Construct realistic 3D view of a scene

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Time: 1 hour, 30 minutes

Overview

Many 3D scenes are reconstructions of elements in the physical world, such as parks, cities, and geological strata. These scenes rely heavily on 3D vector symbology, in which the elements are shown using realistic shapes and sizes. These layers are listed in the 3D Layers category in the Contents pane.

Realistic 3D vector symbology is defined using real-world size units, such as meters or feet, rather than the traditional 2D cartographic unit of points. The features can obtain their base elevations from a surface, stored shape z-values, feature attributes, or from a constant value. Although vector data can be more expensive to render than draped data, it adds 3D volumetric shapes into the view and is usually the focal point of the scene. By default, 3D (z-aware) points, lines, polygons, multipatches, and scene layers are added to the scene under the 3D Layers section.

In this lesson, you will be working with simple GIS data for the city of Naperville. This includes building footprints, city-managed trees, street furniture, and points of interest that will be used to create a realistic 3D view. You will also consider how the scene might be consumed by others.

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

- Extrude building footprints as simple 3D symbology
- Use procedural symbols for advanced 3D symbology
- Add a preset trees layer with per-feature height
- Add street furniture content with per-feature rotation
- Add bookmarks to help users find their way around the scene

Open map package

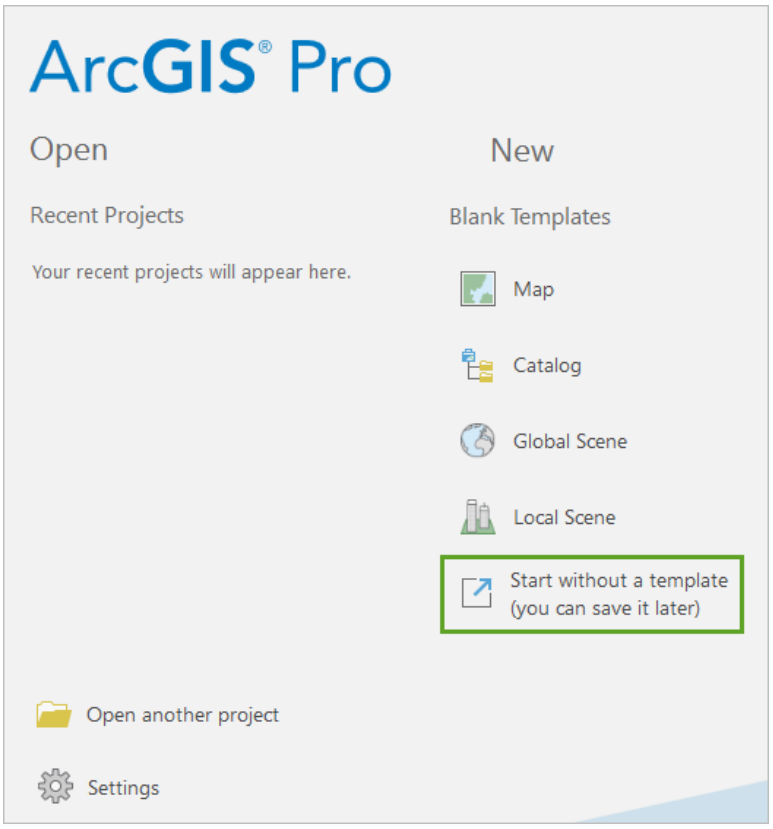
First, download the data. Then create a project in ArcGIS Pro.

1. Download the **Naperville.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.

The data has been provided by the City of Naperville. The folder contains a map package, a scene layer package, and a file geodatabase.

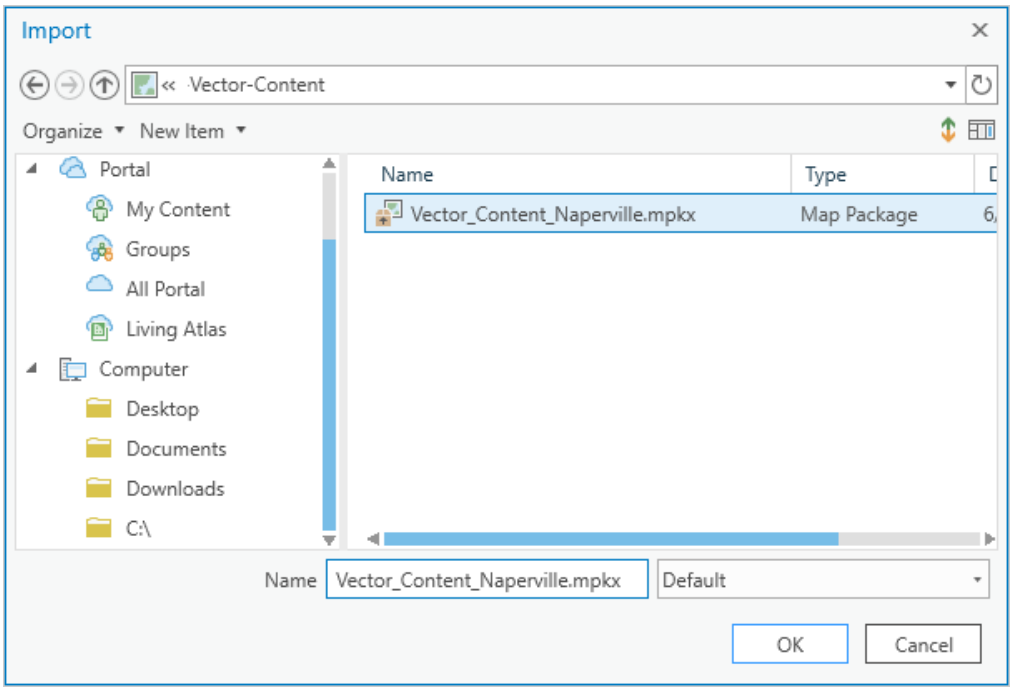
You will now create a project using the Blank Project template.

1. Start ArcGIS Pro and create an ArcGIS project, based on the **Blank** project template



Note: If you don't have ArcGIS Pro or an ArcGIS account, you can sign up for an ArcGIS free trial.

2. On the Quick Access toolbar, press Save or press Ctrl+S to save your project.
3. In the **Save Project As** window, name your project 'CityofNaperville' and browse to your Naperville.zip folder.
4. On the **Insert** tab, in the **Project** group, click **Import Map**.
5. Browse and select **Vector_Content_Naperville.mpkx** from your extracted data location.



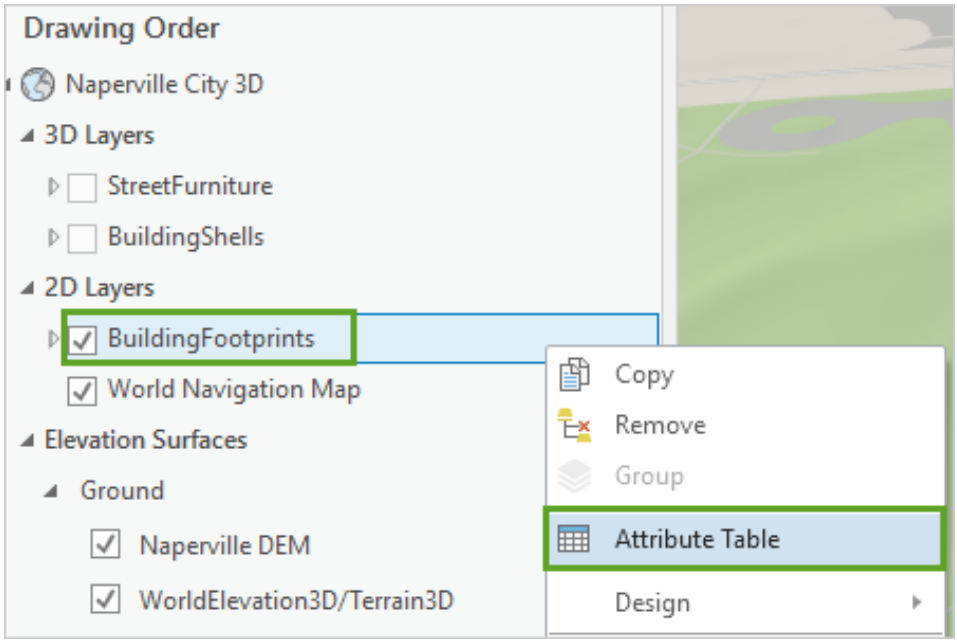
6. Click **OK**.

The **Vector_Content_Naperville.mpkx** file contains a global scene for the city of Naperville. Notice that the **Contents** pane contains a 2D **BuildingFootprints** layer as well as the 3D layers: **StreetFurniture** and **BuildingShells**.

Extrude building footprints

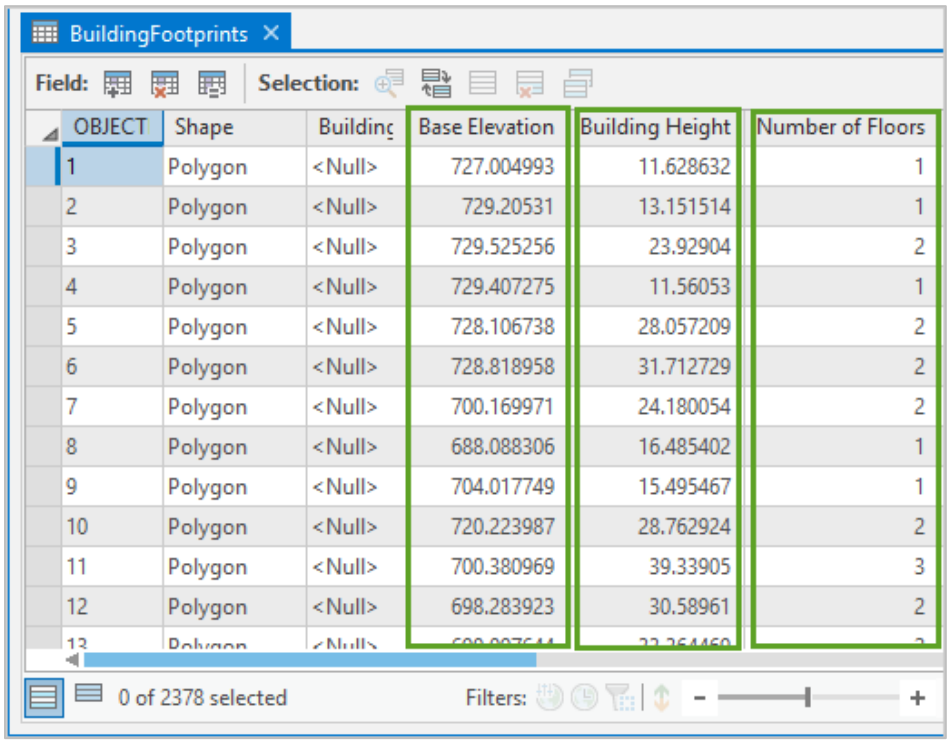
One of the simplest methods for adding volumetric objects into a 3D view is extrusion. This method takes a 2D shape and pushes it vertically to create the appearance of a 3D object. Simple buildings are well-suited for this method because they have vertical walls and their individual heights can be captured (or estimated) in a simple numeric field.

1. In the **Contents** pane, locate **2D Layers**, right-click **BuildingFootprints**, then choose **Attribute Table**.



2. In the **BuildingFootprints** attribute table, review the **Base Elevation**, **Building Height**, and **Number of Floors** fields.

These fields can be used to set the base elevation for buildings and for extrusion of the building features.

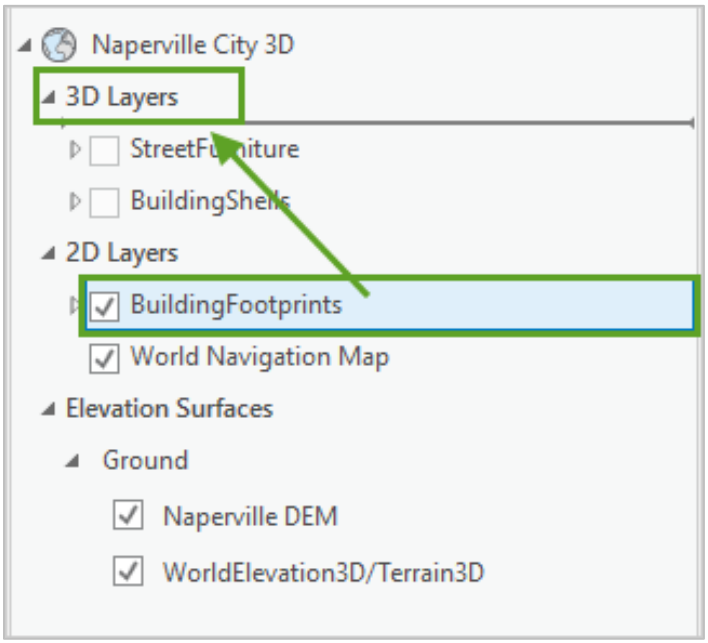


OBJECT	Shape	Building	Base Elevation	Building Height	Number of Floors
1	Polygon	<Null>	727.004993	11.628632	1
2	Polygon	<Null>	729.20531	13.151514	1
3	Polygon	<Null>	729.525256	23.92904	2
4	Polygon	<Null>	729.407275	11.56053	1
5	Polygon	<Null>	728.106738	28.057209	2
6	Polygon	<Null>	728.818958	31.712729	2
7	Polygon	<Null>	700.169971	24.180054	2
8	Polygon	<Null>	688.088306	16.485402	1
9	Polygon	<Null>	704.017749	15.495467	1
10	Polygon	<Null>	720.223987	28.762924	2
11	Polygon	<Null>	700.380969	39.33905	3
12	Polygon	<Null>	698.283923	30.58961	2
13	Polygon	<Null>			

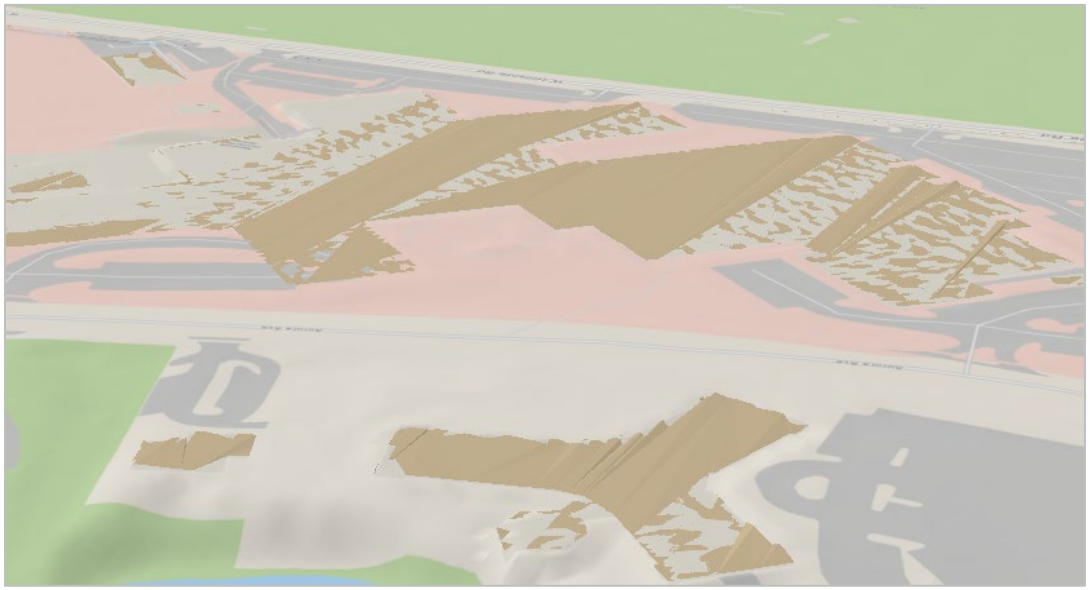
3. When you are done reviewing the **BuildingFootprints** attribute table, close the table.

