Archaeological Remote Sensing Survey
Classics 300 – Greek Archaeology
UMass Amherst – Fall 2021

Wall-building peaked in the mid-1800s when … there were around 240,000 miles of them in New England. That amounts to roughly 400 million tons of stone, or enough to build the Great Pyramid of Giza—more than 60 times over. (Kusmer 2018)

About this tutorial

Starting in the 17th century, settlers in New England built dry stone features like walls, dams, kilns, and houses. Today, it can be difficult to identify features like these that are in overgrown or forested areas. In Massachusetts, many of the open landscapes in which stone features were built have been allowed to regenerate into forests.

Your team of surveyors has been asked to examine LiDAR data for the historical township of Dana in Worcester County, MA, and map visible linear features, including walls and roads. Dana was one of four towns that was abandoned during the construction of the Quabbin Reservoir in 1927-1939. While much of the town and surrounding farms were flooded, the town common is situated on higher ground and escaped inundation (check it out in Google Maps). Many field walls in the surrounding area are also preserved above the water level.

This goal of this tutorial is to introduce you to ArcGIS Online – a collaborative, online workspace that your team can use to complete the remote sensing project together. To complete the tutorial, all you need is a browser (Chrome, Firefox, Safari, or Microsoft Edge). If you have technical difficulties, see Esri's information on supported browsers.

Items in green are extra-helpful pointers.
Items in orange are key terms.

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What is LiDAR?

LiDAR (Light Detection and Ranging) makes it easier to identify built features remotely. LiDAR equipment is often mounted on an airplane. As the plane flies over a target area, it emits light in the form of pulsed lasers, which passes through leafy vegetation to strike hard surfaces before bouncing back to the sensor. The amount of time it takes for this journey allows the equipment to calculate the distance between the plane and the sensor. "Bare-earth" LiDAR strips the vegetation data points out of the model, giving us a chance to visualize surface anomalies (like walls) that are hidden below a forest canopy.


LiDAR point cloud data: vegetation points (green) and "bare-earth" points (red) (Source: National Ecological Observatory Network, courtesy Neon Science)

In the next example, the **left image** shows what a LiDAR hillshade looks like from a bird's-eye view. Note the linear bumps or ridges – these are walls and roads! The **right image** shows the surveyor's interpretation of these different features. Your task is to conduct the same kind of survey for the Dana township.
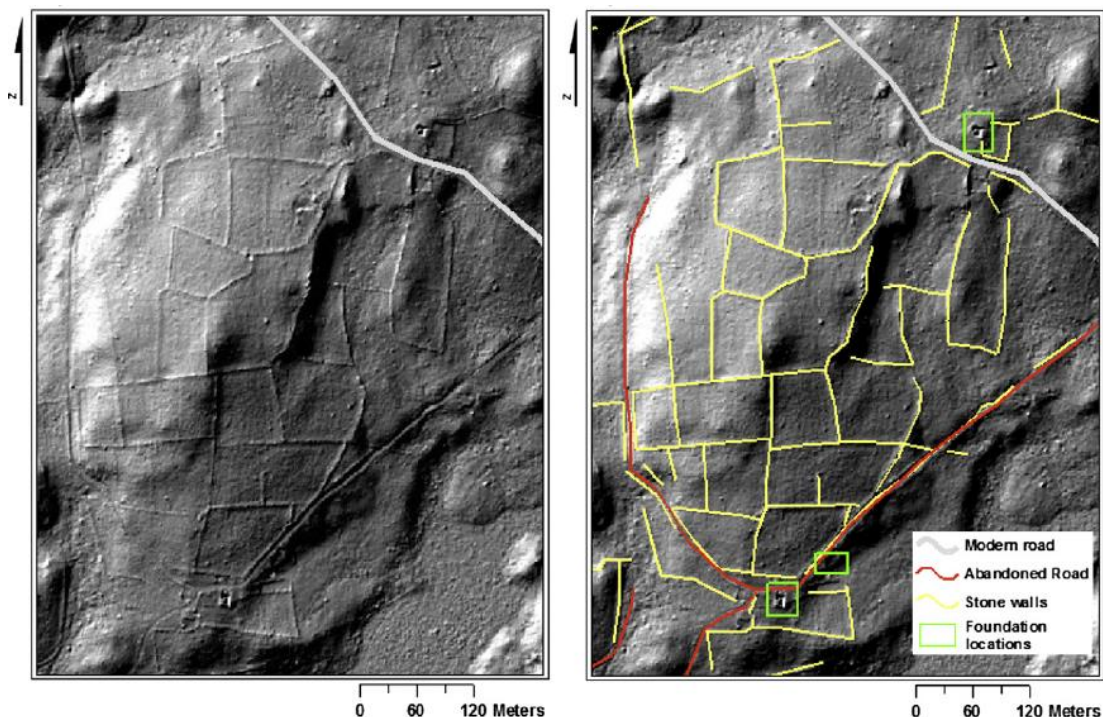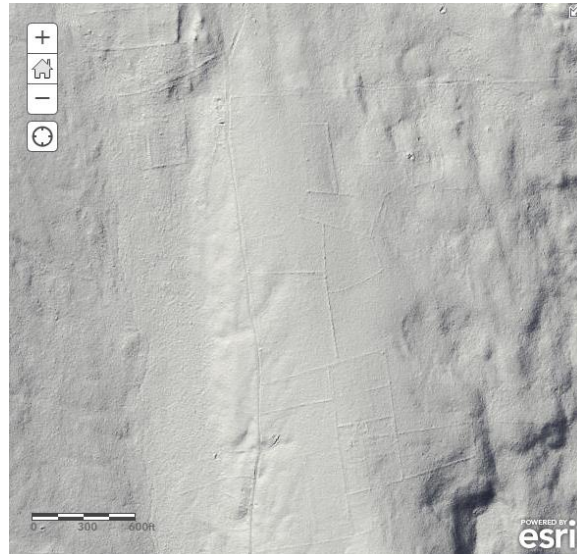

