OFMA OKLAHOMA
FLOODPLAIN MANAGERS ASSOCIATION

Assessing Culvert Conditions Based on Photogrammetry Data Captured Using Drone Technology

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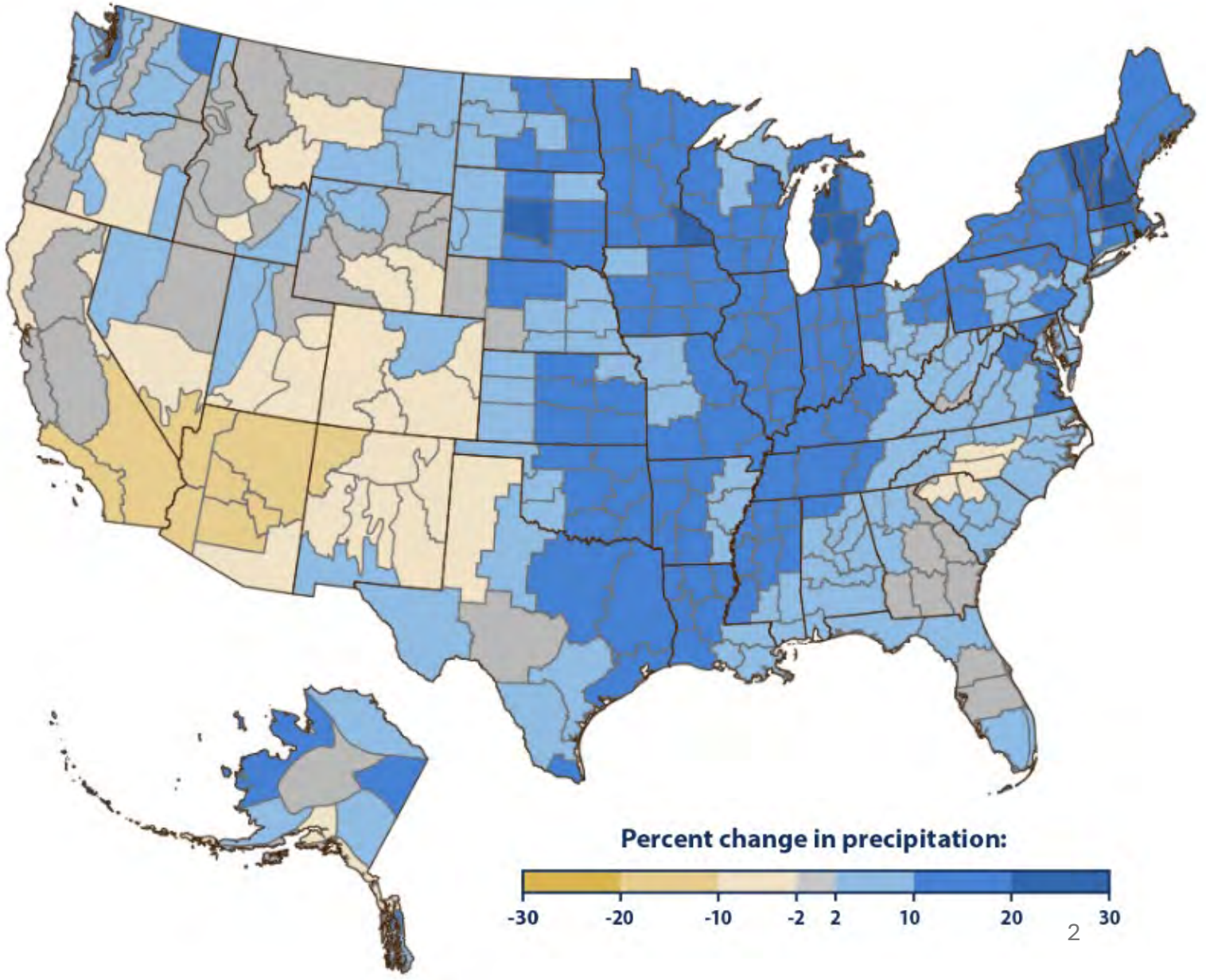
Change in Precipitation in the United States, 1901-2023

- Global precipitation on average has increased 0.03in per decade.
- Precipitation in the U.S. has increased 0.18in per decade.
- Precipitation increase is not evening distributed.



(NOAA, 2024)

The Cost of Flooding…

Flooding costs the U.S. between $179.8 and $496.0 billion each year

Infrastructure upgrades needed for flooding protection is between $68.9 to 344.5B per year

