LiDAR in Support of Transportation Surveying

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Objectives

- Overview of Surveying and Photogrammetry at PennDOT
- Static LiDAR
  - What is it?
  - How do we use it at PennDOT?
  - How has it improved safety?
- Mobile LiDAR
  - What is it?
  - How do we use it at PennDOT?
  - How has it improved safety
- Conclusions/Questions

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PennDOT – District survey operations

- PennDOT – 11 Engineering Districts, ~33 survey crews
- Conventional/GPS surveys on or near highways
- Design, construction and maintenance

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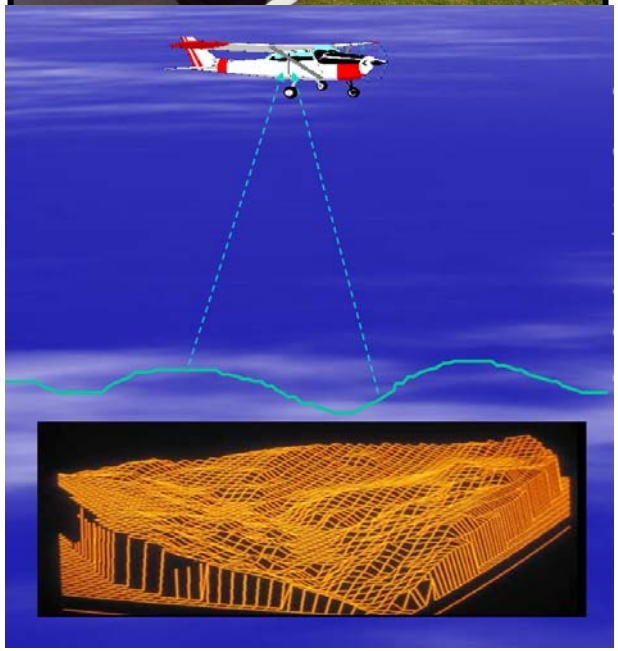
PennDOT – Photogrammetry and Surveys



- PennDOT – B.O.P.D. – C.M.D. – Photogrammetry and Survey Section
- Aerial photography
- Photogrammetry - Remote Sensing – GPS

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Roadway Surveys - Traditional Approach

- Most projects completed with traditional ground surveys
- Ground survey easy to mobilize, very accurate
- Photogrammetry used for difficult to access areas or large area topos
- Data collected remotely/safely, but not as accurate as ground survey
- Ground survey still needed to supplement where higher accuracy is needed

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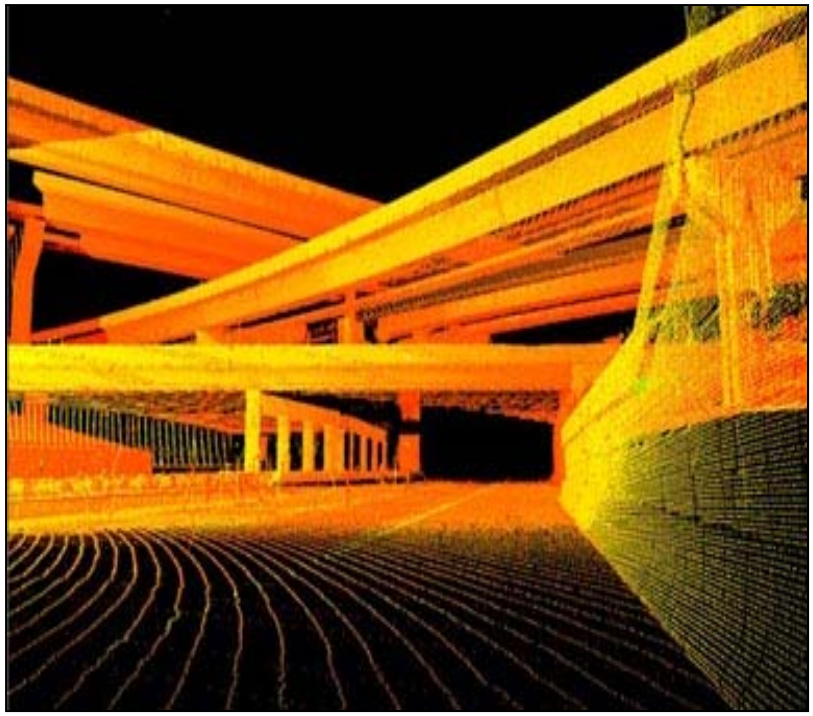
Static LiDAR – Light Detection And Ranging



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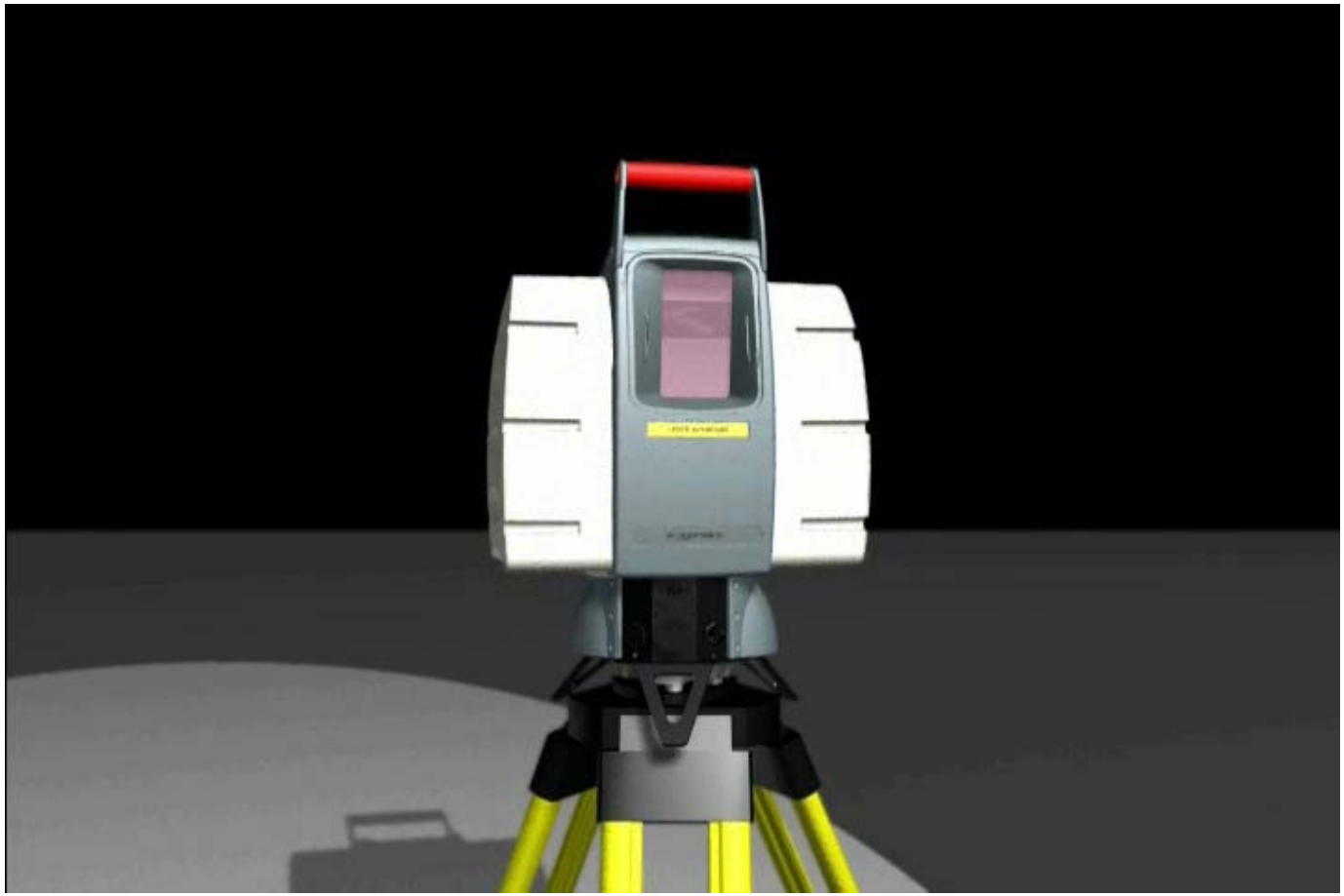
Static LiDAR – How It Works



