Controversy reigns regarding water’s structure and dynamics. Tetrahedral structure with a component of broken hydrogen bonds is not consistent with all experimental data. Here, a new definition for a hydrogen bond is applied to give a detailed characterisation of the structure and dynamics of liquid water. The definition equates a hydrogen bond with an energy well in the potential energy surface, sharply resolves transition states in hydrogen-bond switching, avoids arbitrary parameters and takes into account correlations. In addition to the dominant tetrahedral hydrogen-bond coordination, it reveals that there are smaller trigonal and trigonal bipyramidal components in almost equal proportions and that the fraction of broken hydrogen bonds is very small. These non-tetrahedral components are observed to have higher enthalpy, entropy, density and dynamics. Hydrogen-bond switching proceeds via a decrease and increase in hydrogen bonds of the respective initial and final acceptors. Three mechanisms of hydrogen-bond switching are detected, depending on whether the donor and new acceptor share a hydrogen bond prior to switching.