Creating 3D Engineered Models

January 8, 2013

11:00 am – 12:30 pm EST

U.S. Department of Transportation

Federal Highway Administration

Welcome & Introductions

Douglas Townes, P.E.
FHWA Resource Center

U.S. Department of Transportation
Federal Highway Administration

Introduction: Webinar Topics

Webinar 1:	Overview of 3D Models for Construction
Webinar 2:	Creating 3D Engineered Models
Webinar 3:	Applications of 3D Models in the Contractor's Office
Webinar 4:	Applications of 3D Models on the Construction Site
Webinar 5:	Managing and Sharing 3D Models for Construction
Webinar 6:	Overcoming Challenges to Using 3D Engineered Models for Construction
Webinar 7:	Steps to Requiring 3D Engineered Models for Construction
Webinar 8:	The Future: Adding Time, Cost and other Information to 3D Model

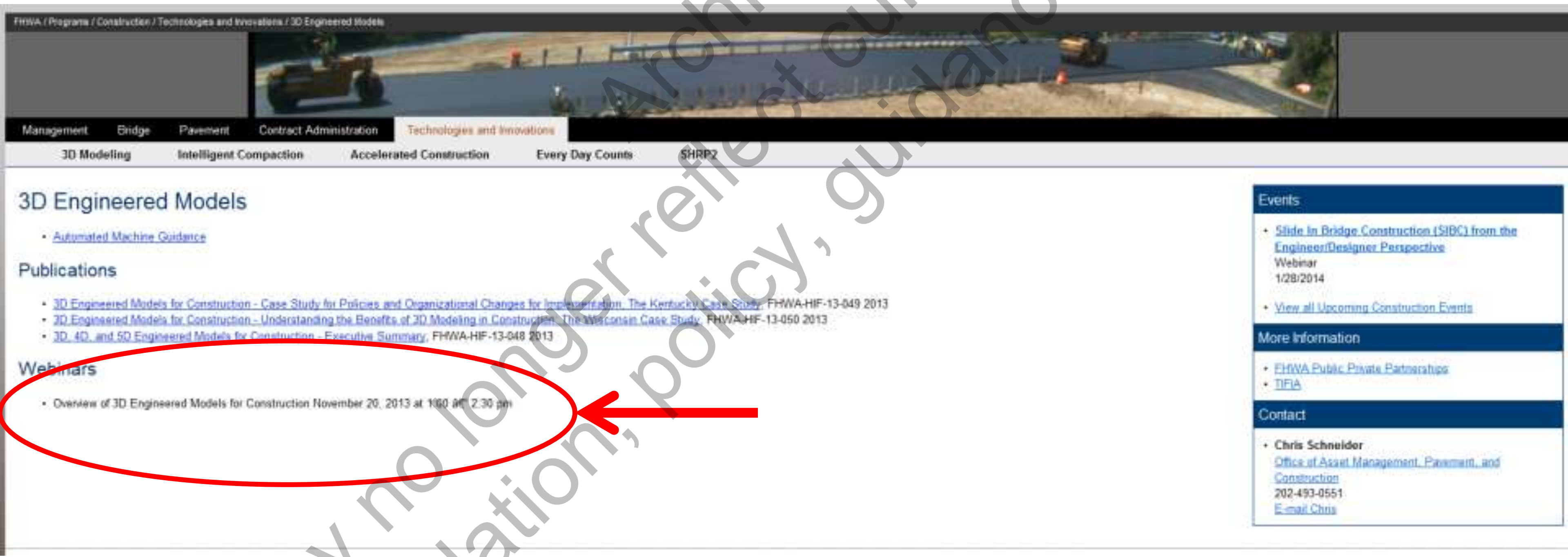
Introduction: Webinar Topics

Webinar 1: Overview of 3D Models for Construction
Webinar 2: Creating 3D Engineered Models
Webinar 3: Applications of 3D Models in the Contractor's Office
Webinar 4: Applications of 3D Models on the Construction Site
Webinar 5: Managing and Sharing 3D Models for Construction
Webinar 6: Overcoming Challenges to Using 3D Engineered Models for Construction
Webinar 7: Steps to Requiring 3D Engineered Models for Construction
Webinar 8: The Future: Adding Time, Cost and other Information to 3D Model

Webinar 1

Overview of 3D Engineered Models for Construction

www.fhwa.dot.gov/3D



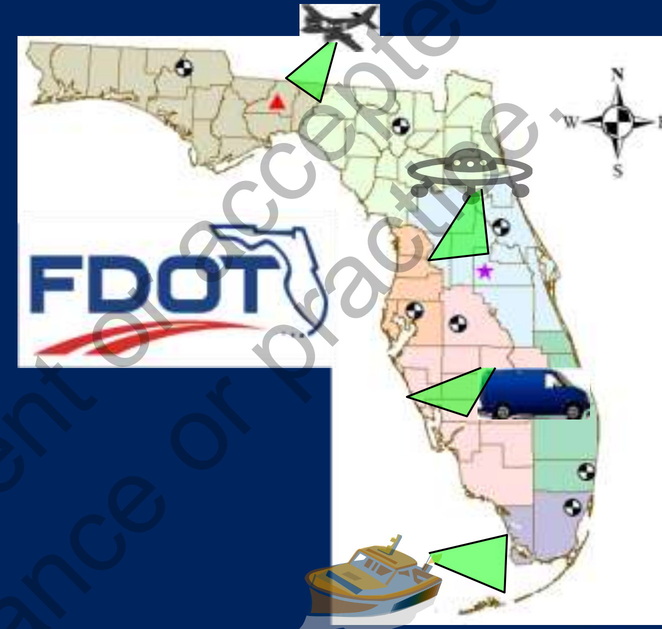
Today's Speakers

Speaker	Topic
Douglas Townes (FHWA-RC)	Welcome and Introductions
John Krause (Florida DOT)	Surveying Methods for 3D Models
Brett Wood (Florida DOT)	Surveying Methods for 3D Models
Francesca Maier (Parsons Brinckerhoff)	Creating 3D Models in Design
Mike Pullen (Multnomah County)	Using 3D Models in Public Outreach
Douglas Townes (FHWA-RC)	Information on Next Webinar and Close

Supporting 3D Design

Florida Department of Transportation
Surveying & Mapping Office

John Krause, PSM and Brett Wood, PSM



U.S. Department of Transportation
Federal Highway Administration

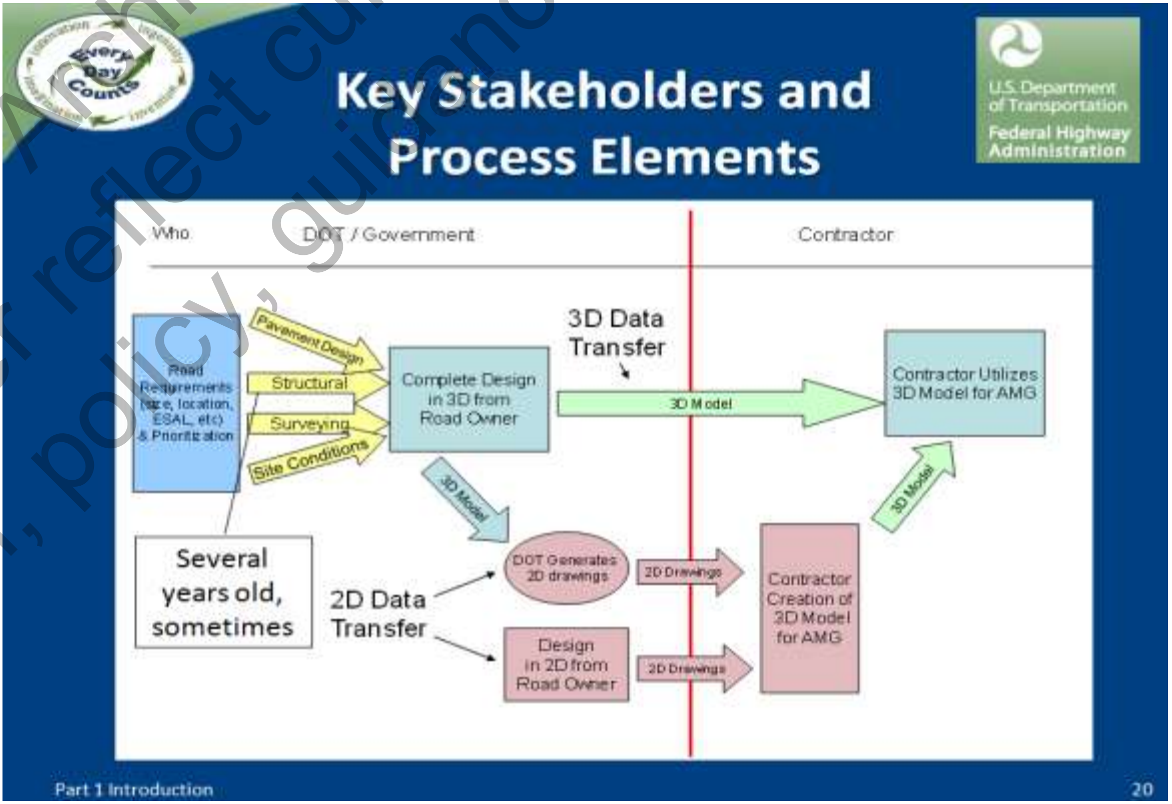
Learning Objectives

- Identify best practice for capturing existing conditions
- Describe how survey data is processed into useful outputs for design and construction

3D design efficiencies start early and go on throughout the life of the project

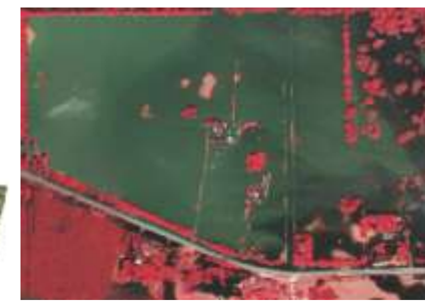
- 3D design efficiencies start early and go on throughout the life of the project
- To fully realize the cost savings of 3D design FDOT is moving towards providing the contractors with digital 3D design plans.
  - This will allow the contractors to estimate the project more accurately.
  - Project packages can be sent to responding contractors much faster and more efficiently than traditional paper hard copies.
  - All respondents will be estimating from the same “sheet of music”.

- Supporting certified digital survey data of existing conditions.
  - Typically this would include a topographic surface and 3D data.
  - Provided with digital signatures using
  - http://www.identrust.com/government/index.html



Supporting 3D Design

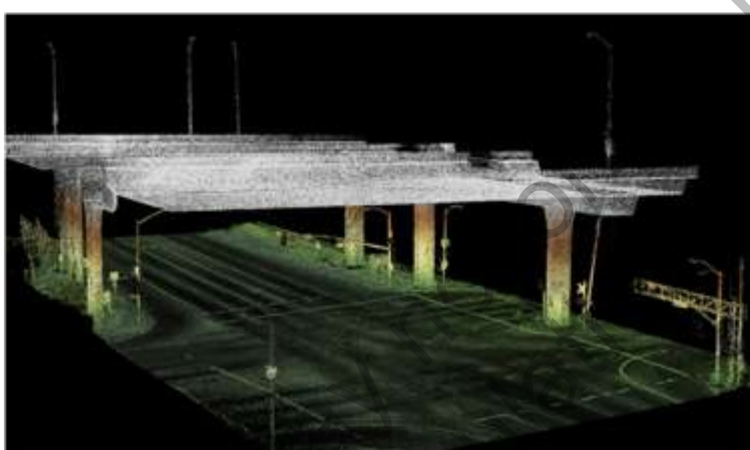
- SOME KEY ELEMENTS DRIVING 3D DESIGN ARE THE ADVANCEMENTS IN SURVEYING WHICH ALLOW SWIFT COLLECTION OF REMOTELY SENSED <u>**IMAGERY**</u> DATA WITH ACCURACIES SUFFICIENT FOR DESIGN.



The Old Way

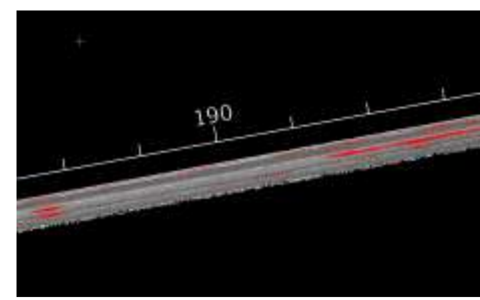
<u>Imagery Characteristics:</u>

- Often includes valuable ancillary information
- Details difficult if not impossible to collect conventionally
- Better representation of change
- More detail
- Downside – storage!



http://www.saminc.biz/project/detail/crenshaw-light-rail-mobile-mapping

http://www.earthmagazine.org



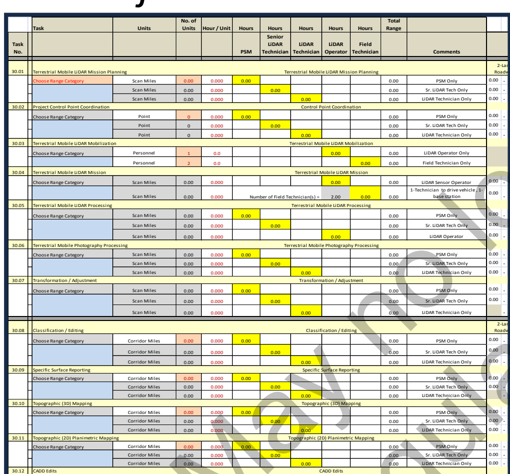
FDOT Implementation of Terrestrial Mobile LiDAR

- TML Task Team established in 2012 by the State Surveyor and District Surveyors
- Establish Consistent, Predictable & Repeatable (CPR) survey processes and documentation
- Included FDOT Central Office Remote Sensing and Location Survey personnel.
- Representatives from each FDOT District
- Interested consultants with experience using technology
- Limited Team size to maintain functionality.

TML Guidelines


TERRESTRIAL MOBILE LIDAR SURVEYING & MAPPING GUIDELINES
Florida Department of Transportation
August 23, 2012

TML Project Staff Hour Form



TML General Scope


30 TERRESTRIAL MOBILE LIDAR

30.1 Mission Planning

30.2 Project Control Point Coordination

30.3 Mobilization

30.4 Mobile LiDAR Mission

30.5 LiDAR Processing

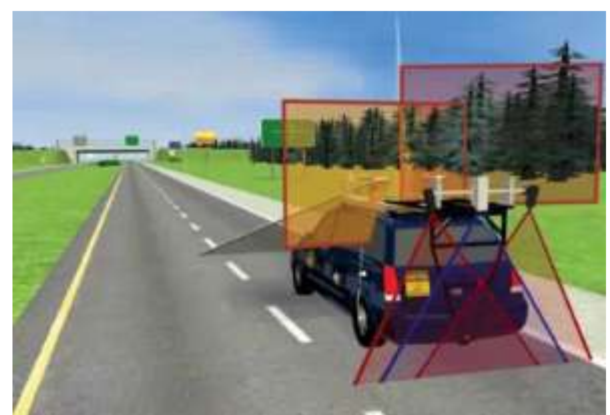
30.6 Terrestrial Mobile Photography Processing

30.7 Transformation / Adjustment

General Mobile LiDAR Survey Methods and Vertical Accuracies

- Fixed Wing Aerial LiDAR Mapping (ALS) = +/- 0.5 – 1.0 feet
- Low Altitude MLS = +/- 0.1 – 0.2 feet
- Vehicle TMLS = +/- 0.050 – 0.1 feet
- Static Laser Scanning = +/- 0.005 – 0.05 feet

3D Design projects are beginning to be supported by several survey imagery technologies



