CIM-Civil Integrated Management: Best Practices & Lessons Learned

WisDOT SE Freeways - Focus on Design & Construction

Bob Gutierrez, PE & Ryan Luck, PE

Chief, SEF Design; Chief, SEF Construction

William Mohr, PE & Wafa Elqaq, PE

Supervisors, SEF Design

Mike Paddock, PE, PS & Chris Johnson, BS

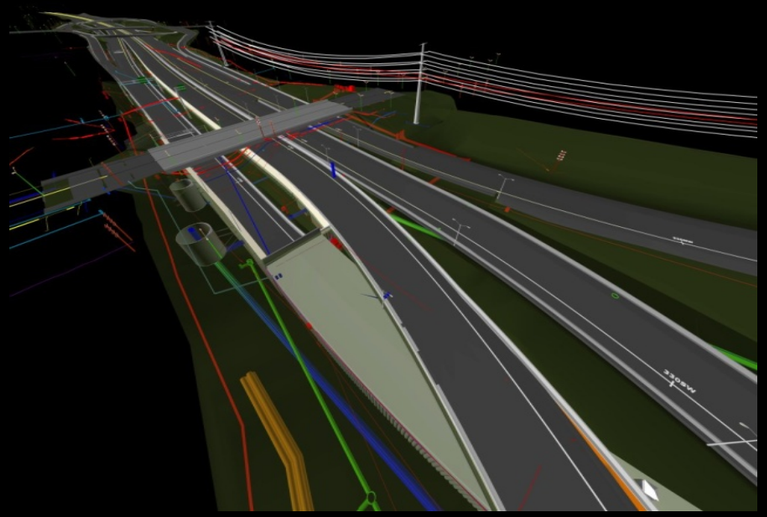
Project Director, F45 Consultant; Associate Technical Leader, F45

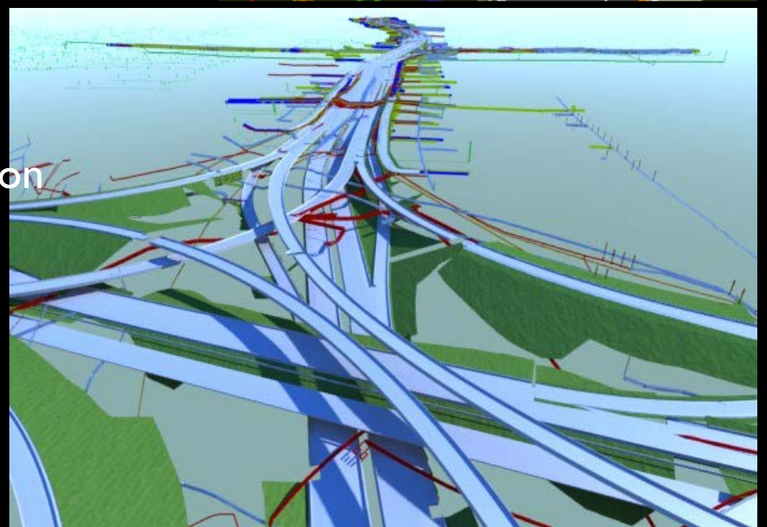
Lance Parve, MSCE, PG & Jerry Zogg, PE

Sr. Project Engineer, SEF Design, TRB VDC-CIM Co-Chairperson in Visualization in Transportation Committee; Chief, Design Methods Unit

Kurt Flierl, PE & Shane Zodrow, PE, PS

PM SEF Construction; Project Eng-Surveyor, Kapur & Associates;





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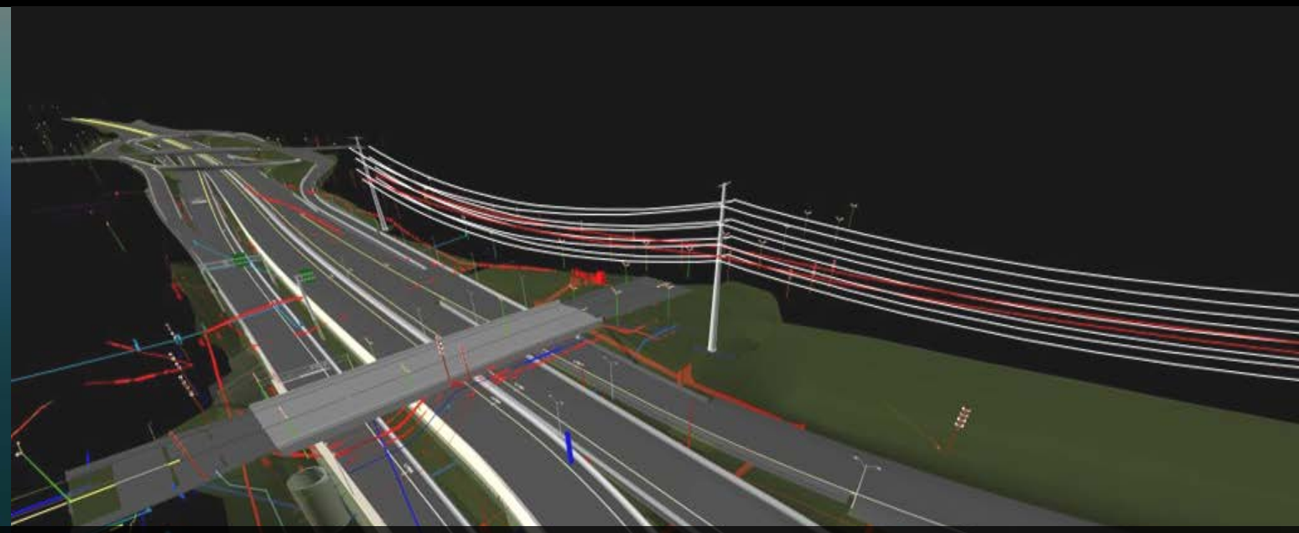
WisDOT SE Freeways - Focus on Design & Construction

Meeting Agenda: 9:00-12:00 p.m. 08-23-12 @ Barstow Bldg Rm 338

- **Intro – WisDOT SE Freeways Projects Overview: Gutierrez & Luck**
- **1. CIM – Technologies, Tools, Benefits, Costs & ROI: Parve & Zogg**
- **2 CIM – Design Applications: Paddock, Johnson & Parve**
- **Q & A – Interactive**
- **3. CIM – Planning-Integrated Survey & LiDAR D.C. Apps: Parve & Zodrow**
- **4. CIM – Maintenance & Operations - Lifecycle Applications: Parve**
- **5. CIM – Future Applications, Challenges & Opportunities: Parve**
- **Q & A – Interactive**
- **6. CIM – Construction Applications: Flierl & Zodrow**
- **Q & A – Interactive**

CIM-VDC

Best Practices & Lessons Learned



Zoo Interchange – Preliminary Design

- Project Overview & Benefits
- CIM-VDC processes
- Workflows & Tools
- 3D Modeling & Clash Detection
- Demo & Conclusions

Mitchell Interchange – Construction

- Project Overview & Benefits
- CIM-VDC processes
- Workflows & Tools
- 3D Modeling, Clash Detection & 4D
- Demo & Conclusions

CIM-Civil Integrated Management: Best Practices and Lessons Learned

WisDOT SE Freeways - Focus on Design

Introduction - Zoo IC Design Project (Construction $1.7 b 2012-18)

- **Planning, Surveying & Data Collection (2007-12)**
  (LIDAR Mobile-Static/APS/RTK GPS/TS)
- **Environmental Study (02/2012 ROD)**
  (EIS & Preferred Alternative)
- **Design (2012-15)**
  (Preliminary/Final Design - P, S & E's)
- **Construction (2012-18)**
  (Arterials & Freeways)
- **Operations/Maintenance**
  (Infrastructure Lifecycle)

CIM-Civil Integrated Management: Best Practices and Lessons Learned

WisDOT SE Freeways - Focus on Design

Zoo IC Design Project

- $1.7 b reconstruction of Zoo IC-Corridor
- Handles almost 350,000 avg. vehicles per day in traffic
- 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
- CIM-VDC is being used throughout Zoo IC Design Project

FORWARD 45

CH2MHILL

HNTB

KAPUR & ASSOCIATES, INC. CONSULTING ENGINEERS

WOOLPERT

Mortenson construction

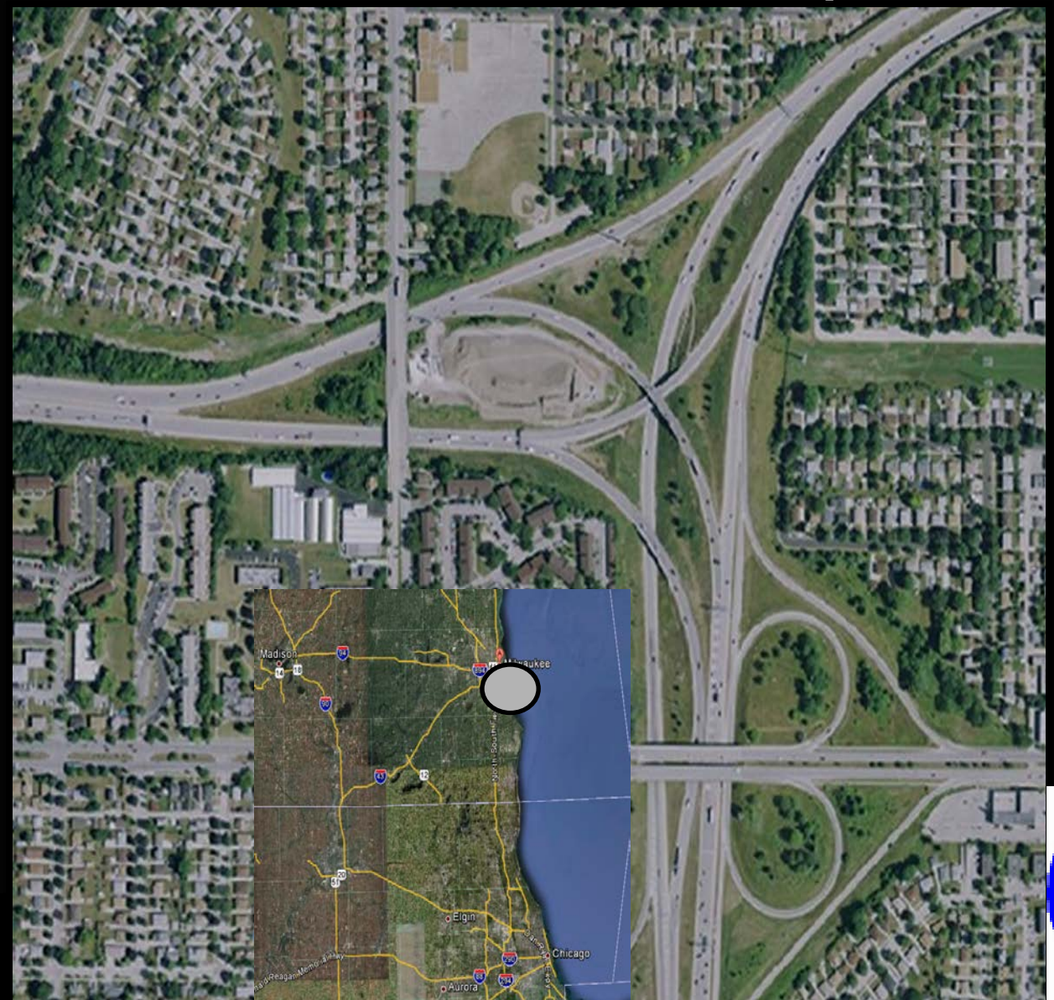
CIM-Civil Integrated Management: Best Practices and Lessons Learned

WisDOT SE Freeways - Focus on Construction

Introduction – Mitchell IC Construction $162.5 m 2011-12 Project

- $162.5 m reconstruction of Mitchell IC – part of the $1.9 b I-94 N-S construction
- Handles over 195,000 avg. vehicles per day
- 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-VDC Pilot Study for Mitchell IC Construction Project



CIM-Civil Integrated Management: Best Practices and Lessons Learned

WisDOT SE Freeways - Focus on Construction

Mitchell IC Construction Project – I-94 N-S Corridor

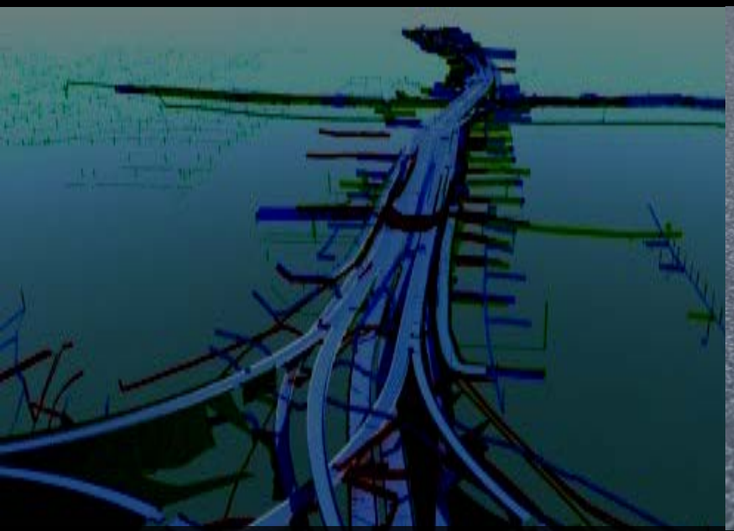
CIM-VDC in Transportation

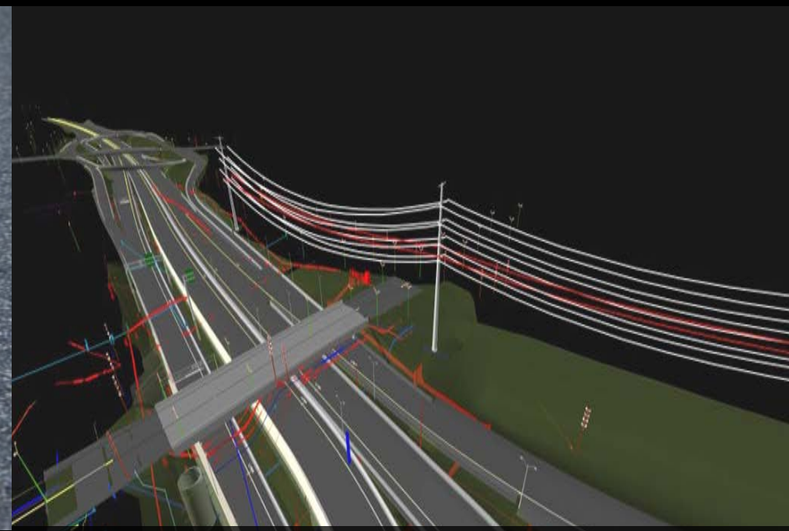
Discussion Topics

- Where are potential savings & cost avoidance being achieved if at all using CIM-VDC?
- How can construction schedules be streamlined & shortened using model-based tools?
- How do the quality of mega project PS&E plans improve with model-based delivery?
- How can data be collected more accurately & efficiently involving 3D plans production?
- What about integrated project delivery (IPD) & WisDOT design-bid-build (DBB) projects as compared to design-build (DB) projects?
- What changes to WisDOT-Consultant workflows including design-reviews and construction reviews are involved using model-based delivery for mega-major WisDOT projects?
- How are design and construction models different?
- What potential investment will be required in workforce training and I.T. infrastructure?
- How will legal issues be handled involving model delivery if provided pre-bid on delivery of P, S & E construction documents?
- How are these initiatives being funded & supported by FHWA & DOT management?
- What are the trends and roadmap for CIM-VDC applications in the future?

CIM-VDC

…the 3D model made me do it…





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- Demo & Conclusions

CIM-VDC

Concepts, Definitions & Processes

- CIM or Civil Integrated Management is “the collection, organization and managed accessibility to accurate data and information related to a highway facility including planning, environmental, surveying, design, construction, maintenance, asset management and risk assessment.”

  - FHWA, AASHTO, ARTBA & AGC

- VDC or Virtual Design & Construction is “the use of integrated multi-disciplinary performance models of design-construction projects to support explicit and public business objectives.”

  - Stanford Center for Integrated Facility Engineering (CIFE)

CIM-VDC

Concepts, Definitions & Processes

Databases, Tools & Processes

- CiM or Civil Information Model is the digital database for a civil facility from inception to life cycle, suite of software tools & associated set of processes to produce, communicate and analyze design and construction.

- BiM or Building Information Model is a digital database for a architectural facility from inception to life cycle, suite of software tools & associated set of processes to produce, communicate and analyze design and construction.

- The databases, tools & processes use multidisciplinary performance models of design & construction input such as Building or Civil Information Models (3D), CPM Schedules (4D), Cost Estimates (5D) and Specifications (6D) to simulate & validate project objectives.

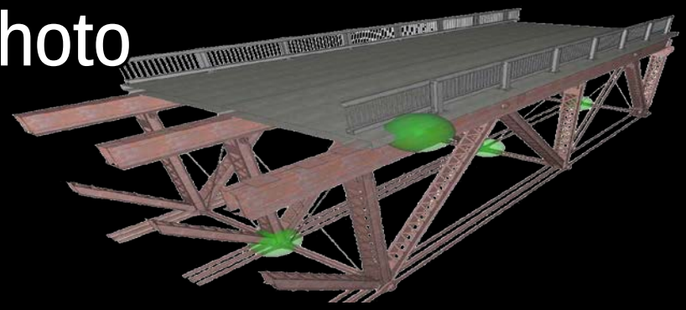
- Michael Lingerfelt, AIA

CIM-VDC

Concepts & Definitions & Processes

Digital Modeling Databases

- CAD - 2D-3D Graphical Vector DB + Raster Aerial Orthophoto
- GIS - Geospatial Features Mapping DB
- CiM - Parametric Objects DB (3D + 4D + 5D +6D)

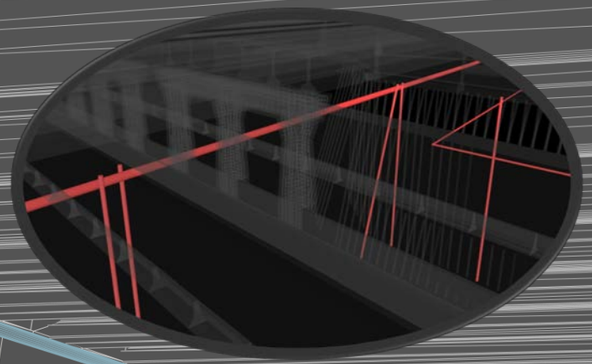


- DTM - Digital Terrain Model (Bare Earth)
- TIN - Triangulated Irregular Network (Bare Earth)
- DSM - Digital Surface Model (Incl. 3D DTM + 3D Structures + 3D Bldgs)
- DDM - 3D Bridges, Ret. Walls, Noise Walls, Sign Structures, Drainage, Utilities, RR, Geotech, Pavement, Subsurface, Signals, Lighting, FTMS, Traffic, PM (draped), Parcels (draped), etc.
- DCM - Grading, etc.

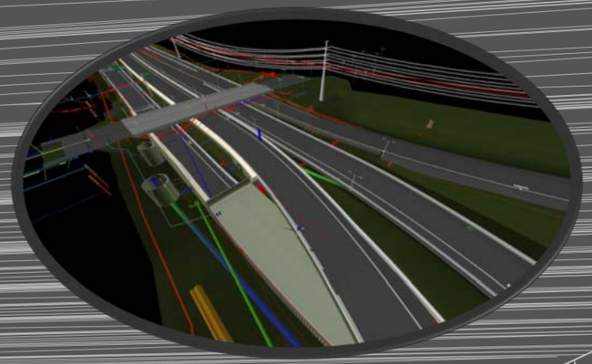
CIM-VDC

Technologies, Tools & Processes

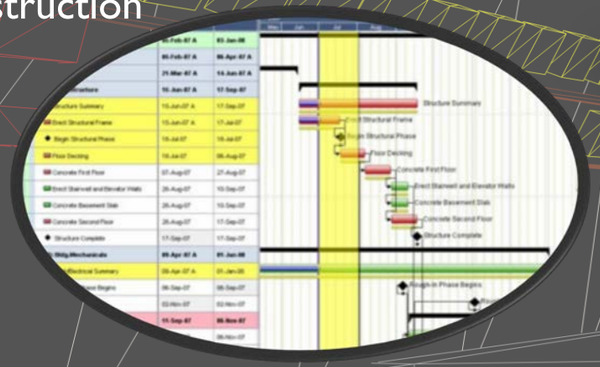
Clash Detection
4D Constructability
Navisworks® Manage
Bentley Navigator



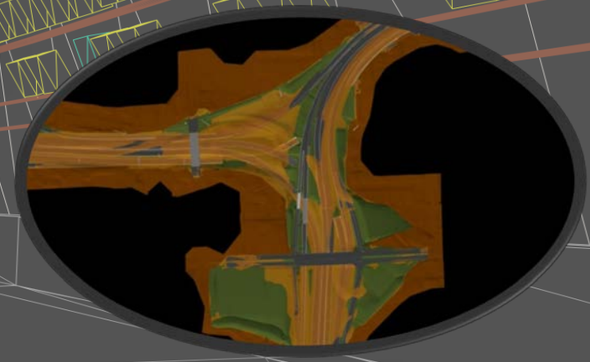
Geometrics
AutoCAD® Civil® 3D
Microstation



Primavera
Schedule
Construction

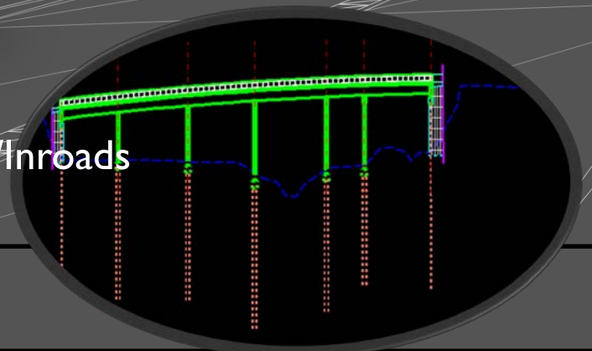


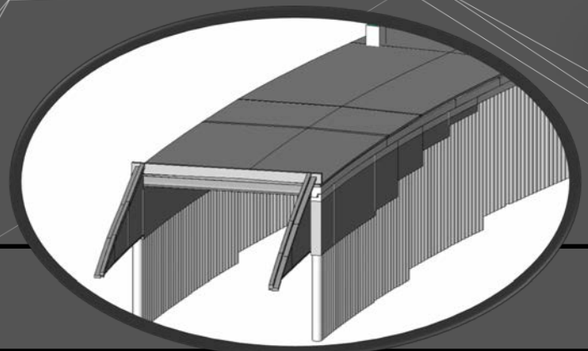
Surfaces
MS/Inroads
AutoCAD®Civil®3D



P, S & E
Construction Docs
AutoCAD® Civil® 3D

MS/Inroads





Structures
Autodesk® Revit®
Structure
Bentley LEAP

CIM-VDC

Technologies, Tools & Processes

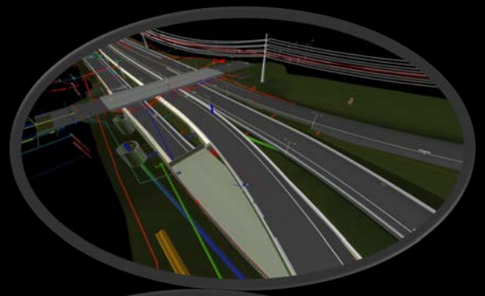
Contract

Construction Management

QA-QC

O & M

Data Collection-Survey



LiDAR-Mobile-Static PCs

RTK GPS-Total Station

Georeferenced Images

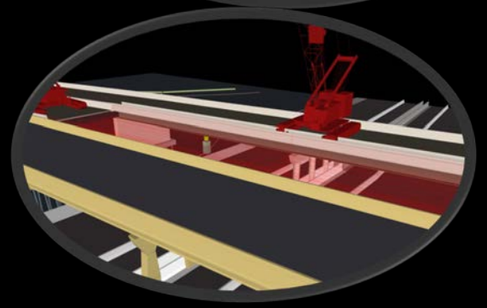
3D Obligue Images

As-builts

- Geospatial
- Graphical-Geometric
- Vector-Raster
- DTMs-TINs
- Features-Ls, Ps & PGs
- Attributes-Tabular

