3D Engineered Models
at
Florida Department of Transportation

Matt Sexton, FDOT

CADD Applications Support Specialist

3D Integrated Modeling – future

Session Summary:

- Brief FDOT CADD/Industry History
- When to deliver 3D Engineered Models?
- QA and QC as defined by FDOT
- QC review on the Model, checklist and tools
- 3D deliverables and Intelligent Design Models

History and Background:

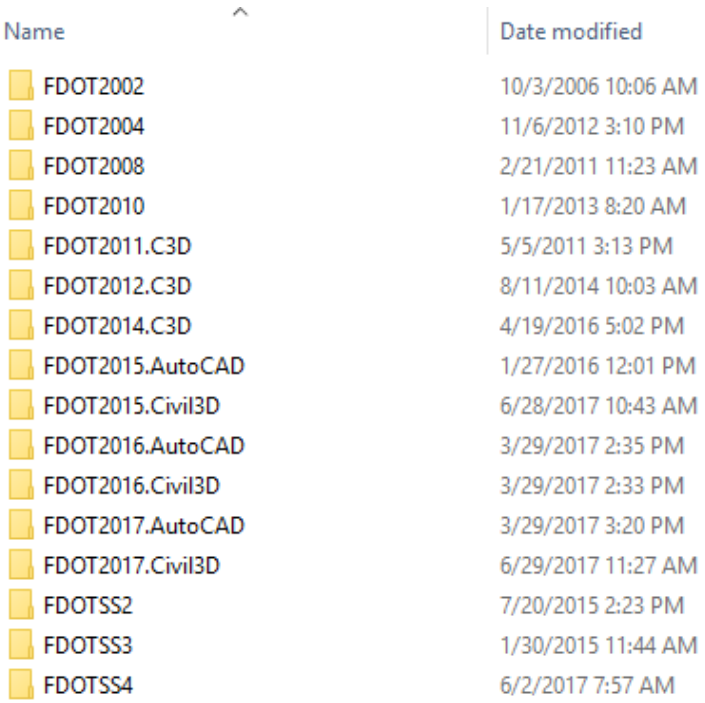
- FDOT – legacy software GEOPAK/MicroStation (2D plan based)
- 2008 FDOT Open CADD Platform GEOPAK/MicroStation and Civil3D/AutoCAD
- 2009 FDOT Corridor Modeling (model for Cross sections)
- 2013 FDOT – OpenRoads SS4, Civil3D (3D model based for designing models and plans)

- Contractors – making models from plans ??? Ugh!
- Consultants – plans AND models, oh my!
- Statewide 3D Task Team (Districts Engrs, Consultants, Contractors, etc.)
- FHWA – EDC , Other State DOT's

History and Background:

Bentley Workspaces and

Civil3D State Kits:



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FDOT2015.AutoCAD	1/27/2016 12:01 PM
FDOT2015.Civil3D	6/28/2017 10:43 AM
FDOT2016.AutoCAD	3/29/2017 2:35 PM
FDOT2016.Civil3D	3/29/2017 2:33 PM
FDOT2017.AutoCAD	3/29/2017 3:20 PM
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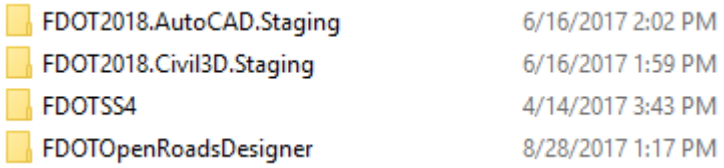
FDOTSS3	1/30/2015 11:44 AM
FDOTSS4	6/2/2017 7:57 AM

In development:



