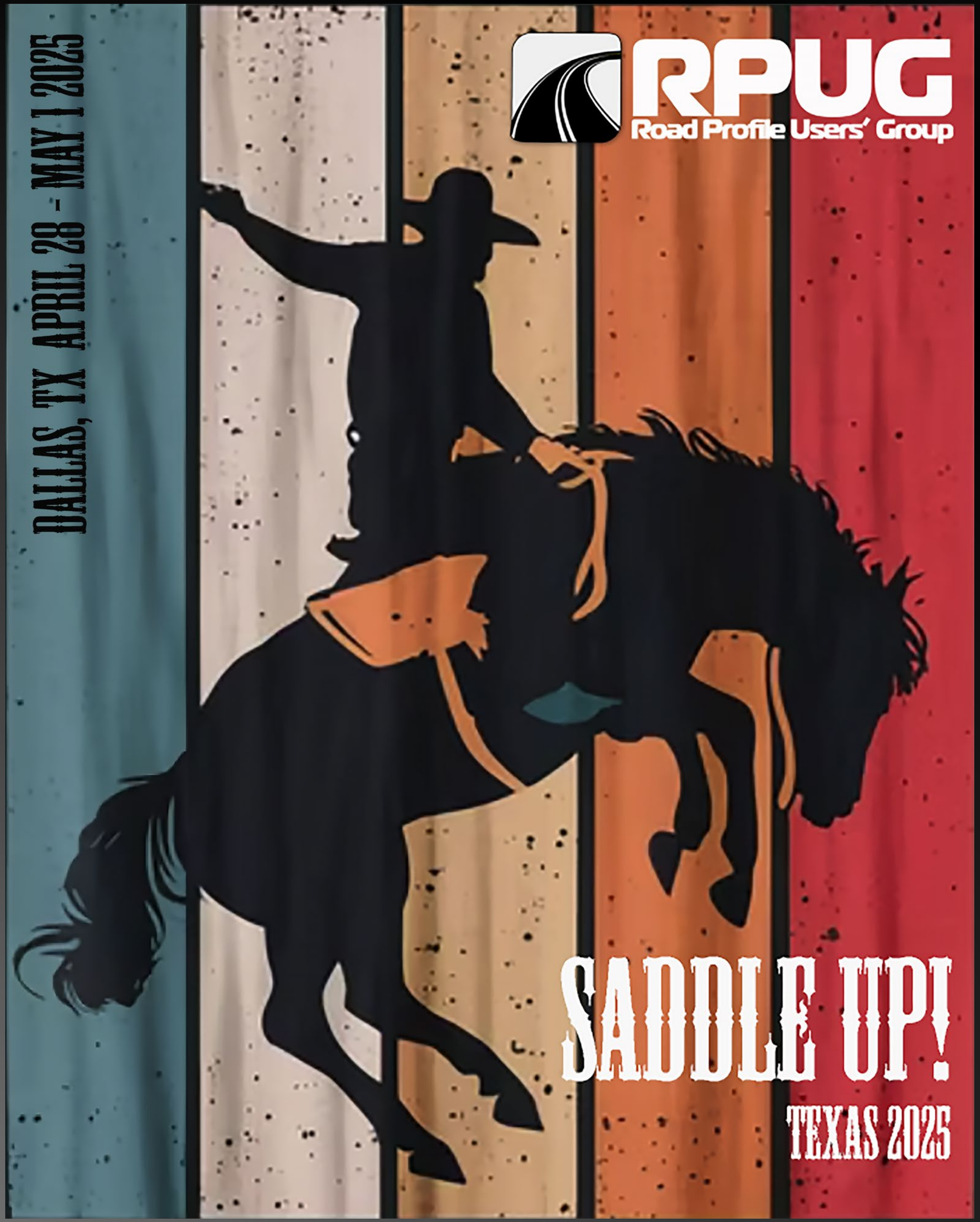


LEVERAGING LIDAR DATA TO CONSTRUCT SMOOTHER PAVEMENTS

Jim Preston, Topcon Positioning Systems

3D Construction Specialist

RPUG
Road Profile Users' Group

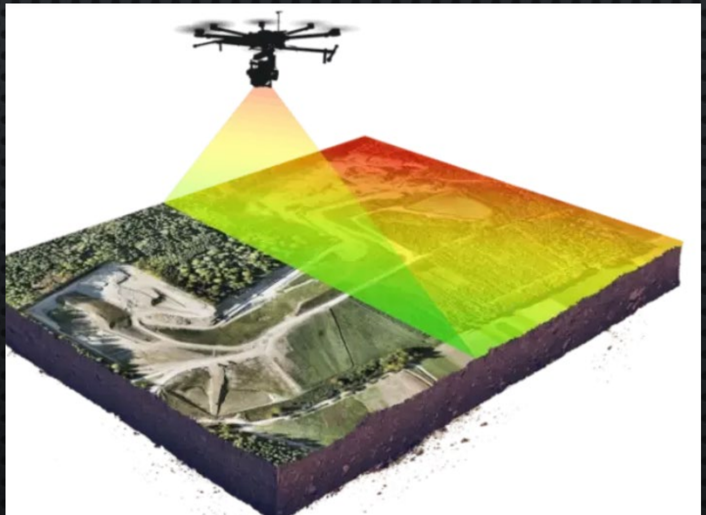
LIDAR STANDS FOR: LIGHT DETECTION AND RANGING

PRINCIPLE OF OPERATION:

- A **LASER LIGHT** IS EMITTED FROM A SOURCE (THE TRANSMITTER).
- THIS LASER LIGHT **BOUNCES OFF OBJECTS** IN VIEW.
- THE REFLECTED LIGHT IS **DETECTED BY THE SYSTEM RECEIVER.**
- THE TIME OF FLIGHT (TOF) IS USED TO DEVELOP A DISTANCE MAP OF THE OBJECTS IN VIEW

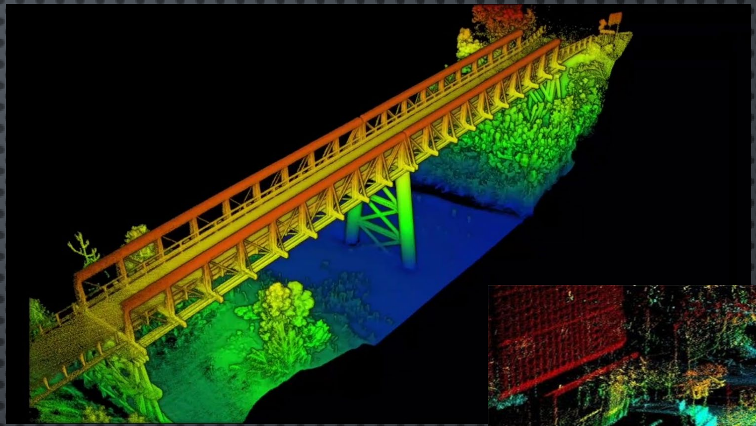
LIDAR TO AID IN THE CONSTRUCTION PROCESS

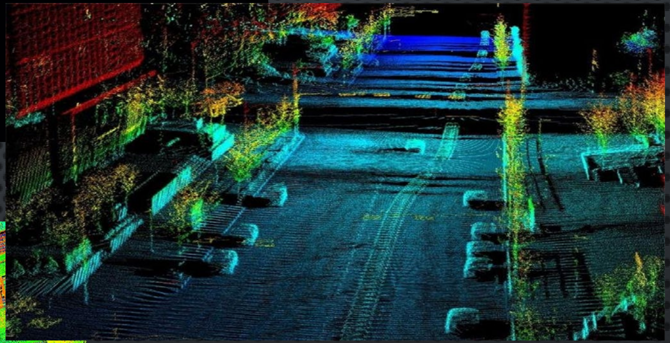
- THIS IS AN ILLUSTRATION OF A 180-DEG DOWNWARD FACING LIDAR SCAN PROCESS.
- SCANNING AT UP TO POSTED ROADWAY SPEEDS.

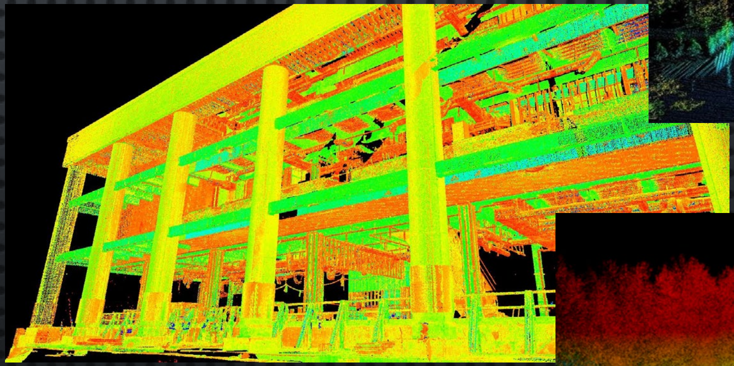


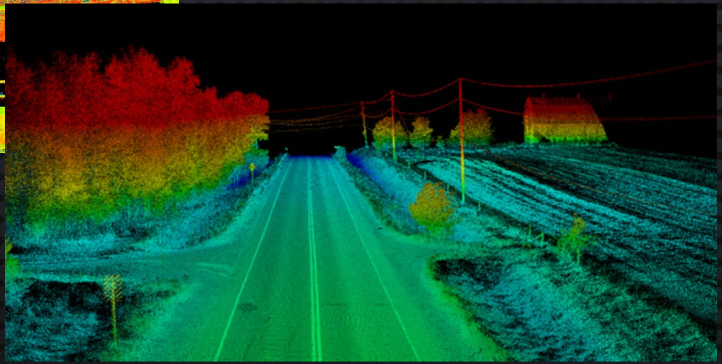
LIDAR AND SCANNING

- KNOWING THE APPLICATION ALLOWS YOU TO CHOOSE THE RIGHT TOOL FOR THE JOB!
- ROAD CONSTRUCTION MAY NEED DIFFERENT SCANNING TOOLS THAN ASSET MANAGEMENT OR VERTICAL CONSTRUCTION.
- FOR EXAMPLE: A ROAD ASSESSMENT MAY NOT NEED THE DETAIL A BRIDGE INSPECTION MAY REQUIRE.