6D

e-Specifications

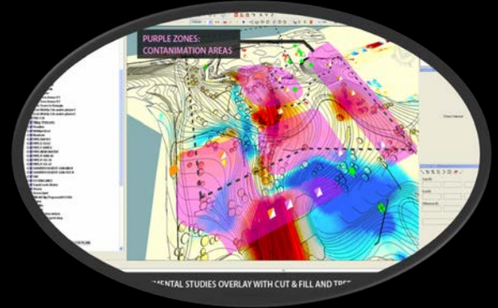


LAN-WAN-NAS-Parallels

PCs-Workstations

Cloud-Internet

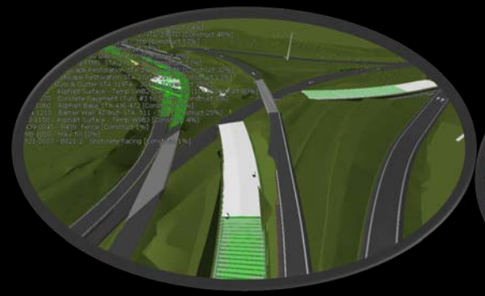
Mobile Devices

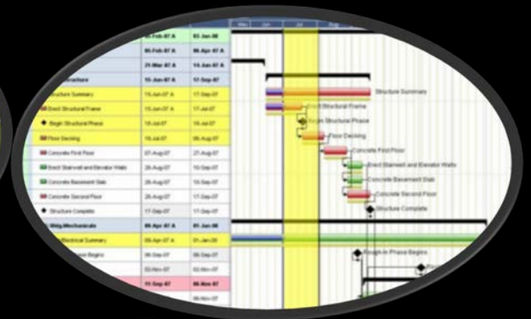


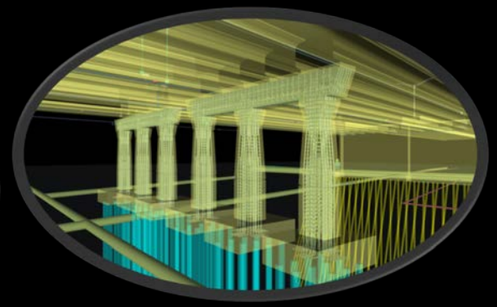
5D

Cost Estimates

EOQ-BOQ







CAD-GIS-BIM-CAE

3D Functional Modeling

3D Rendering

4D Scheduling

CIM-VDC

Technologies, Tools & Processes

CiM-BiM Tools vs. Visualization Tools

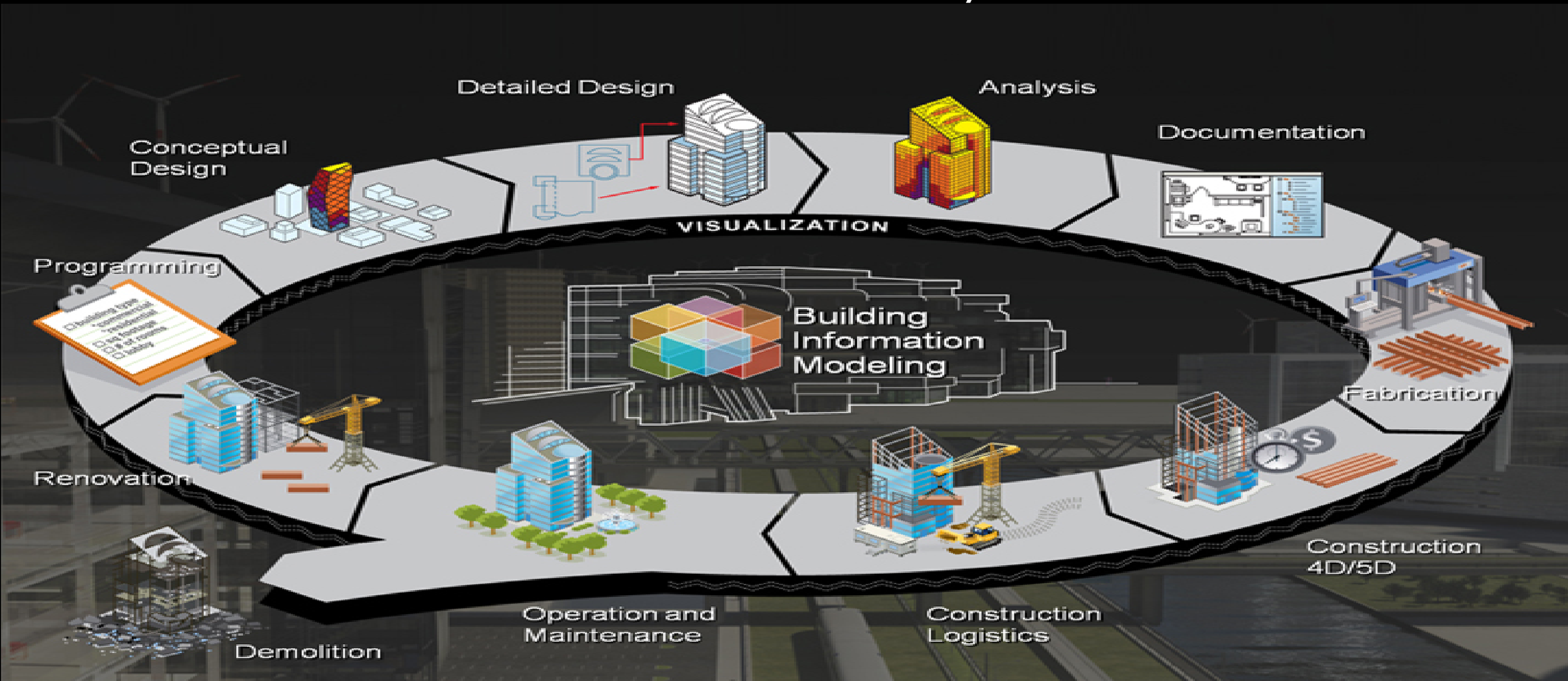
- Hand Rendering
- 2-D CAD (vector graphics) + Images (raster aerial/terrestrial)
- 3-D CAD (features/DTMs-TINs-DSMs) + Images
- Digital Realistic Rendering to 3-D Model (adding color, texture, lighting, shadow, reflectivity, etc.)
- Photo-Simulation to 3-D Model (adding photo-editing)
- Digital Animation (moving the 3-D model & images)
- Real-time Simulation (real-time simulation & virtual-augmented reality)
- Google Earth/Bing, Web, Multi-media, Video & Cloud-based tools

"If I can visualize it, I can understand it."
Albert Einstein

CIM-VDC

Benefits & ROI

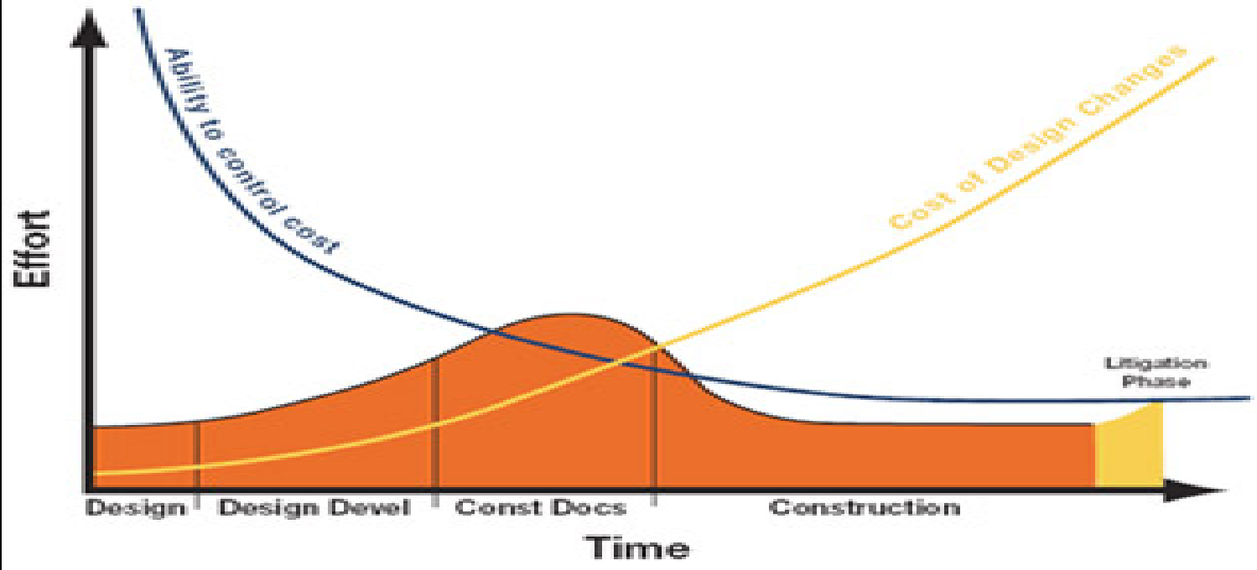
CIM-VDC Information Cycle

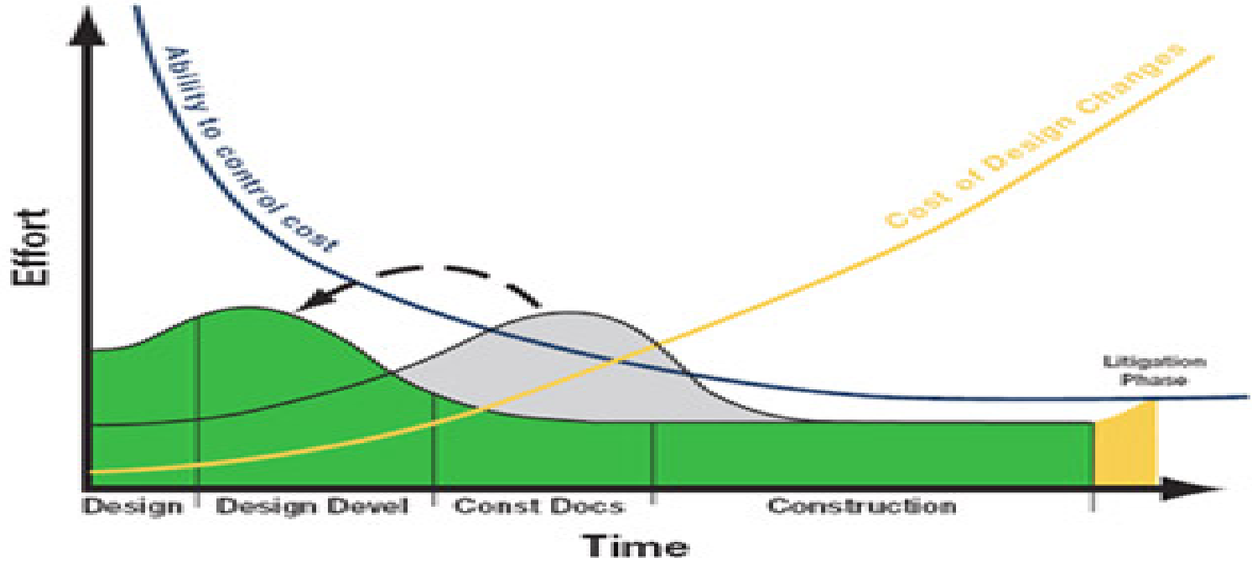


CIM-VDC

Benefits & ROI

Integrated Project Delivery-IPD

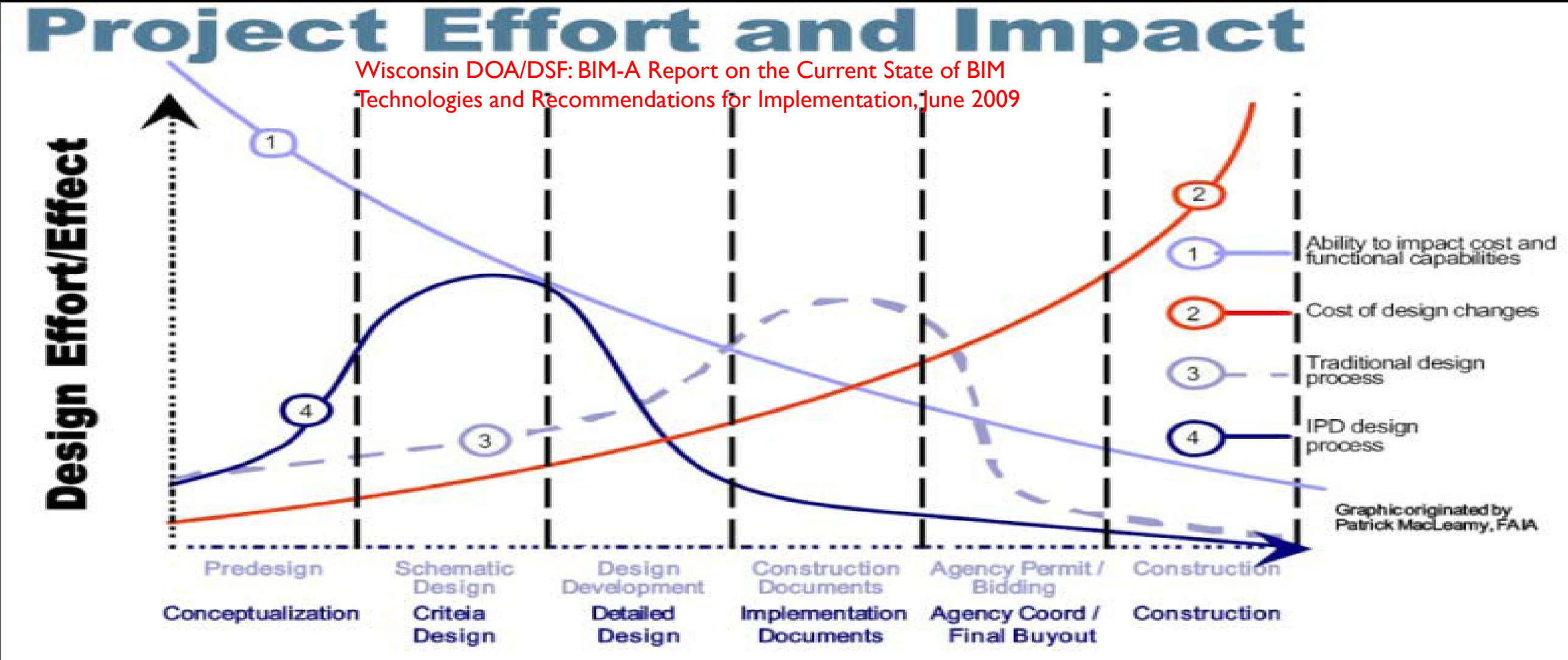




CIM-VDC

Benefits, & ROI

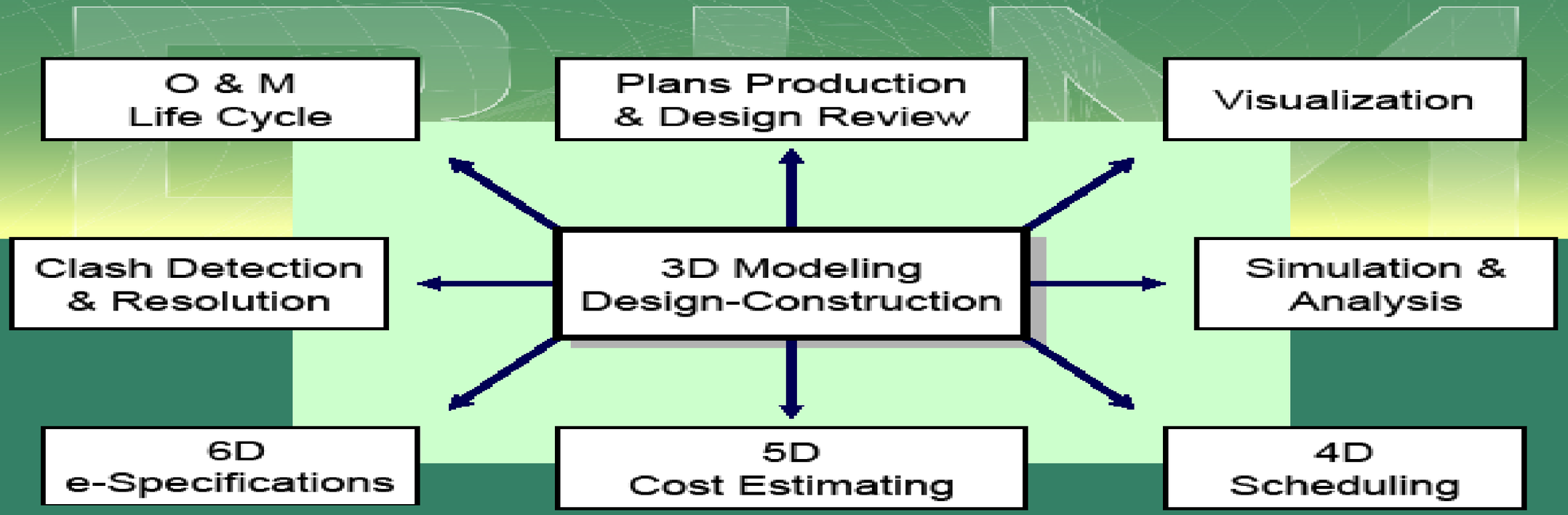
Integrated Project Delivery-IPD



CIM-VDC

Benefits, & ROI

Benefits of CIM-VDC



CIM-VDC

Benefits, ROI & Workflows

"To CIM or not to CIM"

- Cost Savings & Cost Avoidance are achieved more effectively during the Design Phase for the Construction Phase
- Integrated project delivery, 3D data collection & model-based P, S & E construction document delivery are disruptive to the transportation planning, design & construction process
- Collaboration between DOT planning-design-construction-ad hoc & oversight staffs, consultant designers, GC & subcontractors is required to achieve maximum gains
- Processes changes require FHWA & DOT management support
- Workflow changes require a significant investment in workforce training
- Workflow & dataflow changes require a significant investment in I.T. & technologies
- Model-based P, S & E construction-bid document delivery requires additional legal front-end & back-end document language (contracts & model disclaimers)

CIM-VDC

Benefits & ROI

Opportunities for ROI - CBA of CIM-VDC

RFIs for I-94 Layton CD Project-
Field Issues - $? for $81 m project

- RW-Retaining Wall: 19%
- BR-Bridges: 16%
- RD-Roadway: 16%
- NW-Noise Wall: 9%
- WU-Wet Utility: 8%
- SS-Safety/Standards/Specs/Cost Red: 5%
- DU-Dry Utility & EL-Electrical: 4%
- TR-Traffic: 3%
- DM-Demolition: 0%
- EW-Earthwork: 0%
- GN-General: 22%

DINs for I-94 Layton CD Project-
Field Issues - $? for $81 m project

- RW-Retaining Wall: 16%
- WU-Wet Utility: 14%
- RD-Roadway: 13%
- DU-Dry Utility & EL-Electrical: 13%
- BR-Bridges: 10%
- SS-Safety/Standards/Specs/Cost Red: 6%
- NW-Noise Wall: 3%
- TR-Traffic: 3%
- EW-Earthwork: 2%
- DM-Demolition: 0%
- GN-General: 21%

CIM-VDC

Benefits & ROI

Opportunities for ROI - CBA of CIM-VDC

RFIs for I-94 Mitchell IC Project-
Field Issues - $? for $162.5 m project

- BR-Bridges: 23%
- RW-Retaining Wall: 19%
- DU-Dry Utility & EL-Electrical: 16%
- WU-Wet Utility: 13%
- RD-Roadway: 8%
- SS-Safety/Standards/Specs/Cost Red: 4%
- NW-Noise Wall: 2%
- TR-Traffic: 2%
- EW-Earthwork: 2%
- DM-Demolition: 0%
- GN-General: 12%

DINs for I-94 Mitchell IC Project-
Field Issues - $? for $162.5 m project

- BR-Bridges: 23%
- RW-Retaining Wall: 12%
- WU-Wet Utility: 11%
- DU-Dry Utility & EL-Electrical: 8%
- RD-Roadway: 5%
- TR-Traffic: 5%
- SS-Safety/Standards/Specs/Cost Red: 3%
- EW-Earthwork: 2%
- NW-Noise Wall: 1%
- DM-Demolition: 0%
- GN-General: 29%

CIM-VDC

Benefits & ROI

Use CIM-VDC multi-disciplinary performance models to:

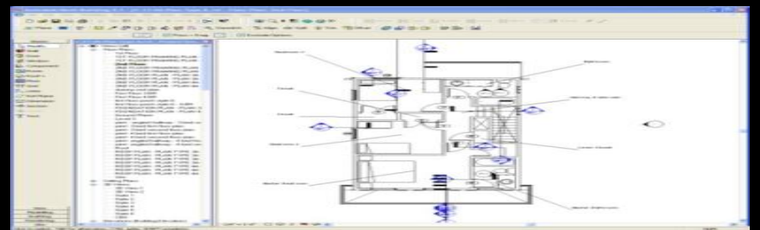
…support business objectives…

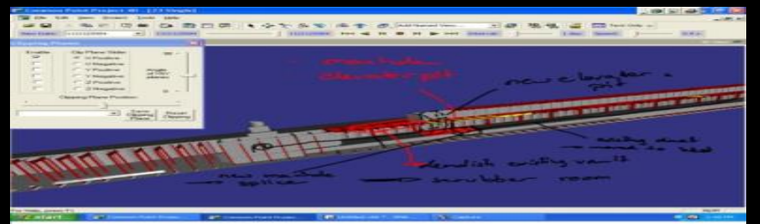
…simulate and validate objectives…

…add value to projects…

<u>Factors to Determine What CiM-BiM Tools are Used</u>

- **Project Objectives, Goals & Scope**
- **Project Schedule**
- **Project Budget**
- **In-house Knowledge & Experience**
- **Costs-Benefits-ROI**





CIM-VDC

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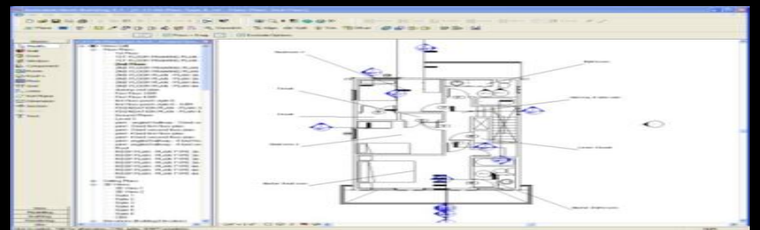
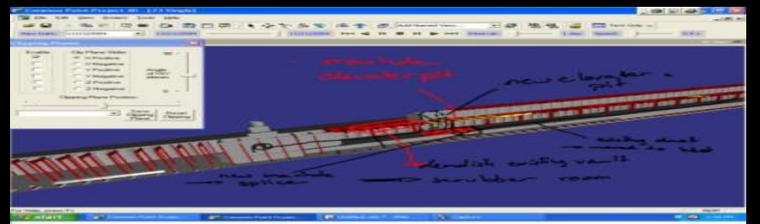




CIM-VDC

Benefits & ROI

Factors to determine what VDC/BIM Tools and Technologies are used

- **Project Objectives – Meet Goals & Scope**
- **Project Schedule - Deliver On-time**
- **Project Budget - Deliver within Budget**
- **Constructability Review, Analysis and Simulation**
- **Support Decision-making by Multiple Stakeholders**
- **Support Public Outreach to Stakeholders (Construction, Traffic, etc.)**
- **In-house Knowledge, Experience and Expertise**
- **Value-added Costs-Benefits/ROI**

CIM-VDC

Overview

Key Best Practices for CIM-VDC

- Design, analyze , simulate & finalize project data "virtually" first using best available office automation before constructing in the field
- Integrate, aggregate, visualize & coordinate multi-disciplinary 3D geospatial project data
- Integrate CIM-VDC to CAD, GIS, Survey, Utility, Geotech, Real Estate & Traffic Databases for Analysis, Visualization, Simulation, Model-based Plans Production & Reporting
- Move to data-centric decisions vs. document-centric defense
- Find & fix clashes/conflicts or at matches/interfaces earlier in the process (Clash Detection & Resolution)
- Reshape current processes, datafows & workflows to use CIM-VDC for appropriate projects, as "the way we do it" may be less efficient, as we integrate & leverage best available technologies
- Reduce project re-work & risk to continue to enhance improvements to cost and schedule
- Increase communication, coordination & collaboration between all project planning, design, construction, ad hoc, maintenance, operations & oversight staffs

CIM-VDC

Technologies, Tools & Processes

CiM-BiM Tools, Dataflows &Workflows

CIM-VDC

Technologies & Tools

Barriers, Opportunities & Challenges

- Open vs Proprietory DB's
  - Bentley Inroads & Autodesk Civil 3D
  - Analysis & Data Management vs. Graphics & Features
- Interoperability Export & Import
  - LandXML
  - Bentley Inroads & Autodesk Civil 3D
  - GIS (ESRI ArcView, Map3D, etc.)
  - Traffic (VISSIM, Paramics, etc.)
- Standards, Guidelines & Protocols
  - FDM, Guidance Manuals & Specs
  - NCS v5, BIM v2

Bentley

Autodesk

WISCONSIN DEPARTMENT OF TRANSPORTATION

Visual Solutions INCORPORATED

VisSim Modeling the Future

US Army Corps of Engineers

GSA

Trimble

AIA

ESRI

CIM-VDC

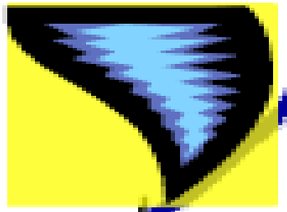
Benefits & ROI

To CIM or not to CIM?

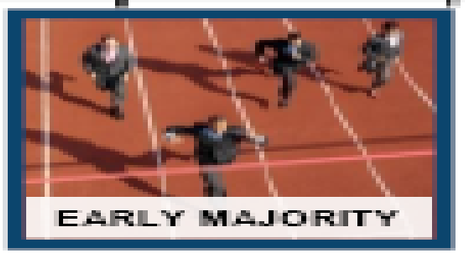
LOCATION ON THE CURVE FOR VDC

-Typ. Young
-Many Ideas
-INVESTMENT

-Tech. Kill Joys
-Love Tech. Failures
-COST



-Revolutionary
-First To Implement Win
-INVESTMENT



-Evolutionary
-Focus on Biz. Efficiency
-INVESTMENT

-New only after 50%
-Only When I Must
-COST

YOU MUST KNOW WHERE:

-YOU?

-COMPANY OWNERS?

-MIDDLE MANAGEMENT?

-STAFF?

-CLIENTS?

-TORNADO?

Raymond L. Goodson, Jr., Inc.
STRUCTURAL CIVIL SURVEY
INTEGRATED PROJECT DELIVERY (IPD)
Presenter: WILL IKERD | wikerd@rlginc.com

CIM-VDC

Technologies, Tools & Processes

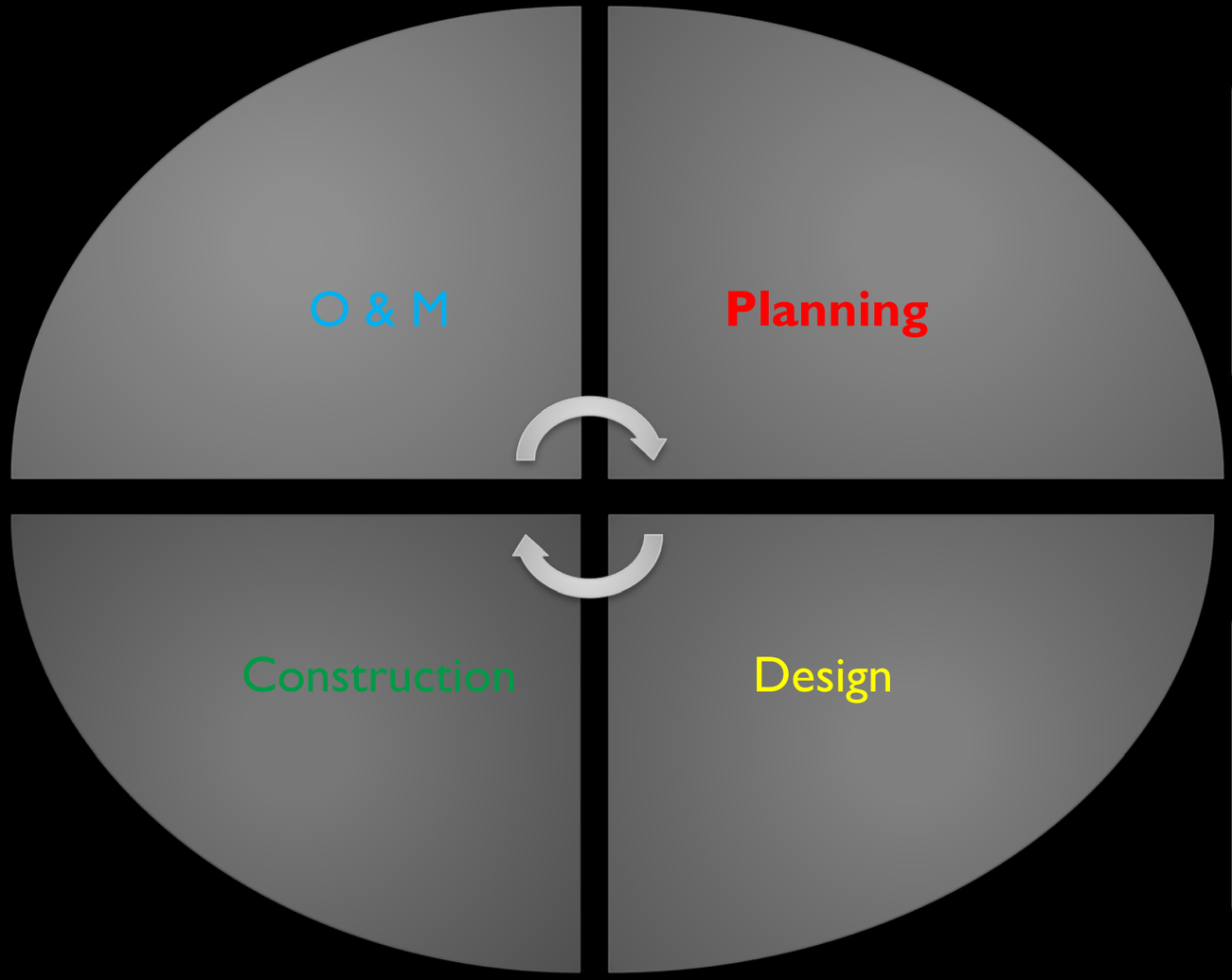
CiM-BiM Tools, Dataflows &Workflows

- Integrated LiDAR Data Collection:
  Static/Mobile LiDAR/RTK GPS/TS/DL Surveying
- HARN:
  WisCORS
- Model-based CAD, C3D Roll-out & CIM-VDC:
  3-D Design & Construction
- Field AMG Grading/GPS Rovers Field Inspection:
  Model-based Field Uses
- Infrastructure Lifecycle:
  O&M-As-built Models, Planning, etc.

