3D Model-based Planning-Design-Construction-O&M for Transportation Project Delivery: Structures Perspective

CIM at Wisconsin DOT SE Freeways

Lance Parve, MSEng, PG, CIM SEF Coordinator

SE Freeways Design-Construction

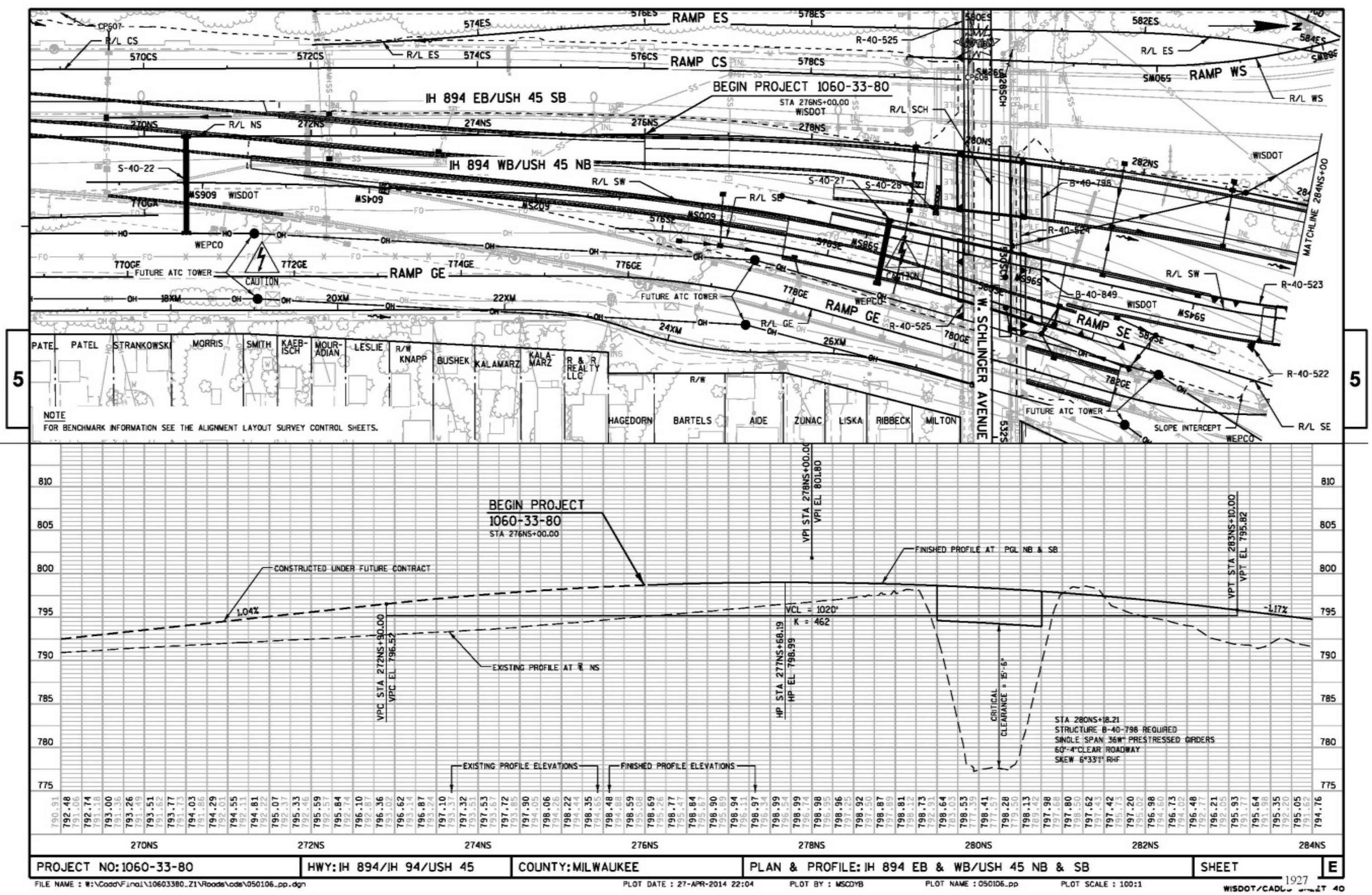
Bio:

Lance Parve, MSEng, P.G.

Mr. Parve works as a Sr. Project Engineer/CIM Coordinator for the WisDOT in SE Freeways. His work involves planning, design, and construction of transportation projects greater than $500 million and also provides CIM-CAD-GIS, 3D technologies, and LiDAR survey coordination and support. Working for WisDOT since 2007 involving public sector work, with 15 years previous involvement in private sector civil and environmental infrastructure work, he has been involved in numerous successful planning, design, and construction mega-major transportation projects at WisDOT. He has a MS Engineering degree, MS Certificate Urban Planning GIS degree, and a BS Geological Sciences degree from the UW-Milwaukee. Additionally, he serves as Co-chairperson of the CIM-VDC Subcommittee of the National Academy of Sciences Transportation Research Board (TRB) ABJ95 Visualization in Transportation Committee.

Contact: lance.parve@dot.wi.gov
Phone: 414-750-1330 / 414-731-5375

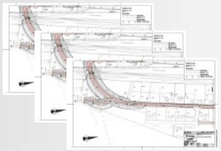
WisDOT Transportation Infrastructure Design Moving from 2D to Robust 3D Models



Design & Construction Best Practice Workflows: WisDOT SE Freeways

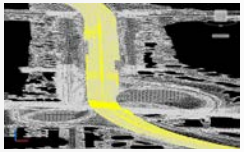
Where we are | **Where we are going**

2D CAD Models



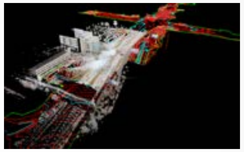
Object Features
Objects Not Intelligent
No 3D TIN-DTM Surfaces
Geospatial
Multi Disciplinary 2D
Project-based

3D CAD Models



Object Features
Objects Not Intelligent
3D TIN-DTM Surfaces
Geospatial
Multi Disciplinary 3D
Project-based

3D CIM Collaboration Models

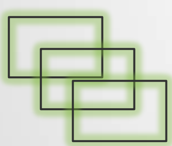


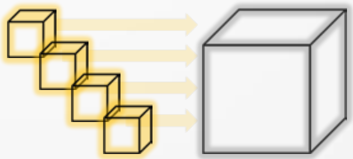
Intelligent Subassembly Features
Collaborative 3D CIM Databases
3D TIN-DTM-3D Face Surfaces
Geospatial
Collaborative Multi Disciplinary 3D
Project-based

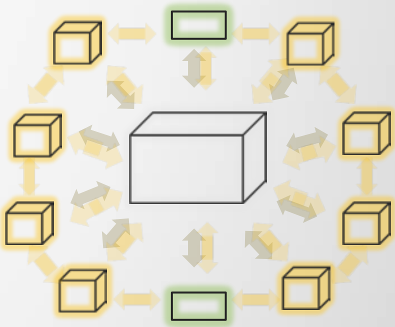
3D CIM Integrated Collaboration Models

Intelligent Subassembly Features
Integrated 2D-3D-4D-5D-xD CIM Databases
3D TIN-DTM-3D Face Surfaces
Geospatial
Integrated Collaboration Multi Disciplinary 3D
Life-cycle-based

ISOLATED | COLLABORATIVE | INTEGRATED







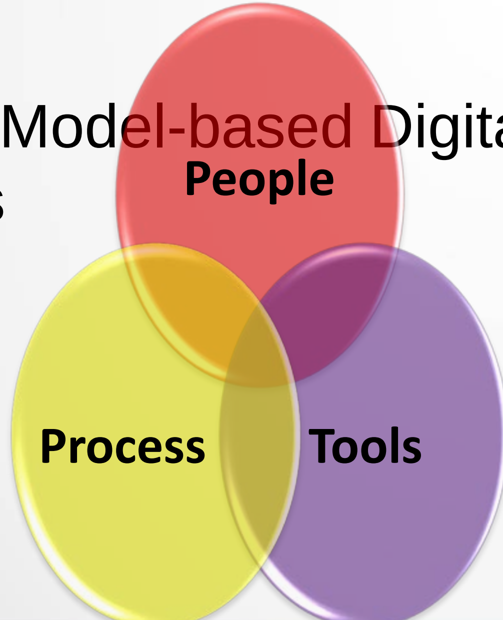
Road & Bridge Design Best Practice Workflows: WisDOT SE Freeways

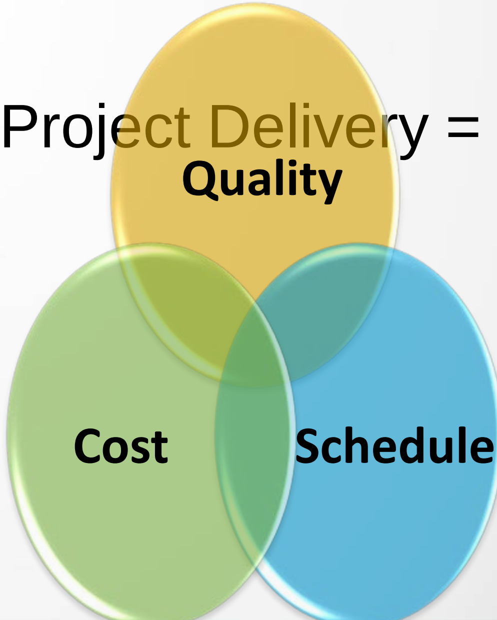
- Strategic Planning for WisDOT SE Freeways