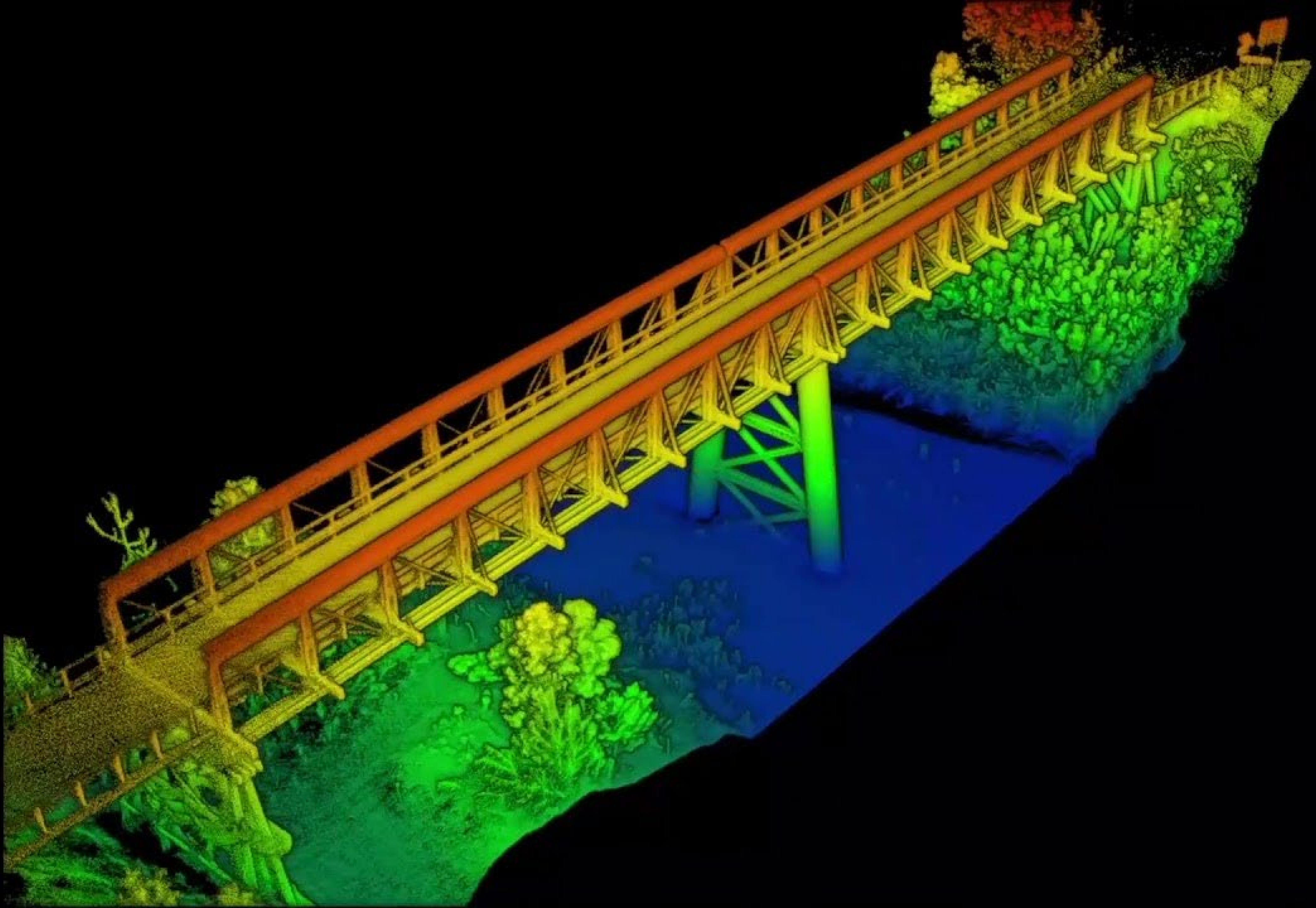


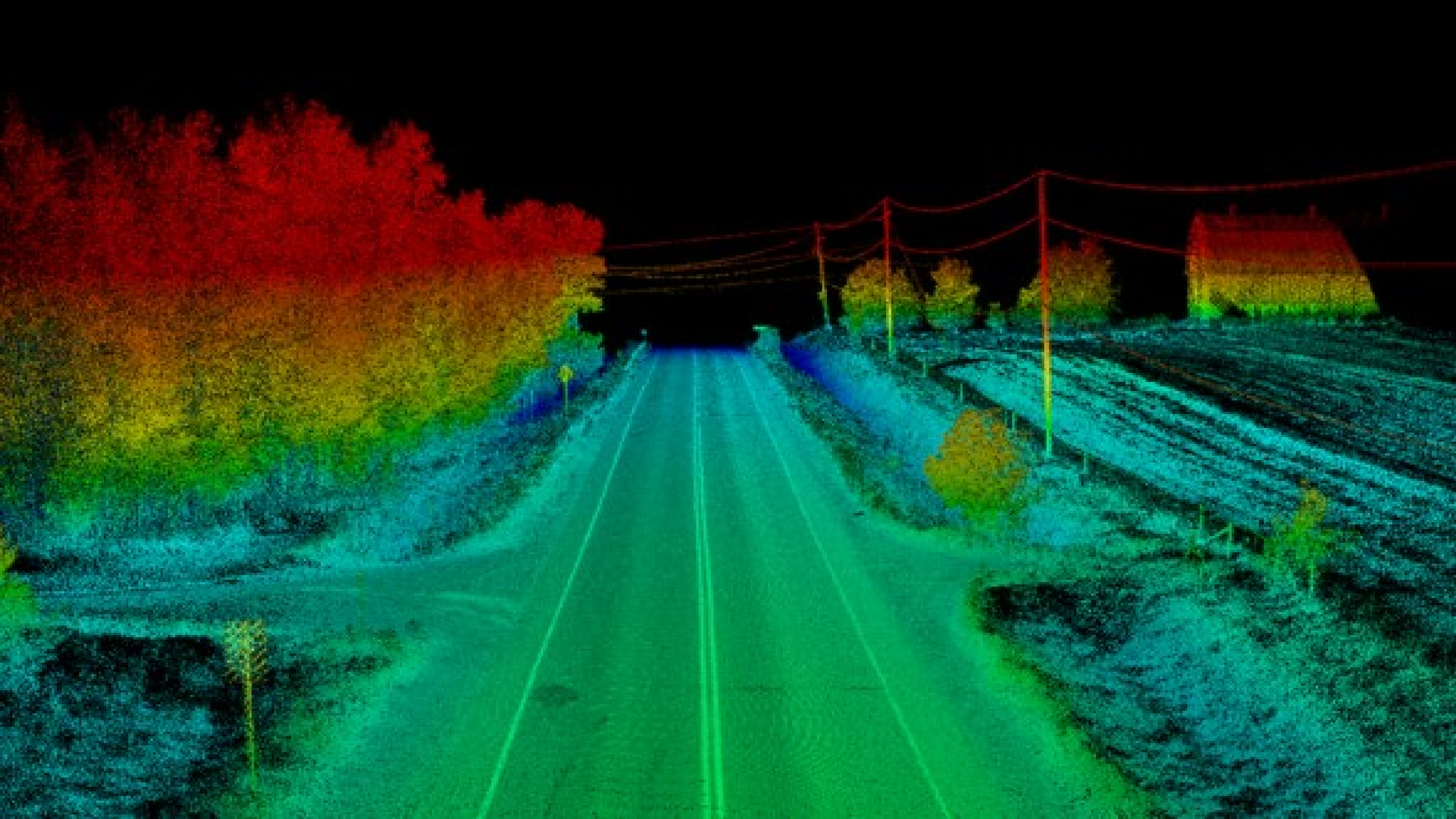


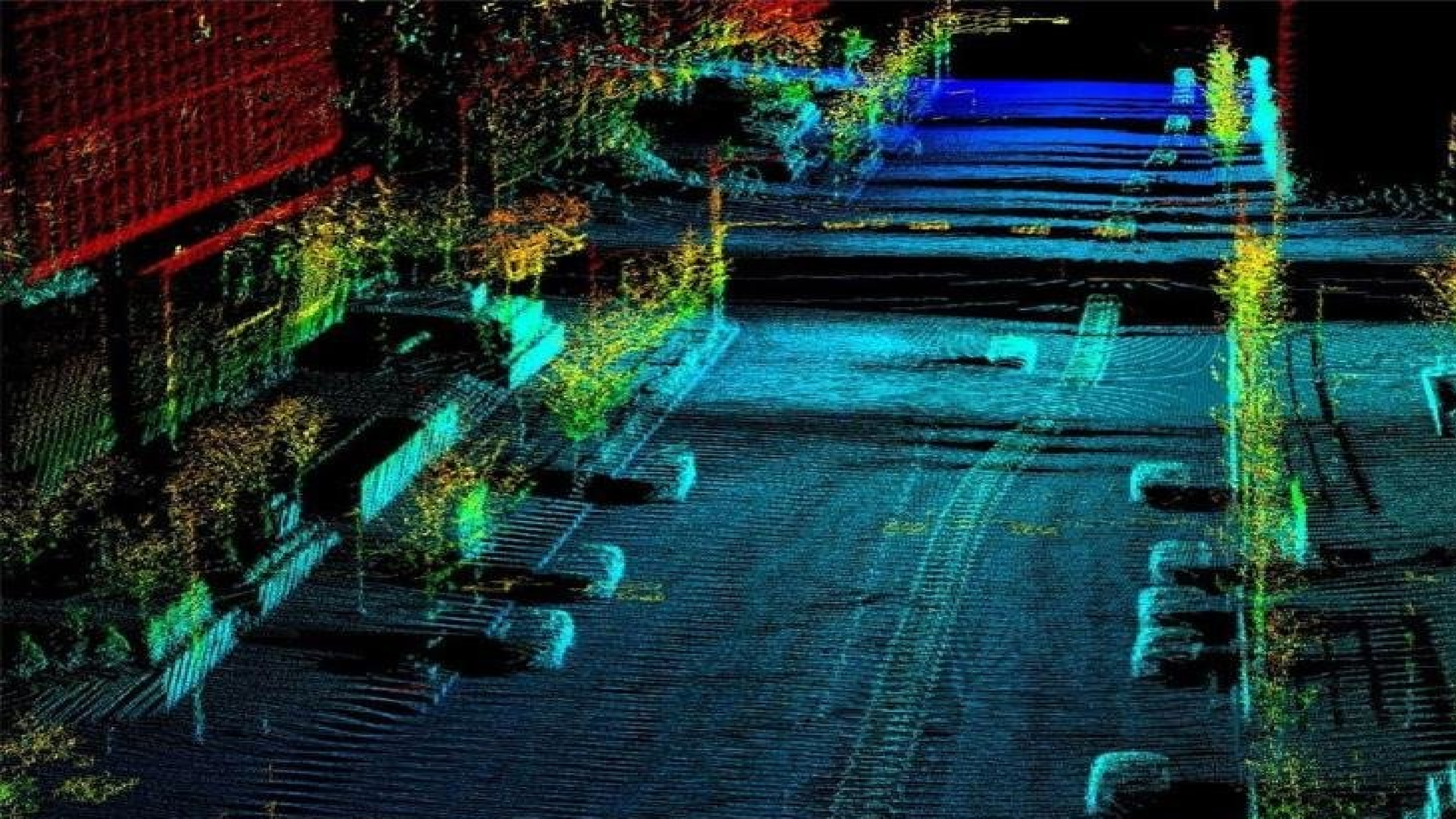


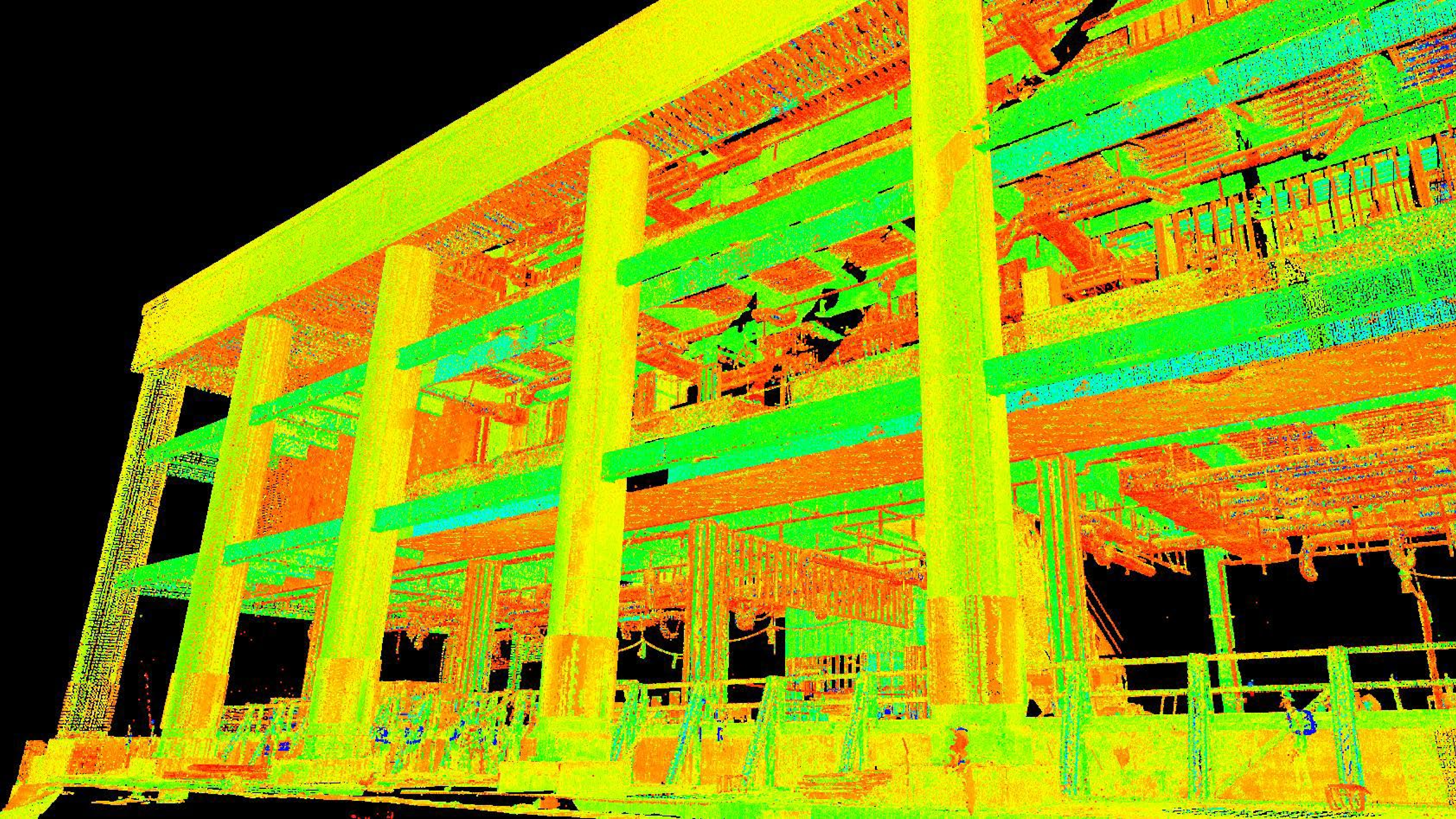


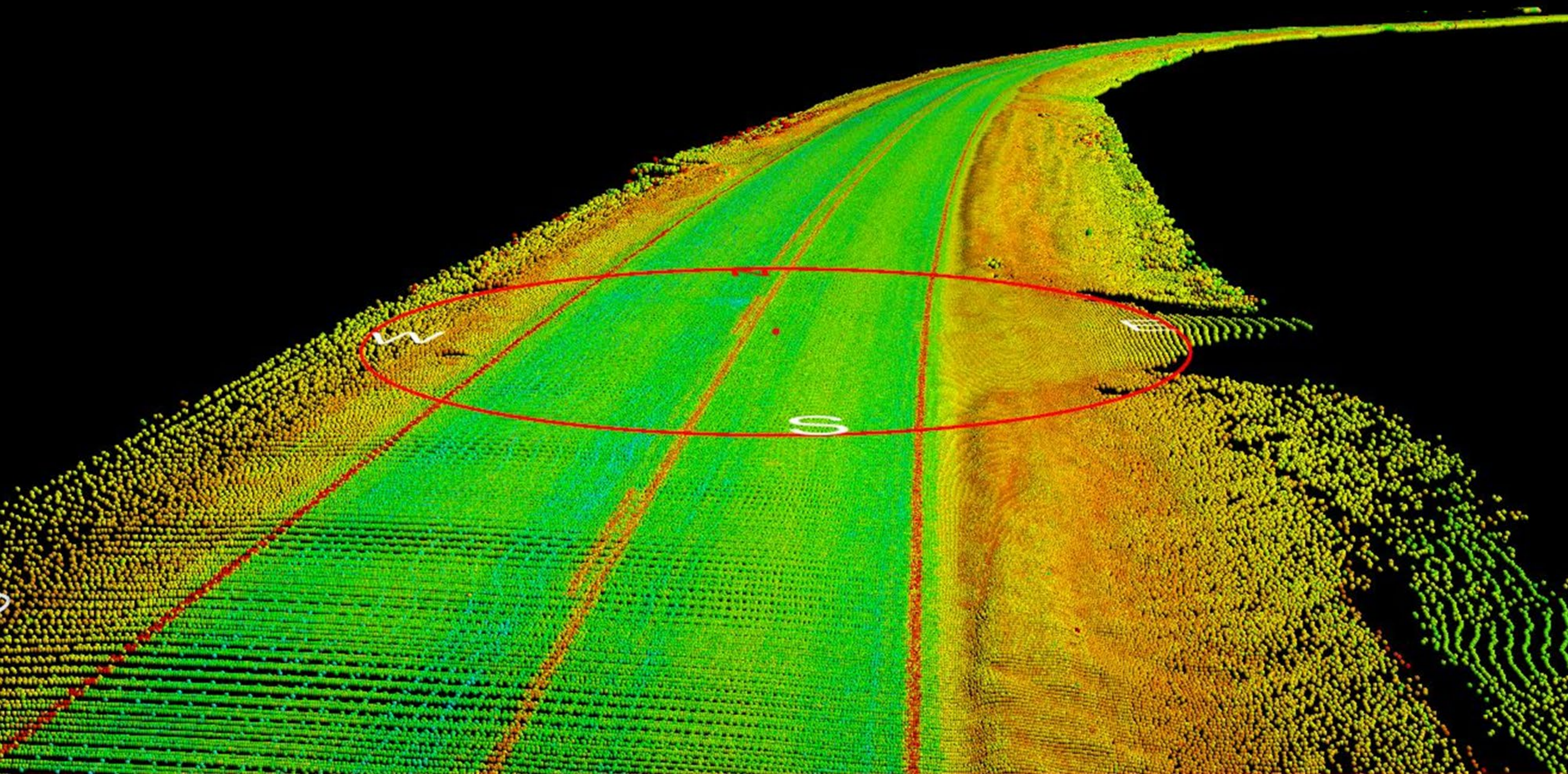
“There are different types of Lidar scanners… we’re focusing on roadway. Some of the most common utilized in roadway surface construction are: 360 deg or a 180 deg