

ArcGIS 10.2 3D Workshop



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Table of Contents

Exercise 1: File Geodatabase Preparation	3
Exercise 2: Raster Data—Lidar and Imagery	6
Exercise 3: Working with CityEngine	29
Exercise 3a: Create a Scene and Apply Rules	29
Exercise 3b: Create a New Building	45
Exercise 3c: Fun with Rules (Introduction to Procedural Modeling).....	51
Exercise 4: CityEngine Web Scenes.....	54

Exercise 1: File Geodatabase Preparation

A geodatabase is a collection of geographic datasets of various types and is a native data storage and management framework for ArcGIS. It acts as an organizational tool to store and manage large lidar datasets and terrains and is also the gateway into advanced GIS capabilities. It provides a central scalable data storage and management system with better data integrity, backup, recovery, and security.

Esri CityEngine relies on three ingredients: feature geometry, feature attributes, and procedural rules. The more detail provided in each element, the greater the complexity and real-world accuracy of the generated 3D content.

CityEngine uses the Esri file geodatabase (including textured multipatches) as its native storage format. This means that you can use any geo-spatial vector data, such as parcels, building footprints, and street networks, in CityEngine.

In this exercise, you will:

- Create a file geodatabase
- Use the Clip tool to select data for the area of interest

 **License:** This data has been provided by Esri and the City of Redlands

Complexity:

Beginner

Data Requirement:

Installed with software

Data Path:

C:\3D_Workshop\

Goal:



Learn how to prepare data for CityEngine

Average length of time to complete:

15 minutes

Part 1: Open ArcMap and Create a Folder Connection

Steps:

1. In Windows Explorer, navigate to **C:\3D_Workshop\Exercise1**.
2. Double-click **Exercise1.mxd** to open it.
3. Click the **Catalog** button () on the Standard toolbar. Drag the Catalog window and dock it at the right tab. Click the pin to keep it open.
4. In the **Catalog** window, click the **Connect to Folder** button ()
5. Navigate to **C:\3D_Workshop** and click **OK**.

You now have access to all the data and exercise folders.

Part 2: Create a File Geodatabase

The map document with Redlands data has been given to you. The map has an outline of an area of interest (AOI.) Your job is to prepare the data within the AOI for a CityEngine project. To do this, you will extract a subset of the original data with the Clip geoprocessing tool, and place the subset into a new file geodatabase.

Steps:


1. Make sure that the ArcGIS 3D Analyst extension is enabled. On the main menu, click **Customize > Extensions** and make sure that **3D Analyst** is checked. Then click **Close**.
2. In the **Catalog** window, navigate to **C:\3D_Workshop\Exercise1**.
3. Right-click the Exercise1 folder and click **New > File Geodatabase**.
4. Rename it to **RedlandsFinal**.
5. Right-click the geodatabase and click **Make Default Geodatabase**.

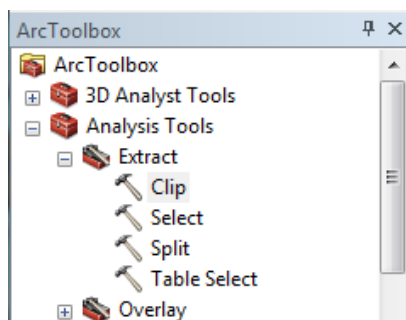
The default geodatabase is the home location for the spatial content of your map. This location is used for adding datasets and for saving resultant datasets created by various editing and geoprocessing operations. The default geodatabase is synchronized with Current Workspace of the Geoprocessing Environments; therefore, all output from tools or models will be saved to this default location. Access to the default geodatabase is available from the Catalog window menu, and as a shortcut in dialog boxes, so that you can quickly get back to the default geodatabase if you have navigated elsewhere in the system.

Part 3: Vector Data Preparation

To prepare the data for import into CityEngine, we're going to generate a subset that just covers our area of interest. We will use the Clip geoprocessing (gp) tool.

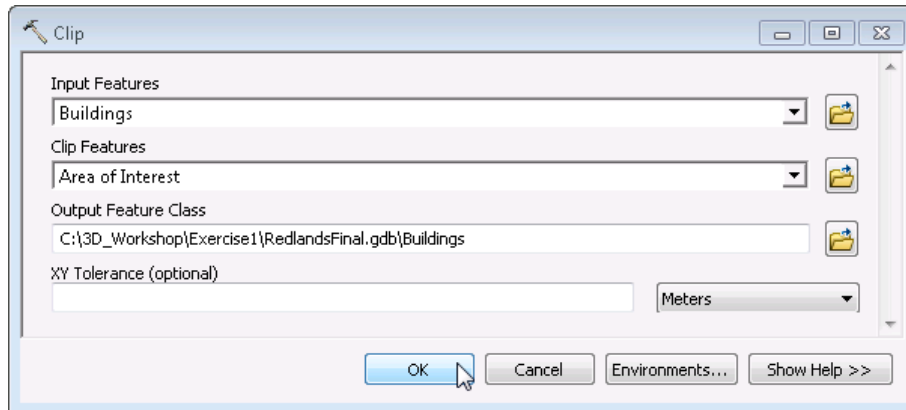
Steps:

1. Click the ArcToolbox button () on the Standard toolbar.
2. Drag and dock under the Table of Contents.
3. Expand the **Analysis** toolbox and then the **Extract** toolbox.

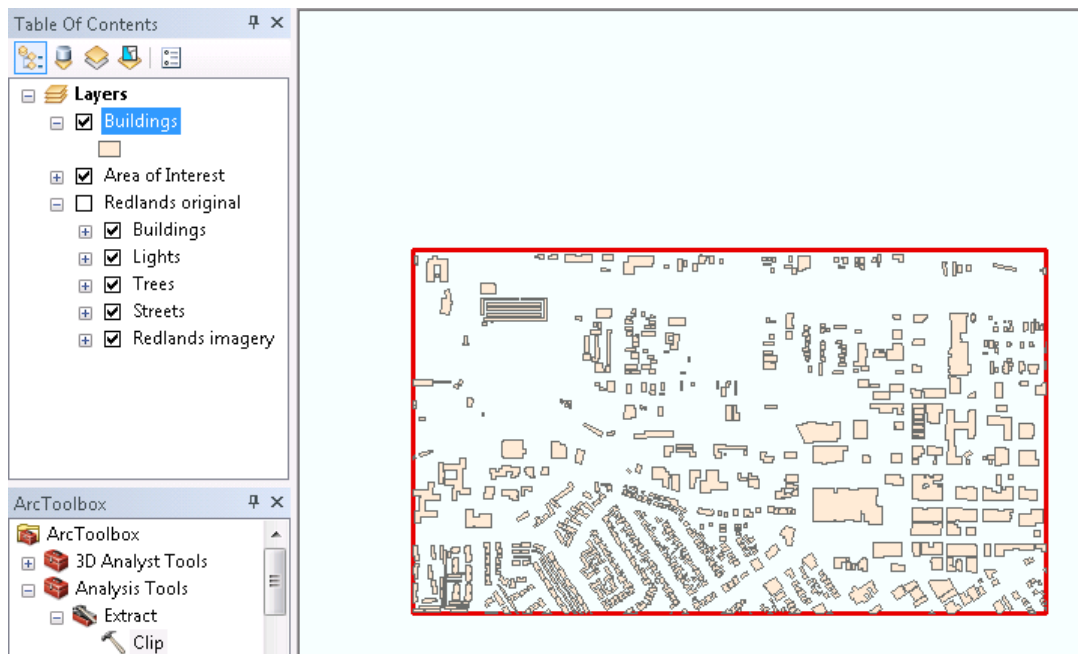


4. Double-click the **Clip** tool to open it.
5. Click the dropdown arrow for **Input Features** and select **Buildings**.

6. Use the dropdown for **Clip Features** to select **Area of Interest**.
7. Notice that the tool has entered the path to the default geodatabase and created a name for **Output Feature Class**. Change the name to just **Buildings** by backspacing over the name right in the text box.
8. Check to see that your tool settings match the image below. If so, click **OK**.



9. When the tool is finished, the new layer **Buildings** is added to the map. Turn off the **Redlands original** layer. Notice that all of the buildings are within the area of interest.



10. Use the **Clip** tool to extract subsets for the other vector layers: **Lights**, **Trees** and **Streets**.

Note: We are not going to clip the imagery in this exercise. We will wait and do that with the other raster preparation in Exercise 2.

11. Click the ArcMap **File** menu button and select **Save As**. Save it into the **Exercise1** folder and give it the name **MyExercise1.mxd**.

Exercise 2: Raster Data—Lidar and Imagery

A fundamental component of any 3D map is a detailed model of the terrain. This provides "texture" for the city scene, but also determines the vertical placement of all the ground-based GIS data: buildings, land cover, street furniture, and other installations. To obtain the level of accuracy required for realistic terrain modeling and feature placement at the street-level, high resolution classified lidar data is required.

For the purpose of terrain modeling and feature extraction, there are three basic surface types used in the 3D City models. These raster surfaces are created based on different return classifications in the lidar dataset:

Complexity:

Beginner

Data Requirement:

Installed with software

Data Path:

C:\3D_Workshop\

Goal:

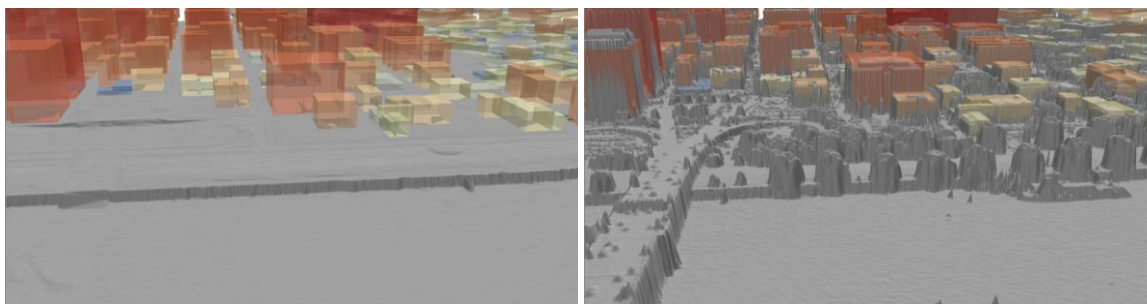
Learn how to create a terrain dataset from lidar data.

Average length of time to complete:

60 minutes

1. Digital Terrain Model (DTM)—A raster representing the elevation of the bare earth, with structures and vegetation removed. This is used as the base elevation surface in the 3D scenes (ArcGlobe, ArcScene, CityEngine). Ground return points are used.
2. Digital Surface Model (DSM)—A raster representing the elevation of all structures and natural features on the earth. The same kind of surface you'd get if you "shrink-wrapped" the landscape. First return points are used.
3. Normalized Digital Surface Model (nDSM)—This surface is used to model the height above the ground surface of structures and vegetation. The surface is derived by subtracting the DSM from the DTM.

The nDSM is the difference between a DTM and a DSM: $DTM - DSM = nDSM$.



Digital Terrain Model (left) and Digital Surface Model (right) along the riverfront with extruded building footprints

In this exercise, you will:

- Import ground lidar points into a multipoint feature class
- Create a rasterized digital terrain model using the ground-based multipoints
- Similarly, create a digital surface model
- Use these models to determine elevation values for the Buildings feature class

In this section of the course, you will learn how to create, visualize, and analyze raster datasets in ArcGIS.

Using the LAS Dataset toolbar in ArcGIS 10.2, it is a simple process to convert high resolution LAS data into these 3 surfaces: DTM, DSM, and nDSM.

Part 1: Add Lidar Ground Points Into the Map


Lidar (light detection and ranging) is a relatively new remote sensing technology allowing us to collect very dense point samples of features in 3D. [Lidar technology](#) has evolved to become a common source of geographic data in GIS. These vast collections of real-world points are typically stored in [LAS files](#). Each lidar point can have [additional attributes](#) such as intensity, class codes, and RGB color values, which can be leveraged inside ArcGIS.

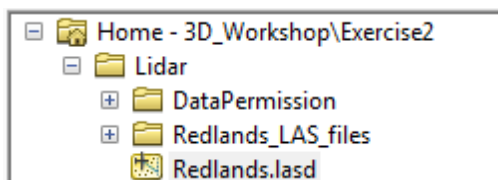
ArcGIS reads LAS files natively, providing immediate access to lidar data without the need for data conversion or import. LAS attributes can be used to filter out content and symbolize points in 2D and 3D. Also, as lidar data often comes as a group of files, ArcGIS provides the ability to define logical sets of LAS files for working in localized projects.

Steps:

1. In Windows Explorer, navigate to **C:\3D_Workshop\Exercise2**.
2. Double-click **Exercise2.mxd**.
3. If you did not do Exercise 1, make sure you have the 3D Analyst extension enabled. To do this, click the **Customize** menu, then **Extensions**. Make sure **3D Analyst** is checked on. Then click **Close**.
4. Enable the LAS Dataset toolbar. To do this, click the **Customize** menu and click on **Toolbars**. Select **LAS Dataset** from the list.
5. Drag the LAS Dataset toolbar to the top next to the Tools menu.



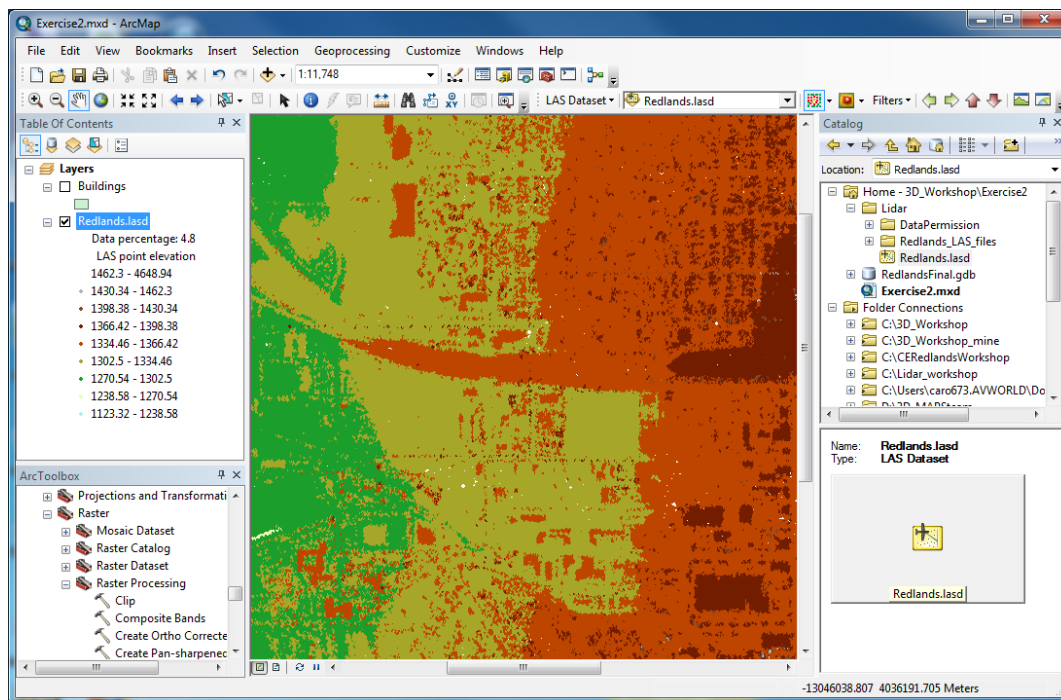
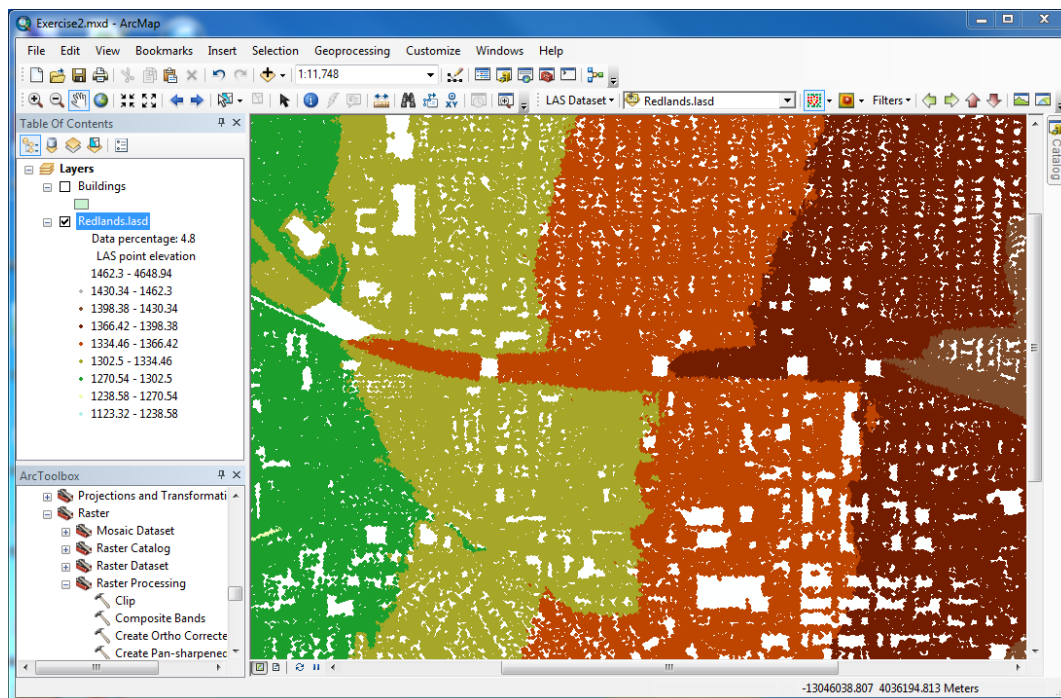
6. Open the Catalog () window (if necessary) and dock it at the right.
7. In the Catalog window, right-click on **RedlandsFinal.gdb** and select **Make Default Geodatabase**.
8. Expand the **3D_Workshop\Exercise2\Lidar** folder.



9. Drag **Redlands.lasd** to the map.


If you get a Geographic Coordinate Systems Warning, just click **Close**.

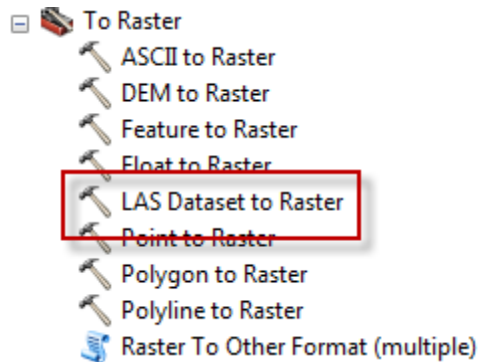
If you don't see the lidar points, but just the red LAS file extent outlines, right-click the **Buildings** layer in the TOC and choose **Zoom To Layer**.

10. Turn off the **Buildings** layer.11. On the LAS Dataset toolbar, click **Filters** and select **Ground**. Now only the ground lidar points are displayed. Click the pin at the top-right of the Catalog window to hide it, so you can see more of the map.

Part 2: Create the Digital Terrain Model

Steps:

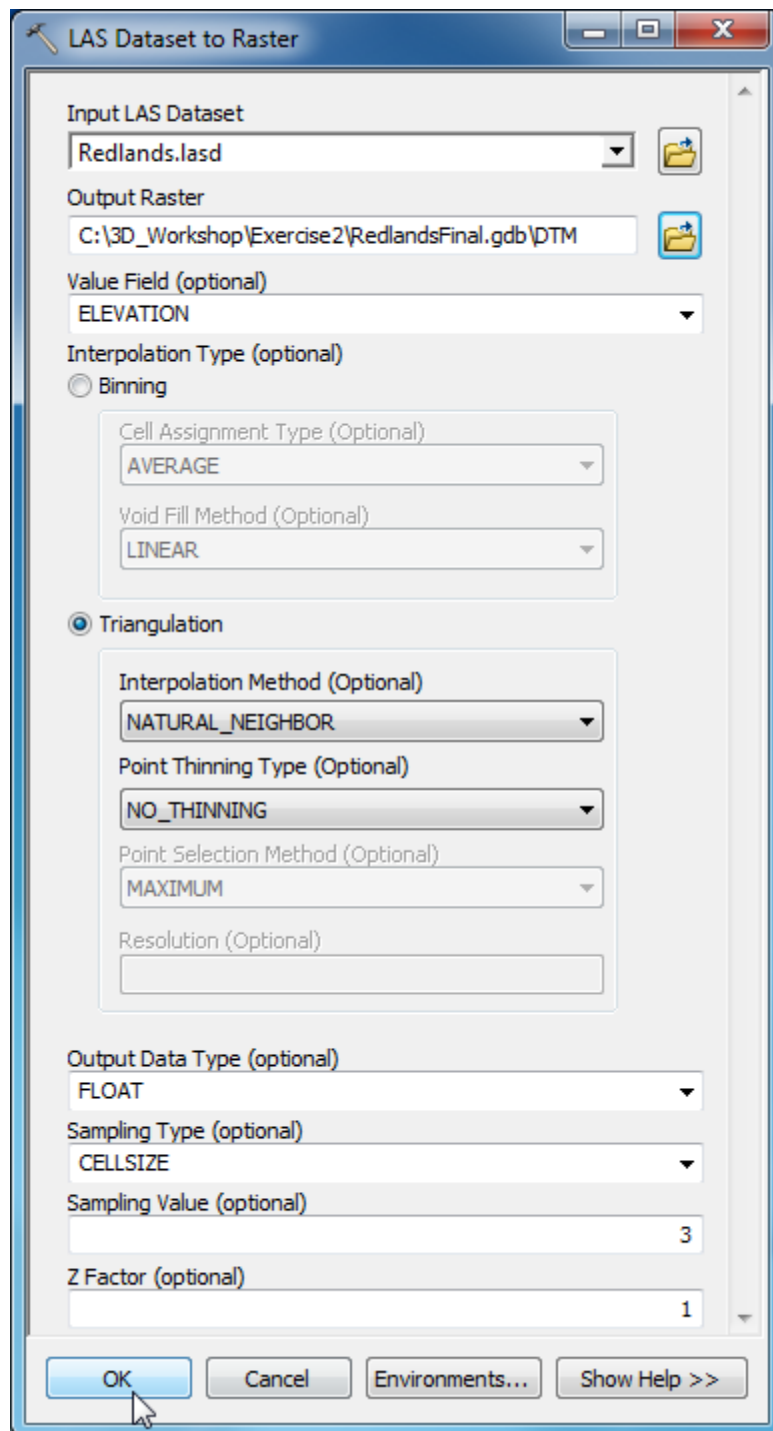
1. If not already, open the Toolbox window () and dock it under the Table of Contents.
2. In the ArcToolbox window, open **Conversion Tools > To Raster**.
3. Double-click the **LAS Dataset to Raster** tool to open it. After the tool is open, you may need to resize it so you can see all the parameters.



