



Mobile Mapping

2014 MSS Fall Conference

- Robert Hanson - Geospatial Information Technologies Practice Manager
- Stephen Clancy - Mobile LiDAR Program Manager

- Mobile LiDAR Introduction
- Mission Planning
- Anatomy of a Collection
- Standard of Care & Practice
- Propagation of Standards
 - States, DOT's, Professional Organizations
- Survey Reports
- Representative Projects

■ The Opportunities

- Some Markets Using Mobile LiDAR
 - *Federal Agencies – USACE*
 - *State agencies - DOTs*
 - *Local municipalities – Public Works, Planning, Engineering*
 - *Public and Private Utilities – Design Projects*

■ Engineering Quality Data

- Asset management
- Design related surveys for infrastructure
- Repurposing data (e.g., inspections)

■ Collect once, process many times

- We've “*Turned the Corner*” using Mobile LiDAR for Transportation Projects
 - “Transportation agencies are using 3D model-based design and asset management”
 - “Efficient use of mobile LIDAR will only increase”
 - “Mobile LIDAR has major implications in geospatial data collection, exploitation, and management internally and in transportation agencies”



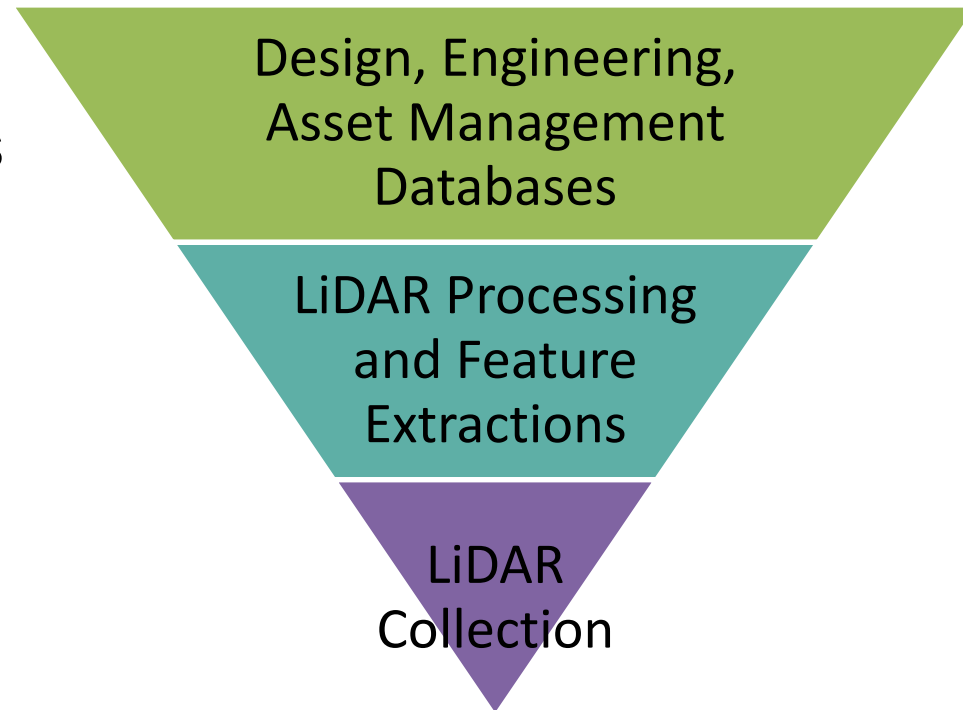
NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
REPORT 748, Guidelines for the Use of Mobile LIDAR in Transportation Applications,
TRANSPORTATION RESEARCH BOARD 2013

■ Mobile LiDAR:

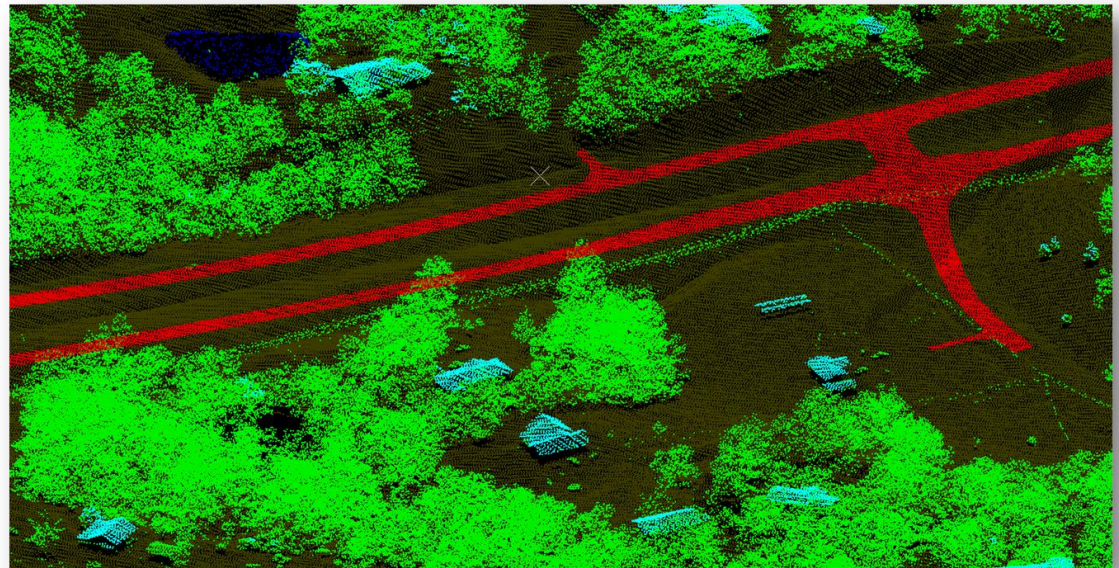
- Less error potential than most surveys
- Faster, better and usually cheaper
- Applicable to many engineering disciplines
- Safer than putting people in harms way
- Improves profitability and completeness for engineering projects

■ Collection

- Accuracy + Completeness
- Surveyor's Expertise is Critical on Every Project

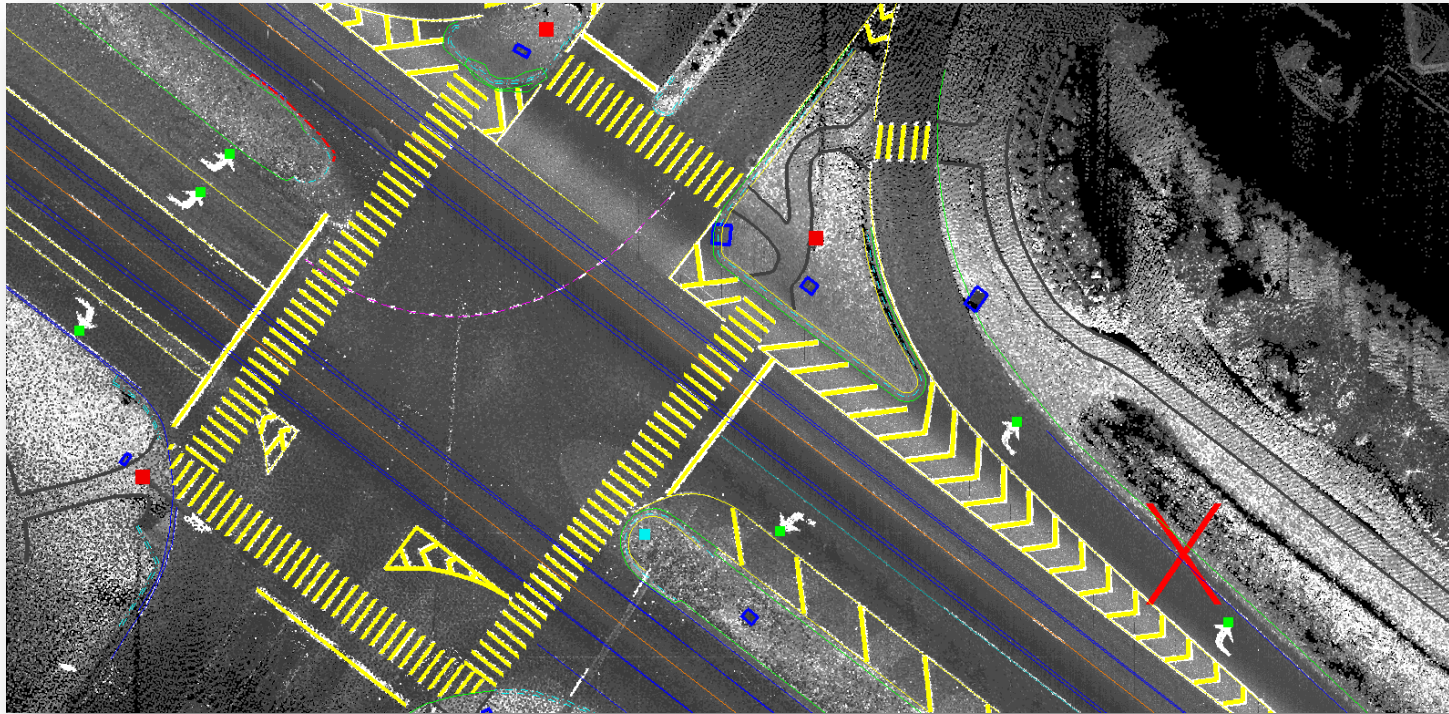


- Aerial vs. Mobile LiDAR
 - Aerial LiDAR provides framework for regional coverage
 - Mobile LiDAR offers finite detail at field surveying accuracies
 - Complimentary Technologies



Aerial LiDAR
Classified Point Cloud

- Mobile and Field Crew Surveys
 - Understand the Cost Benefit Trade Offs
 - Safely Collect Planimetric Data
 - Minimize/Eliminate Lane Closures



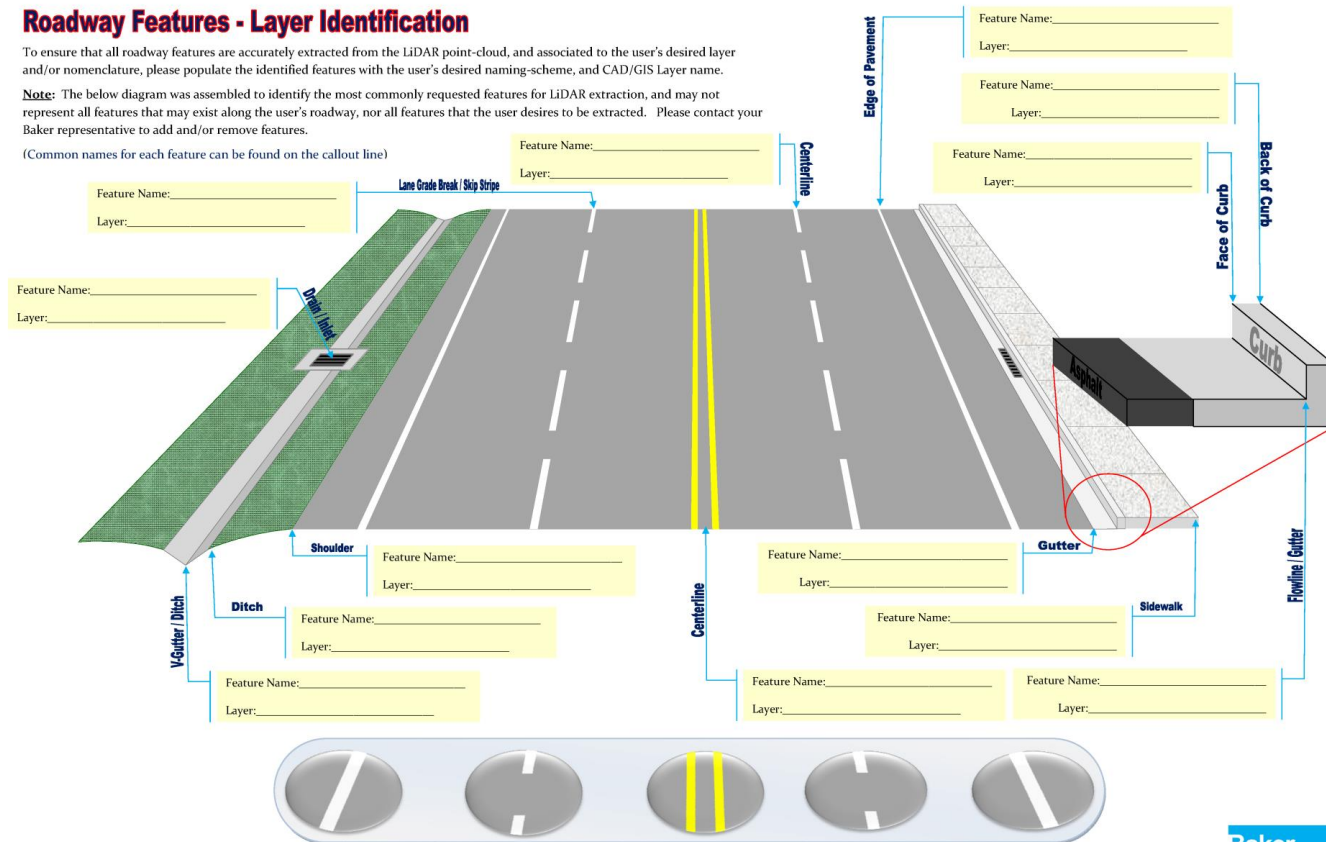
- Mobile LiDAR Allows Many Possibilities
 - Point Densities in the 1 Million+ Per Second
 - Many More Feature Extraction Potentials

Roadway Features - Layer Identification

To ensure that all roadway features are accurately extracted from the LiDAR point-cloud, and associated to the user's desired layer and/or nomenclature, please populate the identified features with the user's desired naming-scheme, and CAD/GIS Layer name.

Note: The below diagram was assembled to identify the most commonly requested features for LiDAR extraction, and may not represent all features that may exist along the user's roadway, nor all features that the user desires to be extracted. Please contact your Baker representative to add and/or remove features.

