CHARM® Analysis of a Sarin Release in an Urban Environment

Besides modeling for regulatory and normal planning needs, modeling can be used to plan for impacts of releases not normally considered. One such an impact is a release of Sarin from munitions. In this example 100 pounds of Sarin liquid are assumed to be released almost instantaneously. CHARM has the properties of Sarin, VX, and Mustard Gas in its database.

The grid used for the simulation has both terrain and some buildings. The released liquid is allowed to flow along the terrain and evaporate. The maximum depth of the Sarin liquid is about 0.1 centimeters. In the simulation the Sarin source is assumed to be an evaporating pool with a shape determined by the terrain. CHARM can also be used to simulate the dispersion of Sarin droplets but that capability was not used for this case. The object of the exercise is to see how much area can be impacted at a Sarin concentration of 0.1 ppm. According to the CDC, Sarin can have life-threatening effects or death at exposures of 0.064 ppm for 10 minutes.

It takes less than a minute and a half for the leading edge of the plume to reach the end of the grid, which is about 350 meters from the source. The footprint of all the areas impacted by the plume during the first three minutes of the release is seen in Figure 1. There is only one meteorological station for this simulation with a wind speed of 5 meters per second at 10 meters above the ground. The temperature is set to 38 °C. If the liquid is allowed to fill a 25 foot diameter area, the liquid would be completely evaporated within 24 hours. If the diameter were larger, the evaporation duration would be shorter.

The plume is deflected by the terrain and the buildings to reach a maximum height of about 29 meters above the altitude of the release site. The vertical extent of the plume approximately along the plume centerline is shown in Figure 2.

Figure 3 through Figure 6 show 3D displays of the plume interacting with the terrain and buildings. The plumes shown depict all areas impacted at the concentrations plotted (0.1, 1, and 10 ppm). The green area is the 0.1 ppm concentration. In these figures the deflection of the plume due to the terrain and buildings can be seen. The atmospheric stability class used for the simulation is D. The air flow in D stability tends to follow the terrain and/or objects.

Besides these static displays of the plume. There is an animation of the growing plume at the CHARM web site. CHARM can be used to make a video in avi format. The avi format can be converted to the shorter wmv format using Windows Movie Maker. The plume is shown every few seconds. In the video the plume can be seen approaching and going over and around some of the buildings.

