

Apply 3D Analysis Tools in ArcGIS Pro

learn.arcgis.com/

380 New York Street
Redlands, California 92373 – 8100 USA

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Apply 3D Analysis Tools in ArcGIS Pro

Time: 40 minutes

Overview

The ArcGIS 3D Analyst extension contains a powerful set of tools for understanding how the local terrain and other 3D features can obstruct the line of sight, or viewshed, between an observer and a target. However, sometimes you wish to quickly explore visibility scenarios in 3D without a lot of data preparation.

The content used in this lesson contains a mix of small-, medium-, and large-scale urban environments. All the analysis tasks in this lesson are done interactively and incorporate the currently visible layers in the scene–if you turn a layer on or off, your analysis changes in real time. These tools can be useful for a quick visual check or exploration of a scenario before conducting more rigorous visibility studies.

If you have some time left after using the Exploratory Analysis tools, you can spend a few minutes reviewing the exploratory tools–the Range and Time sliders in ArcGIS Pro–to discover meaningful patterns within a 3D space time cube.

In this lesson, you will learn to do the following:

- Use the 3D Exploratory Analysis tools in ArcGIS Pro
- Use the line of sight and viewshed tools to observe the effects of objects and terrain
- Explore spatiotemporal patterns in complex datasets using a 3D space time cube

Getting started

The analysis scenarios in this lesson are contained in an ArcGIS Pro Project package (.ppkx).

1. Download the **DisplayAnalytics.zip** compressed folder.

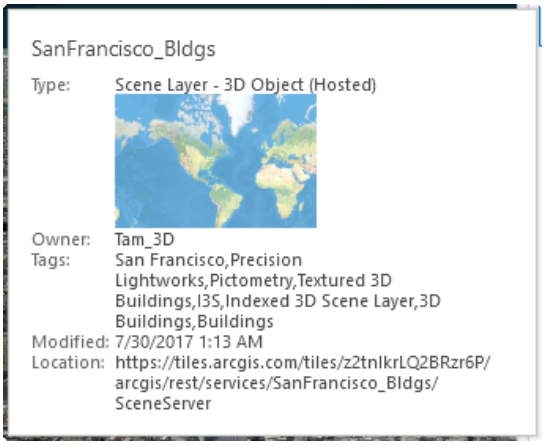
2. Locate the downloaded file on your computer and extract it to a location you can easily find, such as your Documents folder.

3. From the extract location, double-click the **DisplayAnalytics.ppkx** project package to launch ArcGIS Pro and display the package contents.
   When the project opens, you will find three scenes–two global scenes for Exploratory Analysis and one local scene for Exploring a Space Time Cube. Using the Exploratory Analysis scenes, you will

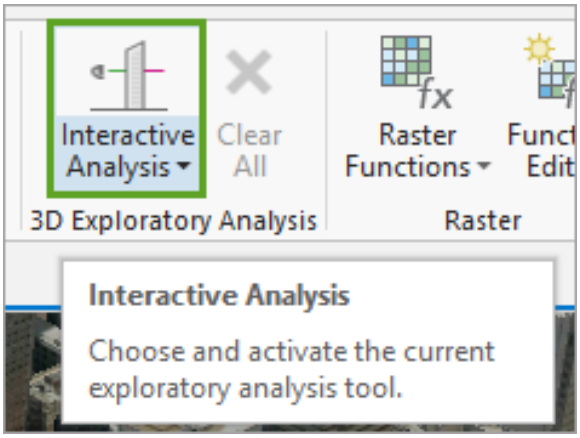
review and use exploratory analysis tools with data for San Francisco and the Esri campus in Redlands, California. In the space time cube scene, you will use a space time cube to explore patterns in water usage in Merced, California.



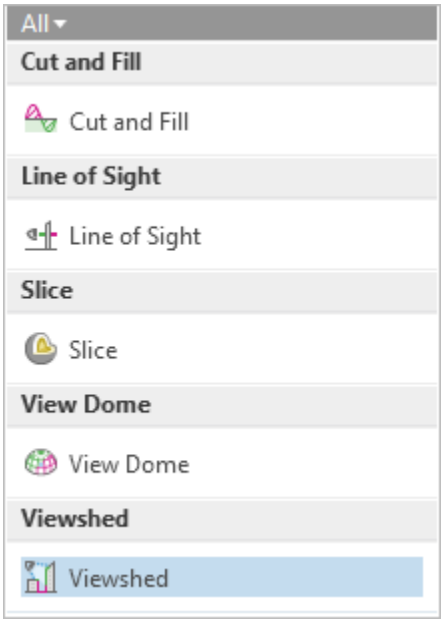
The San Francisco building data used in the lesson is sourced from a scene layer, published on arcgis.com. The original building data used to create the published scene is used with permission from PLW Modelworks (Copyright © 2010-2011 PLW Modelworks, LLC)



4. Review the 3D Exploratory Analysis tools used in this lesson. The tools are located on the ribbon, on the **Analysis** tab in the **3D Exploratory Analysis** group.



5. Click the **Interactive Analysis** drop-down menu and review the available tools.



There are five exploratory tools:

- **Cut and Fill,** which determines the amount of volumetric displacement required to level the ground of a location.
- **Line of Sight**, which creates sight lines to determine if one or more targets are visible from a given observer location.
- **Slice**, which visually cuts through the view's display to reveal hidden content.
- **View Dome**, which determines the parts of a sphere that are visible from an observer located at the center.

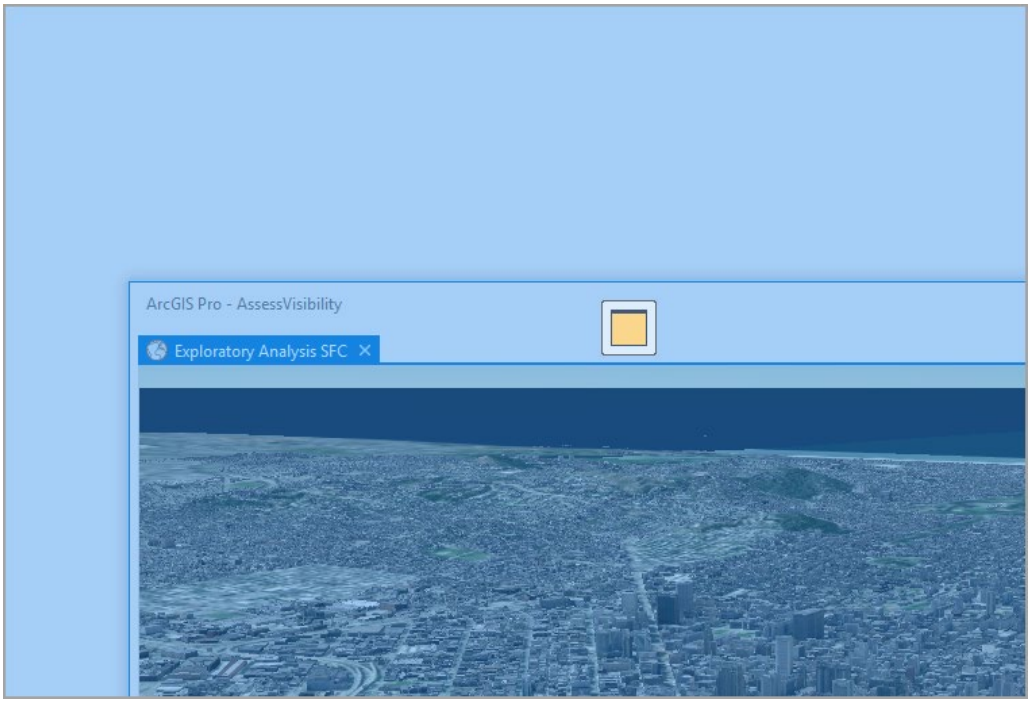
- **Viewshed**, which determines the visible surface area from a given observer location through a defined viewing angle.

6. In the **3D Exploratory Analysis** group, make sure to click **Clear All** before continuing to the next step.
7. Close the **Exploratory Analysis ESRI** and **Space Time Cube** scenes.

Building a view dome

View domes are spherical "bubbles" of visibility that extend out from an observer location, showing what can and cannot be seen. In this step, you will use a view dome to better understand how "urban canyons" caused by tall buildings in San Francisco can limit your ability to view the sky or other features.