(Common names for each feature can be found on the callout line)



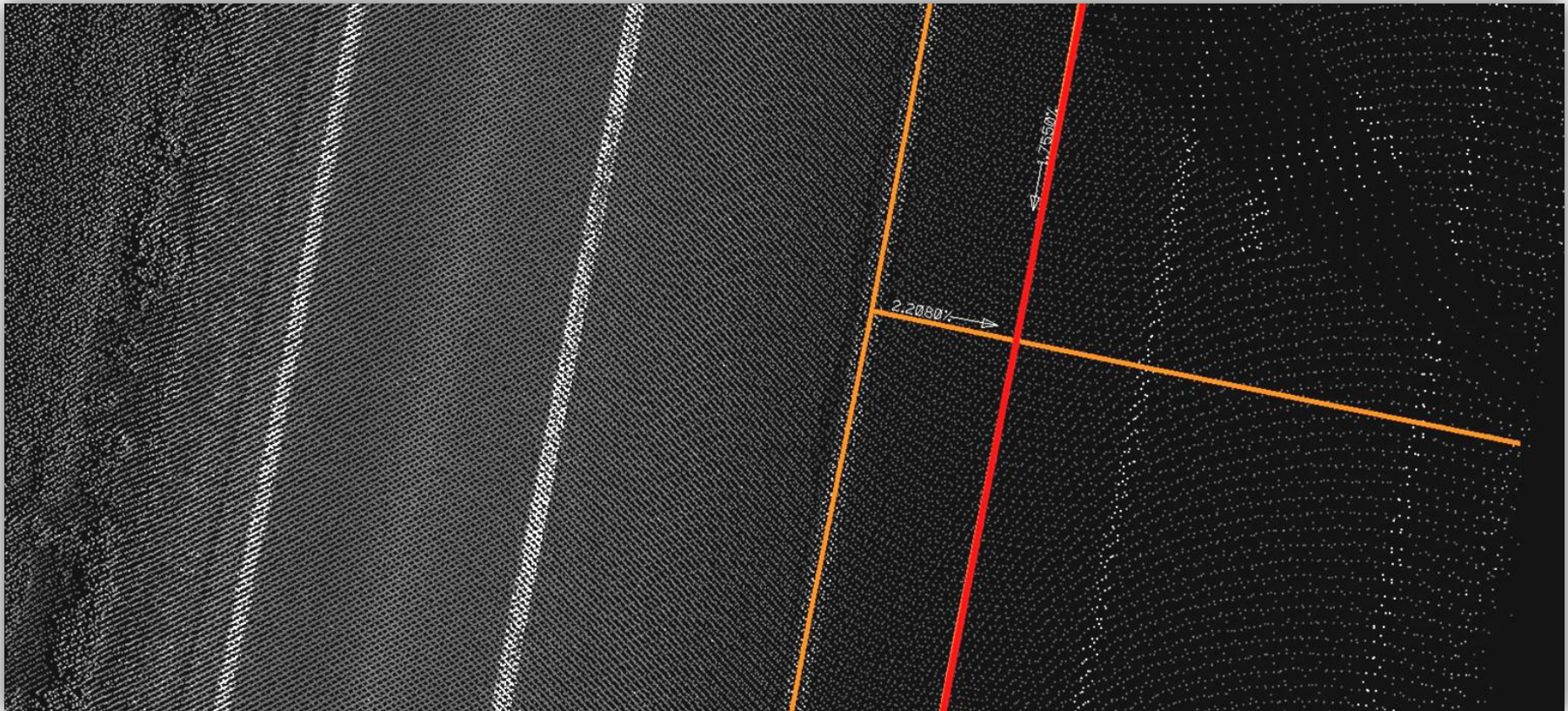
Indicate on each of the above paint-stripping examples, the location at which the linear feature should be extracted (i.e. left-edge, right-edge, or center). The user may draw a line on each example to indicate the desired location.

Baker

- Collected Data is “Rich” in Surveyed Content
 - The Cloud Possesses Detailed Positions
 - Discrete Phenomena are Surveyed
 - Contextual Interpretation of Points is a Talent/Skill
 - Pavement Stress and Surface Deformation Analysis

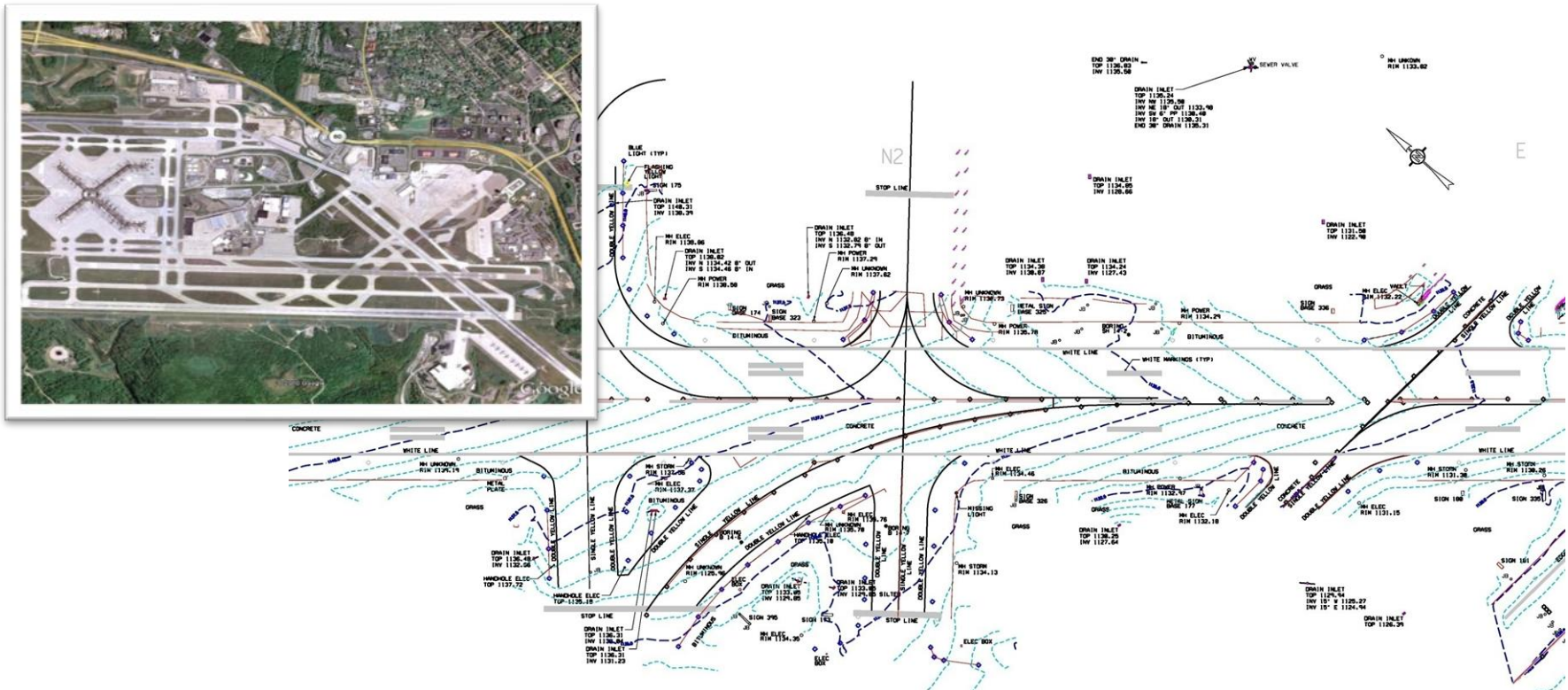


- Calculating Slope and Grade
 - Slope Performed at Lane or Breakline Level
 - Grade Utilizes Lane Centerline

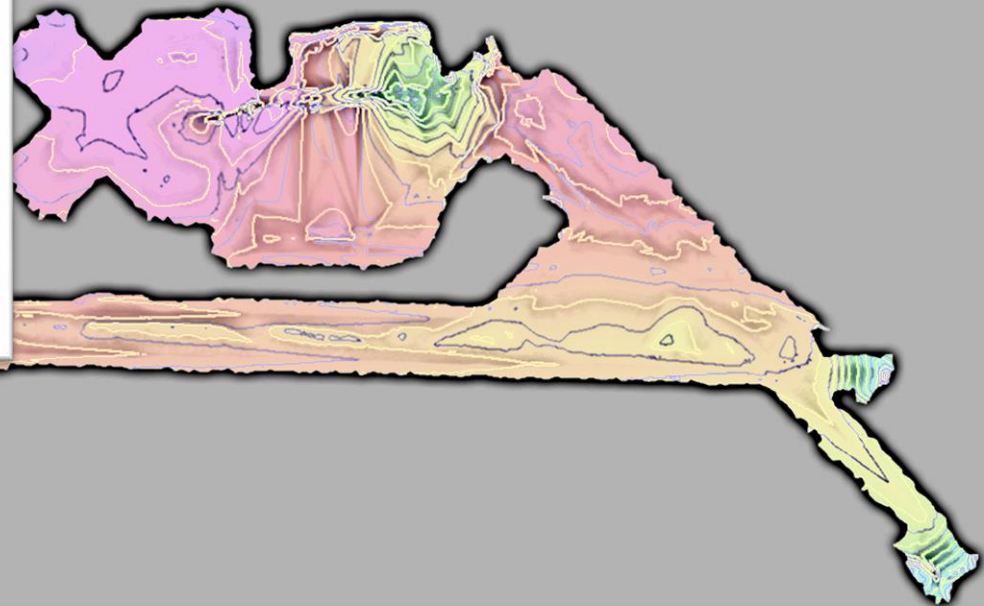


- Airport Mapping AGIS/eALP

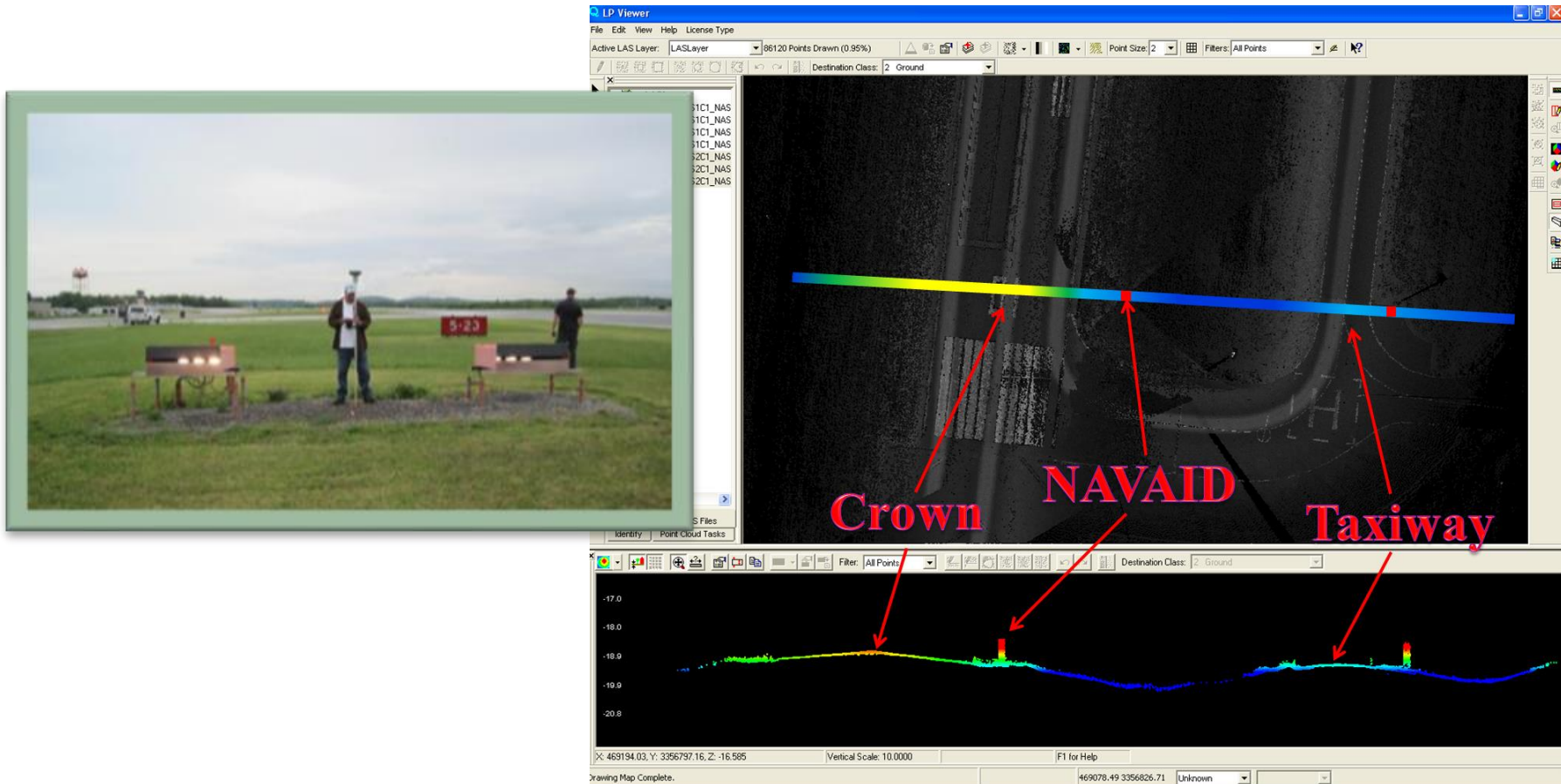
- Meets Accuracy Requirements for Most Airport Features per AC18
- Minimize other Airfield Survey Activities



- Creation of Digital Terrain Models
 - Bare Earth DTM
 - Contours
 - High Accuracy with Appropriate Survey Control



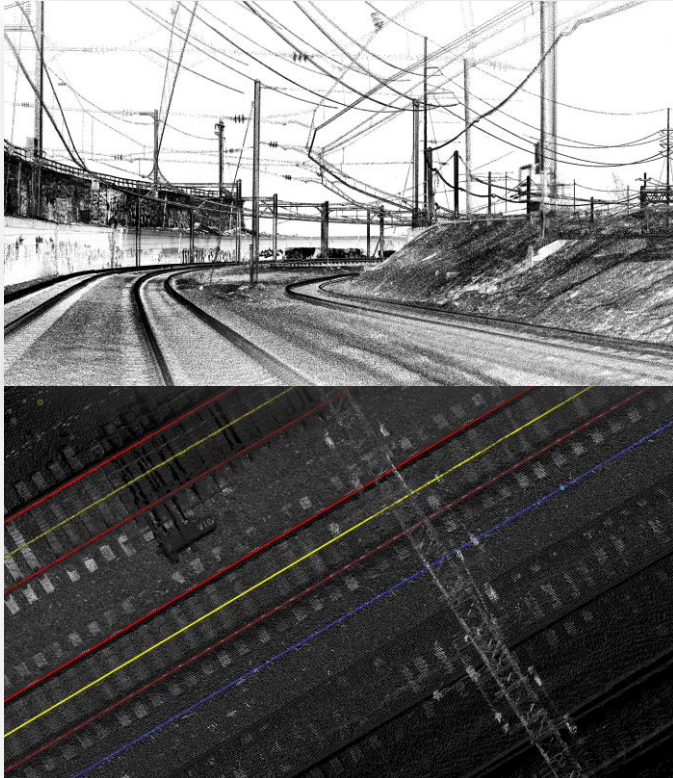
- Cross-sections
 - Generated Anywhere in the Point Cloud
 - Same Accuracy and Completeness



