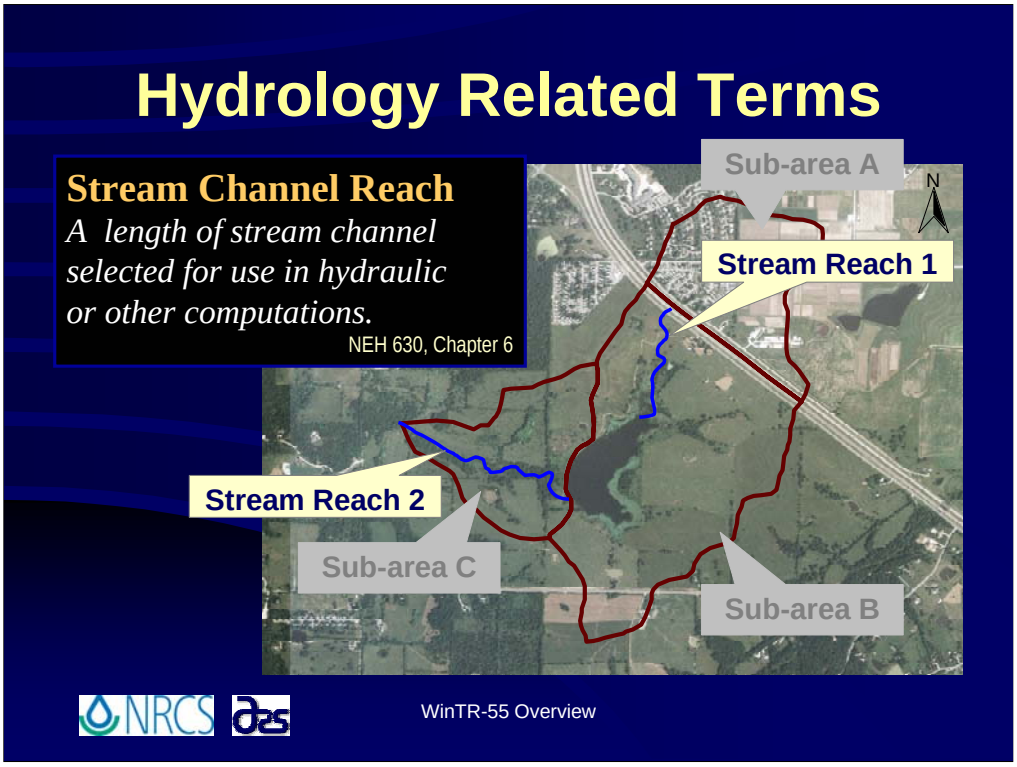
A length of stream channel selected for use in hydraulic or other computations.

NEH 630, Chapter 6

NRCS ars

WinTR-55 Overview

A stream reach is a length of stream channel and it's associated floodplain selected for use in hydraulic or other types of analyses.