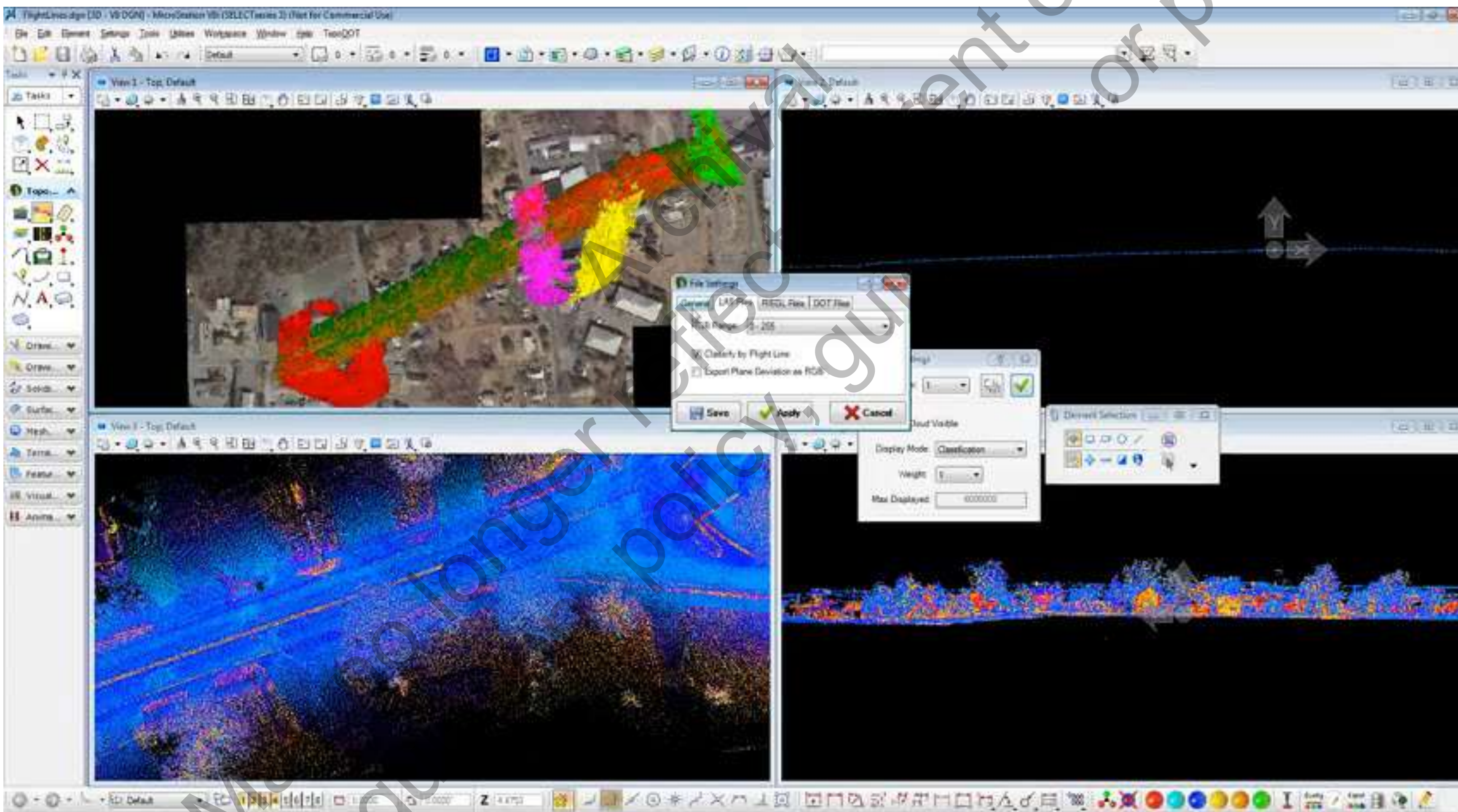
Improving Technology

Low Altitude LiDAR Testing in District 3

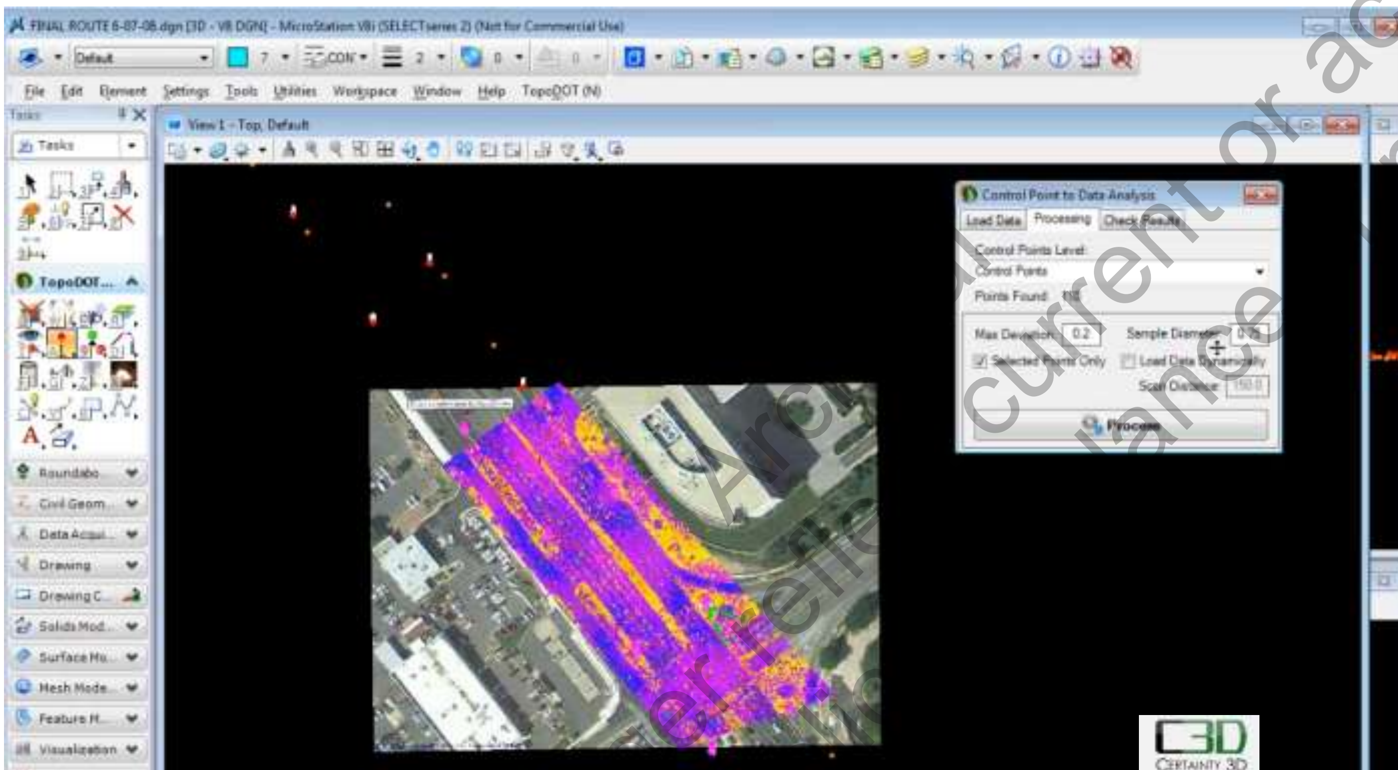
Washington County SR 10	FDOT X-Sections	Difference	150kHz Roto-X	Difference	80kHz FrgSet1-X	Difference	150kHz FrgSet2-X	Difference	240kHz FrgSet3-X	Difference	400kHz FrgSet4-X
BEGIN 1	1	0	1	0	1	0	1	0	1	0	1
1562524.429 649544.226	78.304	-0.163	78.467	-0.097	78.401	0.061	78.243	0.063	78.241	-0.093	78.397
1562523.036 649548.922	78.634	-0.088	78.722	-0.015	78.649	0.202	78.432	0.156	78.478	-0.051	78.685
1562520.116 649560.522	78.959	-0.083	79.042	0.007	78.952	0.21	78.749	0.123	78.836	-0.052	79.011
1562517.459 649572.428	78.967	-0.084	79.051	-0.054	79.021	0.155	78.812	0.153	78.814	0.045	78.922
1562516.255 649576.851	78.722	-0.087	78.809	-0.007	78.729	0.059	78.663	0.034	78.688	-0.06	78.782
END											
BEGIN 2	2	0	2	0	2	0	2	0	2	0	2
1562623.897 649570.799	79.857	-0.109	79.966	-0.081	79.938	0.119	79.738	0.095	79.762	-0.051	79.908
1562622.459 649575.294	80.203	-0.061	80.264	0.002	80.201	0.16	80.043	0.091	80.112	-0.06	80.263
1562619.377 649586.984	80.587	-0.065	80.652	-0.006	80.593	0.207	80.38	0.122	80.465	-0.038	80.625
1562616.357 649598.829	80.443	-0.115	80.558	0.006	80.437	0.2	80.243	0.144	80.299	-0.026	80.469
1562615.191 649603.490	80.168	-0.146	80.314	-0.056	80.224	0.06	80.108	-0.01	80.178	-0.081	80.249
END											
BEGIN 3	3	0	3	0	3	0	3	0	3	0	3
1562722.625 649597.367	82.064	-0.099	82.163	-0.012	82.076	0.114	81.95	0.11	81.954	-0.05	82.114
1562721.847 649601.856	82.399	-0.049	82.448	0.003	82.396	0.195	82.204	0.148	82.251	-0.03	82.429
1562718.872 649613.402	82.696	-0.017	82.713	0.016	82.68	0.165	82.531	0.102	82.594	-0.014	82.71
1562715.747 649625.257	82.498	-0.062	82.56	-0.03	82.528	0.156	82.342	0.145	82.353	-0.08	82.578
1562715.168 649630.244	82.187	-0.108	82.295	-0.051	82.238	0.144	82.043	0.118	82.069	-0.029	82.216
END											

Managing LiDAR Data

- Using TopoDOT to filter Mobile LiDAR Data for quality control
- Usual step is to delineate point cloud data by vehicle trajectory
- Compare passes for coverage and to estimate vertical precision.



Managing LiDAR Data

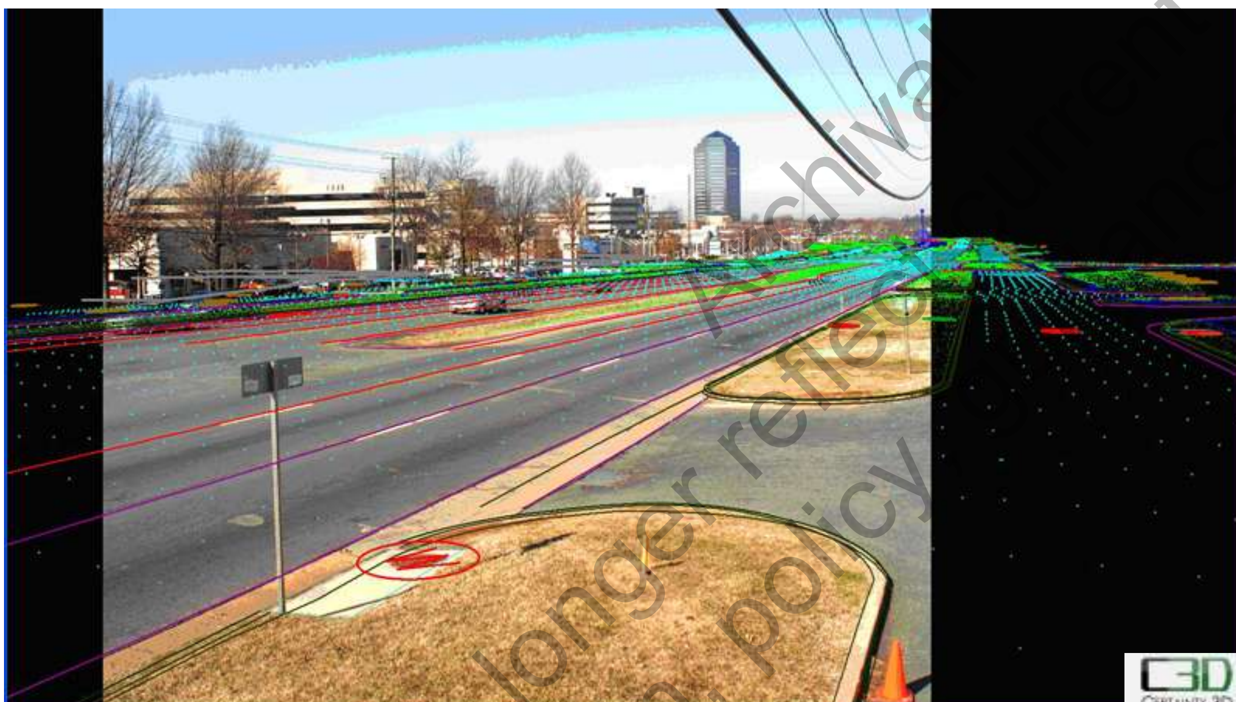


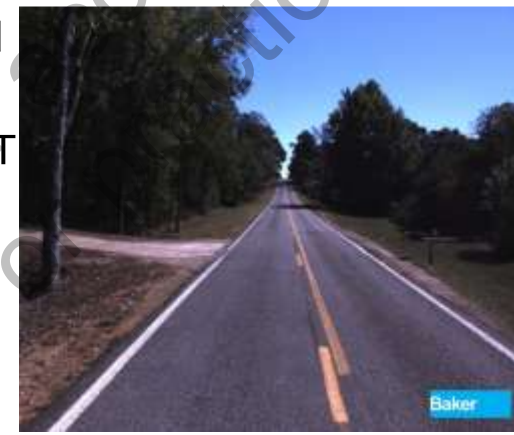
Tool Settings	Effect
Delete Small Files	Deletes small parsed files that have less than 1000 points.
Creating Grid Elements	Specify whether or not to draw the grid tiles within MicroStation.
X Block Size	Specify the width of the block to be used to parse data.
Y Block Size	Specify the height of the block to be used to parse data.
Thin Data	Thins the data by selecting every Nth point (Specified in the next settings box)
Nth Point	The number of points to skip when thinning the data. (Ex: Inputting 2 for Nth point will load every other point into the new parsed data tiles. Inputting 3 for Nth point will load every third point into the new parsed data tiles. Etc)

- Using TopoDOT to filter Mobile LiDAR Data into manageable sizes
- Usual step is to segregate point cloud data by uniform tile areas with matching filenames
- Be careful when thinning data
  - Filter, don't delete
  - Always be mindful of final object design criteria as it relates to accuracy and point density

Combining Photography With Mobile LIDAR

- Combining the two remote sensing technologies yields better 3d survey information
- Keep in Mind it is not independent if processed from same SBET



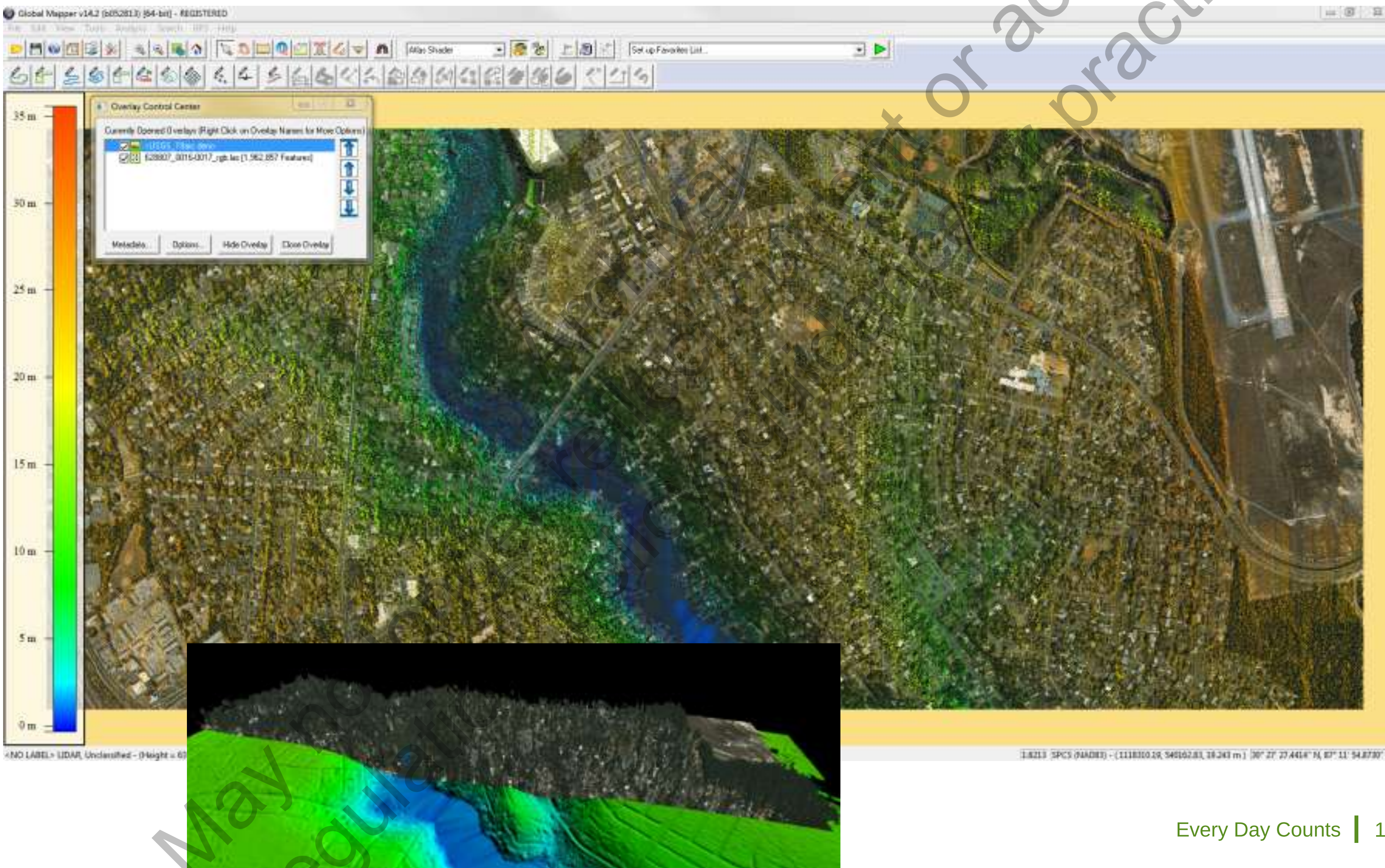


Photogrammetry - Autocorrelation

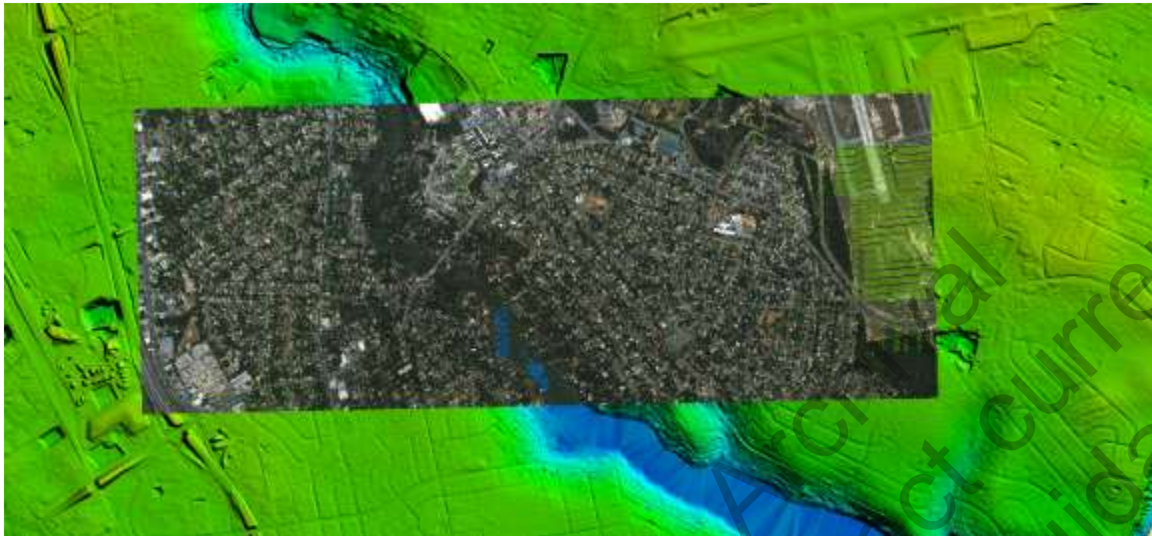
Fort Pickens

Advantage of Additional Datasets

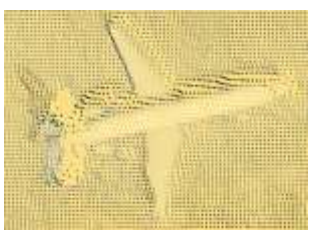
Global Mapper Software – Comparing Image Data

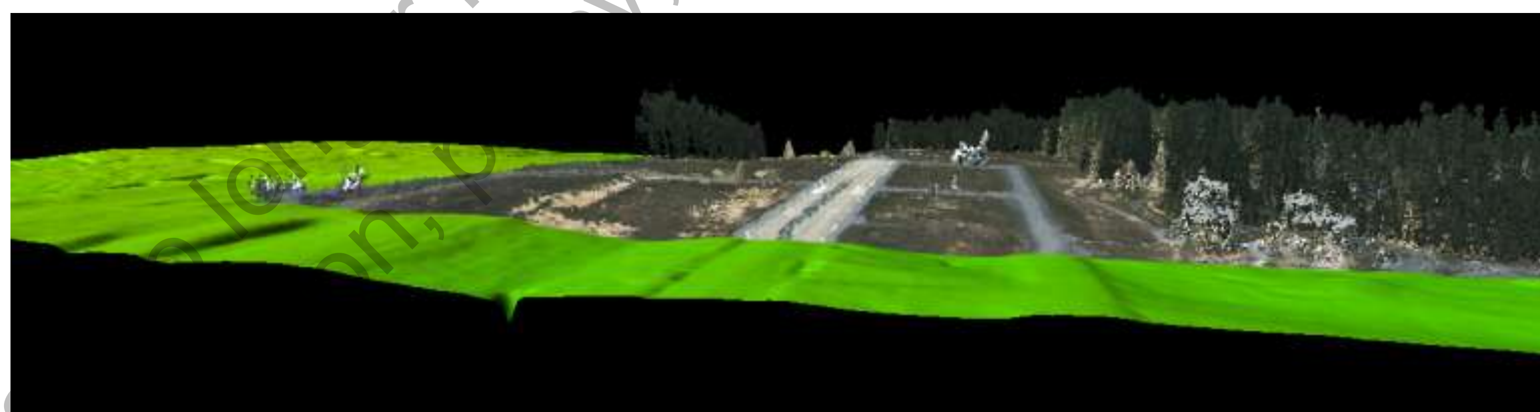


Verifying USGS DEM Surface for Orthophotography



FDOT - SMO

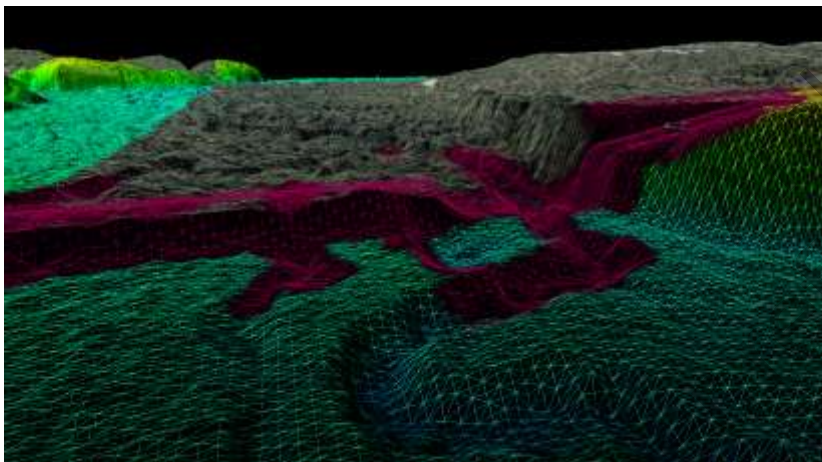




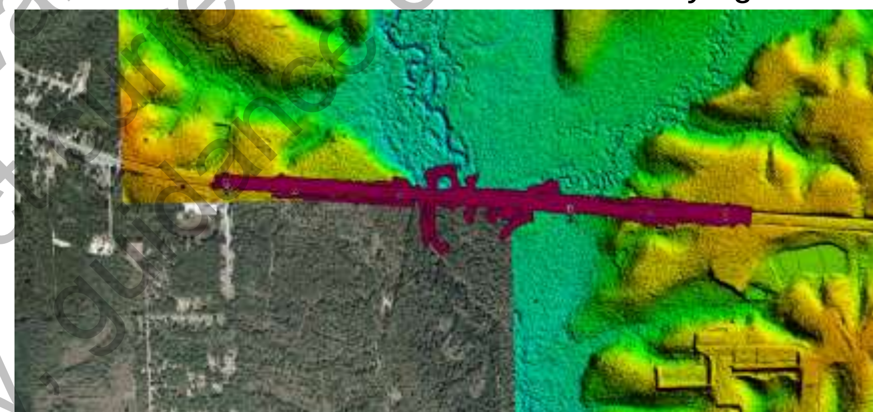
Autocorrelation from Digital Mapping Camera (DMC) Imagery

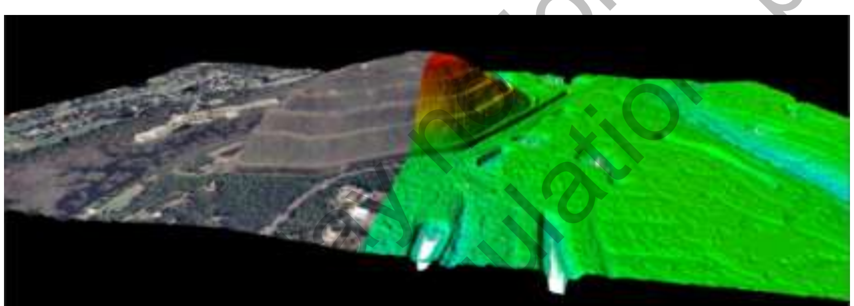
Summary

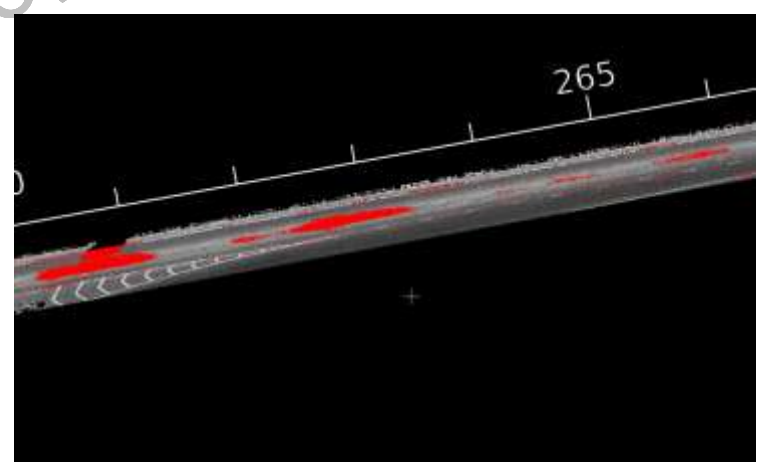
- When measured on a common datum, imagery from different sources can be very beneficial
  - Verify Accuracy
  - More complete Information
  - Change detection
- The 3D model - Greater than the some of it's parts



Photogrammetry, LiDAR, and Conventional Surveying







Rutting on Interstate 10

Verify Learning Outcomes

- Identify best practice for capturing existing conditions
- Describe how survey data is processed into useful outputs for design and construction

