Transportation Data Approach Options
Bridge Deck Inspections

Rick Wallace, Southeast Region Manager

NV5

NV5 provides solutions that help clients develop and deliver cost-effective, sustainable projects to improve lives.

Hollywood, FL

100+
Offices
Worldwide

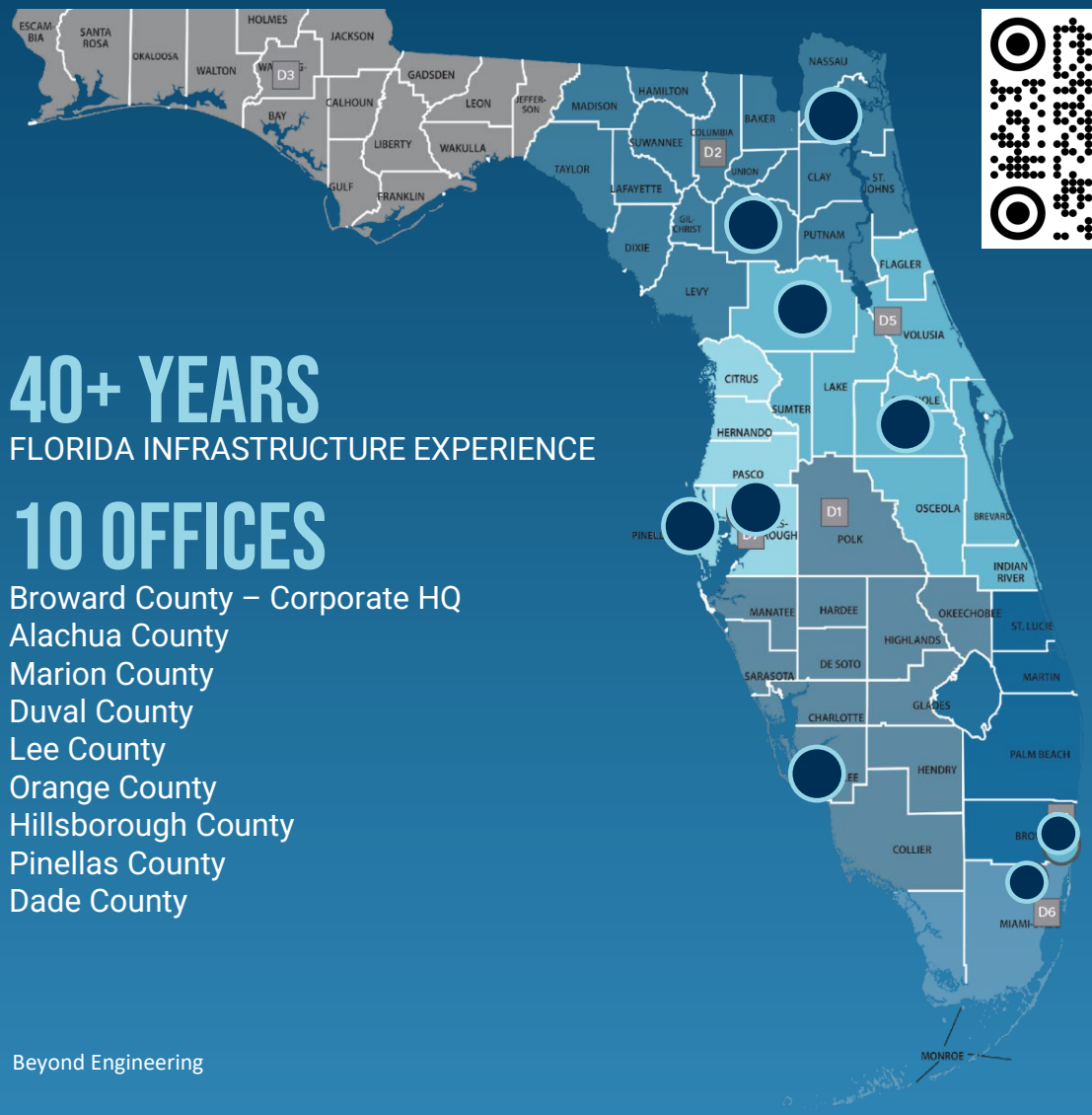
4K+
Employees

12K+
Clients

#24
ENR Top 500 Design Firms (2022)

DELIVERING SOLUTIONS FOR MODERN INFRASTRUCTURE CHALLENGES

NV5



40+ YEARS
FLORIDA INFRASTRUCTURE EXPERIENCE

10 OFFICES
Broward County – Corporate HQ
Alachua County
Marion County
Duval County
Lee County
Orange County
Hillsborough County
Pinellas County
Dade County

INFRASTRUCTURE FLORIDA

Urban and Regional Planning
Environmental / Ecological Services
Transportation + Traffic
Land Development Engineering
Urban Design + Landscape Architecture
Surveying + Mapping
Subsurface Utilities Engineering (SUE)
Construction Quality Assurance

GROWTH
Geotechnical + CMT
Alternate Design Build Delivery
Power & Delivery
Environmental Health Sciences (EHS)

CROSS SELLING
Building Technology
Geospatial
Resiliency & Sustainability

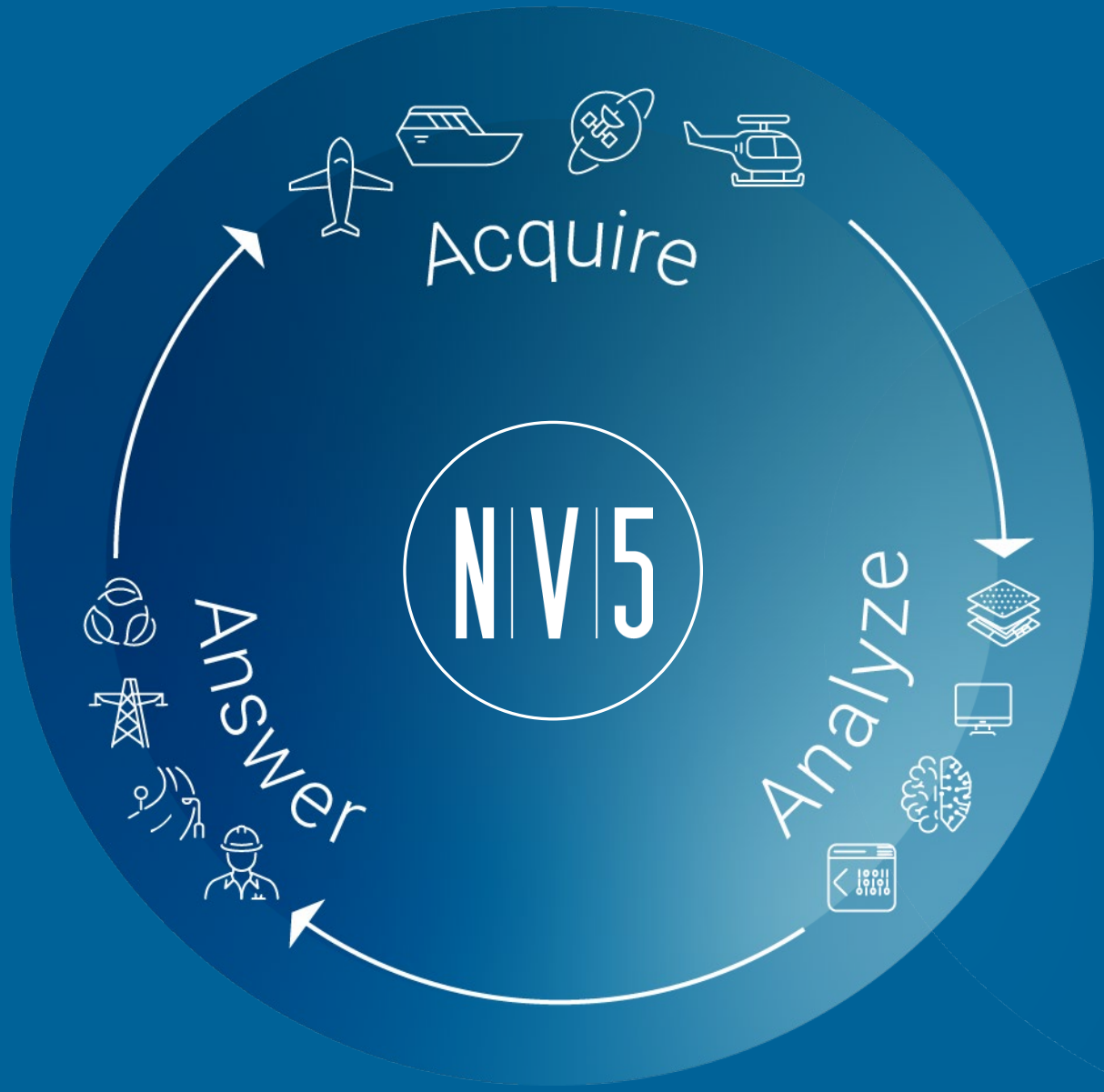
NV5

Our end-to-end geospatial solutions solve the world's toughest challenges.

Resource management
Climate Change
Security
Asset management
Mobility
Public Services
Infrastructure
Environmental Resiliency
Energy
Emergency Response