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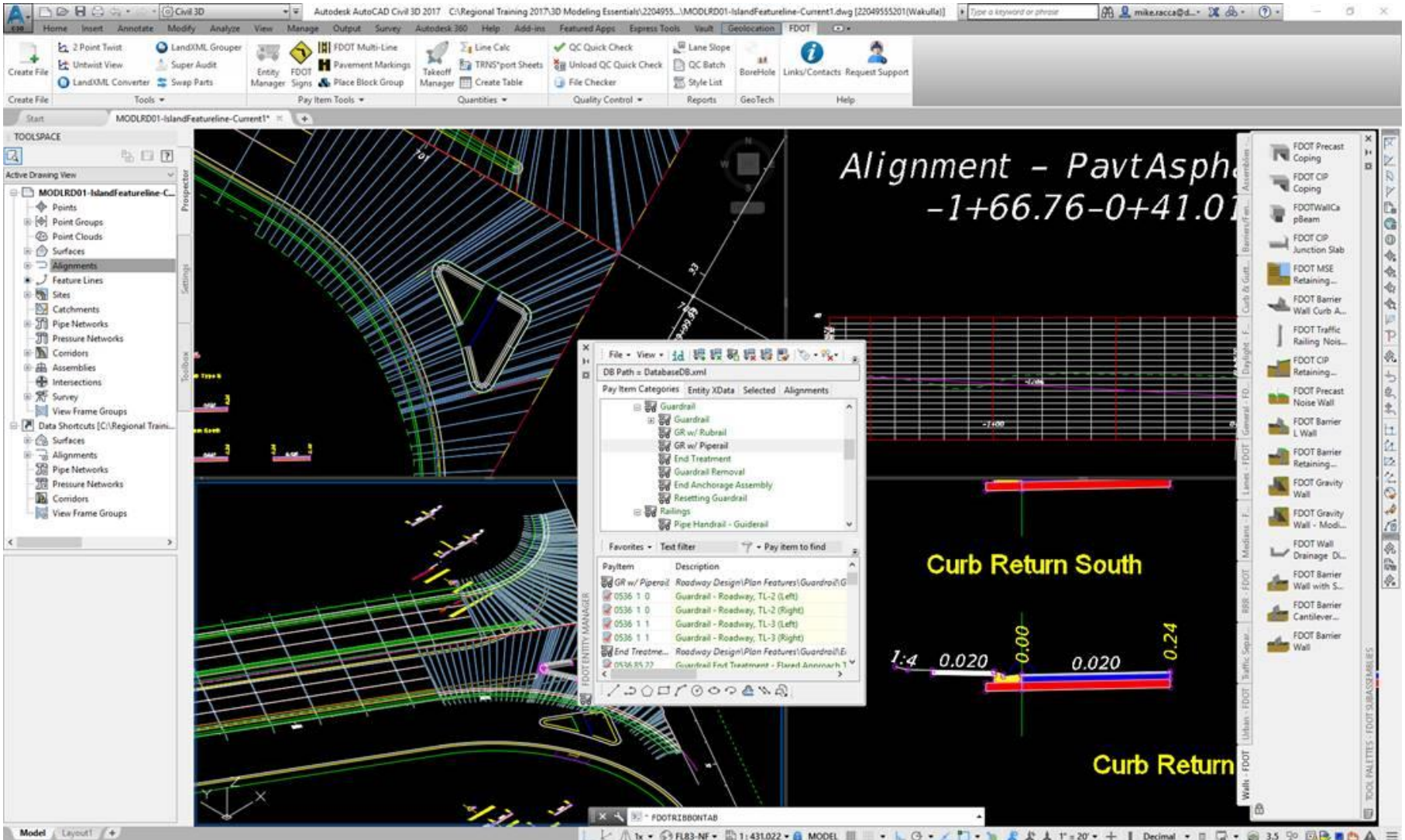
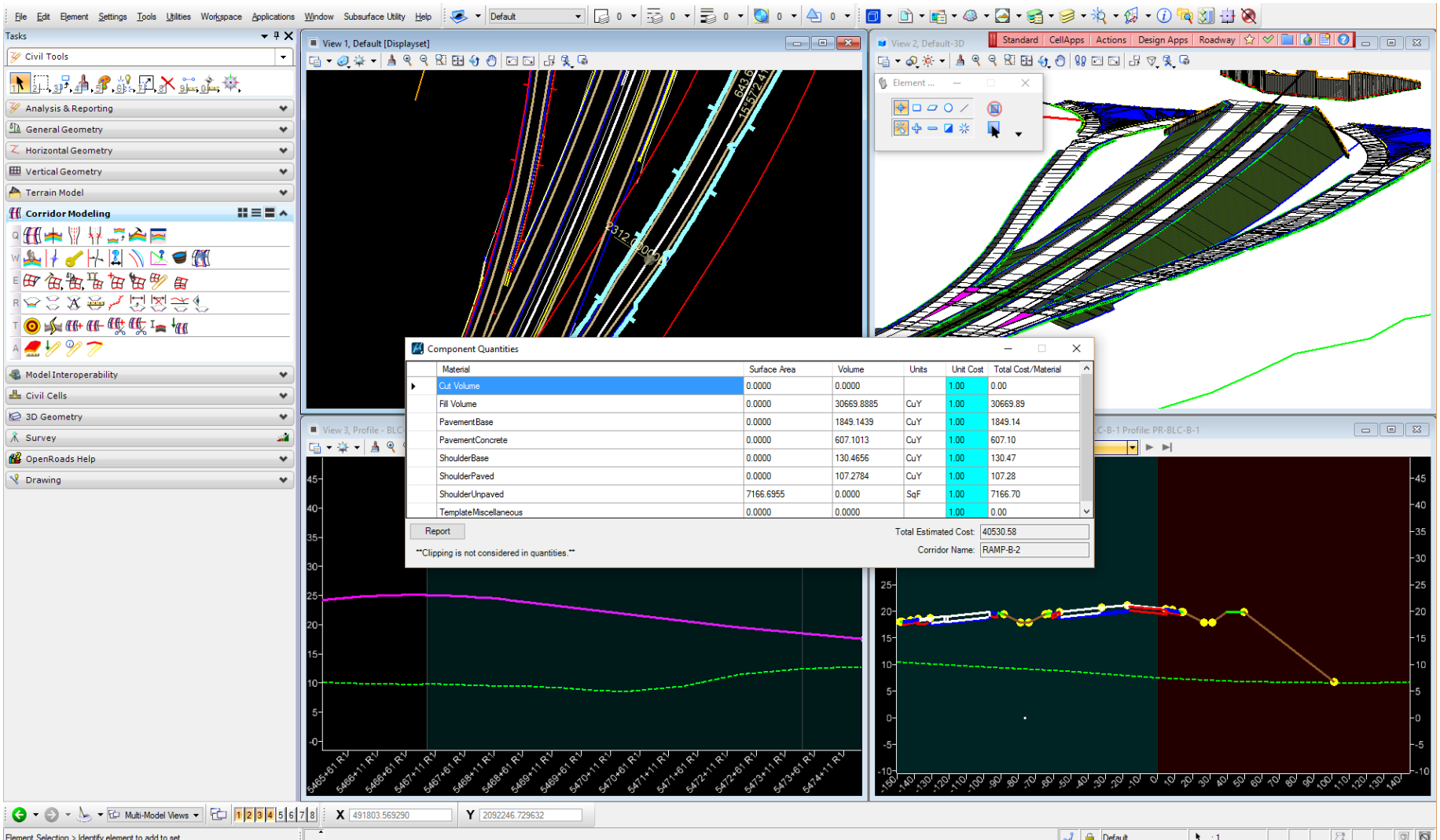
FDOTSS4	4/14/2017 3:43 PM
FDOTOpenRoadsDesigner	8/28/2017 1:17 PM

FDOT Civil 3D 2017:



FDOT PowerGEOPAK SS4 :



When is 3D model delivery required ?

- Project Suite – Work Program Database – 3DPR
- What is in the Florida Design Manual?
- What's in the Professional Services Contract?
- What the CADD Manual defines for deliverables?

When is 3D model delivery required ?