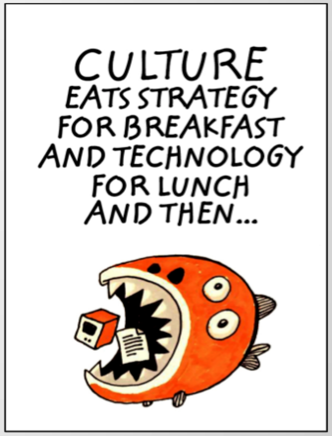
  "plans are useless but planning is essential"
  - Strategic Goals: Organizational Clarity, Common Shared Vision, Model the Way, Align Objectives, Pull Together, Build Trust, Inspire Passion, Challenge the Process, Enable Others to Act
  - Core Goals: Mobility, Accountability, Preservation, Safety, & Service

Road & Bridge Design Best Practice Workflows: WisDOT SE Freeways

- Key findings/Best practices for Transportation Infrastructure
  - People/Workforce+Organization/Process+Tools/Technologies = Success
  - Cost Benefits Analysis/Return on Investment Focus = $, Time, & Quality
  - PS&E 3D Model-based Digital Project Delivery = New Workflows

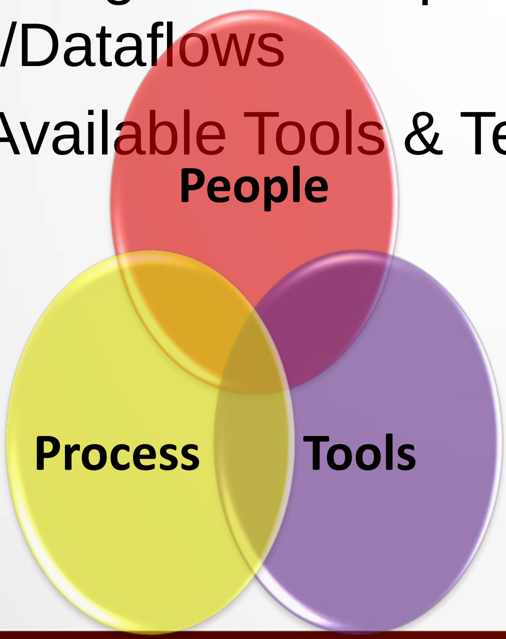


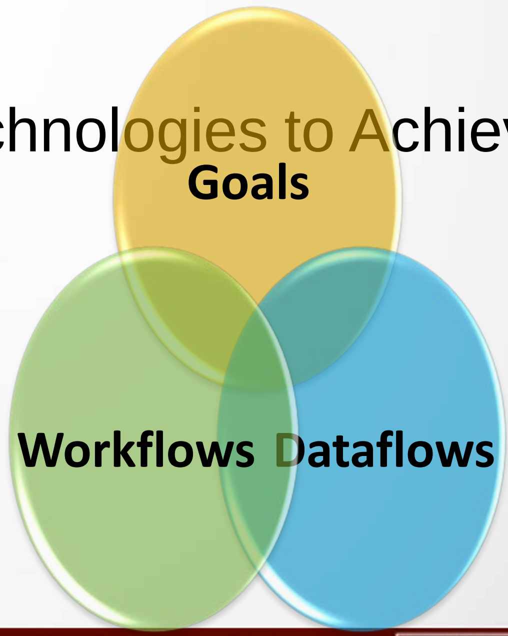




Road & Bridge Design Best Practice Workflows: WisDOT SE Freeways

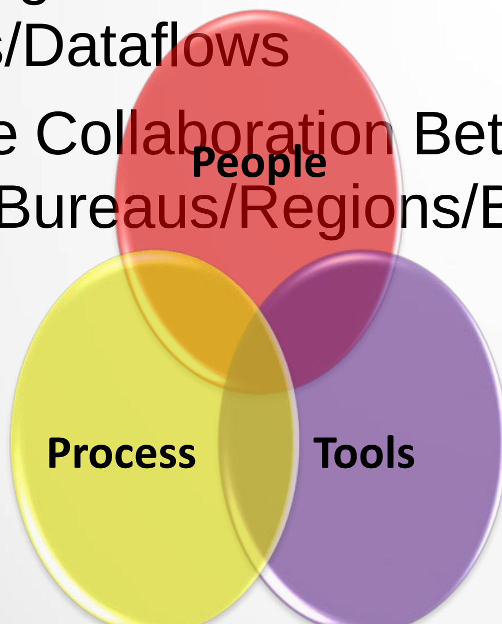
- Key findings/Best practices for Transportation Infrastructure
  - Have Organizational Strategic Plan for 3D Technologies Implementation
  - Manage Change for Disruption to Current/Future Workflows/Dataflows
  - Use Best Available Tools & Technologies to Achieve Business Goals

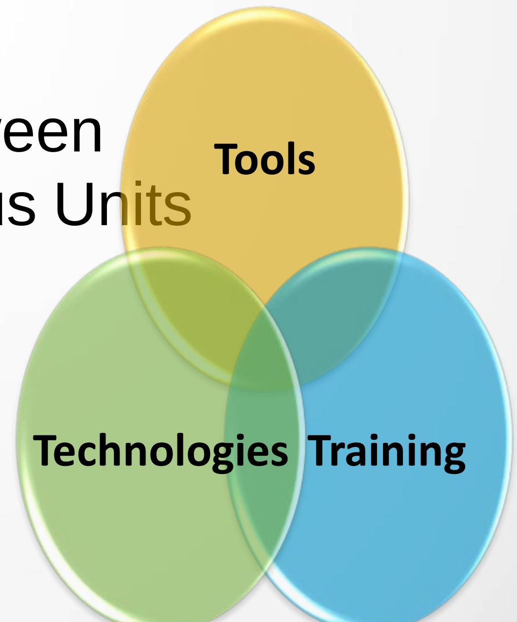




Road & Bridge Design Best Practice Workflows WisDOT SE Freeways

- Key findings/Best practices for Transportation Infrastructure
  - Management Buy-in with Support for Innovation & Funding of 3T’s (ITEC, IT2, DM, BOS, S&M, 3D, Innovation Committees)
  - Reduce Org “Silos of Excellence” Bottlenecks/Poor Workflows/Dataflows
  - Encourage Collaboration Between Agencies/Bureaus/Regions/Bus Units



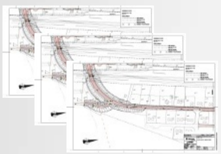


Southeast
Trust.Passion.Champions.

Road & Bridge Design Best Practice Workflows: WisDOT SE Freeways

Where we are | Where we are going

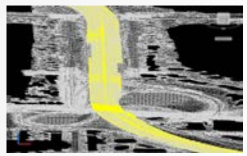
2D CAD Models



Benefits/Advantages:

- Automate drafting/standards
- Draw efficiently/accurately
- Layout scale model-paper space
- Layout dimensions/text/notes
- Visualize/view drawing
- Layers/attributes/properties
- Vector & raster/custom libraries
- Modify/revise to reduce updates
- Link CAE/CAD tools to CADD
- E-construction stakeout
- Organize/access project data

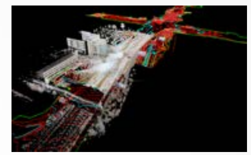
3D CAD Models



Benefits/Advantages:

- Modify, reuse, & revise in 3D to reduce updates
- 3D geospatial & rapid prototyping shop drawings
- 3D visualizations using walk/drive-through simulations/animations
- GPS stakeout/3D QA-QC
- Subgrade grading/string -less paving using AMG up to 30% savings

3D CIM Collaboration Models



Benefits/Advantages:

- Multi-disciplinary collaboration
- Identify/reduce issues earlier by clash detection/resolution
- Reduce redesign, rework, DINs, & CCOs cost savings/avoidance opportunities up to 25%
- Staged-temporary construction
- Constructability analysis
- Optimize/visualize design-construction with VDC-CIM
- Link 3D to 4D & 5D/BOM

3D CIM Integrated Collaboration Models

Benefits/Advantages:

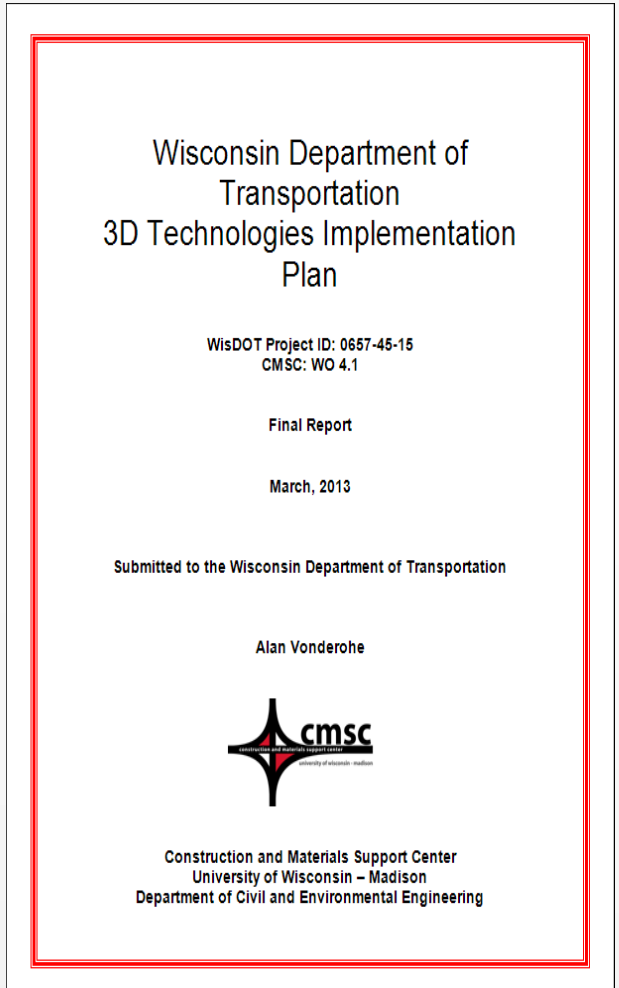
- Multi-disciplinary collaboration
- Clash detection/resolution to eliminate issues to reduce redesign, DINs & CCOs
- Database lifecycle mgmt for O & M with data warehousing
- PLM link to PDM/CRM/BPM/ERP
- Process/workflows management
- Enterprise LAN + WAN & cloud
- E-design/e-construction use of 3D models/tools with mobile devices

