# ACEC
AMERICAN COUNCIL OF ENGINEERING COMPANIES
*of Michigan*

# OFFICIAL ENTRY FORM

## 2020 ENGINEERING & SURVEYING EXCELLENCE AWARDS

## ABOUT THE PROJECT

**Project Name** RAILROAD LINEAR REFERENCING AND ASSET MAPPING        (45 character limit)

**Enter in the following category (check one):**

☐ Studies, Research, and Consulting Engineering Services
☐ Building/Technology Systems
☐ Structural Systems
☑ Surveying and Mapping Technology
☐ Environmental
☐ Waste and Storm Water

☐ Water Resources
☐ Transportation
☐ Special Projects
☐ Energy
☐ Industrial and Manufacturing Processes and Facilities

**Project Location** City  STATEWIDE                     State  MICHIGAN

**Completion/Use Dates**  Scheduled  SEPTEMBER 30, 2019     Actual  SEPTEMBER 30, 2019

**Studies, Research, and Consulting Engineering Costs**  Budgeted $ 338,849   Actual $ 338,849

**Construction Costs**  Total Project Budget  $ NA        Total Project Actual $ 305,000

**\*Entrant's Portion of Total Project Budget**  $ 338,849    **Entrant's Portion of Total Project Actual** $ 305,000

☑ **Check box if project was awarded through a QBS process.**

**\*NOTE:** The Entrant's Portion of the Total Project Budget includes the design fees paid to the entrant for the services provided for this project.

## ABOUT THE FIRM SUBMITTING THE PROJECT

Entering Firm  SPICER GROUP INC

Firm Representative  ERIC S BARDEN, PS

Address (no P.O. Box)  230 S WASHINGTON AVE     City  SAGINAW     State  MI   Zip  48607

Phone ( 989 ) 239-5732        Email  ERICB@SPICERGROUP.COM

I hereby authorize submission of this project into the American Council of Engineering Companies of Michigan 2020 Engineering and Surveying Excellence Awards competition.

Senior Executive/Principal  ERIC BARDEN, PS        Title  PRINCIPAL

Signature _____        Date 8-27-19

## ABOUT THE OWNER(S) OF THE PROJECT (NOT PRIME CONSULTANT/CONTRACTOR)

Owner(s)  MICHIGAN DEPARTMENT OF TRANSPORTATION, OFFICE OF RAIL

I believe the work of the engineer meets the intended uses and expectations for the project and hereby grant permission to enter this project in the ACEC/M 2020 Engineering and Surveying Excellence Awards competition, and authorize publication of its outstanding features, unique aspects, or innovations. I confirm the project was substantially completed and ready for use between November 1, 2017 and October 31, 2019.

Owner Representative  ROB LIPPERT, PE

Title  MGR, RR INFRASTRUCTURE     Signature _____     Date _____

A fee of $325 per entry for ACEC members ($1,200 for non-ACEC members) must be attached (less deposit paid with Intent to Enter). Visit acecmi.org for an electronic version of this form and additional category guidelines.

STATE OF MICHIGAN
**DEPARTMENT OF TRANSPORTATION**
LANSING

GRETCHEN WHITMER
GOVERNOR

PAUL C. AJEGBA
DIRECTOR

September 17, 2019

American Council of Engineering Companies of Michigan
530 W. Ionia, Suite D.
Lansing, MI  48933

Dear American Council of Engineering Companies of Michigan

Through a qualifications-based selection, the Michigan Department of Transportation (MDOT), Office of Rail, hired Spicer Group to complete the network-wide linear referencing data collection project for all MDOT owned railroad Right of Way in Michigan's Lower Peninsula. Spicer Group has been providing surveying services for MDOT for over 30 years and has a long and successful history working with MDOT.

Spicer Group persevered through many challenges, from changes in scope to challenges in gaining track access to the various sections of railroad which are operated by five different freight or passenger railroad companies, all with their own independent safety, insurance and access requirements.

The MDOT, Office of Rail is excited to have worked alongside Spicer Group for this initial data collection project and is looking forward to leveraging the data collected and developing a comprehensive asset management program for MDOT owned railroad assets.  As a result, MDOT will form better decisions and be more efficient and effective with the limited resources we have.

Sincerely,

Robert J. Lippert, Jr., P.E.
Manager - Railroad Infrastructure Section

# MDOT
## RAILWAY SCANNING



**Spicer group**

**2020 ACEC/M**
SURVEYING EXCELLENCE AWARDS

## ROLE OF FIRM

### Brief Overview of Project

The Michigan Department of Transportation Office of Rail (MDOT) manages 665 centerline miles of state-owned railroad corridor in Michigan's Lower Peninsula. These include five lines that are operated on a contract basis by five freight railroad companies. There is an intercity passenger rail service provided by Amtrak that operates on a 135-mile-line between Kalamazoo and Dearborn—known as the Michigan Line.

