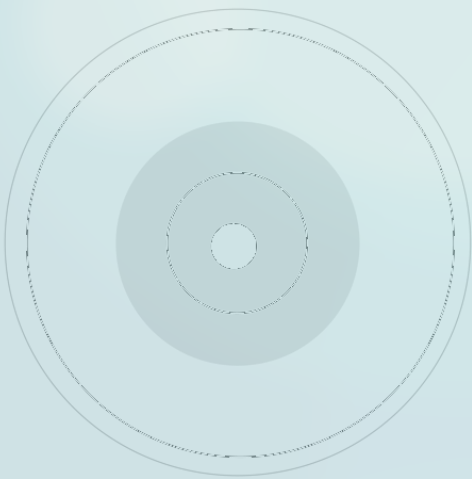


Visualizing an E. Coli Outbreak



Lesson Overview

By December 2018, nearly 24 people had been hospitalized and dozens of others sickened after romaine lettuce tainted with [E. coli](#) in Southern California spread to 15 American states and Canada. This foodborne illness seldom results in death, but it can devastate its victims with kidney failure as well as fever, confusion, vomiting, and seizures.

U.S. health officials want to contain the outbreak, so they've asked for your help. The lettuce has been recalled, but more needs to be done to protect the public. In this lesson, you'll use your GIS skills to identify the outbreak's origin, trace its spread, and update officials.

Build Skills

- Build a spreadsheet in the CSV format and import it into a map
- Mark a location using a Map Note
- Use a proximity tool to generate lines illustrating data and origin points lines

Software Requirements

- ArcGIS Online account (obtain free [ArcGIS Public](#) or [ArcGIS trial](#) accounts)
- Spreadsheet software (Microsoft Excel, Google Sheets)

Estimated Time

- 30 minutes to 1 hour

Exercise

Step 1: Collect data about lettuce recall and E. coli illnesses

On November 20, 2018, the [Centers for Disease Control and Prevention](#) (CDC) and the [U.S. Food and Drug Administration](#) (FDA) announced their investigations into foodborne illnesses related to E. coli bacteria in romaine lettuce. By then, grocery stores had pulled, and customers had thrown out, their romaine lettuce. Eventually, officials determined that the tainted lettuce had originated from a farm in Santa Maria, California.

This lesson assumes you already know how to add and symbolize map data. A basic working knowledge of Microsoft Excel or Google Sheets is helpful but not required.

You will visualize the reported illnesses associated with the E. coli outbreak by doing the following:

- Building a spreadsheet using the comma-separated values (CSV) format and importing it into a map
- Locating the origin of the tainted romaine lettuce using a Map Note
- Generating lines to connect the states with E. coli to the illnesses' origin point
- Updating your map and rerunning the tool

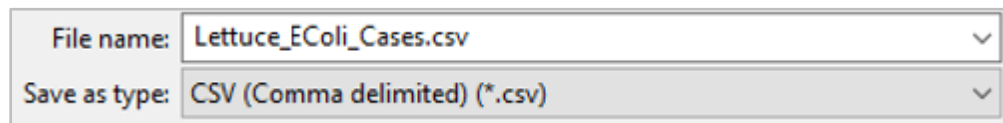
One way to turn tabular data into GIS point data is using a spreadsheet saved in the CSV file format. CSV stands for comma-separated values. A text file of data contains commas that, when brought into a spreadsheet, create columns for the data. You will skip the use of a text file and enter your data directly into a spreadsheet of columns and rows.

As of January 2019, when this lesson was published, the E. coli cases per state were as follows:

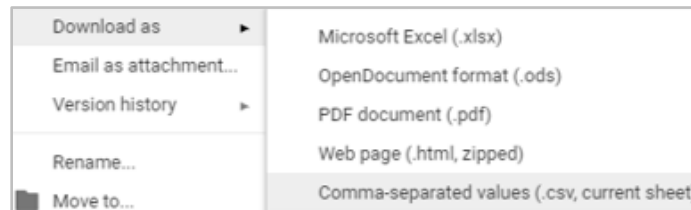
California	12
Connecticut	1
District of Columbia	1
Florida	1
Illinois	2
Louisiana	1
Maryland	1
Massachusetts	1
Michigan	7
New Hampshire	6
New Jersey	12
New York	7
Ohio	1

Pennsylvania	4
Rhode Island	1
Wisconsin	1

- Using a Microsoft Excel or Google Sheets spreadsheet, list all the affected states in one column and the number of cases per state in another column. Include headers (*State* and *Illness Cases*) in the first row. The order of the states does not matter, but correct spelling does. Name the spreadsheet something you can easily remember.
- When saving the spreadsheet to your computer, change the file type to CSV.
 - For MS Excel, select **File** and **Save As** and choose a location on your computer to save it. Save the spreadsheet as **CSV (Comma delimited)**.