Creating 3D Engineered Models in Design

Francesca Maier, PE
Parsons Brinckerhoff

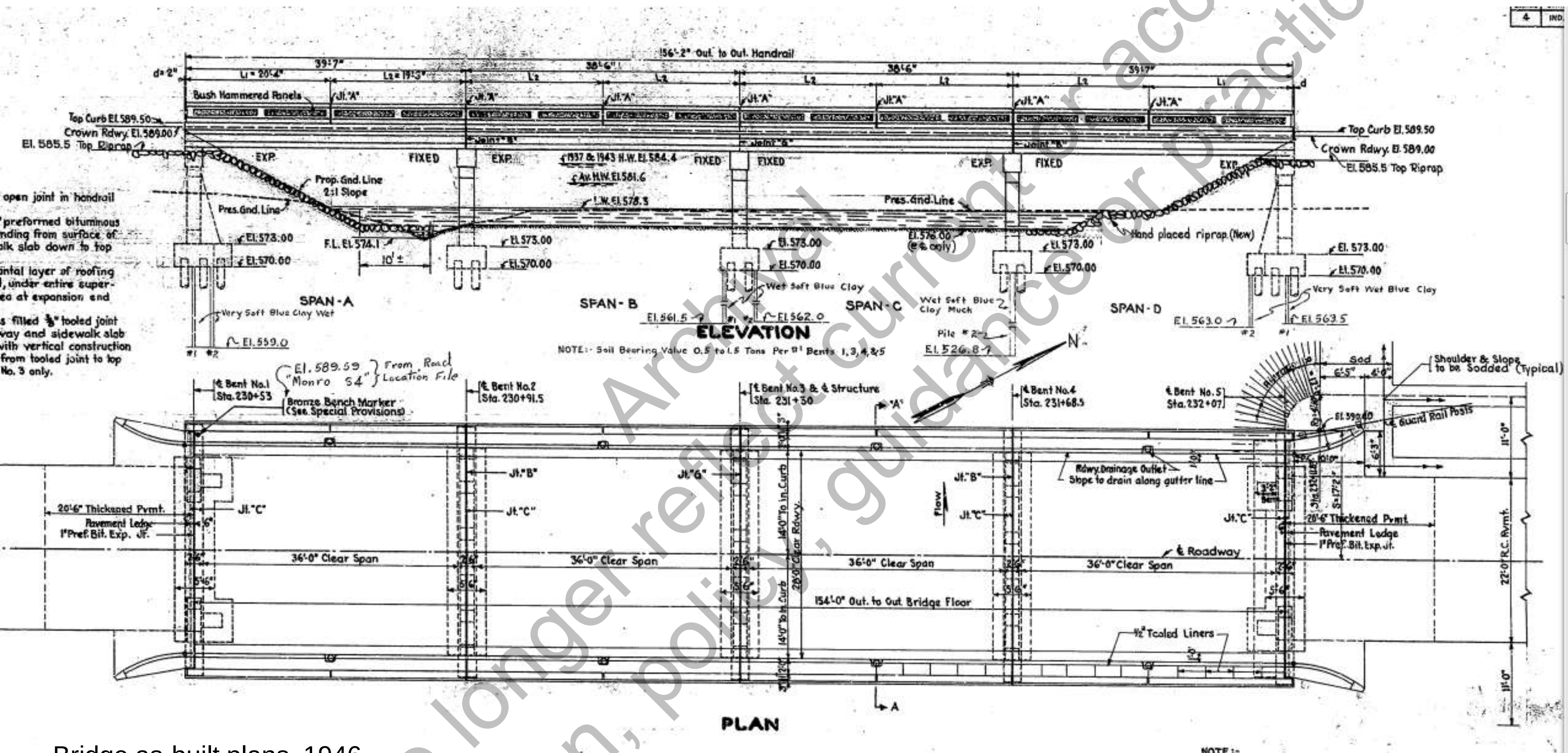
Every Day Counts
innovation ingenuity invention imagination

U.S. Department of Transportation
Federal Highway Administration

Learning Objectives

- Identify rapid 3D Modeling tools using GIS data
- Describe types of 3D models developed during design
- Describe how 3D models are prepared for Automated Machine Guidance

