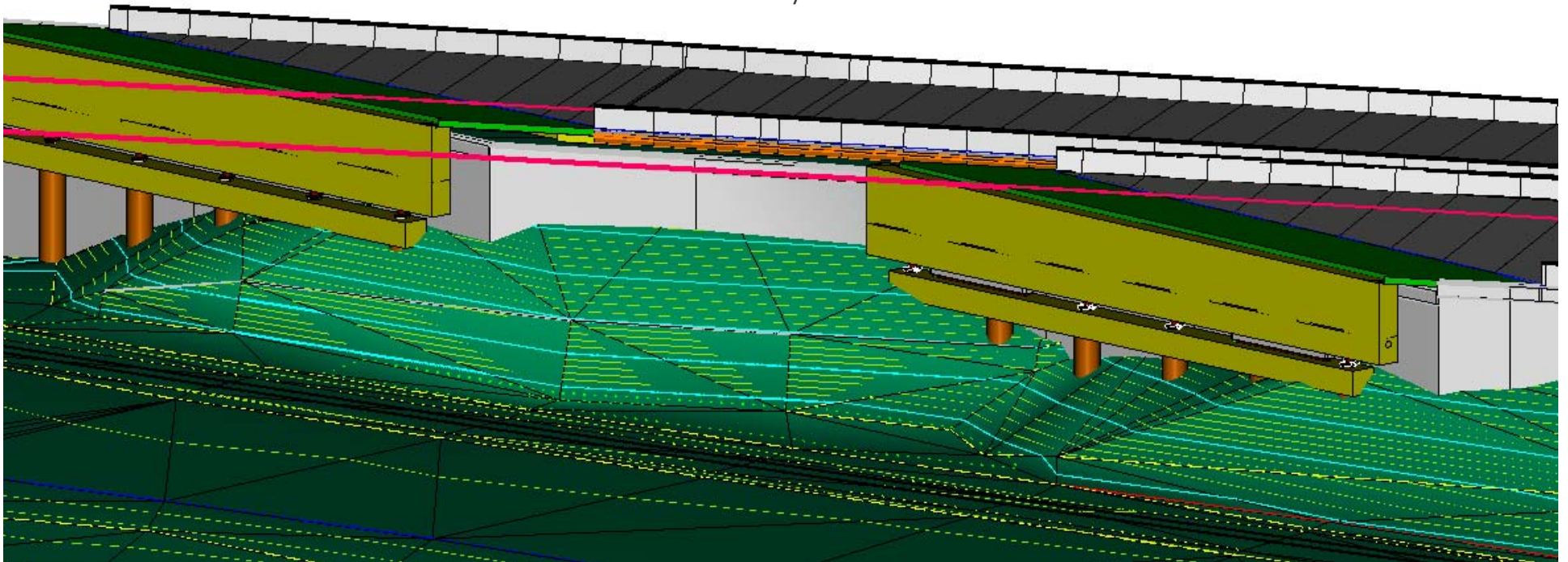


Model Based Design and Construction Project Delivery

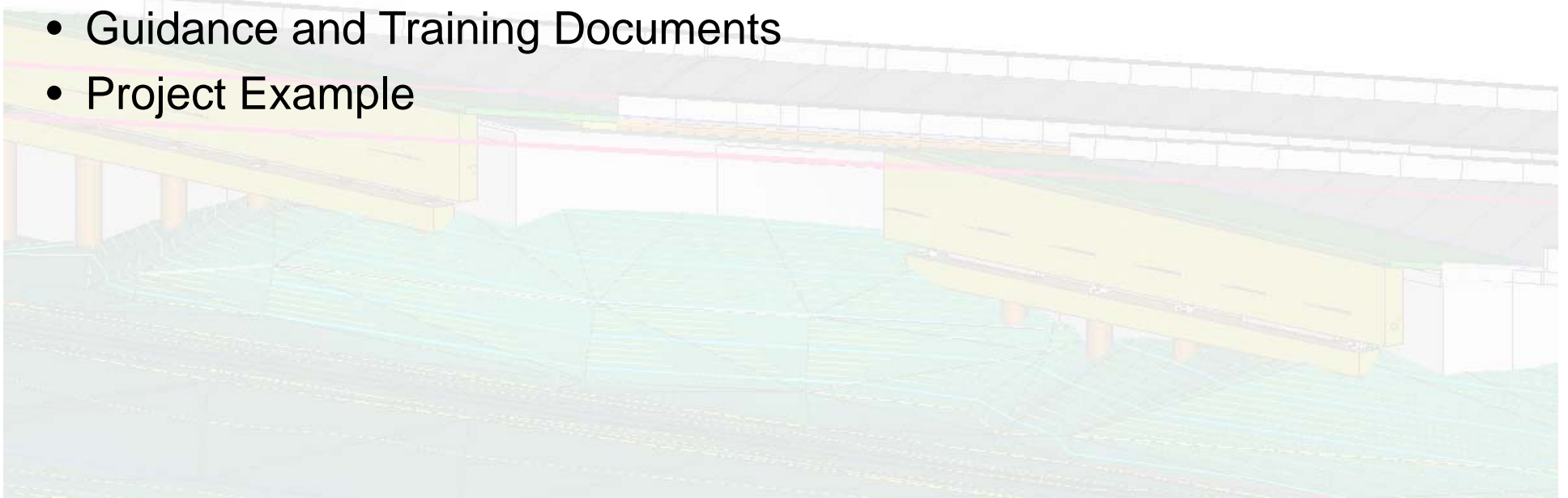
Carmen Swanwick

UDOT Chief Structural Engineer and Deputy Project Development Director

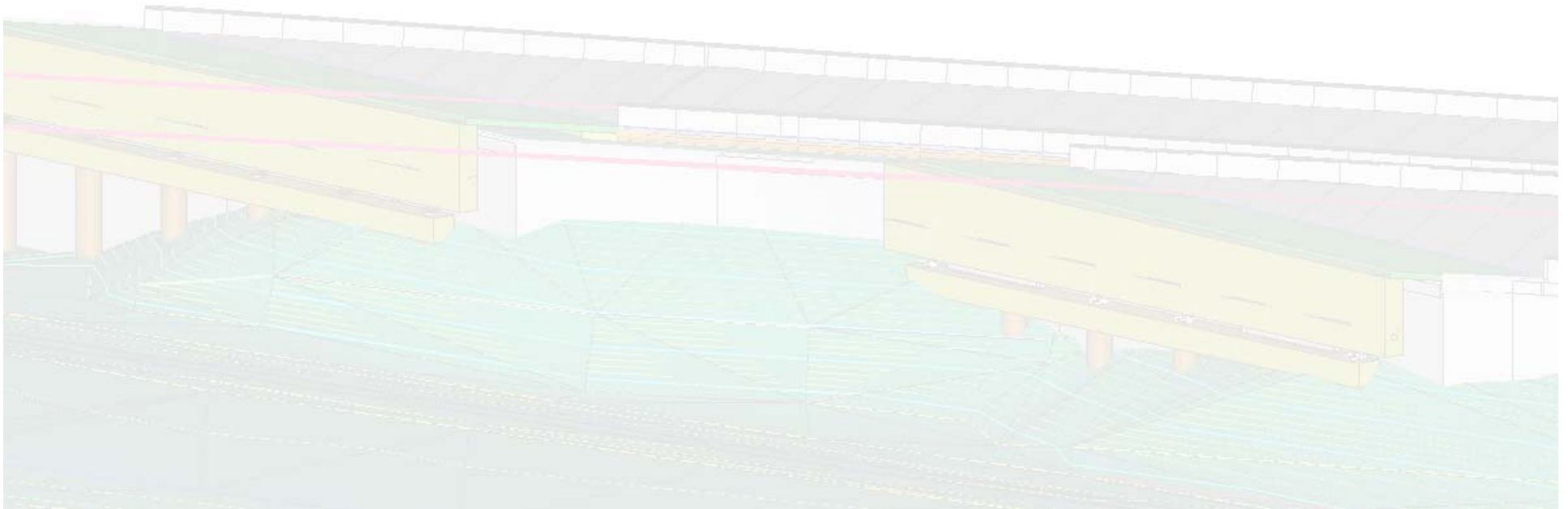
February 2018



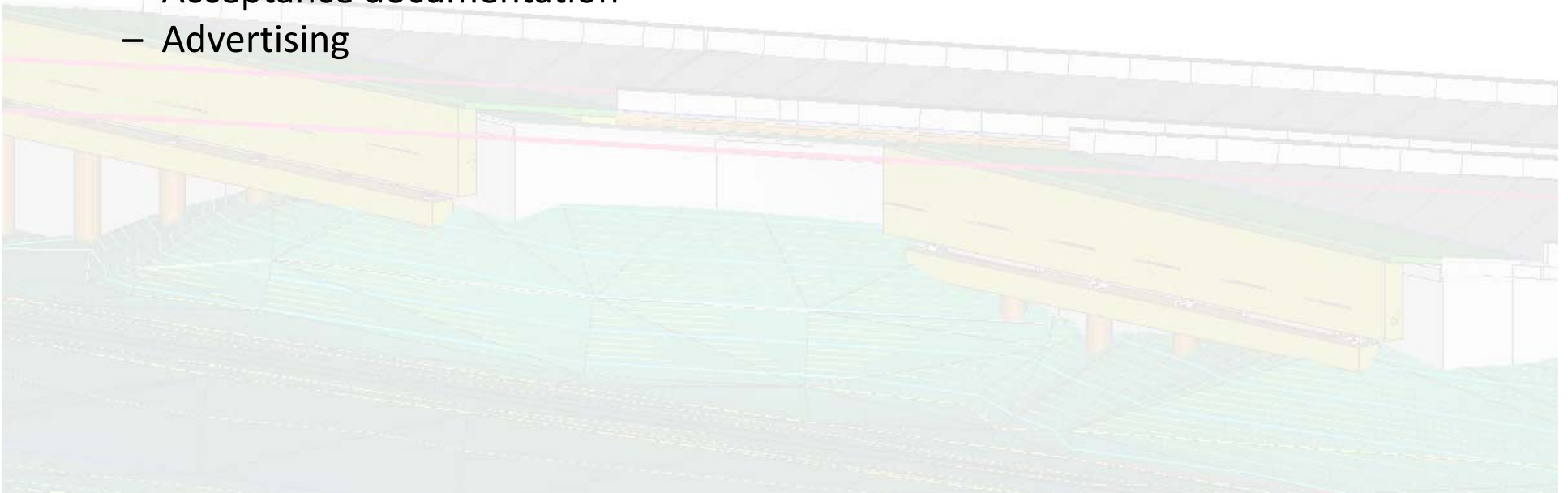
- Model Based Design and Construction (MBDC)
- Background – Model as Legal Document (MALD)
- Mobile Devices – Construction Inspection
- Automation
- BIM for Bridges and Structures
- Consultant Contracting
- Advertising
- Guidance and Training Documents
- Project Example



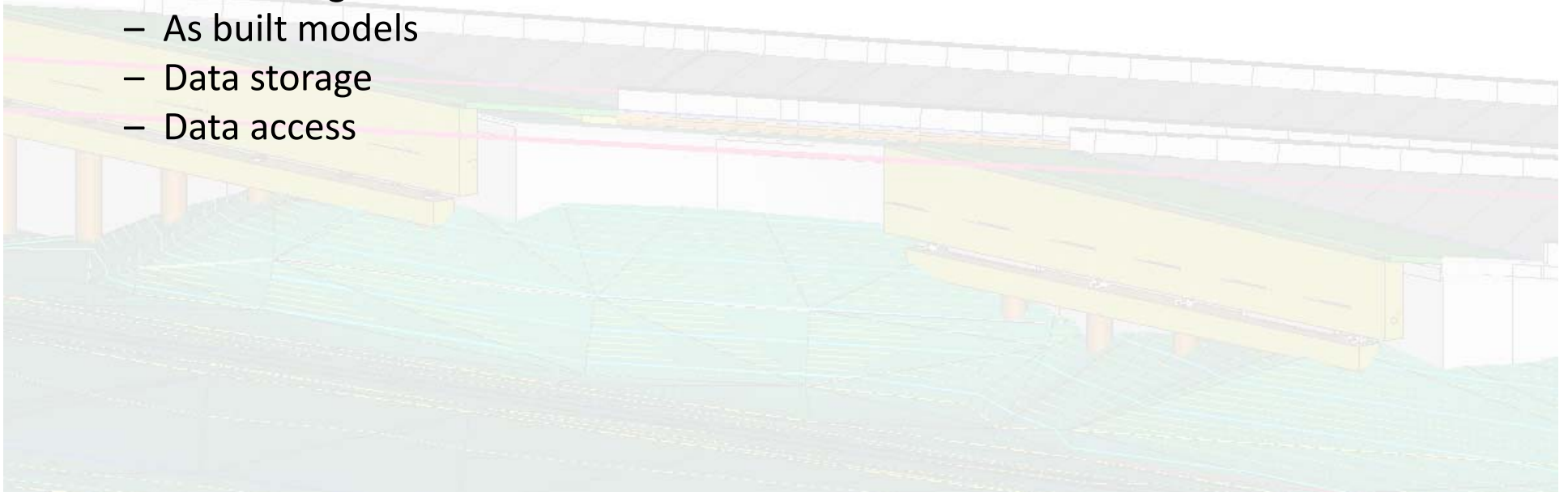
- Gain a clear and complete knowledge of the project
 - Provide clash detection, grading, details, etc. (fully develop the model)
- Improve efficiency and reduce costs
 - Produce 3D design to 2D paper to 3D construction
- Obtain and manage quality data
 - Prevent rework from project to project
- Improve procedures and processes
 - Improve workflows to reduce overlap and unnecessary work



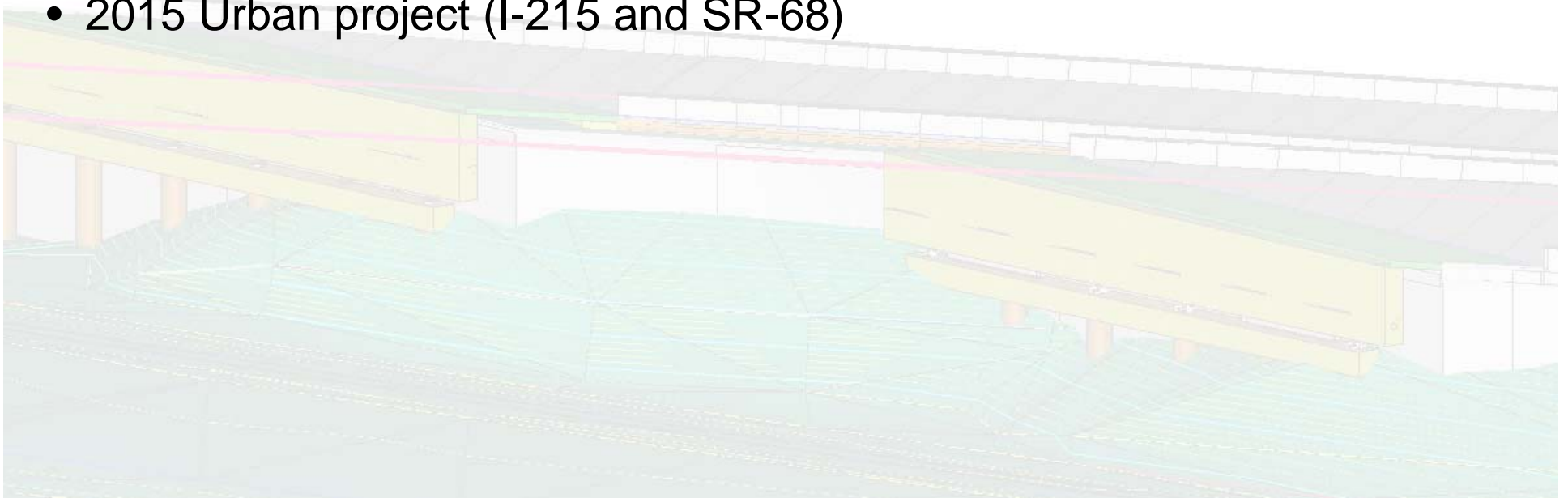
- Planning
 - Concept development
- Design
 - Preconstruction design – discipline coordination
 - Standards and specifications
 - Measurement and payment
 - Quality control (checking)
 - Design reviews and oversight reviews
 - Acceptance documentation
 - Advertising



- Construction
 - Bidding
 - Construction inspection
 - Schedule
 - Pay items
 - Acceptance
 - Request for information
 - Change orders
- Asset management
 - As built models
 - Data storage
 - Data access