CIM-VDC

Transportation Facilities – Design Applications

Operations & Maintenance
- Facilities Maintenance
- Asset Management
- Statewide TOC
- Monitoring
- Renovation



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- RFIs, DINs & CCOs
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Design
- 30% Preliminary Design
- 60% Design
- Utilities/Geotech/RE/Traffic
- P, S & E Final Design + Model
- Construction/Bid Docs

WISCONSIN DEPARTMENT OF TRANSPORTATION

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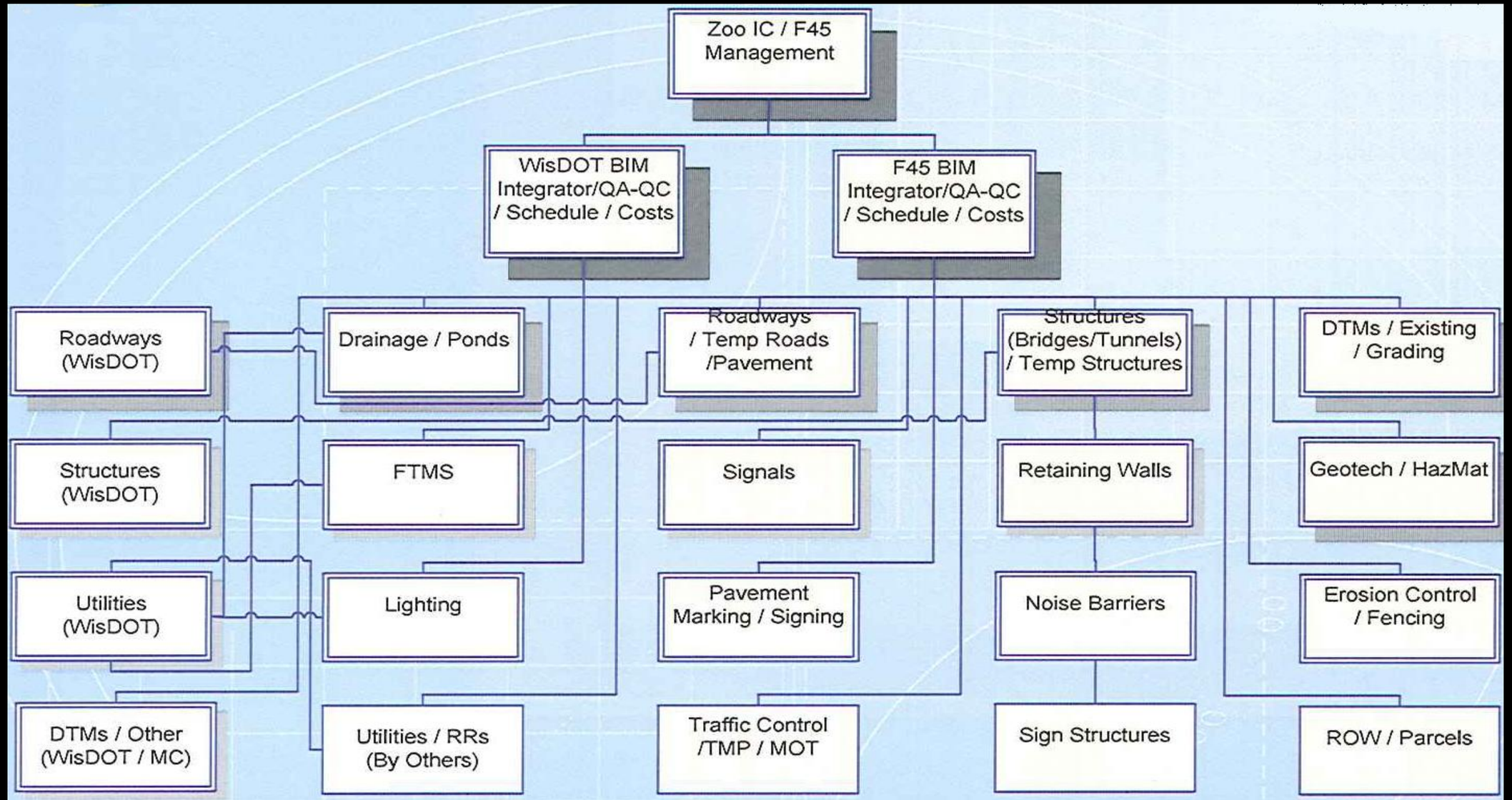
Design Applications - Workflows

CIM-VDC Deployment on the Zoo IC Project



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Design Applications - Workflows

Design-Construction Oversight/Coordination
Multi-disciplinary Integration/Collaboration

Clash Detection, Analysis, Simulation & Visualization (Navisworks / Navigator)

Clash Analysis /Resolution (Navisworks / Navigator / CAD) (RFIs/DINs/CCOs)

Existing & Proposed 3-D Models (C3D or MS In-roads/Geopak/LandXML to CAD & Revit) +
4-D Construction Scheduling Tasks (Primavera Project Schedules to Navisworks/Navigator)

Roadways/Structures/Misc.
(Roads, Bridges, Tunnels, Retaining/Noise Walls, RRs, PM, Storm, Sign Structures, FTMS, Signals, Lighting, Traffic, etc.)

Utilities-UG/AG/OH (Other)
(Sanitary, Water, Electric, Gas, Steam, FO, CATV, Telephone, Communication, Fire Protection, etc.)

Surfaces/Subsurfaces-DSMs
(LiDAR Mobile/Static/Aerial/RTK GPS/TS /DL Survey data, Geotech, HazMat, Landscaping, etc.)

STH 100.jpg

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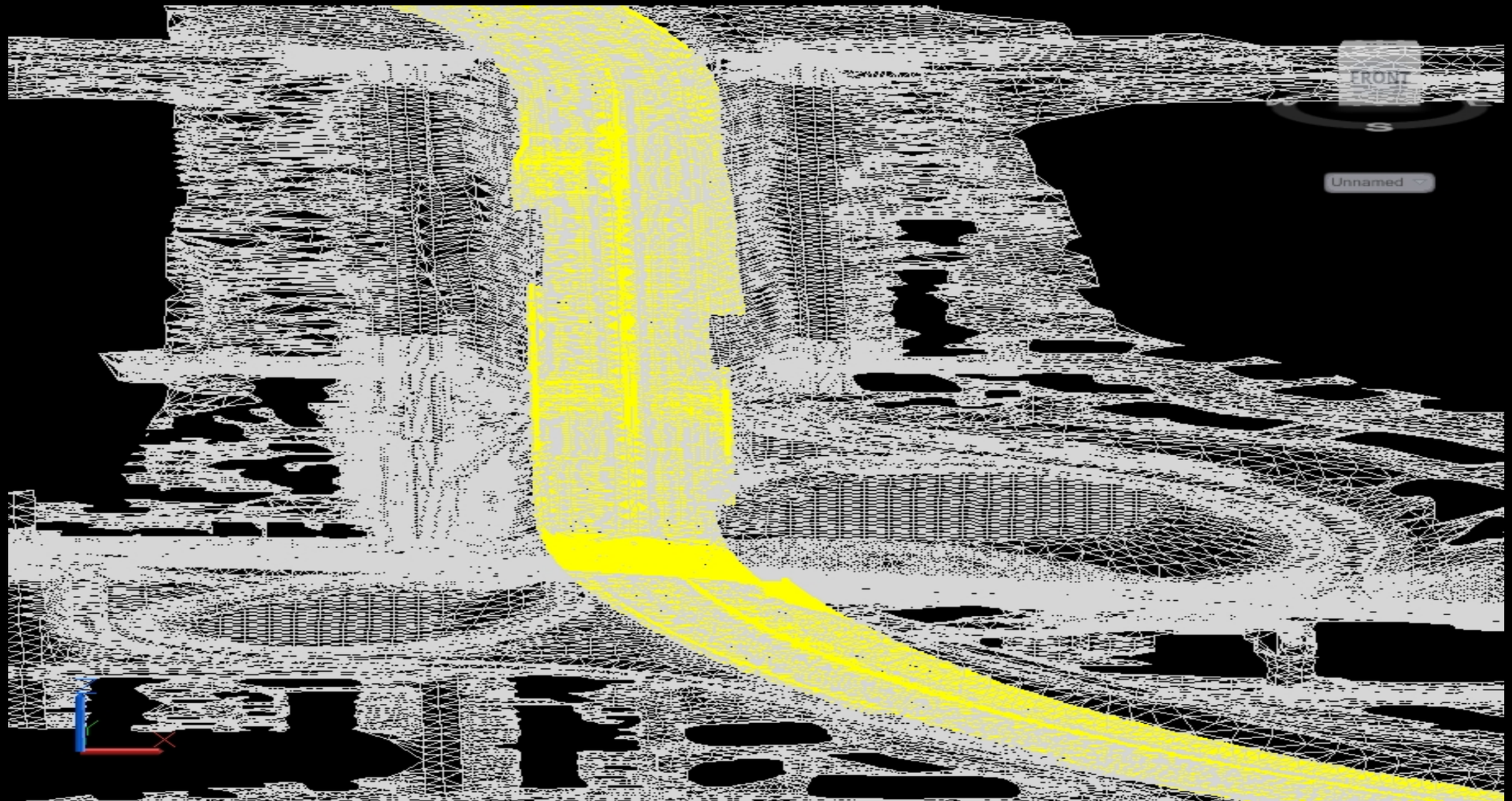
Design Applications

CIM-VDC Deployment on the Zoo IC Project



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Design Applications

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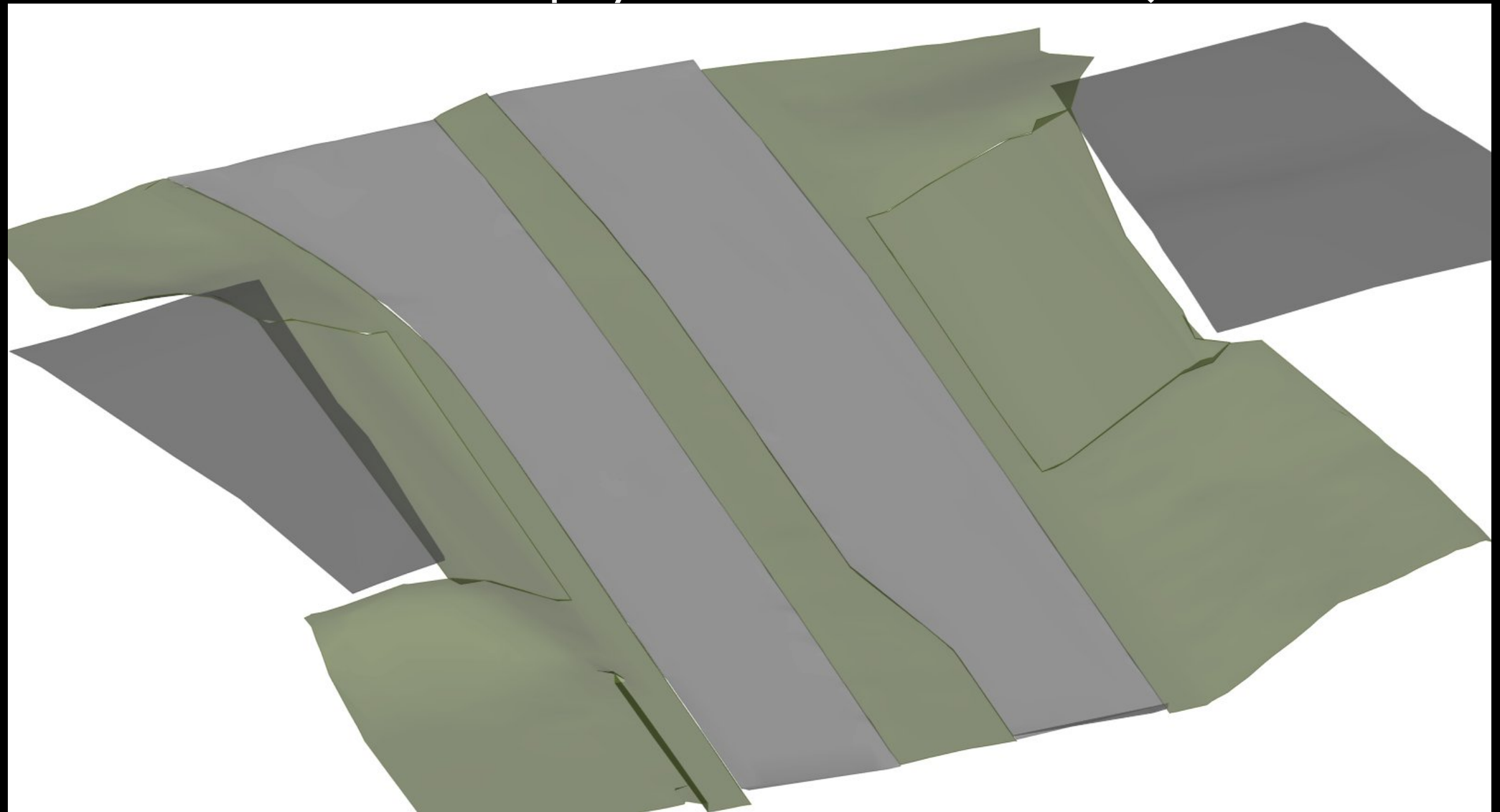

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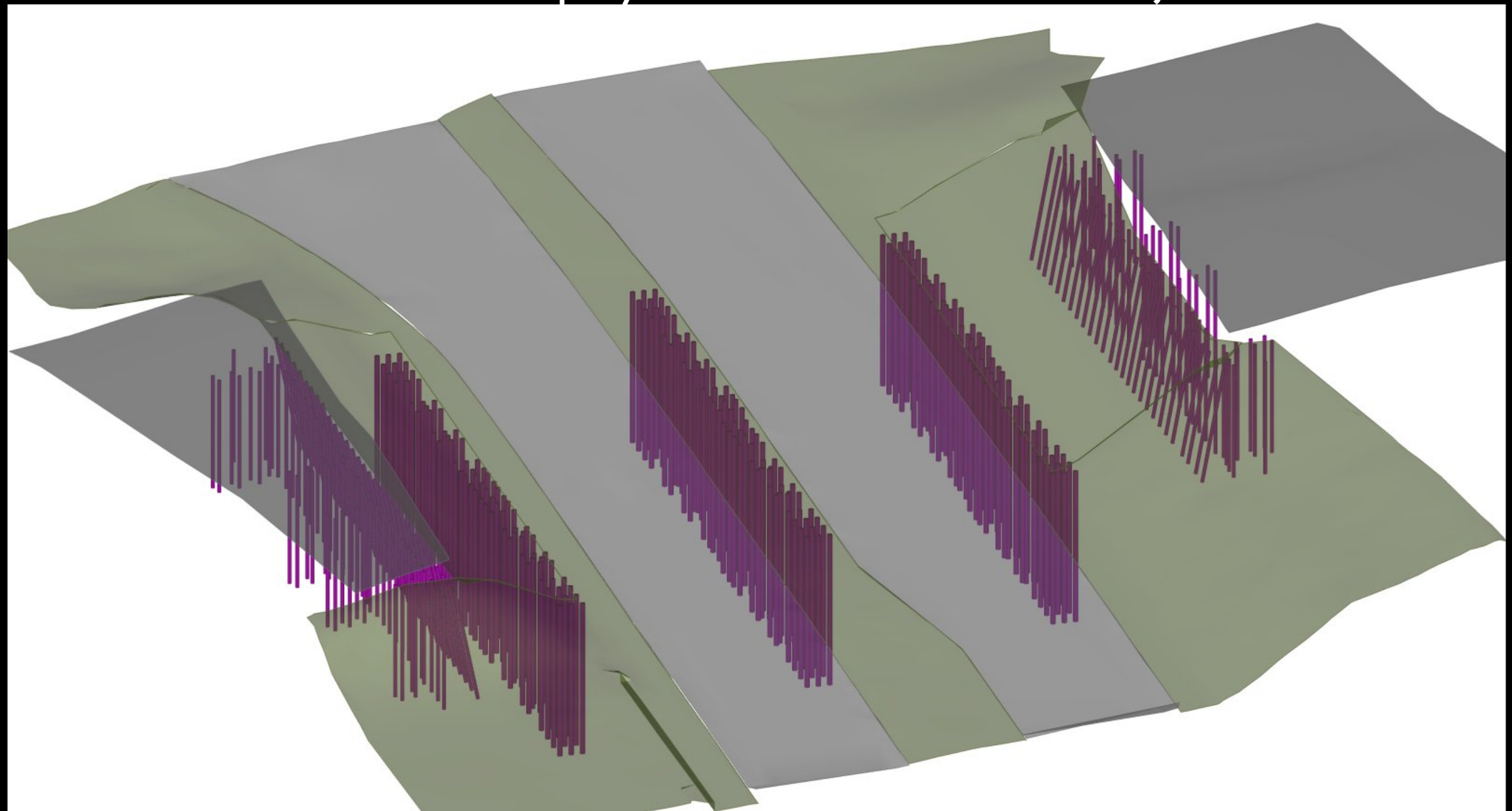

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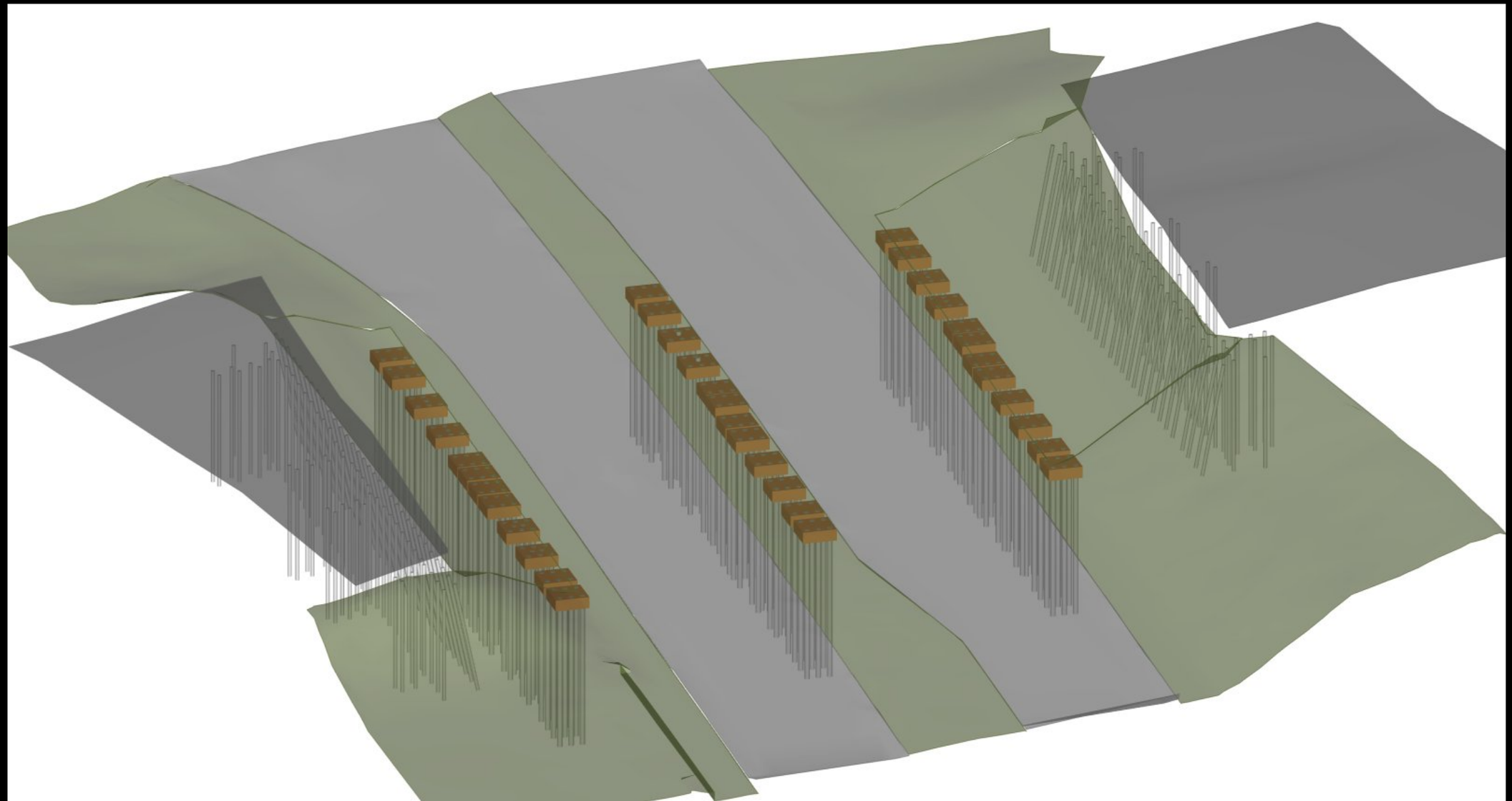

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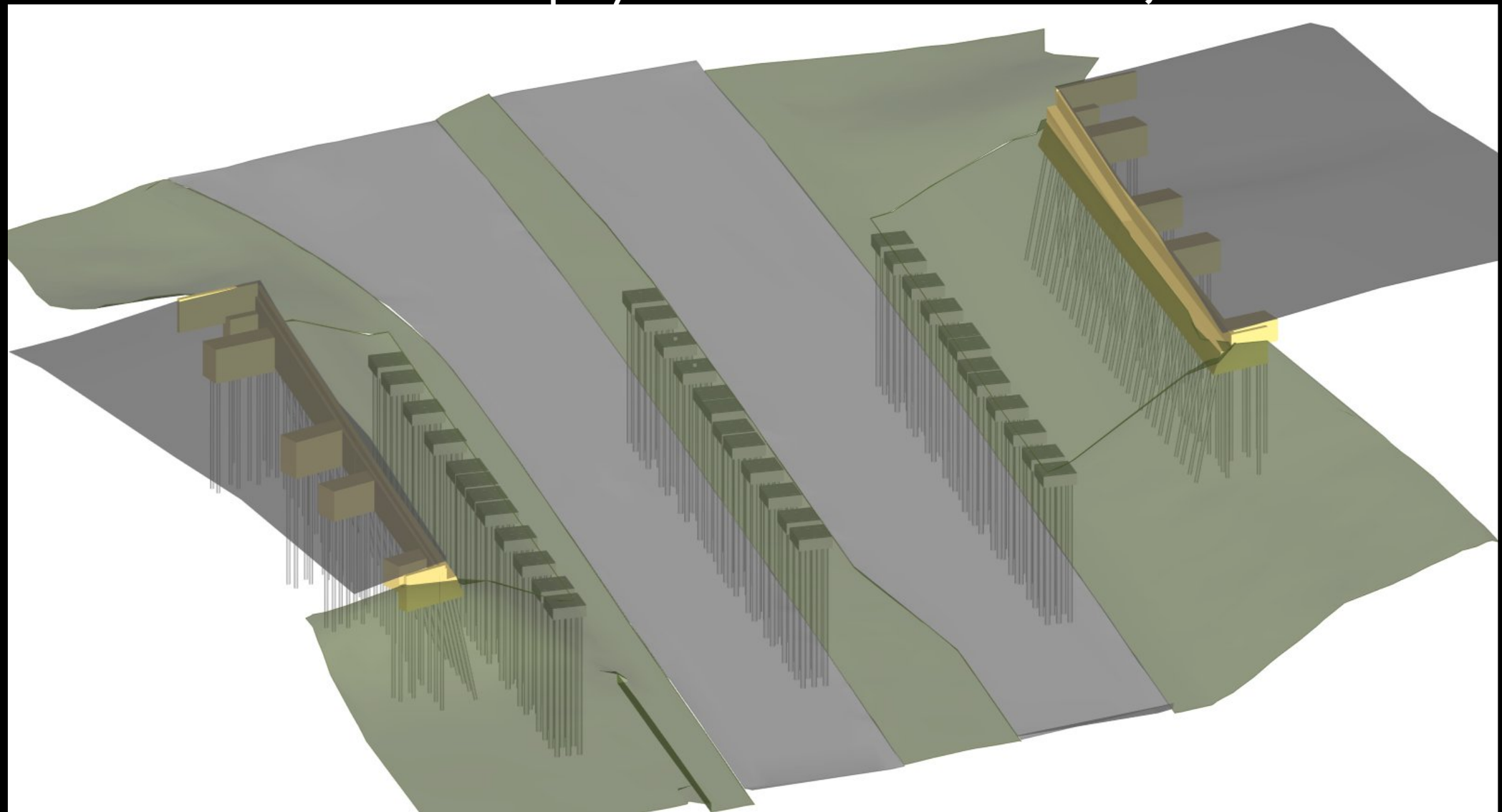