Excerpt from Johnson and Ouimet 2014: Figure 2

Let's zoom in to part of Dana to see what roads and walls look like in our LiDAR hillshade:
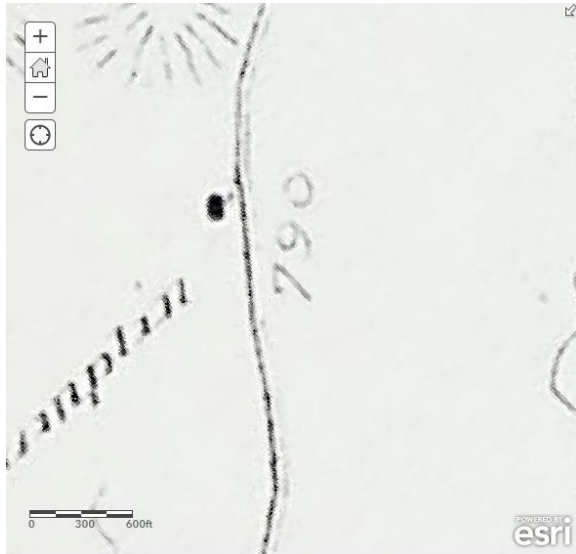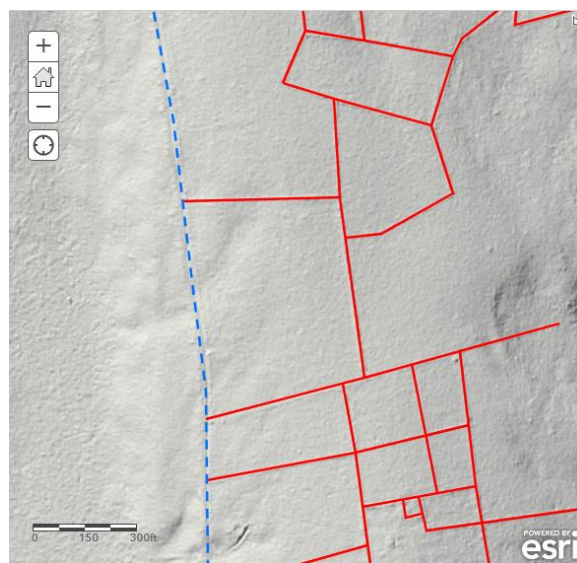

1. *Map from 1870 (notice the road)*

2. *Same area in the LiDAR*

3. *Same area, zoomed in a little more*

4. *Interpretation: road (blue) and walls (red)*

Tips for digitizing features in LiDAR

- **Look at all the available data**. In ArcGIS Online, you can turn individual **layers** on and off by checking the box next to their name. This lets you quickly toggle between different types of data (maps, satellite imagery, and LiDAR) to help you interpret a feature.

- **Zoom out for perspective**. Sometimes it's hard to tell what a feature is if you are zoomed in too closely. Zooming out can help you figure out if the line goes on for ages (a likely road) or if it is short (a likely wall).

- **Zoom in to digitize**. To create a line, you'll click in the map area, adding a point (or **vertex**) with each click. Zooming it will make the features appear larger, and therefore easier for you to "hit the target" while digitizing them.

- **A couple clicks per line is fine.** No need to spend too much time perfecting your clicks. Each line needs a start and end point … and if it is curvy or complex, you can add a few more points in the middle. Voila!

- **Stick to your survey square**. If a feature continues into another square, end it at the boundary of your own grid cell. The surveyor responsible for that square should (hopefully!) continue the line.
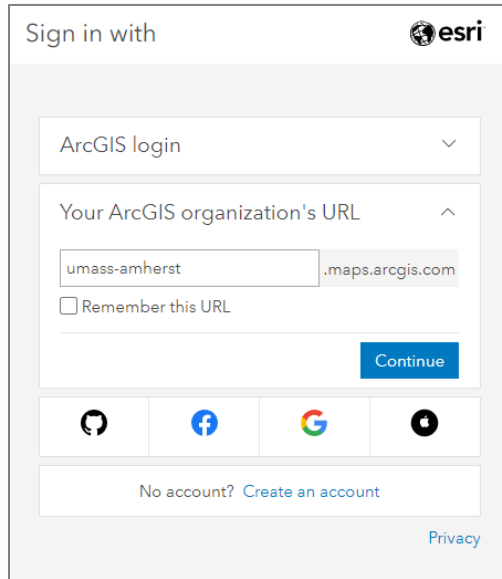
While digitizing…

- You can **zoom in and out** while the drawing tool is activated if you need to get a better look at a feature.

- Hold down the **Ctrl key** to snap your cursor to another feature you already drew.

- When you are done drawing a feature, **double-click** to end the sketch.

- You can **edit the line** after it's finalized by selecting it and adjusting the corners of the selection box – however it might be easier to delete it and start over.

Jump to <u>Step 6: Remote Sensing Survey Time!</u>

Step 1: Sign in to ArcGIS Online

1. Go to ArcGIS Online: https://www.arcgis.com/.
2. Click **Sign In.**
3. Click sign in with **Your ArcGIS organization's URL.**
4. Type **umass-amherst** into the text box, then click **Continue**.
5. If it appears, click the button **UMass-Amherst.**
6. Enter your UMass credentials to login.