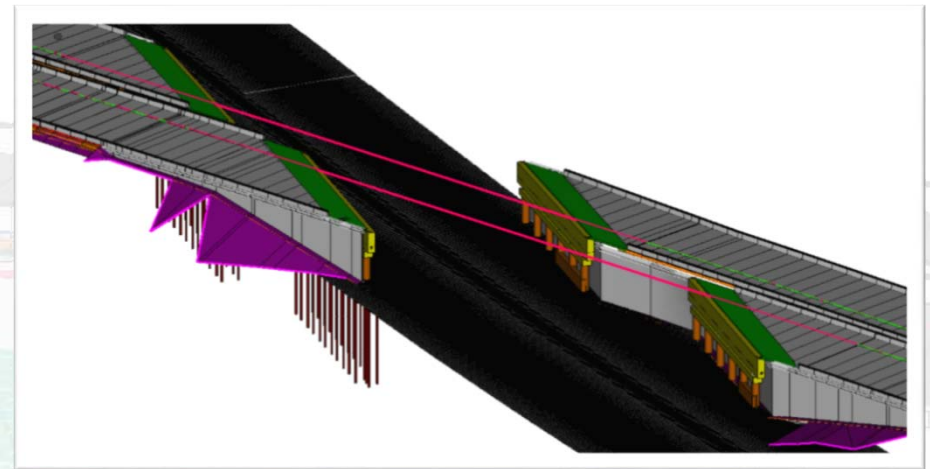
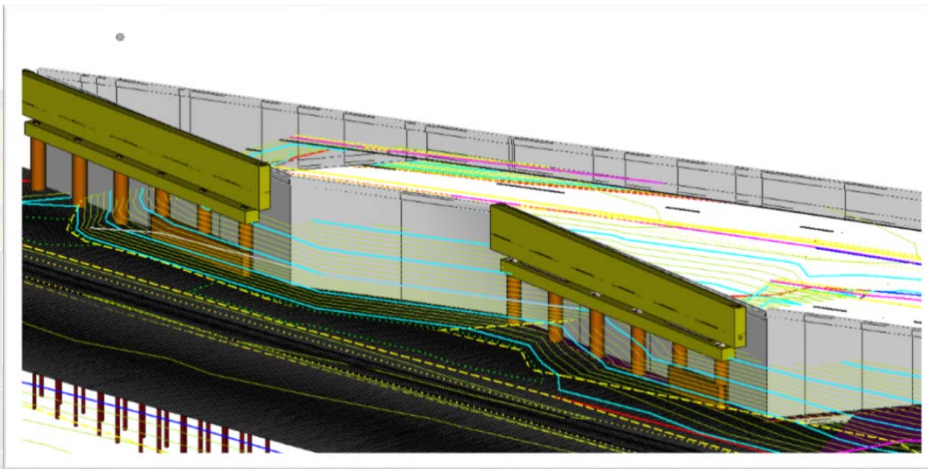
- 2014 FHWA 3D Workshop and Peer Exchange Iowa
 - Implementation plan – short term, mid-term, long term
 - Survey and geomatics manual update
- 2015 Rural widening project (SR-20) – Design
 - CMGC contracting method
 - File format (.icm) Bentley/Trimble
 - Validation process – does not correspond
- 2015 Urban project (I-215 and SR-68)



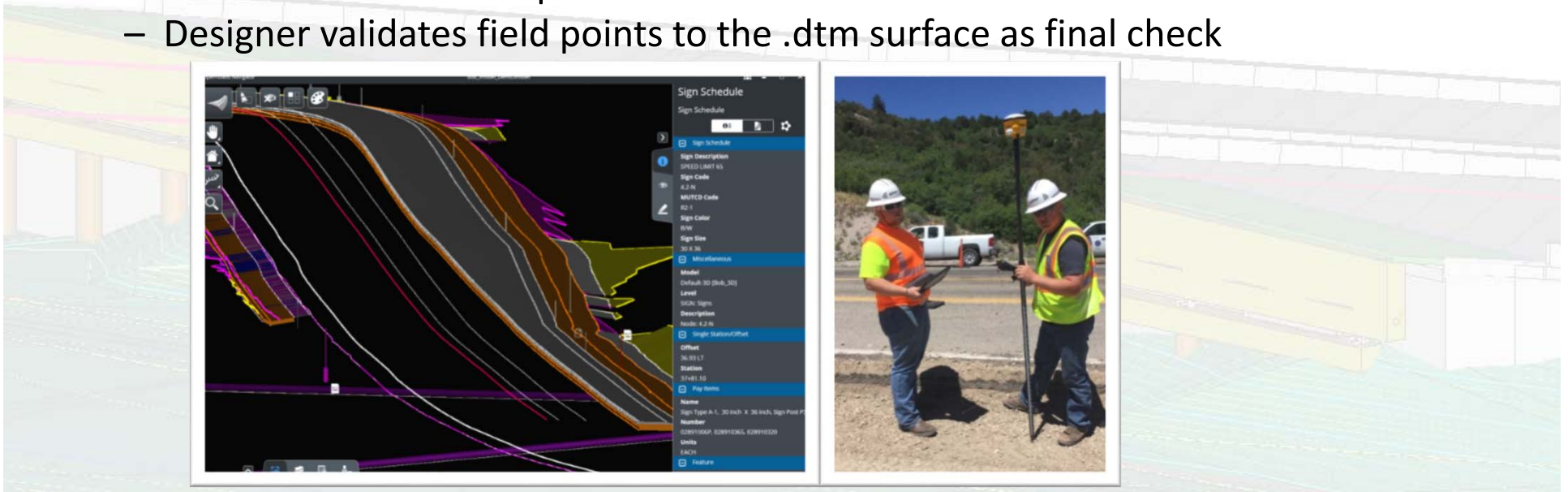
- 2016 Rural widening project (SR-20) – Construction
 - OpenRoads Navigator – field reviews
 - Collaboration – designer, contractor, Bentley, Trimble to fix .icm file issues



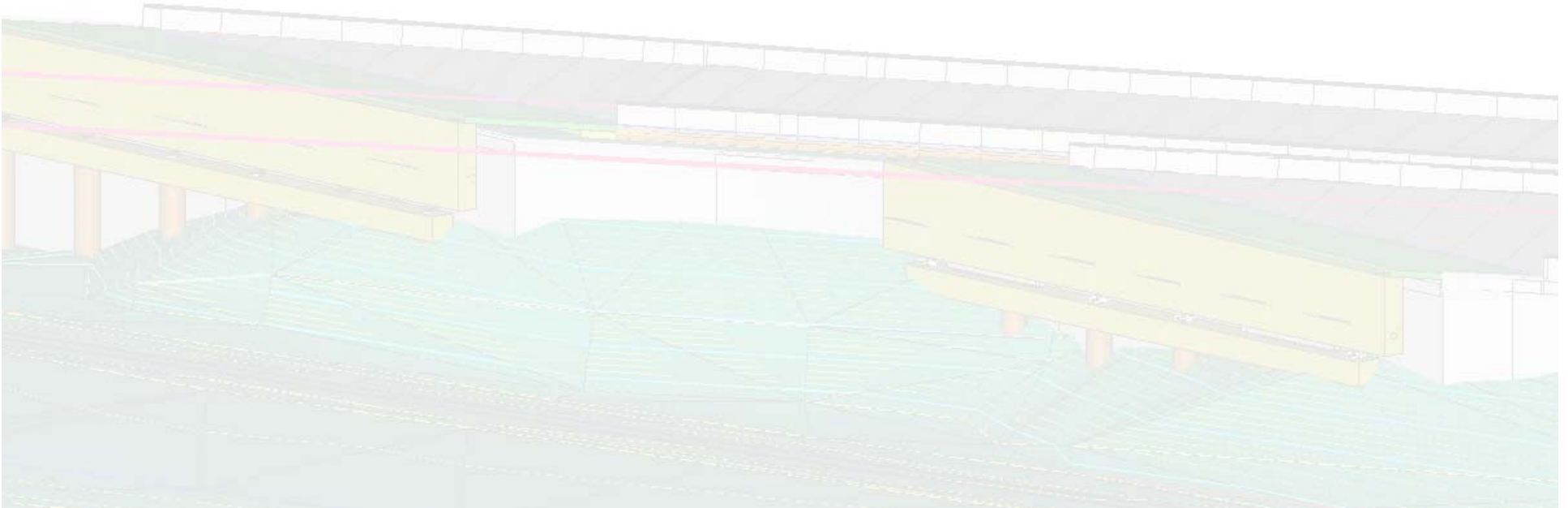
- 2017 Design bid build projects – 2 advertised – 2 design
 - .dgn files - legal document
 - .dtm, .alg, XML, imodels, etc. files – for information only
- 2017 BIM for Bridges and Structures project – Design
 - CMGC contracting method



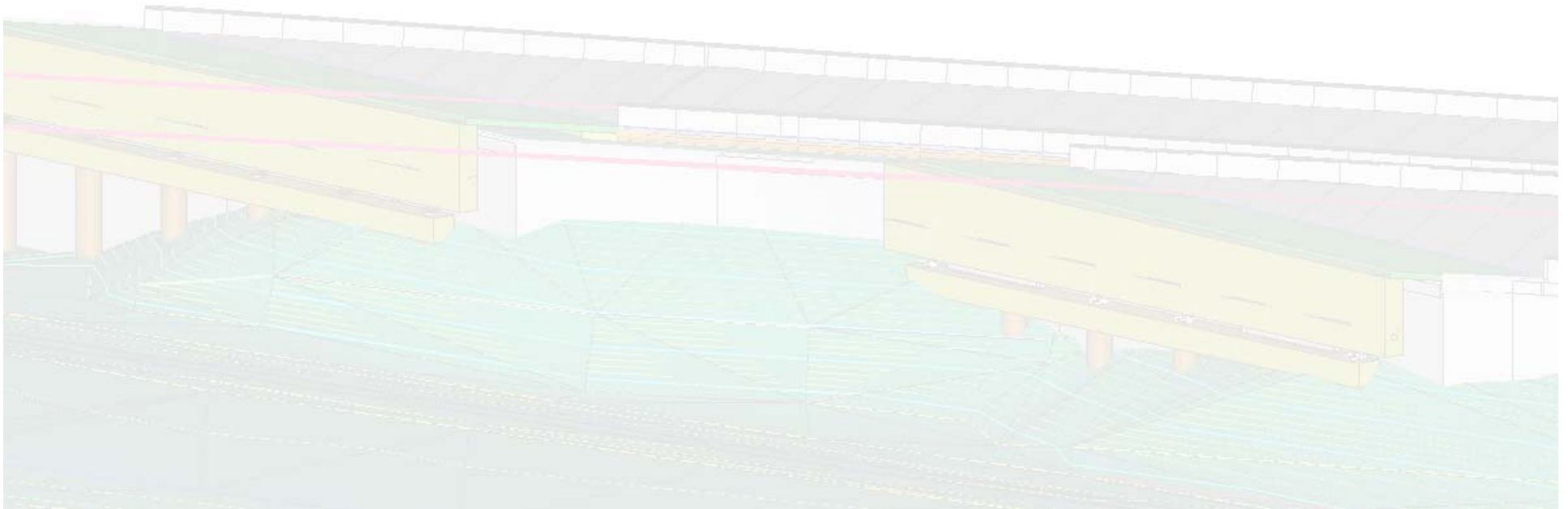
- 2016 OpenRoads Navigator
 - Bentley developed attribute tool (EC attributor)
 - Steep learning curve for field personnel
- 2017 GIS based collector – ArcGIS
 - Internal use of Feature Manipulation Engine (FME)
 - Goal to use on design bid build projects
- Process
 - Contractor supply rovers and rods
 - UDOT construction inspectors use contractor surfaces for initial verification
 - Designer validates field points to the .dtm surface as final check



- Civil Integrated Management (CIM)
 - Automate using FME and MALD
 - Expand meta-data and system features in existing condition database
 - Generate surfaces by drone/lidar to confirm design
 - Integrate design and construction software
 - Develop tools to support design and construction



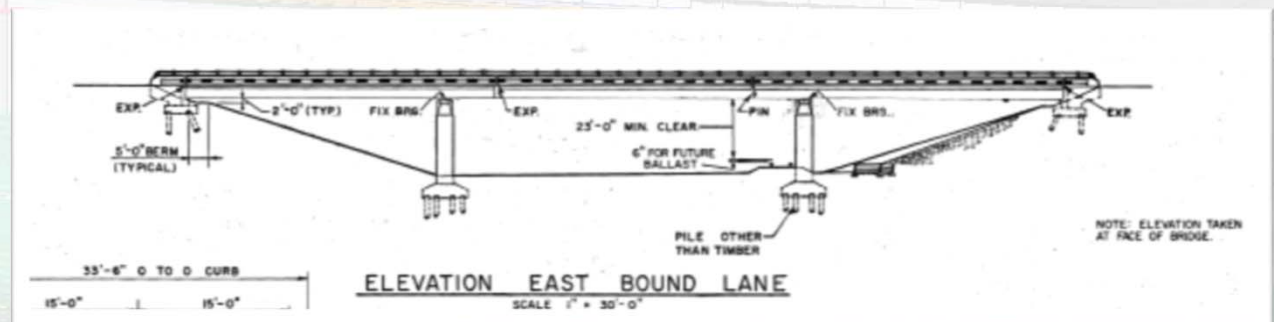
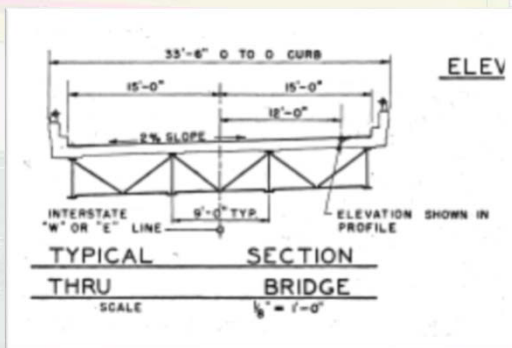
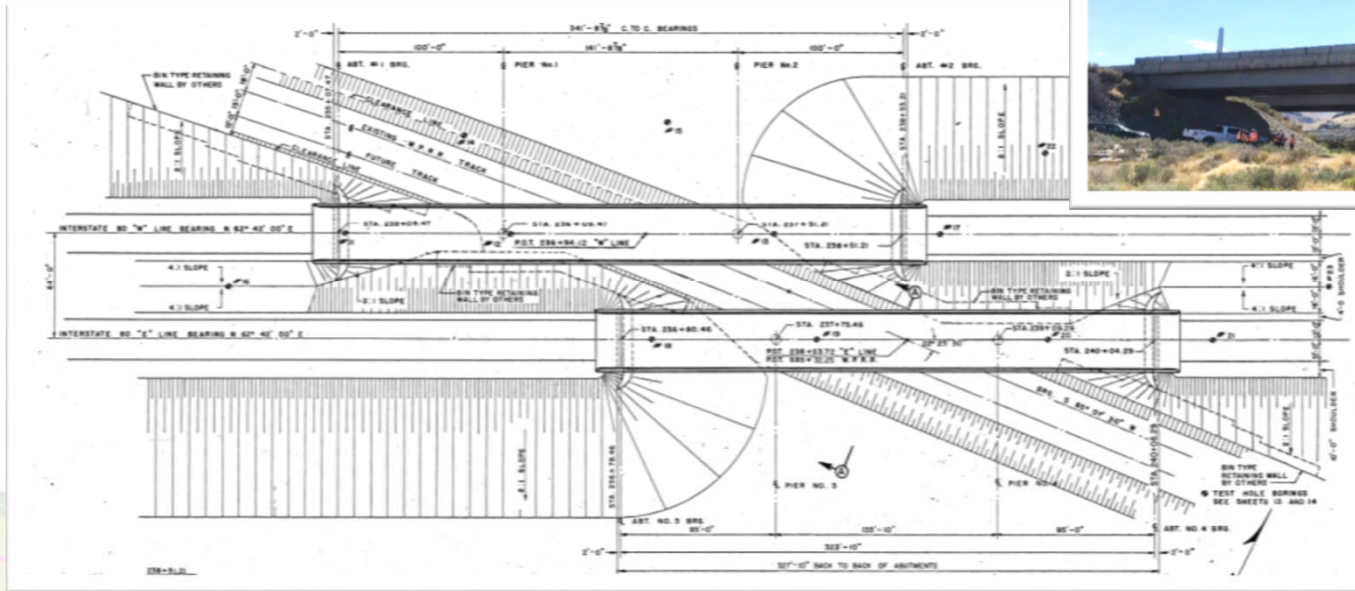
- Alternate structures design approach
 - General notes
 - Contains notes for the majority of elements
 - Summarizes quantities
 - Simplified situation and layout
 - Provides general layout information
 - Supports Federal Highway coordination
 - Details
 - Includes items not in the model



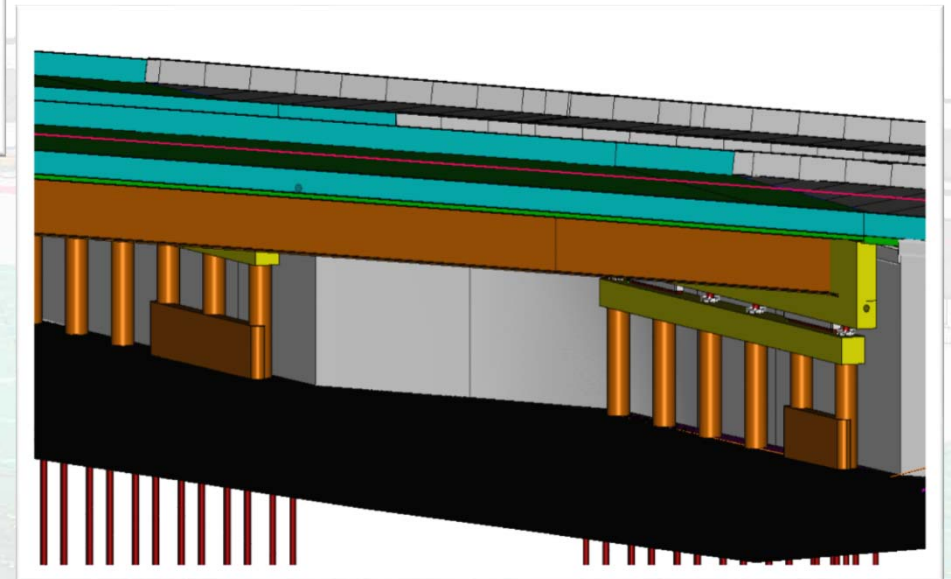
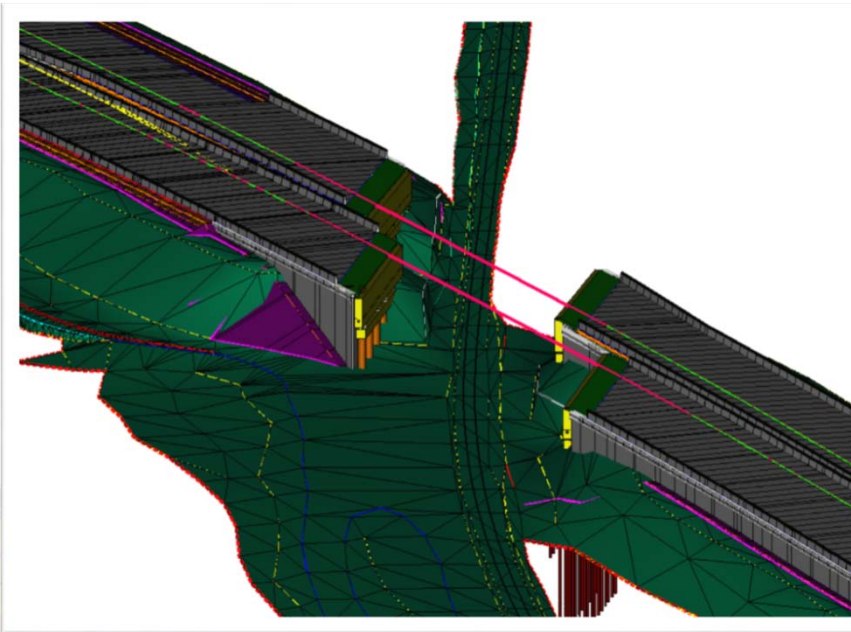
BIM for Bridges and Structures