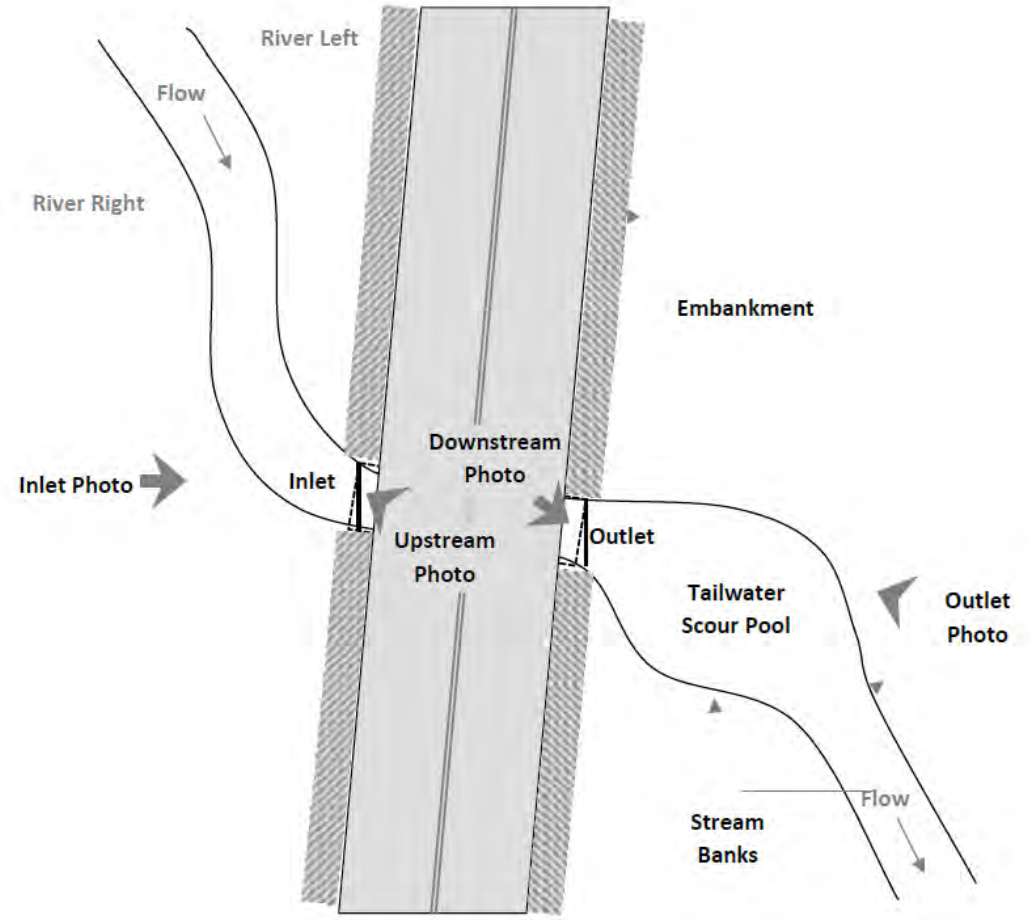
(Joint Economic Committee, 2024)

(U.S. Coast Guard, 2025)

Culverts

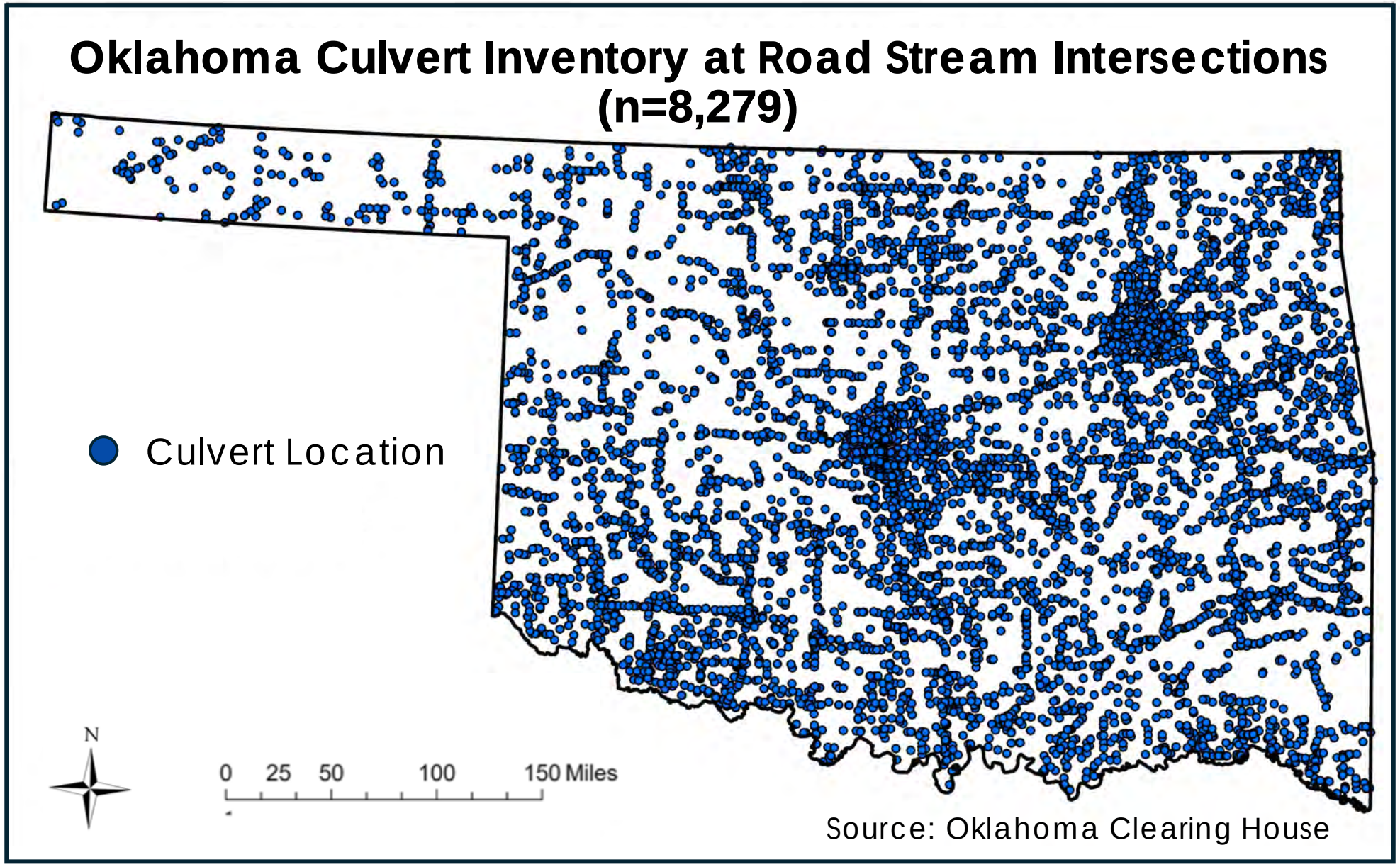
Structure with one of more barrels below an embankment designed to convey water, sediment, debris and aquatic and terrestrial organisms.