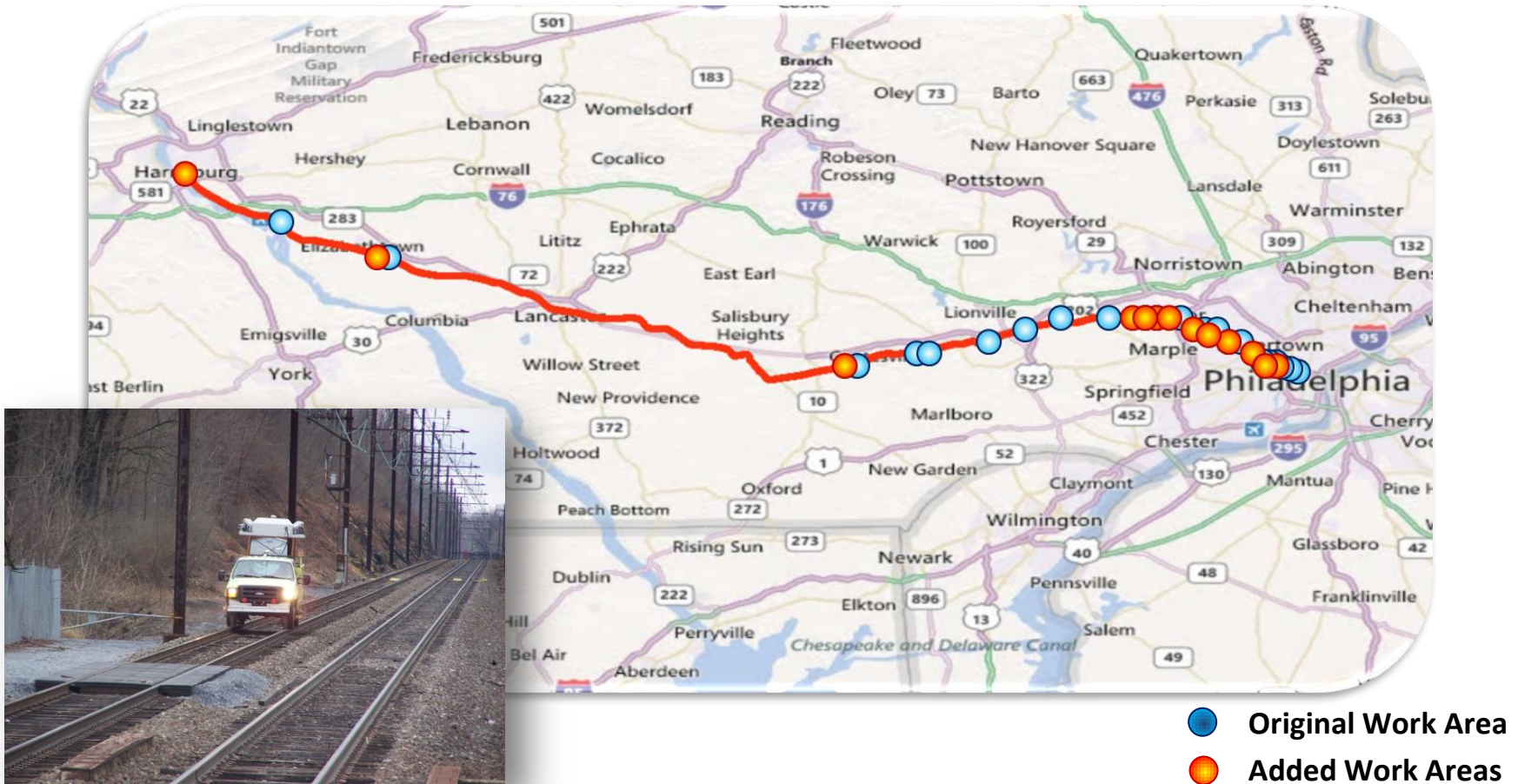
- Mobile LiDAR Enhances the Surveyor's Work
 - Adds Finite Details to Field Derived Surveys
 - Assists in Creation of Air Surfaces (Visualization)



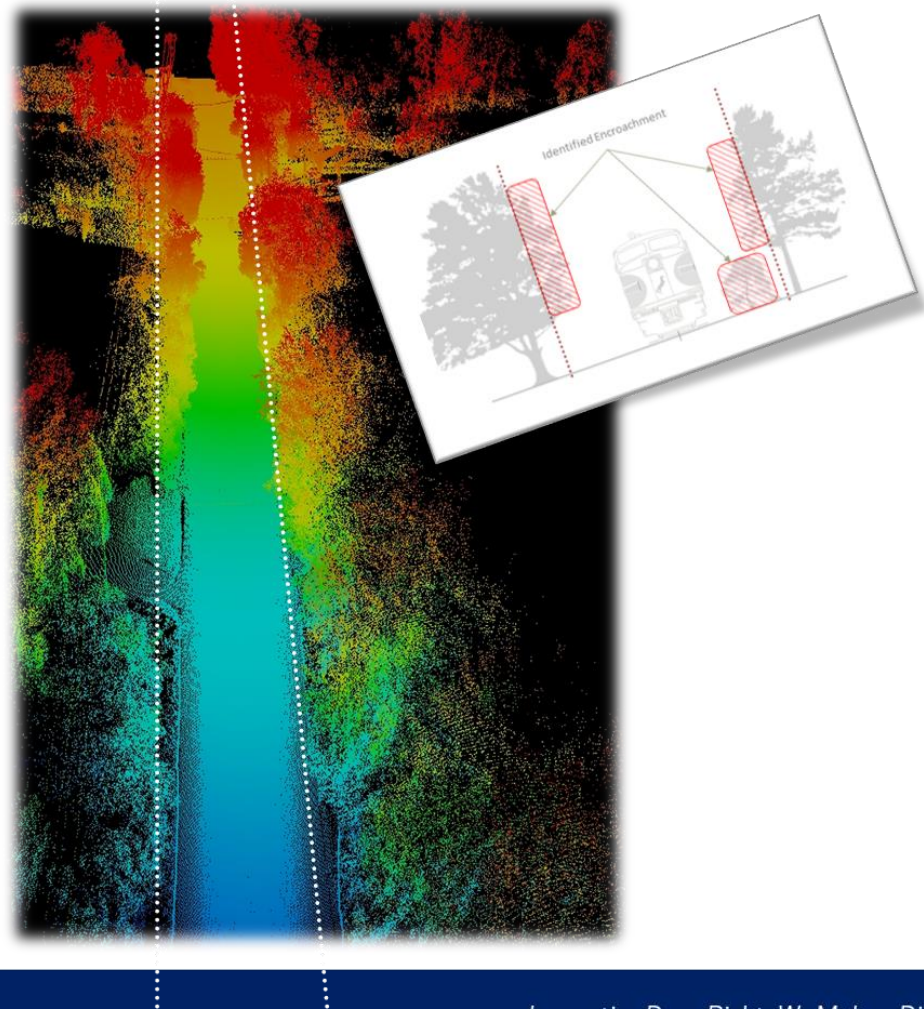
- Linear Projects Such as Railroad Surveys
 - Positive Train Control
 - Track Maintenance and Catenary Structure Analysis
 - Track Clearances – CLASH Detection



- Railroad = 105 Corridor Miles (~240 Track-Miles)
 - Captured over 4-day Period
 - Survey Control Added at Project Sites



- Linear Projects Such as Railroad Surveys
 - Ideal for Mobile LiDAR
 - Survey Control is Required
- Right-of-Way
 - Property Surveys
 - Encroachment Identification
- Vegetation Encroachment
 - Identify problematic areas
 - Strategically schedule for eradication
 - Pinpoint herbicidal placement
- Site Analysis
 - Facility Relocation
 - 3D Visualizations
 - Fly-through animations
- Crossings
 - Sight-Distances
 - At-grade assessments
 - Design modeling
 - Digital photographs / movies



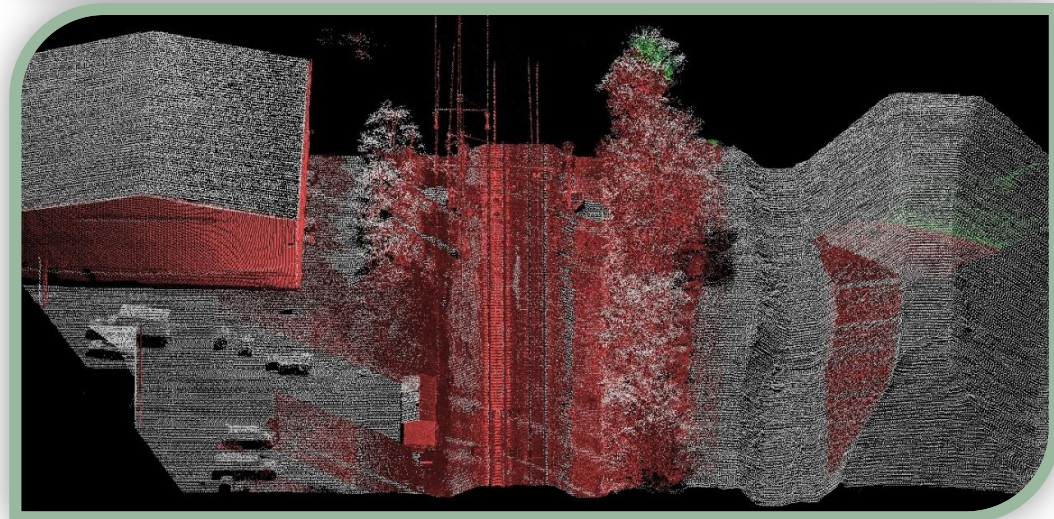
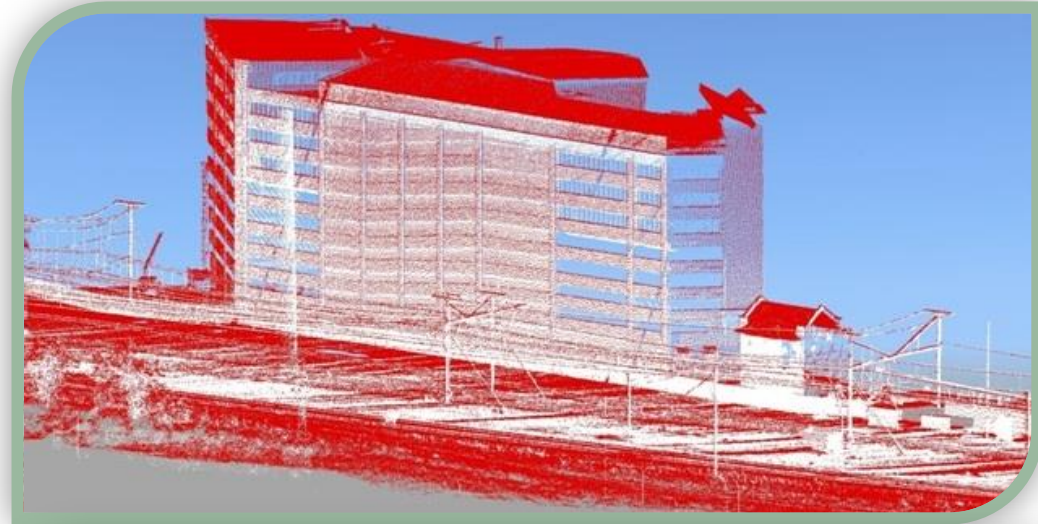
■ Data Fusion Within a Corridor

■ Merging of Data

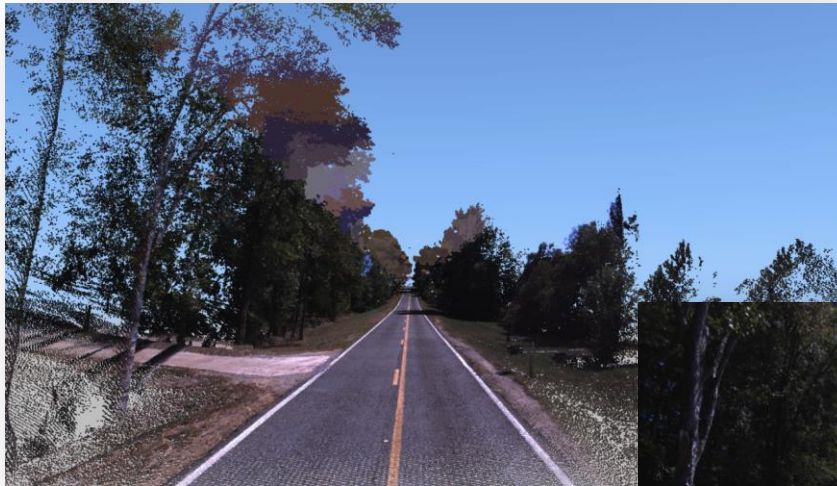
- Aerial LiDAR – Top of structures, wide areas
- Mobile LiDAR – Dense Saturation of Points
- Traditional Surveys – Boundaries, Subsurface

■ Value:

- Single Dataset
- Scene Comprehension
- Common Accuracy
- Minimizes Shadowing
- Spatial Extent



- Point Cloud Colorization
 - Immersive Camera Systems are Used with the Cloud
 - 3D Visualization and Ease in Feature Extraction



Point Cloud



Photograph

- Useful for Common Elevation Studies
 - Quickly Determine Finished Floor Elevations on a Regional Scale
 - Minimize or Eliminate Right of Entry
 - Capture data on a large scale, quickly and cost effectively



- Mobile LiDAR is not the Only Solution
 - Mobile LiDAR is Not Herding All Projects to a Single Survey Approach
 - Knowledge and Application of Professional Surveying is a Must for Any Mobile LiDAR Operation
 - Understand How the Technology Works...
but it won't work in many cases

*The Surveyor is the Professional
that Drives Each Project and
Assess the LiDAR Data's
Conformity to the Standards and
Professional Practices*