Local
State & Regional
Federal
Commercial

Geospatial Practice



1300+
Worldwide Geospatial Professionals

Localized Contracts in All
50 States

Completed Projects on all 7 Continents +
182
Countries

500K+
Software Users Around the World

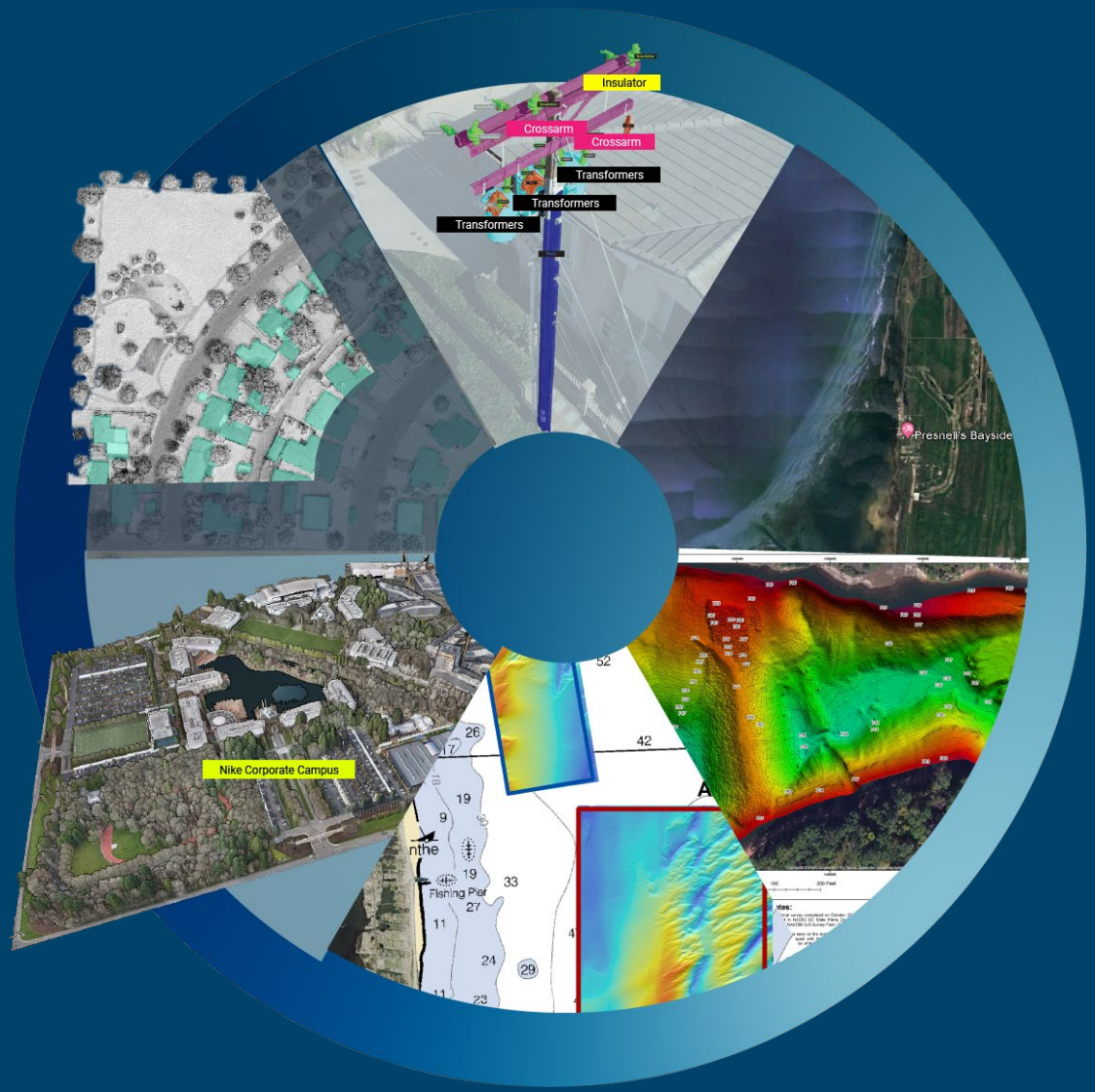
Acquire

When it comes to data acquisition, we don't dabble.

We own and operate a wide array of cutting-edge platforms and sensors to collect data globally, from space to the sea floor.

Analyze

The power to transform raw data.



Behind the scenes of our software, solutions, and services you'll find technologies like deep learning, workflow automation, and real-time data integration.

NV5

Answer

Reliable, actionable information.

- Enterprise GIS
- Digital Twin
- Systems Integration
- Facility & System Security
- Asset Management

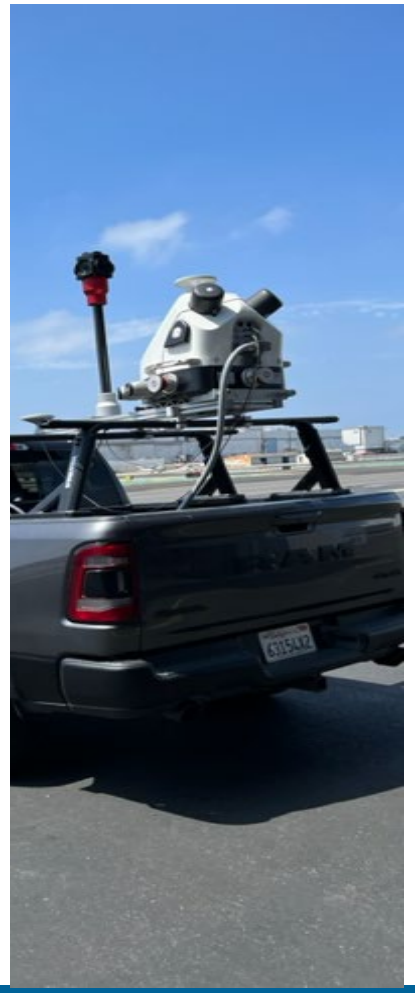
NV5

Remote Sensing

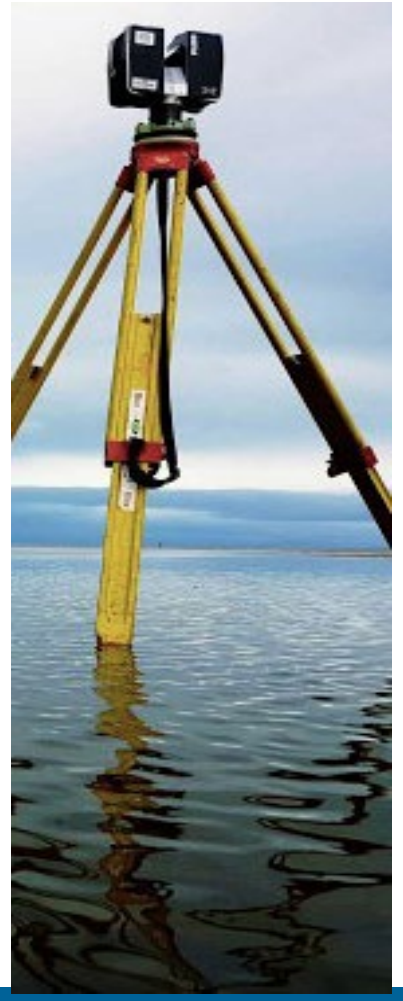
In-house Data Acquisition Options

NV5

Mobile



Terrestrial



Fixed | Rotary

Backpack

UAS

Traditional Solution Services

Schematic Mapping
Route study and design corridor selection

High Accuracy Mapping – Aerial, Mobile, UAS, Terrestrial Lidar and Photogrammetry
Right of way and design mapping

Bridge Modeling
As built documentation of existing structures, bridge modifications/replacements and clearance data

Roadway Sign and Utility Clearance Modeling
Identifying location and clearance of above ground utilities and signs within a corridor

Topobathymetric Lidar
Upstream, downstream and parallel drainage underwater modeling fused with terrain model data

Rock Fracture Studies
Terrestrial/UAS acquired image and lidar data are used to model the rock face

Technical Methodologies

Lidar

Latest generation Near infrared light (laser) sensors to model the earth's surface and planimetric features. Topobathymetric lidar adds green (visible) light sensors to model submerged lands/objects.

Photogrammetry

Dimensioning objects from overlapping imagery from softcopy stereo plotters to extract three dimensional planimetric and topographic features.

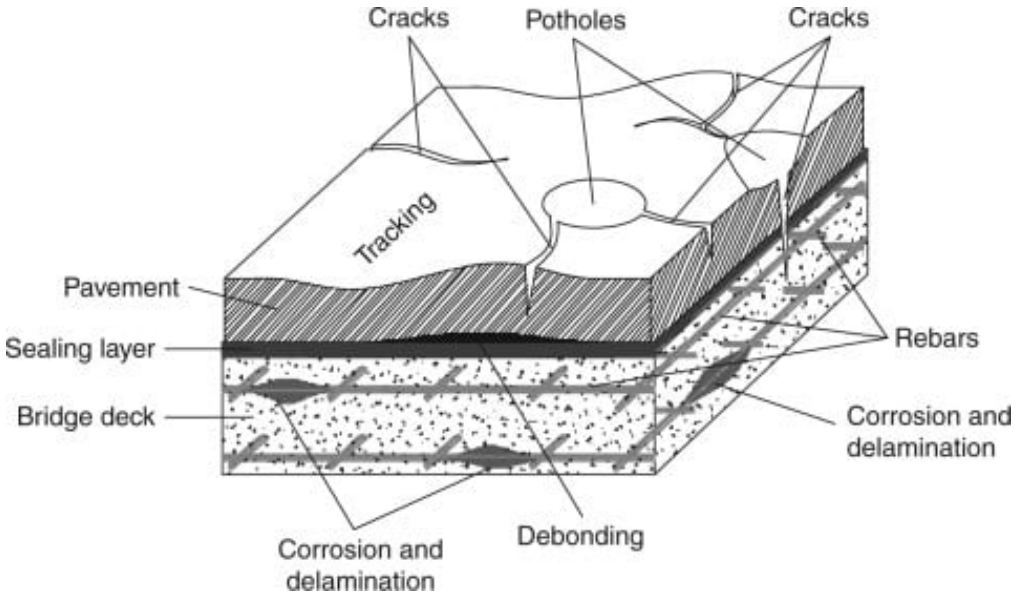
Orthophotos

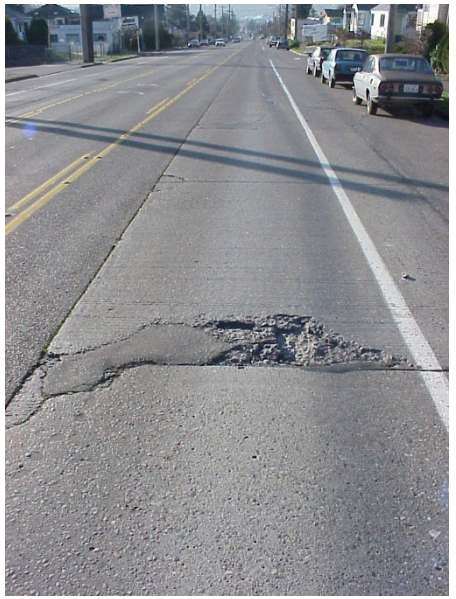
An image representation of the surface that has been corrected for camera distortions and elevation changes in the terrain surface.

Bridge Inspection Using Airborne Thermal Infrared mapping

THE CHALLENGE

- Bridges are mandated to be inspected every 2-4 years
- There are thousands of bridges
- Federal, States, and other agencies each have their own bridge inspection routine
- Every agency has a separate department for inspection and maintenance
- Several approaches to bridge inspection