Lifecycle Data



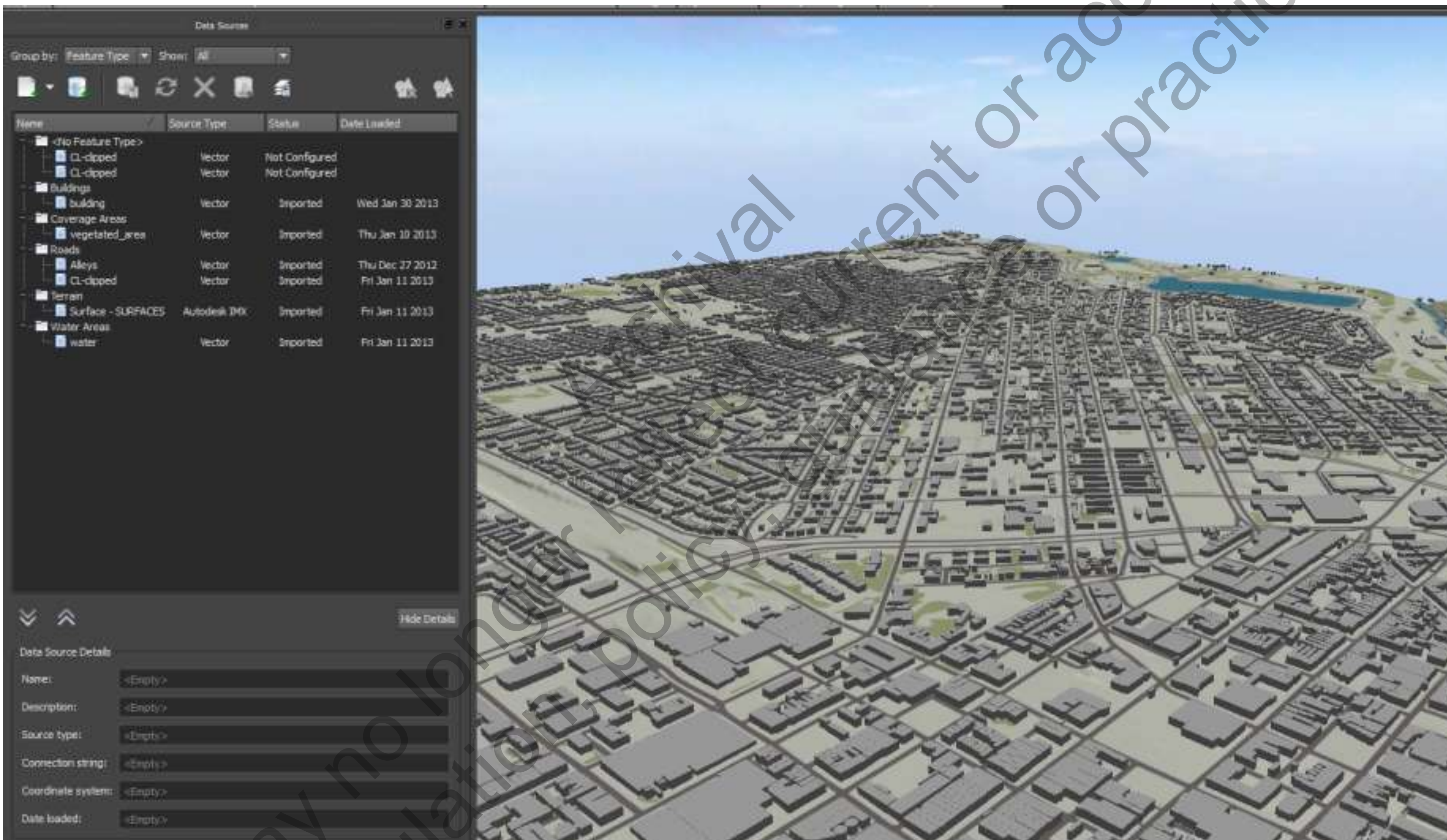
Bridge as-built plans, 1946

Lifecycle Data

Use of 3D Data in Planning

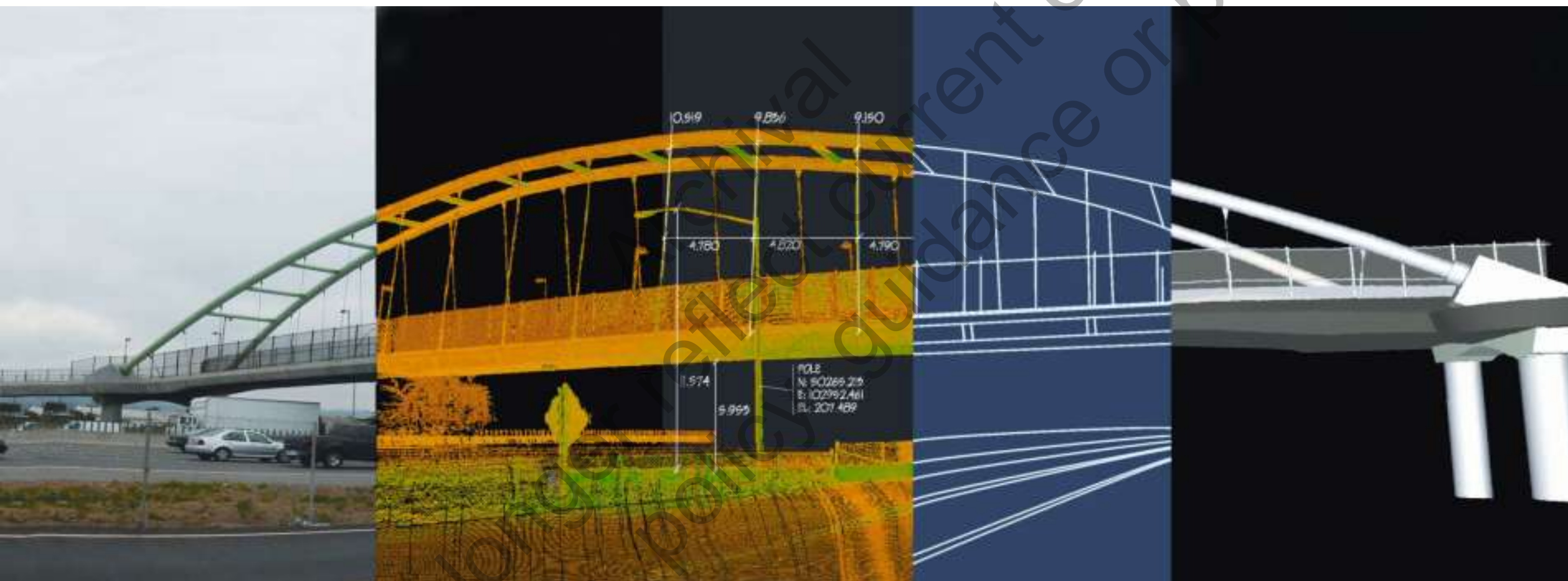
Source: Washington State DOT

3D Context Models from GIS Data



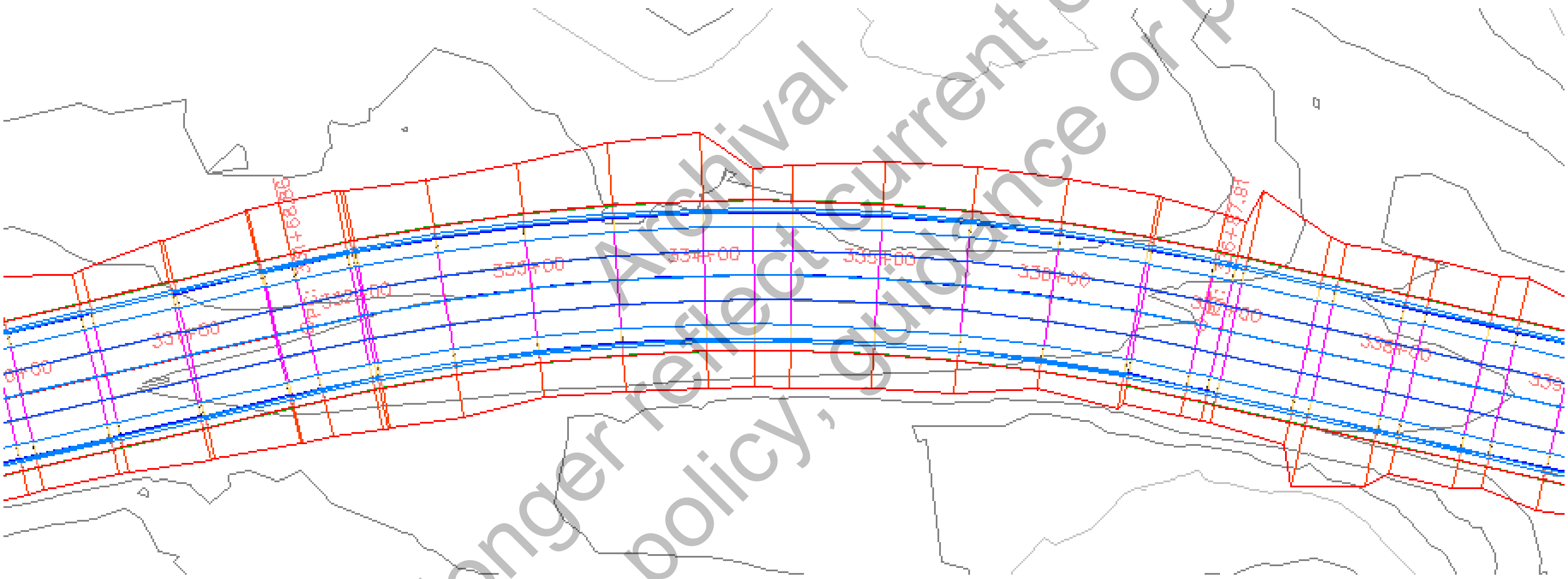
Source: Parsons Brinckerhoff

Growing Detail in Design Models

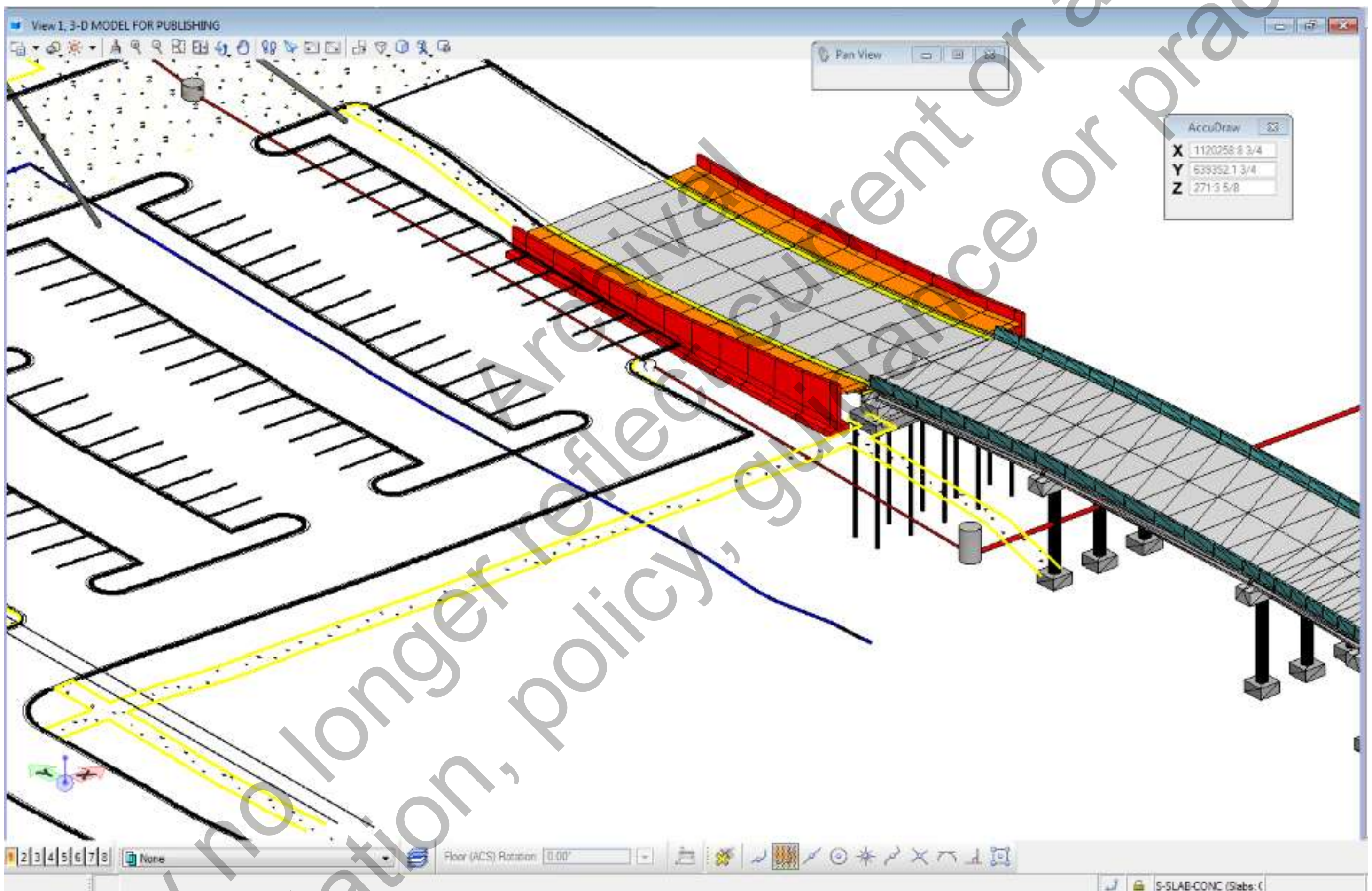


Source: Wisconsin DOT

Growing Detail in Design Models

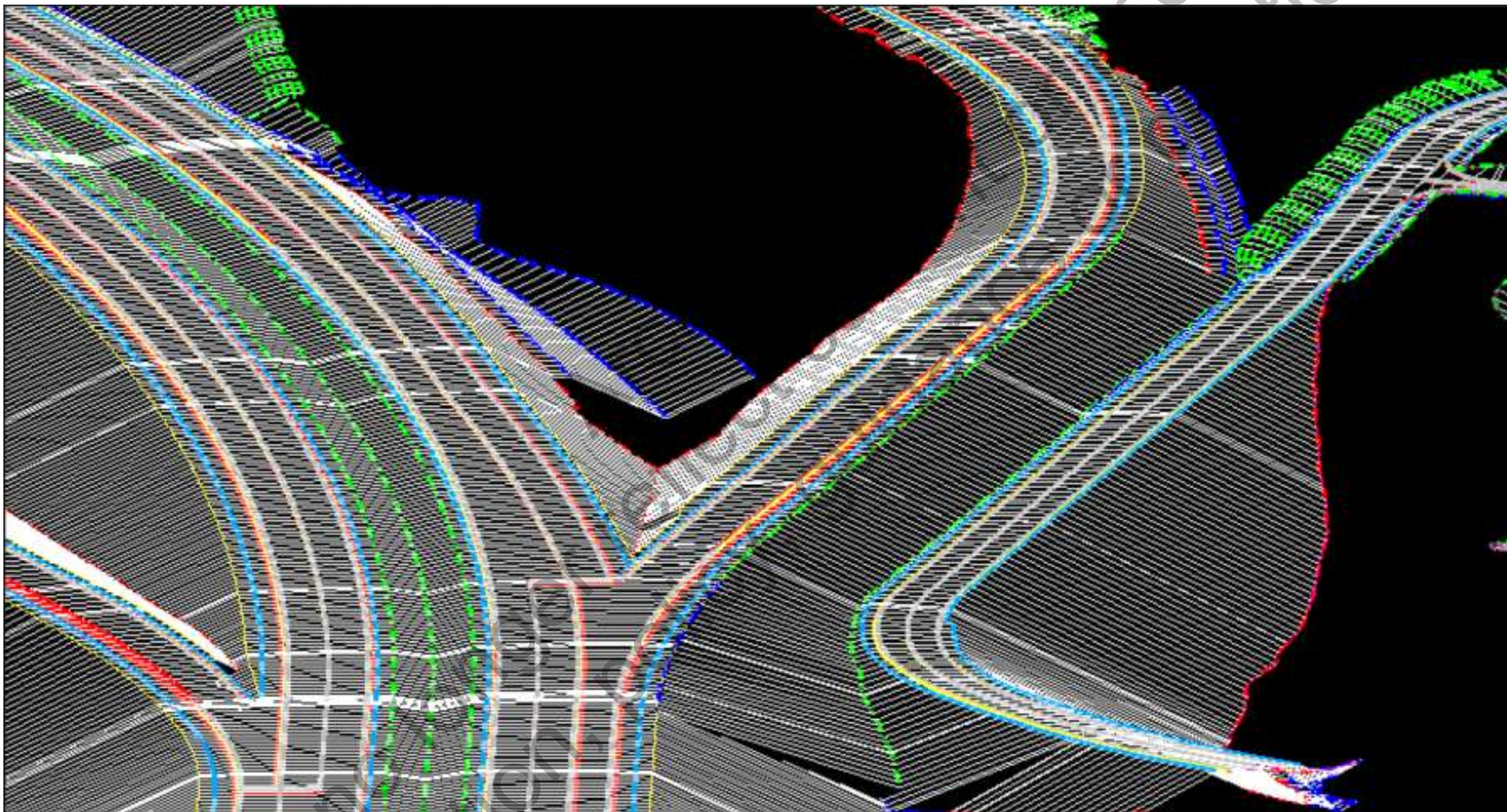


Growing Detail in Design Models



Source: Bentley Systems

Growing Detail in Design Models

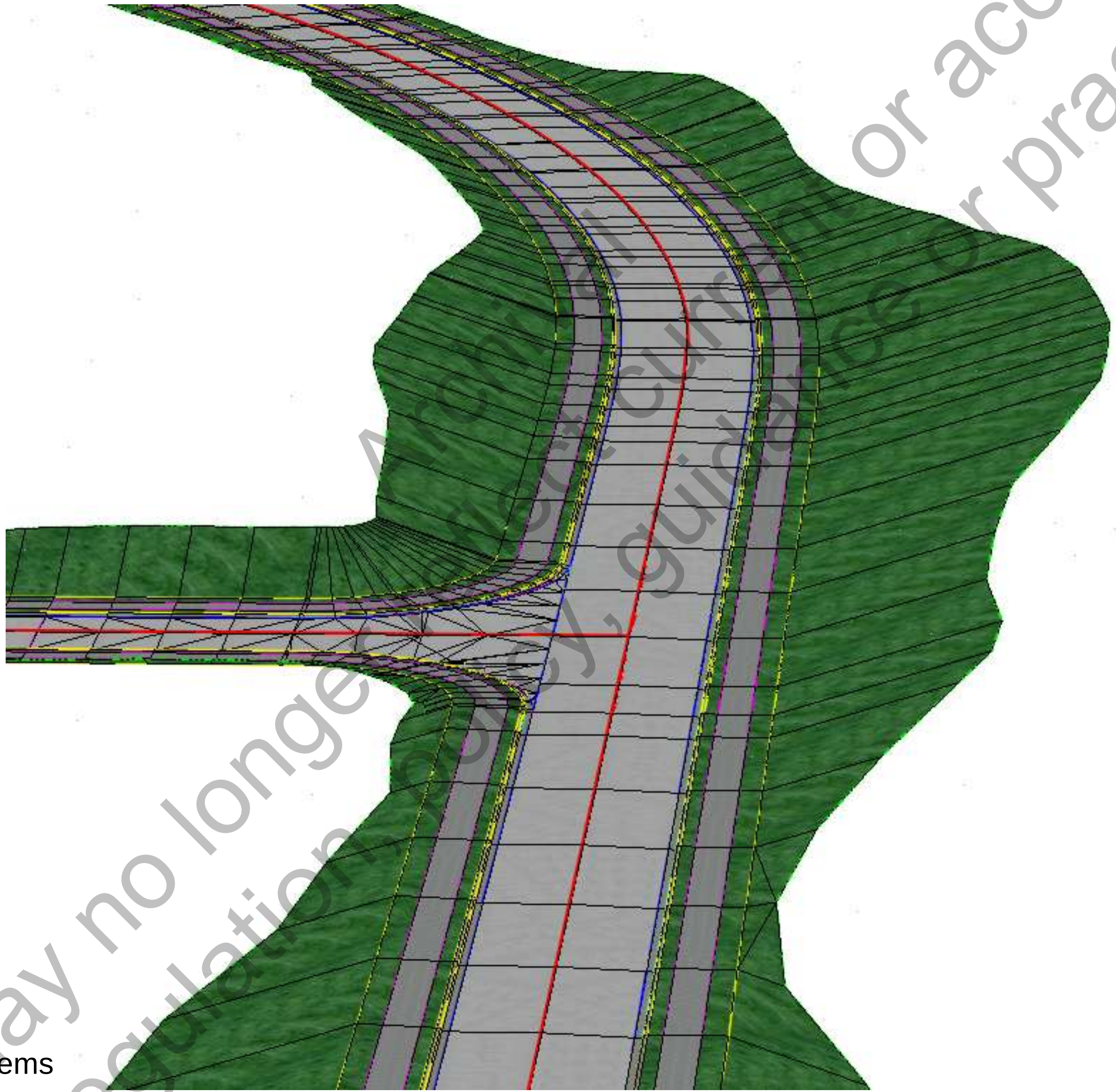


Source: HNTB

What's in your design workflow?

- CADD alignments, profiles and superelevation
- Criteria for cross-sections and earthworks
- Corridor models for cross-sections and earthworks
- Proposed TINs for earthworks
- Outputting LandXML for bidding
- Outputting line strings for bidding
- Releasing corridor models for bidding