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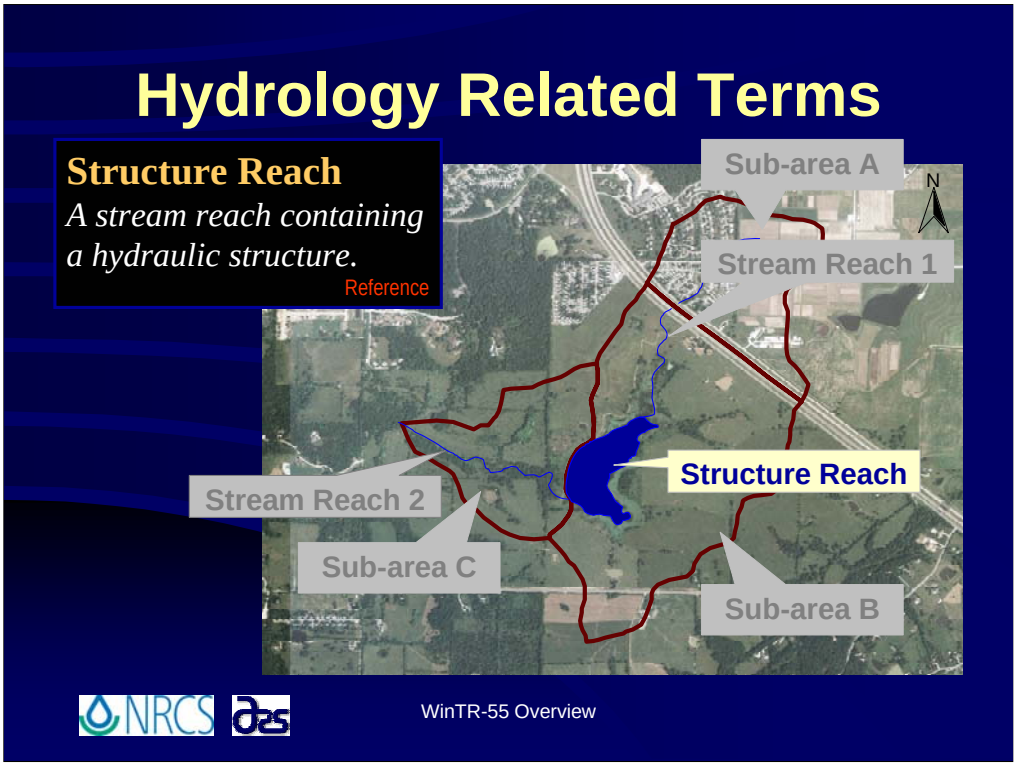
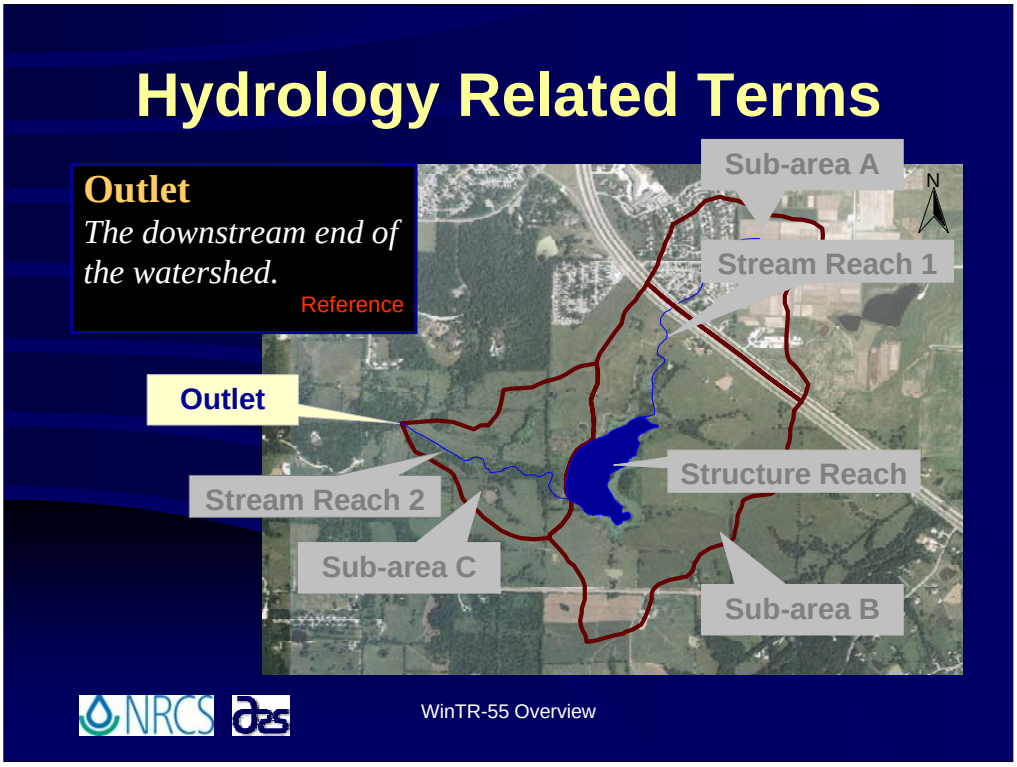
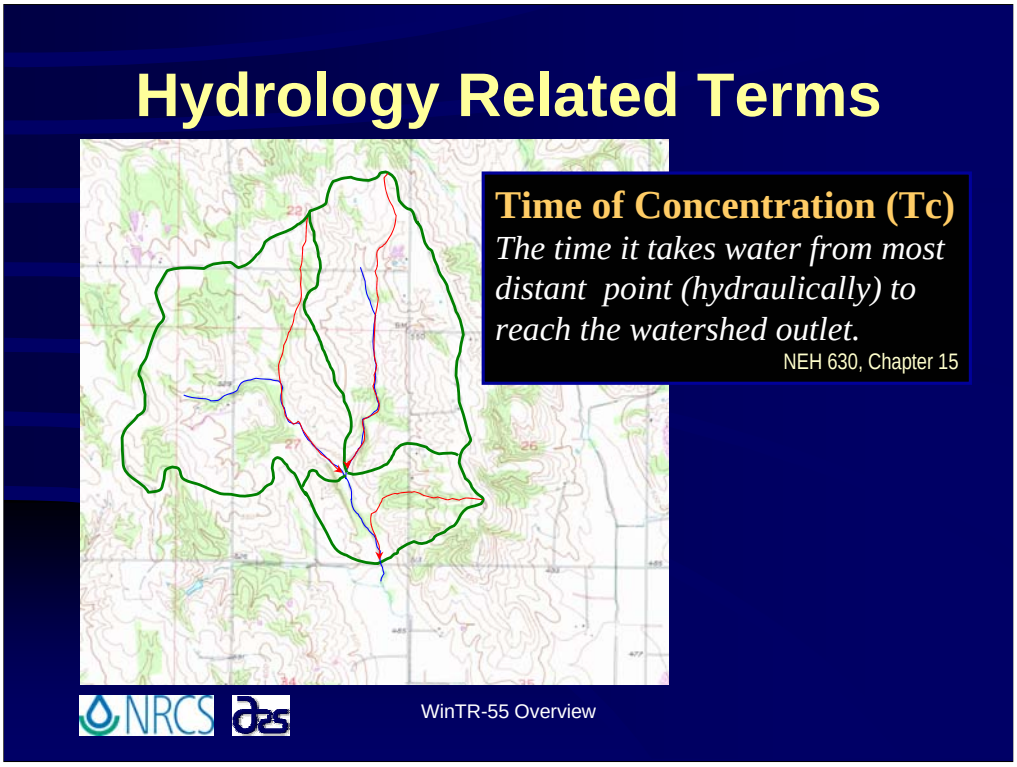


A structure reach is defined as a reach of stream channel which contains a hydraulic structure such as a dam.



The watershed outlet is defined as the most downstream end of a watershed. Remember that sub-areas have their own outlets as well.



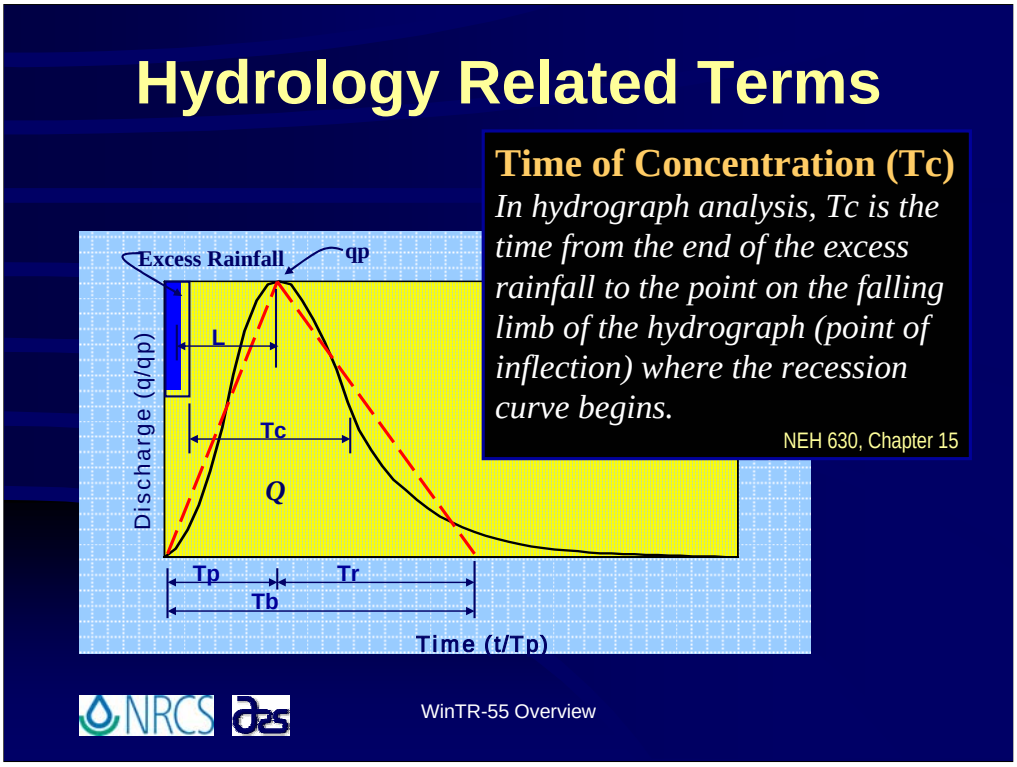
Time of concentration can be defined based upon physical watershed properties as that time it takes water from the hydraulically most remote part of the watershed to reach the watershed outlet. There are disagreements within the hydrology community as to the definition of the term "hydraulically most remote." Some would define it as the longest flow path. Other define it as the flow path with the longest time for the water to reach the watershed outlet. For simplicity sake, however, we most often identify the longest flow path and utilize it to calculate time of concentration.