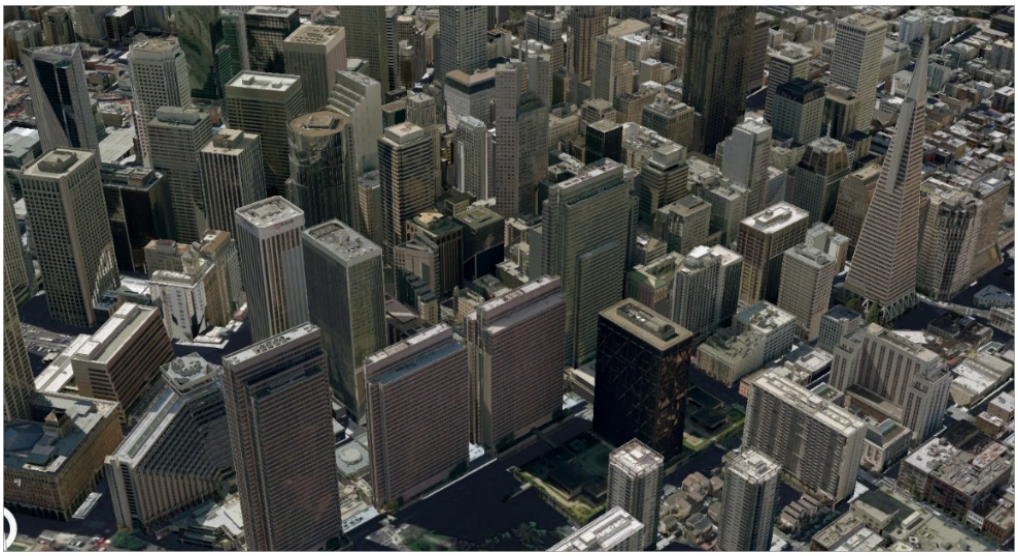
1. Reposition the **Exploratory Analysis SFC** scene within the ArcGIS Pro application. By dragging the tab containing the scene over the yellow square, your scene will expand to fill the view.



   Your **Contents** pane may not be visible.
2. If necessary, on the ribbon, click the **View** tab, **Windows** group, then click **Contents** to display the **Contents** pane.

3. On the ribbon, click the **Map** tab, **Navigate** group, **Bookmarks**, then choose **SFC Financial-District.**

   The scene updates to the extent of the San Francisco Financial District.

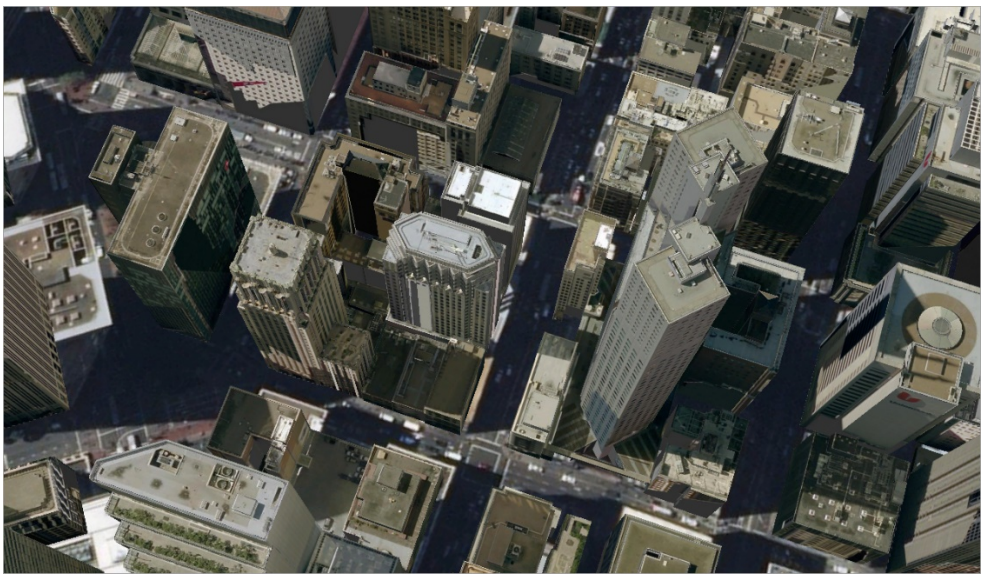


4. On the ribbon, click the **Map** tab, **Navigate** group, then click **Explore**.

5. Using the navigation tools, zoom into and explore the Financial District in San Francisco to familiarize yourself with the area.

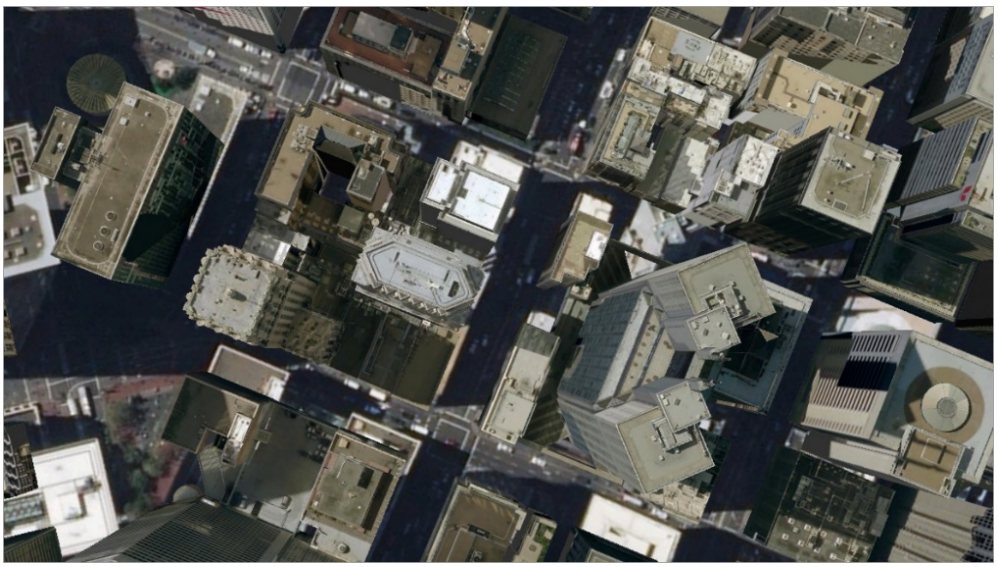


6. When you are done, locate and focus on the area northwest of Market Street.



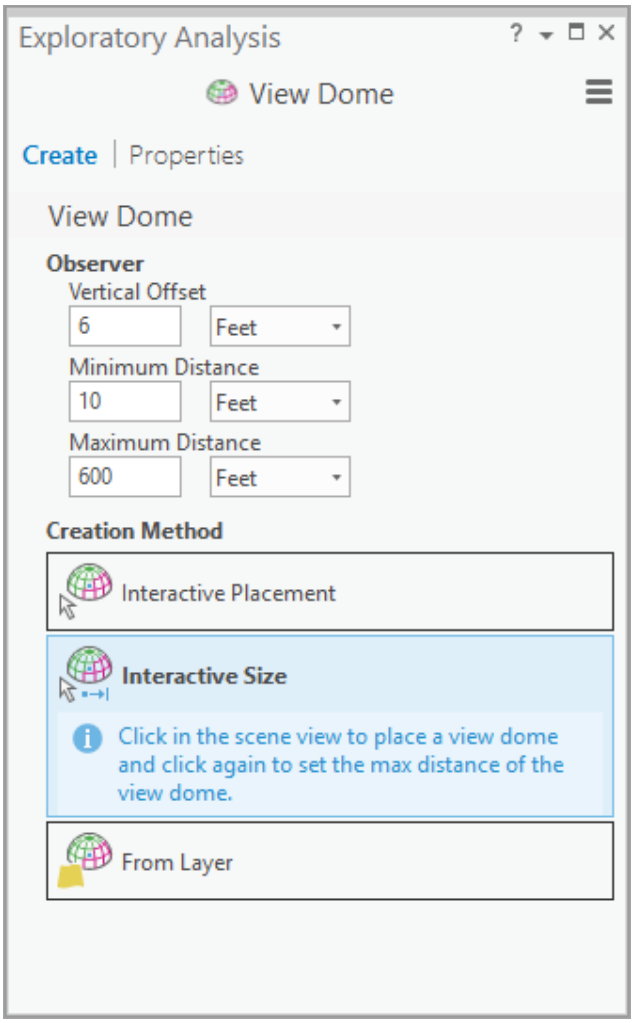
If you are having trouble locating Market Street, use the Market Street bookmark to center yourself in the correct location.

7. Continue zooming in to get to a top-down view, closer to street level

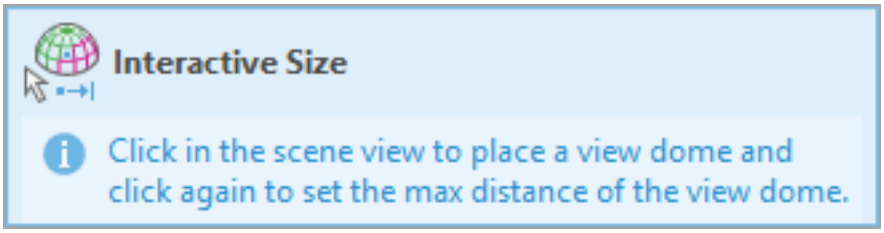


8. On the ribbon, click the **Analysis** tab, in the **3D Exploratory Analysis** Group, then click the drop-down menu for **Interactive Analysis** and choose **View Dome.**

The **Exploratory Analysis** pane appears.



9. Select the **Interactive Size** option.



10. Next, click in the middle of an intersection surrounded by buildings.

    This will start generating the view dome.



Now, you will make a second click, away from your first click, to set the radius of your view dome.

