Section 3
Sugar Creek Geomorphologic Assessment

3.1 Fundamentals of Fluvial Geomorphology

Fluvial geomorphology is the science of how moving water shapes the land. It is the fundamental discipline of river science and allows the quantitative description of stream behavior now and reasonable predictions of future behavior under specified conditions. Fluvial geomorphology and the related disciplines of hydrology and hydraulic engineering, geology and soil science together provide the technical underpinnings for sound watershed management. The paragraphs that follow are a brief overview of geomorphic principles with emphasis on their application to stream and watershed management.

3.1.1 Major Models

Streams exist in a state of dynamic equilibrium in which the forces driving channel form are balanced by the resisting forces. The driving force is gravity. It acts on the stream as the rate at which water and sediment move through a stream. The resisting forces are the strength of the channel boundary materials and friction expressed as the channel shape. When the driving forces exceed the resisting forces, the stress applied by water or sediment exceeds the channel strength. The stream channel responds by altering its shape in plan, profile and cross section to accommodate the change in flow volume and applied shear. Once disturbed, the processes by which streams respond are: 1) incision or degradation, 2) widening, 3) aggradation or deposition and 4) plan form adjustments. Through these processes, streams eventually re-establish equilibrium. Determining which process is dominant and the likely progression of stream processes is one of the principle challenges of stream management.

While gravity and friction are first principles and drivers of channel form at the most fundamental levels, stream managers grapple with their many manifestations including sediment source, sizes and abundance, varying hydrologic conditions, vegetative influences and a broad range of geological influences. Given the large number of independent variables and the complex relationships between the many dependent variables, it is reasonable to seek robust, relatively straightforward models that organize these variables. In disturbed systems such as Sugar Creek, the chosen approach evaluates each channel process separately then develops an integrated assessment using energy relationships.

Although there are three commonly recognized approaches to stream design, each with advantages and limitations (Skidmore et al., 2001), the two simplest approaches, often called analog and empirical methods, explicitly assume equilibrium conditions regarding hydrology and sediment transport. Because Sugar Creek is not in equilibrium, the third approach called the analytical method is more appropriate and was used in this study.