- Identified in the Work Program database

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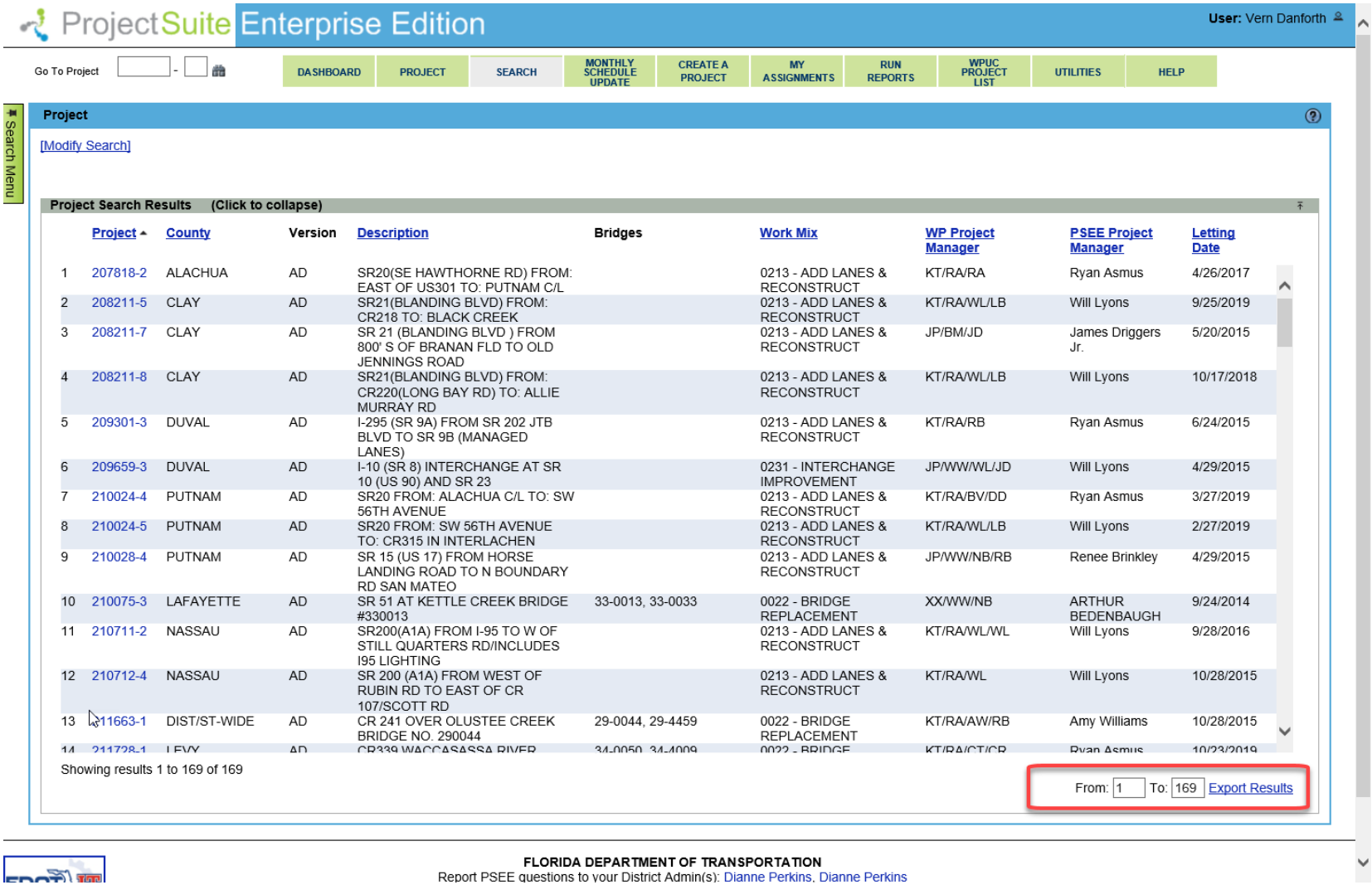


	Project	County	Version	Description	Bridges	Work Mix	WP Project Manager	PSEE Project Manager	Letting Date
1	207818-2	ALACHUA	AD	SR20(SE HAWTHORNE RD) FROM: EAST OF US301 TO: PUTNAM C/L		0213 - ADD LANES & RECONSTRUCT	KT/RA/RA	Ryan Asmus	4/26/2017
2	208211-5	CLAY	AD	SR21(BLANDING BLVD) FROM: CR218 TO: BLACK CREEK		0213 - ADD LANES & RECONSTRUCT	KT/RA/WL/LB	Will Lyons	9/25/2019
3	208211-7	CLAY	AD	SR 21 (BLANDING BLVD) FROM 800' S OF BRANAN FLD TO OLD JENNINGS ROAD		0213 - ADD LANES & RECONSTRUCT	JP/BM/JD	James Driggers Jr.	5/20/2015
4	208211-8	CLAY	AD	SR21(BLANDING BLVD) FROM: CR220(LONG BAY RD) TO: ALLIE MURRAY RD		0213 - ADD LANES & RECONSTRUCT	KT/RA/WL/LB	Will Lyons	10/17/2018
5	209301-3	DUVAL	AD	I-295 (SR 9A) FROM SR 202 JTB BLVD TO SR 9B (MANAGED LANES)		0213 - ADD LANES & RECONSTRUCT	KT/RA/RB	Ryan Asmus	6/24/2015
6	209659-3	DUVAL	AD	I-10 (SR 8) INTERCHANGE AT SR 10 (US 90) AND SR 23		0231 - INTERCHANGE IMPROVEMENT	JP/WW/WL/JD	Will Lyons	4/29/2015
7	210024-4	PUTNAM	AD	SR20 FROM: ALACHUA C/L TO: SW 56TH AVENUE		0213 - ADD LANES & RECONSTRUCT	KT/RA/BV/DD	Ryan Asmus	3/27/2019
8	210024-5	PUTNAM	AD	SR20 FROM: SW 56TH AVENUE TO: CR315 IN INTERLACHEN		0213 - ADD LANES & RECONSTRUCT	KT/RA/WL/LB	Will Lyons	2/27/2019
9	210028-4	PUTNAM	AD	SR 15 (US 17) FROM HORSE LANDING ROAD TO N BOUNDARY RD SAN MATEO		0213 - ADD LANES & RECONSTRUCT	JP/WW/NB/RB	Renee Brinkley	4/29/2015
10	210075-3	LAFAYETTE	AD	SR 51 AT KETTLE CREEK BRIDGE #330013	33-0013, 33-0033	0022 - BRIDGE REPLACEMENT	XX/WW/NB	ARTHUR BEDENBAUGH	9/24/2014
11	210711-2	NASSAU	AD	SR200(A1A) FROM I-95 TO W OF STILL QUARTERS RD/INCLUDES I95 LIGHTING		0213 - ADD LANES & RECONSTRUCT	KT/RA/WL/WL	Will Lyons	9/28/2016
12	210712-4	NASSAU	AD	SR 200 (A1A) FROM WEST OF RUBIN RD TO EAST OF CR 107/SCOTT RD		0213 - ADD LANES & RECONSTRUCT	KT/RA/WL	Will Lyons	10/28/2015
13	211663-1	DIST/ST-WIDE	AD	CR 241 OVER OLUSTEE CREEK BRIDGE NO. 290044	29-0044, 29-4459	0022 - BRIDGE REPLACEMENT	KT/RA/AW/RB	Amy Williams	10/28/2015
14	211728-1	LEVY	AD	CR339 WACCASASSA RIVER	34-0050, 34-4009	0022 - BRIDGE	KT/RA/CT/CR	Ryan Asmus	10/23/2019