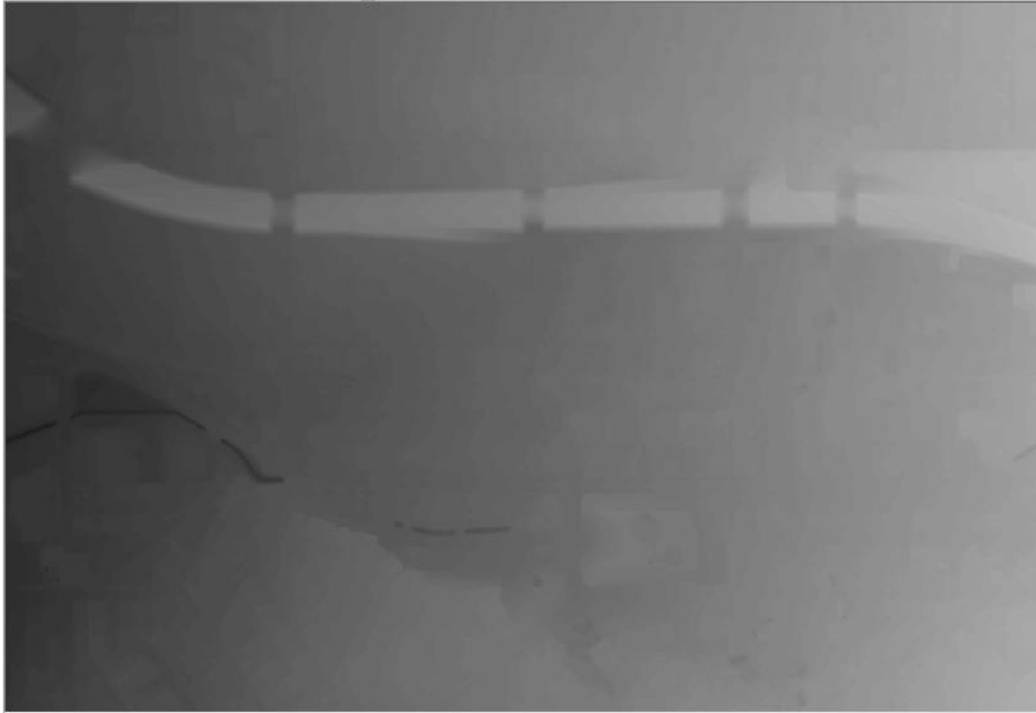
4. On the tool dialog, use the dropdown for **Input LAS Dataset** and select **Redlands.lasd**.
5. For **Output Raster**, change the name provided to **DTM**.
6. Ensure that the **Value Field** is set to **ELEVATION**.
7. Click the radio button for **Triangulation**.
8. Set **Interpolation Method** to **NATURAL_NEIGHBOR**.
9. **Point Thinning Type** should be set to **NO_THINNING**.
10. Change **Sampling Value** to **3**. (This is approximately two times the point spacing of the data.)

11. If your tool looks like the graphic below, click **OK** to run the tool.

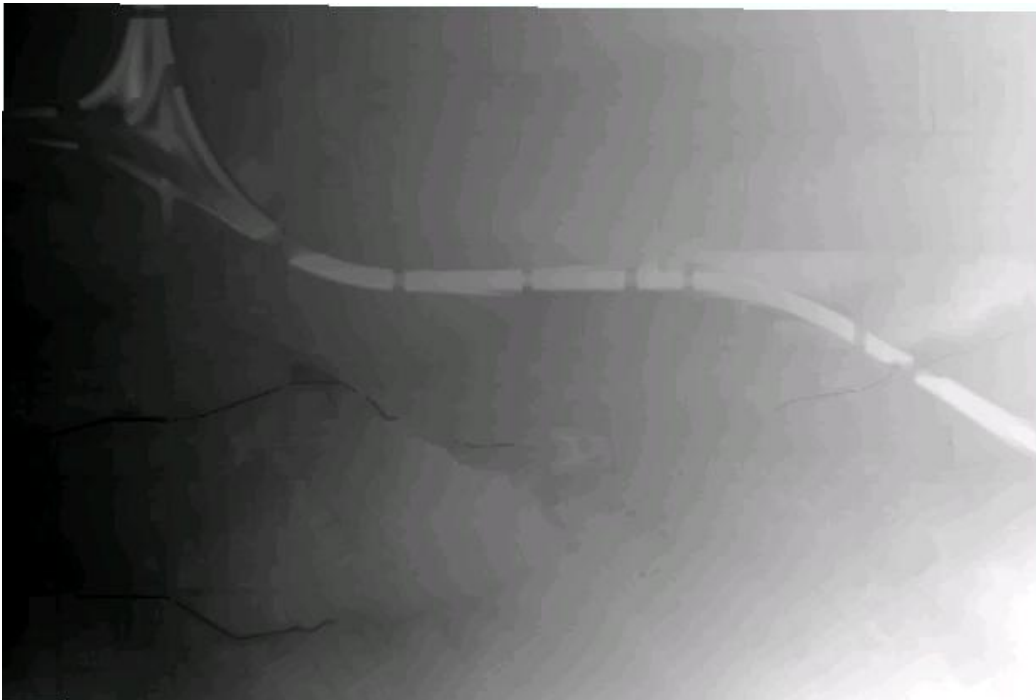
*And please be patient, as it can take a couple minutes to complete.



12. When the tool has completed, the surface is added to the map. Turn off the **Redlands.lasd** layer so you can see the **DTM** layer. It should look like this:



Note that you are viewing only the extent of the Buildings layer. To see the entire DTM, click the **Full Extent** button (🌐).



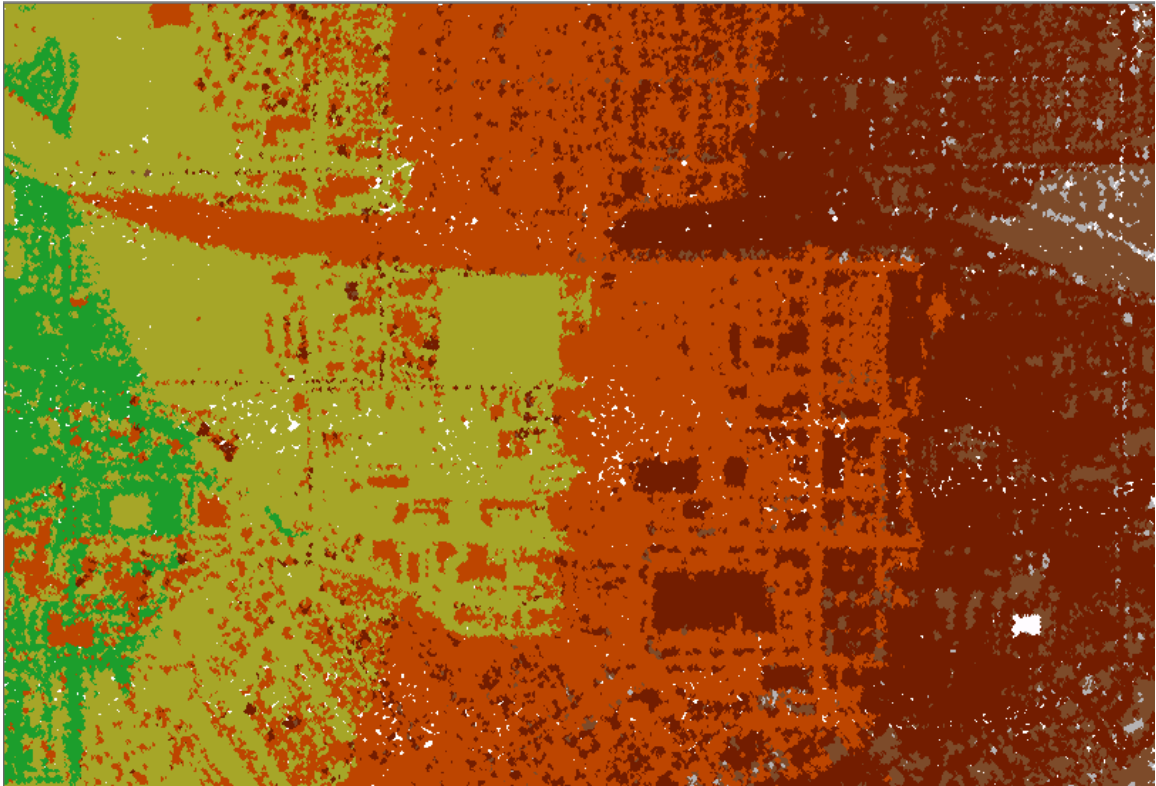
Now click the **Go Back To Previous Extent** button (↩).


Part 3: Create the Digital Surface Model

Before creating the Digital Surface Model we need to change the display of the lidar on the map. We used ground points for the terrain; we will use the first returns (highest points) for the surface model.

Steps:

1. An easy way to turn on one layer and turn off all other layers in the TOC is as follows: while pressing the **Alt** key on your keyboard, click the check box next to the layer you want to be on. Do this now for the **Redlands.lasd** layer.
2. On the LAS Dataset toolbar, click **Filters** and select **First Return**.



Notice the difference in the display of the lidar? Open the 3D View () window to look at the lidar. (Note: There are a few noise points that have not been tagged as such that will appear in the first return.)

3. Open the **LAS Dataset to Raster** tool again.

- Set the parameters of the tool as follows:

Input LAS Dataset: Redlands.lasd

Output Raster: C:\3D_Workshop\Scratch_Workspace\Scratch_Database.gdb\DSM

Value Field: ELEVATION

Binning:

Cell Assignment Type: MAXIMUM

Void Fill Method: NATURAL_NEIGHBOR

Sampling Value: 3

Interpolation Type (optional)

The interpolation method used to produce the raster.

BINNING—Cell values are obtained using the points that fall in the extent of the cell, with the exception of cells that do not contain points in their extent. The following options are available for this technique:

- **Cell Assignment Type**—Method used to define the value for any cell that contains points within its extent.
 - AVERAGE—Assigns the average value of all points in the cell. This is the default.
 - MINIMUM—Assigns the minimum value found in the points within the cell.
 - MAXIMUM—Assigns the maximum value found in the points within the cell.
 - IDW—Uses Inverse Distance Weighted interpolation to determine the cell value.
 - NEAREST—Uses Nearest Neighbor assignment to determine the cell value.
- **Void Fill Method**—The interpolation method used to define values for cells that do not have points within their extent.
 - NONE—NoData is assigned to the cell.
 - SIMPLE—Averages the values from data cells immediately surrounding a NoData cell to eliminate small voids.
 - LINEAR—Triangulates across void areas and uses linear interpolation on the triangulated value to determine the cell value. This is the default.
 - NATURAL_NEIGHBOR—Uses natural neighbor interpolation to determine the cell value.

Note: if you want to know the difference between the Binning and Triangulation methods, click the **Show Help** button on the tool and click on Binning, or anywhere in the Interpolation Type section.

- Click **OK** to run the tool.

6. Turn off the lidar layer so you can see the **DSM**.

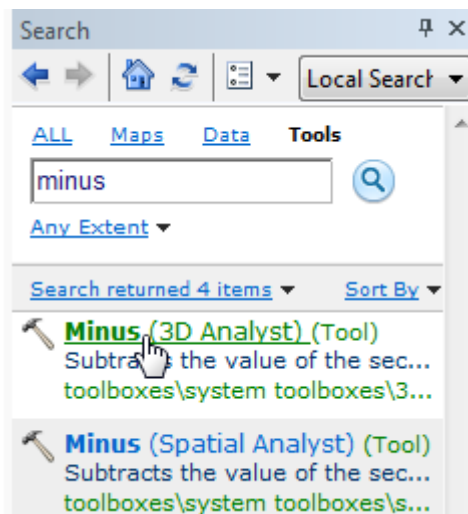


Part 4: Create the Normalized Digital Surface Model

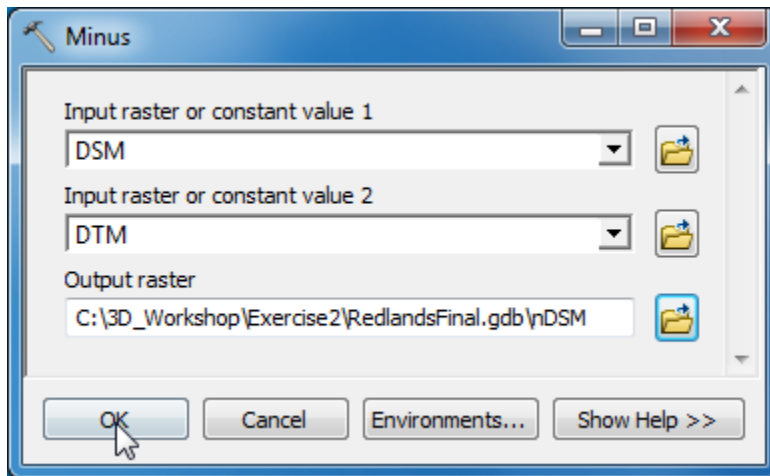
The next step is to Subtract the Ground Terrain Model from the First Return Surface Model to create a Normalized Digital Surface Model (nDSM).

Steps:

1. The easiest way to find the Minus tool is to open the **Search** (🔍) window, click the **Tools** link, type **minus** and then press the **Enter** key.
2. Click the **Minus (3D Analyst)** tool.



3. Use the dropdown for **Input raster or constant value 1** and select **DSM**.
4. Use the dropdown for **Input raster or constant value 2** and select **DTM**.
5. Change the **Output raster** name to **nDSM**.
6. Click **OK** to run



The resulting raster should look like this:



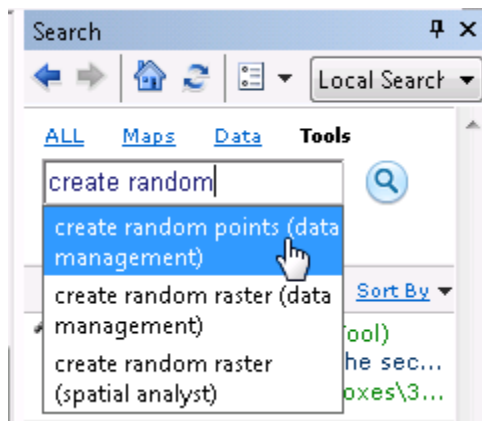
7. Save the map document (**File > Save As**) to **3D_Workshop\Exercise2\MyExercise2.mxd**

Part 5: Determine the Elevation of the Buildings

Now that you have an elevation layer, you will need to determine the elevation of your buildings by sampling at random locations. The first step is to generate a set of random sample points for each building footprint. We will use the Create Random Points geoprocessing tool to generate a set of random sample points in your building footprints.

Steps:

1. Turn off all layers except for Buildings.
2. Find and open the **create random points (data management)** tool from the **Search** window.



(Or locate the tool in the Data Management Tools > Feature Class toolbox.)

3. Set the following tool parameters:

Output Location: this should be set to the default database.

Output Point Feature Class: *Random_Points* (type this directly into the box.)

Constraining Feature Class: **Buildings** (use dropdown)

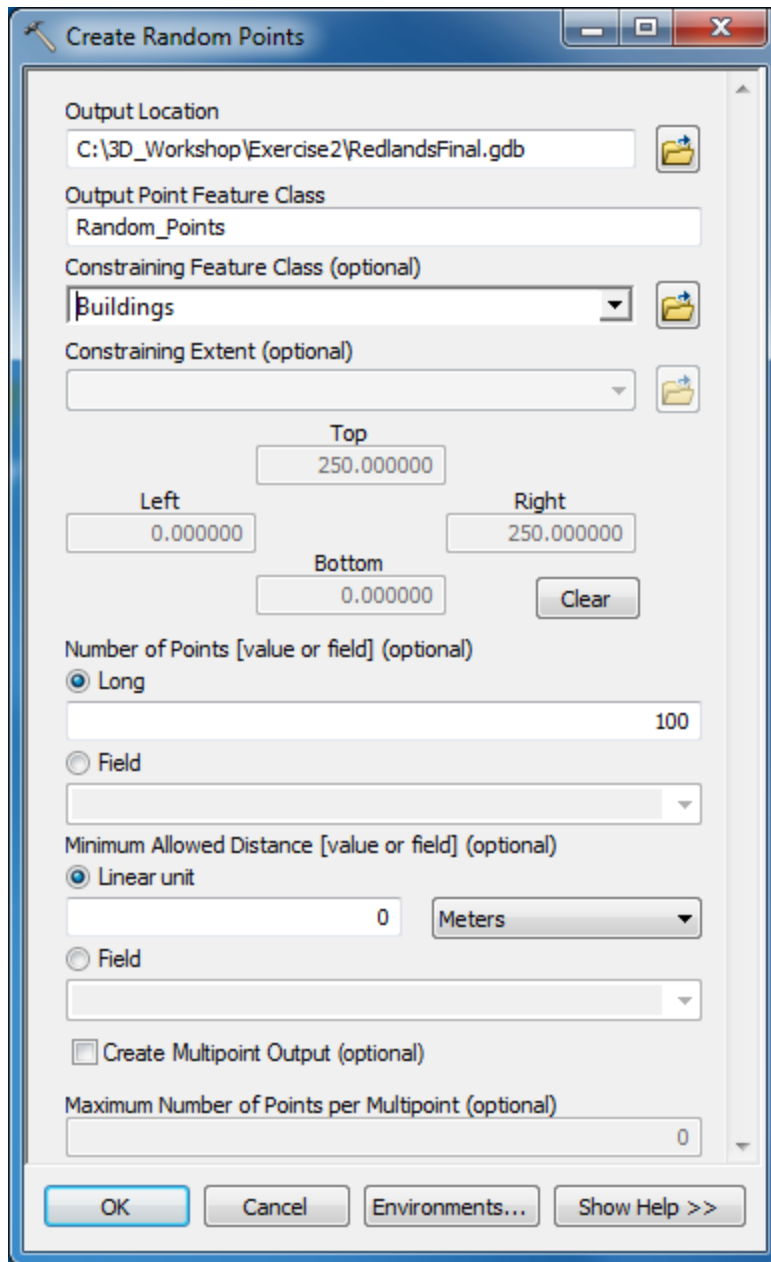
Number of Points:

Long radio button on, value = **100**

Minimum Allowed Distance:

Linear unit button on, units set to **Meters**

Note: When deciding how many random points to generate, remember that the more sample points you have, the more accurate your average height will be, but the longer your processing time is.

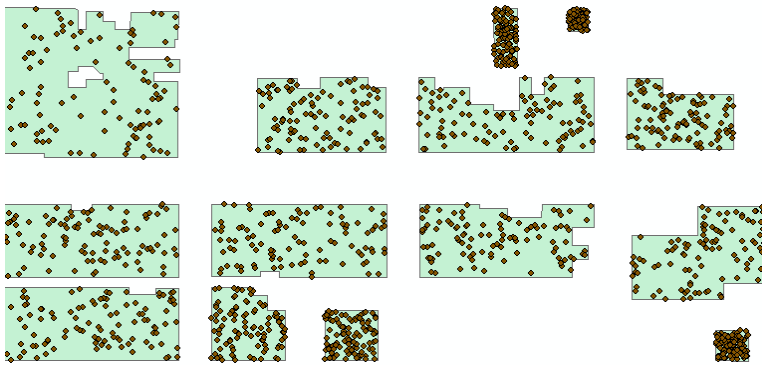


4. Click **OK** to run.

The result is a new feature class containing groups of points, one group for each building. Note that each building may not have the total number of sample points you specified in the geoprocessing tool. The tool stops creating points when it cannot place a new point without violating your parameters.



5. Zoom into some buildings.



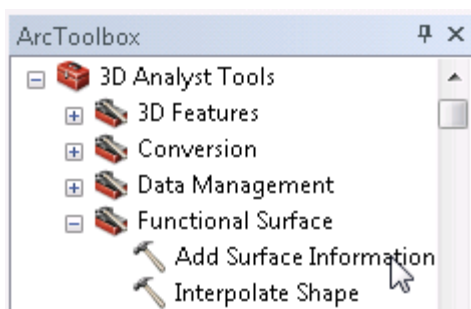
Random point placement in each building might differ from illustrated. The key value we are capturing per point is the average elevation for each building, so a point's exact xy location on a building footprint is not as important.

Part 6: Add Elevation Values to the Random Points

Elevation information from your Normalized Digital Surface Model (nDSM) raster elevation surface can be added to each point as an attribute using the Add Surface Information geoprocessing tool.

Steps:

1. In the ArcToolbox window, navigate to **3D Analyst Tools > Functional Surface** and double-click **Add Surface Information**.