ISOLATED | COLLABORATIVE | INTEGRATED

Road & Bridge Design Best Practice Workflows: WisDOT SE Freeways

3D Technologies Implementation Plan-2014 Roadmap

- PS&E + 3D Model Production
- Design Review
- Multi-disciplinary Collaboration
- Visualization/Augmented Reality
- Simulation & Analysis
- Constructability Analysis
- 4D Schedules/Staging
- 5D Costs
- E-Specifications
- Virtual Clash Detection
- Design LiDAR-Integrated Surveys
- 3D CAD SDDs
- Geotech & Soil Borings
- Public Information
- Cloud DPD/DDE


Wisconsin Department of Transportation
3D Technologies Implementation Plan

WisDOT Project ID: 0657-45-15
CMSC: WO 4.1

Final Report

March, 2013

Submitted to the Wisconsin Department of Transportation

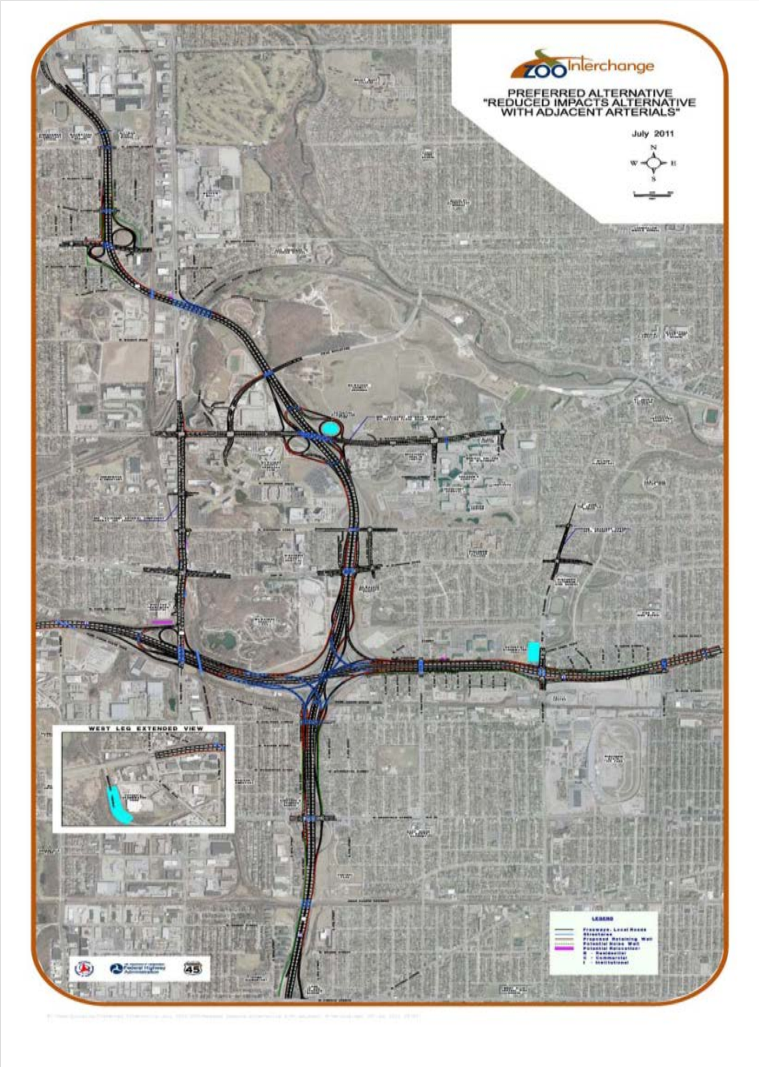
Alan Vonderohe

cmsc

Construction and Materials Support Center
University of Wisconsin – Madison
Department of Civil and Environmental Engineering

- 3D Models - AMG/AMC Earthworks & Stringless Asphalt/Concrete Paving
- Construction Review
- Design-Construction-Contractor Collaboration
- Field Image Capture/Visualization
- Utility Inspection
- SPAR/GPR
- Field Clash Detection
- Construction LiDAR-Integrated Surveys
- Bluebeam vs Adobe Pro As-builts
- O & M Lifecycle
- Asset Management
- Cloud DPD/DDE
- Mobile Devices-Tablet PCs
- E-Construction

CIM 3D Modeling: Zoo Interchange Construction: 2012-2018



- 9 miles of freeway + RRs
- 6 service interchanges
  - North Avenue
  - Watertown Plank Road
  - Bluemound Road
  - 84^{th} Street
  - Greenfield Avenue
  - STH 100
- Major Arterial Roadways
  - STH 100/Mayfair Road
  - Watertown Plank Road
  - Swan Boulevard
  - Glenview Avenue
  - Greenfield Avenue

CIM 3D Modeling: Zoo Interchange Construction: 2012-2018

- $1.7 b reconstruction of Zoo IC-Corridor
- Handles almost 350,000 avg. vehicles per day in traffic
- Over 15 miles of construction including arterials
- Construction involves 68 bridges including 6 RR structures, 1 system/7 service interchanges, 108 retaining walls, 15 noise walls, 2 box culverts,115 sign structures & numerous utilities
- Temp. roads/structures to accommodate 2 lanes of traffic during construction
- 3D CIM for all disciplines is deployed throughout Zoo IC Design-Construction

CIM 3D Modeling: Zoo Interchange Construction: 2012-2018

CBA/ROI involving Contract Change Order Issues (to date):

Zoo IC Construction Project- $446.5 m of 1.7 b total (% - Complete in 2018 as of 03/31/15)
STH 100, Glenview Ave, WTP Rd, Swan Blvd, STH 100/UP RR Bridges, Greenfield Ave, 76th St Bridge, 84th St, Temp Salt Shed, Traffic Mitigation, Advanced Signing, & Int Corridors , Core 1
Field Issues - $12.6 m or 3.0% (1141 DINs/CCOs – avg $7,400) with $4.2m Balancing/Equalizing Mods
Plan Inadequacy Issues - $3.10 m (146 DINs/CCOs – avg $21,200)

- RD-Roadway/Drainage: 34.0% (196-$4.40 m) ($22,300 per issue)
- GN-General: 24.0% (224-$3.10 m) ($13,600 per issue)
- EW-Earthwork: 10.8% (57-$1.40 m) ($24,500 per issue)
- BR-Bridges: 10.8% (89-$1.40 m) ($15,700 per issue)
- WU-Wet Utilities/Drainage: 8.5% (182-$1.10 m) ($5,900 per issue)
- EL-Electrical/ITS/FTMS: 4.8% (131-$0.624 m) ($4,800 per issue)
- TR-Traffic: 4.2% (93-$0.543 m) ($5,800 per issue)
- RW-Retaining Wall: 1.2% (28-$0.152 m) ($5,400 per issue)
- NW-Noise Wall: 0.8% (5-$0.105 m) ($21,000 per issue)
- SS-Sign Structures: 0.6% (16-$0.077 m) ($4,800 per issue)
- SA-Safety: 0.6% (6-$0.073 m) ($12,200 per issue)
- LD-Landscaping: 0.2% (7-$0.026 m) ($3,800 per issue)
- O-Other/Demo: 0.1% (4-$0.017m) ($4,300 per issue)
- Overrun-Underuns/Balancing-Equalizing Mods: 33.3% (108-$4.20 m) ($39,300 per issue)

CIM 3D Modeling: Zoo Interchange Construction: 2012-2018

C3D Technologies/3D Modeling Costs involving Zoo IC (to date):

Zoo IC Construction Project- $1.7 b total (% - Complete in 2018)

- LiDAR and Integrated Survey – Pre-Design Data Collection:
- CIM PXP:
- 3D Modeling - Roads:
- 3D Modeling - Structures:
- 3D Modeling - Utilities:
- 3D Modeling - Traffic:
- 3D Modeling - PI:
- 3D Modeling - Other:
- 3D Modeling QA/QC:
- 3D Modeling e-Construction/3D Rovers (CEC):
- LiDAR and Integrated Survey – Post-Design Data Collection:
- As-built 3D Modeling:
- 3D Modeling Tools
- O-Other:

CIM 3D Modeling: I-94 Mitchell Interchange Construction: 2011-2012

- $294.4m reconstruction of Mitchell IC – part of the 39-mile $1.9 b I-94 N-S construction
- Handles over 195,000 avg. vehicles per day
- Mitchell IC is over 10 miles of construction
- Construction involves 3 tunnels, 13 bridges, 1 system/4 service interchanges (including
- Airport Spur), 29 retaining walls, 7 noise walls, 4 box culverts, 54 sign structures & numerous utilities
- Temp. roads/structures to accommodate 2 lanes of traffic during construction

CIM 3D Modeling: I-94 Mitchell Interchange Construction: 2011-2012

CBA/ROI involving Contract Change Order Issues:

I-94 Mitchell IC Construction Project-$294.4 m

Mitchell IC, CD Road, 27th St, Airport Spur, College/Grange Aves

Field Issues - $22.2 m or 7.5% (651 of 669 DINs/CCOs) (avg - $33,180)

- GN-General: 30.5% (148-$6.8 m) ($45,674 per issue)
- RD-Roadway/Drainage: 25.5% (66-$5.7 m) ($85,631 per issue)
- WU-Wet Utilities/Drainage: 11.1% (90-$2.4 m) ($27,120 per issue)
- BR-Bridges: 8.0% (114-$1.8 m) ($15,557 per issue)
- NW-Noise Wall: 8.0% (14-$1.8 m) ($125,909 per issue)
- RW-Retaining Wall: 7.7% (78-$1.7 m) ($21,818 per issue)
- EW-Earthwork: 4.5% (17-$1.0 m) ($59,220 per issue)
- EL-Electrical/ITS/FTMS: 2.6% (93-$0.6 m) ($15,557 per issue)
- TR-Traffic: 2.1% (26-$0.5 m) ($18,174 per issue)
- SS-Sign Structures: 0.1% (23-$0.02 m) ($738 per issue)

CIM 3D Modeling: I-94 Mitchell Interchange Construction: 2011-2012

CBA/ROI involving Contract Change Order Issues:

I-94 Mitchell IC Construction Project-$294.4 m

Field Issues - $22.2 m or 7.5% (651 of 669 DINs/CCOs)

- Plan Requests RFIs (Plan Submittals, Plan Omissions, Plan Conflicts, Shop Drawings, Calculation Sheets, Additional Info): 42.1% (274 issues)
- Construction Changes (CRI Submittals, Non-conforming Items, Facilitation): 32.4% (211 issues)
- Design Issues (Plan Inadequacies, Quantity Calculations, Premium Costs): 16.1% (105 issues)
- Differing Site Conditions (Soil Conditions, Utility Mislocations, etc.): 9.4% (61 issues)
- Withdrawn: 2.7% (18 Issues)
- Interdisciplinary Conflicts VDC-BIM-CIM Opportunities: 6.9% (45 issues)

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (WisDOT BOS)

CIM Applications:

- 3D Structures Modeling (WisDOT BOS) for SE Freeways

Tool(s) Used/Workflows:

- Bentley LEAP Enterprise Suite–Standard Bridge Structures
- In-house Program–Standard Bridge Structures
- Other–Specialty Bridge Structures
- Bentley Microstation with In-roads–Retaining Walls
- Bentley Microstation with In-roads–Sign Structures
- Bentley Microstation with In-roads–Other

Benefits:

- Structures Design

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures Modeling (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways

Tool(s) Used/Workflows:

- Bentley LEAP Enterprise Suite–Standard Bridge Structures
- Bentley LEAP Enterprise Suite with Microstation–Specialty Bridge Structures
- Bentley Microstation with In-roads–Retaining Walls
- Bentley Microstation with In-roads–Sign Structures
- Bentley Microstation with In-roads–Other

Benefits:

- Structures Design

Challenges:

- Interoperability

Infrastructure Workflows & Tools:
SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Standard Bridge Structures

Tool(s) Used/Workflows:

- Majority are pre-stressed girder, <20^{o} skew, on multi-column piers
- LEAP-Conspan (Superstructure)
- LEAP-RC Pier (Substructure)

Benefits:

- Structures Design (Standard Bridges)
- Structural Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Speciallty Bridge Structures

Tool(s) Used/Workflows:

- Curved Steel Box Girders–(Superstructure
- MDX + Excel with Macros–Preliminary Design, Load Rating
- LARSA–Final Analysis

  Secondary Member Design, Constructability Review, Deflections during Construction
- Excel with Macros–Final Design (Code Check)

  Secondary Members, Splices, Cambers, Screeds

Benefits:

- Structures Design (Specialty Bridges)
- Structural Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools:
SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Speciallty Bridge Structures

Tool(s) Used/Workflows:

- Curved Steel Box Girders–Substructure
  Hammerhead Piers on Drilled Shafts (Pile Footing Option)
- LARSA–Global Stiffness Analysis
- FB Multipier + Excel + In-house Program–Pier Drilled Shaft Design
- Excel–Pier Pile Footing Design
- Mathcad + Excel + In-house Program–Hammerhead Pier Cap & Column

Benefits:

- Structures Design (Specialty Bridges)
- Structural Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Speciallty Bridge Structures

Tool(s) Used/Workflows:

- Railroad Bridge Structures, Deck Girder, Through-plate Girder
- Mathcad + Excel–Superstructure
- FB Multipier–Substructure (Coordination between Structures/Geotech)

Benefits:

- Structures Design (Specialty Bridges)
- Structural Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Specialty Retaining Wall Structures (Geotech Design)

Tool(s) Used/Workflows:

- Cut (Soldier Pile & Lagging, Secant Pile) Walls
- PY wall, Deep Ex (at times with Site-specific P-Y Curves)
- Slide, Excel–External Stability Check

Benefits:

- Structures (Geotech) Design
- Structural/Geotech Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Sign Structures

Tool(s) Used/Workflows:

- SAP, Excel, Mathcad–Superstructure
- Per WisDOT standards (Geotech verify)–Substructure

Benefits:

- Structures Design
- Structural Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Structures (F45)

CIM Applications:

- 3D Structures (F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways
- Standard Retaining Wall Structures (Geotech Design)

Tool(s) Used/Workflows:

- Fill (MSE) Walls (Proprietary)
- Settle 3D, Plaxis–Settlement Check
- Slide, Excel–External Stability Check
- Bentley Microstation

Benefits:

- Structures (Geotech) Design
- Structural/Geotech Analysis

Challenges:

- Interoperability

Infrastructure Workflows & Tools: SE Freeways Zoo IC Geotech (WisDOT/F45)

CIM Applications:

- 3D Geotech (WisDOT & F45-HNTB, CH2MHill, K&A, etc.) for SE Freeways

Tool(s) Used/Workflows:

- Bentley gINT for Soil Borings
- Keynetix/Autodesk Geotech (Pilot)

Benefits:

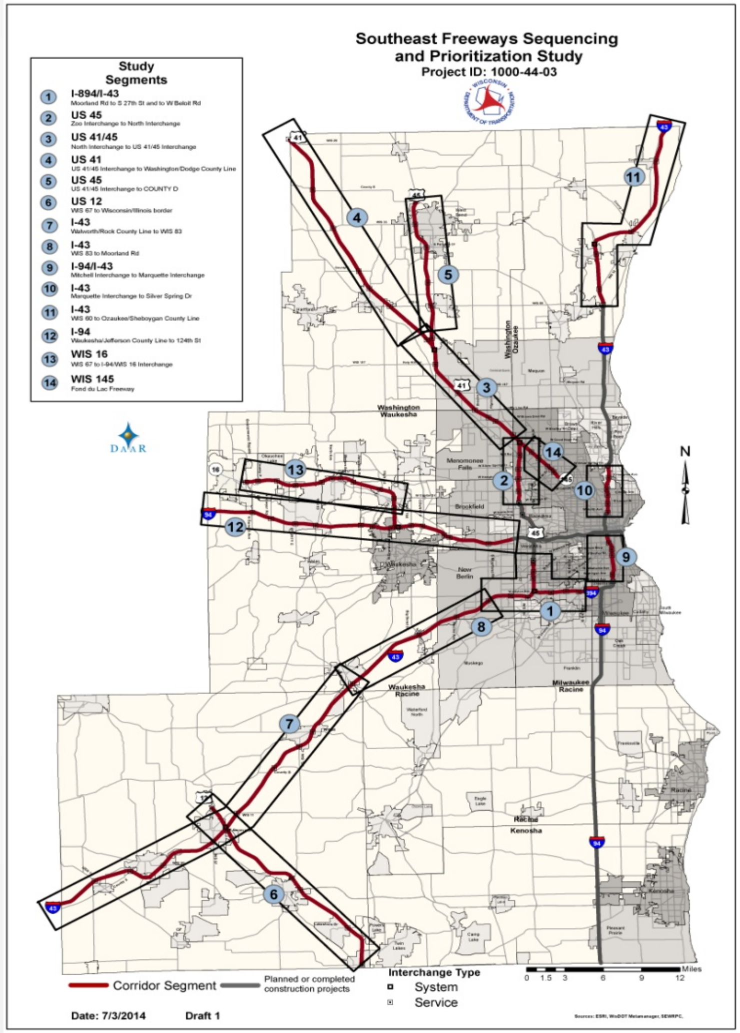
- Geotech

Challenges:

- Interoperability

Automated Infrastructure Planning:
SE Freeways Project Prioritization & Sequencing

SE Freeways Study Segments



55+ miles designed and/or constructed with 218 miles of 273 total miles to be prioritized and sequenced involving freeways in southeast Wisconsin

Automated Infrastructure Planning:
SE Freeways Project Prioritization & Sequencing

