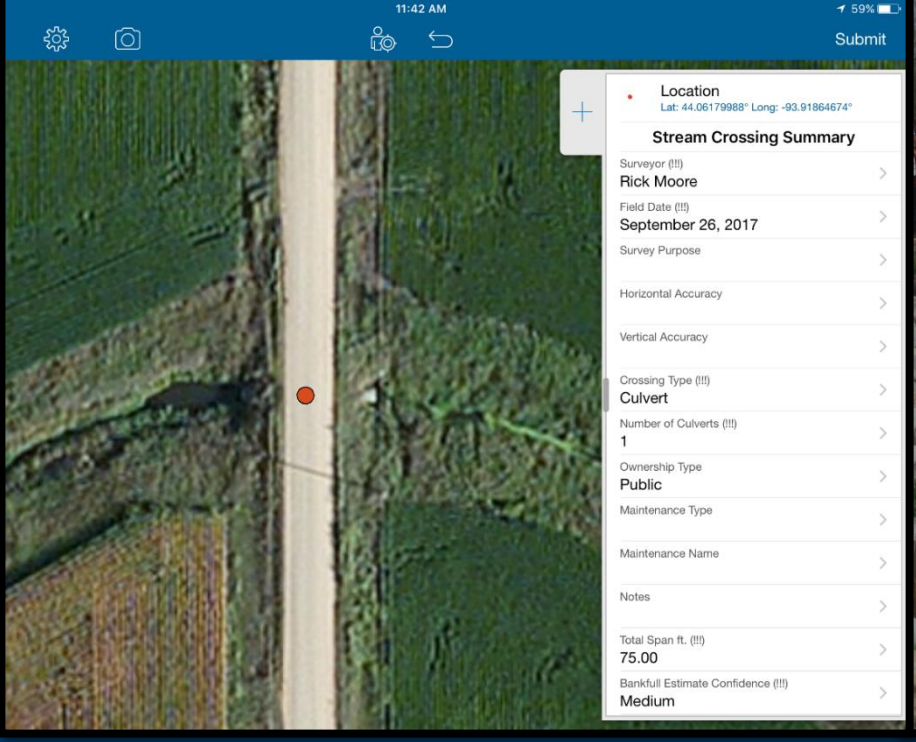

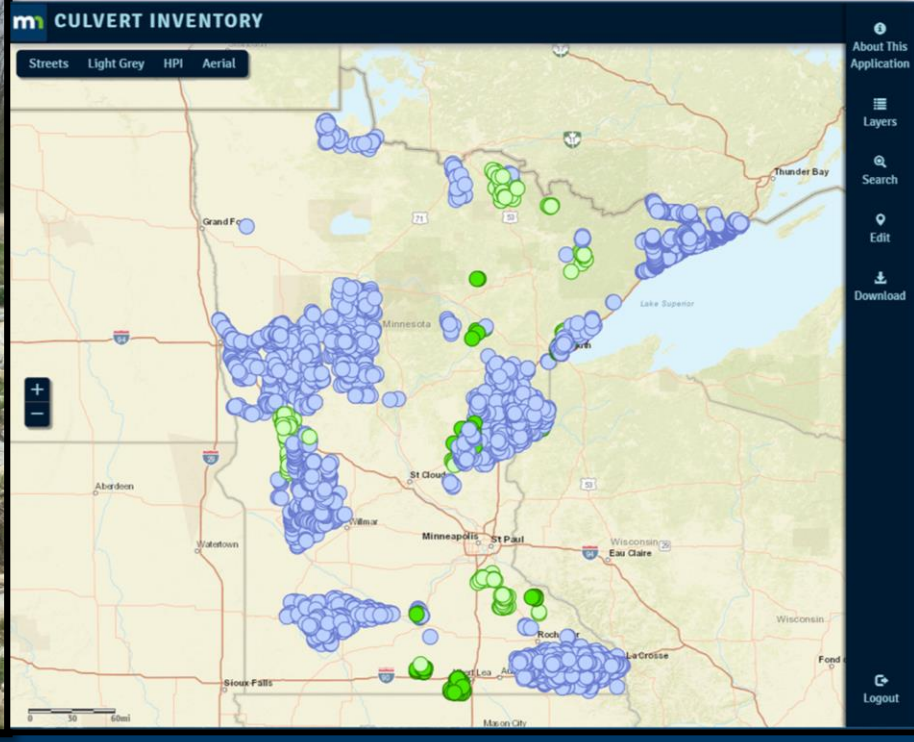

Utilizing a Suite of ArcGIS Applications to Crowdsource Collection of Culverts

Tuesday, July 9, 2019 | 2:30 pm – 3:30 pm | SDCC – Room 29C

Rick Moore | Sean Vaughn | Lyn Bergquist | Andy Williquett | Tim Loesch | Brian Nerbonne | Chris Pouliot

MINNESOTA IT SERVICES

DEPARTMENT OF NATURAL RESOURCES

Stakeholder Funding

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MINNESOTA'S LAKE SUPERIOR COASTAL PROGRAM

MN DNR Culvert Inventory Application Suite

The **MNDNR Culvert Inventory Application Suite** consists of the following related components:

1) **Collector for ArcGIS Mobile Application** – for field data collection
2) **ArcSDE Centralized Database** – for multi-user editing/storage
3) **MNDNR Web Application** – Custom App for data review and approval
4) **Published Statewide GIS layers** – for GIS applications

DNR Culvert Inventory Resources: http://www.dnr.state.mn.us/watersheds/culvert_inventory/index.html

Culvert Suite Purpose

- To allow **simultaneous collection of culvert locations and attributes** in a standardized manner by professional staff across Minnesota
- To **build a statewide database** of culvert features which can be used for a variety of purposes, including:
  - ❖ Hydrologic connectivity of the landscape
  - ❖ Fish/Species Passage
  - ❖ Flood control and hydrologic modeling
  - ❖ Water quality/sediment transport
  - ❖ Hydro-modification of LiDAR-derived DEMs

Culvert Suite Purpose

- The collection of data in digital format and the standardization of attributes is paramount to creating a standardized database of features.
- These tools brought efficiencies into outdated agency processes by reducing data entry time, minimizing human error, and making data available in real-time.

A Brief History…

Stream Survey

Stream Crossing Basic Assessment Form

All units are to be entered in feet. * = Mandatory field to complete

Location: Observer*:_____ Date*:___/___/___ County:_____ T___R___S___

Stream name*:_____ Stream mile:____ UTM:* N_____ E_____

Alt. name:_____ Stream Kittle or AUID (circle which)*:_____

DNR Major watershed/HUC 8*(circle which):_____ Road/Path/Railway name*:_____

Elevation method*: ☐ Monument ☐ RTK ☐ Benchmark/LiDAR ☐ Handheld GPS Accuracy:_____

HI:_____ Notes:_____ Benchmark location:_____

Crossing:

Crossing type*: ☐ Span Bridge ☐ Culvert(s) Num. (if multiple):____ Offset*?: ☐ Y ☐ N Outlet drop*:___ Total span* (sum of culverts):_____

☐ Ford Crossing properly aligned*? ☐ Y ☐ N

Other:_____ Year built:_____

Openings* (left to right, facing downstream)

	Opening 1		Opening 2		Opening 3		Opening 4	
Type*	☐ Thalweg ☐ Offset ☐ Floodplain		☐ Thalweg ☐ Offset ☐ Floodplain		☐ Thalweg ☐ Offset ☐ Floodplain		☐ Thalweg ☐ Offset ☐ Floodplain	
Shape*	☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch		☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch		☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch		☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch	
Material*	☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic		☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic		☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic		☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic	
Length*								
Width *								
Height*								
Inlet invert	FS	El.	FS	El.	FS	El.	FS	El.
Outlet invert	FS	El.	FS	El.	FS	El.	FS	El.
Benchmark el.	FS	El.	FS	El.	FS	El.		
Water depth								
Substrate present?*	☐ Y ☐ N		☐ Y ☐ N		☐ Y ☐ N		☐ Y ☐ N	
% plugged*								

Stream:

Bankfull width*:_____ Bankfull estimate confidence*: ☐ High ☐ Medium ☐ Low

Scour Pool*: ☐ Y ☐ N Upstream pool*: ☐ Y ☐ N Upstream bars/deposition*: ☐ Y ☐ N

Bank erosion caused by crossing*: ☐ Y ☐ N

Summary:

Barrier to fish passage at some flows*? ☐ Y ☐ N Stream stability impact*: ☐ Y ☐ N Priority: ☐ High ☐ Med. ☐ Low

Limiting factor for passage*: ☐ Outlet drop ☐ Velocity ☐ Depth ☐ Substrate

Recommended corrective actions*: _____

Photos: Crossing, upstream and downstream views; Stream, upstream and downstream views from crossing

Stream:

Bankfull width*:_____ Bankfull estima

Riffle max. water depth:_____ Riffle max. ve

Scour Pool*: ☐ Y ☐ N Depth:____ Width:____ Len

Upstream deposition*: ☐ Y ☐ N Bank erosion

Floodprone width:_____ Sedimentation from

Road/Rail/Path:

Ownership:_____ Su

Upstream fill depth:_____ Downstream fill dept

Summary:

Barrier to fish passage at some flows*? ☐ Y ☐ N

Priority: ☐ High ☐ Med. ☐ Low Limiting factor

Recommended corrective actions*: _____

Notes and comments: _____

Photos:

1) Crossing, facing upstream
2) Crossing, facing downstream
3) Stream, facing upstream from crossing
4) Stream, facing downstream from crossing

Sketch:

Stream Survey

Stream Crossing Full Assessment Form

All units are to be entered in feet. * = Mandatory field to complete.

Location: Observer*:_____ Date*:___/___/___ County:_____ T___R___S___

Stream name*:_____ Stream mile:____ UTM:* N_____ E_____

Alt. name:_____ Stream Kittle or AUID (circle which)*:_____

DNR Major watershed/HUC 8*(circle which):_____ Road/Path/Railway name*:_____

Elevation method*: ☐ Monument ☐ RTK ☐ Benchmark/LiDAR ☐ Handheld GPS Accuracy*:_____

HI:_____ Water level ☐ High ☐ Baseflow ☐ Low Velocity method: ☐ Meter ☐ Surface

Benchmark location:_____

Crossing:

Crossing type*: ☐ Span Bridge Total span* (sum of culverts):_____

☐ Culvert(s) Num. (if multiple):___ Offset*?: ☐ Y ☐ N Outlet drop*:___

☐ Ford Crossing properly aligned*? ☐ Y ☐ N

Other:_____ Year built:_____

Inlet type: ☐ Projecting ☐ Mitered ☐ Headwall ☐ Apron ☐ Wingwall ☐ Trash rack ☐ Other:_____

Outlet type: ☐ At stream grade ☐ Cascade over riprap ☐ Freefall into pool ☐ Freefall onto riprap ☐ Apron

Bridge condition: ☐ Good ☐ Fair ☐ Poor Condition issues:_____ Road Fill depth:____

Openings (left to right, facing downstream)

	Opening 1		Opening 2		Opening 3		Opening 4	
Type*	☐ Thalweg ☐ Offset ☐ Floodplain		☐ Thalweg ☐ Offset ☐ Floodplain		☐ Thalweg ☐ Offset ☐ Floodplain		☐ Thalweg ☐ Offset ☐ Floodplain	
Shape*	☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch		☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch		☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch		☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Open bottom arch	
Material*	☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic		☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic		☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic		☐ CMP ☐ SMP ☐ Concrete ☐ Wood ☐ Plastic	
Flow restriction	☐ Y ☐ N Type:_____		☐ Y ☐ N Type:_____		☐ Y ☐ N Type:_____		☐ Y ☐ N Type:_____	
Length*								
Width *								
Height*								
Inlet invert*	FS	El.	FS	El.	FS	El.	FS	El.
Outlet invert*	FS	El.	FS	El.	FS	El.	FS	El.
Benchmark el.	FS	El.	FS	El.				
Water depth								
Substrate?*	☐ Y ☐ N		☐ Y ☐ N		☐ Y ☐ N		☐ Y ☐ N	
Subst. depth								
Subst. size	☐ Cobble ☐ Gravel ☐ Sand ☐ Silt ☐ Bdrk		☐ Cobble ☐ Gravel ☐ Sand ☐ Silt ☐ Bdrk		☐ Cobble ☐ Gravel ☐ Sand ☐ Silt ☐ Bdrk		☐ Cobble ☐ Gravel ☐ Sand ☐ Silt ☐ Bdrk	
% plugged*								
Max. velocity	fps		fps		fps		fps	
% at max vel.	%		%		%		%	

Paper Form to Collector App…

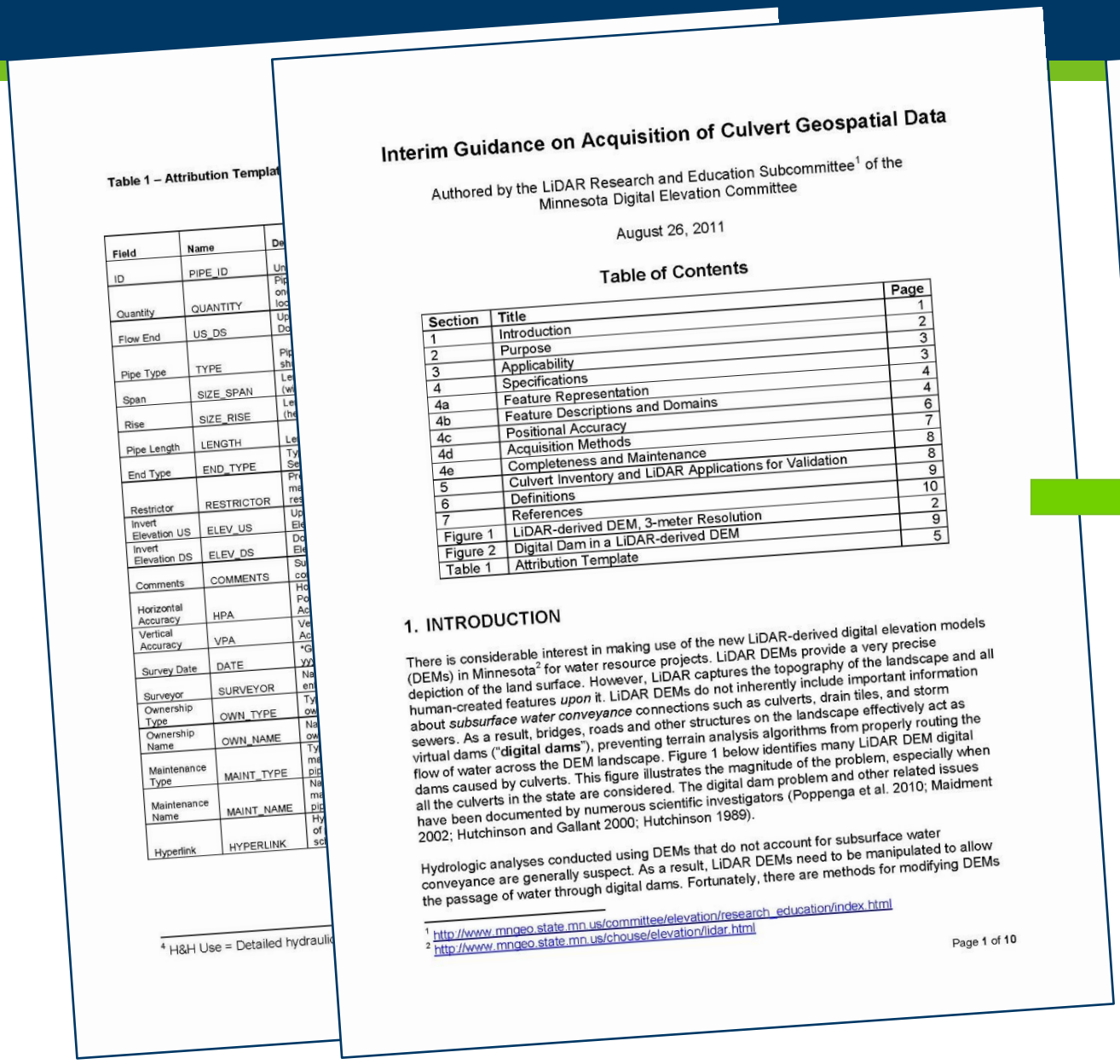

Table 1 – Attribution Templat

Field	Name	De
ID	PIPE_ID	Un
Quantity	QUANTITY	Pip on loc
Flow End	US_DS	Up Do
Pipe Type	TYPE	Pip sh
Span	SIZE_SPAN	Le (wi
Rise	SIZE_RISE	Le (he
Pipe Length	LENGTH	Le
End Type	END_TYPE	Ty Se
Restrictor	RESTRICTOR	Pr me res
Invert Elevation US	ELEV_US	Up Ele
Invert Elevation DS	ELEV_DS	Do Ele
Comments	COMMENTS	Su co
Horizontal Accuracy	HPA	Ho Po Ac
Vertical Accuracy	VPA	Ve Ac
Survey Date	DATE	*G yy
Surveyor	SURVEYOR	Na en
Ownership Type	OWN_TYPE	Ty ow
Ownership Name	OWN_NAME	Na ow
Maintenance Type	MAINT_TYPE	Ty ma pip
Maintenance Name	MAINT_NAME	Na ma pip
Hyperlink	HYPERLINK	Hy of sc

[4] H&H Use = Detailed hydraulic

Interim Guidance on Acquisition of Culvert Geospatial Data

Authored by the LiDAR Research and Education Subcommittee[1] of the Minnesota Digital Elevation Committee

August 26, 2011

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1. INTRODUCTION

There is considerable interest in making use of the new LiDAR-derived digital elevation models (DEMs) in Minnesota[2] for water resource projects. LiDAR DEMs provide a very precise depiction of the land surface. However, LiDAR captures the topography of the landscape and all human-created features *upon* it. LiDAR DEMs do not inherently include important information about *subsurface water conveyance* connections such as culverts, drain tiles, and storm sewers. As a result, bridges, roads and other structures on the landscape effectively act as virtual dams ("**digital dams**"), preventing terrain analysis algorithms from properly routing the flow of water across the DEM landscape. Figure 1 below identifies many LiDAR DEM digital dams caused by culverts. This figure illustrates the magnitude of the problem, especially when all the culverts in the state are considered. The digital dam problem and other related issues have been documented by numerous scientific investigators (Poppenga et al. 2010; Maidment 2002; Hutchinson and Gallant 2000; Hutchinson 1989).