- For Google Sheets, select **File** and **Download as**. Choose **Comma-separated values (.csv)** and save it to your computer.



The CSV file containing your illness data can be imported directly into your map. Note that the data will not be published to your organizational account. Instead, it'll be saved only in the map. Deleting the maps also deletes the imported data, which means you will have to import the CSV file again if you want to use the map.

- Sign into your [ArcGIS Online account](#).

NOTE: If you don't have an organizational account, you can sign up for an [ArcGIS free trial](#).

- Open a new map, click **Add**, and choose **Add Layer from File**.
- Click **Choose File** and browse for the CSV file you just created. Select the file and click **Import Layer**. A small screen may appear with a section for you to review the fields (headers) that will be used to locate your entries.
- In the **Add CSV Layer** window, if necessary, do the following:
 - Confirm that the **Address or Places** option is selected since you used state names in your spreadsheet rather than coordinates.

- Select **United States** for the **In** box.
- Your **State** field (left column) should be matched with the **State** location field in the right column.
- The field for the number of ill people should not be used in identifying the geographic location of the entries, so it should say **Not used** in the right column.

Add CSV Layer ✕

Locate features by:

Coordinates
 Addresses or Places
 None, add as table

In:

Review the location fields. Click on a cell to change it.

Field Name	Location Fields
State	State
Illness_cases	Not used

ADD LAYER
CANCEL

7. Click **Add Layer** to complete the import process.

Your new layer has been added to your map. The layer may automatically be symbolized according to the number of ill people. You can edit this to your liking.

8. Click **Done** to close the symbology menu.

Q1. In the Add CSV layer window, why did you ensure that State in the Field Name, and State in the Location Fields, were matched?

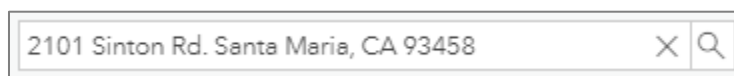
A1. _____

Step 2: Locate the tainted lettuce source using a Map Note

A Map Note is not traditional GIS point data. Rather, think of it as a sticky note that you can use to mark or draw with, complete with a symbol and a description. You will use a Map Note to quickly mark the origin of the tainted romaine lettuce that caused the E. coli outbreak.

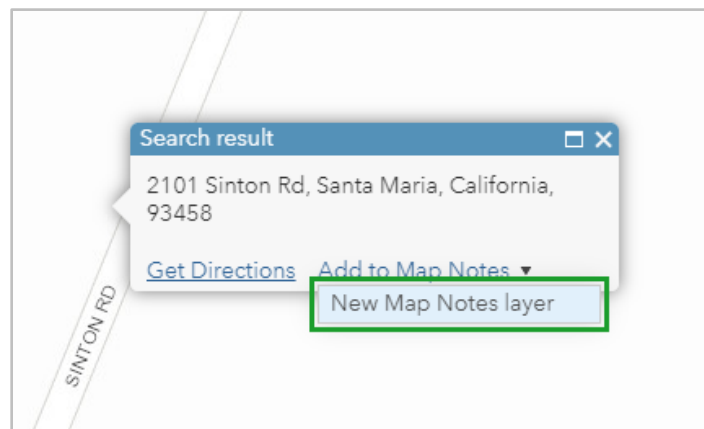
According to recent reports, the tainted lettuce originated from a farm in Southern California.

1. Type 2101 Sinton Rd. Santa Maria, CA 93458 in the search box in the upper right corner of the screen.



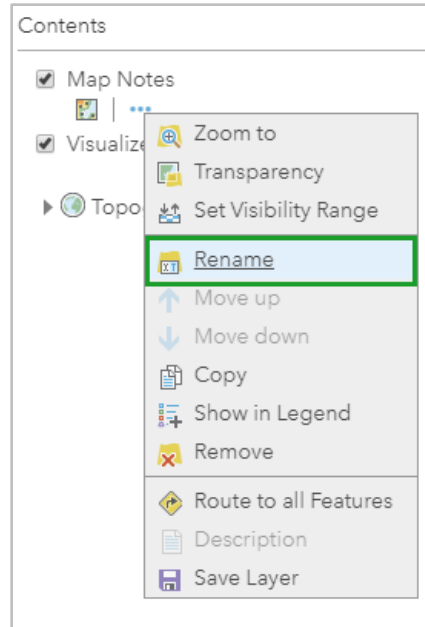
The map zooms to that location. A search result box confirms the location and marks it with a blue pointer, which is hidden behind the **Search result** window.