Detail Needed for Construction: Design Intent



Source: Bentley Systems

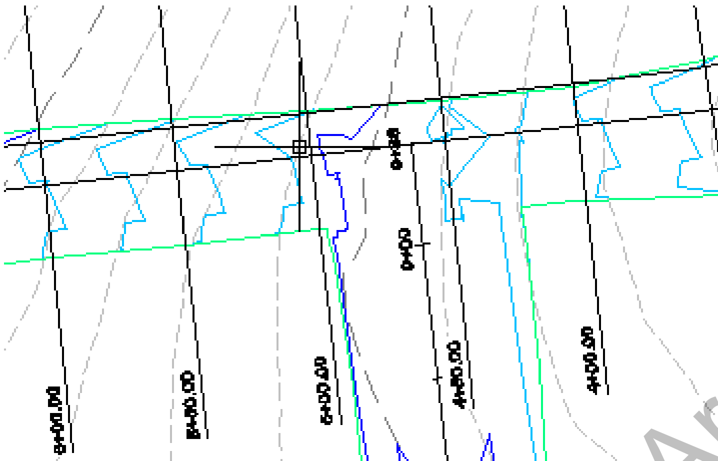
Detail Needed for Construction: AMG

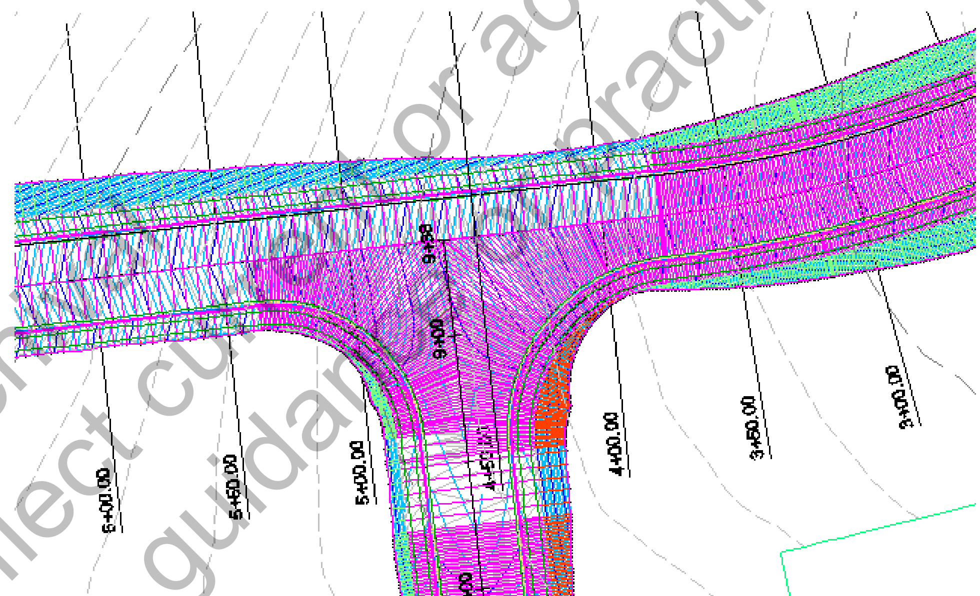
Source: Sundt Construction

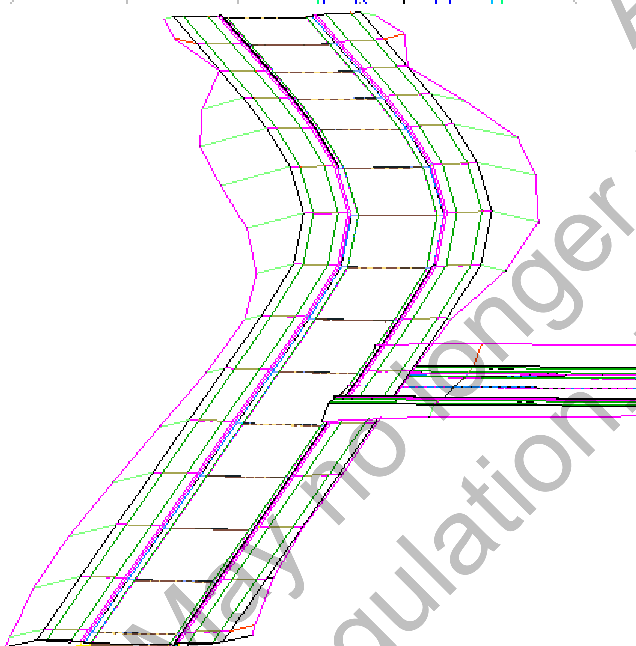
Detail Needed for Construction: AMG

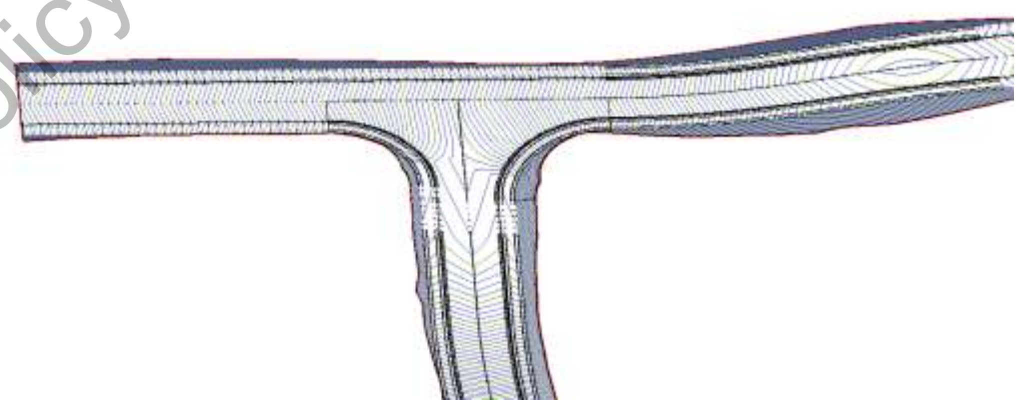
Source: Florida DOT

3D for Plans versus 3D for AMG

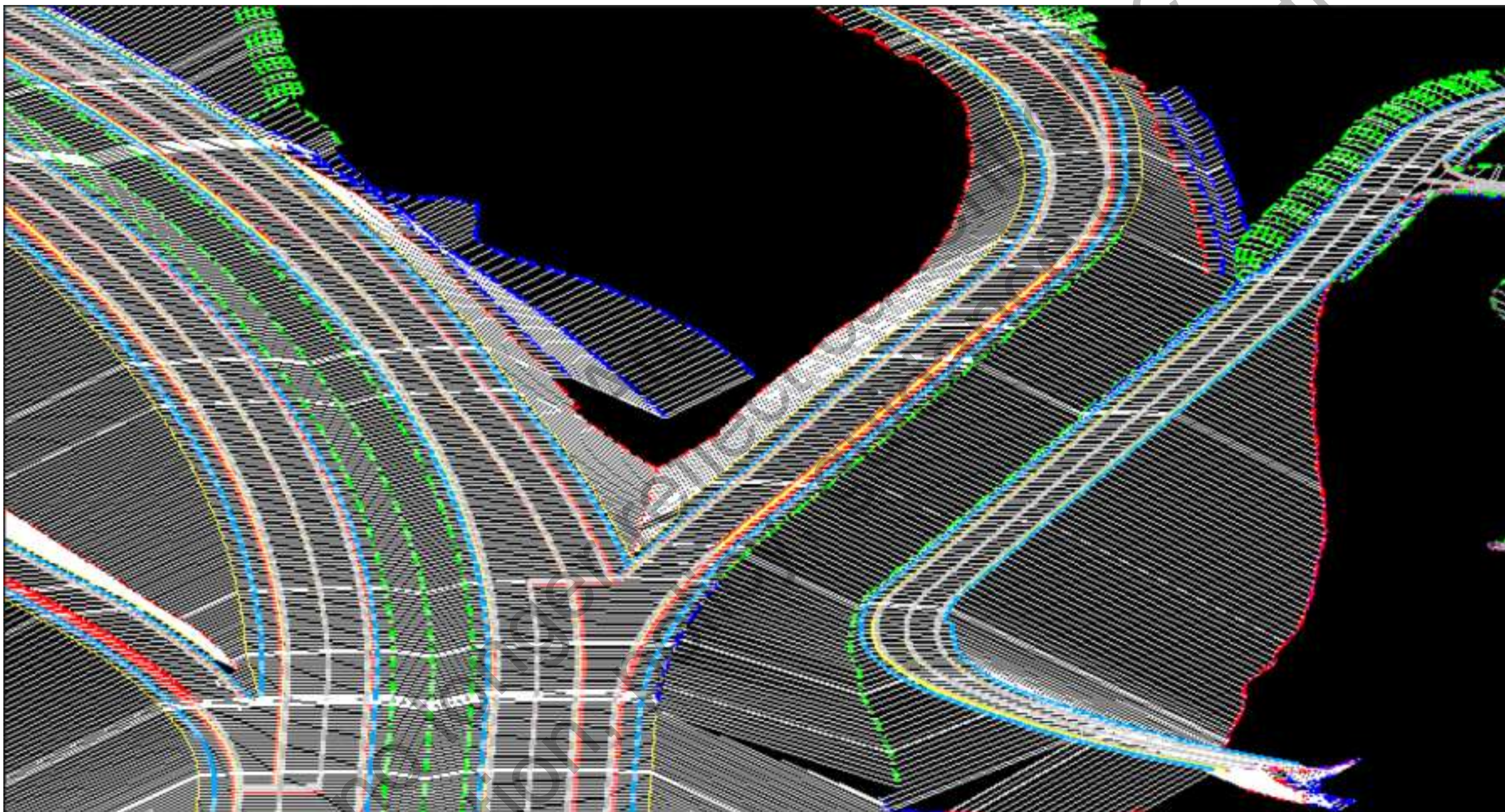




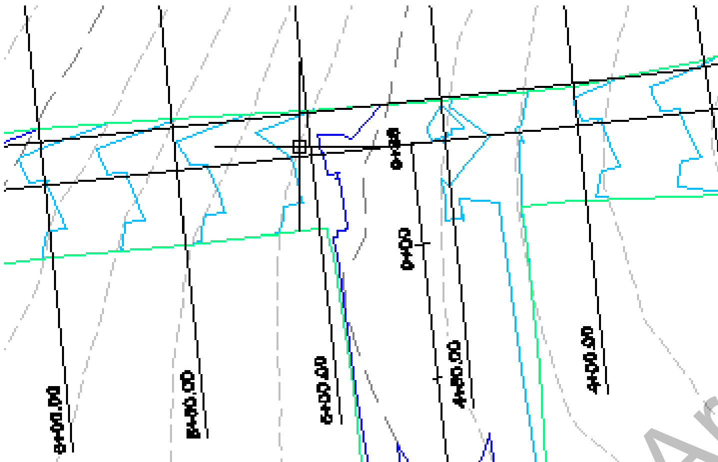


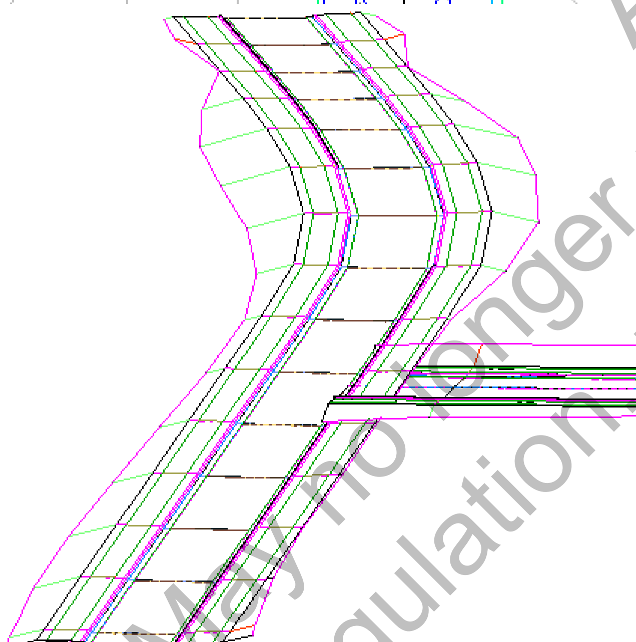


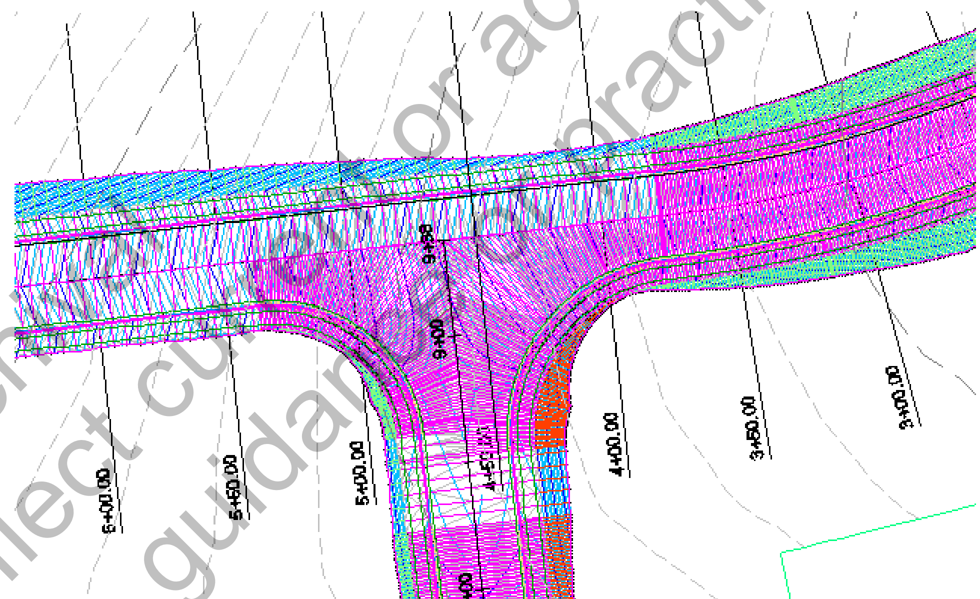
3D for Plans versus 3D for AMG

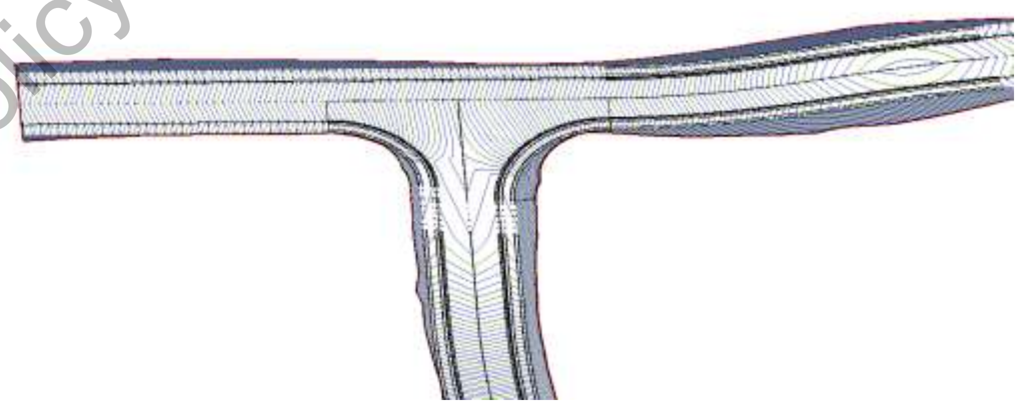


3D for Plans versus 3D for AMG

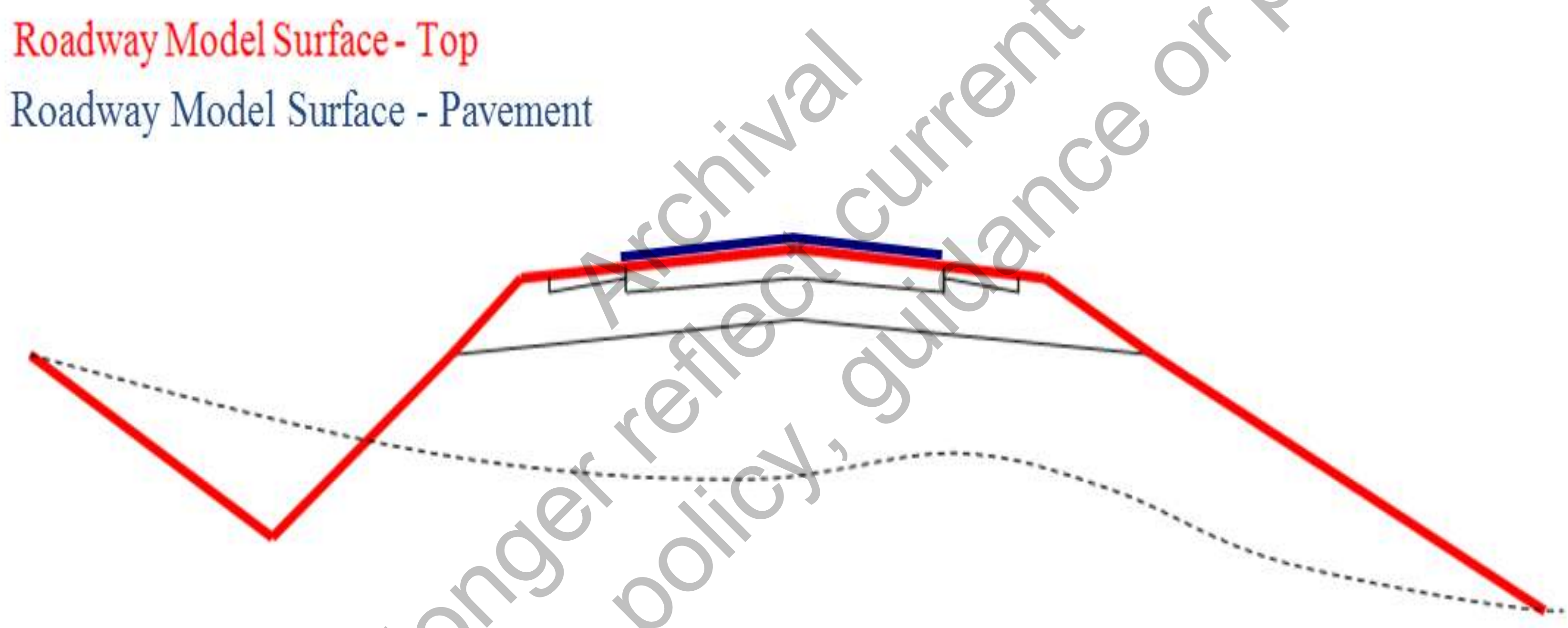






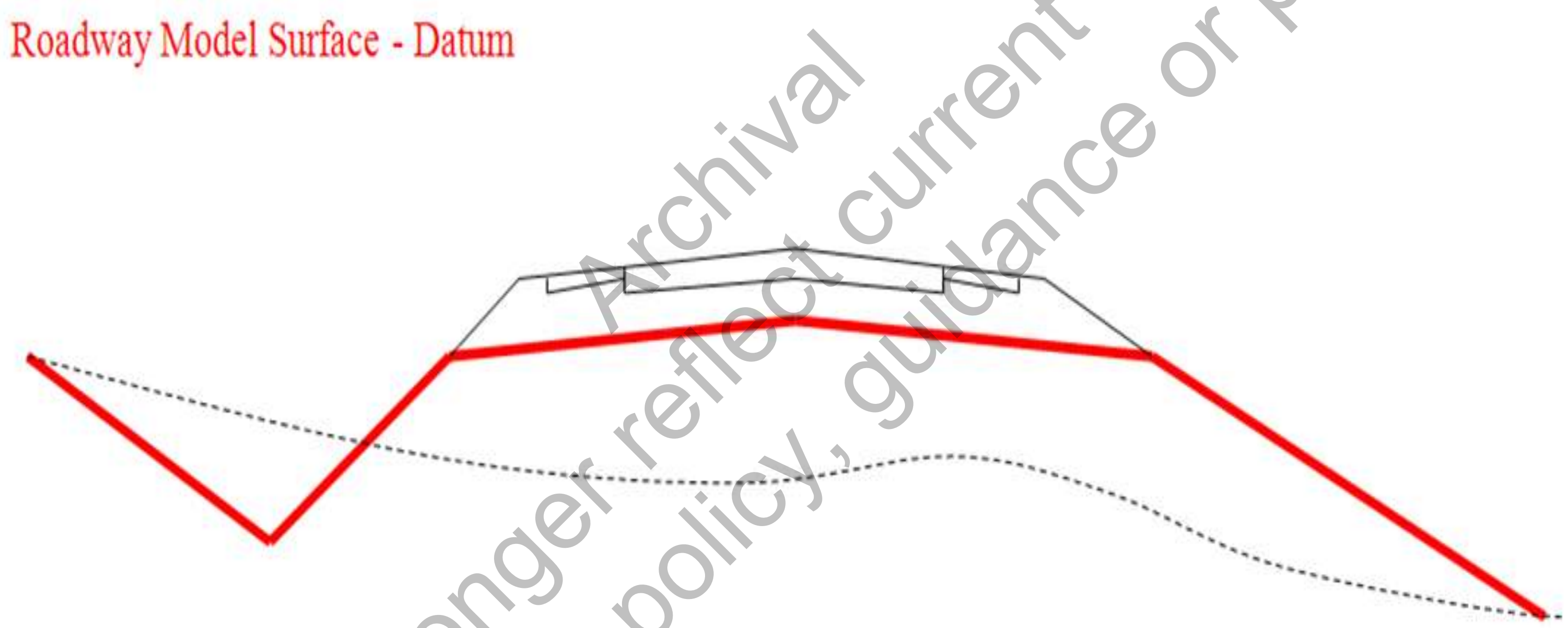


Surface Definitions for AMG



Source: Wisconsin DOT

Surface Definitions for AMG



Source: Wisconsin DOT

Digital Data for Information Only

- Do you have concerns about releasing Digital Data for Information Only?
  - Yes, I'd rather not release any digital data
  - Yes, but I'll release PDFs of the plans
  - Yes, but I'll release Alignments, Control Points and Existing Surfaces
  - Yes, but I'll release LandXML & 3D line strings
  - No, I'd release all digital data

Sharing 3D Models with Others

LAND XML .org

Useful Links | For the Consumer | Schema Versions | About

Welcome Land Development Professionals!

Quick Statistics
November 28, 2013

Members: 757
Organizations: 664
Countries: 41
Registered Software: 70

Stay informed and participate by joining the LandXML.org **Industry Consortium.**
See LandXML.org members from 2006 mapped in Google Earth.

View the message archives.

LandXML.org in a Nutshell
Launched January 2000, LandXML.org is committed to providing an non-proprietary data standard (LandXML), driven by an industry consortium of partners. ***There is no direct cost to join LandXML.org, nor specific level of participation required.***
Once you join, stay informed and participate by using the

News December 8, 2013

Thanks to Ladd Nelson of Carlson Software for updating the web site UI and layout.

New web application to convert FAA NGS survey data to LandXML-1.2 on web applications.

Expanded domain/email mapping to Google Earth & Google Maps web application

Is your software **LandXML Registered and Certified**?

Software vendors Apply for Registered Software status today

LandXML.org has resumed active status. Contact us

LandXML Validator & Report Generator on the Web Applications page.

LandXML to SVG Web Application (Works for LandXML-1.0, LandXML-1.1, LandXML-1.2 files)

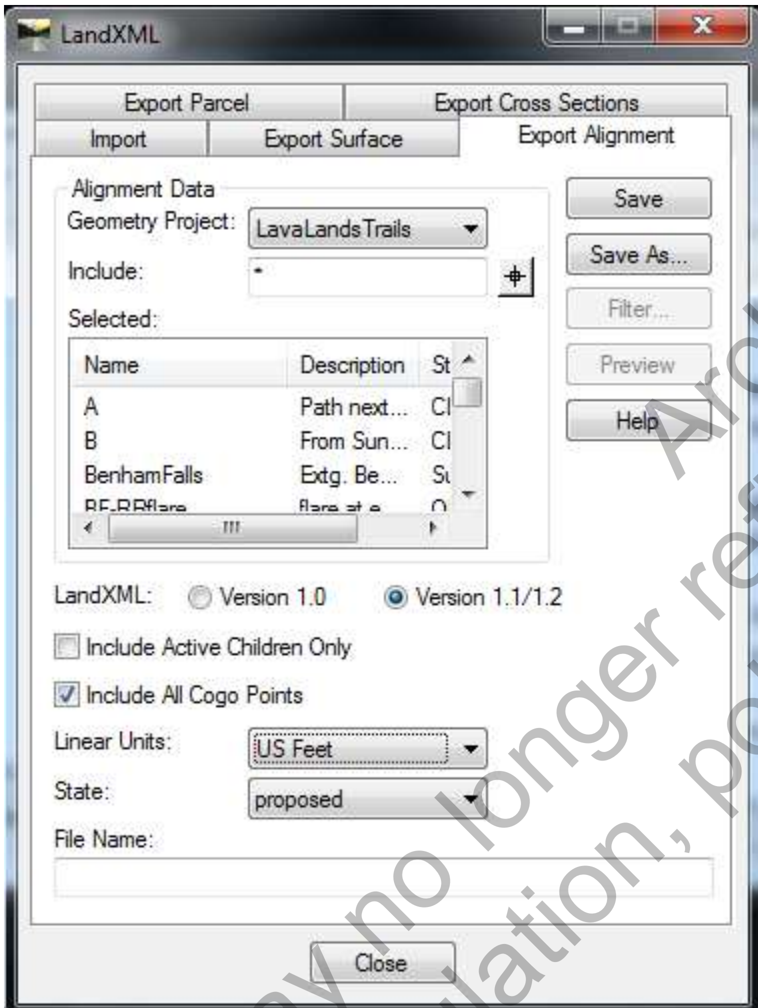
Is your software application LandXML Registered and Certified?

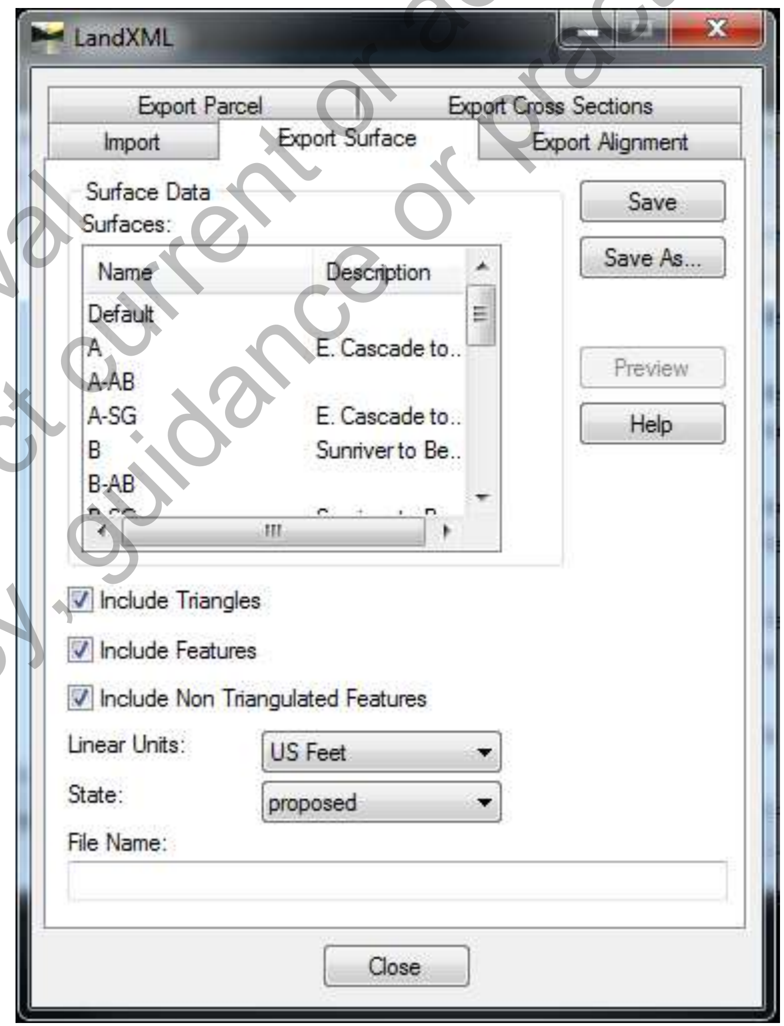
Land XML.org Version 1.2 ✓ | Land XML.org Version 1.1 ✓

LandXML.org XML Data Exchange Standards

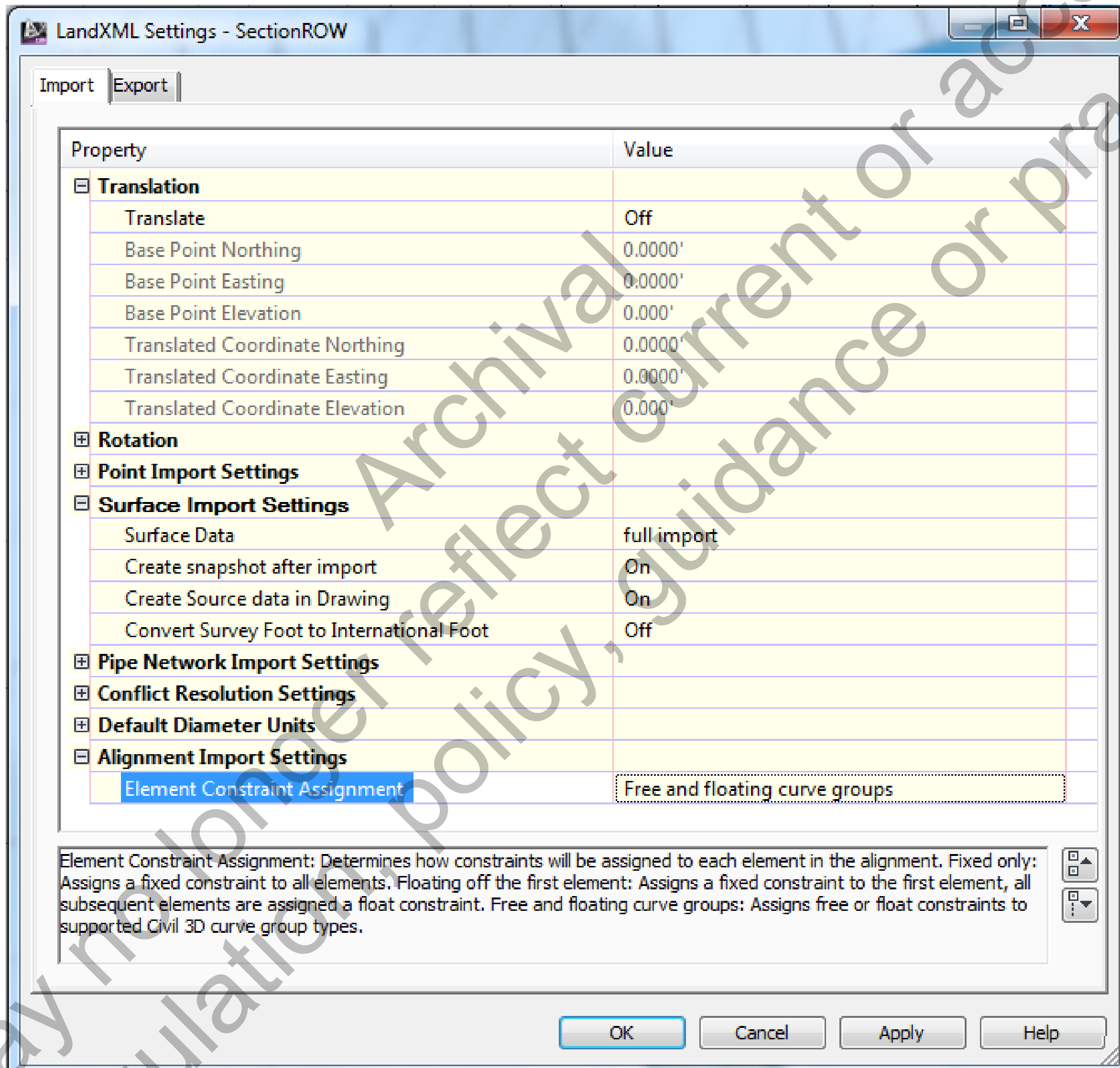
LandXML-1.2 schema: Ratified/Standardized on **August 15, 2008**
LandXML-1.1 schema: Ratified/Standardized on **July 21, 2006**
LandXML-1.0 schema: Ratified/Standardized on **July 17, 2002**

Convert Data to Exchangeable Format

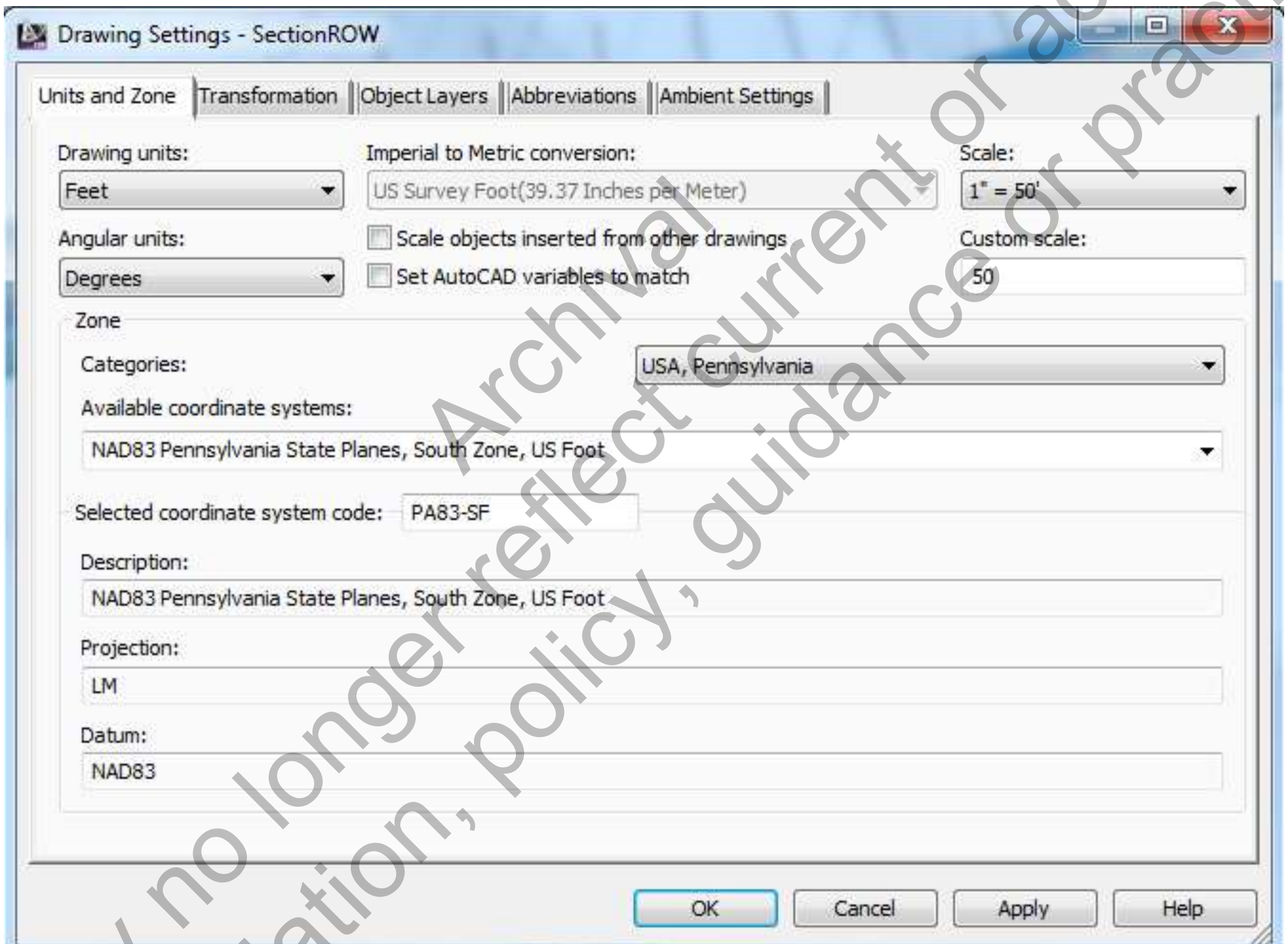




Convert Data to Exchangeable Format



Build a Model from Exchanged Data



Build a Model from Exchanged Data

Coordinate System

Name	PA83-SF
Description	NAD83 Pennsylvania State Planes, Southern Z
Projection	Lambert Conformal Conic
Source	Calculated from PA83-S by Mentor Software
Units	US Survey Foot
First Standard Parallel	40°58'00.0000"N
Second Standard Parallel	39°56'00.0000"N
Origin Longitude	77°45'00.0000"W
Origin Latitude	39°20'00.0000"N
False Easting	1968500
False Northing	0
Quadrant	Positive X and Y
Minimum Longitude	81°00'00.0000"W
Maximum Longitude	74°00'00.0000"W
Minimum Latitude	39°15'00.0000"N
Maximum Latitude	41°30'00.0000"N

Datum

Name	NAD83
Description	North American Datum of 1983
Source	US Defense Mapping Agency, TR-8350.2-B, D

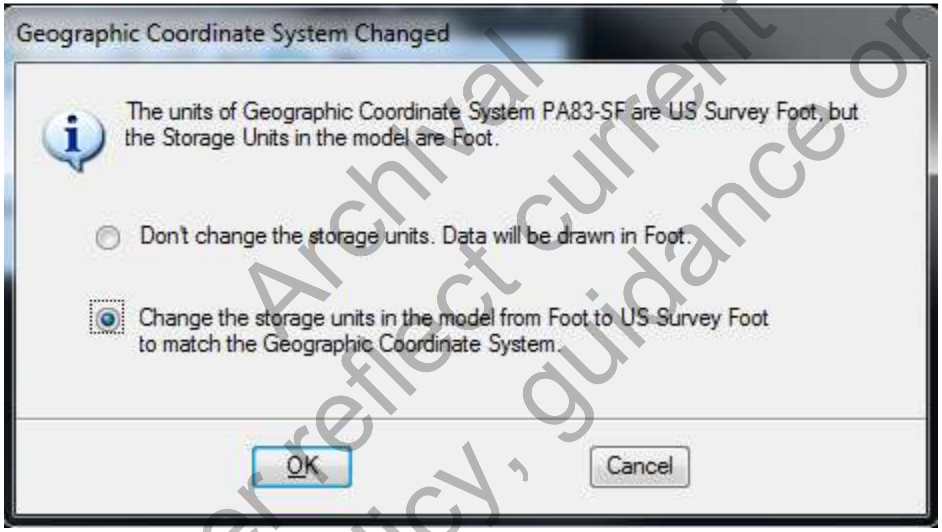
Ellipsoid

Name	GRS1980
Description	Geodetic Reference System of 1980
Equatorial Radius	6378137
Polar Radius	6356752.3141403478
Eccentricity	0.0818191910428630641
Source	Stem, L.E., Jan 1989, State Plane Coordinate