- SG1
 - 1.2 Million PPS
 - 4-5mp Cameras
 - Ladybug 360°
 - 5mm Range Precision

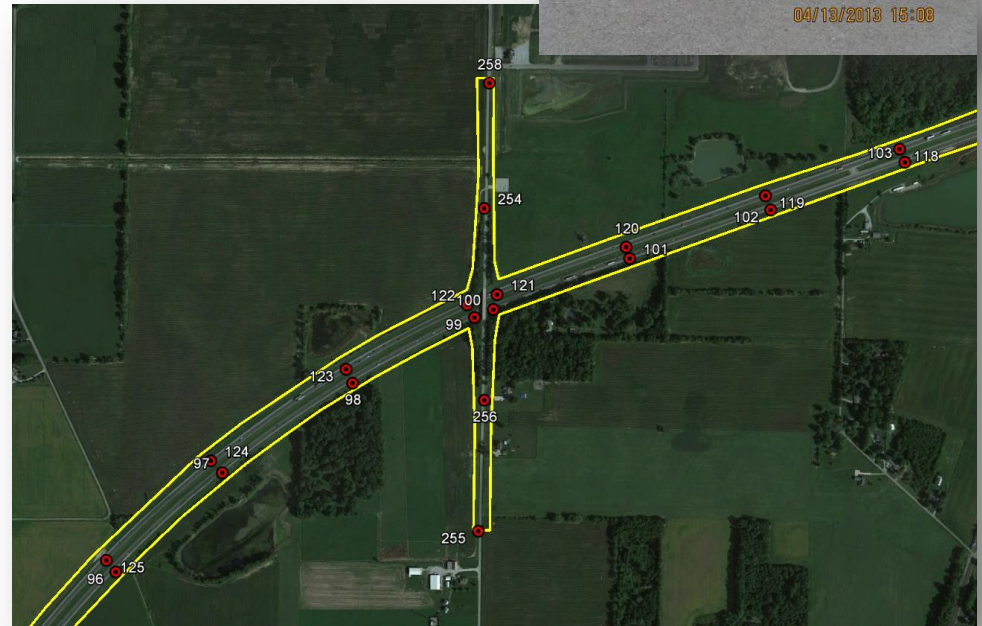
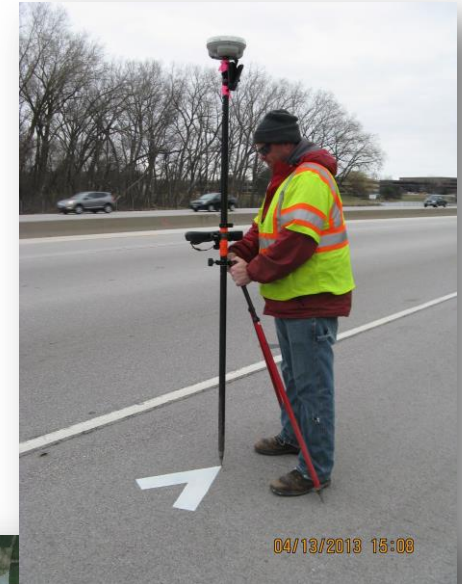


- V200
 - 400k PPS
 - 2-5mp Cameras
 - 7mm Range Precision

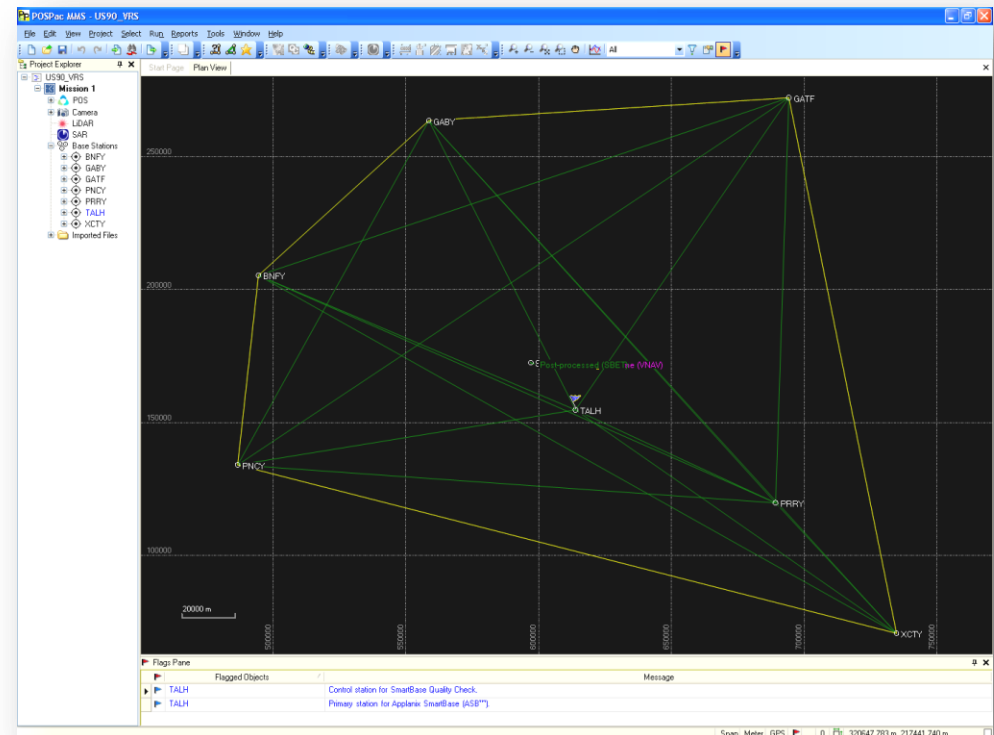


- GNSS Visibility – Obstructions
- Control Requirements
 - Base Station(s)
 - Ground Control
- Traffic – MOT Requirements
- Project Limits
 - Corridor Width
- LiDAR Density
- Imagery Requirements
- Weather

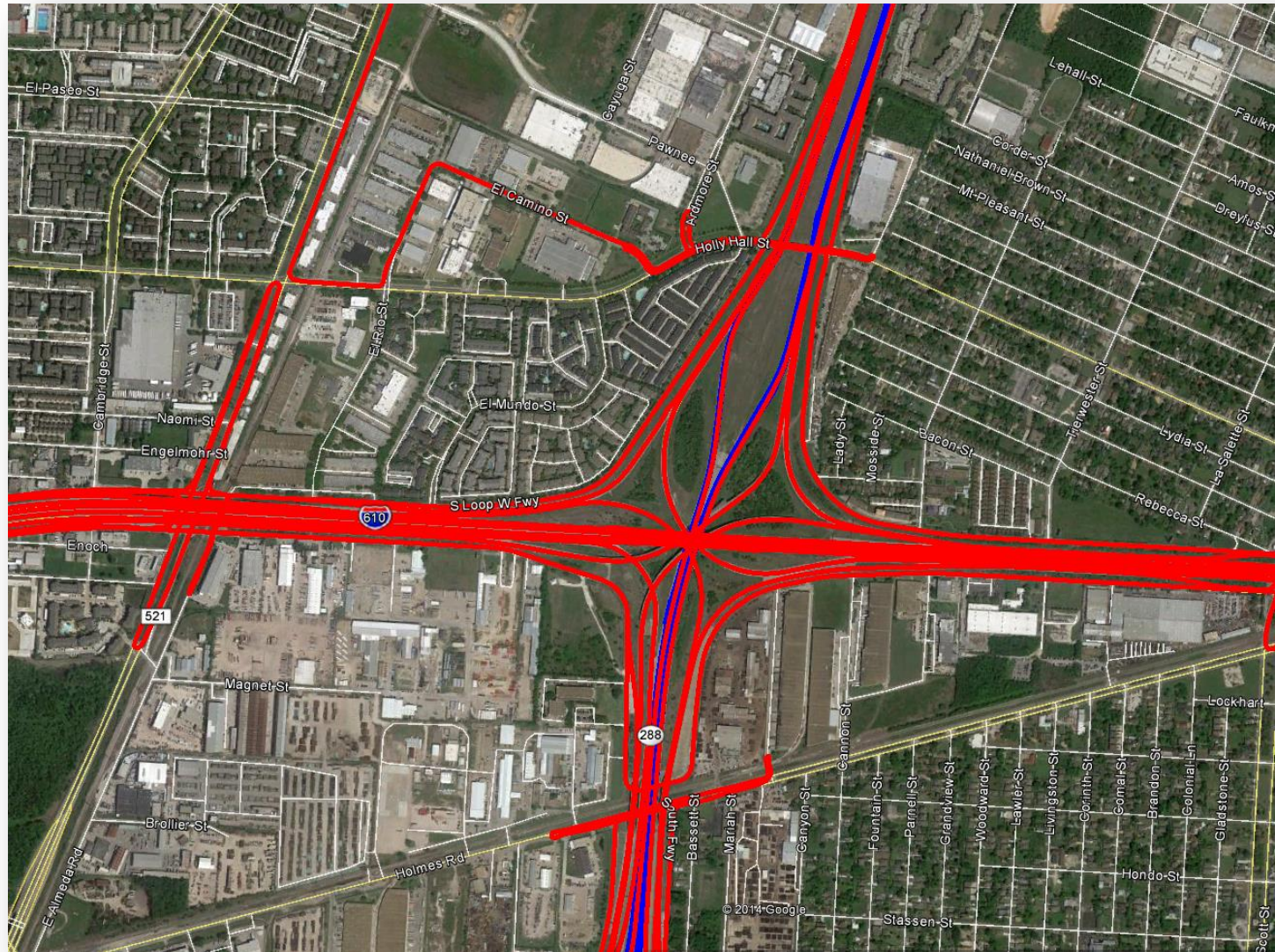
- LiDAR Identifiable Targets
 - New or Existing
- Pre/Post Collection
- Layout considerations:
 - Standards/Specifications
 - Collection Routes
 - GNSS Visibility
 - Safety

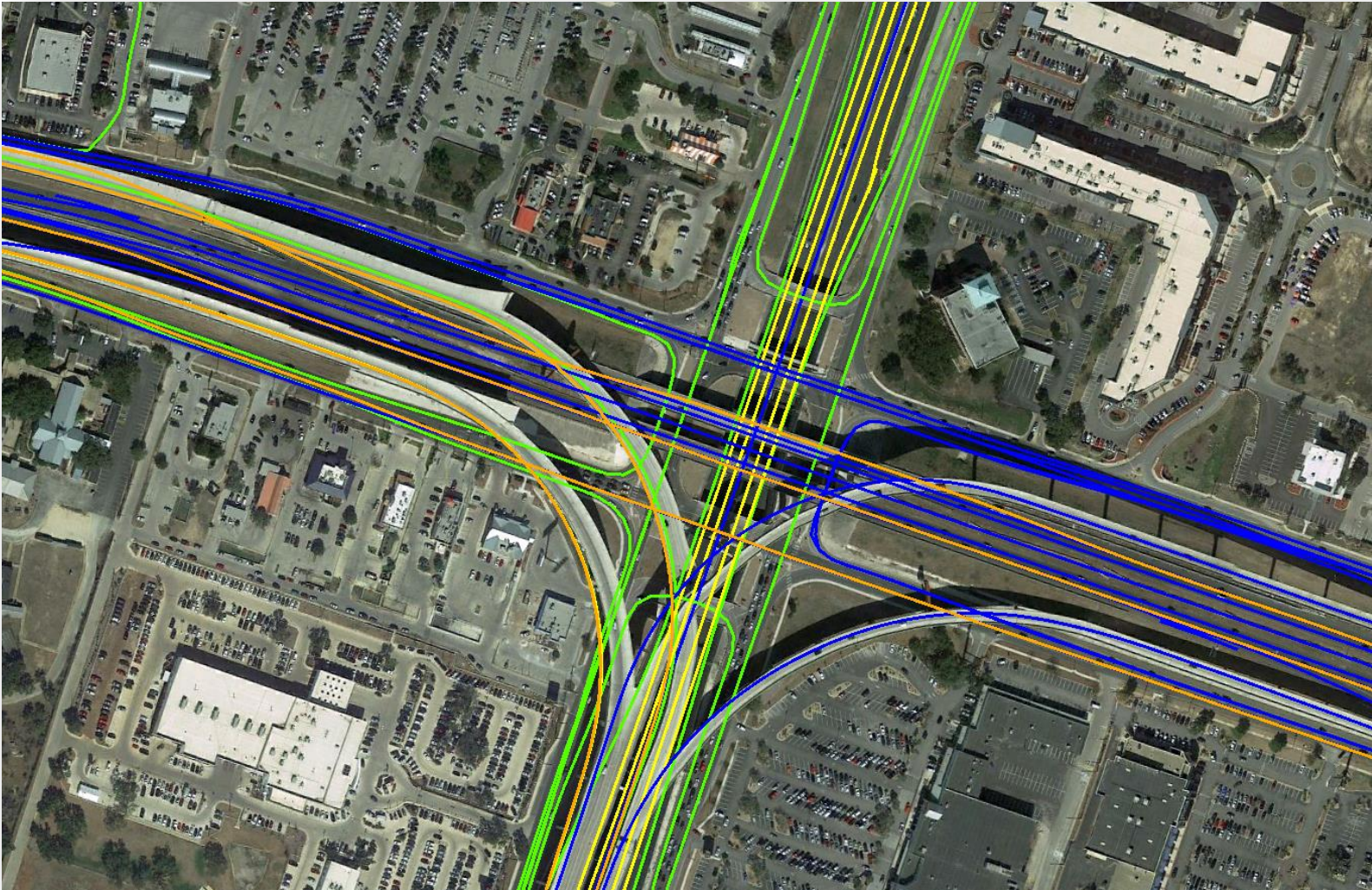


- Baseline Length Requirements
- Options:
 - Single Base Station
 - Multi-Single Base Station
 - Smart Base
- CORS
 - Reliability
 - 1 Second Data
- Real-Time