Step 2: Take a Quick Tour of ArcGIS Online

1. After logging in, you will be directed to the UMass Home page in ArcGIS Online.
2. In the top menu bar, click **Content**.
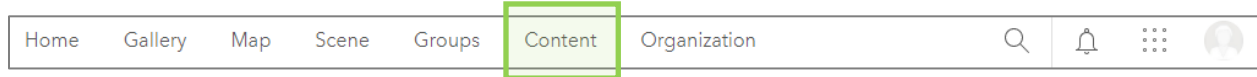
3. Another menu bar appears below this in blue. Click each of the tabs:
   a. **My Content**: this is the space for items that you create. (Note: if this is your first time logging in to ArcGIS Online, you won't have any content here.)
   b. **My Favorites**: items that you find elsewhere and like. (Ditto.)
   c. **My Groups**: items that are shared with you. (Ditto.)
   d. **My Organization**: items that other users at UMass created. (Jackpot! There are lots of items in here that you could use to make your own maps).
   e. **Living Atlas**: items that are created by Esri and anyone else in the world. (There are even more items here – thousands of them!)
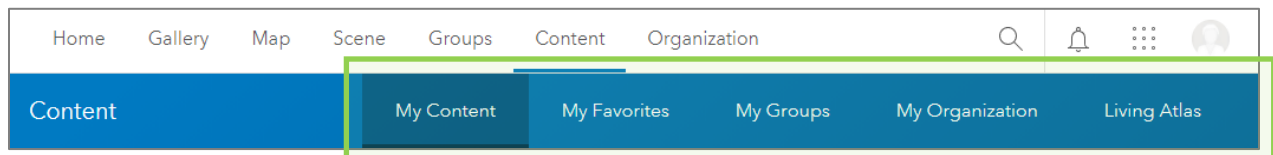
Step 3: Join the Classics 300 Group

Groups are a way to organize content in ArcGIS Online and share it with select colleagues and classmates. The Classics 300 group was set up to contain all the files your team needs to conduct a remote-sensing survey of Dana. To get access to these files, you need to join the group!

1. In the top menu bar, click **Groups**.

2. **If you're already a member of the Classics 300 group**, it will appear in the **My Groups** section of the site. Click the group's name to view its info page and skip to the next section.

3. **If you're not a member yet**, click **My Organization's Groups**. In the search bar type **Classics 300**. The group set up for this exercise will appear in the search results. Click the group name to view its info page.
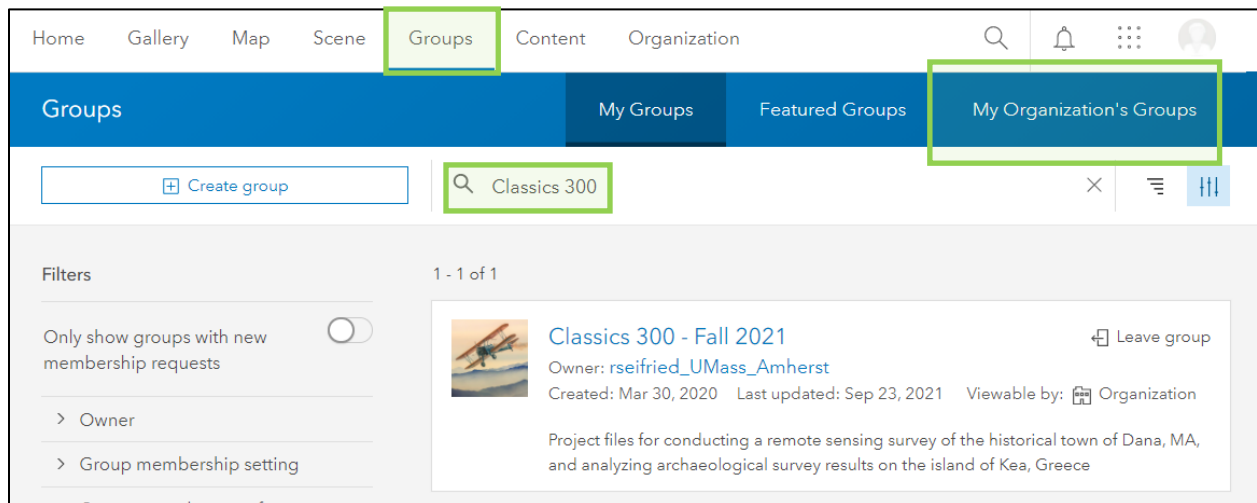

4. In the upper-right corner click **Join This Group**.

5. Once your request is submitted, it may take up to 24 hours for the administrator to approve it. Check back / refresh the page until you are granted access and can view all the details on the group's info page.

Step 4: Prepare Your Project Files

Now that you're a member of the Classics 300 group, you can view the files that have been shared with your teammates. Your task is to make a copy of the project map and create a new feature layer that you will use to digitize linear features visible in the LiDAR.

1. If you're not already there, navigate to the group info page.

2. Scroll down to the section titled **Featured group content**. You will see two web maps: the one you want is called Surveying Dana. This is the project file that you will need to copy into your own Content space.
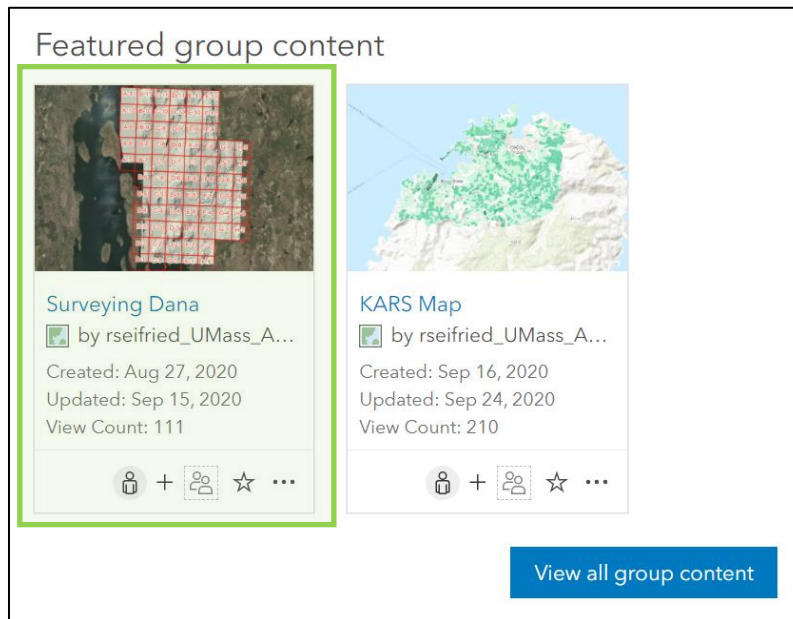
3. Click the title, **Surveying Dana**, to view the item's info page.