Before you can apply 3D vector symbology to the **BuldingFootprints** layer, you will move the layer into the **3D Layers** group.

4. In the **Contents** pane, click-and-drag the **BuildingFootprints** layer into the **3D Layers** category.

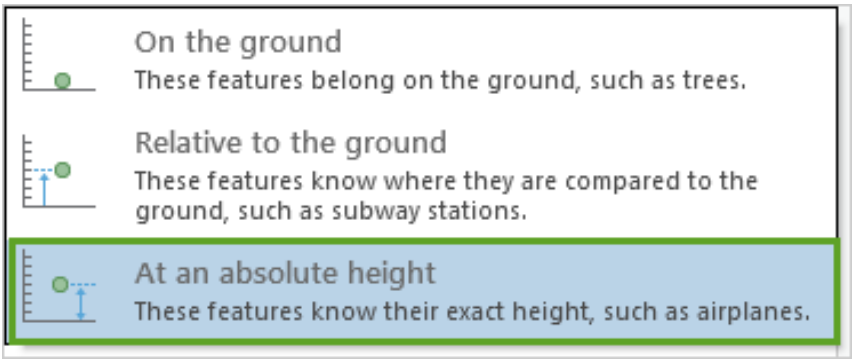


The layer looks like it is fragmented and bumpy because the vertices of each polygon are being placed on the uneven surface, and their interiors are being calculated unevenly across it.

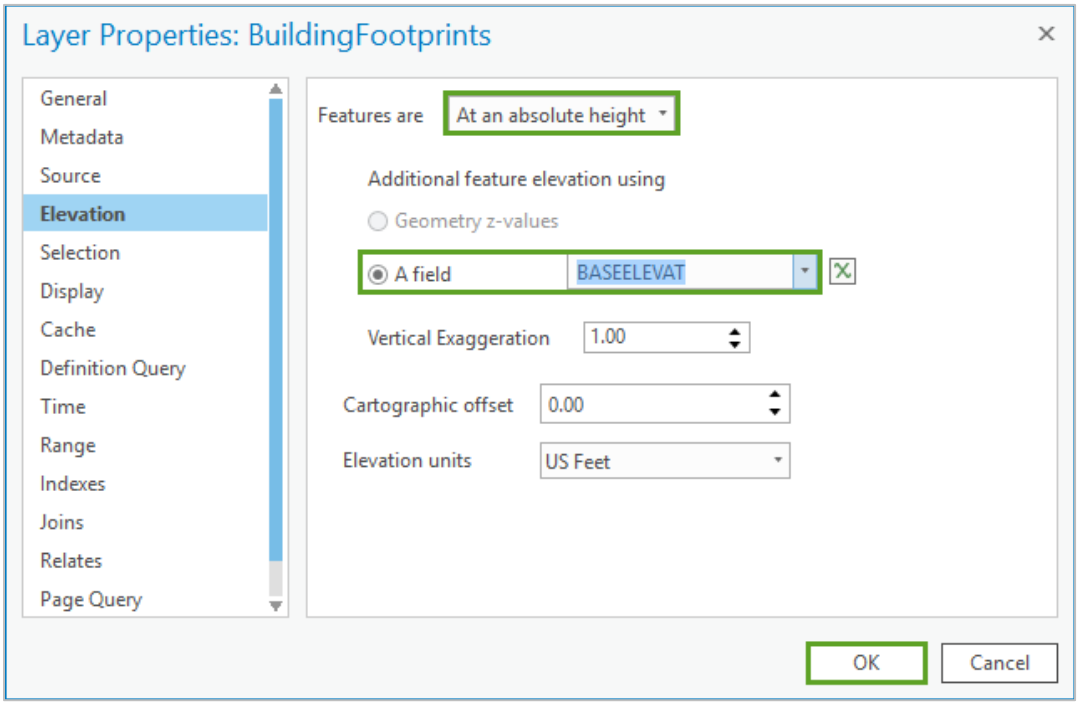


If the elevation of each building footprint is set to a single value, they will appear flat.

5. In the **Contents** pane, right-click the **BuildingFootprints** layer and select **Properties**.
6. In the **Layer Properties** pane, click the **Elevation** tab.
7. Set **Features** to **At an absolute height.**

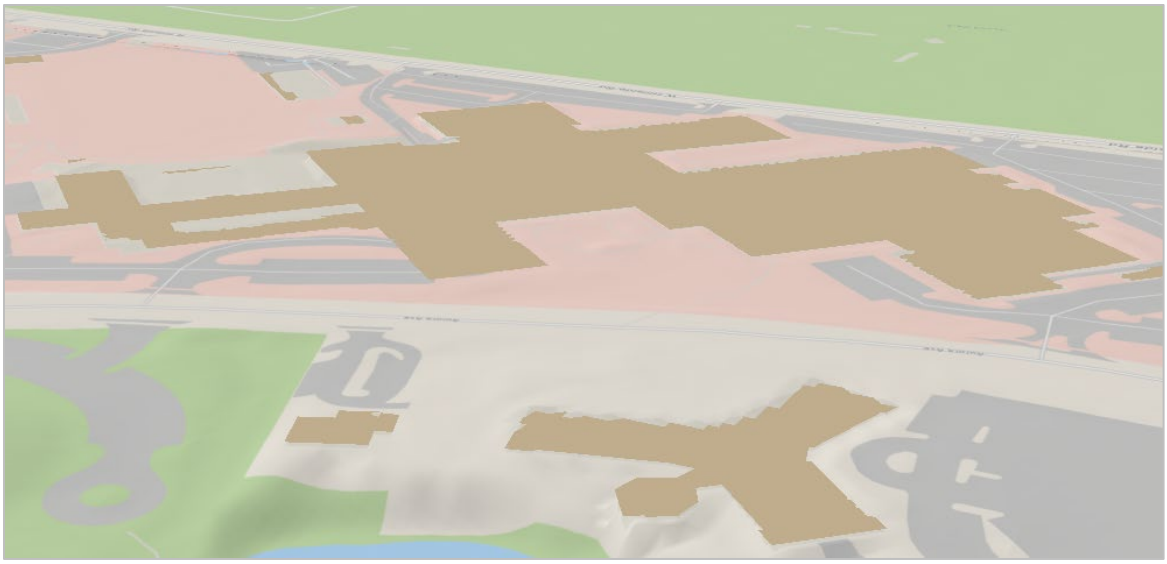


8. Click the **A field** option, then select **BASEELEVAT** from the field drop-down list.



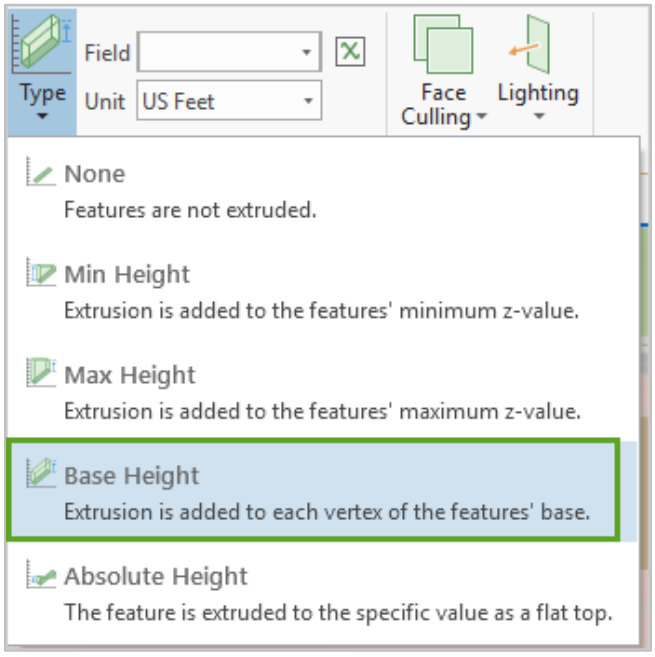
9. Click **OK**.

The building footprints display with flat interiors and are rendered at their correct base elevation.

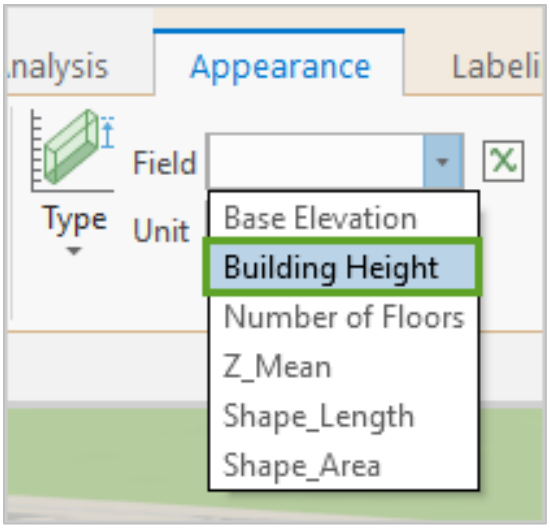


Next, you will extrude each of the buildings up to their building height.

10. In the **Contents** pane, select the **BuildingFootprints** layer.
11. On the ribbon, click the **Appearance** tab.
12. In the **Extrusion** group, click the **Type** drop-down arrow and choose **Base Height**.



13. In the **Field** control, choose the **Building Height** field.



The 2D building polygon layer is displayed as 3D shapes.

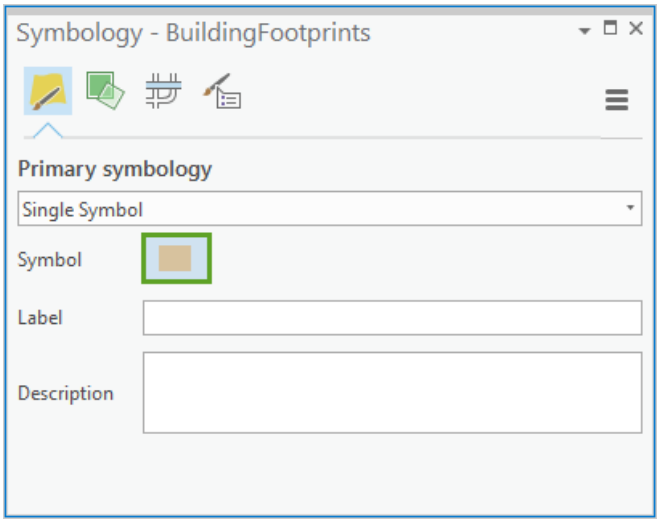
Tip: If you are working with data that doesn't have a dedicated height field, you might be able to estimate building heights using an expression - such as "NumberOfFloors * 3.5".

Using procedural symbology

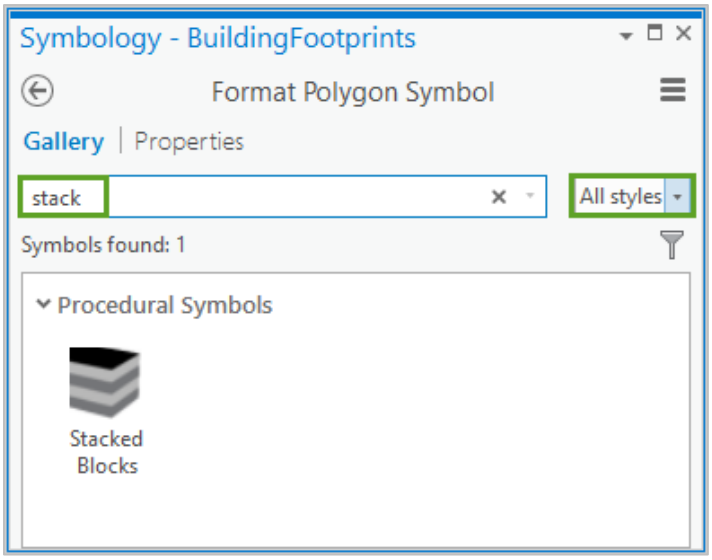
Extrusion helps visualize the real-world space consumed by buildings, but it doesn't show other useful information, such as the number of floors for each building. This could be important for first responders and city planners. We can replace the solid color display with a different kind of symbol–a procedural symbol–to incorporate additional information into the display.