downward facing scanner (which is much more cost efficient).









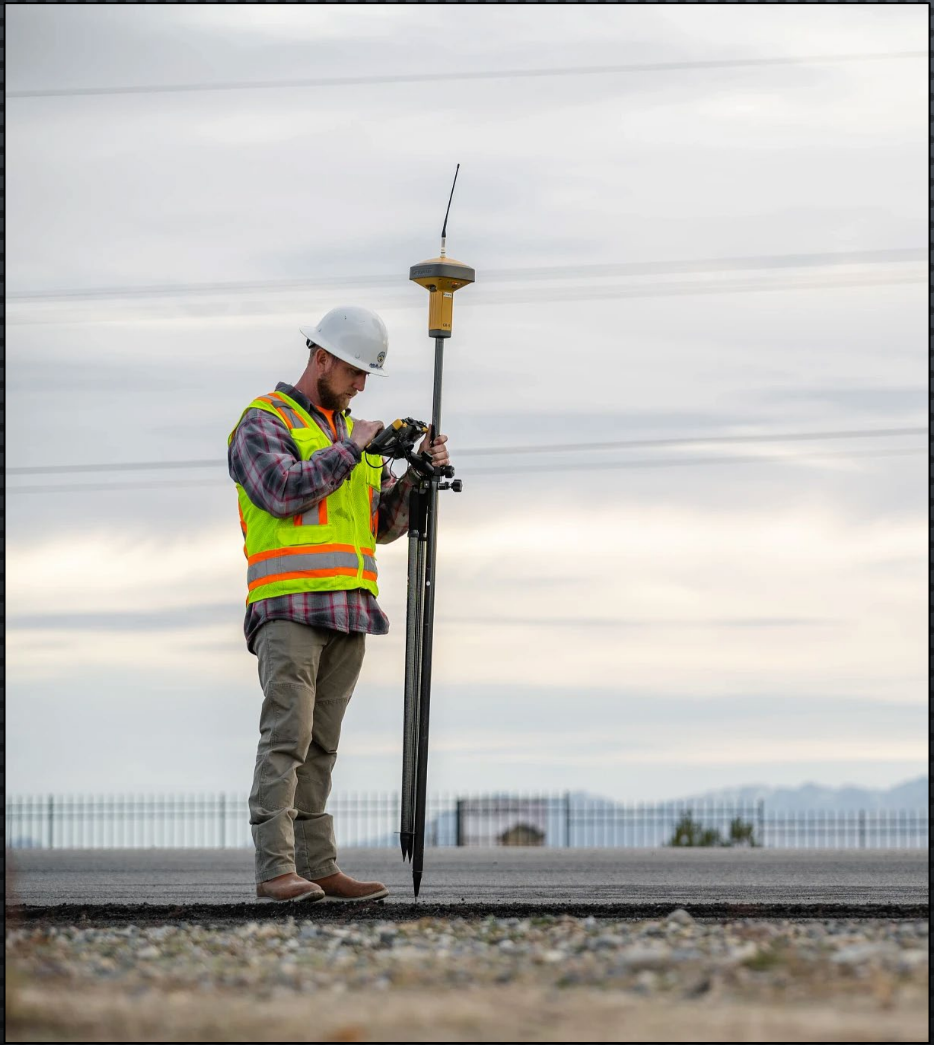

N
W
E
S

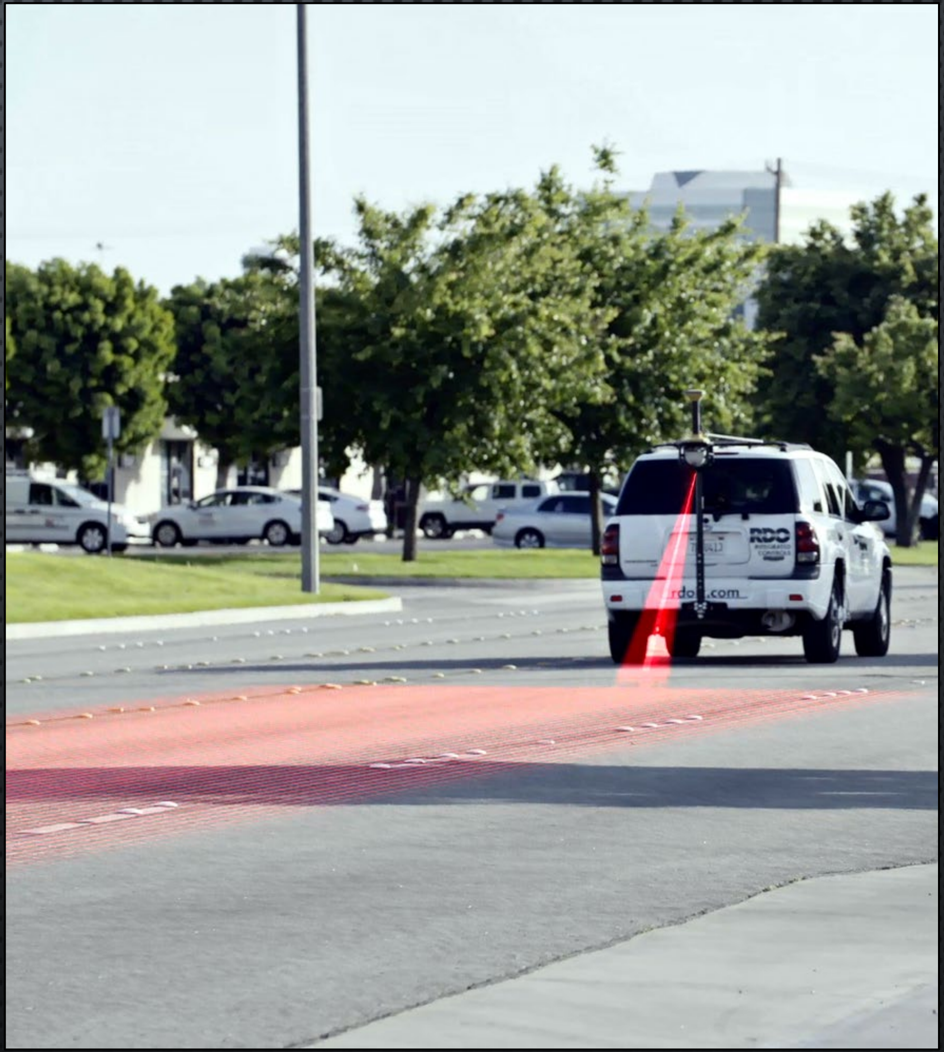
ROAD SCANNER

- GNSS Receiver
- Lidar Scanner
- IMU Sensor
- Wheel Encoder


All In Live Traffic

CONVENTIONAL METHOD





Eliminates the need for tedious point collection

Eliminates lane closures, crash trucks, etc.