I-80 Structure Replacement (MP 101 and 99)

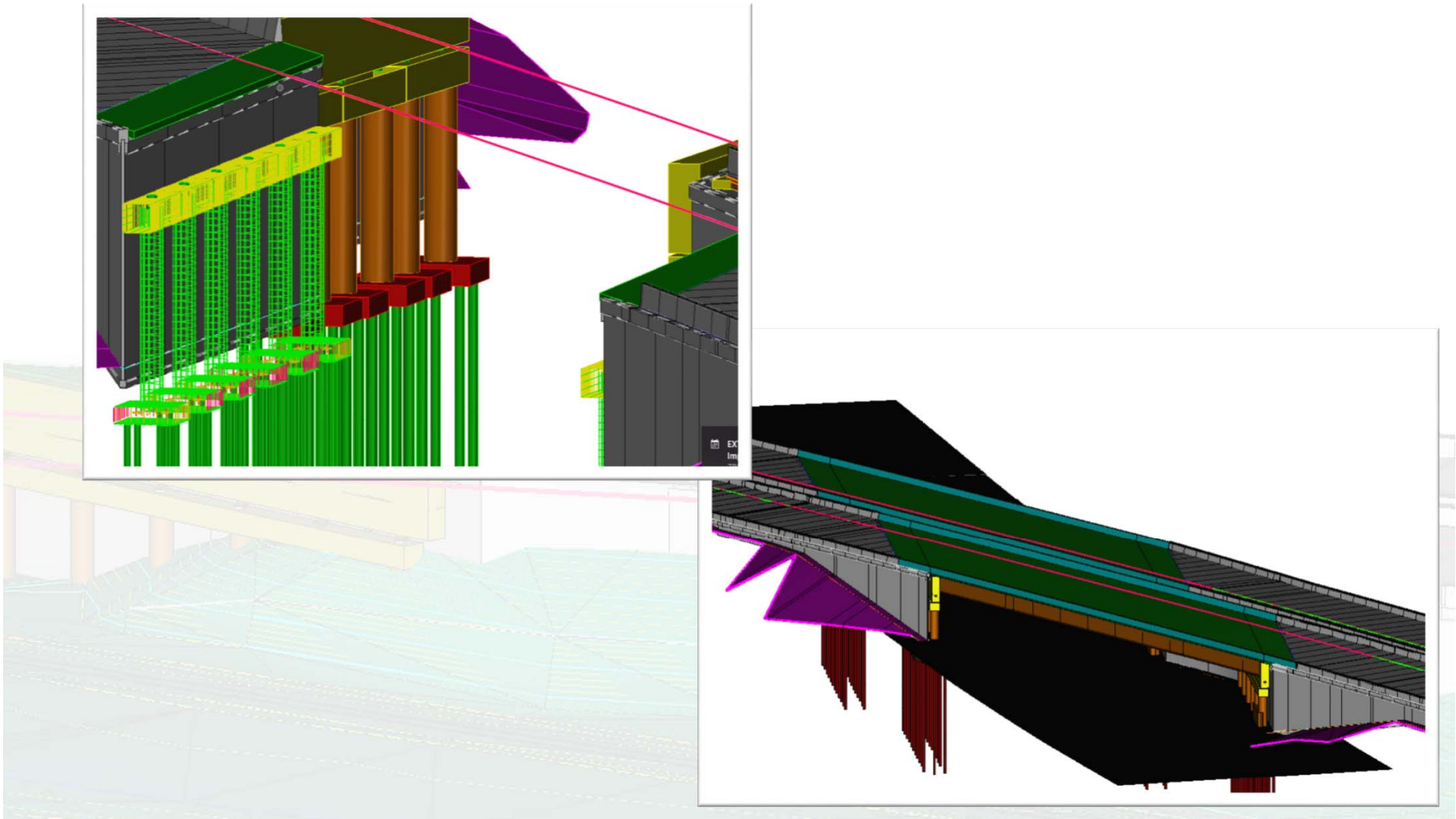
- I-80 over UPRR at Blackrock



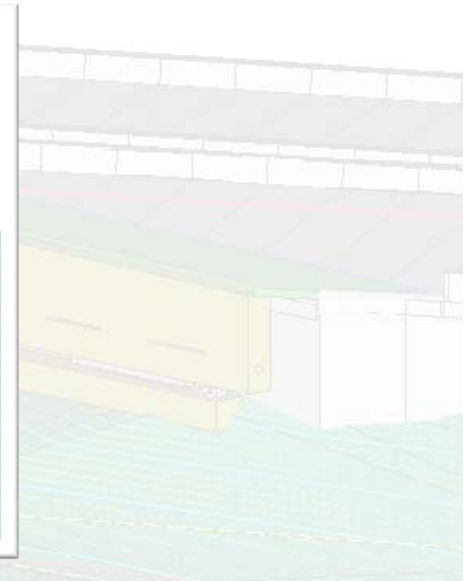
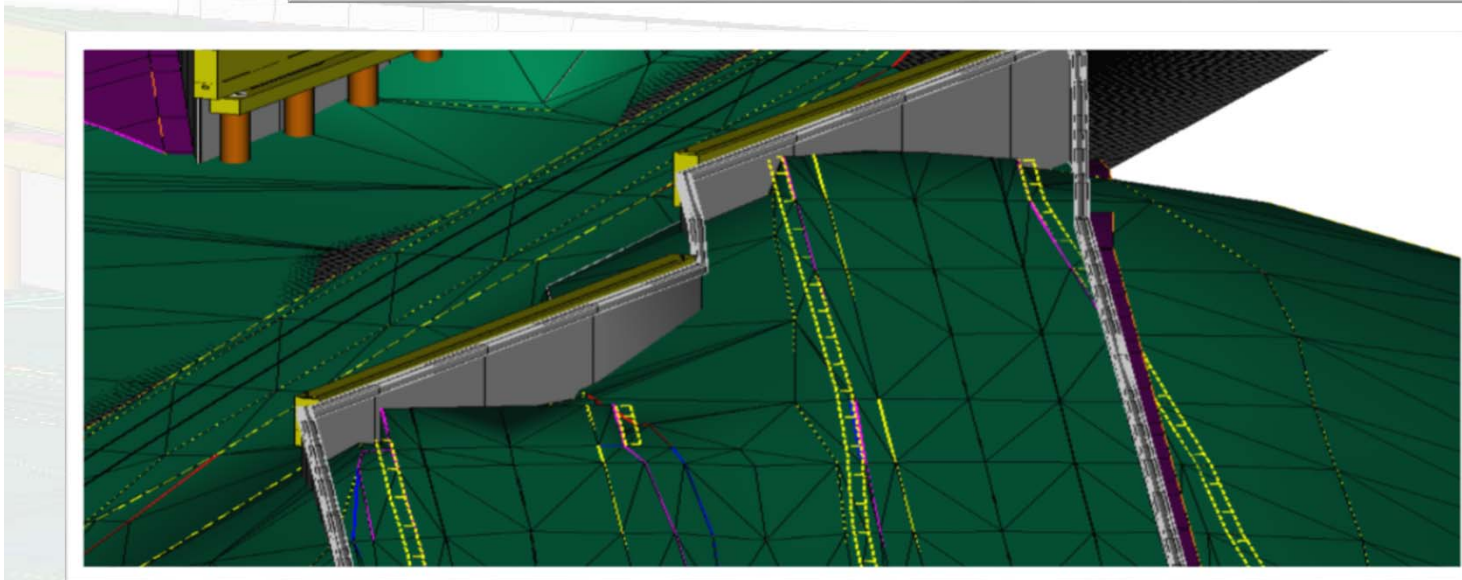
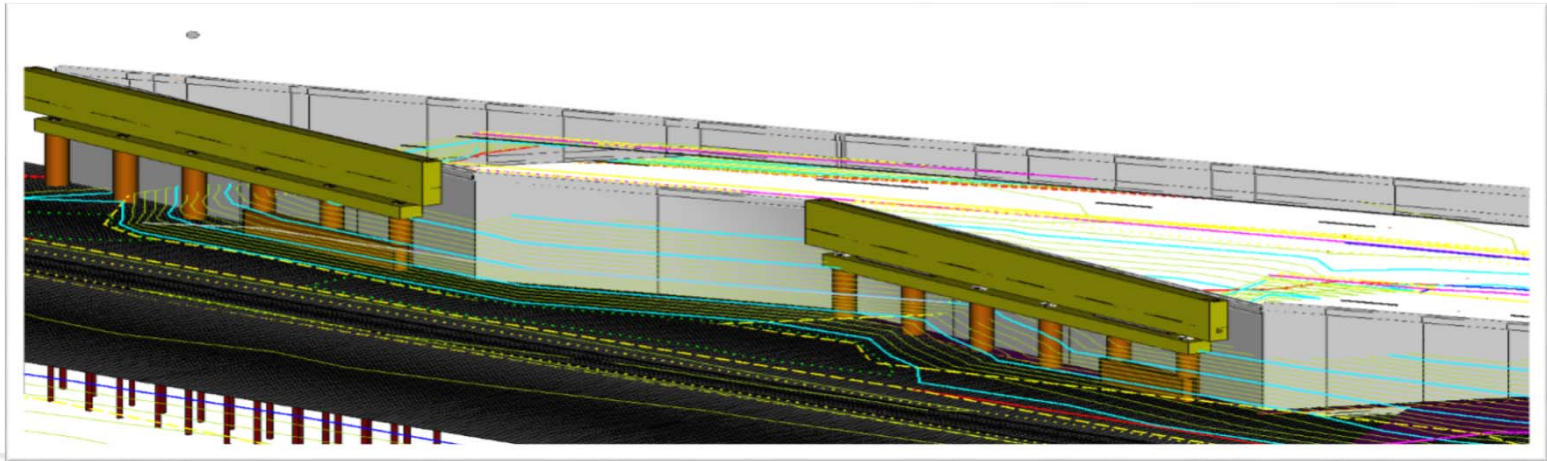
- I-80 over UPRR at Blackrock



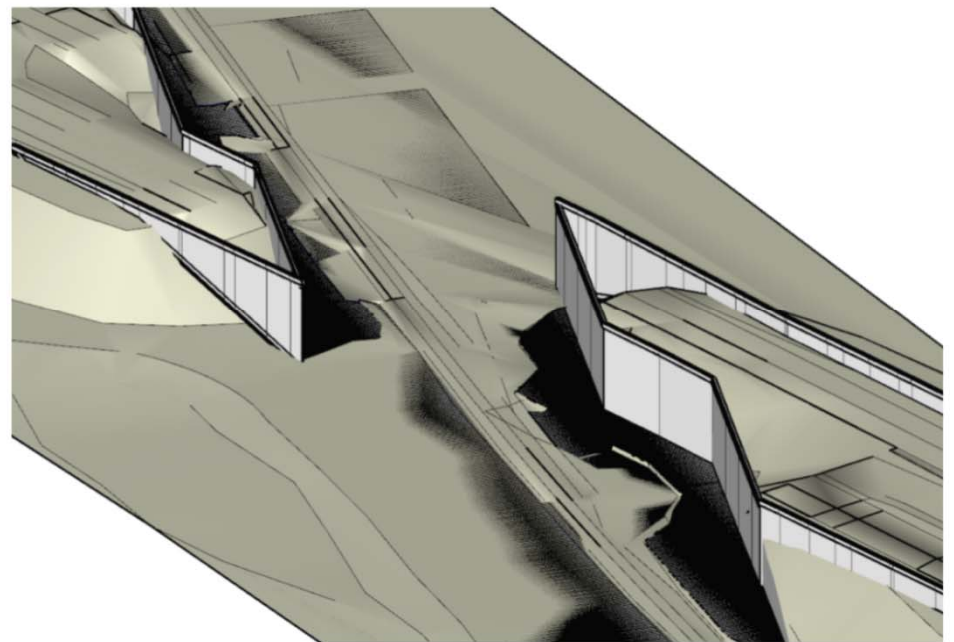
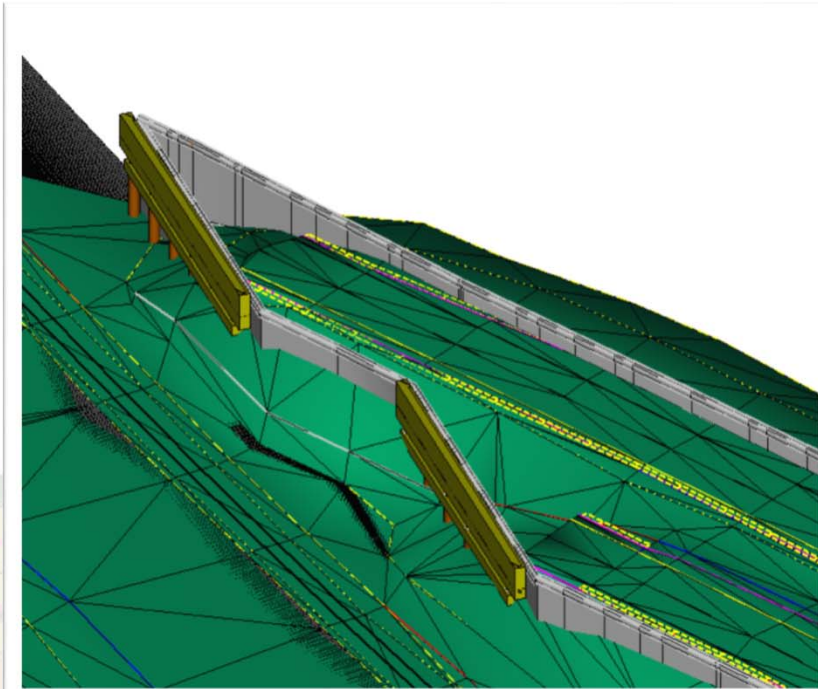
- I-80 over UPRR at Blackrock