Hydrologic analyses conducted using DEMs that do not account for subsurface water conveyance are generally suspect. As a result, LiDAR DEMs need to be manipulated to allow the passage of water through digital dams. Fortunately, there are methods for modifying DEMs

[1] http://www.mngeo.state.mn.us/committee/elevation/research_education/index.html
[2] http://www.mngeo.state.mn.us/chouse/elevation/lidar.html

Culvert Inventor Field Summaries

Stream Crossing Summary – Short Form

1. **Surveyor**
   a. Drop Down List
2. Field Date
   a. Date
3. Survey Purpose
   a. Fish Passage
   b. Routine Structure Assessment
   c. Post-event Assessment
   d. Other
4. Horizontal Accuracy
   a. <0.5m
   b. 0.5 – 3m
   c. 3 – 9m
   d. >9m
5. Vertical Accuracy
   a. <0.03m
   b. 0.03 – 1m
   c. >1m
6. **Crossing Type**
   a. Span Bridge
   b. Ford
   c. Culvert
7. **Number of Culverts**
   a. Text Field
8. Ownership Type
   a. Private
   b. Public
   c. Railroad
   d. Unknown
9. Maintenance Type
   a. Private
   b. Public
   c. Railroad
   d. Unknown
10. Maintenance Name
    a. Text Field
11. Notes
    a. Text Field
12. **Total Span ft.**
    a. Text Field
13. **Bankfull Estimate Confidence**
    a. Low
    b. Medium
    c. High

*- Bold Fields are required

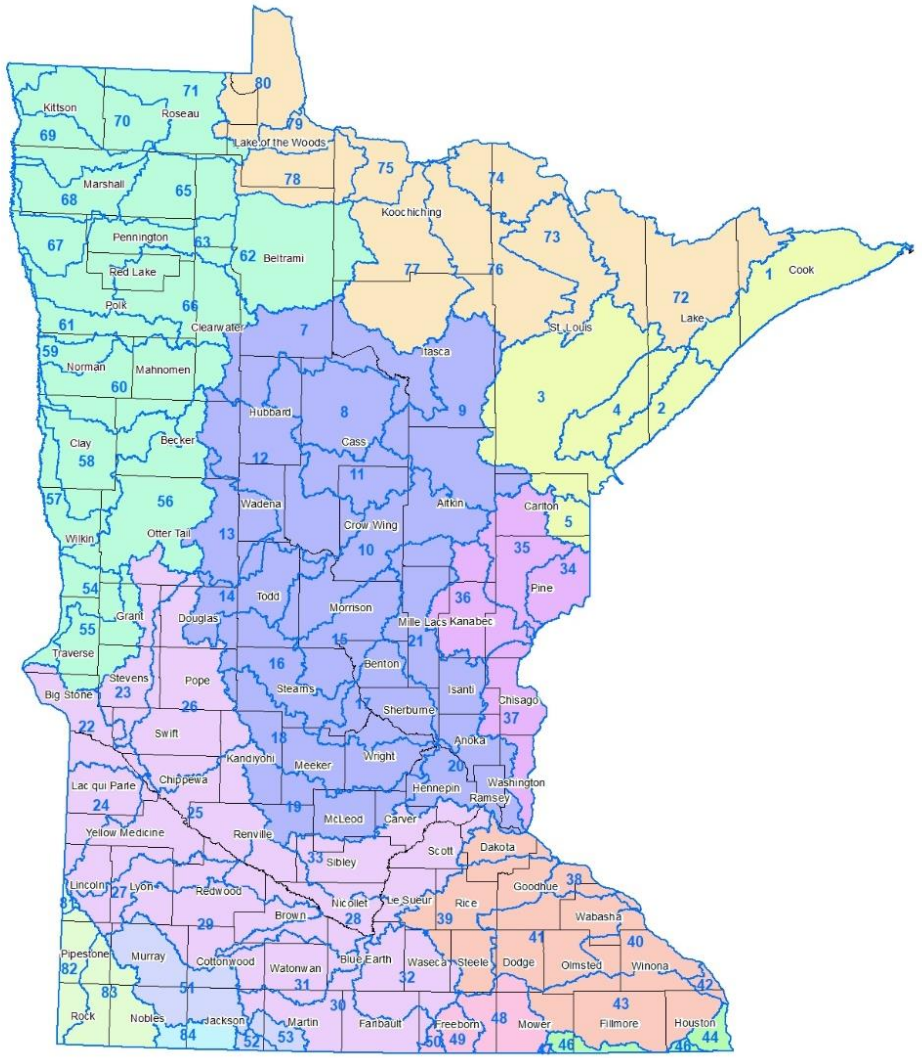
Culvert Inventory Application – MN DNR Field Summaries for Short and Long From

Culvert Openings – Short Form

14. **Pipe ID**
    a. Text Field
15. Inlet Type
    a. Projected
    b. Mitered
    c. Headwall
    d. Apron
    e. Wingwall
    f. Trash Rack
    g. Other
16. Outlet Type
    a. At Stream Grade
    b. Cascade Over Riprap
    c. Freefall into Pool
    d. Freefall onto Riprap
    e. Apron
    f. Other
17. **Opening End**
    a. Inlet of Pipe
    b. Outlet of Pipe
18. **Opening Type**
    a. Thalweg
    b. Offset
    c. Floodplain
    d. Other
19. **Opening Shape**
    a. Circular
    b. Box
    c. Pipe Arch
    d. Ellipse
    e. Open Bottom Arch
    f. Other
20. **Opening Material**
    a. Concrete
    b. Wood
    c. Smooth Metal Pipe
    d. Corrugated Metal Pipe
    e. Corrugated Plastic Pipe
    f. Smooth Plastic Pipe
    g. Other
21. Flow Restriction
    a. Yes
    b. No
22. Flow Restriction Type
    a. Baffle
    b. Debris
    c. Excess Sediment
    d. Grate
    e. Other
23. **Length ft.**
    a. Text Field
24. **Size Span ft.**
    a. Text Field
25. **Size Rise ft.**
    a. Text Field
26. Inlet Invert Elevation ft.
    a. Text Field
27. Outlet Invert Elevation ft.
    a. Text Field
28. Notes
    a. Text Field
29. Culvert Condition
    a. Good
    b. Fair
    c. Poor
30. Condition Issues
    a. Corrosion
    b. Spalling
    c. Cracks
    d. Holes
    e. Piping
    f. Deformation
    g. Joint Separation
    h. Other
31. Maximum Velocity fps
    a. Text Field

*- Bold Fields are required

Culvert Suite Crowdsourcing



- Leveraging Crowdsourcing
  - 87 Counties
  - 45 Watershed Districts
  - 90 Soil and Water Conservation Districts (SWCD)
  - State Agencies
    - Department of Natural Resources (DNR)
    - Board of Water and Soil Resources (BWSR)

Culvert Inventory Application Suite

MINNESOTA IT SERVICES

MNDNR CULVERT INVENTORY APPLICATION SUITE

DEPARTMENT OF NATURAL RESOURCES

Purpose

- To allow simultaneous collection of culvert locations and attributes in a standardized manner by professional staff across Minnesota
- To build a statewide database of culvert features which can be used for a variety of purposes, including:
  - Hydrologic connectivity of the landscape
  - Fish/Species Passage
  - Flood control and hydrologic modeling
  - Water quality/sediment transport
  - Hydro-modification of LiDAR-derived DEMs
- This work was funded by the following stakeholders:

DEPARTMENT OF NATURAL RESOURCES MINNESOTA IT SERVICES

MINNESOTA'S LAKE SUPERIOR COASTAL PROGRAM CLEAN WATER LAND & LEGACY AMENDMENT

The **MNDNR Culvert Inventory Application Suite** consists of the following related components:

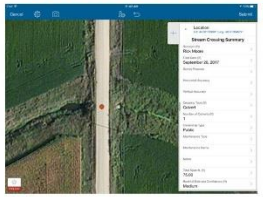
1) **Collector for ArcGIS Mobile Application** – for field data collection
2) **ArcSDE Centralized Database** – for multi-user editing/storage
3) **MNDNR Web Application** – Custom App for data review and approval
4) **Published Statewide GIS layers** – for GIS applications

DNR Culvert Inventory Resources: http://www.dnr.state.mn.us/watersheds/culvert_inventory/index.html

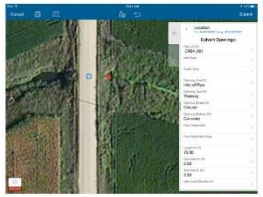
1) COLLECTOR for ArcGIS MOBILE APPLICATION

Collector for ArcGIS Mobile Application allows for field scale collection of data about stream crossings, culvert openings, bridges and DEM digital dam breachlines.

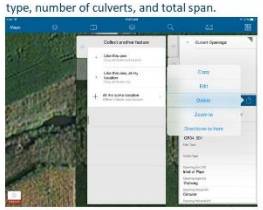
- Crossing Points representing bridges and culverts are represented as a single master point. (Crossings may have multiple culverts)
- Individual culverts are represented as a set of paired points for the inlets and outlets.
- With wireless connectivity, georeferenced data collected in the field is uploaded directly to a centralized SDE database.
- There are two alternate user forms for data collection; a Long Form based on *MNDNR Stream Crossing Full Assessment Form* and a Short Form based on *Interim Guidance on Acquisition of Culvert Geospatial Data*



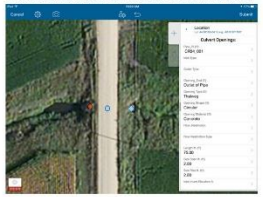
1) A single master point feature represents the road crossing. Attributes specific to the crossing are entered such as surveyor, survey purpose, crossing type, number of culverts, and total span.



2) For culverts, there will be two points; one point each for inlet and outlet. To begin, the user will click on the map at the location of the inlet and enter the attributes associated with the feature.



3) Once an inlet point is placed, it is selected and attribute data can be copied to a new point using the Copy *Like This One, At My Location* function. Next, move the outlet point to the appropriate location.



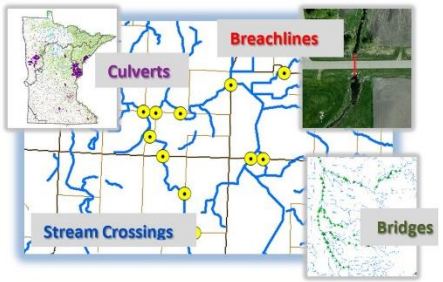
4) Once the outlet point has been placed, the attributes that are unique to the outlet are modified. The points and attributes are then submitted and synced with the ArcSDE database.

2) ArcSDE CENTRALIZED DATABASE

The centralized database allows the following:

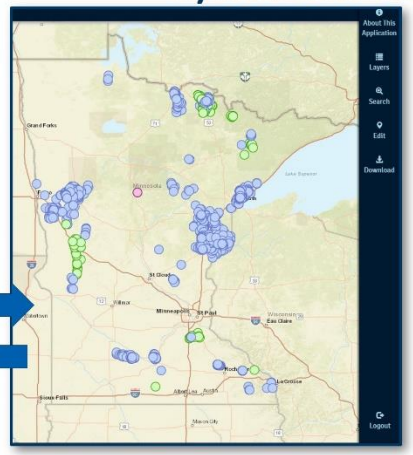
- Simultaneous editing by multiple users
- Standard data domains and values
- Secure centralized data storage
- Regular data backup and maintenance

4) PUBLISHED STATEWIDE GIS LAYERS



- Standardized GIS layers available to all users and only "approved" crossing features are added to GIS layers
- Multiple layers and symbolization possible
- GIS Layers available via MN GeoSpatial Commons

3) MNDNR WEB APPLICATION



The **LAYERS** Button expands the legend to show symbol levels for the layers.

The five Feature Status Levels are:

- **Candidate** – all features are assigned this status by default.
- **Reviewed** – these features have been reviewed for accuracy and completeness by the Data Collector and are ready for approval.
- **Question** – these features have a question asked about them and are waiting a response.
- **Approved** – these Reviewed features have been approved by the Approver-Business for business related uses.
- **Archived** – these un-editable features have been "retired".

The **EDIT** Button expands the legend, allowing for creation of new points and the populating of Spatial attributes for the Crossings using tools under **Set Attributes.**

- Using the Select button, select the Crossing point, hit **Populate Crossings** to add attributes
  - The Crossing ID is assigned based on DNR Level 08 Catchment and the crossing feature type.
- Select the Culvert Openings associated with this Crossing and hit **Associate** to assign the Crossing ID to the Culvert Openings.

Set Status tracks the Review and Approving process for Crossings, Bridges and Culvert Openings.

The **DOWNLOAD** Button allows the download of all features or selected features

The **Search Panel** allows users to find features based on locations and attributes:

- Click on any search result to zoom to that area or feature.

Developed by DNR, the Web Application allows data stewards to conduct in-office review, editing, and approval of their data locations and attributes created in the field using the ArcGIS Collector App.