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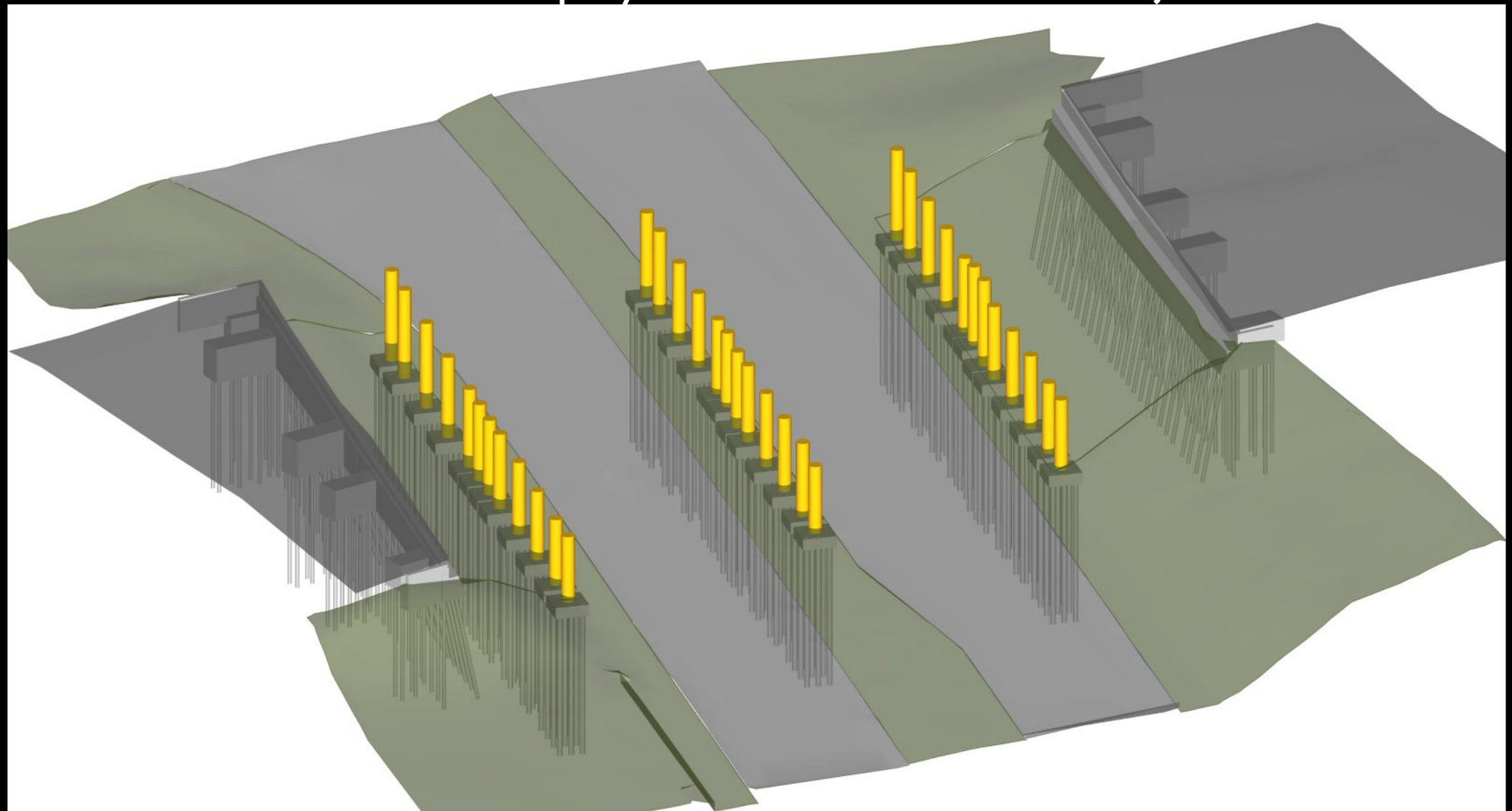

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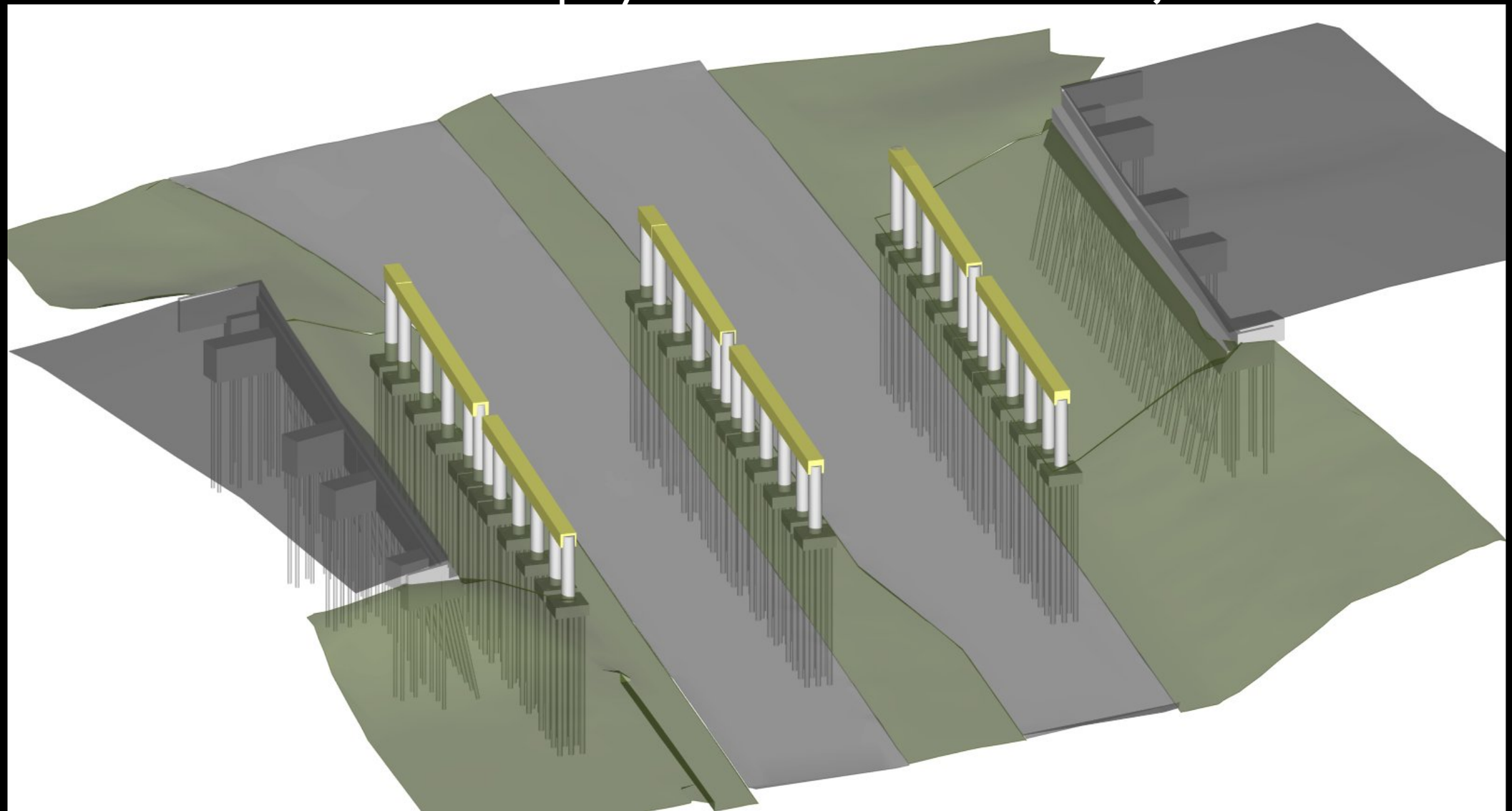

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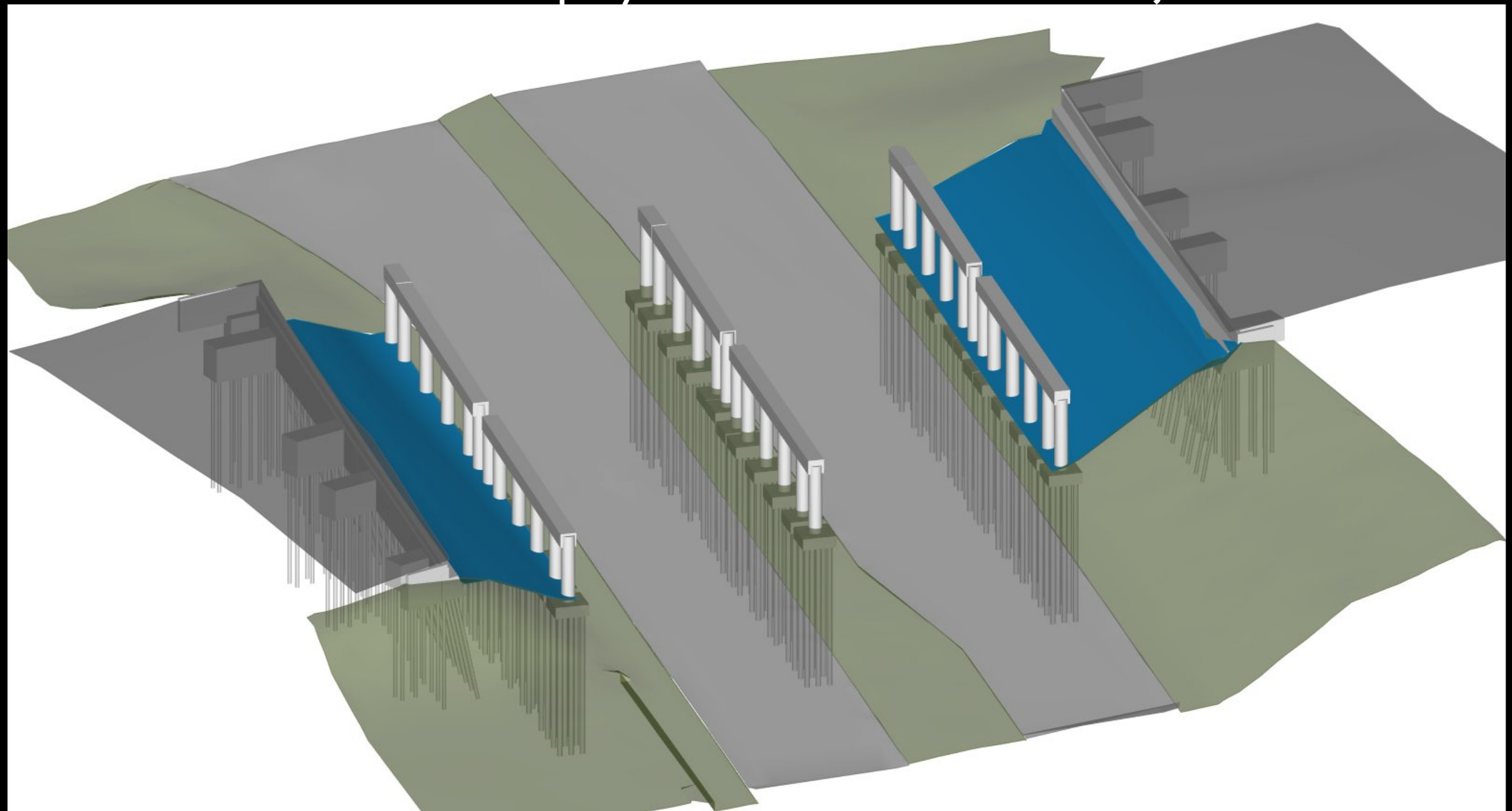

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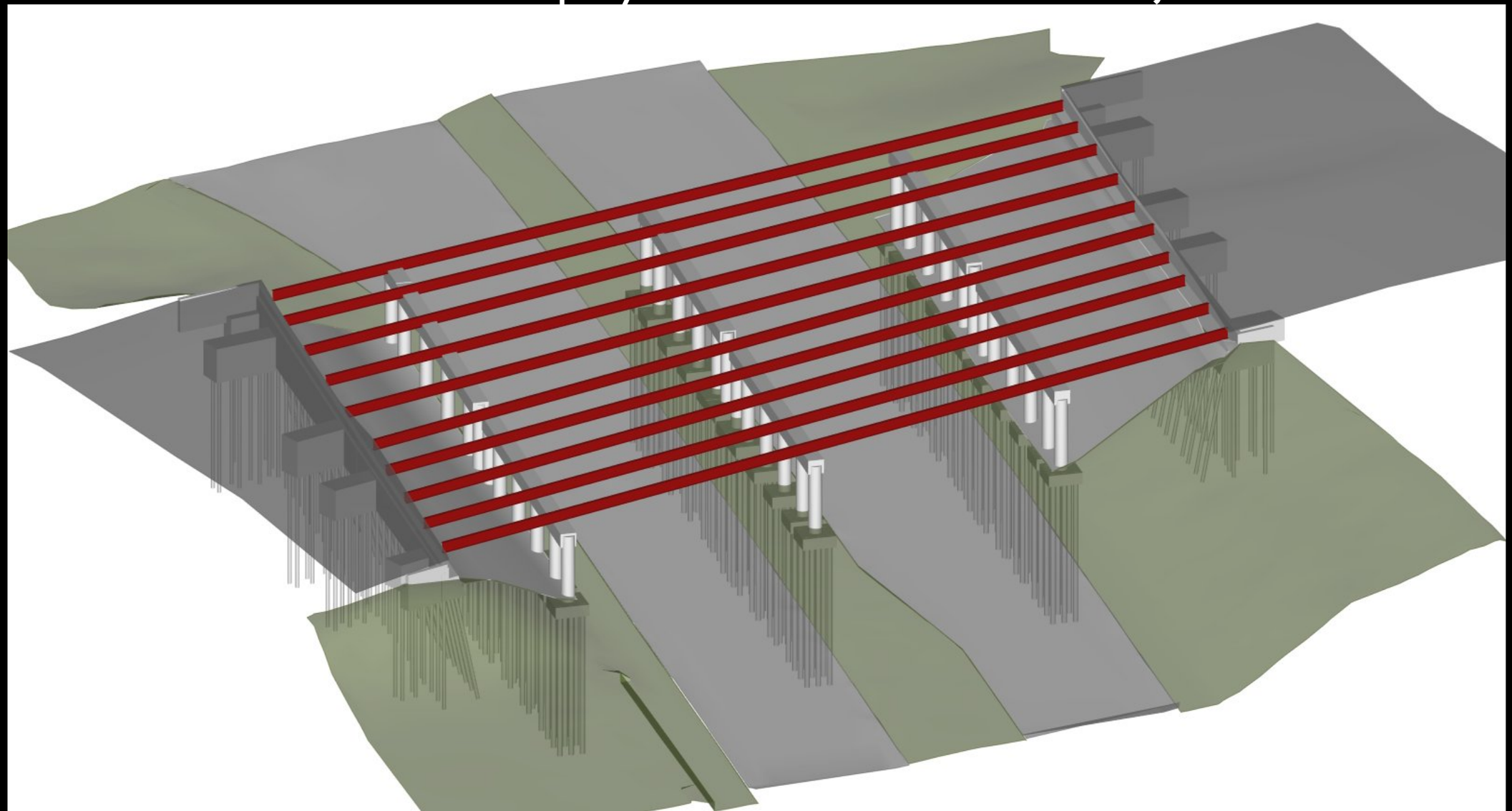

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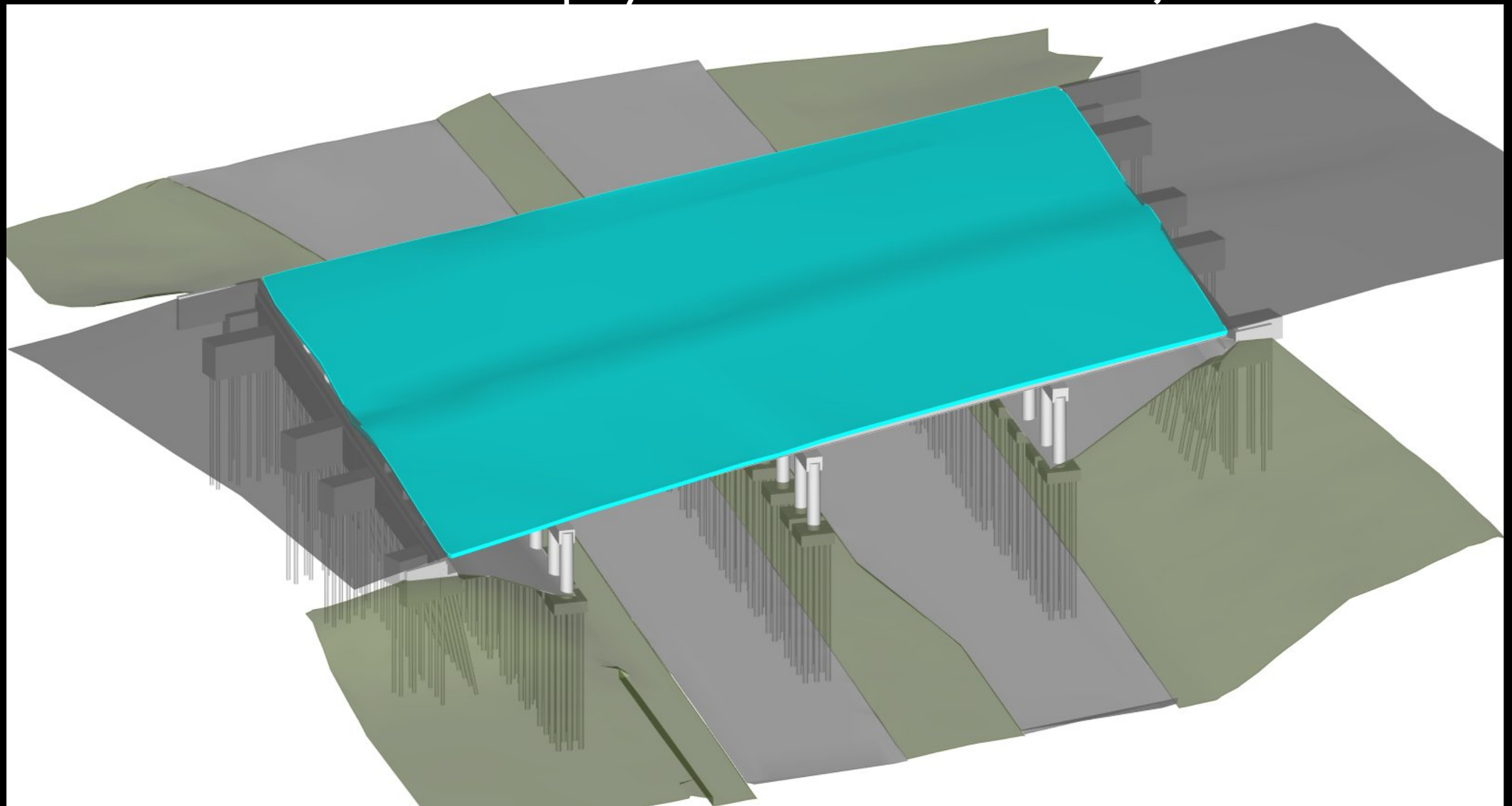

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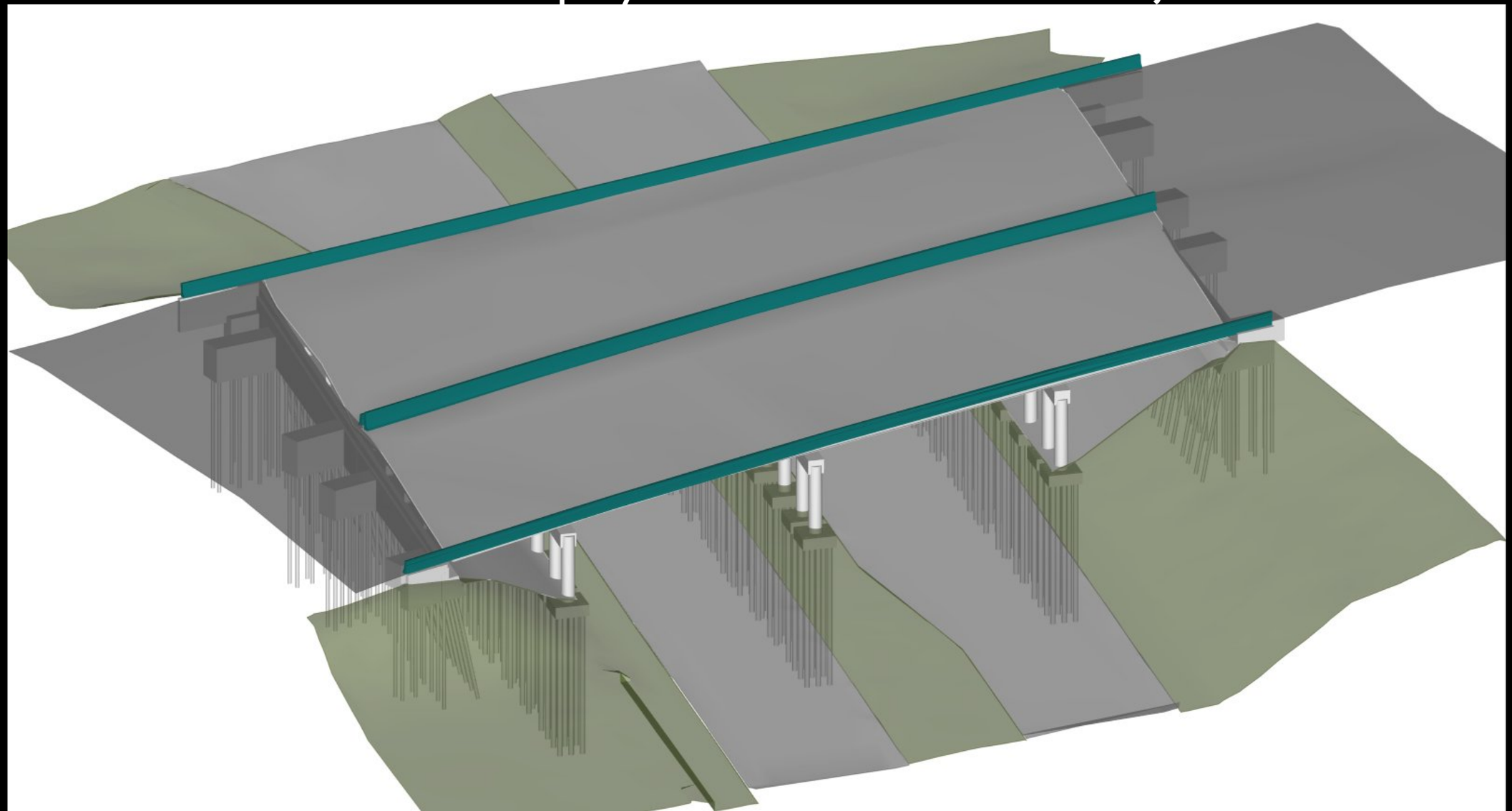

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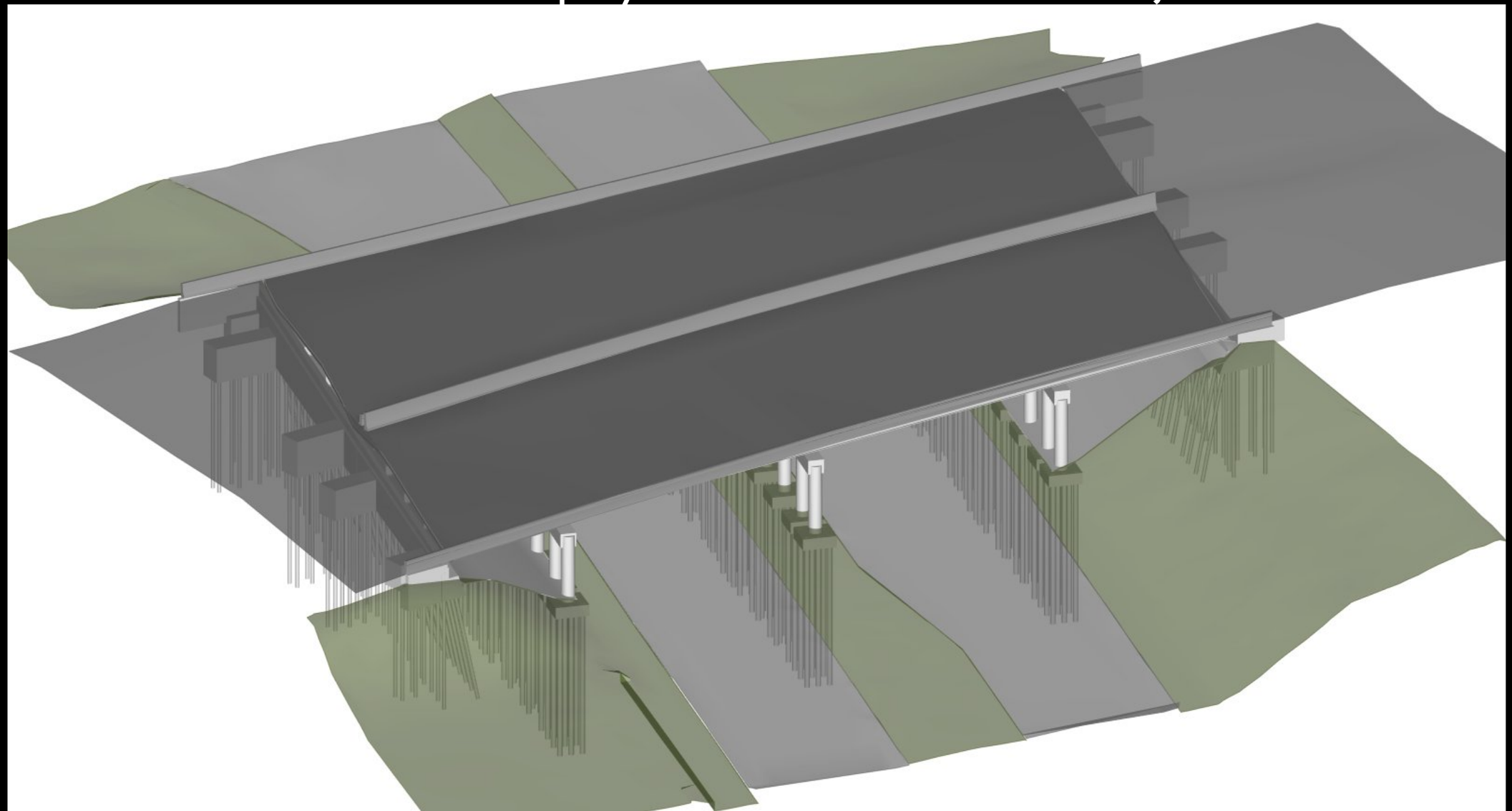