2. To save this location and embed it into the map, click the drop-down arrow next to **Add to Map Notes** and choose **New Map Notes layer**.



This Map Note now appears in your table of contents.

3. On the **Map Notes** layer, click the **More Options** button and select **Rename**.



4. In the **Rename** window, type Tainted Lettuce Source and click **OK**.

The **Contents** pane now shows a Lettuce Source layer created from your Map Note.

Your map now contains all your data: Points on each state symbolized by the number of reported illnesses as well as an origin point marking the source of the tainted romaine lettuce using a Map Note. Next, you will run an analysis tool called **Connect Origins to Destinations** that will visualize the paths of the lettuce from the farm to the various states where illness outbreaks have been reported.

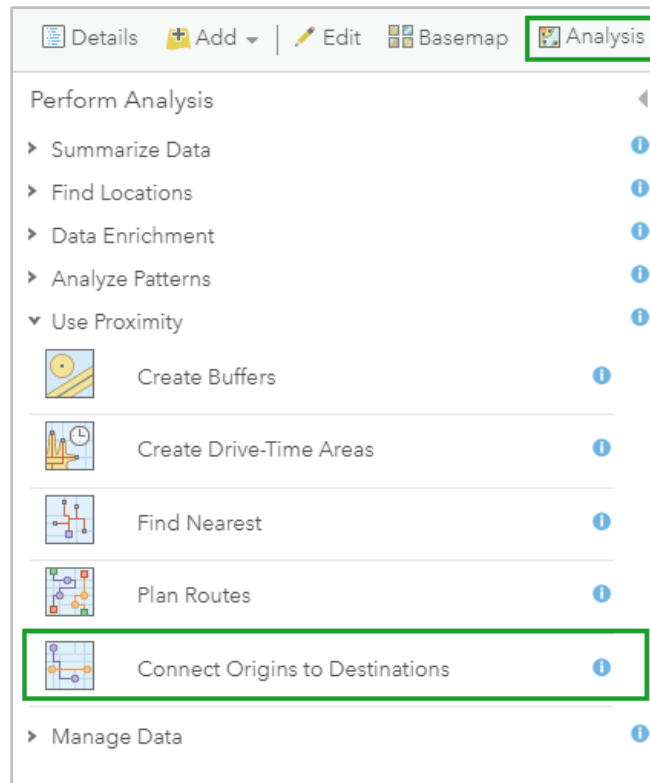
Q2. What happens to your data if you create a Map Note but don't save it as a layer?

A2. _____

Step 3: Visualize the illness paths from the source to the states

The Connect Origins to Destinations tool can calculate routes based on time or distance regardless of whether you're walking, driving, or trucking. However, you will use another option, Line Distance, to ignore actual routes and simply draw lines that will act as a visual by connecting the source farm to the affected states with straight lines.

1. Click **Analysis**, expand **Use Proximity**, and select the **Connect Origins to Destinations** tool.



2. For **Choose point layer representing the origin locations**, if necessary, click the drop-down arrows and select **Tainted Lettuce Source (Points)**.
3. For **Route to destinations in**, if necessary, choose **Visualize E Coli Outbreak** layer, which is your CSV file.
4. For **Measure**, accept your default of **Line Distance**.
5. For **Result layer name**, type a new name for the resulting layer, uncheck **Include route layers**, uncheck **Use current map extent**, and click **Run Analysis**.