A procedural symbol is a script that can construct additional geometry, colors and textures from a source feature's geometry, and then apply that as a symbol within the scene. You can build your own procedural symbols using Esri CityEngine, or simply use one that comes with an Esri product or solution.

1. In the **Contents** pane, select the **BuildingFootprints** layer.
2. In the **Extrusion** group, click the **Type** drop-down arrow and choose **None.**
3. In the **Contents** pane, right-click the **BuildingFootprints** layer and click **Symbology**.
4. In the **Symbology** pane, click the symbol for the layer to modify it.

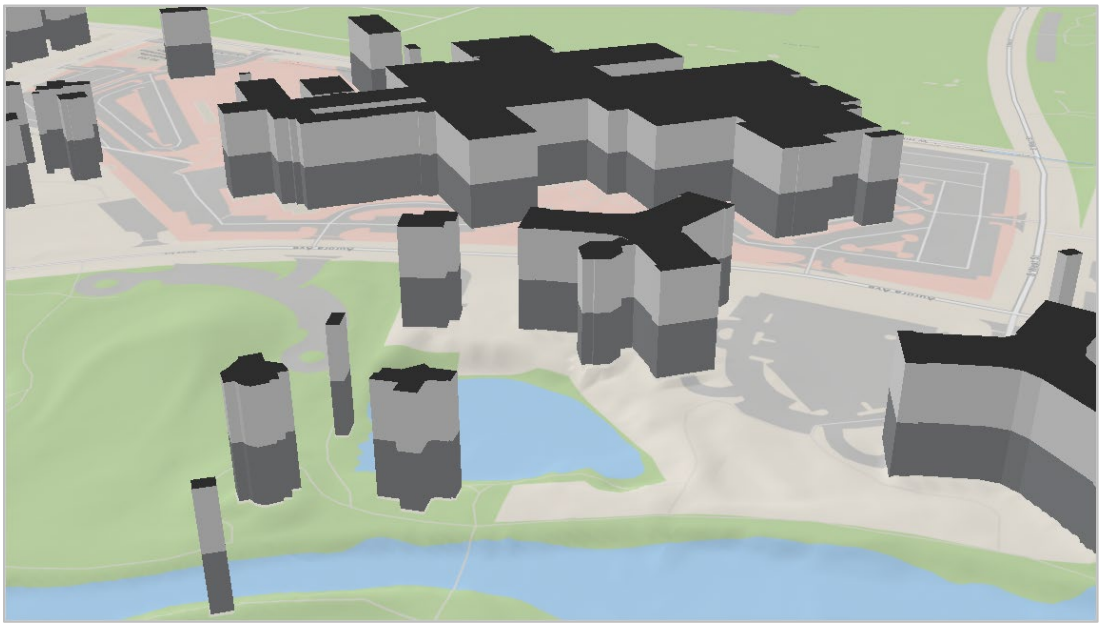


5. In the **Format Polygon Symbol** gallery, type "stack" in the search field and select **All styles** from the drop-down menu next to the search field.



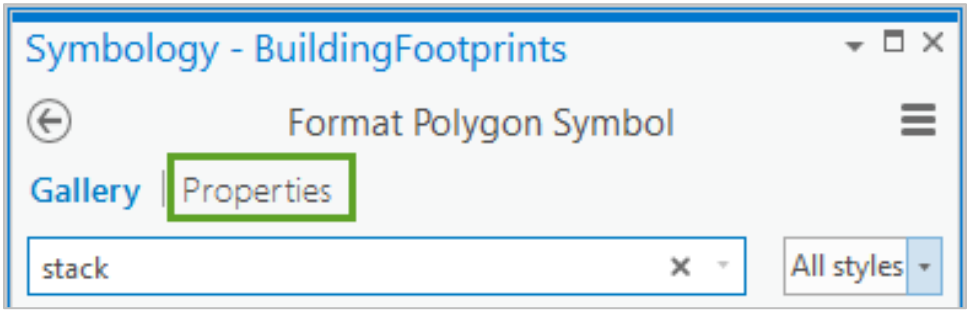
6. From the results, click the **Stacked Blocks** symbol to assign it to the layer.

In the **Contents** pane, you will see the new **Stacked Blocks** procedural symbol appear under the **BuildingFootprints** layer, and in the map window, you will see the building polygons symbolized as stacked blocks.

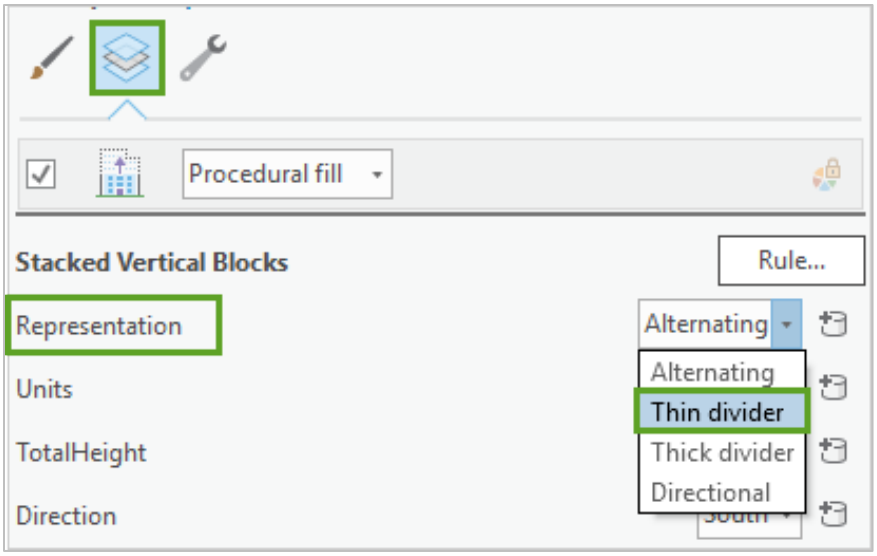


Next, you will configure the procedural symbol to connect to individual feature attributes.

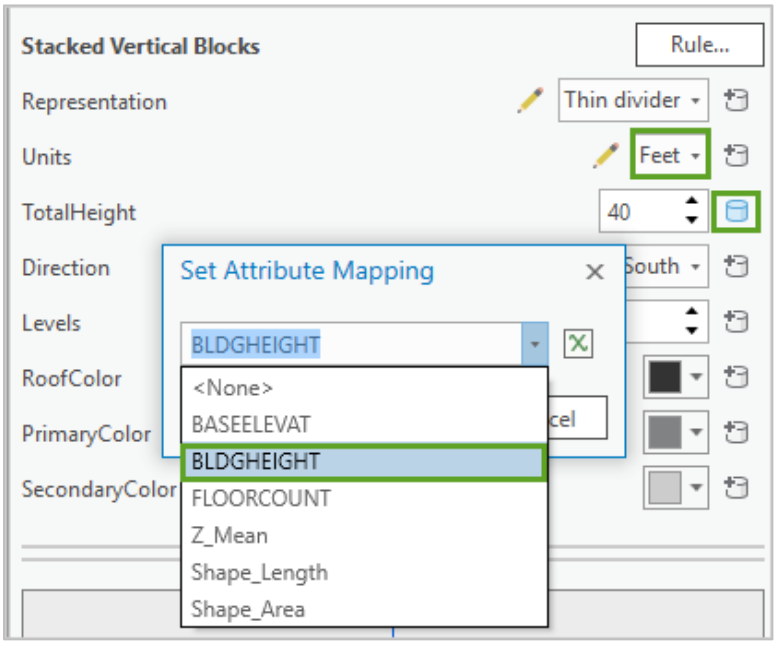
7. In the **Format Polygon Symbol** pane, click the **Properties** tab.



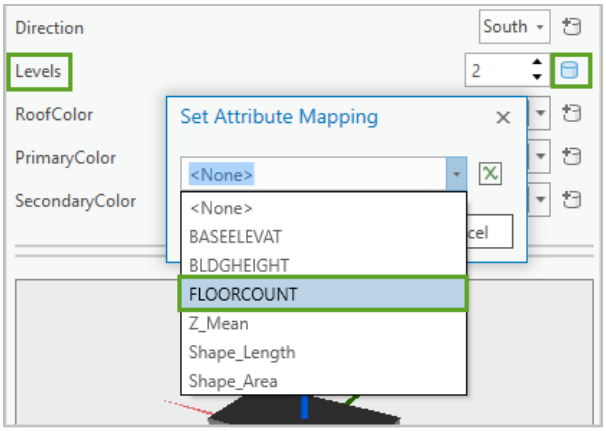
8. Click the **Layers** subtab to configure the symbol.
9. Change the **Representation** to **Thin divider**.



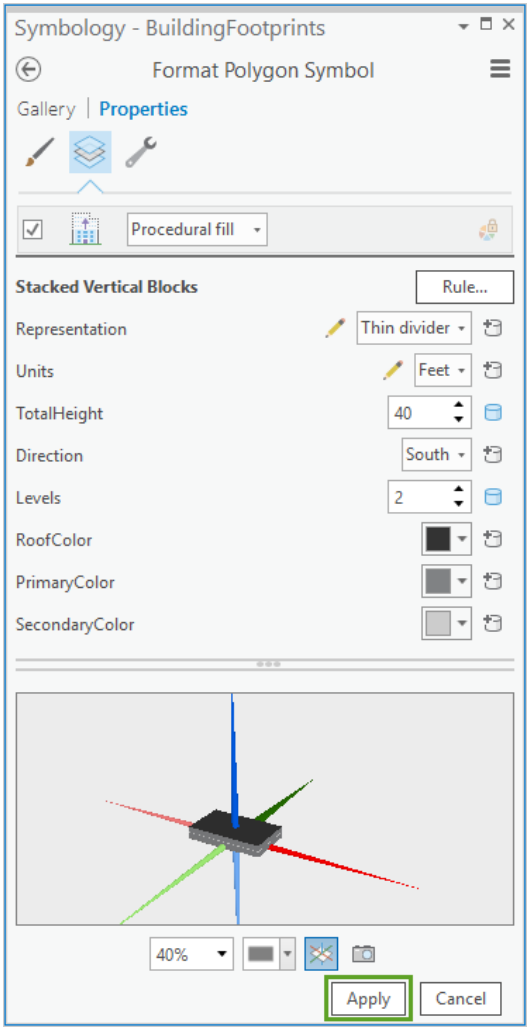
10. Change the **Units** to **Feet**.
11. For **TotalHeight**, click the database icon and choose the **BLDGHEIGHT** field to set the building footprints extrusion height.



12. Click **OK** in the **Set Attribute Mapping** dialog box to apply the choice.
13. For **Levels**, click the database icon and choose the **FLOORCOUNT** field to set the number of levels for each building.

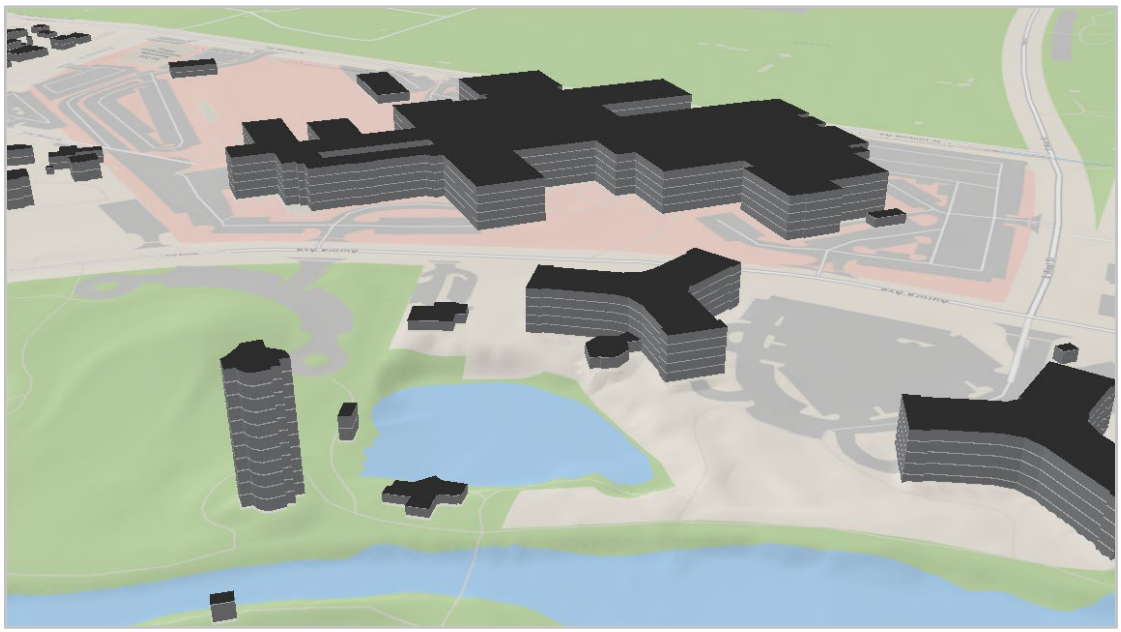


14. Click **OK** in the **Set Attribute Mapping** dialog box to apply the choice
15. At the bottom of the **Symbology** pane, click **Apply** for the changes to take effect.



***Tip**: Symbol properties with attribute mapping have a blue database icon.*

Each building renders at its defined height, with striping that indicates the number of floors. These flat-roofed buildings, sometimes referred to as level of detail (LOD) 1 buildings, provide content that support many 3D mapping needs.