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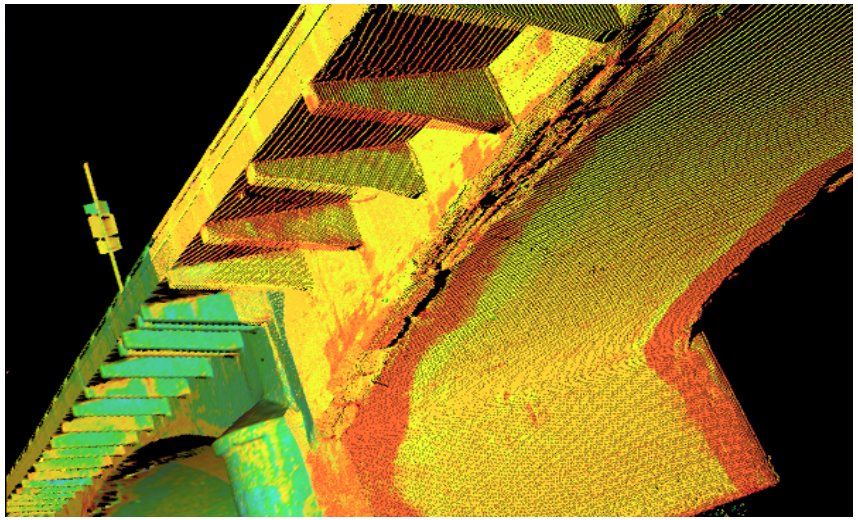
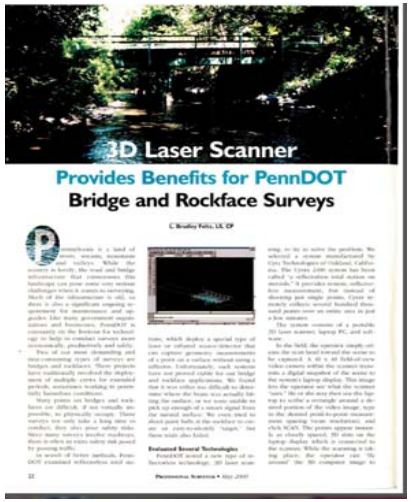
Static LiDAR – At PennDOT

- PennDOT was the first DOT to adopt the new technology in 1999
- Early adoption was a big hurdle.
- Only over the last 5 to 6 years, with evolving CADD software has the technology really taken off.





3D Laser Scanner

Provides Benefits for PennDOT

Bridge and Rockface Surveys

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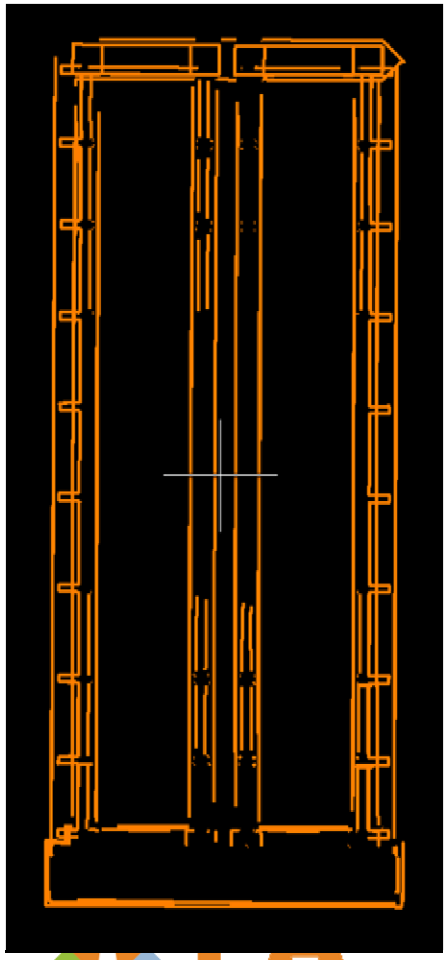
Static LiDAR: Inaccessible Areas

- SR 28 – Allegheny County:
  Unstable cut/inaccessible
- SR 11 – Perry County:
  Geotech - eight state study
- SR 239 – Luzerne County:
  Merged with Photogrammetry

SR 209 – Jim Thorpe:

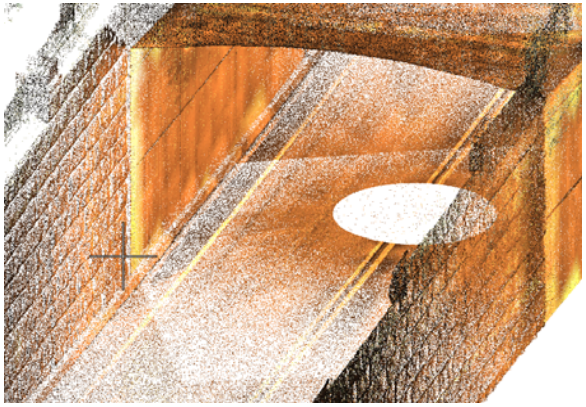
- o Difficult slope
- o Narrow Roadway

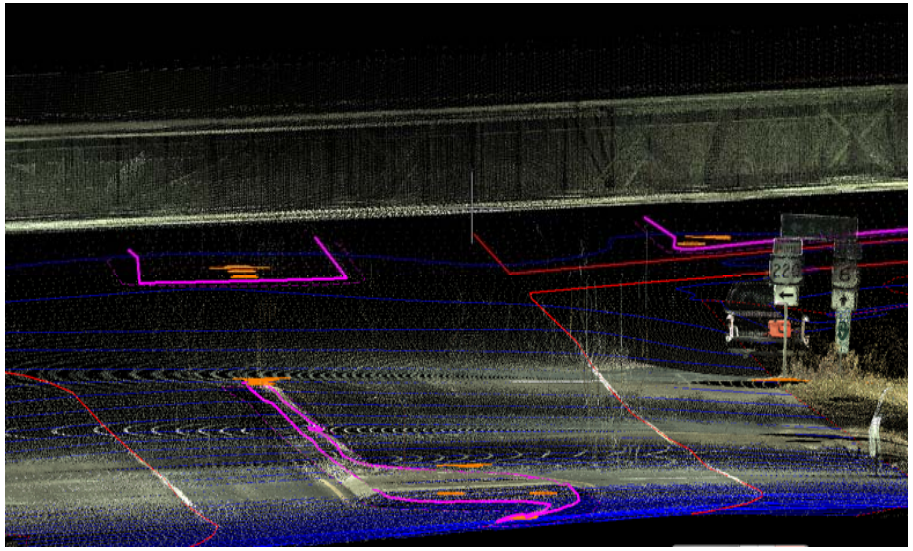
Static LiDAR – Schuylkill River Bridge, Hamburg



Due to complexity of the survey, Static LiDAR was completed in 270 hours versus the conventional estimate of 720 hours (which would also have required bridge cranes)

Other Project Examples





- Tunnels
- High volume/dangerous intersections
- Limited closures/remote data collection
- SR 6 – Bradford county
  - Intersection mapped
  - Bridge girder condition recorded
  - Clearance measured

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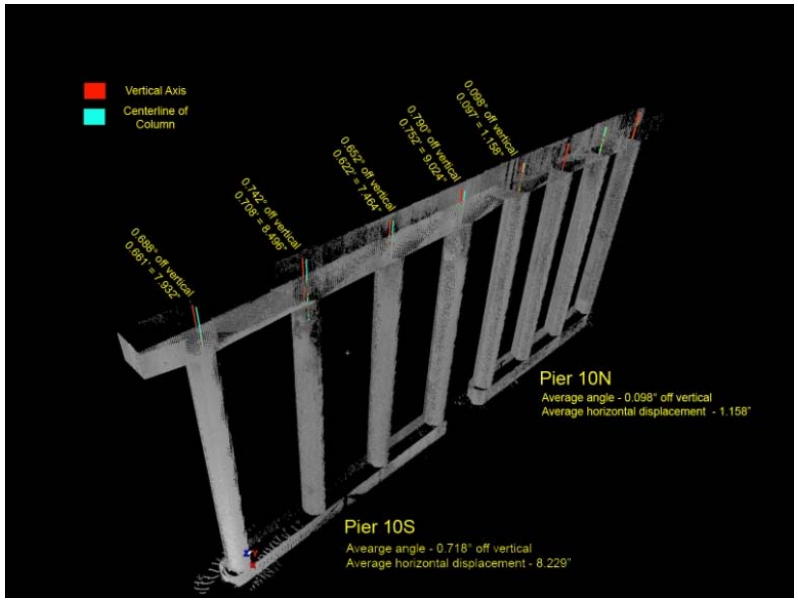
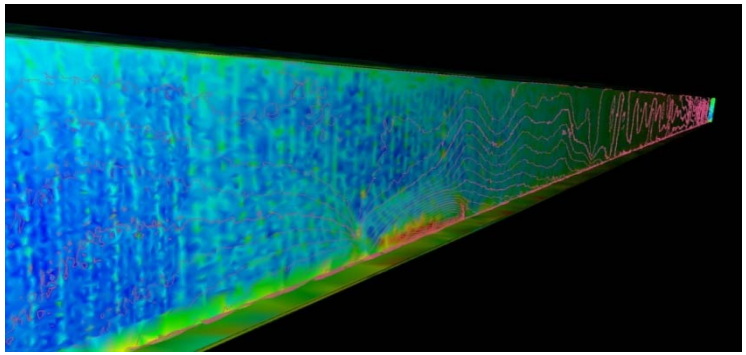
Static LiDAR Projects: Bridge Emergencies





- Birmingham Bridge
- Dysart Bridge
- Girder Condition
- I 81 Bridge Fire

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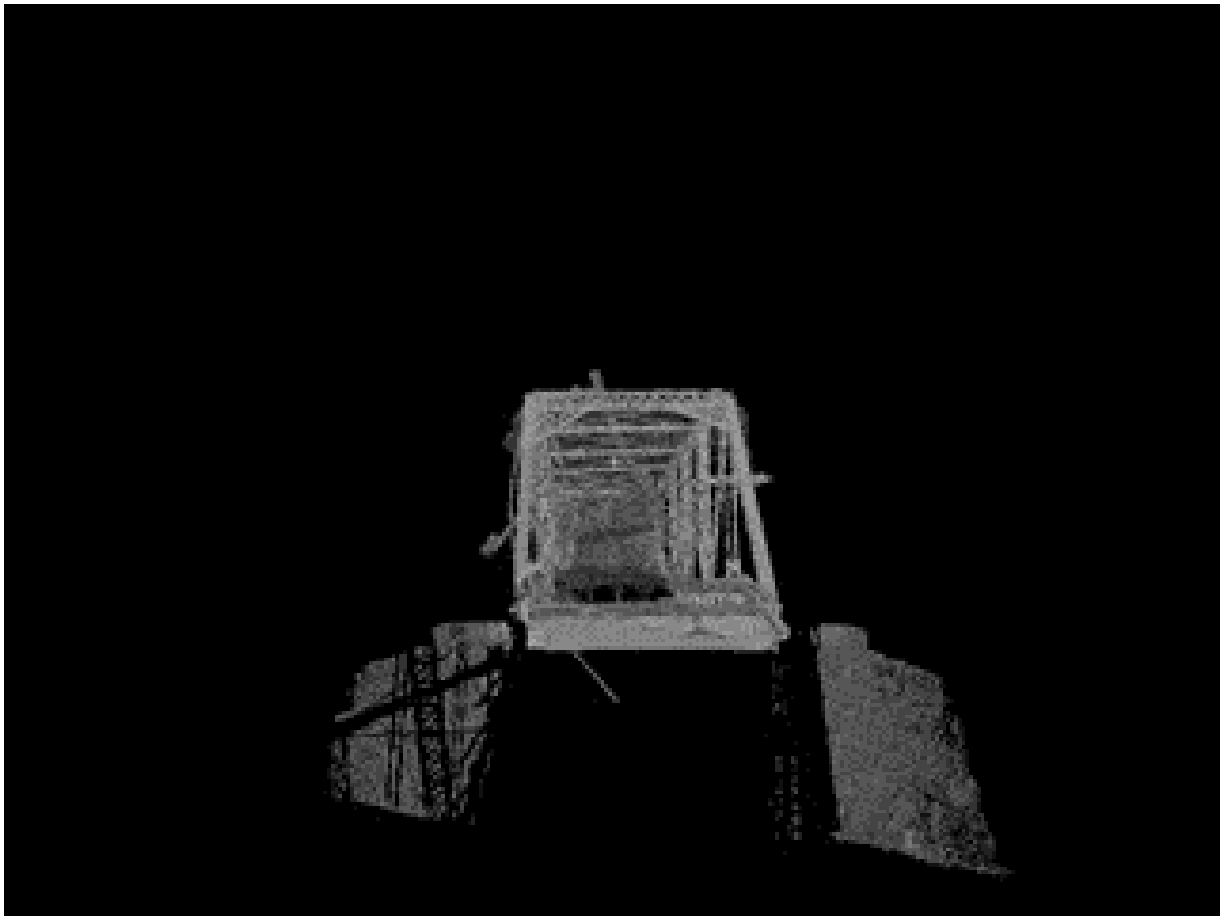
Dysart Bridge Video