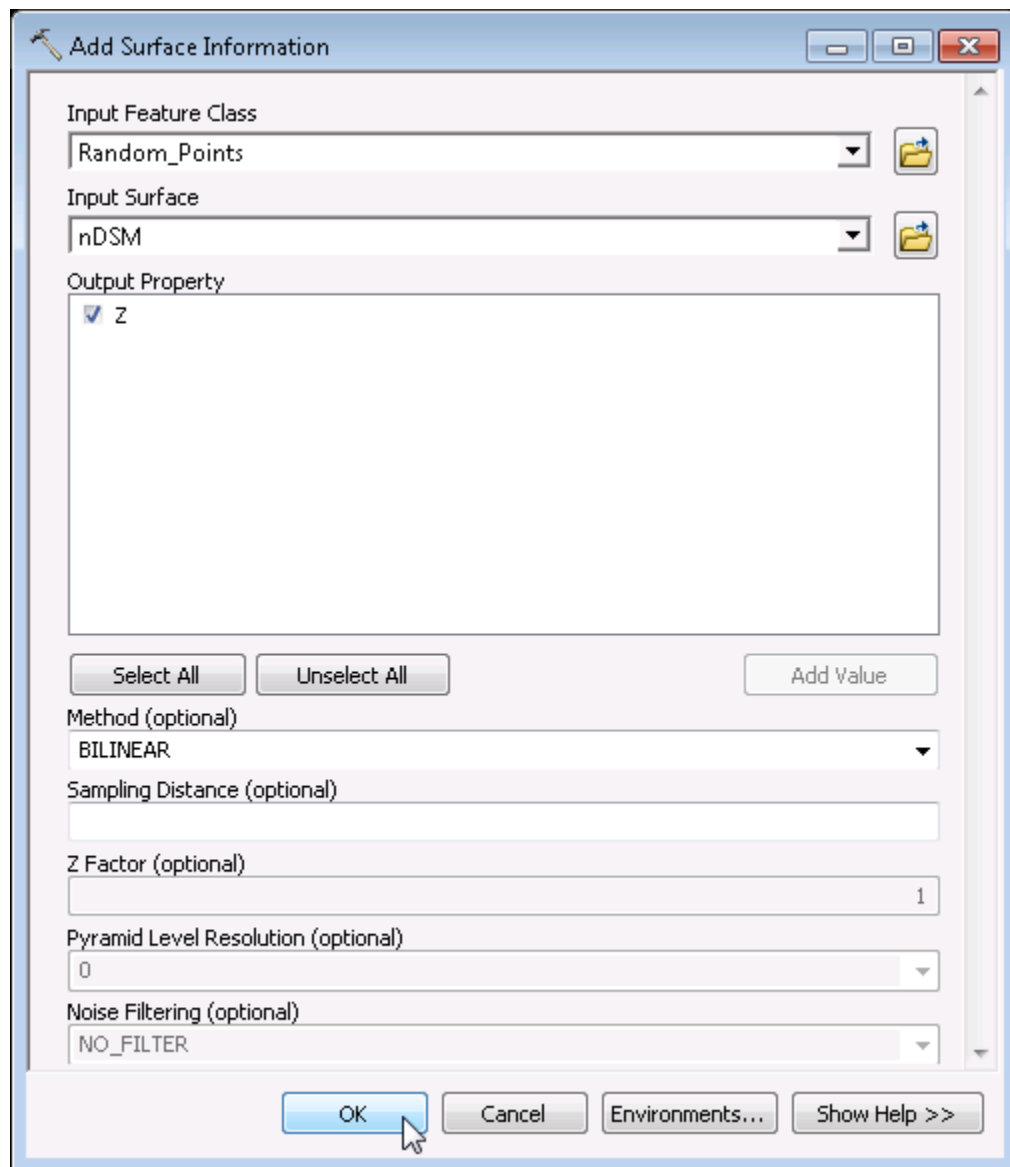
2. Set the following parameters:

Use the dropdown for **Input Feature Class** to select **Random_Points**.

Use the **Input Surface** dropdown to select **nDSM**.

Under **Output Property**, check on the box for **Z**.

Leave the defaults for everything else and click **OK** to run.



Now that all the random points in each building have an elevation, or Z value, we want to get the average, or mean elevation for each building. We'll use the Summary Statistics tool for that.

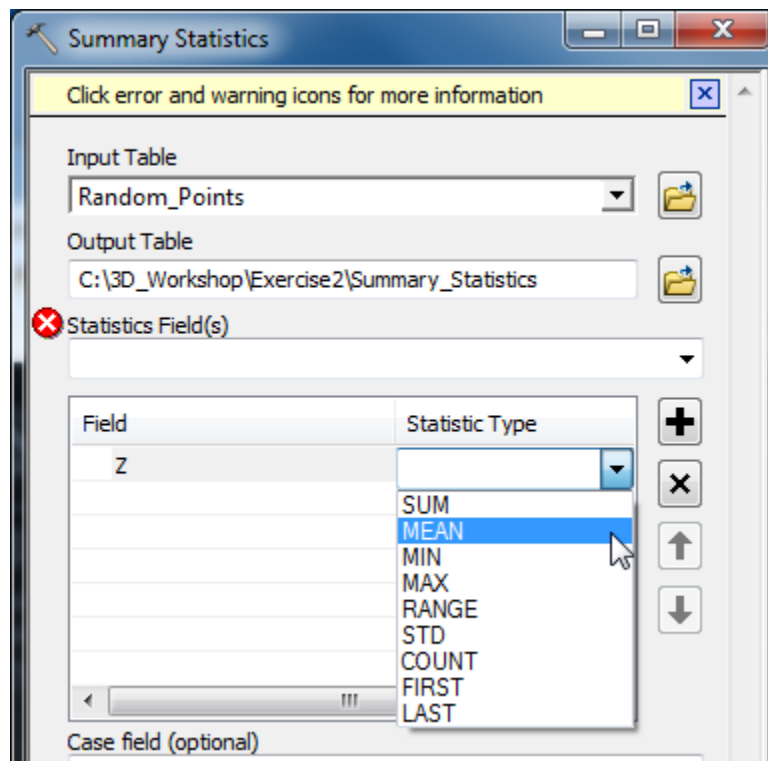
3. From the ArcToolbox window, open **Analysis Tools > Statistics > Summary Statistics**.
4. Set the following parameters:

Use the dropdown for **Input Table** to select **Random_Points**.

Use the **Output Table** browse button to navigate into the Exercise 2 folder. Type **Summary_Statistics** for **Name**. then click **Save**.

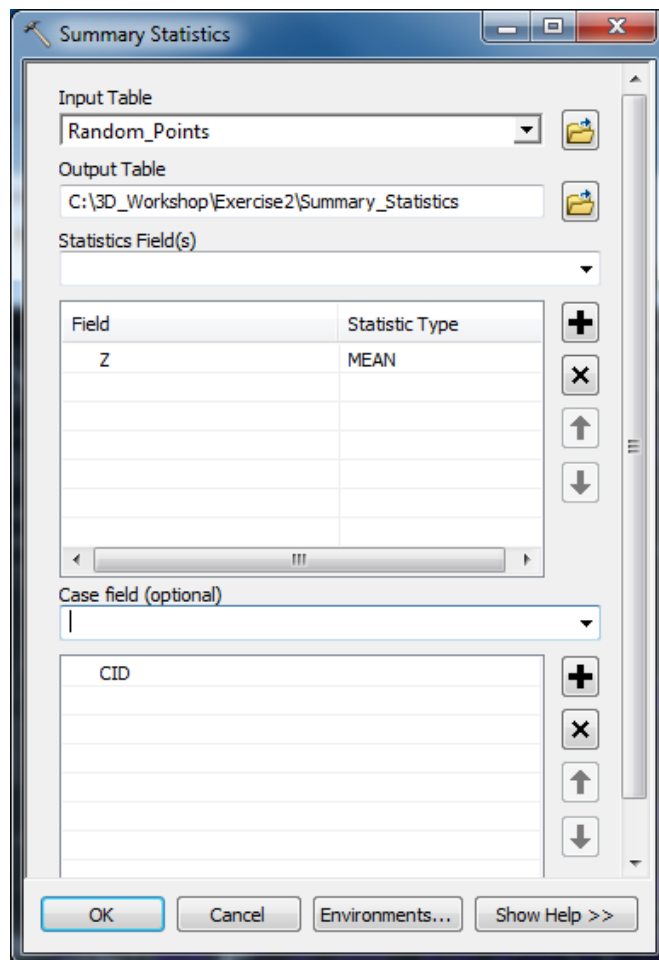
For **Statistics Fields**, use the dropdown to select **Z**. Do not be alarmed when you get an error message! This will go away as soon as you set the Statistic Type to MEAN.

Click in the white space below **Statistic Type** to enable the dropdown and select **MEAN**.



Use the dropdown for **Case field** to select **CID**.

Click **OK** to run.



- When the tool is complete, it automatically changes the TOC view and highlights the table. Right-click the table and select **Open** (resize if necessary.) It should look like this, but you will have different MEAN_Z values.

Rowid	OID	CID	FREQUENCY	MEAN_Z
1	0	1	100	10.16177
2	0	2	100	13.314908
3	0	3	100	14.229366
4	0	4	100	9.40532
5	0	5	100	6.465626
6	0	6	100	12.73944
7	0	7	100	9.245452
8	0	8	100	17.780616

(0 out of 741 Selected)

6. Close the table.

Now we want to attach the Mean_Z values generated for the random points to the Buildings feature class. To do this we will use the Join function. Resize the windows if needed.

7. In the TOC, right-click **Buildings** and select **Open Attribute Table**. Dock the table at the bottom. Scroll all the way to the right to see the fields.
8. Right-click **Buildings** again, hover over **Joins and Relates**, and then select **Join**.
9. Fill out the **Join Data** tool as in the following graphic and then run it:

Join Data

Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.

What do you want to join to this layer?

Join attributes from a table

1. Choose the field in this layer that the join will be based on:

OBJECTID_12

2. Choose the table to join to this layer, or load the table from disk:

Summary_Statistics

☒ Show the attribute tables of layers in this list

3. Choose the field in the table to base the join on:

CID

Join Options

☒ Keep all records
All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.

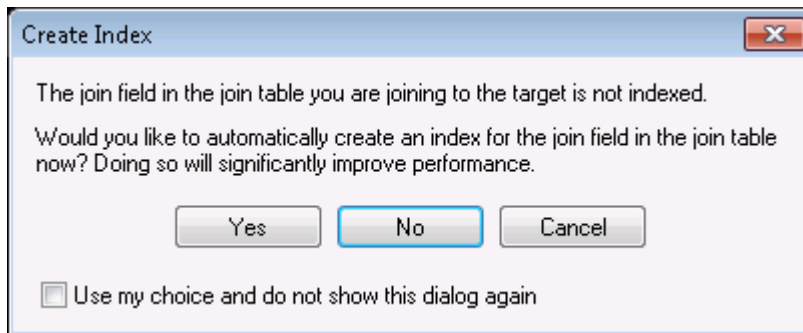
☐ Keep only matching records
If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.

Validate Join

[About joining data](#)

OK Cancel

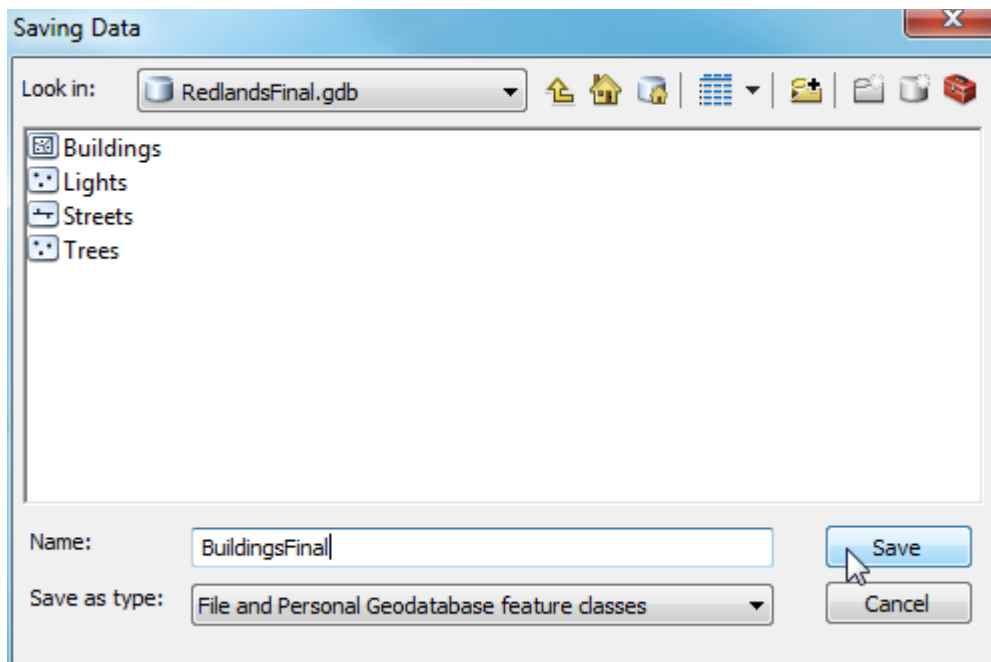
If you get this message, click **No**:



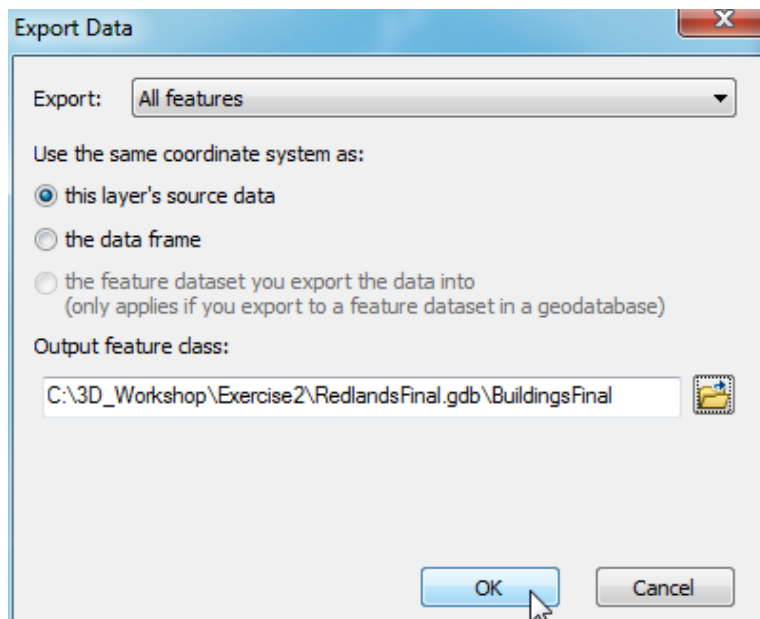
You will see in the attribute table that the new fields were joined.

To permanently join the new fields into the Buildings layer, we need to create a new feature class in the file geodatabase.

10. In the TOC, right-click **Buildings** and then choose **Data > Export Data**.
11. In the **Export Data** dialog, click the browse button for the **Output feature class**.
12. In the **Saving Data** dialog, navigate into your **RedlandsFinal.gdb** if not already there. For **Name**, type **BuildingsFinal**, then click **Save**.




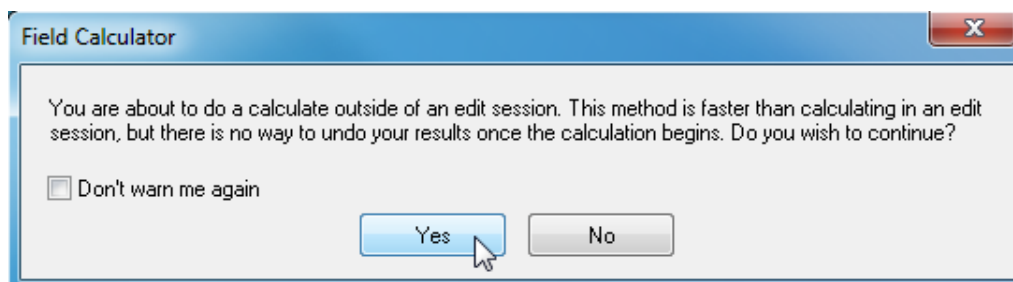
13. On the **Export Data** dialog, click **OK**.



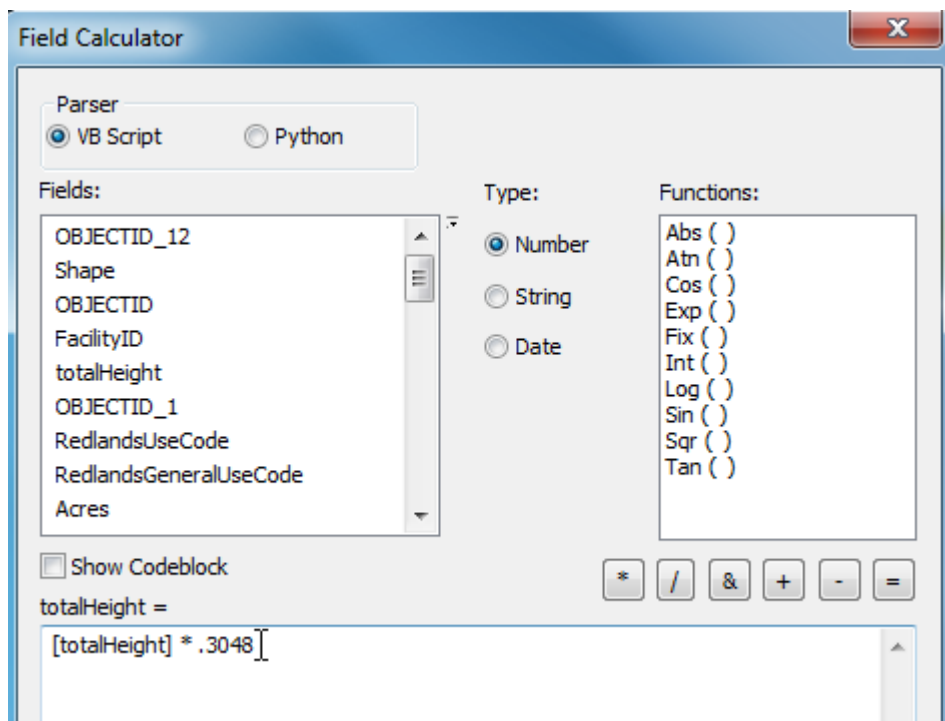
When asked if you want to add the exported data to the map as a layer, click **No**.

Now that the Building footprint layer has an elevation field, we need to make two more changes to it so that it meets CityEngine's data requirements. The CityEngine rule that we will use to generate the 3D buildings expects a field named **totalHeight** with data values in metric units. We can simply change the name of the **MEAN_Z** field, then convert the units from feet to meters.

14. In the **Catalog** window, open **RedlandsFinal.gdb**. Right-click the **BuildingsFinal** feature class and select **Properties**.
15. On the **Feature Class Properties** dialog, click on the **Fields** tab.
16. Find the **MEAN_Z** field name. Change it to **totalHeight** by highlighting the name with the cursor and typing. Click **OK** to dismiss the dialog.
17. Drag **BuildingsFinal** from the Catalog window to the map.
18. In the TOC, right-click **BuildingsFinal** and choose **Open Attribute Table**.
19. In the **Table** window, click the Table Options menu () If **Show Field Aliases** is checked on, click it to turn it off.
20. Locate the **totalHeight** field in the **BuildingsFinal** table. Right-click the name and select **Field Calculator**. Click **Yes** on the dialog to continue.



21. On the Field Calculator, double-click the **totalHeight** field to add it to the equation. Then click the multiply symbol (*), then type in **.3048**.



22. Save the map document into the Exercise2 folder as **MyExercise2.mxd**.

Note: When you move on to Exercise 3, you will use a file geodatabase that has already been prepared in this manner. In that one, the BuildingsFinal feature class has been renamed to simply Buildings.

Part 7: Clip the Raster Imagery to the Area of Interest and Save in .tif Format

CityEngine requires (at version 2012.1) that imagery be formatted in either .tif or .jpg formats. When we created our surface models we placed them into a file geodatabase. Now we are going to reformat the DTM surface and clip it to the area of interest. This DTM will be used as the Heightmap when we create a terrain in CityEngine. Then we'll do the same with the Redlands orthoimagery that you saw in Exercise 1, and use it as the Texture file for the terrain.

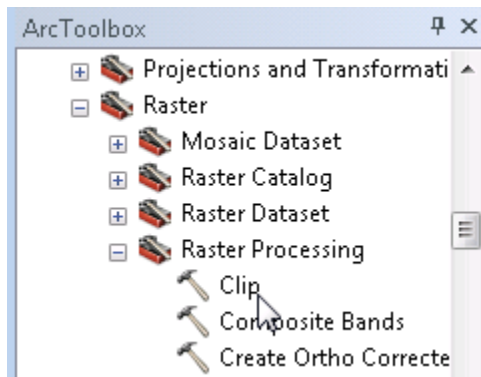
When clipped the vector data in Exercise 1 we placed the results into a file geodatabase. When we clip the imagery layers, we will create output files in the .tif format, not in the file geodatabase.

We will use the raster version of the Clip tool.

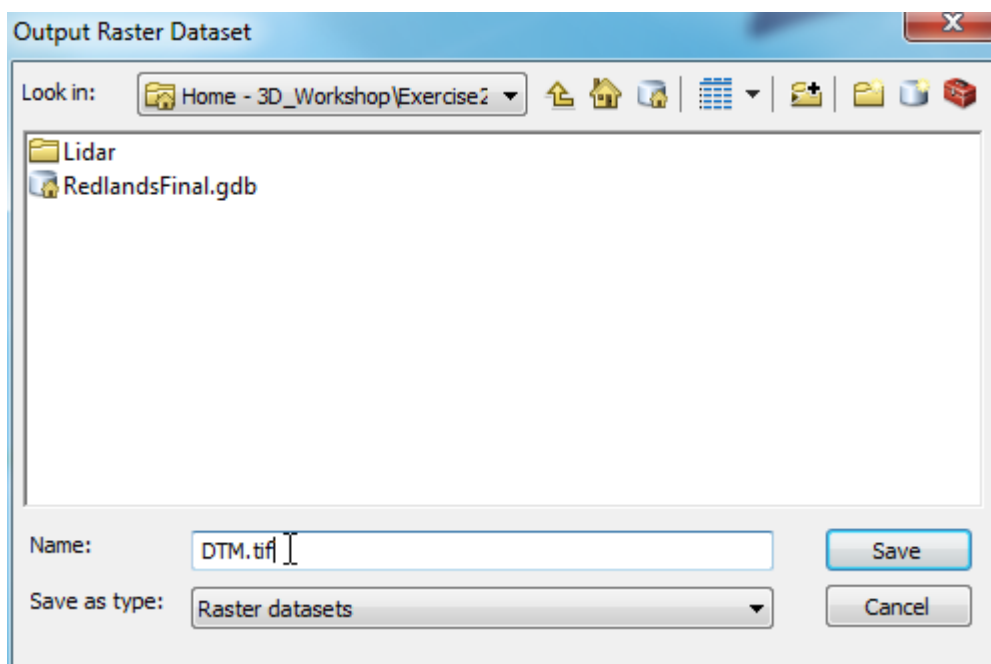
Steps:

1. In the ArcToolbox window, expand the **Data Management Tools > Raster > Raster Processing** toolboxes.

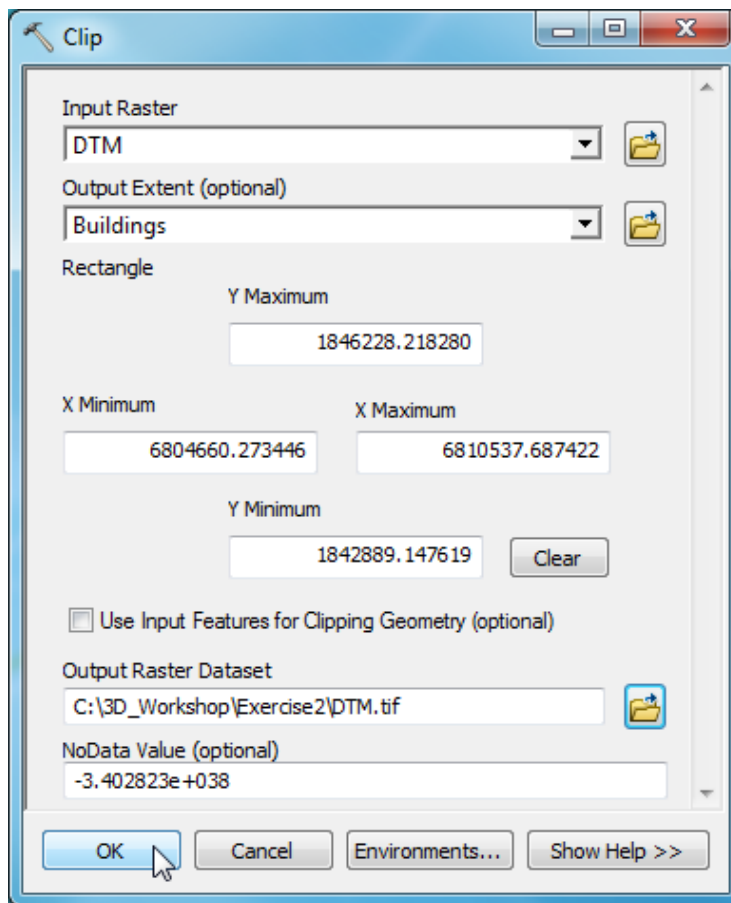
2. Double-click the **Clip** tool.