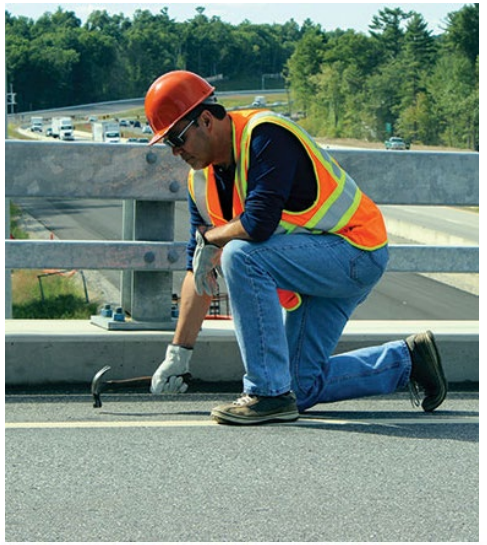




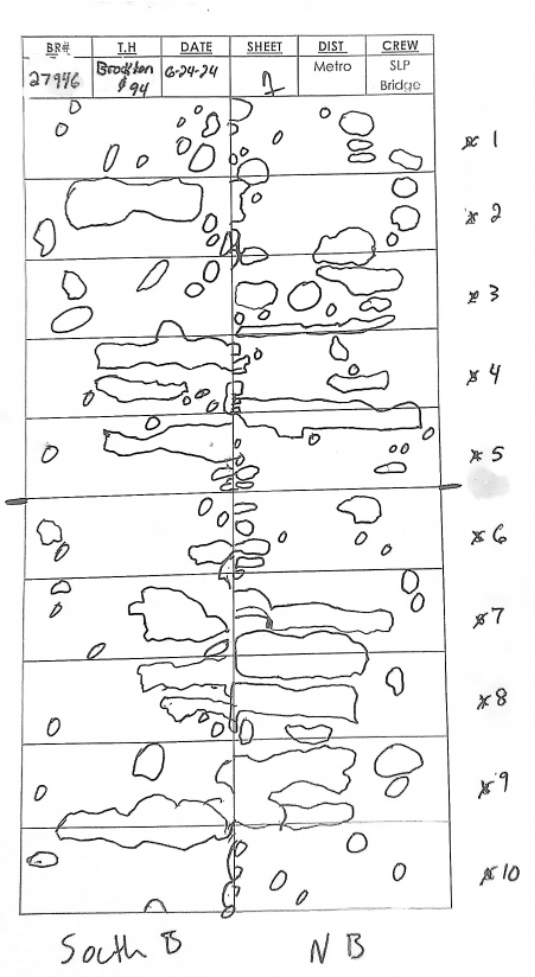
EXISTING TOOLS

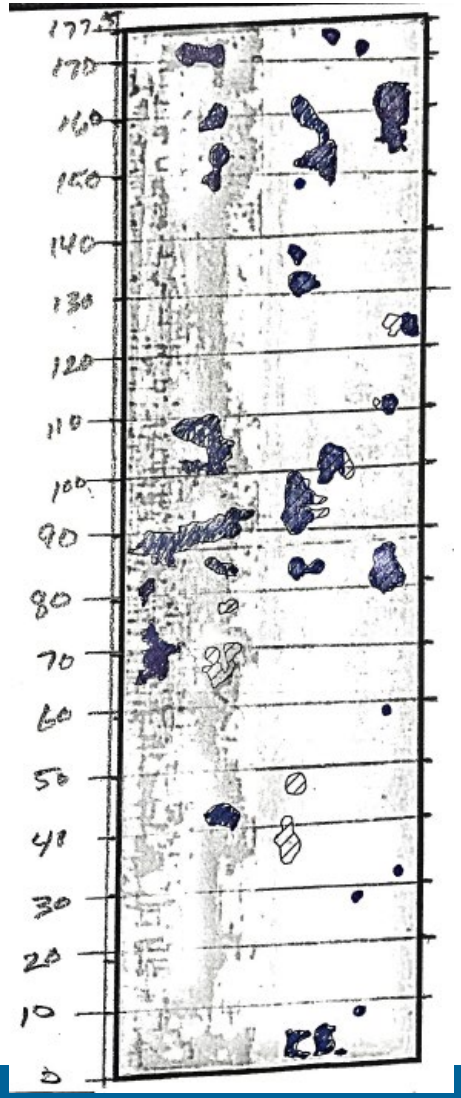
Nondestructive Technologies (NDTs)

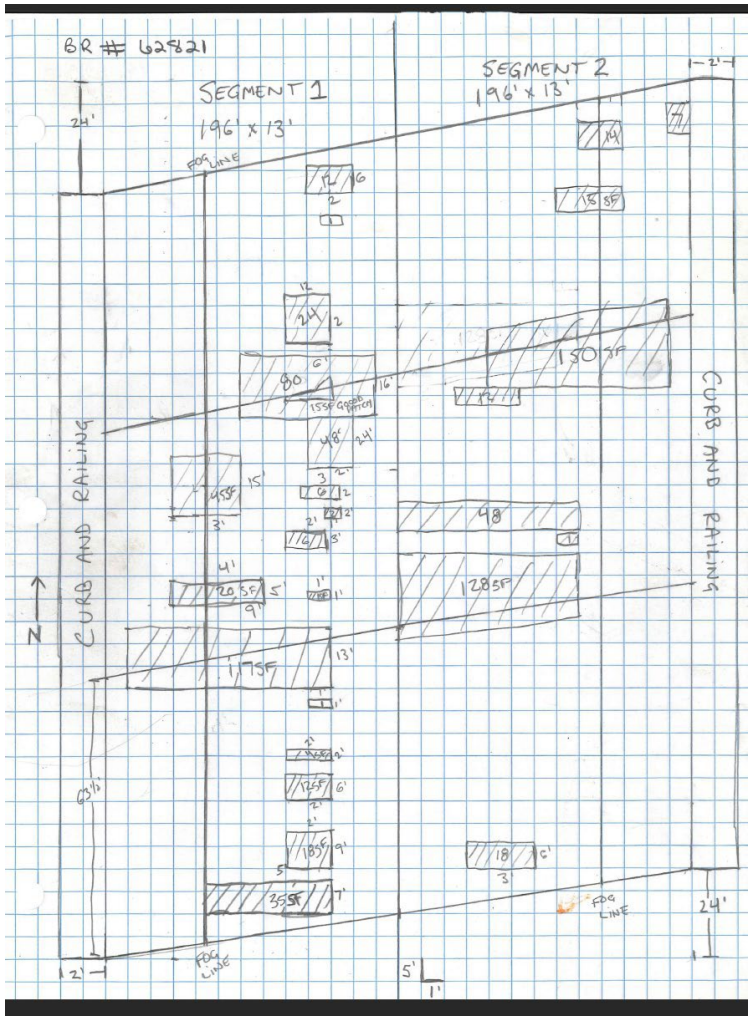
Remote sensing techniques include chain dragging, sounding, impact echo, ultrasonic surface wave, ground-penetrating radar, image-based techniques, and *infrared thermography.*



RESULTS AND REPORTS



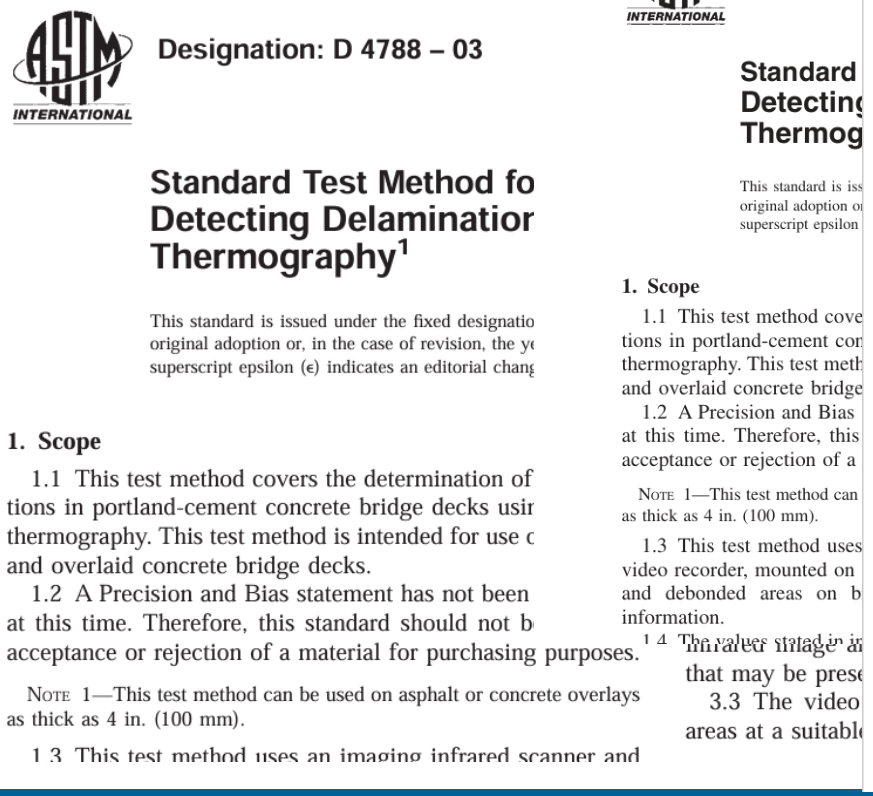




STANDARDS?

Infrared Thermography

- ASTM D4788-03 defined the “standard test method for detecting delamination in bridge decks using infrared thermography in 1997-2022.



Designation: D 4788 – 03

Standard Test Method fo
Detecting Delamination
Thermography[1]

This standard is issued under the fixed designatio
original adoption or, in the case of revision, the ye
superscript epsilon (ϵ) indicates an editorial chang

1. Scope

1.1 This test method covers the determination of
tions in portland-cement concrete bridge decks usir
thermography. This test method is intended for use c
and overlaid concrete bridge decks.

1.2 A Precision and Bias statement has not been
at this time. Therefore, this standard should not b
acceptance or rejection of a material for purchasing purposes.

NOTE 1—This test method can be used on asphalt or concrete overlays as thick as 4 in. (100 mm).

1.3 This test method uses an imaging infrared scanner and

Designation: D 4788 – 03 (Reapproved 2007)

Standard
Detecting
Thermog

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1.3 This test method uses
video recorder, mounted on
and debonded areas on b
information.

1.4 The values stated in i
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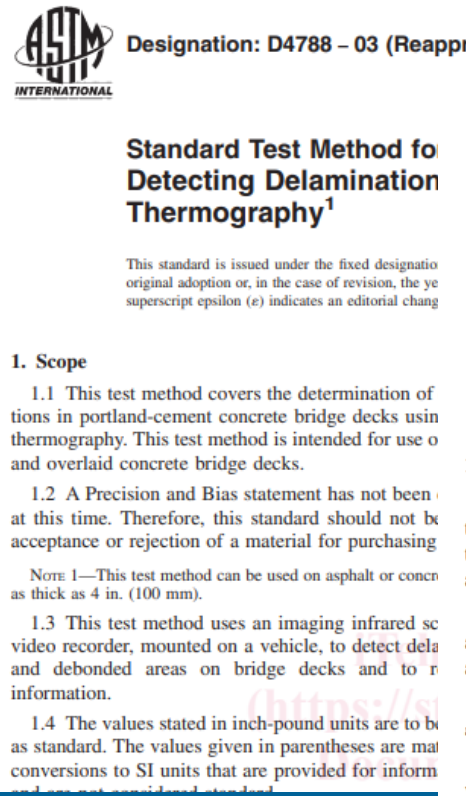
3.3 The video
areas at a suitabl



Designation: D4788 – 03 (Reapproved 2013)

Standard Test Method fo
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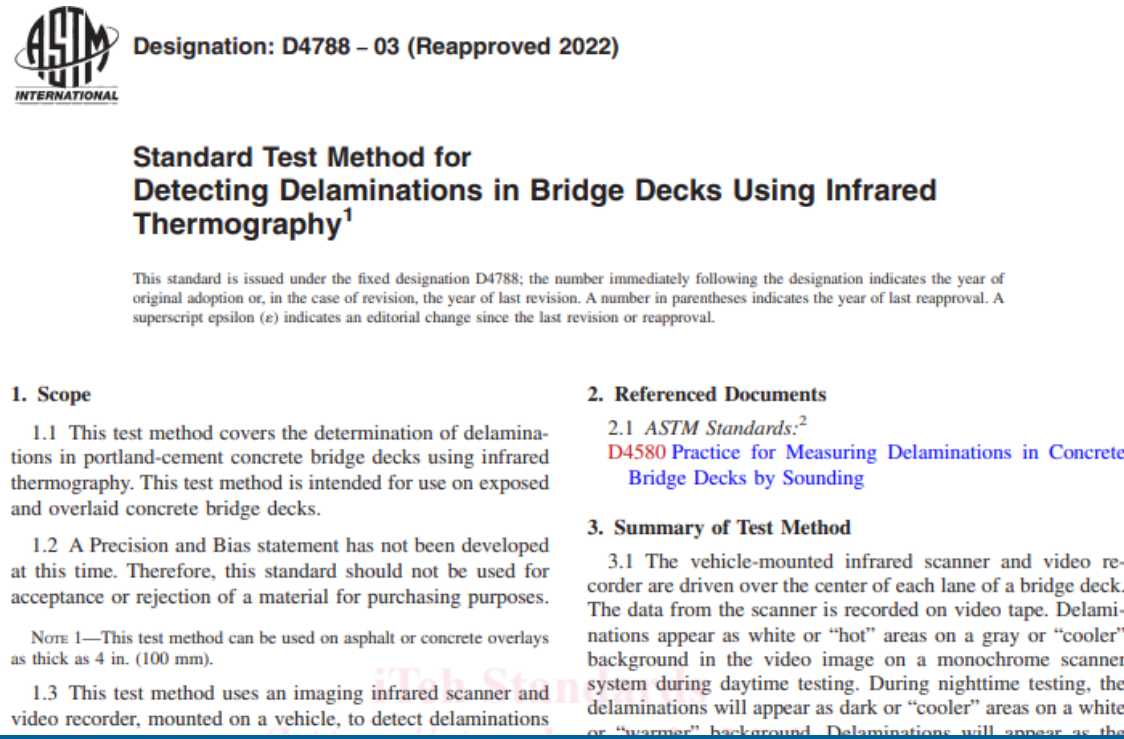
as thick as 4 in. (100 mm).