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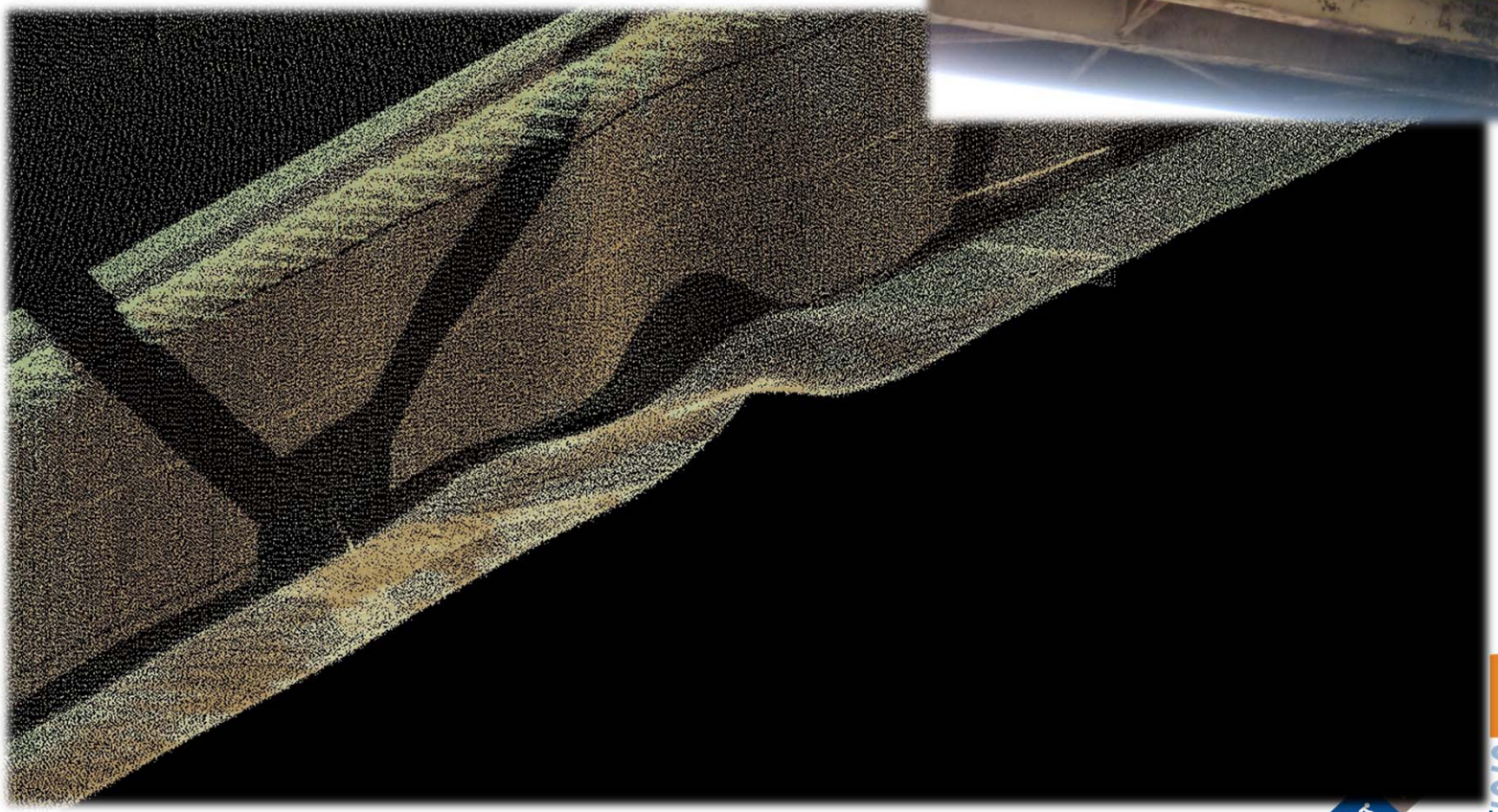
Static LiDAR Projects: Bridge Emergencies
(continued)

I-81 Bridge Fire

Static LiDAR Projects: Bridge Emergencies
(continued)



But What About Long Corridors

Slow Surveyors Working

California Department of Transportation
Report on Helicopter Surveying
1994

"The acquisition of pavement elevations by surveyors is undoubtedly the most dangerous job in *CALTRANS*, since it requires the entire crew to be near or on the traveled roadway."

