Executive Summary – Wine Cellar

The purpose of this report is to investigate how the depth of any passive wine cellar affects the temperature of the cellar, and more critically determine an optimal depth for the cellar to minimise temperature variation from seasonal surface temperature change. This report models temperature variation of a cellar using the one-dimensional heat equation and appropriate boundary conditions dependent on daily and yearly temperature changes, and is investigated using both analytical and numerical methods, with numerical parameters chosen from real-world data. Using temperature data from Maine in 2020, the analytical approximation strongly agrees with the data below depths of a couple metres, however the approximation is more successful for an annual scope due to the stochastic nature of daily variation. The approximation finds the optimal depth to be largely dependent on the heat diffusivity of the ground it is surrounded by; by comparing extremes of real heat diffusivities this is determined to be between 2 and 10 metres. Therefore it would be recommended that work be done in investigating particular heat diffusivities as these span an order of magnitude and strongly affect the optimal depths.