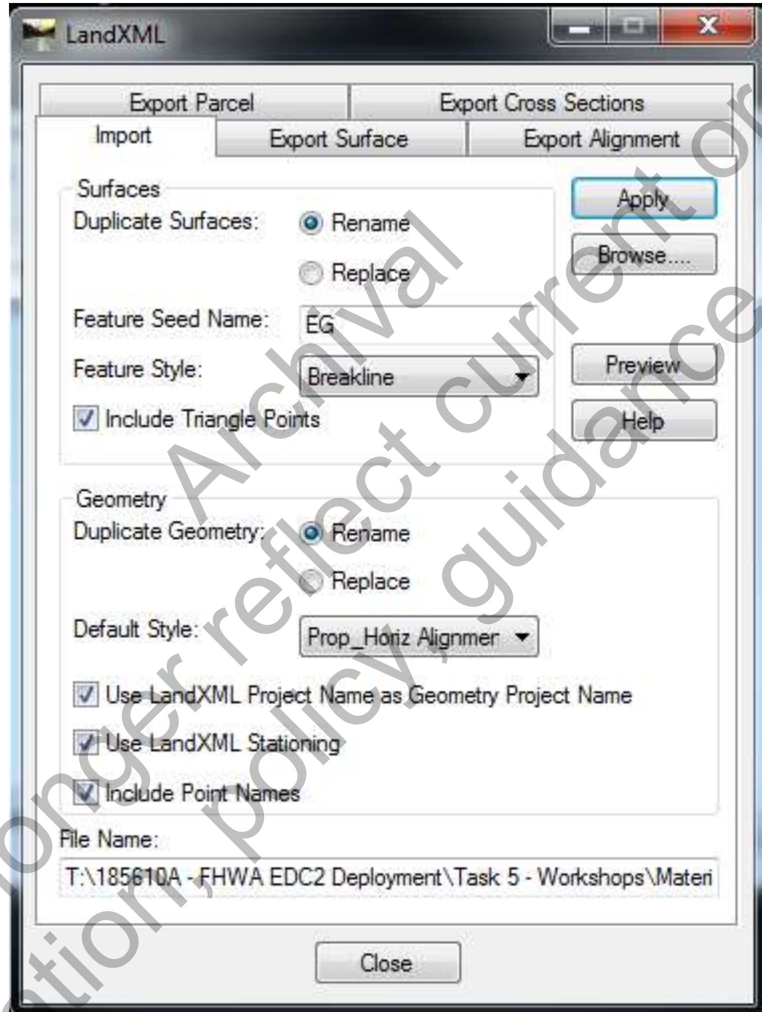
Vertical Datum

Vertical Datum	North American Vertical Datum of 1988

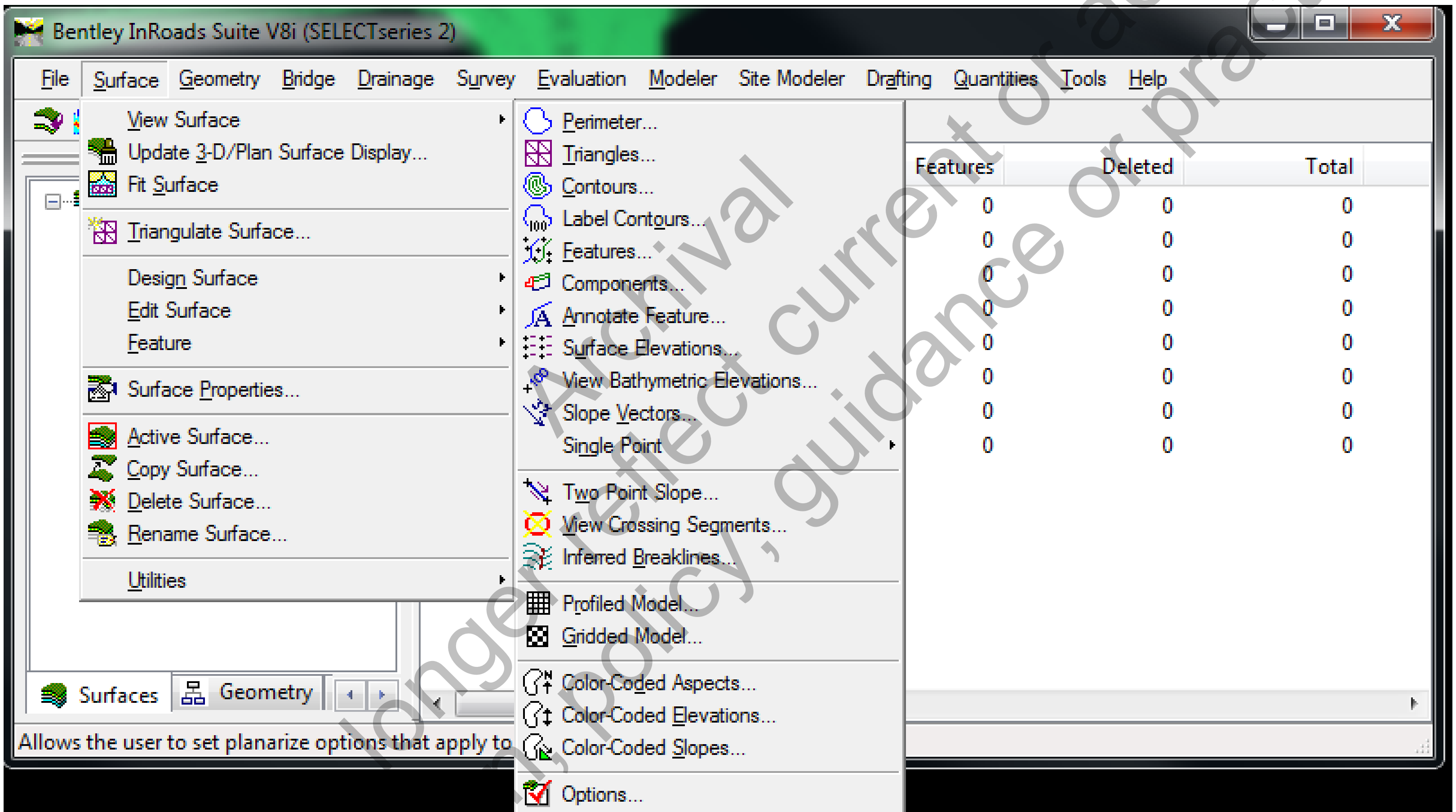
Build a Model from Exchanged Data



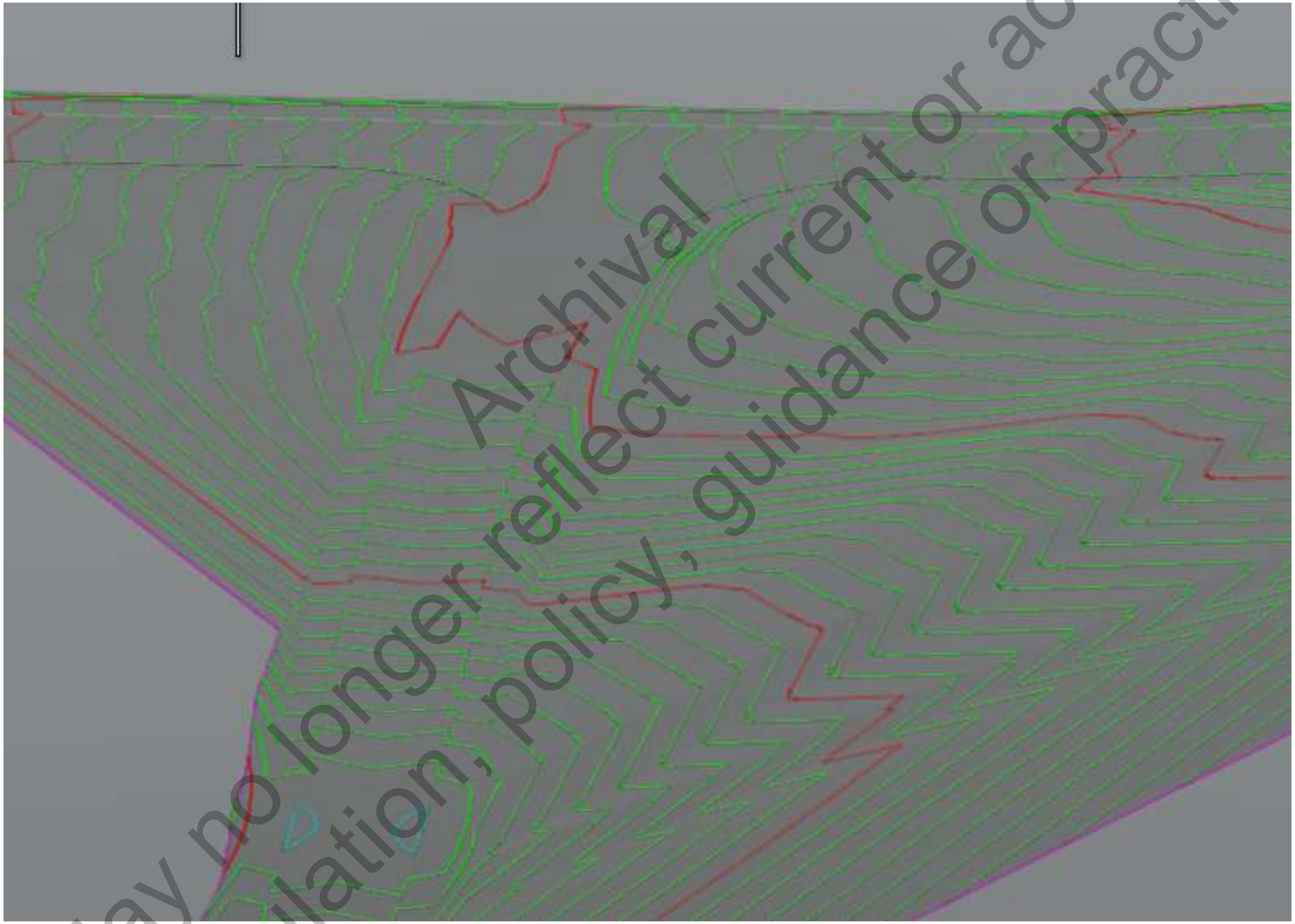
Build a Model from Exchanged Data



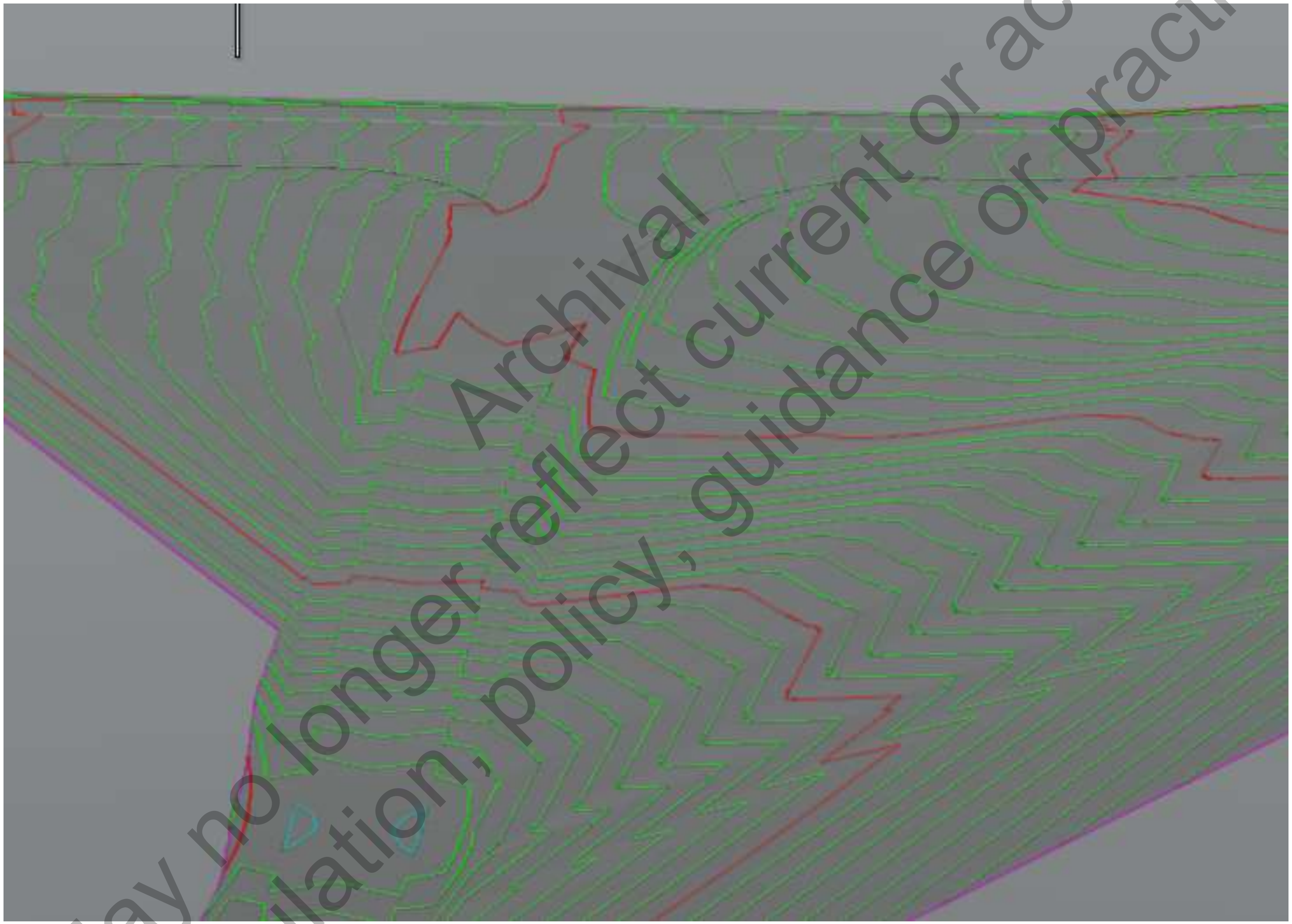
Build a Model from Exchanged Data



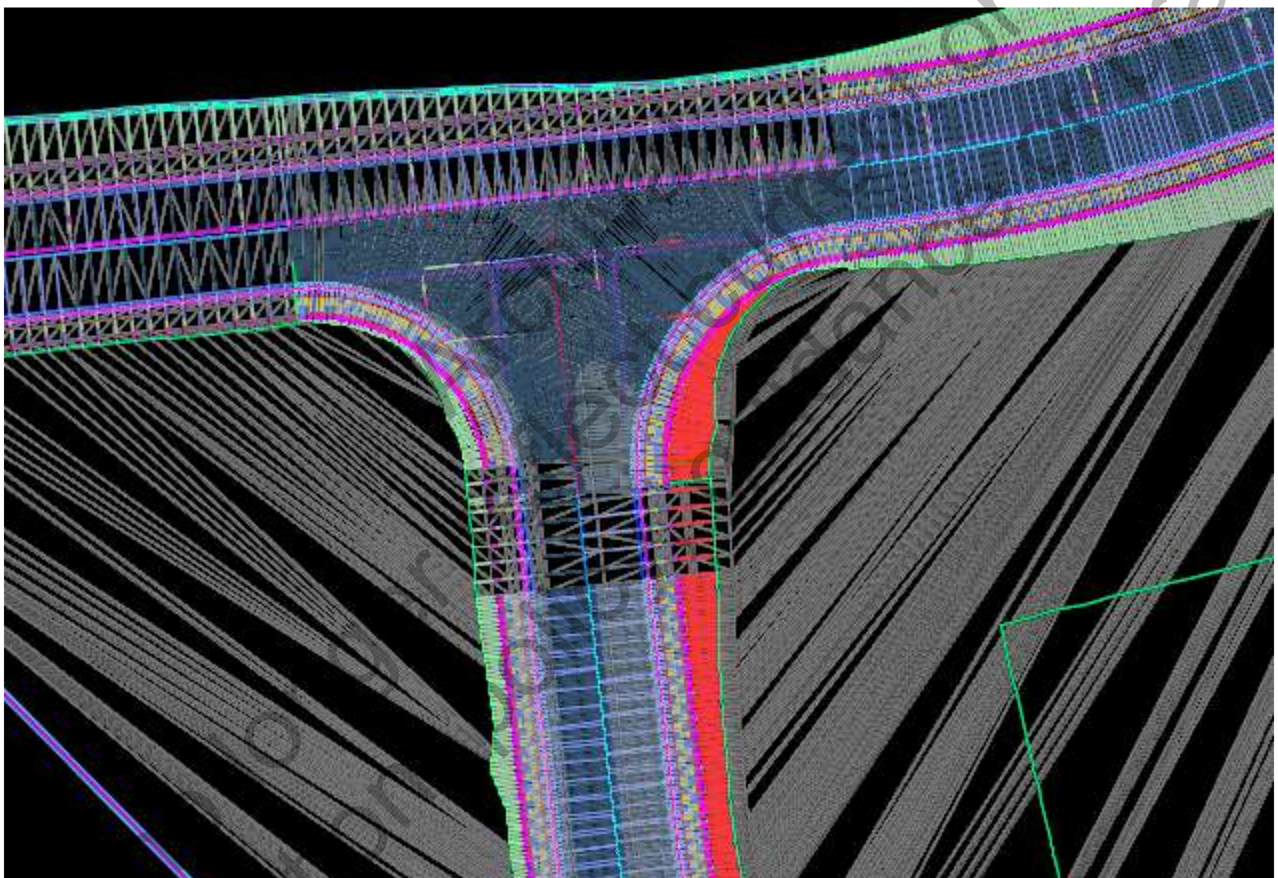
Build a Model from Exchanged Data



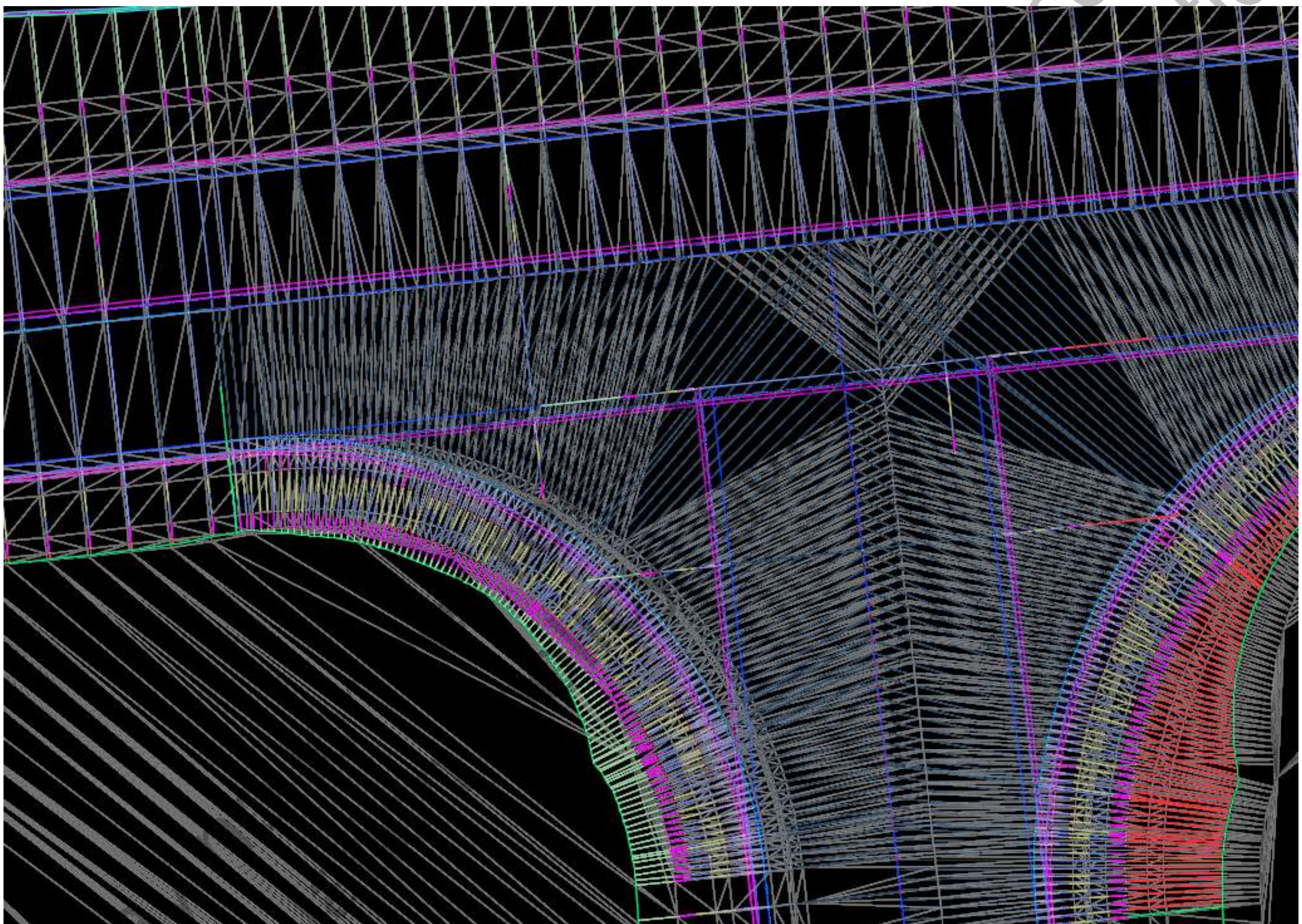
Compare Exchanged Model to Design Model



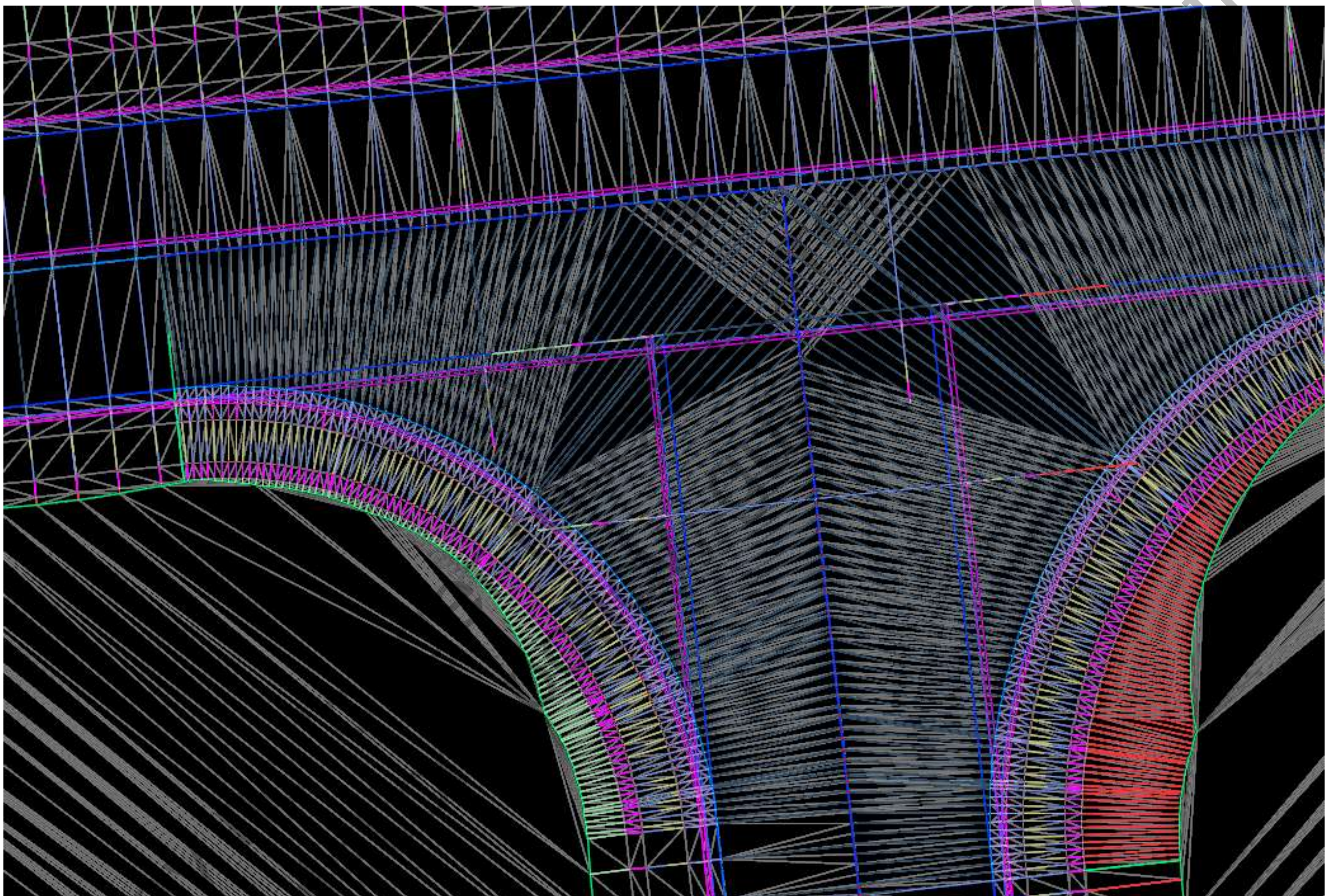
Compare Exchanged Model to Design Model



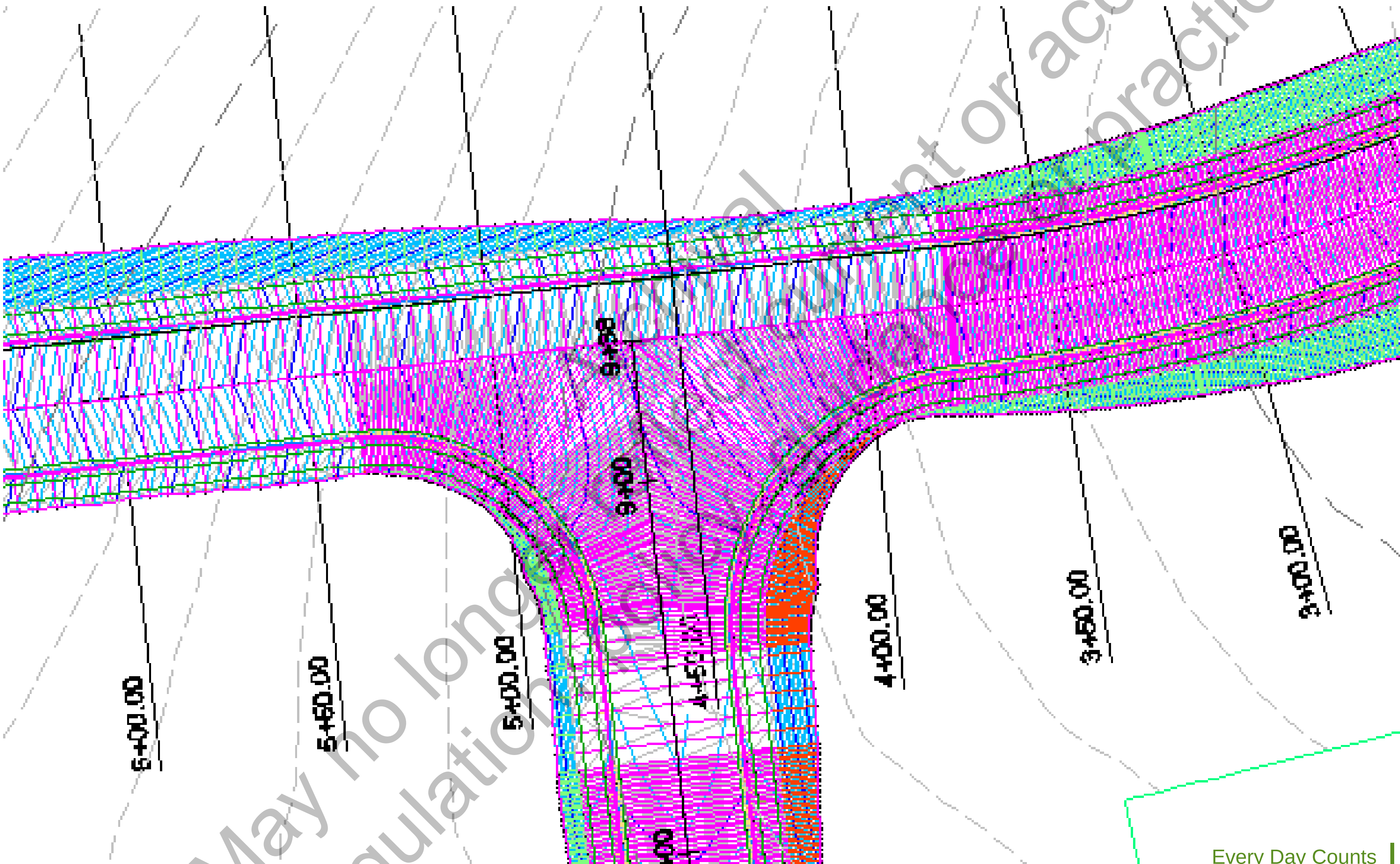
Compare Exchanged Model to Design Model



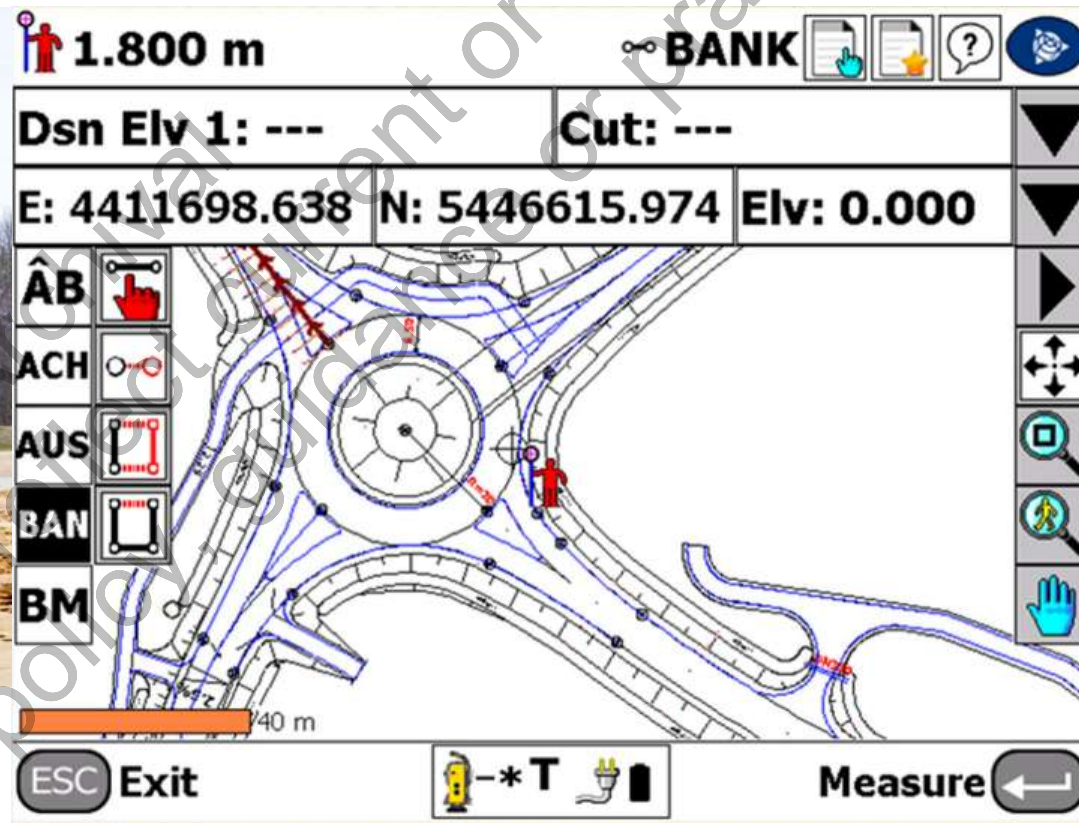
Compare Exchanged Model to Design Model



Compare Exchanged Model to Design Model



Summary



Source: Iowa State University

Verify Learning Outcomes

- Identify rapid 3D Modeling tools using GIS data
- Describe types of 3D models developed during design
- Describe how 3D models are prepared for Automated Machine Guidance

3D Modeling as a Public Information Tool
Multnomah County's Sellwood Bridge Project

Mike Pullen
Multnomah County

U.S. Department of Transportation
Federal Highway Administration

Poll Pod

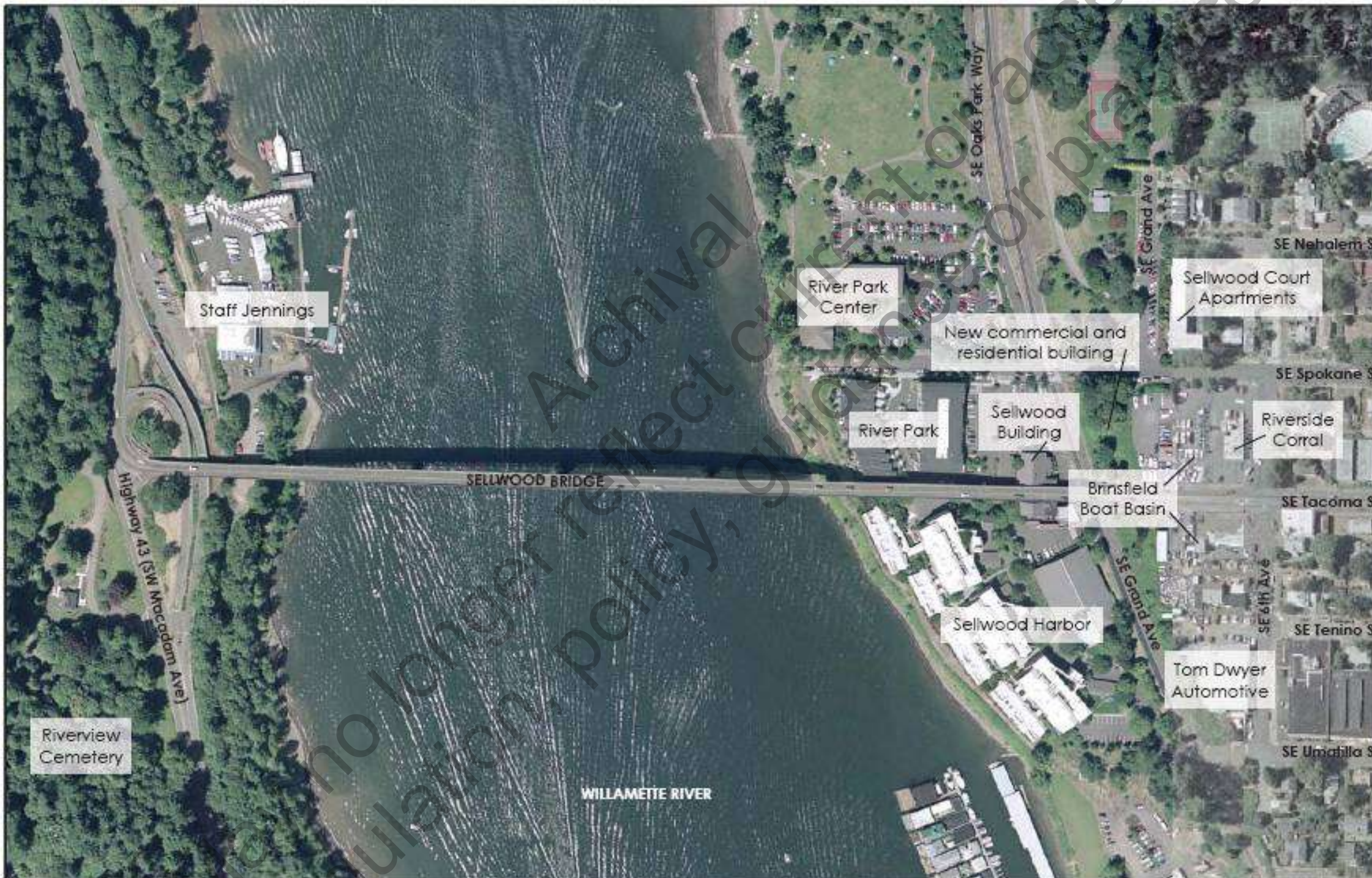
Does your organization use 3D models for public outreach?

- Yes
- No
- Not Sure

Overview

- Project Background
- Phased Construction vs. Detour
- Public Information Challenge
- 3D Model as Tool
- Results

Sellwood Bridge in Portland, Oregon



Project Background

- Investigated closing bridge during construction of new bridge
- Significant economic and business concerns