Identifies possible problem areas ahead of milling / paving

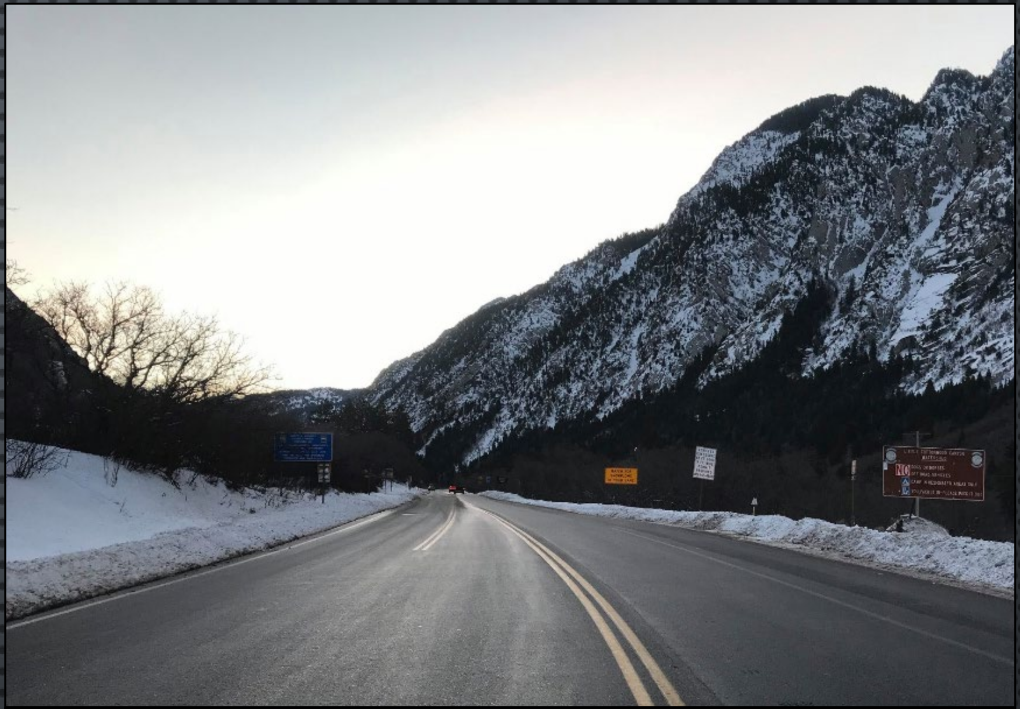
Creates a very dense model of the surface

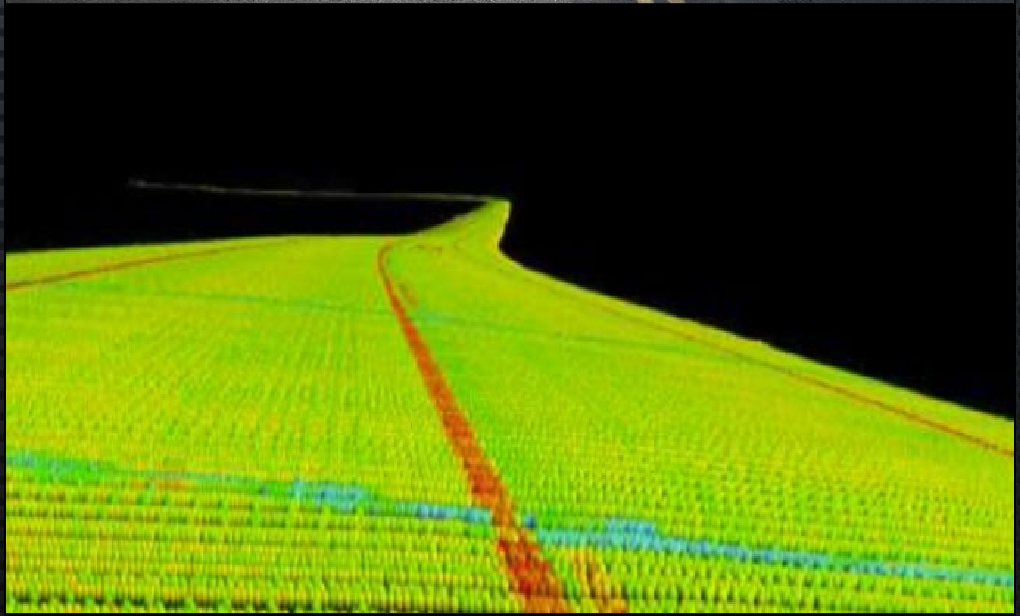
THE DATA

Existing Surface As-Built, Roadway assets As-Built, Line Extraction, Alignment Creation, Surface Design Capabilities Used for Machine Control

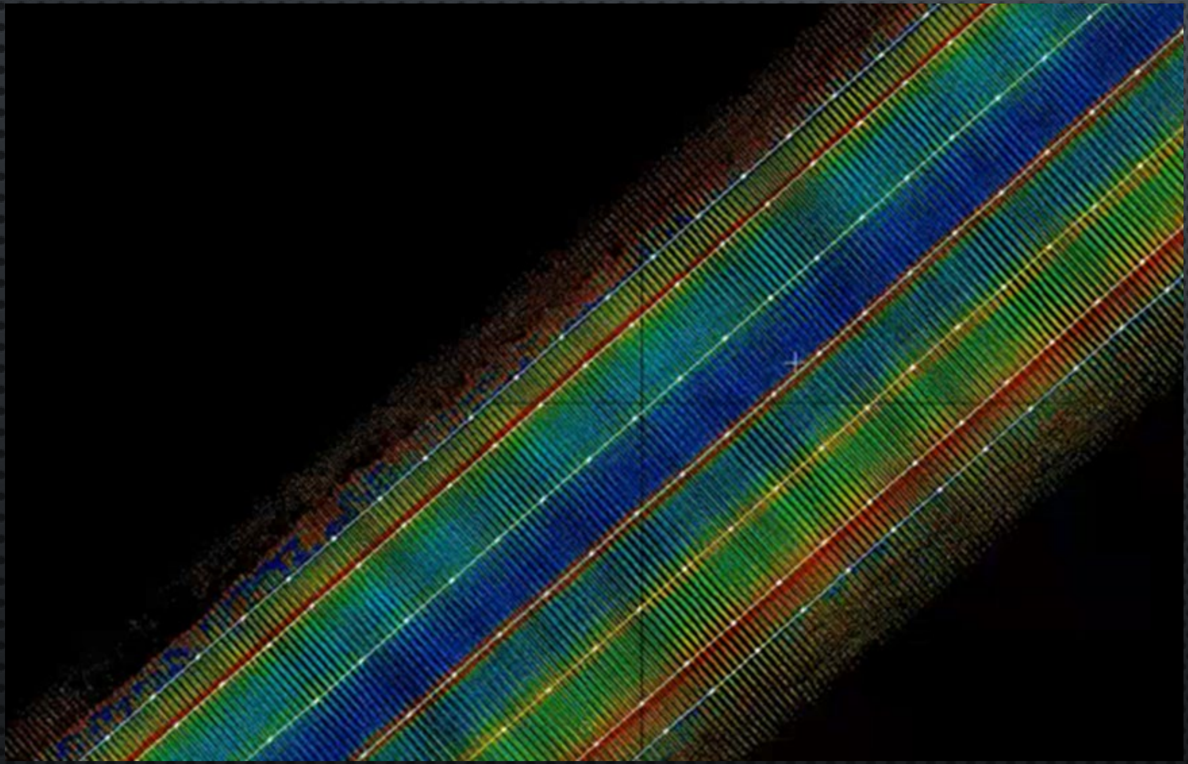
EXISTING ROADWAY DATA

- PROVIDES AN ACCURATE SURFACE OF THE EXISTING CONDITIONS LIKE LANE WIDTHS, ELEVATIONS, SLOPES, AND CAUSES OF ROUGHNESS LIKE CRACKING AS WELL AS UTILITIES.
- THE EXISTING SURFACE GENERATED FROM THE LIDAR SCAN CAN BE USED AS A TRUE ACCURATE AS-BUILT DELIVERABLE.