11. About one city block away from your first click, move your pointer and click.

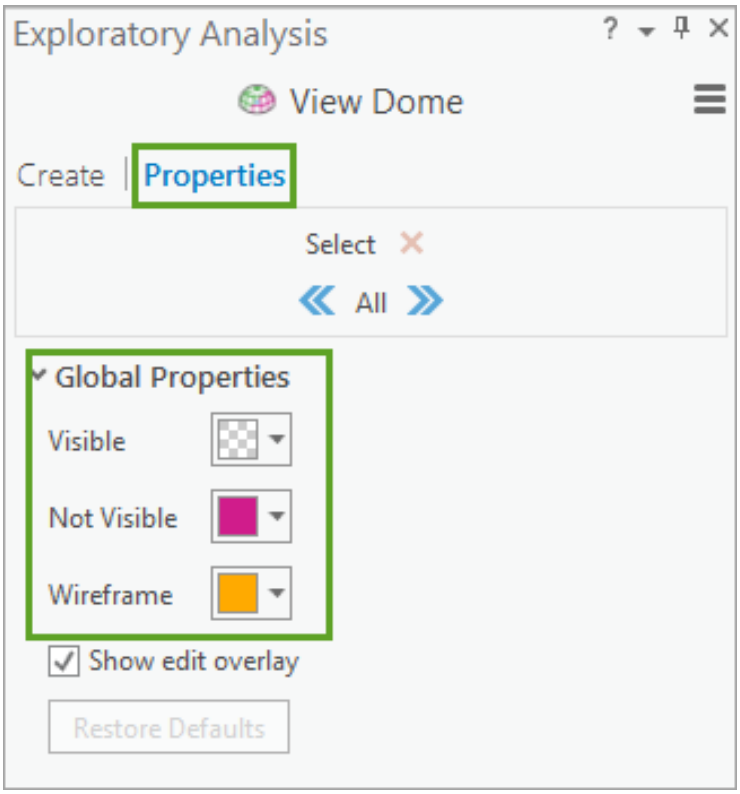


NOTE: If you want to recreate your view dome, you can right-click the center of your first click and click **Delete**. You can also use your Explore tool to pan your scene to the middle of your screen.

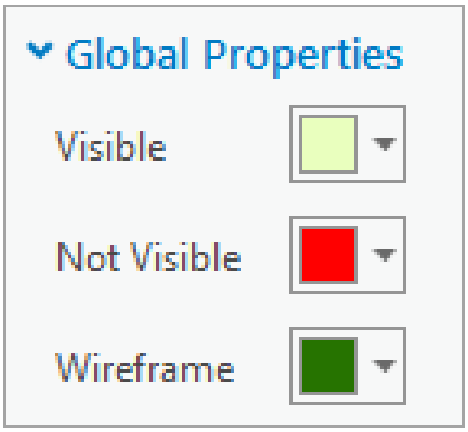
In the view dome, obstructed areas are shown in pink, while the uncolored area indicates a clear view of the sky. You can see how the visible areas of the view dome tend to be aligned with the street orientation.

12. Next, you'll change the view dome symbology. In the **Exploratory Analysis** pane, click **Properties**.

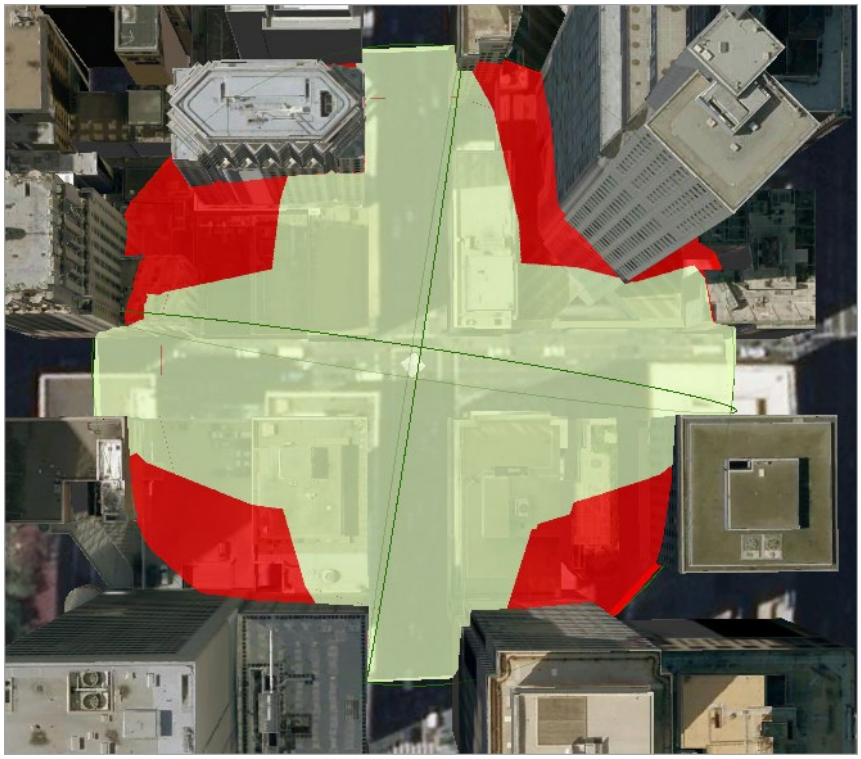
13. Expand the **Global Properties** group.



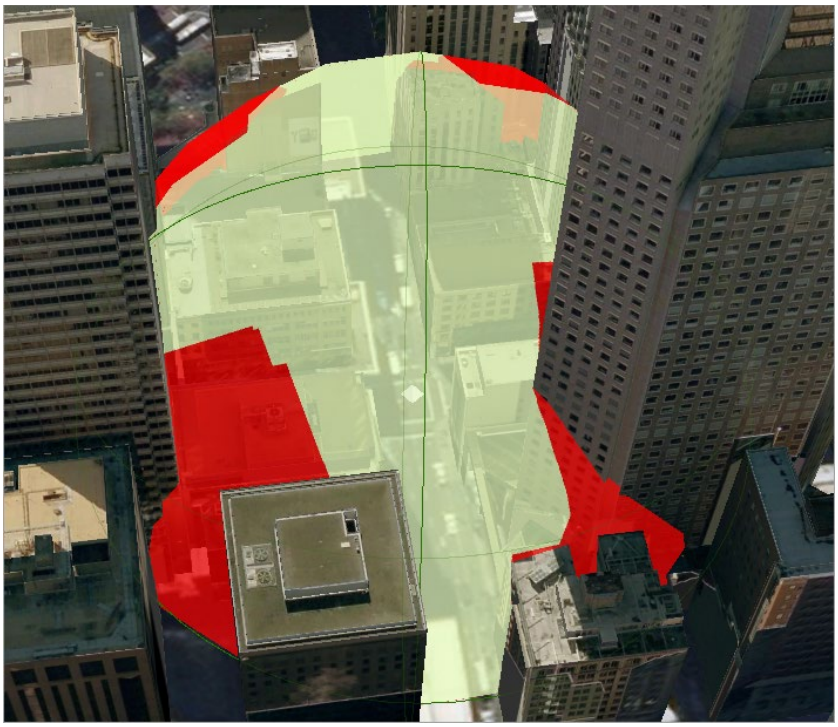
14. Update the color used for **Visible** and **Not Visible** areas to light green and red. In addition, modify the **Wireframe** color to dark green.



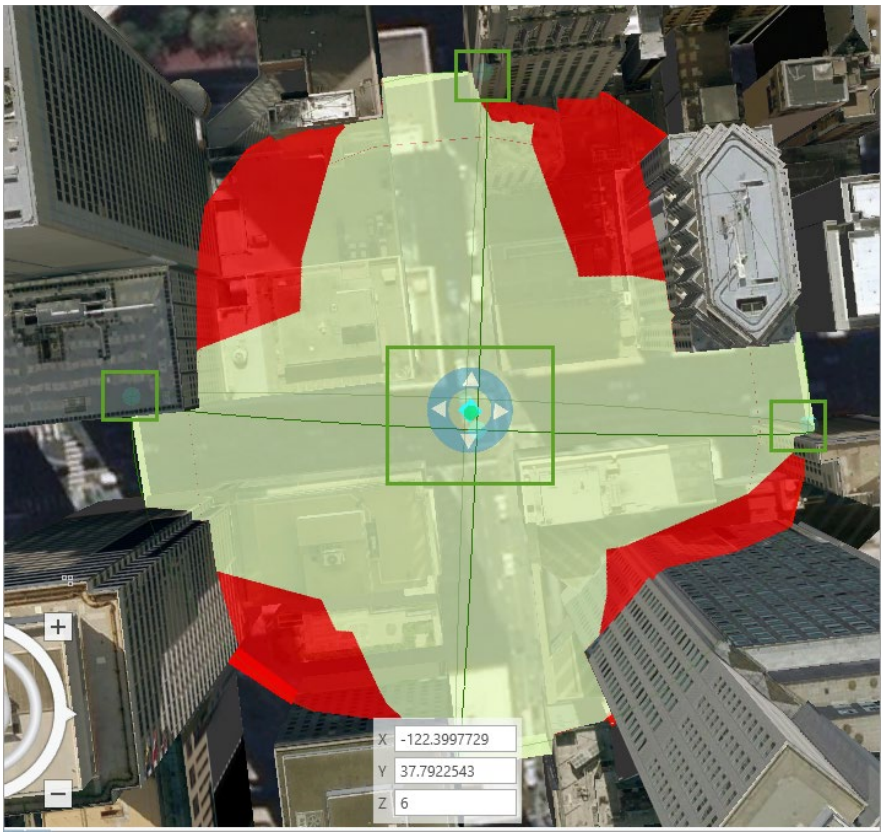
The scene updates and the view dome symbology is easier to interpret.



