Report P6B2 Rapid Assessment Survey for Culvert Crossings
TxDOT Project 0-7095 Evaluate Improved Streamflow Measurement at TxDOT Bridges

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Background

The availability of remotely sensed topographic data (LiDAR) throughout the State of Texas has allowed for the creation of detailed hydraulic models with less need for field survey. Using LiDAR derived ground elevations, a flood prediction model of a river can be created from the available terrain data utilizing federal hydraulic modeling programs such as HEC-RAS. However, when it comes to modeling the flood impacts at bridges and culvert crossings, the use of remotely sensed LiDAR points alone does not provide sufficient detail to model the constriction and typical backwater at road crossings.

To properly model a road crossing, field survey data is necessary to allow a hydraulic modeler to add the structure into a flooding simulation. While these field surveys can often be detailed, this document is provided to establish a workflow to obtain a limited amount of data so that a culvert can be quickly added to a hydraulic model at minimum cost.

The goal is to provide a simple culvert survey construct that would:
1. Minimize the 'time-on-target' required for a field survey team to obtain the necessary data.

2. Providing 'just-enough' appropriately attribute survey points that would allow for the insertion of the hydraulic structure into a flood simulation program. The technique described in this document is referred to as "rapid assessment survey for culvert crossings".

Survey Points

For these surveys, three classifications of survey points are requested. They are (1) road edge, (2) pipe information and (3) staff gage [if available].

1) Road Edge – The field survey team acquires one (1) point on the edge of the roadway. This is used as a check against the site's LiDAR terrain to determine any datum issues between the survey and the remote sensed data.

2) Pipe Information – One survey spot is acquired at the bottom center of each pipe/culvert on both the upstream and downstream face. The point data is attributed with the opening dimensions [height, width, radius] and material parameters [Reinforced Concrete Pipe, Corrugated Metal Pipe, etc..].
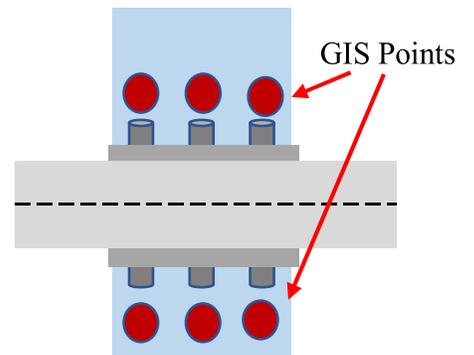
GIS Points

3) Staff Gage – One survey spot is acquired at the staff gage if one is installed at the crossing of concern. This point is recorded at the "zero" elevation of the staff gage.

GIS Point

GIS Point
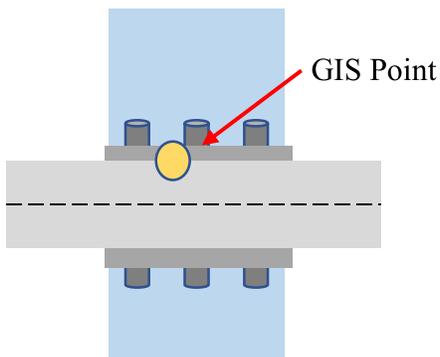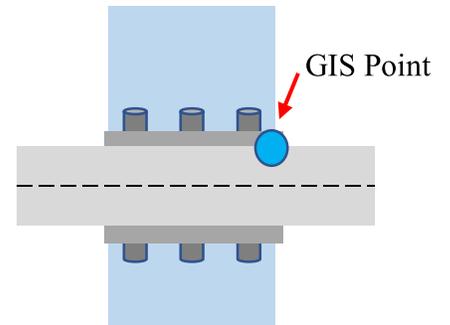
The Final GIS Layer looks like:
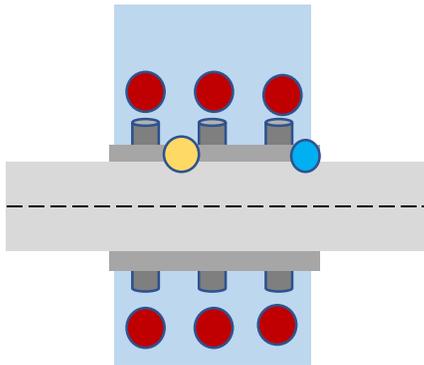
Survey Equipment

As a proof of concept, staff from the Center for Water and the Environment (CWE) of the University of Texas performed field surveys of several low-water crossing culverts in central Texas. For this exercise the following survey equipment was rented from AllTerra Central, Inc:

- Trimble R2 Receiver - pole mounted global navigation satellite system (GNSS) rover

- Trimble TDC600 Data Collector – an Android smart phone with cellular phone service SIM card with the "ArcGIS Collector" and "Trimble Mobile Manager" installed.

- AllTerra VRS Network – through "Trimble Mobile Manager", access and credentials to access the
  Virtual Reference Station (VRS) though cellular data. Level of subscription to the VRS was "centimeter"

Once properly set-up, the Trimble R2 wirelessly overrides and supersedes the positional accuracy of the native Android phone's (TDC600) on board location sensor. For this effort, the R2 accuracy for the surveyed points was "sub-foot" both horizontally and vertically.

