

North Cascades National Park Service Complex

Culvert Inventory Using Survey123 for ArcGIS and ArcGIS Online: GIS Data Access Guide



Purpose

To address the lack of a spatially-based comprehensive culvert inventory in North Cascades National Park Service Complex. During the North Cascadia Adaptation Partnership, culvert inventorying and design improvement was identified as a climate adaptation strategy as climate change impacts peak flows. The limited spatial information on culverts at NOCA in FMSS prevents accurate conversion of culvert data into a GIS layer for analysis. This guide provides instructions to park employees on accessing and manipulating spatial data from the culvert inventory project.

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Introduction

A culvert is any structure not classified as a bridge that provides an opening under a roadway or trail at a stream or drainage crossing. A culvert is typically defined by one of the following:

- A structure that is usually designed hydraulically to take advantage of submergence to increase hydraulic capacity.
- A structure used to convey surface runoff through embankments.
- A structure, as distinguished from bridges, that is usually covered with embankment and is composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert.

Culverts are used primarily to convey water through embankments or other type of flow obstructions. They are also used as a passage for pedestrians, stock, wildlife, and fish, as well as for land access and to carry utilities.

As flood extremes magnify with climate change, culverts are at an increased risk of inundation and failure, impacting stream function, aquatic organism passage, and park transportation infrastructure for staff and visitors. Existing Global Climate Models (GCMs) meteorological data have been utilized as inputs into the Variable Infiltration Capacity (VIC) macroscale hydrological model by University of Washington researchers to estimate future peak flows in the NOCA region. With a geospatial database of culverts, researchers and park staff will be able to overlay these hydrologic models with culvert point location data to determine which culverts are most at risk under projected flood extremes. This will be a crucial tool for transportation infrastructure management as we continue to weigh the impacts of changing temperatures.

This project utilizes the mobile application Survey123 for ArcGIS in tandem with the cloud-based mapping system ArcGIS Online, enabling us to create an online culvert database that can be accessed and downloaded by NPS employees through the ArcGIS Online portal. Given that NOCA comprises at least 75 road miles and 389 trail miles, relying solely upon staff to survey the park's hundreds of culverts would be a costly and time-consuming process. With a mobile app, we empower volunteers to submit culvert data easily, and minimize the training and equipment necessary. In crowdsourcing the data, we have the opportunity to survey culverts more rapidly while also engaging and educating volunteers on the implications of climate change in our local parks.

Our aim is to develop a comprehensive georeferenced inventory of culverts with help from volunteers. Volunteers will work alongside NPS employees with park-furnished iPads or data sheets and measuring tools to gather details on culverts and the surrounding environment.

ArcGIS Online

ArcGIS Online is a cloud-based web GIS that allows users to utilize, create, and share maps, layers, and data. As an Esri product, ArcGIS Online is directly linked to ArcGIS for Desktop as well as other Esri applications. ArcGIS Online is accessible through internet browsers, mobile devices, desktop map viewers, and ArcGIS apps.

ArcGIS Online Organizations

The primary method of accessing ArcGIS Online is through an organizational account. Organizations in ArcGIS allow for a customized experience, enabling organization members to share work, create and participate in groups, and jointly edit files. The National Park Service has its own ArcGIS Online organization you are likely already aware of and affiliated with. For new users, contact GIS personnel with administrative privileges to initiate the account set-up procedure. The NPS organizational ArcGIS Online homepage can be found at <http://nps.maps.arcgis.com/home/index.html>.

Joining the Culvert Inventory Group on ArcGIS Online

Once set up and logged in using the NPS-affiliated organizational account, request to join the “Culvert Inventory” group. Using the search bar in the upper right-hand corner, use the keywords “culvert inventory” and search for groups. The search results should yield a group with the description “NOCA Survey123 Culvert Inventorying.” Select this group, and on the following page, click “Join This Group.” Your join request will be sent to the group administrator for approval.

Note for Group Administrator: Navigate to the “Culvert Inventory” group in the ArcGIS Online interface and click “Membership Requests” to approve any pending members.

As a group member, you have full editing privileges to any of the content shared to the group. See the following section, Linking the ESRI Content, for details on each item shared with the group.

Linking the ESRI Content

There are two methods for recording and submitting data: (1) Survey123 app on cell phone or tablet, or (2) physical data sheet to be filled out by hand and entered into database manually. (See the Survey Guide for more details on both methods.) Both methods populate the same feature layer and attribute table.

Survey123 Content

When a survey for Survey123 is published to an ArcGIS Online account for use, two items are generated: a form and a feature layer.

The form contains the questions, domains, and data definitions and generates the interactive questionnaire for the app. The form cannot be directly edited through ArcGIS Online. (For information on how Survey123 forms are created and how to edit them, see Changing the Data Sheet and App section.)

The feature layer is the item that is automatically updated as new culvert surveys are completed. Each culvert added to the inventory becomes a point feature, and the attribute table of this layer includes all details from the data sheet.

GeoForm Content

When a physical data sheet is used, the data must be entered using the GeoForm. A GeoForm is an ESRI web mapping application that updates an editable feature layer using an online form. The GeoForm for the Culvert Inventory project can be found at <http://arcg.is/2bV4bJY>.

The GeoForm, found in the group as the “Web Mapping Application” item, requires a web map with at least one editable feature layer to generate the form. An ArcGIS Online web map is an interactive display of spatial data containing a basemap (the Imagery basemap is used for this project) and a minimum of one data layer. In this project, the web map and GeoForm rely upon the same feature layer that is generated and updated by Survey123 in order to link the mobile app to the GeoForm that is used for data entry. This insures that all data, regardless of survey method, is input into the same database.