Time of concentration computed using the NRCS velocity based method involves defining the flow path and estimating the time required for the water to move through three flow regimes, or segments, along the flow path. The three segments that are identified are sheet flow, shallow concentrated flow, and open channel flow.

It is possible to have a watershed area small enough that there is no defined channel segment in the flow path. In that situation, the time of concentration flow path might only have a sheet flow and a shallow concentrated flow segment.

Remember that a time of concentration must be determined for each individual sub-area.

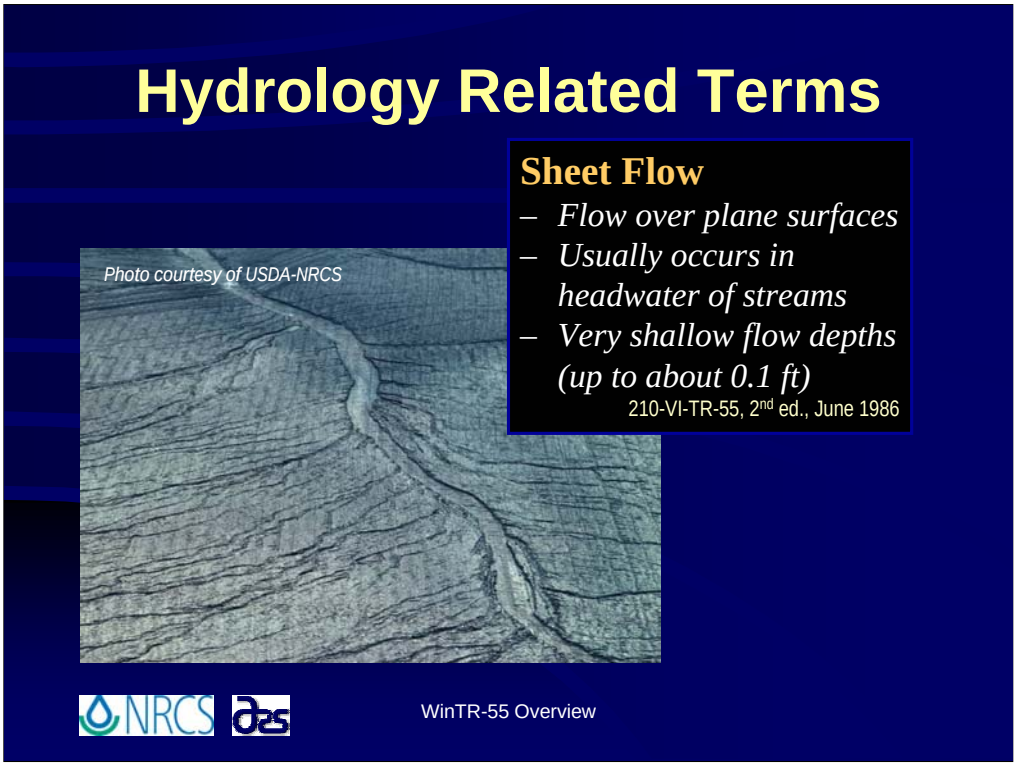
Later on we will discuss the details of how the velocities are computed through each of the three segments, shortly we'll look at the definitions of the three types of flow segments, but first, we'll examine another definition for time of concentration.



On a hydrograph, time of concentration is defined as that time from the end of the excess rainfall (when it stops raining) to the point of inflection on the receding limb of the hydrograph.

Many people often confuse time to peak with time of concentration when looking at a hydrograph. Time to peak is actually the time from the beginning of the rainfall to the time of peak discharge on the runoff hydrograph.

From the graph as shown, you should be able to see that these terms, while related, are quite different.

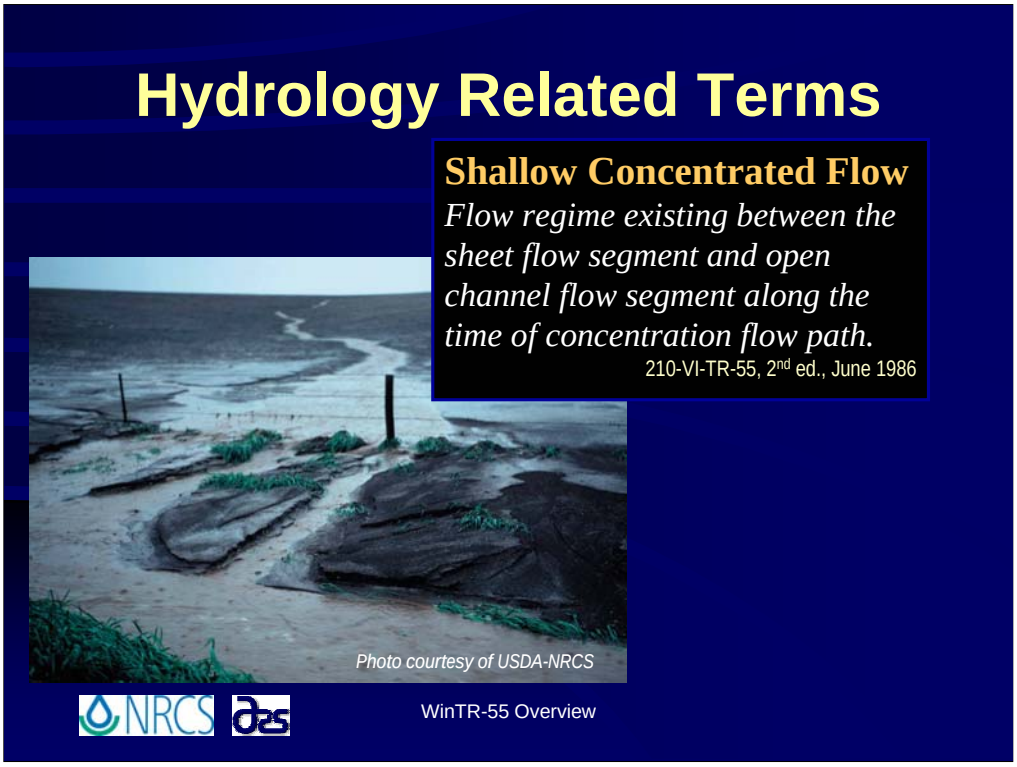


Sheet flow is defined primarily as flow over plane surfaces. This is the type of flow that would be found at or near the watershed divide comprising the uppermost segment of the time of concentration flow path. Sheet flow cannot be maintained for great distances as water will start to accumulate as it flows around obstacles such as litter, crop ridges, or rocks. Sheet flow depths are extremely shallow. Most likely sheet flow depth would be less than 0.05 feet, but most certainly you would not see sheet flow depths greater than 0.1 foot.