CIM Applications:

- Decision Matrix for SE Freeways Planning, Prioritizing, & Sequencing Projects
- Web-based SE Freeways Intranet/Extranet GIS Data Warehouse

Tool(s) Used:

- ESRI ArcGIS (7-County 2D File GeoDB GIS Data Warehouse)
- Autodesk C3D (7-County Project Data 3D to 2D)
- Decision Lens (MS Excel Import-Export to-from GIS)

Benefits:

- Strategic Capital Finance Planning, Resource Allocating, & Asset Management Planning
- Customizable Analytical Heirarchical Decision Matrix Weighting of Criteria Fields

Challenges:

- Data Warehousing of Large 7 County Datasets
- Web-based Access of Collaborative SE Freeways GIS DB - Intranet and/or Extranet

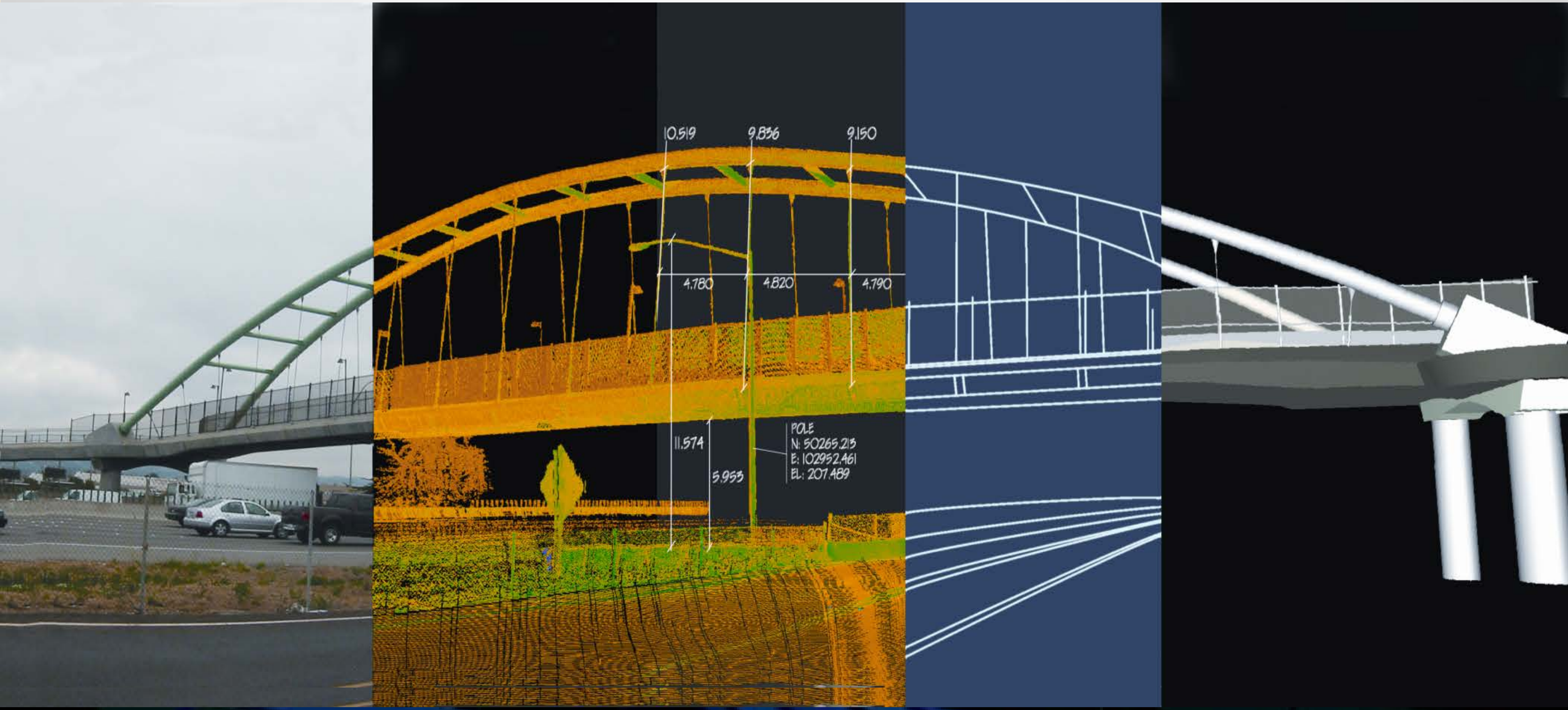
CIM 3D Modeling: Zoo Interchange Design-grade Survey

3D Survey Integrated Mapping using LiDAR-Static/Mobile/Aerial Scanning with Supplemental RTK GPS/Digital Leveling/TS/UAV Existing Conditions

CIM 3D Modeling: Zoo Interchange

Design-grade Survey

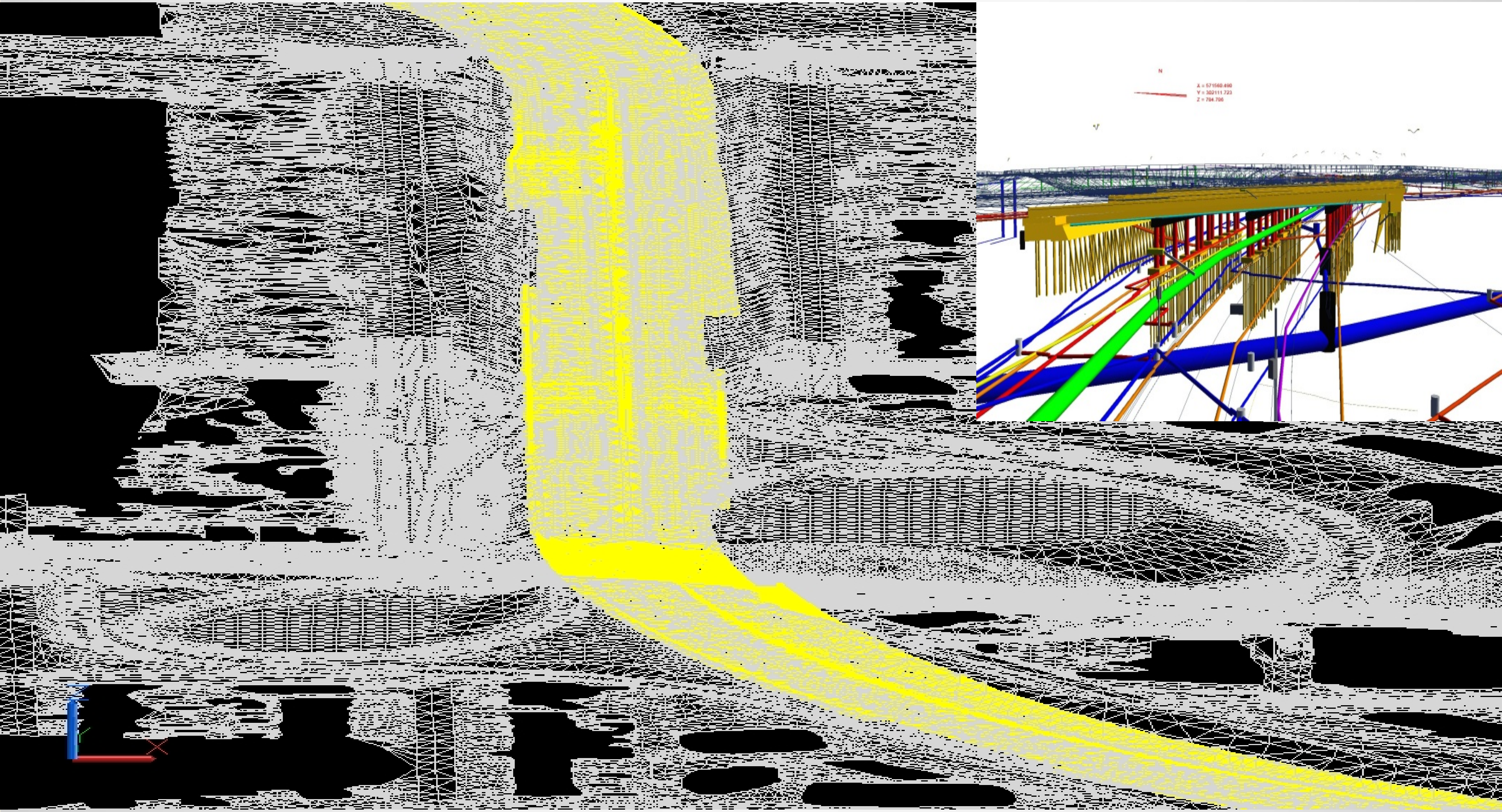
CIM 3D Modeling: Zoo Interchange
Design-grade/Post-construction Surveys



Georeferenced Hi-res Digital Images	3D XYZ Return LAS Point Clouds	2D -3D Feature Lines 3D DTMs-TINs X-Sections	3D CIM-BIM DSMs