(U.S. Department of Transportation, 2022)





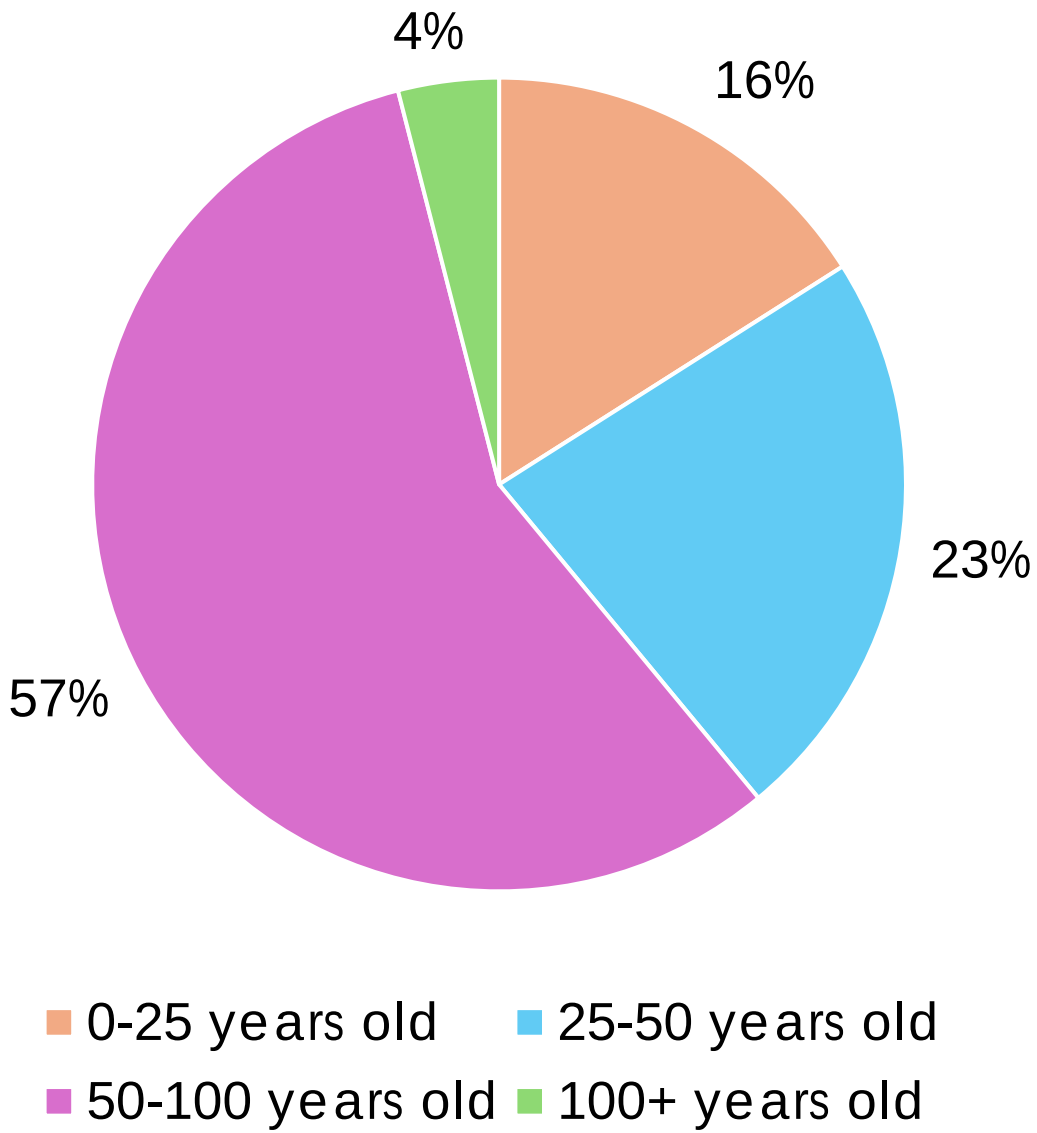


Culvert Database Only represents 19% of all road stream intersections in the state.