Of all the changes from the original TR-55 to WinTR-55, the change in allowable maximum sheet flow length has generated the most comment. Primarily, the developers believe, because of misapplication of sheet flow length in the original TR-55 or a misunderstanding about what sheet flow actually is.

In the original version of TR-55, sheet flow length was limited to less than 300 feet. Many user's will maximize this distance for the mere fact that the program will allow one to enter up to 300 feet. In fact, a search of available references indicate that typical sheet flow lengths are likely in the range of 50 to 75 feet at the most. For this and other reasons, sheet flow length in WinTR-55 was limited to 100 feet.

The developers are continually monitoring for new information on sheet flow length. It is possible that future versions of WinTR-55 would include a subroutine to actually calculate a sheet flow length. For now, the developers are happy to consider input from other users on what a reasonable maximum sheet flow length might be. However, merely a request to change the maximum sheet flow length back to 300 feet without any supporting evidence as to why that should be done will not be considered.

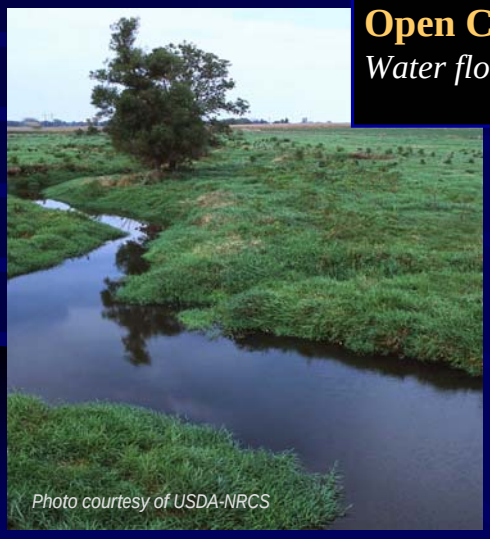


Shallow concentrated flow is that flow regime existing between the sheet flow segment and the open channel flow segment. It is a transition zone so to speak.

If one is seeing what appears to be sheet flow across a parking lot and notices there are ripples in the water surface or what appear to be deeper areas because of tire depressions or other imperfections in the water surface, it can be assumed that one is observing shallow concentrated flow.

Typical shallow concentrated flow depths may be in the 0.1 to 0.5 foot range.

Hydrology Related Terms



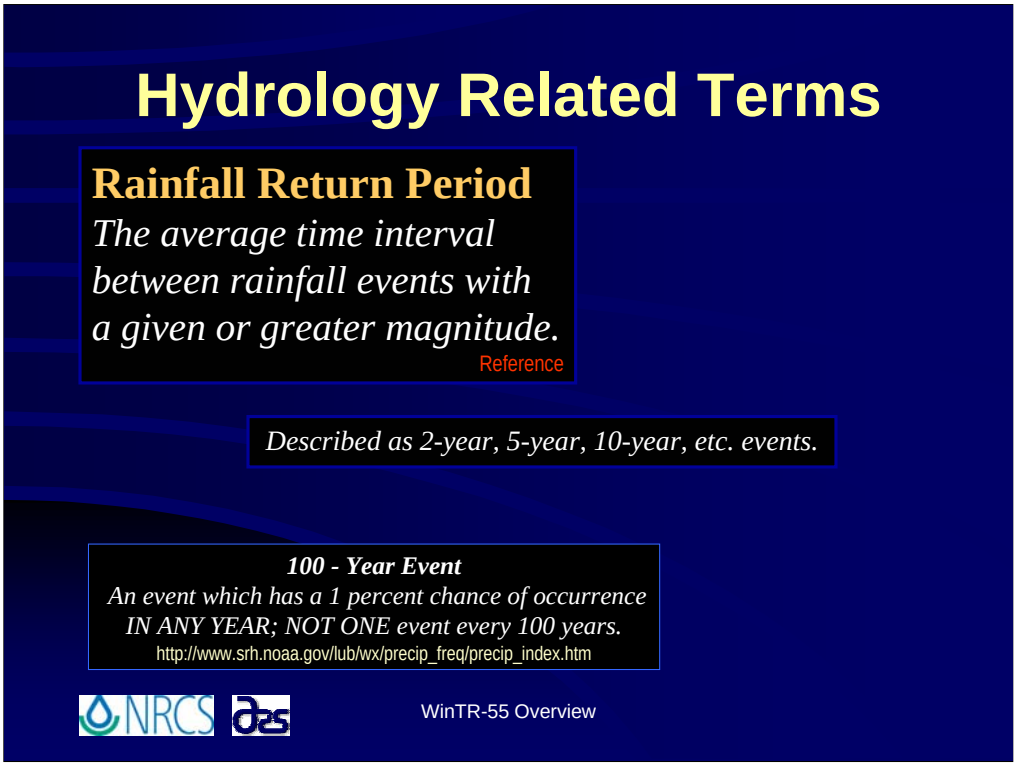
Open Channel Flow

Water flowing in a defined channel.

210-VI-TR-55, 2nd ed., June 1986

WinTR-55 Overview

Open channel flow is the simplest of the flow types to define. It is that flow that exists in a well defined channel. Without a trip to the field, however, it may be a little difficult to determine where the open channel flow starts. Typically, we assume that open channels begin where blue lines indicating streams appear on USGS quadrangle sheets. One warning about that, however. Where the blue lines are placed on USGS quad sheets is subjective. It is a function of the how far the individual who did the mapping decided the blue line had to be drawn. It is also a function of map scale. What appears as a blue line of a 1:24000 scale quad sheet may NOT appear on a map of a differing scale just because there may not be room to show it.