15. Using the Navigator tools, change perspective and zoom into and around the dome to gain a better insight into what may be observed and what may be obscured from the origin point of the dome.



16. If necessary, click the center of your view dome to activate its handles.
17. Use the four handles around the edge of the dome to change its size and see how buildings intersect.



NOTE: You can also move the dome around on the ground by grabbing the blue disc around the observer and dragging it to a new location.

The 3D Exploratory Analysis tools work not only with local multipatch and terrain data, but also with hosted scene layers, such as the textured San Francisco buildings, and with 3D symbols.

18. When you are done, save the project.
19. Close the **Exploratory Analysis SFC** scene.

Slice

The Slice tool allows you to interactively place a clipping surface in a scene that slices through one or more layers. It is useful for exploratory tasks in which you have nested layers that you want to investigate–like cutting into a 3D geologic model to understand how the different strata are organized or internally cut by faults.

In this step, you will use a simple 3D map of the Esri headquarters in Redlands, California, to slice different layers and create ad hoc exploratory views of the campus and buildings.

1. Click the **View** tab. In the Windows group, click **Catalog Pane**.
2. From the **Catalog** pane, expand **Maps**, and open the **Exploratory Analysis ESRI** scene.

   The scene opens to display the buildings and landscape of the Esri campus.



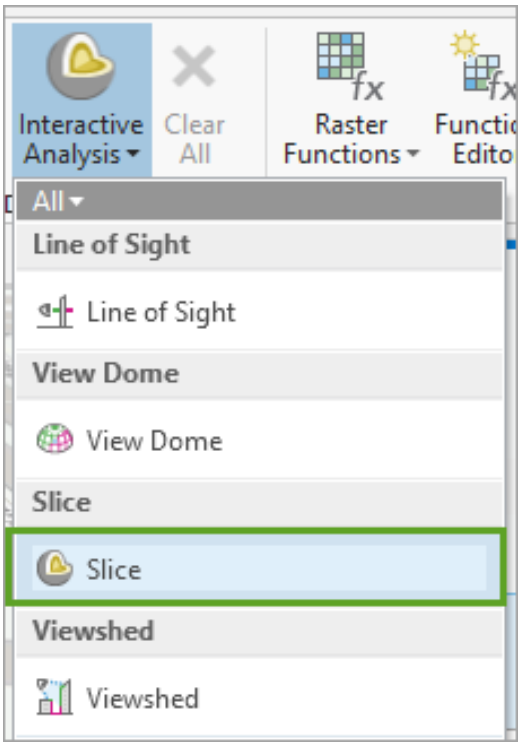
3. Navigate to the front of Building Q, the distinctive wood and glass structure at the end of the street.



   You may need to clear your settings.

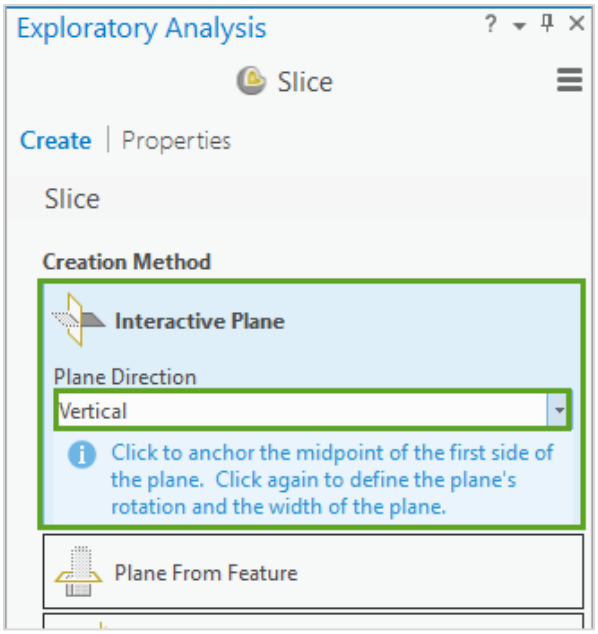
4. On the ribbon, click the **Analysis** tab, in the **3D Exploratory Analysis** group, then click **Clear All** to remove all previous analysis settings.

5. Click the **Interactive Analysis** drop-down menu and choose **Slice.**

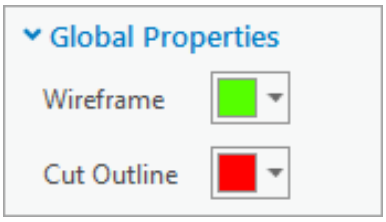


The **Exploratory Analysis** pane updates.

6. In the **Exploratory Analysis** pane, choose the **Interactive Plane**, **Vertical**.



7. In the **Exploratory Analysis** pane, click **Properties**.
8. Expand the **Global Properties** pane and update the Wireframe color to green and the Cut Outline color to red.



9. In the **Exploratory Analysis** pane, click **Create**. Your cursor becomes a crosshair as you hover over the scene.
10. Zoom in to the left front corner of the building.



11. Click the ground near the left bottom corner of Building Q, then click another point that's parallel to the front facade orientation to set the plane.



After the second click, the front of the facade will be removed, showing the interior of the building.



12. Using the light blue anchor points, extend the vertical slice plane to slice through the front of the building



The slice navigator center point, turns into a four-headed arrow when you point to it. Dragging the white arrows within the slice's center point allows you to move the slice backward or forward.

13. Use the move handles to push it back into the building.



14. Use the slice navigator to experiment with the tool as you change angles and slice in different directions.

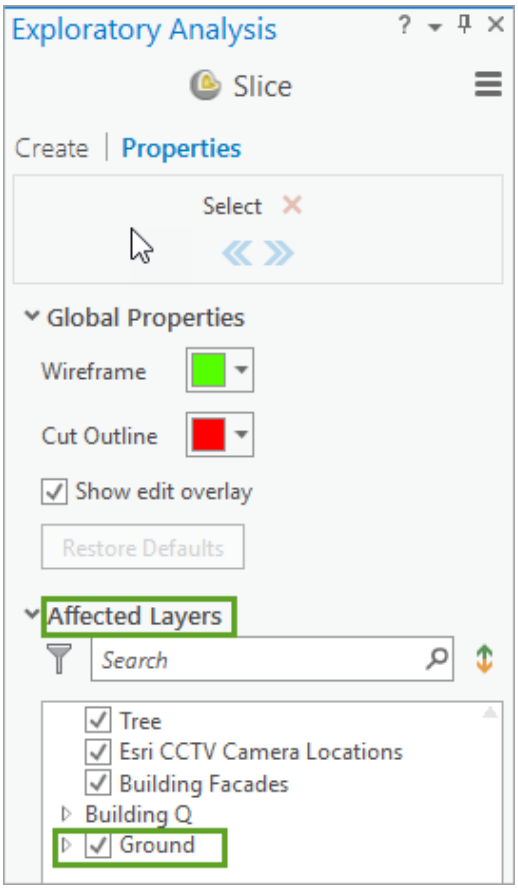


You can create some interesting interior views with the exterior walls “peeled away”–experiment with different plane orientations and angles.

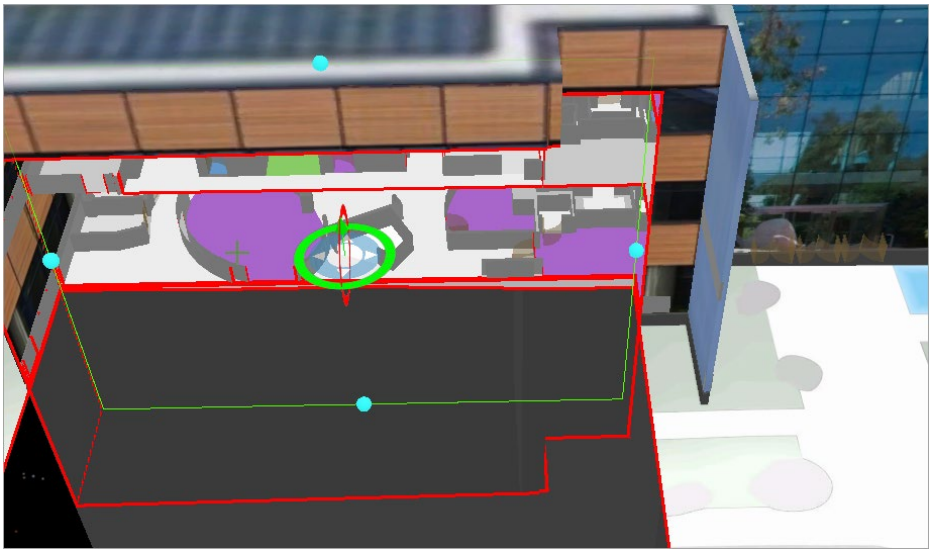
Next, include the ground surface in the slice.