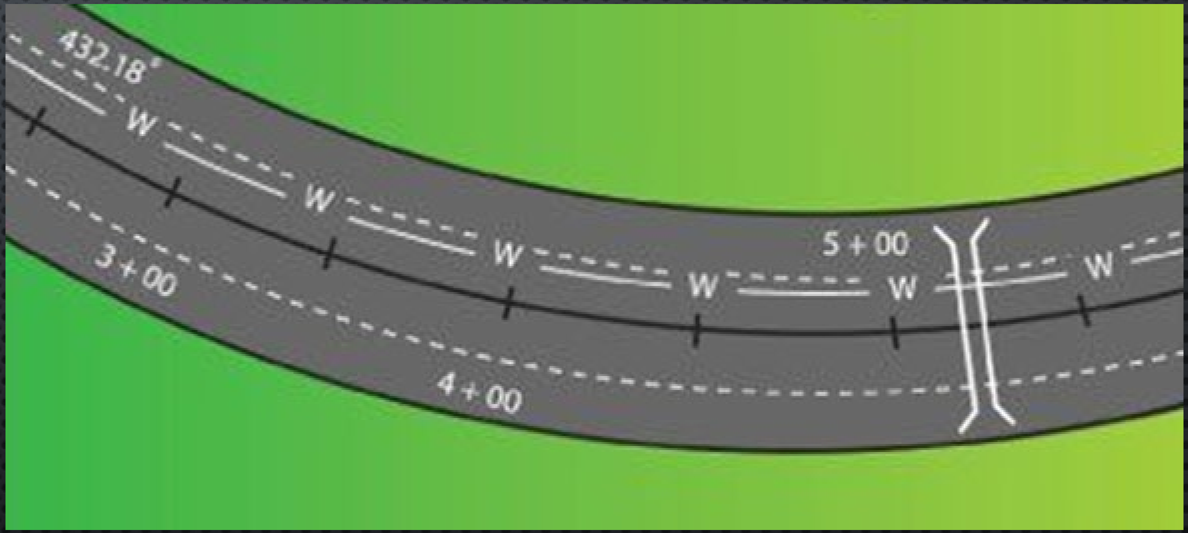


EXISTING ASSET AS-BUILT

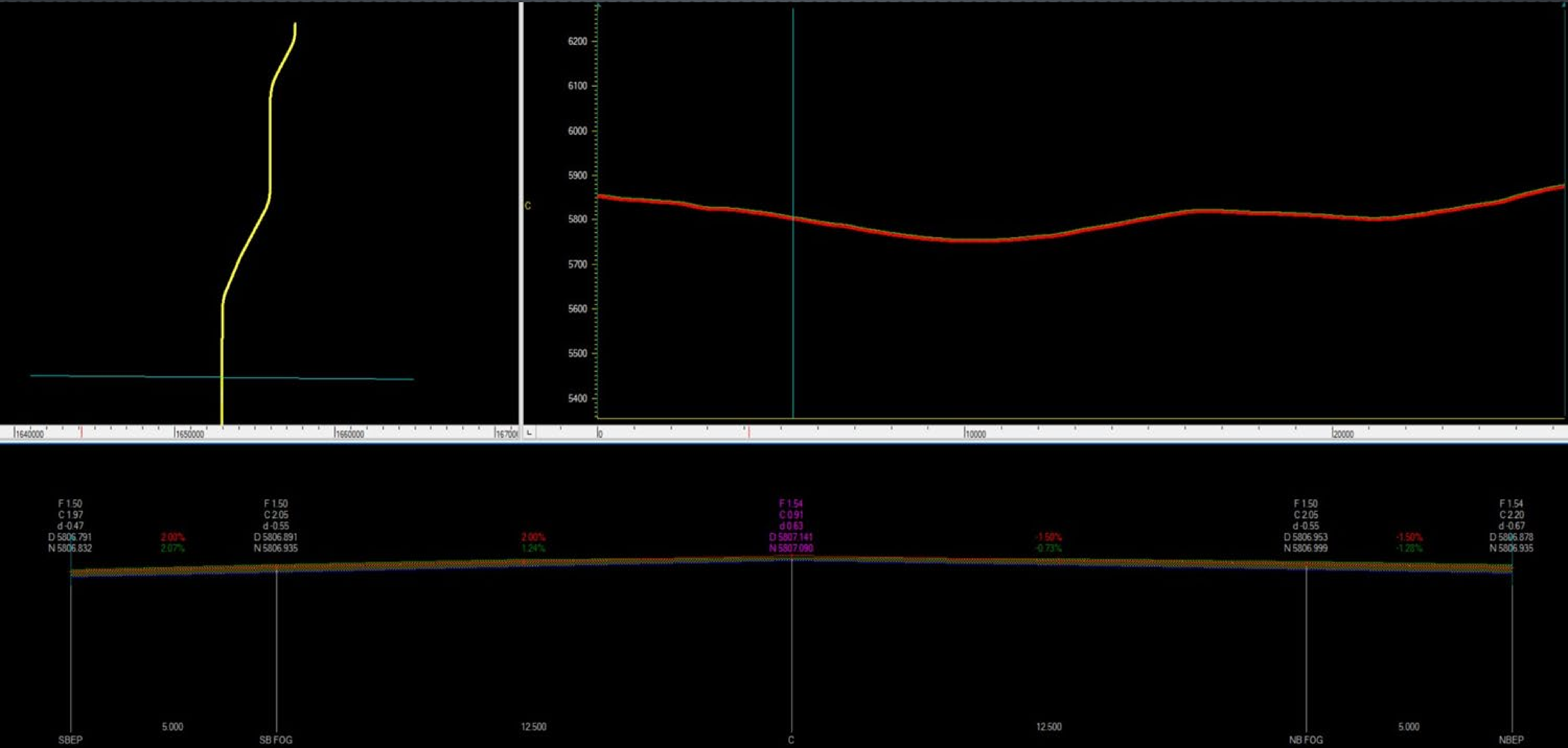


Lane line Extraction

Roadway INSPECTION

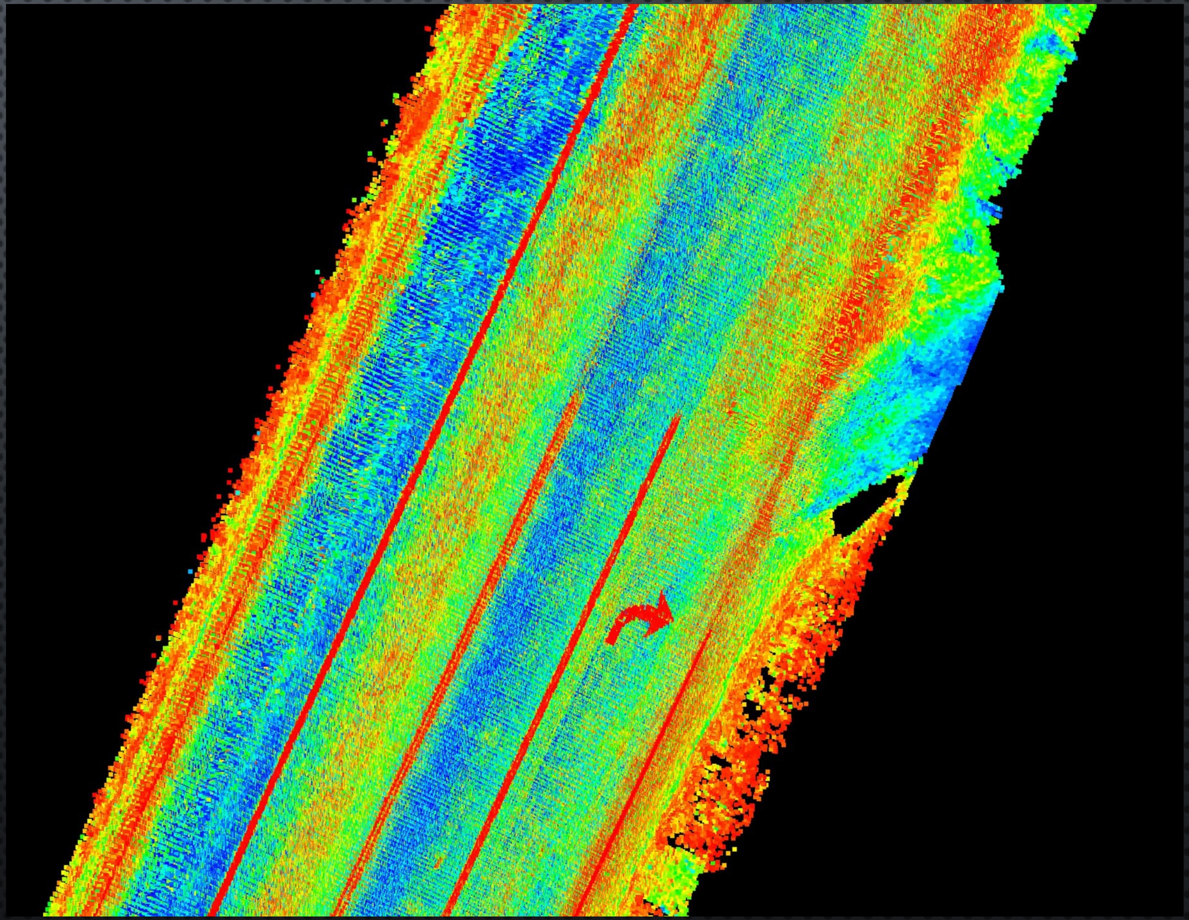


Alignment Creation


6200
6100
6000
5900
5800
5700
5600
5500
5400
C
1640000
1650000
1660000
0
10000
20000
F 1.50
C 1.97
d -0.47
D 5806.791
N 5806.832
2.00%
2.07%
F 1.50
C 2.05
d -0.55
D 5806.891
N 5806.935
2.00%
1.24%
F 1.54
C 0.91
d 0.63
D 5807.141
N 5807.090
-1.50%
-0.73%
F 1.50
C 2.05
d -0.55
D 5806.953
N 5806.999
-1.50%
-1.28%
F 1.54
C 2.20
d -0.67
D 5806.878
N 5806.935
5.000
12.500
12.500
5.000
SBEP
SB FOG
C
NB FOG
NBEP

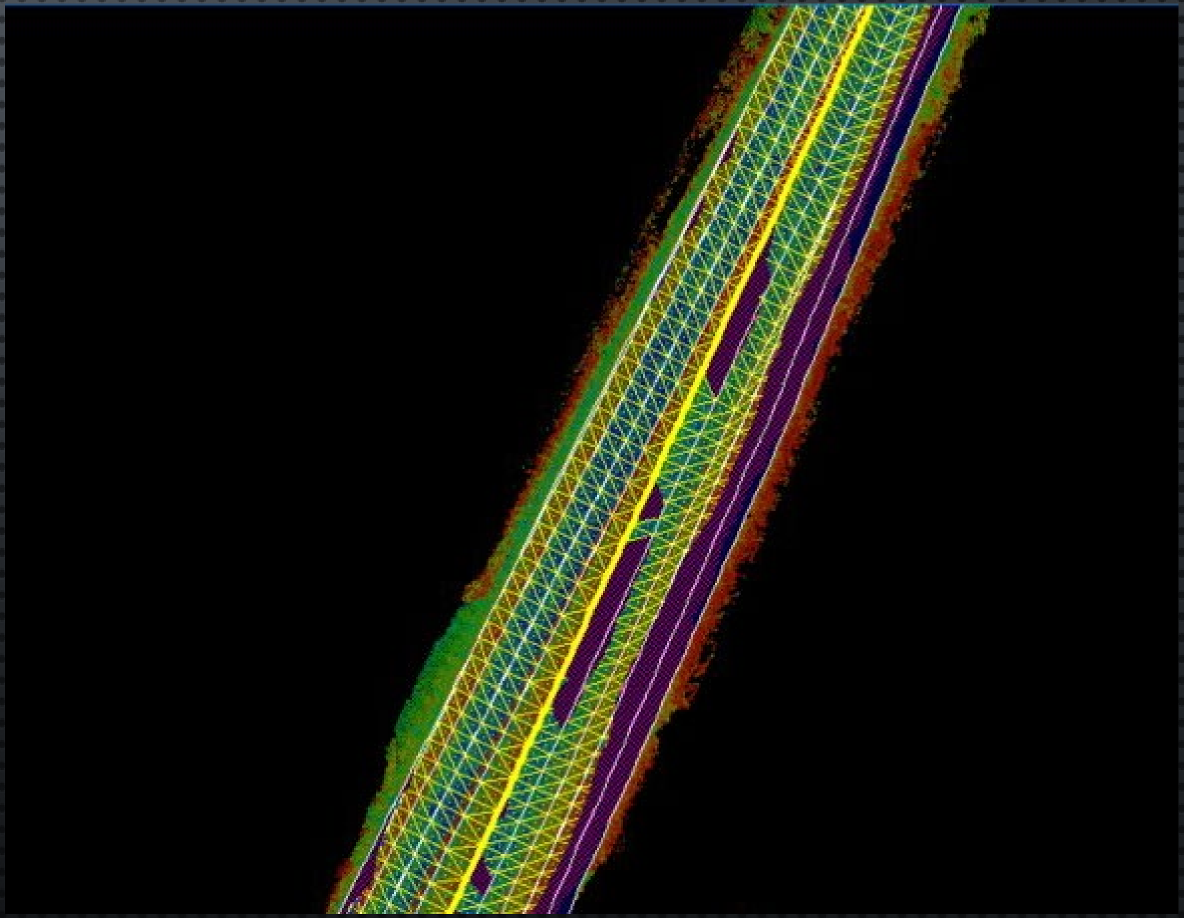
THE SCAN

- Live traffic scan – no closures or TC needed
- Total scan of the 5 miles completed in 2 hours – setup to tear down.
- Post Processed and started design on the same day allowing for quicker turnaround time.
- UDOT Spec 1" cut at the centerline and max 2.5" at the edge of pavement – Improve slope where possible