- County commitment to keep crossing open
- Goal = no more than 30 days of closure during 3-year bridge replacement

Staged Construction

- Original assumed option
- Bridge built in 2 phases, 1 half at a time
- Keep bridge in service during work
- Use existing bridge while first half of new bridge is built on southside
- Traffic shifts to south half of new bridge
- Old bridge removed
- North half of new bridge built to form one new bridge

Detour Construction

- Proposed in 2011 by newly-hired design and construction teams
- Approved by County Board in June 2011
- Old bridge moved north, out of work zone
- Bridge moved *carefully and safely* by specialty subcontractor
- Detour bridge will not include worst sections of old bridge

Detour Construction

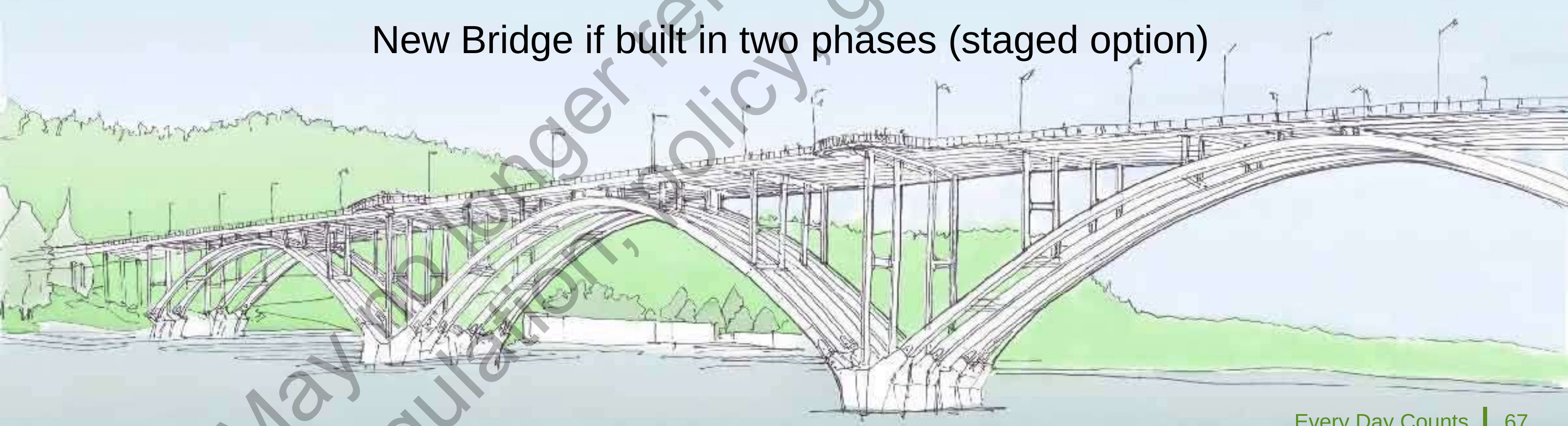
- Uses portion of old east approach
- Detour bridge as strong or stronger than old bridge (including seismic)
- New bridge can be built in one phase
- Similar number of bridge closure days

Detour Bridge Benefits

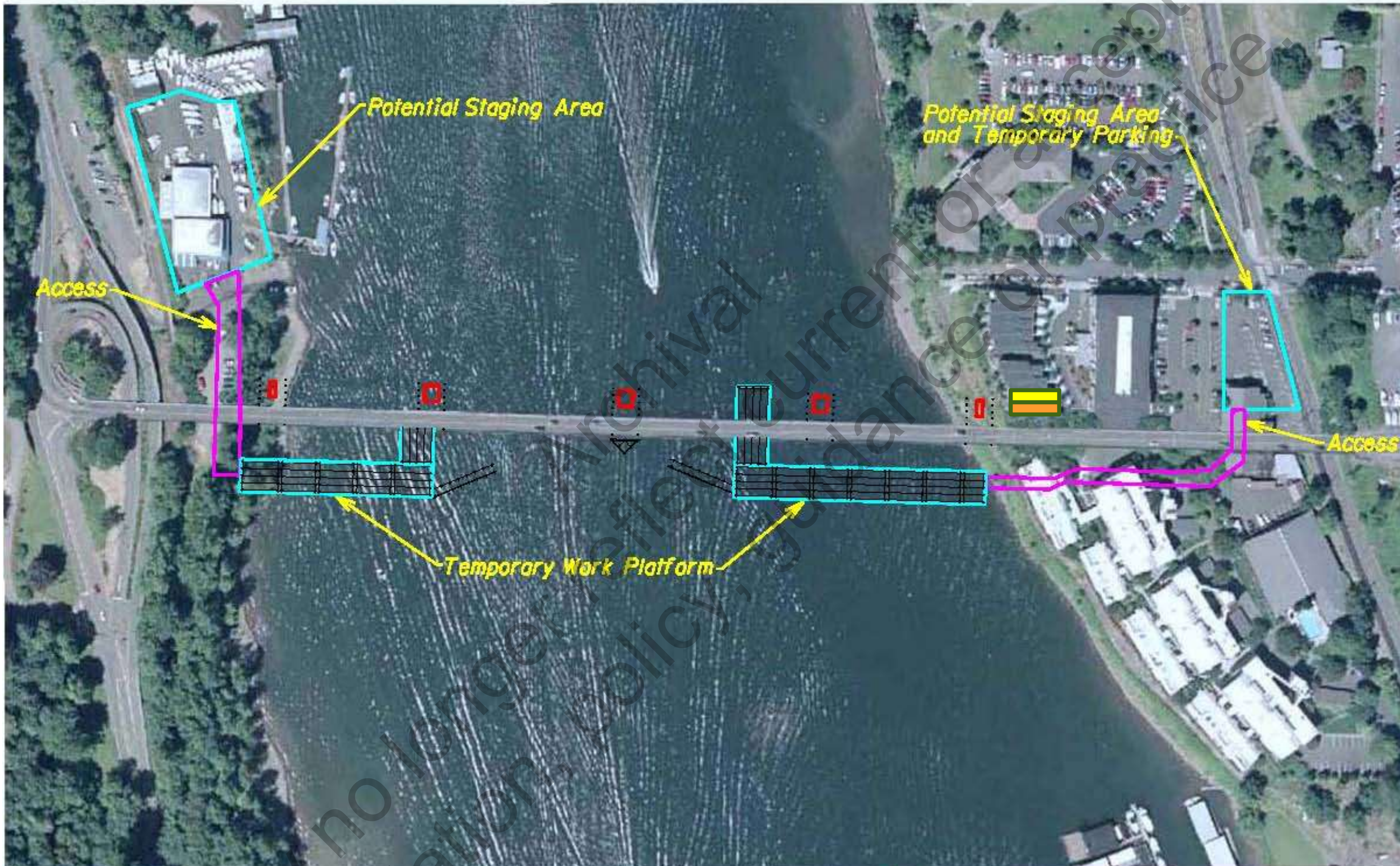
- **Time:**
  - Reduce construction by up to 12 months
- **Money:**
  - Reduce cost ($5 to $10 million) in materials, labor, and equipment
- **Safety:**
  - Separation improves safety for workers and travelling public.
- **Design:**
  - Eliminates redundant features
  - Improves appearance (two arch ribs instead of four)
- **Environmental Impacts:**
  - Fewer temporary work bridges
  - Less construction time
  - Less in-water and riparian impacts

New Bridge if built in one phase (detour option)

New Bridge if built in two phases (staged option)