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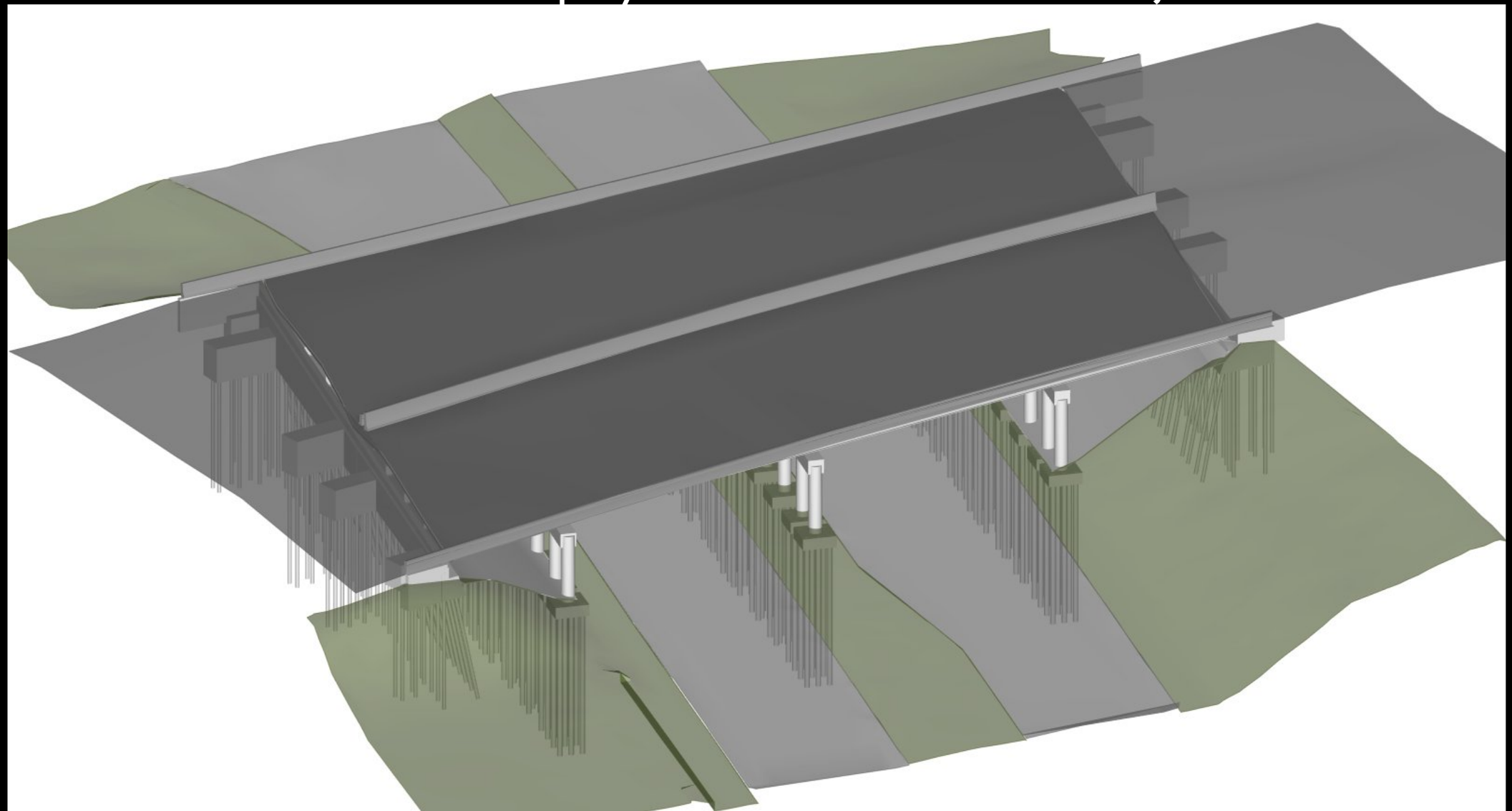

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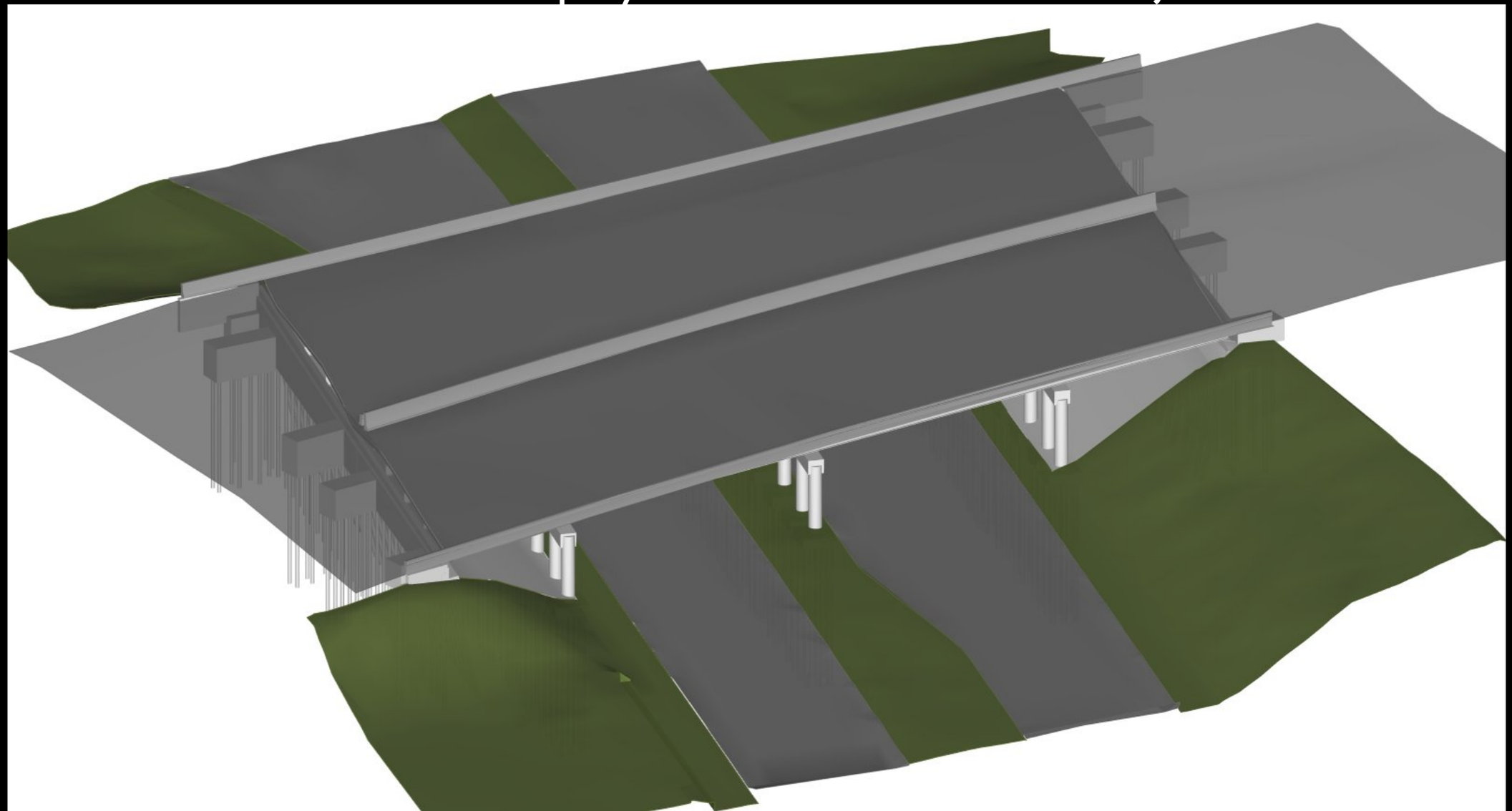

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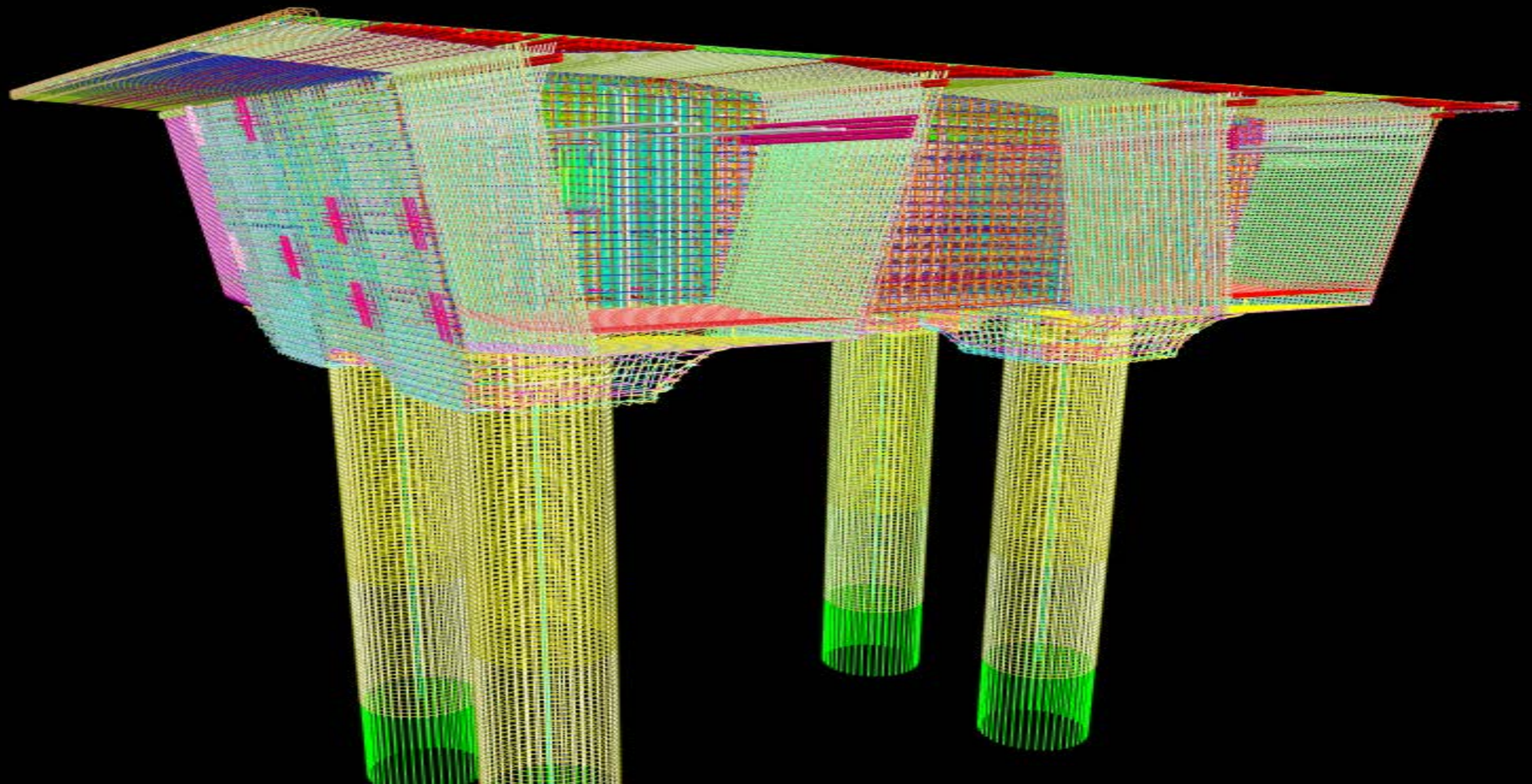

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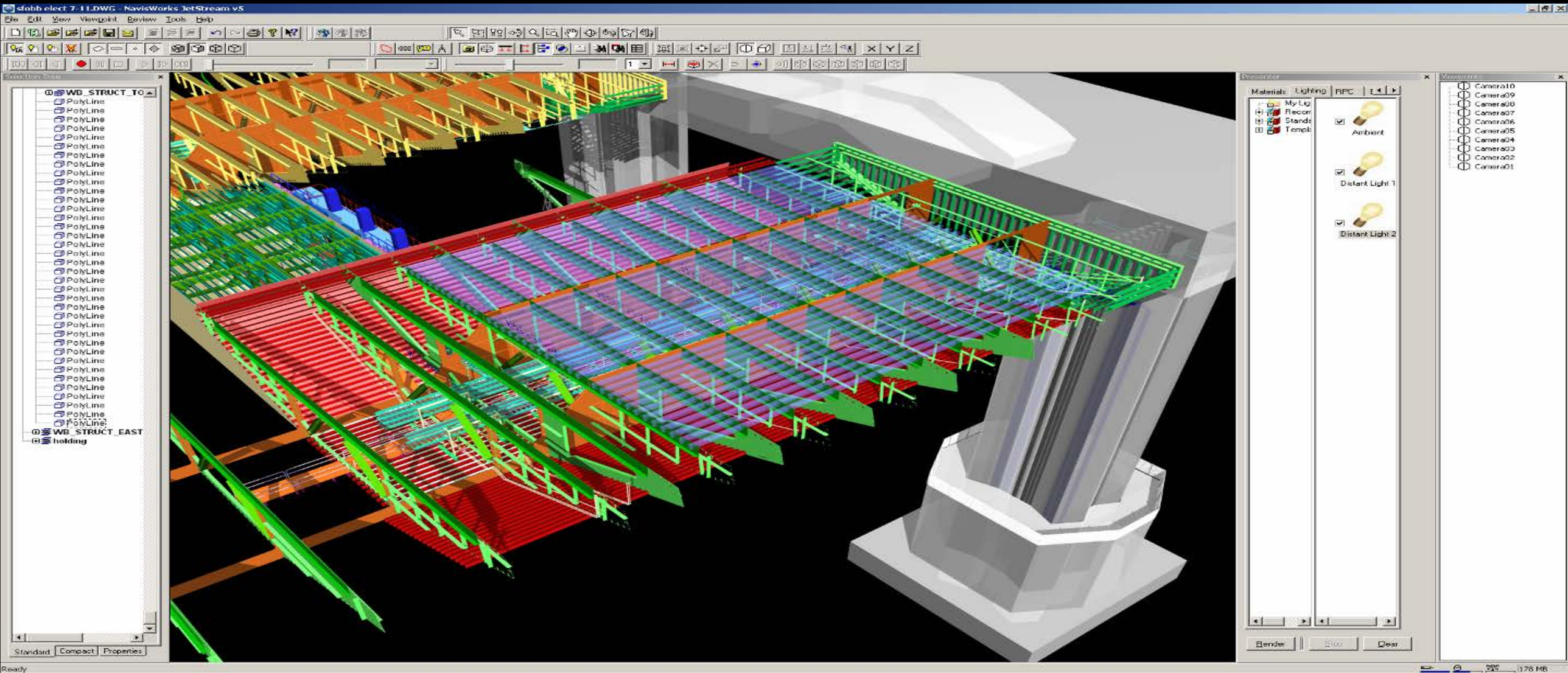

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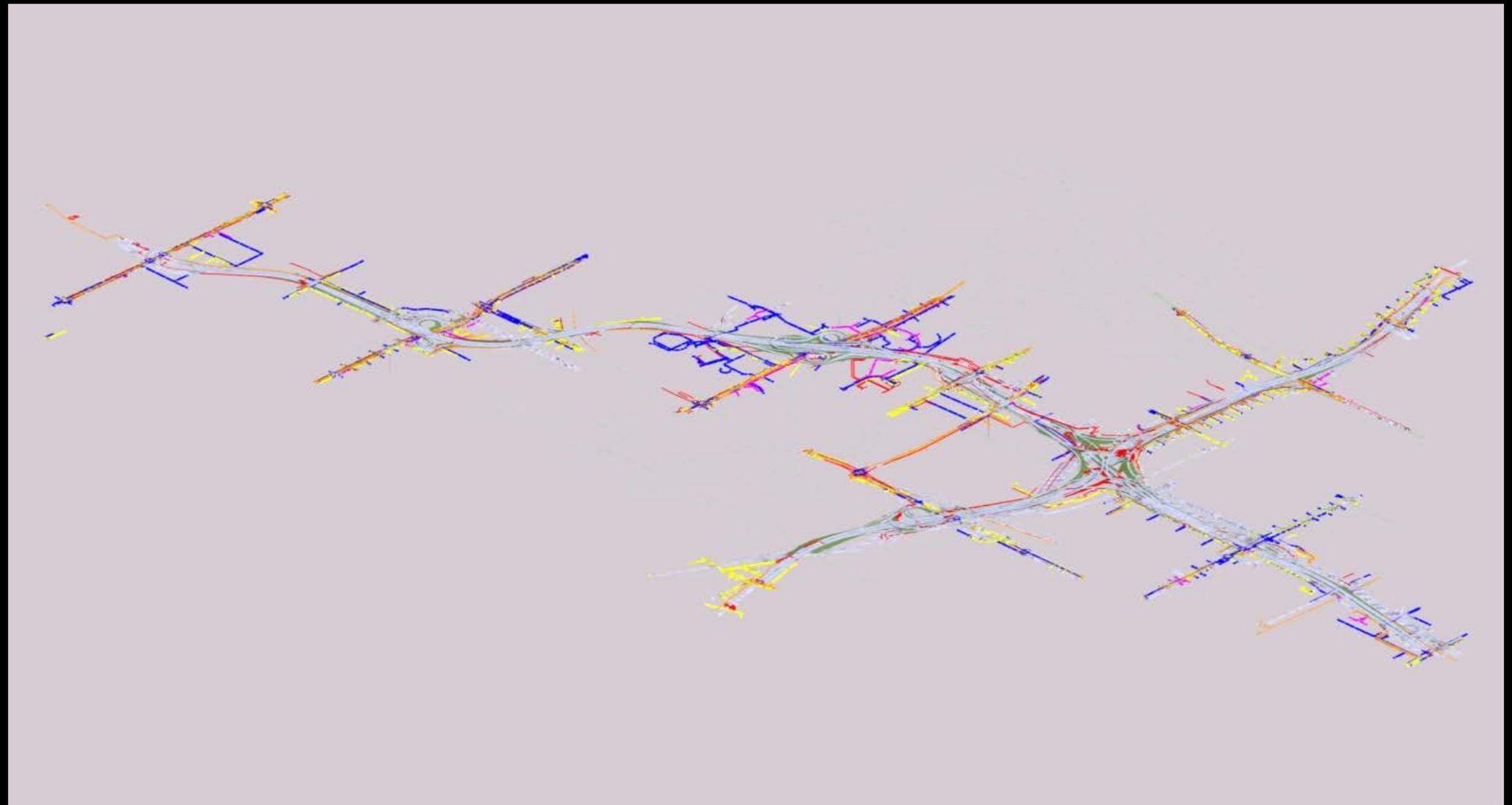

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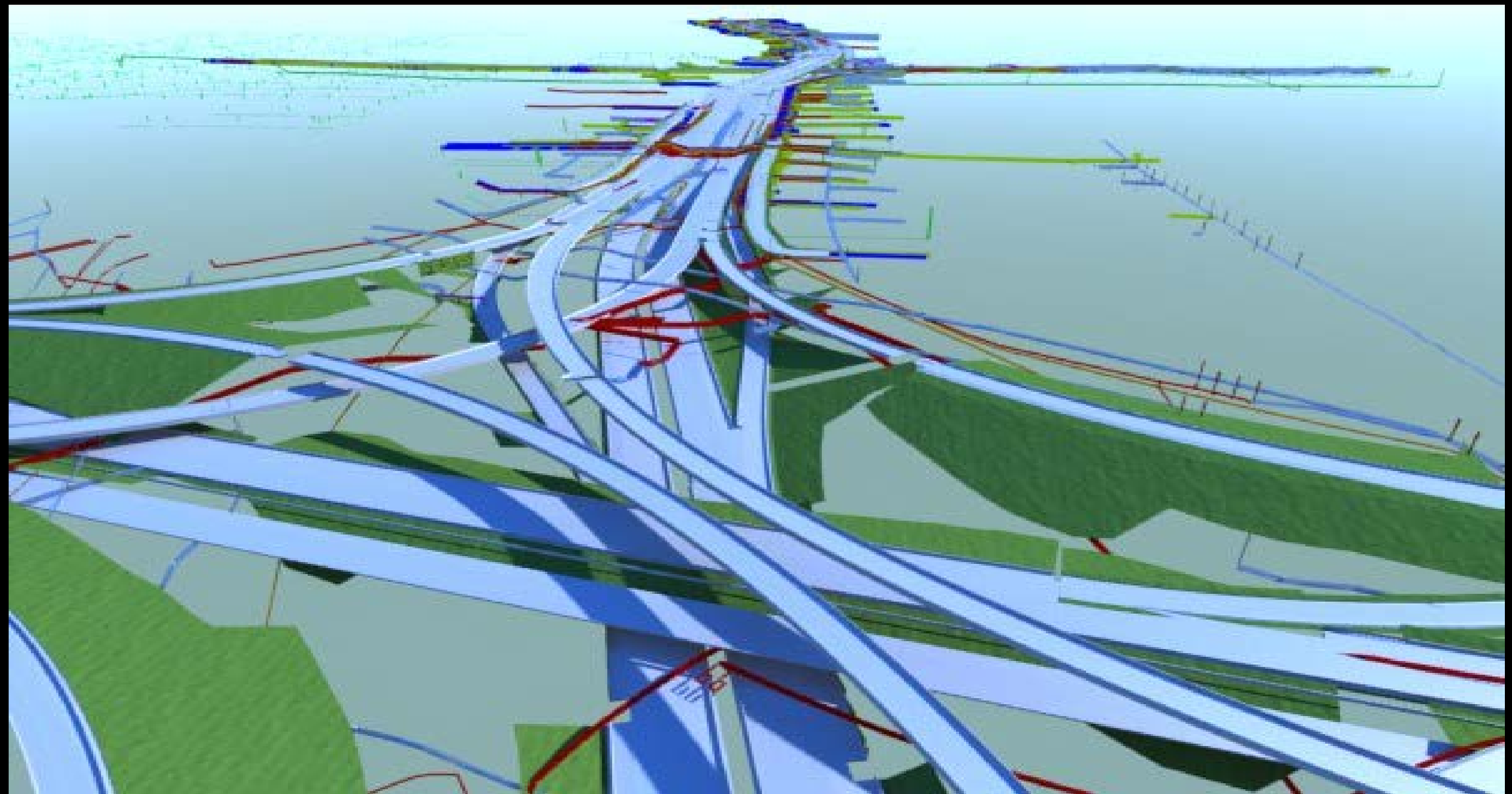

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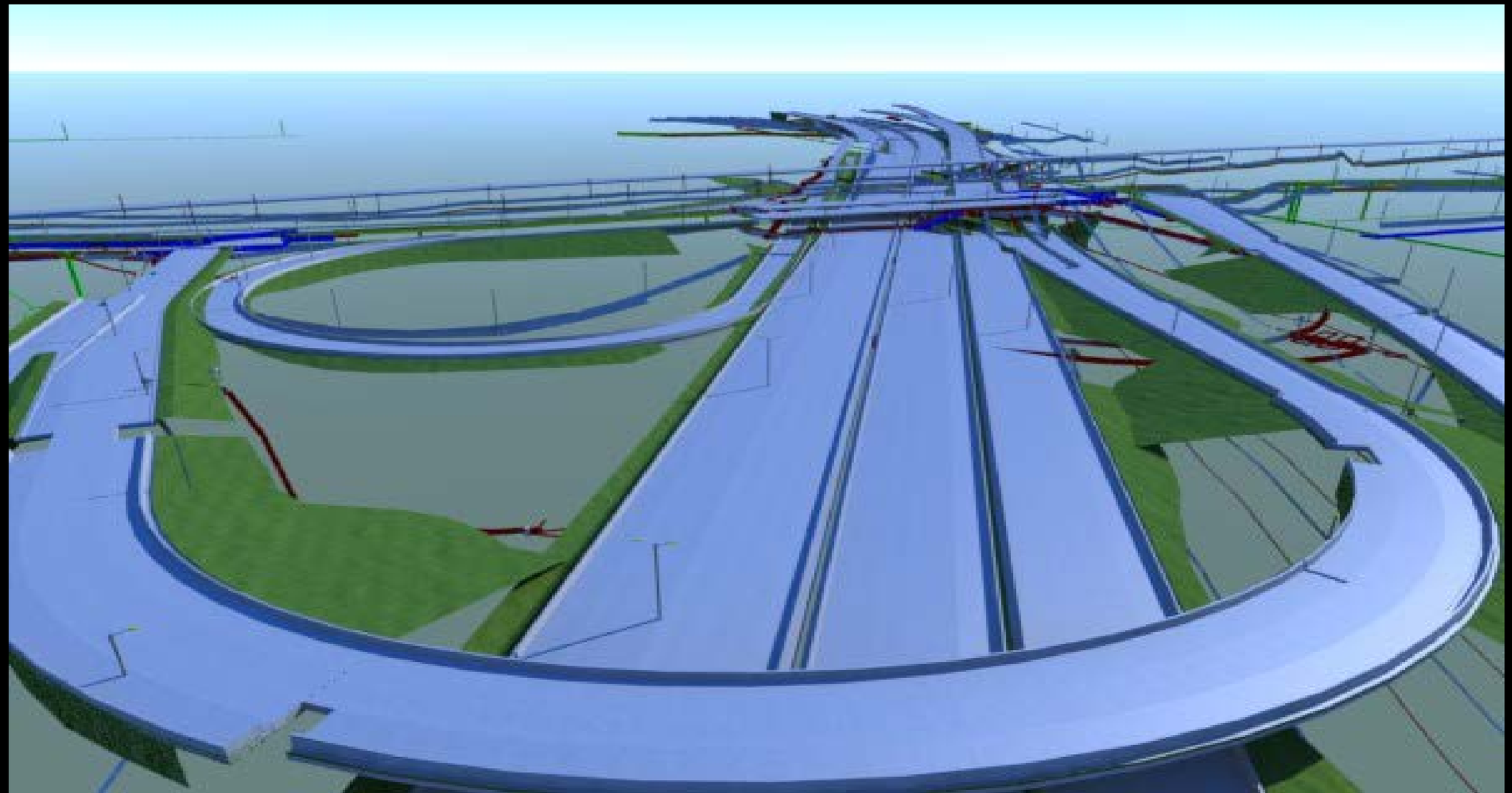