1.3 This test method uses an imaging infrared sc
video recorder, mounted on a vehicle, to detect dela
and debonded areas on bridge decks and to r
information.

1.4 The values stated in inch-pound units are to be
as standard. The values given in parentheses are mat
conversions to SI units that are provided for inform



Designation: D4788 – 03 (Reapproved 2022)

Standard Test Method for
Detecting Delaminations in Bridge Decks Using Infrared Thermography[1]

This standard is issued under the fixed designation D4788; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of delaminations in portland-cement concrete bridge decks using infrared thermography. This test method is intended for use on exposed and overlaid concrete bridge decks.

1.2 A Precision and Bias statement has not been developed at this time. Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purposes.

NOTE 1—This test method can be used on asphalt or concrete overlays as thick as 4 in. (100 mm).

1.3 This test method uses an imaging infrared scanner and video recorder, mounted on a vehicle, to detect delaminations

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D4580 Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding

3. Summary of Test Method

3.1 The vehicle-mounted infrared scanner and video recorder are driven over the center of each lane of a bridge deck. The data from the scanner is recorded on video tape. Delaminations appear as white or “hot” areas on a gray or “cooler” background in the video image on a monochrome scanner system during daytime testing. During nighttime testing, the delaminations will appear as dark or “cooler” areas on a white

THE AIRBORNE SOLUTION

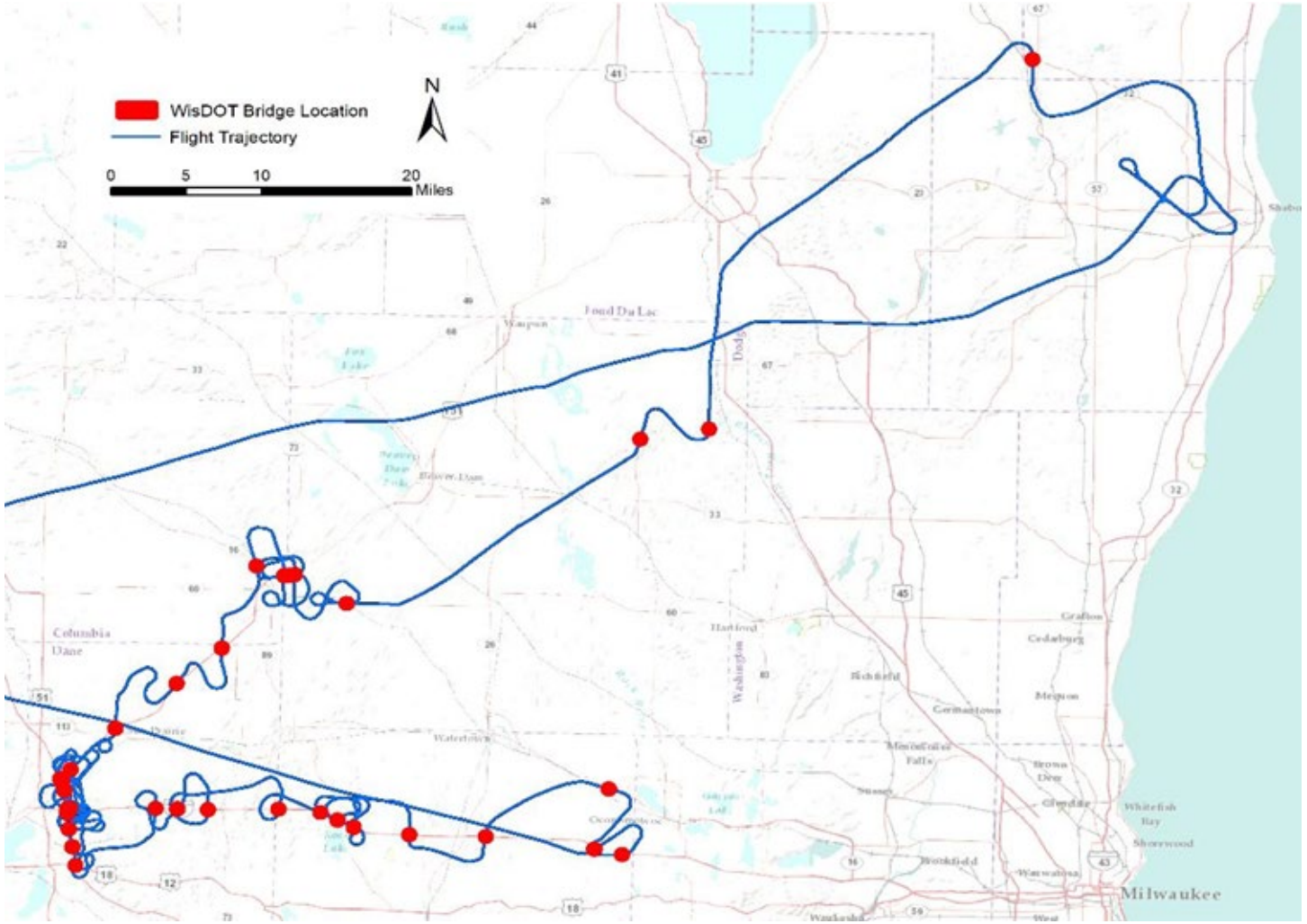
Fixed wing, low-altitude flights

- 1,000-2,000 ft above mean terrain (AMT)
- 100-130 knots nominal airspeed
- Nominal resolution = 1.5-3.0 inch
- 147 ft width x 118 ft length
- 10 frames per sec
- 80% forward overlap

1,000 ft bridge is captured in:

- ≤10 sec
- 100 frames
- Single flight line
- Turn around as needed (≤5 minutes)

40 BRIDGES IN A FEW HOURS

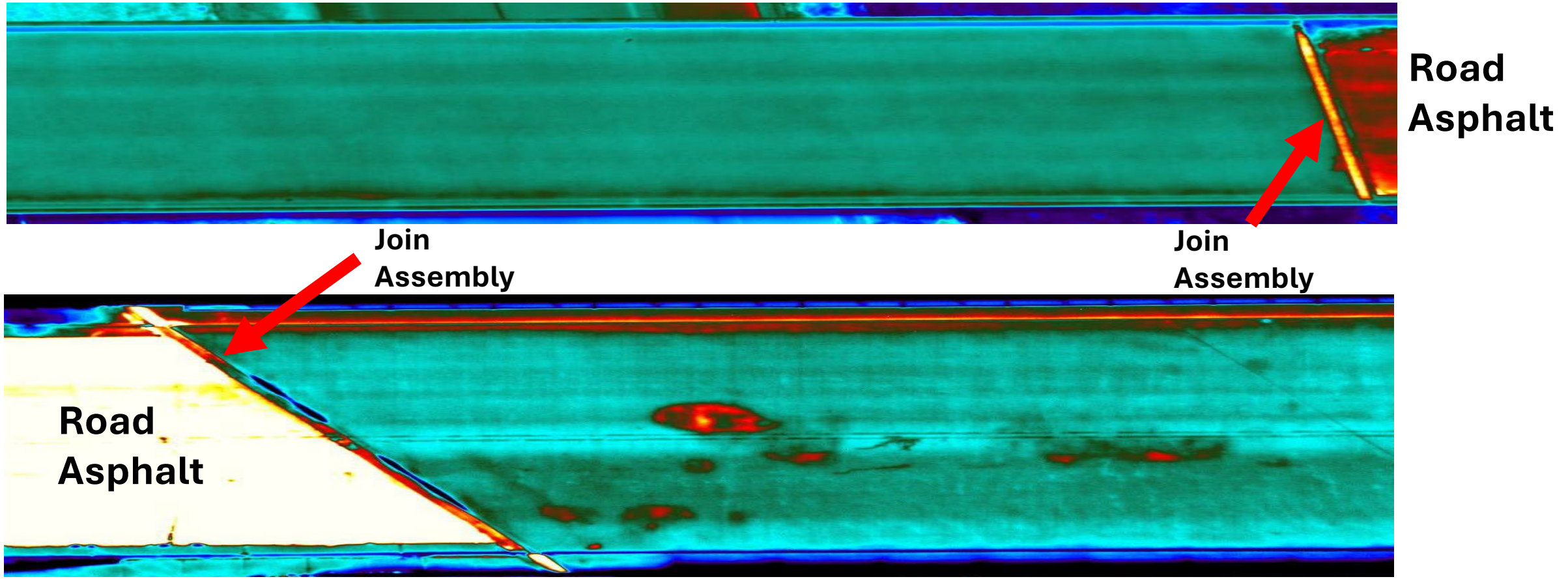


Flight path for surveying 40 bridges in a single mission.