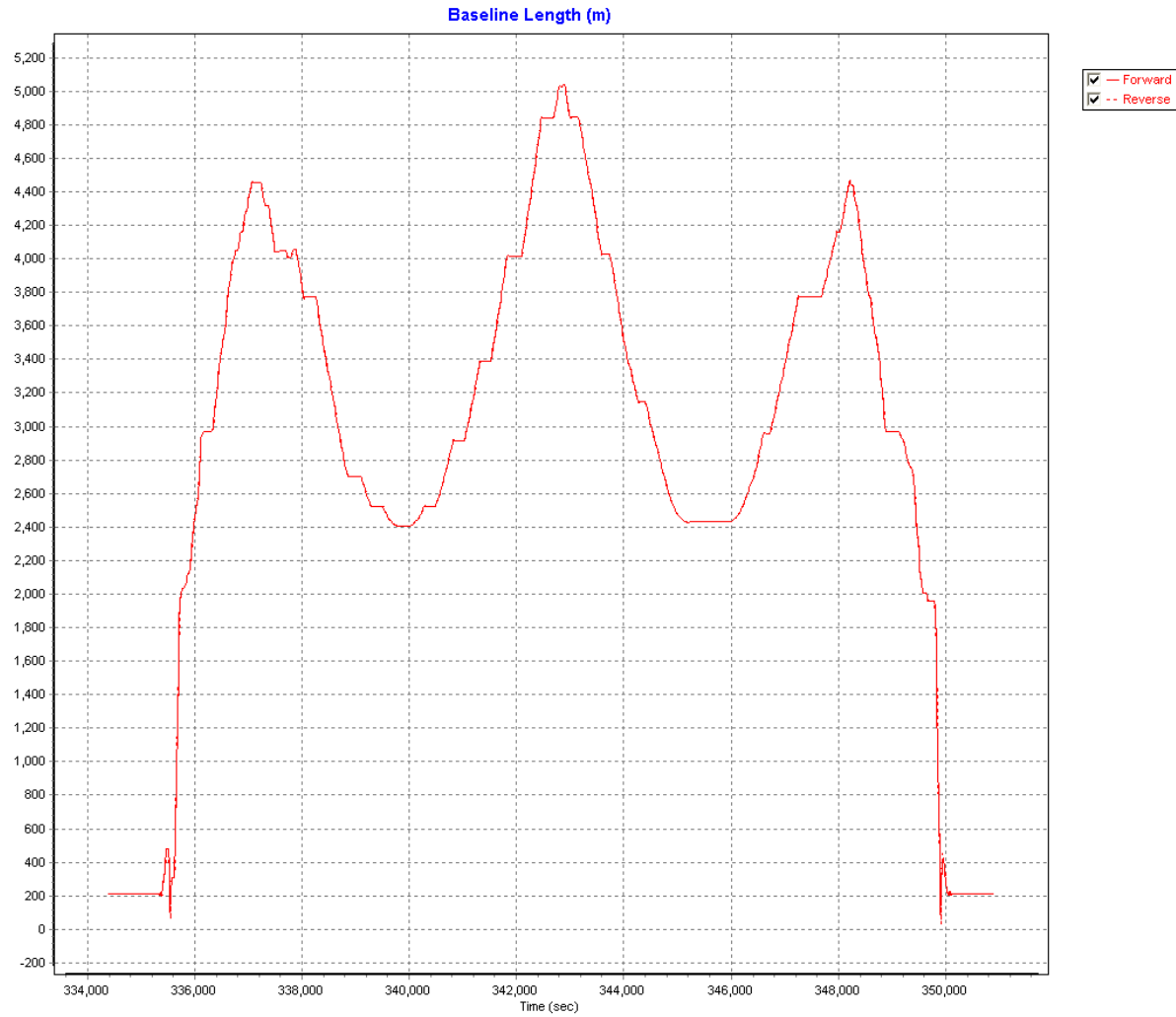


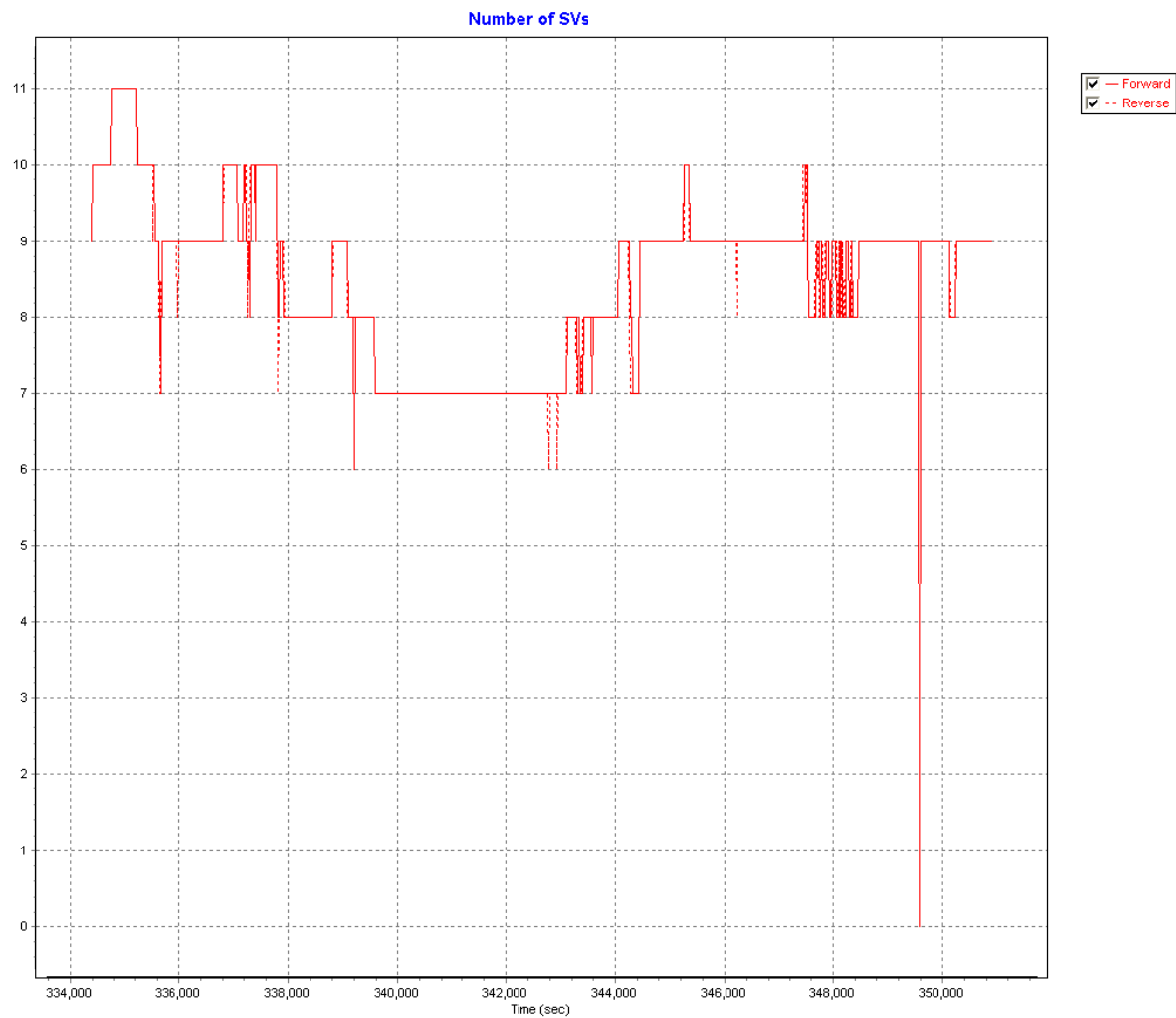
- LiDAR is Line of Sight
 - What you see is what you get! (WYSIWYG)
- Considerations for:
 - Terrain – Side Slope
 - Traffic
 - Ramps, Overpasses, Side streets
- Typically Collecting Each Lane
- “Go Backs” are Costly and Time Consuming
- More is better than not enough!