- Feature locations and attributes can be edited and standardized using drop down domains, and some auto-populated.
- Crossings Points are assigned unique Crossing ID's, associated culverts & bridges are associated with their master crossing point.
- Users are assigned different roles with increasing levels of 'rights' to perform certain editing and approval functions.
- Approved features are exported to MN GeoSpatial Commons

How to get started

1) Contact MNDNR* for a **Culvert Inventory Application Suite** logon.
2) Obtain an Android, IOS or Windows 10 device for data collection.
3) Follow instructions from MNDNR on how to download and operate the application suite.
4) Submit existing culvert inventory, bridge inventory or breach line data to **Andy*** (right)

Authored by ***MNiT@MNDNR Geospatial Water Resources Team (GeoWRT)***

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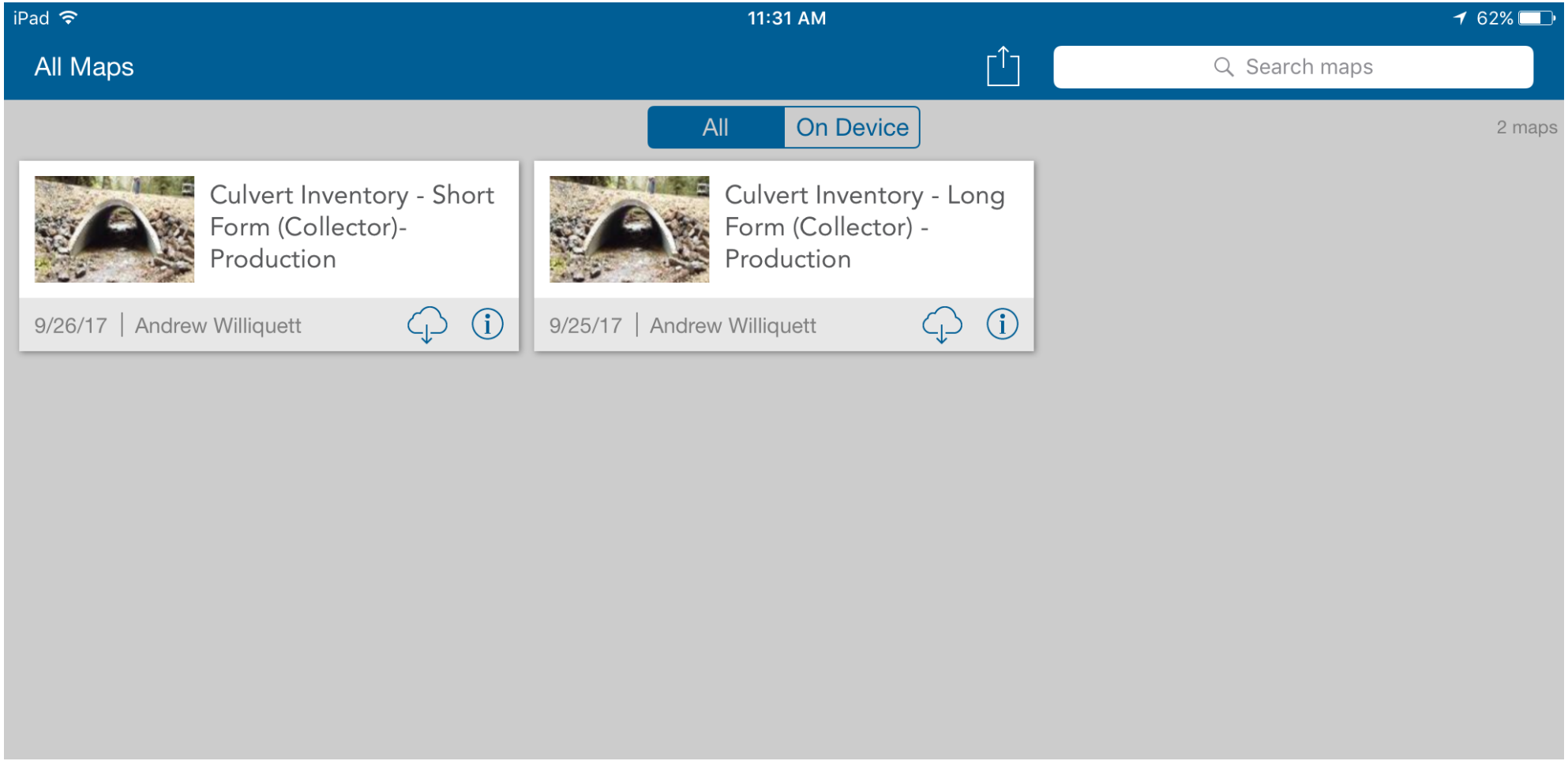
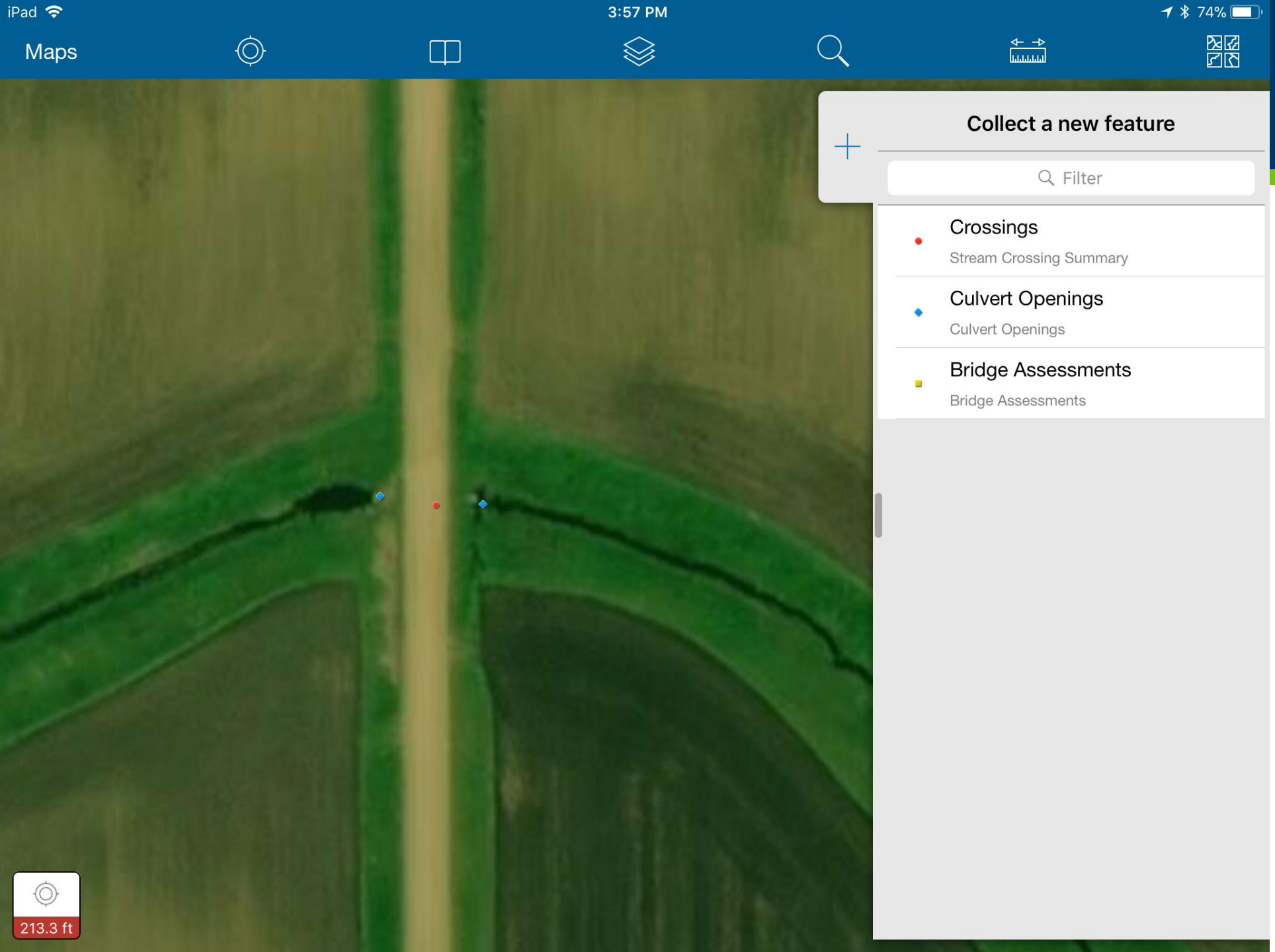
***Andy Williquett,** GIS Specialist 651-259-5244 (St. Paul)
Sean Vaughn, Hydro\LiDAR Coord 763-284-7223 (Cambridge)
Rick Moore, LiDAR Data Steward 507-389-8810 (Mankato)

Website: http://www.dnr.state.mn.us/watersheds/wrt.html

1) Collector

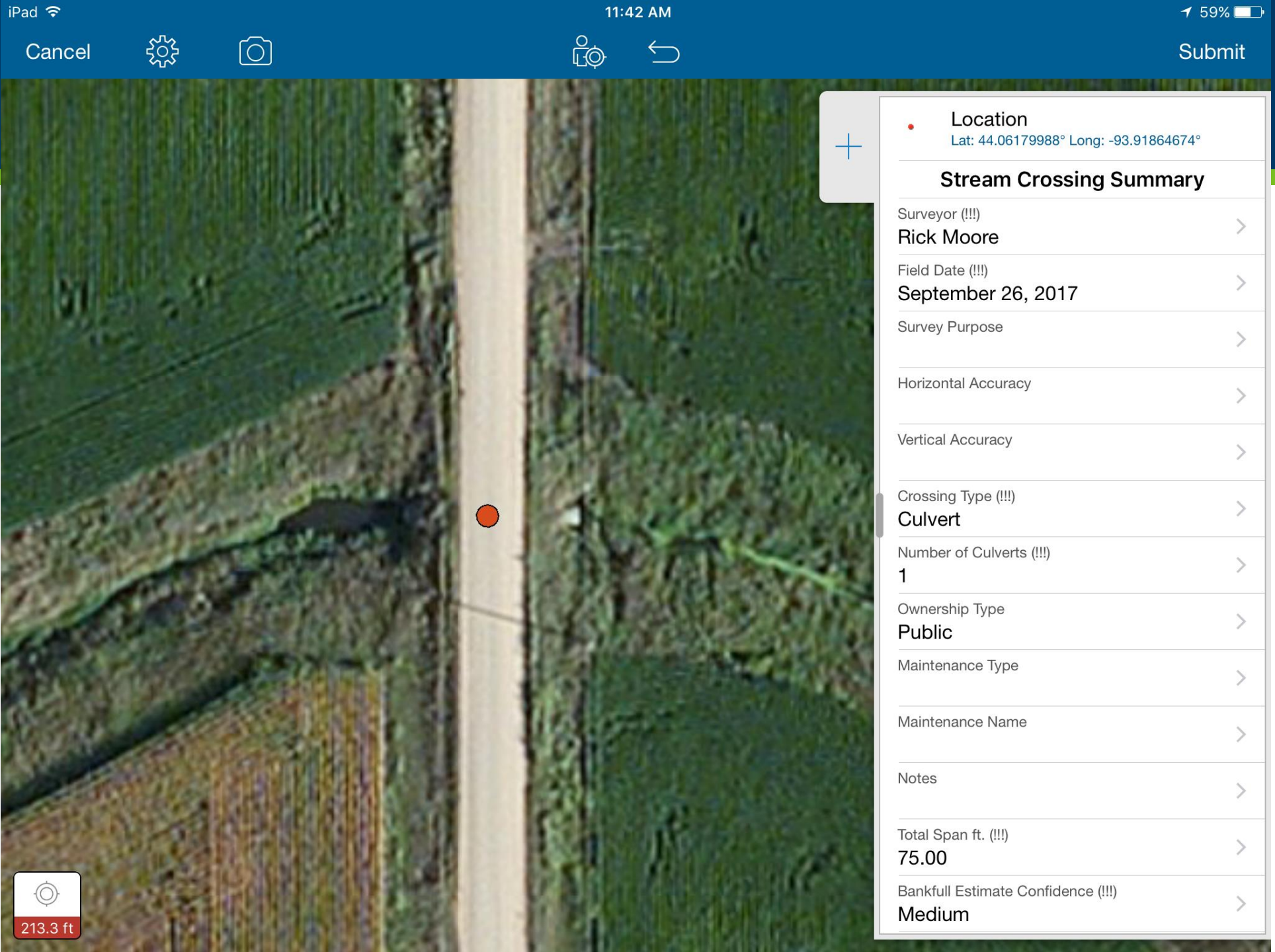
1) Collector


iPad
11:31 AM
62%
All Maps
Search maps
All
On Device
2 maps
Culvert Inventory - Short Form (Collector)- Production
9/26/17 | Andrew Williquett
Culvert Inventory - Long Form (Collector) - Production
9/25/17 | Andrew Williquett



1) Collector

- The Collector for ArcGIS Mobile Application allows for field scale collection of data about stream crossings, culvert openings, bridges and DEM digital dam breachlines.



1) Collector

- Crossing Points representing bridges and culverts are represented as a single master point. (Crossings may have multiple culverts).

1) Stream Crossing Summary

Stream Crossing Summary

Surveyor: Choose name from the domain List

Field Date: Click on TODAY to enter today's date.

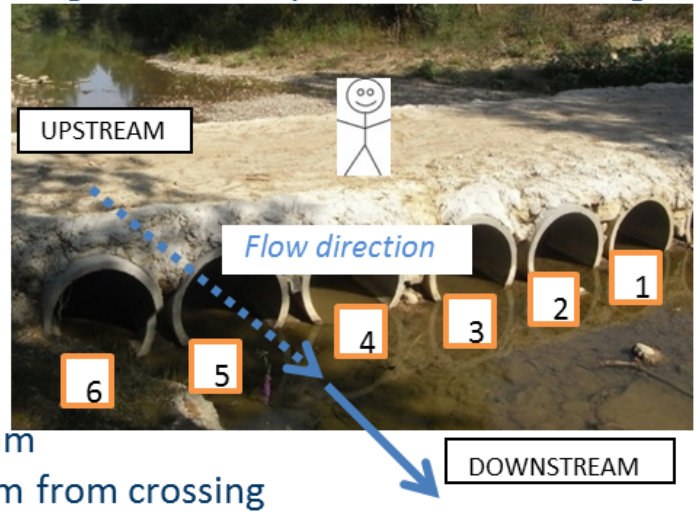
Survey Purpose:

- Fish Passage
- Routine Structure Assessment
- Post-Event Assessment

Crossing Type:

- Span Bridge – A bridge has a deck supported by abutments (or stream banks)
- Ford – A ford is a shallow, open stream crossing in which vehicles pass thru water
- Culvert – A culvert consists of a structure buried under some amount of fill

Number of Culverts: Total number of culvert openings that together convey water thru crossing. Number Culverts left to right while looking downstream toward the culvert inlet. These numbers will correspond to Pipe ID on Culvert Openings Form.



Total Span ft: Width of the opening. For culverts, sum of all spans. Bridges-width between abutments

Bankfull Estimate Confidence: High, Medium, or Low

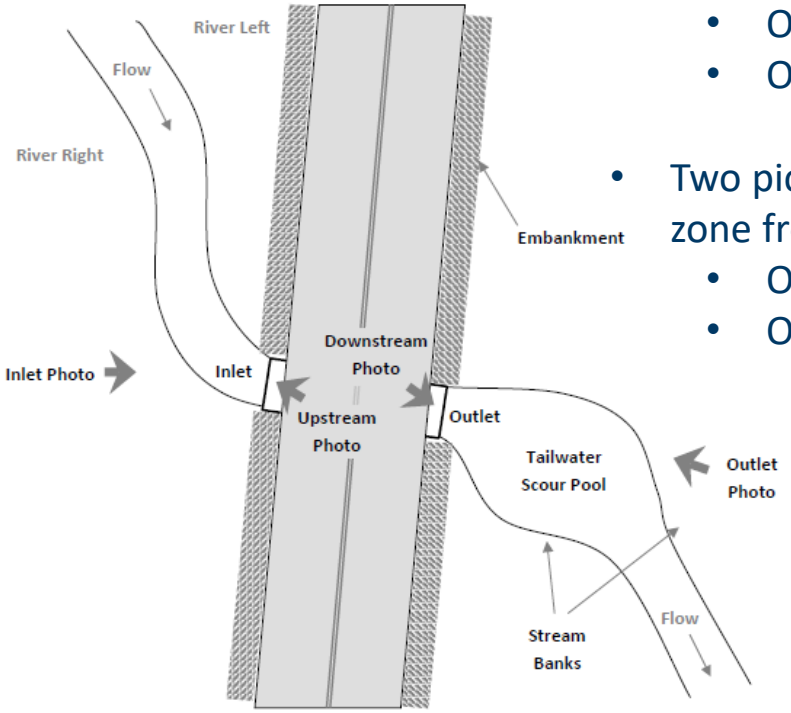
Add Photo Attachments – Identify flow direction