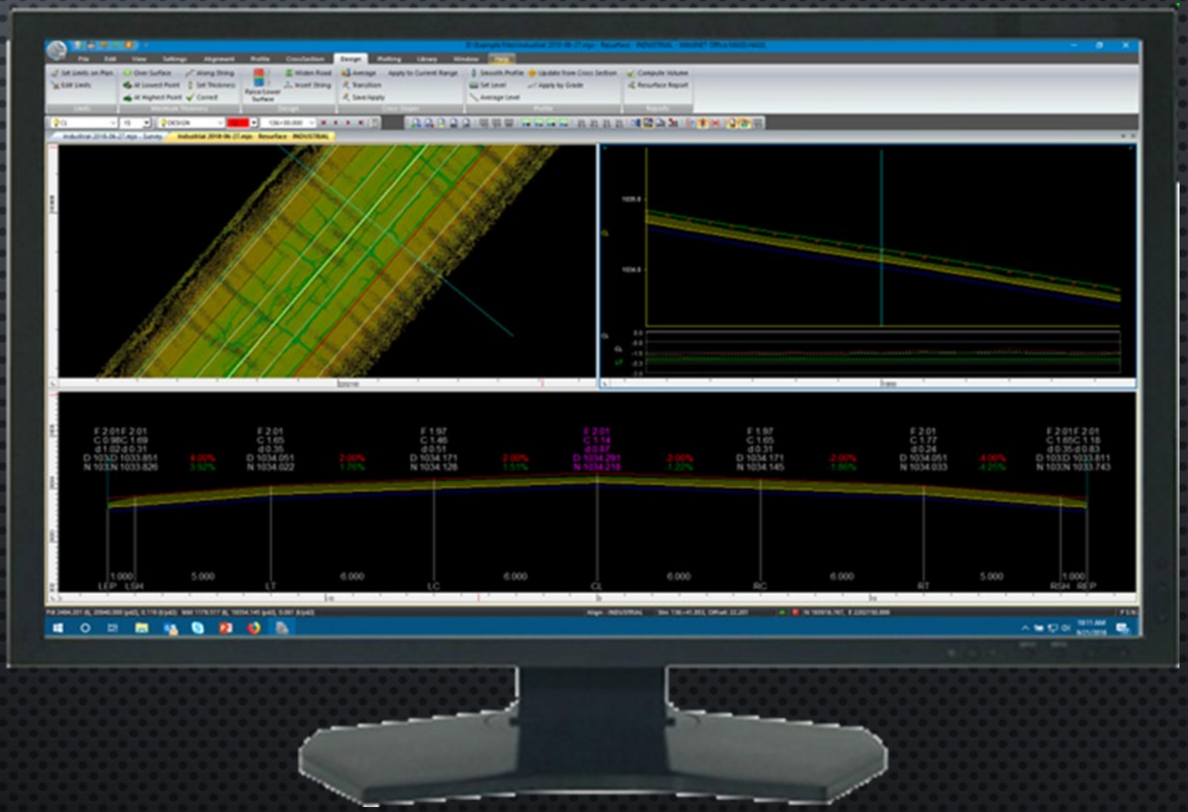
SCAN & DESIGN

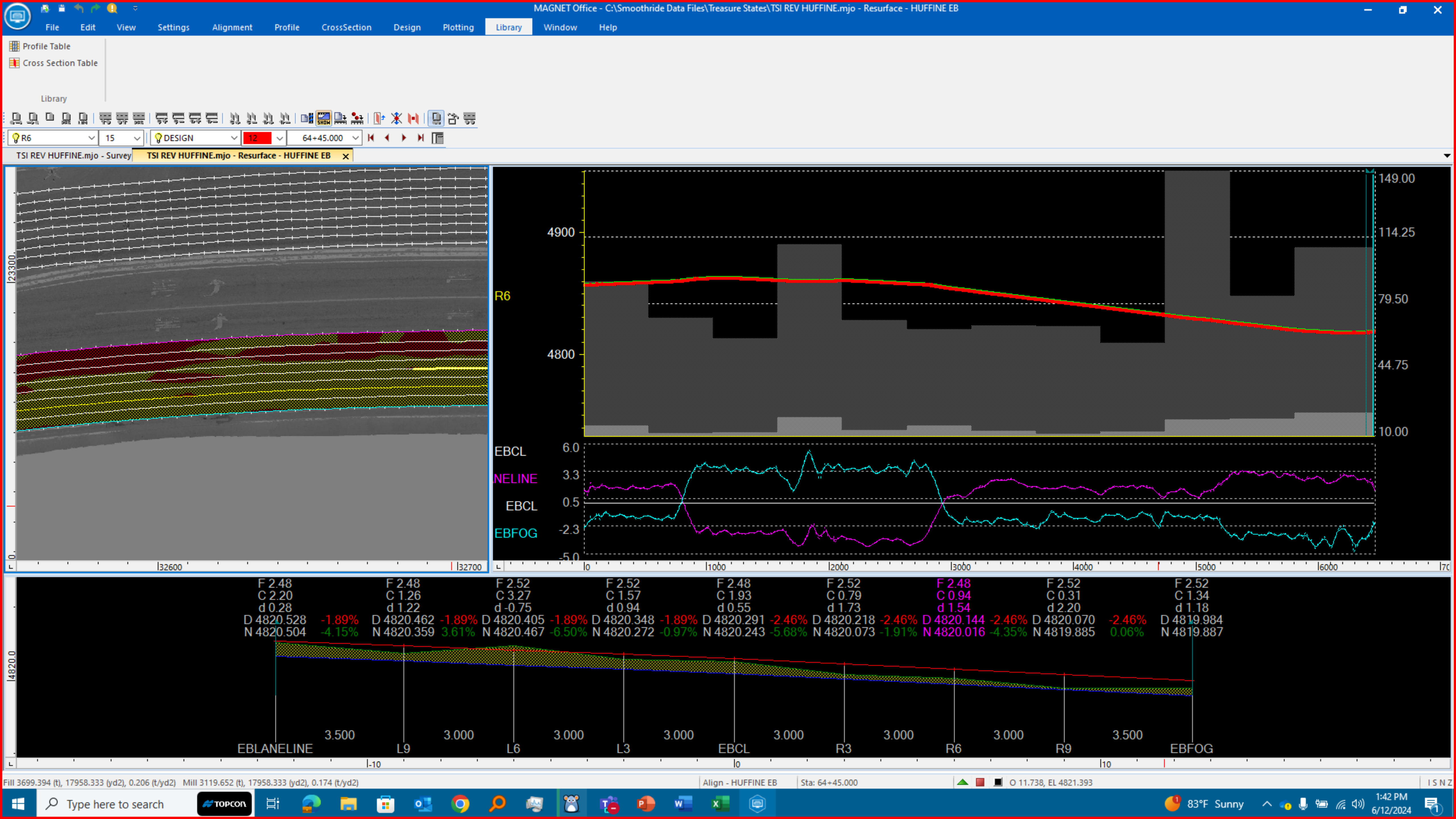
- Visual indicators and representation of the existing road
- Identify where and why you can or cannot meet design criteria



SURFACE DESIGN

- Build a design to meet or exceed the project specifications
- Easy input of project parameters
- Variable depth MIN/MAX entry
- Smoothing Longitudinal wavelengths
- Cross slope correction
- Material management

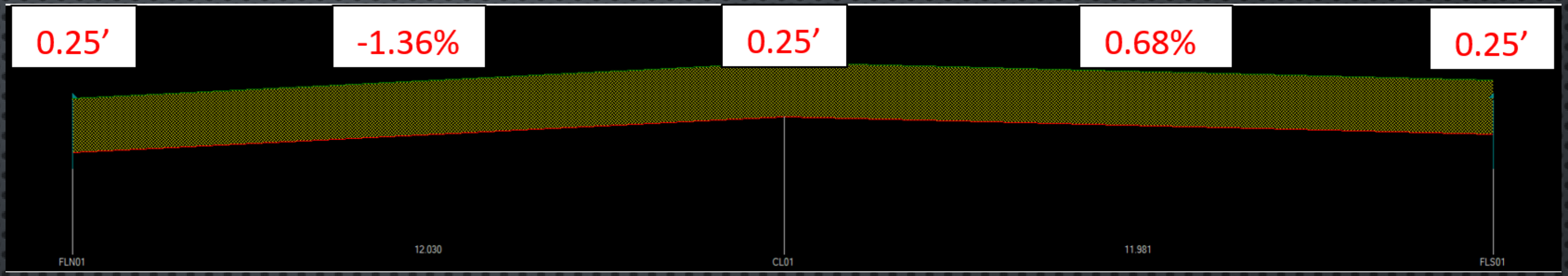



MAGNET Office - C:\Smoothride Data Files\Treasure States\TSI REV HUFFINE.mjo - Resurface - HUFFINE EB
File Edit View Settings Alignment Profile CrossSection Design Plotting Library Window Help
Profile Table
Cross Section Table
Library
R6
15
DESIGN
12
64+45.000
TSI REV HUFFINE.mjo - Survey
TSI REV HUFFINE.mjo - Resurface - HUFFINE EB
4900
4800
R6
149.00
114.25
79.50
44.75
10.00
EBCL
NELINE
EBCL
EBFOG
6.0
3.3
0.5
-2.3
-5.0
F 2.48 C 2.20 d 0.28 D 4820.528 -1.89% N 4820.504 -4.15%
F 2.48 C 1.26 d 1.22 D 4820.462 -1.89% N 4820.359 3.61%
F 2.52 C 3.27 d -0.75 D 4820.405 -1.89% N 4820.467 -6.50%
F 2.52 C 1.57 d 0.94 D 4820.348 -1.89% N 4820.272 -0.97%
F 2.48 C 1.93 d 0.55 D 4820.291 -2.46% N 4820.243 -5.68%
F 2.52 C 0.79 d 1.73 D 4820.218 -2.46% N 4820.073 -1.91%
F 2.48 C 0.94 d 1.54 D 4820.144 -2.46% N 4820.016 -4.35%
F 2.52 C 0.31 d 2.20 D 4820.070 -2.46% N 4819.885 0.06%
F 2.52 C 1.34 d 1.18 D 4819.984 N 4819.887
3.500 3.000 3.000 3.000 3.000 3.000 3.000 3.000 3.500
EBLANELINE L9 L6 L3 EBCL R3 R6 R9 EBFOG
Fill 3699.394 (t), 17958.333 (yd2), 0.206 (t/yd2) Mill 3119.652 (t), 17958.333 (yd2), 0.174 (t/yd2)
Align - HUFFINE EB
Sta: 64+45.000
O 11.738, EL 4821.393
Type here to search
83°F Sunny
1:42 PM
6/12/2024

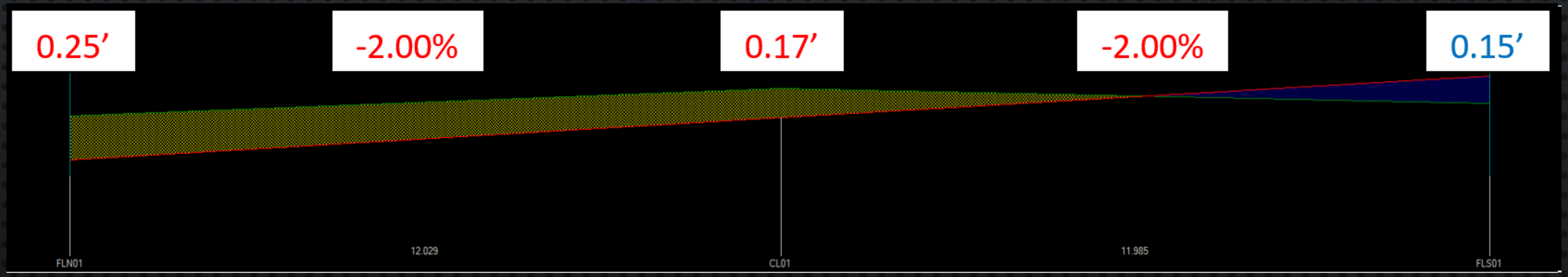
DESIGN EXAMPLES

- Make significant smoothness improvements
- Design to specific grade requirements
- Meet elevation constraints
- Identify the need for leveling courses

Existing



Design



3D AUTOMATIC MACHINE GUIDANCE

- Upload the design generated from the scan to the machine for the use of Automatic Machine Guidance (AMG).
- Having such an accurate surface of the existing allows the use of variable depth machine control that uses a 2D sensor to reference the existing to achieve the design grade.

