Planning and operating activities within urban environments require a sound understanding of the surrounding world often populated with numerous man-made structures. Decision makers, who are tasked to respond effectively to emergencies, must be equipped with information on the details of what is happening, and must stay informed with updates as the event unfolds and remain attentive to the extent of impact the dynamics of the surrounding settings might have. When terrain related spatial information are presented accurately, timely, and are augmented with terrain analysis, enhanced situational understanding could be formed. Painting such enhanced situational pictures, however, demands efficient techniques to process and present volumes of geo-spatial data. Modern Graphics Processing Units (GPUs) have opened up a wide field of applications far beyond processing millions of polygons. This research aims to adapt GPU ray tracing rendering technique for improved accuracy in visualization and understanding of urban terrain, and to achieve real time fusion of 2D images and 3D terrain for enhanced situational awareness. The GPU ray tracing and image fusion based visualization techniques presented herein have the potential to aid in achieving enhanced urban situational awareness and understanding.