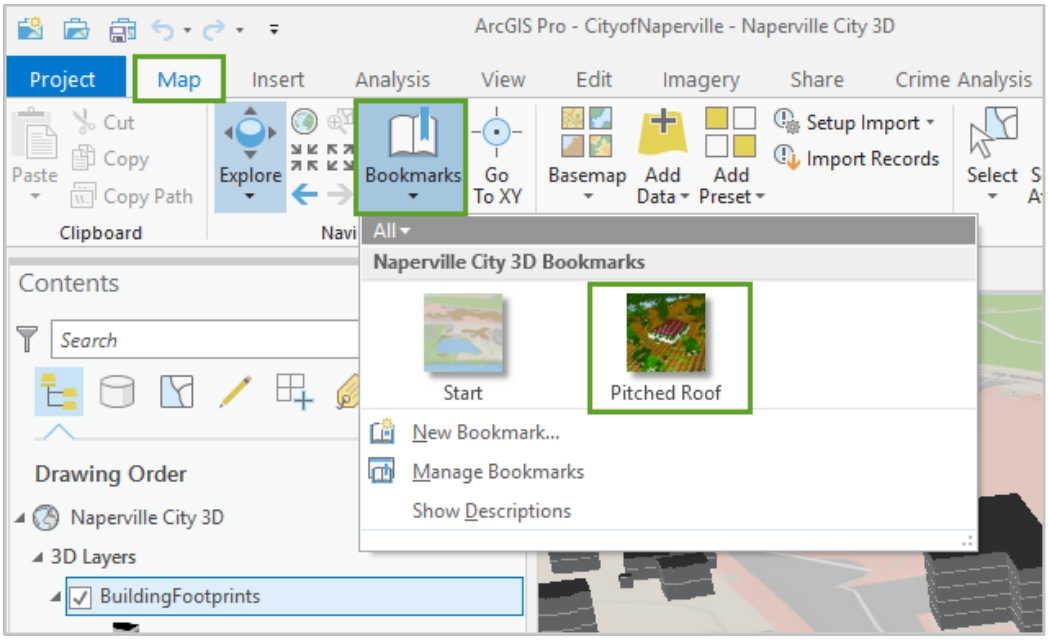


However, not all buildings have flat rooftops. To model pitched-roof forms, we need to move away from simple extruded shapes and into a more comprehensive way of modeling buildings. There are a variety of methods for creating this type of data–some of which will be covered in later sessions–but, for this exercise, we will assume the data is preexisting or has been compiled by a data provider.

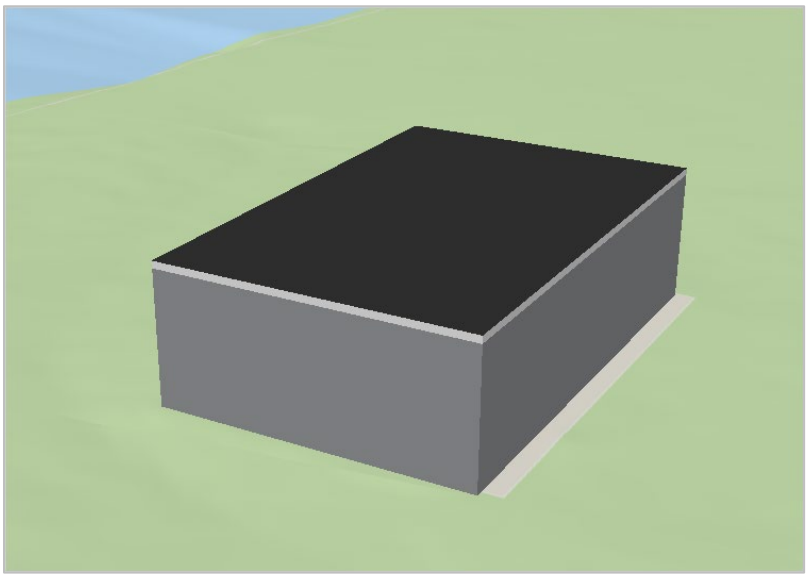
Note: Other Learn ArcGIS lessons are available, such as Extract Roof Forms for Municipal Development and Construct Realistic Buildings with Multipatch Editing for a lidar-centric roof extraction process.

Let's look at a building in which a flat-top roof isn't effective.

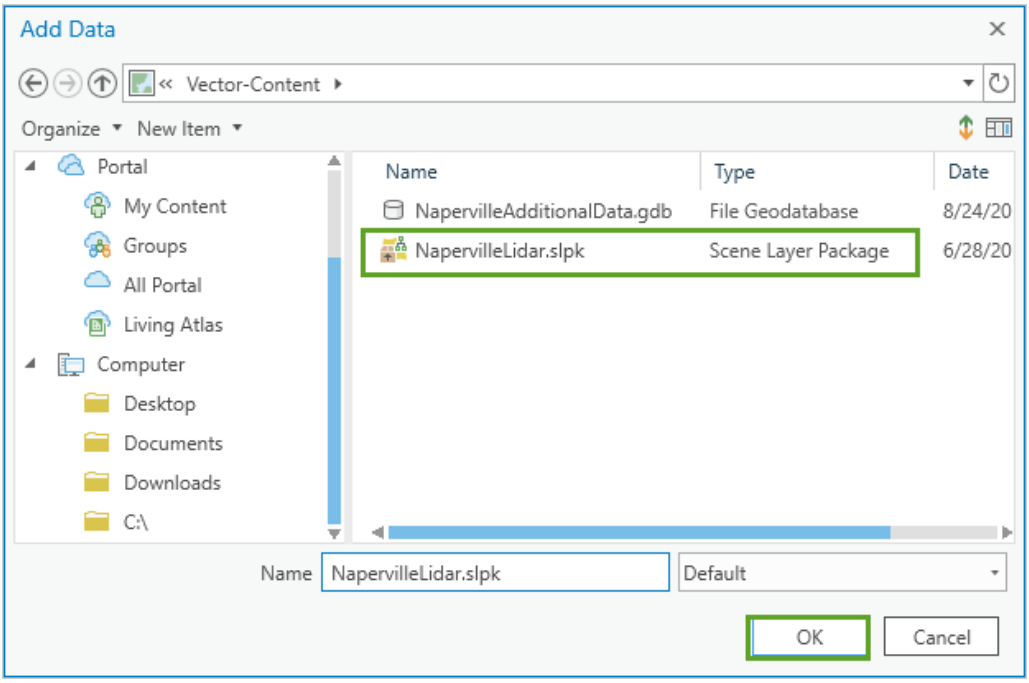
16. On the ribbon, on the **Map** tab, click **Bookmarks**, and click **Pitched Roof**.



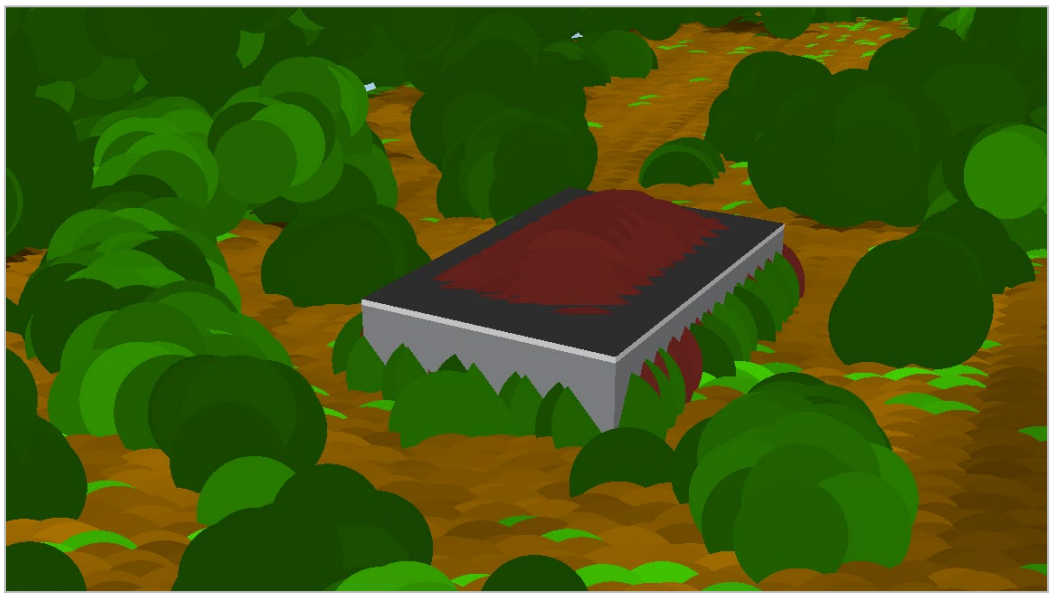
The scene updates and zooms to a rectangular building.



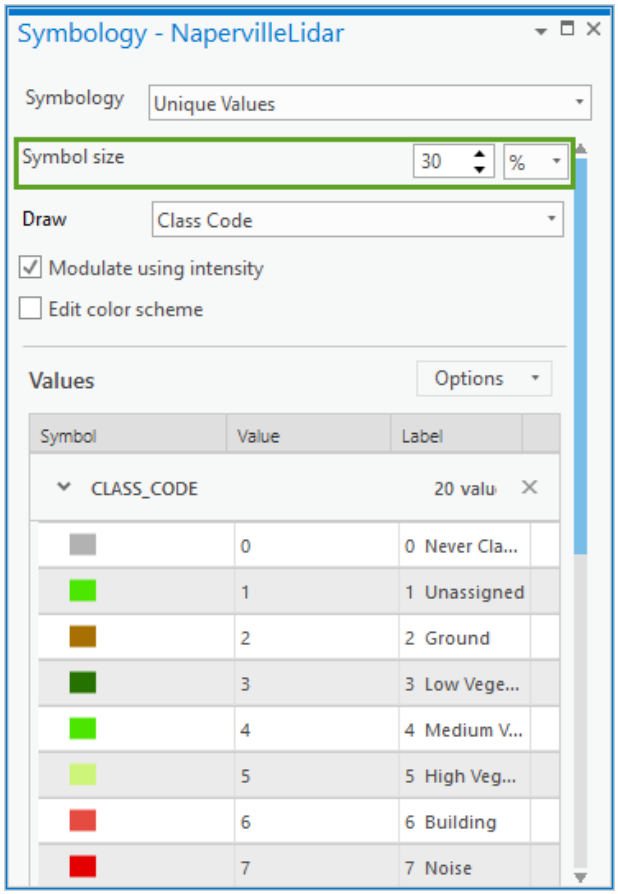
17. In the **Map** tab > **Layer** group, click **Add Data**. Browse to your source data folder, select **NapervilleLidar.slpk**, and click **OK**.



You may receive a notification about uncommitted symbology; click **OK** to proceed.



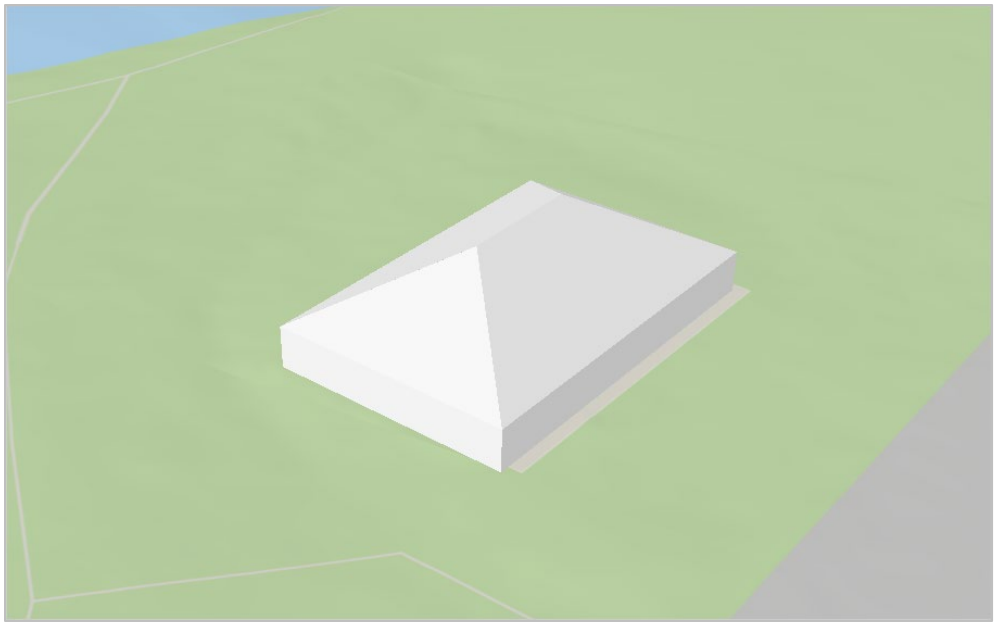
18. In the **Contents** pane, right-click **NapervilleLidar** and click **Symbology**.
19. In the **Symbology** pane, change the **Symbol size** property to **30%.**



20. In the **Contents** pane, turn off the **BuildingFootprints** layer, and turn on the **BuildingShells** layer.

The building footprints are simple 2D polygons that you have extruded based on a height attribute. The building shells are true 3D features and are multipatch features that have their 3D properties maintained as part of the geometry and do not require attributes to be extruded and rendered correctly in 3D space. The lidar points line up with the roof shape; the multipatch layer's (LOD 2) buildings more closely match the real world.