Using the University of Texas' enterprise ArcGIS license, a data collection template was created for use in ArcGIS Collector. This Collector database has a defined schema and limited domain to post surveyed data to a cloud database. Once logged into ArcGIS Collector and pointed to the appropriate University of Texas database, the R2 receiver supplied coordinates (x,y,z) were logged and attributed in the field via the TDC600 collector.

Data Collection

ESRI Collector is used as the data collection application as illustrated below.
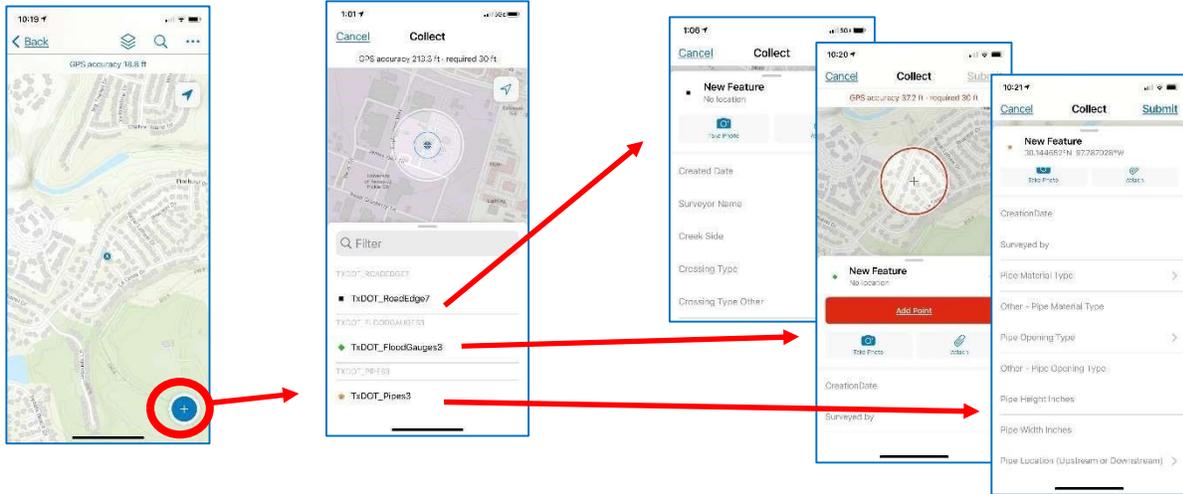
To create the data collection in ESRI's Collector app, requires an ArcGIS Pro license and access to ArcGIS Online.

1. Create separate layers in ArcGIS Pro for each survey type (road edge, culvert, and staff gage)

   - Create layer, add appropriate fields and domains if needed

   - Add attachment capabilities by searching/selecting "Enable Attachments" for each layer

   - Allows you to add "photo" option for the layer in Collector app
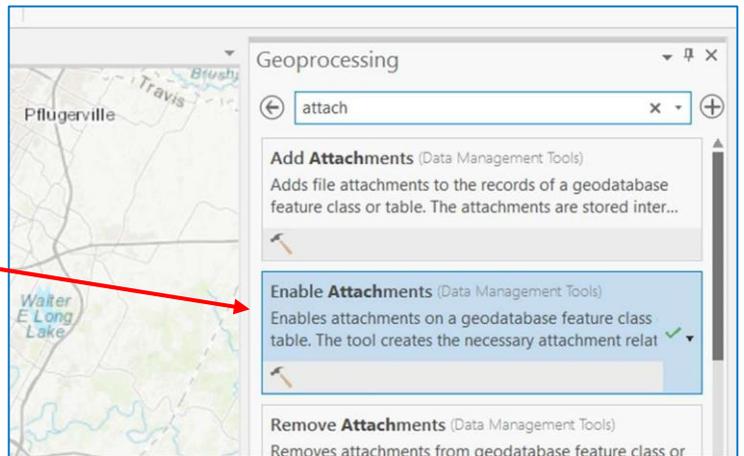
2. Export/Share Web Layer to ArcGIS Online (AGOL)