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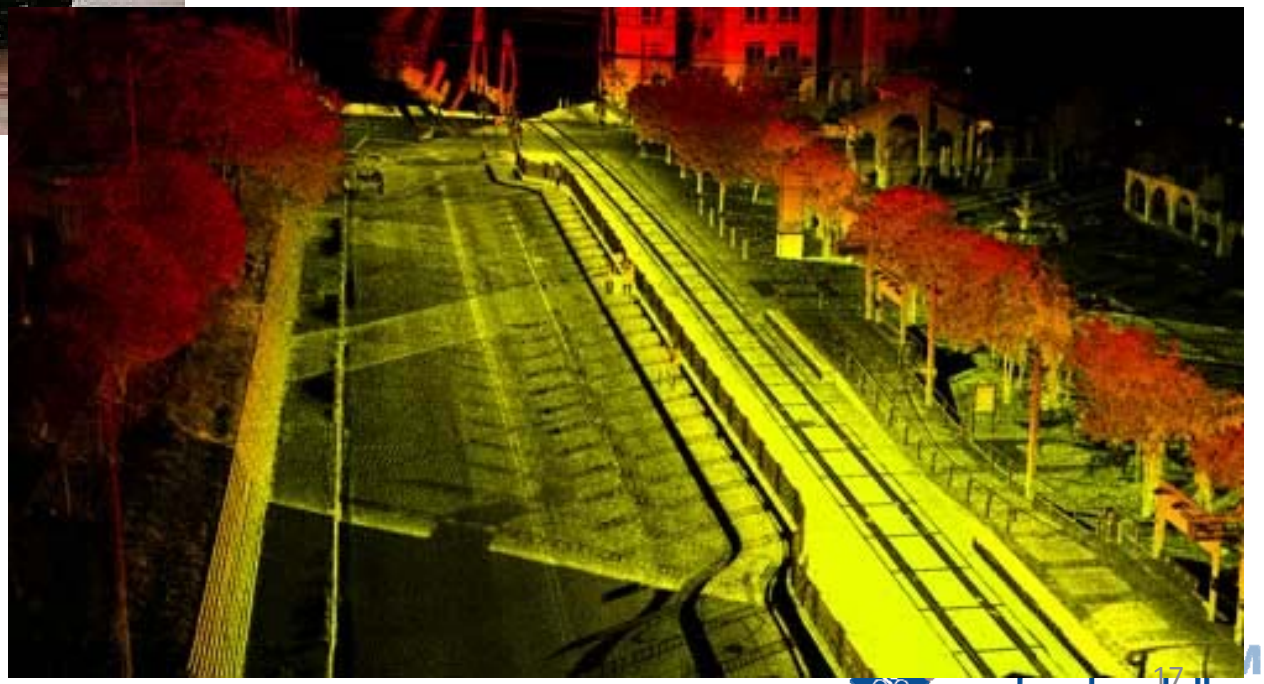
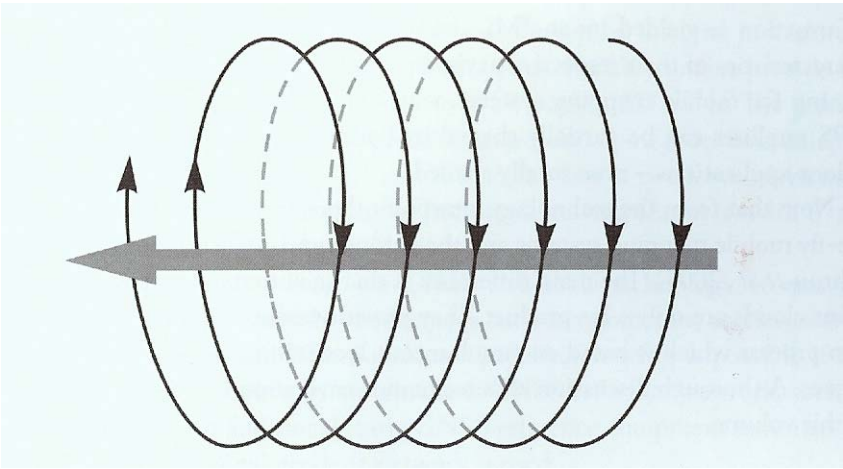
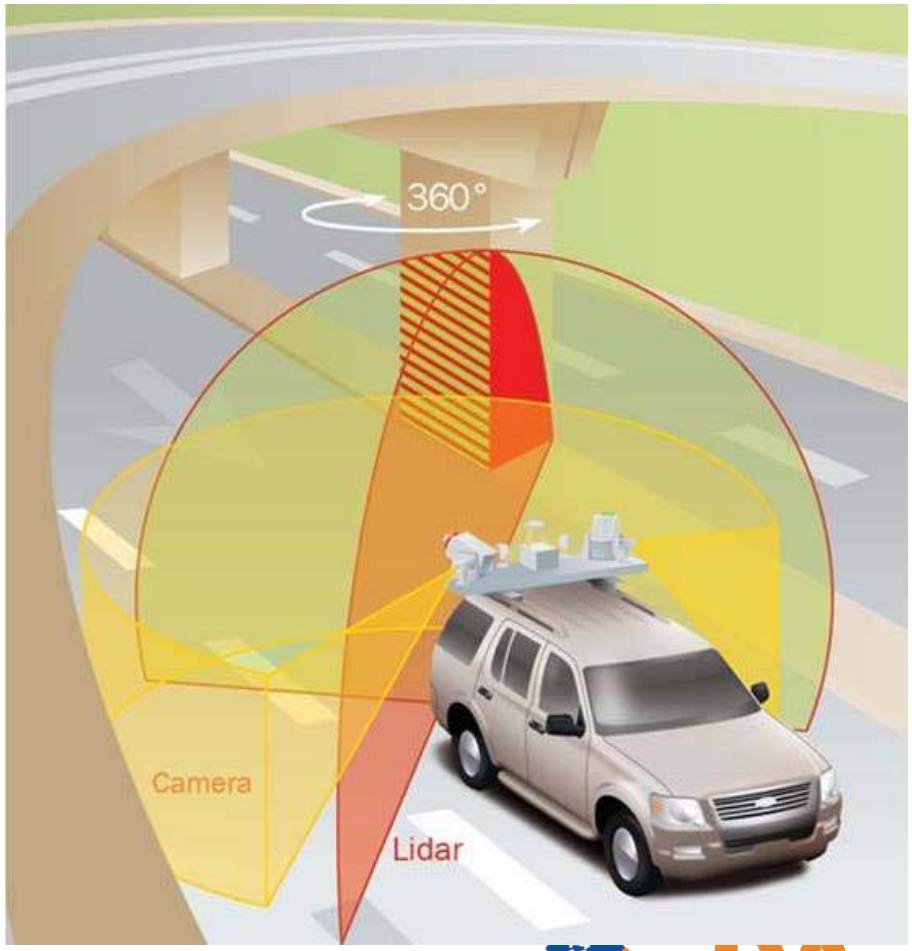
Mobile LiDAR