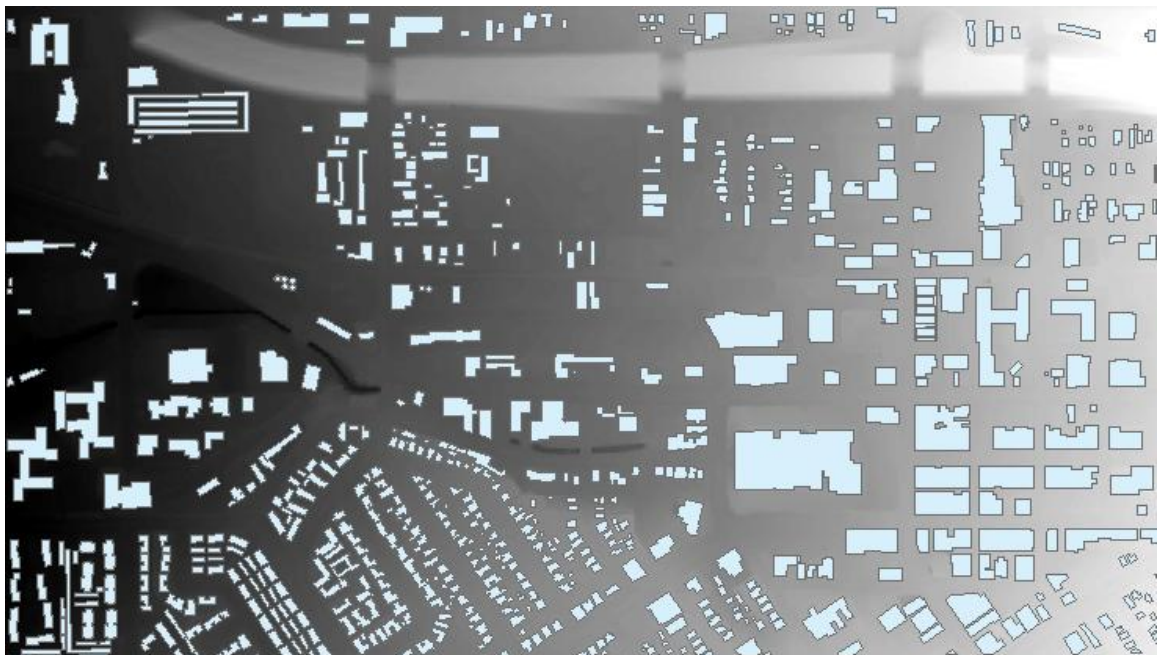
3. Use the dropdown for **Input Raster** and select **DTM**.
4. Use the dropdown for **Output Extent** and select **Buildings**.
5. The location for **Output Raster Dataset** will default to your default geodatabase. Because we want to create a .tif file, we don't want to put it into the geodatabase. For **Output Raster Dataset**, click the browse button. Make sure you are in the Exercise2 folder. Type the name **DTM.tif** and then click **Save**.



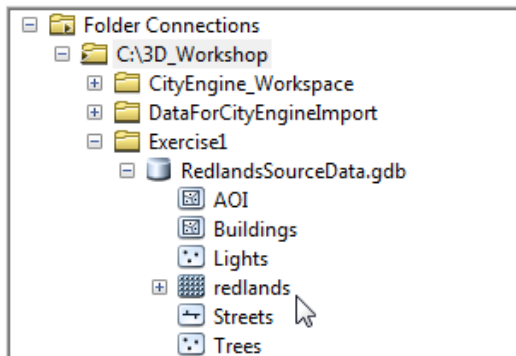
6. Compare your tool with the graphic below, then click **OK**.



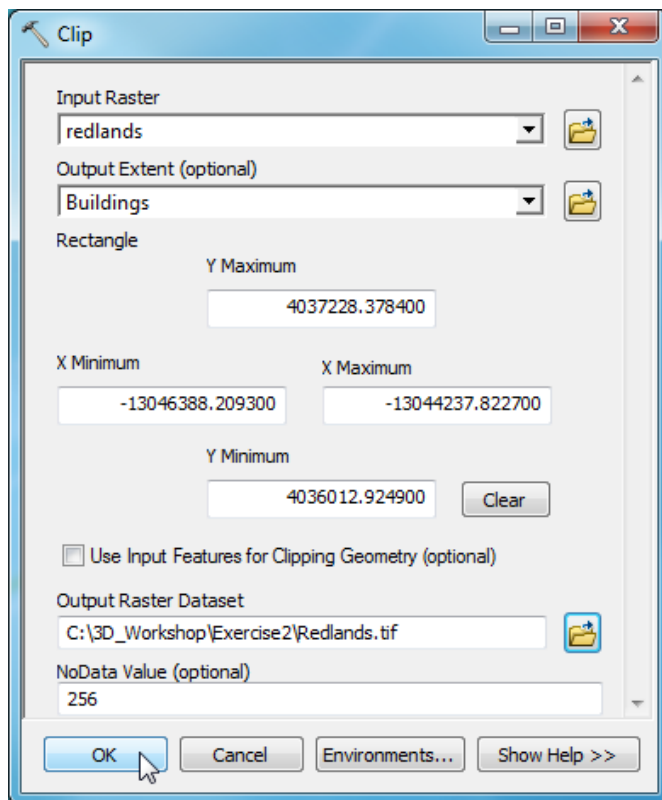
7. After the tool completes, the DTM.tif is added to the map. If you look at it with the Buildings layer on, it will look like this:



8. In the Catalog window, expand **3D_Workshop\Exercise1\RedlandsSourceData.gdb**. Drag the **redlands** raster to the map.



9. Open the **Clip** tool again.
10. Use the dropdown for **Input Raster** and select **redlands**.
11. Set the **Output Extent** to **Buildings**.
12. Click the browse button, make sure you are in the Exercise2 folder, and type the name **Redlands.tif**. Click **Save**.
13. Click **OK** to run the tool.



14. Save the map document.

Exercise 3: Working with CityEngine

CityEngine is a standalone software product that provides professional users in defense, entertainment, architecture, urban planning, GIS and general 3D content production with a unique conceptual design and modeling solution for the efficient creation and maintenance of 3D cities.

More specifically, you can use CityEngine to:

- Efficiently create 3D cities based on your existing 2D/3D GIS data
- Maintain (modify / update) 3D city data
- Do conceptual city design in 3D based on GIS data and urban planning rules
- Share 3D CityEngine scenes via the CityEngine Web Viewer on ArcGIS Online (browser-based, no plugin required)

Complexity:
Beginner

Data Requirement:
Installed with software

Data Path:
C:\3D_Workshop\

Goal:
Learn the basics of 3D mapping with CityEngine

Average length of time to complete:
60 minutes

Exercise 3a: Create a Scene and Apply Rules

Part 1: Create a CityEngine Project

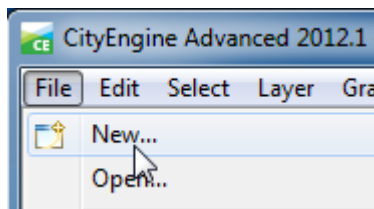
The main component of CityEngine is the project. When you create a new project, CityEngine creates a set of folders that will contain all the data, rules, models and other information for the project.

Steps:

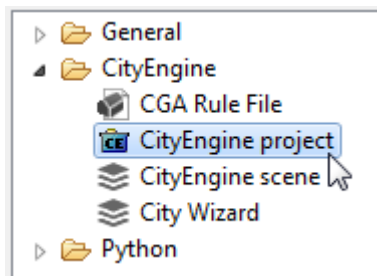
1. Open CityEngine. Click **Launch** to dismiss the Welcome Wizard and start the application.

Note: It takes a while for the software to launch for the first time. If you get the Welcome Wizard again you can close it by clicking the x in the upper right corner.

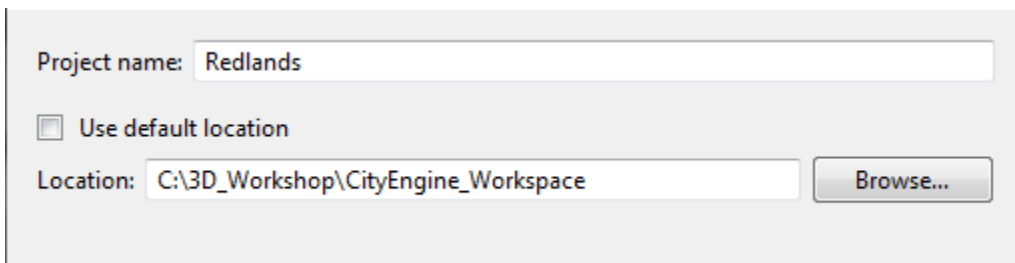
2. Click **File** and select **New**.



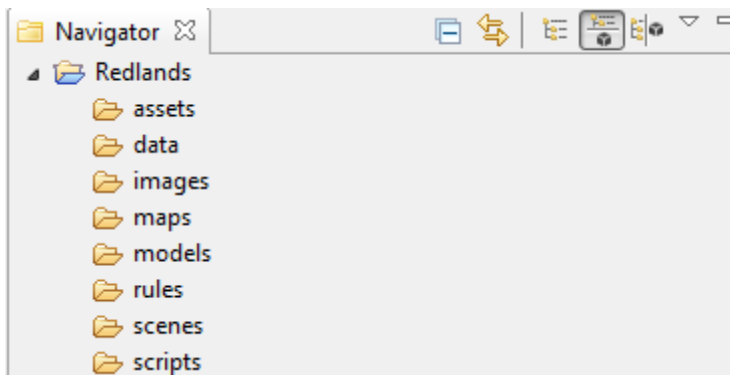
3. In the **Select a wizard** dialog, open the **CityEngine** folder, click on **CityEngine project**, then **Next**.



4. For **Project name**, type **Redlands**.
5. Uncheck the box for **Use default location**.
6. Click the **Browse** button and then open **C:\3D_Workshop**. Select **CityEngine_Workspace** and click **OK**.



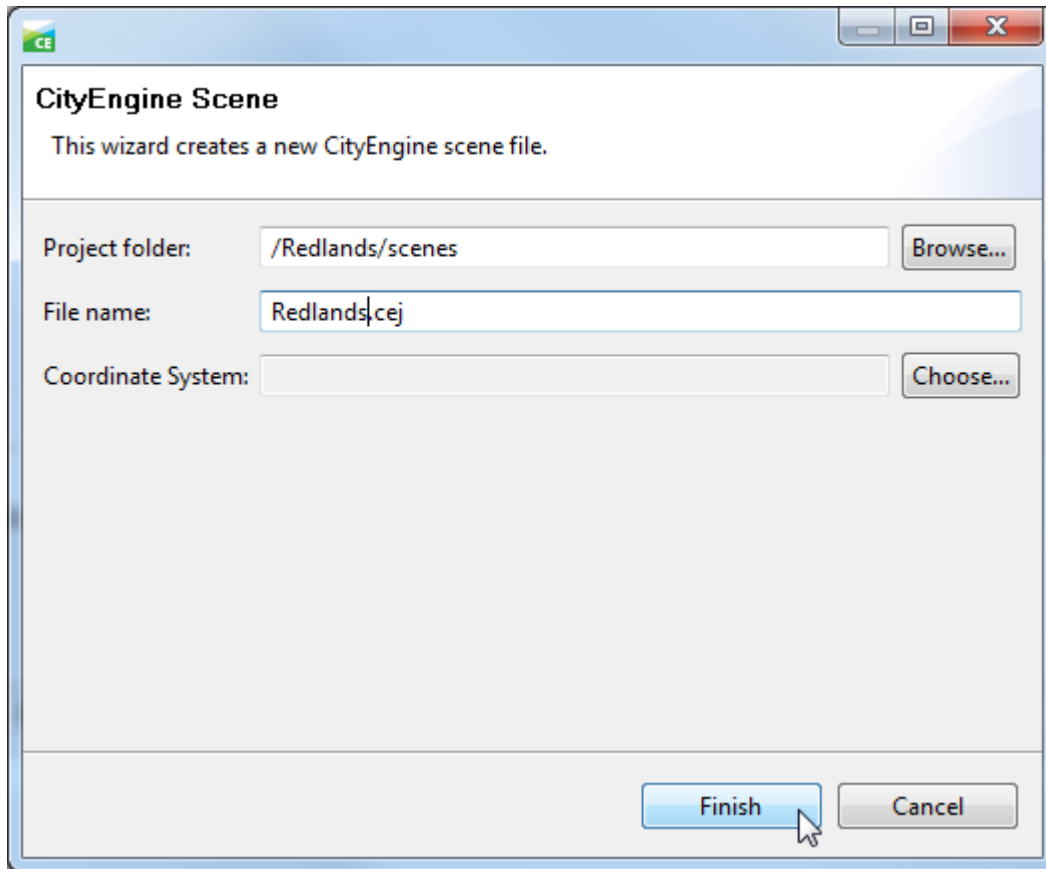
7. Click **Finish** to create the project.
8. Look at the CityEngine **Navigator** window. You will see your new project with many folders under it.



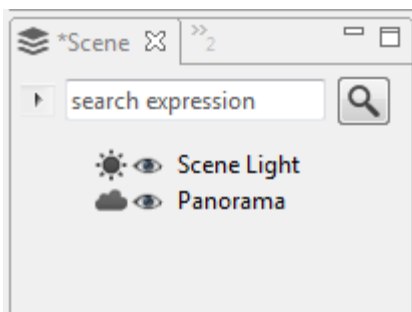
9. Now that you have a project, you need to create a scene. Right-click the **scenes** folder and select **New > CityEngine scene**.

Note: you could also use File > New to open the wizard, but starting from the scenes folder saves you from browsing to the proper Project folder.

10. In the **CityEngine Scene** dialog box, change the **File name:** to **Redlands.cej**. It is important to keep the .cej extension in the name.
11. Click **Finish**.



12. Now look at your CityEngine **Scene** window. It has two layers, **Scene Light** and **Panorama**.

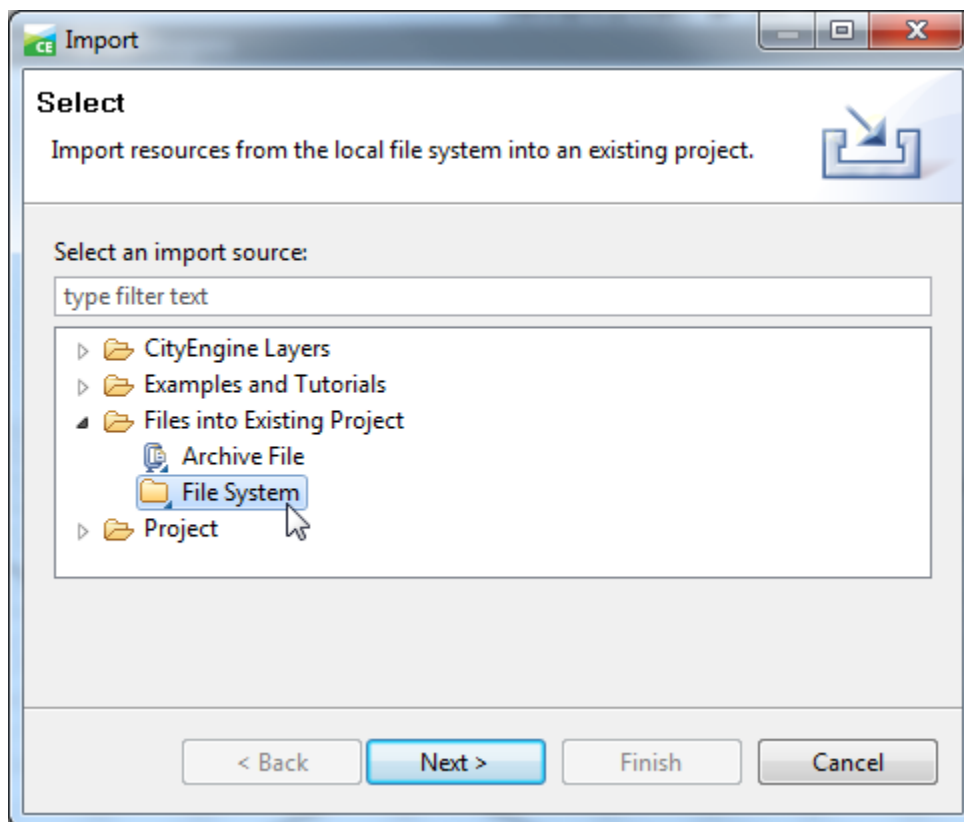


Part 2: Add Data to the Project

If you worked through Exercises 1 and 2, your resulting data could be used here. But we have provided data for you that has already been clipped and formatted. The file geodatabase and the tiff files are in the **C:\3D_Workshop\DataForCityEngineImport** folder. You will add them to the scene in the following steps.

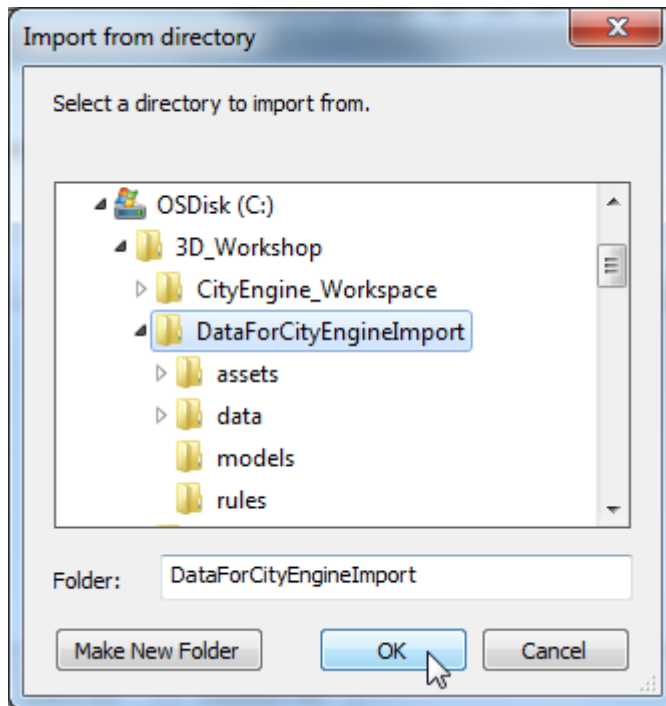
Steps:

1. In the Navigator window, right-click the **Redlands** folder and select **Import**.
2. On the Import wizard, expand **Files into Existing Project**, highlight **File System**, then click **Next**.

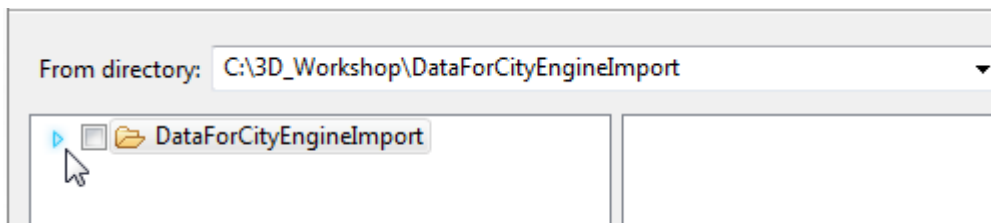


3. On the **File system** dialog, click the browse button for **From directory**:

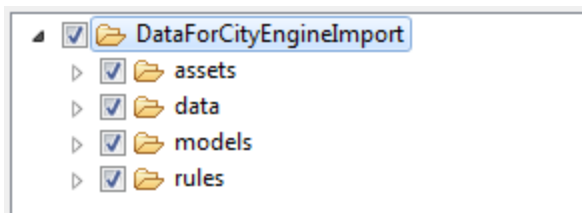
- On the **Import from directory** dialog box, open the **C:\3D_Workshop** folder, click on **DataForCityEngineImport** to select it and then click **OK**.



- On the **File system** dialog, click the arrow to the left of the checkbox to expand the folders.