Aging Infrastructure

- Most Culverts are older than 50 years old.
- Only 16% of culverts are less than 25 years old.



Culvert Degradation

Due to aging infrastructure and increased flooding culverts are negatively impacted.

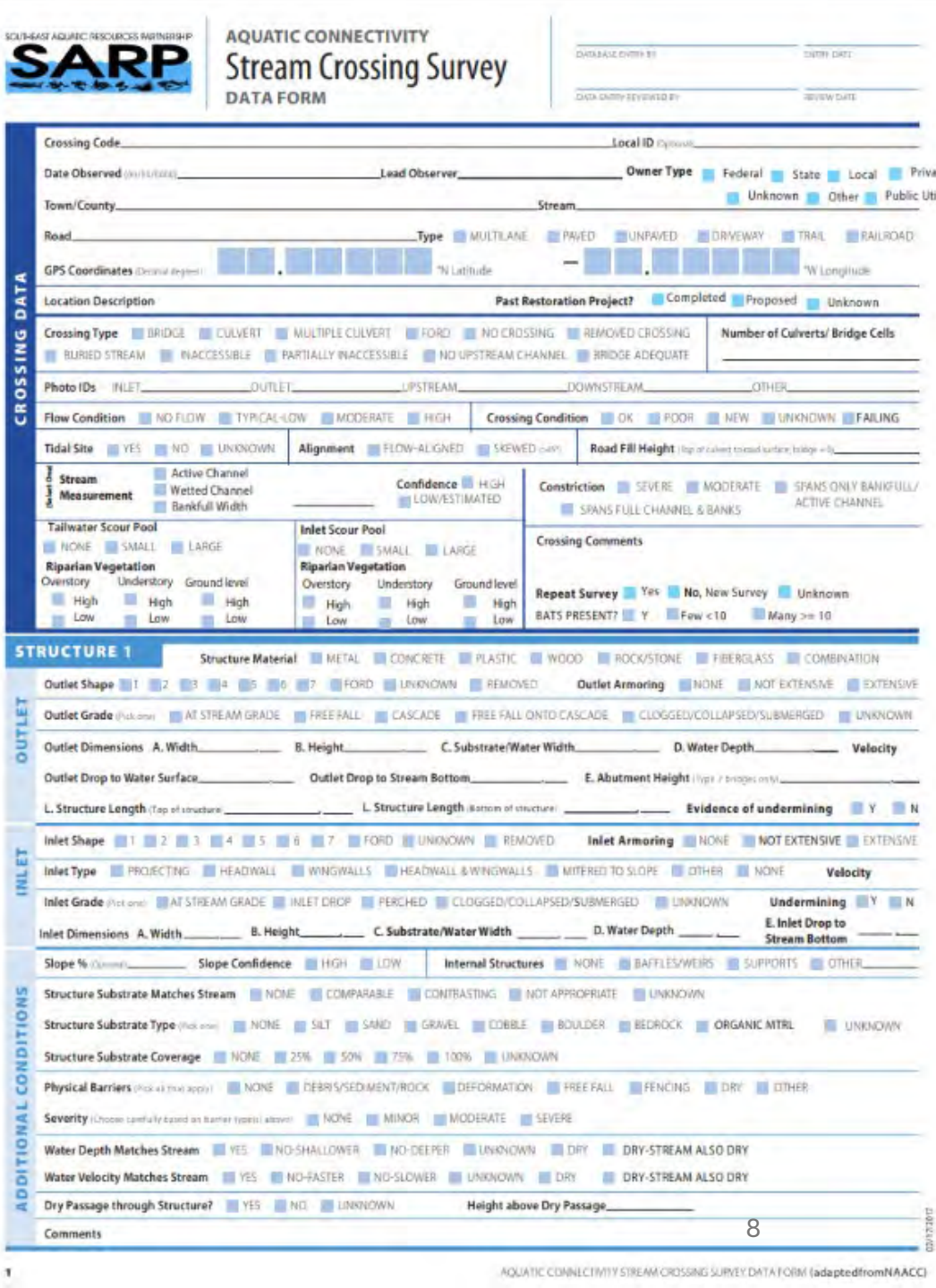
Discontinuity in channels results in habitat fragmentation and blocked fish passages.

(Sleight and Neeson, 2018)

Survey Parameters

NBI database only uses poor, fair or good to rank condition.

The National Aquatic Connectivity Collaborative Stream Crossing Survey Data Form was adopted to assess conditions with an aquatic organism approach.



