It has also been found in most reservoirs that the topset slope will closely approximate one-half the original channel slope. This value may serve as a verification of the slope computed by equations 13 and 14.

The location of the pivot point between the topset and foreset slopes depends primarily on the operation of the reservoir and the existing channel slope in the delta area. If the reservoir is operated near the top of the conservation pool a large portion of the time, the elevation of the top of the conservation pool will be the pivot point elevation. If the original channel is meandering and has frequent overbank flows, the top of the conservation pool also sets the pivot point elevation. Conversely, if the reservoir water surface has frequent fluctuations and a deeply entrenched inflow channel, a mean operating pool elevation should be used to establish the pivot point.

The upstream end of the delta is set at the intersection of the maximum water surface and the original streambed, and the topset slope is projected from that point to the anticipated pivot point elevation to begin the first trial.

The average of foreset slopes observed in Bureau of Reclamation reservoir resurveys is 6.5 times the topset slope. However, some reservoirs exhibit a foreset slope considerably greater than this; i.e., Lake Mead foreset slope is 100 times the topset. By adopting a foreset slope of 6.5 times the topset, the first trial delta fit can be completed.

The volume of sediment computed from the channel cross sections with the delta imposed should agree with the volume of sand size or larger material anticipated to come from the delta stream. The quantity of sediment in the delta above normal water surface elevation should also agree with that estimated to deposit above the normal operating level. If the adjustment necessary to attain agreement is minor, it can usually be accomplished by a small change in the foreset slope.

If a significant change in delta size is necessary, it will be necessary to move the pivot point forward or backward in the reservoir, while maintaining the previously determined elevation of the point. The topset slope is then projected backward from the new pivot point location and the delta volume is again computed. There should be no cause for alarm if the intersection of the delta topset and the original streambed falls above the maximum water surface elevation as this condition has often been observed in small reservoirs.

B. DOWNSTREAM CHANNEL EFFECTS

H-4. Channel Degradation.—A natural flowing stream is usually in a state of quasi-equilibrium; that is, there is no long-term trend toward aggradation or degradation. A stream in equilibrium is said to be a stream in regime [22]. The state of stream equilibrium may be expressed qualitatively by the following equation:

\[ Q_d = kQ_w S \]  
(15)

where:
- \( Q_d \) = bed material discharge
- \( d \) = sediment particle diameter
- \( Q_w \) = water discharge
- \( S \) = slope of the stream
- \( k \) = constant of proportionality.

If any one of the four variables is altered, one or more of the other variables must undergo change to return the stream to a state of equilibrium. In the case of a storage reser-
voir, the sediment load is eliminated or at least greatly decreased and a decreased slope downstream of the dam can be anticipated and the sediment particles remaining in the streambed will be the coarser fractions of the original material. This process of removing sediment particles from the streambed and banks is referred to as degradation.

There are two distinct approaches for estimating the depth or amount of degradation that will occur downstream from a dam or similar structure, each dependent on the type of material forming the bed of the river channel [23].

In cases where the streambed is composed of transportable material and the material extends to depths greater than that to which the channel can be expected to degrade, the approach most useful is that of computing the stable channel slope, the volume of expected degradation, and then determining a 3-slope channel profile which fits these values. However, if large size or coarse material, which cannot be transported by normal river discharges, exists in sufficient quantities an armor layer will develop as the finer material is sorted out and transported downstream. Vertical degradation will proceed at a progressively slower rate until the armor is of sufficient depth to inhibit further degradation.

(a) Dominant Discharge.—The dominant discharge is defined as the discharge which, if allowed to flow constantly, would have the same overall channel shaping effect as the natural fluctuating discharges would. The dominant discharge used in channel stabilization work is usually considered to be either the bank-full discharge or that peak discharge which will be different and some judgment may be required in selecting the proper size. Several laboratory investigations have shown that the size of a particle plucked from a streambed is proportional to the velocity of flow near the bed. The velocity at which the particle starts to move is referred to as the competent bottom velocity [24]. The competent bottom velocity has been found to be approximately equal to 0.7 times the mean channel velocity. Figure H–13 is a plot of competent bottom velocity, $V$, versus the size $d$ of a moveable sediment particle which has been used for determining the armoring size.

Tractive force is the drag or shear acting on the wetted area of the channel bed and can be expressed as:

$$ T.F. = ydS $$

where

- $T.F.$ = tractive force in lb./ft.$^2$
- $y$ = unit weight of water (62.4 lb./ft.$^3$)
- $d$ = mean water depth in feet
- $S$ = stream gradient in ft./ft.