In the computation of multidimensional persistent homology, a popular tool in topological data analysis, a family of planar graphs arises. We have studied the problem of partitioning these graphs in a way that will be useful for parallelizing the persistent homology calculation. Specifically, we desire to partition an edge-weighted, undirected graph $G$ into $k$ connected components, $G_1,\ldots,G_k$. Let $w_i$ be the weight of a minimum spanning tree in component $G_i$. For our purposes, an ideal partition is one that minimizes $\max\{w_1,\ldots,w_k\}$. This problem is known to be NP-hard in the case of general graphs and we are unable to find this specific problem in the graph partitioning literature. We propose two approximation algorithms, one that uses a dynamic programming strategy and one that uses a spectral clustering approach, that produce near-optimal partitions in practice on a family of test graphs. We present detailed descriptions of these algorithms and the analysis of empirical performance data. (Received September 14, 2016)