- I-80 over UPRR at Blackrock



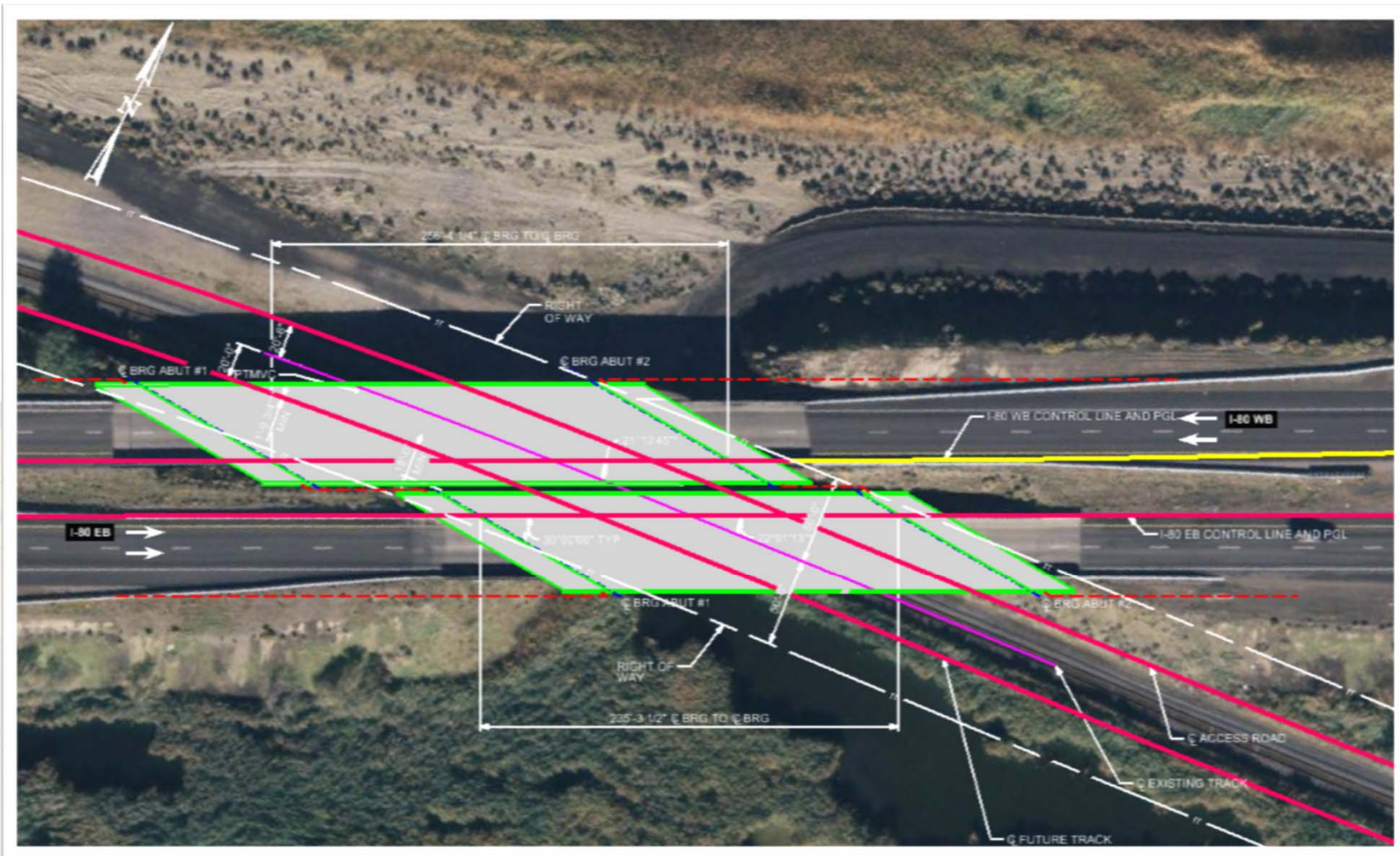
- I-80 over UPRR at Blackrock



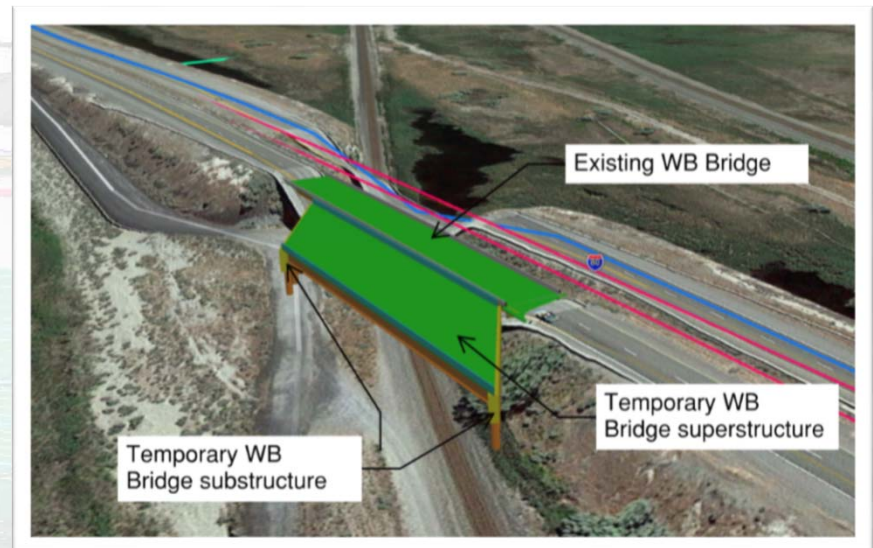
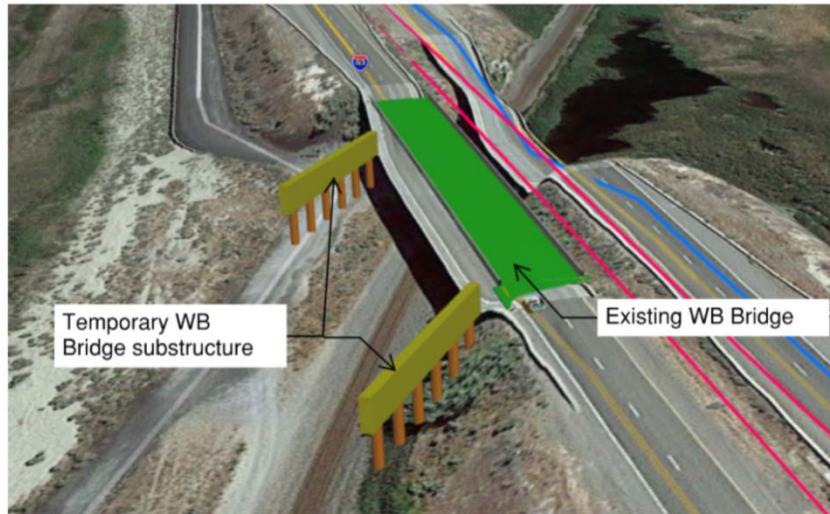
BIM for Bridges and Structures

I-80 Structure Replacement (MP 101 and 99)

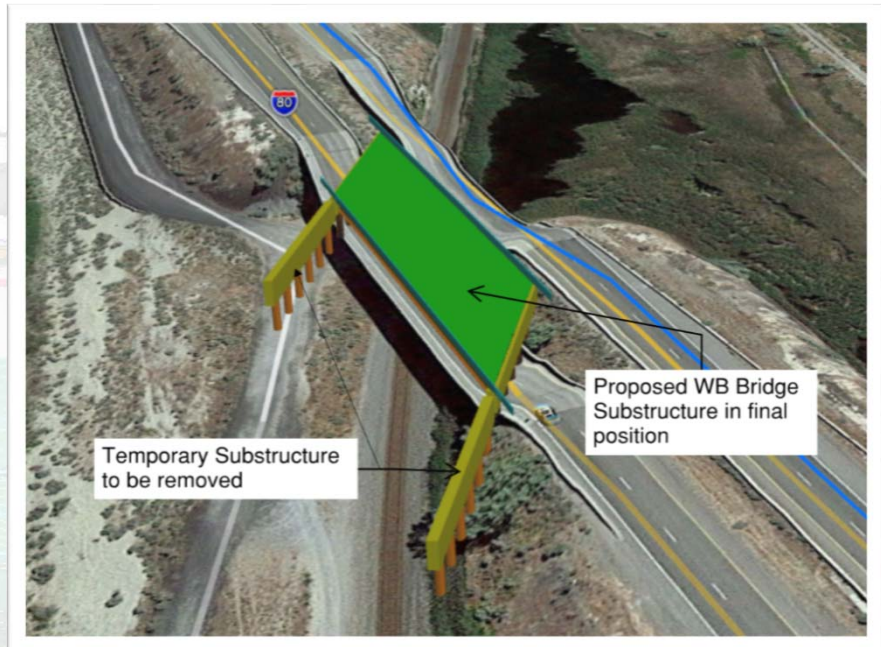
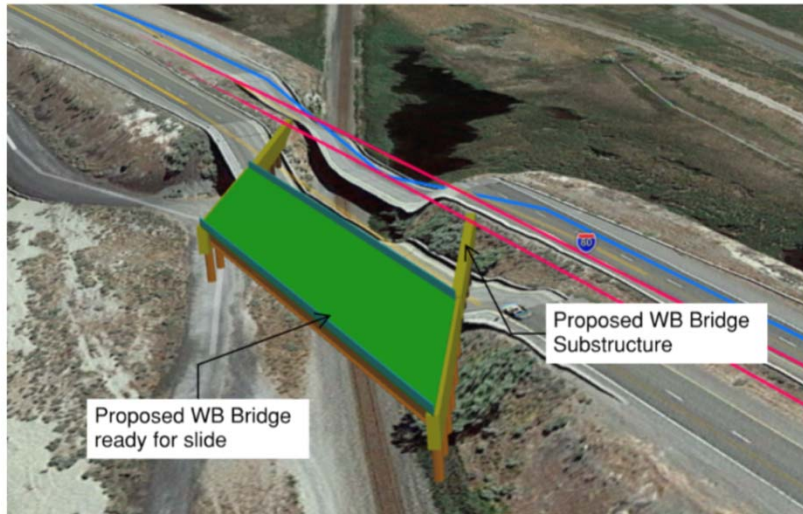
- I-80 over UPRR at Blackrock



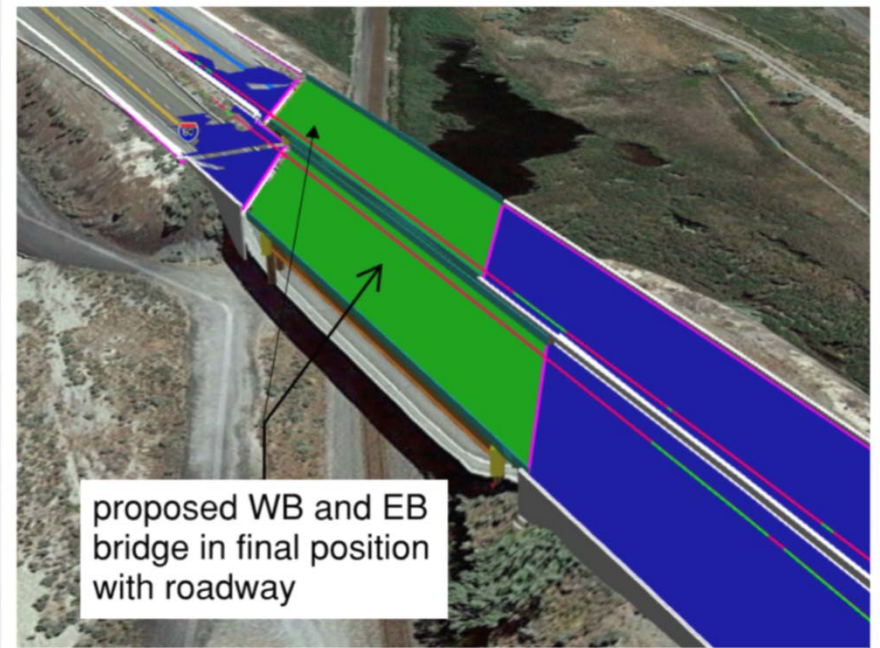
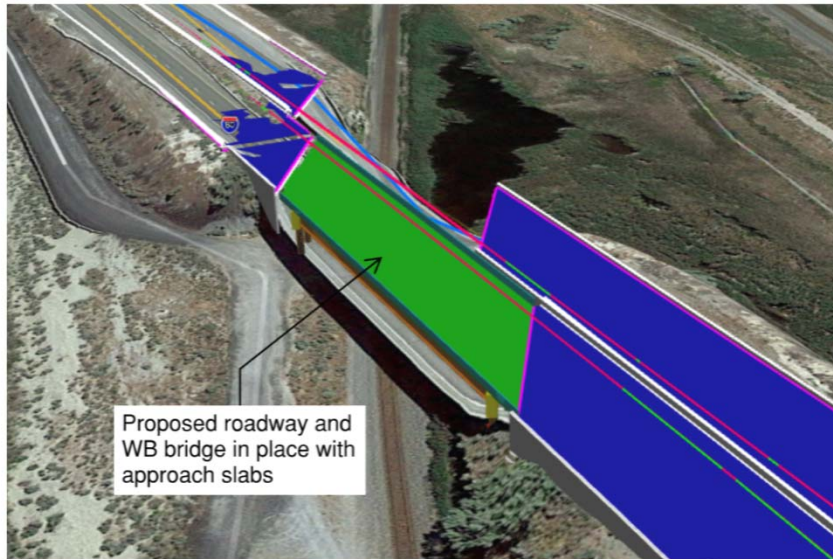
- I-80 over UPRR at Blackrock



- I-80 over UPRR at Blackrock



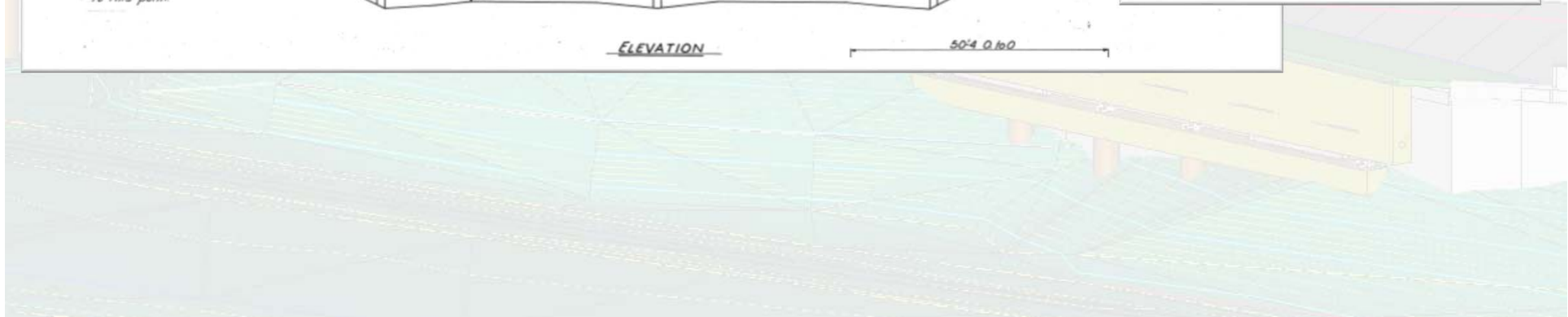
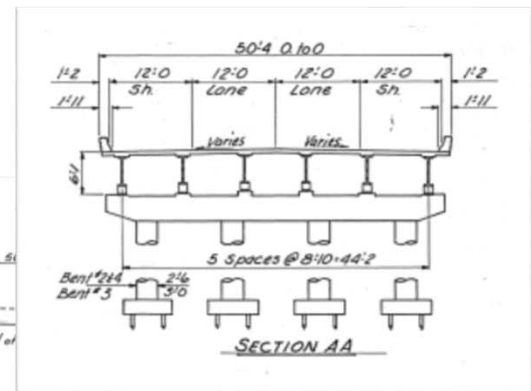
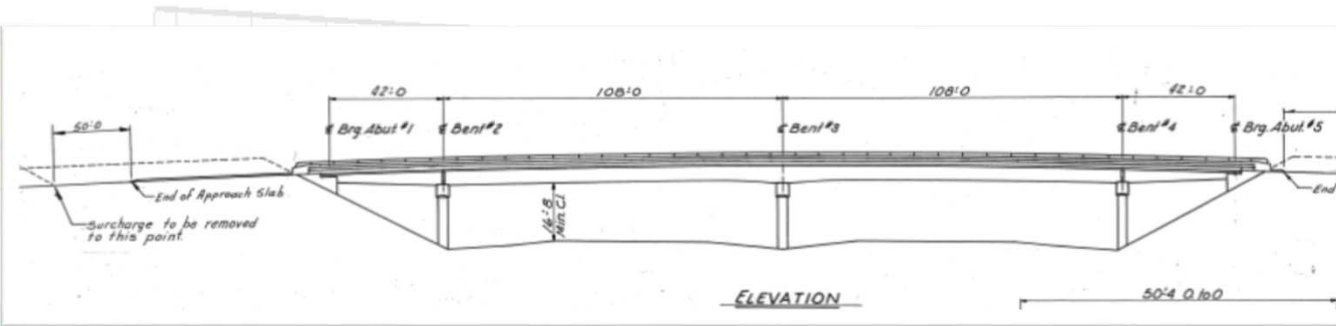
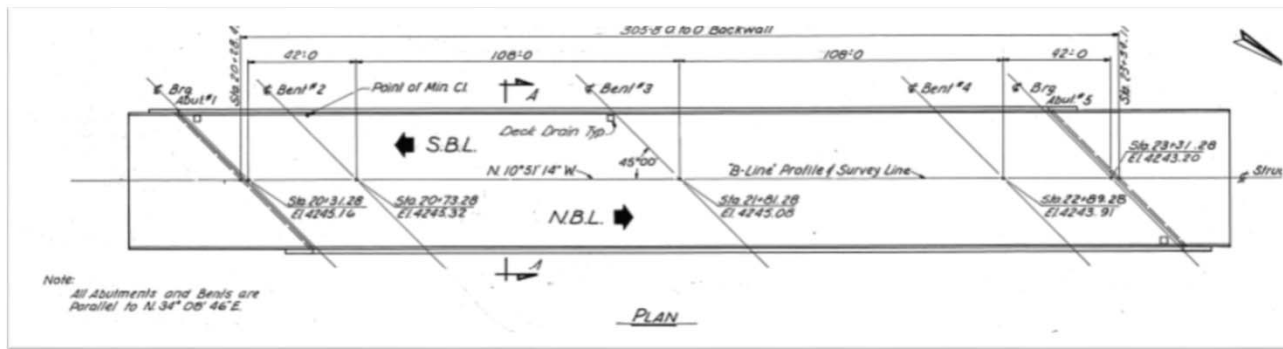
- I-80 over UPRR at Blackrock



