Purpose: To examine the relationship between the primary SCERMA, Sp, and the primary collision KERMA, Kcp, as a function of depth for clinically relevant energy spectra, and to accurately model the SCERMA to KERMA ratio (SKR) for clinical photon beams. Method and Materials: Sp, Kcp, Sp / Kcp (=SKR) for the energy spectra of Cobalt-60 (Co-60), and Mohan 4 MV, 6 MV, 10 MV, 15 MV, and 24 MV photons are analytically calculated over depths from 0 to 40 centimeters in water. The Sp and Kcp are fitted to exponential functions, Sp0exp(-µ’d(1-η’d)) and Kp0exp(-µd(1-ηd)), respectively, with depth d, linear attenuation coefficient µ and beam hardening coefficient η; µ’ and η’ are the corresponding quantities for Sp. The relationships between µ’, η’, and SKR vs. µ are examined. Trends between the fitting parameters and µ were also determined, and the results applied to model the SKR of 6x and 15x clinical beams as functions of only µ, η, and depth. Results: SKR decreases with depth for all spectra. We found µ’ = (0.80496 + 4.8748µ)µ + 0.005736 and η’ = (-0.13076 + 2.6571µ)µ + 0.0036151 for 0.0273/cm<=µ<0.0392/cm, and µ’ = 0.87718µ + 0.010864 and η’ =(-0.009 – 0.50122µ)µ + 0.0037 for 0.0392/cm <= µ <= 0.0667/cm. This model predicts the normalized SKR/(SKR(d=0)) with a relative deviation of 0.1% and max deviation of 1%. SKR/(SKR(d=0)) from clinical beams 6x and 15x is examined to be in agreement with analytic computation from spectral data with 1% and 0.5% maximum error, respectively. Conclusion: Knowledge of normalized SKR is a necessary to calculate scatter dose accurately. We have developed an empirical model to calculate the normalized SKR to be used for clinical (scatter) dose calculation and consequently improve dose calculation accuracy.