

Digital Delivery

Interim Guidance Document



NEW YORK STATE OF OPPORTUNITY

Department of Transportation



January 2025

EXECUTIVE SUMMARY:

Nationally, State Departments of Transportation are shifting towards Building Information Modeling (BIM) to better manage their transportation assets. Technological advancements in software and hardware are changing the way digital information is exchanged and managed for projects and assets. The New York State Department of Transportation has recognized the benefit of these technologies and principles and has developed several Digital Delivery methodologies to better prepare, represent and digitally exchange asset information within the design process. This document was prepared to both educate and provide the latest guidance on digital delivery methods to be used by design staff supporting the capital program. As these methods of delivery continue to expand and evolve with time and experiences, this guidance will be updated.

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Table of Contents

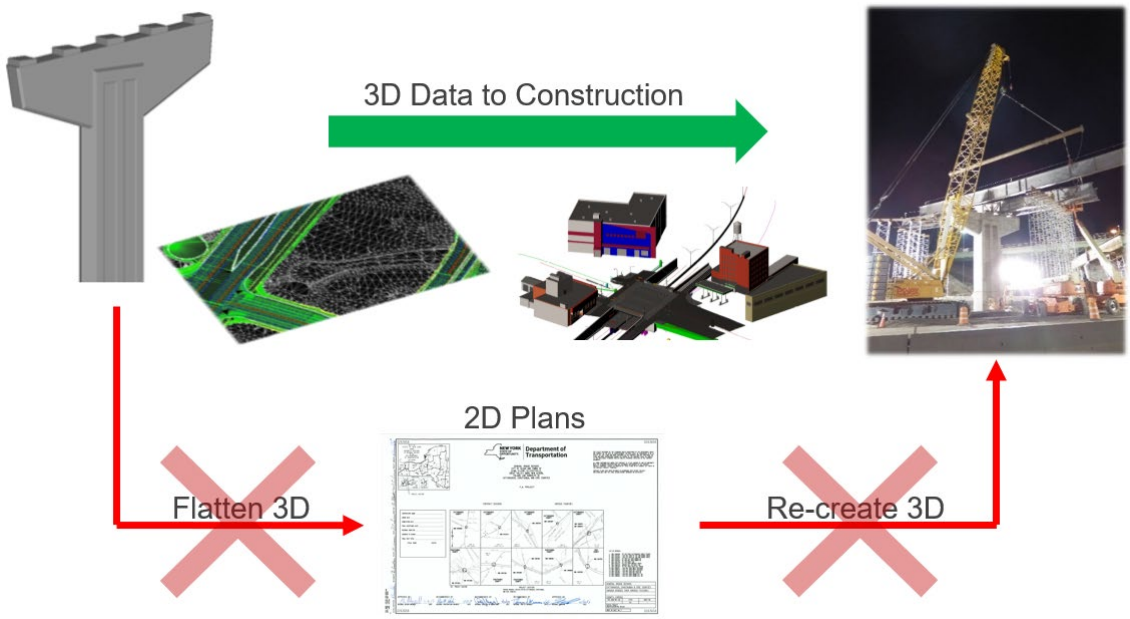
1. Introduction 5
2. Digital Data 7
   A. Electronic Files Identified as Plans 7
   B. Professional Sealing of Electronic Documents 7
   C. Index of Drawings 8
3. Digital Delivery Integration 9
   A. Definition of Terms 9
   B. Electronic Files 10
   C. Level of Development 11
   D. Electronic File Content 12
   E. Software Required & Training Videos 13
   F. Field Revisions to Electronic Files 13
4. Software 13
   A. Computer Aided Drafting (CAD) 14
   B. LandXML 14
   C. PDF 15
5. Hardware 16
   A. Computers and Tablets 16
   B. Project Internet 16
   C. Survey Staff and Equipment 16
6. Design Reviews 17
   A. Importance of Reviews 17
   B. Overcoming Review Challenges 17
   C. Web Based Design Review 17
7. Digital Delivery Best Practices 18
   A. Coordination with Stakeholders 18
   B. Training 18
   C. File Management 19
   D. Quantity of Files 19
   E. Supplemental Information 19
   F. Survey Data 19
   G. Federated File 20
   H. As-builts 20

8. Advanced 3D Modeling Methodologies 21
A. Determination of Features to Model 21
i. Return on Investment 21
ii. Modeling proposed features as supplemental information 21
iii. Modeling of Existing Features 21
B. Software Utilized 22
C. Solid Creation for 3D Solids Model 22
iv. Corridors 22
v. Linear Templates 23
vi. Area Templates 23
vii. Earthwork 23
viii. Traditional Solid Modeling Tools 24
ix. Surface Extrusion 24
x. Utility Modeling 24
xi. Additional Surface Creation 24
xii. Adjusted Elevations 25
D. Configuration of 3D Solids Model Environments 25
xiii. Item Types 25
xiv. Saved Views 26
xv. Embedded Links 26
9. Model Based Digital Delivery Project Application 27
10. Federal Highway Administration Involvement 28
11. Pilot Projects 28
12. Terminology 28
LIST OF APPENDICES 30
APPENDIX A: PILOT PROJECTS 31
APPENDIX B: EMBEDDED DOCUMENTS 41

1. Introduction

The purpose of this document is to provide interim guidance pertaining to the development and implementation of Digital Delivery projects within the New York State Department of Transportation (NYSDOT). The primary goal of Digital Delivery at NYSDOT is to specify contractual work with a variety of relevant electronic files and thereby reducing or eliminating corresponding plan production and cut sheets. Additionally, improved conveyance of design intent provides stakeholders better understanding of the proposed work while streamlining information transfer. These electronic files can be in a multitude of different formats with file name extensions such as: .pdf, .dgn, .xml, .alg, .dtm, .xlsx, etc or similar. The concept is to identify and replace the information that is traditionally found within a set of two dimensional (2D) plans with a digital exchange of information.

Illustration: 3D Data to Construction



A few examples of when a digital exchange of information is superior to a 2D plan are:

1. Providing the horizontal and vertical control line information contractually in a LandXML format versus providing horizontal tables and vertical profiles.
2. Providing the finished grade surface information contractually utilizing a LandXML format versus providing grading plans.
3. Providing a 3D solid model contractually versus providing general plans.

Each of these examples make better use of current technology to convey information to the contractor, retains 3D information and streamlines the design process. As all projects are unique, digital information should be tailored as necessary.

NYSDOT has identified three distinct delivery methods for Digital Delivery as illustrated in the following table. Traditional Delivery (TD) generates a set of 2D drawings or proposal only document that is delivered digitally via PDF. This is the most common format used on past and present NYSDOT projects. Due to the existing familiarity with this delivery method, it will not be

discussed further in this document. Hybrid Digital Delivery (HDD) also utilizes a PDF set of 2D drawings, however portions of the plan set are replaced with various forms of digital data. The aforementioned example of replacing the horizontal control tables with an electronic LandXML file is a good example of HDD. Model Based Digital Delivery (MBDD) is the most sophisticated of the three delivery methods. MBDD replaces the majority of the 2D PDF drawings with a fully comprehensive 3D Solid Model. While this method is the most complex, it also provides the greatest leverage of technology into the project. NYSDOT recognizes both the HDD and MBDD under the common industry term Model as the Legal Document (MALD) where digital data is replacing traditional plan sheets.

Table: Overview of Digital Delivery Methods

Digital Delivery Method	Format	Description	Project Category[2]
Traditional Delivery (TD)	2D PDF Plans	Only 2D PDF plans	Simple
Hybrid Digital Delivery (HDD)	2D PDF Plans + Digital Data[1]	2D PDF plans with digital data substituting specific drawings	Simple Moderate Complex
Model Based Digital Delivery (MBDD)	2D PDF Plans + Digital Data[1] + 3D Solid Model	2D PDF plans(minimal) with digital data and a comprehensive 3D solid model portraying most of the contractual work.	Complex

[1] *Examples of Digital Data include .dgn / .pdf / . xlsx / .xml / etc.*

[2] *Refer to NYSDOT Project Development Manual for project category information.*

Currently, the Department's approach of utilizing Digital Delivery for HDD and MBDD is a blended approach. Meaning that both electronic files and 2D PDF plans are the contractual deliverable for the design of a project. This approach recognizes that there is still specific areas in which 2D plans are a more efficient way to present the design information. Another reason is a concept called return-on-investment. The return-on-investment concept is a decision-making tool that is used while determining which elements will be modeled in 3D/electronically versus what elements will be left in the traditional 2D format. There are areas in which a designer can spend an excessive amount of effort to design an element in 3D/electronically to a high level of development where the result provides little to no benefit to the contractor. One example of this return-on-investment concept is guide rail. A designer can spend a tremendous amount of time detailing each of the rails, posts and bolts to scale in 3D. In reality, the contractor only needs a line string on a 2D plan depicting the guide rail run configuration and the NYSDOT Standard Sheets to be able to successfully install the guide rail. This additional effort would provide little to no enhanced benefit to the contractor and therefore, has a low return on investment. Another aspect that needs to be considered when determining return on investment is obtaining approvals and/or project permits from other local, state, and federal agencies. The design team should coordinate the deliverables closely and agree on the final format early in the process. This early coordination can prevent any duplication of effort and diminished return on investment in the later stages of the project. During the infancy stages of Digital Delivery implementation these can pose a challenge; however, the successes from previous pilot projects can be utilized to build stakeholder confidence.

It should be noted that since the contractual plans will consist of both electronic files and 2D plans, the designer shall not duplicate design information between the two. There is a high level of risk inserted into the project if contractual information is repeated in two separate deliverables. An undue burden is placed on the design team to constantly ensure both elements agree as the design is progressed and evolves. In certain situations, it is unrealistic to not duplicate the information. One example may be if the project is primarily fully modeled as a 3D solids model as in the case of MBDD, but the striping plans are still in 2D. Some of these proposed 3D elements will be needed on the 2D plan sheet to accurately depict the proposed striping. To do so a designer will also have to detail these 3D elements again in 2D. This is acceptable since the contractor will not be able to build any of these recreated elements from the 2D plans. However, in situations like this, the preference shall be to keep the number of proposed elements duplicated to the absolute minimum so that duplications of effort are curtailed.