When is 3D model delivery required ?

- The Florida Design Manual

(1) Roadway
(2) Signing and Pavement Marking
(3) Signalization
(4) Intelligent Transportation Systems (ITS)
(5) Lighting
(6) Landscape
(7) Architectural Plans
(8) Structures Plans

Each Utility Work by Highway Contractor Agreement may have a separate phase for each Financial Project Identification Number (FPID). The plan set for each agreement is placed in the back of the contract plans set under the associated FPID.

Modification for Non-Conventional Projects:
Delete the two sentences above and see the RFP.

These component sets, the specifications package, and the pay items list with calculated quantities are assembled and packaged as the construction contract letting documents.

Modification for Non-Conventional Projects:
Delete the sentence above and replace with the following: These component sets, the specifications package, and the pay item list are assembled and packaged as the construction contract documents.

111.3.1 Three-Dimensional Models

If horizontally and vertically controlled cross sections are required for plans production to communicate design intent and construct the project, then that section of the project should be three-dimensionally (3D) modeled.

Modification for Non-Conventional Projects:
Delete ***FDM 111.3.1*** and see RFP for requirements.

When is 3D model delivery required ?

- The Professional Services Contract?

STAGE I **FPID(S): 999999-1-52-01**
[DATE]

36 3D MODELING

The CONSULTANT shall analyze and document Roadway Tasks in accordance with all applicable manuals, guidelines, standards, handbooks, procedures, and current design memorandums.

The CONSULTANT shall deliver all master design files, 3D surface design models, and all supporting digital files for the development of plans as required in the DEPARTMENT's CADD Manual.

The CONSULTANT shall prepare a 3D model using the latest FDOT software in accordance with the FDOT CADD Manual. Includes all efforts required for developing files for 3D deliverables supporting automated machine guidance for design models. This includes importing survey data and creation of existing 3D surface features and models, and developing proposed corridor models with necessary detail of features to depict the proposed project in 3D to comply with the DEPARTMENT CADD Manual.

The CONSULTANT shall add detail to the corridor and design model for 3D design. Includes many elements that contribute to this including but not limited to slope transitions, typical section transitions, changes in pavement depth, berms, swales/ditches, and other feature transitions. Extra corridor structure leads to extra assemblies, extra targeting, etc. Dynamic relationships must be maintained. Frequency must be increase to achieve a useable model.

The CONSULTANT shall create an accurate roadway design model which includes modeling the intersections.

The CONSULTANT shall provide sufficient detail in the 3D model to account for driveways, Guardrail Terminal Locations, etc. and other graded areas where surface triangles are delivered as break lines.

36.1 Phase I 3D Design Model (30% Plans)

The CONSULTANT shall prepare, submit and present for approval by the DEPARTMENT, 30% complete 3D interactive model, comprised of, but not limited to: Existing features (pavement, shoulders, sidewalk, curb/gutter, utilities-if required per scope, drainage - if required per scope) and proposed corridor(s).

36.2 Phase II 3D Design Model (60% Plans)

The CONSULTANT shall prepare, submit and present for approval by the DEPARTMENT, 60% complete 3D model, comprised of, but not limited to: Modification of 30% model to update the model to comply with changes based on 30% review comments and to include the addition of ponds, floodplain compensation sites, retaining walls, barrier walls, guardrail terminals, cross overs, gore areas, side street connections, roundabouts, and driveways.

[List optional services to be included, i.e. Curb Ramps, Closed Drainage Network, Bridge Modeling, Bridge Abutment, Overhead sign post/structures with foundation, Toll gantry and overhead DMS structures with foundation, proposed utilities (pressure pipe/gravity), etc.].

36.3 Phase III 3D Design Model (90% Plans)

The CONSULTANT shall prepare, submit and present for approval by the DEPARTMENT, 90% complete 3D model, comprised of, but not limited to: Modification of 60% model to update the model to comply with changes based on 60% review comments and to further refine areas of transition between templates, detailed grading areas, bridge approaches and end bents, median noses, shoulder transition

When is 3D model delivery required ?

- The Professional Services Contract?

STAGE I **FPID(S): 999999-1-52-01**
[DATE]

areas, retaining walls, barrier walls and guardrail.

36.4 Final 3D Model Design (100% Plans)

The CONSULTANT shall prepare for approval by DEPARTMENT, 100% complete 3D model, comprised of, but not limited to: Modification of 90% model to update the model to comply with changes based on 90% review comments and to accurately generate, export and otherwise prepare the final 3D deliverable files as described in the DEPARTMENT's CADD Manual.

36.5 Cross Section Design Files

The CONSULTANT shall establish and develop cross section design files in accordance with the DEPARTMENT's CADD manual and Plans Preparation Manual. Includes all work required to establish and utilize intelligent/automated methods for creating cross sections including determining the locations for which all cross sections will be shown, existing and proposed features, cross section refinement, placement of utilities and drainage, soil boxes, R/W lines, earthwork calculations, and other required labeling.