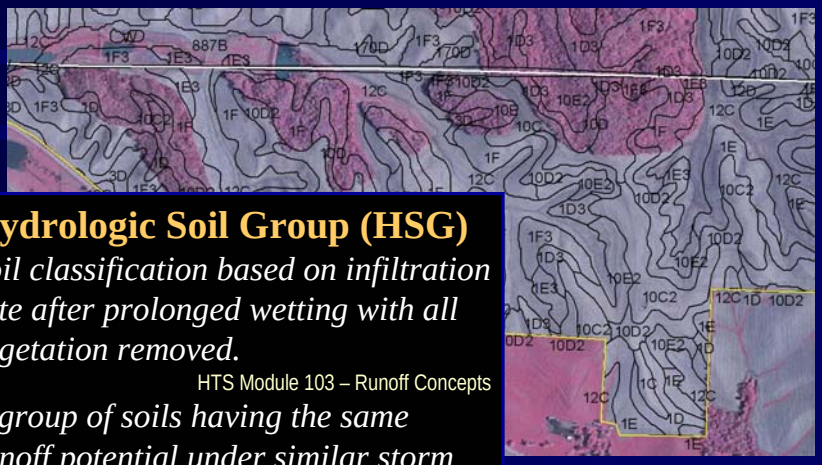


Rainfall return period is defined as the average time interval between rainfall events with a given or greater magnitude. When someone refers to, for example, a 10-year flood, what they mean is that a flood equal to or greater than the current one being experienced can reasonably be expected to occur, on average, once every 10 years.

It is quite possible to have a 10-year, 25-year, and even 100-year event all occur during the same year, or even in consecutive years. Though highly unlikely it is possible to have a 100-year event occur one year and then another 100-year event occur during the following year.

Remember, that the return period is defined as the expected average time interval between events over a long period, say 100 years or more, of time. It does NOT refer to the actual time interval which has occurred between events.

Hydrology Related Terms



Hydrologic Soil Group (HSG)

Soil classification based on infiltration rate after prolonged wetting with all vegetation removed.

HTS Module 103 – Runoff Concepts

A group of soils having the same runoff potential under similar storm and cover conditions.

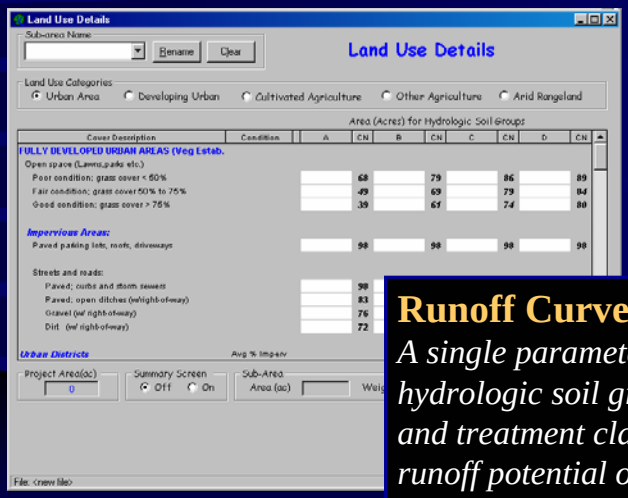
NEH 630, Chapter 7

NRCS

WinTR-55 Overview

A hydrologic soil group is a grouping of soils with similar runoff potential under similar storm and cover conditions. This soil classification is determined based upon infiltration rate after prolonged wetting of the soil with all vegetation removed.

Hydrology Related Terms

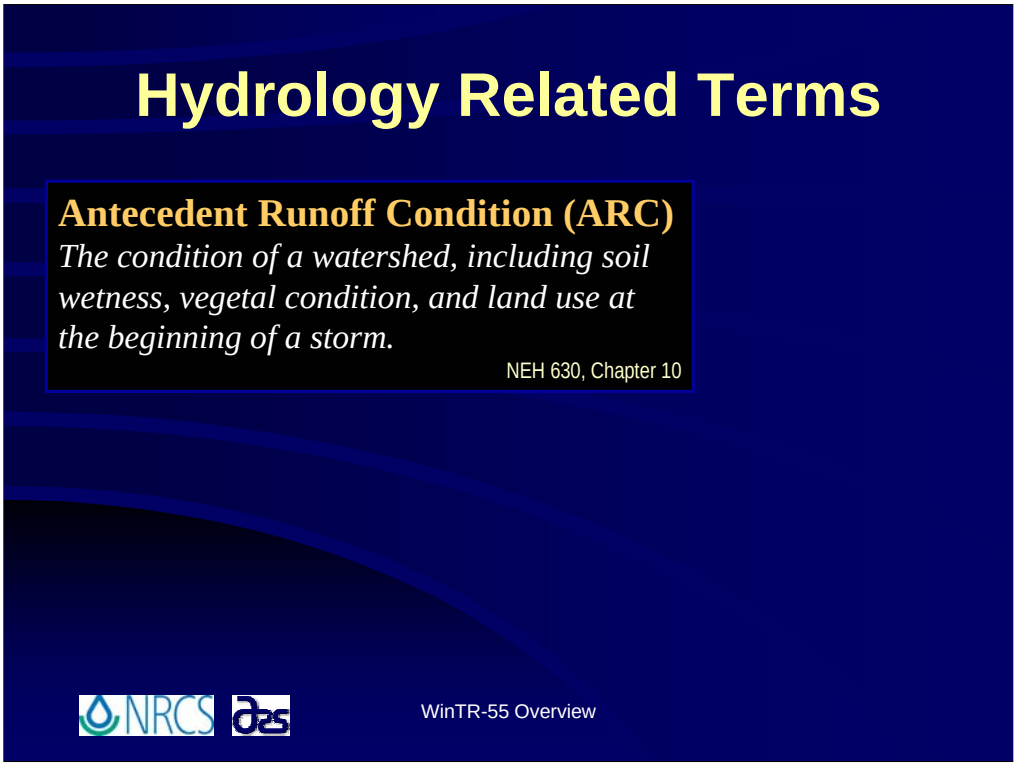


Runoff Curve Number (CN)

A single parameter, combining hydrologic soil group and land use and treatment class, describing runoff potential of that single hydrologic soil-cover complex.

NEH 630, Chapter 9

A runoff curve number describes runoff potential by taking into into account land use, condition of the vegetative cover and the hydrologic soil group.