SOUTHEAST AQUATIC RESOURCES PARTNERSHIP
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Stream Crossing Survey
DATA FORM

CROSSING DATA

Crossing Code _____ Local ID (Optional) _____

Date Observed (m/d/yyyy) _____ Lead Observer _____ Owner Type Federal State Local Priva Unknown Other Public Uti

Town/County _____ Stream _____

Road _____ Type MULTILANE PAVED UNPAVED DRIVEWAY TRAIL RAILROAD

GPS Coordinates (Decimal degrees) ___.____ °N Latitude — ___.____ °W Longitude

Location Description _____ Past Restoration Project? Completed Proposed Unknown

Crossing Type BRIDGE CULVERT MULTIPLE CULVERT FORD NO CROSSING REMOVED CROSSING BURIED STREAM INACCESSIBLE PARTIALLY INACCESSIBLE NO UPSTREAM CHANNEL BRIDGE ADEQUATE

Number of Culverts/ Bridge Cells _____

Photo IDs INLET _____ OUTLET _____ UPSTREAM _____ DOWNSTREAM _____ OTHER _____

Flow Condition NO FLOW TYPICAL-LOW MODERATE HIGH

Crossing Condition OK POOR NEW UNKNOWN FAILING

Tidal Site YES NO UNKNOWN

Alignment FLOW-ALIGNED SKEWED (>45°)

Road Fill Height (Top of culvert crossed surface; bridge = 0) _____

Stream Measurement (Select One) Active Channel Wetted Channel Bankfull Width _____ Confidence HIGH LOW/ESTIMATED

Constriction SEVERE MODERATE SPANS ONLY BANKFULL/ ACTIVE CHANNEL SPANS FULL CHANNEL & BANKS

Tailwater Scour Pool NONE SMALL LARGE

Riparian Vegetation Overstory High Low Understory High Low Ground level High Low

Inlet Scour Pool NONE SMALL LARGE

Riparian Vegetation Overstory High Low Understory High Low Ground level High Low

Crossing Comments

Repeat Survey Yes No, New Survey Unknown

BATS PRESENT? Y Few <10 Many >= 10

STRUCTURE 1

Structure Material METAL CONCRETE PLASTIC WOOD ROCK/STONE FIBERGLASS COMBINATION

OUTLET

Outlet Shape 1 2 3 4 5 6 7 FORD UNKNOWN REMOVED

Outlet Armoring NONE NOT EXTENSIVE EXTENSIVE

Outlet Grade (Pick one) AT STREAM GRADE FREE FALL CASCADE FREE FALL ONTO CASCADE CLOGGED/COLLAPSED/SUBMERGED UNKNOWN

Outlet Dimensions A. Width _____ B. Height _____ C. Substrate/Water Width _____ D. Water Depth _____ Velocity

Outlet Drop to Water Surface _____ Outlet Drop to Stream Bottom _____ E. Abutment Height (Type 2 bridges only) _____

L. Structure Length (Top of structure) _____ L. Structure Length (Bottom of structure) _____ Evidence of undermining Y N

INLET

Inlet Shape 1 2 3 4 5 6 7 FORD UNKNOWN REMOVED

Inlet Armoring NONE NOT EXTENSIVE EXTENSIVE

Inlet Type PROJECTING HEADWALL WINGWALLS HEADWALL & WINGWALLS MITERED TO SLOPE OTHER NONE

Velocity

Inlet Grade (Pick one) AT STREAM GRADE INLET DROP PERCHED CLOGGED/COLLAPSED/SUBMERGED UNKNOWN

Undermining Y N

Inlet Dimensions A. Width _____ B. Height _____ C. Substrate/Water Width _____ D. Water Depth _____ E. Inlet Drop to Stream Bottom _____

ADDITIONAL CONDITIONS

Slope % (Optional) _____ Slope Confidence HIGH LOW

Internal Structures NONE BAFFLES/WEIRS SUPPORTS OTHER _____

Structure Substrate Matches Stream NONE COMPARABLE CONTRASTING NOT APPROPRIATE UNKNOWN

Structure Substrate Type (Pick one) NONE SILT SAND GRAVEL COBBLE BOULDER BEDROCK ORGANIC MTRL UNKNOWN

Structure Substrate Coverage NONE 25% 50% 75% 100% UNKNOWN

Physical Barriers (Pick all that apply) NONE DEBRIS/SEDIMENT/ROCK DEFORMATION FREE FALL FENCING DRY OTHER

Severity (Choose carefully based on barrier type(s) above) NONE MINOR MODERATE SEVERE

Water Depth Matches Stream YES NO-SHALLOWER NO-DEEPER UNKNOWN DRY DRY-STREAM ALSO DRY

Water Velocity Matches Stream YES NO-FASTER NO-SLOWER UNKNOWN DRY DRY-STREAM ALSO DRY