Mobile LiDAR - Sensor Configuration

Sensors Rotate
in a 360 Degree Arc





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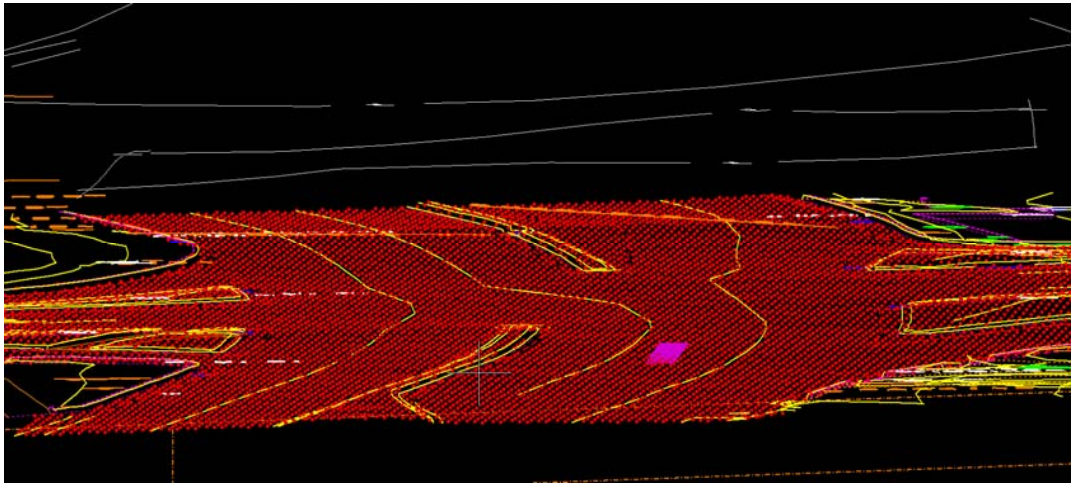

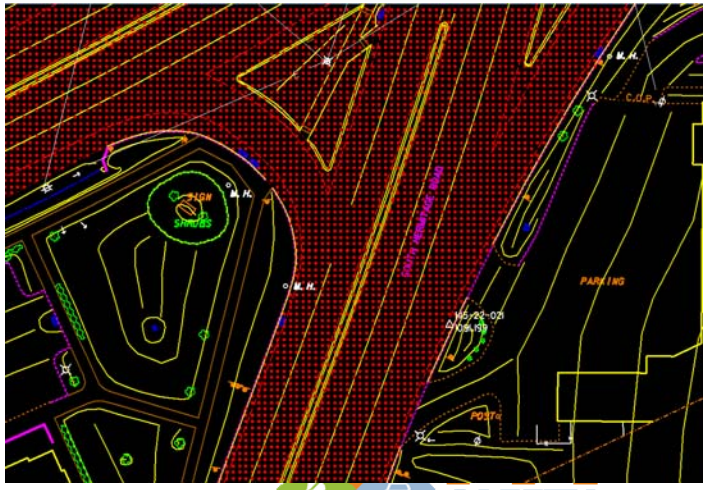
M.H.
C.O.P.
SIGN
SHRUBS
PARKING
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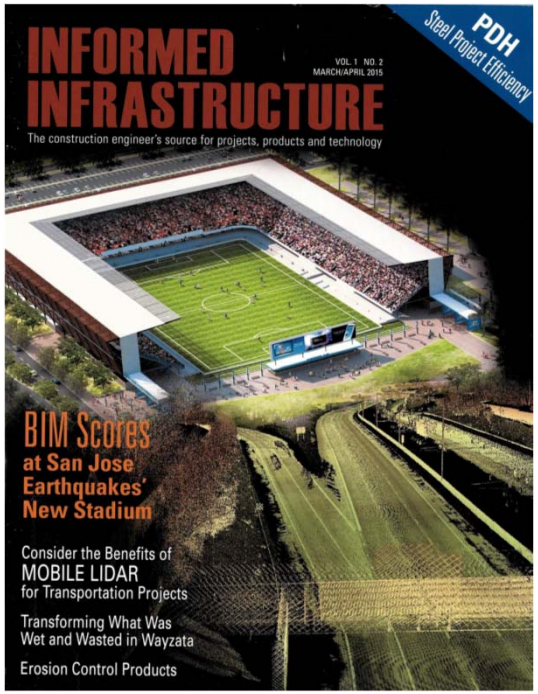
Mobile LiDAR at PennDOT

- First project completed in 2010
- Conducted a test to validate Mobile LiDAR in 2013
- Resulted in a research paper and a national magazine article
- Led to replacement of other technology



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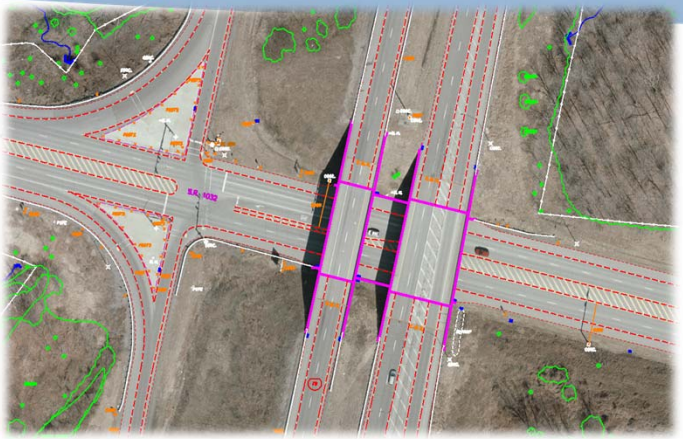
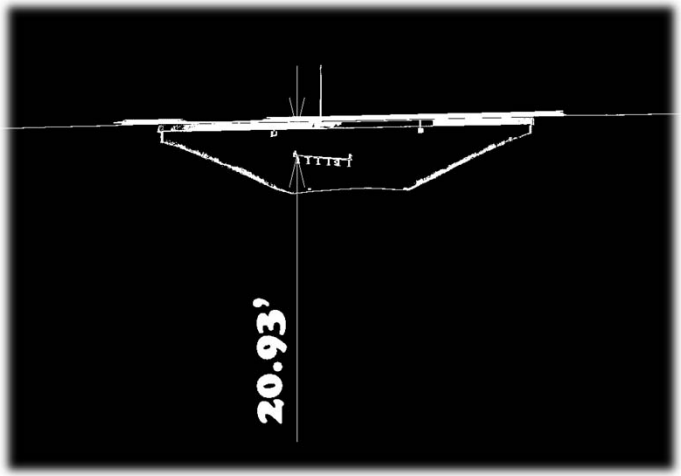
Integrated Topo – Mobile LiDAR





- Approximately 20 projects combining ground survey, Photogrammetry and Mobile LiDAR
- Best approach combining benefits of all technologies
- **I84-282 is a great example and actually used all four technologies discussed including Static LiDAR**

SR 84 Section 282:

Replacement or Rehabilitation of Three Structures and Widening to Three Lanes in Each