2. Digital Data

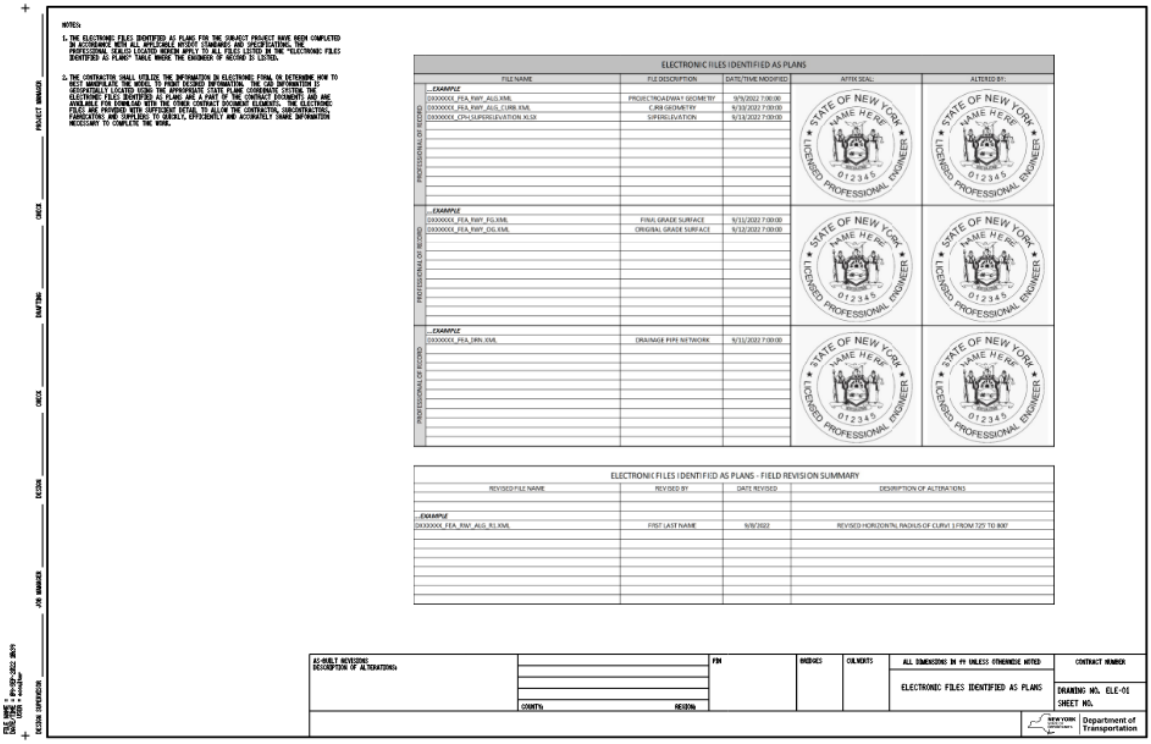
A. Electronic Files Identified as Plans

Digital Data collectively represents the electronic files identified as plans that are replacing the information traditionally conveyed by 2D plan sheets. Designers should identify the design elements that will be delivered as digital data to prevent duplication of effort. This information needs to provide a downstream benefit to stakeholders such as the contractor and fabricator. The design benefits will result naturally by way of streamlining plan production efforts. It is important that the design team coordinate in the preliminary design phase of the project among other groups including Environment, Geotechnical, Structures and Construction to identify any potential issues such as permitting, design integration/dependencies and constructability. A meeting early in the process can prevent a lot of confusion and inefficiencies later in the project.

B. Professional Sealing of Electronic Documents

Contractual electronic files on Digital Delivery projects are sealed by the professional of record by way of a new drawing included within the 2D plans called the “Electronic Files Identified as Plans”. Each of the contractual electronic file names are listed on this sheet along with a brief file description, the professional of record and most importantly the date/time stamp of the file. The inclusion of the date/time stamp of the file enables the Department to enact document control procedures that make it easy and obvious if a change has been made to the original contract file. Lastly, a box is included on the drawing for the professional of record to place their seal. An Excel file and CAD file have been developed to streamline the preparation of this drawing and are embedded within this document. Refer to Appendix B for instructions on how to obtain these files.

Illustration: Electronic Files Identified as Plans Drawing



C. Index of Drawings

With the implementation of a new concept, it is often beneficial to provide a crosswalk or roadmap to help illustrate the changes. The index of drawings serves this purpose well as it contains a list of traditional drawings that users are very familiar with. A customized index for Digital Delivery has been created that enables the design team to illustrate what 2D plan drawings are not being provided, and what digital data is replacing the traditional plan sheet. This is accomplished with the addition of two columns. The first column provides a location to list the digital data and the second column provides a location for supporting information. The supporting information is essential for downstream users, as it provides a convenient way to view the digital data. For instance, a LandXML file contains data schema that would require a reviewer to make use of CAD software or similar viewer to interpret the contents. By providing a supporting document that illustrates what is contained in the LandXML file, a reviewer can quickly visualize the data. A more detailed example would be providing the horizontal geometry in LandXML format and accompanying it with a tabular export in PDF format. The supplemental information should require very minimal effort to produce. Another example would be providing the vertical geometry in LandXML format. A vertical profile can be quickly annotated using standard CAD tools and plotted to a PDF. This requires minimal effort by the designer and is already part of the normal design workflow. An illustration of the index is shown below, and a digital version of the index is embedded within this document. Refer to Appendix B for instructions on how to obtain this file.

Illustration: Digital Delivery Index of Drawings

			TOTAL NUMBER OF SHEETS	XXX
INDEX OF DRAWINGS				
SHEET NO.	DESCRIPTION	DRAWING NUMBER	DIGITAL DELIVERY COMPONENT	
			DIGITAL DATA	SUPPORTING INFORMATION (NOTE 1)
	TITLE SHEET	COV-01		
	INDEX AND ABBREVIATIONS	IND-01		
	LEGEND SHEETS	LEG-01 TO LEG-02		
	ELECTRONIC FILES IDENTIFIED AS PLANS	ELE-01		
	TYPICAL SECTIONS	TYP-01 TO TYP-00		
	GENERAL NOTES	GNN-01 TO GNN-00		
	WORK ZONE TRAFFIC CONTROL SECTIONS	TCS-01 TO TCS-00		
	WORK ZONE TRAFFIC CONTROL NOTES	TCN-01 TO TCN-00		
	WORK ZONE TRAFFIC CONTROL DETAILS	TCD-01 TO TCD-00		
	WORK ZONE TRAFFIC CONTROL PLANS	TCP-01 TO TCP-00		
N/A	BASELINE TIES	NO DRAWINGS	DXXXXXX_FEA_RWY_BSL.XML	PIN#_RPT_SURVEY.PDF
	HORIZONTAL CONTROL TABLE	NO DRAWINGS	DXXXXXX_FEA_RWY_ALG.XML	PIN#_RPT_ALIGNMENT.PDF
	ALIGNMENT PLANS	NO DRAWINGS	DXXXXXX_FEA_RWY_ALG.XML	PIN#_RPT_ALIGNMENT.PDF
	MAINTENANCE JURISDICTION PLAN	MJP-01 TO MJP-00		
	MAINTENANCE JURISDICTION TABLE	MJT-01 TO MJT-00		

3. Digital Delivery Integration

The backbone for integrating Digital Delivery on NYSDOT projects is the Digital Delivery Special Note. This special note is inserted into the project proposal book for projects utilizing the Hybrid Digital Delivery & Model Based Digital Delivery methods of delivery. It is used as a guide to help communicate the specifics with respect to Digital Delivery to all downstream users. There are six key components of the Digital Delivery special note: Definition of Terms, Electronic Files, Level of Development, Electronic File Content, Software Required & Training, and Field Revisions to Electronic Files. It is important to note that there are slight differences in the special notes for the type of digital delivery methods. Refer to the appendices for the current approved notes for each method of delivery.

A. Definition of Terms

The NYSDOT Standard Specification Section 101-02 defines plans as “The official contract drawings and applicable standard sheets, which show the location, character, dimensions and details of the work to be performed.” Section 101-02 also defines contract plans as “The official contract drawings which show the location, character, dimensions, and details of the work to be performed.” These definitions restrict and limit plans to only traditional 2D plans & standard sheets. To contractually include electronic files as part of the contract documents, a modification is required to these definitions. A special note has been drafted that redefines the word “Plans” by adding the following to the definition: “The Plans will also include any electronic files identified as Plans. This may include engineering models, spreadsheets, CAD files or other electronic files used to convey the design.” This change in definition enables the designer to leverage other file formats to convey the design.

The special note shall be included as the first sheet of the Digital Delivery Special Note on every Digital Delivery project with the understanding that any modification to Section 100 needs to be approved by NYSDOT Legal. The project manager shall submit the request for approval at the Advanced Detail Plans stage in the project to the Design Quality Assurance Bureau (DQAB) PS&E Section. The DQAB PS&E Section will facilitate the approval process with Main Office Legal and notify the project manager if/when approval is granted. It is the intent of the Digital Delivery

Committee to have section 100 permanently modified with the language included in the special note as Digital Delivery projects begin to become a more standard practice at NYSDOT.

The electronic files identified as plans are recorded and professionally sealed on a drawing within the 2D plan set referred to as drawing ELE-01. Both the CAD file and excel file table to prepare the list of files are embedded within this document. Refer to Appendix B for instructions on how to obtain these files.

B. Electronic Files

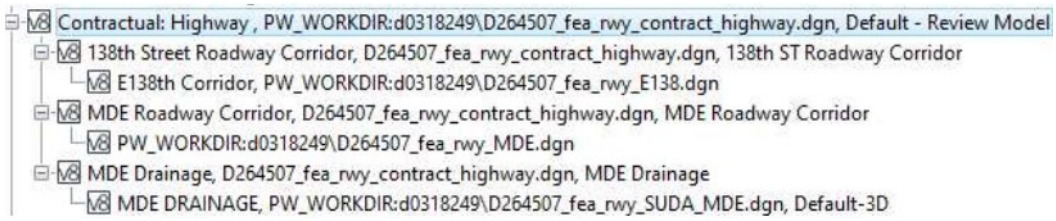
Digital Delivery projects typically consist of numerous electronic files and formats to convey the project design. This section provides information on how the electronic information is being provided and where to locate it. On MBDD projects, the 3D solid model is federated into one CAD file in order to visually see the project whole. This requires diligent and extensive file referencing. It is important to illustrate how the various references/models relate to each other by showing the dependencies and interrelationships of each file. These illustrations/charts are incredibly useful to downstream users as they become acclimated with the project. On HDD projects, the digital data provided typically does not require this level of detail be provided.

Illustration: Model Based Digital Delivery - Reference File Structure

A. *X72031_mbc_federated.dgn*



B. *D264507_fea_rwy_contract_highway.dgn*



C. *X72031_fea_rwy_supplemental_highway.dgn*

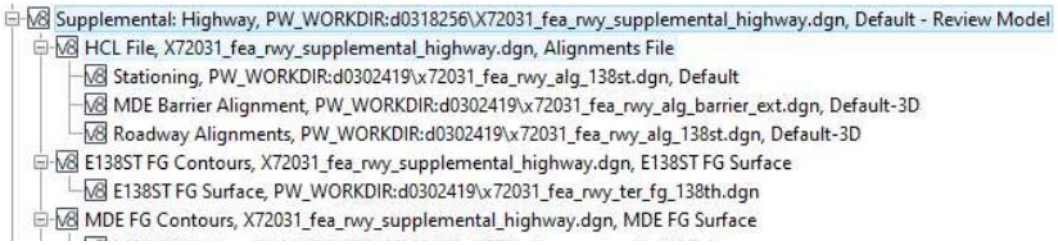
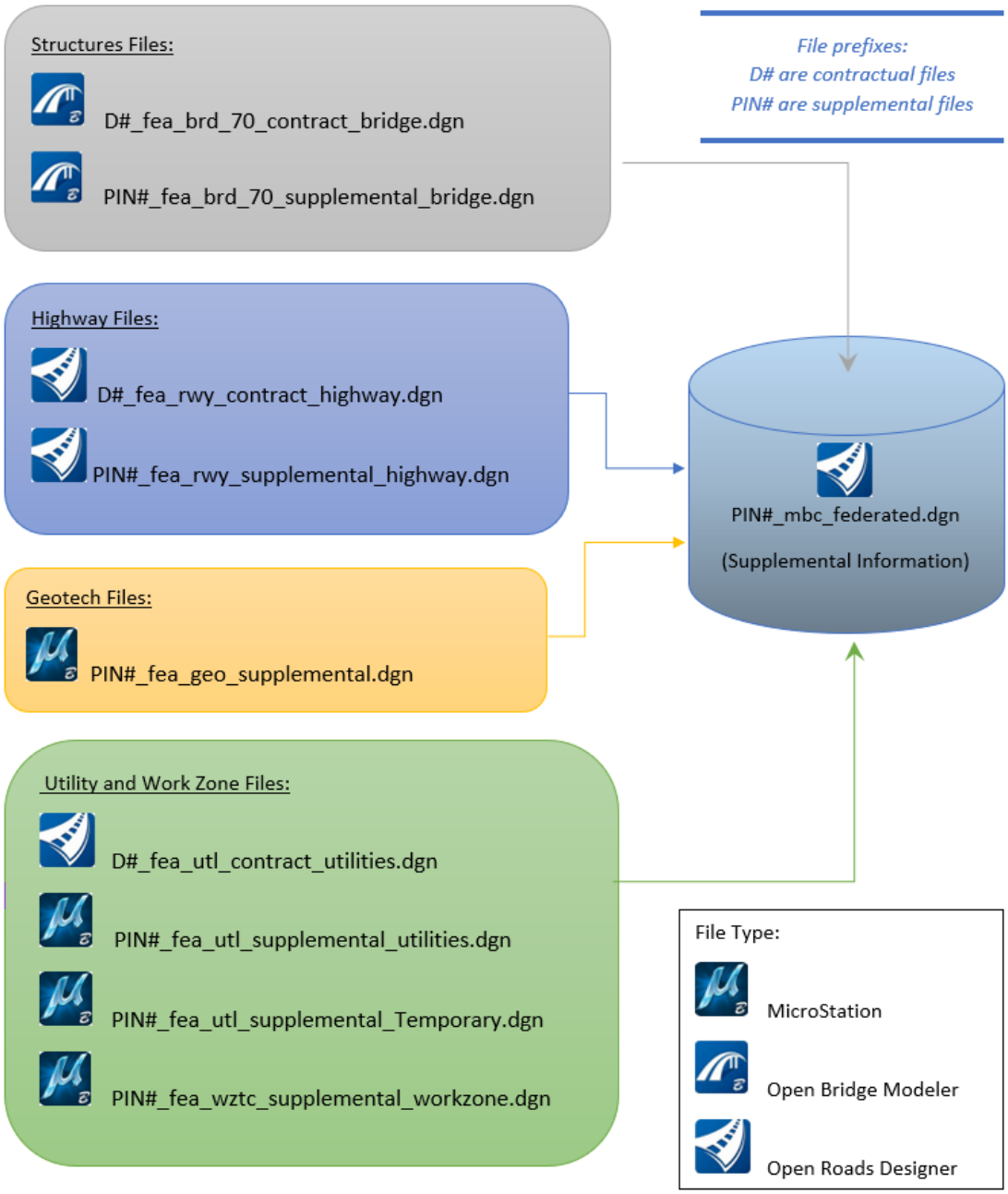