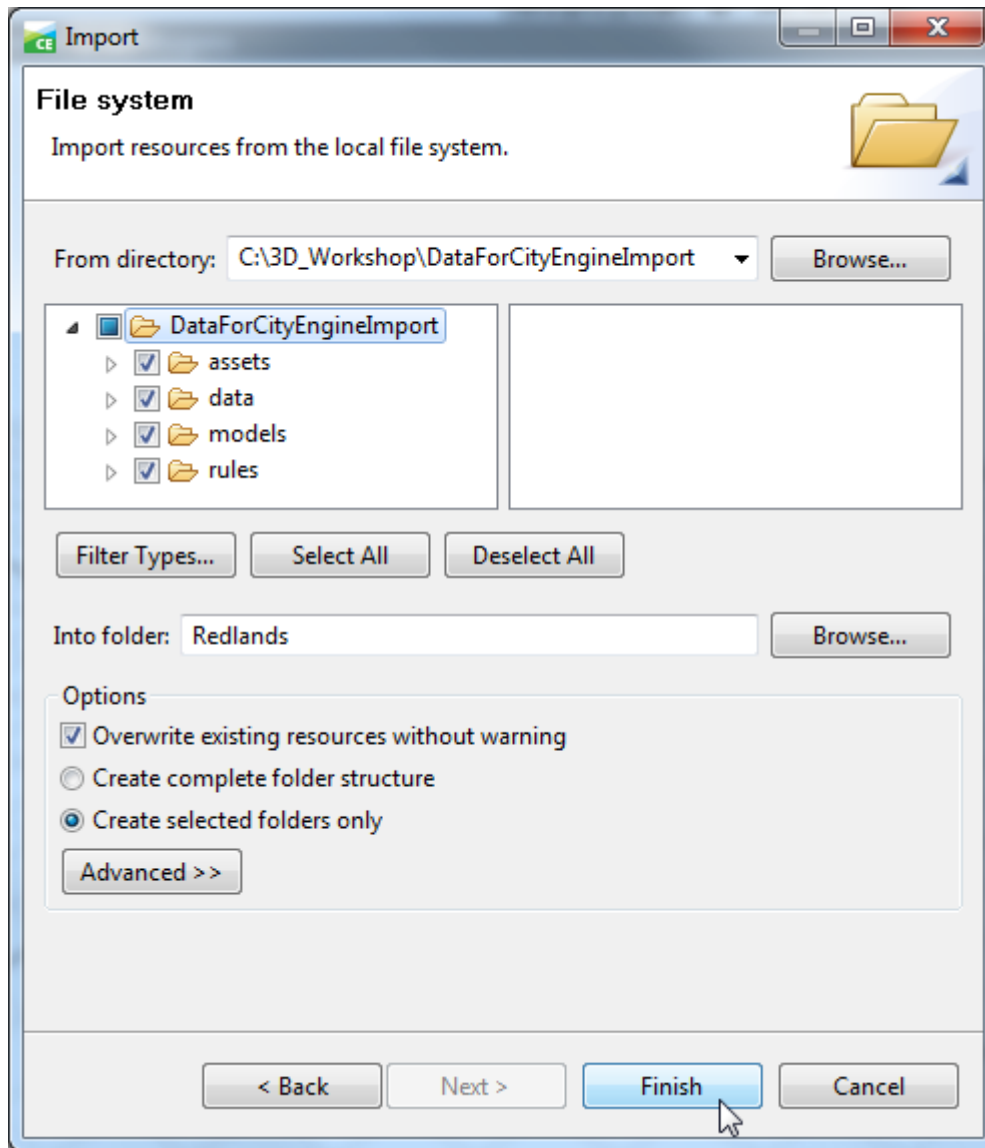


- Check the top checkbox to check all the folders: **assets**, **data**, **models**, and **rules**.



- Into folder** should be set to **Redlands** already; if not, browse to it.

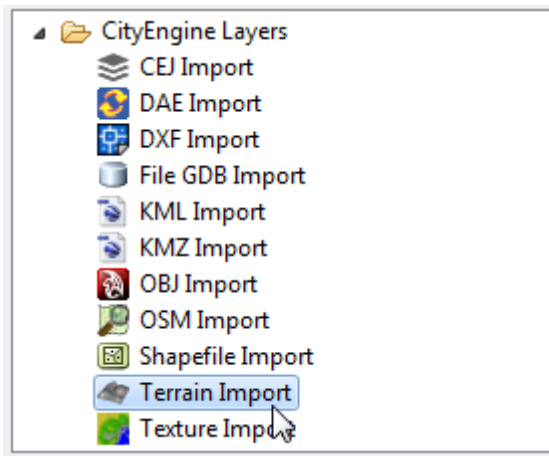
8. The Import dialog should look like the graphic below. Click **Finish**. The import will take a minute or so.



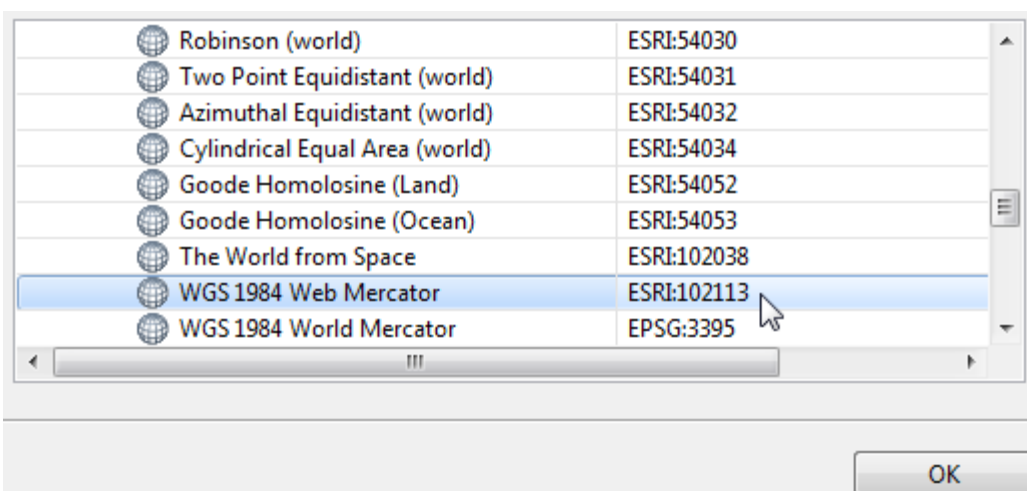
Part 3: Add Terrain to the Scene

Steps:

1. Click **File** and select **Import**.
2. On the **Select** dialog, open **CityEngine Layers**, select **Terrain Import** and click **Next**.



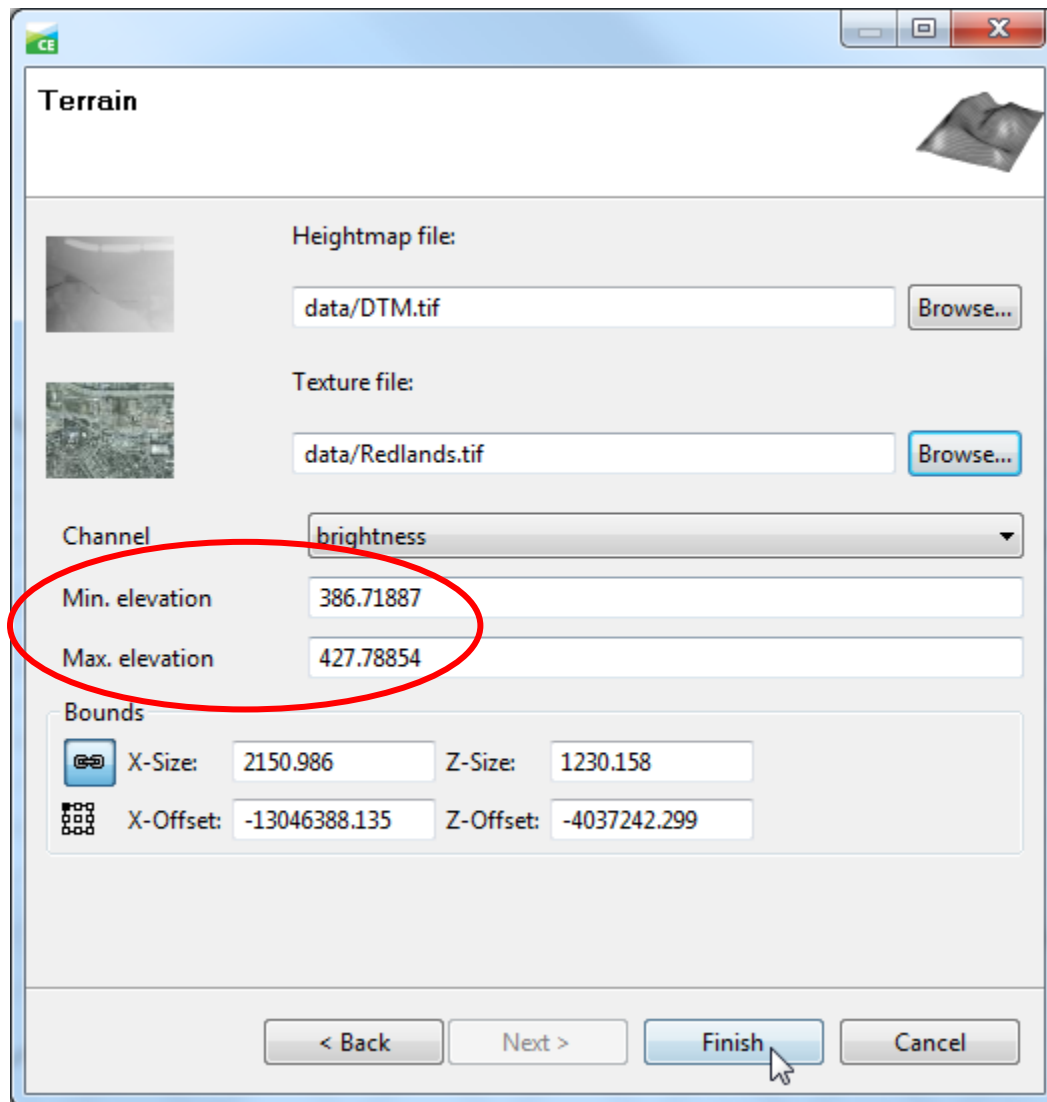
3. On the **Terrain** dialog, click the browse button for **Heightmap file**.
4. On the **Select Heightmap file** dialog, click the **data** folder in the left column, then in the right column click **DTM.tif** and then click **Open**. You will be presented with a coordinate system dialog. (Note: If you do not see two columns, click the **toggle tree view** button in the upper left.)
5. Expand **Projected Coordinate Systems > World** and select **WGS 1984 Web Mercator Esri:102113**, then click **OK**. This will align the heightmap to the appropriate coordinate system.



6. Back on the **Terrain** dialog, click the browse button for **Texture** file:

7. Select **Redlands.tif** from the **data** folder and click **Open**. Select the same coordinate system as in step 4, **WGS 1984 Web Mercator Esri:102113**.

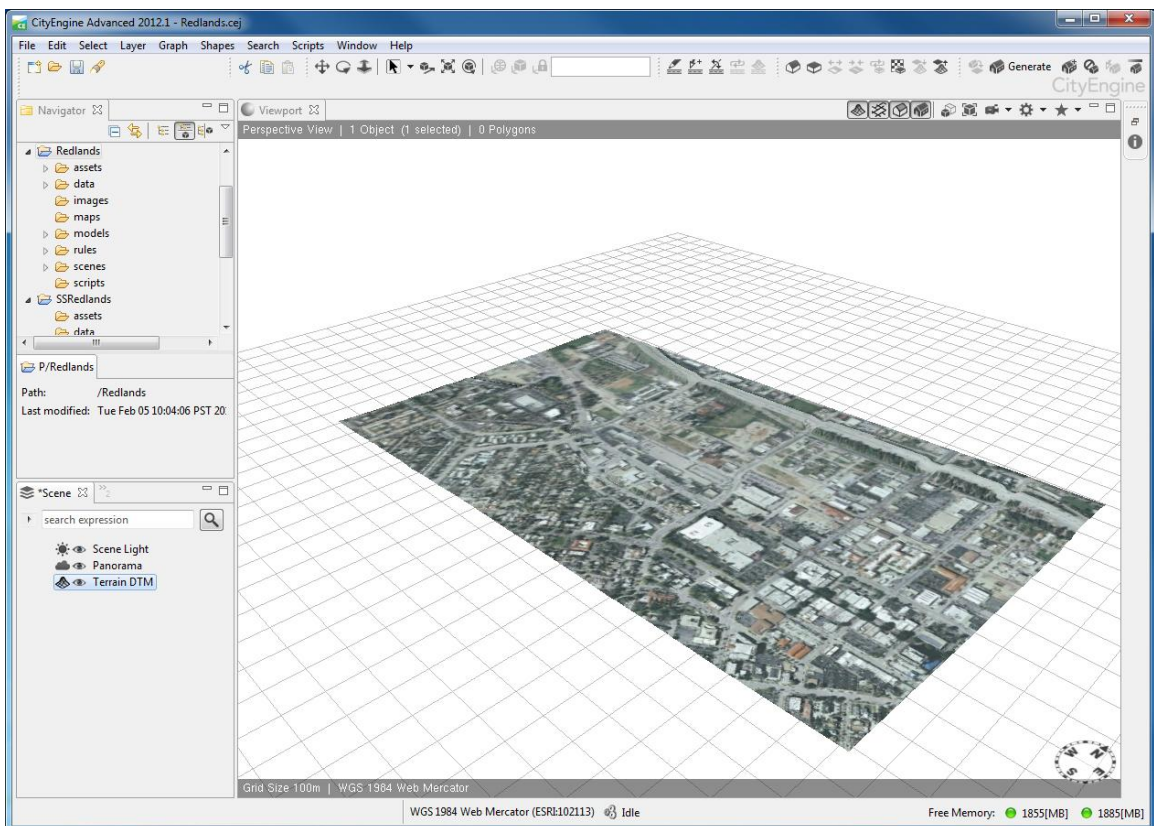
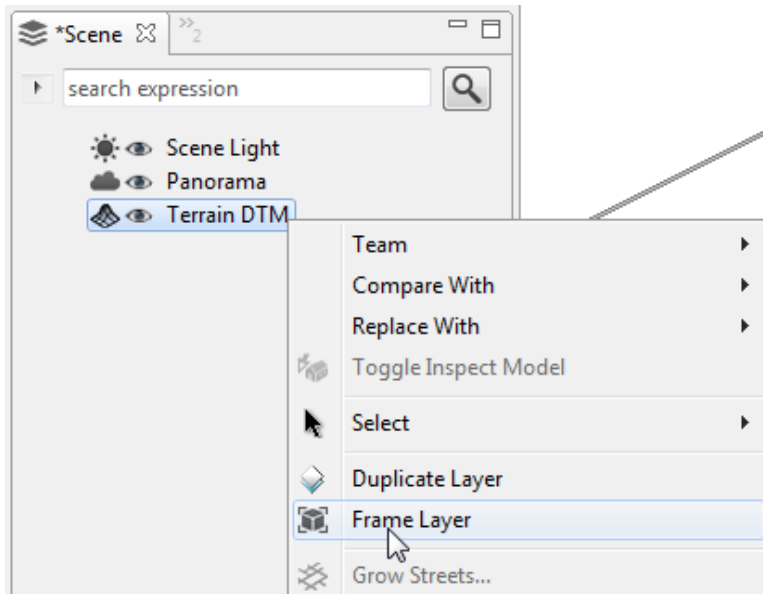
Notice how CityEngine's Terrain import wizard automatically detected elevation height from the heightmap.



8. Leave all other settings and click **Finish**.

Once the terrain is added, the layer becomes visible in the **Scene** window.

9. To see the terrain in the Viewport window, right-click on the **Terrain DTM** layer and select **Frame Layer**.



Part 4: Add Data from the File Geodatabase to the Scene

The data folder that you imported in Part 2 contains a file geodatabase. You will now add that data to the scene.

Steps:

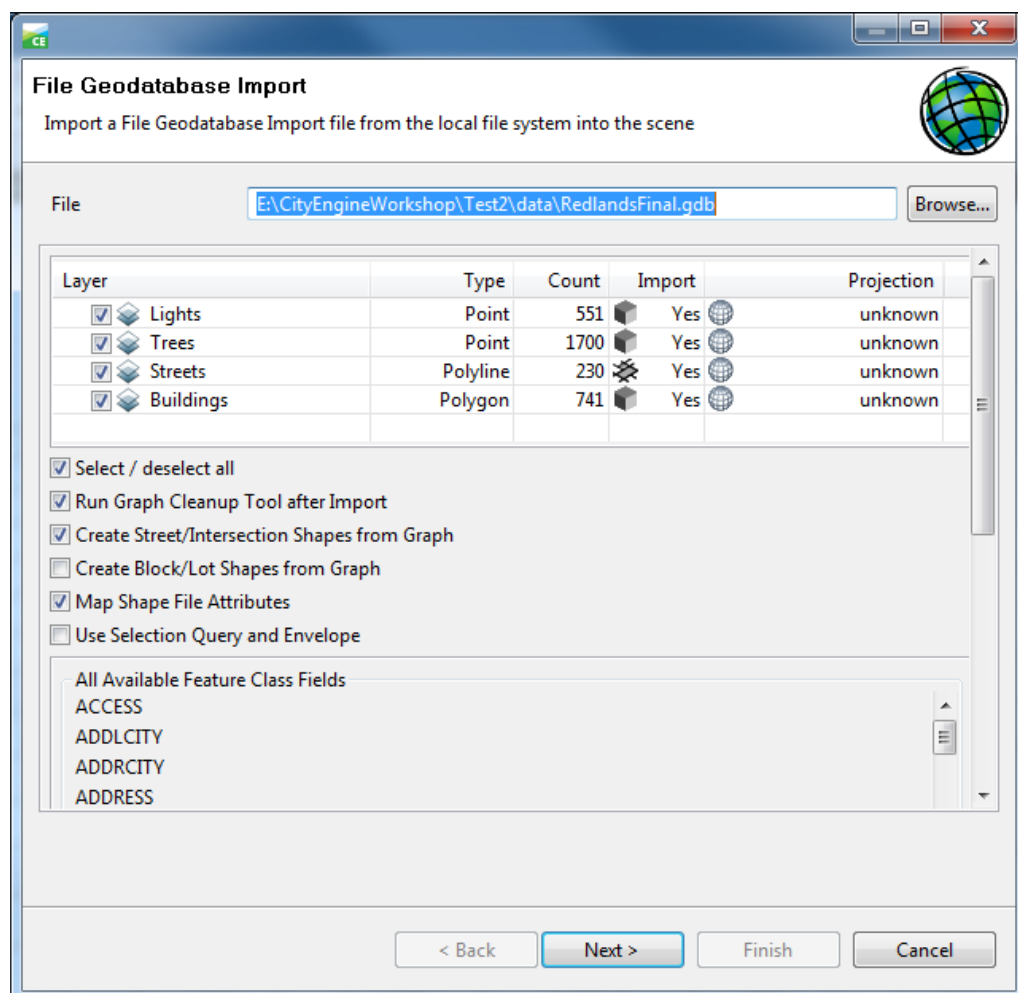
1. In the Navigator window, expand the data folder.
2. Drag and drop **RedlandsFinal.gdb** into the **Viewport** window. This will bring up the **File Geodatabase Import** wizard.
3. In the wizard:

These layers should be checked on: **Lights, Trees, Streets, and Buildings**.

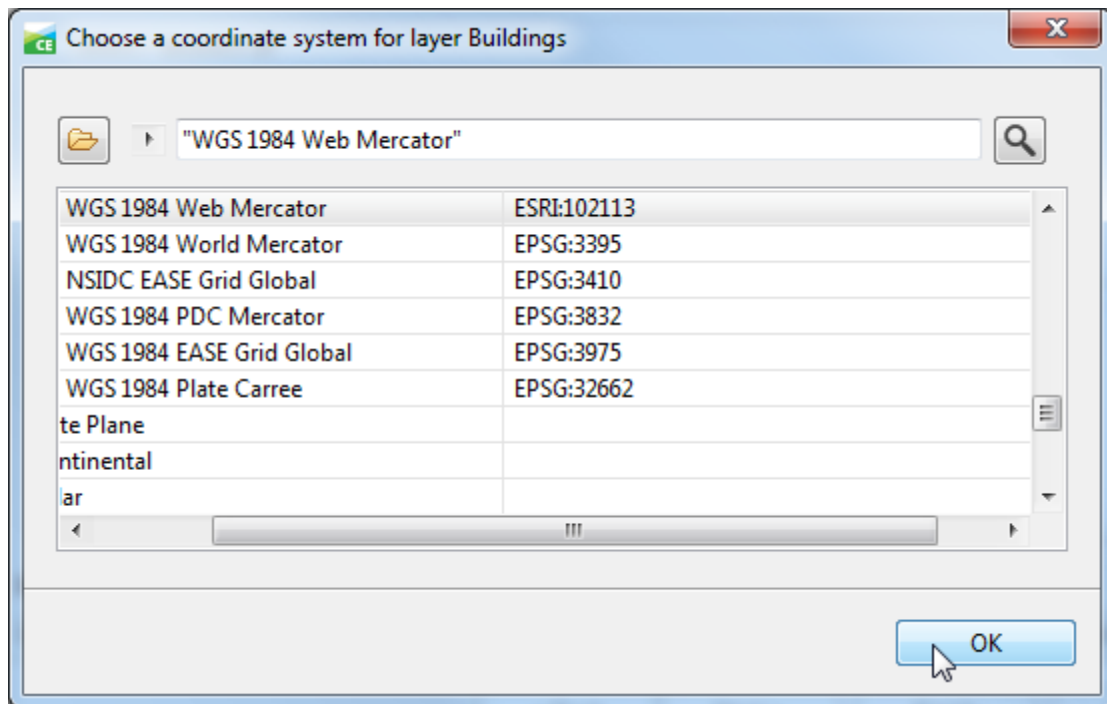
Ensure that the following options are checked:

Run Graph Cleanup Tool after Import
Create Street/Intersection Shapes from Graph
Map Shape File Attributes

Click **Finish**.

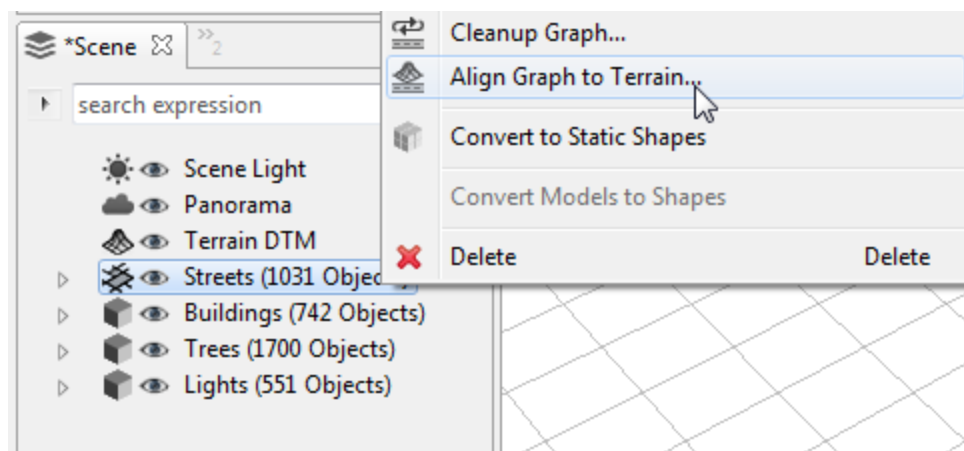


- You will get a dialog asking you to choose the coordinate system for each layer. The dialog should have **WGS 1984 Web Mercator ESRI:102113** already selected, so you can just click **OK** (four times.) If not already selected, choose **Projected Coordinate Systems > World > WGS 1984 Web Mercator ESRI:102113**, then click **OK**.