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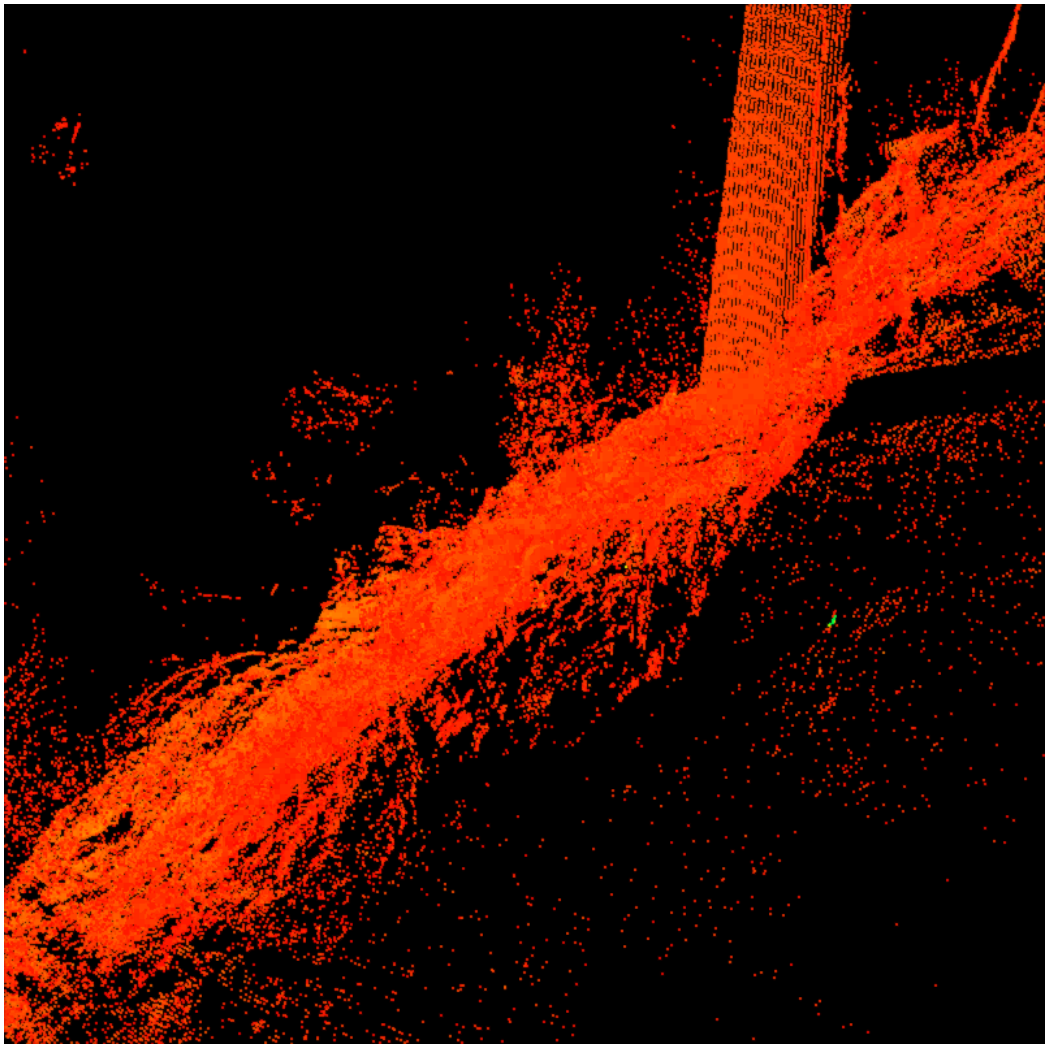
Static LiDAR to Monitor I84 Pier



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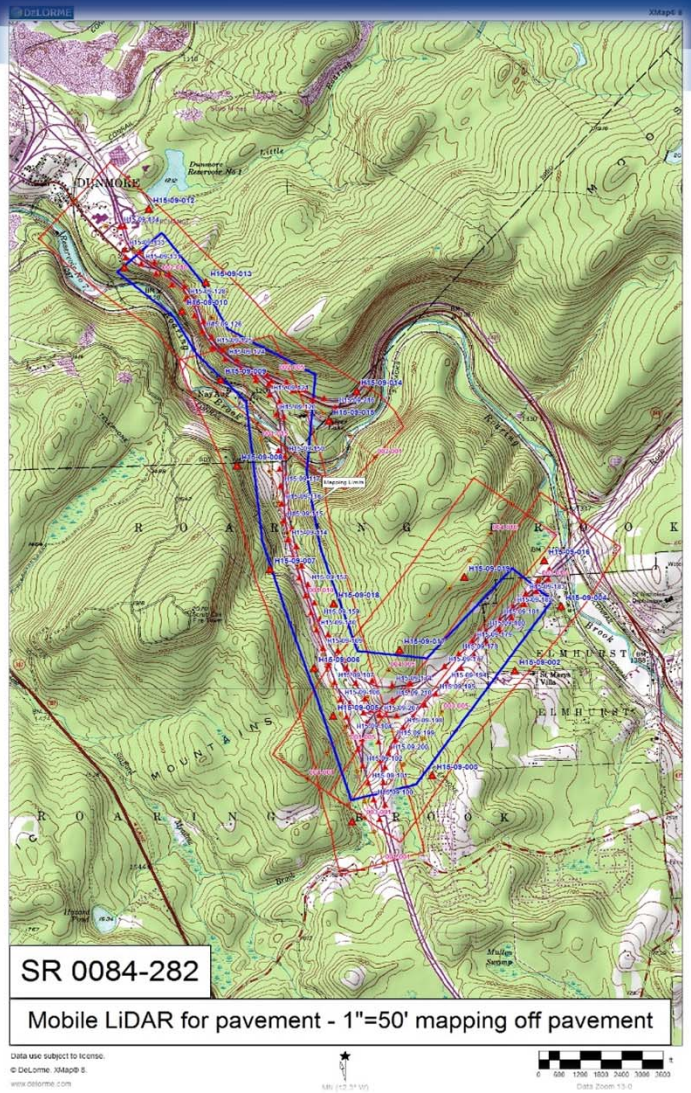
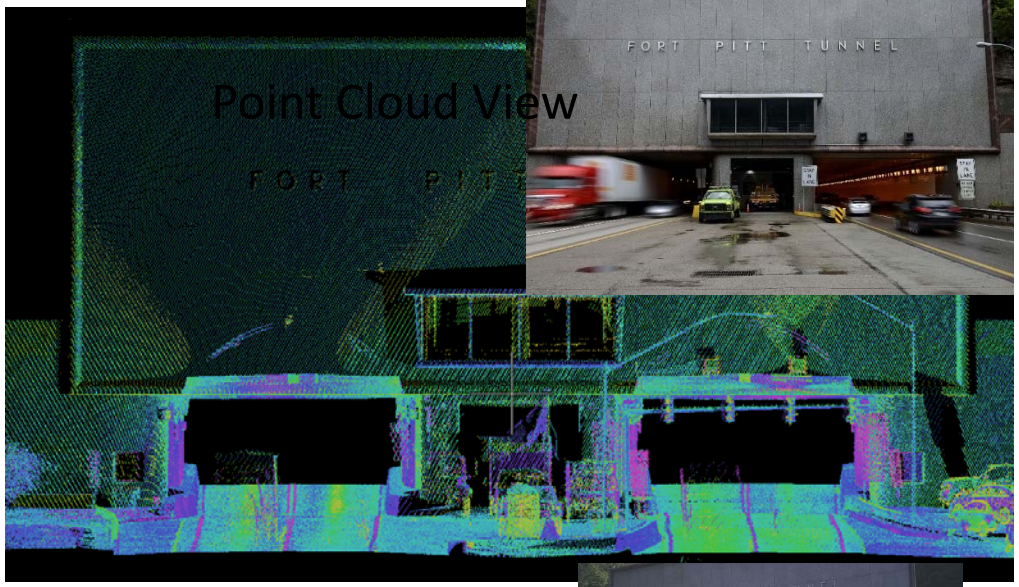
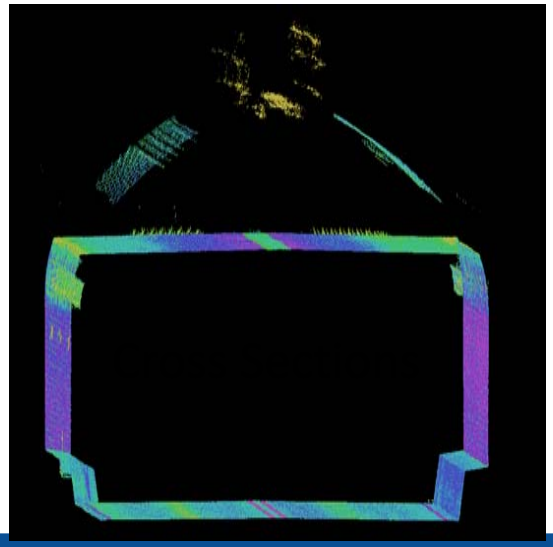