Illustration: Model Based Digital Delivery - Federated File Structure



C. Level of Development

The Level of Development (LOD) table is a reference that enables the design team to specify and articulate with a high degree of clarity the content and authorized use of the information model. The following table shall be included in the Digital Delivery Special Note for both HDD and MBDD projects.

Table: Level of Development Descriptions

Level of Development (LOD)	Model Content Requirements	Authorized Uses
Conceptual LOD 100	Overall massing indicative of height, volume, location and orientation. Massing will be three dimensional and may include other data.	Limited analysis, aggregate preliminary cost estimating, conceptual level scheduling and staging.
Approximate Geometry LOD 200	Elements are modeled as generalized assemblies or systems with approximate quantities, size, shape, location and orientation. Attributes may be linked to model elements.	Preliminary analysis, accurate for cost estimating and scheduling.
Precise Geometry LOD 300	Elements are modeled as specific assemblies and are accurate in quantity, size, shape, location and orientation. Attributes may be linked to model elements and as required by the Engineer.	Construction documents, detailed quantity take offs, analysis and project management and controls.
Fabrication LOD 400	As per LOD 300 plus complete fabrication, assembly and detailing information.	Model based fabrication Actual cost tracking look-aheads and virtual mock-ups.
'As-Built' LOD 500	Elements are modeled as constructed or 'As-Built', field verified accurate assemblies, quantities, dimensions, shapes, location and orientation. Major transportation asset class attributes are linked to modeled elements and as required by the Engineer.	Maintenance and operations asset management applications and future planning.

D. Electronic File Content

The electronic file content outlines for each component what information can be taken from that electronic file, and what information is contained in the 2D Plans. For example, on a MBDD project the special note would state that the Northings, Eastings & Elevations can all be taken directly from the 3D solids model. It may also indicate that elements such as the typical chamfer details for piers are still contained within the 2D Plans.

Most elements contained within the 3D solids models are contractual in nature as they indicate the proposed build condition. However, in specific scenarios it can be helpful to include information within the 3D solids models that are supplemental in nature. The inclusion of supplemental elements in the 3D solids model is typically to provide a more comprehensive picture of the overall project. The Department's current approach for differentiating contractual and supplemental information is by way of the file naming procedure. Contractual files that are "plan" level in the document hierarchy will have the contract D number as a prefix. Contractual files that are "base line data" in the hierarchy which are often referred to as supplemental

information for bidders will have the project identification number (PIN) as a prefix. The special note shall provide direction on how contractors can differentiate between what information is plan vs. base line data.

E. Software Required & Training Videos

Digital Delivery inherently increases the need for various software to interpret and review the design information being provided, as a multitude of electronic file types are common. The most common file formats used are PDF, DGN and XML. The Department's intent with Digital Delivery is to not require downstream users to purchase software to review the contractual deliverables. A PDF file format has been a standard in the industry for a long time and several free PDF viewers are available for download. Currently, NYSDOT utilizes Bentley software for CAD applications and therefore the end CAD product is a DGN file format extension. Bentley View Connect Edition is a free viewing software that can be installed and utilized to view any DGN file provided. This viewer is available at https://www.bentley.com/en/products/product-line/modeling-and-visualization-software/bentley-view. A XML file is a relatively neutral file format capable of being imported and exported by several software applications. XML files typically contain data (points, lines, etc.) regarding surface and alignment information. A free XML viewer capable of importing and viewing alignment and surface information is available for download at LandXML.org.

As many downstream users will be new to these software applications, the Department has prepared several training videos to assist with the installation and basic functions necessary to properly view and review the files provided. These training videos are accessible here: https://www.youtube.com/playlist?list=PLCLB1DlVfROohVSfJooQCBtr0GnLppAEf. In addition to self-guided training, it is recommended the design team evaluate their downstream users and determine if any additional support is required.

F. Field Revisions to Electronic Files

The process in which field revisions are to take place is also included in the Digital Delivery Special Note. The intent is to keep the process as similar as possible to the current procedure for plan sheets. The special note specifically states that field revisions will follow the current process outlined in the Department's Construction Administration Manual, Section 91. If the need for a field revision is identified in construction, the professional of record will be responsible for making that contractual change to the digital data. Additional guidance is also given in this section of the note to help provide direction when field revisions arise. File management is a major component in Digital Delivery as there are a greater variety and overall number of files when compared to a traditional delivery project. The Field Revision process is aimed to keep the number of revisions to the digital data to the minimum amount required. This portion of the special note also provides guidance on file naming procedures and how the revised files will be delivered to the contract team.

4. Software

Regardless of vendor, software applications are plentiful and rapidly changing. The design team should always consider downstream use and reviewability when determining deliverable formats. The design team should make use of the available free review methods to alleviate the monetary

burden to potential stakeholders and prospective bidders. Following are the three most common file formats generated by digital delivery and their intended means of consumption.

A. Computer Aided Drafting (CAD)

CAD files generate the primary components for plot files and therefore plan sheets. These files typically consist of features, break lines, shapes, symbols, etc. to portray both existing and proposed information. CAD files are most commonly submitted contractually with the Model Based Digital Delivery method. The Department is leveraging Bentley View or similar for review of these files.

The Bentley View software platform is designed to be a free viewer and users can expect a read only experience with limited tools. Users can perform several routine basic functions in Bentley View such as: rotate & navigate the model, obtain coordinate information, and conduct measurements. Bentley View does not have the ability to view profiles, cut cross sections or conduct reviews of the civil geometry in a live manor. An easy way to overcome this is to generate profiles & sections within the CAD file for review purposes.

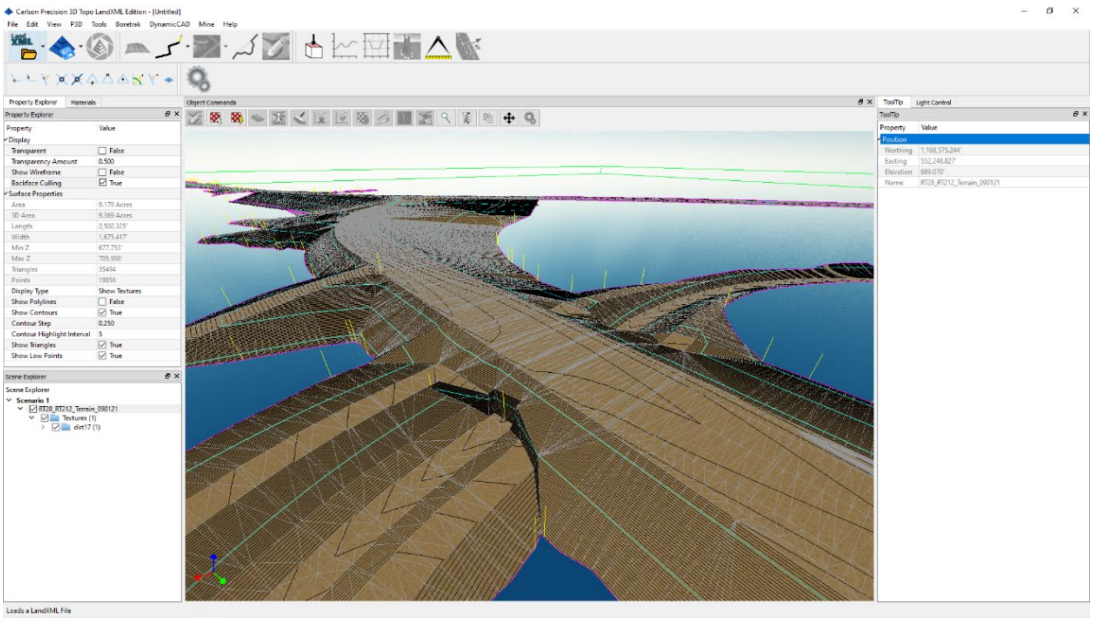
Instructional videos for Bentley View were created to help new users learn the basic functions of the software. Each lesson is broken down to specific functions and are only of 2-3 minutes in length. The intent is to be able to provide new users very detailed information on the topic of interest and to not have to go through a long-drawn-out instructional video that covers multiple subjects. The training videos have been posted on the NYSDOT Structures YouTube website so that any potential model users will have access to them. There has been a lot of positive feedback on the usefulness of the videos, with some videos having over 2,000 views to date.

A preference configuration file shall be provided with the model documents. This preference batch file will need to be installed by non-DOT users prior to using Bentley View. This preference batch file enables outside users to have DOT workspace configurations so that materials & levels look as intended. One of the training videos provided covers this process.

B. LandXML

Similar to Bentley View not having the capability to review civil geometry, LandXML files are difficult to review due to the files consisting of coding. One way to overcome this is to display the information contained within the LandXML file in a supplemental CAD file or PDF. Another way to assist the review of this information is to provide a report of the geometry in the case on the LandXML representing an alignment. Lastly, a free LandXML viewer is available for download at LandXML.org. This viewer takes a few minutes to download and is an effective tool for visualizing and reviewing LandXML information. The website provides an instructional video on how to install the software. Below is an example of a design surface opened in this viewer.