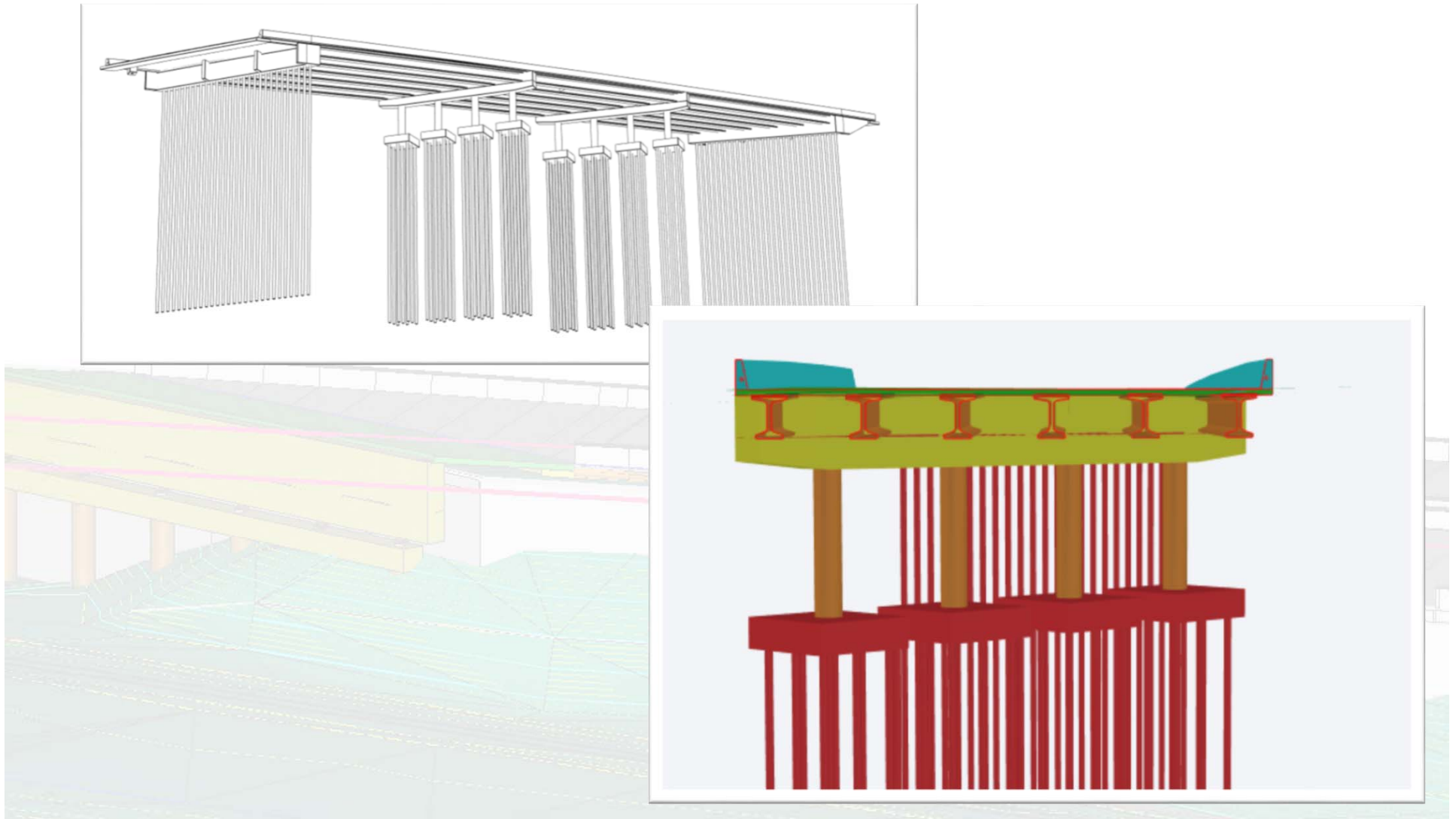
BIM for Bridges and Structures

I-80 Structure Replacement (MP 101 and 99)

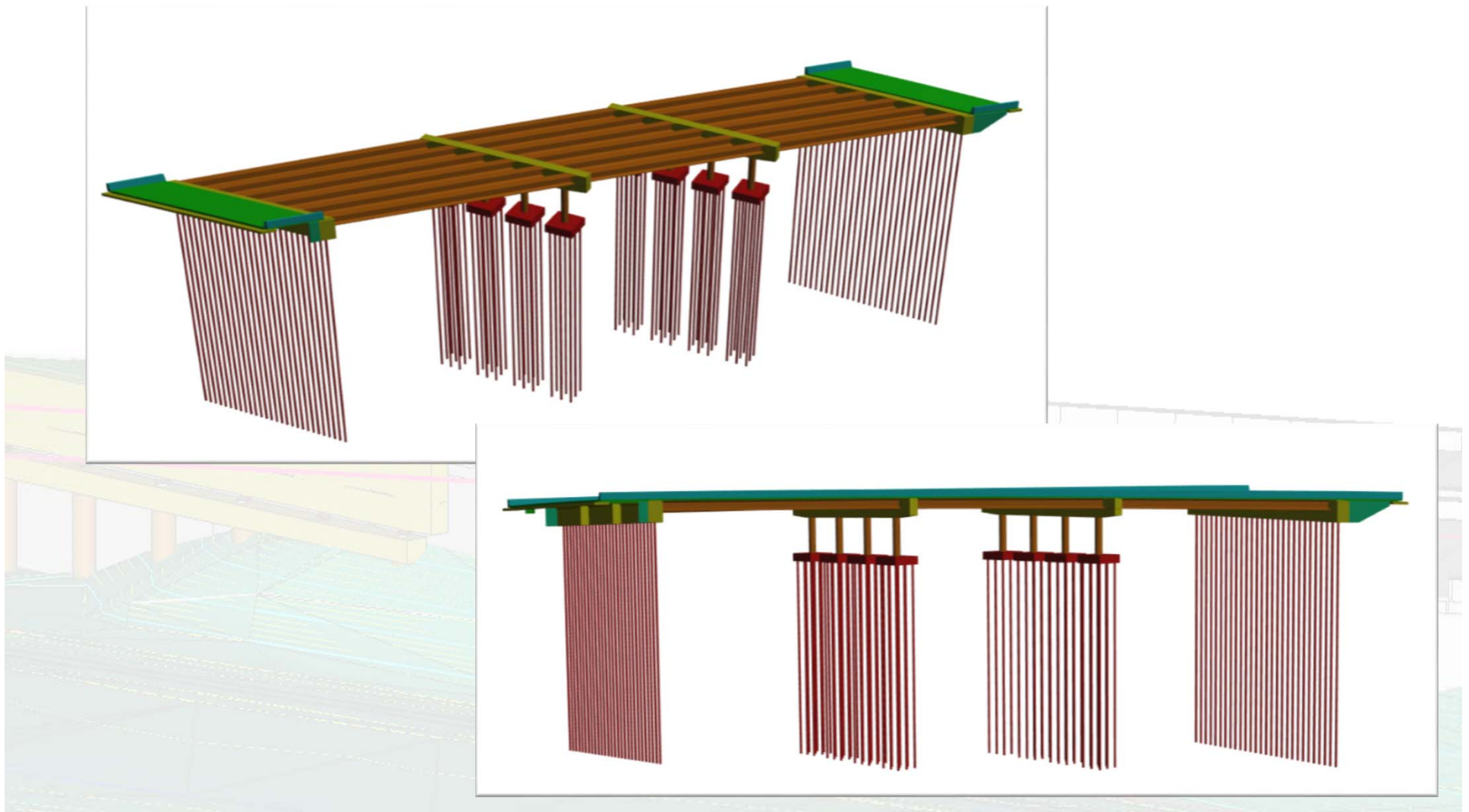
- SR-36 over I-80



- SR-36 over I-80



- SR-36 over I-80



BIM for Bridges and Structures

I-80 Structure Replacement (MP 101 and 99)

- Scope of work

Contract Goals:

- Replace the I-80 Eastbound over UPRR Bridge (2C-438) and the I-80 Westbound over UPRR Bridge (4C-438) including bin walls at Blackrock
- Replace the Tooele Interchange Bridge (0C-583) at Lakepoint
- Minimize impacts to traffic during construction
- Develop an integrated 3D model which includes the geometrics, structures design, and construction planning
- Deliver the project contract documents electronically in conjunction with plan sheets as needed
- Assist the Department to move from document-based information exchanges to integrated data models by developing Bridge Information Model (BrIM) standards, workflow processes, and procedures for design and construction
- Use the BrIM for design, construction, and management of the structures

The Consultant will be responsible for developing an implementation strategy which illustrates support of the Department's goals while ensuring the successful on-time, under budget delivery of the work. The strategy will include communication, integration of all design disciplines to meet the project goals, task distribution, and lessons learned for future efforts.

Aspects to evaluate, but not limited to, in the design process:

- BrIM coordination with other design disciplines
- BrIM development independent of specific software
- Level of detail required
- Inclusion of parametric information
- Design templates for attributes and constraints
- Exchange formats to meet designer's and contractor's needs
- Coordination with the Contractor
- Using BrIM for construction (staging visualization, demolition planning, estimating, scheduling, and fabrication) and inspection
- As-builts incorporated into BrIM

BIM for Bridges and Structures

I-80 Structure Replacement (MP 101 and 99)

- CMGC Contracting
 - Opinion of Probable Construction Cost (OPCC)
 - Early release packages

Black Rock - Single Span - 2 Phase Construction - Slide - Rev 1
TASK filter: All Activities

WB I-80 DETOUR SCHEDULE ASSUMPTIONS

- Bottom of Pile Cap poured prior to detour
- Columns poured prior to detour
- Walls started prior to detour
- Outside fill walls and fills built prior to detour
- Top of Pile Cap poured after start of detour
- Bent Caps to be precast and set after start of detour
- Leaving span slab low so we can pave over with HMA and rebuild in the following spring
- We are using geofram and soil nail walls in UPRR property
- We are using MSE wall outside of UPRR property
- Parapet on prior to detour
- Fence on parapet prior to detour
- Quantities to do in detour:
 - HMA – 4,809 TN
 - UTBC – 2,009 CY
 - GB – 4,017 CY
 - 2,691 CY on West Side
 - 1,326 CY on East Side
 - FILL – 12,587 CY (75% of 17,783 CY)
 - 8,433 CY on West Side
 - 4,144 CY on East Side
- No approach slab other than the one needed to span the w
- Wall facing on UPRR property will be done during detour
- 30 Pile caps about 70' long - driven prior to detour (75' P.A.)