1 Choose point layer representing the origin locations:

Tainted Lettuce Source (Points)

2 Route to destinations in

Visualize E Coli Outbreak

3 Measure

Line distance

Select barrier layers

4 Result layer name

Tainted Lettuce Source to E Coli Outbreaks

Include route layers

Save result in: Your Folder

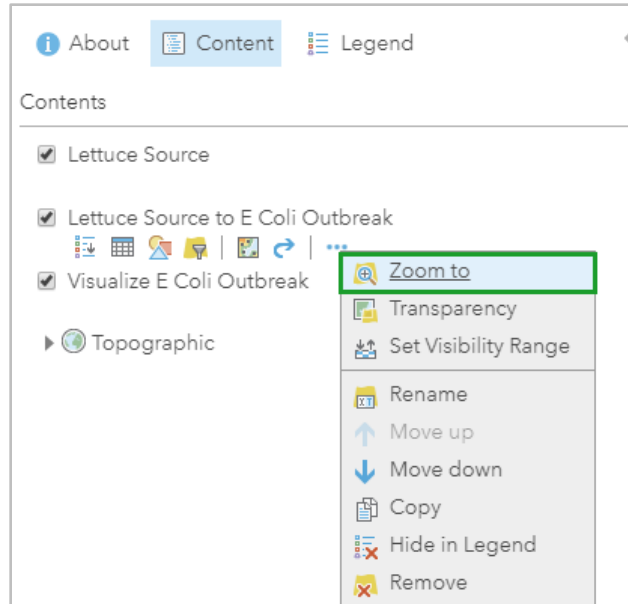
Use current map extent [Show credits](#)

RUN ANALYSIS

The result of the tool, which can take several moments to run, is a layer connecting the suspected origin of the tainted lettuce to reported E. coli outbreaks. These lines can be symbolized by an attribute (such as the number of ill people, which may be redundant) or by distance, or left as a single symbol using one color scheme.

For now, you'll see the entire map.

6. On the **Tainted Lettuce Source to E. Coli Outbreaks** layer (or whatever you named the new layer resulting from the tool), click **More Options** and choose **Zoom to**.



Your map zooms out to show all the connections tracing the outbreaks back to their source.



Further embellishments can be made, including adding labels, changing the basemap, adjusting symbology and transparency, and customizing the pop-ups.

Finally, you'll want to save your map.

7. On the ribbon, click **Save** and click **Save As**.

8. In the **Save Map** window, do the following:

- For **Title**, type E Coli Source and Outbreaks.
- For **Tags**, add E Coli, romaine lettuce, 2018 (press **Enter** after each tag).

- For **Summary**, type Map connecting 2018 E Coli outbreaks with their origin.
- Store in a folder of your choice and save.

Save Map

Title: E. Coli Source and Outbreaks

Categories: + Assign Category

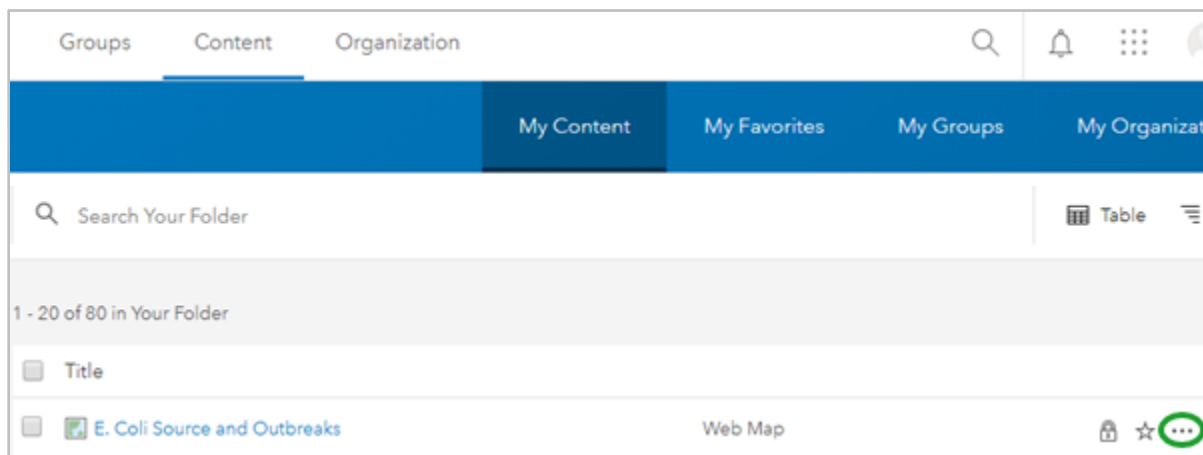
Tags: E Coli x romaine lettuce x 2018 x
Add tags

Summary: Map connecting 2018 E Coli outbreaks with their origin

Save in folder: Your Folder

SAVE MAP CANCEL

You've created a web map. You can find its folder by clicking **Content** on the top ribbon and **My Content** on the blue ribbon. The **More Options** button (...) gives you options including **Open in Map Viewer**.



