In this work, the influence of phosphate buffer and proteins on the potentiometric response of a polymeric membrane-based solid-contact Pb\(^{2+}\)-selective electrode (Pb\(^{2+}\)-ISE) was studied. The effects of bovine serum albumin (BSA) adsorption at the surface of the ion-selective membrane combined with electrode conditioning in phosphate-buffered saline (PBS) solution was elucidated by potentiometry and electrochemical impedance spectroscopy. The adsorbed BSA at the surface of the Pb\(^{2+}\)-ISE slightly lowered the detection limit but did not influence the selectivity of the Pb\(^{2+}\)-ISE towards the interfering ions studied (Cu\(^{2+}\), Cd\(^{2+}\)). Conditioning of the Pb\(^{2+}\)-ISE in 0.01 mol dm\(^{-3}\) PBS resulted in a super-Nernstian response which was related to fixation/extraction of Pb\(^{2+}\) in the ion-selective membrane via precipitation of Pb\(_3\)(PO\(_4\))\(_2\) by PO\(_4^{3-}\) anions present in PBS. By conditioning of the Pb\(^{2+}\)-ISE in 0.01 mol dm\(^{-3}\) PBS + 1 mg/ml BSA it was possible to extend the linear response range of the Pb\(^{2+}\)-ISE towards lower analyte concentrations. The utilization of this conditioning procedure was validated by determination of Pb\(^{2+}\) concentrations down to ca 20 ppb in aqueous samples by Pb\(^{2+}\)-ISEs and by comparing the results with those obtained by ICP-MS.