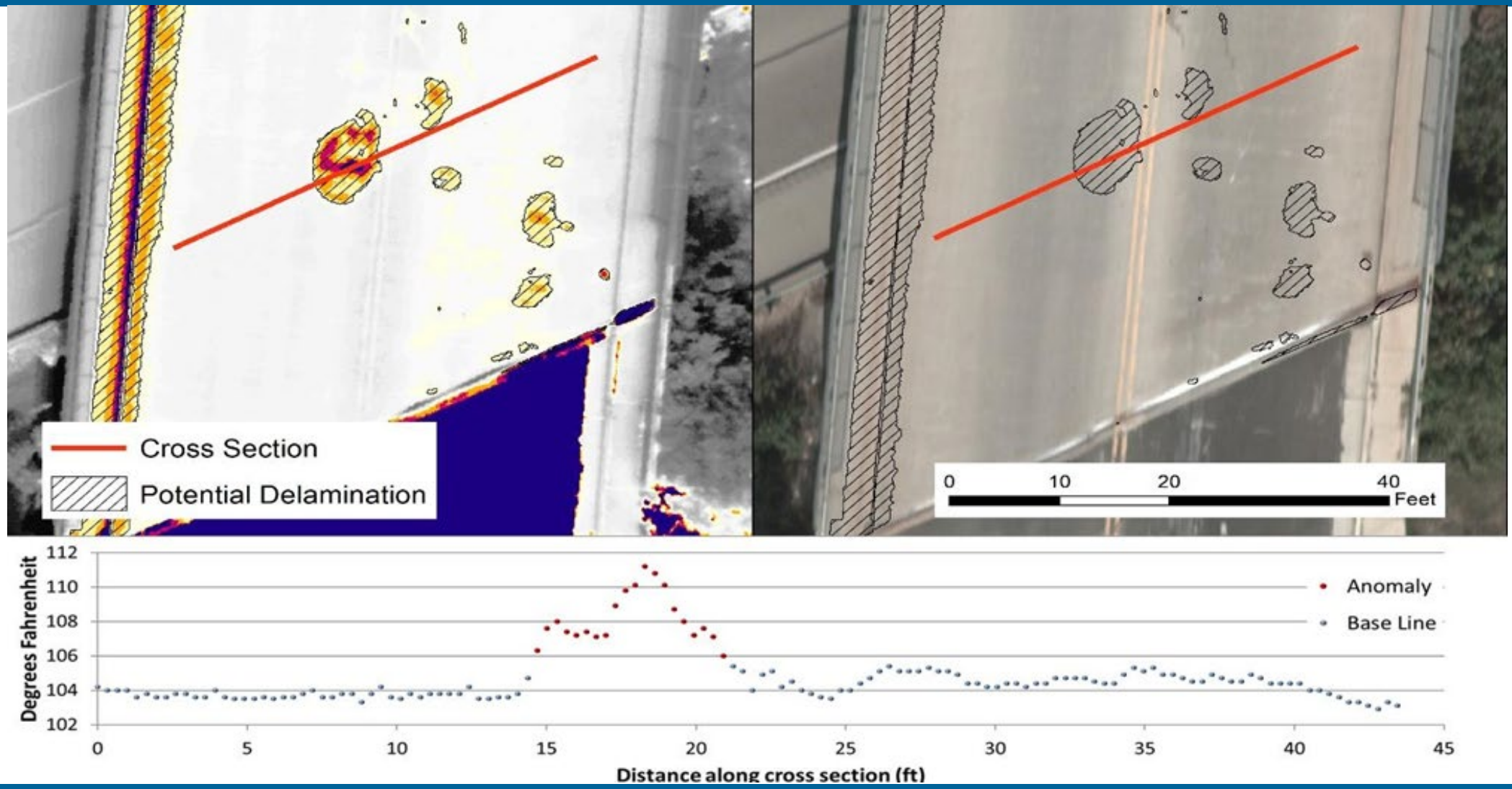
ACQUISITION CONDITIONS

- Dry and warm season
- Day time 12:00-4:00 PM
- Clear sky and sunny
- 5 hrs. of direct solar loading (300 kw/m^2) prior to acquisition
- No fog, no snow or water on the bridge
- Re-flights are expected

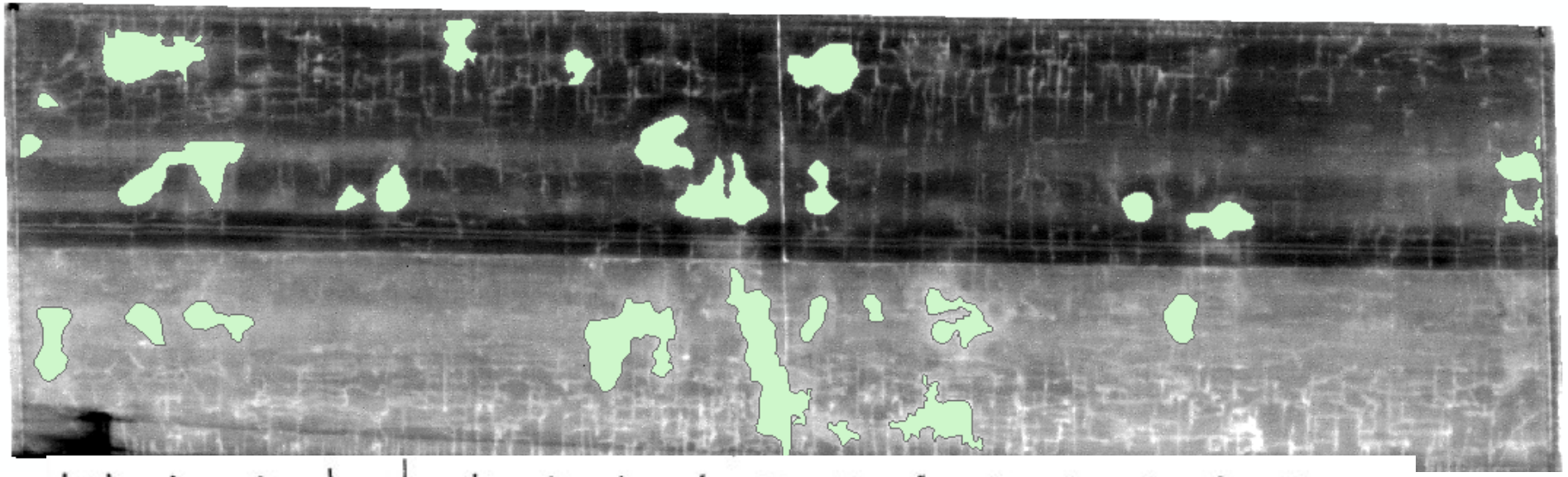
THERMAL ANOMALIES

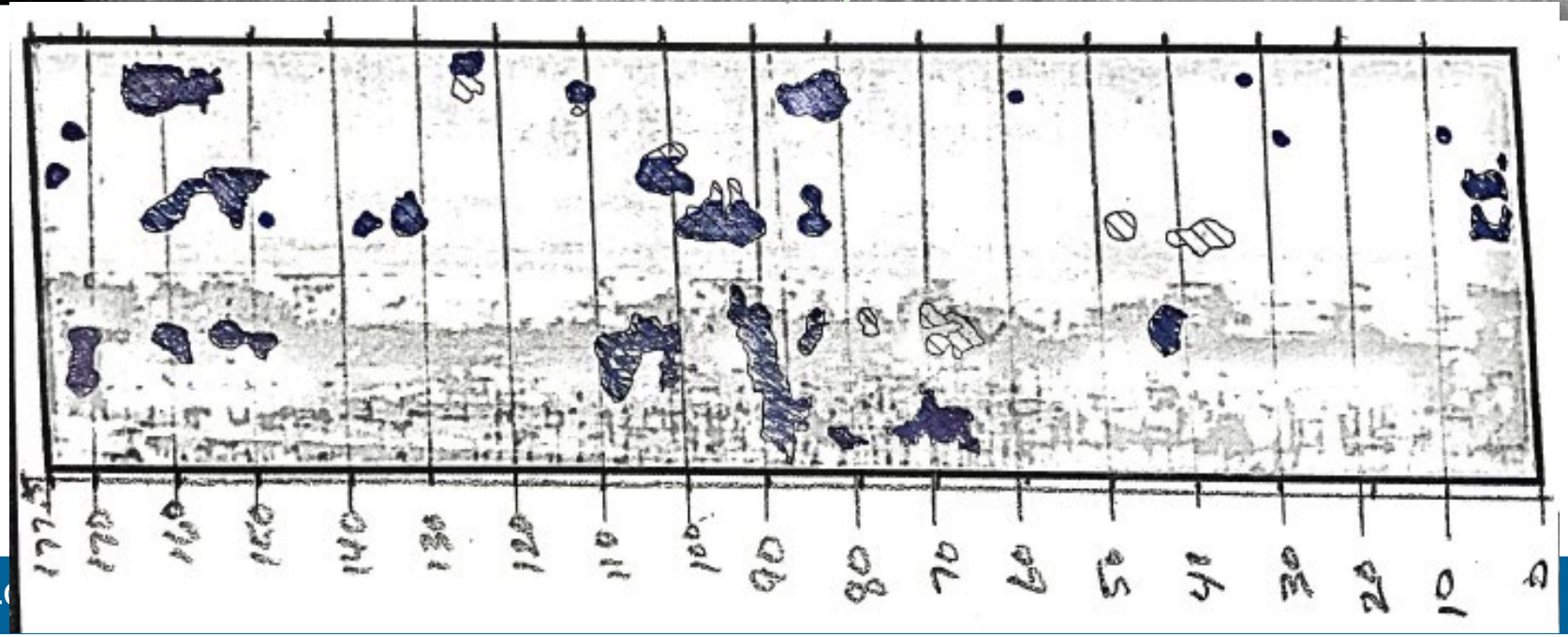


HOW HOT IS HOT?