15. In the **Exploratory Analysis** pane, click **Properties.**

16. Expand the **Affected Layers** group, and check **Ground.**

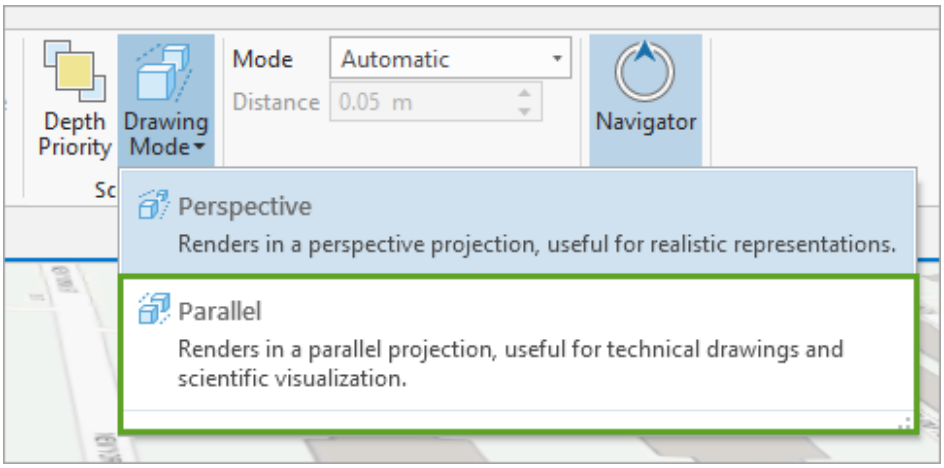


Now you can see underground, which is useful for subsurface data visualization.



Isometric cutaways are a common method for viewing architectural models or drawings.

17. In the **View** tab, in the **Scene** group, try changing the **Drawing Mode** from **Perspective** to **Parallel**, to see how that alters the scene.

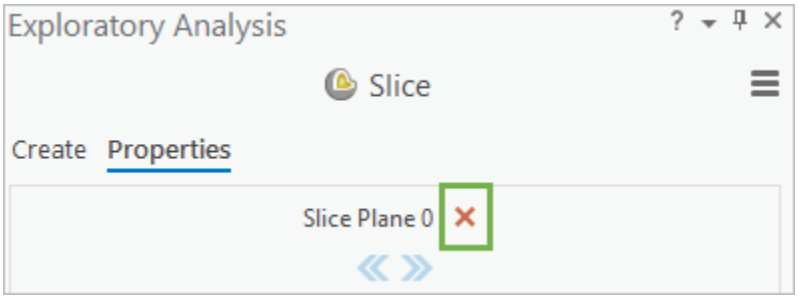




18. Change the **Drawing Mode** back to **Perspective** when you are ready to continue.



19. In the Exploratory Analysis pane, click the red X to close the Slice tool.



20. Save the project.

Viewshed

Viewsheds are used to visualize which parts of the environment can be seen from a given observer location. Unlike a view dome, which is a spherical surface of a set size, a viewshed renders on the surface of the terrain and any 3D objects what is visible and what is not visible within a given distance.

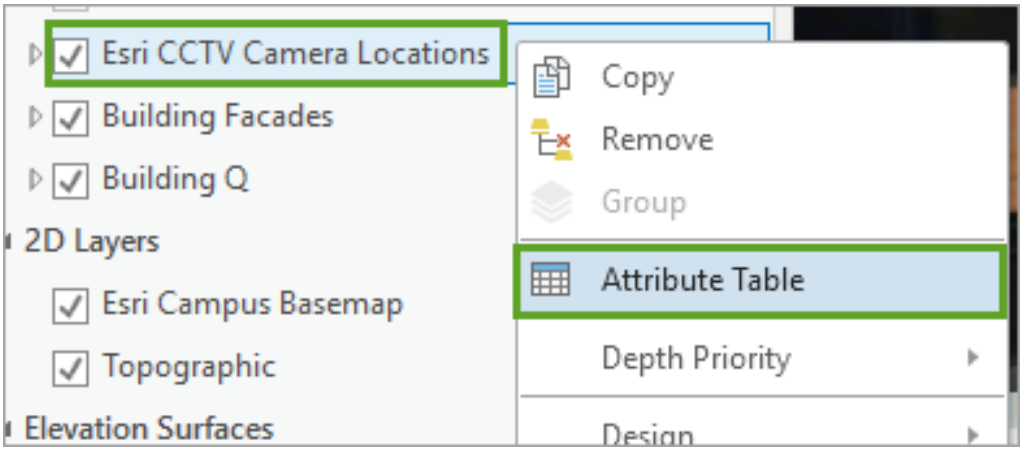
In this step, you will again use the **Exploratory Analysis ESRI** scene.

1. If necessary, navigate back to the area in front of Building Q.
2. In the **Contents** pane, check all scene layers except the Tree layer.

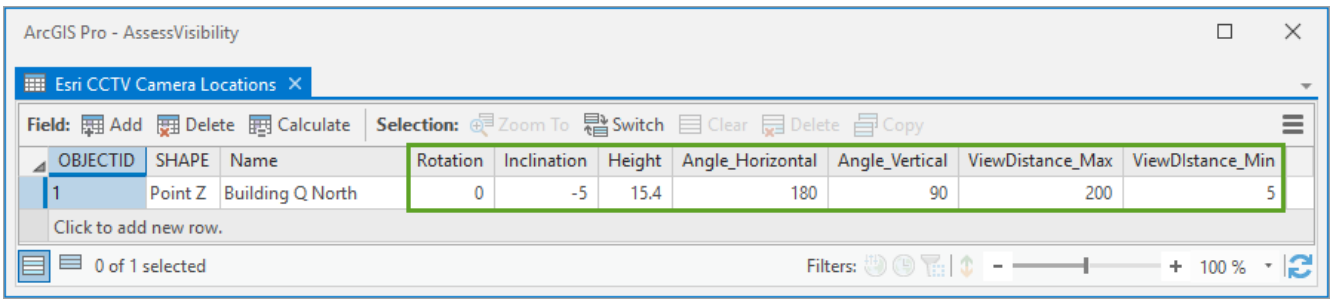


Note the location of the CCTV camera on the third floor, to the left of the glass atrium.

3. In the **Contents** pane, right-click the **Esri CCTV Camera Locations** layer and choose **Attribute Table**.



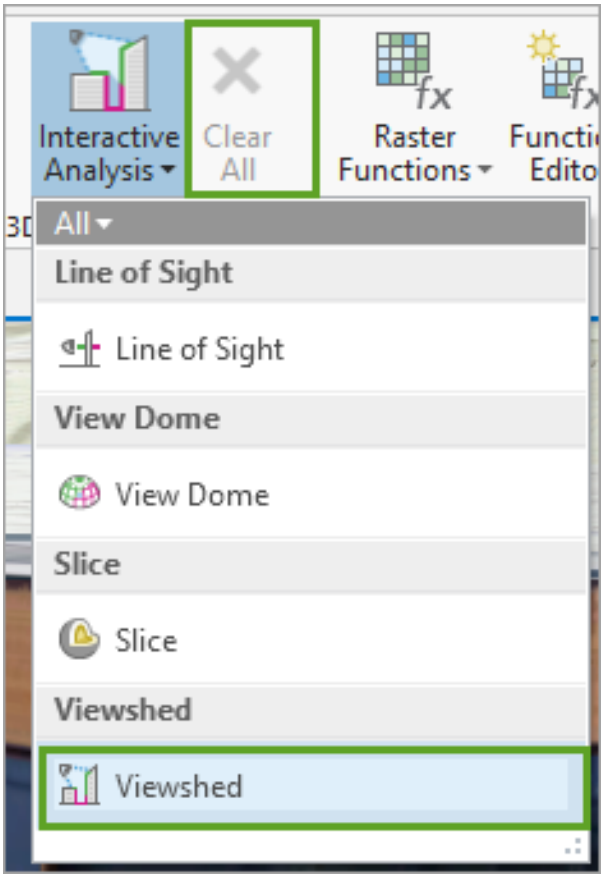
4. Review the **Esri CCTV Camera Locations** attribute table and note the attribute fields populated with camera properties such as direction, camera angle, and viewing distances.



The viewshed tool can use these parameters to calculate what may or may not be visible based on the horizontal and vertical viewing angle and the minimum and maximum viewing distance of the camera.

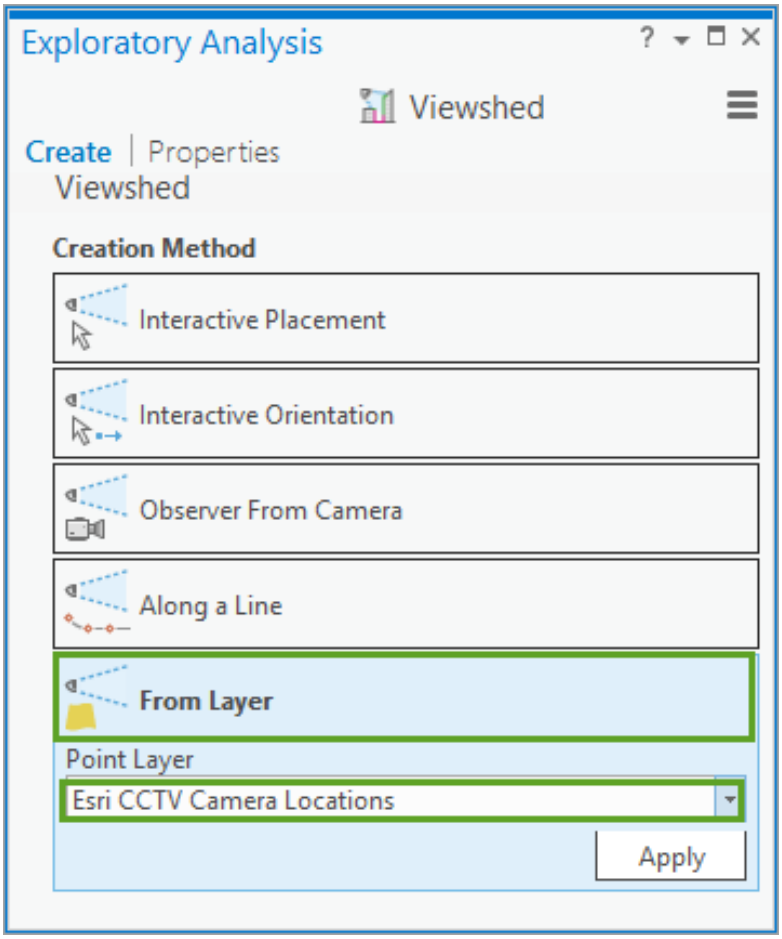
5. After exploring the information in the attribute table, close the table.

