



$a$  = Cross-sectional area of waterway  
 $p$  = wetted perimeter  
 $R = a/p$  = Hydraulic radius



For pipes full or half full  
 $R = D/4$

### Section of Any Channel

$V$  = Average or mean velocity in m/s

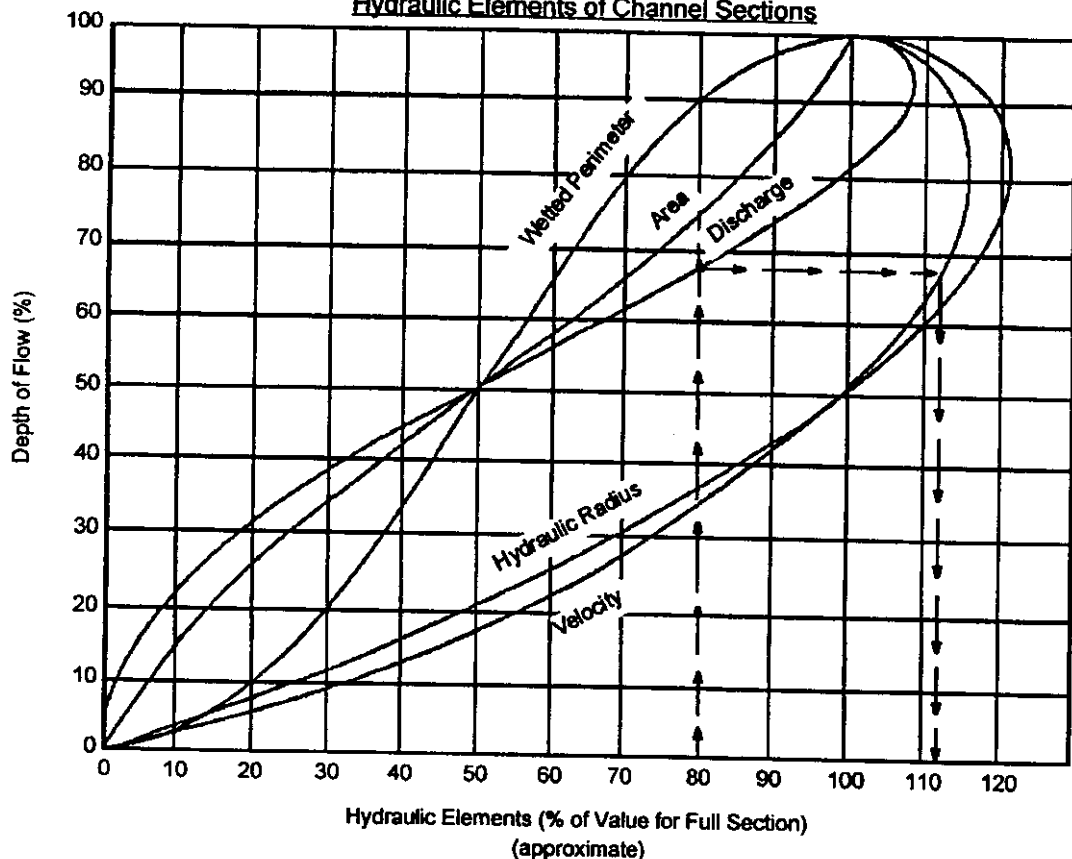
$Q = a V$  = Discharge of pipe or channel in m<sup>3</sup>/s

$n$  = Coefficient of roughness of pipe or channel surface

$S$  = Slope of hydraulic gradient (water surface in open channels or pipes not under pressure, same as slope of channel or pipe invert only when flow is uniform in constant section)

### Section of Circular Pipe

### Hydraulic Elements of Channel Sections



**VALUES OF HYDRAULIC ELEMENTS OF CIRCULAR SECTION  
 FOR VARIOUS DEPTHS OF FLOW**

**Figure 36-12D**