21. In the **Contents** pane, turn off the **NapervilleLidar** layer.

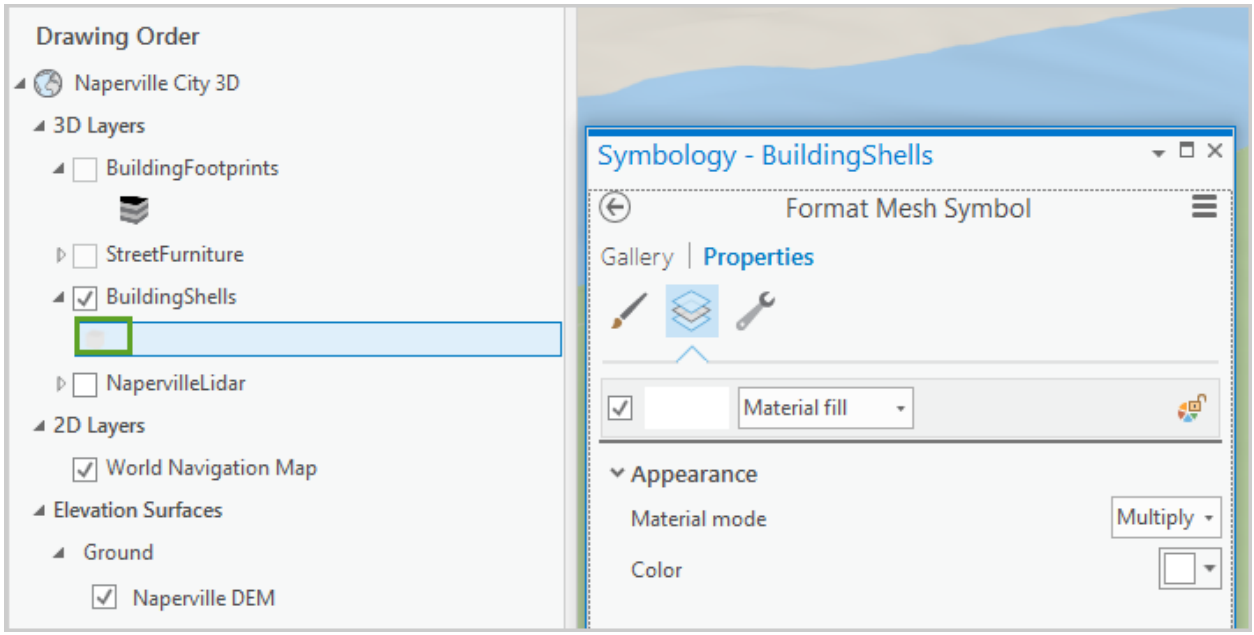


Using procedural texturing

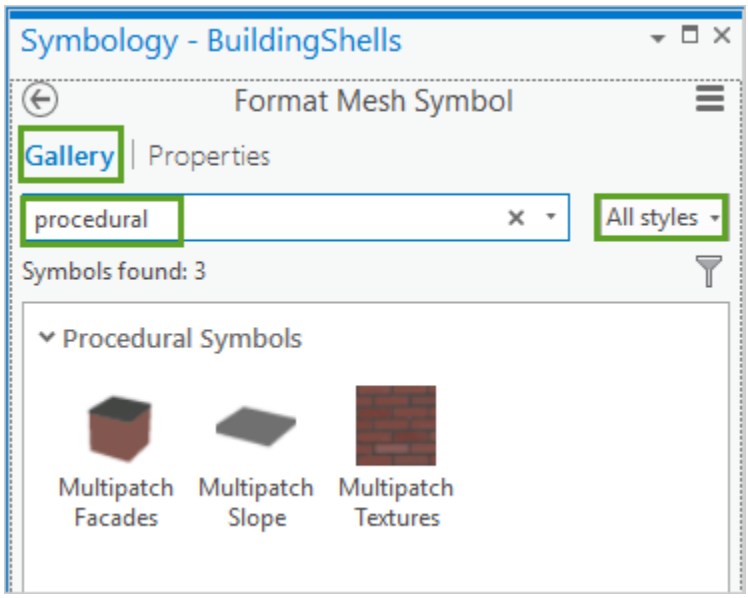
3D models are stored in the geodatabase as multipatch feature classes. A multipatch feature class is the same as other feature class types, like points and polygons, in that it contains per-feature geometry and per-feature attribute values. Additionally, it has specific options for how it can be symbolized.

The exterior shell of a multipatch can be “painted” in a variety of ways. It might use imagery, like a photo taken from the street, or it might use a color, like its zoning code, or it might be procedurally generated and added in real time. We often refer to the exterior representation of a multipatch generically as its texture. This exercise will use procedural texturing to convert our flat-white buildings into something more useful.

1. In the **Contents** pane, expand the **BuildingShells** layer, and click the symbol to open the **Symbology** pane.

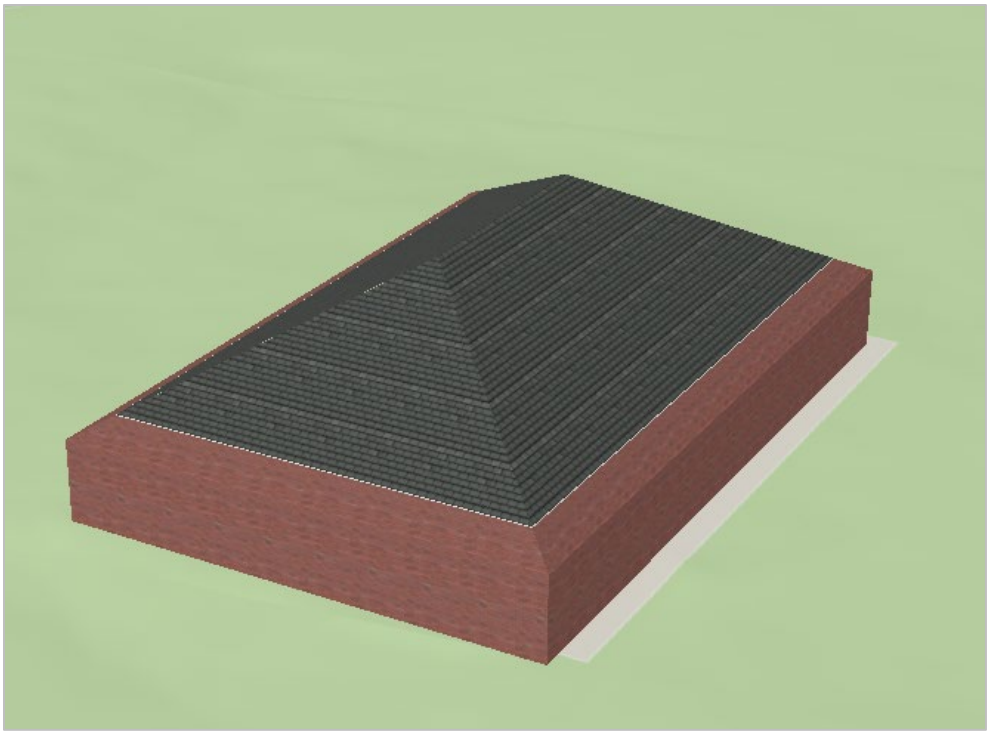


2. At the top of the **Format Mesh Symbol** pane, click the **Gallery** tab.
3. In the search text box, type “procedural” , make sure **All styles** is selected, and then press **Enter**.

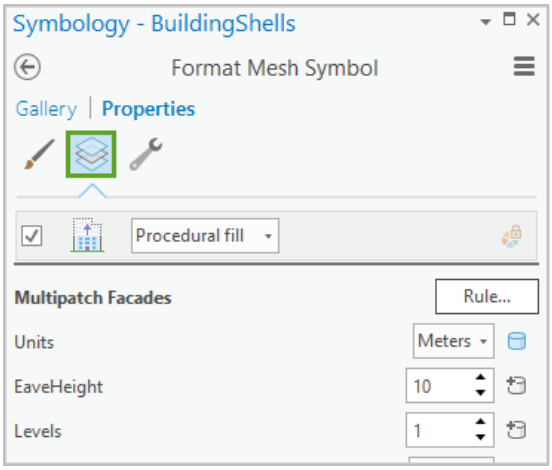


4. In the results, click **Multipatch Facades**.

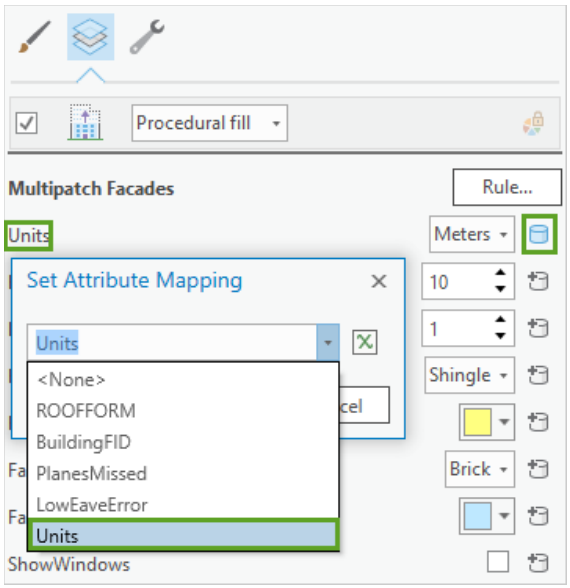
The multipatch draws with procedurally generated textures, using the symbol’s default settings.



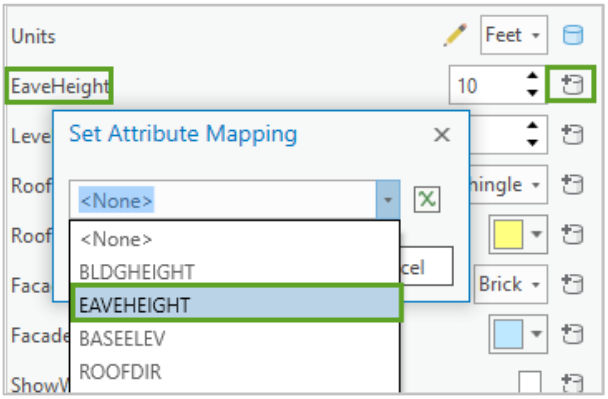
5. In the **Symbology** pane, click the **Properties** tab, and then click the **Layers** subtab.



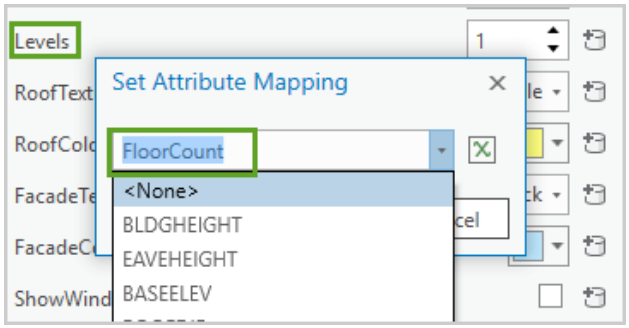
6. For **Units**, click the database icon and verify that it is mapped to the **Units** field.



7. Click **OK** to apply the attribute mapping. Verify the **Units** value is set to **Feet**.
8. For **EaveHeight**, click the database icon to map the property to the **EAVEHEIGHT** field and click **OK**.

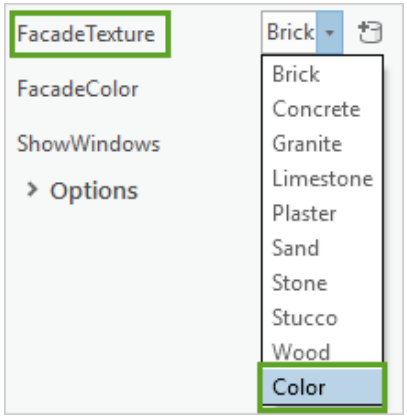


9. For **Levels**, click the database icon to map the property to the **Floor Count** field and click **OK**.

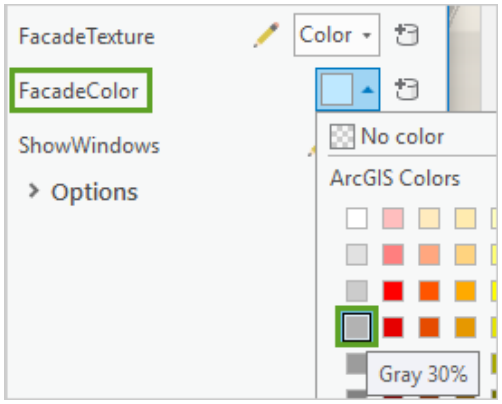


Next, you will set the parameters for the vertical-wall stripe texture.

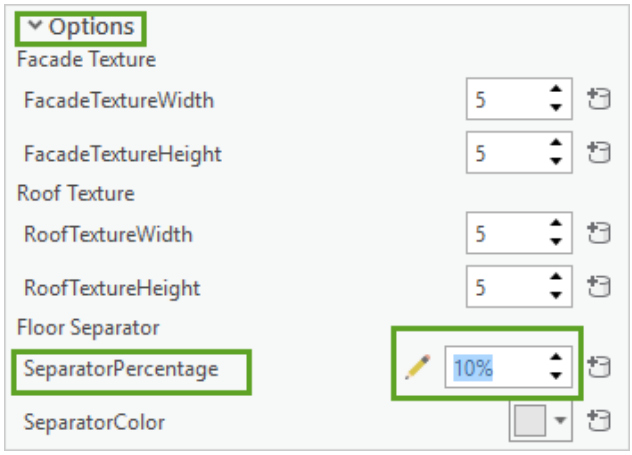
10. For **FacadeTexture**, choose **Color** from the drop-down list.



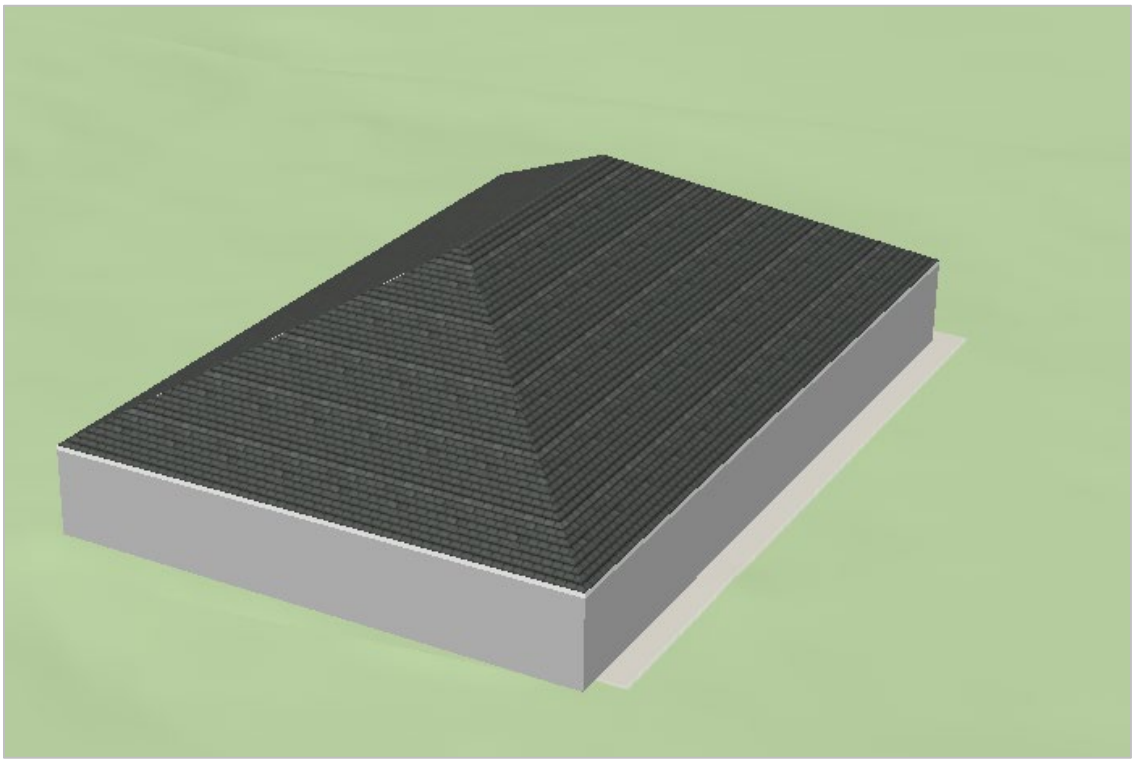
11. For **FacadeColor**, choose a mid-gray, such as **Gray 30%**, from the color picker.



