A Brief Overview of
Typical Two-Stage Ditch Characteristics

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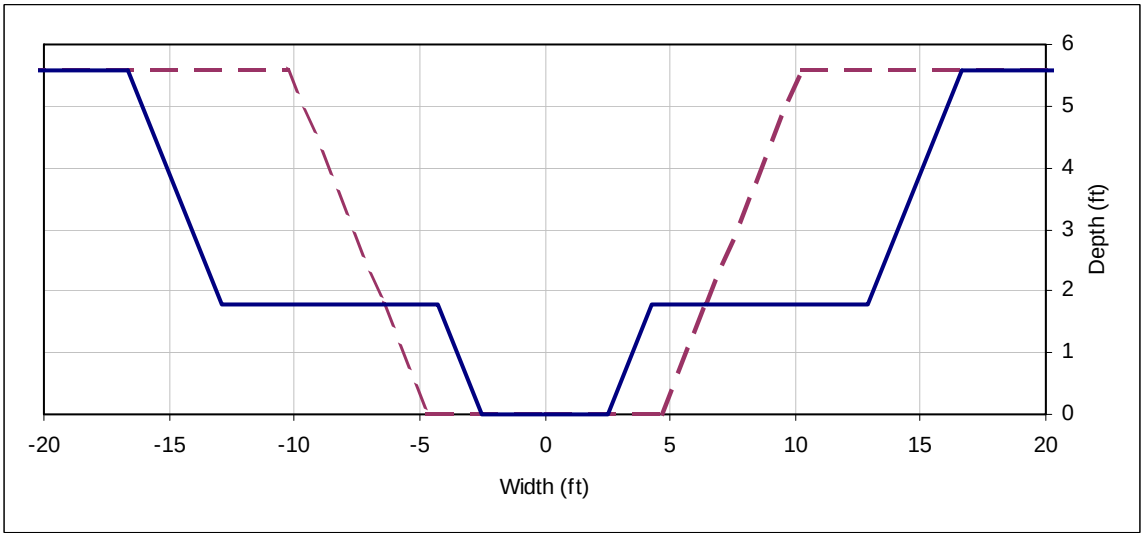
To illustrate the two-stage ditch design concept, examples of typical dimensions and characteristics are presented for conventional ditch and two-stage ditches. The first example is a comparison of the dimensions of both approaches characteristic of a 2 square mile watershed in Northwestern to Central Ohio.

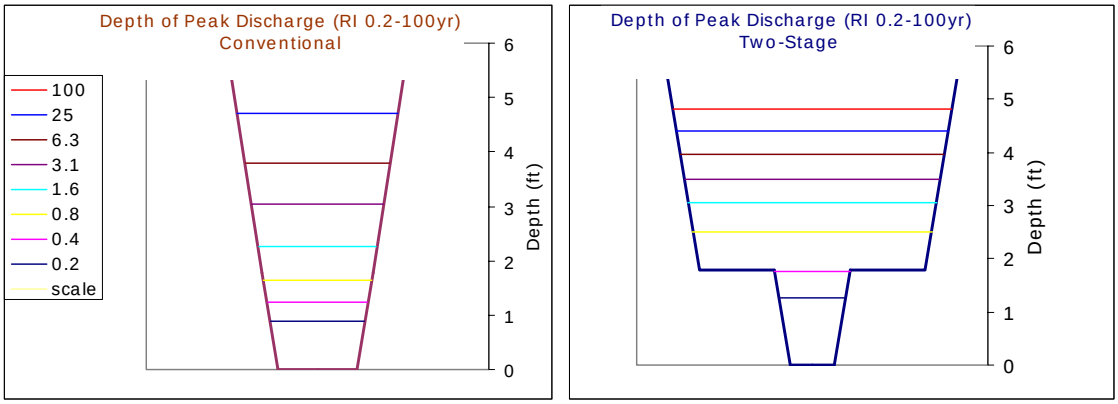


The two-stage design is based on the width of the channel anticipated to form within the ditch. Typical designs have used that width times 3 for the width of the ditch at the bench stage. The following are the difference in top width on each side for a range of drainage areas:

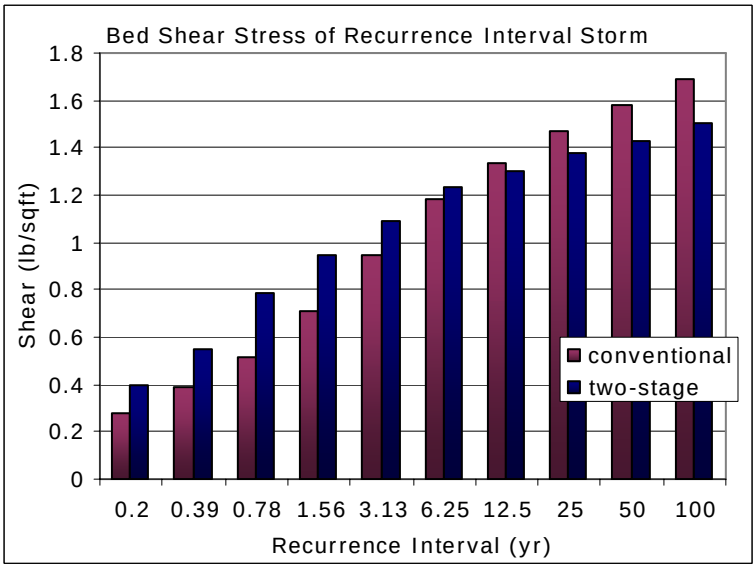
Drainage Area (mi^2)	Increased Width Each Side (ft)
1	4.9
5	9.3
10	12.2

The two-stage configuration provides more capacity at higher stages. For example the capacity of the conventional design in the 2 square mile example is 440 ft^3/s compared to 660 ft^3/s with the two-stage design, or 150% of the conventional design.

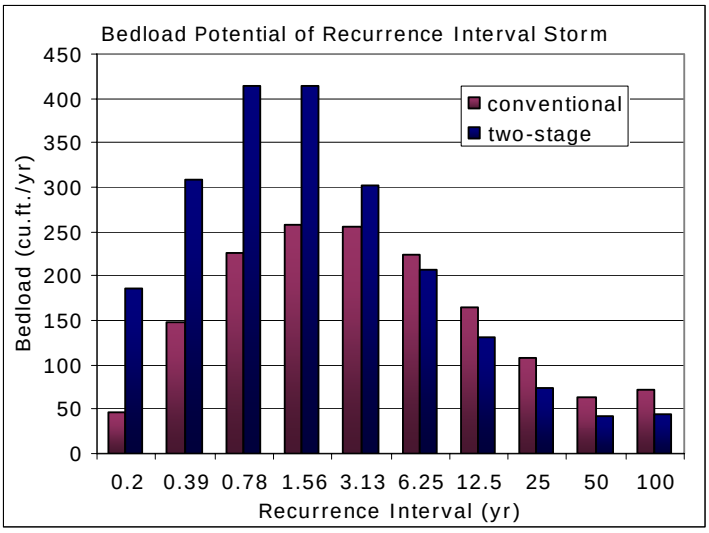
The following diagrams show the flow stages of various recurrence interval storms from very frequent, 0.2-year recurrence interval up to the 100-year storm, again for a 2 mi^2 drainage area in N.W. Ohio.