This will align the layers to the appropriate coordinate system.

- In the **Scene** window, right-click **Streets** and select **Align Graph to Terrain**.



- In the Align Graph to Terrain dialog box:

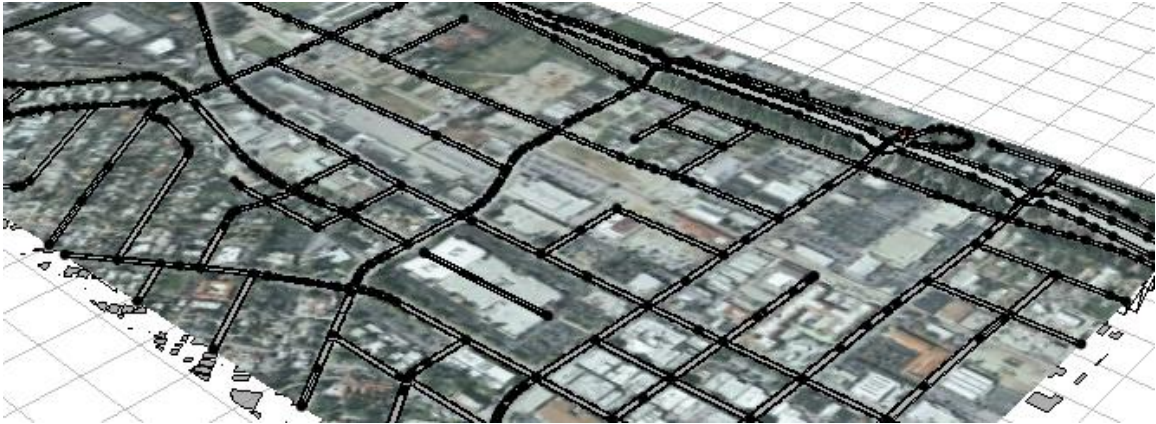
Use the dropdown for **Align function** and select **Project All** (if not already selected).

For Heightmap, use the dropdown and select **Terrain DTM**.

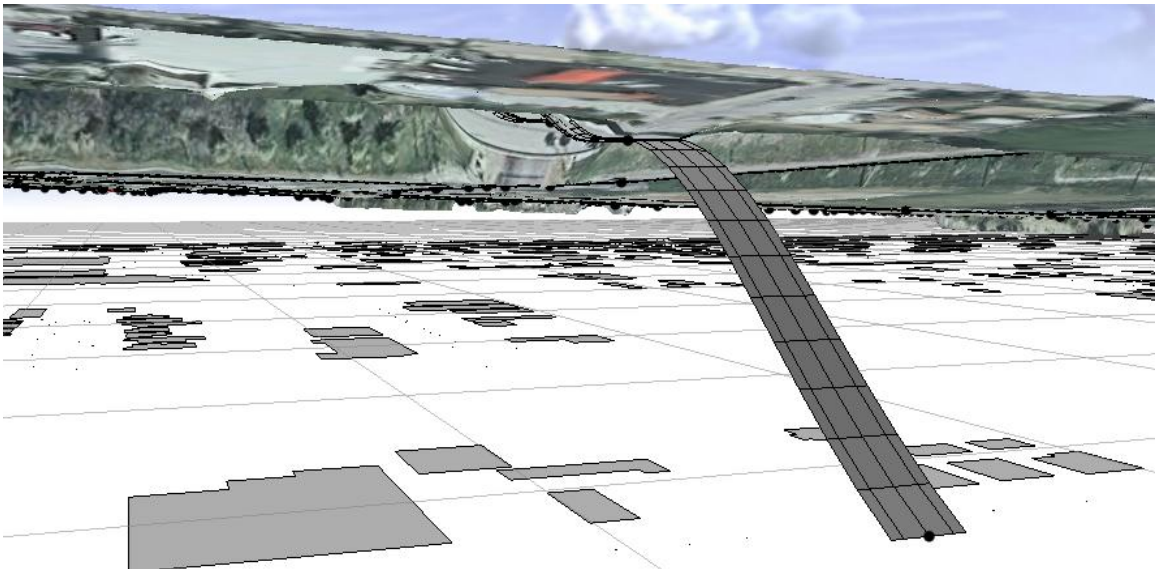
Click **Finish**.

7. In the **Scene** window, click the eye (👁) next to **Streets** to turn off the layer, then click again turn it back on.

Notice how CityEngine automatically drapes the road data on top of the terrain file.



8. Click the **Tumble/Rotate** (👁) tool, then click in the **Viewport** window. Hold the left mouse button down and move the cursor to rotate. You can zoom in and out with the mouse wheel.
9. Back in the **Viewport**, navigate to an edge where a road is going down to the unaligned Buildings layer.



10. Click the Select tool, then click on the black point at the bottom of the road. When selected it becomes blue.



11. Click **Edit > Delete** (or use the Delete key on your keyboard.) The point and the incorrect street are removed from the scene.

12. Delete the other stray points in the same manner. Remember to enable the **Tumble/Rotate** tool after you've used the **Select** tool.

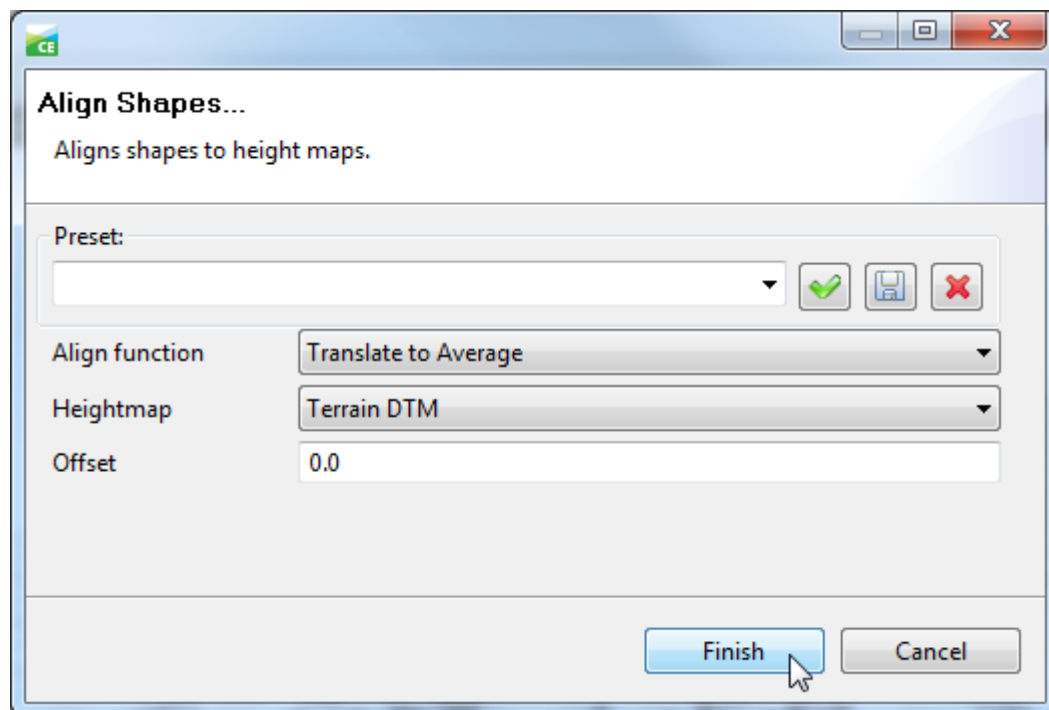
Tip: you can also rotate and zoom in the Viewport by holding down the keyboard **Alt** key while pressing the left mouse button and moving the cursor.

13. The next step is to align all other vector data to the terrain. Holding down the **Ctrl** key, in the **Scene** window, select all of the following: **Buildings**, **Trees**, and **Lights**.
14. Right-click the selected layers and choose **Align Shapes to Terrain**.
15. In the **Align Shapes** dialog box:

Set **Align function** to **Translate to Average**.

Set **Heightmap** to **Terrain DTM**.

Click **Finish**.



16. If you have shapes that are still below the terrain, select them and run **Align Shapes to Terrain**, this time setting **Align function** to **Translate to Maximum**.

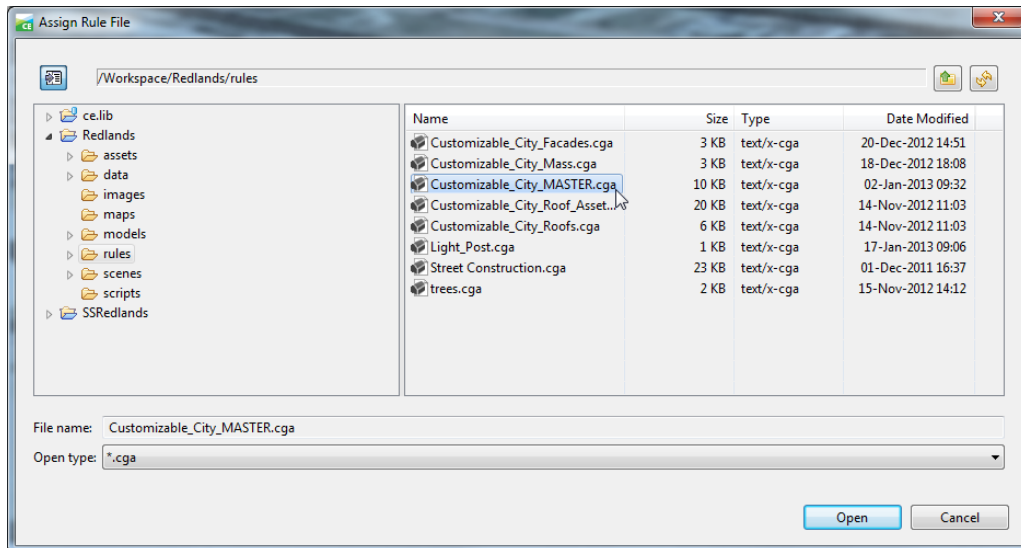
The vector data is now draped on top of the terrain.

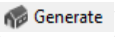
The next steps will cover how to apply Rule files to GIS data and extrude the imported files into a Smart 3D City Model.

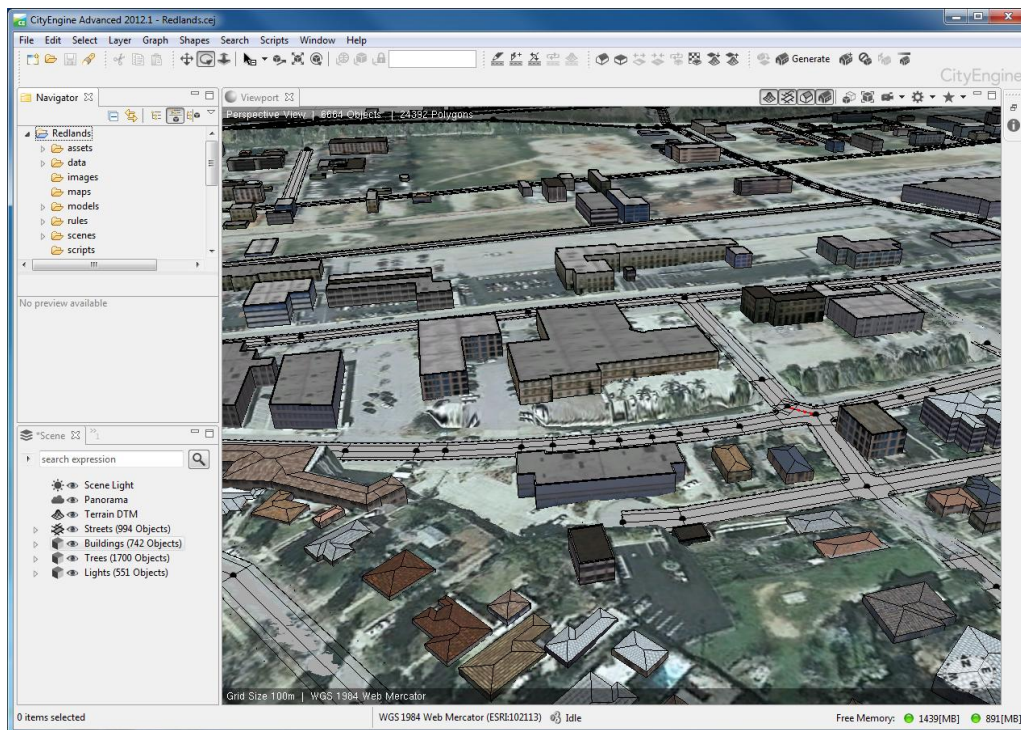
Part 5: Assign CityEngine Rules

Steps:

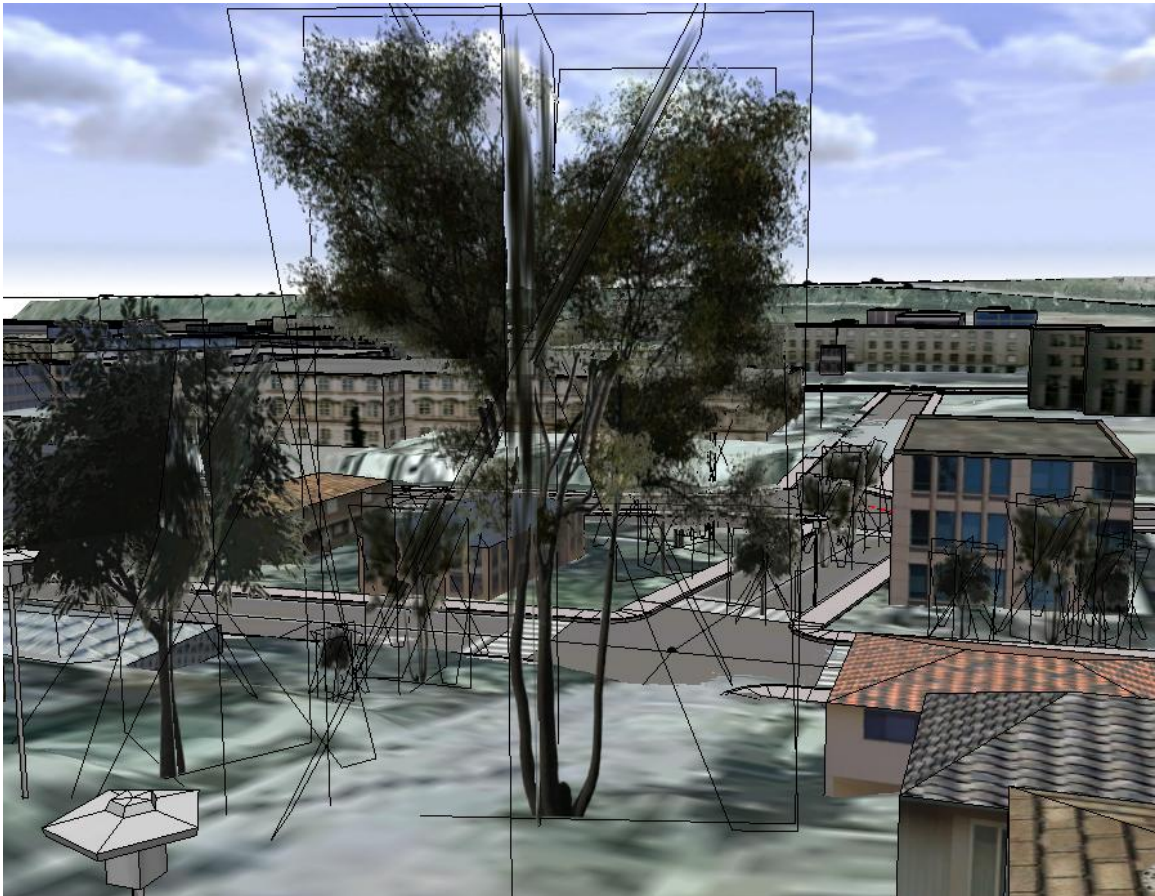
1. In the Scene window, right-click **Buildings** and choose **Assign Rule File**.
2. The **Assign Rule File** dialog box opens to the Redlands/rules folder, with the available rules listed at the right. click on **Customizable_City_MASTER.cga** and then click **Open**.



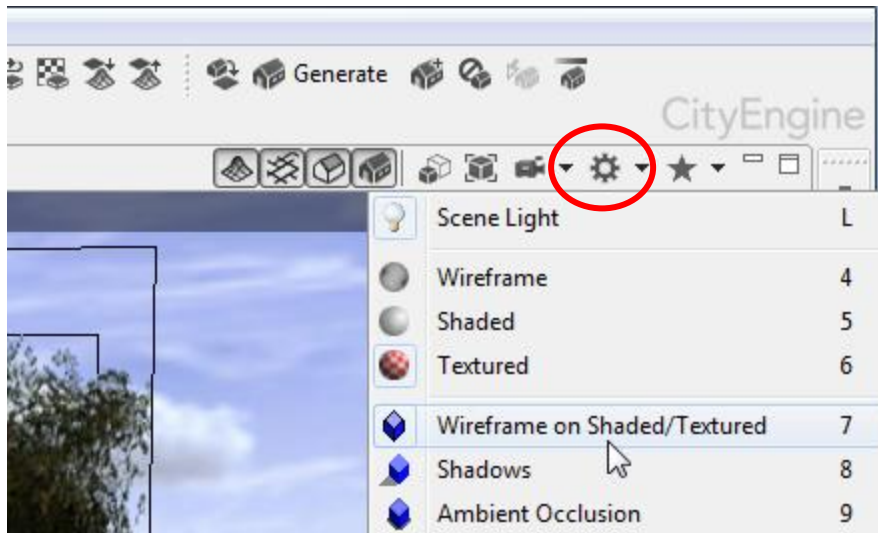
3. Look for the **Generate** button () on the toolbars at the top of CityEngine. Click it to generate the buildings. Alternatively, you can right-click Buildings and choose Generate from the context menu. Be patient, and watch the buildings grow.



4. In the same manner, right-click **Streets**, **Assign Rule File** and choose **StreetConstruction.cga**.
5. Click **Generate** to create the streets.
6. Assign the **trees.cga** to the **Trees** layer and generate.
7. Assign **Light_Post.cga** to the **Lights** layer and generate.
8. If your trees or other layers have wireframes:



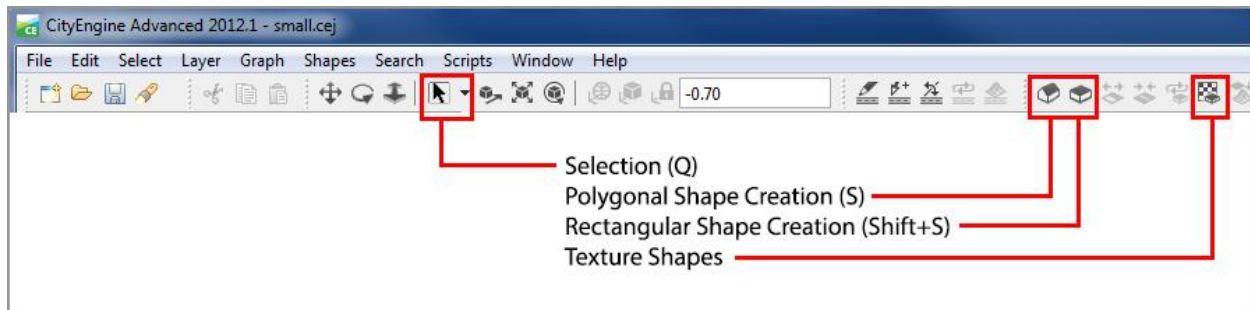
You can turn them off by clicking the **Settings** dropdown and clicking on **Wireframe on Shaded/Textured**.



Exercise 3b: Create a New Building

CityEngine has editing tools for the quick sketching and texturing of 3D (multitpatch) data. This exercise demonstrates basic shape creation and texturing options.

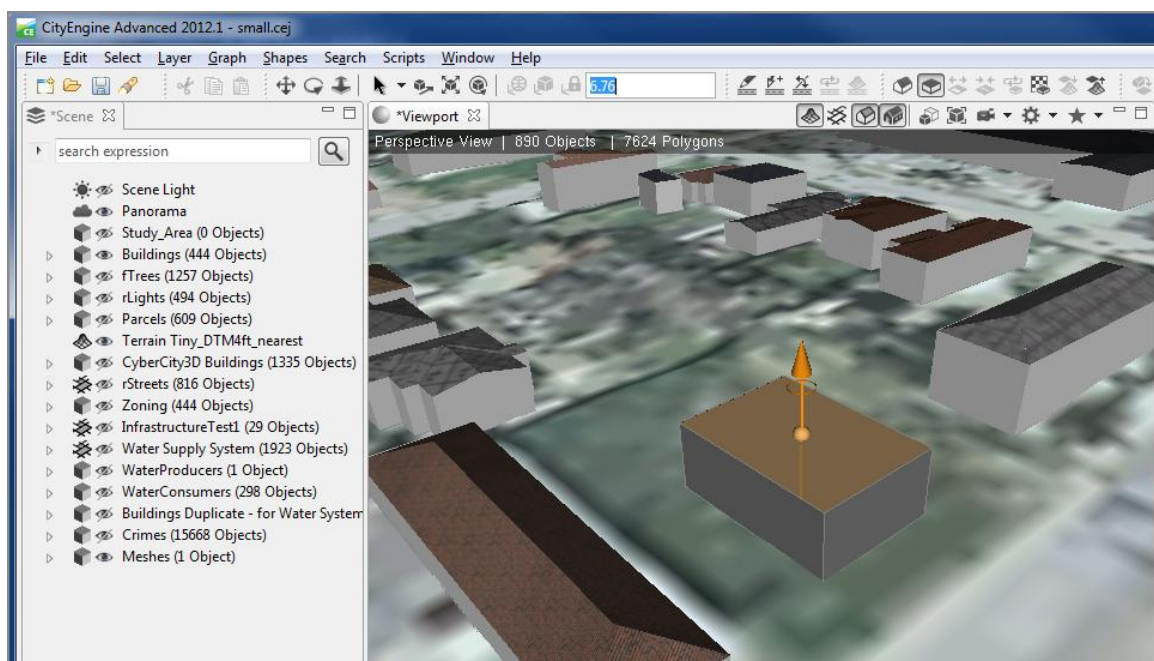
Four tools will be used:



Part 1: Draw a Basic Mass

Steps:

1. Find an empty lot where you'd like to sketch a building.
2. Choose the **Rectangular Shape Creation** tool.
3. Click once to begin shape creation, and click again at opposite corner to complete shape.
4. After completing rectangle, hover over shape to find the orange "grip".
5. Click the grip and pull upwards to create a 3D rectangular mass.



