3.7.2.1 Cell-level delivery function

Sediment delivery through each cell is modeled by a set of equations that distinguish between overland and channel flow. Sediment delivery through cells under overland flow is represented by Equation (3.12). Development of Equation (3.12) is discussed below, followed by presentation and discussion of the channel flow delivery equation (Equation 3.15).

$$d = \min \left\{ \alpha \sqrt{\frac{s}{l}}, \quad 1 \right\} \tag{3.12}$$

where
d = sediment delivery ratio through an overland cell,
α = land use coefficient [dimensionless],
s = slope steepness across cell [m/m], and
l = length of flow path across cell [m].

The slope steepness and length of flow path across each overland cell are determined by a GIS. The α-value was calculated for each management practice used in evaluation of the optimization procedure, as discussed below.

Novotny and Olem (1994) listed land cover and slope as key factors in affecting delivery rates. Additionally, they stated the importance of factors specific to storm events, such as rainfall impact, infiltration, ponding, and overland flow energy. However, because this research uses average annual erosion, consideration of storm specific factors was not feasible. Instead, sediment delivery was related more generally to overland flow velocity. This was done by basing the overland sediment delivery function (Equation 3.12) on the SCS flow velocity equation (Equation 3.13) (Haan et al., 1994).

$$v = as^{1/2} \tag{3.13}$$

where
v = velocity [m/s],
s = slope [m/m], and
a = land use coefficient.

This equation is applicable to overland and shallow channel flow. Also it considers the effects of land use and slope.

Watershed-level sediment delivery is a complex function of individual watershed characteristics. In particular, multiple studies, summarized by Walling (1983) have shown sediment yield at the watershed outlet to decrease as watershed area increases. Additionally, Walling (1983) summarized sediment delivery prediction equations developed for several regions of the United States. These equations proposed that sediment delivery ratios at the watershed level also decrease as watershed area increases. The prediction equations are functions of watershed area, relief, length, and slope.

The research summarized by Walling (1983) indicates that both slope and flow length are significant factors in predicting sediment delivery. Additionally, the inverse relationship between sediment delivery and watershed area suggests an inverse relationship between sediment delivery and overland flow length. Thus, to create a cell-level delivery function, the