Antecedent runoff condition refers to how wet or dry the watershed area might be at the time a rainfall event starts. Typically antecedent moisture is judged based upon the amount of rain that occurred during the previous 5-day time period. ARC is really a subjective term and the User, when modeling actual rainfall events, will have to make a judgment call based upon his or her experience as to what the antecedent runoff condition of the watershed was when the rainfall actually occurred. Antecedent runoff is defined as ARC I, ARC II, or ARC III with ARC I being the driest and ARC III being the wettest. In design work, an ARC II condition is assumed. ARC II being an "average" condition. Therefore unless you are doing an analysis of an actual rainfall event, use ARC II unless otherwise directed.

Hydrology Related Terms

Impervious Areas

Areas into which water cannot infiltrate, such as roads, roofs or parking lots.

210-VI-TR-55, 2nd ed., June 1986

NRCS ars

WinTR-55 Overview

Impervious area should be a pretty self-explanatory term. It is simply any area into which water cannot infiltrate. In the subdivision pictured here, there is obviously a very high percentage of impervious area and large runoff volumes from even small storms can be expected.

Hydrology Related Terms

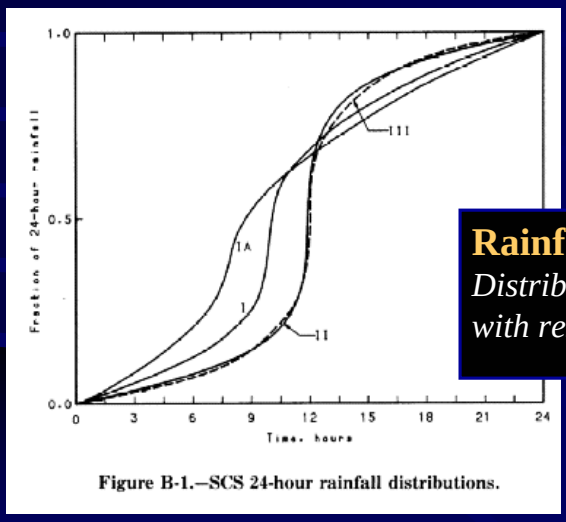


Figure B-1.—SCS 24-hour rainfall distributions.

Rainfall Distribution
Distribution of rainfall with respect to time.
210-VI-TR-55, 2nd ed. June 1986

NRCS

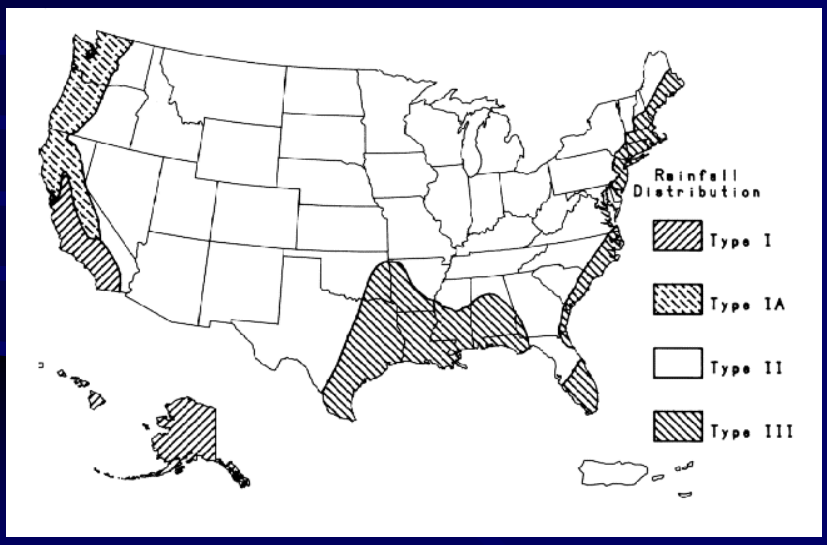
WinTR-55 Overview

A rainfall distribution in it's simplest form describes the percentage of rain that has fallen at a particular time during a rainfall event. WinTR-55 utilizes several standard synthetic rainfall distributions for making analyses. These rainfall distributions were constructed based upon the theory of a nested distribution which incorporates shorter duration storm events within the longer events. For example, the 15-minute duration rainfall is nested within the 30-minute duration rainfall which is nested inside the 1-hour duration rainfall continuing up to the 24-hour duration rainfall.

Most conservation practice designs are based upon 24-hour rainfall totals, so WinTR-55 requires a 24-hour rainfall distribution.

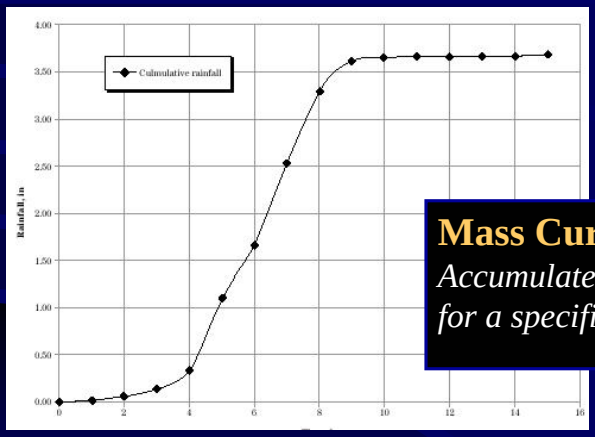
It is possible to utilized other than these standard distributions by constructing a specific distribution, but the distribution must have a 24-hour duration.

Hydrology Related Terms



This slide shows the geographic distribution of the standard NRCS Type I, IA, II, and III rainfall distributions. There are various other distributions used in different parts of the country and so several New Mexico rainfall distributions were also built in to the rainfall distribution database. As was noted previously, it is possible to construct a custom distribution, but all distributions must have a 24-hour duration.