Similar to a highway or public utility system, railroads have their unique set of assets that play a role in their safety, reliability and function. Everything from crossing arms to mile post signs, switch points and mechanisms to overpass clearances and even overhanging vegetation are key assets that make up a railway system, and each have their own unique attributes. To get a comprehensive understanding and accurate record of all assets along its railroad corridors, MDOT pursued an initiative to develop a comprehensive asset management program for its rail assets.

Ultimately, with MDOT's implementation of its overall Transportation Asset Management System (TAMS), the Office of Rail is focused on integrating its asset management plans and developing a program that ties its assets into the overall TAMS system.

### Role of Spicer Group in the Project

MDOT's first task was to inventory its assets geospatially so each asset has an accurate spatial component. Once inventoried, the assets can be integrated into MDOT's TAMS GIS environment, and a linear referencing system can be developed where all other railroad assets can be referenced. However, accomplishing this across 665 miles of active railway is not a simple task and required alternative methods of data collection. Without having the in-house capabilities to complete such a task, the MDOT Survey Support Unit selected Spicer Group to perform the work under the Unit's statewide as-needed survey contract. Spicer Group's first task was to evaluate the best method to spatially inventory the required assets for the entire Lower Peninsula rail network.

Spicer Group identified various data collection technologies for consideration, and a cost benefit analysis was prepared for each method, and in some cases, a combination of methods. Ultimately a hybrid approach, using Airborne LiDAR, hi-rail mounted mobile LiDAR, Unmanned Aerial Vehicles (UAV) and conventional survey techniques, was identified as the best approach to maximize value and ensure efficiency.

Spicer Group implemented the data collection of the entire 665-mile rail network, using the hybrid approach and combined all data into a single, seamless data source detailing MDOT's current assets of concern including track
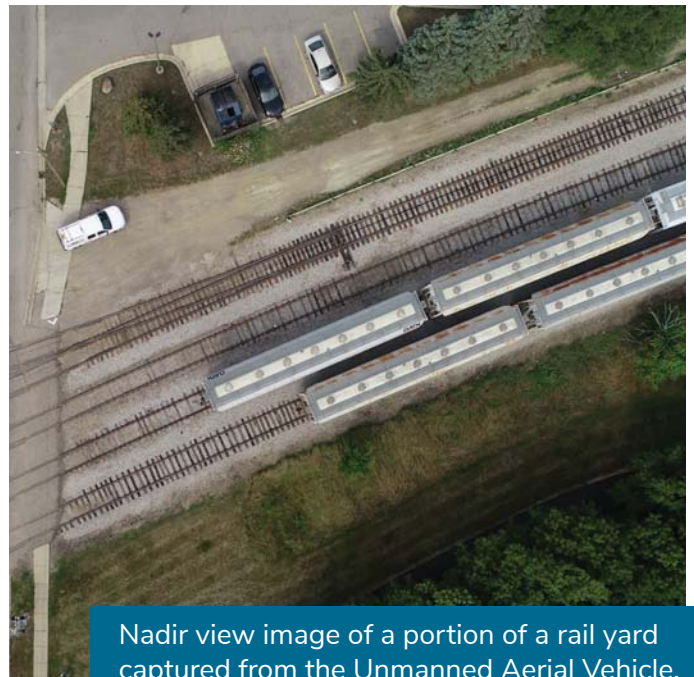


Nadir view image of a portion of a rail yard captured from the Unmanned Aerial Vehicle.

View from the web-based viewer showing rail-view imagery next to the LiDAR point cloud of the same area.

centerline, milepost signs, points of switch and points of frog. Data related to these assets has been organized and delivered to MDOT Office of Rail through a simple viewing service accessible by anyone, anywhere through a standard web browser, with immersive 3D viewing and measurement capabilities.

## UNIQUENESS OR INNOVATIVE APPLICATION OF NEW OR EXISTING TECHNIQUES

Depending on the surrounding environment of the tracks, four different methods of data collection were deployed to ensure safety of staff and a high level of efficiency. Airborne LiDAR was used to collect data while minimizing impact to Michigan's busiest rail corridor known as the Michigan Line—the Amtrak passenger service line from Kalamazoo to Dearborn. Hi-rail-truck-mounted mobile LiDAR was chosen to collect a large portion of the remainder of the rail network. Track access and obtaining permits was much easier for these rail sections, and once coordinated, Spicer staff were able to quickly drive the hi-rail truck equipped with a Pegasus Mobile LiDAR sensor mounted to collect the data.

Some areas of tracks had not been used in several years and had experienced significant vegetation growth including encroaching tree canopies and growth through tracks, so these areas required the use of conventional surveying techniques. Spicer Group's Unmanned Aerial Vehicles came in handy when working around congested rail yards where significant train traffic was present. Staff used the UAVs equipped with high-resolution digital cameras to collect photogrammeric data and develop a 3D model of the yard and tracks.