36.6 Template and Assembly Development (Optional)

The CONSULTANT shall prepare for approval by DEPARTMENT, specialty templates or assemblies needed to develop the features required to deliver the 3D model.

36.7 Quality Assurance/Quality Control

36.8 Supervision

36.9 Coordination

When is 3D model delivery required ?

- What the CADD Manual defines for deliverables?

5.10.4.2 3D Deliverables Supporting AMG for 3D Designed Projects

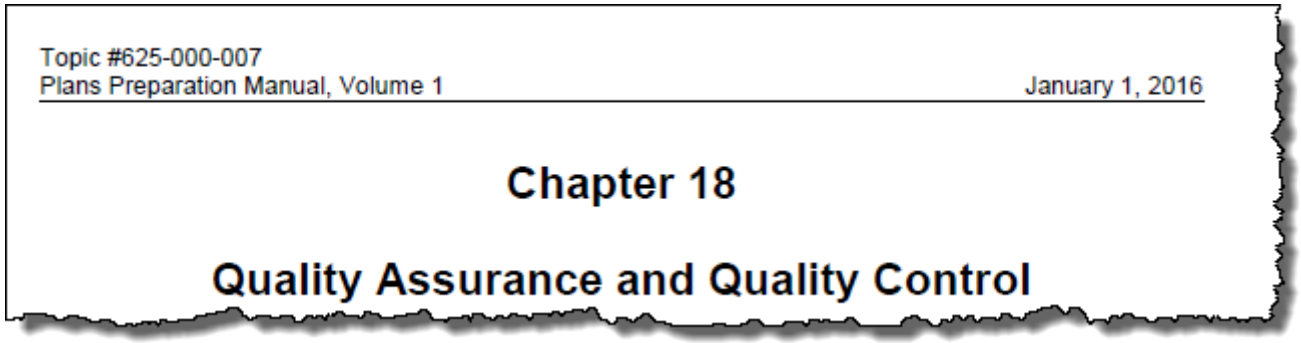
The following table describes the file(s) to be provided for construction. Contractors have requested the Department isolate the CADD and LandXML files they would typically need with a consistent name scheme. These files are usually copies of files already produced in the ordinary course of 3D Design CADD work and copied to a convenient folder location (\3DDeliverables\) for the contractor's usage. The Department provides a tool called *Create3DDeliverables* to aid designers in this process for the contractor.

3D DELIVERABLES SUPPORTING AMG for 3D PROJECTS	
File Name *(put in \3DDeliverables\)*	**Description**
Design Alignments and Profiles	
AMG-ALGN##.xml	All Alignments and Profiles extracted from the \Roadway\ALGNRD, PROF or model files and \Roadway\DSGNRD or CORRRD files in LandXML format.
2D Proposed Planimetrics Design	
AMG-2DSGN##.dwg/dgn	2D proposed Roadway design extracted from the \Roadway\DSGNRD file. (Production of this file for construction is at the designer's discretion.)
AMG-2DRPR##.dwg/dgn	2D proposed Drainage design extracted from the \Roadway\DRPRRD file. (Production of this file for construction is at the designer's discretion.)
AMG-2PDPL##.dwg/dgn	2D proposed Pond design extracted from the \Roadway\PDPLRD file. (Production of this file for construction is at the designer's discretion.)
2D Existing Survey *(Note: These are being considered to merge into a single survey Planimetrics file)*	
AMG-2TOPO##.dwg/dgn	2D proposed existing Topography extracted from the \Survey\TOPORD file. (Production of this file for construction is at the designer's discretion.)
AMG-2DREX##.dwg/dgn	2D proposed existing Drainage extracted from the \Survey\DREXRD file. (Production of this file for construction is at the designer's discretion.)
AMG-2UTEX##.dwg/dgn	2D proposed existing Utilities extracted from the \Survey\UTEXRD file. (Production of this file for construction is at the designer's discretion.)
3D Existing Survey Surfaces	
AMG-3SURFACEEX##.xml	3D existing terrain surface to be exported from the \Survey\GDTMRD file as LandXML format. (Production of this file for construction is at the designer's discretion. This file will be produced if the 3D Existing Surface dwg/dgn file(s) are not produced.)
AMG-3SURFACEEX##.dwg/dgn	3D existing terrain surface to be exported from the \Survey\GDTMRD file. (Production of this file for construction is at the designer's discretion. This file will be produced if the 3D Existing Surface LandXML file(s) are not produced.)
3D Proposed Surfaces	
AMG-3SURFACEPR##.xml	3D proposed finished (top) surface to be exported as LandXML format from the \Roadway\AMGMRD file. (Production of his file for construction is at the designer's discretion. This file will be produced if the 3D Proposed Break line(s) dwg/dgn file is not produced.)
3D Proposed Break Lines	
AMG-3DSGN##.dwg/dgn	3D proposed Roadway design extracted from the \Roadway\DSGNRD file. (Production of this file for construction is at the designer's discretion. This file will be produced if the 3D Proposed Surface(s) LandXML file(s) is not produced. Geometric elements should be in vector.)

QA / QC the model:

Quality Assurance(QA) and **Quality Control(QC)** are two processes used to ensure the public receives a quality product.

- Quality Assurance is the responsibility of, and performed by the Central Office.
- Quality Control is a responsibility of the District Offices, and is performed by the Districts and their Agents (Consultants), as appropriate.