Hydrology Related Terms



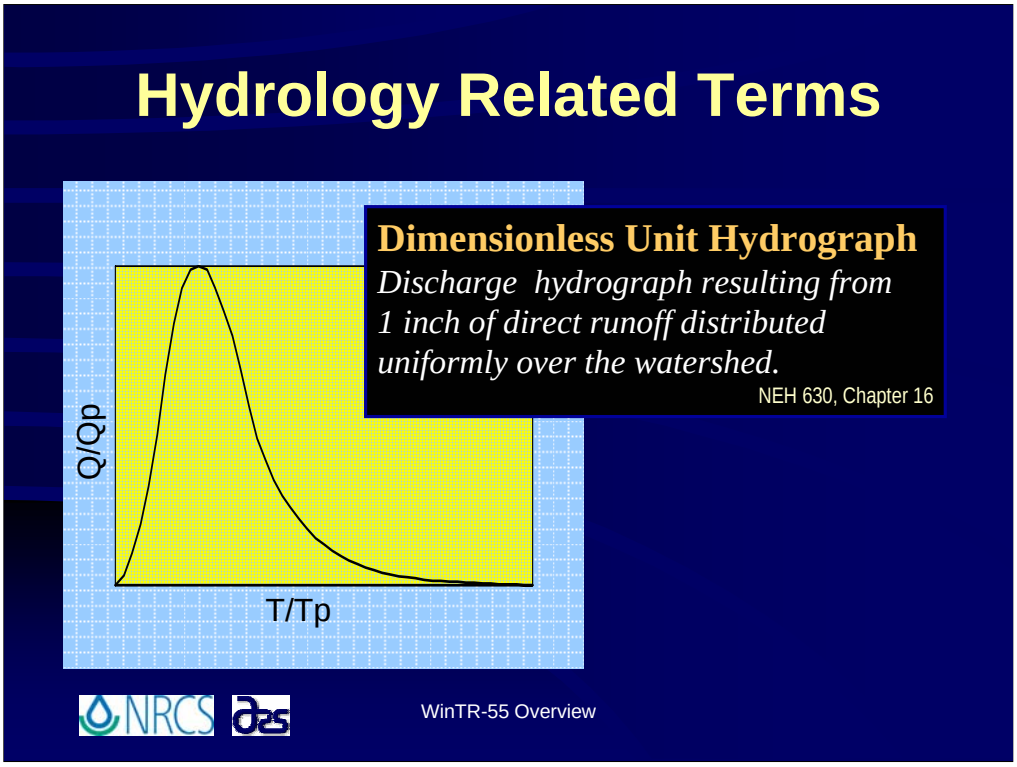
Mass Curve of Rainfall

Accumulated rainfall total for a specific rainfall event.

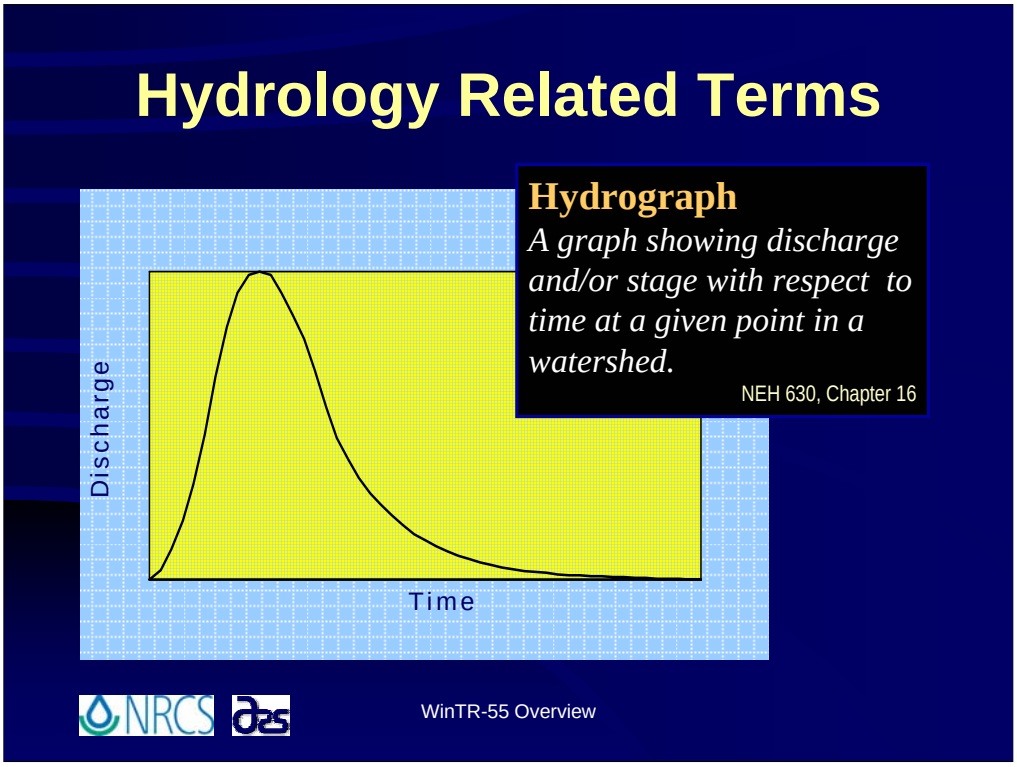
Reference

WinTR-55 Overview

A mass curve of rainfall is a plot of accumulated rainfall total over the storm duration for a specific rainfall event. WinTR-55 does allow modeling of specific (or historical) measured rainfall events.



A dimensionless unit hydrograph is a plot of a discharge hydrograph resulting from 1 inch of direct runoff distributed uniformly over the watershed. In other words, the volume under the hydrograph equals 1 inch. WinTR-55 utilizes the standard peak rate factor 484 unit hydrograph. The DelMarVa unit hydrograph is also built in to WinTR-55 and it is possible to utilize a custom dimensionless unit hydrograph, but it is up to the user to develop the appropriate unit hydrograph.



Most frequently when we speak of a hydrograph we are referring to a plot of discharge with respect to time at a given point in a watershed. With WinTR-55 it is possible to generate hydrographs at several points throughout the watershed area. This is a major change from the manual TR-55 which allowed one to generate only a partial hydrograph and only at the watershed outlet.

Hydrology Related Terms

Storm Rainfall Data

Rainfall amounts measured at rain gages, published, and statistically analyzed by NWS.