Dry Passage through Structure? YES NO UNKNOWN Height above Dry Passage _____

Comments _____

02/17/2017

1 AQUATIC CONNECTIVITY STREAM CROSSING SURVEY DATA FORM (adapted from NAACC)


Outlet Armoring


Free Fall


Height

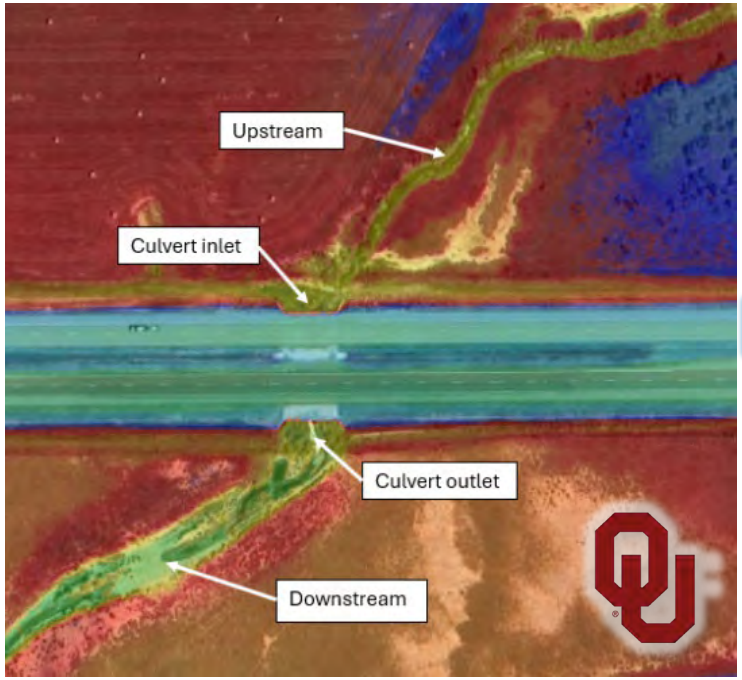

Debris

Culvert Survey Methods

Ground Survey

- 104 surveyed
- Safety Issues
- Time consuming

Lidar Data



- Results statistically different from ground survey.

Drone Survey

- Current method being used.

UAV Equipment

Tri Pod for Rover (for use with tilt)

Tri Pod for Rover (regular use)

Wingtra

Control Point Checker Boards x4.

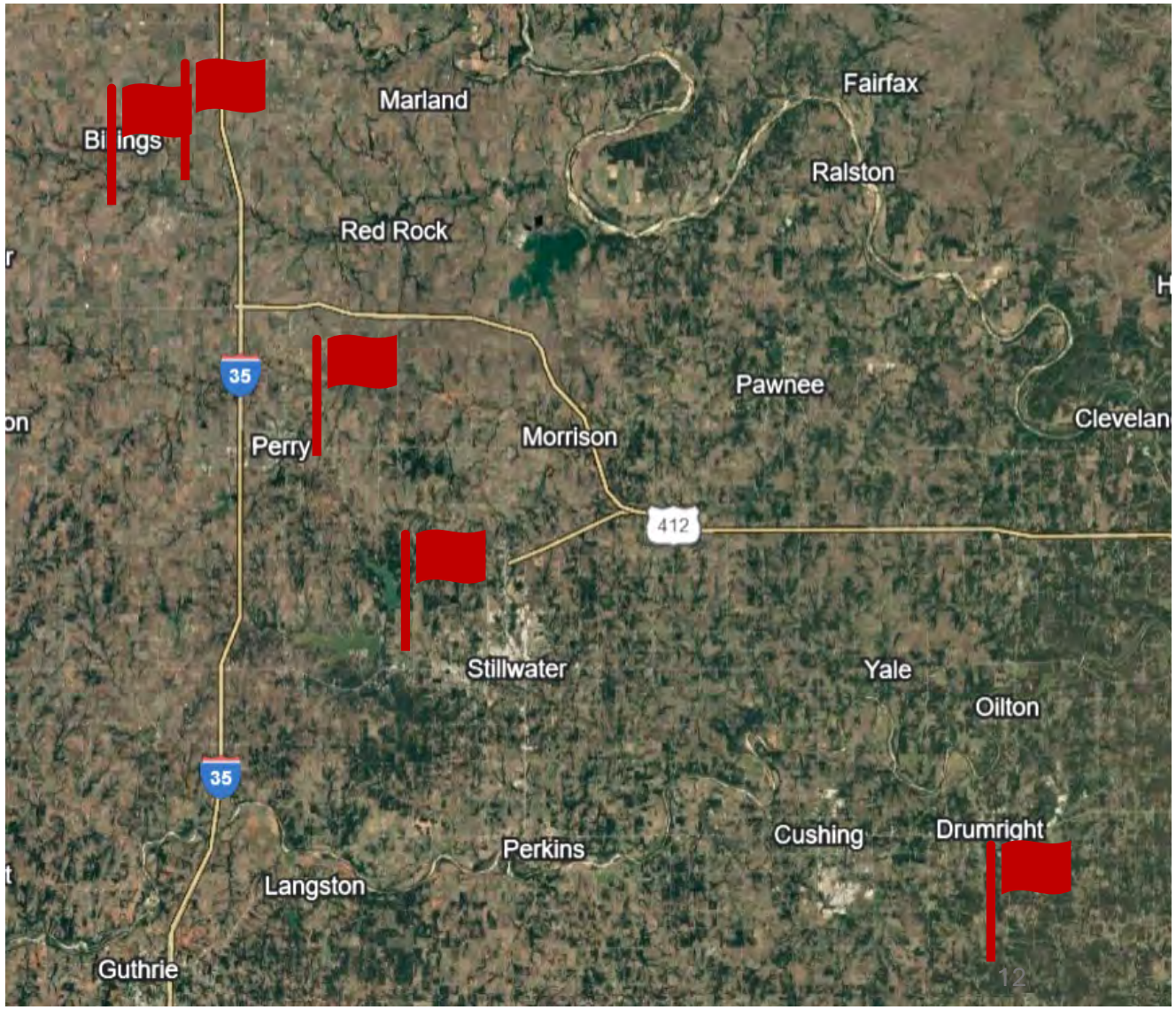
Trimble R980 GNSS Rover tablet and accessories

Wingtra batteries, chargers, tablet and antenna.

