In addition, special cases where a dam failure could cause *domino-like* failure of downstream dams resulting in a cumulative flood wave large enough to cause a threat should be considered.

The area affected by dam failure during a given flow condition on a river is the additional area inundated by the incremental increase in flood elevation due to failure over that which would occur normally by flooding without dam failure. The area affected by a flood wave resulting from a theoretical dam breach is a function of the height of the flood wave and the downstream distance and width of the river at a particular location. An associated and important factor is the flood wave travel time. These elements are primarily a function of the rate and extent of dam failure, but also are functions of channel and floodplain geometry and roughness and channel slope.

The flood wave should be routed downstream to the point where the incremental effect of a failure will no longer result in unacceptable additional consequences. When routing a dambreak flood through the downstream reaches, appropriate concurrent inflows should be considered in the computations. Downstream concurrent inflows can be determined using one of the following approaches:

- Concurrent inflows can be based on historical records if these records indicate that the tributaries contributing to the flood volume are characteristically in a flood stage at the same time that flood inflows to the reservoir occur. Concurrent inflows based on historical records should be adjusted so they are compatible with the magnitude of the flood inflow computed for the dam under study.

- Concurrent inflows can be developed from flood studies for downstream reaches when they are available. However, if these concurrent floods represent inflows to a downstream reservoir, suitable adjustments must be made to properly distribute flows among the tributaries.

- Concurrent inflows may be assumed equal to the mean annual flood (approximately bankfull capacity) for the channel and tributaries downstream from the dam. The mean annual flood can be determined from flood flow frequency studies. As the distance downstream from the dam increases, engineering judgment may be required to adjust the concurrent inflows selected.

In general, the study should be terminated when the potential for loss of life and property damage caused by routing floodflows appears limited. This point could occur when the following takes place:

- There are no habitable structures, and anticipated future development in the floodplain is limited.

- Floodflows are contained within a large downstream reservoir.

If the study under normal flow conditions indicates no adverse consequences, the same analyses should be done for several larger flood levels to determine the greatest unacceptable consequences. Under each incrementally larger inflow condition, identify the consequences of failure. For each larger assumed flood inflow condition (which can be percentages of the probable maximum flood (PMF)):

- assume the dam remains in place during the nonfailure conditions; and
- assume the dam fails when the *peak* reservoir elevation is attained for the assumed inflow condition.

It is not appropriate to assume that a dam fails on the rising limb of the inflow hydrograph. For example, current methods cannot accurately determine the extent of overtopping that an earth dam can withstand or how rapidly the dam will erode and ultimately breach from overtopping. Therefore, until such methodologies are available and proven, a conservative approach should be followed which assumes that failure occurs at the peak of the flood hydrograph. The assumption should also be made that the dam has been theoretically modified to contain or safely pass all lower inflow floods. This is an appropriate assumption because this procedure requires that the dambreak analyses start at the normal operating condition, with incremental increases in the flood inflow condition for each subsequent failure scenario up to the point where a failure no longer constitutes unacceptable additional consequences. In summary, before selecting larger floods for analysis, determine what failure at a lower flood constituted a threat to downstream life and property.

The above procedure should be repeated until the flood inflow condition is identified such that a failure at that flow or larger flows (up to the PMF) will no longer result in unacceptable additional consequences. The resultant flood flow is the IDF for the project. The maximum IDF is always the PMF, but in many cases the IDF will be substantially less than the PMF.

A PMF should be determined if it is needed for use in the evaluation. If a PMF value is already available, it should be reviewed to determine if it is still appropriate. The probable maximum precipitation (PMP) for the area should be determined either through the use of the Hydrometeorological Reports (HMR's) developed by the NWS or through the services of a qualified hydrometeorologist. In addition, the hydrologic characteristics of the drainage basin that would affect the runoff from the PMP into the reservoir should be determined. After this information is evaluated, the PMF can be determined.

Once the appropriate IDF for the dam has been selected (whether it is the PMF or something less), it should then be determined whether the dam can safely withstand or pass all floodflows up through the IDF. If it can, then no further evaluation or action is required. If it cannot, then measures must be taken to enable the project to safely accommodate all floods up through the IDF to alleviate the incremental increase in unacceptable additional consequences a failure may have on areas downstream.