6. On the Analysis tab, in the 3D Exploratory Analysis group, click the Clear All button to clear any active analysis layers, then use the **Interactive Analysis** drop-down menu to select **Viewshed.**



7. In the **Exploratory Analysis** pane, select the **From Layer** creation method.

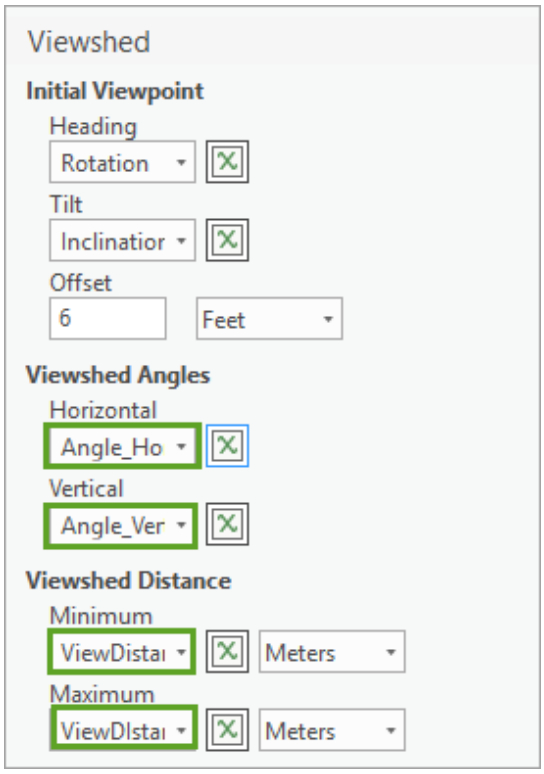
8. For **Point layer**, choose **Esri CCTV Camera Locations**, if necessary.



The **Initial Viewpoint** values for Heading and Tilt are automatically populated with values from the **Esri CCTV Camera Locations** layer attributes.

9. Update the values for **Viewshed Angles** and **Viewshed Distance** as follows:

    - For **Viewshed Angles**:
        - For **Horizontal,** choose **Angle_Horizontal**
        - For **Vertical**, choose **Angle_Vertical**
    - For **Viewshed Distance**:
        - For **Minimum**, choose **ViewDistance_Max**
        - For **Maximum**, choose **ViewDistance_Min**



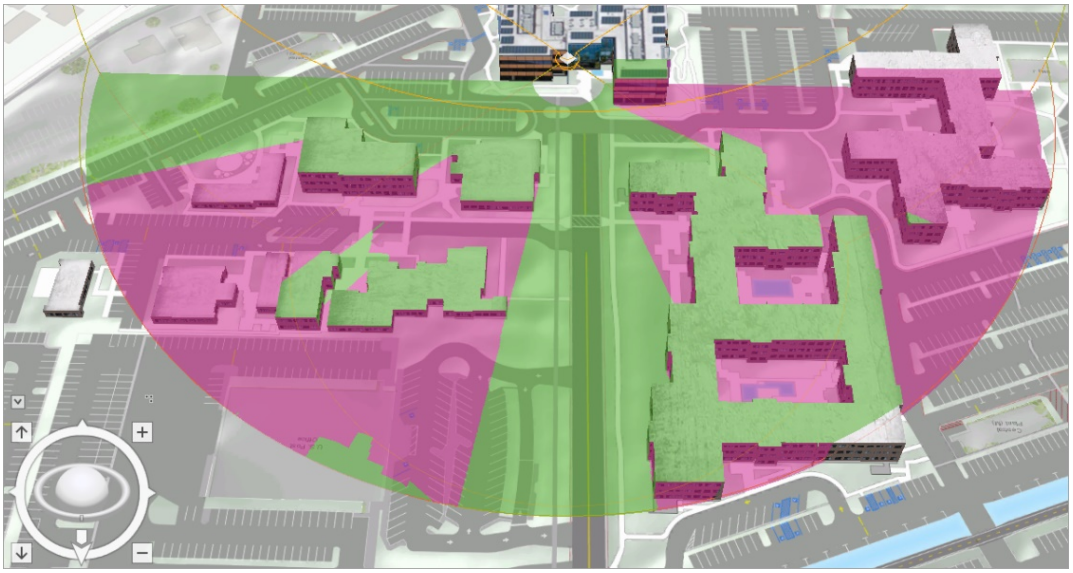
10. When finished, click **Apply** to add a viewshed to the scene.

11. Using the 3D navigator, zoom out to visualize what the camera can observe based on its current parameters.



With the camera facing north, all locations visible to it are rendered in green, while locations not visible to the camera are rendered in pink.

12. **Tilt** the scene to see how the 3D building objects and the placement of the camera impact the calculated viewshed.



Many of the buildings obscure the visibility of the camera, and it appears to be most effective at observing the street and parking spaces in front of the camera. However, we have the trees layer turned off and the viewshed is currently not including trees in its computation of visibility.

13. In the **Contents** pane, check the **Tree** layer.



With the **Tree** layer turned on, the viewshed is recalculated and the impact of the trees is notable, as trees certainly impact visibility.

14. Using the 3D navigator, place yourself in the same northerly direction that the camera is facing.



Notice how visibility is now largely confined to the street corridor and a few smaller paths between the tree canopy.

15. Zoom in and notice how the south-facing parts of trees are also visible to the camera.



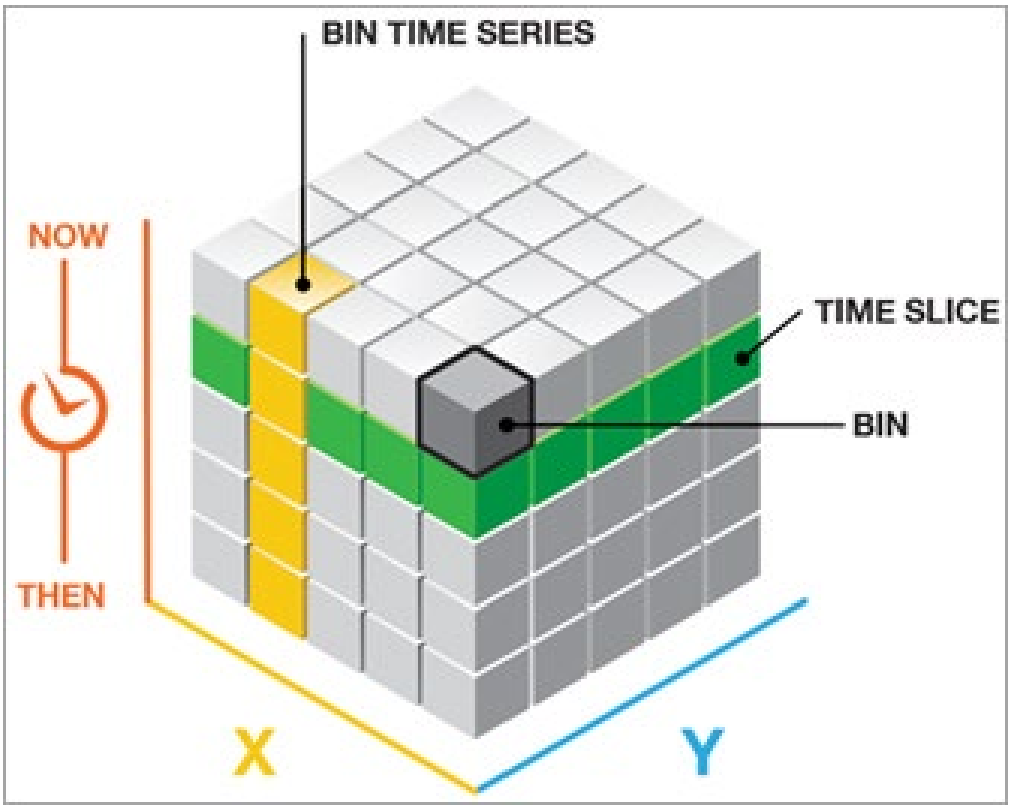
Trees have a big impact on viewsheds–without vegetation, about half of the campus was visible. With trees added, the viewshed was reduced to a narrow strip along New York Street. The exploratory analysis tools in ArcGIS Pro allow you to quickly understand and test a variety of visibility scenarios.

16. On the Analysis tab, in the 3D Exploratory Analysis group, click the Clear All button to clear any active analysis layers
17. Close the **Exploratory Analysis ESRI** scene.