Trimble R980 GNSS Rover

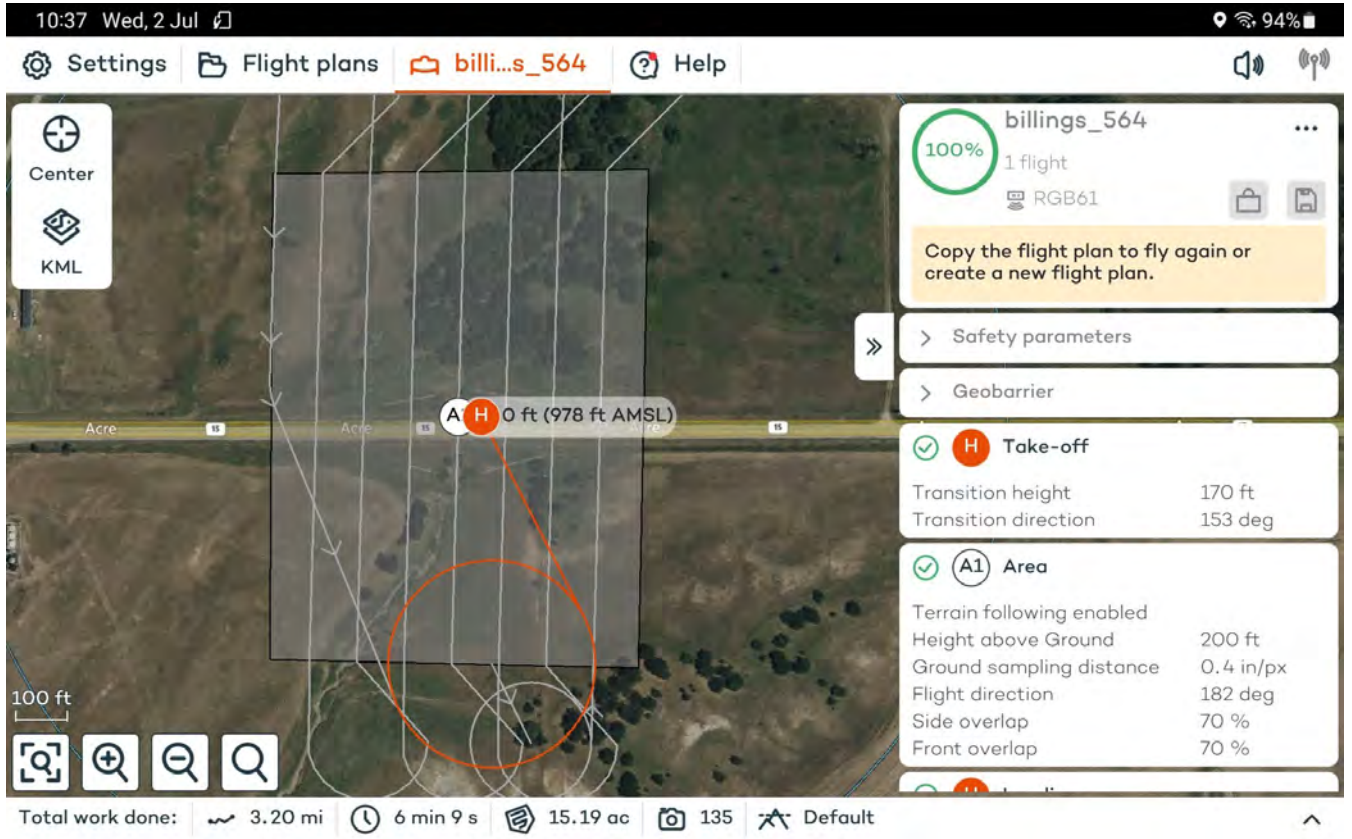
Drone Surveyed Culverts

- 4 sites with manual survey data and lidar data mismatch.
- 1 site with a culvert collapse.