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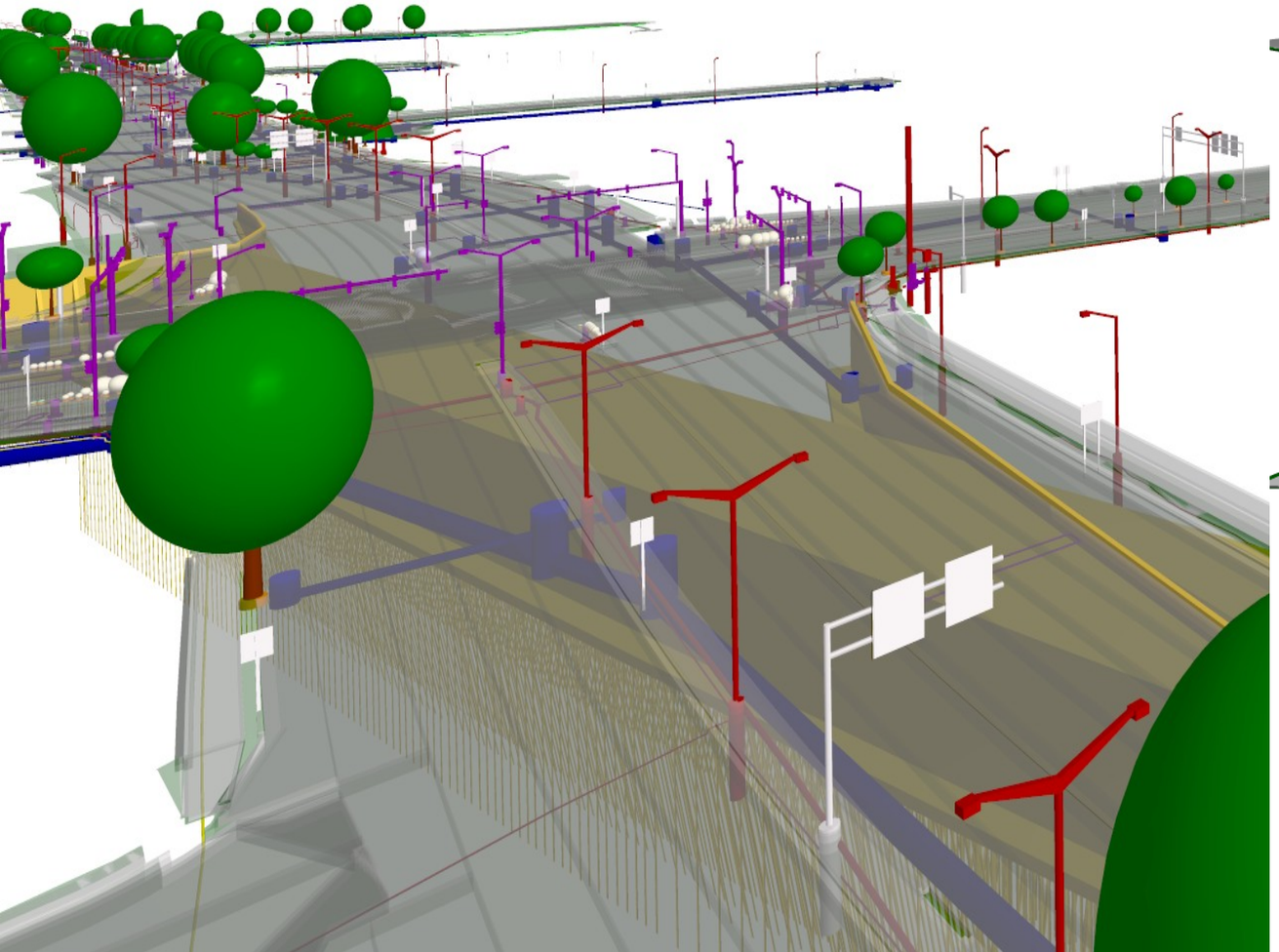

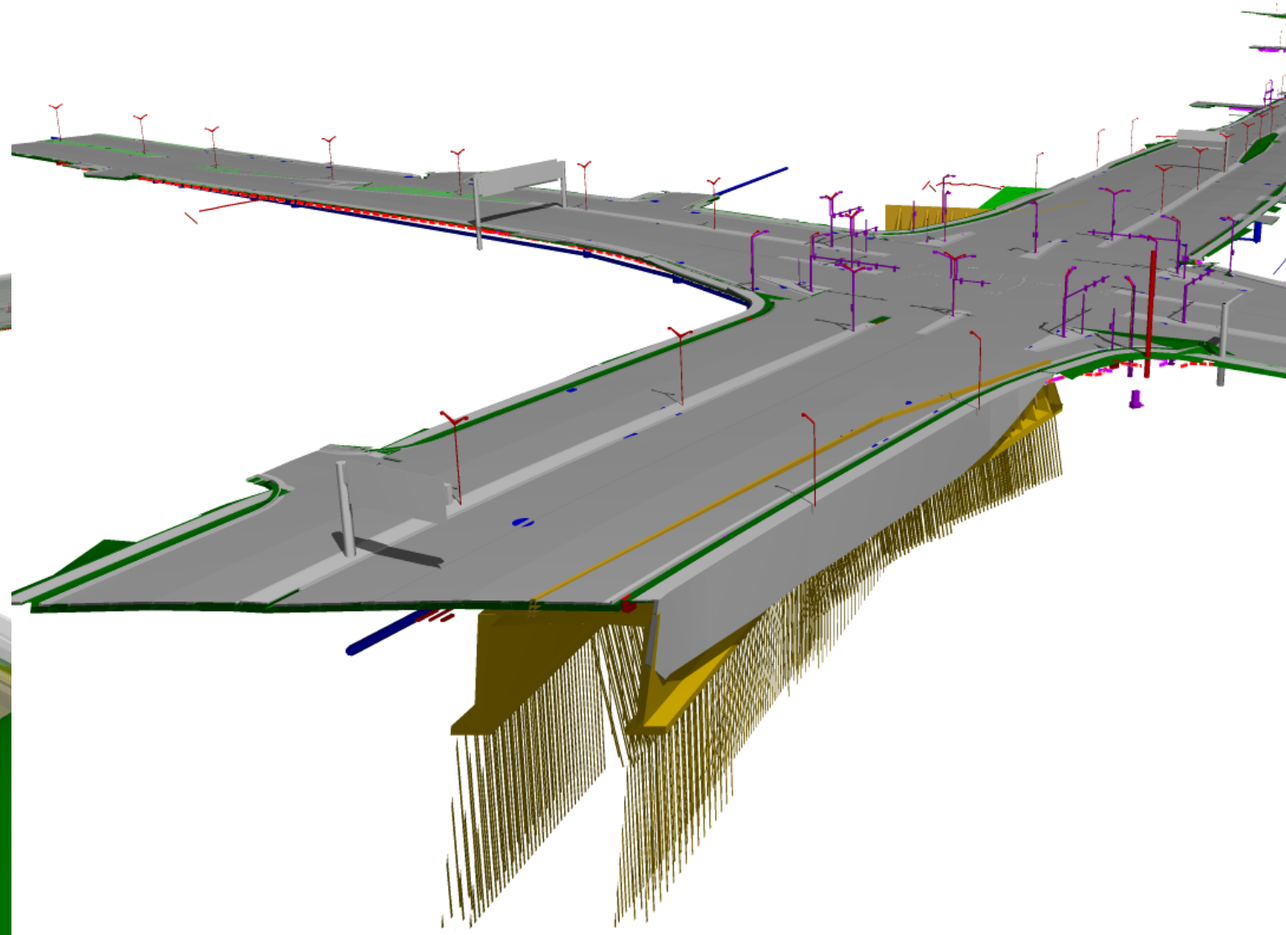

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Operations & Maintenance

- Facilities Maintenance
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- Statewide TOC
- Monitoring
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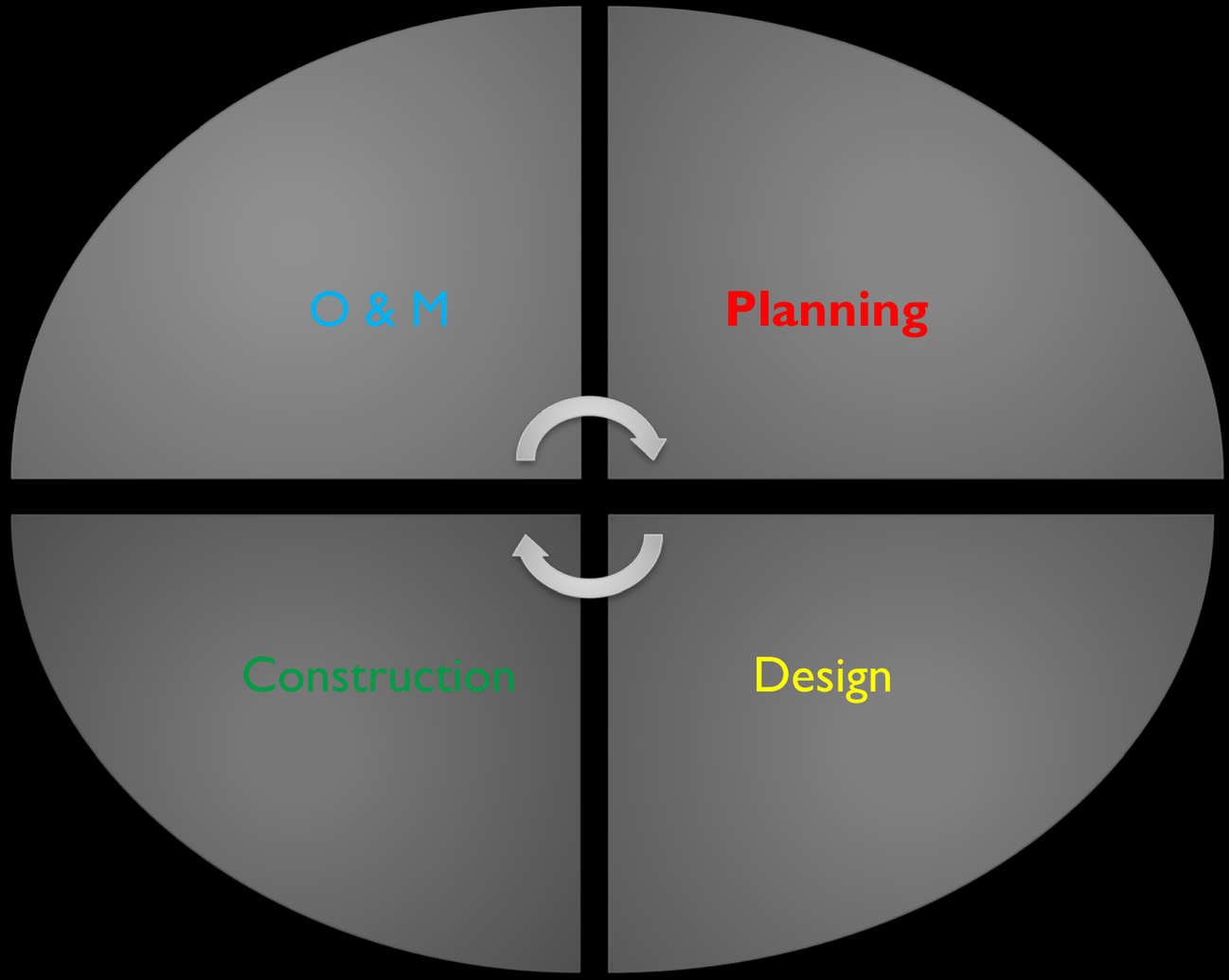

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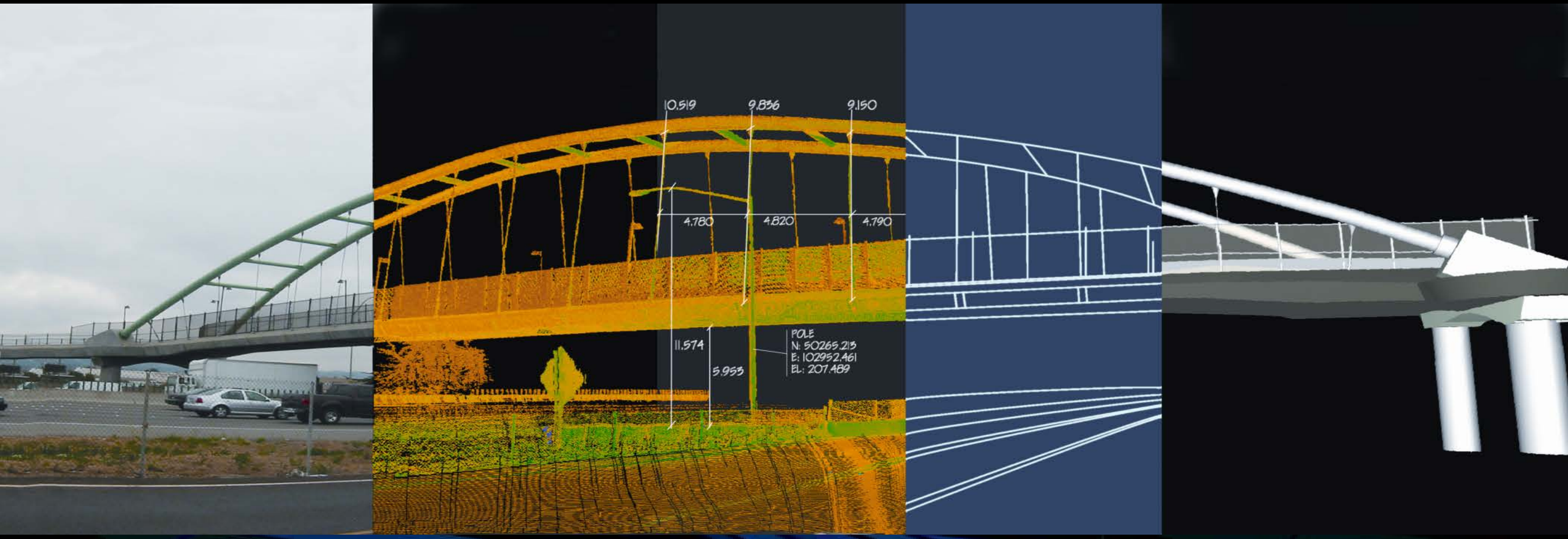
CIM-VDC

Integrated Survey with LiDAR Data Collection - Planning



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-VDC

Integrated Survey with LiDAR Data Collection - Planning

LiDAR Point Cloud courtesy of WisDOT, CH2MHill, HNTB, Kapur & Associates and Woolpert

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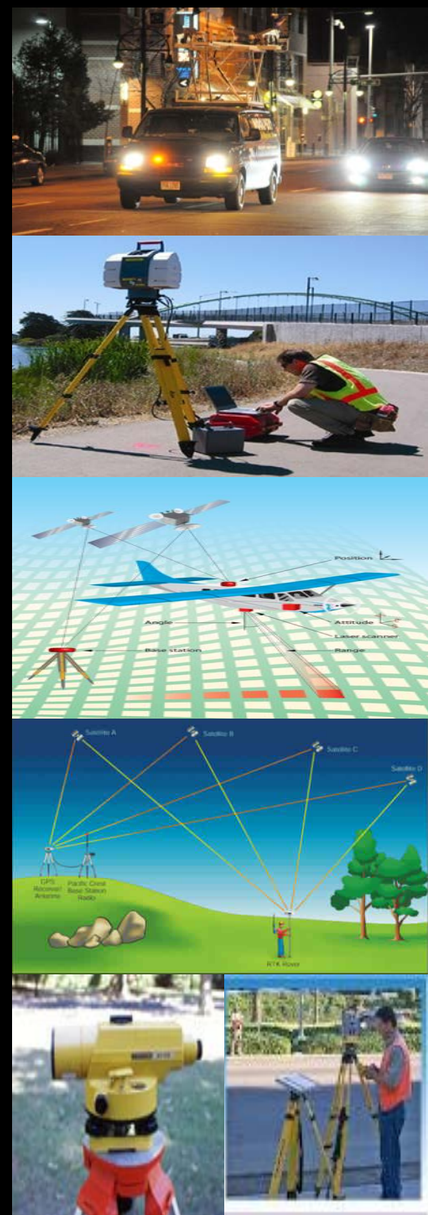
Integrated Survey - Mobile/Static/Aerial LiDAR/APS/RTK GPS/TS/DL

- **LiDAR (Light Detection And Ranging) Laser** – an optical remote sensing technology measuring scattered light and time delay to determine distance to an object or surface using reflected laser pulses
- **Mobile Laser Survey (MLS)** – Terrestrial LiDAR
- **Static Laser Survey (SLS)** – Terrestrial LiDAR
- **Aerial Laser Survey (ALS)** – Fixed Wing, Helicopter, UAV
- **Aerial Photogrammetric Survey (APS)** – Fixed Wing
- **Real-Time Kinematic Global Positioning System (RTK GPS)** – WisCORS (Continuing Operating Ref. Station) & Base Station(s)
- **Conventional Survey TS & DL** – Servo or Robotic Total Station (TS) & Differential Leveling (DL)



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Integrated Survey - Mobile/Static/Aerial LiDAR/APS/RTK GPS/TS/DL

Comparison of Typical Survey Accuracies

- Fixed Wing Aerial Photogrammetry
  - ± 6" Vertical Accuracy (Low and Slow) (0.3'-0.5')
- Low Altitude Helicopter Photogrammetry
  - ± 1"-2" Vertical Accuracy (Lower and Slower) (0.1'-0.2')
- Mobile LiDAR Laser Scanning (with Differential Leveled HATs)
  - ± ½"-1" Vertical Accuracy (0.06'-0.08')
- RTK GPS (WisCORS) (Supplemental GPS)
  - ± ½" – 1" Vertical Accuracy (0.06'-0.08')
- Static LiDAR Laser Scanning
  - ± ¼" - ½" Vertical Accuracy (0.02'-0.05')
- Total Station & Differential Leveling
  - ≤ ± ¼" - ½" Vertical Accuracy (<0.01'-0.05')

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Integrated Survey with LiDAR Data Collection - Planning

- Planning/Mapping Level Data
  - Done without benefit of ground control (≅0.2'±) with good satellite visibility
  - Done without benefit of ground control (≅1.0'±) with poor satellite visibility
- Design Level Data
  - Done with benefit of ground control
    - ≅0.06'-0.10'± using Mobile Mapping System (2σ)
    - <0.06' using Tripod Mounted Scanners (2σ)

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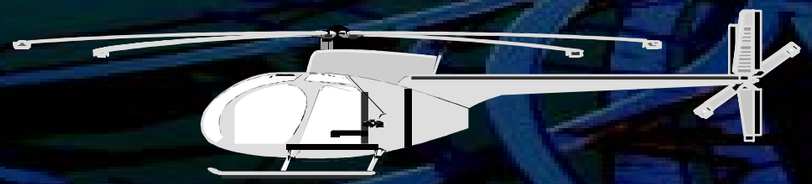
Integrated Survey – Photogrammetry (APS)

Every 100’ of altitude for aircraft = 0.01’+/- vertical accuracy

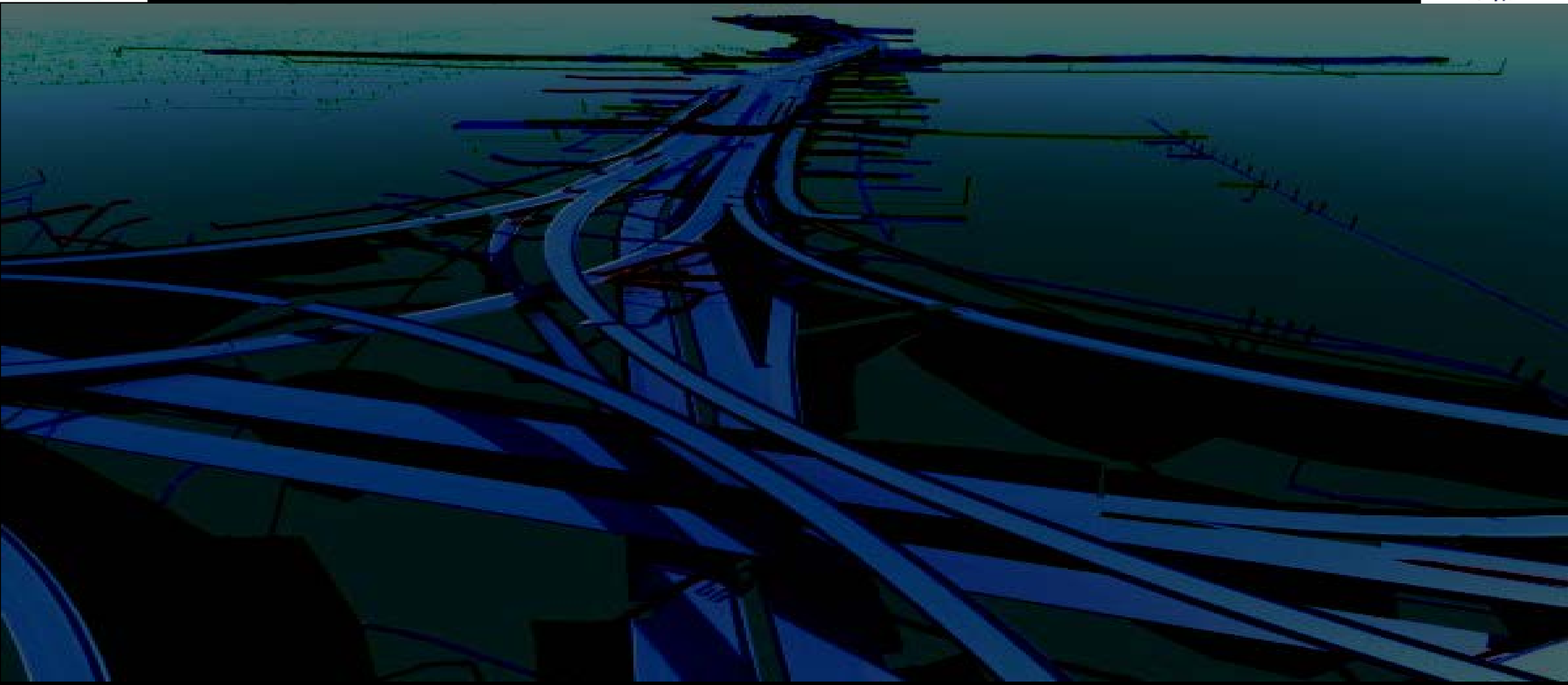


500’

1,000’-2,500’
FAA “Floor”=
1,000’

1” = 83’ photo scale
0.05’ vertical accuracy

1” = 166’ photo scale
0.12-0.30’ vertical accuracy



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Integrated Survey with LiDAR Data Collection - Planning

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Integrated Survey with LiDAR Data Collection in Planning

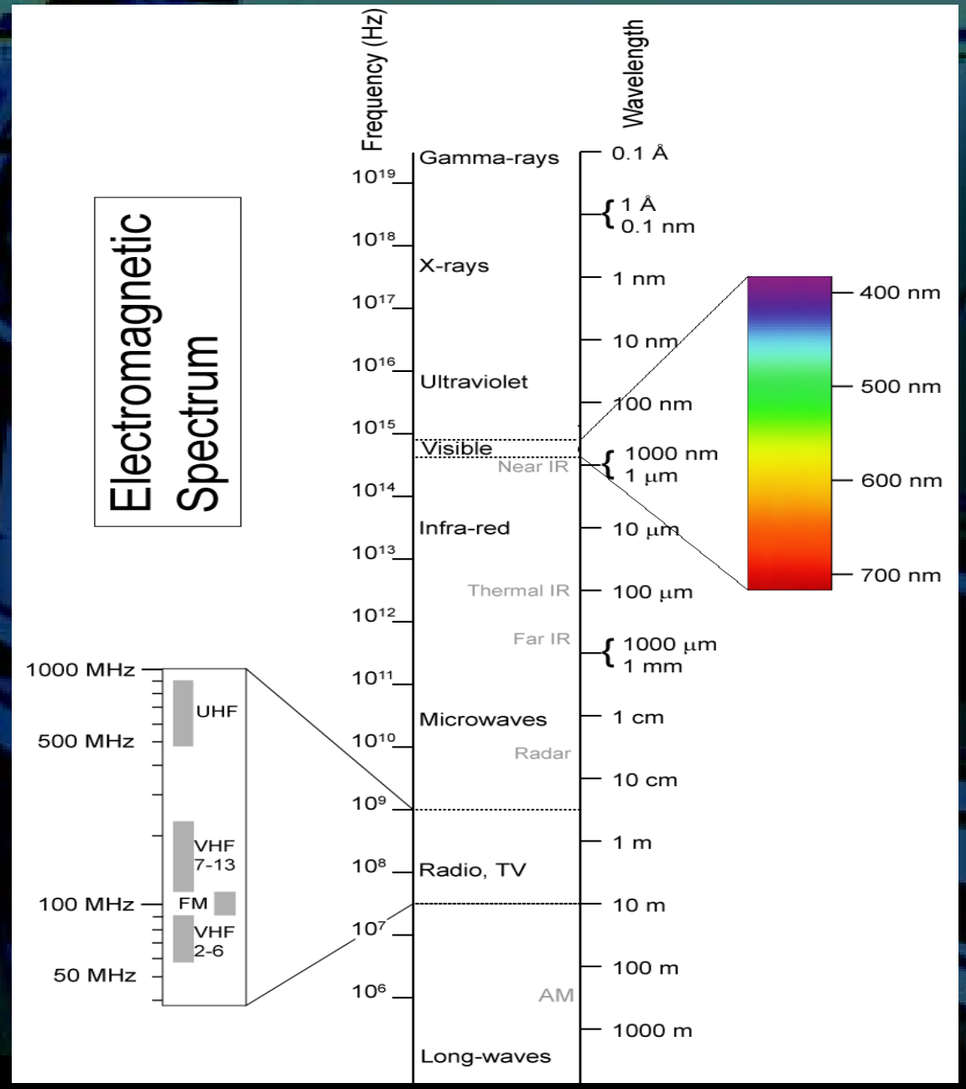
- LiDAR, and similarly, RADAR, both have ability to image an object only as small, or detailed, as the wavelength itself.
- A small object detectable by RADAR is the size of a quarter.
- A small object detectable by LiDAR is at nano technology size.
- Both technologies actively transmit pulses of waves (ultraviolet, visible or near infrared for LiDAR or radio, TV, or microwave for RADAR).
- Transmitted pulses of waves bounce off objects in their paths and portions of these waves return to the instrument.
- Portions of pulses returned by various LiDAR scanners range from one, through multiple, to practically unlimited.
- Single pulse LiDAR is good for hard surfaces and multiple pulse penetrates vegetation.

CIM-VDC

Integrated Survey with LiDAR Data Collection in Planning

+LiDAR (Light Detection and Ranging) wavelengths encompass the ultraviolet, visible and near infrared range of the electromagnetic spectrum at range from 10^{-6} m (μm) to 10^{-9} m (nm).

+RADAR (Radio Detection and Ranging) wavelengths range from cm's to 100 m.