WB I-80 DETOUR SCHEDULE ASSUMPTIONS

PLAN

ELEVATION

LOCATION PLAN

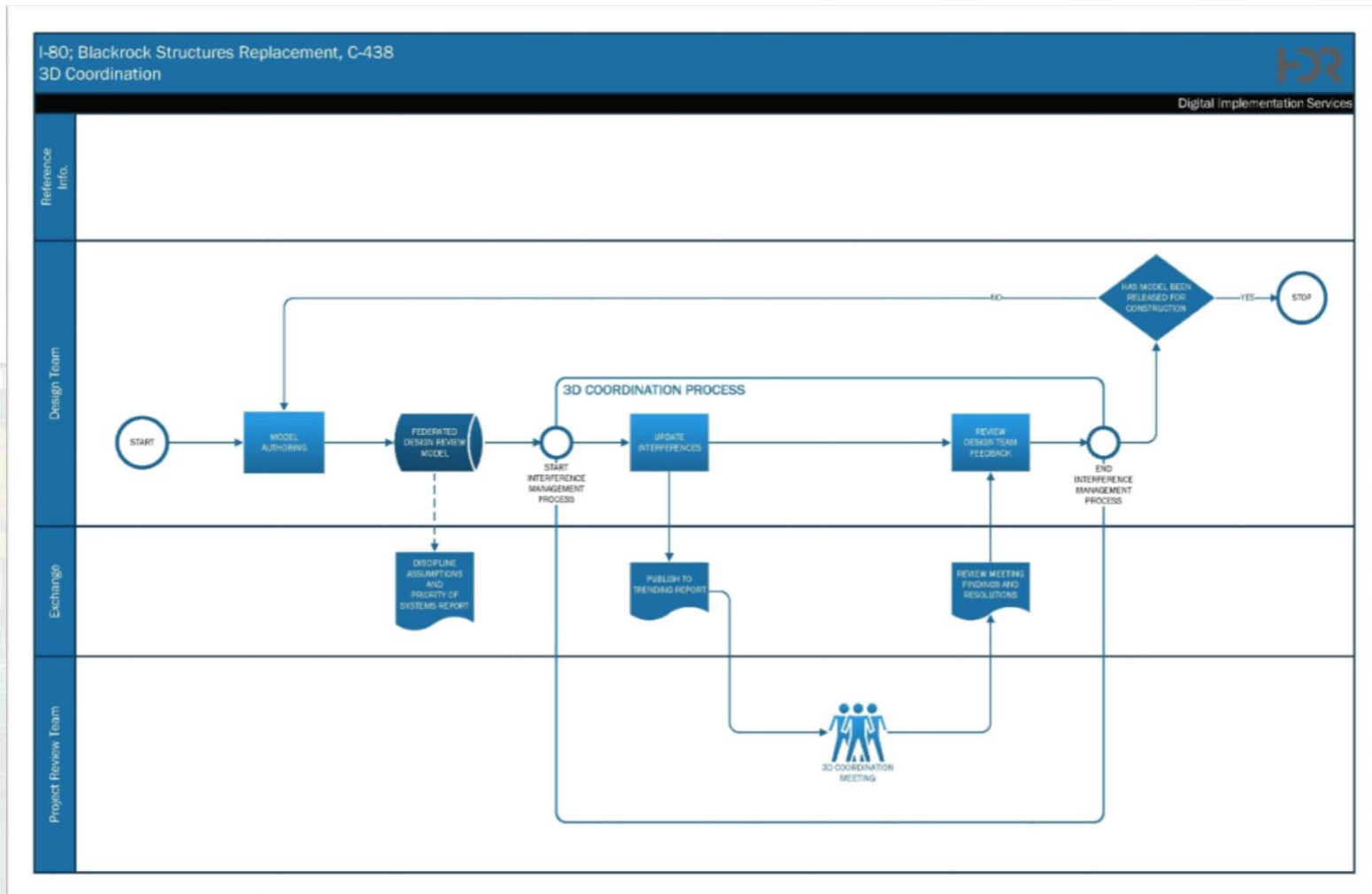
GENERAL NOTES

DESIGN DATA

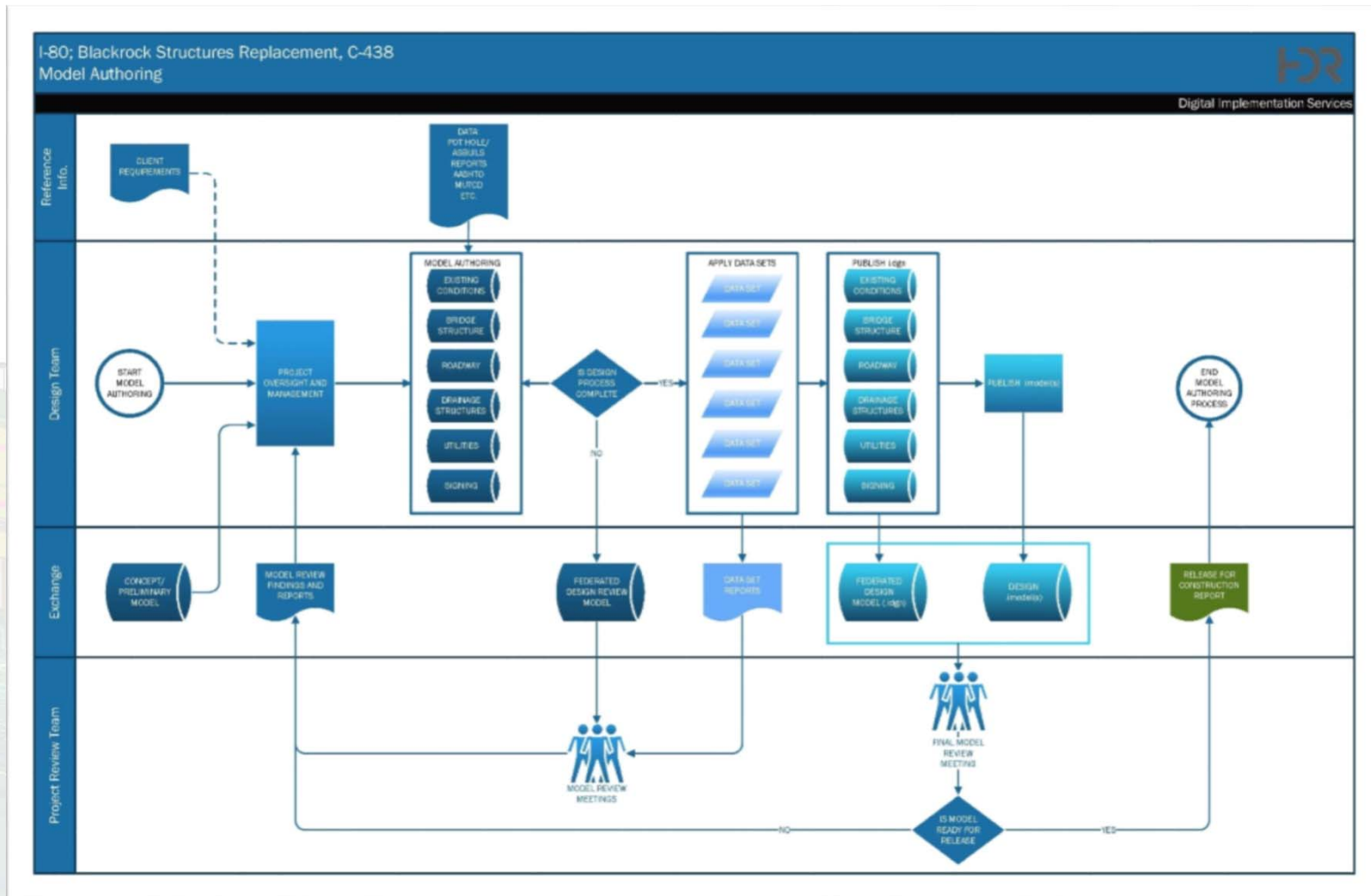
INDEX OF SHEETS

UPPER DIVISION
TRANSPORTATION

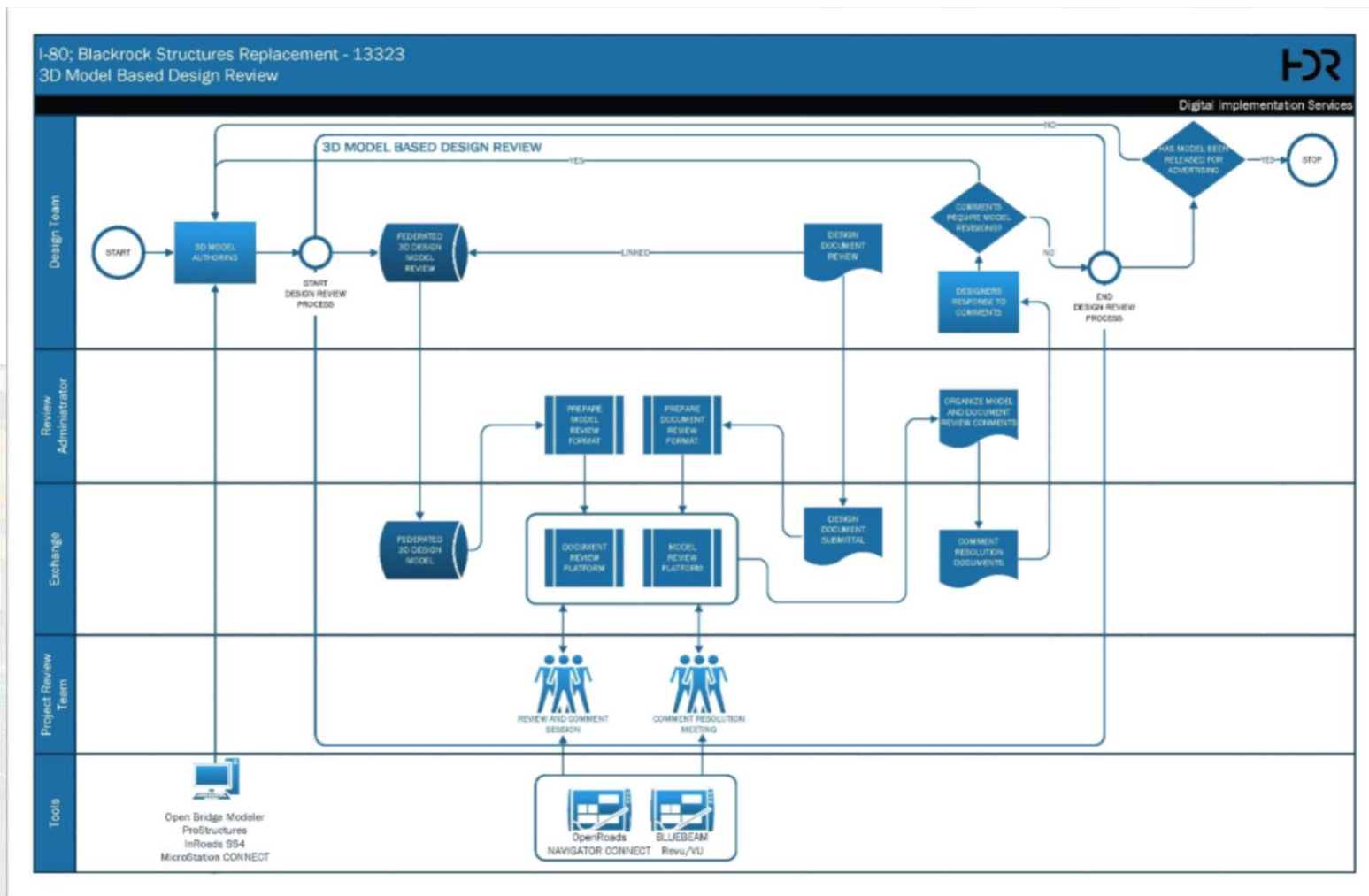
- Execution plan
 - Model coordination



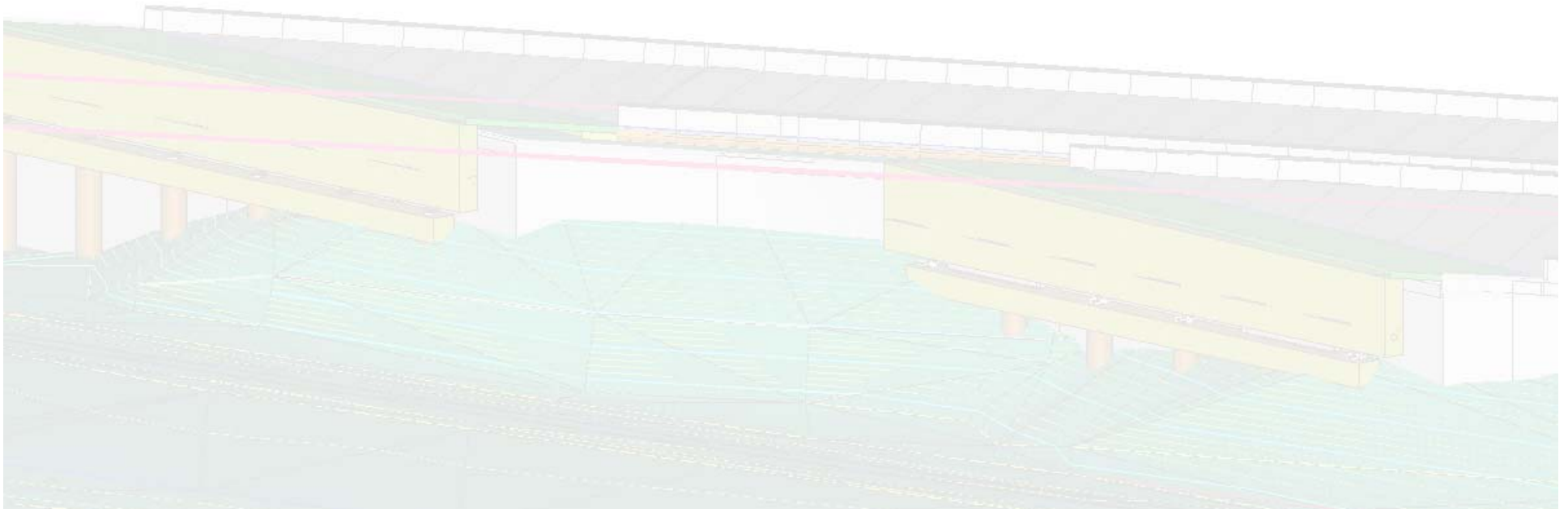
- Execution plan
 - Model authoring



- Execution plan
 - Design review (design review guide)



- Software evaluation
 - Software comparison
 - Exchange formats (designer, fabricator, contractor)
 - Bentley OpenRoads Navigator Connect Edition
 - Bentley Navigator
 - Bentley OpenBridge Modelr v8i
 - Trimble business systems
 - File formats (ifc, xml, dgn, imodel, etc.)

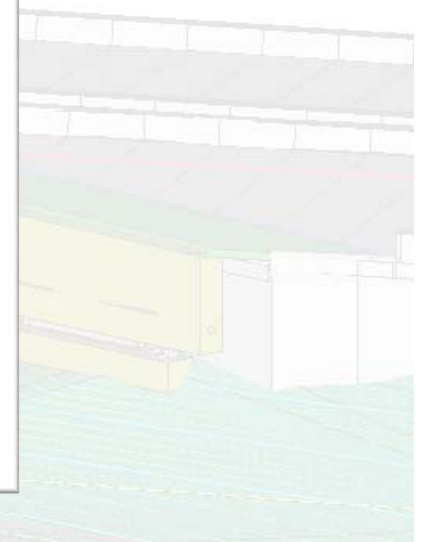
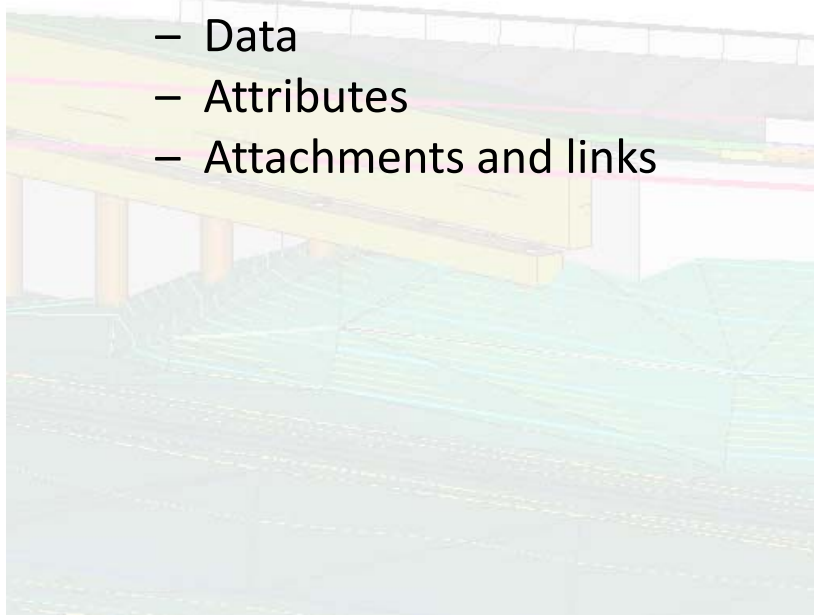


- Design model (progression)

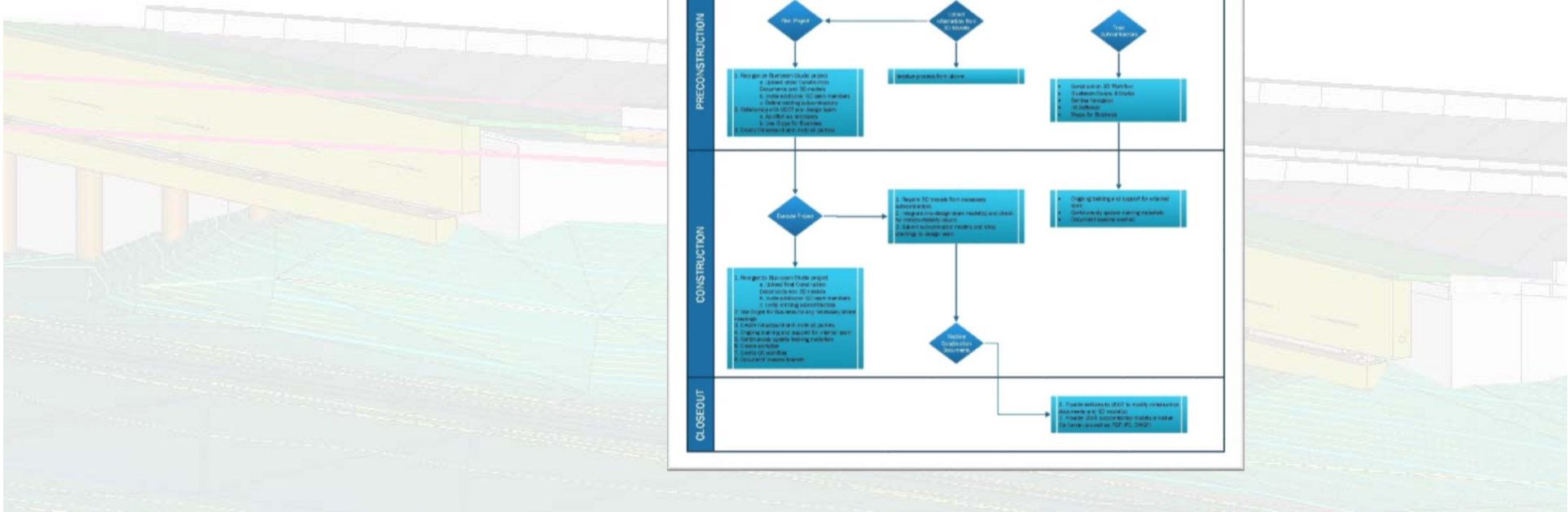
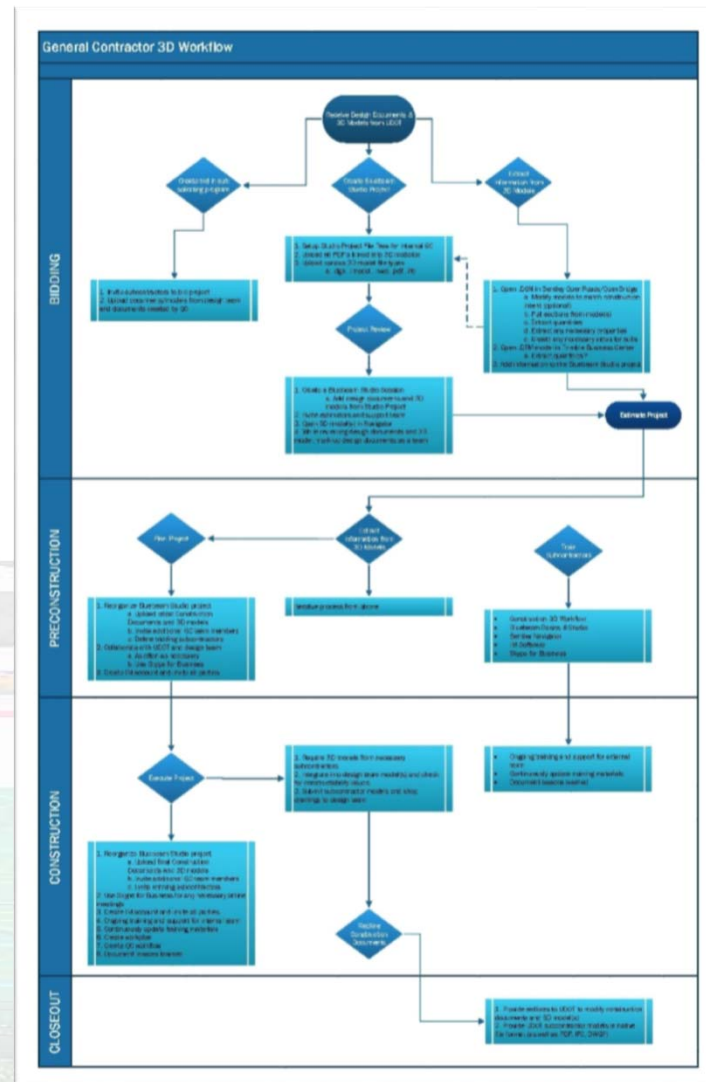
- Discipline coordination
- Feature definitions
- Level of detail
- Elements
- Templates
- Naming conventions
- Layers
- Levels
- Data
- Attributes
- Attachments and links

Bridge Element Breakdown

Element	Geometry	MSP	Details	Notes	NBH	Special Provision
Piles	Data Location Length Top EL Cut off DL Embed Depth Pile Type Header Material prop Pile data table	Data Attachment	Attachment: Pile Details	Attachment	Data	Attachment
Granular Backfill	Data Location Top TL Item EL	Data Attachment	--	--	--	--
Beni Pile Cap	Data Location Top TL Item EL I.W.D Material Prop	Data Attachment	--	--	Data	--
Integral Abutment Pile Cap	Data Location Item EL Bearing Seat TL Material Prop	Data Attachment	--	--	Data	--
Bearings	Data Location Bearing Seat TL Type	Data Attachment	Attachment: Bearing Details	--	Data	--
Steel Girders	Data Location Plate sizes Material Prop	Data Attachment Includes Coating Spec	Attachment: Field Splices Shear Studs Camber (dg) Steel Girder details Welding details Stiffener details Deck/Floor Cover Plate	Attachment	Data	--
Diaphragm/Cross Braces	Data Location Material Prop	Data Attachment Includes Coating Spec	Attachment: Details	--	Data	--
Deck	Data Location Material Prop Thickness Overlay Type & Thickness	Data Attachment	Attachment: Drip Groove Scribed Pour Sequence Joint Details	--	Data	--
Paradeis	Data Location Material Prop Type/Shape	Data Attachment Includes Sealing	Attachment: Panel Details Conduit Details Electrical Details Asphalts Structure Pro.	--	Data	--
Approach Slab	Data Location Overlay Type & Thickness	Data Attachment	Attachment: Catch Basin (Use Rtwy Template) Joint Details	--	Data	--
Sloper Slab	Data Location	Data Attachment	--	--	Data	--
Wingwall/Finwall	Data Location	Data Attachment	--	--	Data	--
Reinforcing Steel	Data Location Bar size Length Splicing Clear distance Bar Mark Bar type Orientation	Data Attachment	Attachment: Bar diagram	Attachment	--	--



- Construction workflow
 - Bidding
 - Preconstruction
 - Construction
 - Closeout



- Review terms and conditions
- Define scope of work

DocuSign Envelope ID: 441E5C47-04E1-46AC-8DA6-12B2506C7FB1

ATTACHMENT B

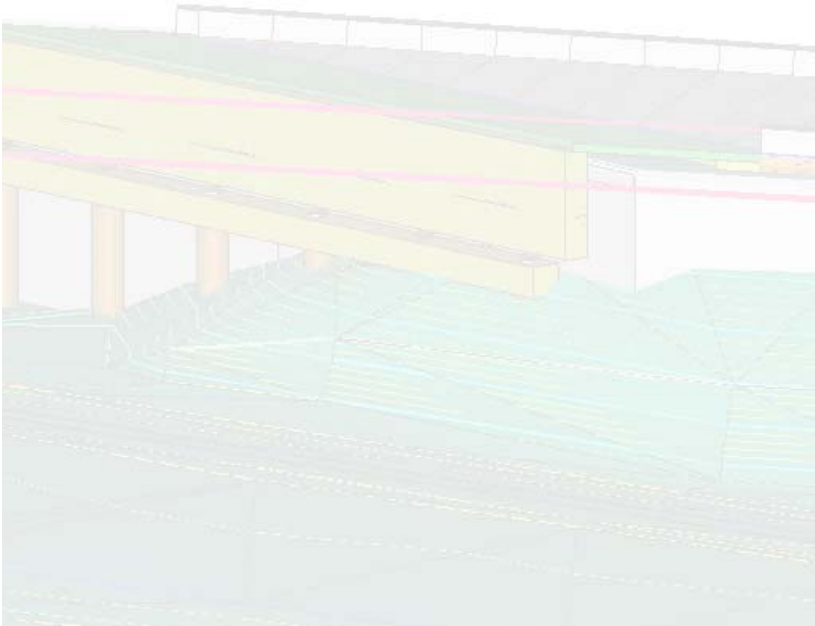
34. POLLUTION CONTROL: The CONSULTANT agrees to comply with all applicable standards, orders, or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671g) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251-1387). The DEPARTMENT shall report violations to the applicable Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA). *(Provision added June 22, 2016.)*

35. ELECTRONIC DESIGN SUBMISSION: All consultants will be expected to adhere to the current DEPARTMENT development standards on the web site. It is the CONSULTANTS responsibility to provide all plans, specifications, surveys, and associated data in the DEPARTMENT acceptable electronic formats into the DEPARTMENT's content management system with the correct attributes assigned. All project data will be organized in the DEPARTMENT'S project directory structure as specified in the DEPARTMENT'S current CADD Standards. It is the CONSULTANT'S responsibility to be aware of all DEPARTMENT requirements and formats. The DEPARTMENT CADD standards are available at the CADD Support sub-page of the DEPARTMENT website www.udot.utah.gov/go/cadd. Computer Aided Drafting and Design acceptable formats are as follows.

