This paper presents 25 new laboratory experiments involving the wave-induced backfilling of wave-induced scour holes beneath submarine pipelines (so-called wave-to-wave backfilling scenarios). The experiments complement the previous 8 wave-to-wave backfilling experiments of Fredsøe et al., as well as recent current-to-wave backfilling experiments of Bayraktar et al. It is found that the wave-induced backfilling time scale is generally an order of magnitude larger than for scour, and is relatively insensitive to the initial (current- or wave-induced) pre-backfilling scour profile. Based on this, the data sets involving wave-induced backfilling are collectively analyzed, resulting in a new generalized expression for estimating the wave-induced backfilling time scale beneath pipelines in the live-bed regime. This expression accounts for primary dependence on the Shields parameter, as well as secondary dependence based on the difference between the (estimated or known) initial and expected final equilibrium scour depth due to the backfilling wave condition.