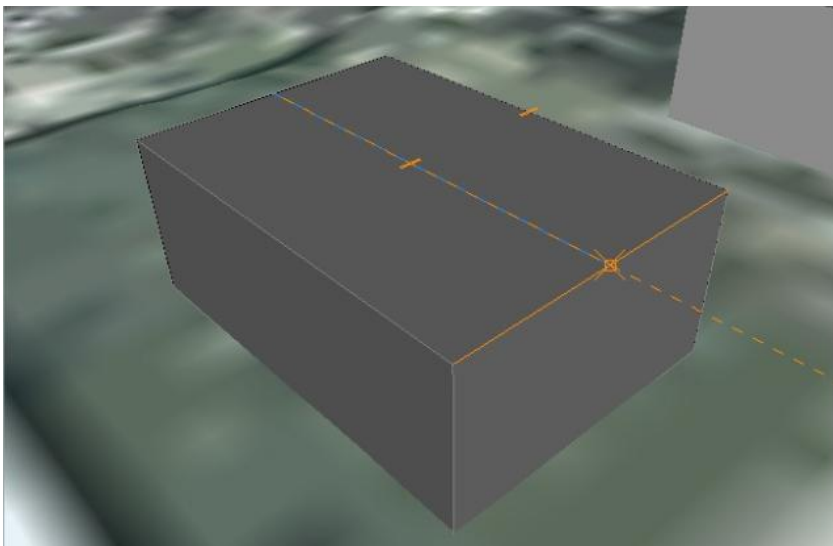
Part 2: Add a Roof

Steps:

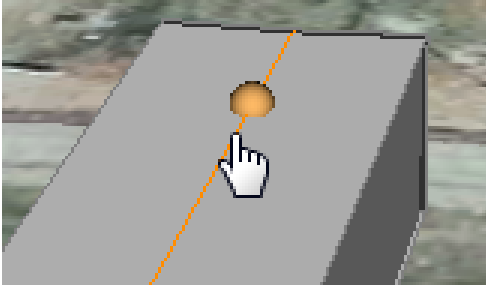
1. Choose the **Polygonal Shape Creation** tool, since it will allow center snap on edges.
2. Hover over one edge of your building to locate its center – an orange X will appear when it is snapped.



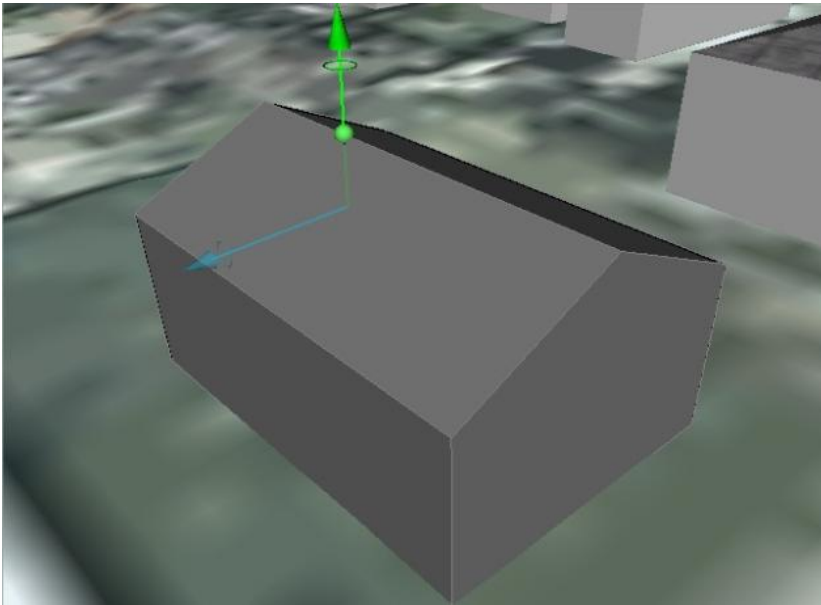
3. Click once and then move towards the opposite edge –orange guidelines appear if parallel to edge.
4. Find the center snap (orange X) and click to complete the ridge line of the roof



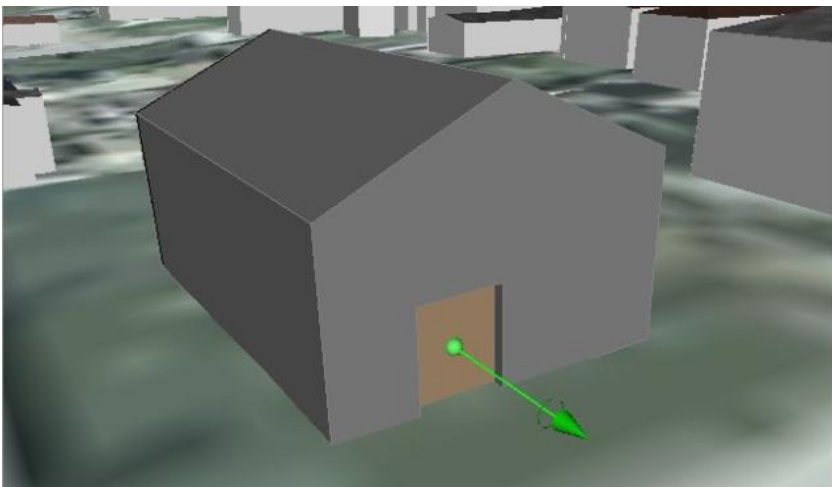
5. Hover over the ridge line until the orange dot appears. Put the cursor on the dot



and then press-drag upwards to create a gable roof shape.





6. Now, use either of the **Shape Creation** tools to draw a door.
7. Hover over the door shape and use the grip to push it into the house slightly.

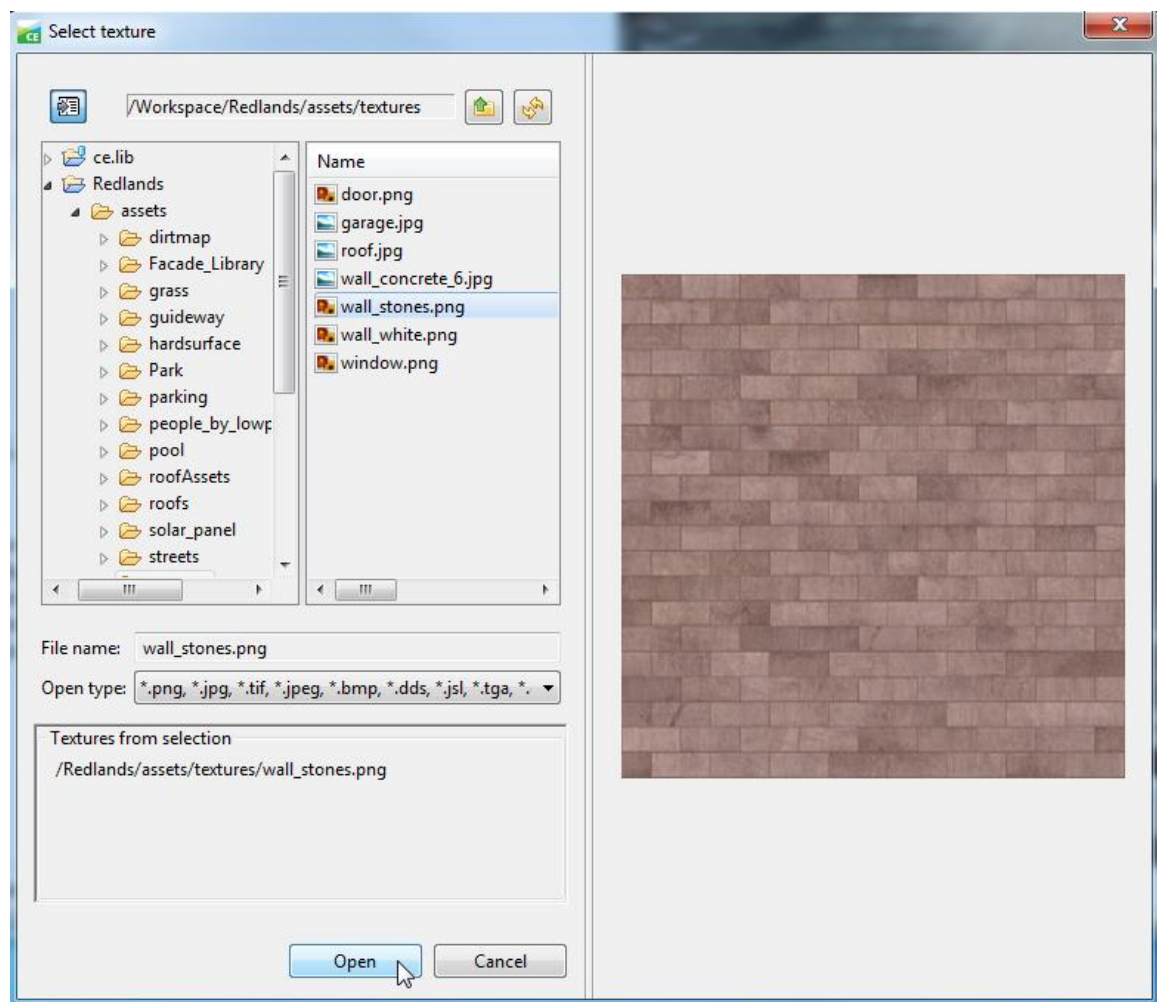


Part 3: Add Texture to the Building

Steps:

1. Choose the **Selection** () tool and click on the building to select it.
2. Choose the **Texture Shapes** () tool, which will open the **Shape Texturing Tool**.
3. On the **Shape Texturing Tool**, **General** section, click the **Browse/pick** button.
4. On the left side of the **Select texture** dialog box, expand **Redlands\assets**. Click on the **textures** folder.

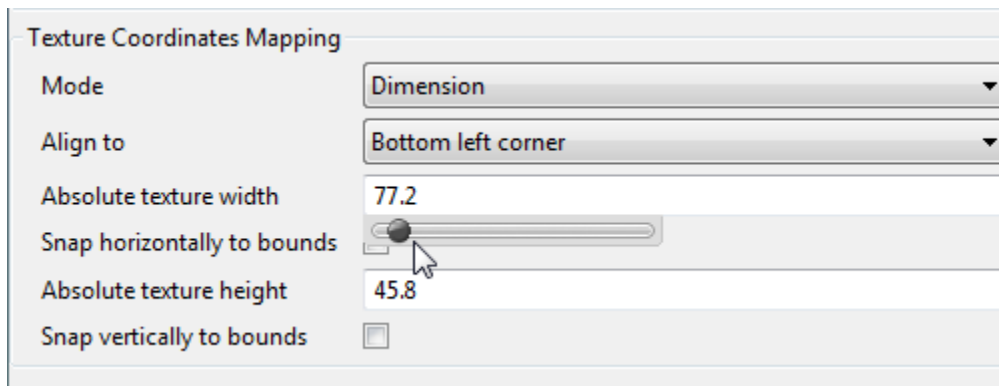
On the right side of **Select texture**, click **wall_stones.png**. Then click **Open**.



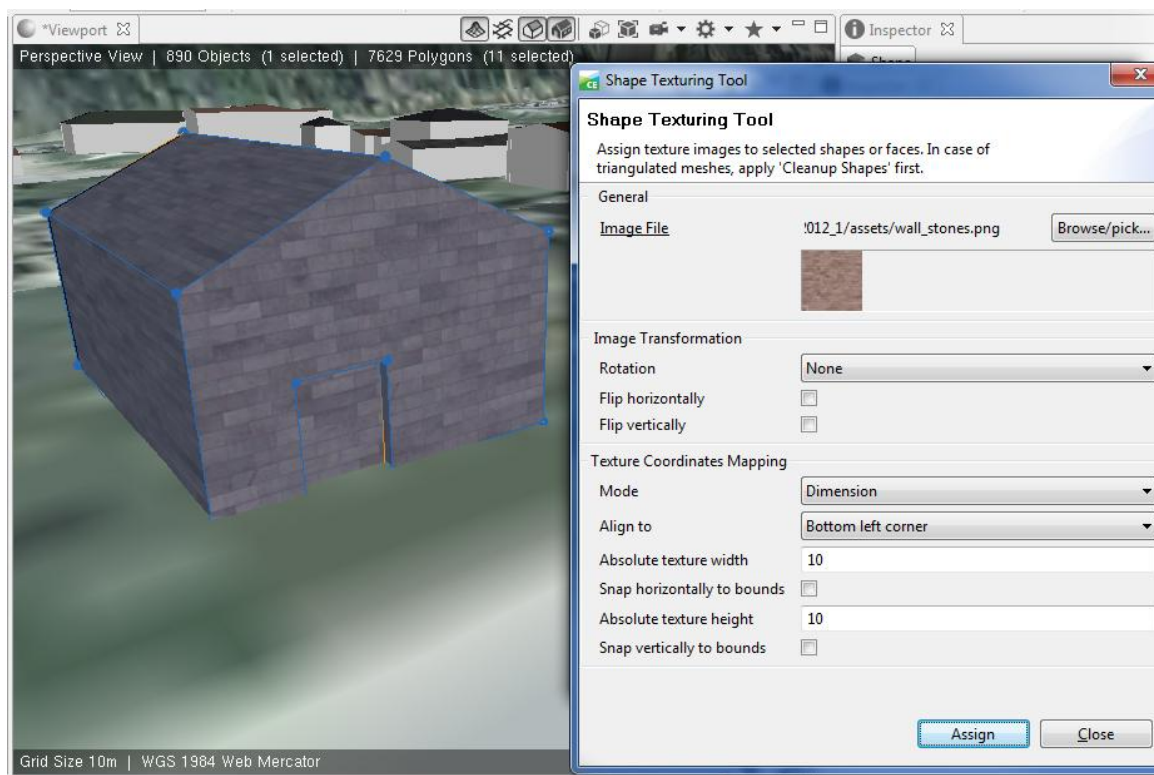
5. On the **Shape Texturing Tool**, click **Assign** to apply the wall texture. This happens immediately, so make sure your tool dialog is not covering up your building.

- Under **Texture Coordinates Mapping**, change the **Mode** setting to **Dimension** so that all walls will use the same texture mapping regardless of their differently sized faces.

Adjust **Absolute texture width** and **Absolute texture height** if the texture is not sized appropriately. When you click next to the numbers for these attributes, a scrollbar appears that you can use to change the sizes.



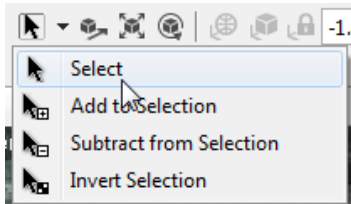
- Leave the tool open for the next part of the exercise.



Part 4: Add Texture to the Roof and Door

Steps:

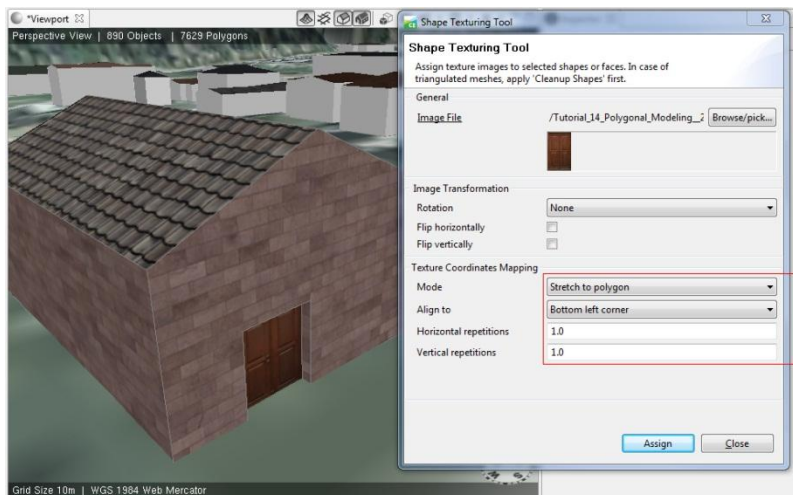
1. With the **Shape Texturing Tool** open, click the dropdown for the **Selection** tool and choose **Select**.



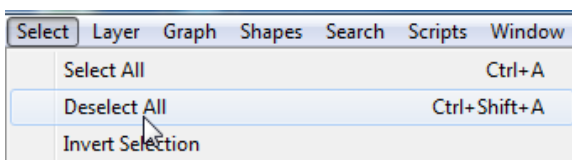
2. Click one side of the roof. This will deselect the entire building, and select only the roof.
3. Select the other roof face by holding down the **Ctrl** or **Shift** key while clicking.

Note: the **Ctrl** key toggles the selection, while **Shift** adds to the selection.

4. Click the **Browse/pick** button and then click the **roof.jpg** texture. Click **Open**.
5. Click **Assign** and follow the same process from Part 3 to adjust the roof texture.
6. Select the door, and use **Browse/pick** to open the **door.png** texture, then **Assign** it.
7. Change the door texture **Mode** to **Stretch to polygon**. This will match the edges of the door texture to any size door shape.



8. Click **Select > Deselect All** if your door is still selected.



9. Rotate in the Viewport to admire your new building!

Exercise 3c: Fun with Rules (Introduction to Procedural Modeling)

Quick Introduction to Procedural Modeling with CityEngine

This is a short demonstration of how CityEngine generates architecture using rules. Procedural rules are driven by inputs, which can come from GIS data, such as attributes and raster images. For this demo, we will alter these inputs and watch CityEngine regenerate buildings in real time.

Part 1: Import the NYC 2259 Example Project

Steps:

1. In CityEngine, click **File > Import**.
2. Select **Existing Projects into Workspace** and then click **Next**.
3. Click the radio button for **Select archive file** and then click **Browse**.
4. Navigate to **C:\3D_Workshop\Exercise3c**, click on **Example_NYC2259__2012_1.zip** and then click **Open**.

(Note: If you don't have this project you can find it on the [CityEngine web site](http://www.cityengine.com))

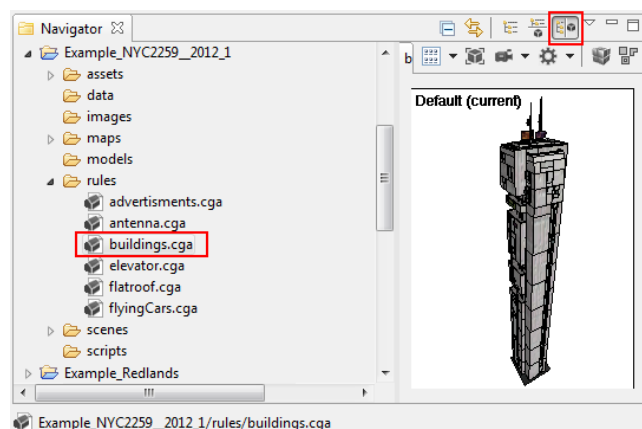
5. On the Import dialog, click **Finish**. You will see the Example_NYC2259_2012_1 project in the **Navigator** window.

Part 2: Preview the NYC Building Rule

Steps:

1. In the Navigator window, expand the NYC project by double-clicking the project name, and then expand the **rules** folder similarly.
2. Single click the **buildings.cga** rule file, and you will see a preview of the model.

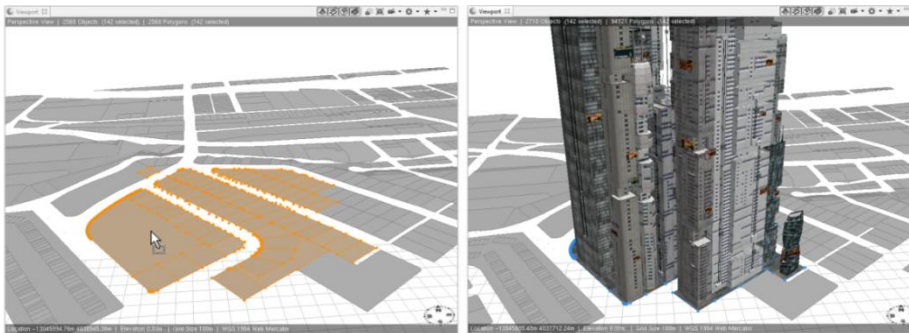
(Note: If preview pane is hidden, use the button highlighted in upper right of below image.)



Part 3: Assign this Rule to Some Shapes

Steps:

1. Create new shapes with the Rectangular Shape Creation tool or the Polygonal Shape Creation tool.
2. Click the **Select** tool and then select your shapes.
3. Drag the **buildings.cga** rule file onto the selected shapes until they turn orange, then release the mouse button to assign the rule.
4. Wait a moment for the buildings to generate, then you will see buildings from the future!



Part 4: Alter Building Parameters

Steps:

1. Click the side of one building to select it.
2. Optional: Click the **Isolate** button (🔍) on the **Viewport** to show only this building.
3. Open the **Inspector** window.



4. You will see the attributes for the selected building. (Widen the window if necessary.)
5. Alter the **Building_Height** attribute by sliding the button or by typing a new number, and the building will regenerate with the new height.

- Now try altering any of the attributes to see how they affect the model.

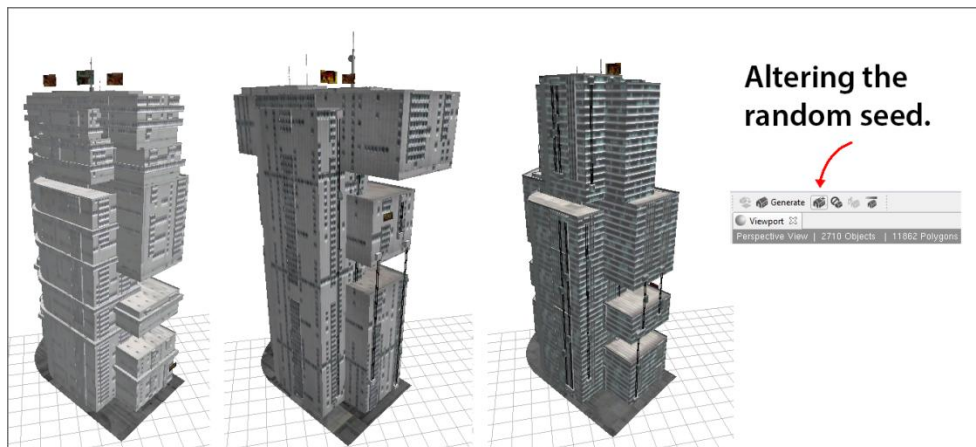


Part 5: Change the Random "Seed"

These buildings have randomly determined attributes – we can re-seed this randomness.