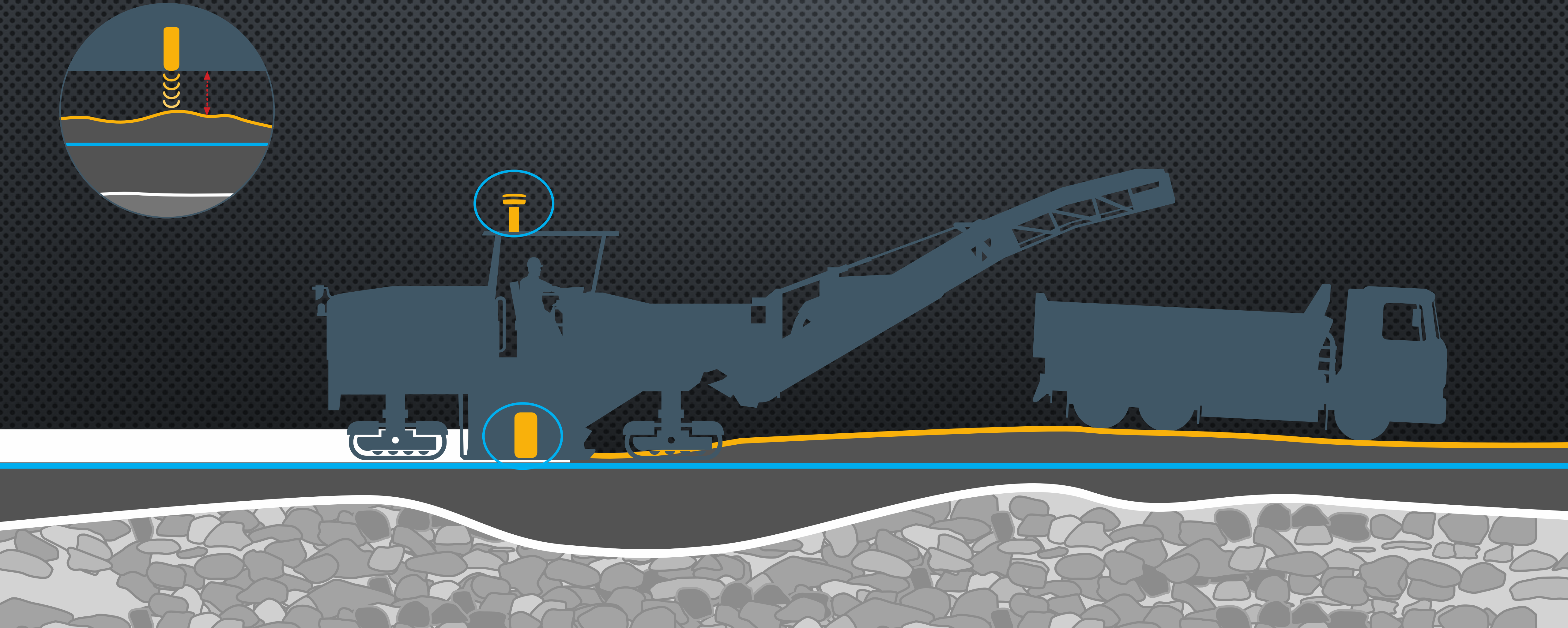
CONTROL OPTIONS FOR ANY PROJECT CONDITION

CONTROL OPTIONS FOR ANY PROJECT CONDITION

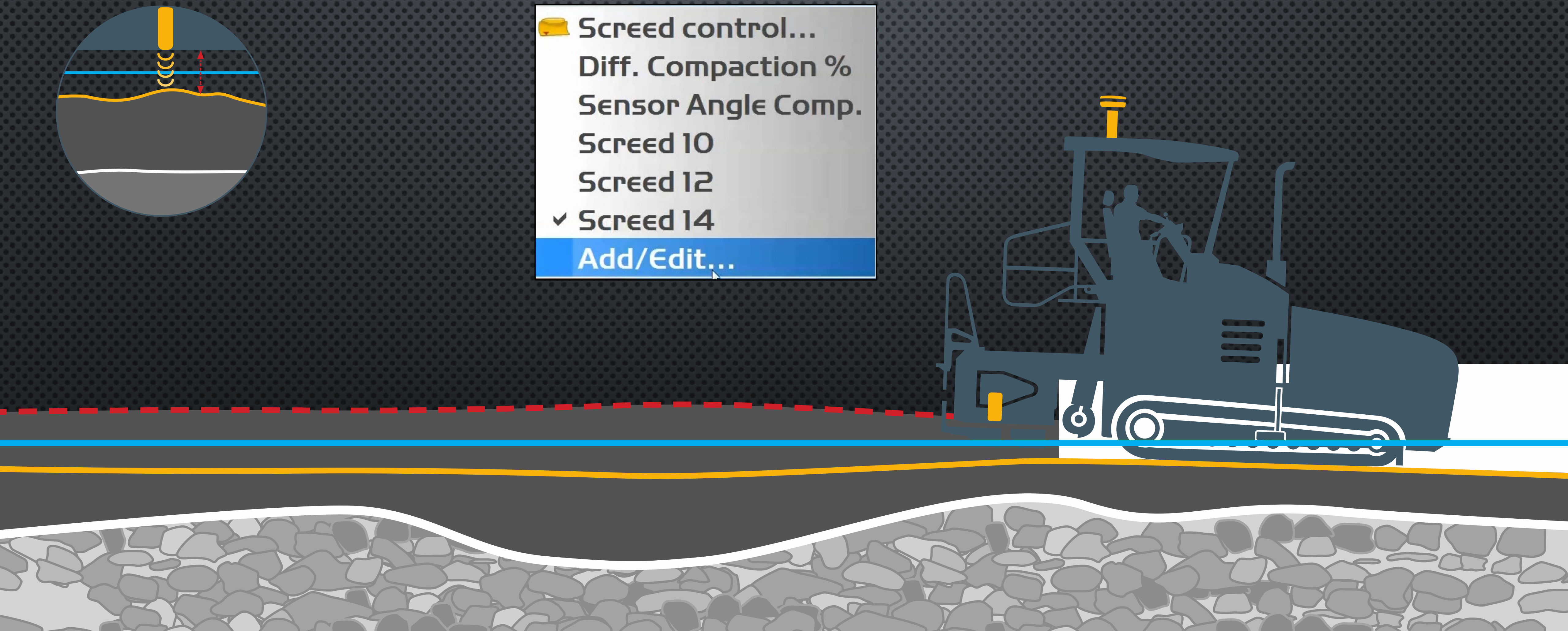
Robotic Total Stations

mmGPS

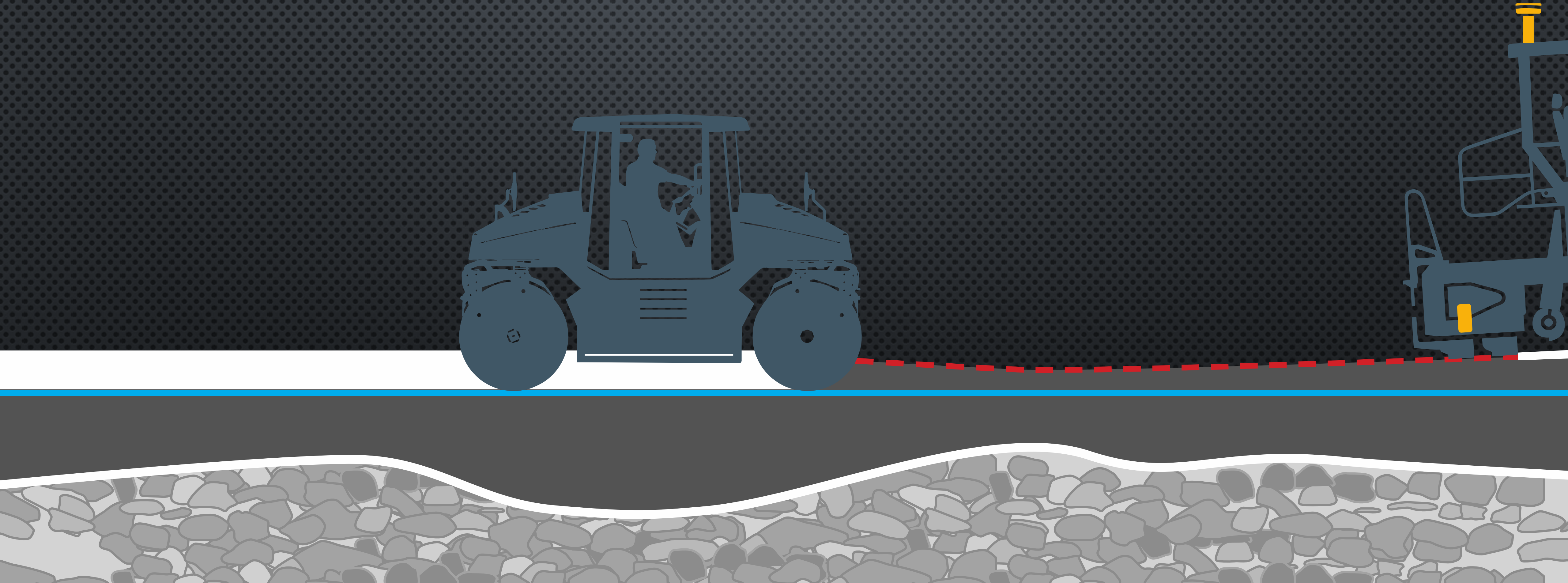
Variable Depth Milling



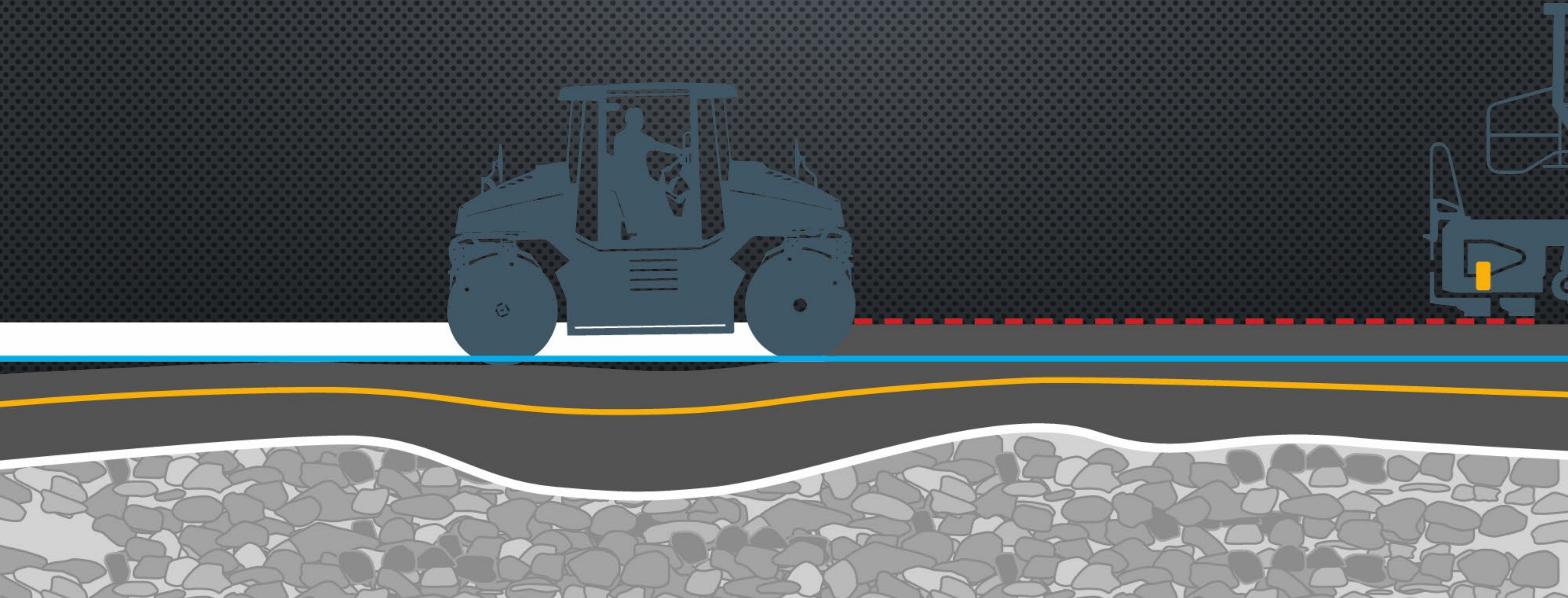
VARIABLE DEPTH PAVING



COMPACTION PROCESS IMPROVED



CONVENTIONAL COMPACTION PROCESS



SCANNING THE MILLED SURFACE

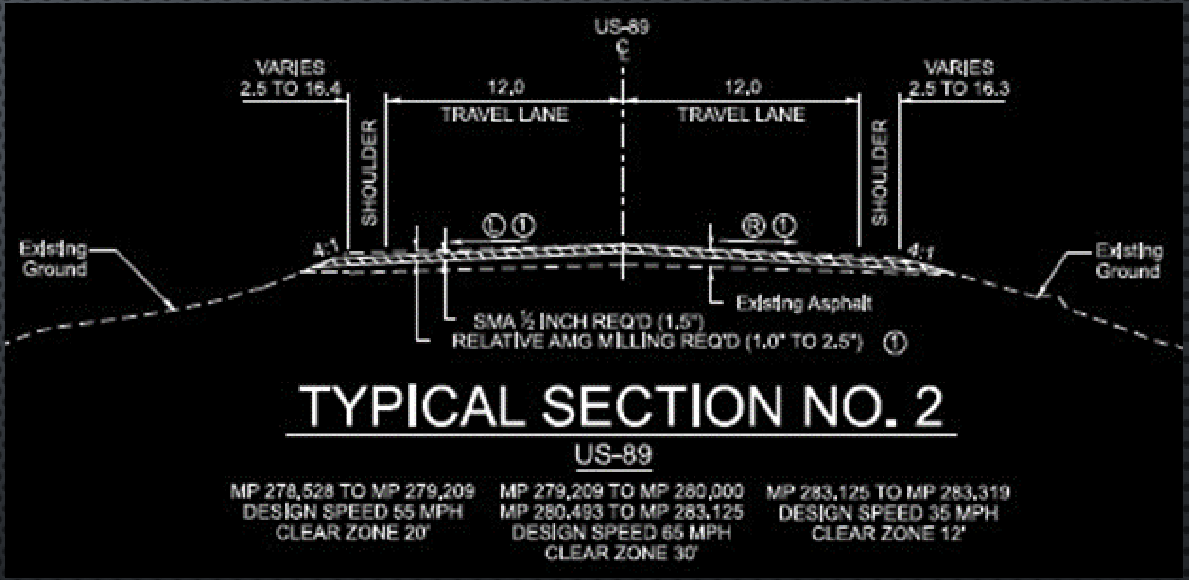
- Verify milled surface to design
- Confirm paving quantities before paving
- Make any corrections if needed

Scanning the Final Surface

- Verify lane lines, and roadway slope, confirm thicknesses, and confirm pavement accuracy to the design
- Digital records of roadway

UDOT US89 Mt. Pleasant to Fairview

- Section 02963S Relative Automated Machine Guidance Milling
- Scan, Design, Review for Approval
- Mill to accepted design



① PAVEMENT CROSS SLOPES ARE TO BE IMPROVED DURING MILLING OPERATIONS. ADJUST RELATIVE AMG MILLING DEPTH AT EACH PAVEMENT EDGE AND CENTERLINE FROM 1 INCH TO 2.5 INCH IN ORDER TO ACHIEVE DESIRED CROSS SLOPE WHEREVER POSSIBLE. PROVIDE CONSTANT CROSS SLOPE ON MILLED SURFACE THROUGH EACH LANE AND SHOULDER. TO ACHIEVE 2% NORMAL CROWN IN SPECIFIED AREAS SET RELATIVE AMG MILLING DEPTH AT CENTERLINE TO 1 INCH AND ADJUST DEPTH AT PAVEMENT EDGES TO 2% OR 2.5 INCH MAXIMUM.

THE PROJECT

THE PROJECT

MILLING AS-BUILT

datetime_utc	station(ft)	horizontal_	design_xsl	actual_xslo	north_l(ft)	east_l(ft)	auto_l	mode_l	ground_eleva	design_elevat	sensor_de	design_de	depth_off:	target_de	estimated	error_l(ft)
5/16/2023 13:32	18335.75	-2.8435	-2.6685	-2.6506	7023935.381	1655991.433	1	Thickness	5818.0091	5817.8884	-1.0375	0.1207	0	0.1207	0.1225	-0.0018
5/16/2023 13:32	18334.09	-2.8444	-2.6676	-2.7007	7023933.744	1655991.43	1	Thickness	5818.0091	5817.8904	-1.04	0.1187	0	0.1187	0.12	-0.0013