4. Take a moment to read the **metadata**: the description, list of included layers, terms of use if you want to reuse the content, and how to credit the map if you do. You can also click each of the layers to view their own info pages and read their specific metadata.

5. Go back to the information page for Surveying Dana. In the upper-right corner, click **Open in Map Viewer Classic**.
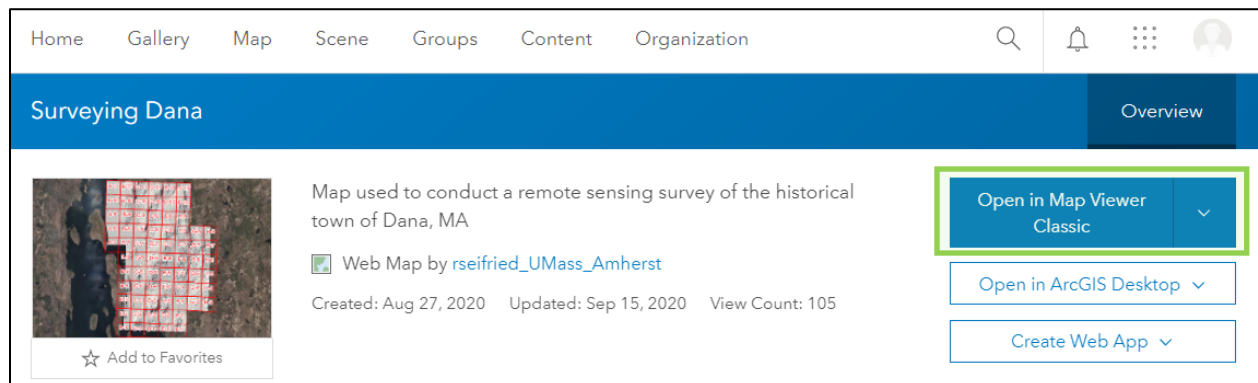
6. The Map Viewer launches and you can now interact with the map.

Don't worry – we will explore the Map Viewer in the next step! For now, let's finish getting your project files set up.

7. In the menu bar, click the save icon, then click **Save As**. This will let you save a copy of the map to your own Content space.
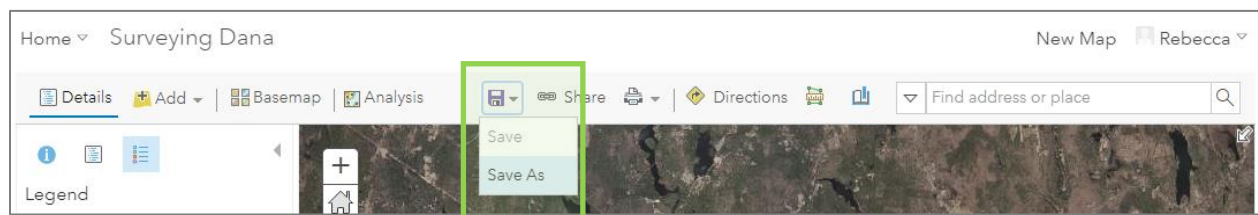

8. **In the Title box, name the map "Surveying Dana" followed by your initials or last name.** There can't be another file with the same name in our entire UMass ArcGIS Online account – so make it something unique to you! You can keep the default values for the **Tags**, **Summary**, and **Save in folder** fields. Then click **Save Map**.

9. The map you are now looking at is your own personal copy of the map, saved in your Content space. If you make any changes, only your copy of the map will be updated (not the version in the shared group space).

10. In the top menu bar, click the **Home** button, then **Content**. This will bring you to your personal Content space. You should see the map you just saved.
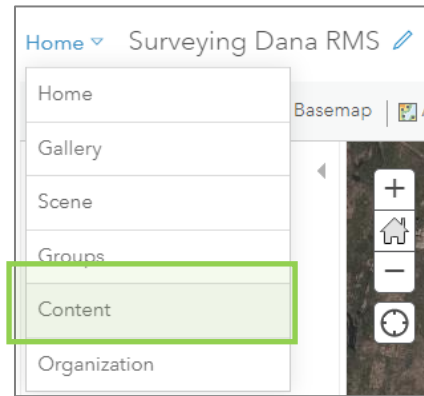