In addition to being necessary for the GeoForm, the web map is the primary method of viewing and accessing the inventory data.

Accessing the Inventory Data Online

To view the data collected and the affiliated attribute table, navigate to the Group content by logging into ArcGIS Online through your organizational account. In the topmost navigation bar, click on “Groups” and select the Culvert Inventory group. In the list of the Group Content, locate the web map. If you click the title, you will be taken to the item details page, from which you can select “Open in Map Viewer” on the right-hand side of the page. You can also select “Open in Map Viewer” from the Group Content list by clicking the arrow underneath the web map icon next to “Open.”

Note that the map may take a few minutes to fully load. The viewer tends to load the basemap quickly, but spends more time before pulling up the culvert inventory feature layer. The feature layer is loaded once it appears in the Contents list on the left side of the page. If there is no Contents list, click the leftmost icon in the Map Viewer toolbar, “Show Details of Map,” to pull the sidebar out.

This will provide an interactive map of all points inventoried thus far. You are able to zoom in and out, perform analyses, and click on individual points for more details. To see the attribute table for all culverts inventoried, hover over the feature layer name in the left sidebar’s Contents list and select “Show Table.”

If you are familiar with the ArcGIS Online interface, analysis of the data can be done here. Make sure to create a new web map using the feature layer rather than editing the original web map shared with the group to prevent manipulation to the map used by the app and GeoForm.

Verification of Data Entered and Editing Data

Before data is downloaded and used in analysis, a common-sense verification of the data for accuracy should be performed. Both human and equipment error are factors to consider in data verification. Verify data by opening the data table and sorting the rows by date. Any new entries should be verified prior to download.

Measurement Errors

The primary sources of error in measurement or entry will be due to conversion issues and wrong units. Check the dimensions for extreme values. (Note that culvert height is measured in feet while diameter/width is measured in inches.)

If the measurements are in the wrong units, perform the necessary conversions. If there was a possible error in conversion or there is uncertainty about the issue, do not attempt to determine the original value. Add a note about the potential error in the comments, and flag the site for resurveying.

Location Errors

There are two possible reasons a point could be input in the wrong location: (1) GPS margin of error, especially when using the mobile application; or (2) conversion and input errors when submitting data through the GeoForm.

Especially when there is a small margin of error due to the limitations of mobile devices, it is possible to utilize satellite imagery and mildly adjust the point as needed. Road-stream crossings are typically noticeable on imagery, and in most cases, the culvert will only be off by a few meters. However, major errors should be flagged and noted, and resurveying will be necessary.

Editing Existing Data

If a minor error is noted, edits can be made directly in the ArcGIS Online Map Viewer. In the table, select the entry that will be edited. This will highlight the point on the map. Clicking on the point will open up an in-window box, select “Edit” in order to make adjustments as necessary. The point can also be dragged to a new location. Make sure to zoom in to an appropriate level prior to moving the point.

Downloading Data

In the Culvert Inventory group's Contents list, locate the feature layer and select the item's *name* – this will take you to the item details page. Underneath the "Layers" section of the page, click on the button that says "Export To." A list will appear. The options for export are:

- Shapefile
- Comma Separated Values (CSV)
- ESRI File Geodatabase (FGDB)
- GeoJSON (JavaScript Object Notation)
- Feature Collection

Select the desired file type and fill out the pop-up form. The next page will automatically load to show the item details of the new object; select "Download" on this page.

Once the file is downloaded, you can delete the item from your ArcGIS Online account by finding it in the saved folder under "My Content," checking the box next to its name, and clicking "Delete."

Note: Those with scripting/ArcPy experience can follow the steps at the following link to automate the data download:

<https://geonet.esri.com/groups/survey123/blog/2015/11/10/downloading-data-captured-with-survey123-for-arcgis>

This will create a script that you can run on command to download the data without having to iterate through the above steps.

Changing the Data Sheet and App

As the project continues, necessary edits to the data sheet or Survey123 form may be identified. To edit the physical data sheet, adjust the Word document as necessary, making sure to change the date in the header of the document to reflect the date the form was edited.

Editing the app is more complicated. Survey123 uses XLSForms to generate the form seen in the app. An XLSForm is a Microsoft Excel workbook formatted in a specific manner that informs the app on what the survey fields are, what the user's choices should be, and what additional details are included. Survey123 forms are created using a desktop application called Survey123 Connect (download link: <https://doc.arcgis.com/en/survey123/download/>) in tandem with Excel. Survey123 Connect allows you to preview XLSForms as they are being authored or edited and is the only way to publish XLSForms into ArcGIS Online. More information on XLSForms and Survey123 Connect can be found at the following links:

- <https://doc.arcgis.com/en/survey123/desktop/create-surveys/xlsformessentials.htm>
- <http://xlsform.org/>

The XLSForm for this project has already been created and published. To edit the XLSForm and the app, first open Survey123 Connect. If the survey does not appear on the main screen, select "New Survey," and follow the on-screen prompts to load a survey from its file location. Once the survey is loaded on Survey123 Connect, click the first icon in the toolbar on the left-hand side of the screen to open the XLSForm spreadsheet. This will open the form in Microsoft Excel. You can also navigate directly to the folder containing the survey documents and open the Excel file from there. Following XLSForm protocol (as already done in the document, and explained in the links above), make edits to the document. As you save the document, Survey123 Connect will auto-update to show the new version of the survey. Once you are finished editing, click the cloud icon on the left-hand toolbar in Survey123 Connect. This will republish the survey to your ArcGIS Online account.

Note: If the edits change the choices or add new questions, the original data will be cleared because those survey responses will no longer fit the survey's parameters. Make sure to download and save the data as outlined in the previous section prior to publishing these edits.