12. Expand **Options.**
13. Update the **SeparatorPercentage** value to **10%**.



14. At the bottom of the **Symbology** pane, click the **Apply** button

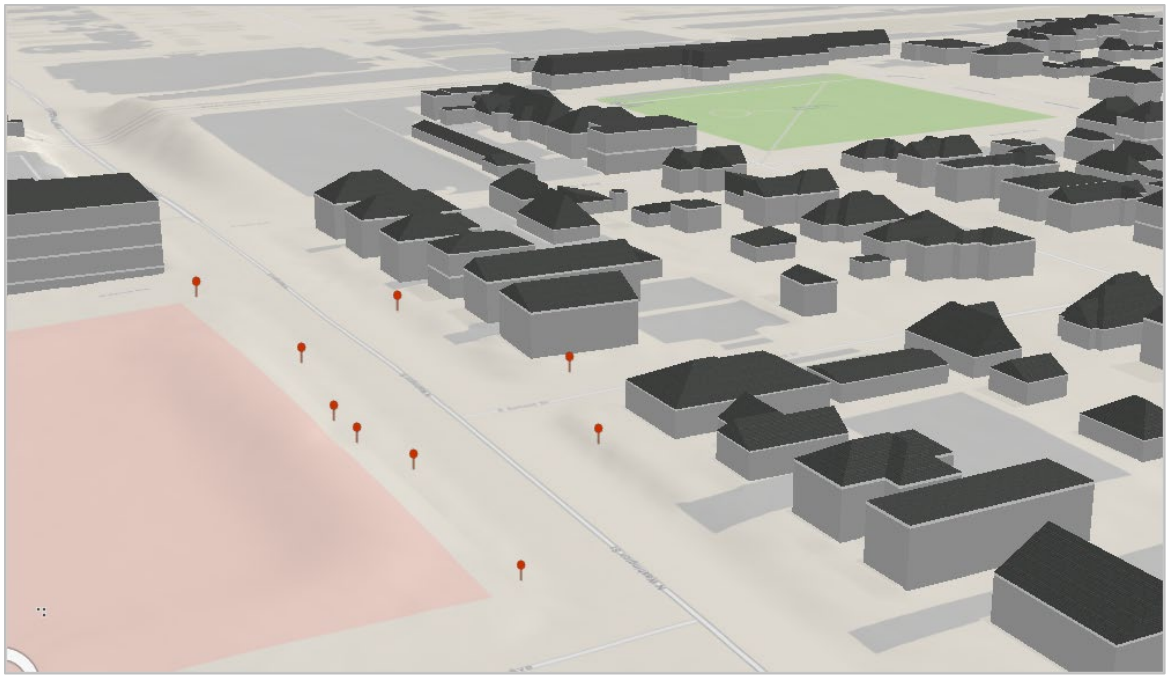


To enhance the appearance of your 3D city map, you may want to add some additional vector layers.

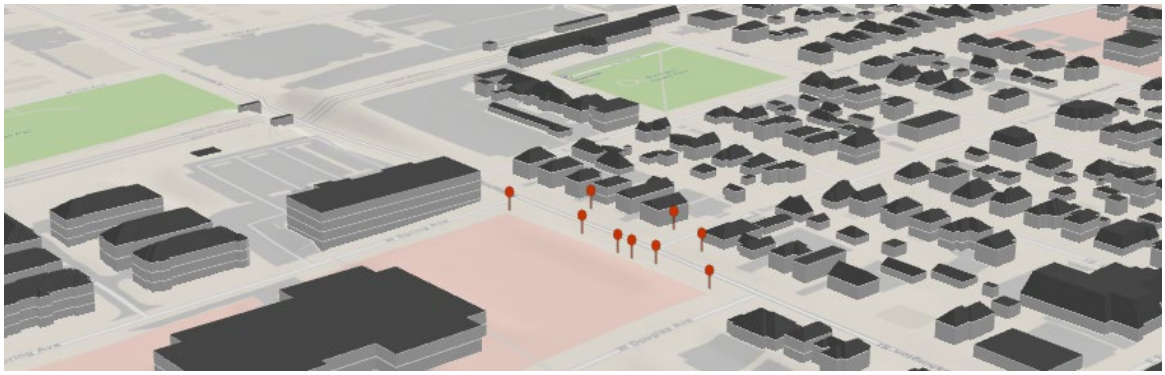
Add street furniture

Apart from buildings, another commonly managed feature in a city is street furniture, such as benches, light poles, and bus stops. These are important locational elements that residents will be aware of, and refer to, in most urban environments. For this exercise, we only have a small set of example features, but the technique remains the same, regardless of feature count.

1. Turn on the **StreetFurniture** layer.
2. In the **Contents** pane, right-click **StreetFurniture**, and click **Zoom to Layer**.
3. Use the mouse's wheel button to rotate the view to a more oblique view position.



4. Use the right mouse button and drag to zoom in/out–pay attention to the size of the pushpin symbols.

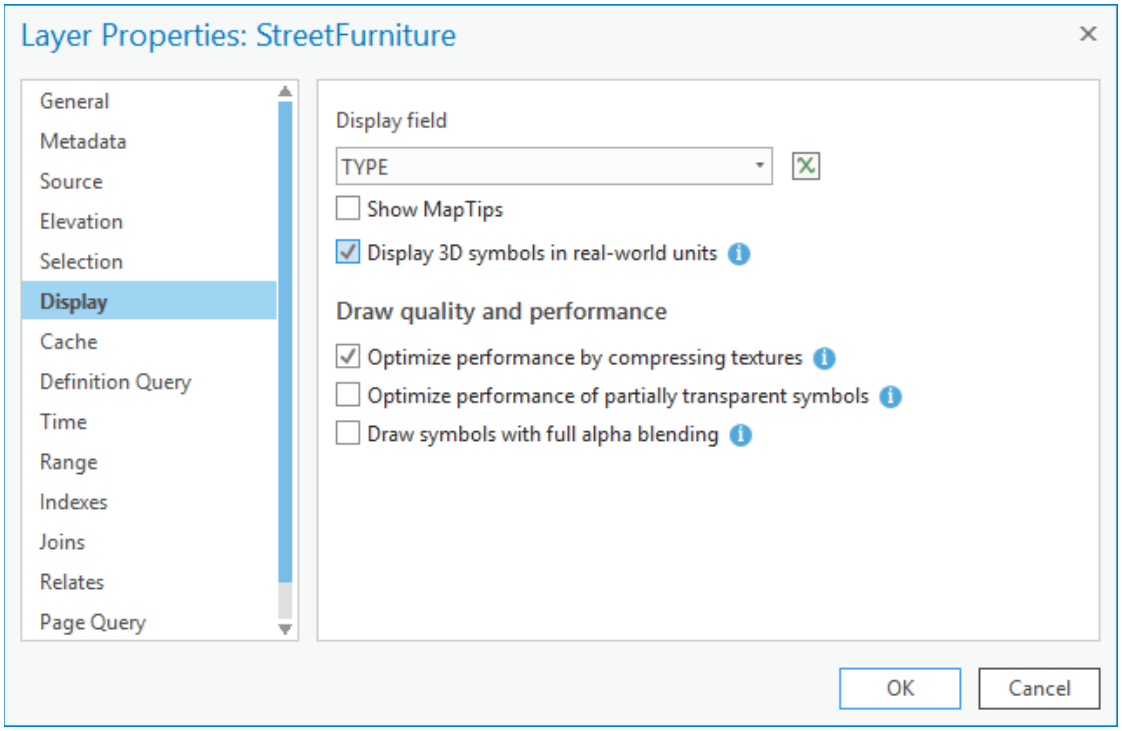


The points are being symbolized with a red billboarded pushpin that is in screenspace size.

Screenspace-sized symbols render with a size based on the pixels on your screen. They are very effective for locational points because they are guaranteed to be seen at all viewing distances. However, they are not useful for representing real-world objects.

Real-world-sized symbols, on the other hand, render with a consistent volumetric size. This is consistent with our day-to-day interaction with the world, where objects that are farther away appear smaller. Our street furniture data needs to use this rendering method.

5. In the **Contents** pane, right-click the **StreetFurniture** layer and click **Properties**.
6. In **Layer Properties**, on the **Display** tab, check the **Display 3D symbols in real-world units** check box.

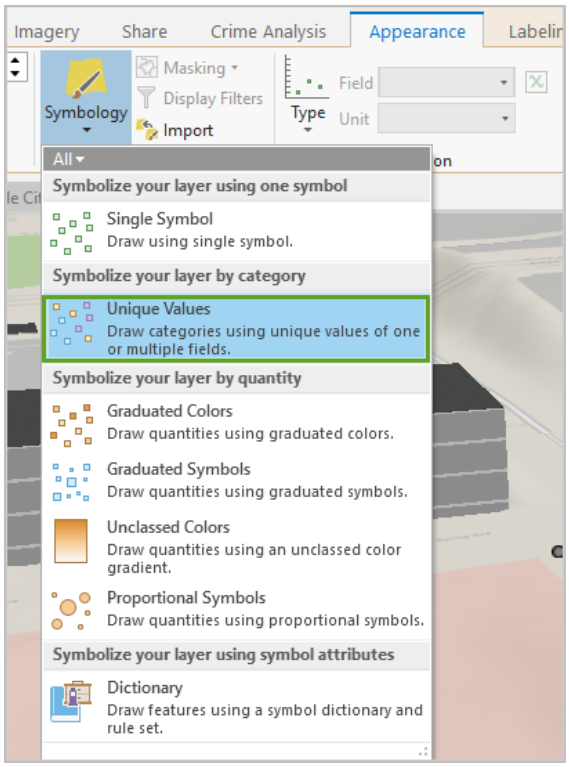


7. Click **OK** to close **Layer Properties**.
8. Use the right mouse button and drag to zoom in/out–pay attention to the size of the pushpin symbols.

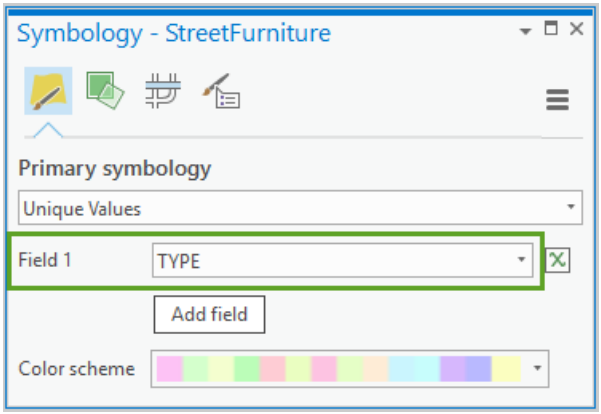
Next, you will replace the pushpins with representative 3D models.

The **StreetFurniture** data we are using for this exercise includes unique values to identify light poles and park benches. We will use these unique values in the data to create two classes. You can then apply a different 3D model symbol to each class. For your own data, you can use as many classes as you need.

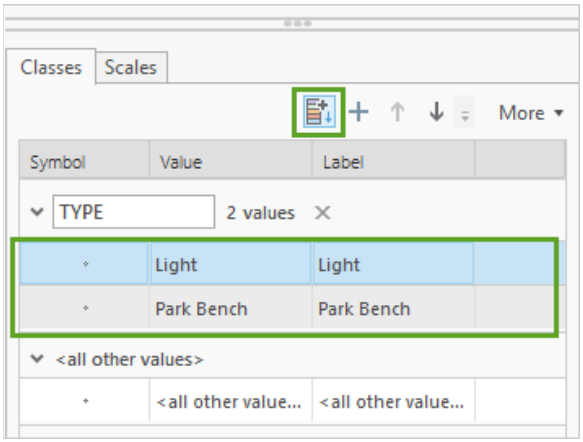
9. In the **Contents** pane, click and select the **StreetFurniture** layer.
10. Click the ribbon, and open the **Appearance** tab.
11. In the **Drawing** group, click the **Symbology** drop-down arrow and select **Unique Values**.



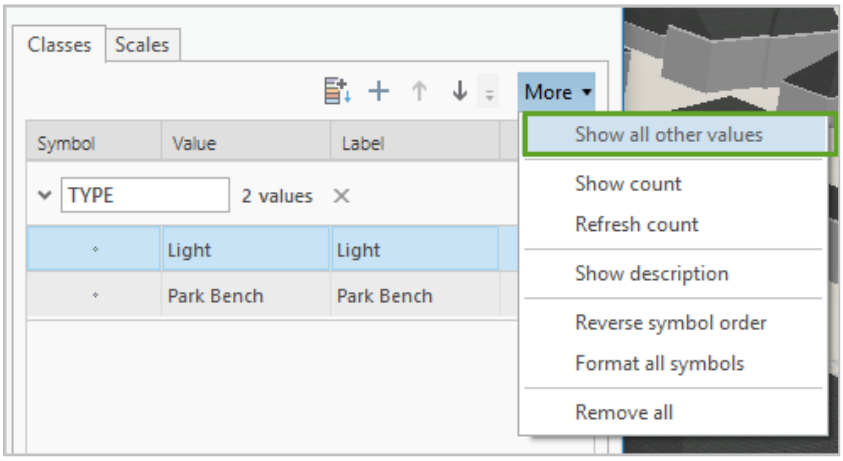
12. In the **Symbology** pane, confirm **TYPE** is specified in **Field 1**.