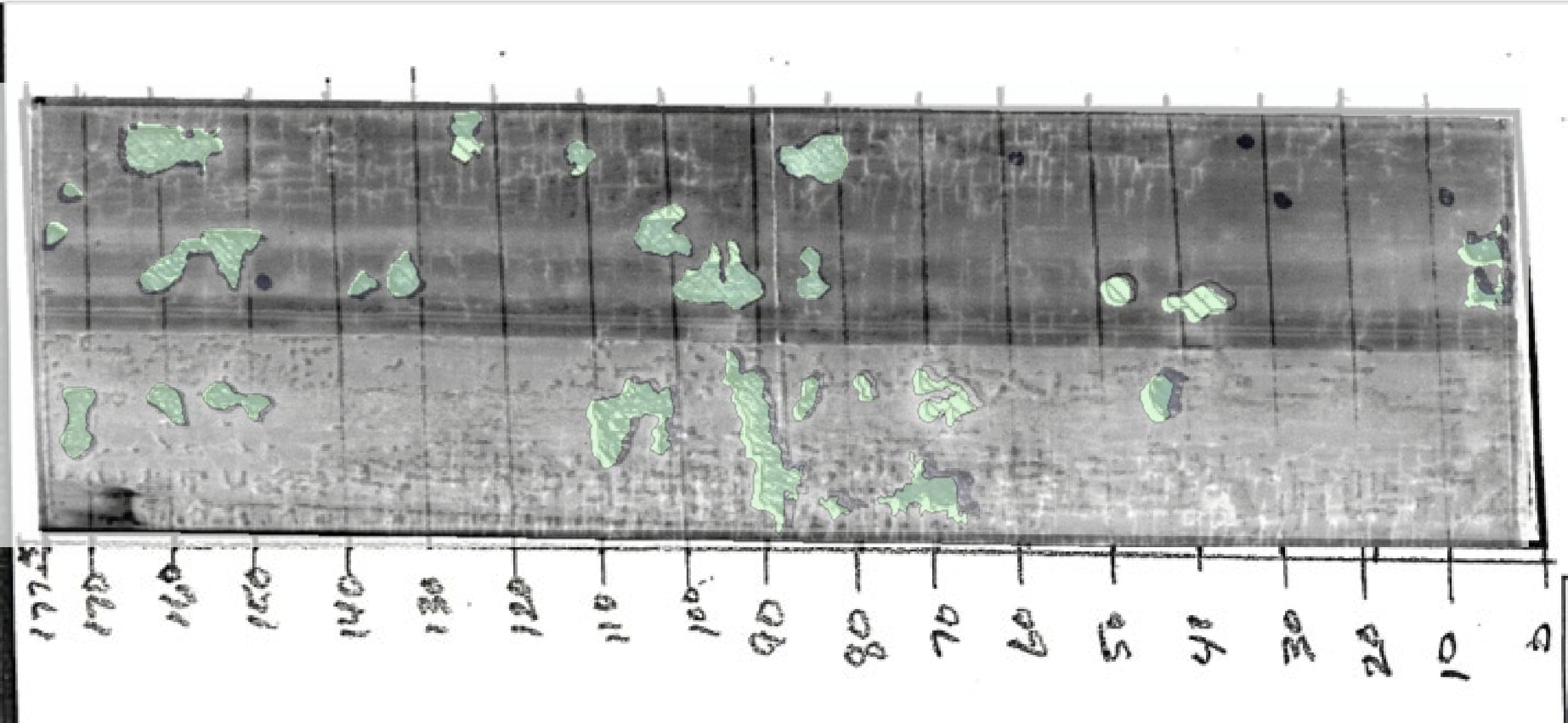
THERMAL VS. CURRENT METHODS RESULTS



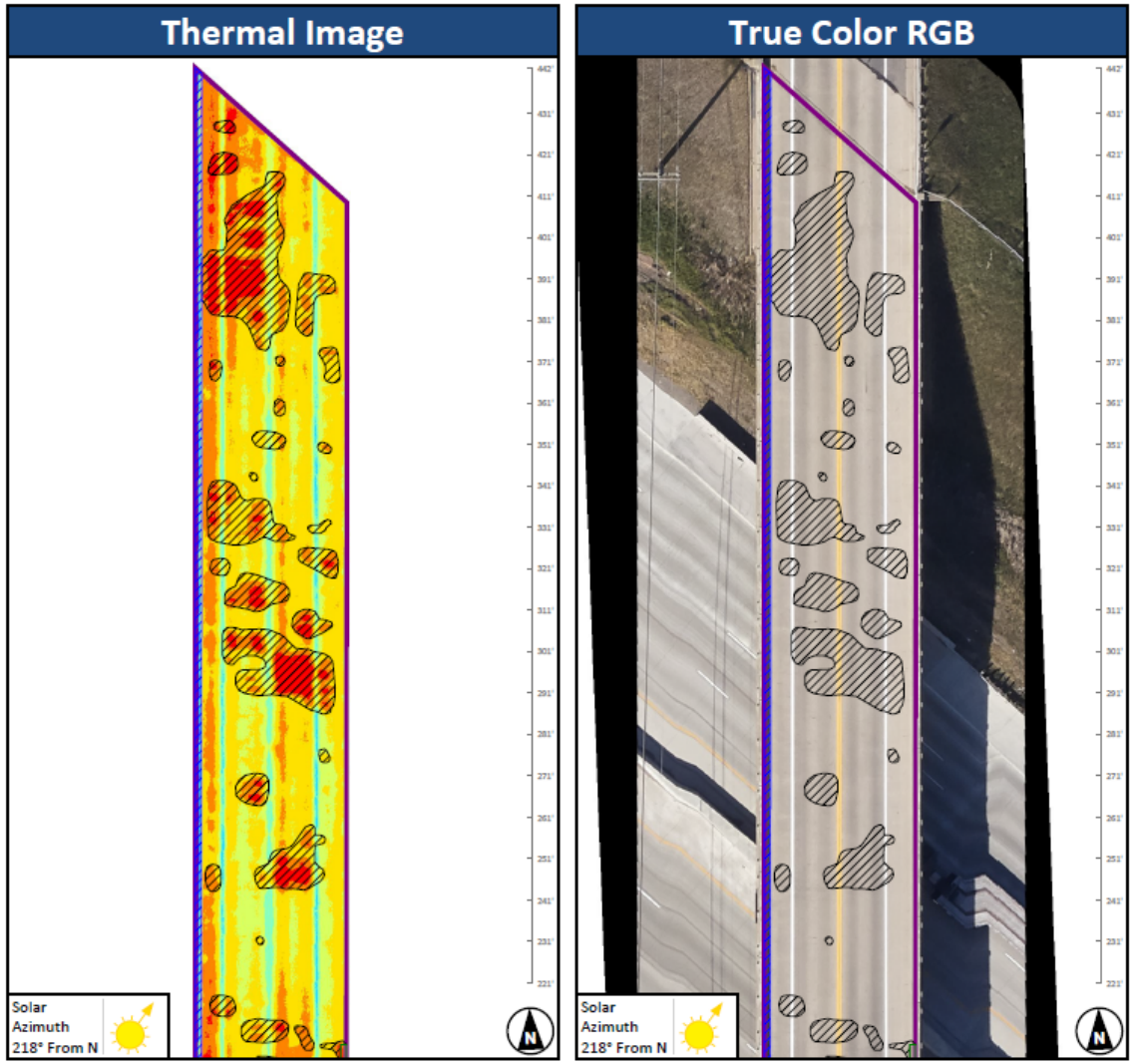


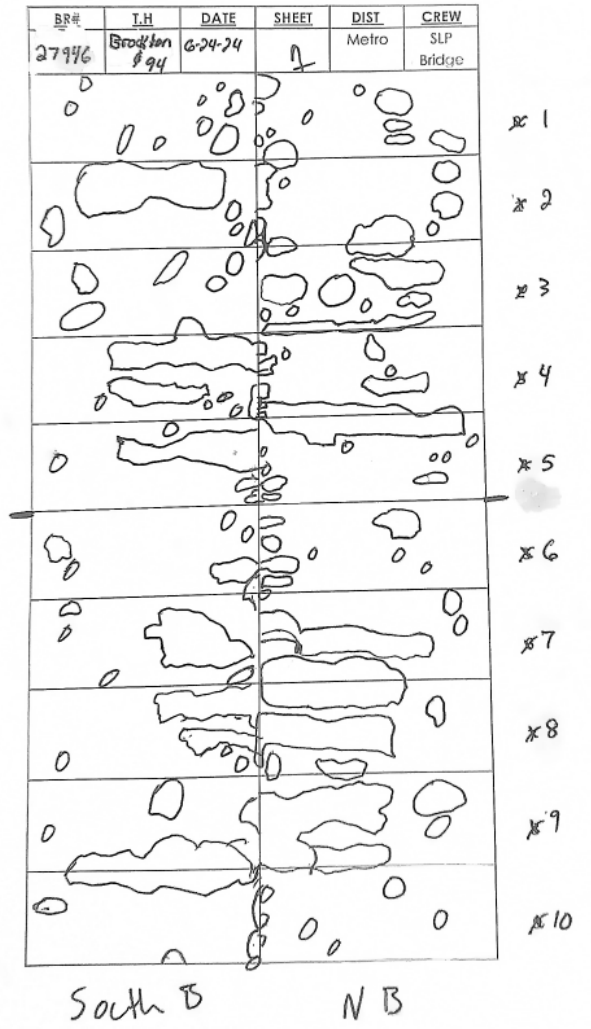
Not detected by chain dragging

Detected by chain dragging and TIR


170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

THERMAL INSPECTION VALIDATED #27946



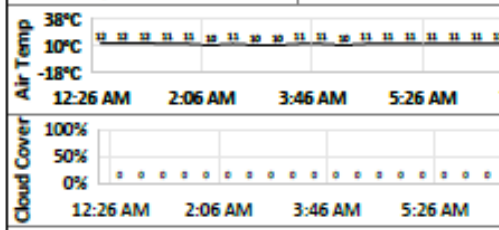


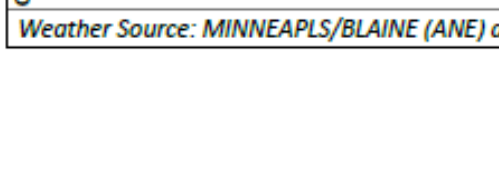
TECHNICAL REPORT

- Intuitive and user-friendly reports
- Customizable

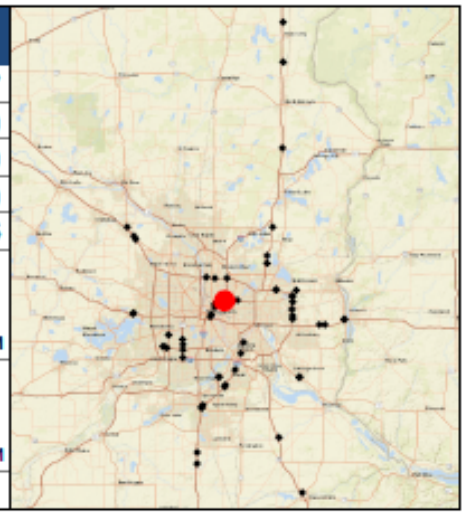
Bridge Information

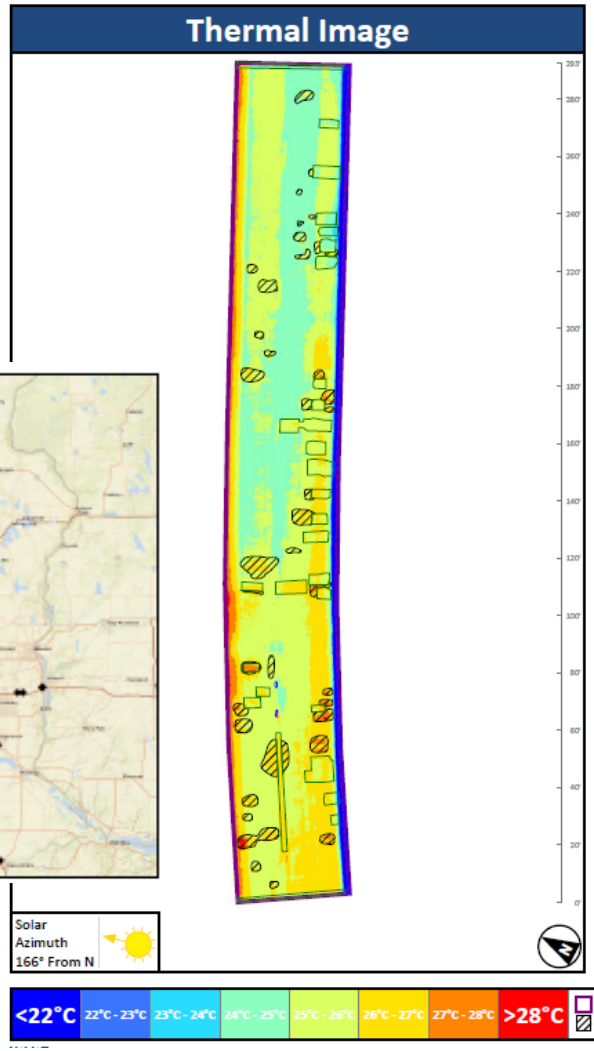
Name 62853	Acquired 9/14/2023 12:30 PM CDT (-5)	Solar Altitude 47.5°
Bridge Area 11,382.5ft²	Delamination Area 649.7ft² (5.7%)	PCC patch Area 893.3ft² (7.8%)
AC patch Area 0.0ft² (0.0%)		Spall Area 2.6ft² (0.0%)
Shade/debris Area 431.1ft² (3.8%)		Debonding Area 0.0ft² (0.0%)
Air Temperature 25.0°C	Cloud Cover Clear (0-5%)	Humidity 41.4% / Wind 10 mph S