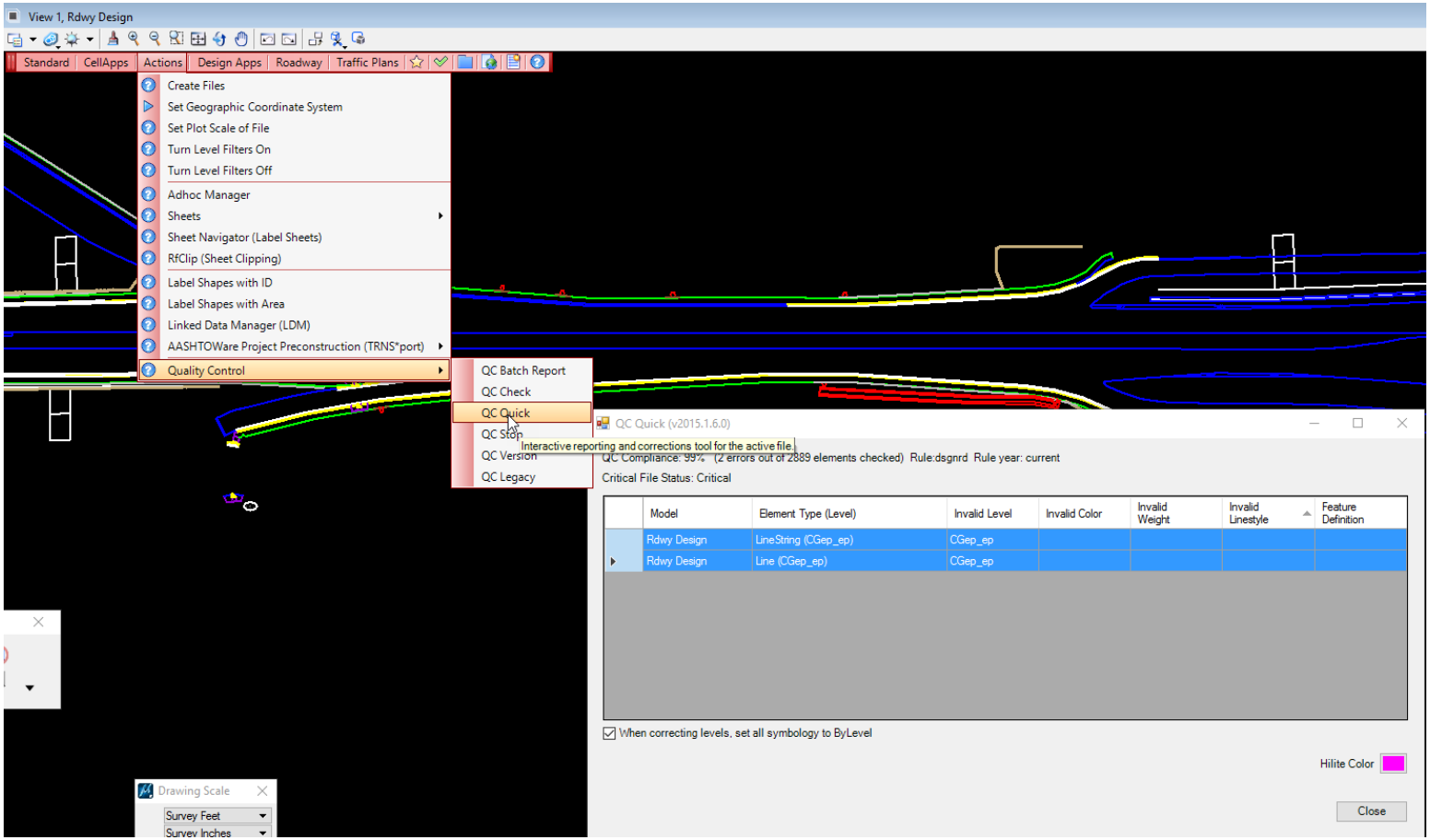
Topic #625-000-007
Plans Preparation Manual, Volume 1 January 1, 2016

Chapter 18

Quality Assurance and Quality Control

Quality Assurance:

The FDOT Workspaces and State Kits have tools that check for CADD compliance the 2D and 3D design files.



QC the model:

- Who will review the model?
  - Consultant Designers, Engineers, Project Managers, EOR
  - FDOT District Project Reviewer
  - Other agencies;
    - FHWA,
    - local cities and counties,
    - Permitting,
    - Utility Companies, etc.. How does this project affect me?
  - Construction Contract Estimators
  - Contractors/Builders

QC the model:

What will they want to QC?

- Does the model look complete visually?
  - gaps, spikes, overlaps, transitions, harmonization's
- Normal checklist items?
  - Pavement Lanes, Shoulders, Sidewalks, Curbs
  - Are the slopes correct, superelevation, slope breaks
  - Clearances, conflicts utilities, drainage, signs, etc.
  - Are the depths correct, pavement, sidewalk, base, driveways
- Does the model match the plans or … Do the plans match the model?
- Details, details, details
- Validate 3D Deliverables

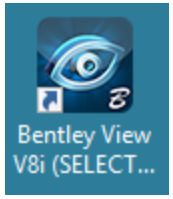
Example:

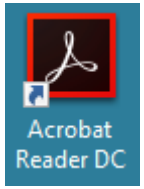
3D Engineered Model QC Checklist

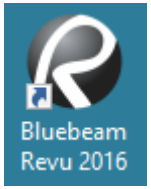
Implementation Items	Originator	Reviewer	Comments
	Initials	*Initials*	
Geographical Coordinate System has be defined in the model(s)/design file			
3D Baseline/Centerline has been displayed in the model(s)			
Referenced 3D model break lines match the 2D planimetric lines			
Review of model(s) for completeness, visually: o Gaps along the model o Spikes or lips along seams o Overlapping components o Transitions between corridors and templates o Transitions between varying slope values o Slopes harmonization with existing surface o Median Crossovers o Separator Islands			
Component Depths match the Typical Section: o Pavement Layers o Driveway o Sidewalk o Concrete			
Verify Station Offset Elevation at Critical Location: o EOP at Drainage Nodes o Begin / End Taper Transitions o Begin / End Radius o			
Verify Cross Slopes: o Pavement Lanes o Shoulders o Sidewalk o Cross Over Medians o Slopes			
Vertical Clearance			
Clash Detection - Interference Checking			
3D Deliverable Created o XML files for Corridor Alignments o XML files for Existing and Proposed Surfaces (verified against 3D design) o Dgn or Dwg files for 2D and 3D lines o Icm file for OpenRoads Design Delivery			

QC model applications

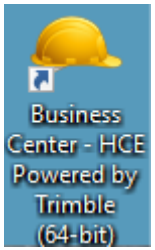
- What non CADD tools are available?
  - DGN files
    - Bentley Navigator
    - Bentley DGN Viewer
  - 3D pdf tools
    - Adobe Reader
    - Bluebeam
  - I models and tablets for field review
    - OpenRoads Navigator Connect
    - Bentley Navigator Connect
  - Construction Software
    - AGTEK
    - Trimble Business Center