Example 100 lb impact release
Species: Sarin
Met:Damascus D, 5 m/s

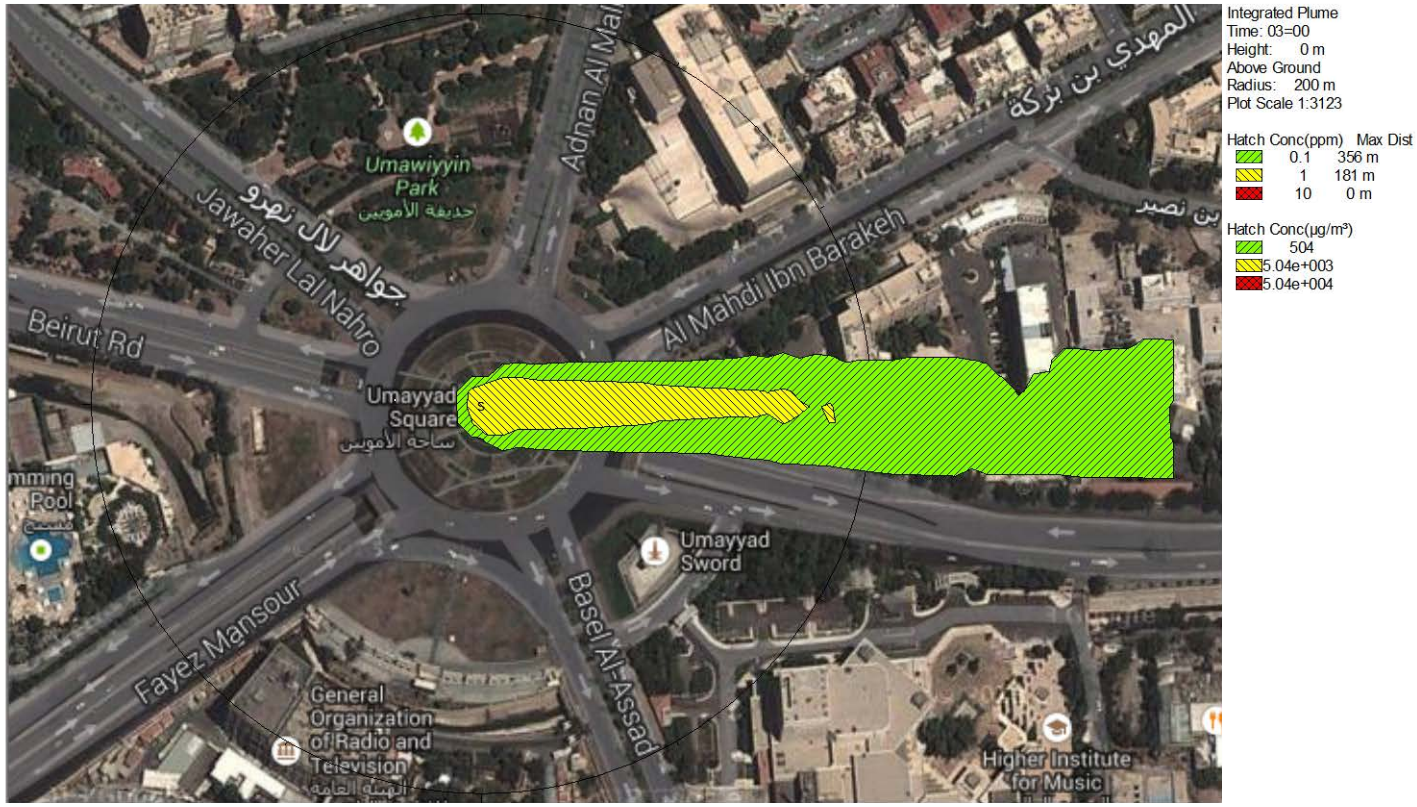

Figure 1 Plan view of all areas impacted by plume from Sarin release. Flat edge to the right is due to the plume exiting the calculation grid.