This project is an example of where combining cutting-edge technologies with traditional surveying technology and fundamental surveying principles produced a successful project for MDOT. In this case, airborne LiDAR, hi-rail mounted mobile LiDAR, UAV acquired imagery, and conventional surveying were all used to capture 665 miles of railroad assets in support of a network-wide asset management project. In addition, all data was combined and delivered to MDOT Office of Rail through a web browser-based interface, providing interactive access to the data for any approved users in a standard web browser with no specialized software.

## FUTURE VALUE TO THE SURVEYING PROFESSION AND ENHANCED PUBLIC AWARENESS/ENTHUSIASM OF THE ROLE OF THE SURVEYOR

The role of the surveyor has changed dramatically in recent years with the rapid advancement in measurement and remote sensing technology. Many surveyors are beginning to embrace technological advancements and willing to use new tools to accomplish project objectives.

Cutting-edge surveying technology is a key driver in recruiting new individuals into the surveying profession at universities and community colleges. Spicer Group leverages the latest technologies in surveying to attract and recruit new talent to the profession and our firm. This project is a showcase of using various surveying technologies, new and old, to accomplish a project objective, and provide additional downstream value to the client.



Isometric view of a drone-based-image derived point cloud.

## SOCIAL, ECONOMIC AND SUSTAINABLE DEVELOPMENT CONSIDERATIONS

There is no argument that the railroad industry helped shape the United States, and it continues to play a major role on an economic and social level. Passenger trains take tourists from town to town and workers from home to business. Freight trains carry a substantial amount of commercial goods from point A to point B every day to various customers. Railroads are an essential alternative to roadways for moving both freight and passengers.

According to a report from the U.S. Department of Transportation and Federal Highway Administration, railways were responsible for the shipment of $628 billion in goods in 2015. It is also estimated that the railway directly employs over 200,000 people. That number can increase substantially when considering the number of jobs that are related to the railroad industry. It's a fair statement to say if the railroads stopped working for one day, a substantial impact would be felt nationwide both economically and socially.

The importance of railroads is obvious, and ensuring their reliability and safety is just as important. Taking a proactive approach in terms of understanding the condition and location of its railroad assets rather than being reactive was the main focus of MDOT for this project, and Spicer Group's method of collecting rail data and making all related information available to easily view was essential in accomplishing that goal.

Now, MDOT Office of Rail staff can view every inch of railway and all visible assets under their ownership at any time on a computer or smart phone. They can measure various object distances and sizes, see welds in tracks, and even view an asset's condition at the time of collection. This unique ability will help them

plan for life cycle costs on key assets, identify potential areas of concern, and the opportunity to maintain a digital record of assets within the railroad rights of way—all contributing to the reliability and safety of the railway system.

## COMPLEXITY

In regards to the data collection phase, the railroad environment is very complex, especially when working along tracks that carry passenger trains up to 79 MPH such as the Michigan Line stretching from Kalamazoo to Dearborn. Even working on the more common freight rail lines involves a well-thought-out plan before beginning. Railroad access, permit coordination, railroad pilot coordination, and construction projects/railroad maintenance activities all had to be coordinated in advance by Spicer Group before staff could step foot within a MDOT-owned railroad.

After all data is collected, and the drones, planes, hi-rail trucks, and high-tech survey equipment are put away, processing data from many different sensor types becomes a significant challenge and requires professionals with a significant amount of experience successfully doing so to be able to efficiently deliver a quality deliverable. LiDAR is not created equal especially when collected from different sensor types. Measurement frequencies, equipment calibrations and lever arm values, laser technology used, type of collection environment and many other factors add to the complexity of processing and combining data from various sources.