11. Now you'll create an empty feature layer that you will use to trace the features visible in the LiDAR hillshade. In the upper left corner, click **New item**, then **Feature Layer**.
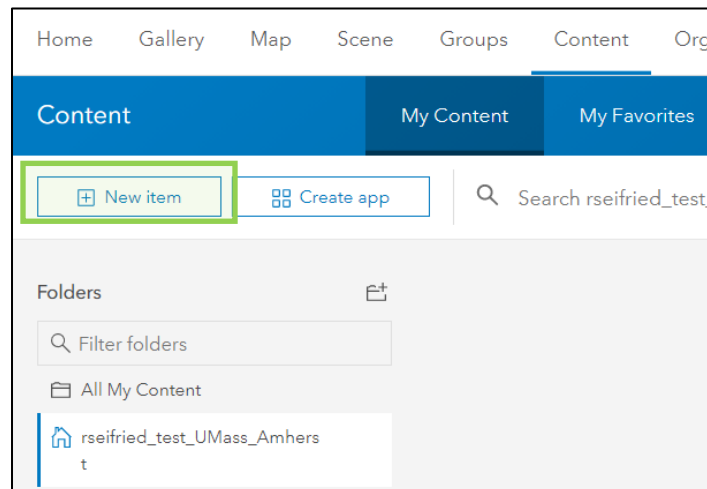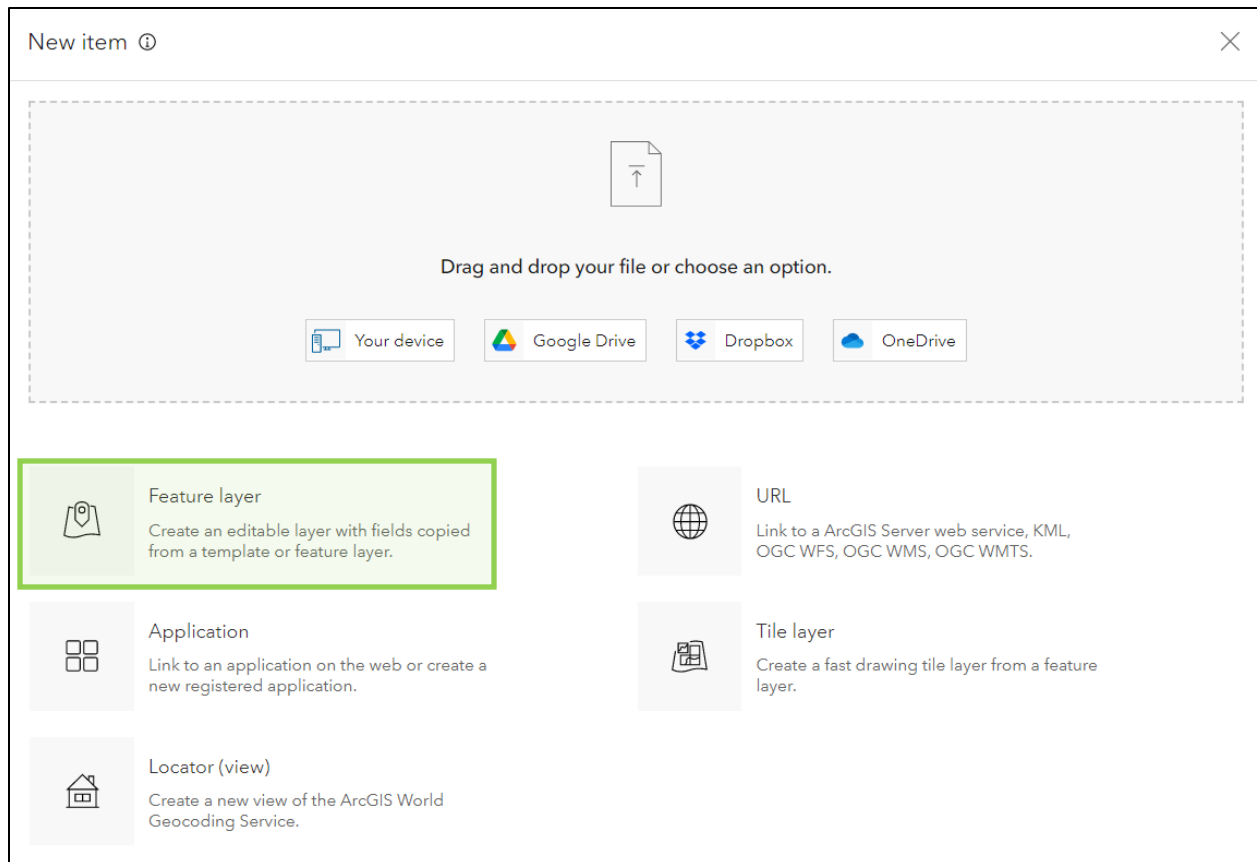
12. A template feature layer was created for this project and is shared with your group. You will create your own layer based on this template. In the top menu, click **From Existing Layer**. In the search bar, type **SurveyFeatures** (one word).
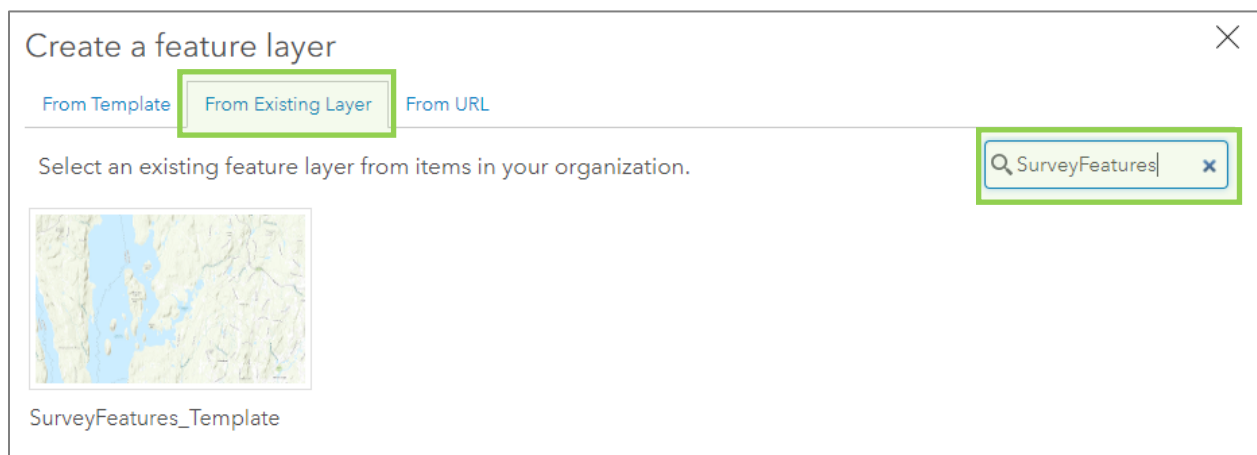
13. Select the item **SurveyFeatures_Template**, then click **Create**.

14. Make sure the layer SurveyFeatures is **checked**, then click **Next**.

15. Keep the extent coordinates as their default values. Click **Next** again.

16. **In the Title box, name the feature layer "SurveyFeatures" followed by your initials or last name.** You can keep the default values for the **Tags**, **Summary**, and **Save in folder** fields. Then click **Done**. Once the feature layer is created, you are taken to its information page.


Optionally, you can edit the metadata fields for the feature layer. For this exercise, it is not critical. But if you ever share an item with other people at UMass or with the public, it is very important to fill out the metadata so that they know who made the layer, how it was made, whether they have permission to reuse it, and how to give credit to the creators!