- (a) Drafting: MicroStation Design format (.dgn) by Bentley Systems Inc., version 8.9 or higher (v8 file format).
- (b) Civil Design: InRoads by Bentley Systems Inc. version 8.9 or higher acceptable formats are as follows: Geometry files (.alg), Surface or digital terrain models (.dtn), Template libraries (.tli), Roadway Designer files (.ird), and Open Roads technology files (.dgn).
- (c) Survey and Photogrammetry: InRoads Survey format (.fwd) or Open Roads technology file format (.dgn) by Bentley Systems Inc. version 8.8 or higher. Raw survey files will be in ASCII format, (point number, Northing, Easting, Elevation and code). Survey points will be coded using the DEPARTMENT feature codes located in the DEPARTMENT preference file (.xin) and Raster Images (aerial photos) will be in MicroStation compatible formats. Design and Survey work will adhere to the DEPARTMENT CADD Standards and "Mapping & Aerial Photogrammetry" Guide.
- (d) Plotting: In order for the project to be republished by the DEPARTMENT, the CONSULTANT will prepare a file to direct the DEPARTMENT's plotting software, InterPlot, by Bentley Systems Inc. to produce the correct output. This is the InterPlot Organizer's plot-set file (filename.ips). This file contains specifications for each sheet in the plan set and controls the order and name of each sheet as they will appear in the PDF plan set. Instructions for preparing this file can be found at the DEPARTMENT CADD Support website as stated above.
- (e) Responsibility: Region Designers/Consultants, Action - When submitting electronic files for advertising, Region or consultant designers must deliver to the DEPARTMENT the design files in the DEPARTMENT's content management system in the established project directory structure. The following files must be included in the submittal: 1) Major design files, including roadway design, structure, striping, signing, signals, and profiles (Microstation format), 2) Existing topography and existing utilities (Microstation format), 3) Existing and proposed surfaces (dtn or dgn format), 4) InRoads alignments (alg or dgn format), templates (tli), roadway designer files (ird or dgn format) and preference files (xin), 5) Configuration and resource files including font and linestyle resource files.
- (f) Placement: Action - Project data must be delivered to the DEPARTMENT in the DEPARTMENT's content management system in the established project directory structure. All documents must be attributed correctly in the system.

The CONSULTANT will be responsible for the accuracy of the translated data.

Technical and Standards support will be provided to the CONSULTANT through the Design and Standards Group of the Project Development Division at the DEPARTMENT. *(Provision revised June 22, 2016.)*





Advertising

- Project Development Bid System (PDBS) – Masterworks
- Project Explorer
 - Survey and control of work specifications
 - Certified letter by Engineer of Record (EOR)
 - File descriptions



Project No.: F-I70-1(94)49
 Project Name: I-70; Sigurd Interchange to Salina
 Rehabilitation High Volume
 County: SEVIER
 Advertising Date: JAN 20, 2018
 Bid Opening Date: FEB 27, 2018

THIS PROJECT REQUIRES USING THE ELECTRONIC CERTIFIED PAYROLL PROGRAM. SEE ATTACHMENT TO NOTICE TO CONTRACTORS. THIS IS A WORKING P&T (PRICE + TIME) PROJECT. ELECTRONIC 3D CADD FILE/MODELS PROVIDED ON PROJECT EXPLORER.

DBE Goal:5% Wage Rates: APPLY

Engineer's Estimate:
Greater than \$1.5M but less than \$3M
(QUALIFIED HEALTH INSURANCE REQUIRED)
Project Manager: (Primary Contact During Advertising)
WALL UDOT, AARON
Resident Engineer:
 Monroe, Devin M. (435)893-4767

3D CADD files provided for information only
 3D CADD Files
 3D CADD Legal Files

DOWNLOAD SECTION
 EBS Bid Items
 (Bid Items Download Instructions)

Click on Submit Bids below to login to Electronic Bidding.

Submit Bid

If the page does not load, Make sure to enable JavaScript

Project Documents | Plan Holders | Addendums (2 available)

FILE NAME	DESCRIPTION	DATE & TIME
SP-20 MAINLINE DATA		
S&D_Existing_Ground_10-8-13.dwg / .xml	Existing terrain and ground for all modeled data	1/8/2018 3:42 PM & 8:40 PM
S-20_Altitude_Alg	Alignment File for the Design Data	1/7/18 2:25 PM
DT_MESH_SP-20_MAINLINE.dwg / .xml	Design Top Surface of the Mainline Corridor	1/9/2018 10:43 AM & 10:53 AM
DT_MESH_SP-20_MAINLINE.dwg / .xml	Design Bottom Surface of the Mainline Corridor	1/9/2018 10:42 AM & 10:47 AM
US-20 ACCESS ROAD		
S-20_ACCESS_Alg	Alignment File for the Road	1/9/2018 2:28 PM
DT_MESH_US-20_ACCESS.dwg / .xml	Design Top Surface of the Access Road	1/9/2018 10:38 AM & 10:39 AM
DT_MESH_US-20_ACCESS.dwg / .xml	Design Bottom Surface of the Access Road	1/9/2018 10:38 AM & 10:37 AM
MAINTENANCE TURN AROUND DATA		
UNBOUND_Alg	Alignment File for the Turnaround	1/9/2018 10:38
DT_MESH_TURNAROUND.dwg / .xml	Design Top Surface of the Access Road	1/9/2018 11:05 AM & 11:05 AM
DT_MESH_TURNAROUND.dwg / .xml	Design Bottom Surface of the Access Road	1/9/2018 11:03 AM & 11:03 AM
DRAINAGE DATA		
S-20_Altitude_Alg	Alignment File for the Shoulder Aggregate Data	1/7/18 2:28 PM
DT_MESH_S&D_Alg.dwg / .xml	Design Top Surface of the Shoulder Aggregate	1/9/2018 11:47 AM & 11:49 AM

FileName	Created	Updated
13359_Eastbound Alignment.xml	27-DEC-17	09-FEB-18
13359_Westbound Alignment.xml	27-DEC-17	09-FEB-18
13359_Westbound EOP Inside Alignment.xml	27-DEC-17	09-FEB-18
I-70_Westbound Design Surface Triangles.xml	27-DEC-17	09-FEB-18
13359_Eastbound_Westbound Design Surface Triangles.dgn	27-DEC-17	09-FEB-18
Tx17220.00 - I70 Sigurd Interchange-Salina.dwg	27-DEC-17	09-FEB-18
13359_DESIGN.dxf	27-DEC-17	09-FEB-18
13359_Existing Surface Triangles.dxf	27-DEC-17	09-FEB-18
13359_Model Feature Lines.dgn	27-DEC-17	09-FEB-18
13359_Existing Surface Triangles.dgn	27-DEC-17	09-FEB-18
13359_DESIGN.dgn	27-DEC-17	09-FEB-18
13359_Model Feature Lines.dxf	27-DEC-17	09-FEB-18
13359 Eastbound EOP Inside Alignment.xml	27-DEC-17	09-FEB-18
13359_Existing Surface Triangles.xml	27-DEC-17	09-FEB-18
13359_EXTPO.dxf	27-DEC-17	09-FEB-18

1 - 15 Next >

February 1, 2017

SPECIAL PROVISION

PROJECT # F-I70-1(88)37
PIN # 14277

SECTION 01721S

SURVEY

Delete Section 01721 and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Construction surveying, staking, measurement, and calculations essential to complete the project and properly control the entire work.

B. Directed surveying.

C. Processes and procedures for implementing Machine Control Guidance (MCG) technology. MCG uses Global Positioning System (GPS) and Robotic Total Station (RTS) in conjunction with three-dimensional computer models to determine the precise location and elevation of the material layers, sub-grade, granular borrow, UTBC, HMA and SMA.

1.2 RELATED SECTIONS

A Section 02765: Pavement Marking Paint

- Capture project lessons learned
- Develop project delivery manual for MBDC
- Develop construction inspection manual for MBDC
- Provide training
 - ORN Learning Series 01: <https://youtu.be/2ZQA5z3iKT4>
 - ORN Learning Series 02: https://youtu.be/A_xxL1D5Y3I
 - ORN Learning Series 03: <https://youtu.be/zmxy7eA8s3Q>
 - ORN Learning Series 04: <https://youtu.be/ivwrlMkbVZ4>
- Provide hardware and software
- Partner with software developers



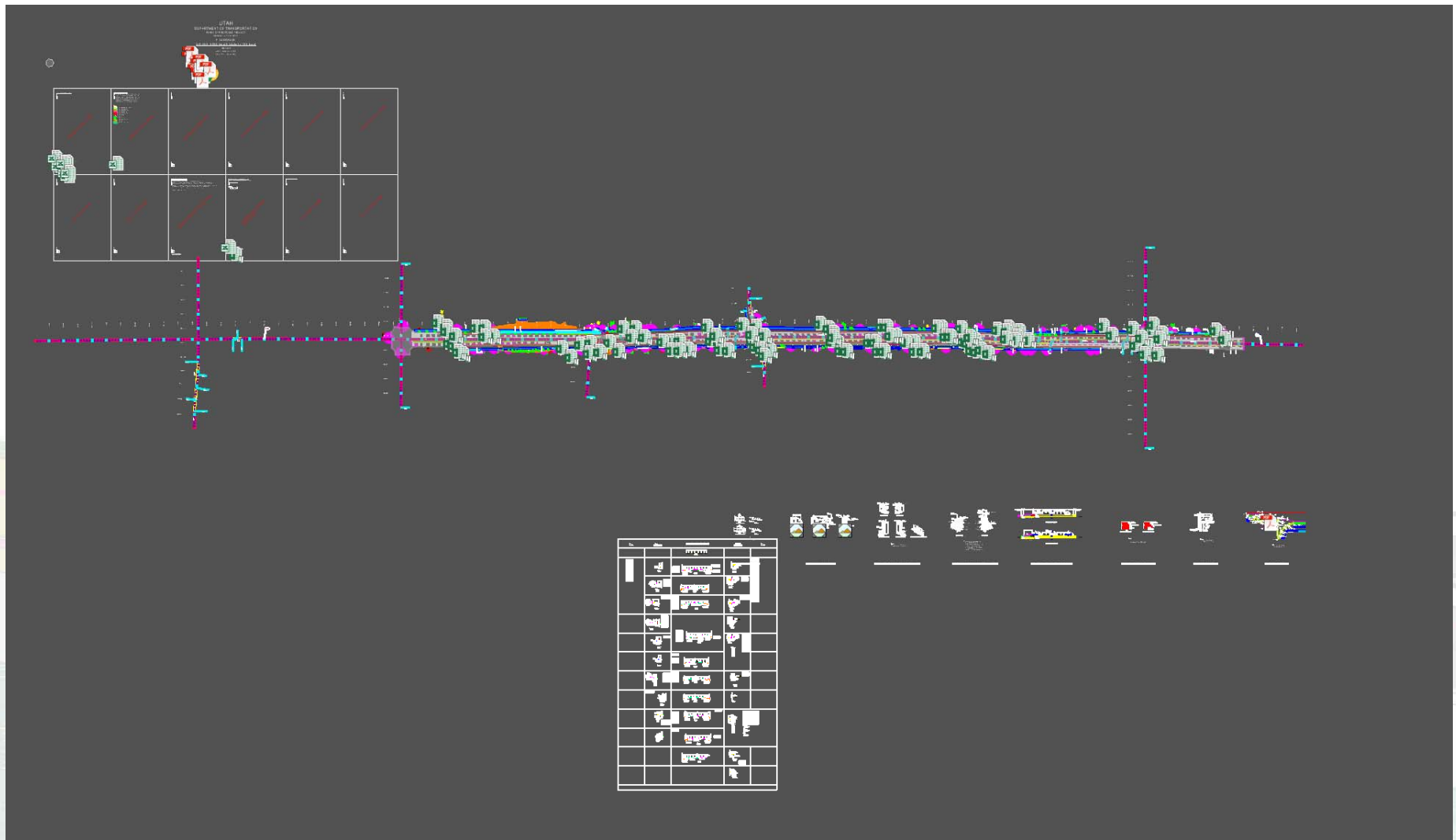
INTELLIGENT DESIGN & CONSTRUCTION GUIDANCE DOCUMENT

March 2017

Prepared For:
Utah Department of Transportation
Preconstruction Division

Submitted By:
Lochner, Inc.
3995 S. 700 E. Suite 450,
Salt Lake City, UT 84107

Authored By:
George Lukes - UDOT
Jim McDowell - Lochner





Project Example

UTAH

DEPARTMENT OF TRANSPORTATION

PLANS OF PROPOSED PROJECT

FEDERAL AID PROJECT

F-0209(42)8

SR-209; 9000 South State to 700 East

PIN: 13578

SALT LAKE COUNTY

LENGTH 1.10 MILES

GENERAL PROJECT LINKS

- [SPECIAL PROVISIONS](#)
- [MEASUREMENT AND PAYMENT](#)
- [ALIGNMENT REPORT](#)
- [2017 UDOT STAKEHOLDERS WEBSITE](#)
- [SURVEY CONTROL](#)
- [SUMMARY OF ITEMS](#)
- [TYPICAL SECTIONS](#)
- [ROADWAY DETAILS](#)
- [DRAINAGE DETAILS](#)
- [PAY ITEM INFO](#)

STRUCTURE LINKS

- [VMS PLAN SHEETS](#)
- [VMS FOUNDATION SPEC](#)

RIGHT OF WAY LINKS

- [RIGHT OF WAY PLAN SHEETS](#)



Project Example

GENERAL PROJECT LINKS

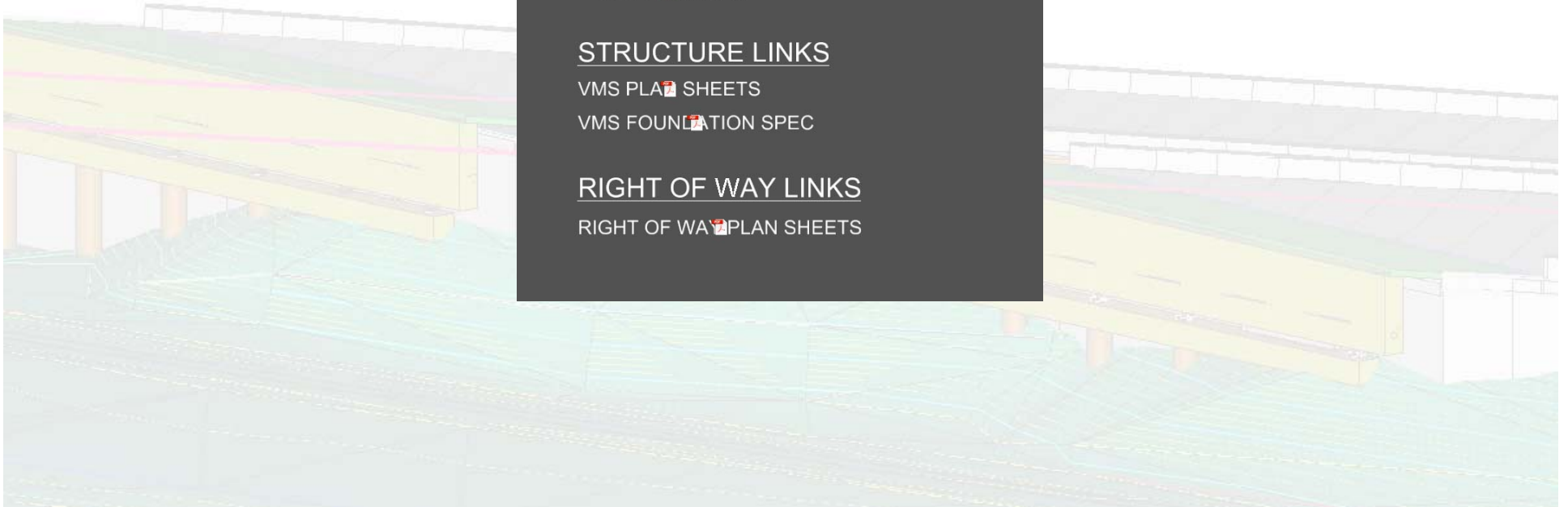
SPECIAL PROVISIONS
MEASUREMENT AND PAYMENT
ALIGNMENT REPORT
2017 UDOT STANDARDS WEBSITE
SURVEY CONTROL
SUMMARY OF ITEMS
TYPICAL SECTIONS
ROADWAY DETAILS
DRAINAGE DETAILS
PAY ITEM INFO