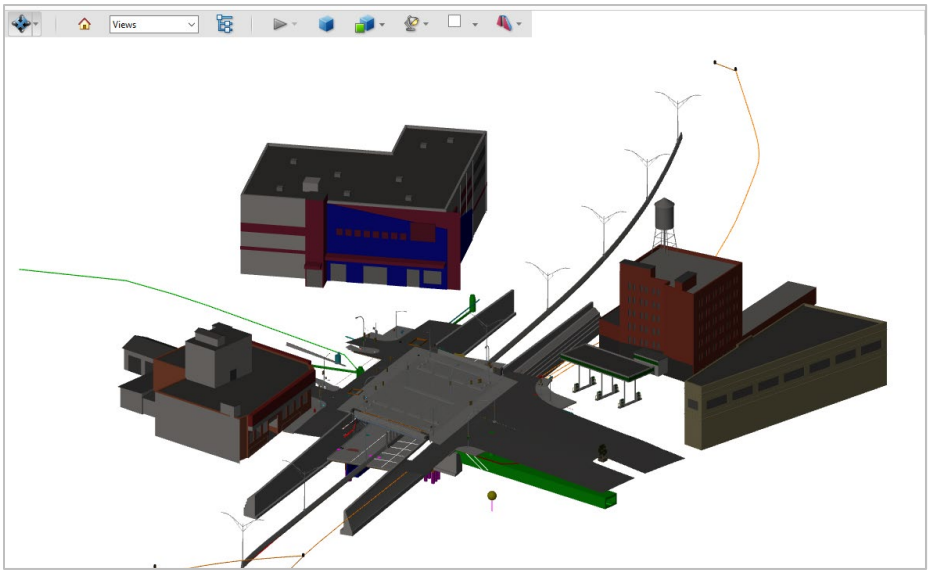
Illustration: LandXML.org Design Surface



C. PDF

The 2D PDF has been a staple file format for many years which has created user familiarity with many. There are several free viewers available which makes it very practical to utilize as a deliverable format. A 3D PDF is a great way to represent a 3D CAD model that can portray the information without requiring the installation and training required by CAD software. The 3D CAD model when published to PDF creates layers comprised of all of the data found in file. It allows users to become acclimated with the project and data in a familiar platform before they conduct their review within CAD. The 3D PDF should only be considered as supplemental information and requires a better understanding of the PDF software to maximize the review potential. Below is an illustration of a 3D PDF.

Illustration: 3D PDF Printed from CAD



5. Hardware

A. Computers and Tablets

Software and hardware are dependent on each other and need to be matched accordingly to ensure a successful outcome. The design team should be cognizant of this and communicate the system requirements to their information technology staff. The MBDD method relies heavily on 3D models and therefore requires a higher performance workstation for the design preparation and construction use of the 3D model. Providing digital data to construction requires the ability to view electronic information in the field on the project site. Various tablets and 2-in-1 computers are available to help fulfill this need. Similarly, the intended field use should be communicated with information technology staff to ensure the necessary software applications are supported by the particular device and capable of achieving the requirements.

B. Project Internet

To maximize the technological benefits of a digital delivery project, cellular data or Wi-Fi on the project site is encouraged to promote the use of devices such as tablets. Enabling communication is essential for revealing the full potential of digital delivery. With web-based applications becoming more common place as well as information assets viewers available online such as NYSDOT's Maps and Apps, this will allow for users to access these applications on site in real time.

Illustration: Project Wi-Fi



C. Survey Staff and Equipment

The design, survey and construction staff should discuss the digital delivery method selected for the project as it will have the potential to affect the survey staff and equipment resources required for the project. Typically, MBDD projects require more staffing resources, expertise and more capable equipment such as a total station to effectively utilize the 3D solids model and check the as-built condition. HDD projects are more in line with the current survey

requirements for TD projects. It's important to evaluate each project based on the scale, staff, location, characteristics, and complexity as all projects are unique in these aspects.

6. Design Reviews

A. Importance of Reviews

Ensuring properly coordinated reviews are conducted at key milestone points is critical to the successful delivery and outcome of any project. Design reviews are even more imperative for projects that are utilizing innovative techniques such as Digital Delivery. This is primarily due to there being more risk involved with a new process.

Consideration should be given to the wide range of project stakeholders that are typically made-up various DOT functional groups, local municipalities, state and federal agencies, homeowners, engineering consulting firms, contractors, public and others. Unfamiliarity and the presence of several file formats has the potential to present challenges for stakeholders as many may not have CAD experience. If proper reviews are not conducted of the electronic files that are identified as plans, then it not only puts the project at a significant risk, but it could also potentially jeopardize the future of this project delivery method as well.

B. Overcoming Review Challenges

2D paper plans have long been considered the standard for reviewing projects. In the past few years, the Department has been transitioning reviews to become digital in nature. These digital/cloud-based reviews are much more efficient by providing users with additional tools to increase both the speed and quality of the reviews. Even with these known advantages, some users still prefer to print out the 2D plan set, because that is ultimately what they're more comfortable with. The desire to stick to traditional methods undermines the advantages of these new delivery methods.

Based on prior experiences, a reduced participation and commitment to design reviews is not uncommon. It is suspected that this is primarily due to users not feeling comfortable utilizing the new software platform and struggling to learn the software within the allocated window of time for the review. It is recommended to hold periodic virtual open house format meetings to assist reviewers with questions they encounter while navigating the new technology and review methods.

C. Web Based Design Review

Advancements in software have enabled web-based design review applications. The big advantage of a web-based review is omitting the requirement to install software to your computer. Another added benefit is the software can be updated behind the scenes without having to run updates manually. One such application is Bentley's iTwin Design Review. iTwin Design Review allows users to conduct 2D and 3D CAD reviews similar to the previously mentioned cloud-based reviews of 2D plans. Reviewers can comment their issues right inside the software. This feature streamlines reviews as all comments are housed in one central location for all reviewers to see. The comment can then be responded to and closed within the software as well. iTwin Design Review also has additional civil functionality by providing tools to

analyze profiles and to cut a cross section anywhere they choose. iTwin Design Review is currently available for use by any users that have a current ProjectWise license and account to review. This would include all NYSDOT staff to create what is referred to as an ad-hoc review. If an external party needs to access a review session and does not have a ProjectWise account, then the party hosting the review will have to pay for an additional subscription service per project.

7. Digital Delivery Best Practices

A. Coordination with Stakeholders

Generally speaking, most project stakeholders have limited exposure to the technology involved with Digital Delivery projects. This results in additional coordination required to ensure stakeholders understand the project's scope and that their needs are met. If this coordination begins early in the project's design life, and remains continuous through the completion of design, the project will be successful in meeting the stakeholder's needs.

The traditional mindset of 2D plans being the only allowable form to deliver a project will likely be an obstacle to overcome when coordinating with project stakeholders. Traditional 2D plans have long been the gold standard for communicating designs to another party. The fact that they are tangible in nature has created a level of comfort for personnel that just can't be matched when plans are electronic in nature. This will require a major cultural shift and time for it to become more commonly accepted.

While this cultural shift is taking place, the Department can use the success of completed projects to advocate Digital Delivery buy in to project stakeholders. This success can further be built upon through training in the use of the various software platforms to access the electronic files identified as plans. If a contractual 3D solids model is proposed as part of the Digital Delivery Project such as in the case of Model Based Digital Delivery, it can be used as a tool to communicate with stakeholders. Depending on the stakeholder, it may be difficult for them to understand 2D Plans. Even if they can functionally read plans, a 3D solids model does a far superior job at communicating design intent and project intricacies. If this 3D solids model is used throughout the coordination phase with project stakeholders, they will inherently become more comfortable in accepting the electronic documents as the contractual plans. Designers should be mindful that due to the various stakeholder requirements, 2D plans may need to be created in order to receive project permits & acceptance. The designer should exhaust all digital efforts and only create 2D plans as a last means to gain project acceptance.

B. Training

The technology shift related to Digital Delivery Projects requires a significant investment in training in order to ensure project success. Training shall be integrated in all phases of the project starting with reviewers of the project and ending at the contractor that will use the electronic documents identified as plans to build the project. In order for the training to be effective, it needs to be specific to the group receiving the training and well-rounded enough to encompass the complete Digital Delivery process. Training will typically be required for the following groups: Project Stakeholders, Reviewers, and Department Field Staff/Contractors. Recording training is recommended to allow stakeholders to reference the information

repeatedly afterwards and to reduce the need for additional training as new stakeholders get involved throughout the project. Until a library of tutorials and training videos are developed, training will rely heavily on the design team.

C. File Management

Digital Delivery Projects inherently have more files than a traditional 2D project as electronic files are included as part of the contract documents. This requires the design team to have an even higher regard for proper file management. File naming procedures shall follow the Project Development Manual (Appendix 14) and the Highway Design Manual (Chapters 20, 21 and 22). It is good practice to assign one member of the design team as the data manager. The data manager's responsibility would be to ensure that proper conventions are being followed by way of routine auditing.

D. Quantity of Files

More data is not always better. Designs generate a substantial amount of electronic files. While the thought of providing all these files as supplemental information would be an asset to downstream users, the result may be the opposite. Too many files can be overwhelming, especially if file naming conventions are not followed. As a result, users may end up not fully leveraging all this beneficial information. Therefore, this concept that more doesn't always coincide with better, should be kept in mind throughout the design process. An effort shall be made to evaluate each piece of information that will be provided electronically and determine if it provides a tangible benefit to downstream users.

E. Supplemental Information

HDD and MBDD has the potential to produce more supplemental information than traditional delivery projects. These delivery methods typically add mitigating information for LandXML's, supplemental 3D solids models and CAD files for example. The CONR9 is purposefully structured to well organize and provide a smooth hand off of information to the contractor and inspection staff. Chapter 21.8 of the Highway Design Manual provides additional information on preparing supplemental information.

F. Survey Data

Digital Delivery Projects inherently provide a more refined design and finished deliverable. This refined design is only as good as the accuracy of the survey that it was designed from. The current standards for photogrammetry allow for a tolerance of as much as 3 inches horizontally and 4 inches vertically. This tolerance may not by suitable for certain design applications such as tying into door sills, existing bridge features, stairs or constructing ADA facilities for example. The design team should also keep the survey accuracy in mind when illustrating precision in their designs as it may lead to a misunderstanding for end users. Showing a length or elevation to the thousandths of a foot when the accuracy is only to the tenth of a foot is a great example. While hard survey is much more accurate, there still can be discrepancies if there are not enough survey shots taken at key locations. This results in designers designing off interpolated data between these distant points and results in a less accurate product. These issues are also prevalent on traditional delivery projects. However, their impacts can be much more profound

when a designer is delivering a refined design such as a 3D solids model in lieu of a 2D plan set. Therefore, a greater investment should be made in the quality of the survey for these projects. If the initial survey does not meet the accuracy necessary to support the method of delivery and constructability of the project, then the designer should obtain supplemental survey at key locations to refine and enhance the original survey. It is also important to convey the type of survey and coordinate system that was used for collection of the survey information. The Electronic Files section of the Digital Delivery Special Note provides a location for this information to be conveyed.

G. Federated File

The term "Federated" is defined as a network setup in which there is a single centralized unit that allows each division to keep some level of autonomy. On Model Based Digital Delivery Projects, a federated file is included to provide this exact function. The federated 3D solids model (the single centralized unit) file brings in all the various 3D information from the different disciplines (each division) into one central location. This allows a contractor to understand the interrelationships and dependencies between elements in one 3D solids model environment. Both electronic files identified as plans and supplemental information can be brought into the federated file. Since the federated file is repeating the information displayed in the contractual 3D solids models and there is also supplemental information being shown in the federated file, it is provided as supplemental information.

H. As-builts

The Department's approach to Digital Delivery is to retain the existing process used for traditional plans where possible. The HDD and MBDD methods apply this logic with added information as necessary. A traditional delivery project establishes a baseline standard by providing the 2D PDF plans with markups as the as-built record. Similarly, the HDD and MBDD are to provide the 2D PDF plan with markups. In addition to the 2D PDF plan, all the electronic files identified as plans provided for the project will be provided with the project as-builts.

Understanding that the concept of an as-built is to provide valuable information to depict the constructed condition, providing the federated model on MBDD projects should be considered. The federated model represents both plan and baseline data in the hierarchy of contract documents, however it provides a valuable comprehensive representation of the project.