1) Crossing, facing upstream 2)Crossing, facing downstream

3) Stream, facing upstream 4) Stream, facing downstream from crossing

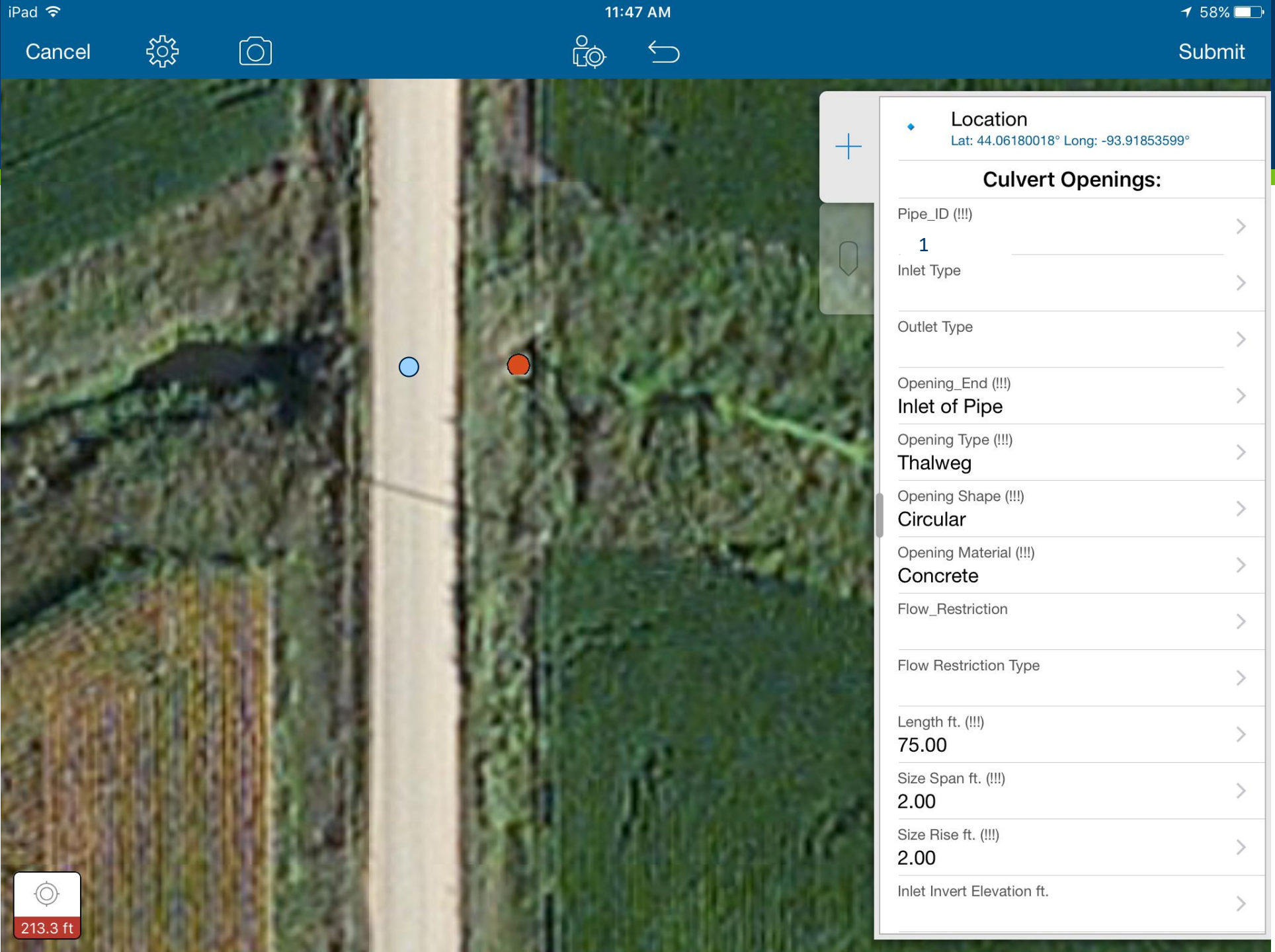
1) Photos Upstream and Downstream

Figure 5: A) image of structure looking downstream, B) image of structure looking upstream, C) image of stream looking downstream and D) image of stream looking upstream. Note that there is indication of flow direction in each picture.



A minimum of four photos are taken at each site (culverts, bridges, fords) to provide visual documentation of conditions at the time of site visit. (Note: something should be used to indicate direction of flow).

- Two Pictures of the structure itself
  - One from Upstream
  - One from Downstream
- Two pictures of the stream/riparian zone from the top of the crossing
  - One looking downstream
  - One looking upstream



1) Collector

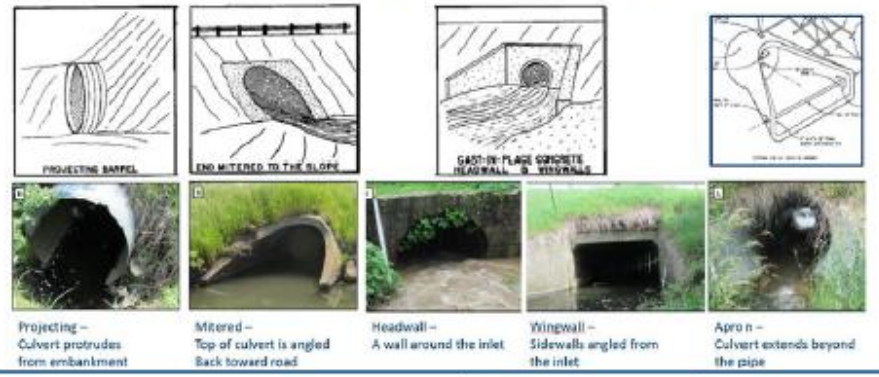
- Individual culverts are represented as a set of paired points for the inlets and outlets.
- With wireless connectivity, georeferenced data collected in the field is uploaded directly to a centralized SDE database.

1) Culvert Openings

Culvert Openings

Pipe ID - Number that indicates the order that you evaluate the openings of a multi-culvert crossing (# left to right)

Inlet Type



Projecting – Culvert protrudes from embankment

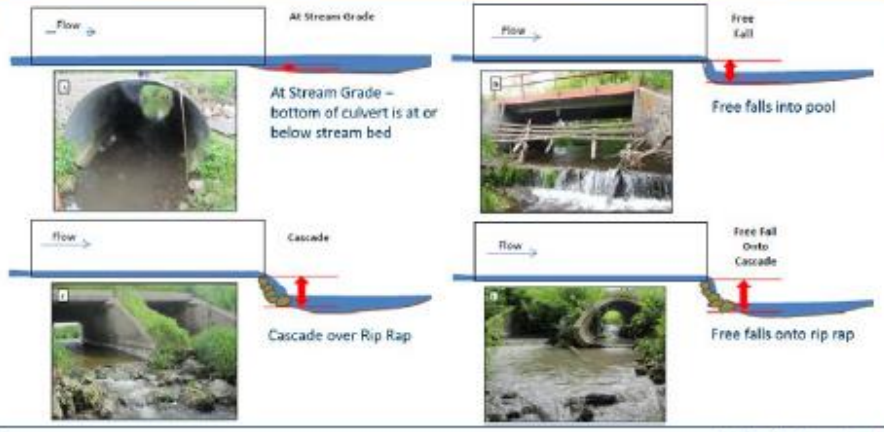
Mitered – Top of culvert is angled Back toward road

Headwall – A wall around the inlet

Wingwall – Sidewalls angled from the inlet

Apron – Culvert extends beyond the pipe

Outlet Type



At Stream Grade – bottom of culvert is at or below stream bed

Free falls into pool

Apron – extension of culvert beyond pipe

Cascade over Rip Rap

Free falls onto rip rap

Opening Type

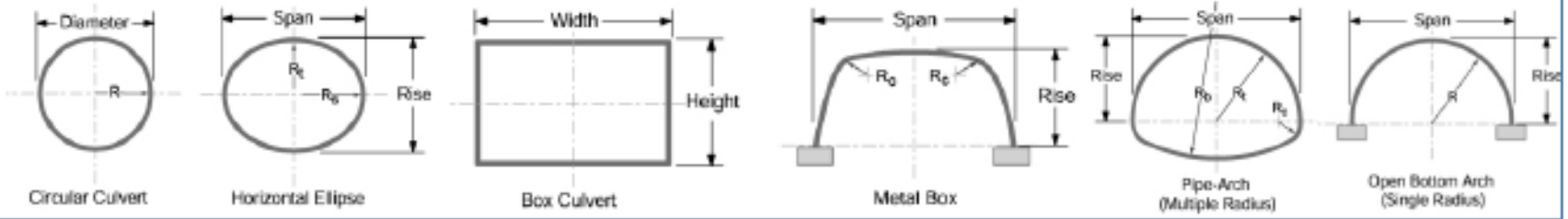
- **Thalweg** – For crossing with only one pipe, choose this option. For crossings with multiple pipes, the thalweg pipe is set at the bed elevation of the stream

- **Offset** – For crossings with multiple pipes, offset pipes are set at a higher elevation than the thalweg pipe, but are still intended to convey flows from the bankfull channel.

- **Floodplain** – Culverts set at an elevation that will convey only floodplain flows.
- **Other** - Other types of openings

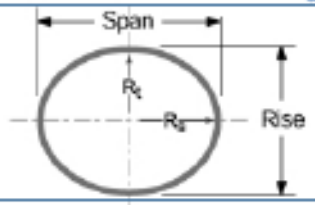
1) Culvert Openings

Opening Shape – Use the categories from the images below. (Choose from list)



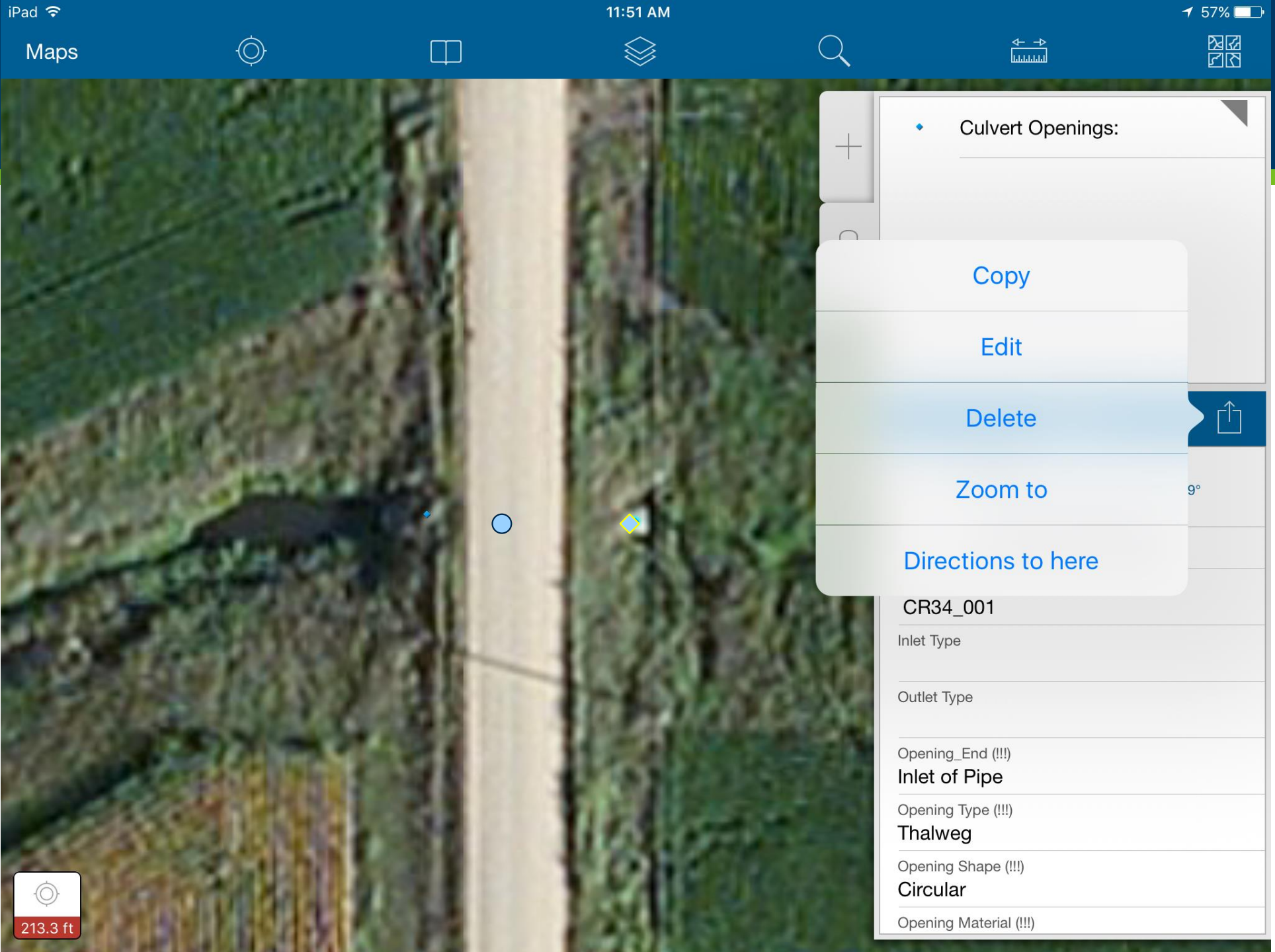
Length ft. – To the nearest tenth of a foot, measure the length of the structure at its top.

Size Span – To the nearest tenth of a foot, measure the full width of the structure inlet. Take this measurement inside the structure.