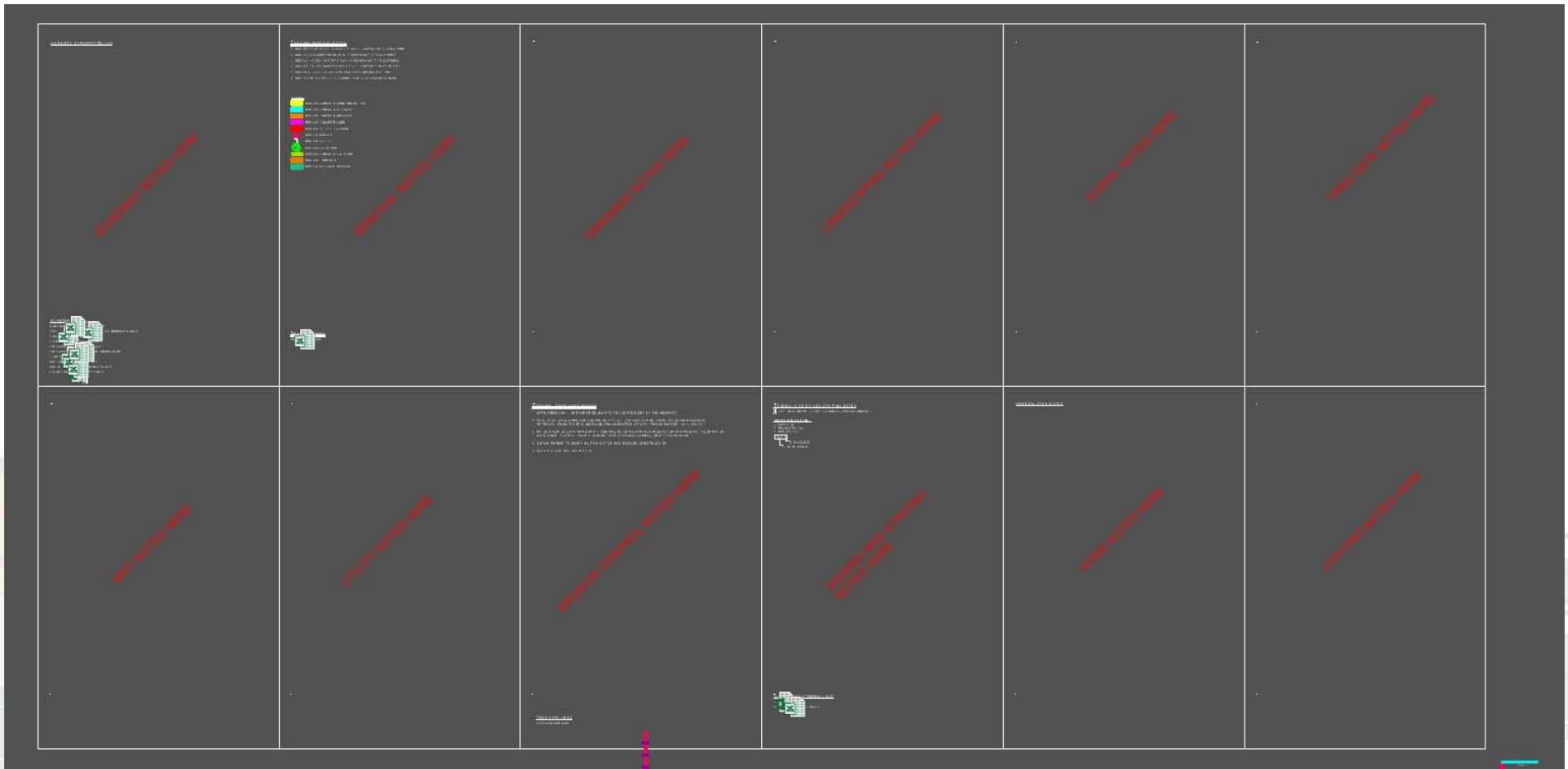
STRUCTURE LINKS

VMS PLAN SHEETS
VMS FOUNDATION SPEC

RIGHT OF WAY LINKS

RIGHT OF WAY PLAN SHEETS





ROADWAY LINKS

EARTHWORK SUMMARY SHEET

DUST CONTROL AND WATERING SUMMARY SHEET

SURFACING SUMMARY SHEET

CONCRETE SUMMARY SHEET

DRIVEWAY SUMMARY SHEET

DRIVEWAY SUMMARY SHEET DIMENSIONS

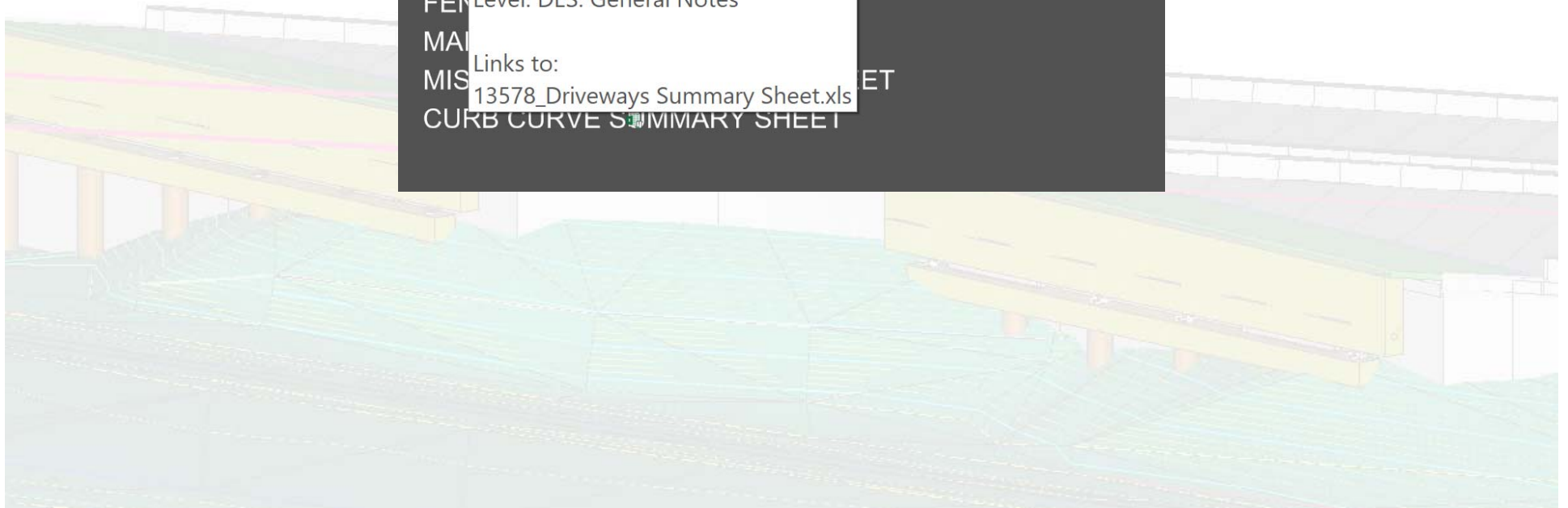
FENCE SUMMARY SHEET

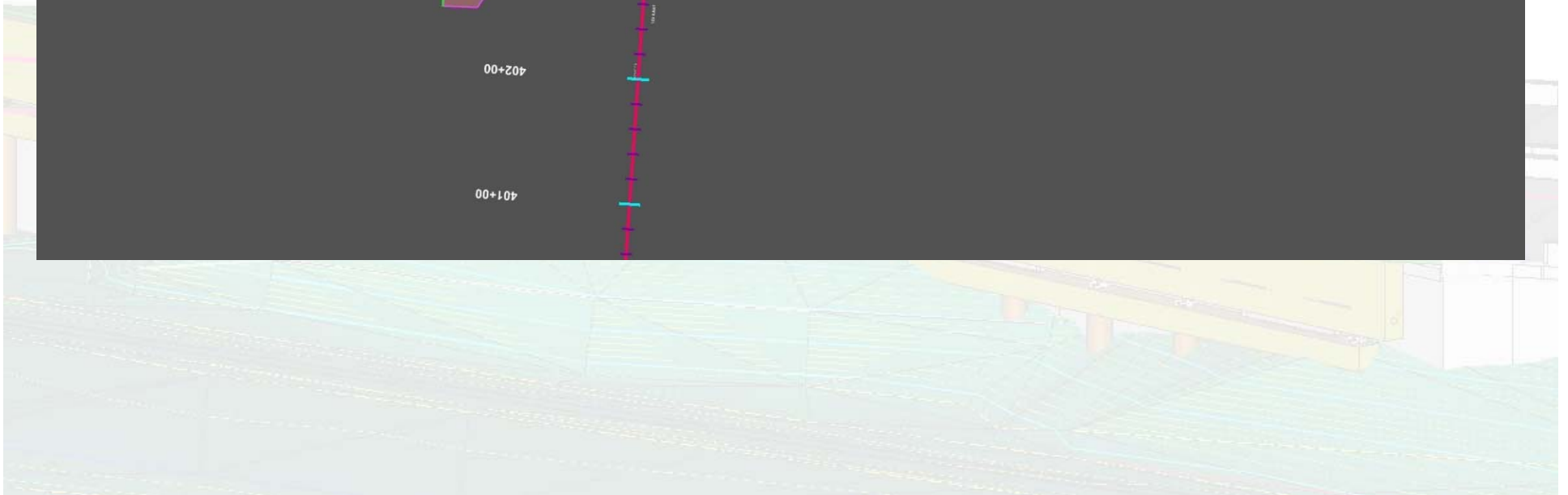
MAINTENANCE

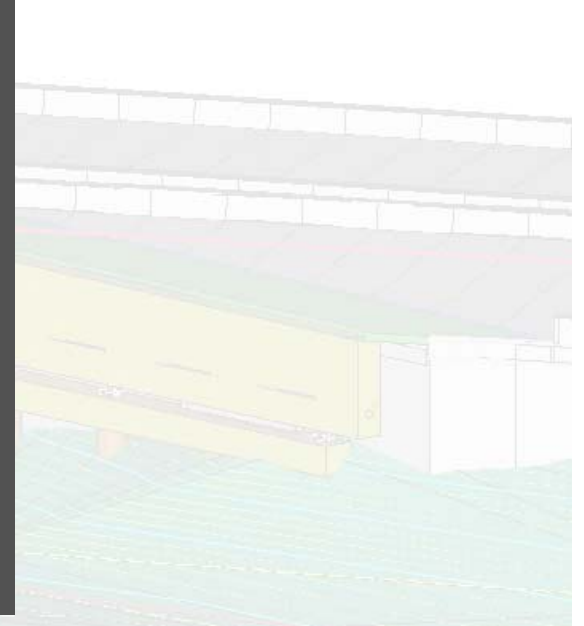
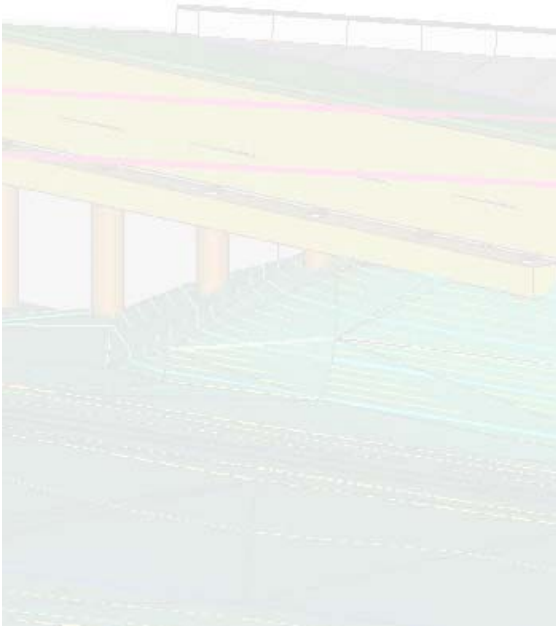
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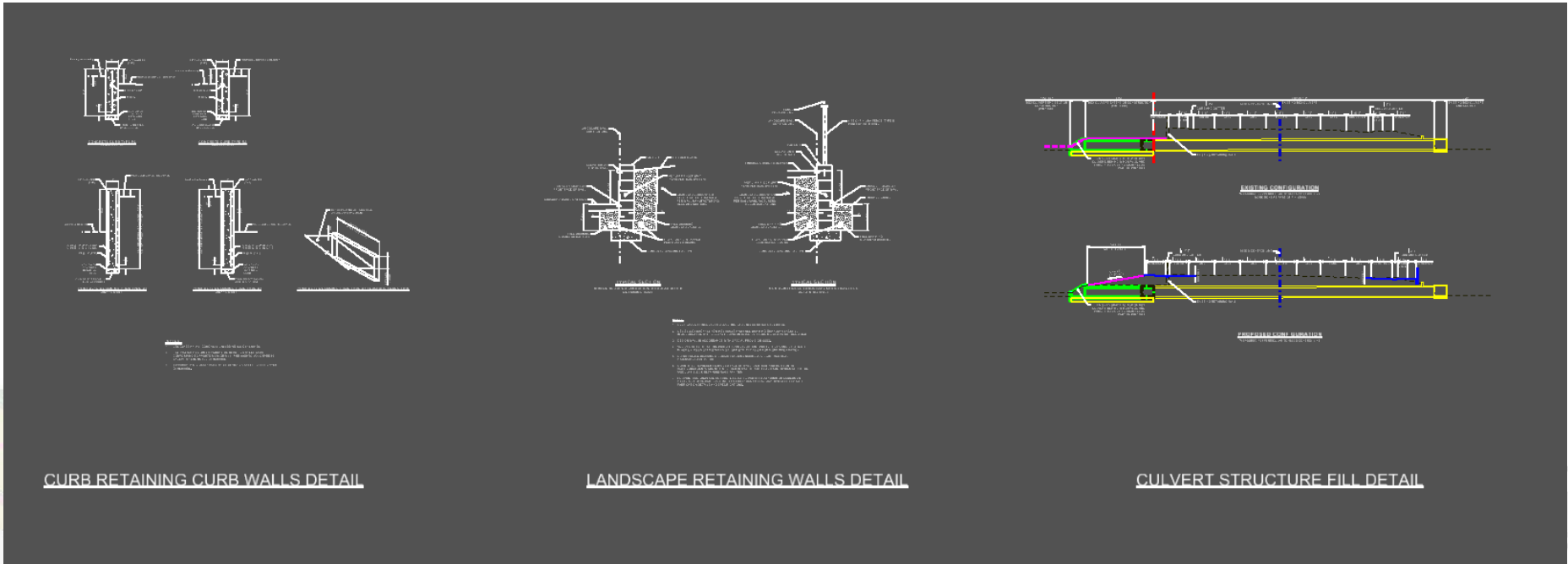
MISCELLANEOUS SUMMARY SHEET
[13578_Driveways Summary Sheet.xls](#)

CURB CURVE SUMMARY SHEET





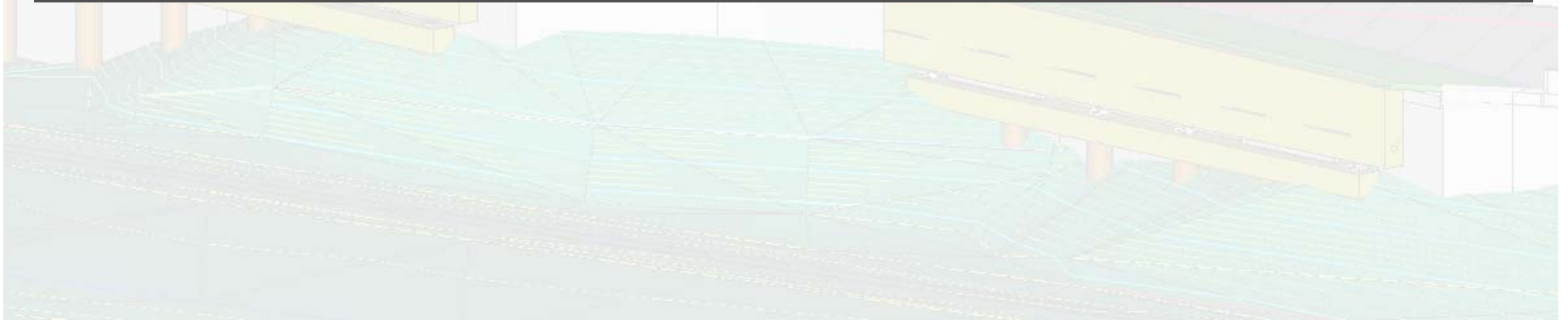




CURB RETAINING CURB WALLS DETAIL

LANDSCAPE RETAINING WALLS DETAIL

CULVERT STRUCTURE FILL DETAIL



Thank You

Carmen Swanwick

UDOT Chief Structural Engineer and Deputy Project Development Director

February 2018