In construction, the process for obtaining and recording the as-built information on HDD and MBDD projects is the same except for minor changes to the project affecting the electronic files identified as plans. Major changes to the project resulting in either field revisions of field changes follow the current process and are submitted to the professional of record for redesign. The professional of record will make the corrections and issue an updated plan sheet and or electronic file. Minor changes to the contract documents during construction are traditionally documented by the Engineer-in-Charge (EIC) at the completion of construction on the 2D PDF plans. However, the electronic files identified as plans submitted on HDD and MBDD typically require CAD modeling capabilities and the software to incorporate the changes. Generally speaking, it is not feasible to have the EIC do this on a HDD or MBDD project and a process should be discussed between design and construction at the beginning of the project. A recommended process for minor changes is for the EIC to keep track of these changes

throughout construction. At the completion of construction, or at a major field revision issuance during construction, the EIC will provide these changes to the appropriate professional of record to make the change to the contract files.

8. Advanced 3D Modeling Methodologies

A. Determination of Features to Model

i. Return on Investment

For each element to be modeled with electronic information/3D solids model it shall be determined if there is a reasonable return on investment (ROI) for the effort it takes to model said element.

ii. Modeling proposed features as supplemental information

For some proposed features it may be beneficial to model them as 3D solids, however there may be a better method of conveyance for the contractor to digest this information. These are often situations in which the 3D solid provides a benefit by being able to visualize the work, but another delivery method is superior at conveying the information required to construct the specific element such as several two-dimensional details.

As an example, a custom median barrier transition is useful to show in the 3D model as it conveys the limits of replacement, provides volumetric information and provides the visual illustration of design intent. However, detailing this custom transition in the 2D plans would make it easier for the contractor to construct this segment of barrier. Therefore, the contract approach would be to provide the 3D solid for the median barrier transition as supplemental information and the detail within the 2D plans as the governing deliverable.

iii. Modeling of Existing Features

As discussed in the previous section, it may be useful to model specific elements in 3D for visual purposes. This is also true for the modeling of existing features. Without any existing elements in the 3D model, it may appear that the proposed elements are “floating” and make it difficult to understand the relationship between the existing and proposed work. By having some of the existing features modeled, it can provide valuable insight on the intricacies at the interface of the proposed and existing work. Also, by having elements such as landmarks near the project in the 3D model, it provides users a quick and efficient way to help become orientated in the 3D model. Since these elements are recreations of existing conditions that are modeled utilizing limited record plan and base mapping information, they should only be provided as supplemental information.

B. Software Utilized

The recommended software applications for preparing HDD and MBDD projects are Open Roads Designer (ORD) and Open Bridge Modeler (OBM). These software platforms have a much higher processing capacity than their predecessor, as it's a 64bit software application. This additional processing capacity allows for more intricate tools and features that are essential when delivering a Digital Delivery project. Note that careful coordination shall be made at the commencement of design to ensure all design teams are working on the same version and schema between the various Bentley platforms. If newer versions of the software are released during the design stage, all members of the design team will need to upgrade simultaneously to the new version of the respective software platforms. Operating on different schemas will result in the newer software schema taking control, leaving designers utilizing the older version unable to access the file. This is particularly important when combining files in the federated model.

C. Solid Creation for 3D Solids Model

iv. Corridors

The corridor tool in ORD is the primary tool to create solids for highway designers. The corridor tool will generate 3D solids based on the template utilized and for the extent of the alignment that it is applied along. This provides a multitude of ways to create solids that is only limited by the designer's imagination and ability. This also requires the various templates utilized to be fully detailed and reviewed. Since the features of the 3D solid will be the contractual element, features of the template such as depth of pavement course, need to be reviewed to the same extent as a typical section would be on a traditional project. Designers shall ensure correct point names, feature definitions, shape names, depth/width of shapes, etc. are all correct. Since all of this information will be ultimately written to the attributes of the created solid, it is imperative that they are all accurate. While the primary objects utilized from the corridor are the 3D solids, the 3D feature lines created by the corridor are also beneficial. Inclusion of the crown, edge of travel way and pavement edge lines into the 3D model provide contractors another methodology to import the information into their survey collector files. These various feature lines are recommended to be provided contractually, in addition to the corridor solids.

A good example of a non-traditional method to create solids by way of templates is the inclusion of a topsoil solid in the project templates. This is typically an element that is not included on a standard highway template. However, by including the topsoil solid into the template it allows the designer to utilize one methodology (corridors) to generate several 3D solids at the same time. The inclusion of these various solids into the highway template also provides the designer the ability to dynamically update all these elements with one step, as the design is progressed. Other innovative solids included in the 3D solids model by way of the highway templates were Mill & Inlay and Truing & Leveling solids that dynamically varied to modify the existing cross slope to comply with the proposed design.

There are also potential shortcomings encountered with using corridors to create 3D solids. Corridors are developed by "dropping" a proposed template perpendicularly to the proposed alignment. In certain situations, this is not desirable. For example, when a highway section needs to tie into a bridge section that is skewed, there is inherently a gap created between the perpendicular highway solids & the skewed bridge solids. This can be overcome by ways discussed later in this section. (See Area Templates)

A particular modeling deficiency within ORD is not being able to easily round shoulders and slope intersection points with a desired number of tessellations. This can be overcome by including a detail within the contract plans that shows the desired rounding. However, it is preferable to have this represented correctly in the 3D model especially for Automated Machine Guidance (AMG) technologies.

v. Linear Templates

Linear templates are similar to the templates utilized in roadway corridor creation. However, linear templates allow designers a greater degree of flexibility. They can be attached and extruded along any 3D feature line. They provide an excellent solution for situations in which the roadway end conditions vary. Linear templates also create solids similar to the corridor tool.

vi. Area Templates

Area templates allow a designer to apply a proposed template section to any surface. Area templates provide a good solution to areas that cannot be modeled with standard solid creation practices. For example, if a designer creates feature lines for a proposed curb ramp, they would then create a triangulated surface of that segment of sidewalk. Then the designer would take the proposed sidewalk section (created in the template library) and apply it as an area template to that surface. This results in 3D solid creation for each of the layers indicated in the template. In this scenario, a concrete solid and subbase solid would be created. Another possible use for area templates is tying in the roadway corridor to the bridge in scenarios that are skewed as mentioned in previous sections. Note that the 3D solid will reflect any errant triangulation. Surface triangles should be corrected before the area template is applied.

vii. Earthwork

ORD includes a tool that allows a user to create 3D solids for the cut/fills on a project. This tool is called "Create Cut Fill Volumes." The tool works by calculating the volume between a corridor and existing surface. The solids quickly provide a one-click volume within the item properties. The accuracy of the cut/fill solids provided a high degree of confidence to the field staff and resulted in no disputes over quantities. Note- In certain situations, a user might have to run a "mock" corridor, that consists of slope projection links in the template in order to create a cut/fill solid for that volume.

viii. Traditional Solid Modeling Tools

For certain situations where regular 3D polygons need to be modeled, the traditional solid modeling tool palette does a superior job at creating these shapes. Tools such as extrude, revolve and sweep can be combined to create any regularly shaped object. Modeling 3D solids for a precast concrete culvert, modeling a tapered end section for a concrete median barrier and modeling security bollards are a few examples.

ix. Surface Extrusion

For areas that require a very specific portion of the proposed design extruded and the area templates tools are not sufficient, it is recommended to use this methodology. This method starts with the designer using the proposed surface. The surface is then converted into a mesh and then trimmed to the specific area of interest. This portion of the mesh is then extruded and cut to the desired depth of the solid. Note that all previously mentioned methods should be attempted before this method is utilized.

x. Utility Modeling

Utilities can be modeled by utilizing the traditional solid modeling tools as previously mentioned or by way of the SUDA application inside of ORD. SUDA stands for Subsurface Utility Design and Analysis. This program will not only build 3D shapes of your design, but also perform the specific analysis of your utility as well i.e. drainage design. If only a 3D representation of utilities is needed the traditional solid modeling tools are adequate. If more civil intelligence is needed such as invert information, top of structure elevation, etc. then SUDA is the preferred as all of this smart civil data is automatically embedded in the 3D solids. Note that the department is currently in the process of developing its SUDA library so that it encompasses the wide range of utilities commonly encountered/designed. The use of SUDA is not isolated to just subsurface utilities as it can also be used to model luminaire poles, traffic signals, etc.

xi. Additional Surface Creation

The Department has been issuing the Finish Grade (FG) surface as supplemental information for several years. However, with it only being supplemental information, a contractor would be putting themselves at risk if they used the FG surface and there was an error within it or the plans indicated something contrary. Providing the FG surface as electronic files identified as plans reduces this risk and promotes the use of this digital data in survey collectors and utilization in construction equipment. Designers should also consider providing additional surfaces that can be very beneficial for construction operations. Surfaces such as subgrade, subbase, bottom of various excavations (i.e. trenches, piers, wingwalls, culverts) provide significant value for AMG technologies and Global Positioning System (GPS) operations. Note that the application of the alternate surface function within templates can streamline the creation of these additional surfaces.

xii. Adjusted Elevations

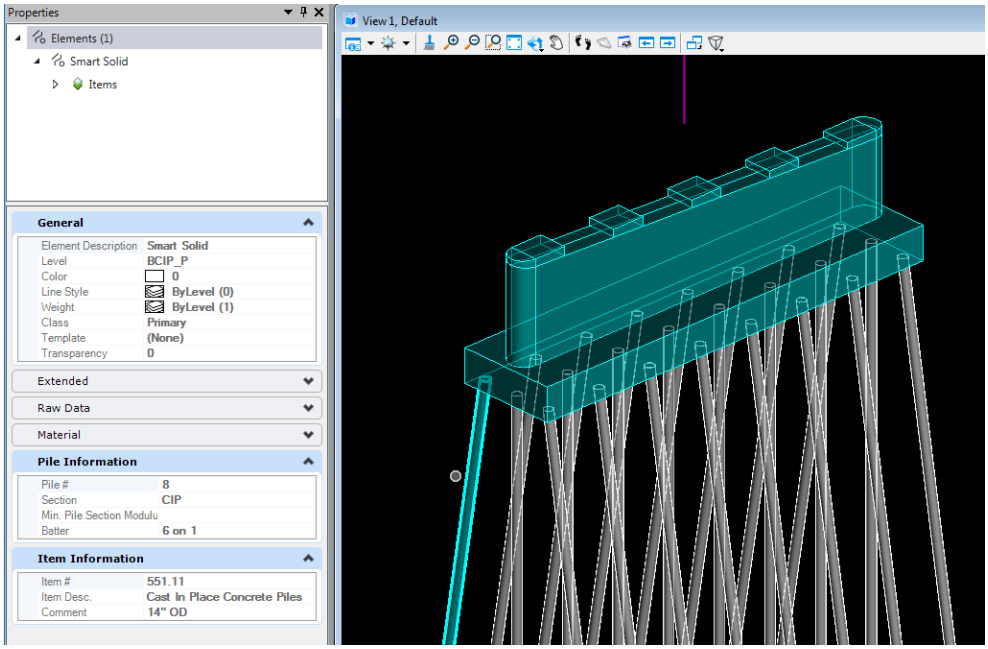
It can be helpful or necessary to modify the elevation of objects within the 3D solids model to better visualize the information. For example, the horizontal control line stationing cannot be represented in a 3D manor. Therefore, the elevation of the stationing text can be elevated above the model so that users can see the stationing while in top view. Another example of this was modeling the bridge deck at elevation zero.

D. Configuration of 3D Solids Model Environments

xiii. Item Types

The item type function inside of Bentley's connect edition of software provides a valuable tool to designers, to embed extended element information to each solid within the 3D solids model. The item type function has served as the primary tool to replace the callout information that designers would typically use to convey information on a traditional 2D plan sheet. Item types can be utilized to convey pay item information, designer notes and bring attention to specific elements of concern. Multiple item types can be added to an element. This allows a designer to include as much information as needed to convey design intent. The specific item types required for the project should be created and distributed in the early phases of design for consistency. Additional item types should only be created on an as-needed basis as design is progressed. Note that Bentley has recently added the ability to search for item types within the project explorer. This function is intended to be expanded upon in future product releases.