17. Now you'll add the layer to your copy of the map. On the top menu bar, click **Content**. Find your **Web Map** in the list. Click the three buttons on the right side, then click **Open in Map Viewer Classic**.
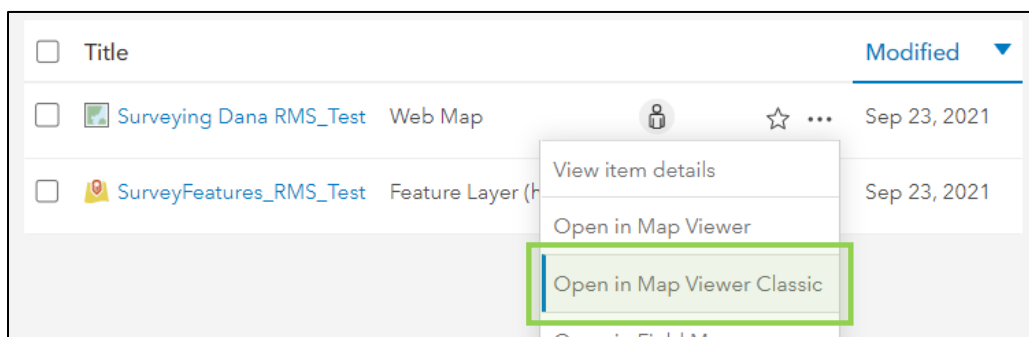
18. In the menu bar, click the **Add** button, then **Search for Layers**. By default, the window shows you all the items in your own Content space. The new feature layer you just created should appear.
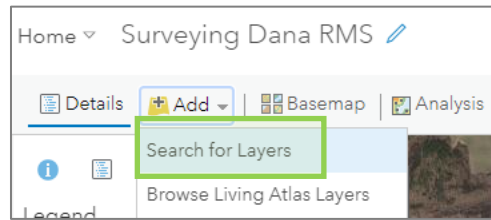
19. Click the **plus icon** in the bottom right corner of the item's box. Then click the **left-arrow icon** in the top right corner to return to the Contents pane.
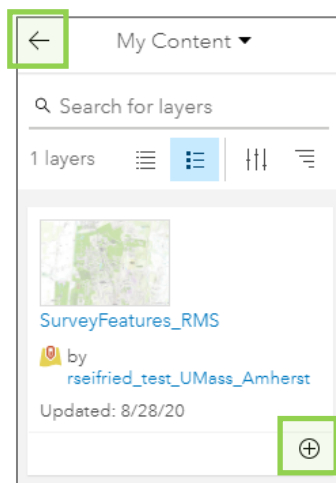

20. In the menu bar, click the save icon, then **Save**. If you need to sign out and take a break, the next time you open the map it will resume the session exactly where you saved it.

Step 5: Take a Quick Tour of the Map Viewer

Great job! You're now all set up and ready to begin surveying your assigned grid squares. But first, let's take a quick tour of the features that will help make your task easier.

1. If it isn't open already, open your copy of the **Surveying Dana Web Map**.

2. The **Details** panel is on the left side of the screen. It has three different view options to let you interact with the map in different ways.

   a. The **About** 🛈 panel shows the summary of the map and has a link (More Details…) to return to the item's information page.

   b. The **Contents** 🗏 panel shows a list of all the layers in the map. You can turn them on/off by checking the boxes to the left of their names.

   c. The **Legend** 🗎 displays information about the active layers in the map.

*About*   *Contents*   *Legend*
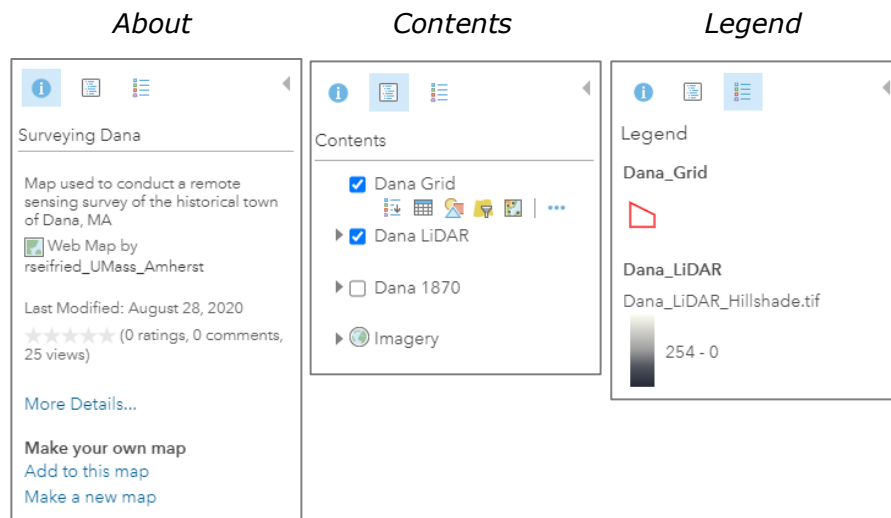
3. Activate the **Contents** panel. Each of the items in this list is called a **layer**.

4. Turn off the layers **Dana Grid** and **Dana LiDAR** by **unchecking** their boxes. Turn on the layer **Dana 1870** by **checking** its box.

5. Quickly zoom to the historical map by clicking the three buttons below **Dana 1870**, then click **Zoom to**.
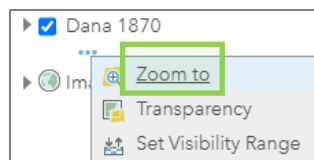

6. Use the + and − buttons in the upper left corner of the map OR use your mouse scroll wheel to in and look for the area labelled **Dana Centre P.O.** This was the town common in the 19th century. Note that the map shows the location of all the roads in the township, as well as locations of different farmsteads along with the owners' names. This could be helpful information when you are digitizing features visible in the LiDAR!