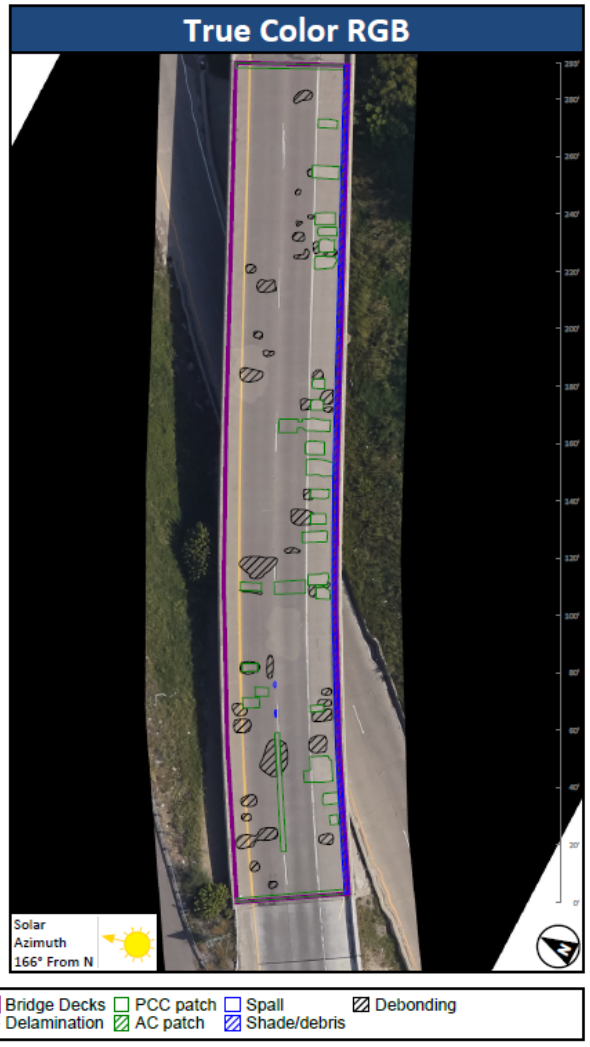


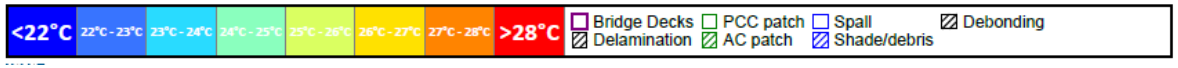


Weather Source: MINNEAPLS/BLAINE (ANE) at 12:50 PM | 9 Miles N, 19 Minutes After







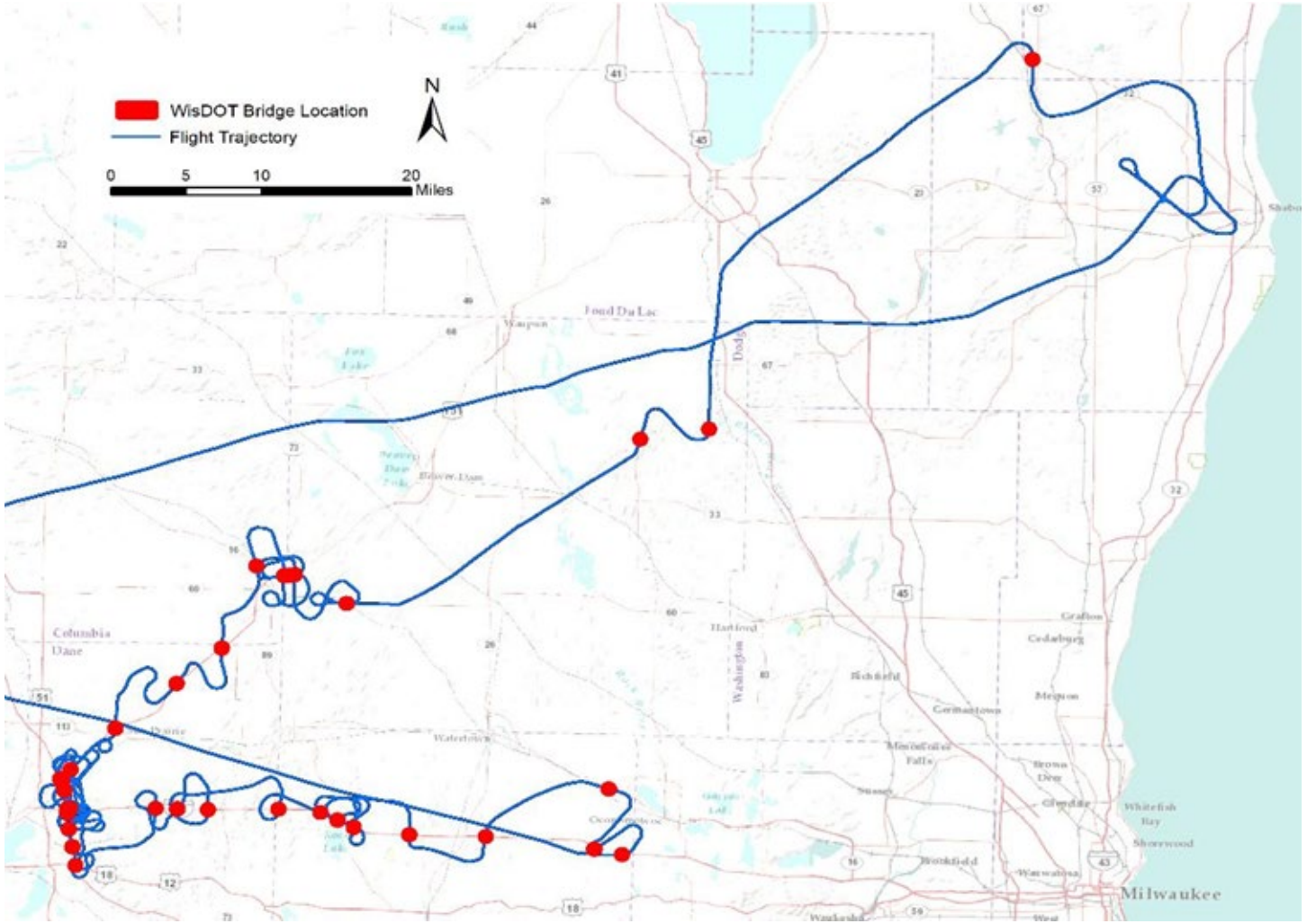


ACCURATE, REPEATABLE, SCALABLE

MN DOT Metro 2023 2 Bridge Deck Condition Evaluation Delamination Inspection Results

Bridge Name	Bridge Deck Area (sq ft)	Delamination Area	PCC patch Area	AC patch Area	Spall Area	Shade/debris Area	Debonding Area	Combined Area
2802	6139.8	2412.8ft² (39.3%)	0.0ft² (0.0%)	0.0ft² (0.0%)	4.0ft² (0.1%)	590.1ft² (9.6%)	0.0ft² (0.0%)	3006.9ft² (49.0%)
9389	9459.8	379.7ft² (4.0%)	0.0ft² (0.0%)	23.3ft² (0.2%)	0.0ft² (0.0%)	44.1ft² (0.5%)	0.0ft² (0.0%)	447.1ft² (4.7%)
9432	8269.5	40.7ft² (0.5%)	120.2ft² (1.5%)	0.0ft² (0.0%)	0.0ft² (0.0%)	366.7ft² (4.4%)	0.0ft² (0.0%)	527.6ft² (6.4%)
9488	5374.8	55.4ft² (1.0%)	0.0ft² (0.0%)	0.0ft² (0.0%)	0.0ft² (0.0%)	179.0ft² (3.3%)	0.0ft² (0.0%)	234.4ft² (4.4%)
9675	5562.9	9.6ft² (0.2%)	322.4ft² (5.8%)	0.0ft² (0.0%)	0.0ft² (0.0%)	401.8ft² (7.2%)	0.0ft² (0.0%)	733.8ft² (13.2%)
9860	4993.2	825.1ft² (16.5%)	5.2ft² (0.1%)	0.0ft² (0.0%)	0.0ft² (0.0%)	22.8ft² (0.5%)	0.0ft² (0.0%)	853.1ft² (17.1%)
9868	5620.5	398.0ft² (7.1%)	0.0ft² (0.0%)	0.0ft² (0.0%)	0.0ft² (0.0%)	230.1ft² (4.1%)	0.0ft² (0.0%)	628.0ft² (11.2%)
9894	9735.0	49.3ft² (0.5%)	21.7ft² (0.2%)	0.0ft² (0.0%)	0.0ft² (0.0%)	93.0ft² (1.0%)	0.0ft² (0.0%)	163.9ft² (1.7%)
13802	5340.5	384.8ft² (7.2%)	0.0ft² (0.0%)	0.0ft² (0.0%)	0.0ft² (0.0%)	359.8ft² (6.7%)	0.0ft² (0.0%)	744.6ft² (13.9%)
13807	6864.8	24.3ft² (0.4%)	0.0ft² (0.0%)	0.0ft² (0.0%)	0.0ft² (0.0%)	961.0ft² (14.0%)	0.0ft² (0.0%)	985.3ft² (14.4%)
13810	6211.2	7.0ft² (0.1%)	8.6ft² (0.1%)	0.0ft² (0.0%)	0.0ft² (0.0%)	371.2ft² (6.0%)	0.0ft² (0.0%)	386.9ft² (6.2%)

