SECTION 2 - CAUSES OF STREAM BANK EROSION

All streams erode to some extent as a part of natural processes. Natural erosion is typically caused by:
1) Hydraulic forces that remove bank material;
2) Geotechnical instabilities;
3) Or, most commonly, a combination of both these two forces.

Hydraulic Failures

Hydraulic failures occur when the force or velocity of the water is greater than the natural cohesion of the soil. In other words, the forces that bind the soil together are overcome by the water. Some visible features of hydraulic failures are erosion near the bottom, (or at the "toe,") of a stream bank, or alteration of the streambed. Changes in the direction of flow, constrictions, increases or decreases in the amount of sediment, and increased amount and duration of flow from impervious areas can all accelerate erosion of the stream bank or alteration of the streambed, and in turn, hydraulic failure. Some of the sediment that is introduced into the stream will naturally deposit on the bottom of the stream. Over time, this may raise the bottom of the stream and reduce the capacity of the active channel, forcing the water to spread out laterally. This causes erosion and steepening of the stream banks. This can also occur when a stream is starved of sediment (typically by dams or erosion control structures) and the excess energy that would have been used to transport sediment is now free to erode bed and banks. This condition typically occurs with the construction of hardened channel linings, or with the addition of other types of instream debris, sediment, or detention basins that trap sediment. In this case, the erosion (down-cutting and steepening) of the streambed and banks occurs below the lined section (or "instream basin"), causing the eroded sediment to settle farther downstream. Nonetheless, the impact on the stream is similar. Thus, for hydraulic failures, the most effective erosion repairs are accomplished by addressing the root cause of the failure, which may include installation of measures to redirect flow, increasing the erosion resistance of the bank, by planting vegetation on the bank or adding protection to the toe of the stream bank.

Geotechnical Failures

Geotechnical failures occur when gravitational forces are greater than the strength of the soil. These failures are usually caused by over steepened banks and/or excess moisture in the soil. This results in the movement of earth, better known as a landslide. Near a stream, the likely causes of this type of failure are a high groundwater table, poorly designed surface drainage systems (such as those that drain surface runoff directly over the top of the stream bank), leaking swimming pools, and leaking septic systems or water lines (which saturate the stream bank). Thus, for most geotechnical failures, what must be addressed is the source of the water that's causing excess moisture in the vicinity of the stream bank.

Combination Failures

The third type of failure is a combination of hydraulic forces and geotechnical instabilities. Hydraulic failures often lead to geotechnical failures. As the toe of the stream bank erodes, or the channel cuts downward because of hydraulic forces, the bank effectively increases in height and becomes too steep and unstable. Sometimes, the upper portion of the stream bank fails from lack of support, and slides into the stream. This process is well described in the document *Maintaining Corte madera Creek: A Citizen's Guide to Creek-side Property Protection*, which was prepared by Phil Williams and

Associates in Collaboration with H. T. Harvey and Associates for the San Francisquito Creek Joint Powers Authority. They write, "The higher a bank is, the flatter the angle must be to prevent slumping. For example, most soils will support a three-foot high vertical bank, but if the river cuts a deeper channel (say five feet) the bank will collapse under its own weight. A five-foot tall bank would need to be graded to a lower gradient to be as stable as a three-foot vertical bank, and a ten-foot high bank would have to be excavated to an even lower gradient to be stable. The higher the bank, the lower the stable gradient becomes." The best remedy for this problem—the problem of an over-steepened bank experiencing both hydraulic and geotechnical failures—combines several steps. The first step involves regrading the slope to a more stable angle, which is why it is called "laying it back." The second step involves reinforcing the toe, where necessary, with biotechnical methods such as logs and rocks. The third step involves reducing erosive energy on the bank by planting the bank, so that it does not become over-steepened again.
For an illustration, see figure 3 below.

Figure 3: Laying Back a Streambank to Increase Stability