## SUCCESSFUL FULFILLMENT OF OWNER/ CLIENT NEEDS

MDOT now has network-wide LiDAR data available to support their immediate and future asset management needs. The dataset can be continually "mined" for other assets as MDOT Office of Rail progressively secures funding for various assets. The dataset can be used to support full design-level topographic survey mapping for design projects with the introduction of control points and additional processing. The network-wide data can be shared with the lessees of each section of railroad and used by their engineering and maintenance staff. Most importantly, the final deliverables are in standard GIS format and easily integrated into MDOT's TAMS application for long-term management and maintenance of railroad assets.
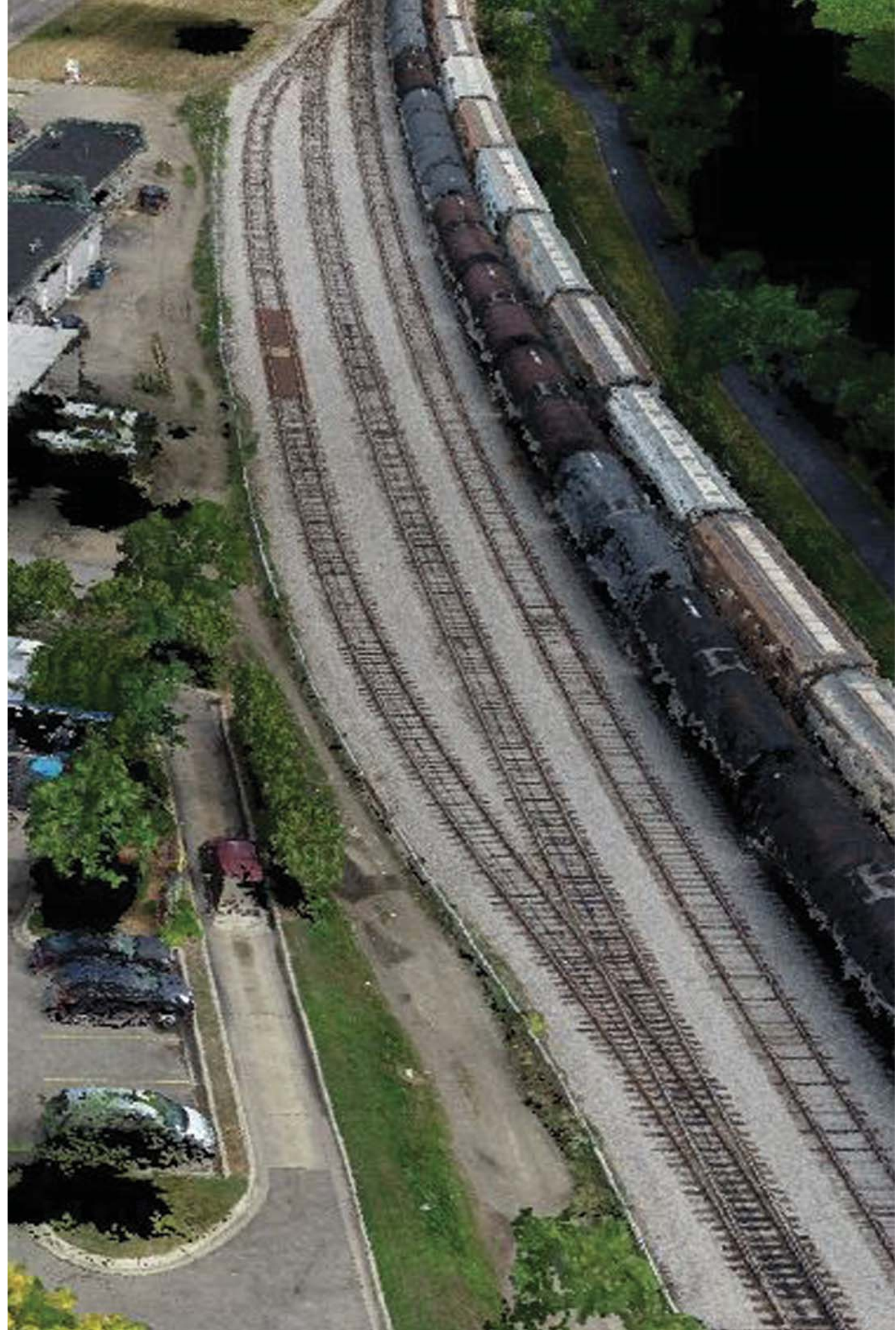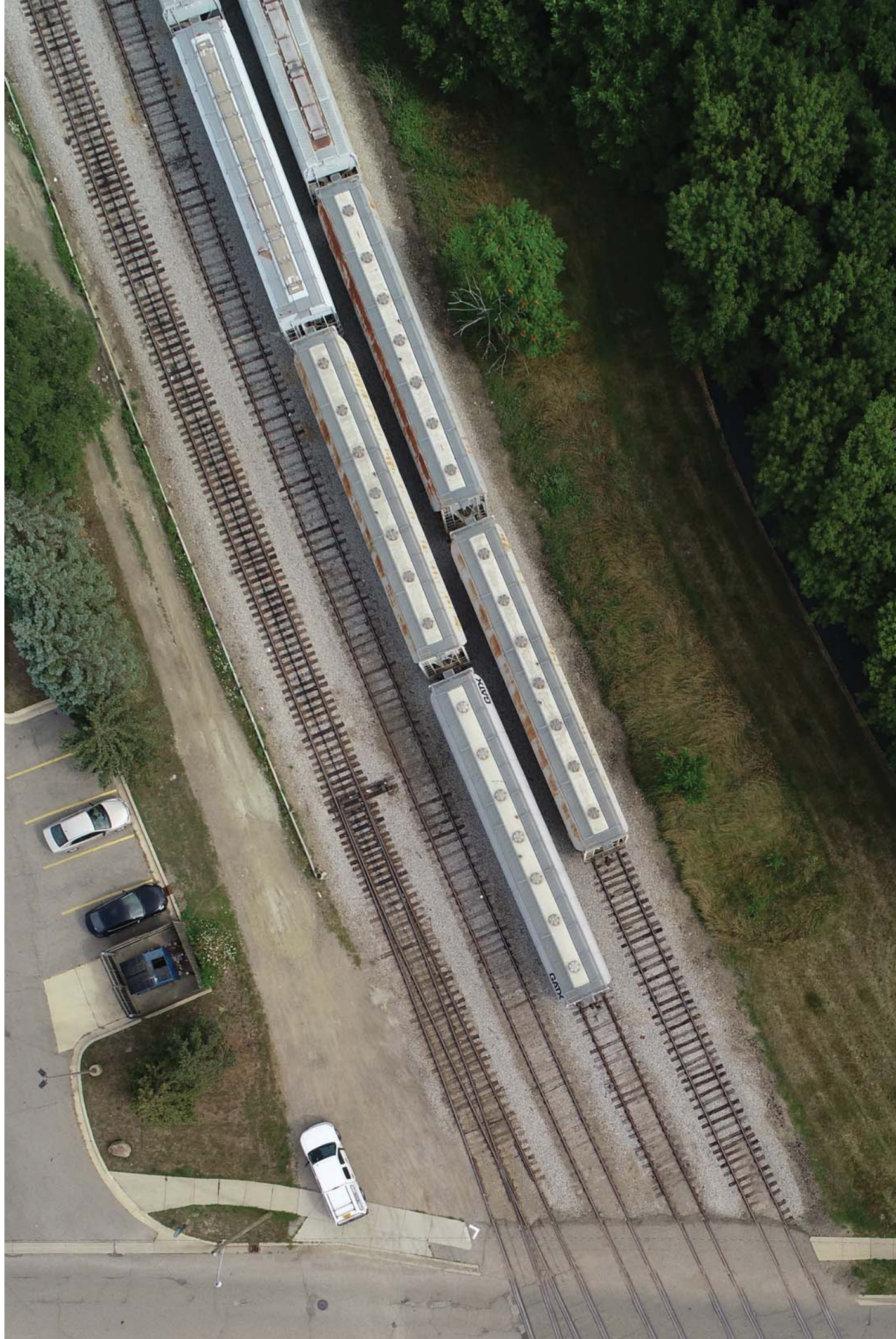