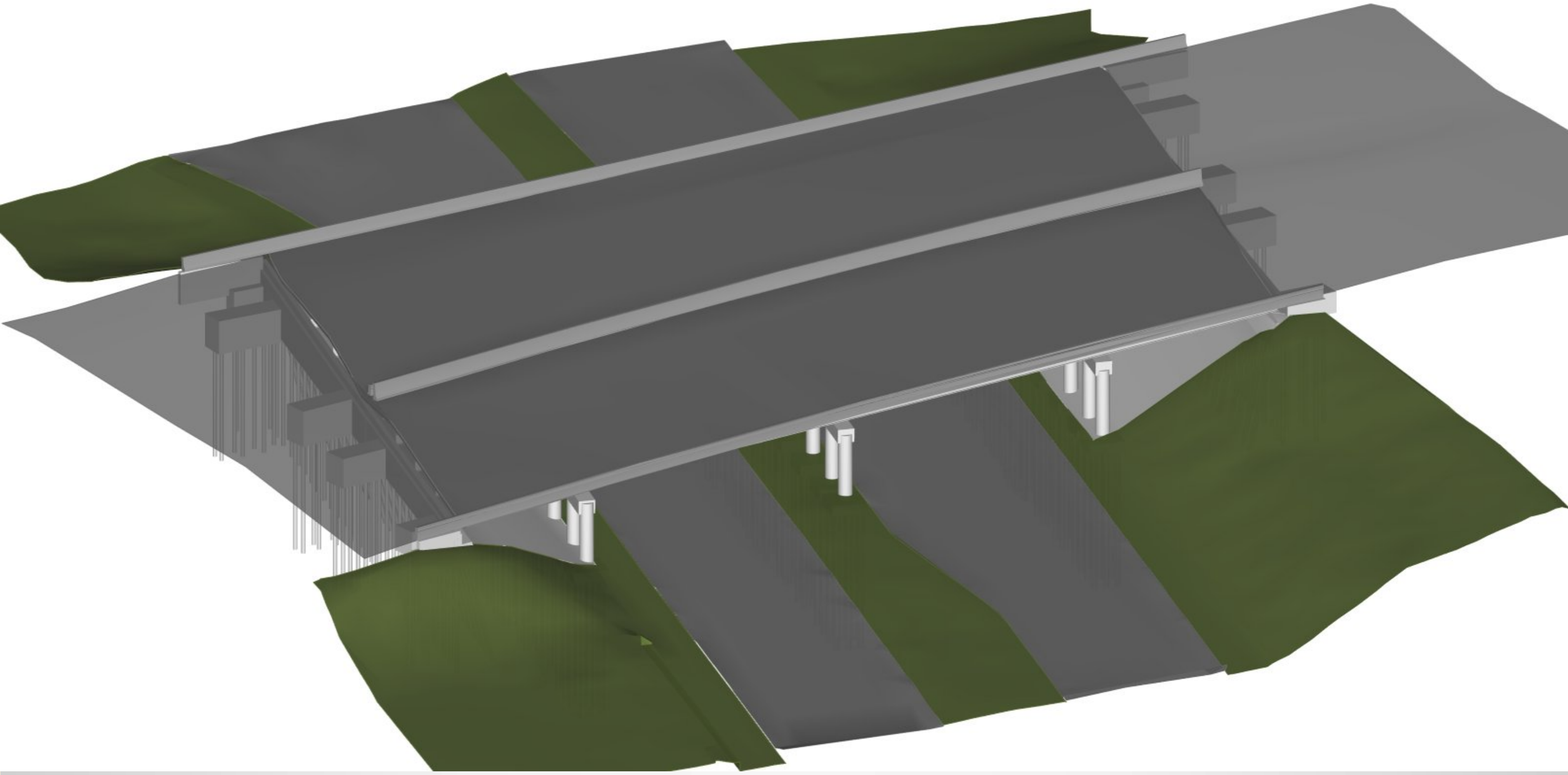
CIM 3D Modeling: Zoo Interchange Design

3D Roads/Drainage/Surfaces



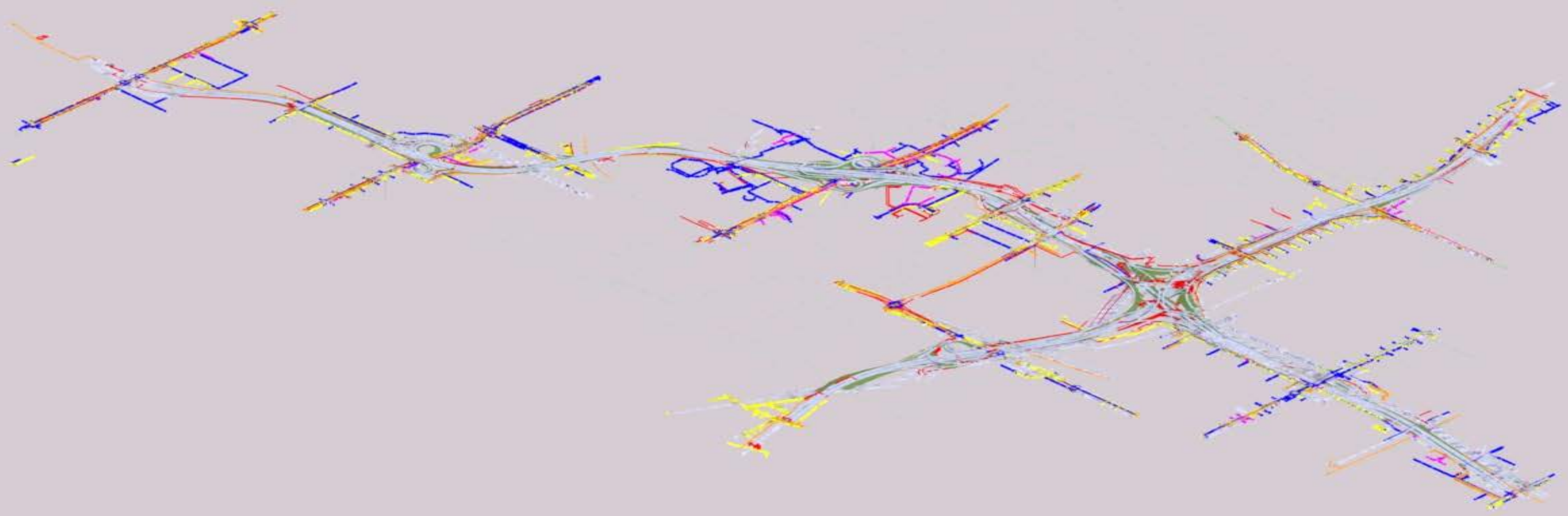
CIM 3D Modeling: Zoo Interchange Design

3D Structures: Bridges, Ret Walls, Noise Walls, Tunnels, Sign Bridges, Other



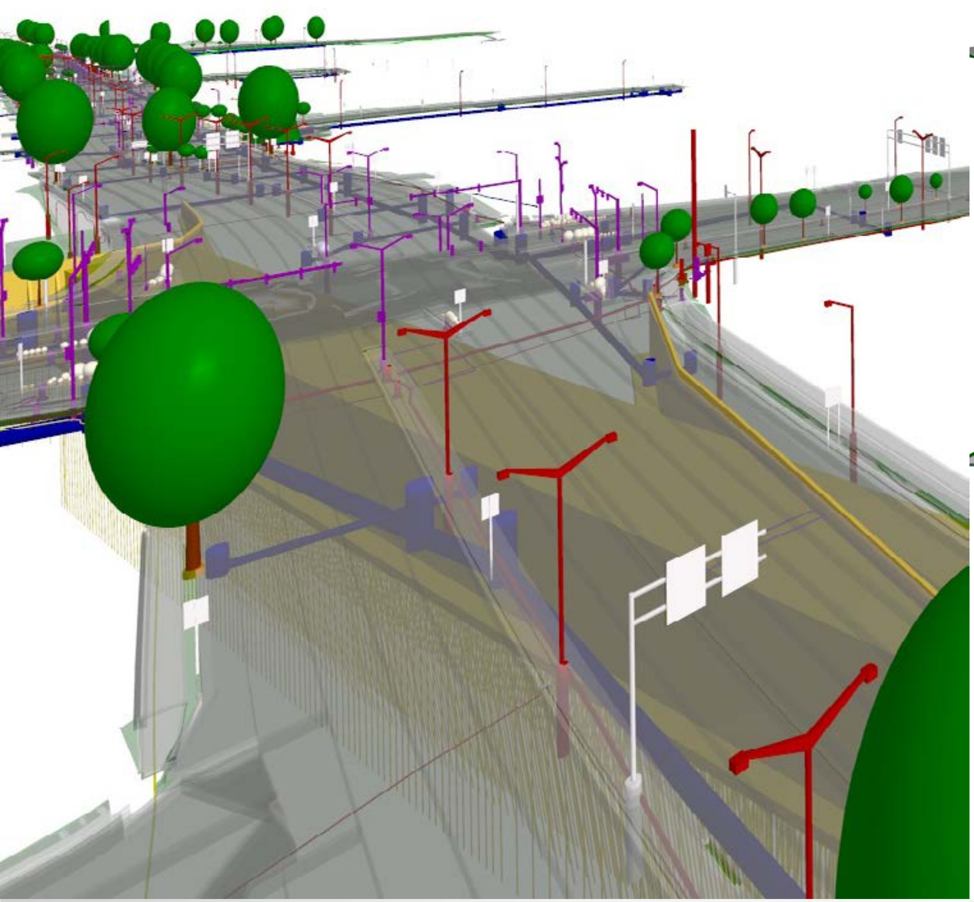
CIM 3D Modeling: Zoo Interchange Design

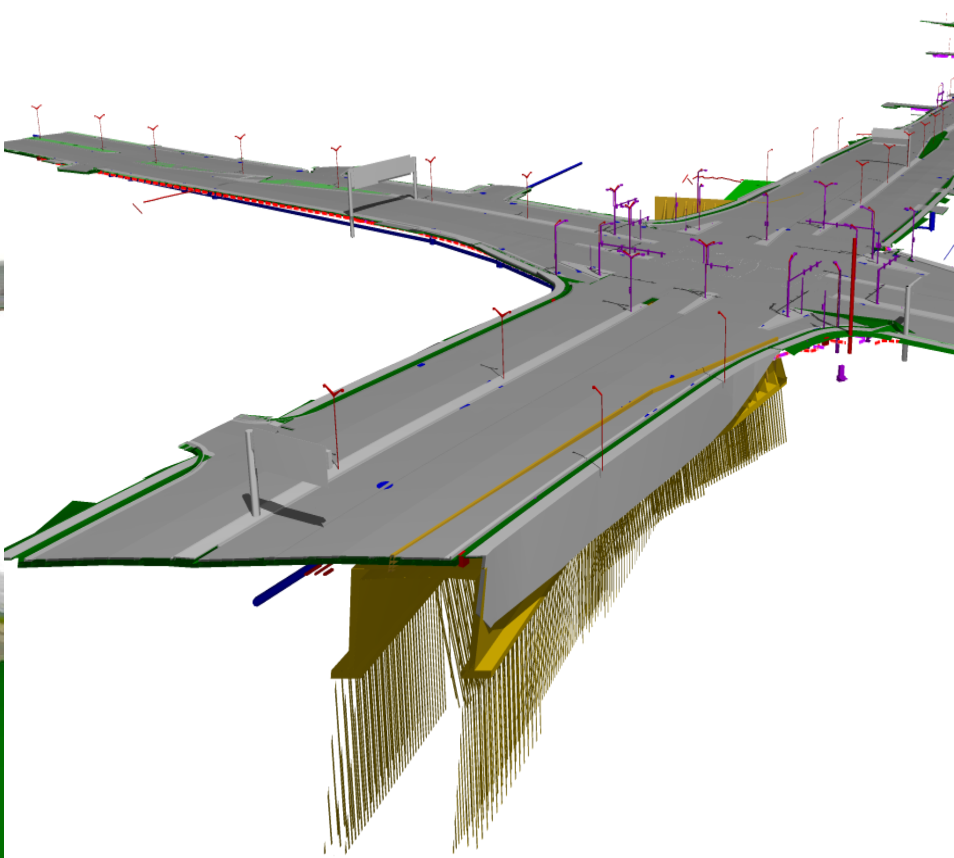
3D Utilities-Gas, Steam, Electrical, Comm, Fiber Optic, Tel/Data, CATV/Data, Other



CIM 3D Modeling: Zoo Interchange Design

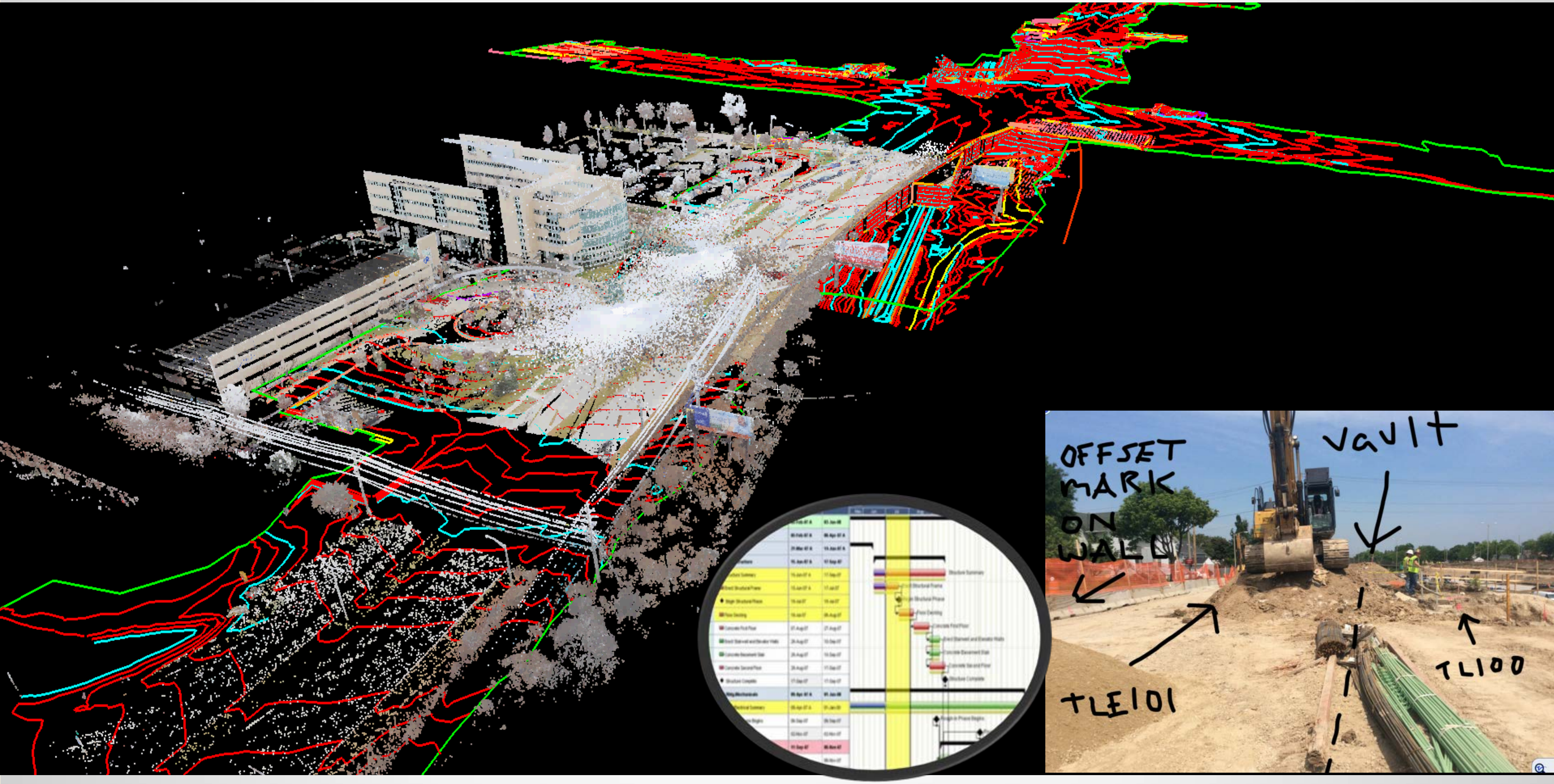
3D ITS/FTMS, Lighting, Signs, Signals, Landscaping, Water, San Sewer, Other





CIM 3D Modeling: Zoo Interchange Design

3D Staged Model with Temporary Surfaces, Roads, Drainage, Structures, Other



CIM 3D Modeling: Zoo Interchange Design

CIM – Multi-disciplinary Integrated 3D Design

CIM Applications:

- Multi-disciplinary Integrated 3D Design Workflows for Roadway, Structures, Geotech, Utilities, Traffic, S&S, Other
- Clash Detection between Disciplines in Design Reviews

Tool(s) Used:

- Bentley Microstation + In-roads (Design) SS2 / Autodesk C3D 2014
- Bentley Navigator (Clash Detection) / Autodesk Navisworks 2014

Benefits:

- Improved Design & Design-Construction Reviews
- Earlier Detailed Clash Detection-Resolution