   - Make sure you update the "Configuration" tab and enable most options
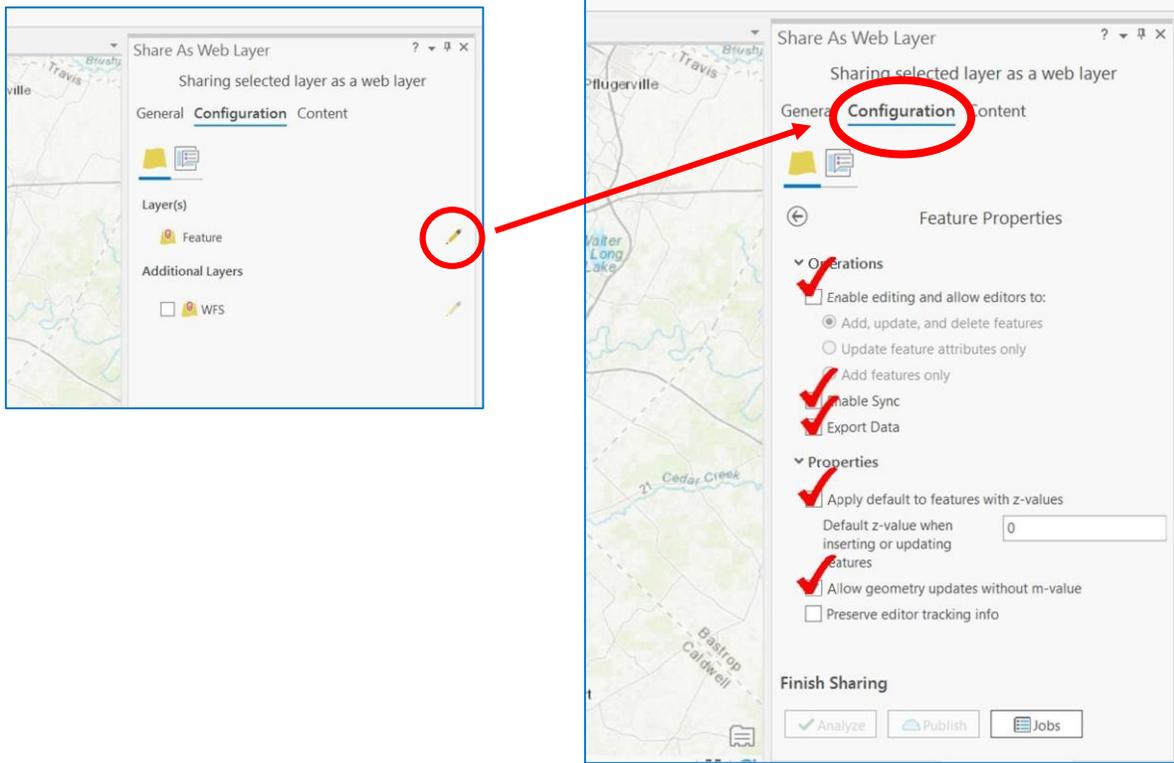
3. Open In ArcGIS Online and create a Web Map which has all three layers

How to Collect Survey Points

Road Edge – Field survey team acquires one (1) point on the edge of the roadway.

1. Open data collection application (ex: Collector, Field Maps)
2. Select 'road edge' point collection option 3. Place GPS unit on the road edge, at the level of the road pavement
4. Enter data in data collection application
5. Take photo of GPS unit at roads edge
6. Hit "Update Point" (Make sure accuracy of GPS unit is less than 5 inches)
7. Submit

Place GPS unit on the road edge, at the level of the road pavement

Pipe Information – One survey spot is acquired at the center of each pipe/culvert on both the upstream and downstream face.

1. Open data collection application (ex: Collector, Field Maps)
2. Select 'pipe' point collection option
3. Place GPS unit at the opening/end of the culvert
4. Enter data in data collection application
5. Take photo of GPS unit at culvert (only one photo per upstream/downstream side)
6. Hit "Update Point" (Make sure accuracy of GPS unit is less than 5 inches)
7. Submit

Place GPS unit at opening/end of the culvert

Staff Gage – One survey spot is acquired at staff gage if one is installed at the crossing of concern.
1. Open data collection application (ex: Collector, Field Maps)
2. Select 'staff gage' point collection option
3. Place GPS unit at the bottom (first) line of the staff gage. 4. Enter data in data collection application
5. Take photo of GPS unit at staff gage.
6. Hit "Update Point" (Make sure accuracy of GPS unit is less than 5 inches)
7. Submit

Place GPS unit at the bottom (first) line of the staff gage

StoryMap of Collected Information
An ArcGIS StoryMap providing access to information collected using this procedure at 17 culverts is presented at: https://arcg.is/10aXr0 Use the tabs at the top of the page to obtain the data for each culvert.

Rapid Assessment Survey for Culvert Crossings - Central Texas

While working on the TxDOT Streamflow II project, the Project Team reviewed the 2017 TxDOT "Low Water Crossing Survey" which identified the Top 20 low water crossings in Central Texas. These crossings flood often and impact both traffic flow and public safety.

- Full TxDOT **"Low Water Crossing Survey"** report can be found here: https://utexas.box.com/s/fhtmzwme6o7aej3y25qb5syxvwoafdcl

The Project Team realized we could inform the Area / Maintenance office of potential flooding without the need to drive out to the site. To do this, we would need to model the low water crossings

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The goal is to provide a simple culvert survey construct that would:

1. **Minimize the 'time-on-target'** required for a field survey team to obtain the necessary data.
2. **Providing 'just-enough' appropriately attribute** survey points that would allow for the insertion of the hydraulic structure into a flood simulation program. The technique described in this document is referred to as **"rapid assessment survey for culvert crossings"**.

The Team create this 'How To' document describing the rapid assessment survey key components. You can find the document here: https://utexas.box.com/s/4nfgzaep6xfv7ru9yf3euq2r9qsdtdvz

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