Viewing southeast
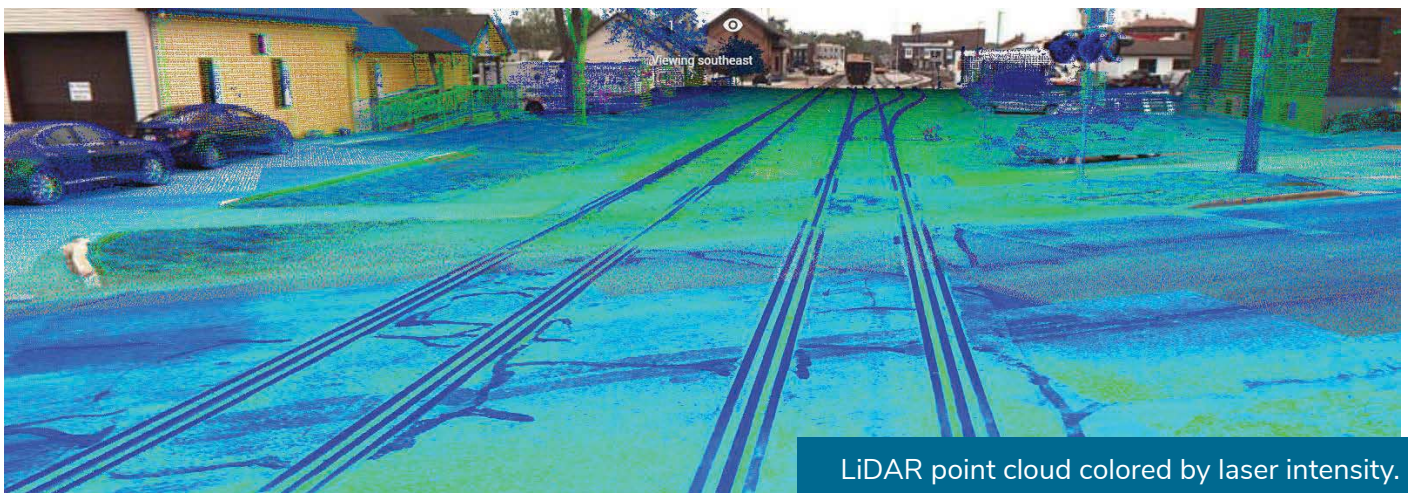
LiDAR point cloud