7. Let's experiment with **layer visibility and transparency**! Layers at the top of the list appear "above" the other layers in the map area. This means that layers at the bottom of the list might not be visible.

   a. Turn on **Dana Grid** and **Dana LiDAR**. Click the whitespace to the right of **Dana 1870** and drag it so it is between the two layers. Now the LiDAR layer is hidden.
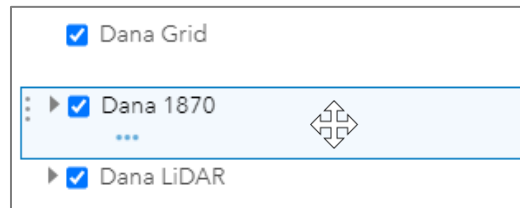
   b. Click the **three buttons** below Dana 1870 and click **Transparency**. Adjust the slider so that the LiDAR layer below it starts to become visible. This is one way to quickly compare information between different layers in the map. Another way is to toggle layers on/off.

   c. Turn off **Dana 1870**.

8. Now let's take a look at an **attribute table**. When you copied the SurveyFeatures template, you also copied information that is stored in an associated table. Open the attribute table by hovering over the layer's name, then clicking the **table icon** that appears.
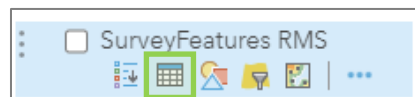
   a. The table appears at the bottom of the screen.

   b. Note that there are 0 features – nothing has been mapped yet!

   c. Right now, you can see only a few of the fields that are stored in the table. In the upper-right corner of the table, click the **three parallel lines**. Then click **Show/Hide Columns**.
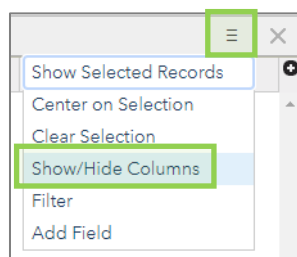

   d. Now you can see all the fields that are associated with this feature layer. The two fields will be adding information to are **Category** and **Notes**. Some of the fields (like Creator and CreationDate) will be updated automatically as you create new features.

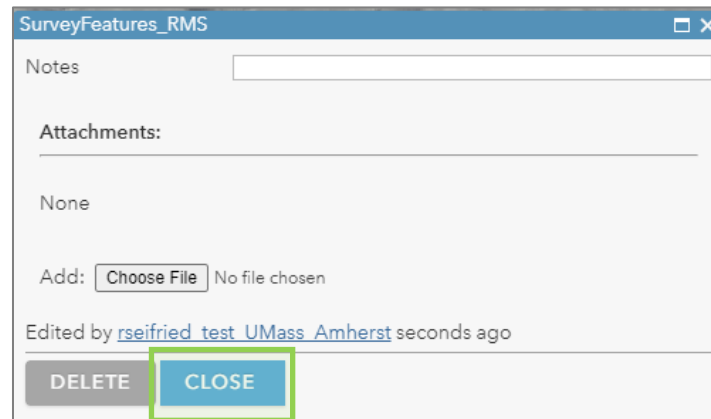   e. Close the table by clicking the **X** in the upper-right corner.

Step 6: Remote Sensing Survey Time!

1. Locate one of the grid cells you were assigned.

2. Trying zooming in and out to the grid cell.
   a. **Zoom in** far enough that the grid cell fills your screen. Notice how the label automatically disappears and makes it easier for you to view the LiDAR imagery.
   b. **Zoom in** even further until the LiDAR imagery disappears.
   c. You will need to stay between these two zoom levels when digitizing features in the LiDAR imagery.

3. In the Contents pane, make sure your **SurveyFeatures** feature layer is turned on. In the menu bar, click the **Edit** button. The Edit button will only appear if the layer is activated, since it is the only layer you have permission to edit.

4. There are two predefined categories of feature that you can map: **Roads** and **Walls**. Click one of the categories to activate the drawing tool, then start clicking in the map area to draw a feature.

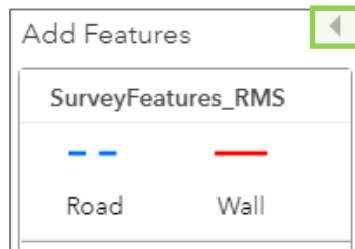**See the Tips for digitizing features in LiDAR for more guidance.**
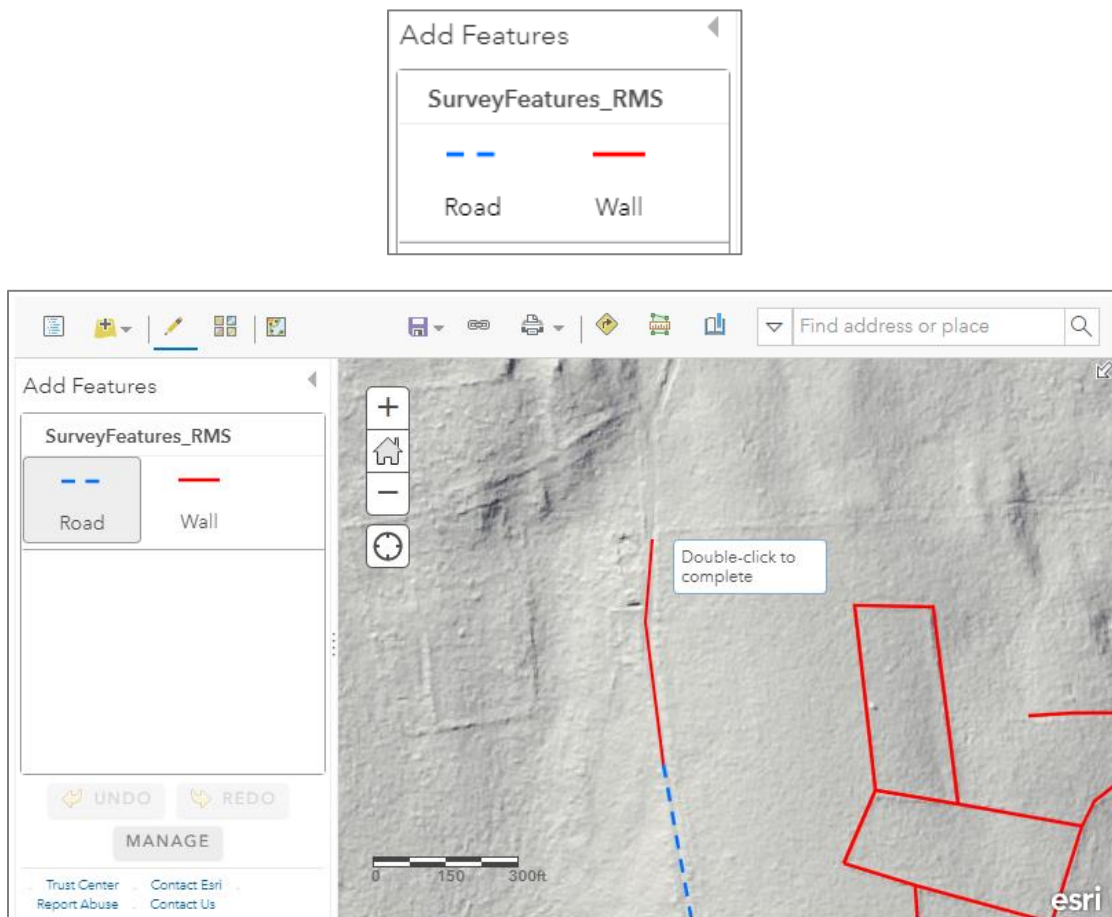
5. When you finish a sketch, a window pops up allowing you to add a comment to the Notes field or add an attachment. The **Notes** field is optional – if you feel it important to add a note that your fellow surveyor's may find interesting, do so! Ignore the Attachments section for this exercise. When you are done, click **Close**.