Illustration: Example Item Type applied to bridge pile

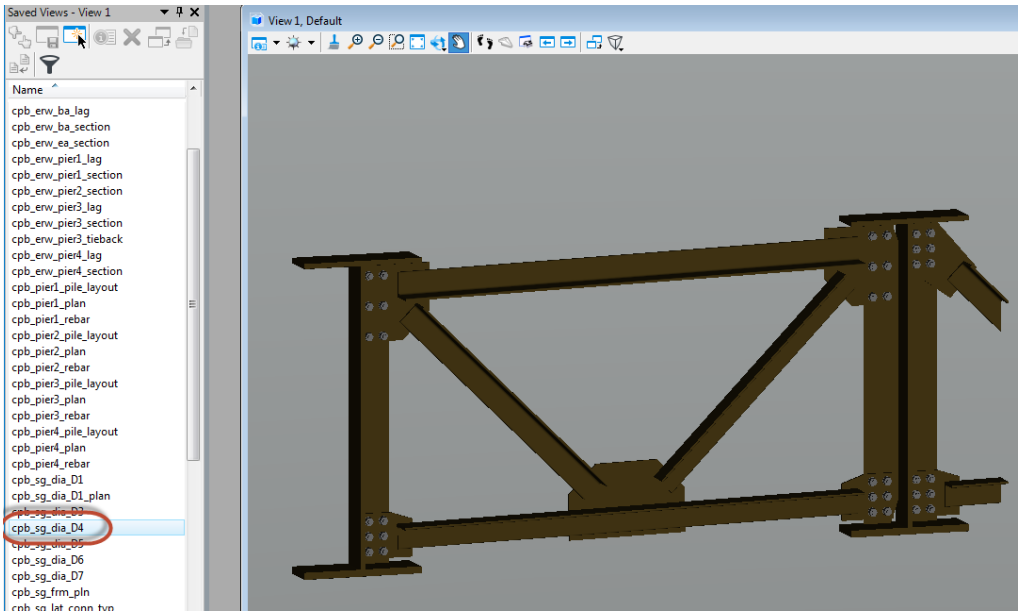


xiv. Saved Views

On Model Based Digital Delivery projects, saved views are utilized to set predefined views within the 3D model. Each view is carefully crafted by the designer by configuring the display style, applying a clip volume, and turning off unwanted references and levels until the desired view is established. With the 3D solids model having such a wide breadth of information, it can be difficult for a model user to dial into a specific element and view. By having a saved view predefined, it allows a user to quickly navigate to a specific viewpoint within the 3D model. The specific saved views required for a project will vary from project to project. A list of required saved views should be generated as the design is progressed with specific attention paid to key design elements and included in the Digital Delivery Special Note.

Saved views are typically applied in the contract files and the federated file. They can also be applied in each of the supplemental files if it would provide additional benefit to model users. Since saved views manage which levels and references are on, they are usually not configured until all updated models have been brought into the federated file. If a new level or reference is added, it may inadvertently display in a saved view resulting in less than desirable results. If a reference needs to be updated to a newer version of a design file, it is recommended that the reference link is just updated within the federated file in lieu of adding/deleting references. A reset saved view is recommended, which will turn all references and levels on.

Illustration: Saved view of diaphragm



xv. Embedded Links

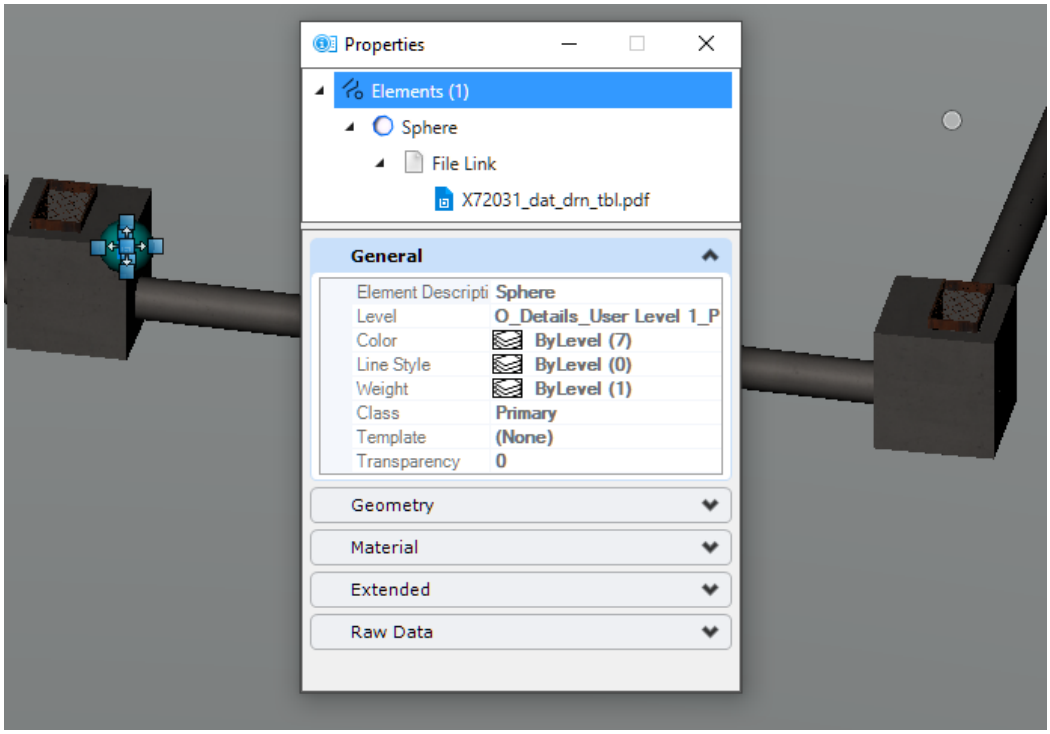
Another tool that can be leveraged to help convey information to model users is the embedded links feature inside of Bentley's connect edition of software. The "link" tool allows a user to link any file such as a pdf, xlsx, jpeg, web address, etc. to an element

within the model. When a user selects the link, the file is instantaneously opened without ever leaving the 3D solids model. This provides a time savings as users can quickly access relevant data without having to navigate through a database of files.

This tool can applied in several different applications to help convey information. For example, a link to the contract website will enable a user to quickly navigate to the website and access the relevant contract files. Another example could be providing a link on a soil boring in the 3D solids model that would open a PDF of the project boring logs.

Note that in order to apply an embedded link to a 3D element, that element must physically be present in that file and not referenced. Since this is not true for any element in the federated file, a 3D orb/sphere was drawn in the federated file near the relevant 3D feature. The link was then applied to that 3D orb.

Illustration: Embedded drainage table



9. Model Based Digital Delivery Project Application

A project application is required for all projects delivered utilizing MBDD due to the increased complexities and coordination. The application serves to identify the design elements that will be delivered as well as the team leads from each group. In addition, the application identifies a project mentor and liaison who will assist with the development and oversight of the deliverable. This includes matters such as the model level of development, stakeholder outreach, design reviews and training where needed are implemented. The application also requires approval from design and

construction which guarantees both parties have discussed and agreed upon the method of delivery. The project application is embedded within this document. Refer to Appendix B for instructions on how to obtain this file.

10. Federal Highway Administration Involvement

The MBDD projects are typically of FHWA interest as Digital Delivery is an emerging technology with increased complexities in both design and construction. It is very important to coordinate with FHWA early in the design process to obtain their level of interest in the project. If a project is selected for MBDD after the initial determination has been made, project managers need to reach out to FHWA and notify them of the change in delivery method.

11. Pilot Projects

Pilot projects have allowed NYSDOT to explore and test more efficient ways to deliver design projects and simultaneously leverage available software and hardware technologies. Pilot projects are an effective way to engage stakeholders and gather feedback on new concepts without altering standard guidance. The intent of each pilot project has been to build upon the previous project's success and lessons learned. Along with this success, also comes increased stakeholder confidence in the process. As projects continue to succeed in both design & construction, Digital Delivery will continue to grow and become a recognized delivery method both state and nationwide.

A summary of past pilot projects including lessons learned can be found in Appendix A

12. Terminology

3D Solids Model - For purposes of this document a 3D solids model shall be defined as a realistic coordinate-based environment that replicates the existing and proposed conditions by way of 3D solids. A 3D model shall NOT be considered a triangulated surface for purposes of this document

Electronic Files Identified as Plans – Various formats of digital data replacing specific elements of the contract plans. This information is equated to plans in the hierarchy.

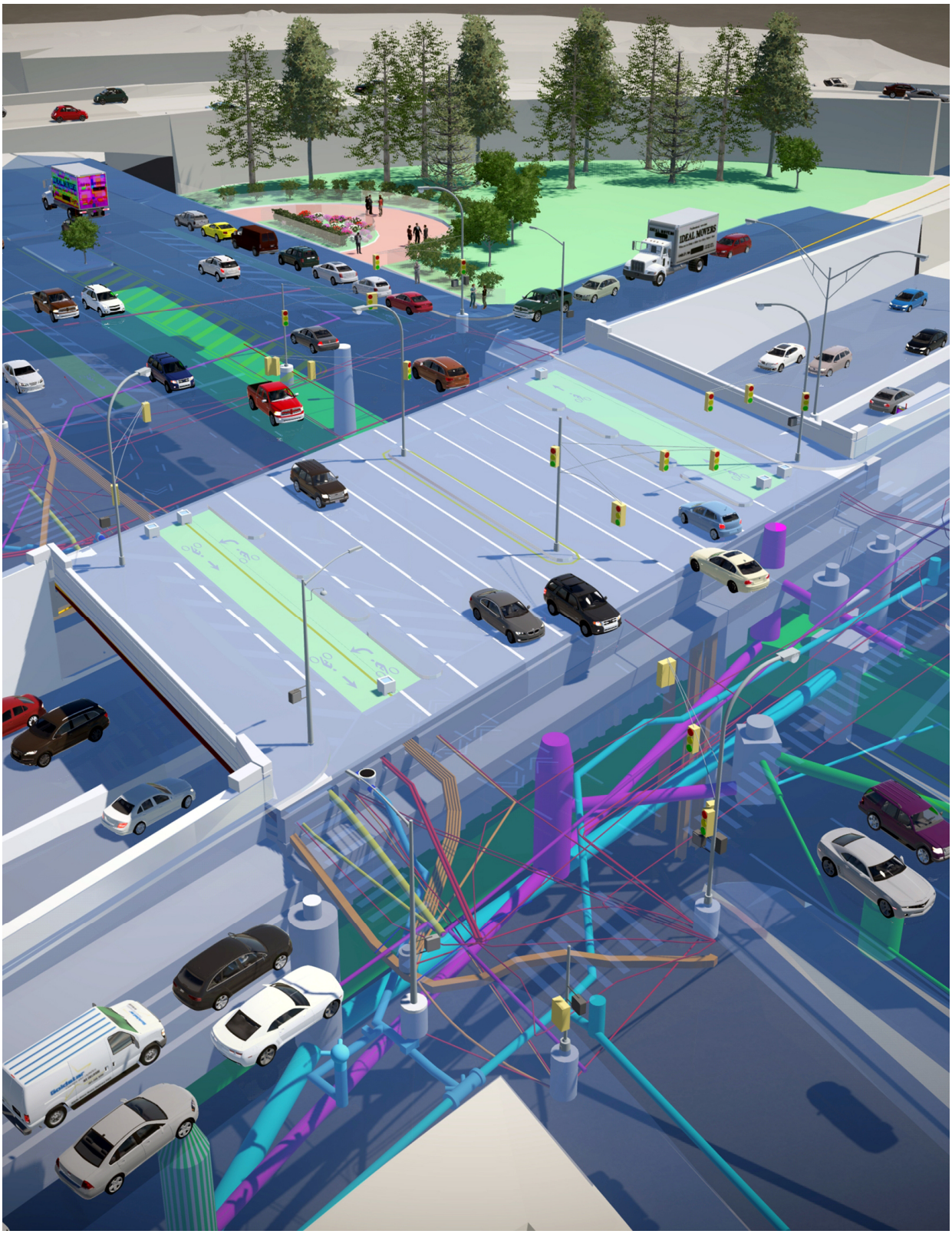
Digital Data Electronic Information presented in digital format for utilization in electronic devices.