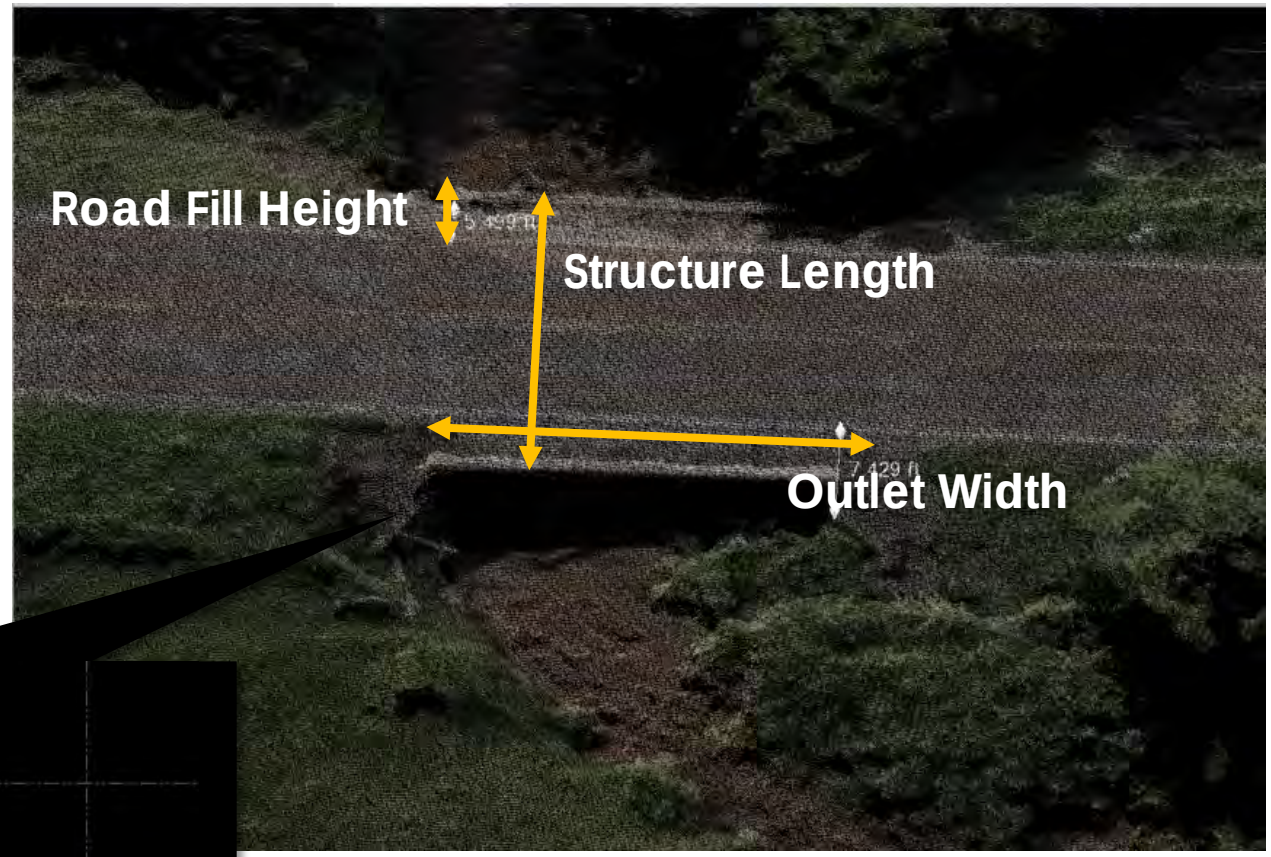
Flight Plan

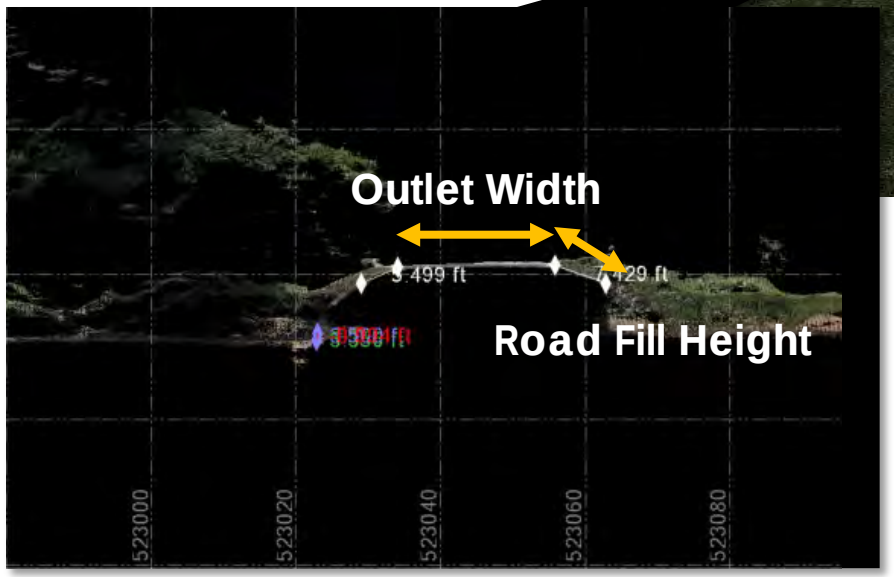
- Maximum UAV ceiling is 400ft.
- Flight height is 200ft.
- Fixed wing drone, transition height 170ft.
- Flight direction is perpendicular to road.



Culvert Characteristics

- Using 3D imaging to assess the culverts.
- Categorical data and external measures are easy to derive.
- Limited internal measurements of culvert.





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Stream Crossing Survey
DATA FORM

Ground Survey vs. UAV Survey Data

	Road Fill Height (ft)		Structure Length (ft)		Outlet Height (ft)	
Culvert ID	Ground	UAV	Ground	UAV	Ground	UAV
621	2.2	2.2	33.2	32.3	6.5	10.4
564	1.9	2.1	81	81.6	6.7	8.8
1998	4.1	1.1	90	85.9	6	8.3

Collapsed Culvert Findings

Ariel Image of Collapsed Culvert

- Debris blocking Inlet.
- Road collapsed, culvert intact.
- New use for the technology.


Ground View of Culvert

Next Steps

- Continue to collect ariel data on culverts with data mismatch.
- Compare findings with LIDAR data.
- Goal → Map all culverts in a case study watershed.
- Potentially purchase a copter type drone to assess internal culvert structures.

Thank-You!

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