Steps:

- With one or more buildings selected, click the **Update Seed and Generate Models** button (🔄).
- You will see the building regenerate with new random variations.



Now you can see the power of procedural modeling. Combine this with real-world GIS data and you can create geo-typical city models very quickly.

Exercise 4: CityEngine Web Scenes

A CityEngine Web Scene is a custom, web-optimized format. It can be viewed from CityEngine or it can be shared to ArcGIS Online.

If there are specific locations in the scene that you would like a viewer to see, you can create bookmarks for these places. The viewer can go to the bookmarks individually, or can press a "Play" button which makes the scene move itself through the bookmarked locations.

In this exercise you will create three bookmarks, create a web scene and then view it.

Complexity:

Beginner

Data Requirement:

Installed with software

Data Path:

C:\3D_Workshop\

Goal:

Learn the basics of creating a web scene and using ArcGIS Online

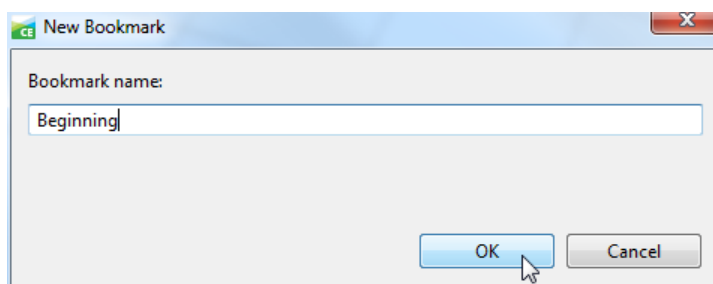
Average length of time to complete:
30 minutes

Part 1: Create Bookmarks in CityEngine

Find three places where you want to create bookmarks.

Steps:

1. Navigate to the first place that you want your web scene to show.
2. On the **Viewport** window, click the **Bookmarks** (★) menu button.
3. On the **New Bookmark** dialog box, type a name for your bookmark, then click **OK**.

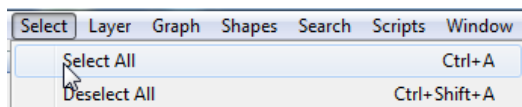


4. Navigate to the next place for a bookmark, and create another one in the same manner.
5. Create at least one more bookmark so that you have at least three; create more if you have time.

Part 2: Create the Web Scene

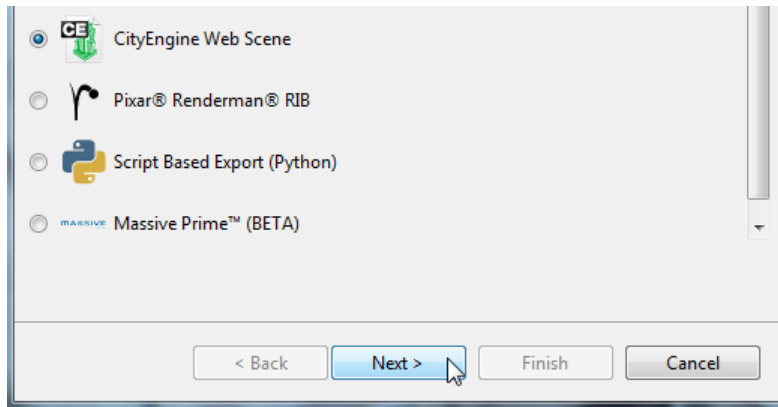
To create a web scene, you select features and export them to the CityEngine Web Scene format.

1. Click **Select > Select All**.



Dive-in: The **Ctrl+A** to the right means that you could alternatively press those two keys to select all the geometries currently in CityEngine. If you use CityEngine a lot you will probably want to learn its shortcuts.

2. Click **File > Export Models**.
3. In the **Choose format for model export** dialog box, choose **CityEngine Web Scene**, then click **Next**.



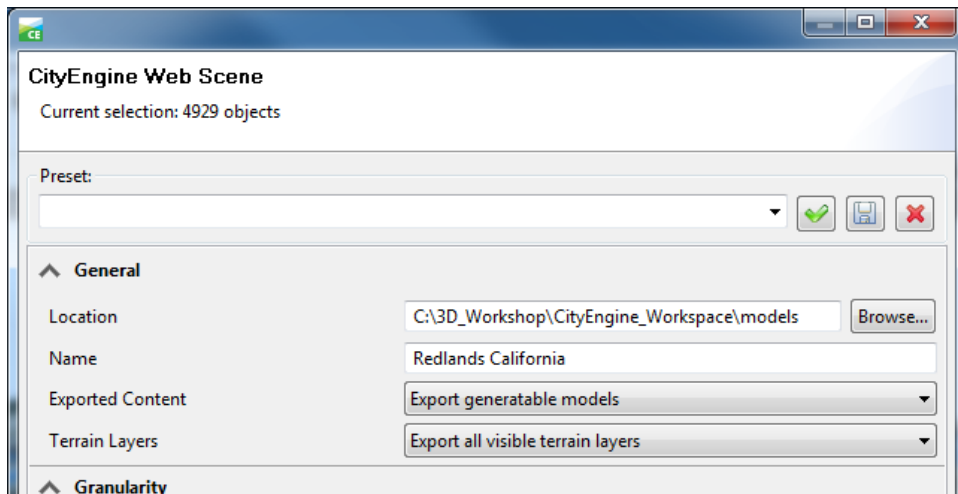
4. In the **CityEngine Web Scene** dialog box, set the following parameters:

Location: should be set to **C:\3D_Workshop\CityEngine_Workspace\models**

Name: should be set to **Redlands**; add **California**

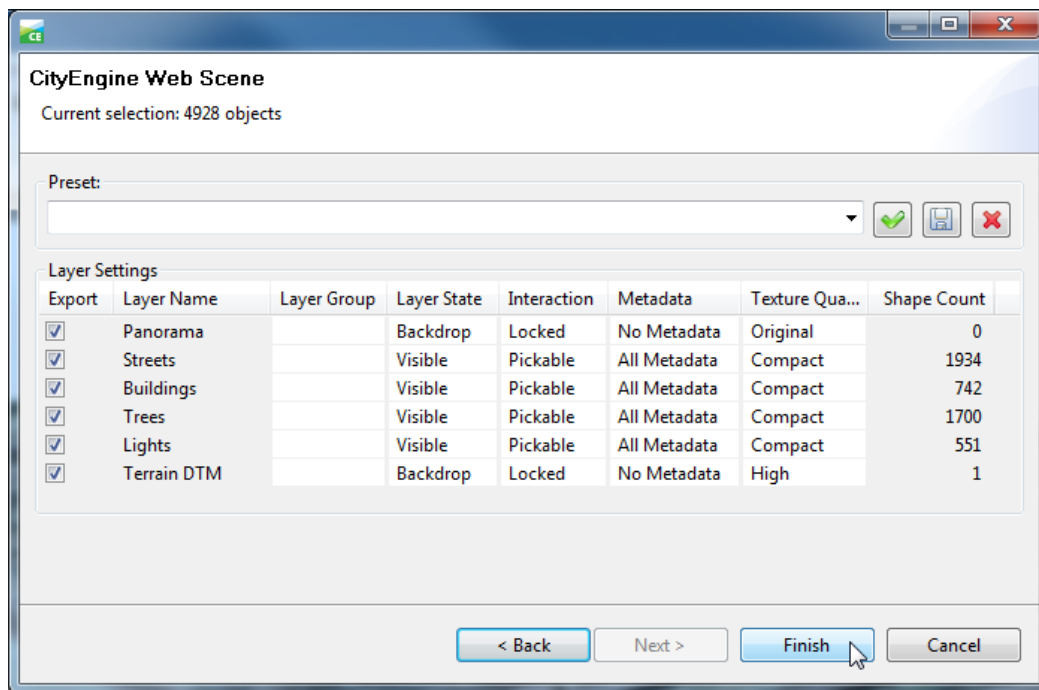
Exported Content: use dropdown to choose **Export generatable models**

Terrain Layers: should be set to **Export all visible terrain layers**



5. Click **Next**.

- Verify that you have the same layer settings as in the next graphic; if so, click **Finish**.

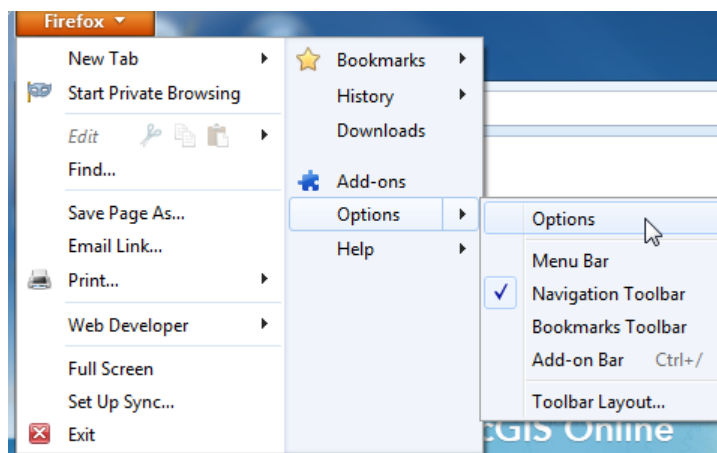


Be patient while CityEngine generates the web scene.

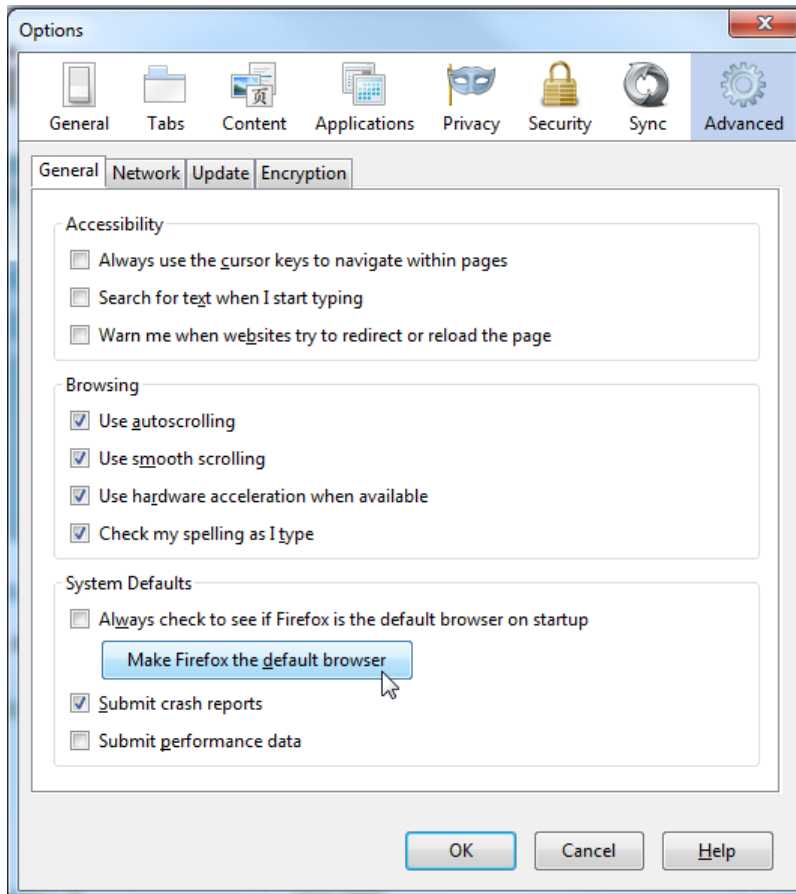
Part 2: View the Web Scene

After the scene is generated, you can view it in a browser opened directly from CityEngine. You must be sure that your default browser supports WebGL.

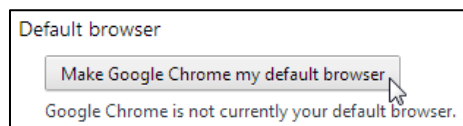
- First you must click **File > Refresh Workspace**.
- Ensure that the default browser is Firefox. Open a Firefox browser and click **Firefox > Options**.



On the **Options** dialog box, go to the **Advanced** tab. Click the **Make Firefox the default browser** button, then **OK** to dismiss.

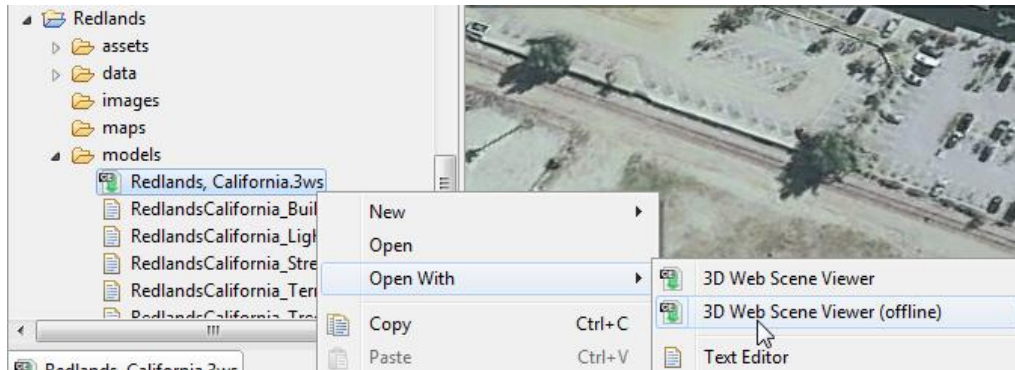


Alternatively, you can use the Google Chrome browser. Click the Customize button (☰) and go to **Settings**. Click the button at the bottom of the page.



3. Go to the **Navigator** window and expand the **Redlands\models** folder.

- Right-click your **Redlands California.3ws** file, hover over **Open With** and choose **3D Web Scene Viewer (offline)**.

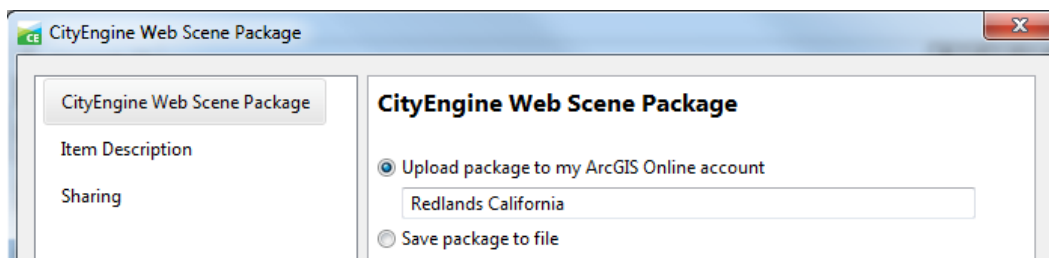


- When the web scene opens, experiment with it by turning off and on the different layers, going to the bookmarks (★) and going to the Settings (⚙) and other buttons on the toolbar at the top right column.

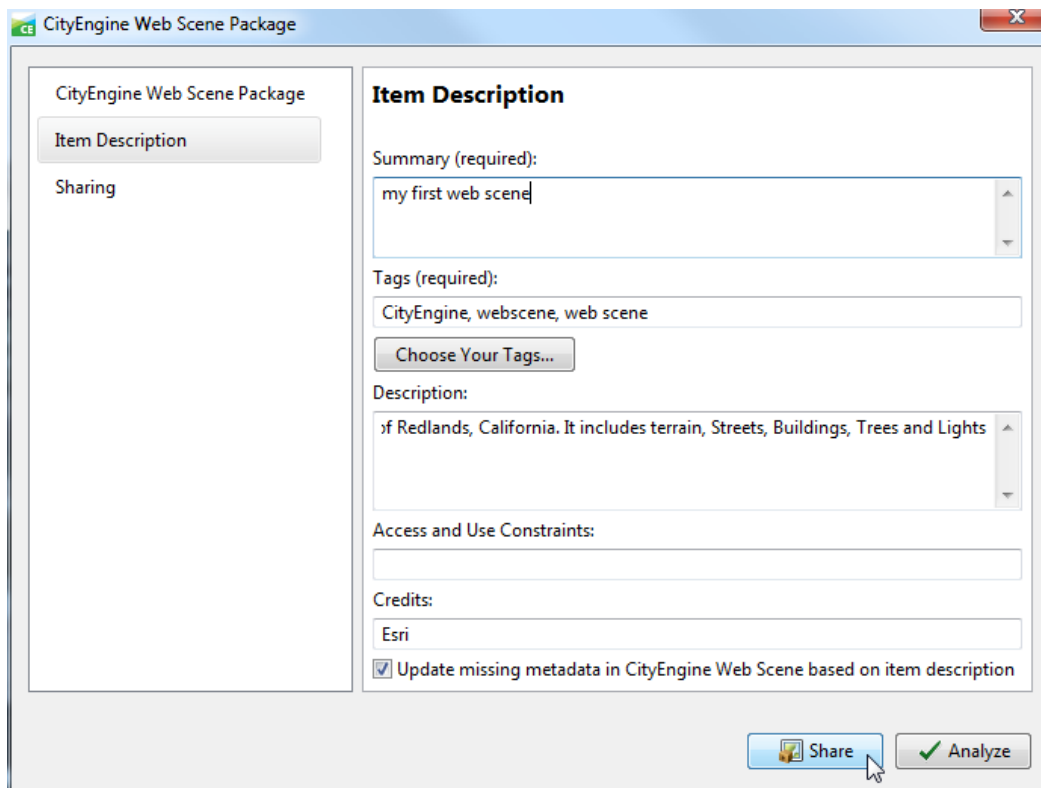
Part 3: (Optional) Share the Web Scene to ArcGIS Online

If you have an ArcGIS Online account, you can share the web scene and view it from there.

- In the Navigator window, right-click **Redlands California.3ws** and select **Share As**
- Ensure that you select **Upload package to my ArcGIS Online account**



- Click the **Item Description** tab and enter a **Summary**, **Tags**, and **Description**.

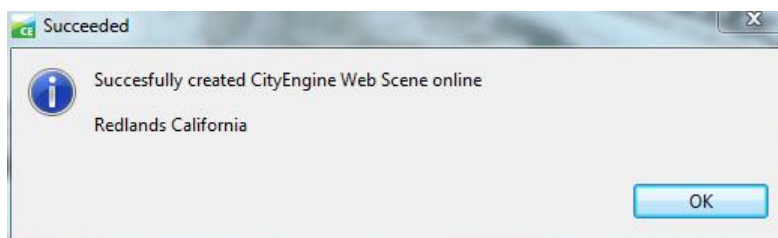


The image shows the 'CityEngine Web Scene Package' dialog box with the 'Item Description' tab selected. The dialog has a sidebar on the left with 'CityEngine Web Scene Package', 'Item Description', and 'Sharing' options. The main area contains the following fields:

- Summary (required):** A text box containing 'my first web scene'.
- Tags (required):** A text box containing 'CityEngine, webscene, web scene' and a 'Choose Your Tags...' button.
- Description:** A text box containing 'of Redlands, California. It includes terrain, Streets, Buildings, Trees and Lights'.
- Access and Use Constraints:** An empty text box.
- Credits:** A text box containing 'Esri'.
- ☒ Update missing metadata in CityEngine Web Scene based on item description

At the bottom right, there are two buttons: 'Share' (with a globe icon) and 'Analyze' (with a green checkmark icon).

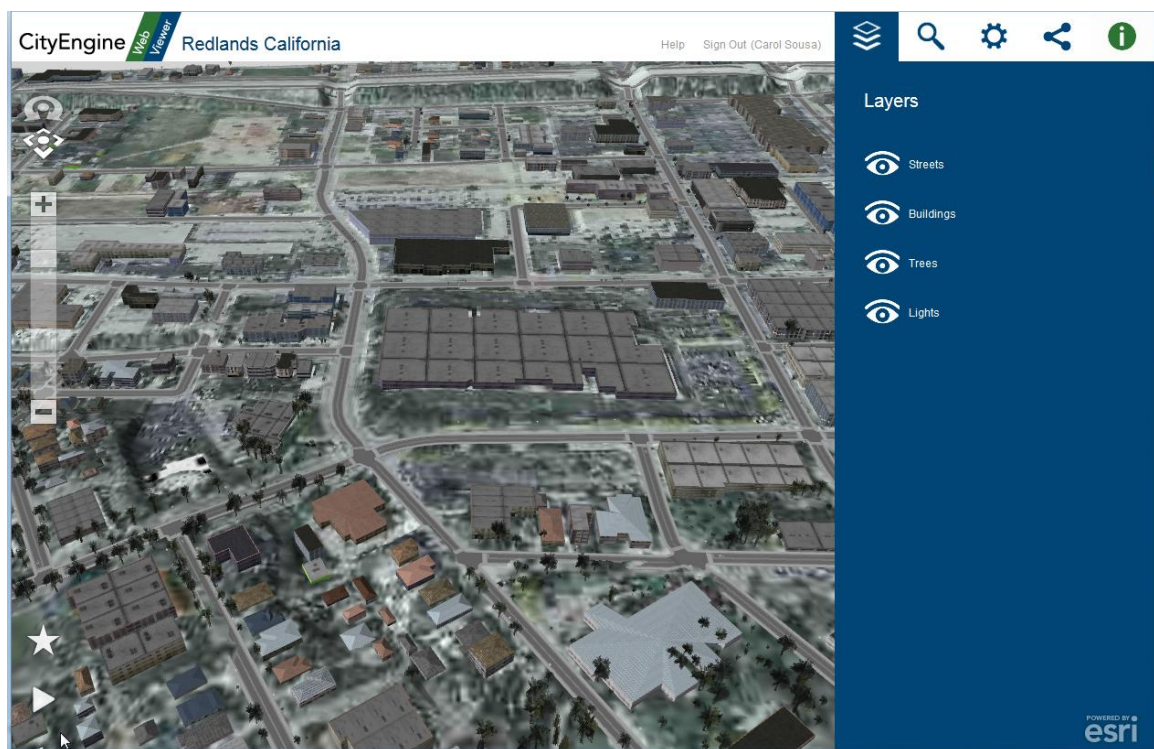
- Click **Share**. The ArcGIS Online sign in dialog will appear (unless you are already signed in.) After you sign in, the upload will begin.
- When complete you will get a message; click **OK**.




- Open a Firefox browser and log in to ArcGIS Online. Go to your web scene's Details page and click **Open > View Application**.



- When the web scene opens, notice the play button in the lower left corner. Click it to have CityEngine fly through the bookmarks you created for your web scene.



- Press the button again (which now looks like this: ) to stop flying.

You have now completed the last exercise and can close CityEngine without saving.