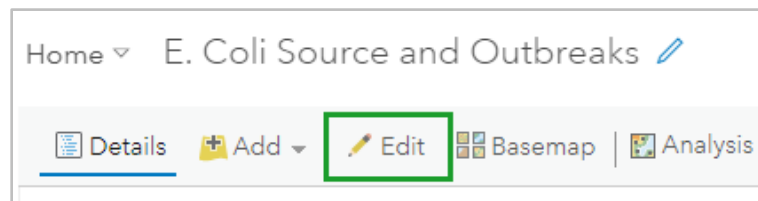
Q3. The Connect Origins to Destinations tool measures the time or distance between pairs of points using straight lines or travel modes. You own a trucking business and you want to become more efficient to save money. How could this tool help?

A3. _____

Step 4 (Optional): Update illness information and rerun the tool

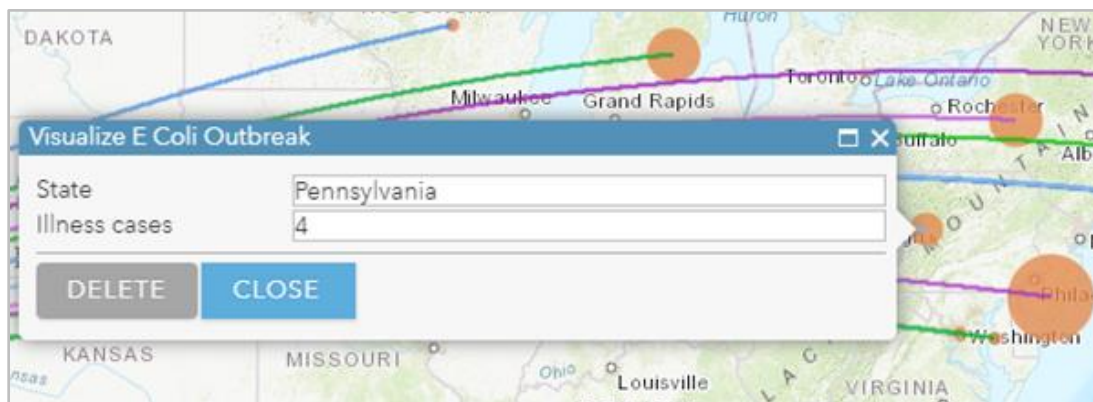
When mapping an illness outbreak, it's important to remember that additional cases may be reported after your map is published. There are many ways to update your data. This module focuses on one method, which involves using the **Edit** button to add or edit features, and then using the **Rerun** button to update the analysis.

When you create a layer, or are authorized to edit one, an **Edit** button appears in the top ribbon.



Clicking this button allows you to edit layers. In this case, you'll edit the Map Notes and illness CSV layers. You'll start by editing an existing point.

1. Click **Edit**, point to the orange circles representing New Jersey or Pennsylvania, and click. (These states were the only ones that updated their outbreak information after this lesson was published.)



A pop-up opens with editable fields.

2. Change the illness count to reflect [updated information](#) from the CDC and click **Close**.

Alternative method: Without clicking **Edit**, open the attribute table of the illness layer. The fields in the table are editable because you're authorized to edit the layer.

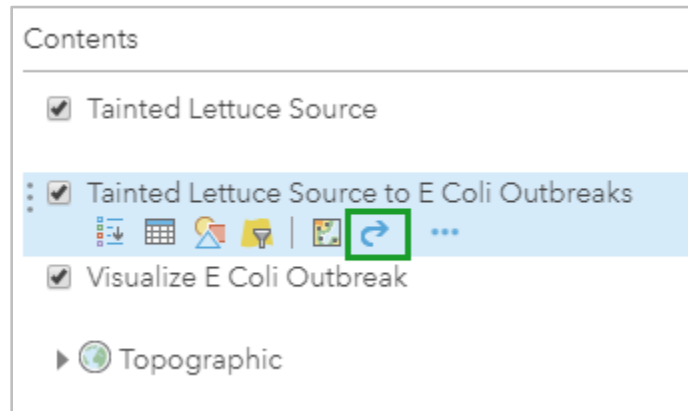
3. Add a new illness point to another state: Click **Edit** and find the **Visualize E. Coli Outbreak** layer in the **Add Features** menu. Click **New Feature** and click any state without an orange dot.

4. Type that state's name and a number and click **Close**.

To connect a line from the origin source to your state, you will need to rerun the Connect Origins to Destinations tool, so your map reflects the latest data.