- Improved PS&E Production Quality & 3D Model Delivery

Challenges:

- All Design Disciplines Designing in 3D
- Better 3D Modeling SW Tools Needed for Structures & Utilities

CIM 3D Modeling: Zoo Interchange Design

CIM - Visualization & Clash Detection

CIM Applications:

- Digital Project Delivery 3D Model-based PS&E Production +
  3D Models (3DAMG Model @Prebid & 3D Ancillary Model @Precon)
- Clash Detection Preformed after 60% & Draft PS&E Reviews

Tool(s) Used:

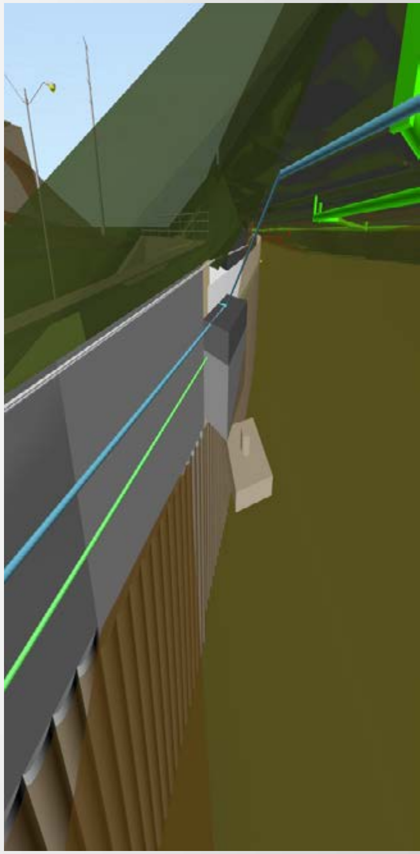
- Bentley Microstation + In-roads (Design) SS2 / Autodesk C3D 2014
- Bentley Navigator (Clash Detection) / Autodesk Navisworks 2014

Benefits:

- Earlier Detailed Clash Detection-Resolution
- Improved PS&E Production & 3D Model Delivery Pre-bid/Pre-con

Challenges:

- “Rule-based” Clash Detection
- Pre-bid - AMG/Precon - Ancillary 3D Model Delivery Timeframes



CIM 3D Modeling: Zoo Interchange Design

4D/ Constructability Analysis

Applications:

- Final design and staging plan development
- Public Involvement

Tool(s) Used:

- Autodesk Navisworks
- Bentley Navigator

Benefits:

- Evaluate staging options
- Evaluate utility relocations

Challenges:

- Requires 3d elements from design
- Requires detailed schedule and durations
- Accuracy of existing surface or utility data
- Design tool or visual aid??