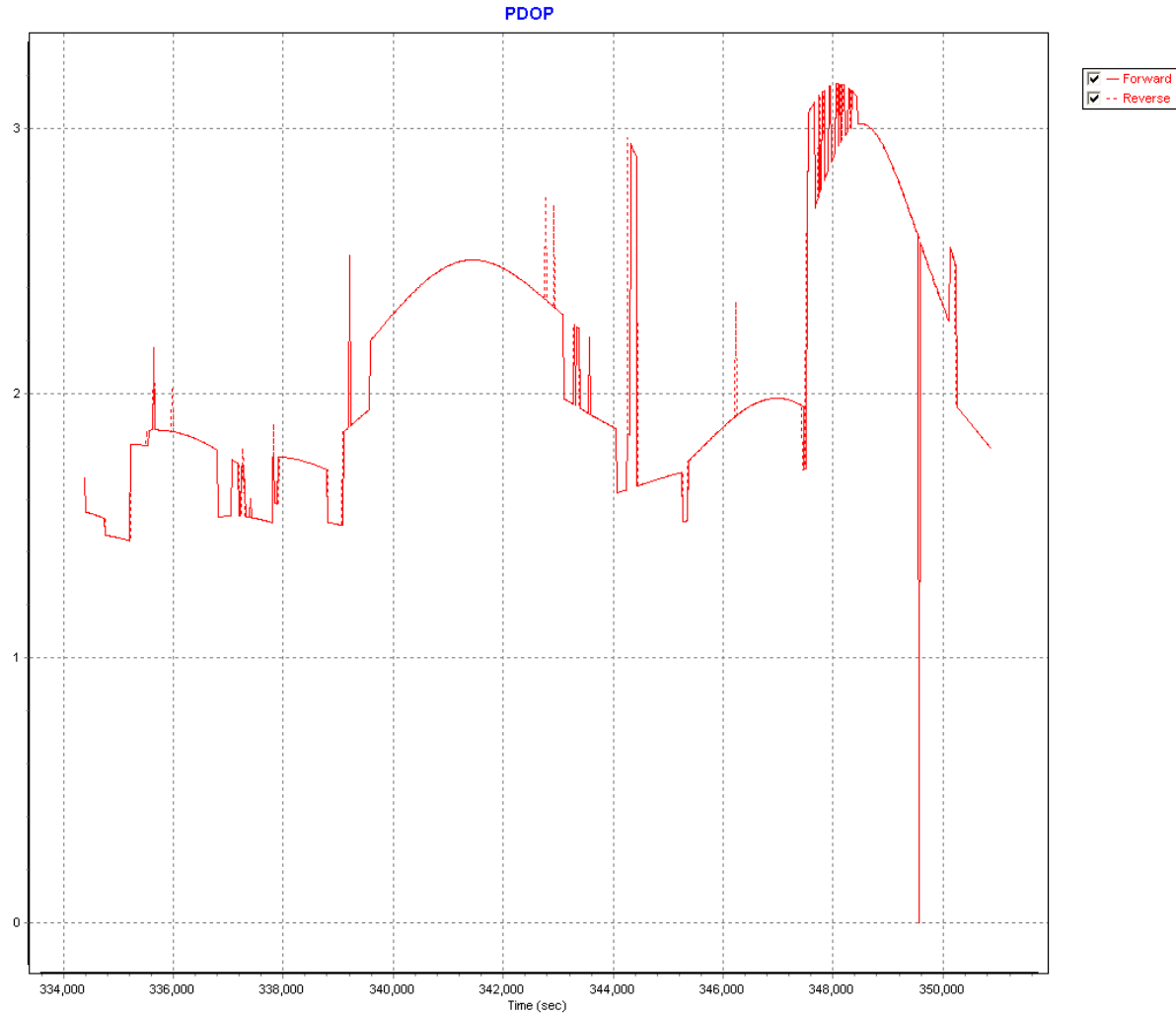


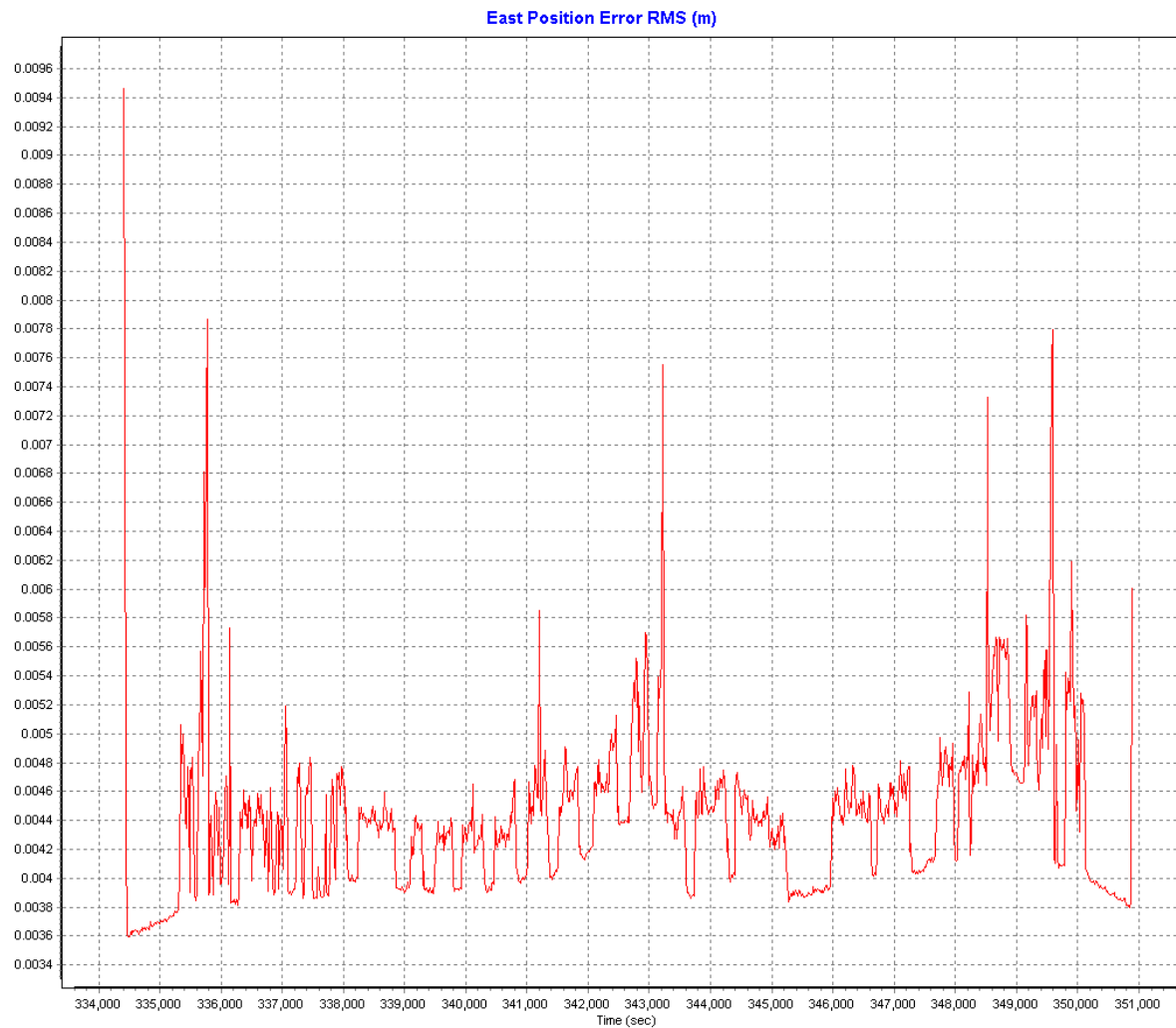


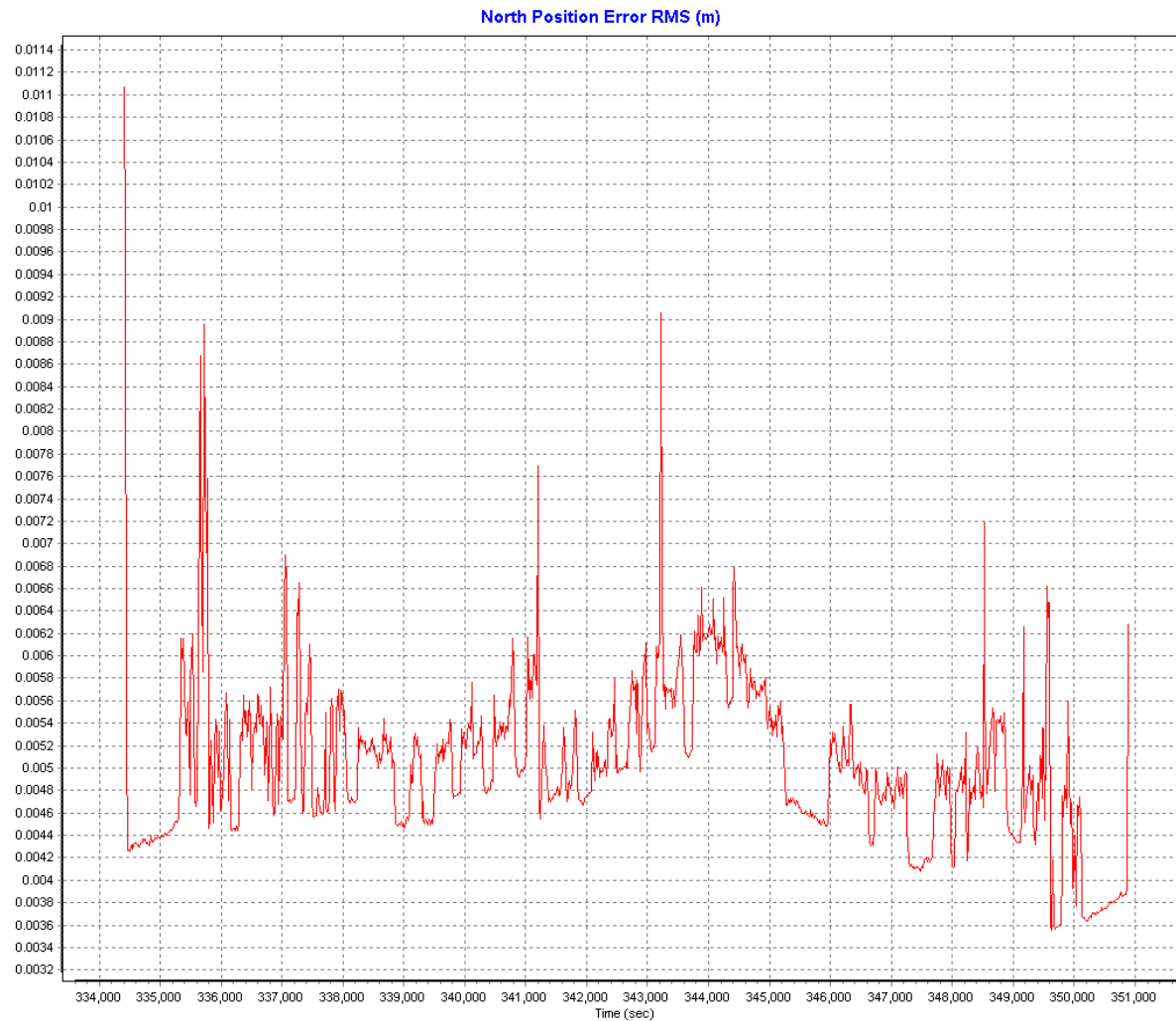
- Post Processed Vehicle Trajectory
- First Step to Success
- Results are routinely part of the project report
- Surveyors like Statistics
- Confirmation crew followed Best Practices

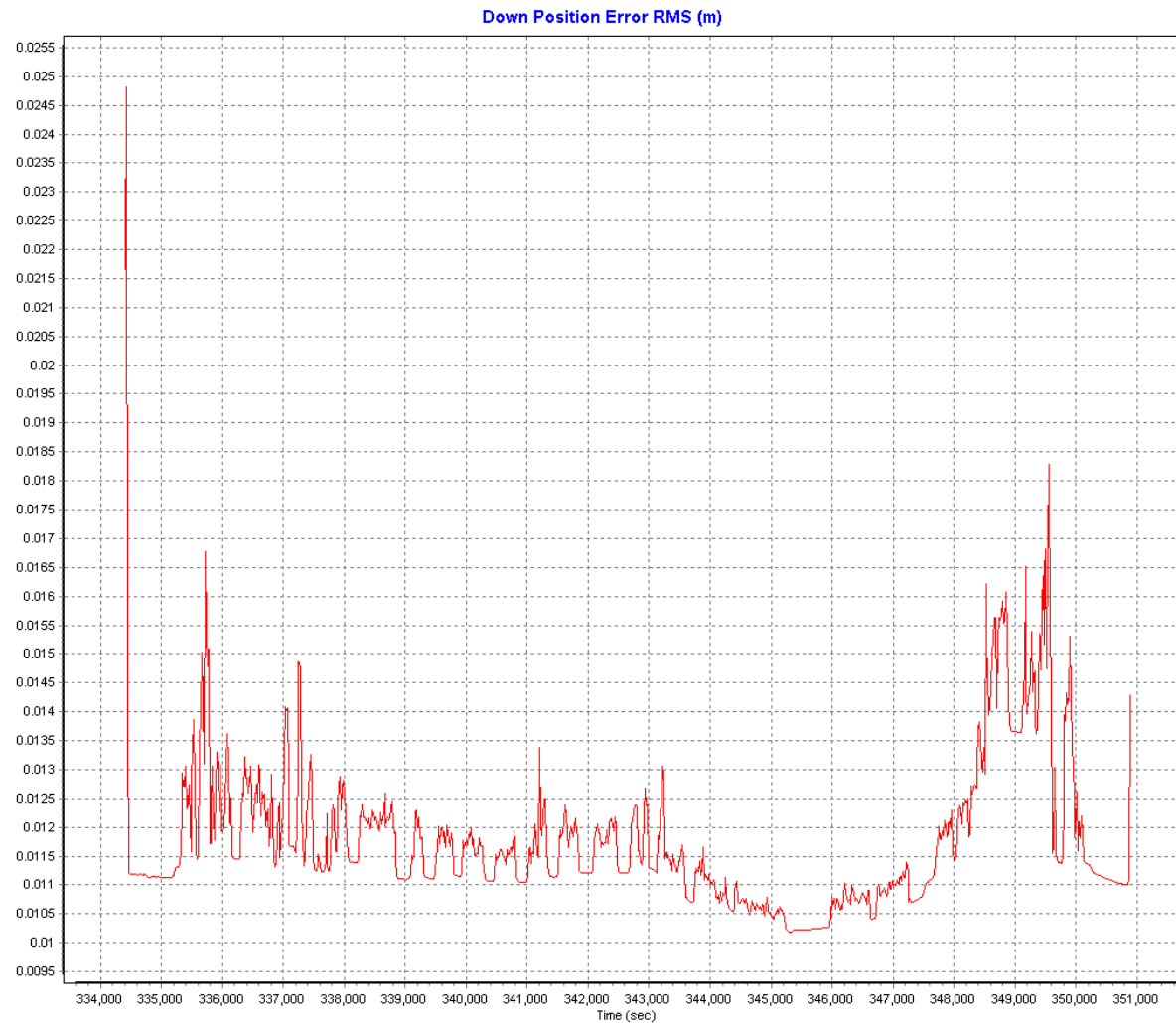












- Professional Practices
 - State Standards for Mobile LiDAR Surveys
 - *Primarily being driven at the State level by DOT's, not regulatory boards.*
 - *Some states have elected to include Standards in contract language.*
- “Surveying” versus “Mapping”
 - The intended application of the technology determines level of control.

- California (CalTrans) implemented the first standards for “Mobile Terrestrial Laser Scanning” (MLTS) in January 2011
- Known as Chapter 15, it outlines the following:
 - Project Types and Applications
 - Transformation and Validation Points
 - Documentation and Deliverables
 - Varying requirements by Purpose/Application
- These are “Specifications”
- Other states have begun to adopt verbatim or have made modifications over time.

- Florida, for instance, has developed “Guidelines” following California’s lead and by committee:
 - Increased Categories for Collection
 - Developed Staff Hours and Standard Scope Language
 - Provides more flexibility and “Professional Judgment”
- One-size fits all does not necessarily work.
 - Not all systems are created equal.

Application Categories

Type A

- Design Engineering topographic
- As-built
- Structures and bridge clearance
- Deformation surveys

Type B

- Design Engineering topographic Corridor Study / Planning
- Detailed Asset inventory and management surveys
- Environmental
- Earthwork
- Urban mapping and modeling Coastal zone erosion analysis

Type C

- Preliminary Planning
- Transportation Statistics
- General Asset inventory surveys

Decimal Feet (<0.06')

Feet

**Terrestrial Mobile LiDAR Surveying & Mapping Guidelines - FDOT*

- Professional Organizations
 - Promotion of dialog on technologies
 - Healthy debate and discussion
 - Education
 - *ASPRS Mobile Mapping Committee*
 - *National development of standards or best practices*
- Transportation Research Board
 - Guidelines for the Use of Mobile LiDAR in Transportation Applications
- Standards keeping up with Technology
 - Or, not keeping up with technology (the UAV debate)
 - Non-Transportation Related Activities

Review Guidelines

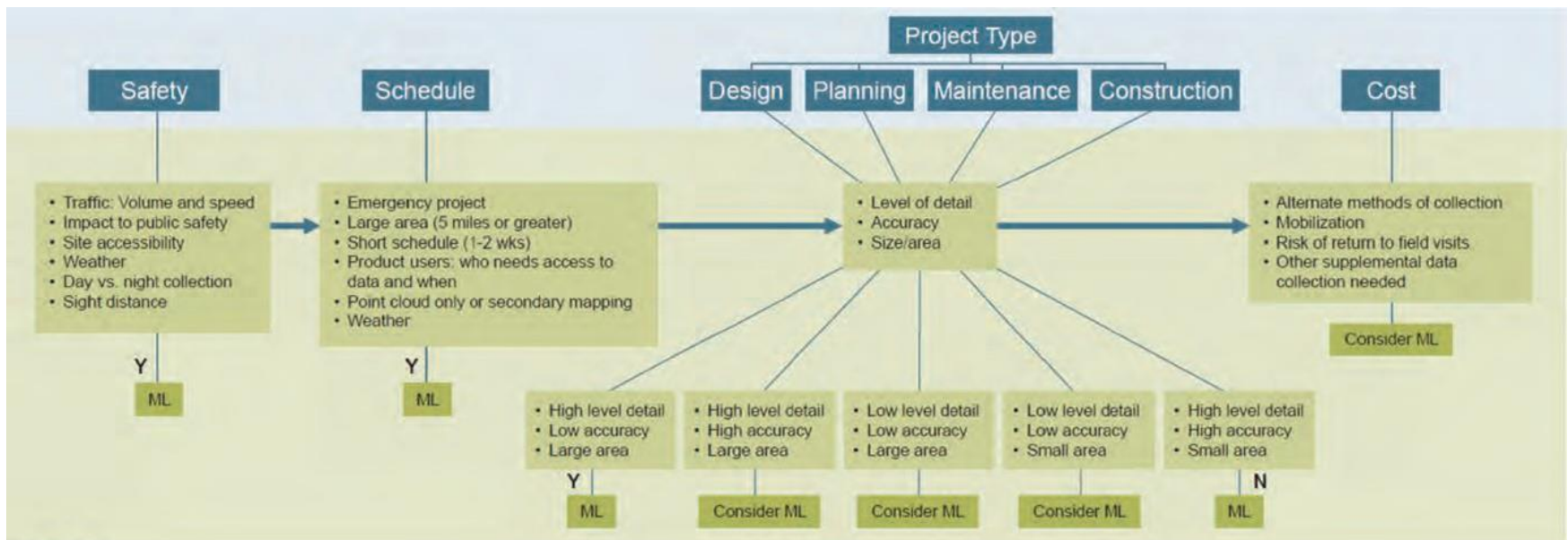


- Project name: County, Route, Section
- Survey date, limits, and purpose
- Datum, epoch, and units
- Control found, held, and set for the survey
 - Base Station(s) Utilized
 - Transformation & Validation Points
- Personnel, equipment, and surveying methods used
 - Calibration Details

- Problems encountered
- Declare what accuracy was achieved
 - NSSDA Accuracy
 - Survey Type
- Results of constrained adjustment of TML data to local transformation control points
 - Unconstrained variances
- QA/QC reports
 - SBET Plots
 - Various statistical analysis
- Digital Metadata for the Point Cloud



- The technology is being considered in more instances during a complete project lifecycle.
- Provides data to the engineers to determine what other information can be exploited.