5/16/2023 13:32	18332.45	-2.8484	-2.6676	-2.5756	7023932.098	1655991.425	1	Thickness	5818.0091	5817.8918	-1.0375	0.1172	0	0.1172	0.1225	-0.0053
5/16/2023 13:32	18330.68	-2.8004	-2.6675	-2.9509	7023930.338	1655991.47	1	Thickness	5818.0132	5817.8925	-1.035	0.1208	0	0.1208	0.125	-0.0042
5/16/2023 13:32	18328.9	-2.8659	-2.667	-2.4255	7023928.561	1655991.403	1	Thickness	5818.017	5817.8949	-1.04	0.1222	0	0.1222	0.12	0.0022
5/16/2023 13:32	18327.11	-2.8109	-2.667	-2.5756	7023926.785	1655991.456	1	Thickness	5818.0199	5817.8947	-1.0375	0.1253	0	0.1253	0.1225	0.0028
5/16/2023 13:32	18325.47	-2.835	-2.6669	-2.4255	7023925.151	1655991.43	1	Thickness	5818.0199	5817.8959	-1.04	0.124	0	0.124	0.12	0.004
5/16/2023 13:32	18323.83	-2.8069	-2.6667	-2.6756	7023923.512	1655991.456	1	Thickness	5818.0199	5817.8956	-1.0425	0.1244	0	0.1244	0.1175	0.0069
5/16/2023 13:32	18322.18	-2.8057	-2.6667	-2.5506	7023921.867	1655991.456	1	Thickness	5818.0199	5817.8957	-1.04	0.1242	0	0.1242	0.12	0.0042
5/16/2023 13:32	18320.39	-2.7881	-2.6667	-2.5255	7023920.075	1655991.472	1	Thickness	5818.02	5817.8956	-1.0375	0.1244	0	0.1244	0.1225	0.0019
5/16/2023 13:32	18318.71	-2.8151	-2.6676	-2.2504	7023918.404	1655991.443	1	Thickness	5818.0199	5817.8954	-1.0375	0.1245	0	0.1245	0.1225	0.002

- During Milling using Log
- As-built data showing design depths and estimated depths constructed
- Error Column (Far Right)

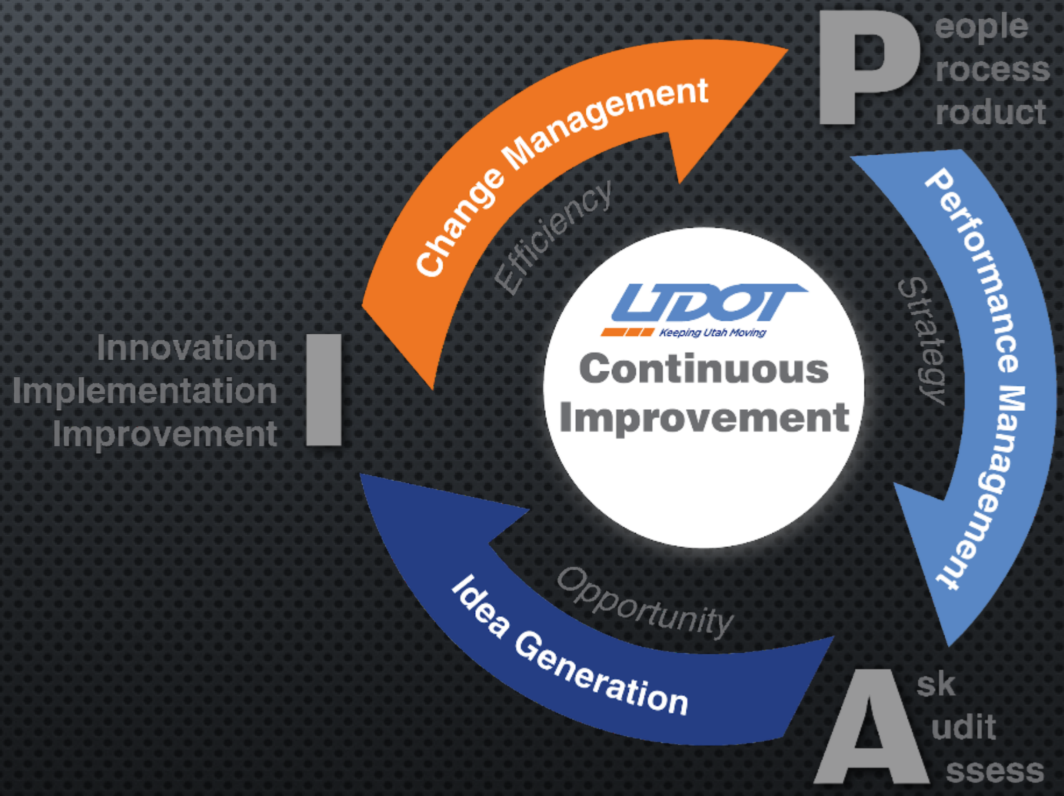
SMOOTHNESS DATA

AMG Milling, 1.5” SMA Overlay

File	MRI (in/mi)
FINAL US-89 MT PLEASANT TO FAIRVIEW NB DRIVING LANE CAT1 RR_01	59.68
FINAL US-89 MT PLEASANT TO FAIRVIEW SB DRIVING LANE CAT1 RR_01	55.48
US 89 Mt Pleasant to Fairveiw - NB Run 1 Existing T1 to T2	140.66
US 89 Mt Pleasant to Fairveiw - SB Run 1 Existing T1 to T2	133.63

PROJECT SUMMARY

- Corrected Cross Slopes
- Improved Smoothness
- Managed existing assets within specified parameters



TOPCON

Thank you