    In the next step, you will explore complex spatiotemporal data using the space time cube.

Space Time Cube

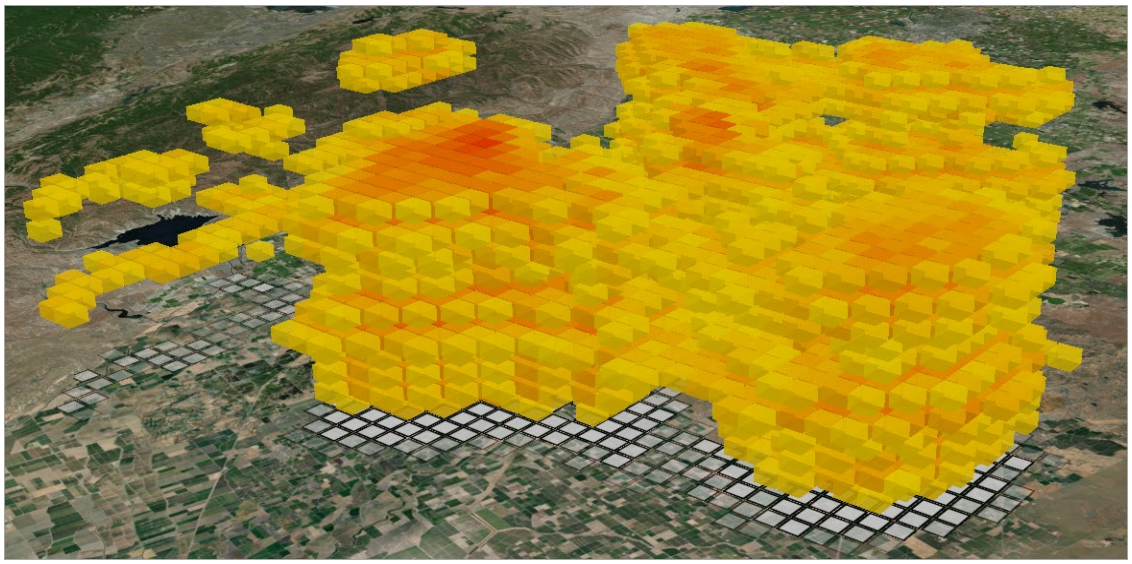
The space time cube is a data visualization approach that analyzes large spatiotemporal datasets by aggregating them into bins across space and time. Within each bin, points are counted, and specific attributes are aggregated. Bins covering the same x,y area share the same location ID. Bins encompassing the same duration share the same time-step ID:



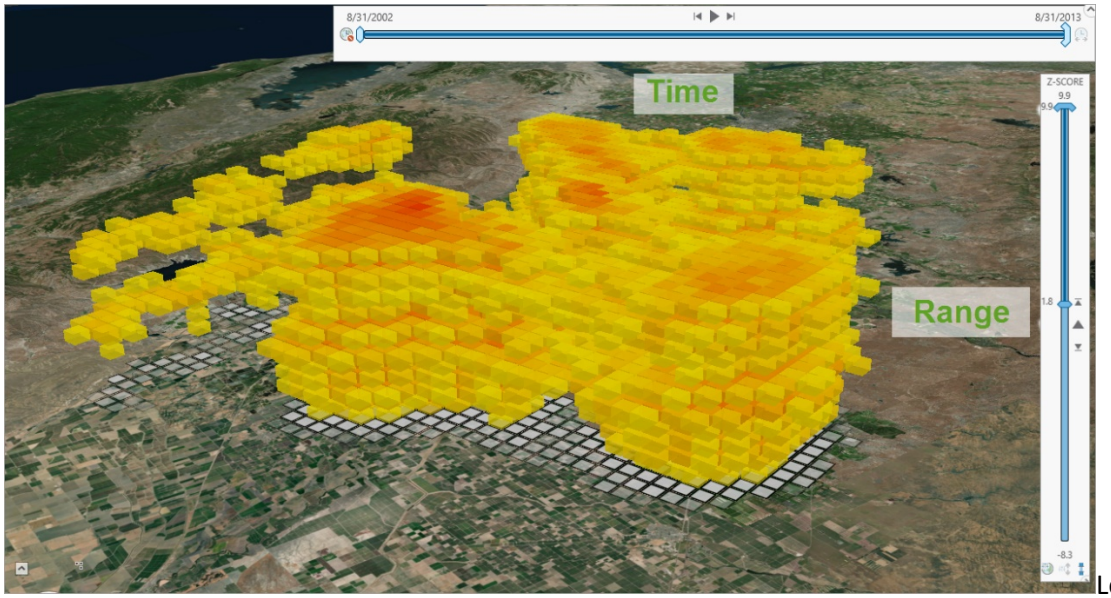
In this example, you will use a space time cube to explore patterns in water consumption over a 12-year period in central California.

1. In the Catalog pane, expand Maps and 0pen the **Space Time Cube** scene.

   The scene opens to display a space time cube using 1-mile x 1-mile bins to highlight areas of high water consumption from August 2002 to August 2013.

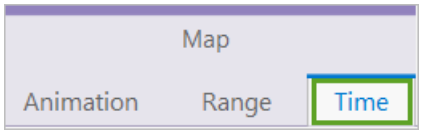


In this scene, the Range slider and Time slider are both enabled for the visible layers to allow for the filtering of visible attributes and time slides.



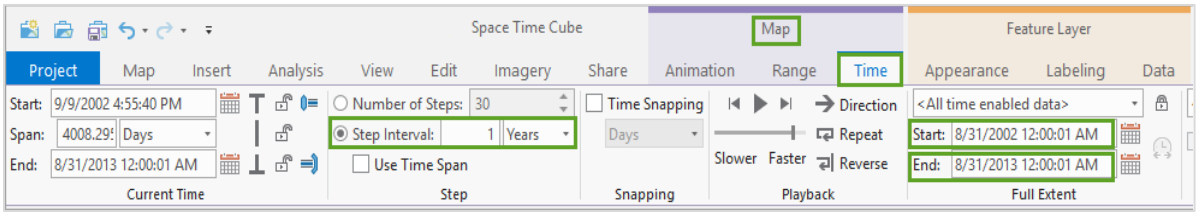
Let's explore the Time slider setup.

2. On the ribbon, under the **Map** tab, click the **Time** tab.

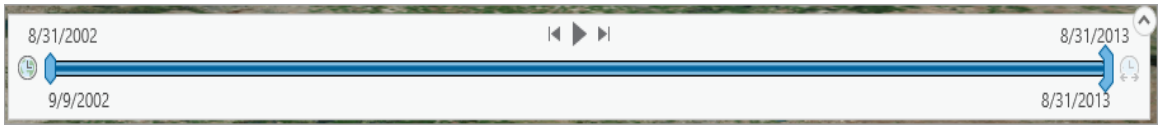


3. In the **Full Extent** group, note the **Start** date set to **8/31/2002 12:00:01 AM** and the **End** date set to **8/31/2013 12:00:01 AM**.

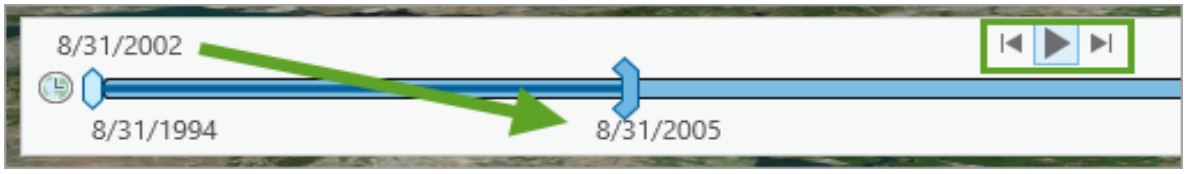
   These dates represent the 12-year period of water consumption visualized in this Space Time Cube. Note that the **Step Interval** is set to **1 Year**, meaning that the **Start** and **End** time will be offset by one year.