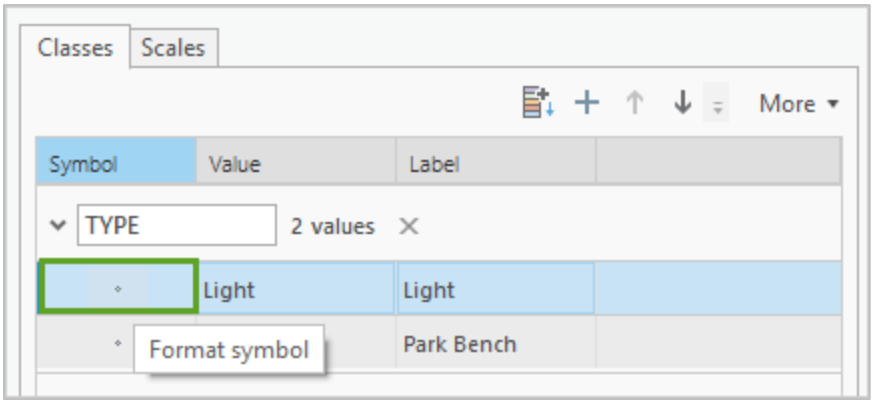
13. Click the **Add All Values** button.



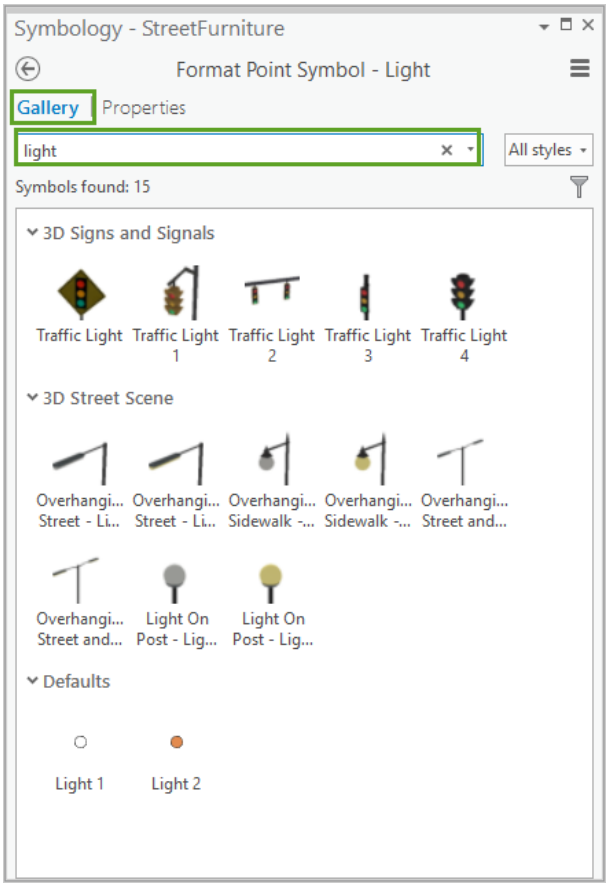
14. Expand the **More** drop-down list and uncheck **Show all other values**.



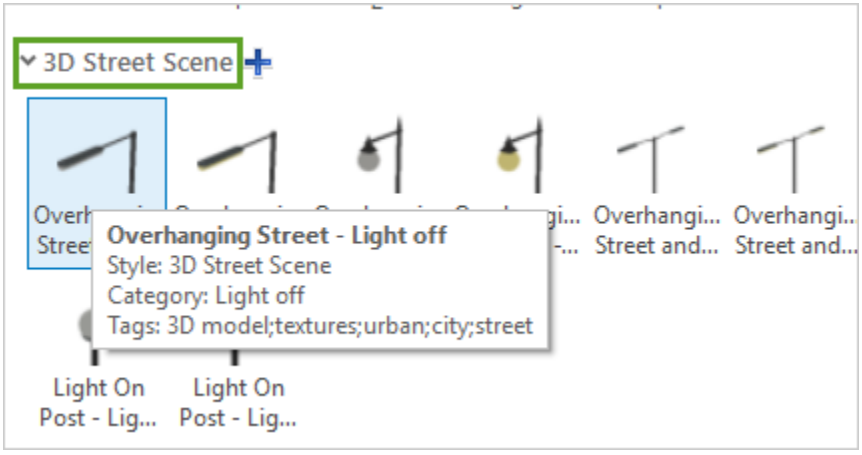
15. In the **Symbology** pane's symbol list, click the symbol (left column) for the **Light** type to modify.



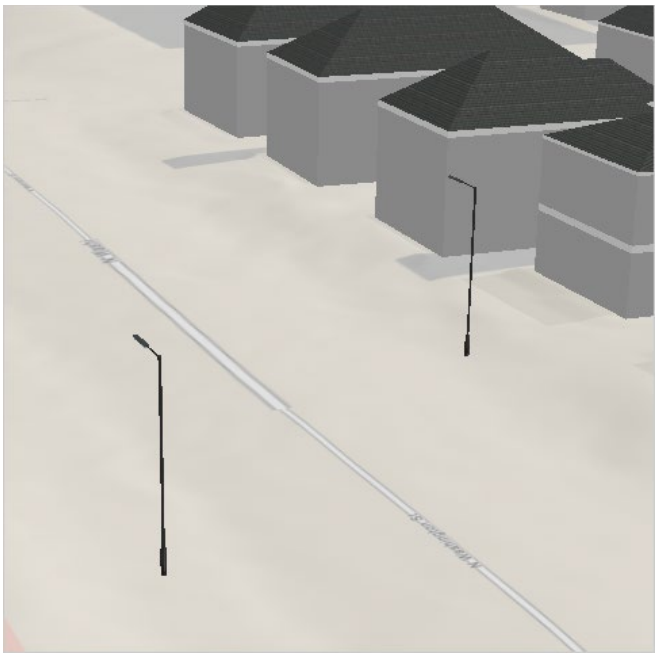
16. Select the **Gallery** tab and search for “light” in **All styles**.



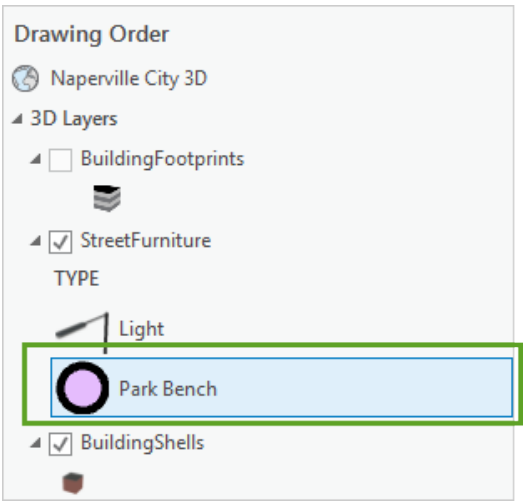
17. In the **3D Street Scene** section of the results, select the **Overhanging Street – Light off** symbol.



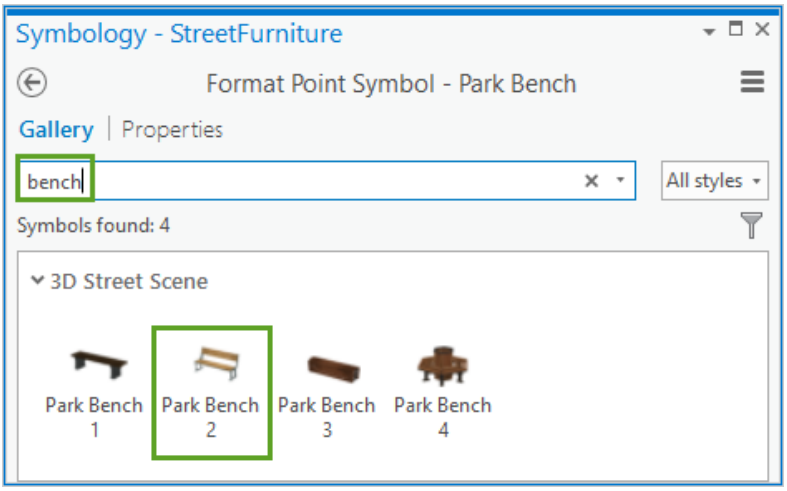
The scene updates and lights are now displayed with overhanging street lights symbols.



18. In the **Contents** pane, expand and click the symbol for the **Park Bench** type in the **StreetFurniture** layer.



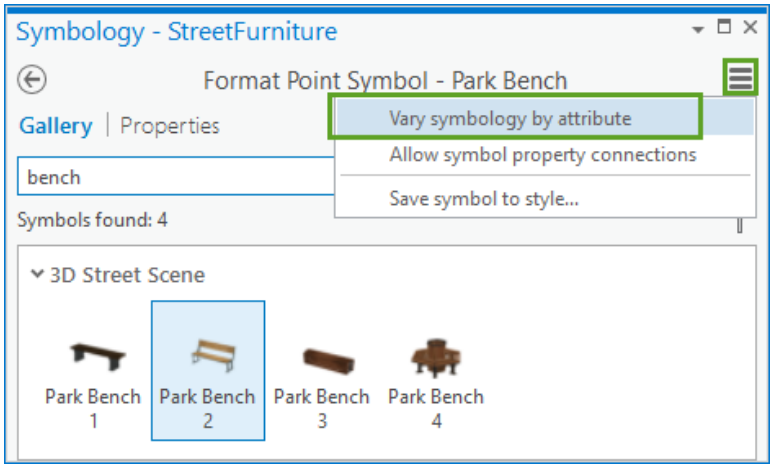
19. In the **Symbology** pane **Gallery** tab, search for “bench” in **All styles**.
20. Select the **Park Bench 2** symbol.



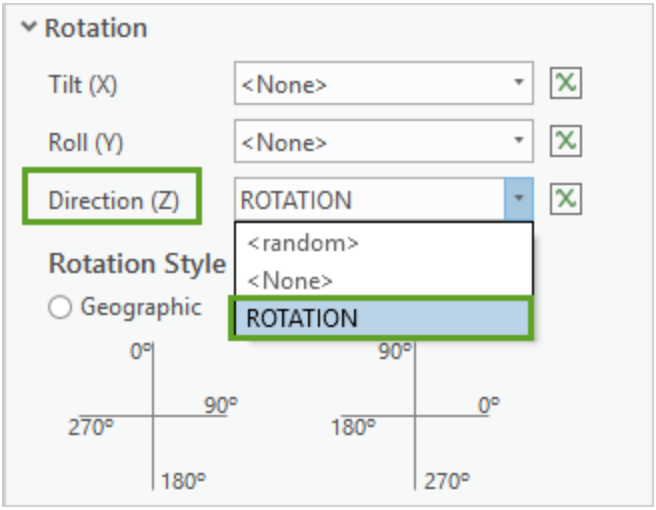
The points are now displayed with realistically sized models … but they are facing the wrong direction.

Next, you will set attribute-driven rotation for the symbols.

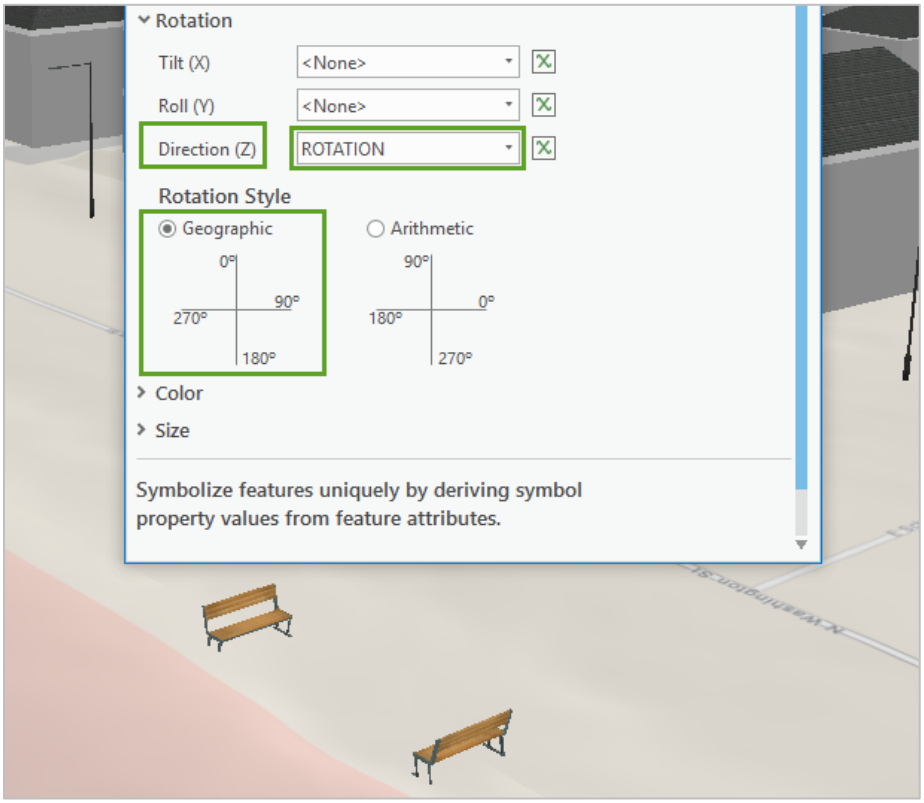
21. In the **Symbology** pane, click the menu button, and click **Vary symbol by attribute**.



22. Expand the **Rotation** group.
23. For the **Direction (Z)** rotation property. apply the **ROTATION** field.



24. Set the **Rotation Style** to **Geographic**.



The light symbols are rotated to hang over the street, and the park benches now face each other.