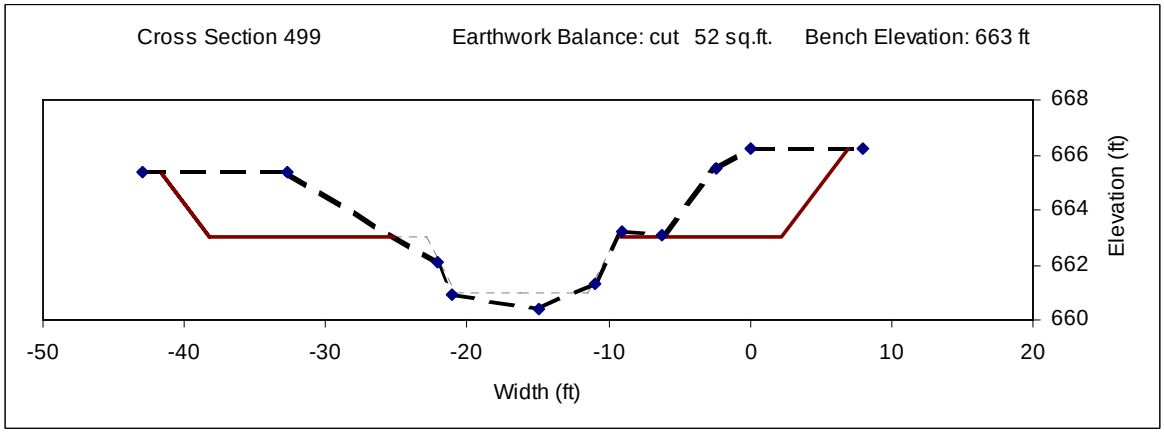
Note in the diagram above that while the flow depths of large events are lower in the two-stage design, depths of more frequent events are deeper. Flows contained within the small channel are narrower and thus deeper. Deeper flow has a greater ability to scour and reduce the accumulation of fine sediment building up on the bed. The two-stage configuration moderates the bed shear stress as shown in the graph below. The shear stress is higher for frequent flows when accumulation of fine sediment is concern but is less at high flows when erosion is more of a concern.

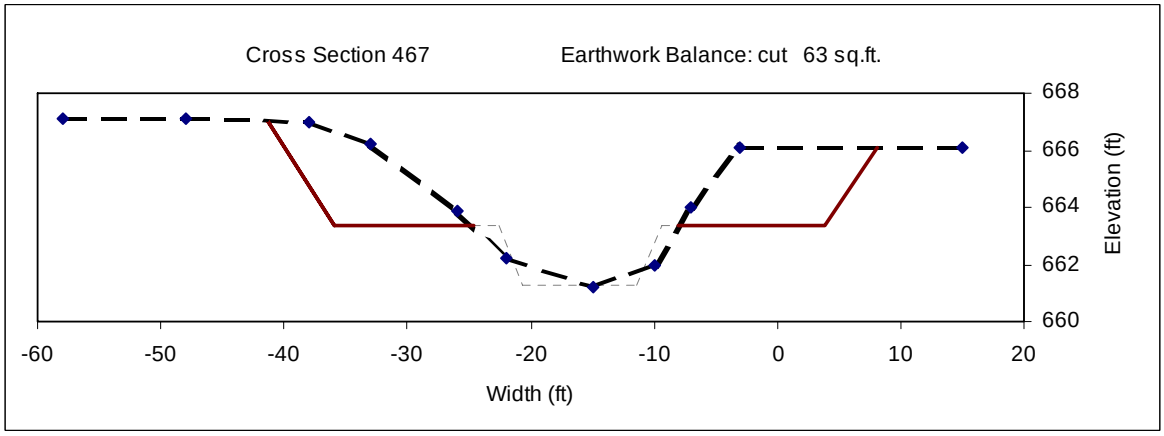


The same information is presented again in the graph below except the amount of work done by the shear stress is multiplied by the number of times each particular flow occurs. The results suggest two-stage channels should be significantly less prone to filling in with sediment and thus require less maintenance.



Often within conventional ditches small benches begin to form but then these unintentional benches are removed with periodic ditch maintenance. The following two cross sections are from a ditch in Sandusky County. They show an alternative maintenance approach used to produce a two-stage configuration





Two-stage ditch construction has demonstrated benefits both for drainage and ecological. Research by Ohio State University and Ohio Department of Natural Resources suggests two-stage ditches result in reduced maintenance, greater capacity, better habitat and increased pollutant assimilation. The cost is more earthwork and in the increased width that is not available for production.