NEH 630, Chapter 4

NRCS

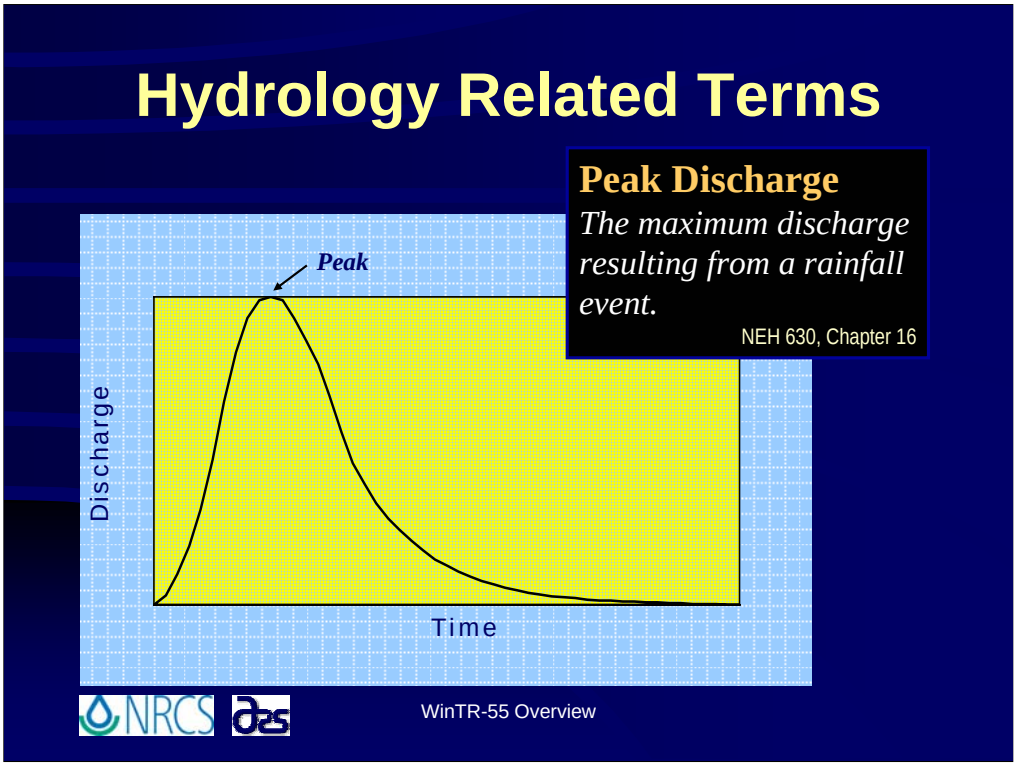
WinTR-55 Overview

Definition from NEH Part 630, Chapter 4, Storm Rainfall Depth

WinTR-55 utilizes 24-hour storm rainfall data although data for other storm durations are available in a wide variety of National Weather Service and other Federal and State agency publications.

For areas east of the 105th Principal Meridian, the primary rainfall data source document is Technical Paper Number 40, commonly referred to as TP-40, titled "Rainfall Frequency Atlas of the United States". This document was published by the United States Weather Bureau in 1961. Efforts are underway to update TP-40. Status is unknown at this time.

Other areas of the United States use a variety of other references, including NOAA Atlas 2 for many of the western states; NOAA Atlas 14 for the semiarid Southwest; Technical Paper No. 43 for the Hawaiian Islands; and Technical Paper 47 for Alaska.



Quite simply, the peak discharge is the maximum discharge occurring as a result of a rainfall event.

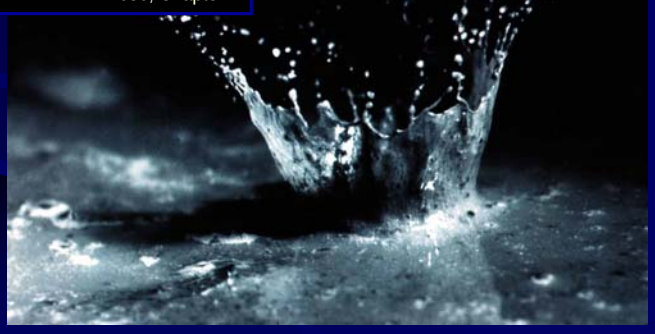
Hydrology Related Terms

Rainfall Depth

Average depth of storm rainfall over the watershed area for a specified storm duration.

NEH 630, Chapter 4

Photo courtesy of USDA-NRCS



WinTR-55 Overview

Rainfall depth is the average depth of storm rainfall over a watershed area for a specified storm duration.

Hydrology Related Terms

Runoff

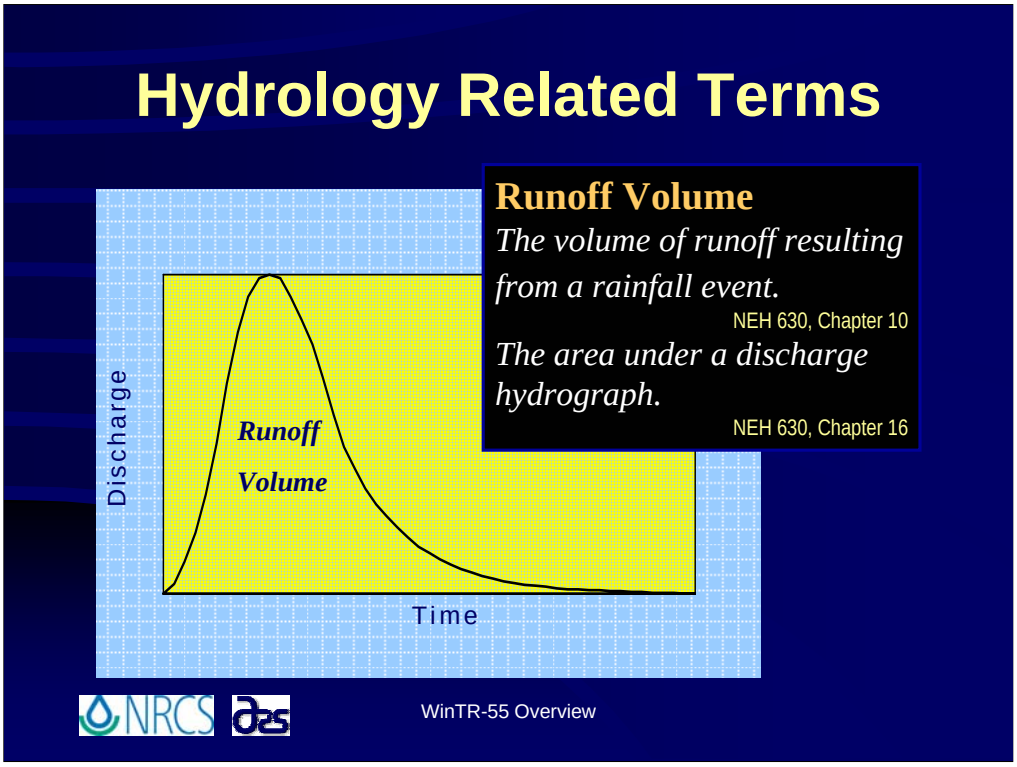
The portion of precipitation that makes its way to the watershed outlet.

NEH 630, Chapter 10

Photos courtesy of USDA-NRCS

WinTR-55 Overview

Runoff is that portion of rainfall over a watershed that is not intercepted, evaporated, or infiltrated and makes it's way to the watershed outlet.



Runoff volume is that volume of runoff resulting from a rainfall event that made it's way to the watershed outlet. The runoff volume is represented on a discharge hydrograph as the area under the hydrograph.

Note to Instructor:

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