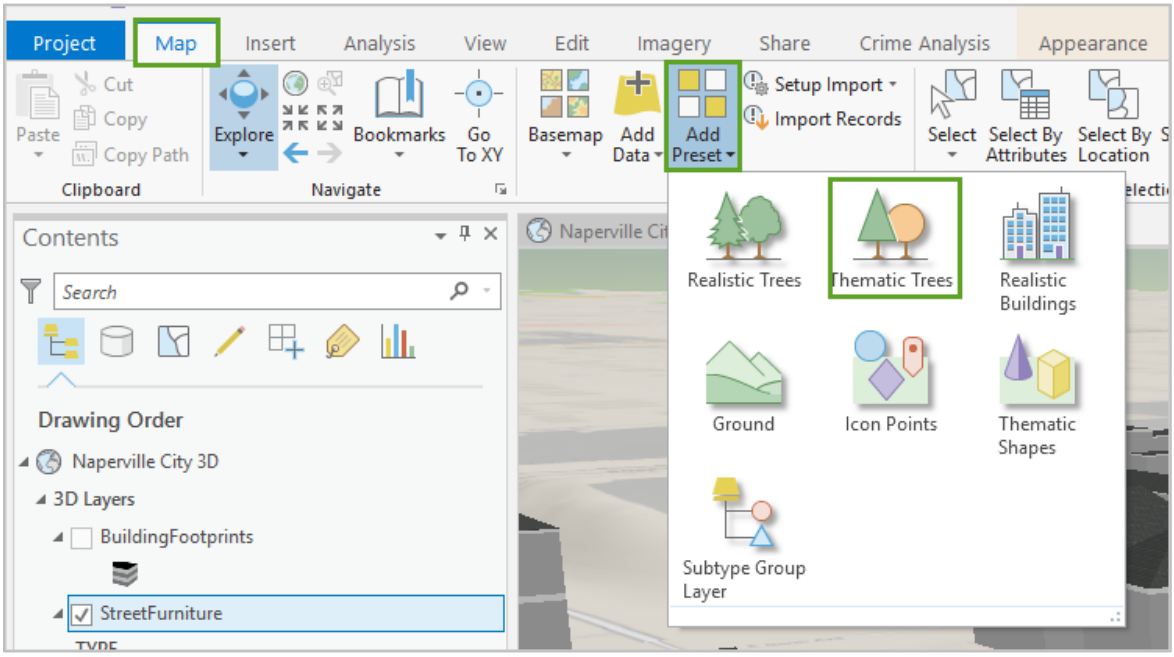
The rotation values were pre-calculated for this data. For your own content, you can manually enter values for a few features, or use geoprocessing tools against nearby streets for many features.

Add trees

Another primary element of most cities is vegetation and trees. You can use the same technique for tree point features as you did for street furniture–that is, create a set of unique classes and individually define each symbol–or you can use ArcGIS Pro's built-in preset layer option. The Preset Layer gallery provides a streamlined way to add, and configure, common types of 3D content into the scene.

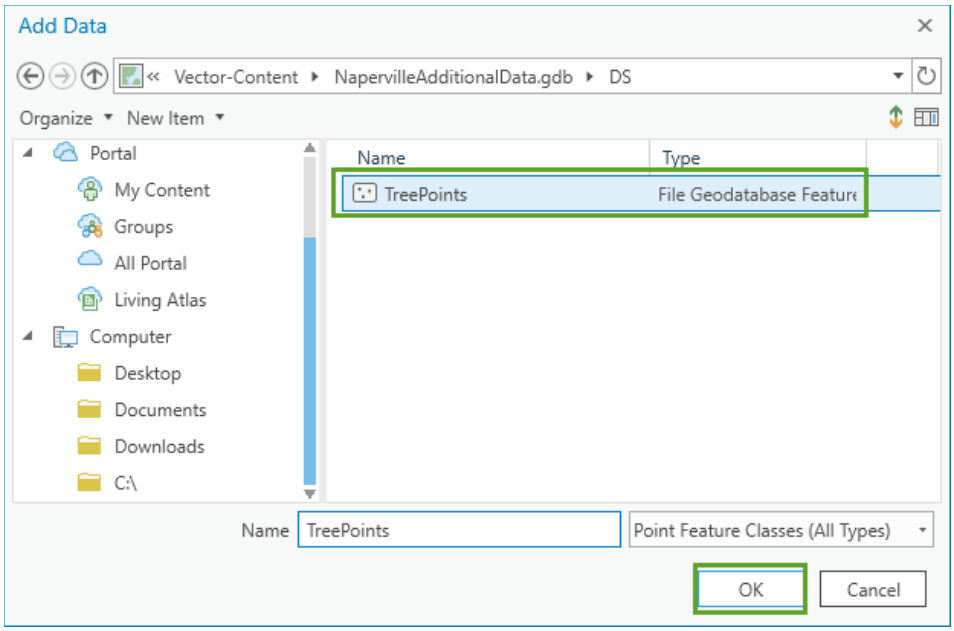
The Thematic Trees option uses geometric forms, such as spheres and cones, to represent the tree shape. This display option fits better with this scene (rather than the Realistic option) because it matches the thematic styling of the current basemap and building features.

1. On the ribbon, click the **Map** tab, in the **Layer** group, click the Add **Preset** gallery drop-down list.



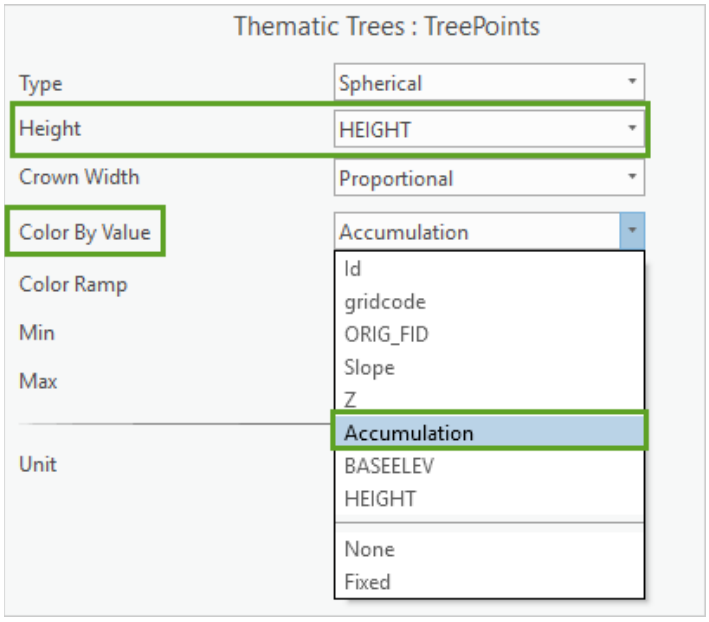
2. From the list, choose **Thematic Trees**.

3. Browse to your home data folder and choose **NapervilleAdditionalData.gdb > DS > TreePoints** and click **OK**.



The tree layer's **HEIGHT** field will automatically have populated because the field name matches the symbol property name. For color, each tree has a property for carbon accumulation that we can match to a color ramp.

4. In the **Symbology** pane, set the **Color By Value** option to the **Accumulation** field.

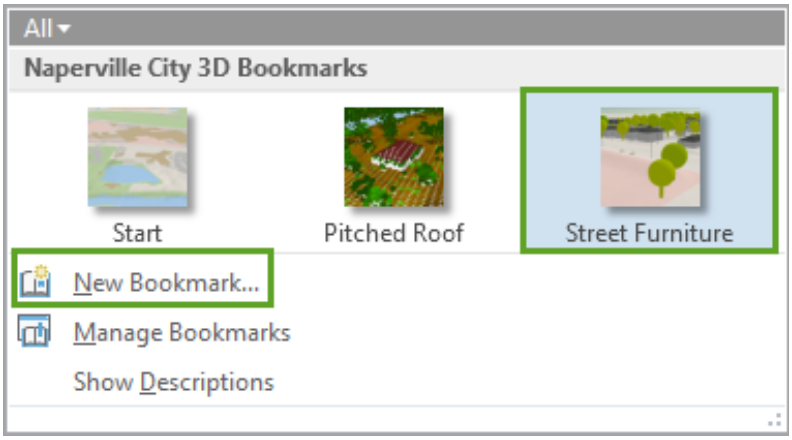


All symbology changes for preset layers are automatically applied, and the **TreePoints** layer, with the applicable height and accumulation color defined for each feature, is added to the scene.

Setting useful bookmarks

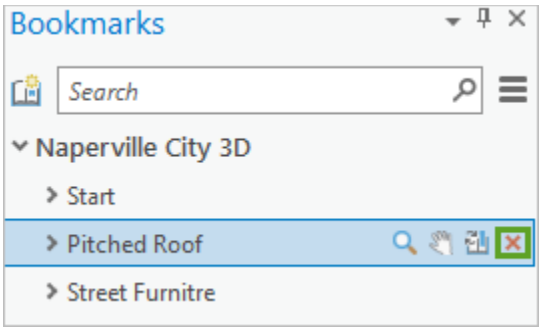
The city scene is looking good, but it can be difficult to get to specific locations, especially if you are not familiar with the geography of Naperville. Bookmarks store important viewpoints in the scene, and can help users quickly zoom to key locations, or reorient themselves if they get lost.

1. On the **Map** ribbon tab, expand the **Bookmarks** drop-down menu and click **Manage Bookmarks**.
2. Navigate in the scene to get a ground-level view of the street furniture features.
3. In the **Bookmarks** pane, click **New Bookmark**, set the name to **Street Furniture** and click **OK**.



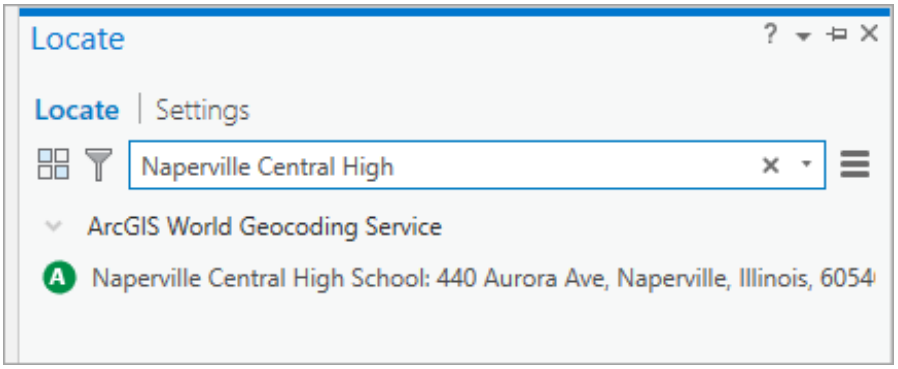
For this exercise, we used a bookmark for the pitched roof example. This is not important for future users of the scene, so let's delete it.

4. In the **Bookmarks** pane, click **Manage Bookmarks**.
5. In the **Bookmarks** manager pane, hover over **Pitched Roof** and click the remove button .



Some cities have well-known landmarks or points of interest. It can be helpful to create bookmarks for these locations so users can get there quickly. Let's create one for the local high school.

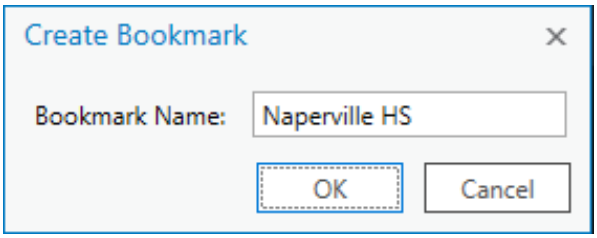
6. On the **Map** tab, in the **Inquiry** group, click **Locate**.
7. In the **Locate** pane, in the search text box, type "Naperville Central High" and press **Enter**.



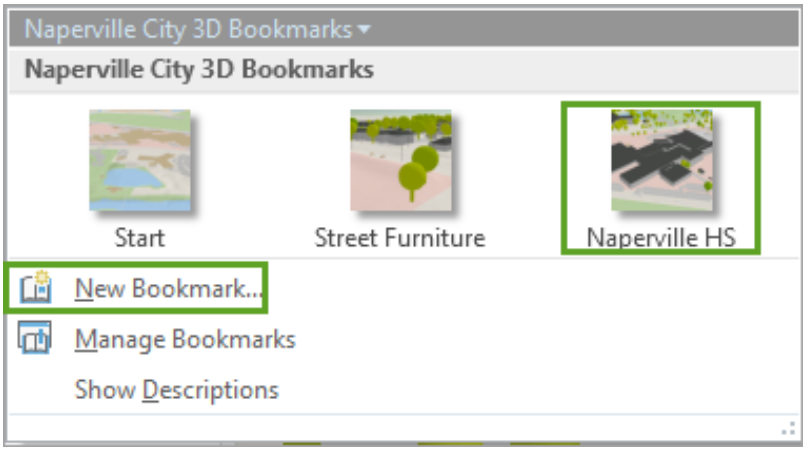
The search will locate the high school and zoom the view, so it is centered on the screen.

8. Right-click and drag on the high school to zoom in closer.

9. In the **Bookmarks** pane, click **New Bookmark**, set the **Bookmark Name** to “Naperville HS” and click **OK**.



This gives the user three bookmarks to access when navigating the view.



You can add as many as you like. If you were to share this scene to the web, the bookmarks would be automatically included as slides in the online scene viewer.

10. Save your project and close ArcGIS Pro.

Summary

Many scenes are focused on modeling a realistically sized and shaped representation of the world for workflows such as visual impact, construction planning, and environmental impact studies. These scenes tend to use real-world-sized symbols that are tied to individual feature attributes, especially for properties such as rotation, width, and height.

The use of thematic elements is still encouraged, though primarily through colors and textures that don't impact the volumetric shape of the features. We used a color ramp for the trees' carbon accumulation value, and we used procedural texturing on the buildings to differentiate the roof from the walls and indicate the number of floors. You also considered how users would interact with the scene by including bookmarks for a few key viewing positions.