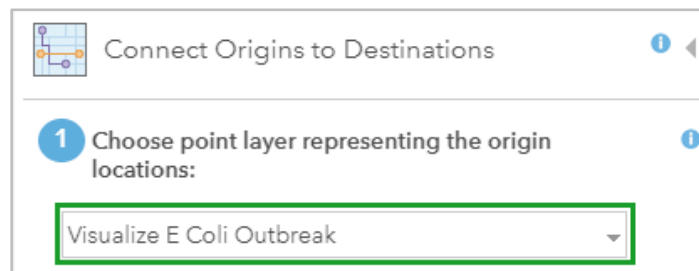
5. If necessary, click **Edit** to return to the **Contents** pane.

6. Point to the **Tainted Lettuce Source to E Coli Outbreaks** layer and click the **Rerun Analysis** button to reopen the **Connect Origins to Destinations** tool.

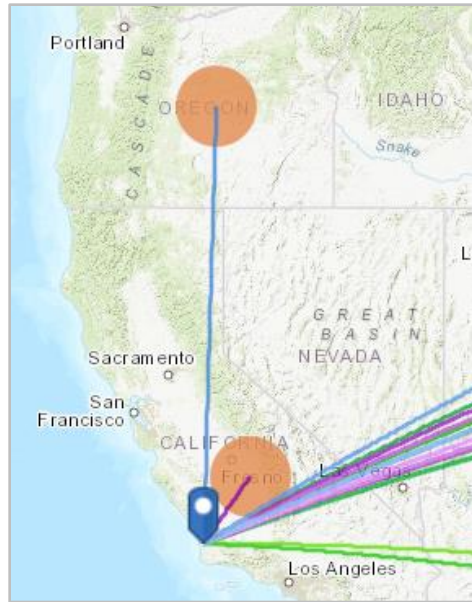


Most of the information in the tool pane is correct; however, you need to reset the first step's point layer to the Visualize E Coli Outbreak layer, where the added data for your state is embedded.

7. For **Choose a point layer representing the origin locations**, click the arrow and select the **Visualize E Coli Outbreak** layer.



8. Update the resulting layer's name and click **Run Analysis**. When finished, turn off the original resulting layer in favor of the new one.



Q4. By rerunning the Connect Origins to Destinations tool, you updated your map. Why is it important to always have an updated map?

A4. _____

Next steps:

- Map other recent outbreaks using data from the CDC website.
- Add to a web app, such as a story map, or a dashboard using Web AppBuilder.

Questions and comprehension:

- Where can I learn more about CSV files?
- The following link explains CSV files in greater detail: [CSV, TXT, and GPX files](#)
- For more practice using CSV files, try this lesson: [Add a layer from a CSV file](#)
- Besides CSV, what other file types can be published to my ArcGIS Online account?
- The following link explains publishing hosted feature layers: [Publishing hosted feature layers](#)
- What is a Map Note?
- The following link explains Map Notes: [Map Notes](#)
- How does the Connect Origins to Destinations tool work?
- The following link explains how the analysis tool works: [Connect Origins to Destinations](#)
- How do I create a story map or other web application?

- The following link will help you create a web application: [Choosing a Configurable App](#)
- How are credits used?
- The following link will help you understand credit usage: [Understanding credits](#)

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Exercise Answers

Q1. In the Add CSV layer window, why did you ensure that State in the Field Name, and State in the Location Fields, were matched?

A1. You must have a matching field to convert addresses from a spreadsheet into spatial data you can plot on a map.

Q2. What happens to your data if you create a Map Note but don't save it as a layer?

A2. It disappears. Map Notes are temporary sticky notes until you save them as part of the map.

Q3. The Connect Origins to Destinations tool measures the time or distance between pairs of points using straight lines or travel modes. You own a trucking business and you want to become more efficient to save money. How could this tool help?

A3. Answers could vary widely; however, possible answers include calculating mileage to estimate gas costs, organizing driver schedules to avoid needless overtime, rerouting trucks to faster roads, and so on.

Q4. By rerunning the Connect Origins to Destinations tool, you updated your map. Why is it important to always have an updated map?

A4. Answers could vary, but generally, having an updated map gives you credibility as a cartographer. People viewing your product could rely on your map for accurate analysis, images, and information, so not checking for the latest data means those people may act on incomplete information.

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About the Author



Jason Smolinski is a geospatial analysis teacher at a Virginia high school. He is also a former GIS analyst.

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