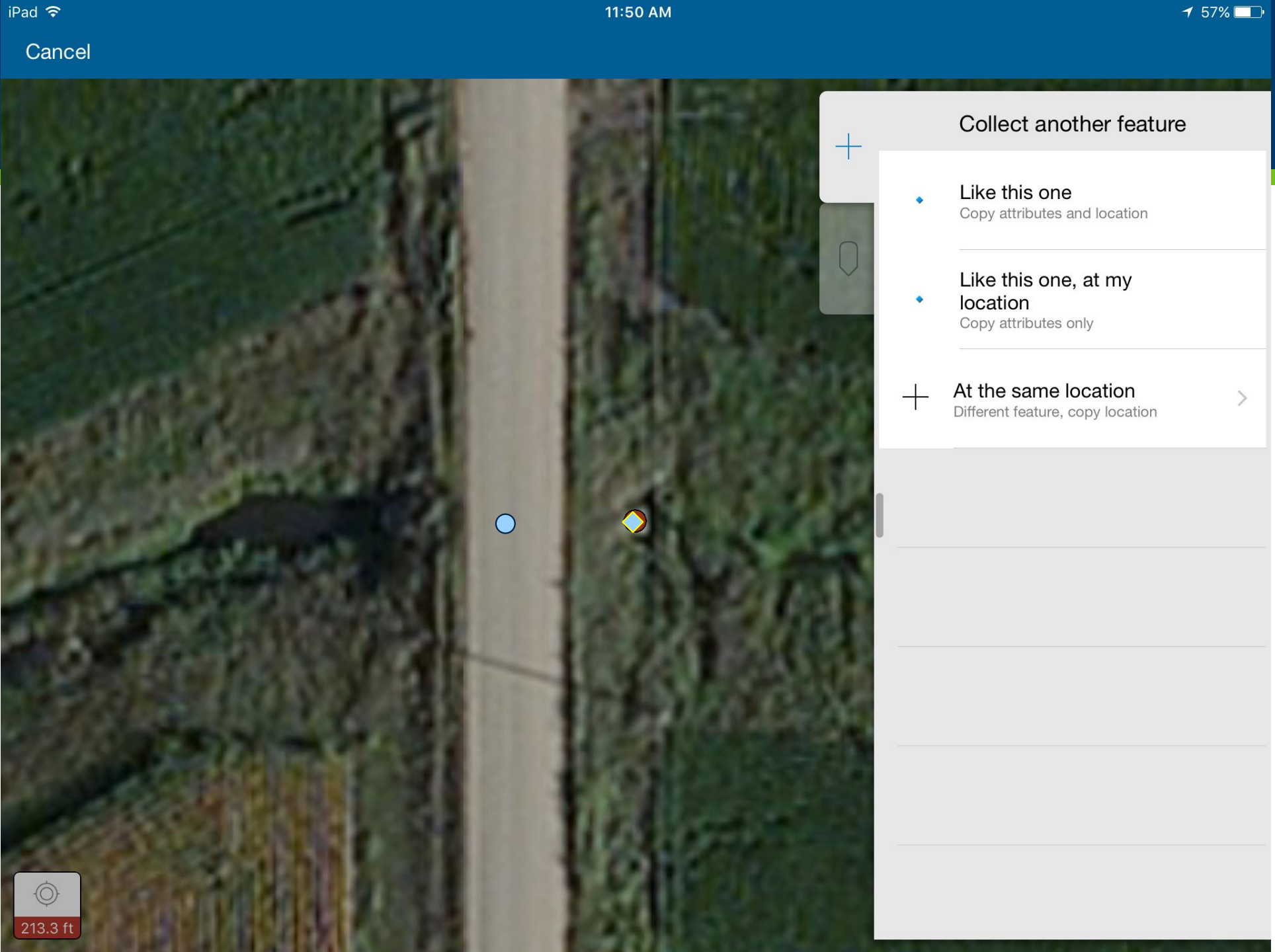


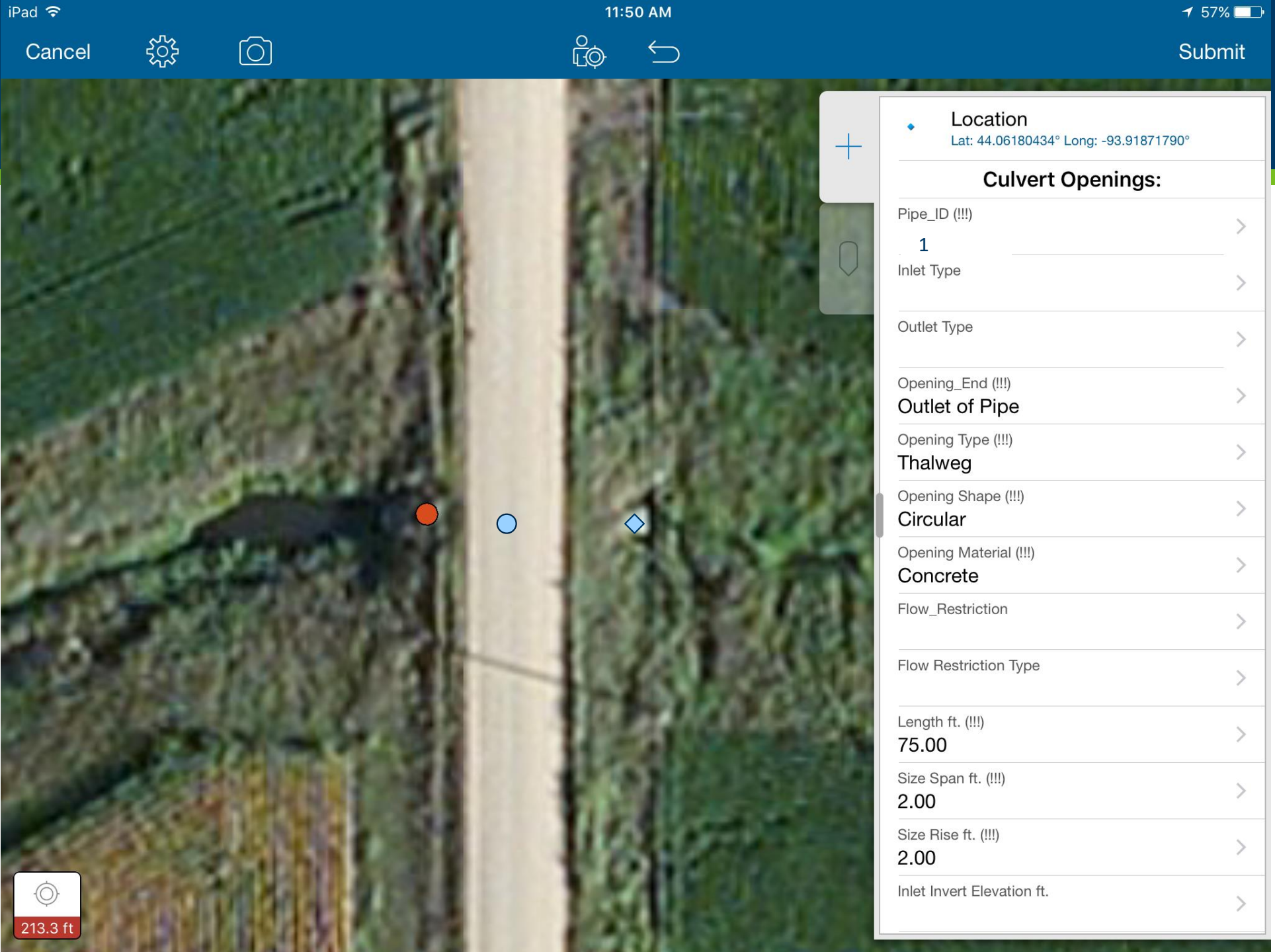
Size Rise – To the nearest tenth of a foot, measure the height of the structure inlet. Take this measurement inside the structure.

1) Collector


iPad
11:51 AM
57%
Maps
Culvert Openings:
Copy
Edit
Delete
Zoom to
Directions to here
CR34_001
Inlet Type
Outlet Type
Opening_End (!!!)
Inlet of Pipe
Opening Type (!!!)
Thalweg
Opening Shape (!!!)
Circular
Opening Material (!!!)
213.3 ft

1) Collector


iPad
11:50 AM
57%
Cancel
Collect another feature
Like this one
Copy attributes and location
Like this one, at my location
Copy attributes only
At the same location
Different feature, copy location
213.3 ft



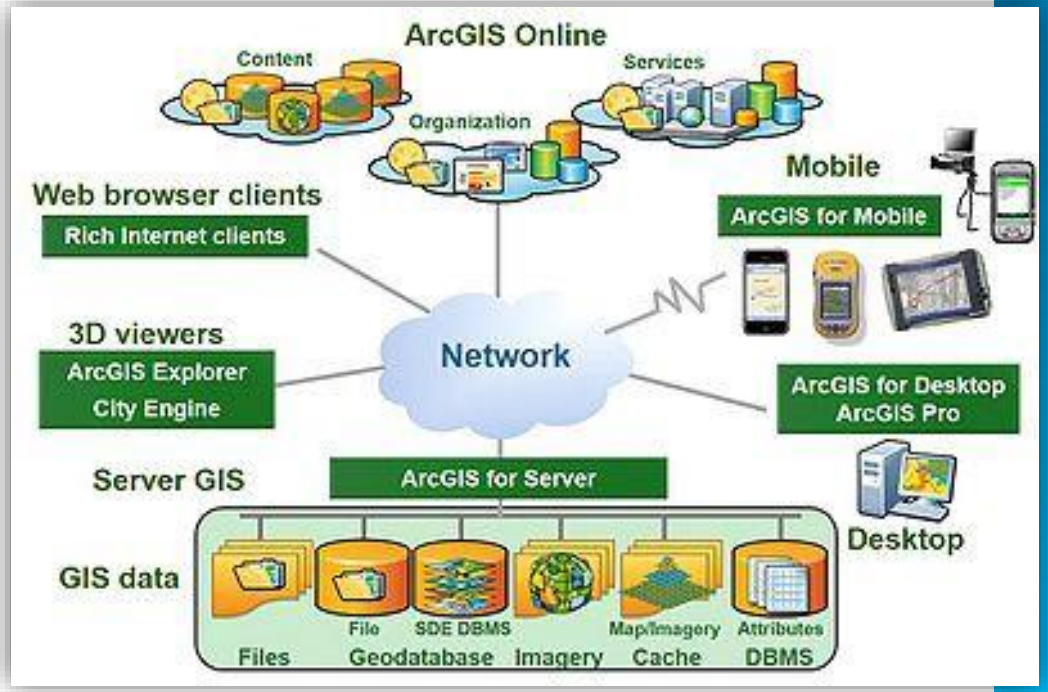
1) Collector

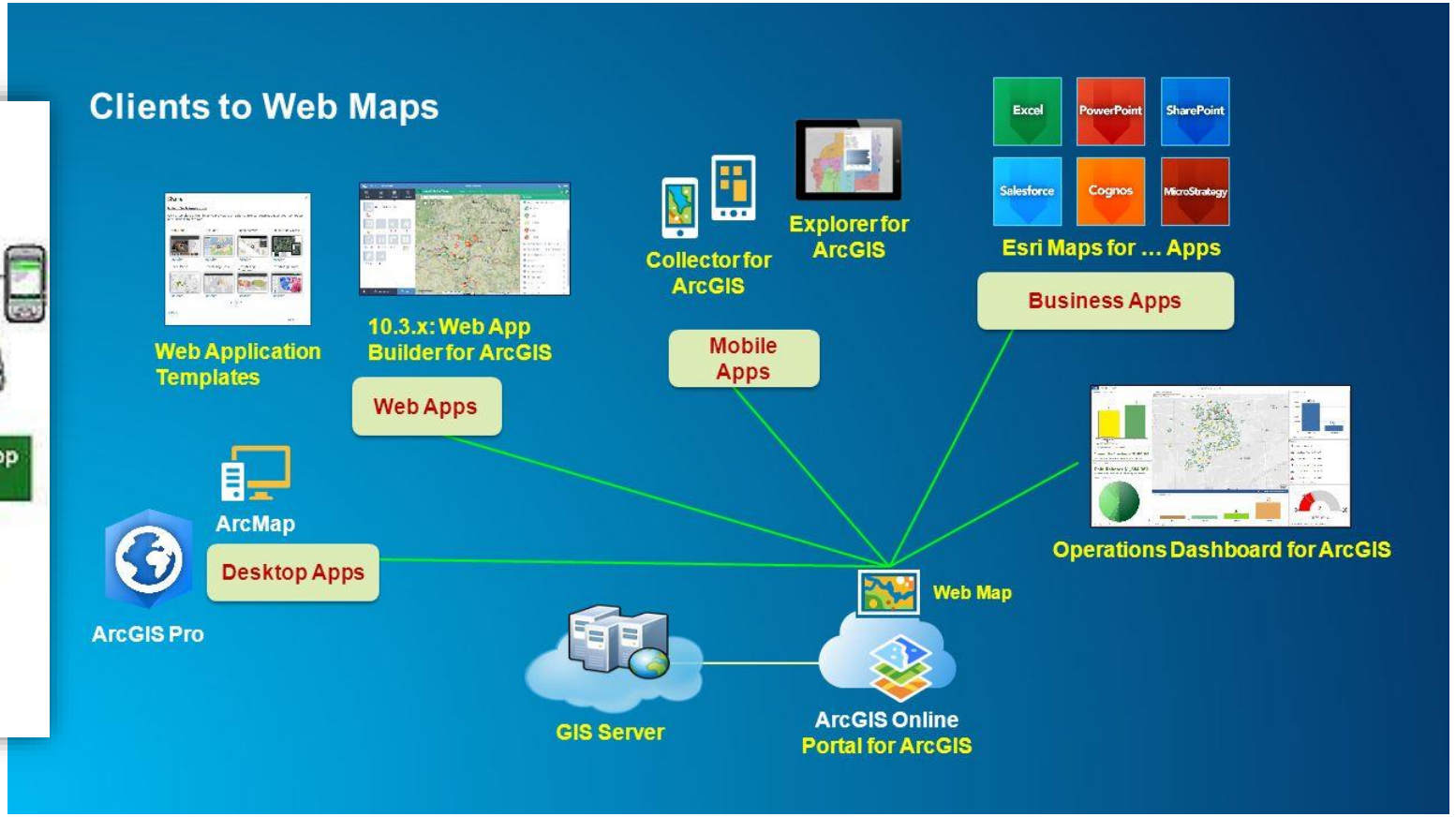
- Individual culverts are represented as a set of paired points for the inlets and outlets.
- Outlet of Culvert Openings Attributes are copied over from Inlet Point – reduces data entry time as well as standardization