CIM 3D Modeling: Zoo Interchange Design

3D Photorealistic/Augmented Reality/Rendered Model

CIM 3D Modeling: Zoo Interchange Design

CIM & Public Involvement Applications

CIM Applications:

- Exhibits & Maps from 3D Engineered Models & GIS for PI
- Renderings & Simulations from 3D Engineered Models for PI

Tool(s) Used:

- Bentley Microstation SS2 / Autodesk C3D 2014 / 3DS Max/ RDV Systems / Forum8
- Autodesk 3DS Max

Benefits:

- Improved Renderings & Simulations Directly from 3D Models
- Improved Visualizations for Stakeholders

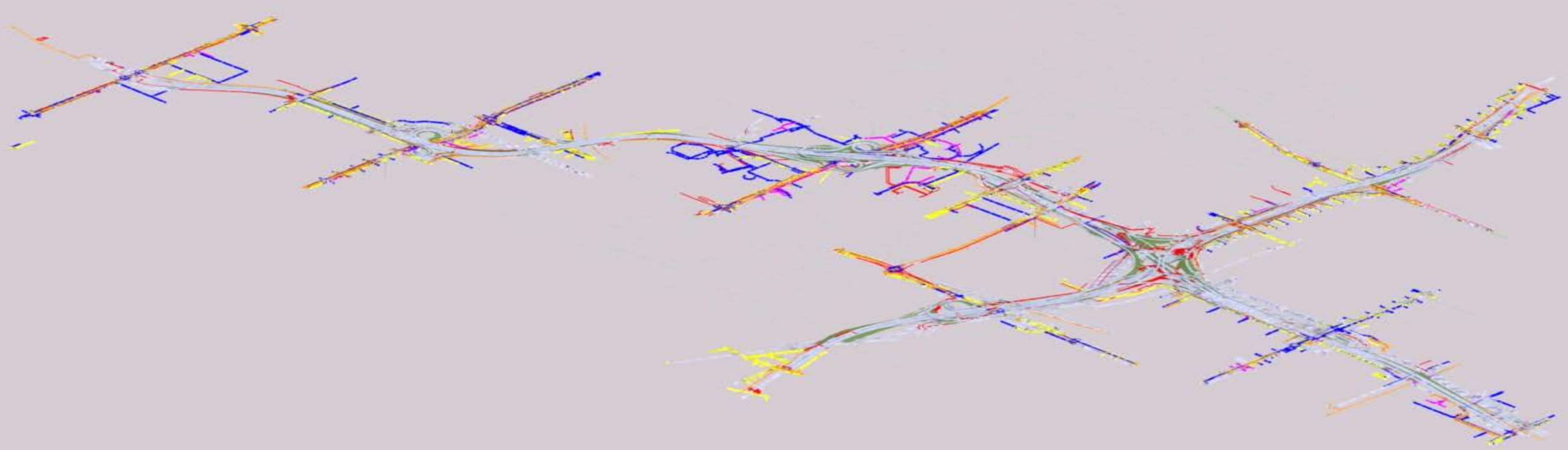
Challenges:

- Renderings & Simulations 3D Workflows Timeframes
- Better 3D Rapid Modeling Software Tools Needed

CIM 3D Modeling: Zoo Interchange Design

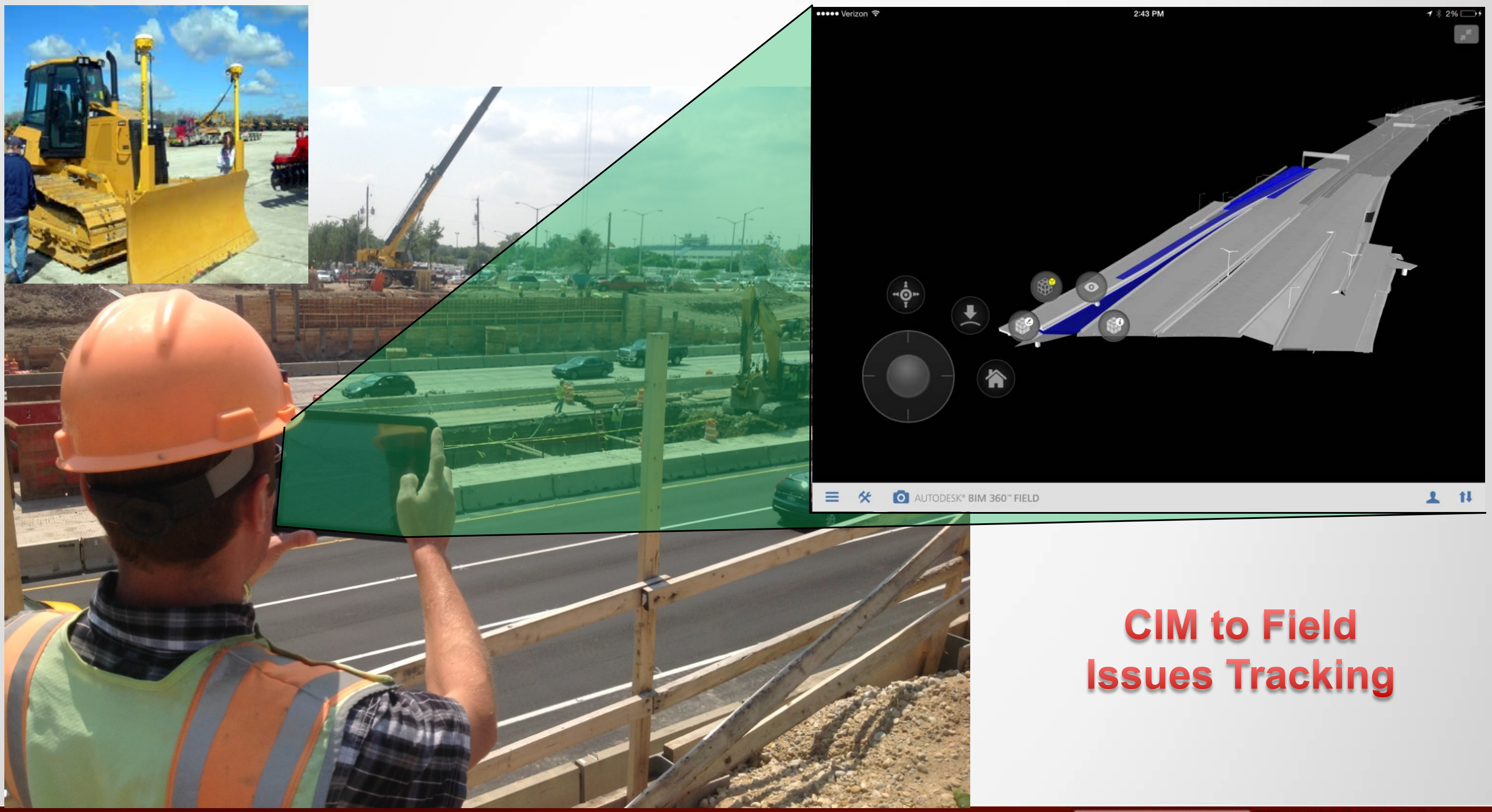
Post-Construction Initiatives:

As-built Record CEC Updating of 3D Model Pilot Project



CIM 3D Modeling: Zoo Interchange Construction

3D Engineered Models in Construction-SE Freeways/Region



CIM to Field Issues Tracking

CIM 3D Modeling: Zoo Interchange Construction

3D Engineered Models in Construction-SE Freeways/Region

CIM 3D Modeling: Zoo Interchange Construction

CIM – BIM Field 360

CIM Applications:

- Collaboration Using Autodesk BIM Field 360, Glue, & Buzzsaw
- Construction Issues Management + Design-Construction Reviews

Tool(s) Used:

- Autodesk BIM Field 360, Glue, & Buzzsaw (Pilot)
- Office & Field Mobile Devices (Pilot)

Benefits:

- Improved Issues Notification
- Improved Design-Construction Reviews
- Improved Construction Collaboration & Coordination

Challenges:

- Mobile Devices Hardware (iOS Apple vs MS Win Office Tablets)
- Software Applications (Apple vs 32-bit MS Windows software)

3D Technologies/Modeling Trends

- Standards (CAD, BIM/CIM, LandXML, IFC, ISO, Other)
- Integrating Infrastructure Chain (Fabricators, etc.)
- Schedule-4D (Constructability/Staged Construction)
- Costs-5D
- Constructability Review with Schedule/Costs
- Reality Capture (Photo Point Cloud vs LiDAR Point Cloud)
- VR/AR
- As-builting (2D Blue Beam, 3D Markup, etc.)
- UAS/UAVs
- Life-cycle use of the 3D Model

Intelligent Vehicles + Sensor Technologies + Intelligent Roads with Automated 3D Design

Driverless Vehicles

Machine-Controlled UAV

Traffic Operations

UAV Accident Monitoring

Lane, Distance, Time Compression