We present a new model for ultrasoft charged colloidal particles, which we term soft restricted primitive model. The model is based on an effective pair potential describing the interaction between Gaussian charge distributions, such as those encountered, for instance, in polyelectrolytes in solution. Contrary to the standard, hard primitive model [1], the interaction potential of our model is continuous for all interparticle separations and is finite at the origin, i.e., particles are penetrable. Detailed Monte Carlo and molecular dynamics simulations for a symmetric mixture of such oppositely charged ultrasoft particles indicate a very rich phase behaviour at low densities and temperatures: a liquid-vapour phase separation (with an estimated critical point at reduced density of approximately 0.08 and temperature of approximately 0.002; a conductor-insulator transition, possibly linked to phase separation; cluster formation. In particular, phase separation appears to be induced by a complex scenario for cluster formation: while at high temperatures the system consists essentially of isolated particles, long-lived dimers become dominant at temperatures where phase separation occurs. As an example, spontaneous formation of dense droplets in MD simulations (see Figure) is observed well within the paired regime. In addition, higher order clusters can form, but their lifetimes are typically by a factor 10 smaller than for the dimers. Complementing integral equations results for the structure and thermodynamics show very good agreement with simulations for high densities and/or high temperatures; however, major discrepancies appear in the phase separation region. This shows that the theoretical description of phase behaviour in primitive models for polyelectrolytes and charged colloids remains one of the major challenges of soft condensed matter.