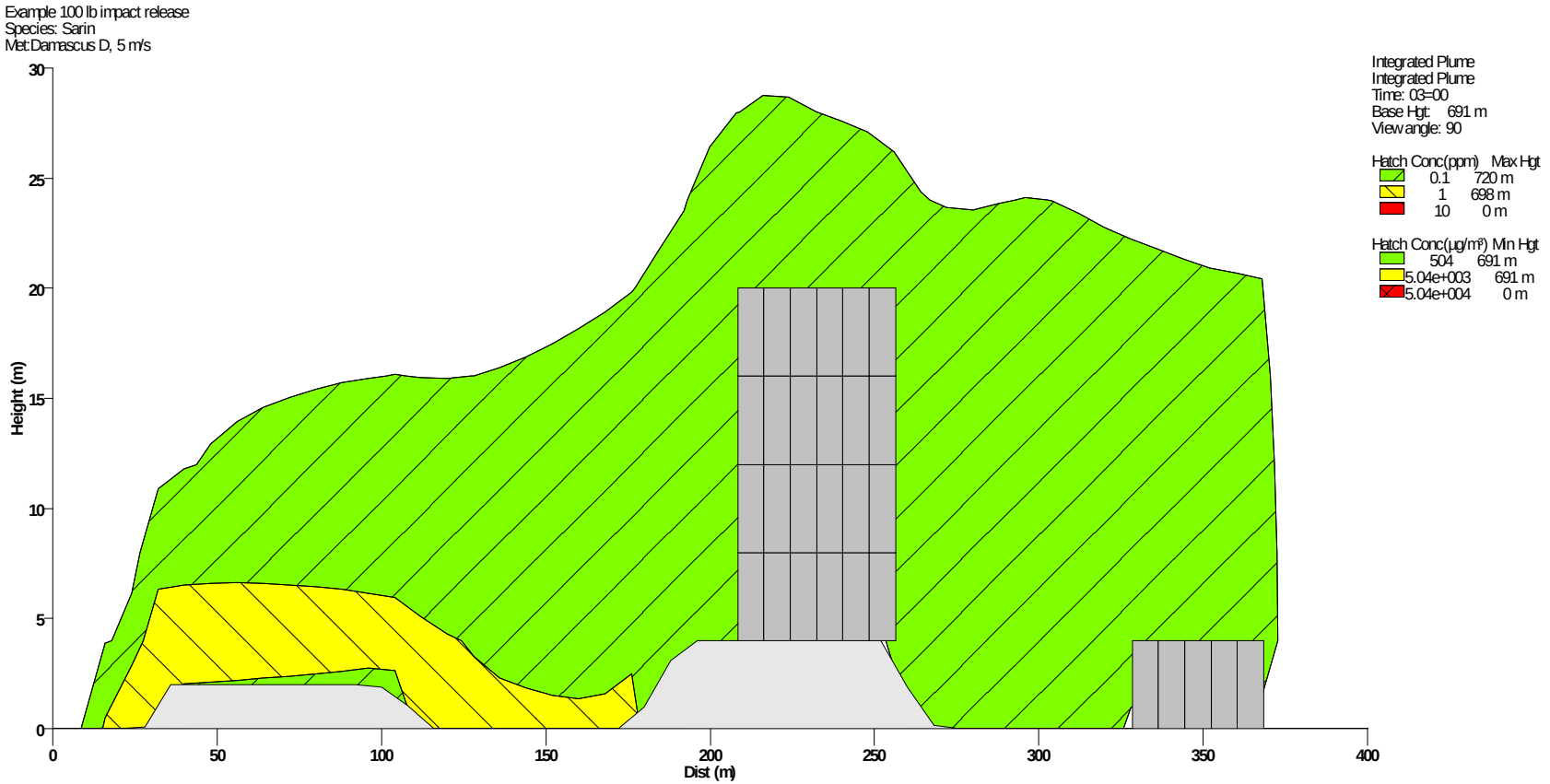

Figure 2 Vertical Cross-section view of all areas impacted by plume from Sarin release. Cross-section is approximately along the plume centerline. Terrain and buildings also appear.