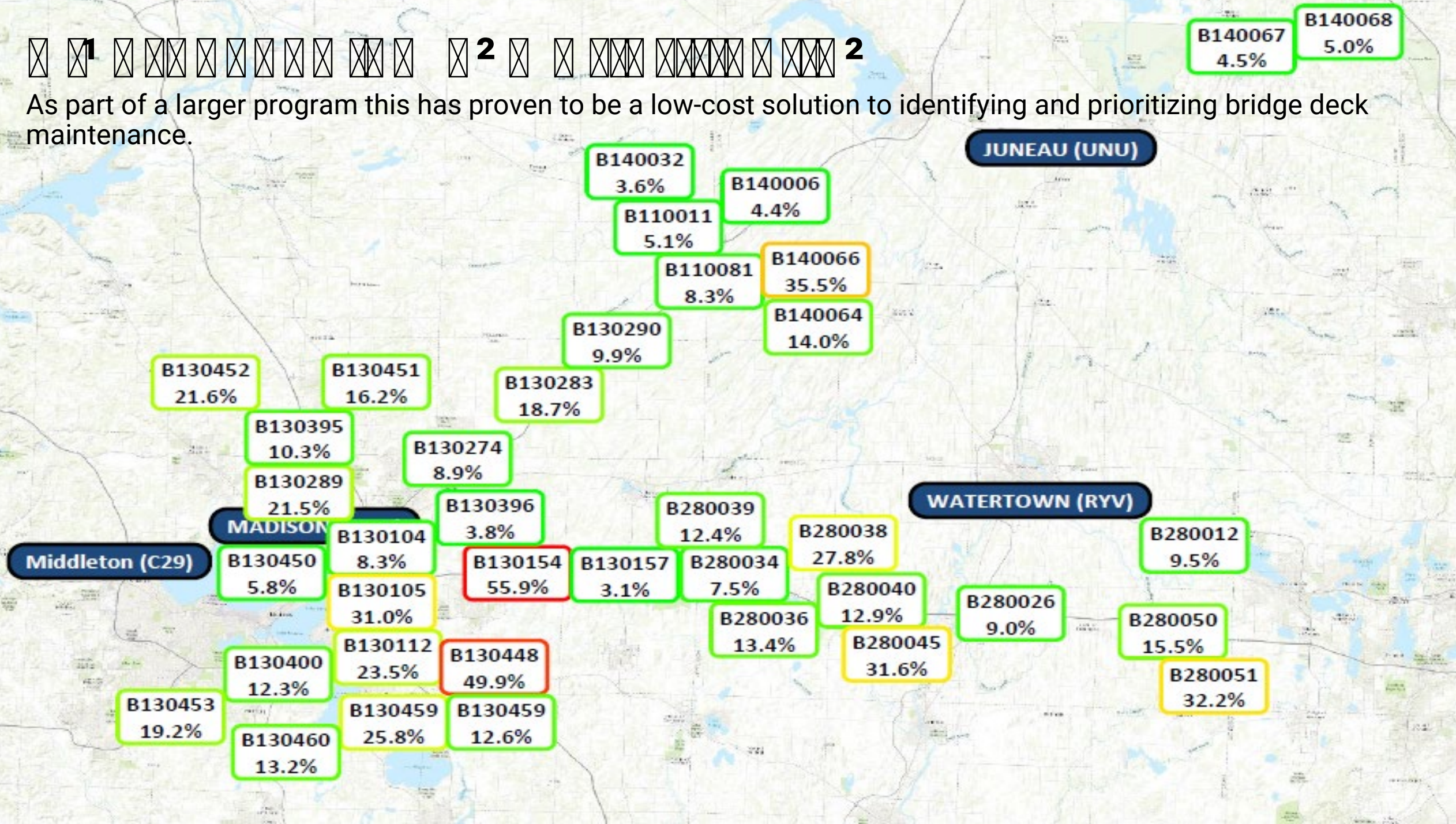
40 BRIDGES IN A FEW HOURS



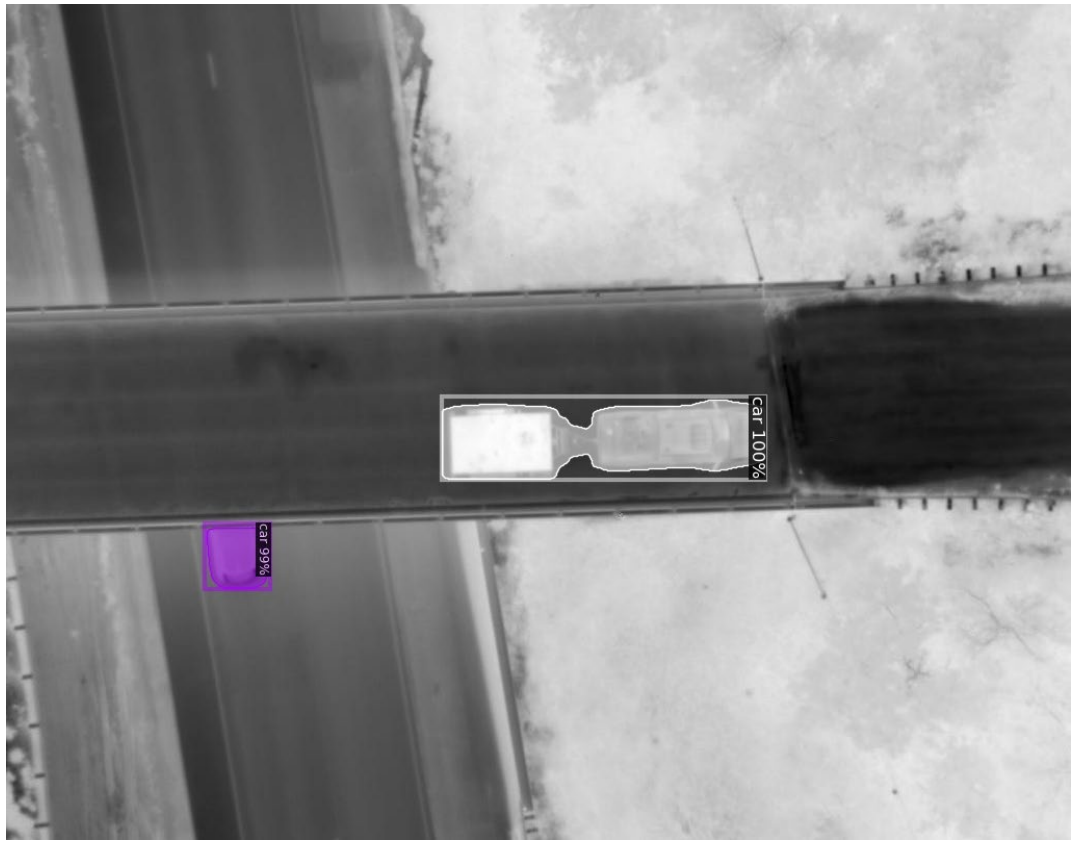
Flight path for surveying 40 bridges in a single mission.

[illegible]

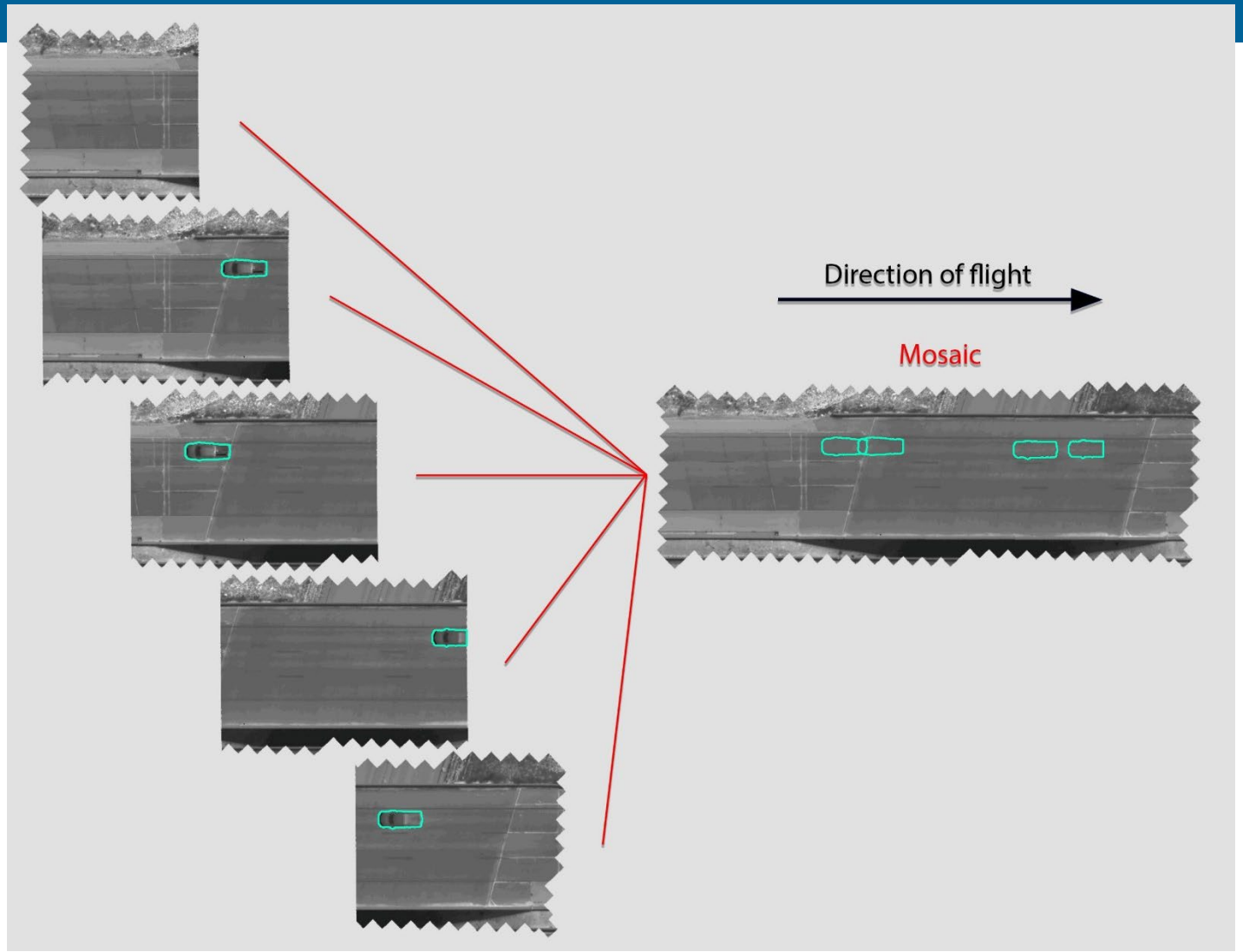
As part of a larger program this has proven to be a low-cost solution to identifying and prioritizing bridge deck maintenance.



WHAT ABOUT CARS, TRUCKS, TRAILERS?

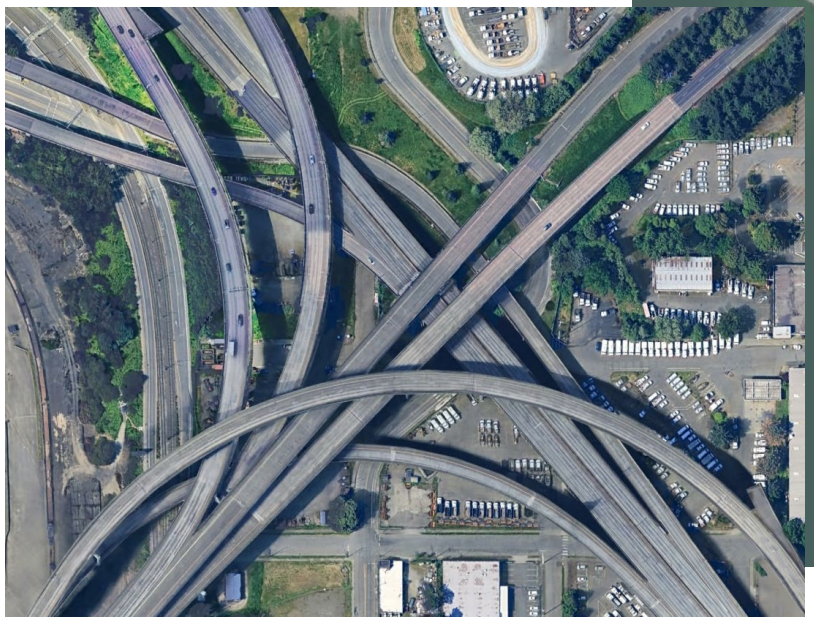


One frame at a time


Direction of flight
Mosaic

BRIDGES WE CANNOT DO

- Bridges with Obstacles
  - Trusses
  - Multi-deck bridges
  - Heavy traffic
  - Narrow Terrain



COMPLEMENTARY TOOLS- SINGLE BRIDGE SOLUTION

- UAVs solution- Pros
  - Single bridge
  - Similar resolution
  - Additional data
- UAVs solution- Cons
  - On-site requirement
  - Time consuming
  - Multiple passes required
  - Safety
  - Extensive coordinating

- Van-based- Pros
  - Single bridge
  - Higher resolution
- Van-based- Cons
  - Slower than traffic
  - Multiple passes required
  - safety
  - Transition time
  - Lacks automation
  - Lack geospatial reference

THANK YOU

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