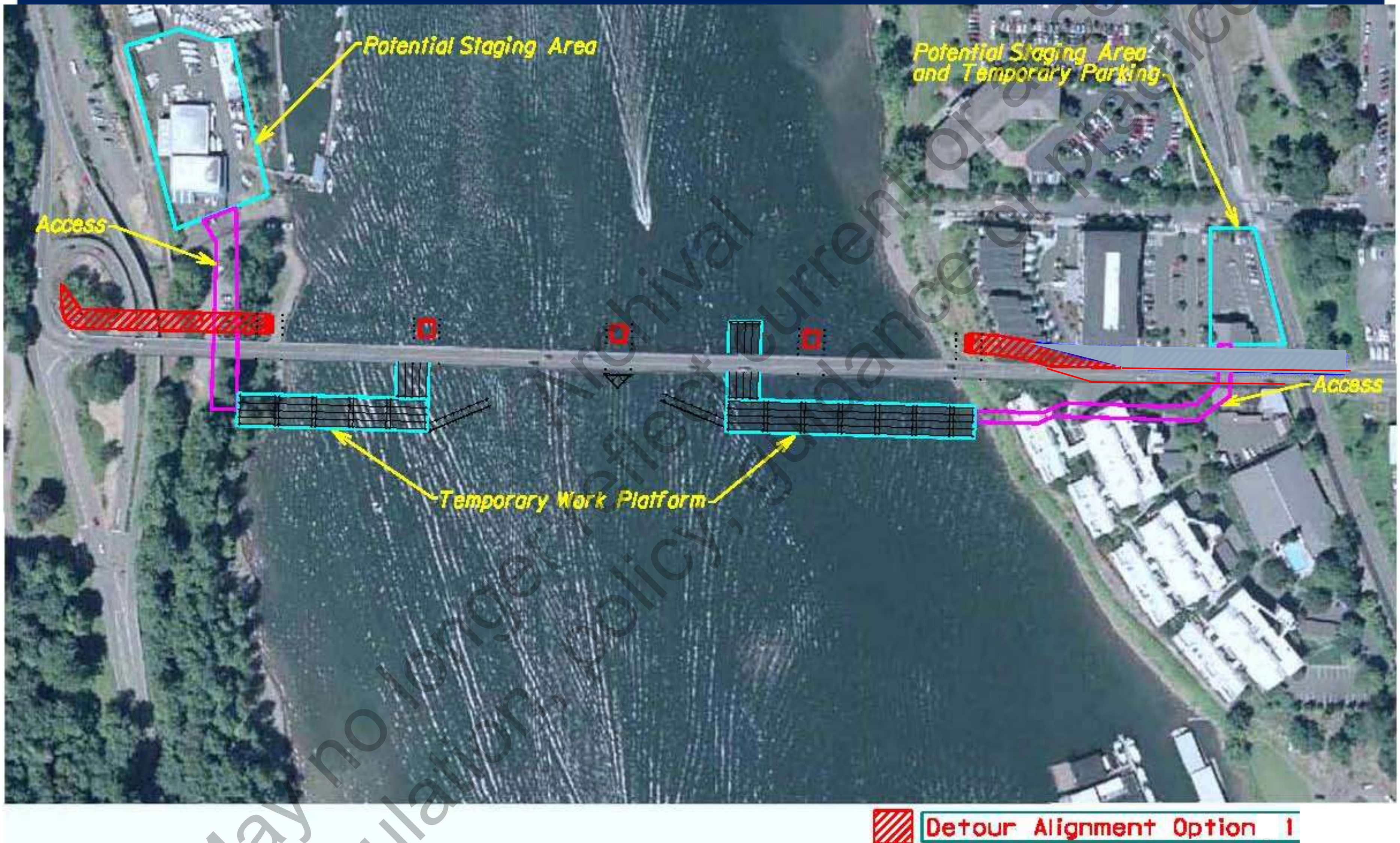


Detour Construction: Early Phase

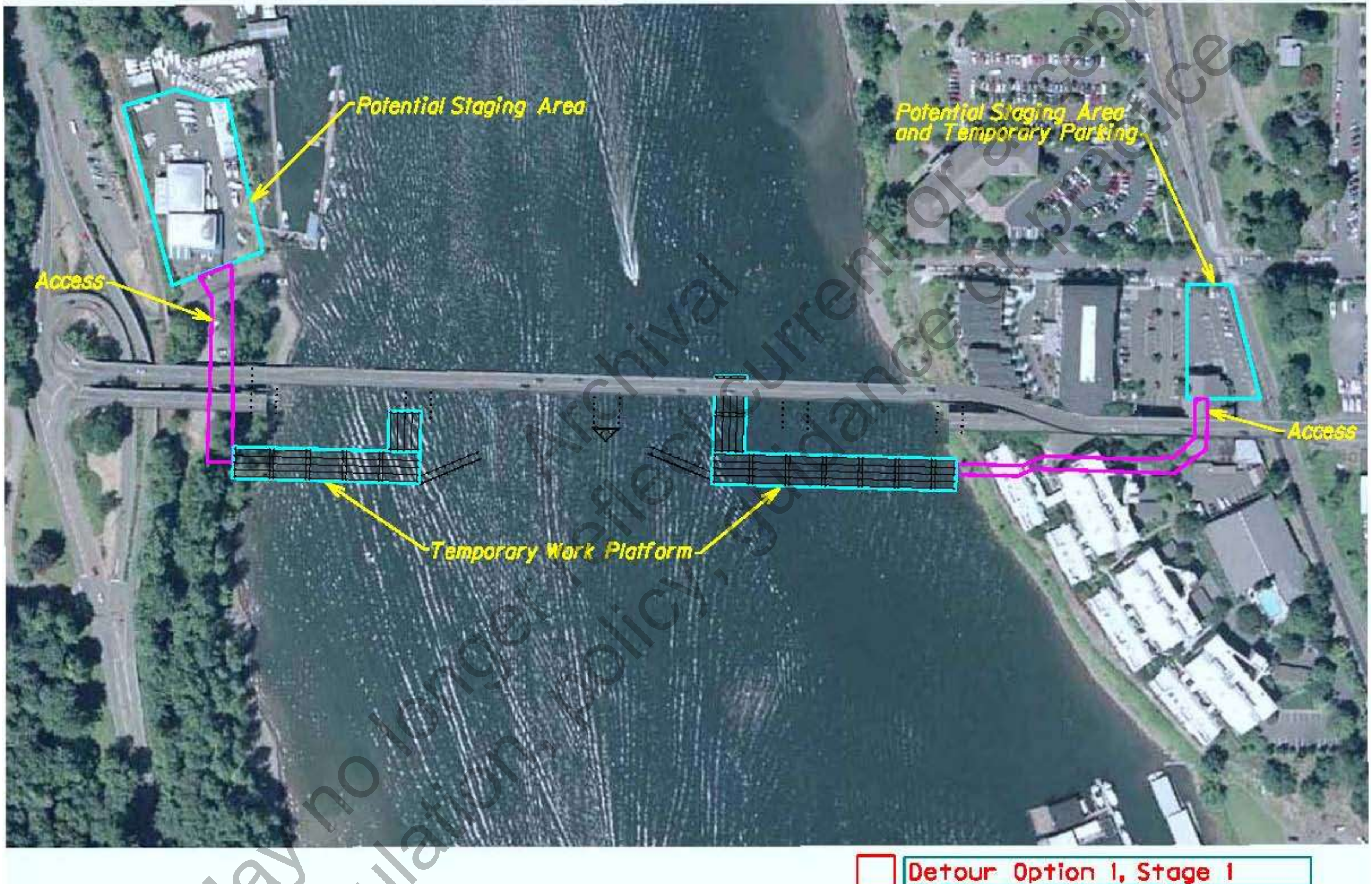


Detour In-Water Foundations

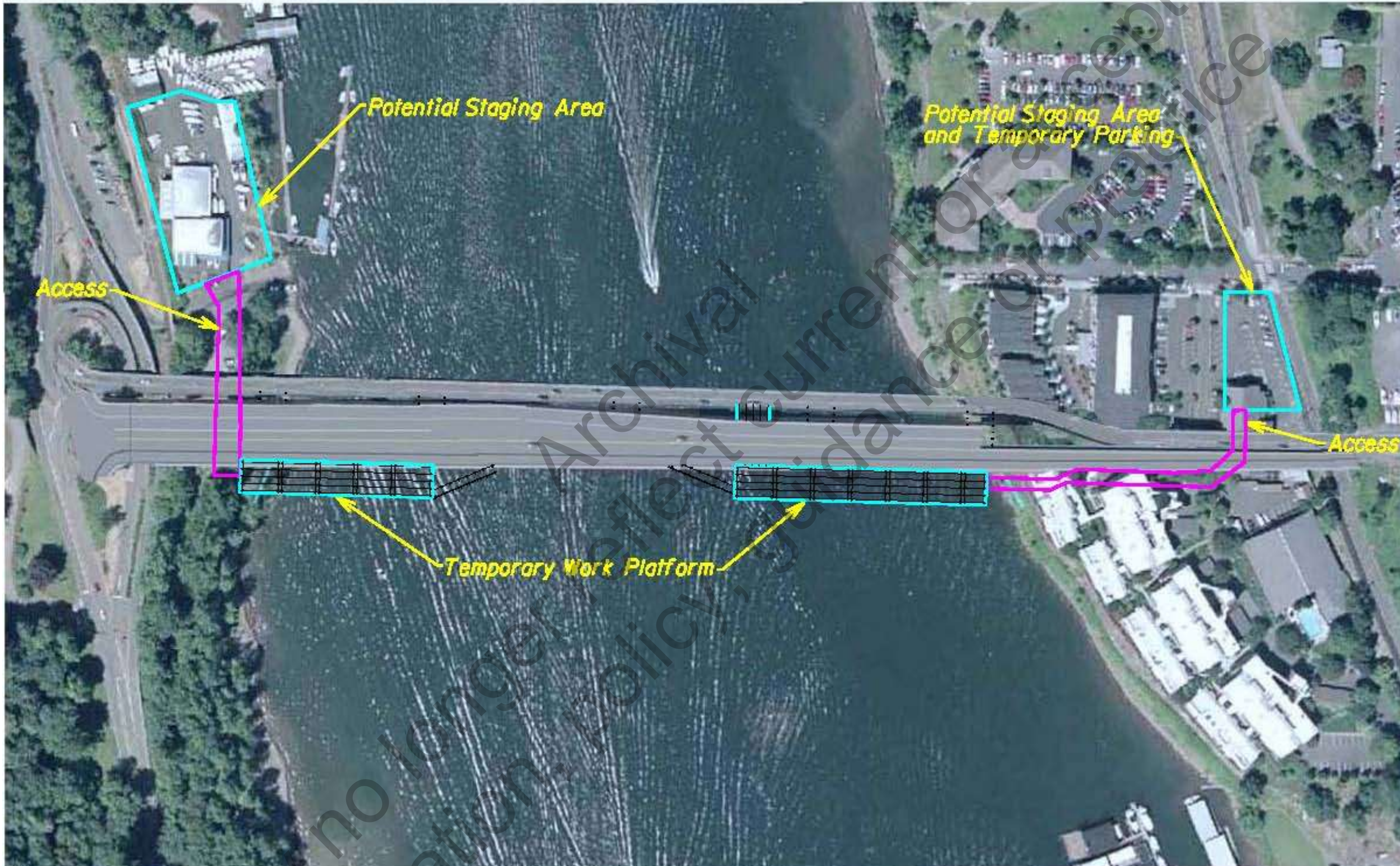
Detour Construction: Approaches & Piers



Detour: Slide Old Bridge North

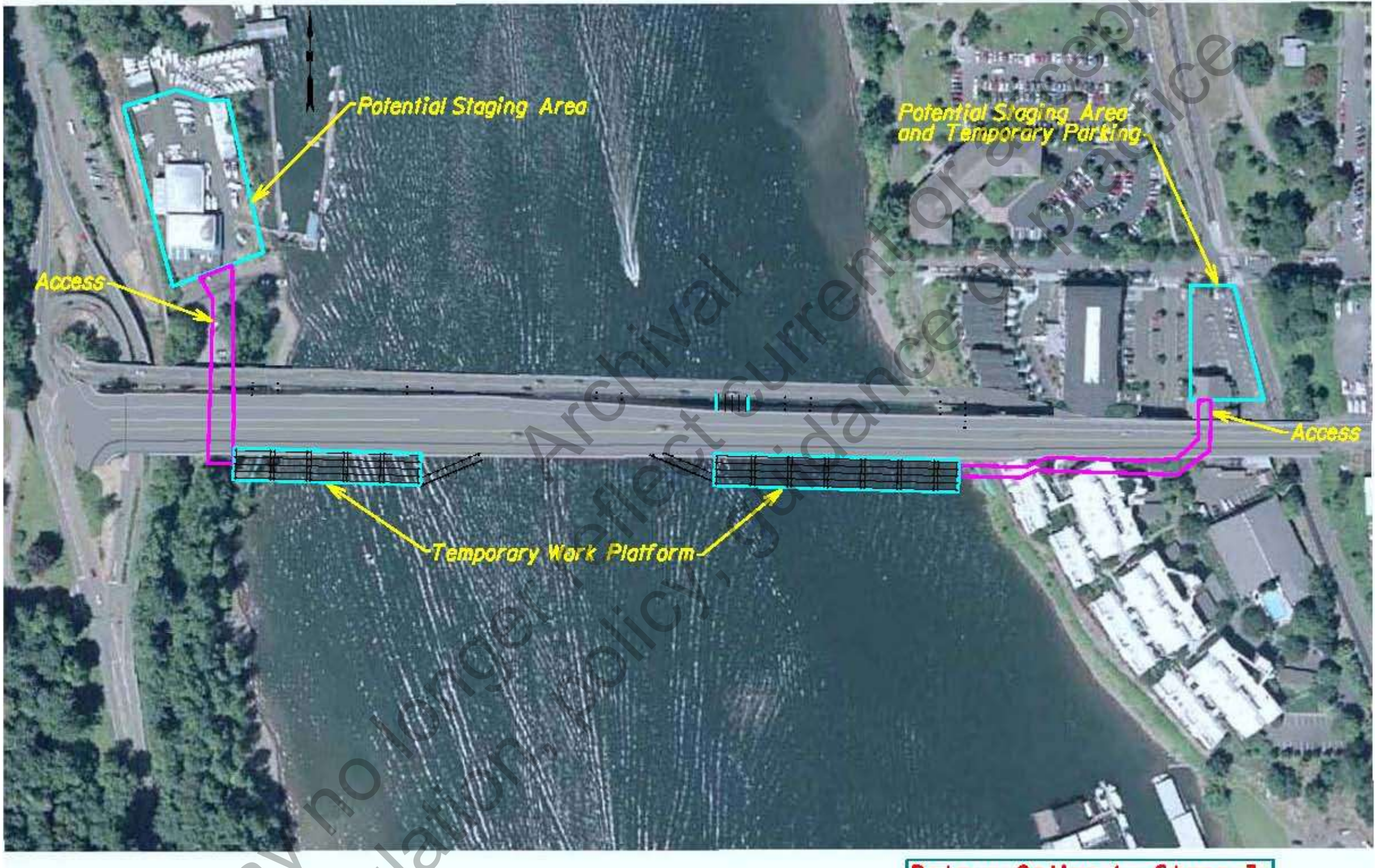


Detour: Construct New Bridge

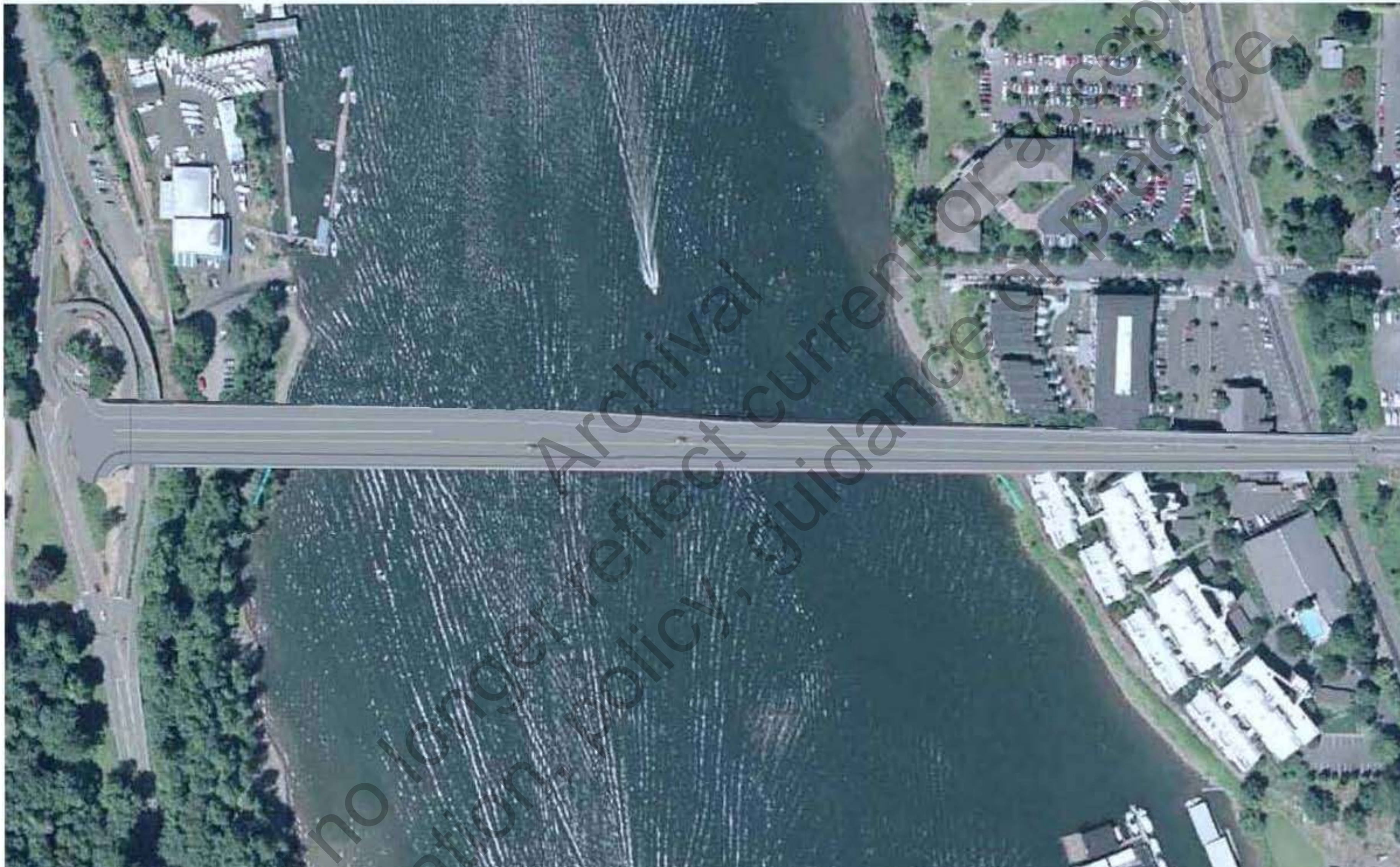


Detour Option 1 - Stage 2,
East Approach First
Stage Construction

Detour: Fill In East Approach



Detour: Completed Bridge



Finished Bridge

Public Information Challenges

- Public doubts about moving the old bridge, then re-opening it
- Neighbor concerns about proximity of new alignment
- Risks to regional traffic flow and county's reputation if bridge was damaged during move

Public Information Tools

- Meetings with neighbors, businesses
- Newsletter
- Drawings to explain bridge move
- Website update
- Media (news conferences, tours)
- Timelapse video
- **3D model**

3D Model as Public Information Tool

- Animated 3D model by general contractor Slayden-Sundt prepared for proposal
- County and web consultant added narration by general contractor and titles to video for lay audience
- Posted video with 3D model to website and shared with public audiences to show bridge move sequence

Video Sequence

Screen 3D animation of bridge construction sequence

3D Model Images of Detour Bridge

Concept for detour bridge construction

3D Model Images of Detour Bridge

Constructing detour bridge near residences

3D Model Images of Detour Bridge

Traffic on detour bridge during construction of new bridge

3D Model Images

Completed new bridge after removal of detour bridge

Results

- Successful bridge move in January 2013
- Bridge closure limited to five days, over holiday weekend
- Positive local and national media coverage
- Large public turnout on bridge move day
- Increased credibility for project owner, contractor and design team


531 A-4
Q1

Bridge Move Facts and Figures

- Truss span moved –
  - 6.8 million pounds (3,400 tons)
  - 1095 feet long
  - 31 feet wide
  - 32 feet tall
- Lift – about 2-1/2 inches
- Sliding
  - 66 feet North at West End
  - 33 feet North at East End
  - Maximum Speed – 6 inches per 10 seconds
  - Move Time = 14 hours

Project Information

- Overall budget - $307.5 million
- Traffic on detour bridge –January 2013
- Traffic on new span – Summer 2015
- East approach/Hwy. 43 interchange complete – Summer 2016

Bridge Move Team

- Slayden/Sundt Joint Venture – General Contractor (prepared 3D model)
- Omega Morgan – Heavy move Subcontractor
- T. Y. Lin International – Design in-river piers
- Multnomah County – Owner, oversight

Verify Learning Outcomes

- Describe uses of 3D models during design and construction

Questions

U.S. Department of Transportation
Federal Highway Administration

Upcoming Webinars and Close

Douglas Townes, P.E.
FHWA Resource Center

U.S. Department of Transportation
Federal Highway Administration

Webinar Series Topics

Webinar 1:	Overview of 3D Models for Construction
Webinar 2:	Creating 3D Engineered Models
Webinar 3:	Applications of 3D Models in the Contractor's Office
Webinar 4:	Applications of 3D Models on the Construction Site
Webinar 5:	Managing and Sharing 3D Models for Construction
Webinar 6:	Overcoming Challenges to Using 3D Engineered Models for Construction
Webinar 7:	Steps to Requiring 3D Engineered Models for Construction
Webinar 8:	The Future: Adding Time, Cost and other Information to 3D Model

Webinar 3

Applications of 3D Models in the Contractor's Office

February 19, 2014

1:00 pm – 2:30 pm

www.fhwa.dot.gov/3D

Douglas.townes@dot.gov