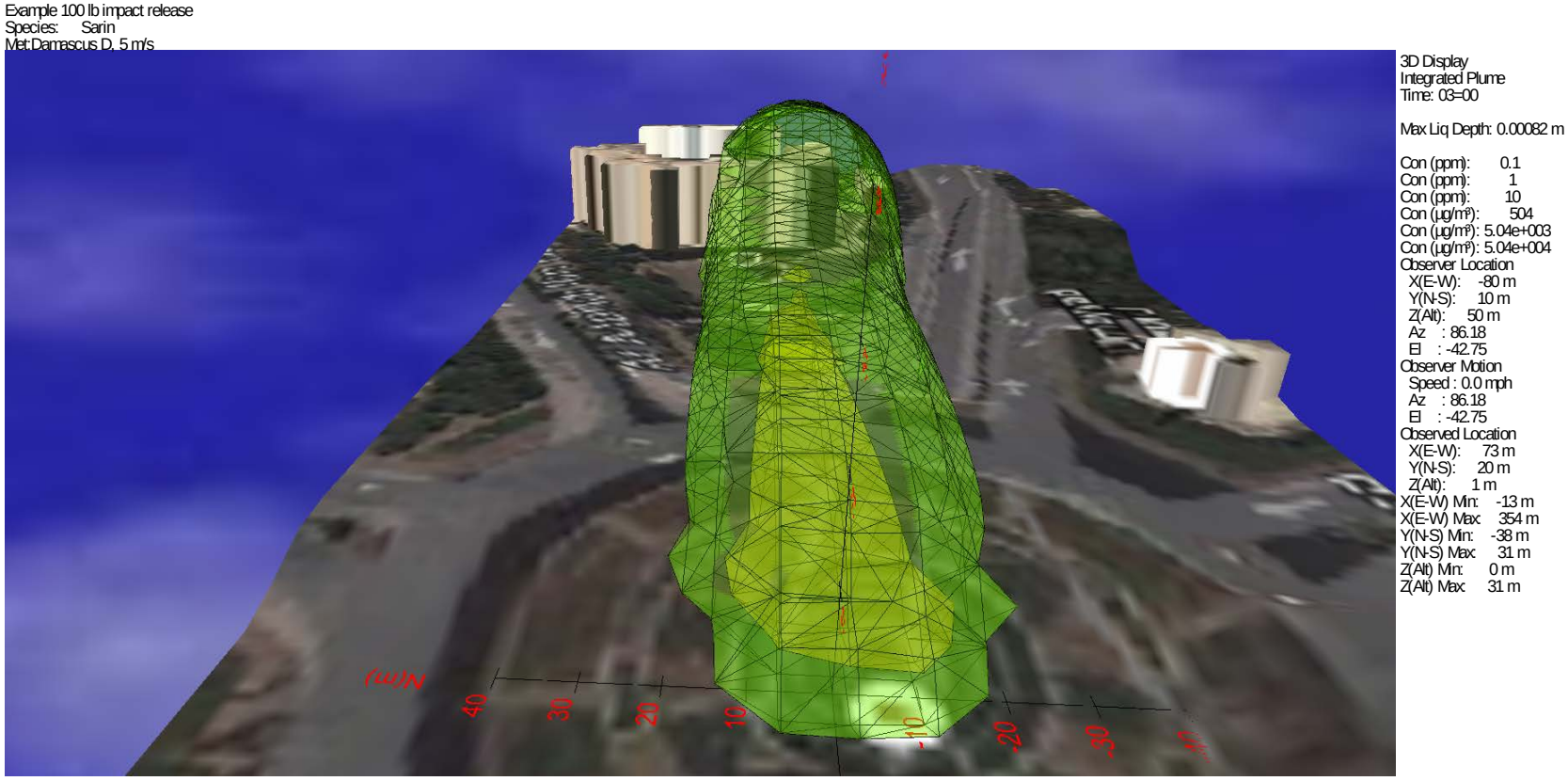

Figure 3 3D view of all areas impacted by plume from Sarin release. View is toward the East (downwind).

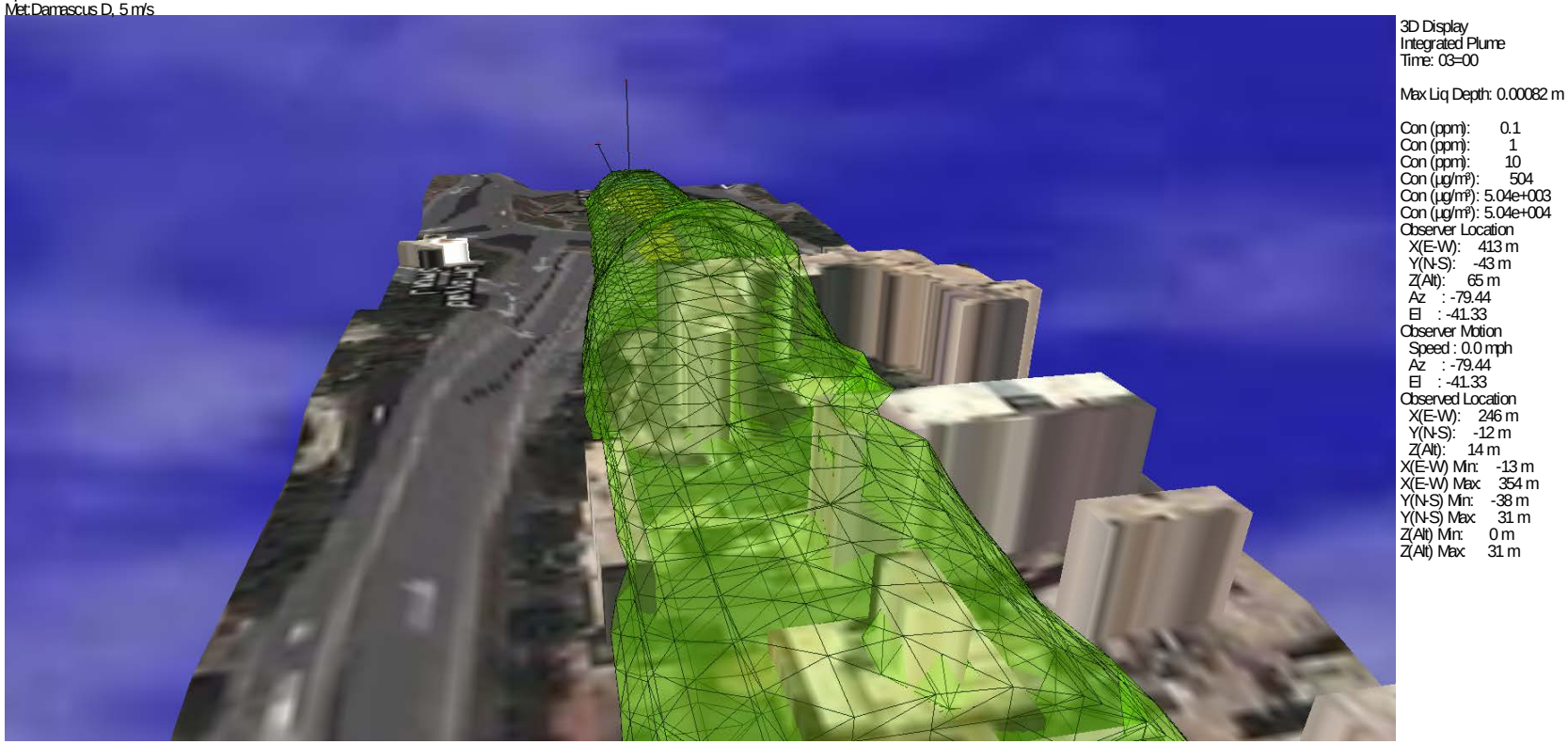

Figure 4 3D view of all areas impacted by plume from Sarin release. View is toward the West (upwind).