colored by laser intensity.
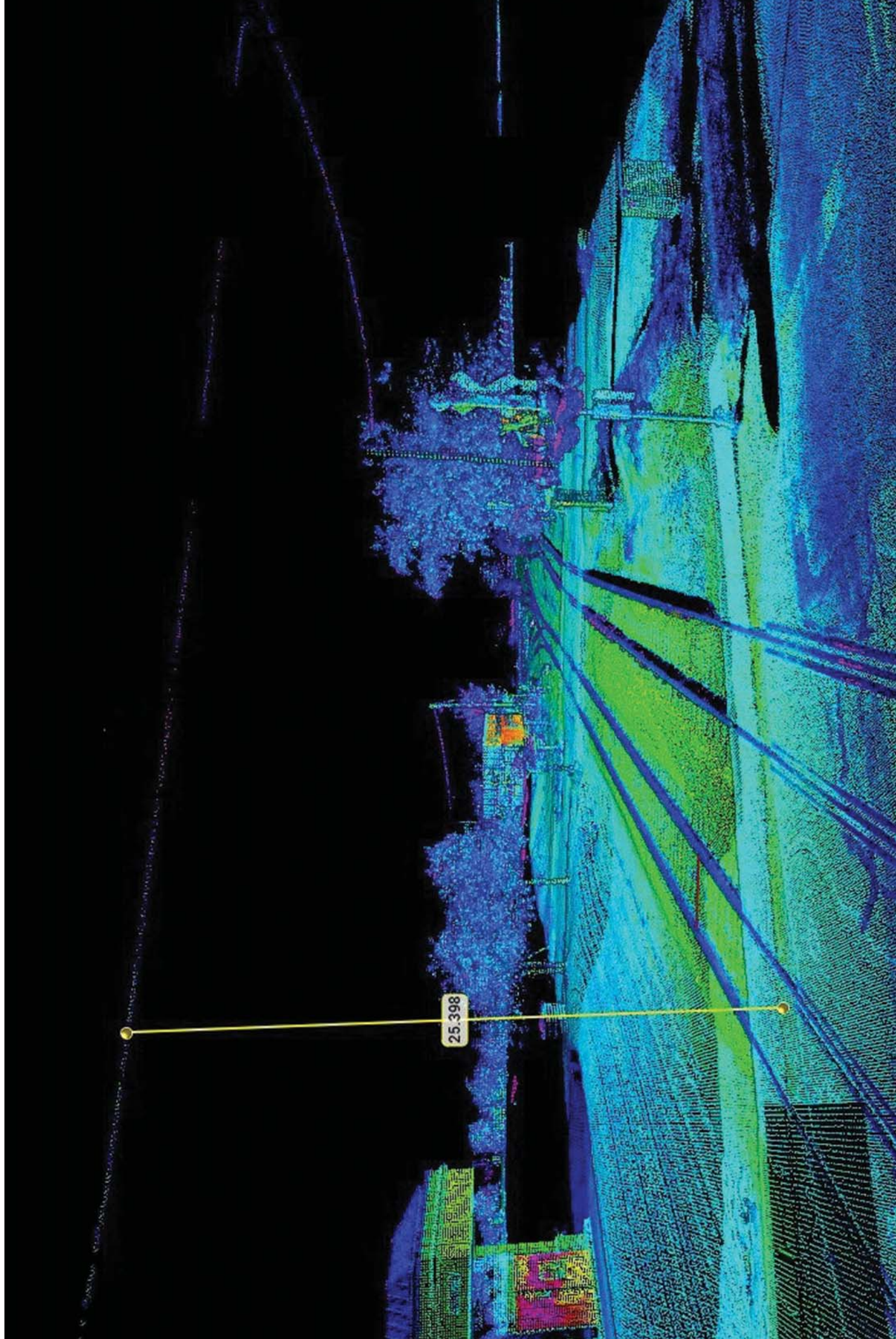