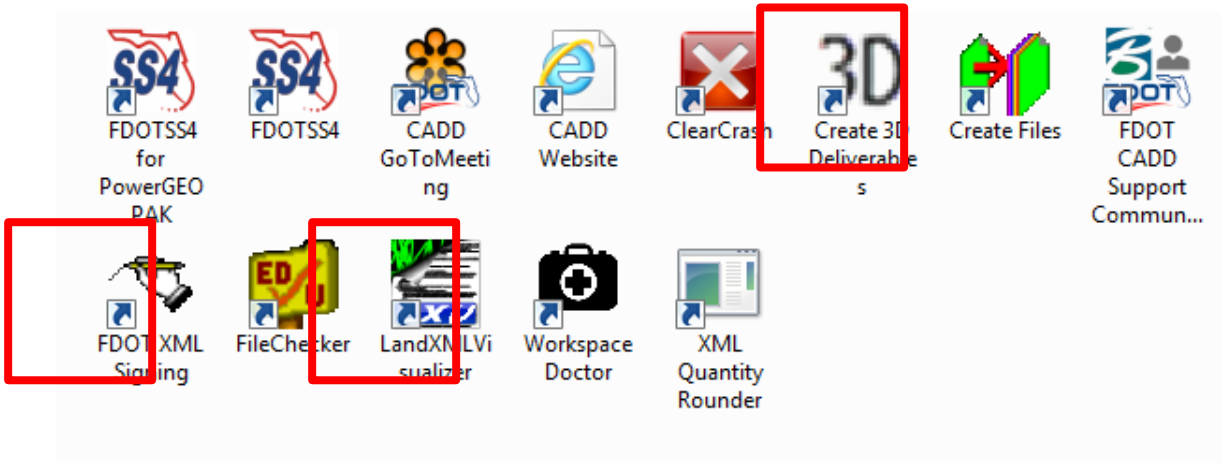
A360
View, share, and find 2D and 3D design
project files in one central workspace.



BIM 360 Team
View, mark up, share, and revi
files from any device, track ver
extend BIM to your entire tean

QC model applications

- What non CADD tools are available?
  - XML files
    - Create 3D Deliverables
    - LandXML Visualizer
    - XML Signing – electronic signatures



3D Deliverables

What is delivered for the contractor?

- Alignments and profiles in xml file
- Existing and Final Grade surface in xml file
- 2D planimetrics and 3D breaklines files in dgn or dwg
- Intelligent design models(near future)

Other Integrated Models

- 3D Drainage Network model?
- 3D Bridge Model?
- 3D Utility Model?
- 3D Signals, Lighting, Signing?

Project Example – State Road 9B

We are working with FDOT Awarded Design/ Build Construction Contractor, Superior Construction for this project south of Jacksonville, FL. Phase 2 is complete and Phase 3 will finish this spring, ahead of schedule. We delivered models as .XML files to Superior for this phase. They used them to grade the road, place asphalt and concrete using automated machine guidance.