Federated - A network setup in which there is a single centralized unit that allows each division to keep some level of autonomy.

LandXML - A LandXML file is a non-proprietary file format that stores civil/survey data such as points, faces, etc. making it easier to share surfaces between different programs. Several CAD and other packages support exporting data into the LandXML format.

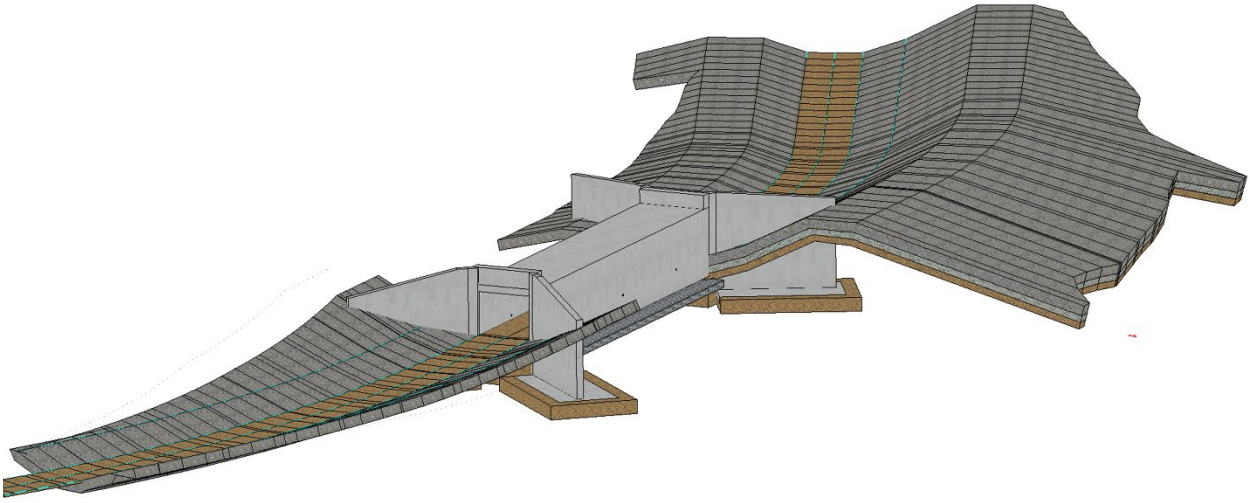
Level of Development/Level of Detail - the level of completeness and accuracy that modeled elements are to developed. Levels of Development progress from the lowest level, LOD 100, to the highest level, LOD 500. The five levels range from conceptual through 'As-Built' with progressively more complete and accurate levels of detail for each level.

Triangulated Surface Model – is a representation of a continuous surface consisting entirely of triangular facets.

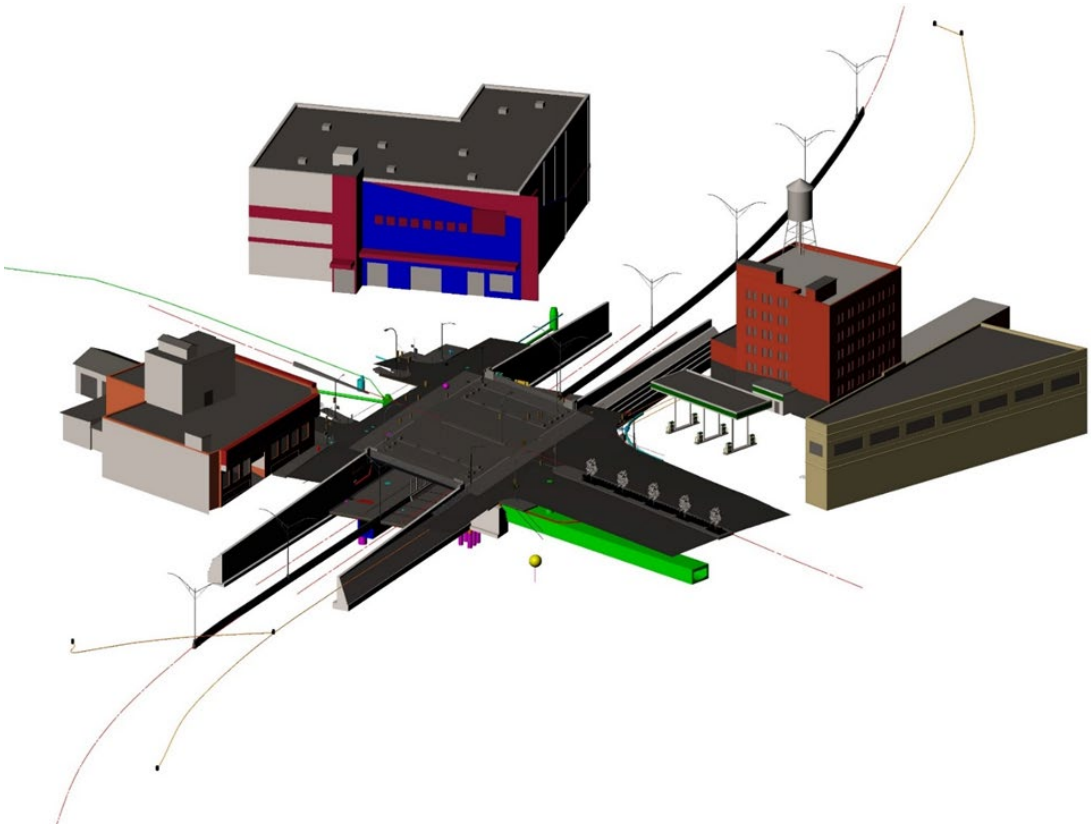

IDEAL MOVERS

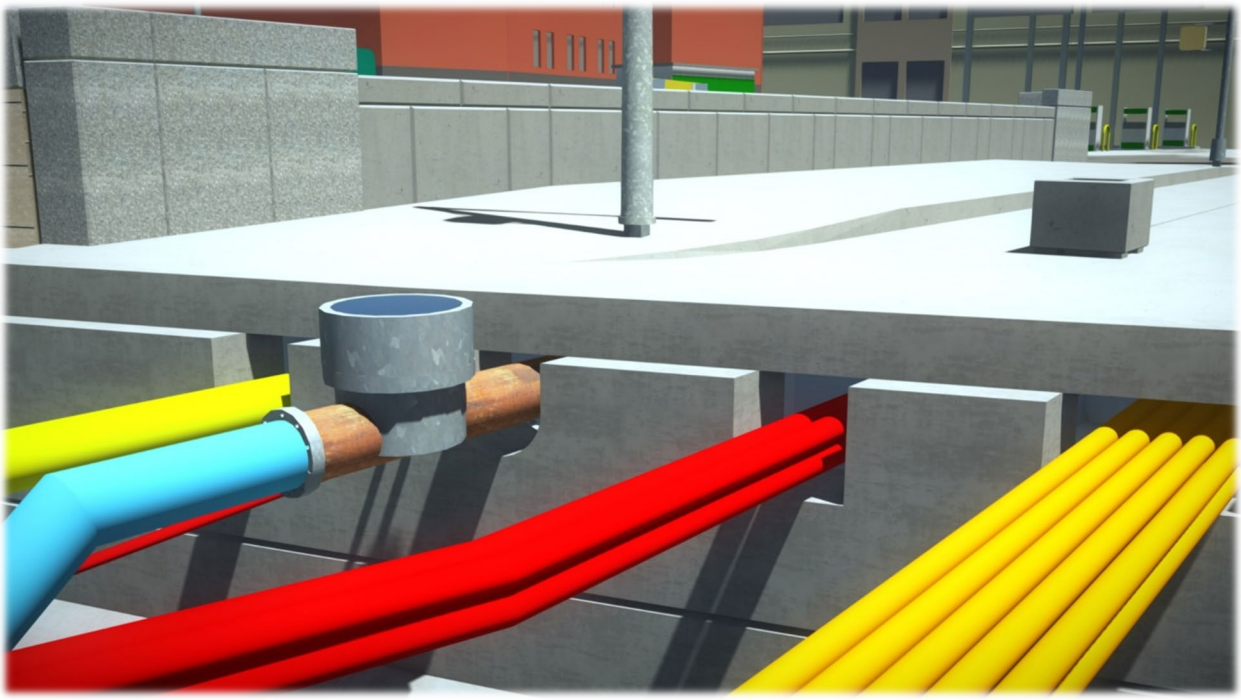
LIST OF APPENDICES

APPENDIX	DESCRIPTION
A	Pilot Projects
B	Embedded Document Instructions



APPENDIX A: PILOT PROJECTS





Pilot Project #1: RT 28 over the Esopus Creek

Bridge Replacement – BIN 1091290

Design Bid Build Contract D264093

Location: Mount Tremper, NY

Project Award: Spring 2020

Project Website: https://www.dot.ny.gov/doing-business/opportunities/const-contract-docs?p_d_id=D264093

Background:

In 2016 NYSDOT set along a path to develop a process that would allow electronic information to be included as part of the legal contract documents for NYSDOT design bid build projects. With that task in hand, a committee was assembled with representation from several NYSDOT staff across the state including design, construction, legal and contracts to collaborate and identify the hurdles as well as the opportunities to our current design delivery process. In 2018, a pilot project was identified in the Catskill Mountains located on Route 28 in the Hamlet of Mount Tremper, Region 8. The project consisted of replacing an existing hydraulically deficient 330ft long bridge with an 800ft long bridge that was nearly 10ft higher in elevation. The project location was rural in nature, located in the Catskill mountains. This resulted in minimal utility relocations and stakeholder involvement & coordination. Extensive earthwork was required in order to remove a U.S. Army Corp of Engineers berm, reconfigure the alignment and raise up an adjacent perpendicular roadway that totaled to nearly 60,000 cubic yards. This roadway realignment provided the ability to construct the proposed bridge offline and complete construction with minimal staging. A tributary stream of Esopus creek was also realigned to provide a more direct discharge to Esopus Creek. This realignment required a new 8x8ft box culvert to carry the stream across the proposed roadway.

A project team was assembled with staff from the Main Office Design and Structures Design Bureaus and work in this unchartered territory began. The team evaluated the intricacies of the project and decided to utilize Bentley's newly released Open Roads and Open Bridge design software. This presented its own challenge as this was a new software application that the team had to learn and become proficient with over the course of the design, however, the team knew this would produce the best product. This method of project delivery required significant planning and outreach to both internal personnel and the General Contractors Association to educate, receive feedback and guide the course of implementation.