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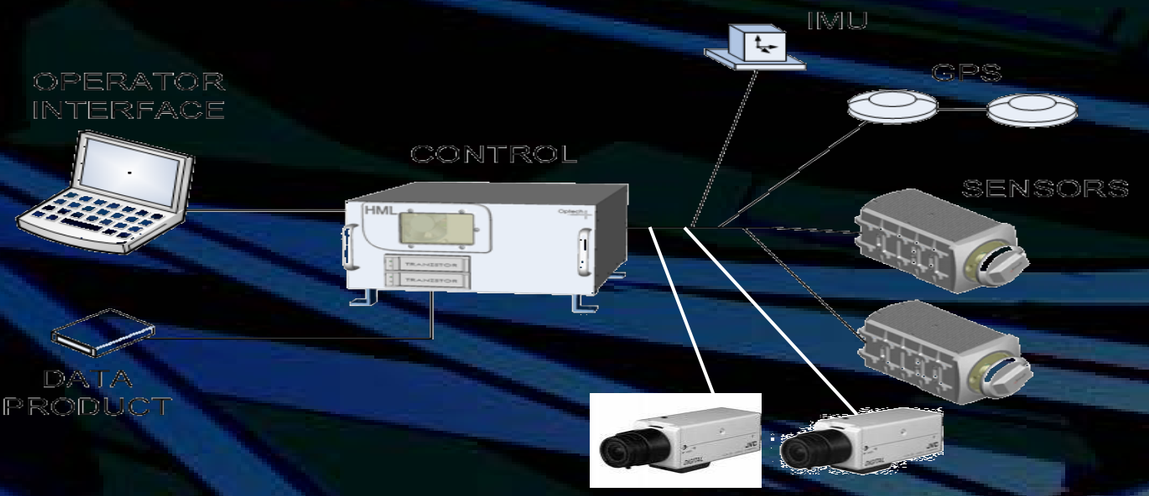
Integrated Survey with LiDAR Data Collection in Planning

- LASER- Light Amplification by Stimulated Emission of Radiation – a continuous beam of highly focused light



- LiDAR systems consist of lasers, mirrors, scanners, photodetectors, receivers, and a position and orientation system (GNSS, IMU)

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Integrated Survey - Mobile/Static/Aerial LiDAR/APS/RTK GPS/TS/DL

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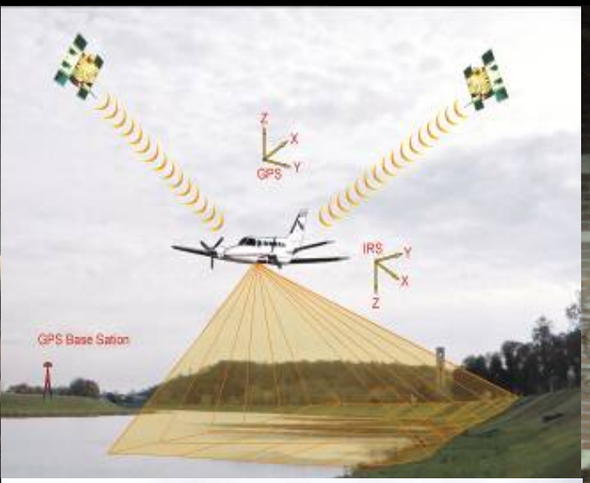
Integrated Survey - Mobile/Static/Aerial LiDAR/APS/RTK GPS/TS/DL



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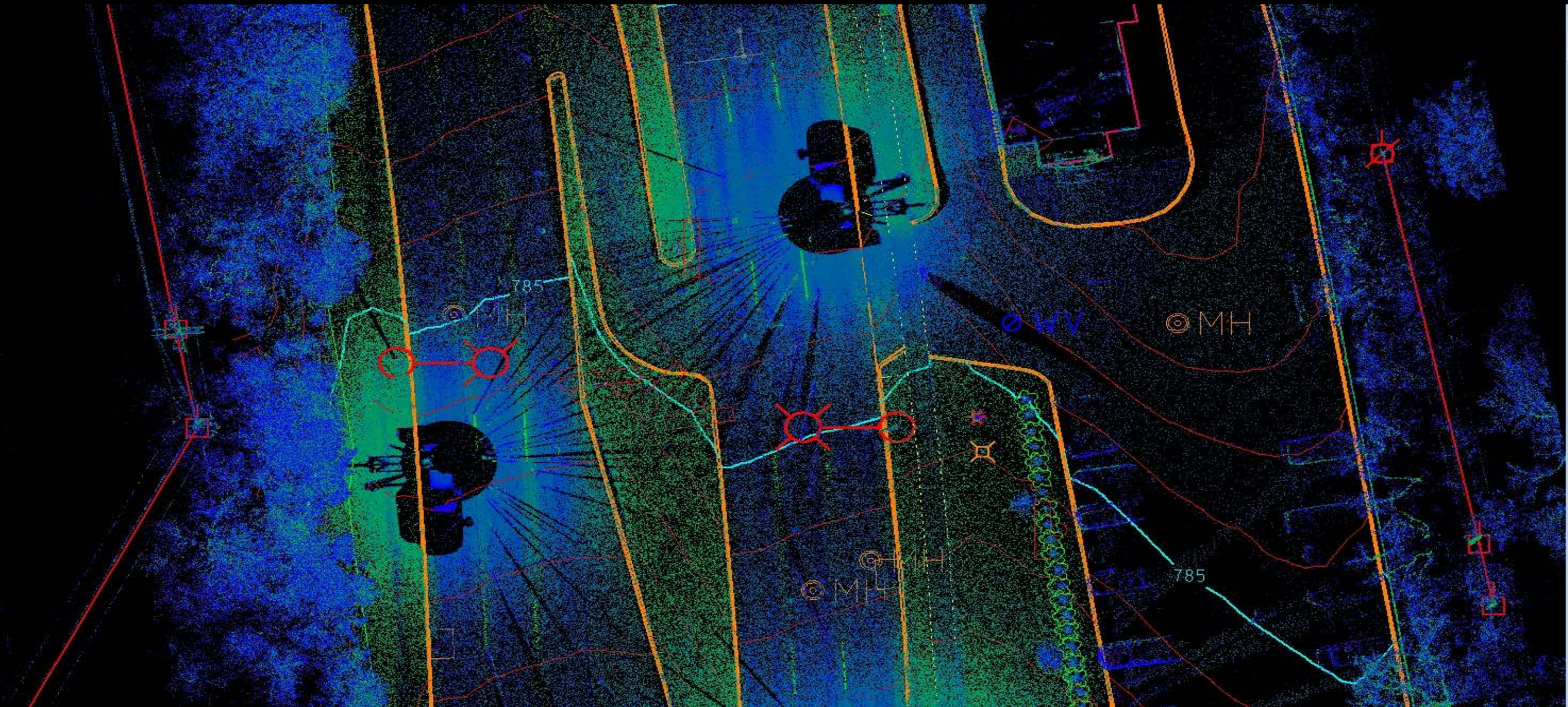


CIM-VDC

Integrated Survey with LiDAR Data Collection - Planning

CIM-VDC

Integrated Survey - Mobile/Static/Aerial LiDAR/APS/RTK GPS/TS/DL

Integrated Survey + LiDAR Data Collection - Typical Workflow

- Project Planning/Scheduling – LiDAR Mobile/Static/Airborne, Season, Weather, and Trajectories-Mobile/Airborne or Terrestrial Setups-Static
- Control Survey – RTK GPS (X,Y,Z) and Differentially Leveled (Z) Survey High Accuracy Targets (HATs) or Vertical Targets
- Data Acquistion – LiDAR HW-specific Collection SW
- Data Adjustment – LiDAR SW
  - Calculate Smoothed, Best Estimated Trajectory (SBET)-Mobile
  - Create Initial LAS File
  - Edge Match Data
  - Geometrically Constrain Point Cloud (PC) Data to Ground Control or in field in field
  - Colorize Point Cloud
  - Transform Point Cloud to Project Coordinate System
- Data Classification – Point Cloud including Bare Earth Ground Points Using LiDAR SW
- Mapping – Point and Line Feature Extraction including Break Lines with QA/QC X-secs Using Mapping SW with Calibrated Digital Images
- Mapping – DTM Surface Model from Bare Earth Ground Points and Break Lines Using LiDAR SW
- Viewing – Viewing, Measuring & QA/QC

CIM-VDC

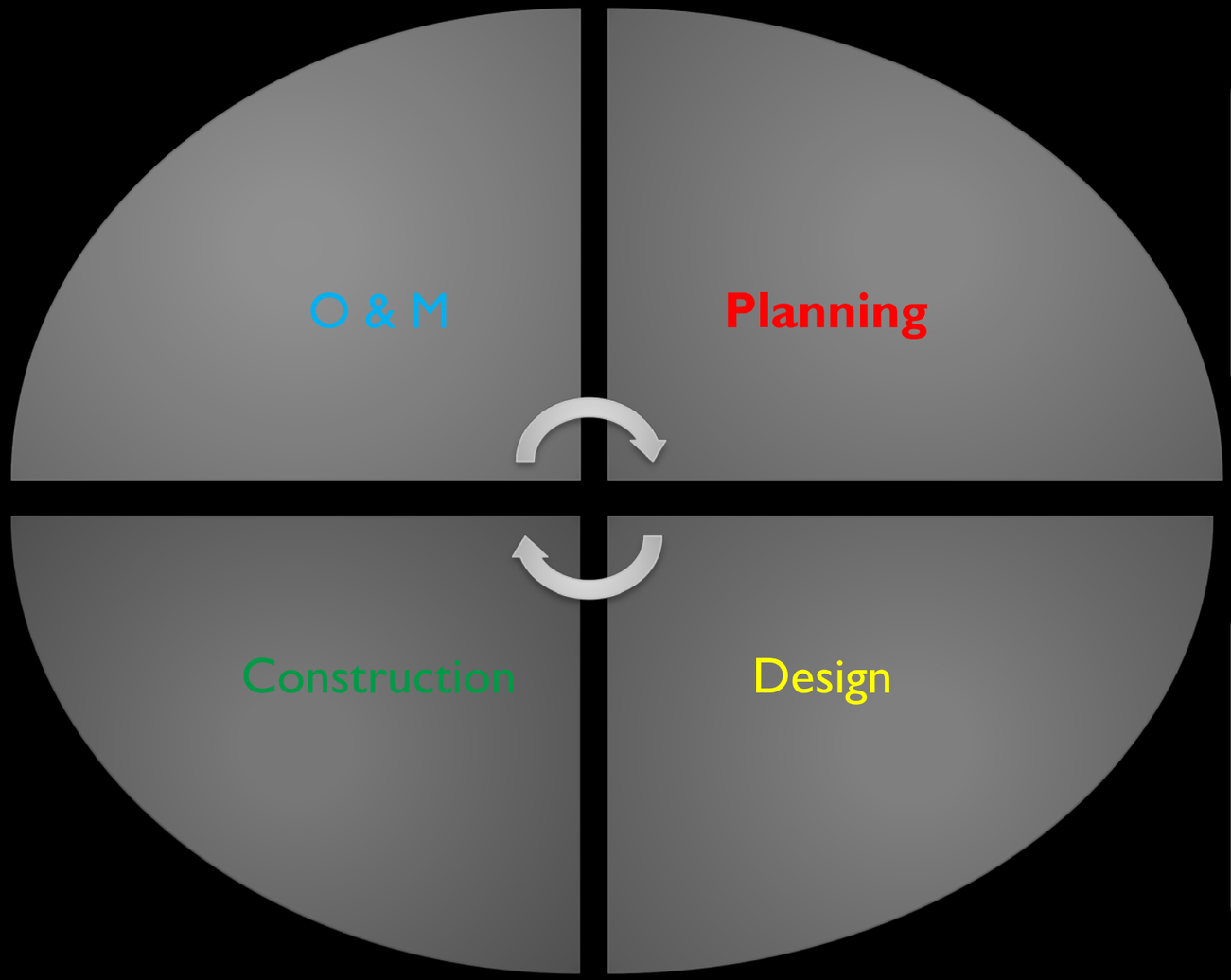
Integrated Survey - Mobile/Static/Aerial LiDAR/APS/RTK GPS/TS/DL

- Two-mile Test Section of Urban Arterial (STH100)
- Pairs of Targets every 1,000 ft (500 ft when needed)
- Check Sections every 4,000 ft
- Targets controlled horizontally via RTK GPS and vertically via Conventional Surveying Methodologies
- Results on surfaces:

	Hard	Soft
◦ Uncontrolled check sections:	0.82’ (1σ) v	0.75’ (1σ) v
◦ Check sections tied to ground:	0.09’ (1σ) v	0.11’ (1σ) v
◦ Check sections tied & matched:	0.025’ (1σ) v	0.10’ (1σ) v

CIM-VDC

Transportation Facilities – Construction Applications



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- As-built Plans

Design
- 30% Preliminary Design
- 60% Design
- Utilities/Geotech/RE/Traffic
- P, S & E Final Design + Model
- Construction/Bid Docs

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Construction Applications

CIM-VDC Pilot Deployment on the Mitchell IC Project

How is a **4,572** P, S & E construction bid document converted and transformed it into a 3D Model?…

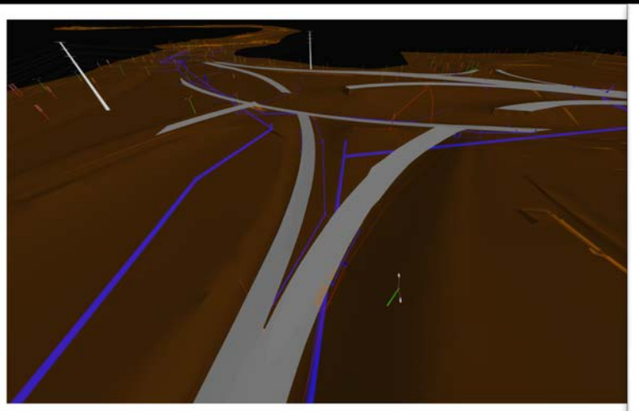
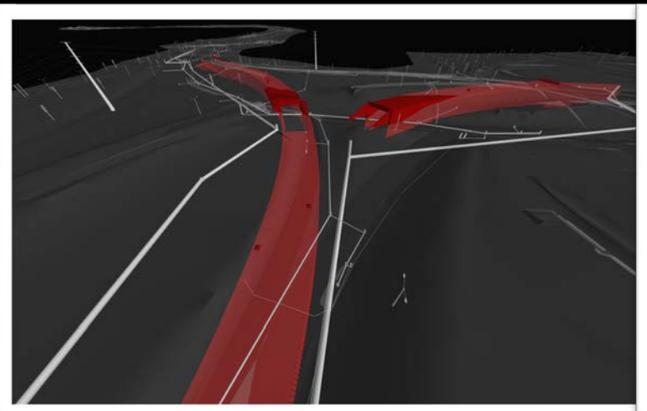
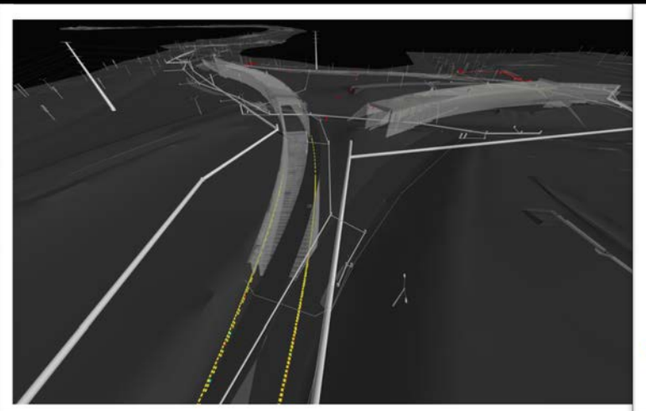
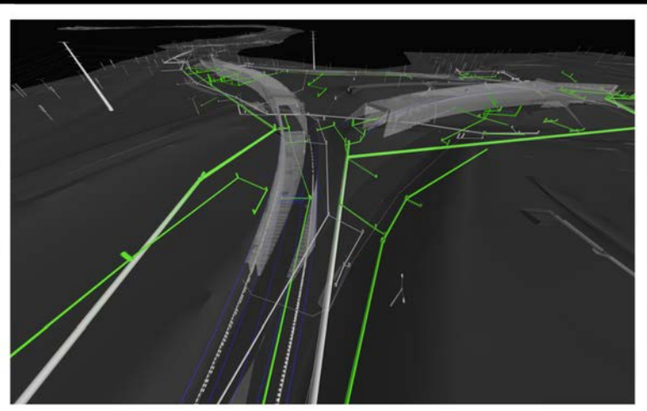
…and **2,677** schedule tasks added?

CIM-VDC

Construction Applications

CIM-VDC Pilot Deployment on the Mitchell IC Project

- 3D Modeling was deployed "brute force" after design was completed
- P, S & E construction documents - 4,572 plan sheets
- 4D Schedule involved design sequencing of construction phases
- 2,677 tasks in CPM Schedule

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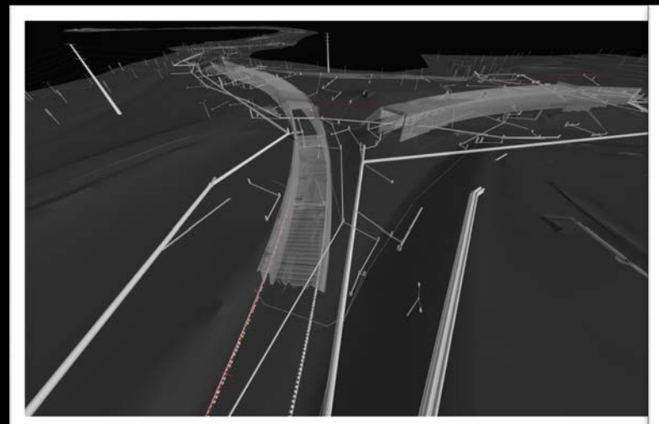
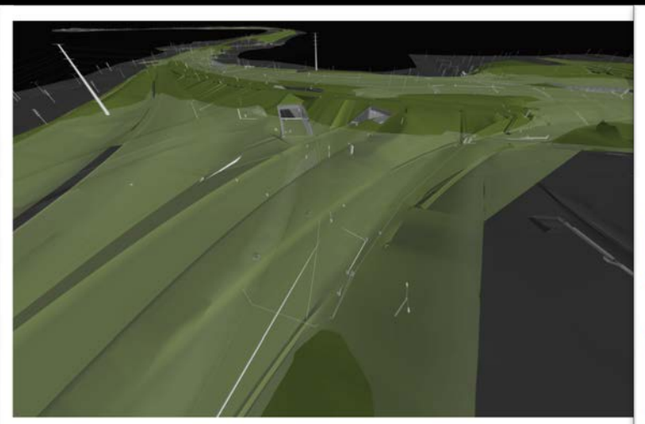
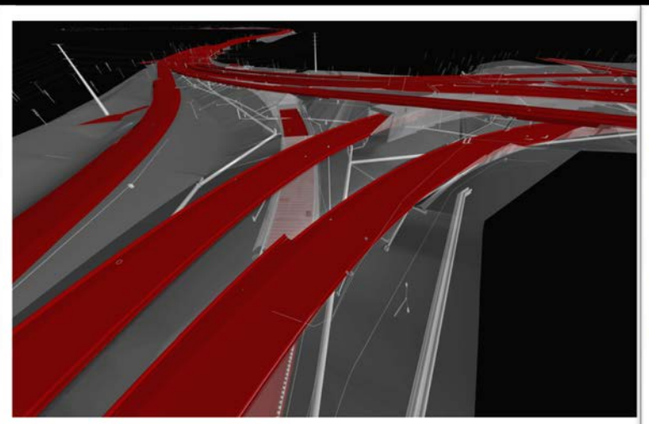
Construction Applications

CIM-VDC Pilot Deployment on the Mitchell IC Project

- Tunnel Structures (3) modeled in Revit
- Utilities modeled in C3D
- 3D model compiled in Navisworks
- Clash detection generated in Navisworks
- Visualization of 3D model in Navisworks
- 4D design constructability schedule simulated in Navisworks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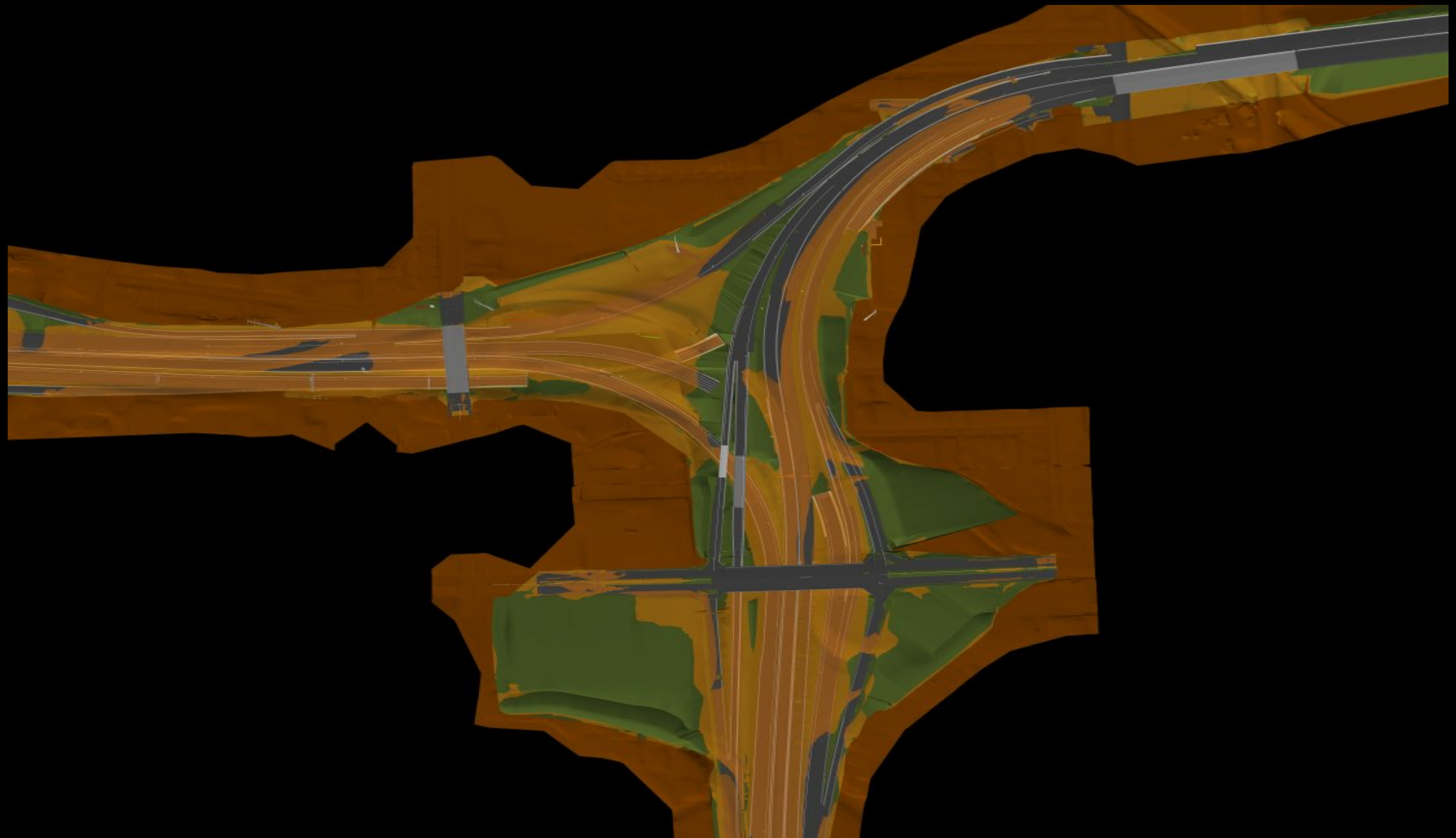
Construction Applications



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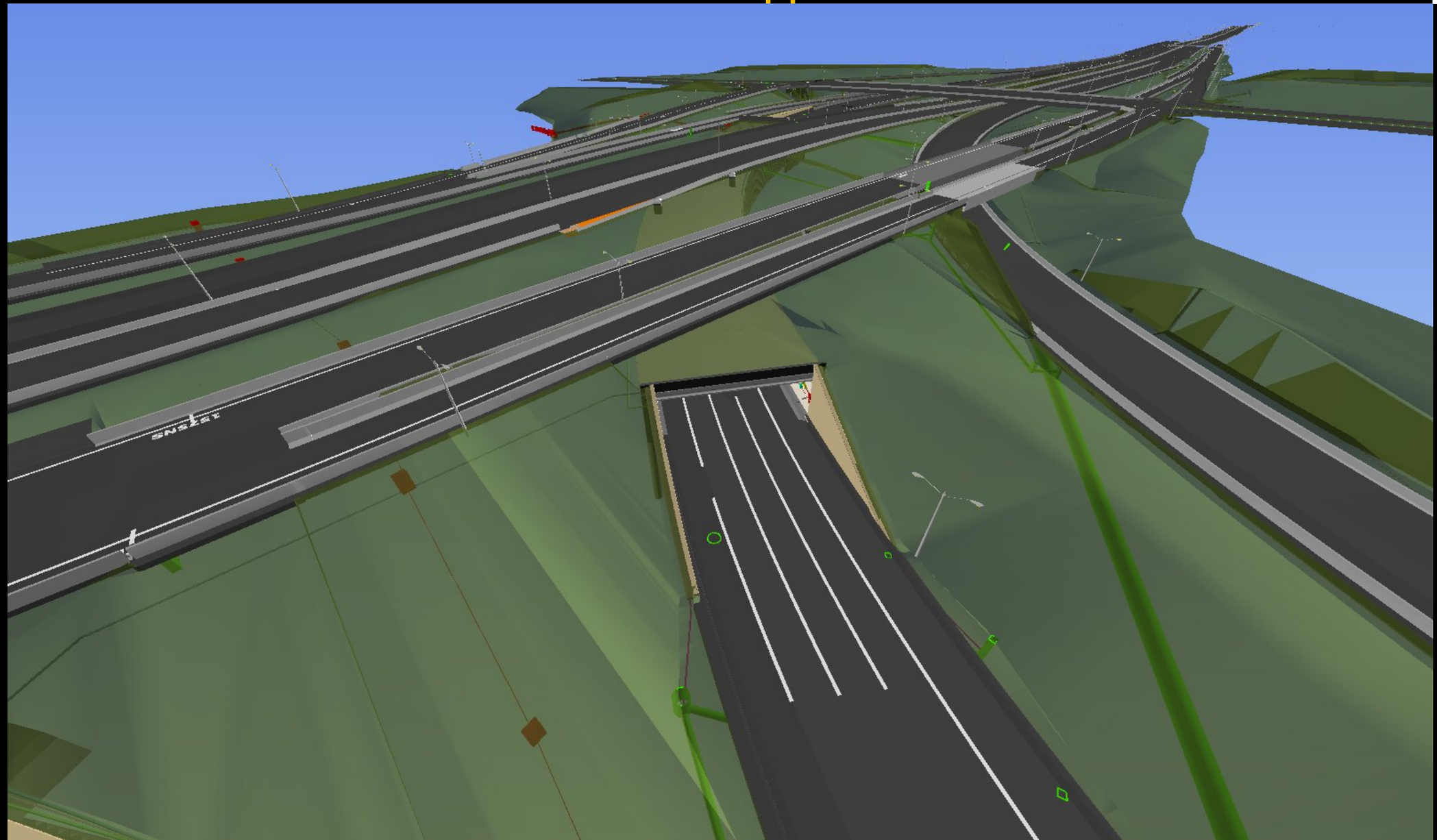
Construction Applications