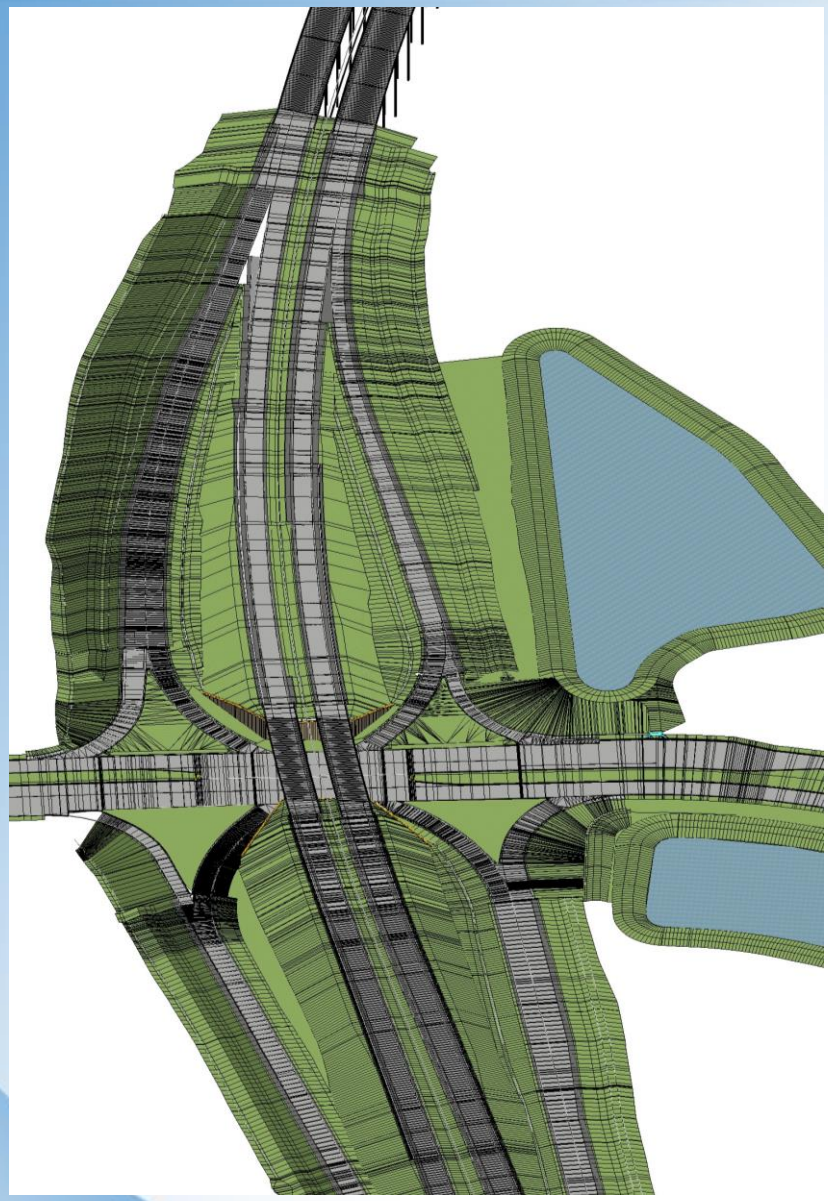
Project Example – State Road 9B

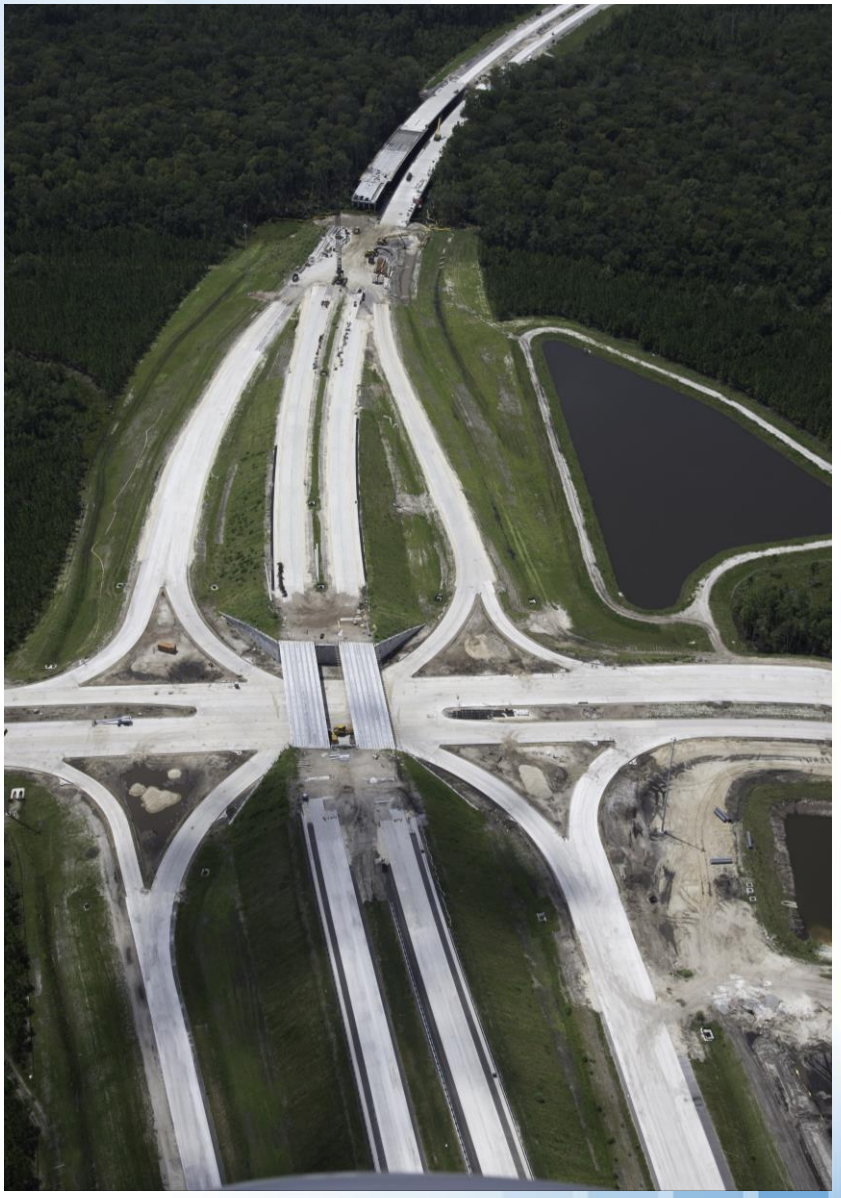
Checking the Model

Superior Construction created a spreadsheet they formerly used to build the 3D model from the 2D plans. We used the same format to compare the plans to the model to check the models before delivering the surfaces to them for construction.

SR 9B Right - Russel Sampson to Station 441+25

Lane 1 EOP Left				PGL				Station	Lane 1 EOP Right				Lane 2 EOP Right			
Calculated from Plans	Arcadis Model	O/S	Difference	Calculated from Plans	Arcadis Model	O/S	Difference		Calculated from Plans	Arcadis Model	O/S	Difference	Calculated from Plans	Arcadis Model	O/S	Difference
43.29	43.29	-19.59'	0.00	42.49	42.49	0.00'	0.00	1434+40	41.51	41.51	24.00'	0.00	41.03	41.03	35.58'	0.00
43.09	43.09	-18.00'	0.00	42.41	42.41	0.00'	0.00	1434+60	41.50	41.50	24.00'	0.00	41.12	41.12	34.00'	0.00
43.02	43.02	-18.00'	0.00	42.37	42.37	0.00'	0.00	1434+69.40	41.49	41.49	24.00'	0.00	41.12	41.12	34.00'	0.00
42.73	42.73	-12.00'	0.00	42.31	42.31	0.00'	0.00	1434+80	41.48	41.48	24.00'	0.00	41.41	41.41	26.00'	0.00
42.58	42.58	-12.00'	0.00	42.20	42.20	0.00'	0.00	1435+00	41.44	41.44	24.00'	0.00	41.37	41.37	26.00'	0.00
42.42	42.42	-12.00'	0.01	42.08	42.07	0.00'	0.01	1435+20	41.38	41.38	24.00'	-0.01	41.33	41.32	26.00'	0.01
42.24	42.24	-12.00'	0.00	41.94	41.93	0.00'	0.00	1435+40	41.32	41.31	24.00'	0.00	41.27	41.26	26.00'	0.00
42.05	42.05	-12.00'	0.00	41.78	41.78	0.00'	0.00	1435+60	41.23	41.23	24.00'	0.00	41.19	41.19	26.00'	0.00
41.96	41.96	-12.00'	0.00	41.70	41.70	0.00'	0.00	1435+69.40	41.19	41.19	24.00'	0.00	41.15	41.15	26.00'	0.00
41.87	41.87	-12.00'	0.00	41.63	41.63	0.00'	0.00	1435+77.79	41.15	41.15	24.00'	0.00	41.11	41.10	26.00'	0.00





ARCADIS

Contact Information:

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