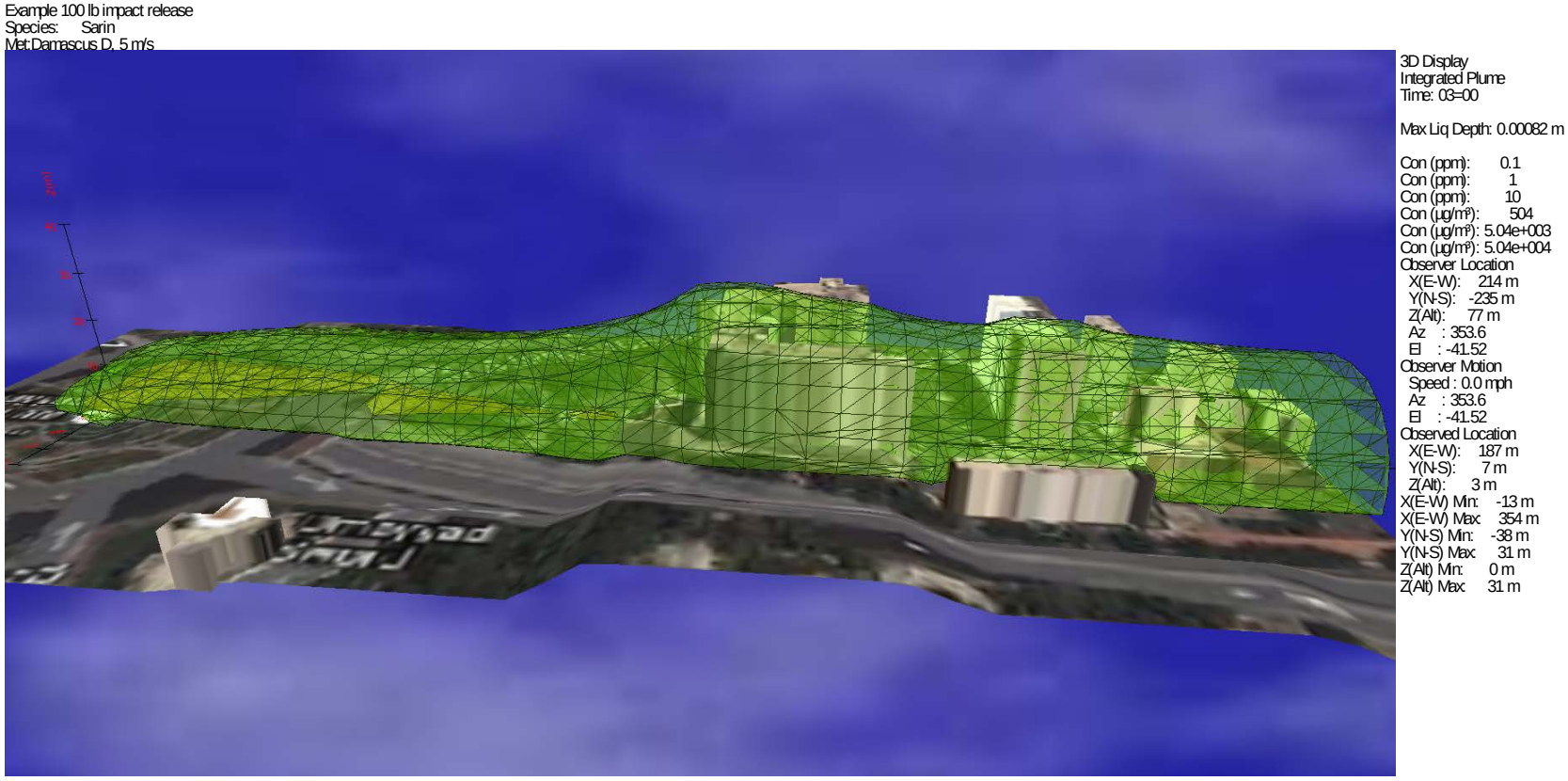

Figure 5 3D view of all areas impacted by plume from Sarin release. View is toward the North. Source at left.

Figure 6 3D view of all areas impacted by plume from Sarin release. View is toward the South. Source at right.