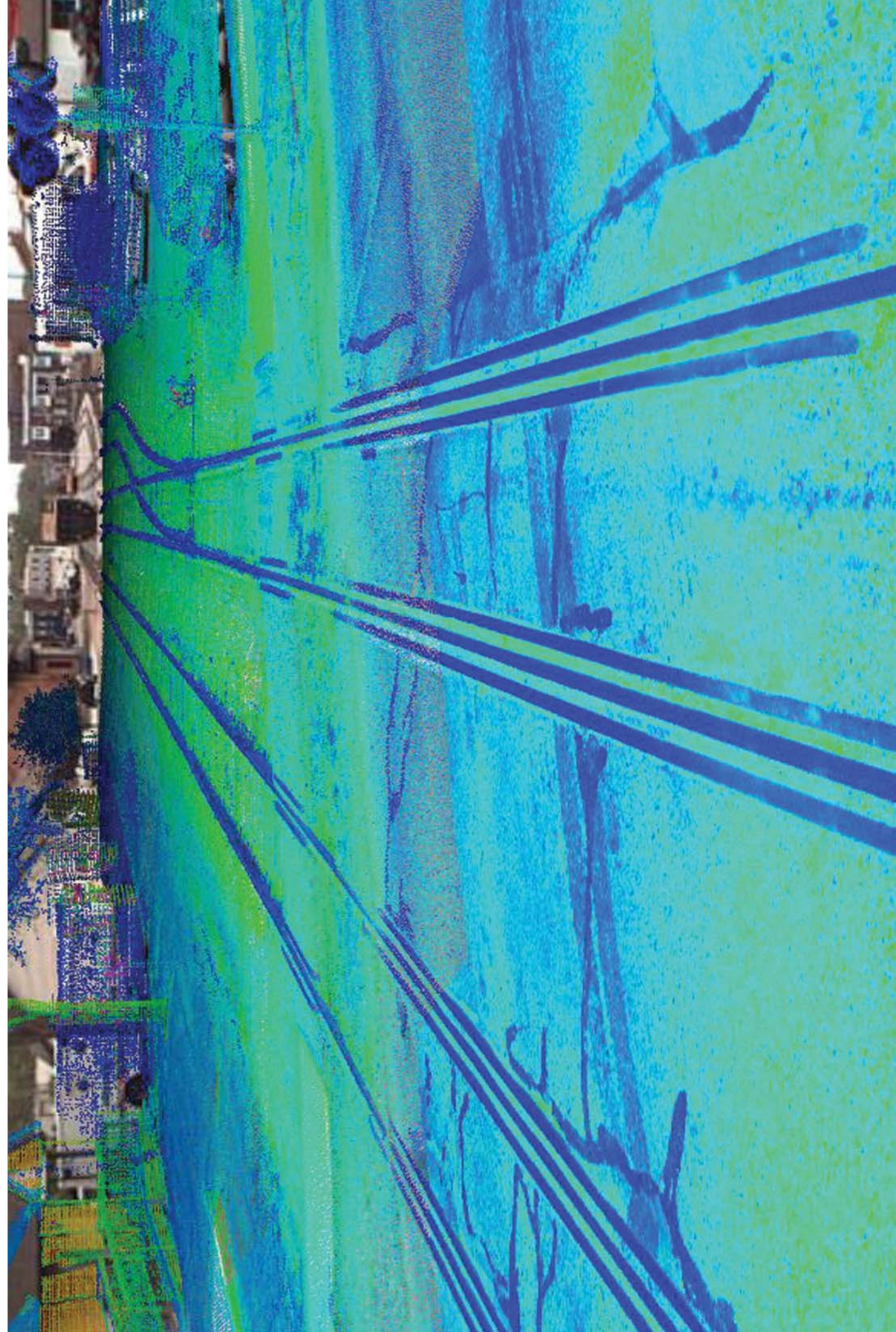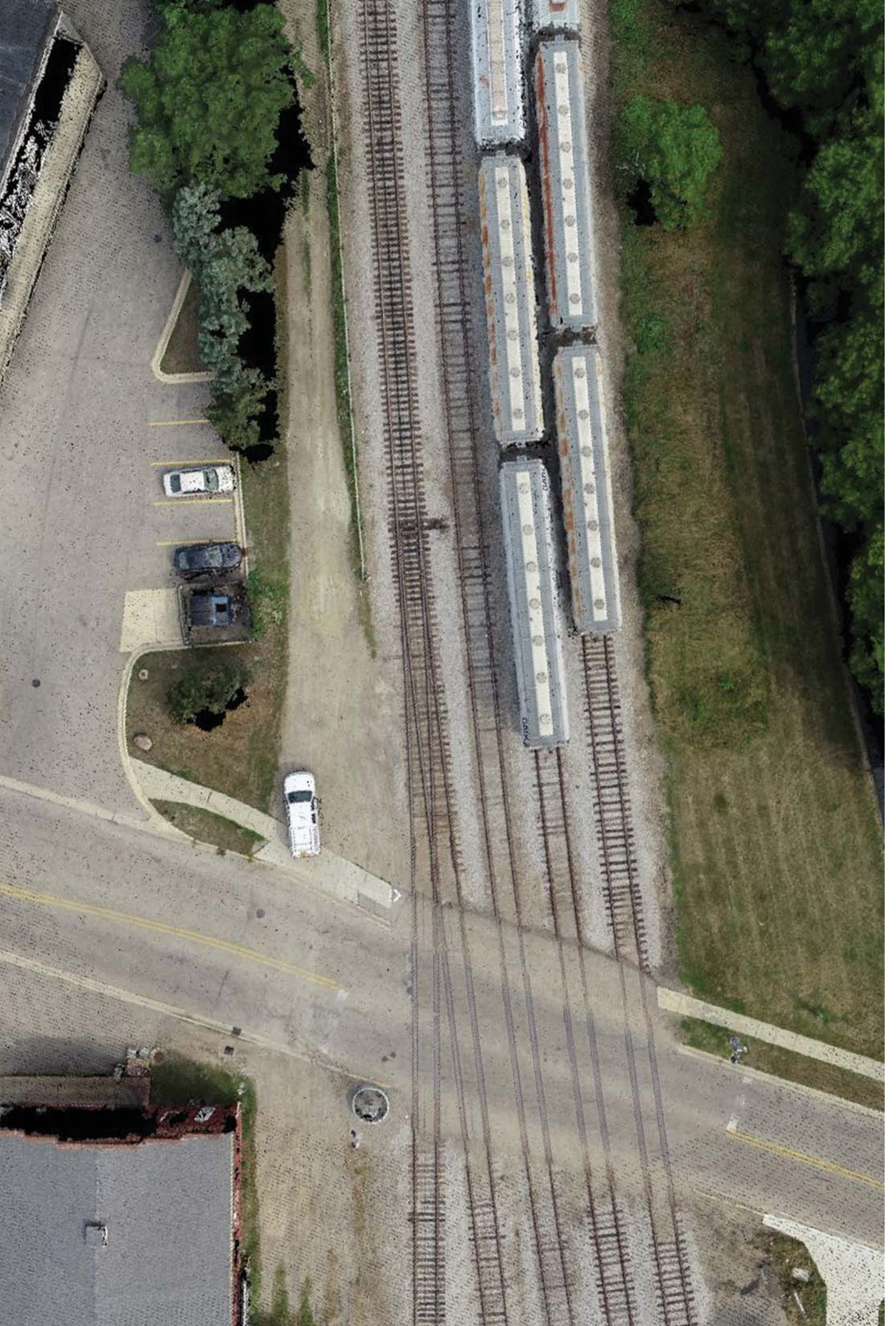
Captions