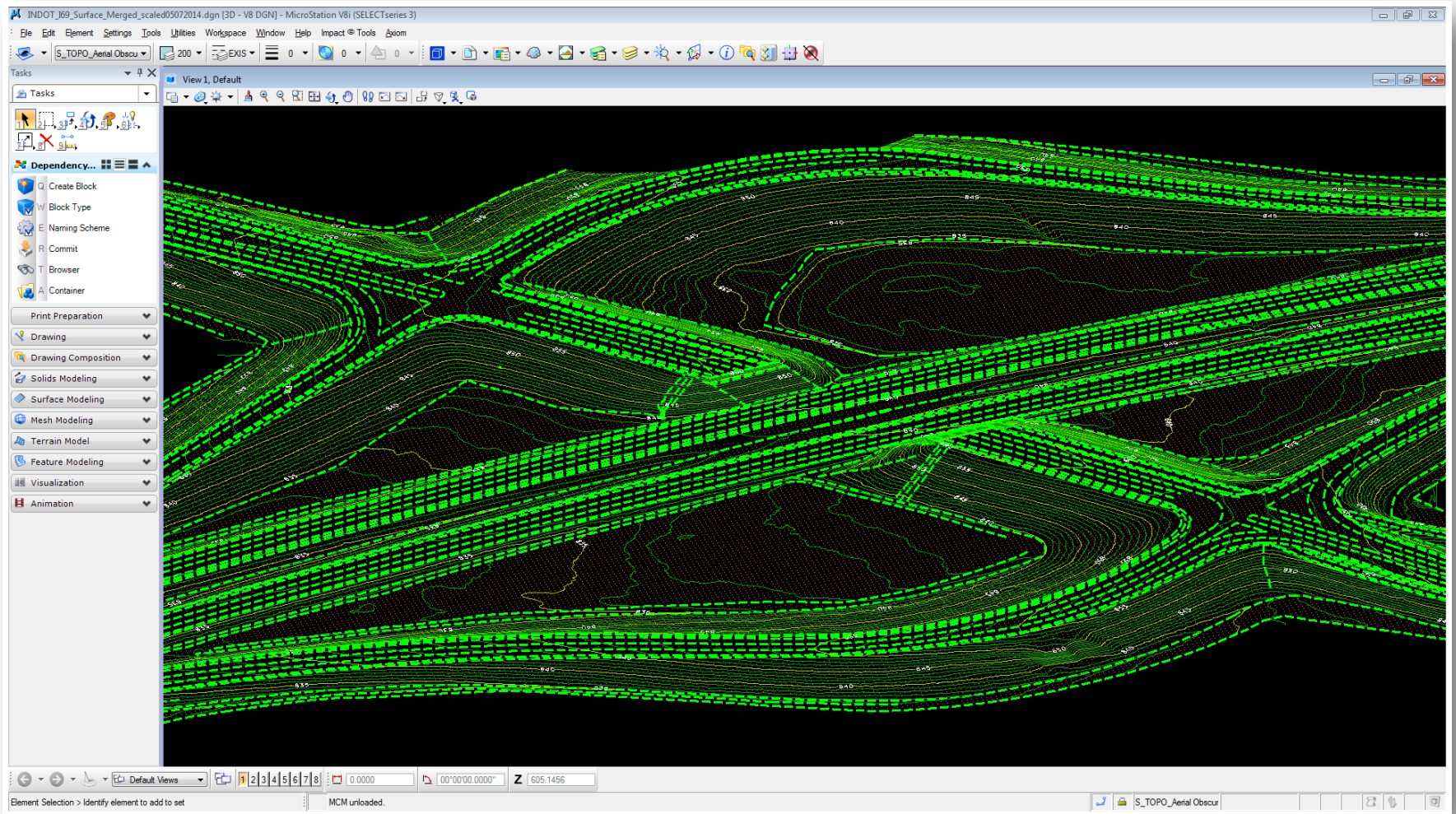


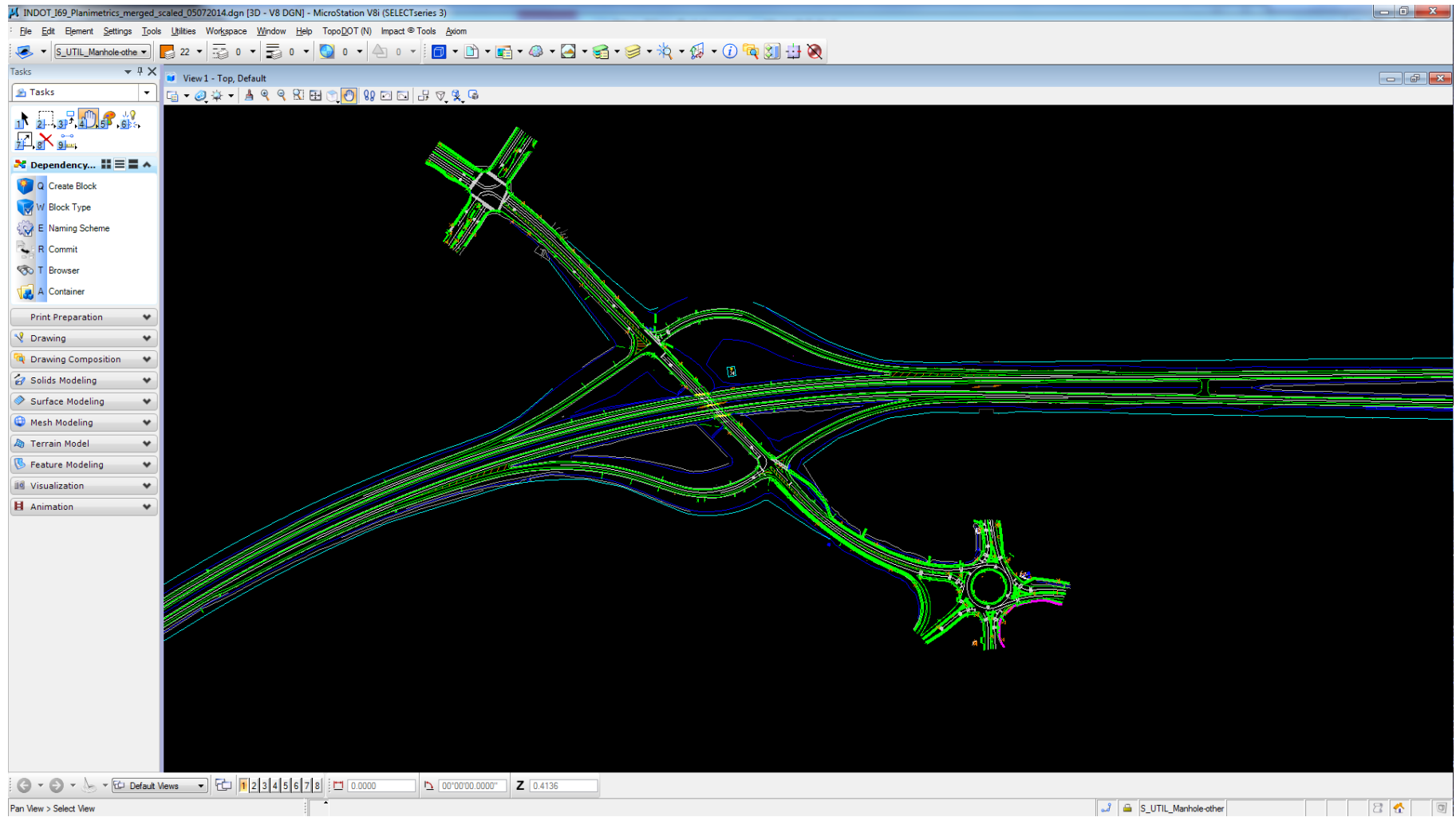
LEGEND

Decision
Considerations
ML Mobile Lidar

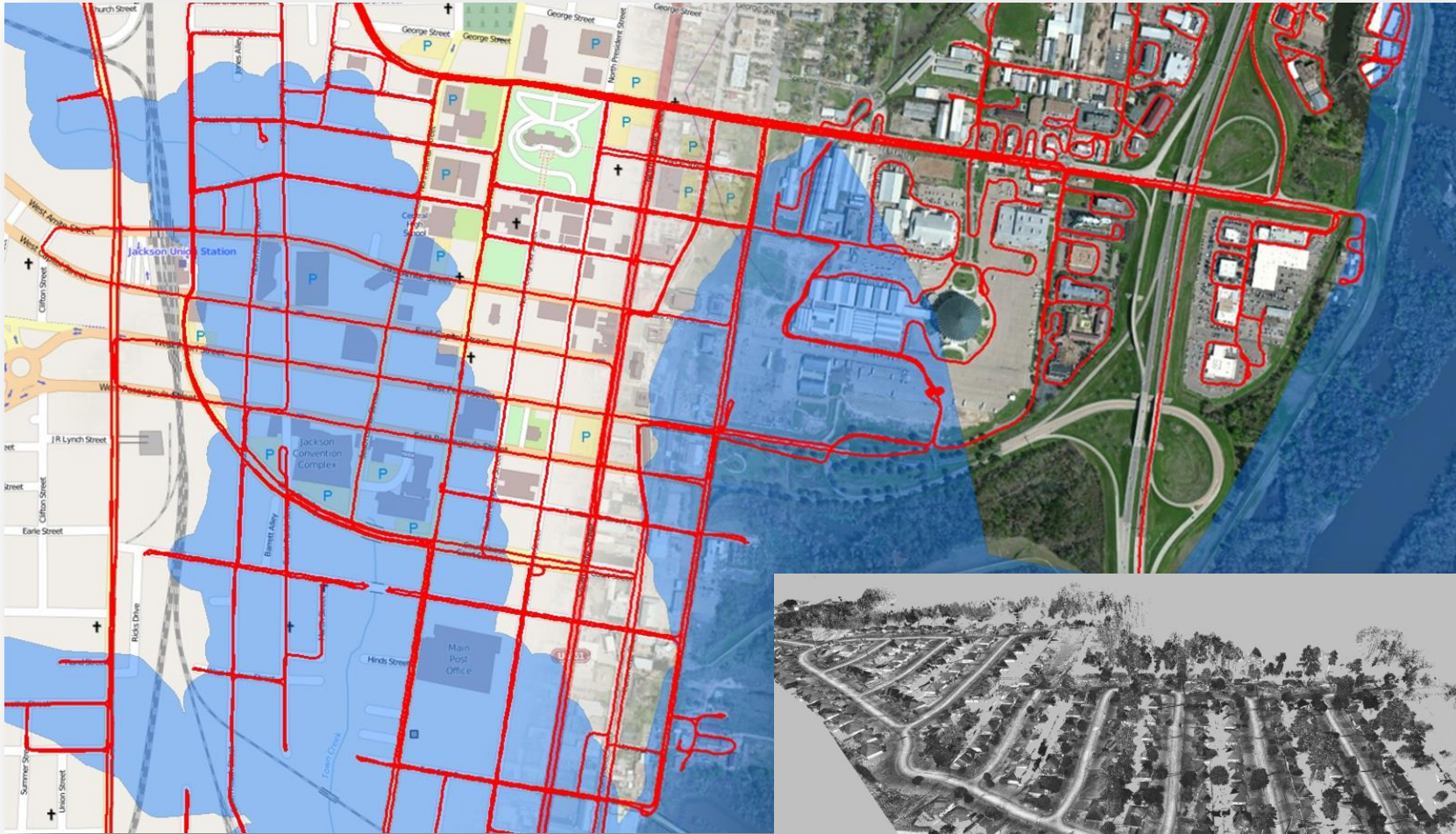
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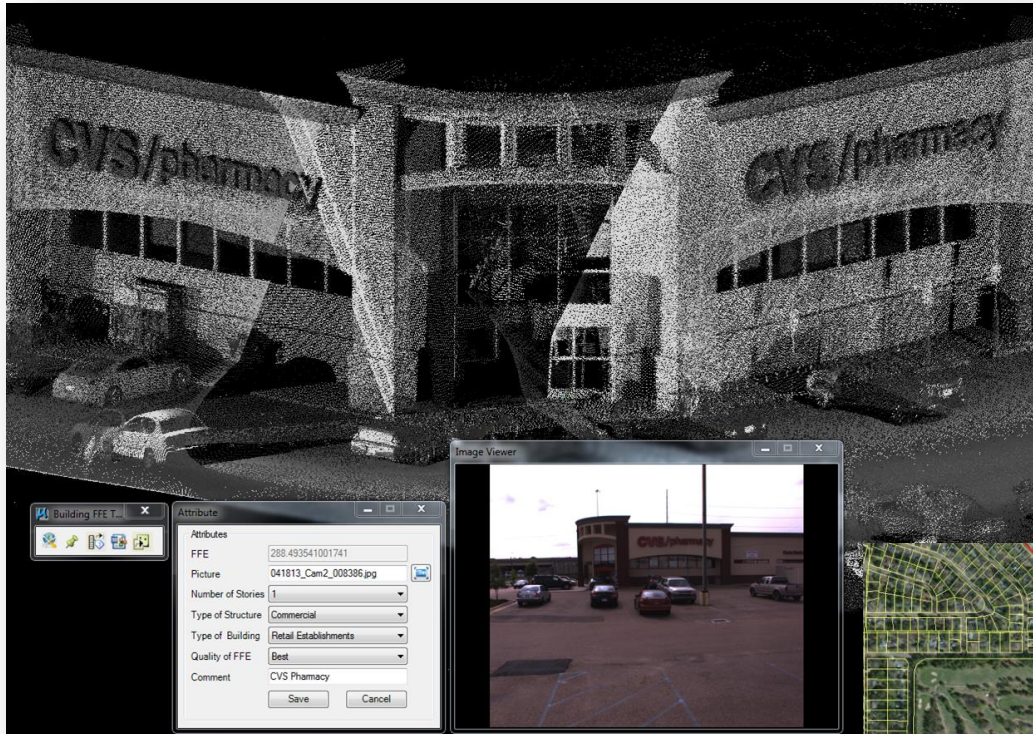
- Interstate 69 – Indiana (Pre-Design/Build)
- ~20 mile corridor with ramps and overpasses
- Two Survey firms providing Control and Validation Points
- Utilized ~260 Targets and Two Base Stations
- Collection completed over 3 Days
- Provided Obscured Areas in 1 Week, Final products in 6 weeks
- MicroStation Design File and DTM in Scaled Project Coordinates
- RMS of LiDAR to Verification Points: 0.026'





- One Lake First Floor Elevations – Jackson, MS
- Flood Impact Studies
- ~320 Centerline Miles of Collection
 - Over 700 miles of collection in 14 days
- 700 Control Points and 200 Validation Points
 - Project RMS of 0.06'
- First Floor Extraction of 12,000 points of entry
- GIS Integration with Tax Parcels
- Road Centerline Profile Extraction