1) Stream Crossing Summary & Culvert Openings

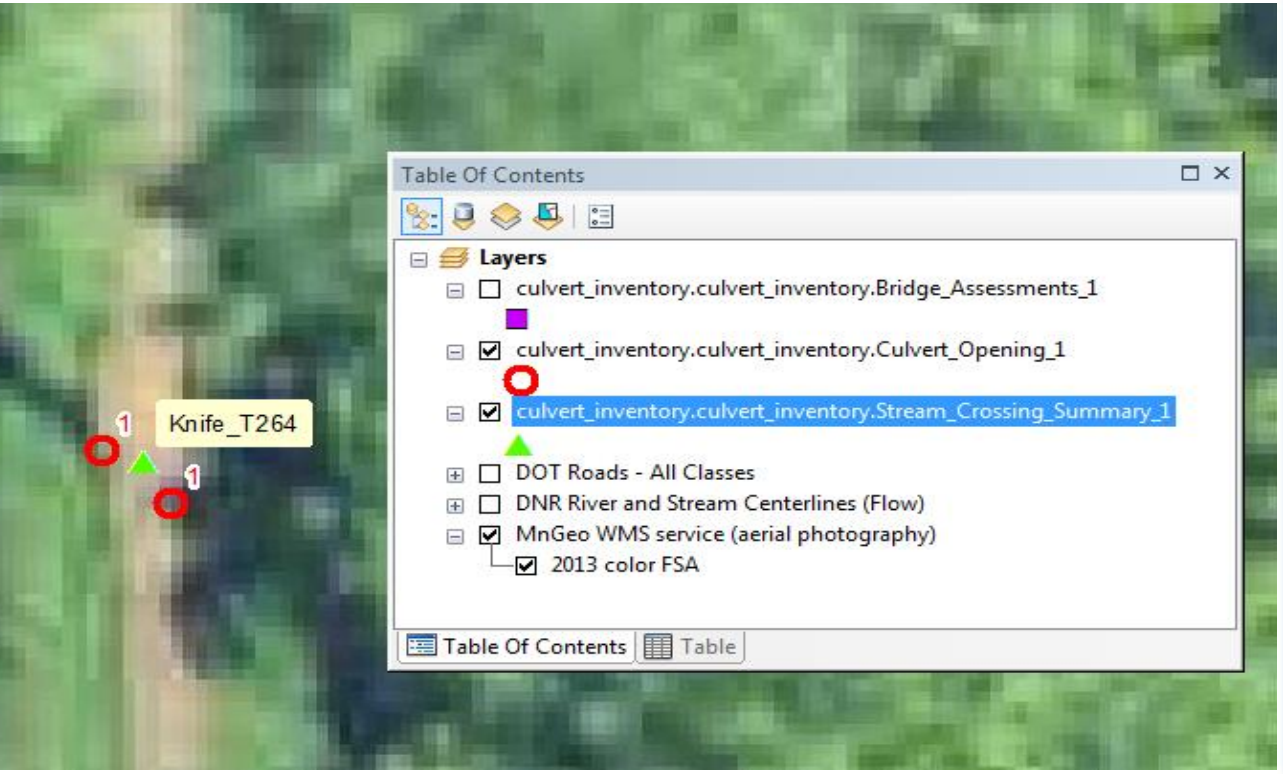
DEMO

2) ArcSDE Database





2) ArcSDE Database



2) ArcSDE Database - Crossings

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1	Required Short User Inpu	Required Long User Inpu	WebApp User Input	Feature Name	Alias	CollectorShort_Or	CollectorLong_(	SDE_Order	WebApp_Order	Feature Type	Feature Length	Domain Name	Domain Type	Doma
2	Required	Required	Required	surveyor	Surveyor	1	1	2	5	String	100	AD_user_name	Coded Values	
3				secondary_surveyor	Secondary Surveyor	2	2	89	6	String	100	AD_user_name	Coded Values	
4	Required	Required	Required	field_date	Field Date	3	3	54	7	Date				
5				survey_purpose	Survey Purpose	4	4	80	23	String	100	survey_purpose	Coded Values	Fish P
6				hpa	Horizontal Accuracy	5	6	67	25	String	10	HPA	Coded Values	<0.5m
7				vpa	Vertical Accuracy	6	7	68	26	String	10	VPA	Coded Values	<0.3m
8	Required	Required	Required	crossing_type	Crossing Type*	7	21	14	4	String	25	Crossing_Type	Coded Values	Span
9	Suggested Field	Suggested Field	Bolded (FSH Suggested)	quantity	Number of Culverts [0-1000]	8	23	79	41	Short Integer	5	Quantity	Range	
10				own_type	own_type	9	27	71	45	String	30	Ownership	Coded Values	Privat
11				maint_type	maint_type	10	28	72	46	String	30	Ownership	Coded Values	Privat
12				maint_name	Maintenance Name	11	29	3	47	String	30			
13				notes_and_comments	notes_and_comments	12	61	78	79	String	500			
14	Suggested Field	Suggested Field	Bolded (FSH Suggested)	total_span	Total Span ft.	13	22	69	40	Short Integer	5		Range	
15	Suggested Field	Suggested Field	Bolded (FSH Suggested)	bankfull_estimate_confidence	bankfull_estimate_confidence	14	33	74	51	String	12	High_Medium_Low	Coded Values	Low
16				elevation_method	elevation_method		5	66	24	String	25	Elevation_Method	Coded Values	Monu
17				height_of_instrument	Height of Instrument (HI)		8	55	27	Float	3		Range	
18				water_level	Water Level		9	56	28	String	25	water_level	Coded Values	High
19				benchmark_location	Benchmark Locaton		10	11	29	String	50			
20				benchmark_elevation_foresight	Benchmark Elevation Foresight ft.		11	12	30	Double	38	benchmark_elevation_fores	Range	
21				benchmark_elevation_elevation	Benchmark Elevation Elevation ft.		12	13	31	Double	38	benchmark_elevation_eleva	Range	
22				headwater_surface_foresight_ft	Headwater Surface Foresight Ft.		13	86	32	Float	5		Range	
23				headwater_surface_elevation	Headwater Surface Elevation		14	43	33	Double	38		Range	
24				tailwater_surface_foresight_ft	Tailwater Surface Foresight Ft.		15	87	34	Float	5		Range	
25				tailwater_surface_elevation	Tailwater Surface Elevation		16	44	35	Double	38		Range	
26				inlet_bed_foresight_ft	Inlet Bed Foresight Ft.		17	84	36	Float	5		Range	
27				inlet_bed_elevation	Inlet Bed Elevation		18	45	37	Double	38		Range	
28				outlet_bed_foresight_ft	Outlet Bed Foresight Ft.		19	85	38	Float	5		Range	
29				outlet_bed_elevation	Outlet Bed Elevation		20	46	39	Double	38		Range	
30		Suggested Field	Bolded (FSH Suggested)	offset_culverts	Culverts Offset?		24	57	42	String	3	Yes_No	Coded Values	Yes
31		Suggested Field	Bolded (FSH Suggested)	crossing_properly_aligned	crossing_properly_aligned		25	70	43	String	1	Yes_No	Coded Values	Yes
32				year_built	Year Built		26	15	44	Short Integer	5	year_built	Range	
33				crossing_condition	Crossing Condition		30	16	48	String	4	Crossing_Condition	Coded Values	Good
34				condition_issues	Condition Issues		31	17	49	String	100	Condition_Issues	Coded Values	Corro
35		Suggested Field	Bolded (FSH Suggested)	bankfull_width_ft	bankfull_width_ft		32	73	50	Double	3		Range	
36				riffle_bankfull_max_depth	Riffle Bankfull Max Depth ft.		34	18	52	Double	38	riffle_bankfull_max_depth	Range	
37				riffle_maximum_velocity	Riffle Maximum Velocity		35	19	53	Double	38	riffle_maximum_velocity	Range	
38				riffle_dominant_substrate	Riffle Dominant Substrate		36	20	54	String	50	Riffle_Dominant_Substrate	Coded Values	Silt
39		Suggested Field	Bolded (FSH Suggested)	scour_pool	Scour Pool?		37	42	55	String	3	Yes_No	Coded Values	Yes

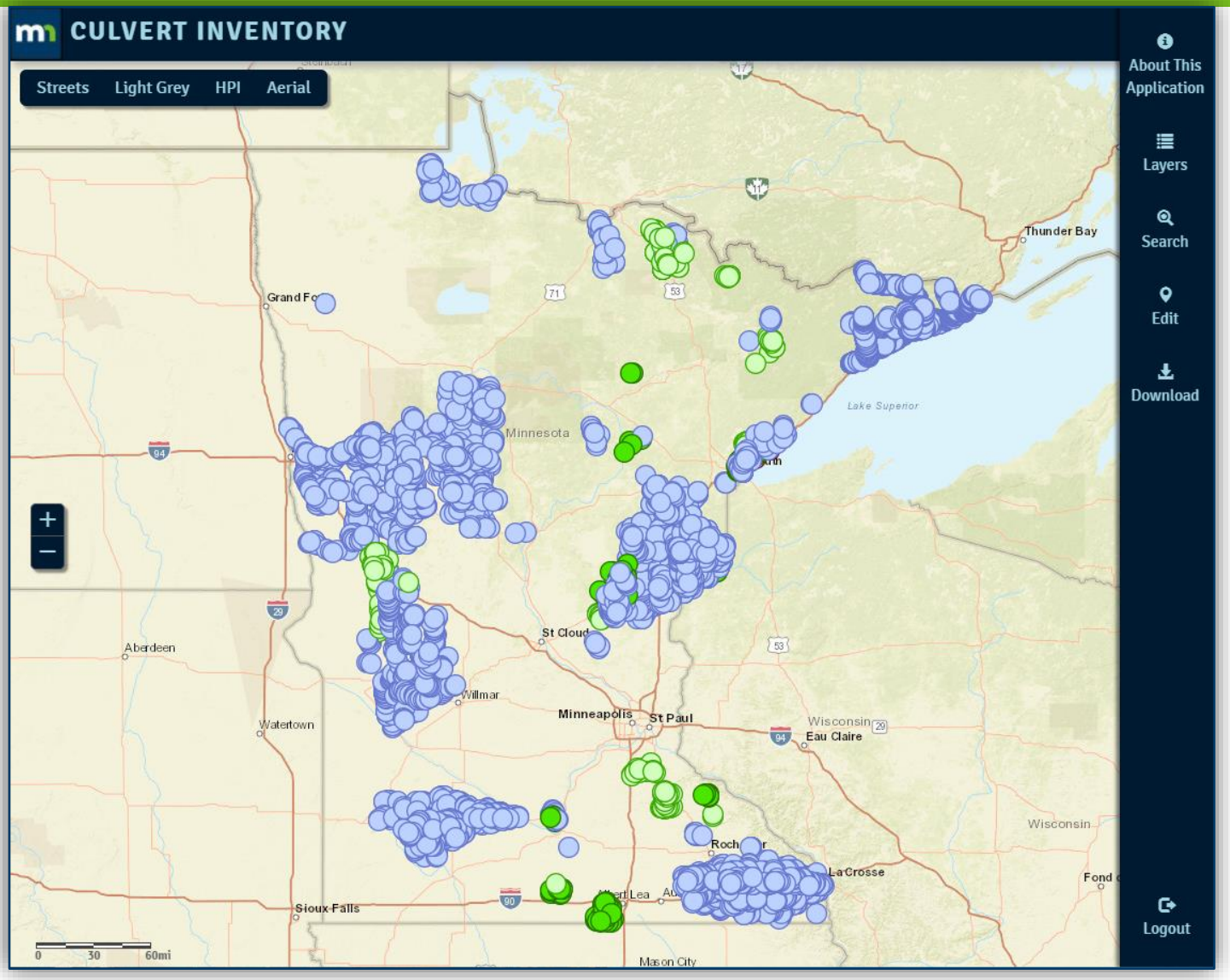
Stream Crossing Summary | Culvert Opening | Bridge Assessment

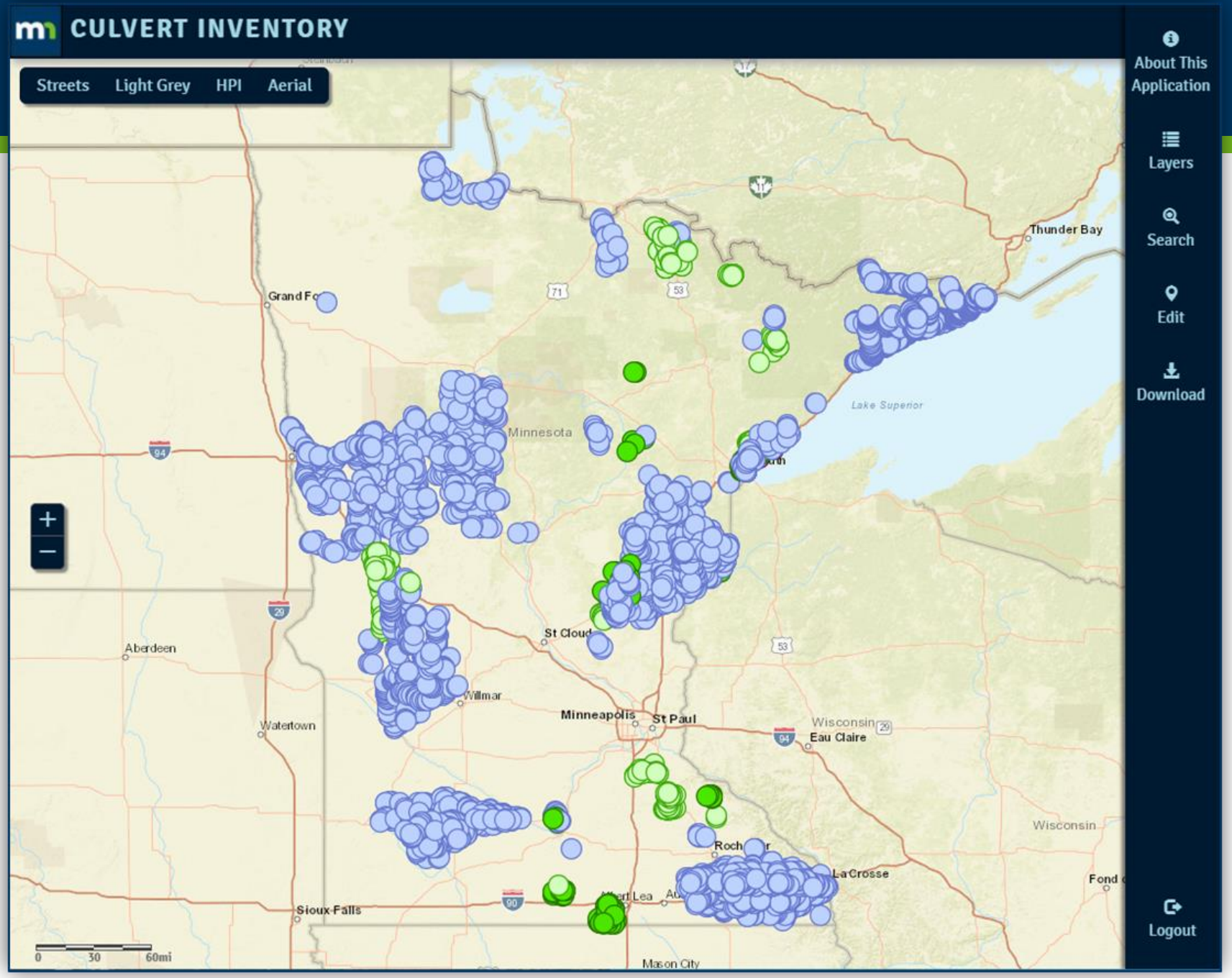
2) ArcSDE Database – Culvert Opening

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Required Short User	Required Long User	WebApp User Input	Feature Name	Alias	CollectorShort_	CollectorLong_C	SDE_Order	WebApp_Order	Feature Type	Feature Length	Domain Name	Domain Type	Domain_1
2				globalid	globalid			17	1	GlobalID	38			
3			Bolded (FSH Suggested)	crossing_id	crossing_id			33	2	String	15			
4	Required	Required	Required	pipe_id	Pipe_ID	1	1	2	3	String	20			
5				inlet_type	Inlet Type	2	2	22	4	String	25	Inlet_Type	Coded Values	Projected
6				outlet_type	Outlet Type	3	3	23	5	String	30	Outlet_Type	Coded Values	At Stream Gr
7	Suggested Field	Suggested Field	Bolded (FSH Suggested)	opening_end	Opening_End	4	4	3	6	String	15	Opening_End	Coded Values	Inlet of Pipe
8	Suggested Field	Suggested Field	Bolded (FSH Suggested)	opening_type	opening_type	5	5	34	7	String	12	Opening_Type	Coded Values	Thalweg
9	Suggested Field	Suggested Field	Bolded (FSH Suggested)	opening_shape	opening_shape	6	6	35	8	String	25	Opening_Shape	Coded Values	Circular
10	Suggested Field	Suggested Field	Bolded (FSH Suggested)	opening_material	opening_material	7	7	36	9	String	25	Opening_Material_1	Coded Values	Concrete
11				flow_restriction	Flow_Restriction	8	8	4	10	String	25	Yes_No	Coded Values	Yes
12				flow_restriction_type	Flow Restriction Type	9	9	5	11	String	25	Flow_Restriction_Typ	Coded Values	Baffle
13	Suggested Field	Suggested Field	Bolded (FSH Suggested)	length	Pipe Length ft.	10	10	6	12	Double	38	length_ft_1	Range Domain	0-5000
14	Suggested Field	Suggested Field	Bolded (FSH Suggested)	size_span	Span ft.	11	11	7	13	Double	38	size_span_1	Range Domain	0-5000
15	Suggested Field	Suggested Field	Bolded (FSH Suggested)	size_rise	Rise ft.	12	12	8	14	Double	38	size_rise_1	Range Domain	0-99
16				inlet_invert_foresight	Inlet Invert Foresight ft.	13	13	9	15	Double	38	inlet_invert_foresigh	Range Domain	0-200
17				inlet_invert_elevation	Inlet Invert Elevation ft.	14	14	10	16	Double	38	inlet_invert_elevatio	Range Domain	600-2000
18				outlet_invert_foresight	Outlet Invert Foresight ft.		15	11	17	Double	38	outlet_invert_foresig	Range Domain	0-200
19				outlet_invert_elevation	Outlet Invert Elevation ft.		16	12	18	Double	38	outlet_invert_elevati	Range Domain	600-2000
20				water_depth_ft	Water Depth ft.		17	13	19	Double	38	water_depth_ft	Range Domain	0-20
21				outlet_drop_ft	Outlet Drop ft.		18	27	20	Short Integer	5	outlet_drop_ft	Range Domain	0-100
22		Suggested Field	Bolded (FSH Suggested)	substrate	substrate		19	37	21	String	1	Yes_No	Coded Values	Yes
23				substrate_depth_ft	Substrate Depth ft.		20	14	22	Double	38	substrate_depth_ft	Range Domain	0-10
24				substrate_size	substrate_size		21	38	23	String	12	Substrate_Size	Coded Values	Cobble
25		Suggested Field	Bolded (FSH Suggested)	pct_plugged	Percent Plugged		22	15	24	Short Integer	5	Pct_Plugged	Coded Values	0%
26				velocity_method	Velocity Method		23	28	25	String	10	Velocity_Method	Coded Values	Meter
27				maxumum_velocity_fps	maxumum_velocity_fps	18	24	40	26	Double	38	maximum_velocity_f	Range Domain	0-6
28				distance_at_maximum_velocity	Distance at Maximum Velocity ft.		25	16	27	Short Integer	5	Distance_aat_Maximu	Range Domain	0-300
29				upstream_fill_depth	Upstream Fill Depth		26	25	28	Double	38	Fill_Depth_1	Range Domain	0-99
30				downstream_fill_depth	Downstream Fill Depth		27	26	29	Double	38	Fill_Depth_1	Range Domain	0-99
31				culvert_condition	culvert_condition	16	28	31	30	String	4	Crossing_Condition	Coded Values	Good
32				condition_issues	condition_issues	17	29	32	31	String	100	Condition_Issues	Coded Values	Corrosion
33				notes_and_comments	notes_and_comments	15	30	39	32	String	500			
34				created_user	Created User			18	33	String	255			
35				created_date	Created Date			19	34	Date	8			
36				last_edited_user	Last Edited User			20	35	String	255			
37				last_edited_date	Last Edited Date			21	36	Date	8			
38				feature_status	Feature Status		31	24	37	String	25	Status	Coded Values	Candidate
39				question	Question		32	43	38	String	1000			
40				arch_reason	Archived Reason		33	29	39	String	100			
41				breach_line_created	Breach Line Created		34	30	40	String	3	Yes_No	Coded Values	Yes
42				~~us_ds~~				~~999~~	~~999~~	~~String~~	~~4~~	~~US_DS~~	~~Coded Values~~	~~Upstream~~
43		~~Required~~		~~restrictor~~				~~999~~	~~999~~	~~String~~	~~3~~	~~Restrictor~~	~~Coded Values~~	~~Yes~~