Photo 1: Isometric view of point cloud derived from UAV based imagery

Photo 2: Mobile LiDAR data colored by laser intensity laid over rail-view imagery

Photo 3: Point cloud derived from UAV imagery, showing camera exposure locations

Photo 4: UAV Image derived point cloud of rail yard

Photo 5: Mobile LiDAR data showing vertical clearance measured via interactive web-based viewer

Photo 6: One-inch pixel nadir image of rail yard

**Presentation Script**

Project Title: MDOT Railway Scanning
Firm Name: Spicer Group, Inc.

Spicer Group completed a network-wide data collection project for MDOT's Office of Rail for approximately 665 miles of railroad corridor. Various data collection technologies were used including, Mobile Terrestrial LiDAR and rail-view imagery, Airborne LiDAR and ortho-imagery, UAV acquired ortho-imagery, and traditional RTK GNSS surveying. Using advanced data fusion techniques, all data was fused together to create a network-wide geospatial dataset of all MDOT-owned railroad assets. The data was used to map the centerline of all railroad track owned by MDOT, and extract milepost signs, points of switch, and points of frog.

**Brochure Text**

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**Award Information**

Project Title: MDOT Railway Scanning
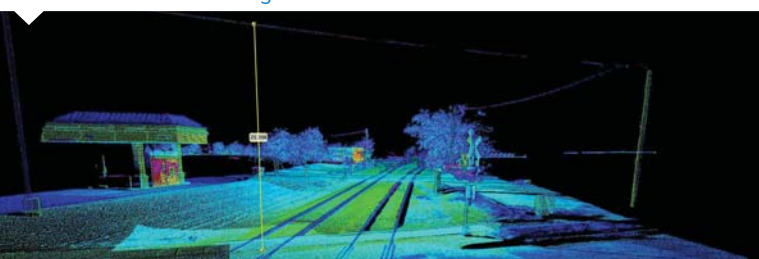Owner Name: MDOT Office of Rail
Firm Name: Spicer Group, Inc.

Michigan Railroads
Michigan Department of Transportation
Spicer Group | Saginaw, MI

# MDOT RAILWAY SCANNING

Mobile LiDAR data showing vertical clearance measured via interactive web-based viewer.



In collaboration with the MDOT Survey Support Unit, Spicer Group completed a network-wide data collection project for the MDOT Office of Rail across its 665-mile railroad network in the Lower Peninsula. Various data collection technologies were used including Mobile Terrestrial LiDAR/rail-view imagery, Airborne LiDAR/ortho-imagery, UAV-acquired ortho-imagery, and traditional RTK GNSS surveying. All data was fused together using advanced data fusion techniques to create a network-wide geospatial dataset of all MDOT-owned railroad assets. The data was used to map the centerline of all railroad track owned by MDOT and extract milepost signs, points of switch, and points of frog. All extracted asset data was delivered in a standard file geodatabase to support the development of a railroad linear referencing system and integration into MDOT's Transportation Asset Management System (TAMS).

All LiDAR, imagery and extracted asset data is hosted on Spicer Group's cloud server and available to MDOT Office of Rail staff using an online data viewer accessible in any standard desktop or mobile web browser. The web viewer allows immersive interaction with the data, full 3D visualization, as well as measurement, markup and annotation capabilities. All extracted asset information vector data is also presented in the 3D web viewer as a 3D overlay with visible attribute information. The MDOT Office of Rail now has a current 3D LiDAR and imagery dataset that can be leveraged to map additional asset features as funding becomes available. The data can also be used to support rail corridor inspections and future design projects.

Rail-view image from rear camera of Pegasus Mobile LiDAR sensor.





True color point cloud generated from Pegasus Mobile LiDAR sensor.



One-inch pixel nadir image of rail yard.

LiDAR point cloud with clearance measurement performed in web viewer.

jpc group