4. In the initial scene, the Time slider control is hidden; hover over the control to activate.

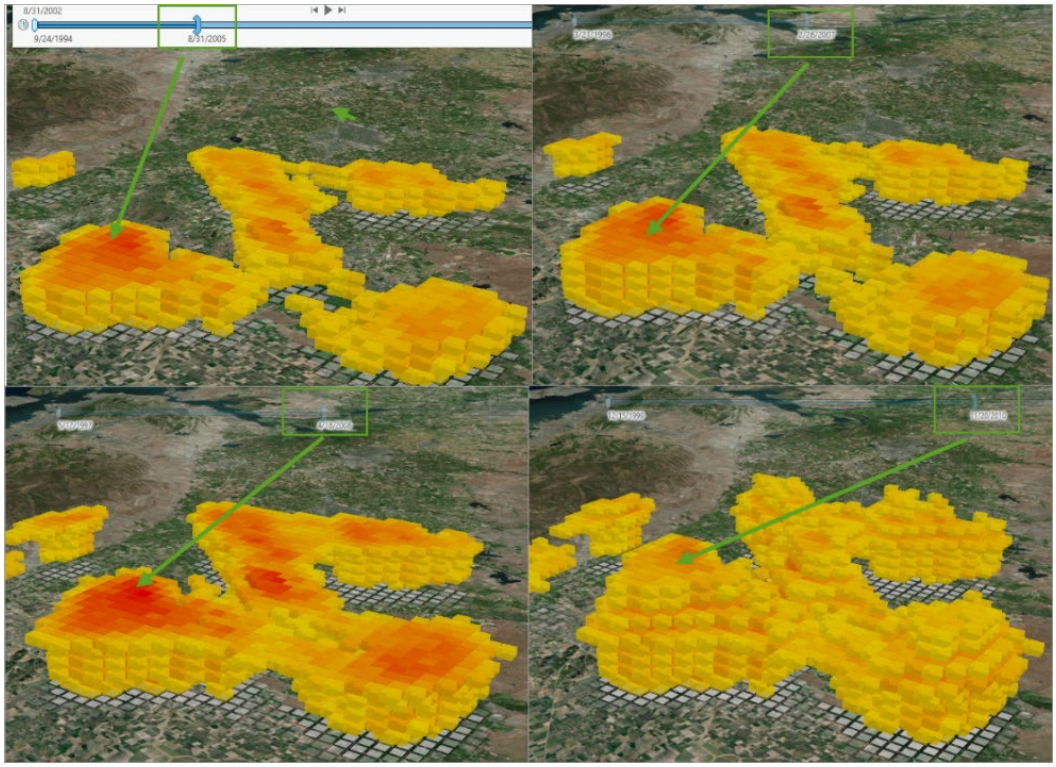


5. On the **Time** slider control, click the auto-play button in the middle, or you can use the single-step button to the right to initiate stepping through the time range in one-year increments.



As you interact with the Time slider, it will filter the 2D and 3D data to display the current active time range.

6. On your own, step through the time series a couple of times–do you see a visual change in water consumption in certain years over other years?

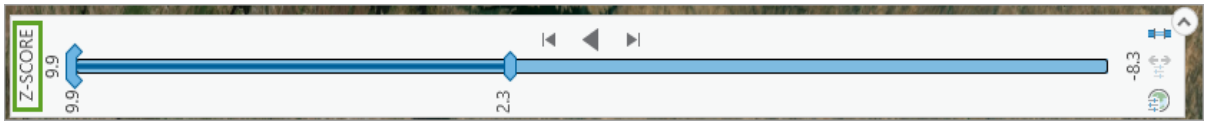


Before proceeding, disable the **Time** slider to display the full data range.

7. On the **Time** slider control, click the globe symbol to disable the control.



Next, you'll investigate the Range slider on the right edge of the scene. It is configured to display a subset of the total z-score range of each cube bin.

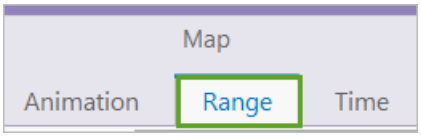


(Image rotated -90)

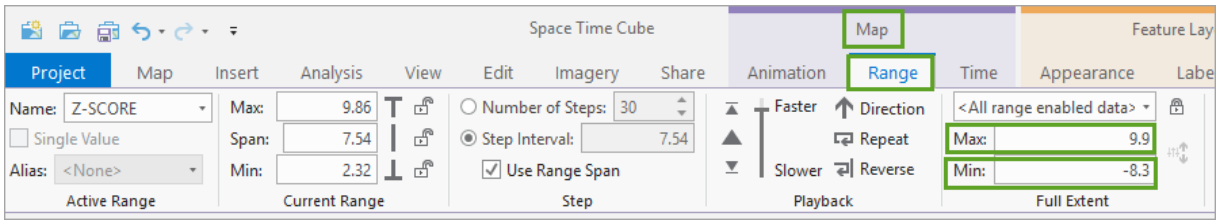
In this example, the z-score is a standard deviation measure of water consumption.

If a bin has a z-score of 2.5, you would say that the result represents 2.5 standard deviations. A bin with a very high or very low (negative) z-score indicates that it is highly unlikely that the observed spatial pattern reflects a theoretically random pattern.

8. On the ribbon, click the **Map** tab, then click the **Range** tab.

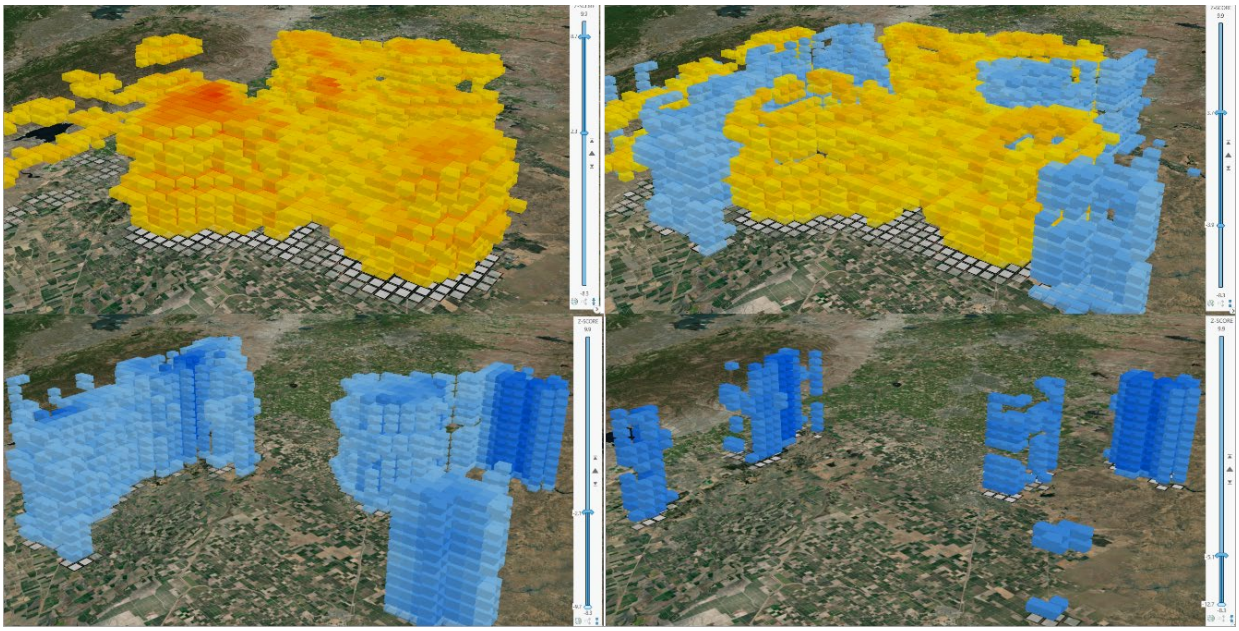


9. In the **Full Extent** group, note the **Max** and **Min** range.



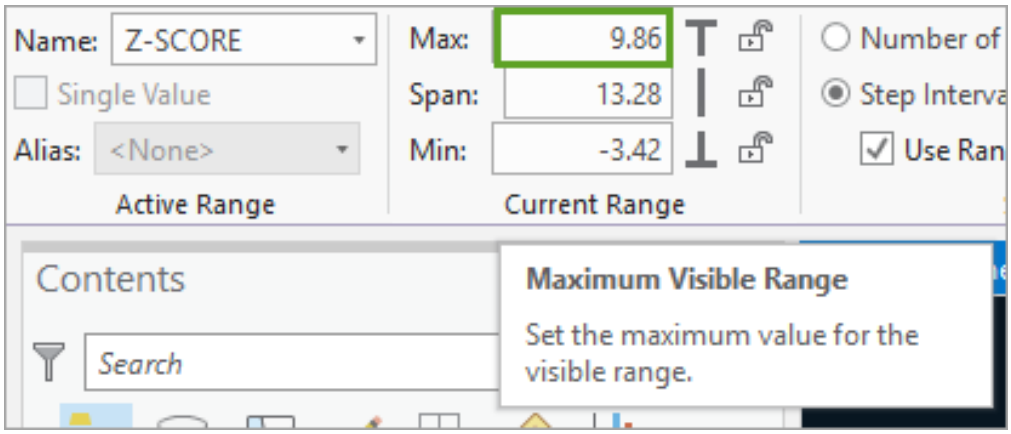
Notice that the z-score ranges from a **Max** of 9.9 to a **Min** of -8.3.

10. In the scene, drag the active range span down to show the negative z-score values. The cube symbology will change from orange/red (positive) to a blue (negative) color gradient.



11. On the **Range** tab, in the **Current range** group, update the upper end of visible range span by setting the maximum (negative) z-score incrementally to -1.65, -1.96, and -2.58.

    These values represent 90 percent, 95 percent, and 99 percent confidence levels, respectively.



    You can also make these settings manually on the **Range** slider control if you choose.

12. On the **Range** slider control, drag the range slider back up to show positive z-values above 1.65, 1.96, and 2.58, and look at bins that represent 90 percent, 95 percent, and 99 percent confidence levels, respectively.

13. Save the project.

For more information on how to create your own space time cube, refer to the ArcGIS Pro online documentation.

Summary

In this lesson, you used the 3D Exploratory Analysis tools to conduct real-time visibility studies at the city and campus scale–employing the view dome, slice, and viewshed tools. Using these tools, you learned how to conduct line-of-sight studies by placing observer locations interactively in the scene, and by loading observer locations from a predefined layer's attributes. Finally, you learned how to interact with the space time cube to filter out and discover statistically significant patterns of water usage with the Range slider and Time slider functionality in ArcGIS Pro.