Stream Crossing Summary | **Culvert Opening** | Bridge Assessment

3)Web Application

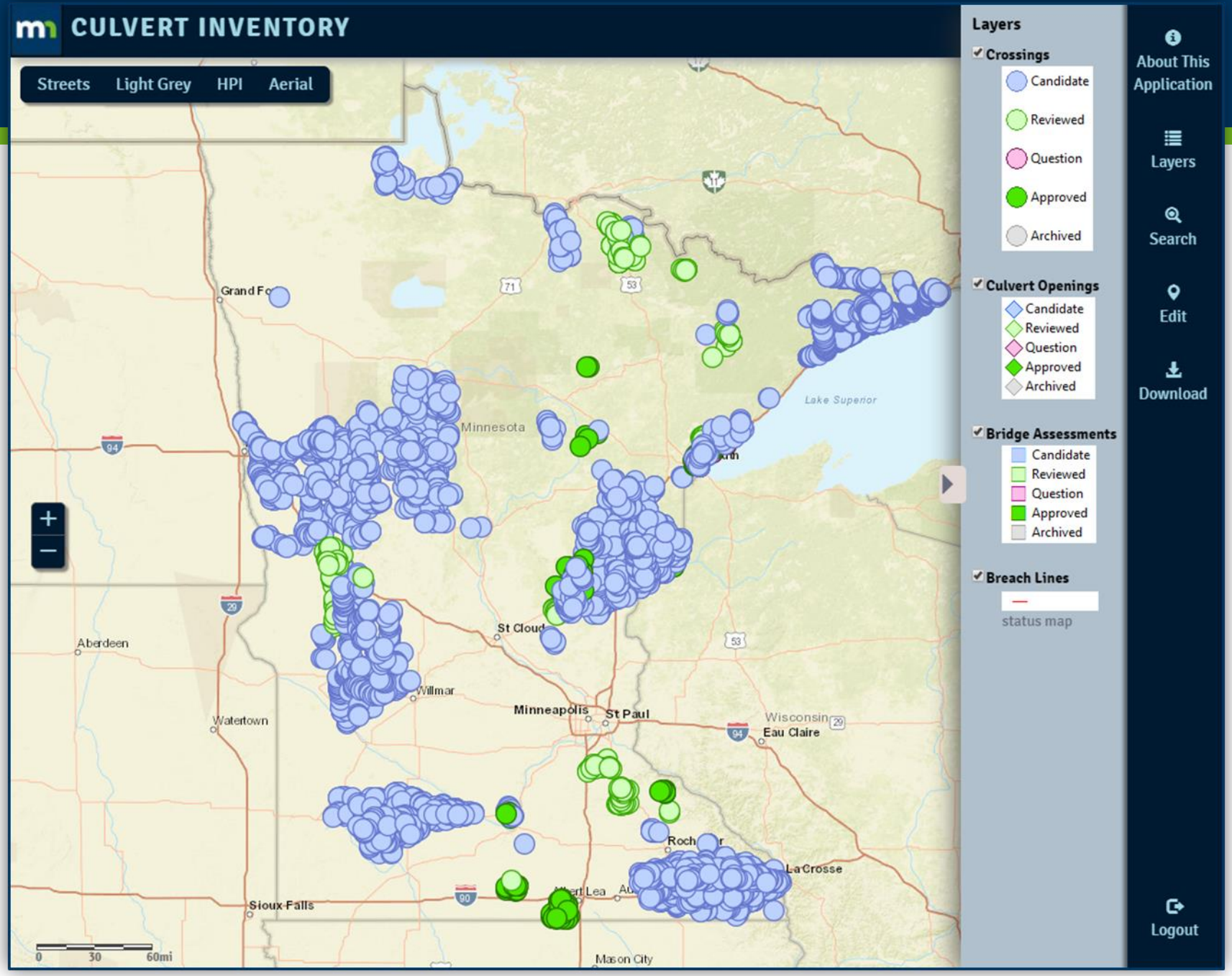




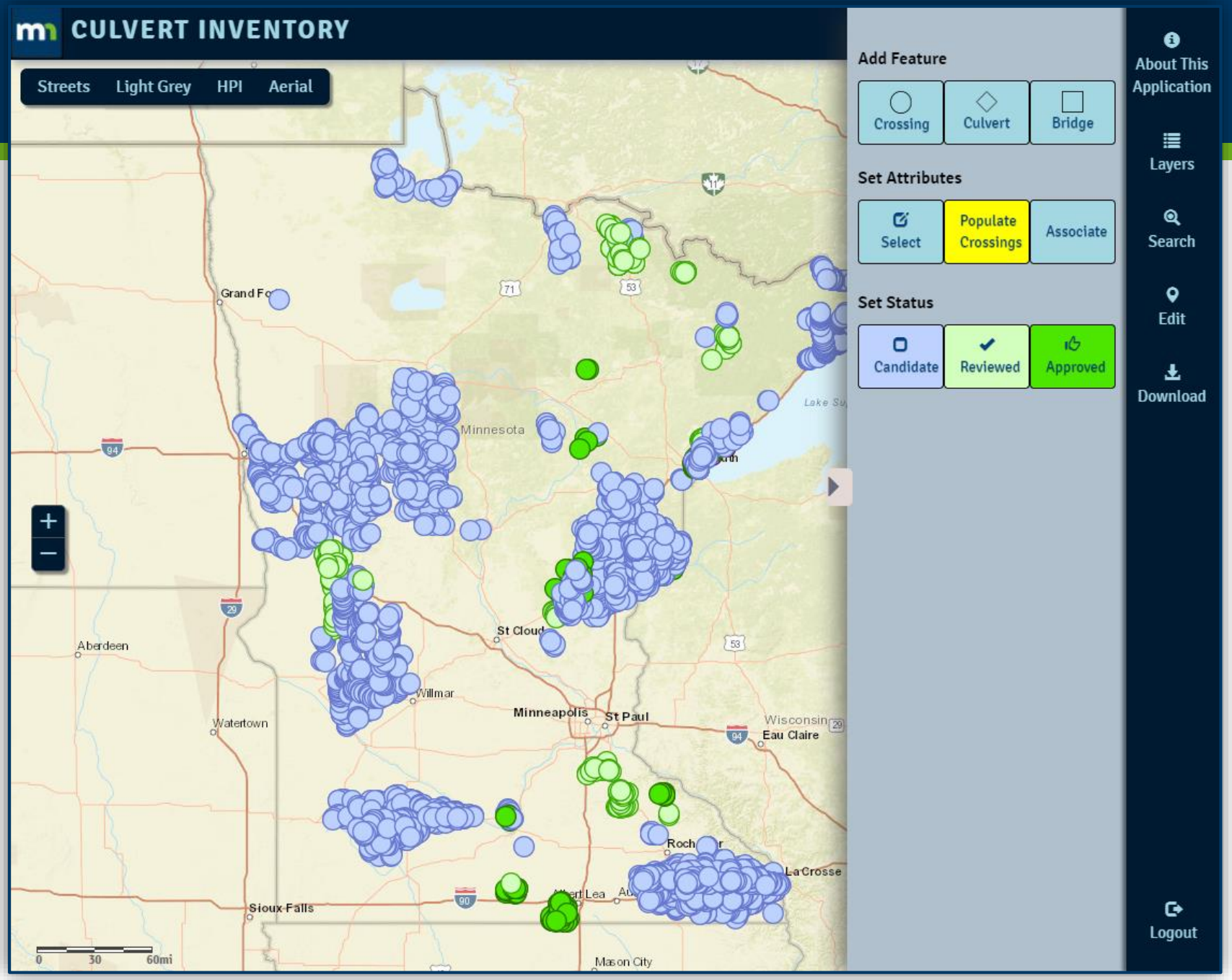
3)Web Application

- Developed by DNR, the Web Application allows data stewards to conduct in-office review, editing, and approval of their data locations and attributes created in the field using the ArcGIS Collector App.

3)Web Application



- Crossings Points are assigned unique Crossing ID’s, associated culverts & bridges are associated with their master crossing point.
- Users are assigned different roles with increasing levels of ‘rights’ to perform certain editing and approval functions.
- Approved features are exported to MN GeoSpatial Commons

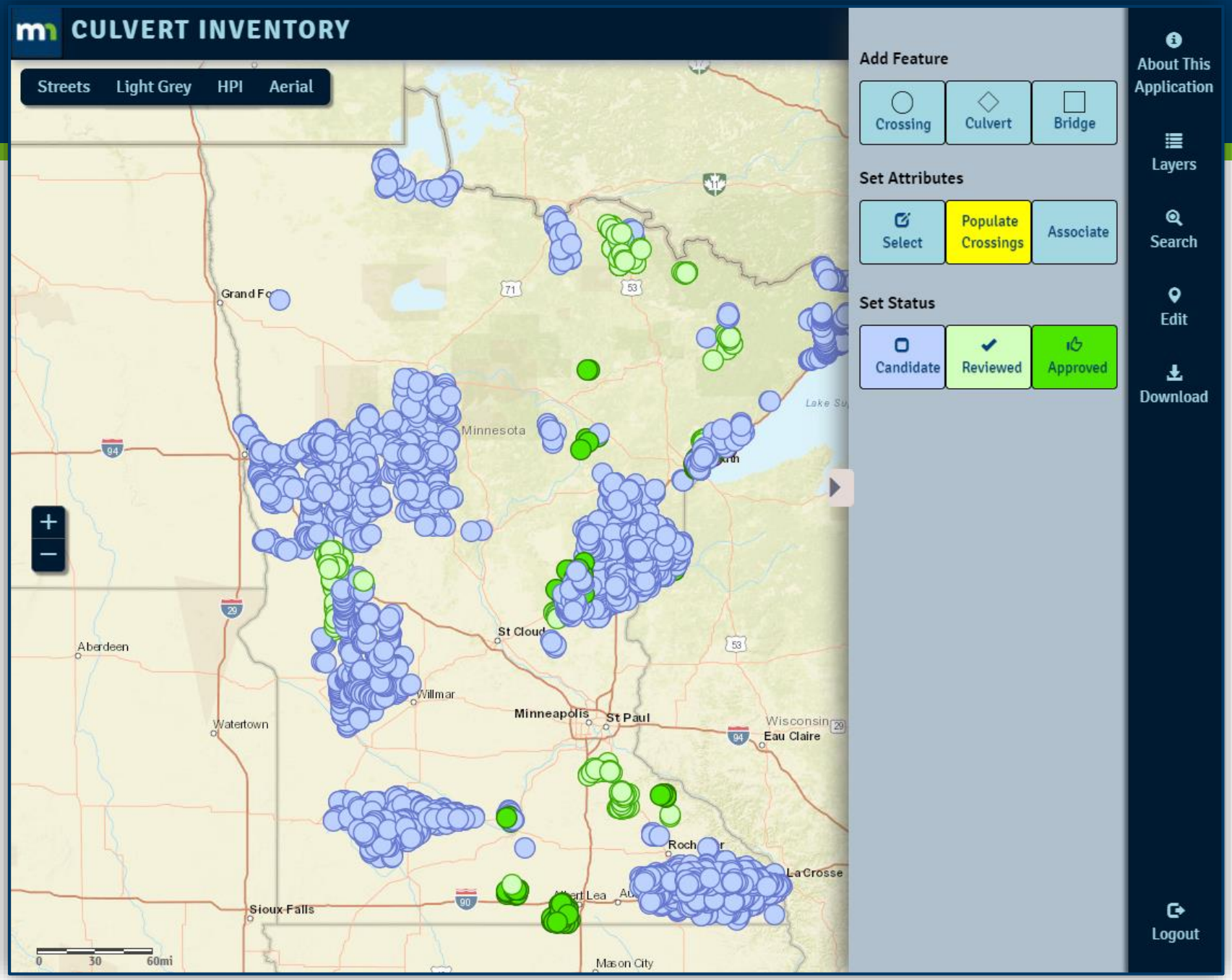


3)Web Application

- The **EDIT** Button expands the legend, allowing for creation of new points and the populating of Spatial attributes for the Crossings using tools under **Set Attributes.**

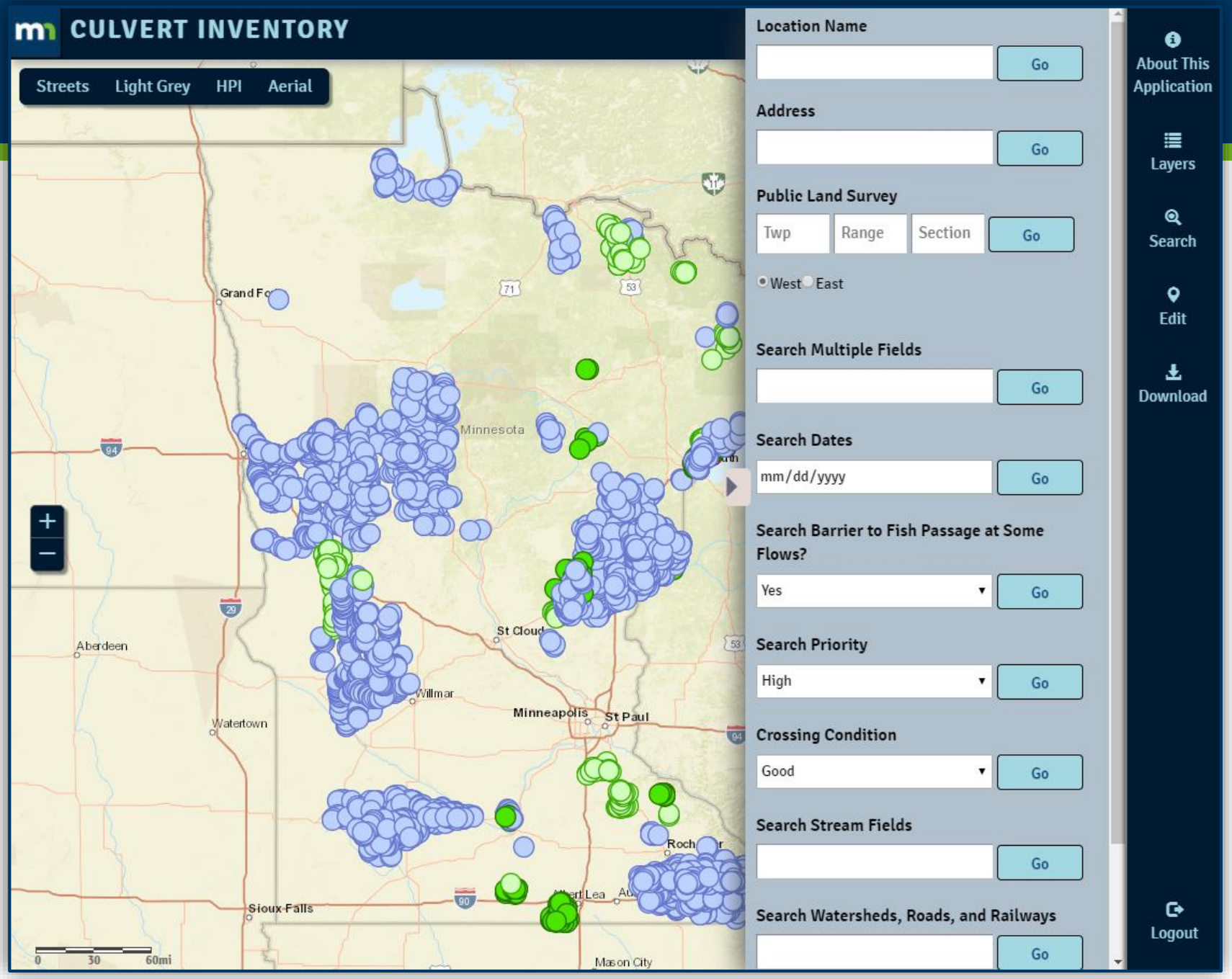
- **Set Status** tracks the Review and Approving process for Crossings, Bridges and Culvert Openings**.**

3)Web Application



The five Feature Status Levels are:

- **Candidate**–all features are assigned this status by default.
- **Reviewed**–these features have been reviewed for accuracy and completeness by the Data Collector and are ready for approval.
- **Question**–these features have a question asked about them and are waiting a response.
- **Approved**–these Reviewed features have been approved by the Approver-Business for business related uses.
- **Archived**–these un-editable features have been “retired”.