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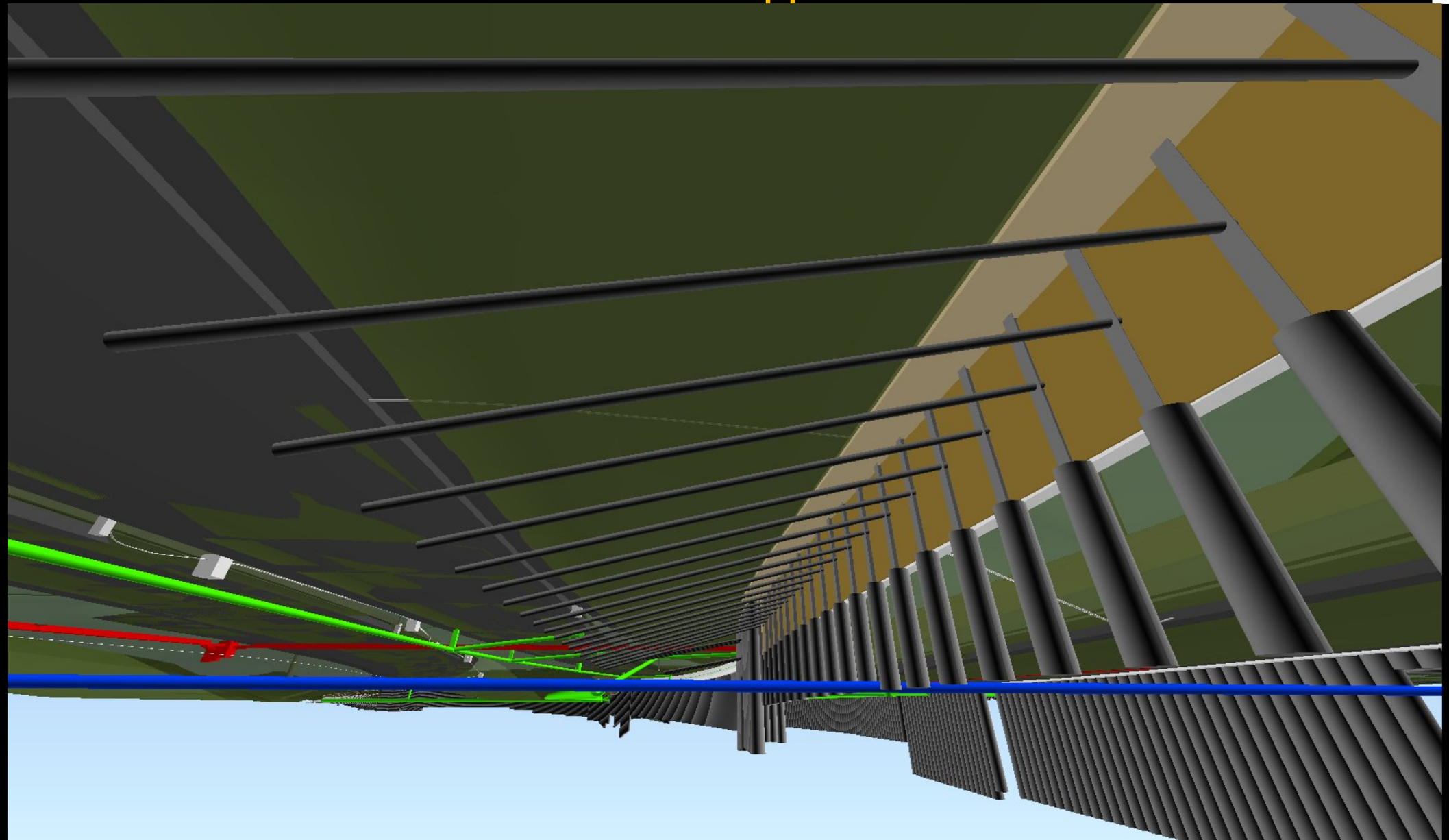
Construction Applications



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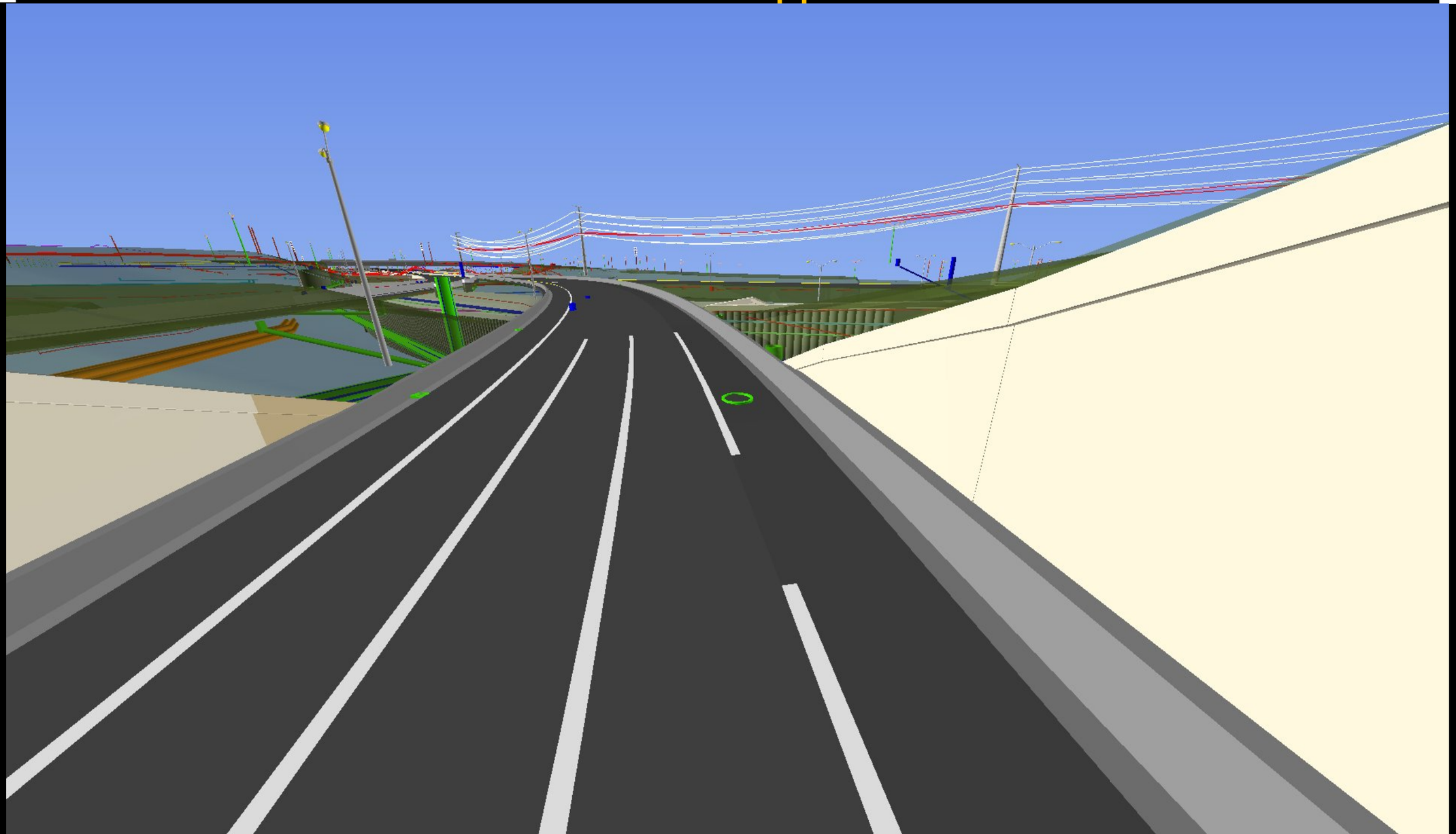
Construction Applications



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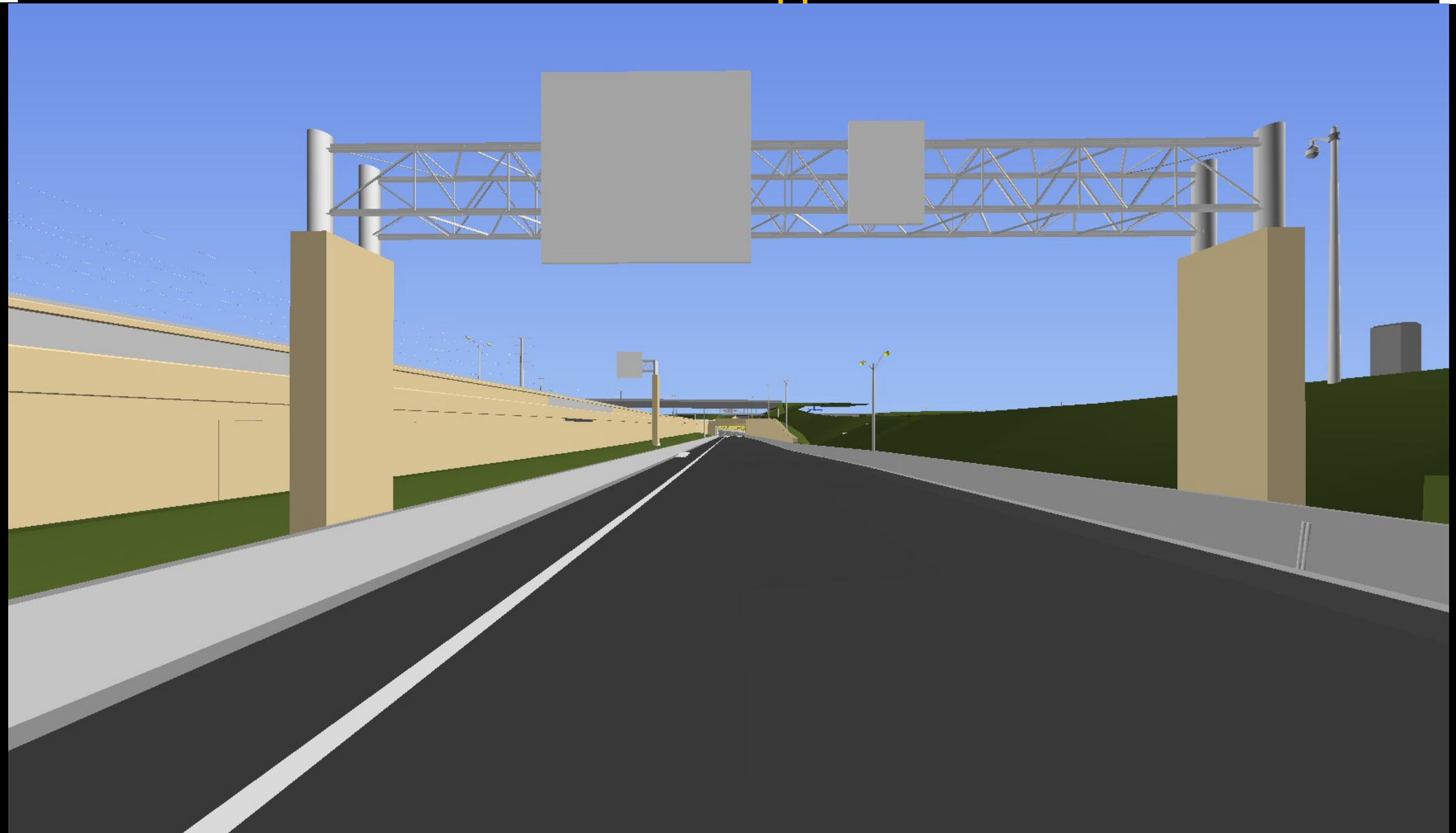
Construction Applications



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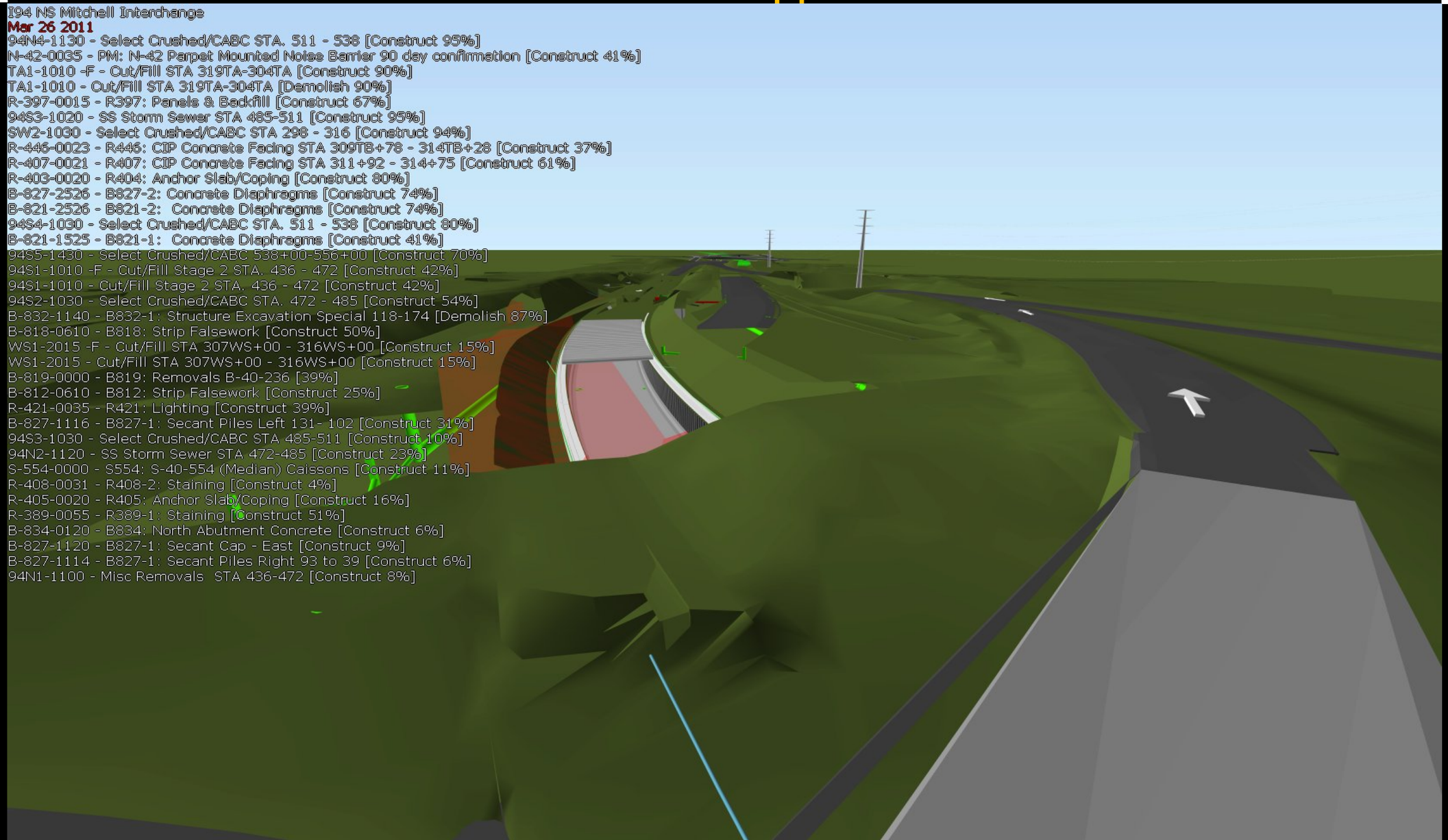
Construction Applications



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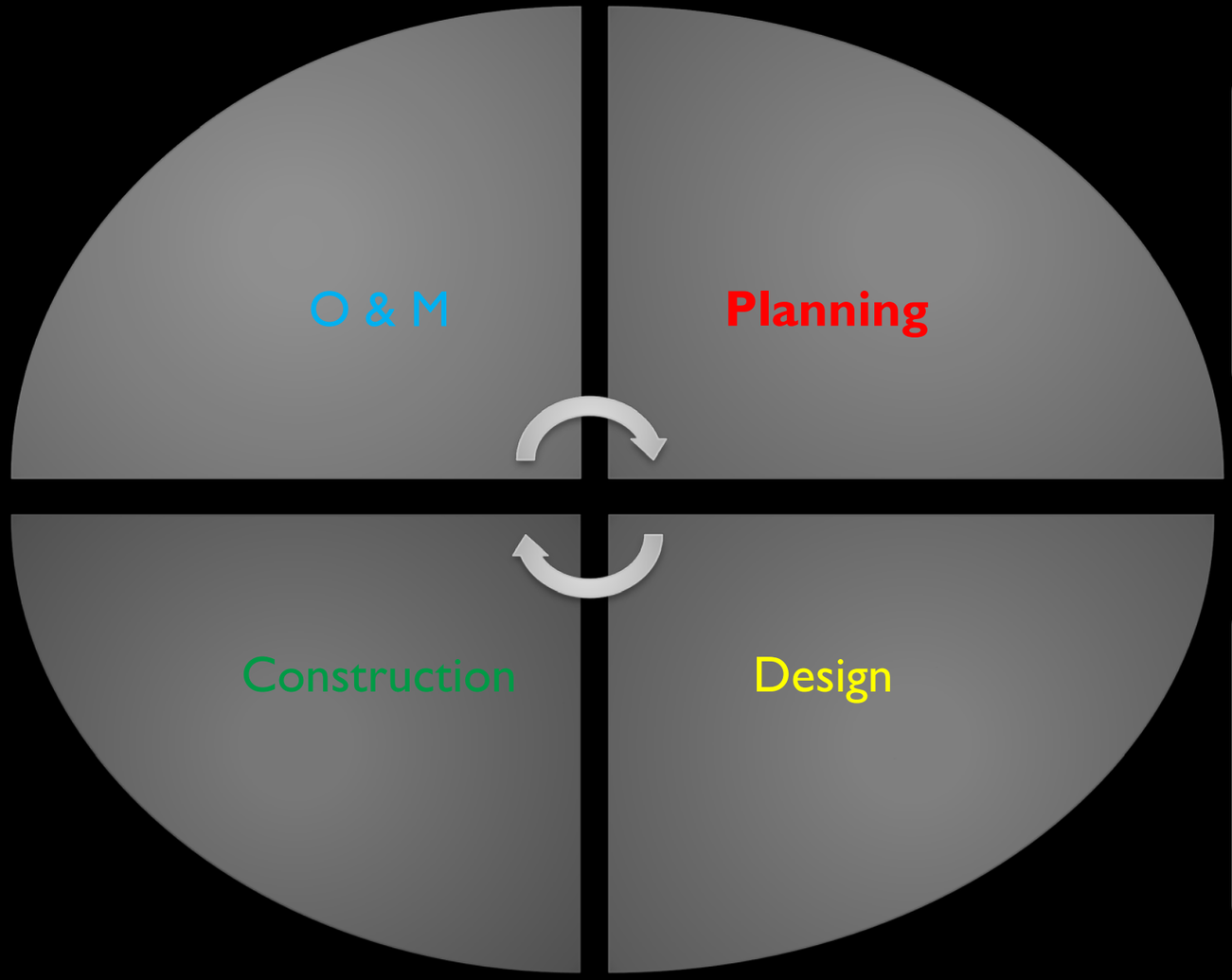
Transportation Facilities – O & M Applications

Operations & Maintenance
- Facilities Maintenance
- Asset Management
- Statewide TOC
- Monitoring
- Renovation



Planning
- Program-Project Initiation
- Finance/Budget
- Environmental Study/Doc/PI
- Survey, Mapping & D.C.
- Design Alternatives

Construction
- Construction Bid/GC
- DBB/DB/IPD
- Construction /CEC
- RFIs, DINs & CCOs
- As-built Plans

Design
- 30% Preliminary Design
- 60% Design
- Utilities/Geotech/RE/Traffic
- P, S & E Final Design + Model
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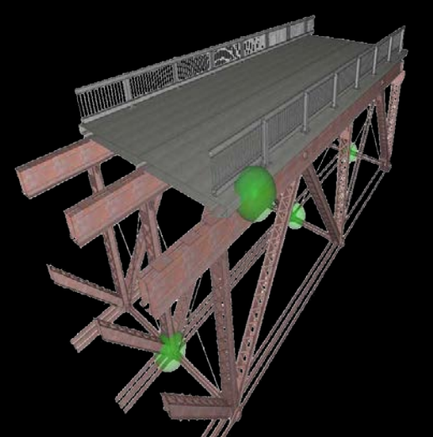
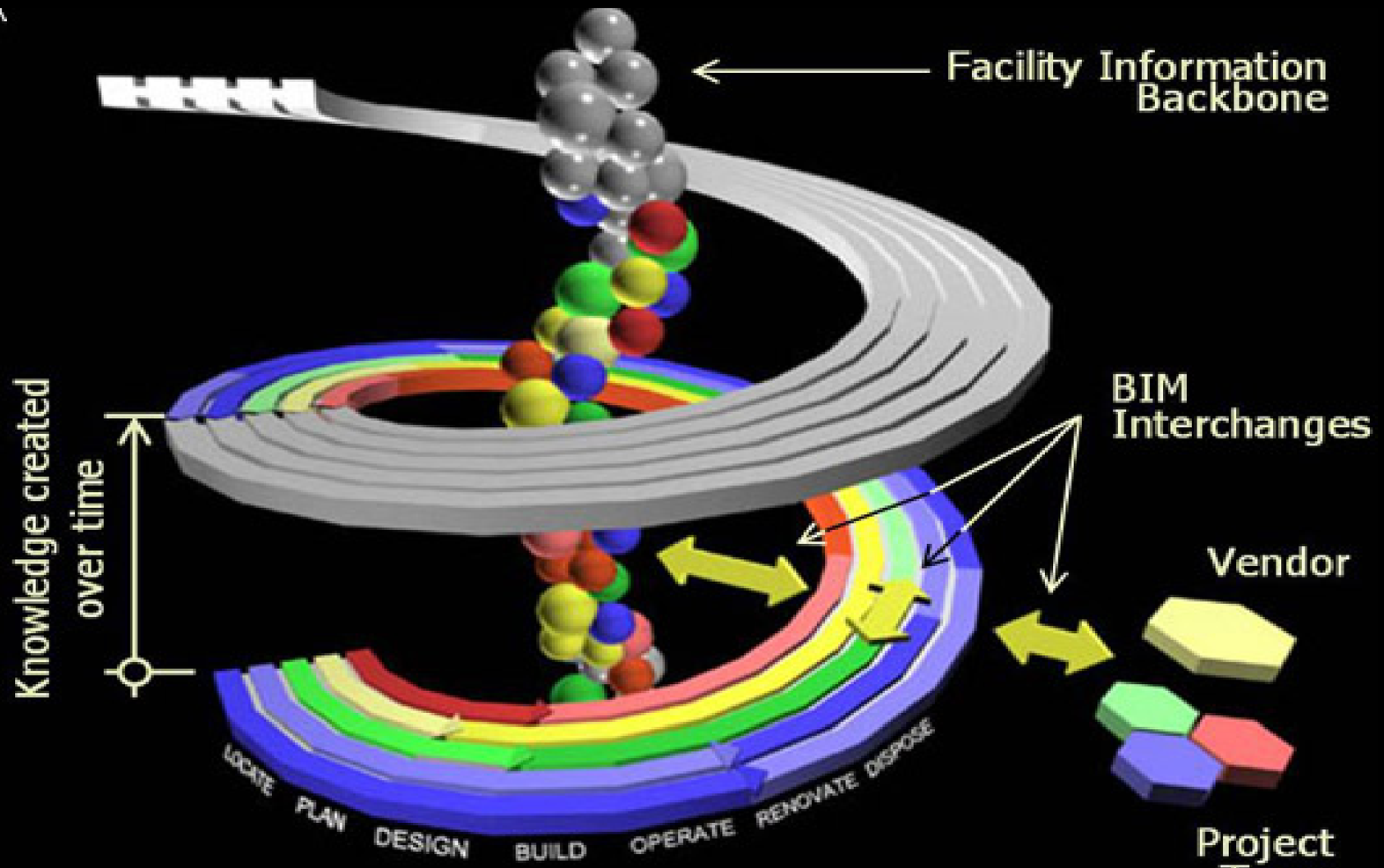
Maintenance & Operations – Lifecycle Applications

Lifecycle FM Information





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Future Applications for Modeling

Trends, Challenges & Opportunities

- Increased use of Mobile Devices & Cloud-based Tools (Office/Field Tablet PCs, Smartphones, etc.)
- Model-based CAD to Cim-BiM and model-based CAD to GIS (2D to 3D) will improve
- 3D will be increasingly enhanced by 4D (schedule), 5D (costs), 6D (specs), etc.
- Software will become more efficient, faster & automated at finding & classifying clashes/conflicts or matches/interfaces for Clash Detection & Resolution (Navisworks, Navigator, etc.)
- Software will become more efficient, faster & automated for point cloud processing, classifying & visualizing for Features & Surfaces Data Processing (PC engines, etc.)
- Software will become smarter for data management & data exchange involving multi-disciplinary DB's (Import-Export, LandXML, TransXML, Axiom, Vault, Projectwise, etc.)
- Standards & protocols will be further documented & enhanced to enable improved workflows & dataflows for Collaboration
- New technologies will be used for enhanced data collection, visualization, analysis & presentation (UAV, Software will become more efficient, faster & automated at finding and classifying clashes/conflicts or matches/interfaces for Clash Detection & Resolution

CIM-Civil Integrated Management: Best Practices and Lessons Learned

WisDOT SE Freeways - Focus on Design & Construction

Q & A Discussion

Thank You!

Bob Gutierrez, PE & & Ryan Luck, PE
roberto.gutierrez@dot.wi.gov, 262-548-5622; ryan.luck@dot.wi.gov, 414-750-1461

William Mohr, PE & Wafa Elqaq, PE
bill.mohr@dot.wi.gov, 262-548-5666; wafa.elqaq@dot.wi.gov, 262-548-5687

Mike Paddock, PE, PS; Chris Johnson, BS
mike.paddock@ch2m.com, 414-272-2426; christopher.johnson@ch2m.com, 262-548-5952

Jerry Zogg, PE & Lance Parve, MSCE, PG
jerry.zogg@dot.wi.gov, 608-750-3085; lance.parve@dot.wi.gov, 414-750-1330;

Kurt Flierl, PE & Shane Zodrow, PE, PS
kurt.flierl@dot.wi.gov, 414-750-3085 szodrow@kapur-assoc.com, 414-254-5698;