6. At any time, you can exit the Add Features panel by clicking the **back-arrow** in the upper-right corner. Any features that you were in the middle of digitizing will not be saved – **make sure to finish the sketch you are working on before exiting**.

7. **Save** your map if you need to sign out and take a break.

Step 7: Share Your Results with the Group

1. When you are finished surveying all your assigned squares, save your map one last time. Return to your Content space by clicking **Home** in the upper-left corner, then **Content**.

2. Let's finalize your work by updating the extent of your **SurveyFeatures** feature layer. Click the layer to go to its information page.

   a. In the blue menu, click **Settings**.

   b. Click the **Edit Extent** button.

   c. On the left panel, expand **Coordinates**. Enter the following values:

Top (Latitude):	42.49
Bottom (Latitude):	42.38
Left (Longitude):	-72.28
Right (Longitude):	-72.20

   d. In the bottom right corner, click **Save**.

3. Next, let's share the layer with the Classics 300 group. Right now, your **SurveyFeatures** layer is not shared with anyone – only you have permission to view it. To change this setting, in the blue menu click **Overview**, then click the **Share** button.
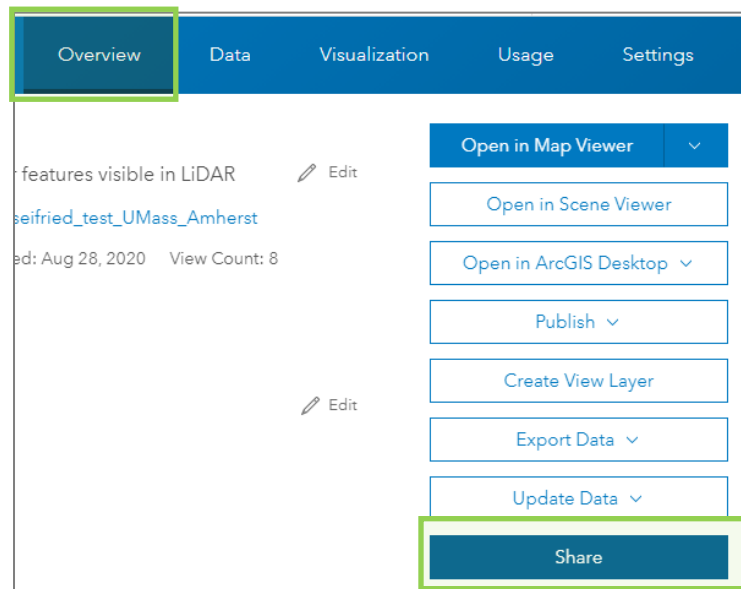
4. Near the bottom of the window, click **Edit Group Sharing**.

5. Check the box next to the Classics 300 group, then click **OK**. Click **Save**.

6. Now we can take a look at what your fellow surveyors have been up to! Navigate to the Classics 300 group (top menu > Groups > Classics 300 > Content).

   a. Click one of **SurveyFeatures** layers that a fellow surveyor has shared with the group to view its information page.

   b. On the info page, click the **dropdown arrow** next to Open in Map Viewer, then click **Add to New Map**.

Congratulations! You and your team have completed a remote sensing survey of the historical township of Dana, Massachusetts. Your ArcGIS Online administrator will compile the results of the survey so you can analyze all the results as a team – expect more information about how to view those results soon!

Further Reading

Stone walls in New England

- [Atlas Obscura – New England Is Crisscrossed With Thousands of Miles of Stone Walls](#)
- [Terra Firma, Part 5 – Stones that Speak: Forgotten Features of the Landscape](#) (PDF)
- [University of Connecticut – Stone Wall Initiative](#)

LiDAR

- [The Basics of LiDAR Remote Sensing](#)
- Johnson, Katherine M. and William B. Ouimet (2014). Rediscovering the lost archaeological landscape of southern New England using airborne light detection and ranging (LiDAR). *Journal of Archaeological Science* 43: 9-20. ([Link to UMass Libraries](#))
- [New Hampshire Stone Wall Mapper](#)

History of the Quabbin Reservoir

- [Mass GIS – Quabbin Reservoir](#)
- [The Quabbin Valley – Gate 40: Dana Town Common Map](#)