- Mobile LiDAR is very accurate to a distance of approximately 30 feet from the shoulders.
- Photogrammetry is used to supplement mobile LiDAR but does not match the accuracy.
- Ground survey was still required in areas where LiDAR or photogrammetry was obscured
- Surveyors were kept off of slopes, bridges and roadway.

Fort Pitt Tunnel – District 11
Safety for Surveyors, No Lane Closures





- Survey for designated historic structure
- High traffic volume
- Scan of entire tunnel structure prior to removal of ceiling
- Arranged for stoppage of traffic for only a few minutes to allow for mobile LiDAR scan vehicle to proceed without traffic interference.

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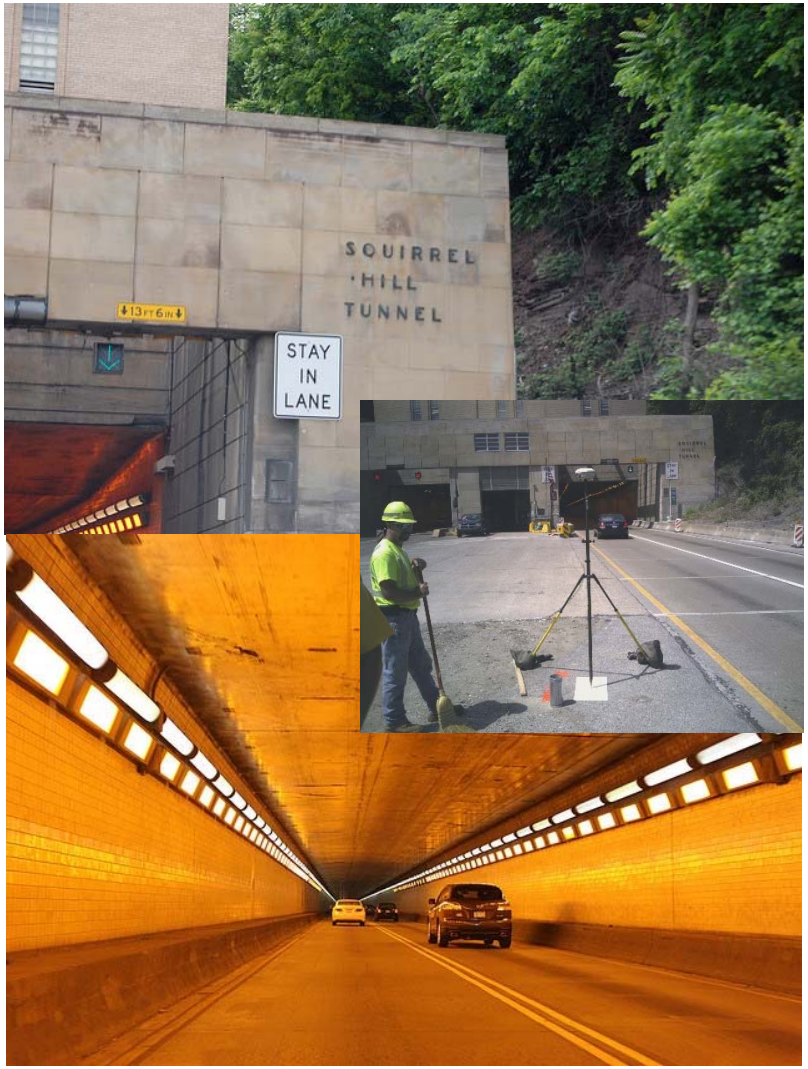
Squirrel Hill Tunnel – District 11
Safety for Surveyors, Limited Lane Closures



- LiDAR scan to capture As Built data post-construction
- Captured utility conduits, light fixtures, signs, and structure dimensions
- Control points were traversed and leveled through tunnel.
- Required one overnight single lane closure and full closure during Greenfield Bridge implosion to adjust survey control points.

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Clash Detection Simulation

- LiDAR point cloud model
- Software simulation for oversized loads

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Conclusion

- Static LiDAR for smaller sites
  - Greatly reduce or eliminate need to occupy…
    - Dangerous slopes and cuts
    - Bridge girders and decks
    - High traffic intersections
    - Tunnels and underpasses
  - Detailed data for monitoring
    - Retaining walls
    - Bridge abutments and wing walls

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Conclusion

- Mobile LiDAR for corridors
  - Nearly eliminates the need for lane closures
  - Eliminates the need to occupy the travel lanes
  - Captures bridge and other overhead structures
  - Best when combined with photogrammetry and Ground survey

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Questions

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