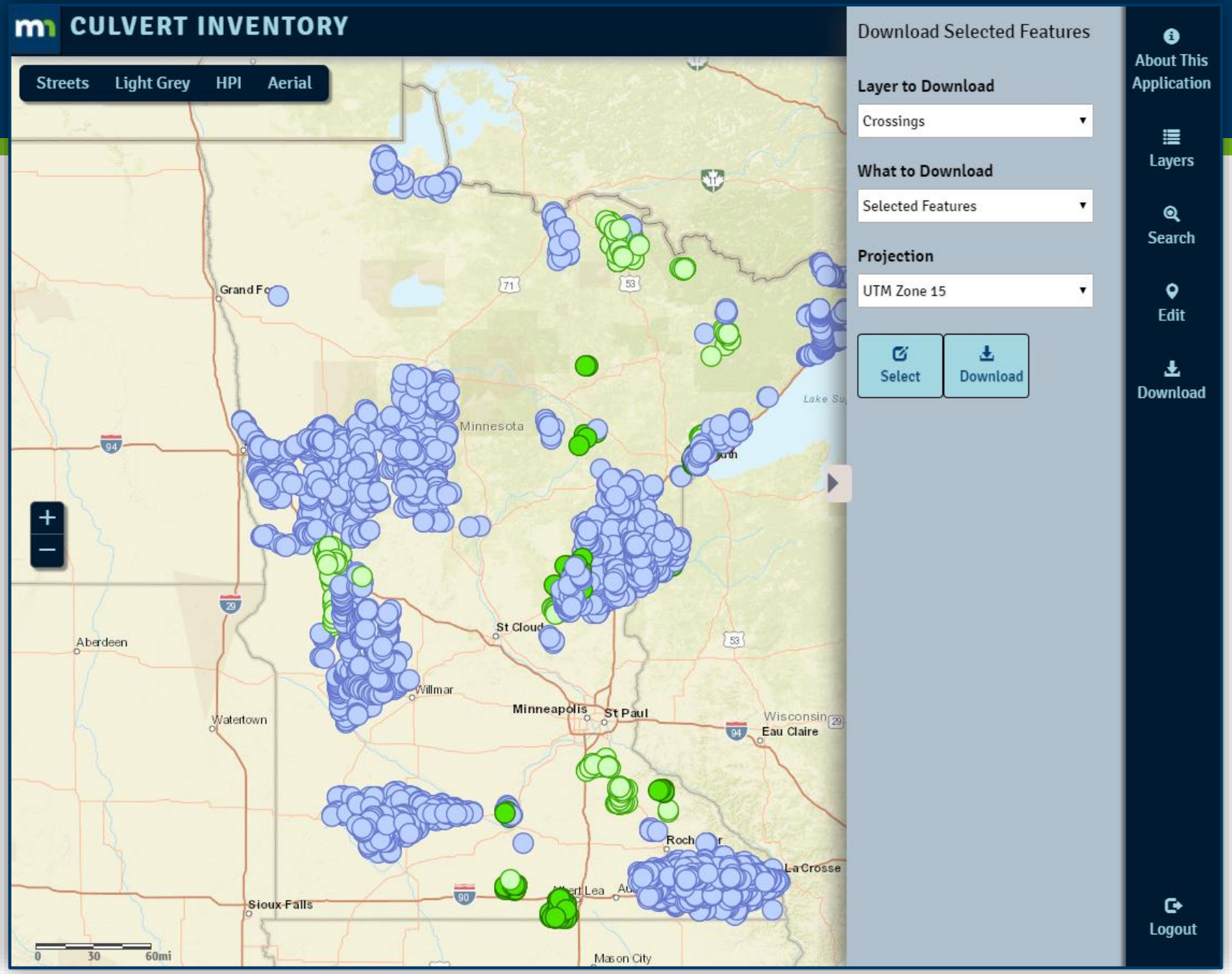


3)Web Application

The **Search Panel** allows users to find features based on locations and attributes:

- Click on any search result to zoom to that area or feature

3)Web Application

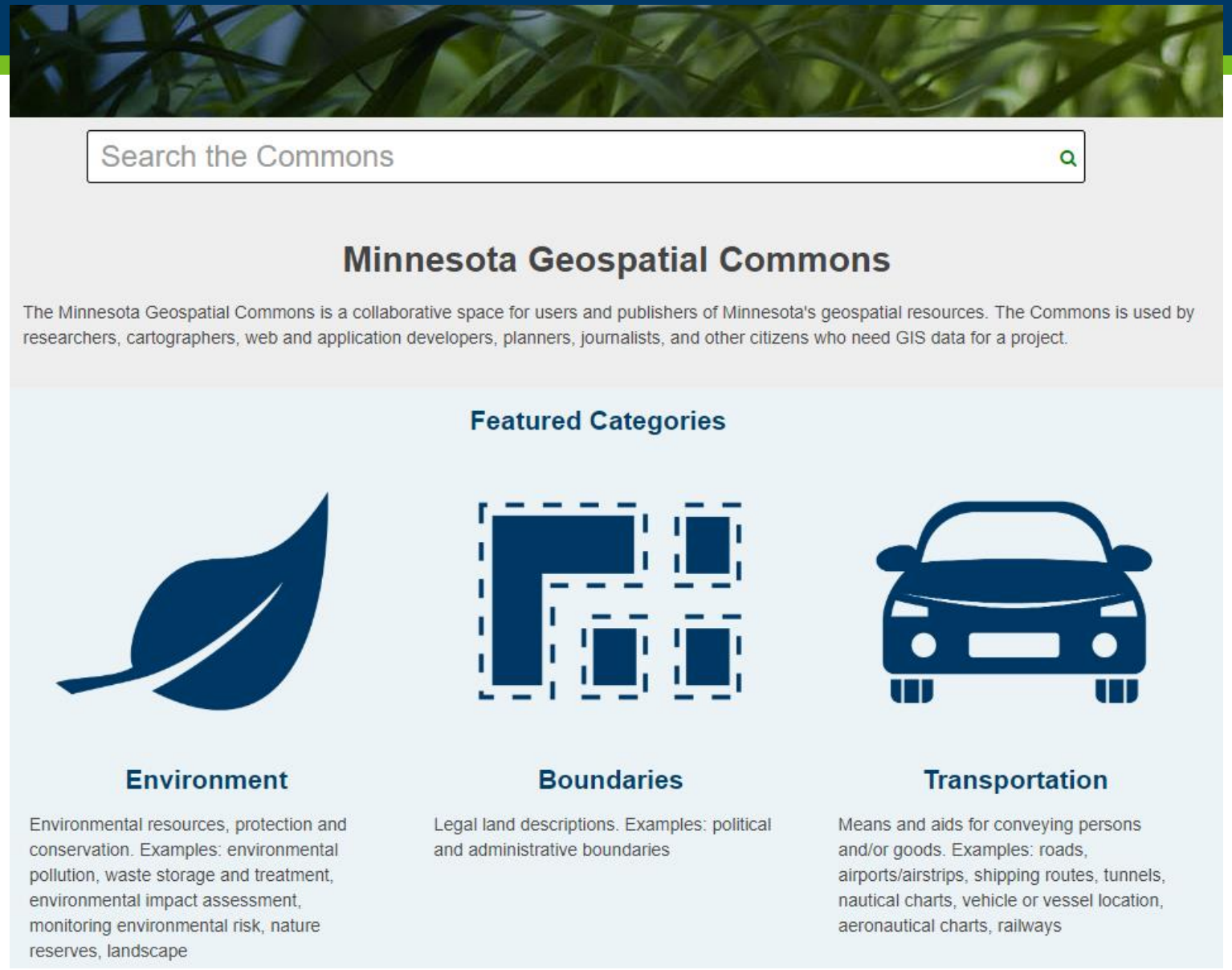


The **DOWNLOAD** Button allows the download of all features or selected features

3) Stream Crossing Summary & Culvert Openings

DEMO

4) Published Statewide GIS Layers



- Standardized GIS layers available to all users and only “approved” crossing features are added to GIS layers
- Multiple layers and symbolization possible
- GIS Layers available via MN GeoSpatial Commons

MN DNR Culvert Inventory Application Suite

MINNESOTA IT SERVICES

MNDNR CULVERT INVENTORY APPLICATION SUITE

DEPARTMENT OF NATURAL RESOURCES

Purpose

- To allow simultaneous collection of culvert locations and attributes in a standardized manner by professional staff across Minnesota
- To build a statewide database of culvert features which can be used for a variety of purposes, including:
  - Hydrologic connectivity of the landscape
  - Fish/Species Passage
  - Flood control and hydrologic modeling
  - Water quality/sediment transport
  - Hydro-modification of LiDAR-derived DEMs
- This work was funded by the following stakeholders:

DEPARTMENT OF NATURAL RESOURCES MINNESOTA IT SERVICES MINNESOTA'S LAKE SUPERIOR COASTAL PROGRAM CLEAN WATER LAND & LEGACY AMENDMENT

The **MNDNR Culvert Inventory Application Suite** consists of the following related components:

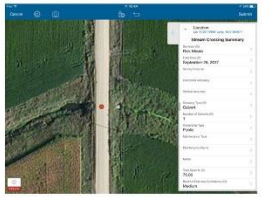
1) **Collector for ArcGIS Mobile Application** – for field data collection
2) **ArcSDE Centralized Database** – for multi-user editing/storage
3) **MNDNR Web Application** – Custom App for data review and approval
4) **Published Statewide GIS layers** – for GIS applications

DNR Culvert Inventory Resources: http://www.dnr.state.mn.us/watersheds/culvert_inventory/index.html

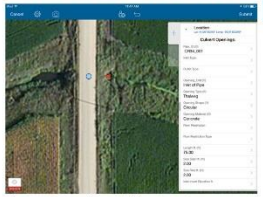
1) COLLECTOR for ArcGIS MOBILE APPLICATION

Collector for ArcGIS Mobile Application allows for field scale collection of data about stream crossings, culvert openings, bridges and DEM digital dam breachlines.

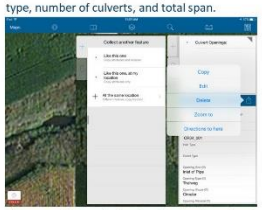
- Crossing Points representing bridges and culverts are represented as a single master point. (Crossings may have multiple culverts)
- Individual culverts are represented as a set of paired points for the inlets and outlets.
- With wireless connectivity, georeferenced data collected in the field is uploaded directly to a centralized SDE database.
- There are two alternate user forms for data collection; a Long Form based on *MNDNR Stream Crossing Full Assessment Form* and a Short Form based on *Interim Guidance on Acquisition of Culvert Geospatial Data*



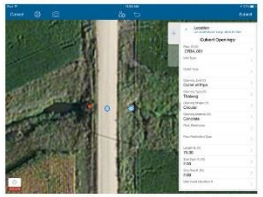
1) A single master point feature represents the road crossing. Attributes specific to the crossing are entered such as surveyor, survey purpose, crossing type, number of culverts, and total span.



2) For culverts, there will be two points; one point each for inlet and outlet. To begin, the user will click on the map at the location of the inlet and enter the attributes associated with the feature.



3) Once an inlet point is placed, it is selected and attribute data can be copied to a new point using the Copy *Like This One, At My Location* function. Next, move the outlet point to the appropriate location.



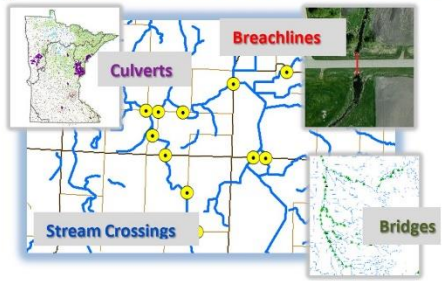
4) Once the outlet point has been placed, the attributes that are unique to the outlet are modified. The points and attributes are then submitted and synced with the ArcSDE database.

2) ArcSDE CENTRALIZED DATABASE

The centralized database allows the following:

- Simultaneous editing by multiple users
- Standard data domains and values
- Secure centralized data storage
- Regular data backup and maintenance

4) PUBLISHED STATEWIDE GIS LAYERS



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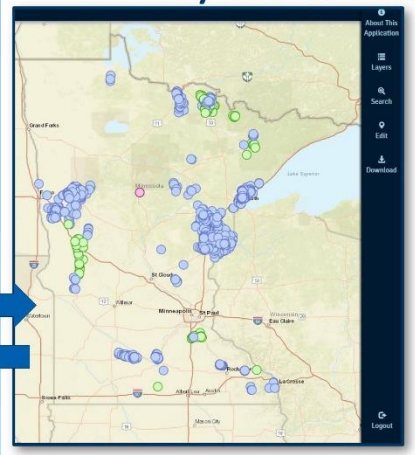
3) MNDNR WEB APPLICATION



The **LAYERS** Button expands the legend to show symbol levels for the layers.

The five Feature Status Levels are:

- **Candidate** – all features are assigned this status by default.
- **Reviewed** – these features have been reviewed for accuracy and completeness by the Data Collector and are ready for approval.
- **Question** – these features have a question asked about them and are waiting a response.
- **Approved** – these Reviewed features have been approved by the Approver-Business for business related uses.
- **Archived** – these un-editable features have been "retired".

The **EDIT** Button expands the legend, allowing for creation of new points and the populating of Spatial attributes for the Crossings using tools under **Set Attributes.**

- Using the Select button, select the Crossing point, hit **Populate Crossings** to add attributes
  - The Crossing ID is assigned based on DNR Level 08 Catchment and the crossing feature type.
- Select the Culvert Openings associated with this Crossing and hit **Associate** to assign the Crossing ID to the Culvert Openings.

Set Status tracks the Review and Approving process for Crossings, Bridges and Culvert Openings.

The **DOWNLOAD** Button allows the download of all features or selected features

The **Search Panel** allows users to find features based on locations and attributes:

- Click on any search result to zoom to that area or feature.

Developed by DNR, the Web Application allows data stewards to conduct in-office review, editing, and approval of their data locations and attributes created in the field using the ArcGIS Collector App.

- Feature locations and attributes can be edited and standardized using drop down domains, and some auto-populated.
- Crossings Points are assigned unique Crossing ID's, associated culverts & bridges are associated with their master crossing point.
- Users are assigned different roles with increasing levels of 'rights' to perform certain editing and approval functions.
- Approved features are exported to MN GeoSpatial Commons

How to get started

1. Contact MNDNR* for a **Culvert Inventory Application Suite** logon.
2. Obtain an Android, IOS or Windows 10 device for data collection.
3. Follow instructions from MNDNR on how to download and operate the application suite.
4. Submit existing culvert inventory, bridge inventory or breach line data to **Andy*** (right)

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Website: http://www.dnr.state.mn.us/watersheds/wrt.html

Thank You!

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Culvert Suite Expanded Abstract

The Minnesota Department of Natural Resources Culvert Inventory Application Suite is a crowdsourcing set of tools that collects culvert and bridge data across the state of Minnesota. The suite includes a mobile application, a central ArcSDE database, and a web application with online maps. Its design allows simultaneous collection of feature locations and attributes in a standardized manner by multiple users. The inventoried information serves a variety of purposes, including LiDAR-derived DEM modeling and digital dam removal; fish migration-barrier documentation and species enrichment; stream geomorphology and floodplain hydrology revitalization. The Collector for ArcGIS Mobile Application of the suite works on any handheld device for in-field collection of culvert locations, onsite images, and feature attributes. A single master control point represents each inventoried bridge and culvert feature. A set of paired points digitized at the inlet and outlet of culverts link spatially to the master control point that carries unique attributes for single or multiple culverts. With wireless connectivity, these georeferenced data collected in the field upload directly to a centralized ArcSDE database supported by real-time editing. Built upon the ArcGIS Online web application interface, data stewards can conduct in-office review, editing, and approval of their data locations and attributes created in the field. This feature provides an opportunity to incorporate local knowledge of features into the database strengthening earlier field work. Minnesota's premier spatial distribution portal, the GeoSpatial Commons hosts approved data for end-user consumption. The resulting database will improve government's efficiency and effectiveness in protecting the safety of citizens, enhancing the quality of water, and conserving aquatic habitats. This presentation will demonstrate the effectiveness of a crowdsourced Culvert Inventory Application Suite for Minnesota with an element geared towards how organizations outside of Minnesota can use the suite of applications as a template for their own business needs.