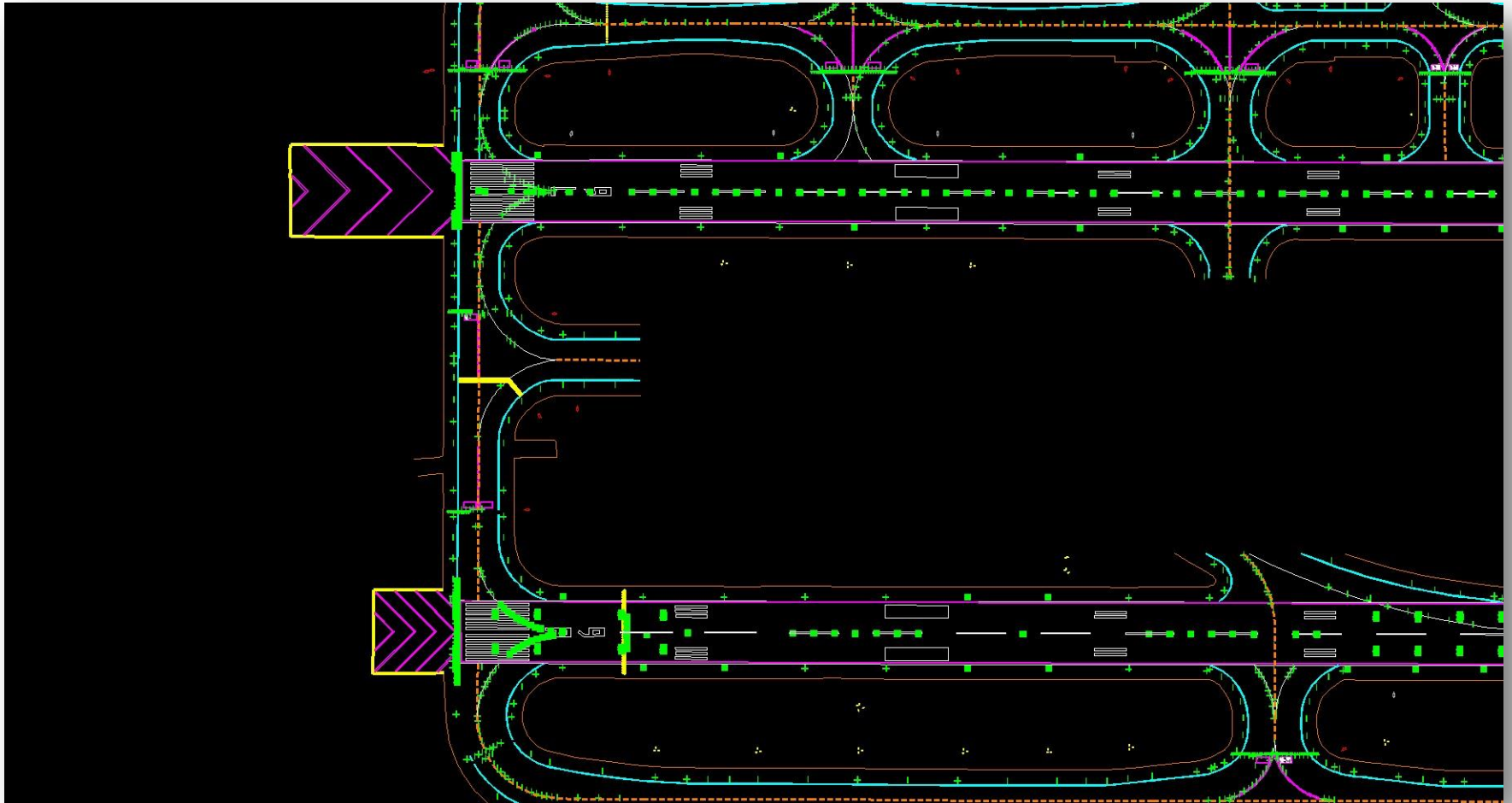


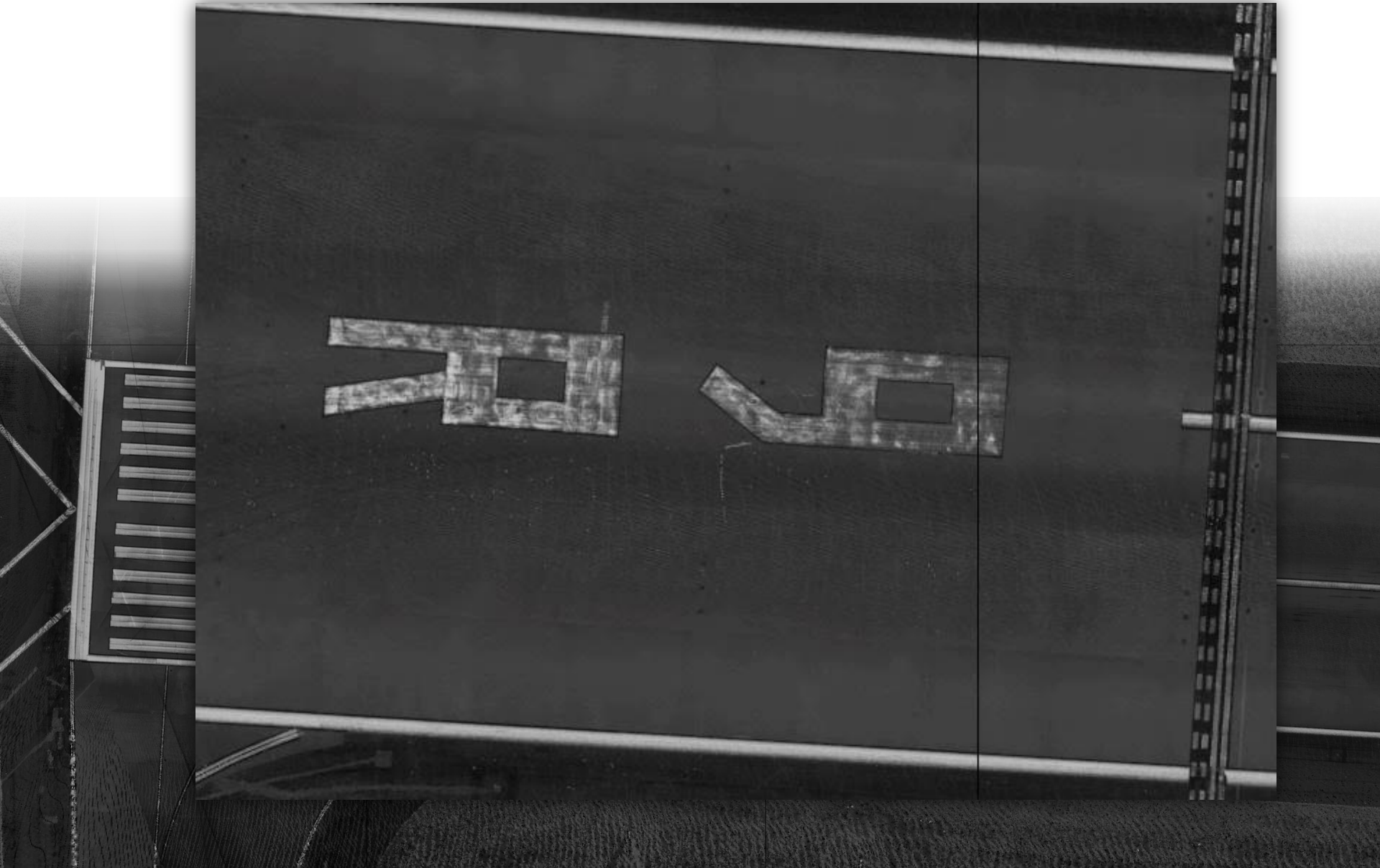
Custom Application Developed
for Extraction, Attribution and
Photography

Extraction of Road Centerlines
and FFE Points (in green)



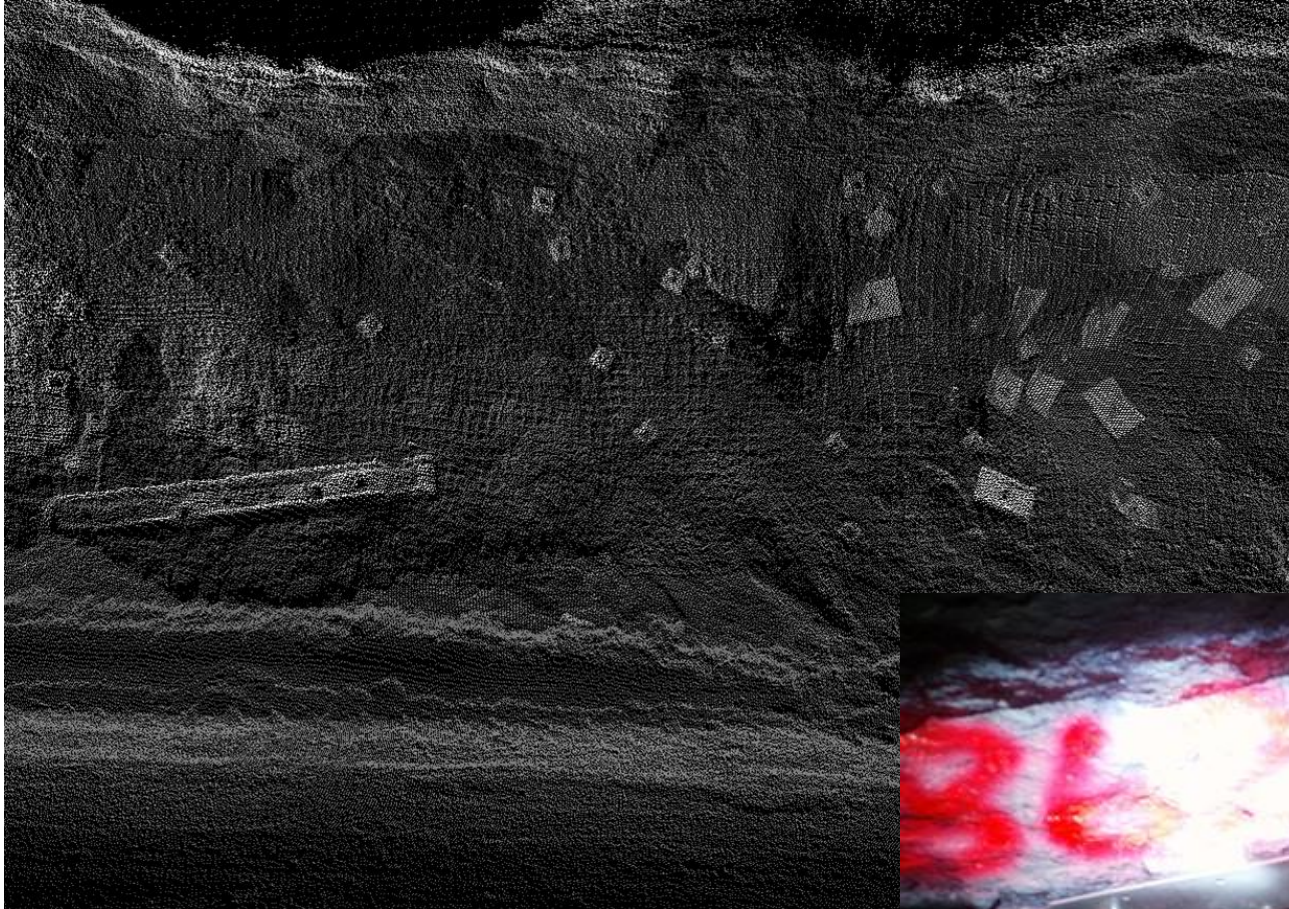
- Runway and Taxiway Surveys for Design
- Runway improvements to support A380
- Collection performed over a period of 2 nights
 - 1 hour of daytime collection – lunch break
- AutoCAD Drawing and Digital Terrain Model
 - FAA AC18 Compliant Layering Schema
- Project delivered in Airport Coordinates
- Supplemental Surveying
 - Safety Critical Features – RW Endpoints, Centerline, NAVAID's
 - “Infield/Soft” Areas





- Underground Gold and Silver mine
 - Remote Alaskan Island
- 12 miles of “one way” ramps
- Control established in the back (roof)
- Dead-reckoning – no GPS
 - Testing of accuracies prior to project scoping
- Adjusted, classified point cloud
- Wireframe of mine – ribs, ramps and walls
- Miscellaneous survey services

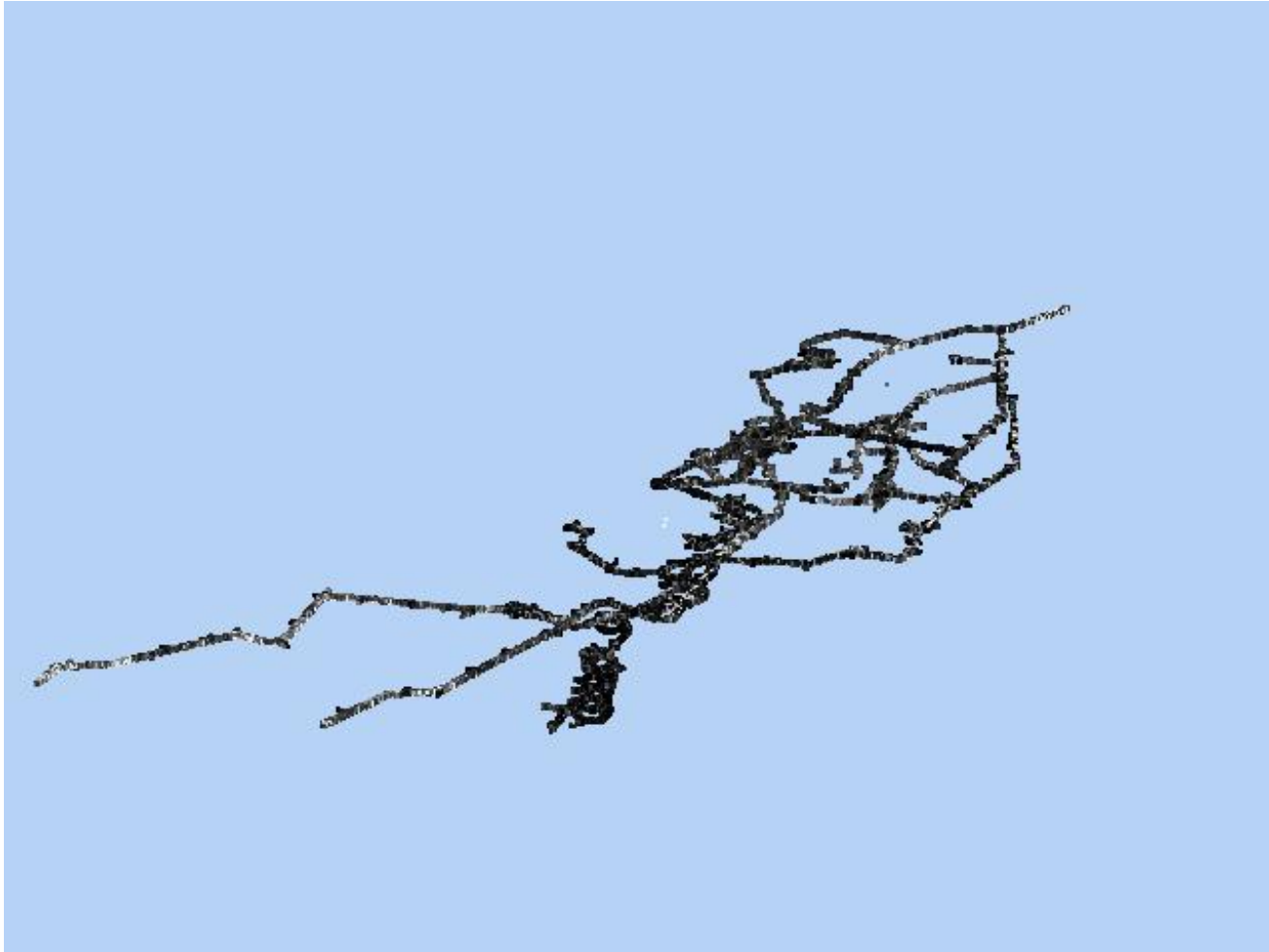




Mine “Ground Control”



Survey “Ground Control”



- Mobile LiDAR is a step change in the surveying industry.
- The technology is another tool in the toolbox.
- Successful surveying projects depend upon control – in the field and the office.
- Professional judgment reigns supreme.

Questions and Answers

Thank You

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