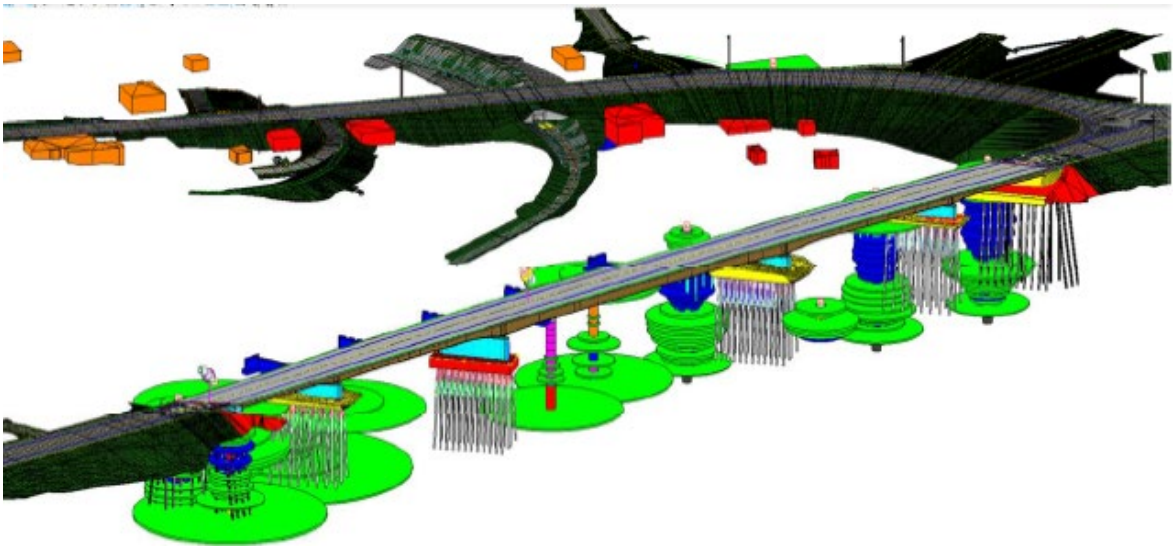
Digital Delivery for Transportation projects is in its infancy across the United States with only a handful of States and projects being advertised and constructed in this format currently. There are multiple ways to incorporate electronic information contractually into the project and NYSDOT has chosen to take a blended approach. The blended approach allows the team to create a digital twin of the proposed design and then utilize that digital twin as part of the contract documents. A significantly reduced 2D plan set is still provided as part of the contract documents to represent information that is easier to depict on a drawing. As part of the committee's vision and efforts, additional contractual electronic files were also used to deliver the project such as excel sheets, alignment files and XML terrain files. Delivery and downstream use of electronic information is the goal of Digital Delivery and insight to the future.

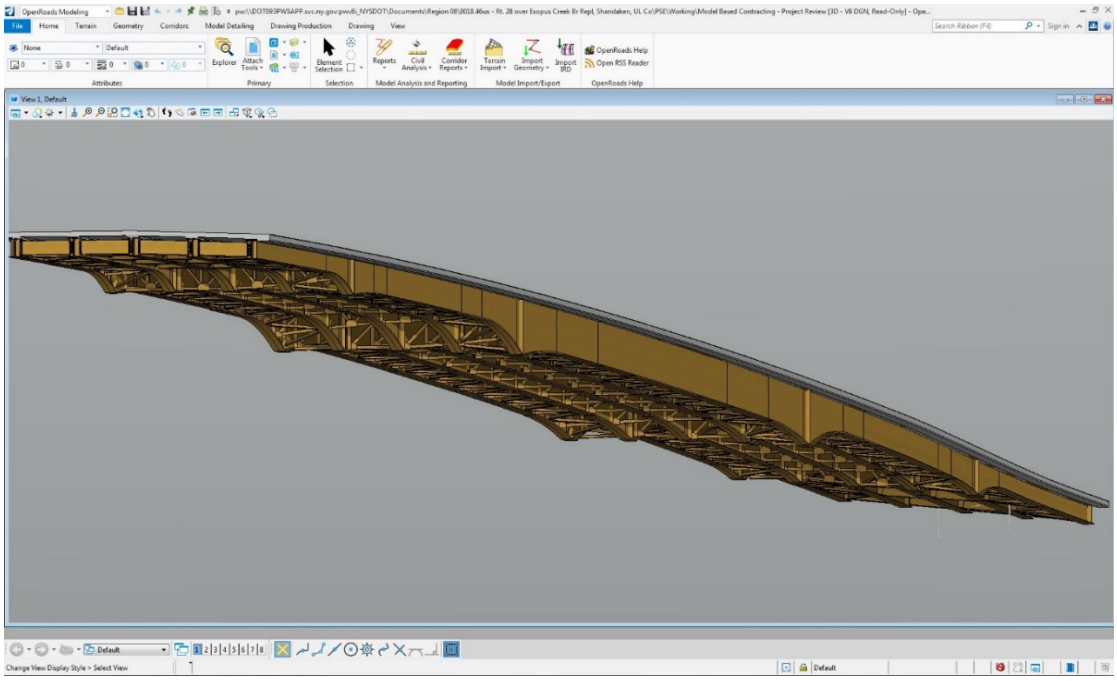
The hard work and perseverance by everyone committed to this task was recognized at Bentley's 2020 Year in Infrastructure Conference. The annual conference receives, reviews and awards contracts from across the world. The Route 28 over the Esopus project received a special recognition award for Advancing Model-based Delivery through Digital Twins.

Digital Delivery Method:

The Digital Delivery approach on this project was a Model Based Digital Delivery that consisted of a fully complete 3D solids model that replaced 60% or more of the traditional 2D plans. All elements that were mentioned above were fully modeled with 3D solids. This wide range of elements allowed the project team to fully test the Model Based Digital Delivery approach across a variety of civil disciplines.

3D Solids Model:





Awards/Recognition:

Special Recognition: Advancing Model-based Delivery through Digital Twins



Articles:

https://www.governor.ny.gov/news/governor-hochul-announces-work-complete-state-route-28-bridge-over-esopus-creek-ulster-county

Construction Photos:






Link-Belt









Tablet Reference – End Abutmen

Pilot Project #2: East 138 Street over the Major Deegan Expressway

Bridge Replacement – BIN 1066790

Design Bid Build (Best Value) Contract D264507

Location: Bronx, NY

Project Award: Summer 2021

Contract Website: https://www.dot.ny.gov/doing-business/opportunities/const-contract-docs?p_d_id=D264507

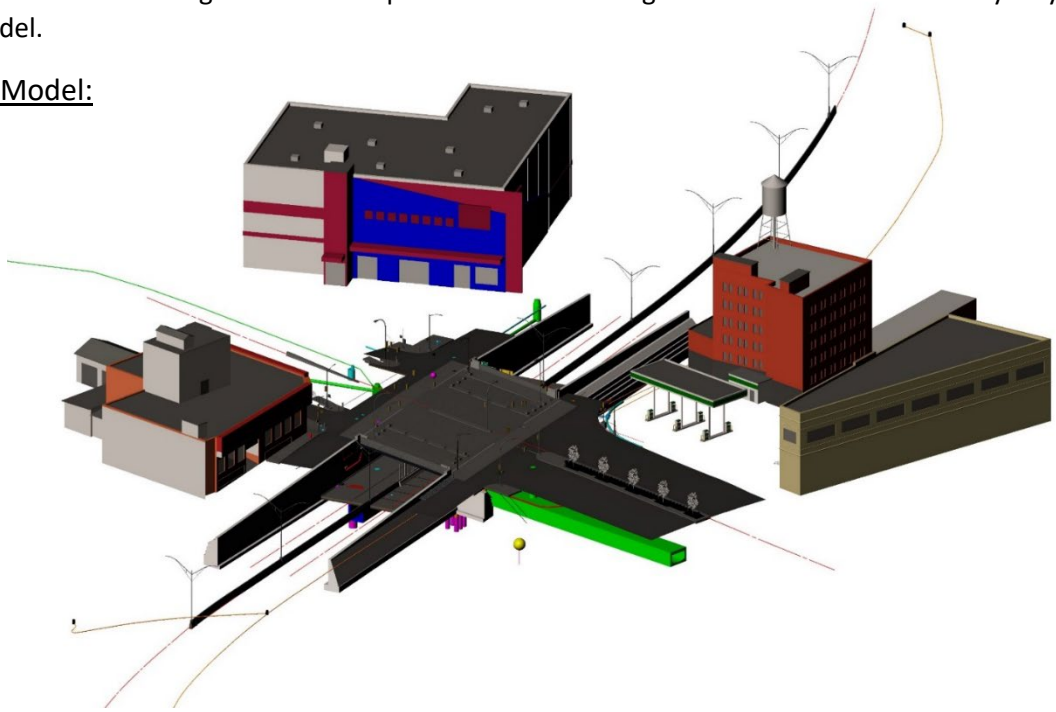
Background:

The East 138 Street over the Major Deegan Expressway Bridge Replacement project consisted of replacing an existing bridge in the Bronx over the Major Deegan Expressway (MDE). The bridge functions as a grade separated diamond interchange between E. 138 St over the MDE. The highway work on the project was focused on reconstructing the intersections at each end of the bridge and reconstructing the PCC pavement along the MDE below. Due to this project being located in a heavily urbanized environment, there were numerous project stakeholders and utilities located throughout the project. This required a great amount of coordination in comparison to the first pilot project. Also, due to the AADT of the interchange exceeding 150,000vpd, the staging of the bridge had to be carefully planned to ensure access remained constant. During construction this resulted in a staging plan that replaced the bridge in 4 independent stages.

Digital Delivery Method:

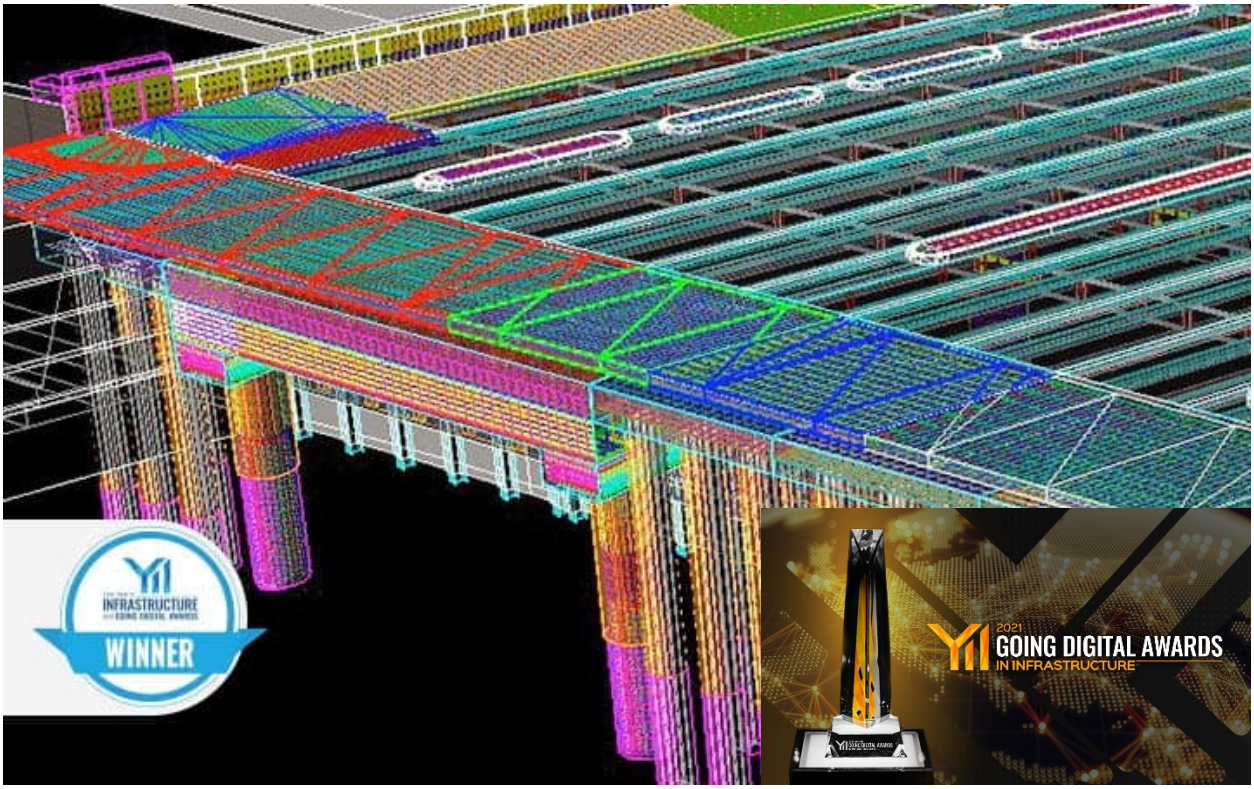
Similar to the first pilot project, the Digital Delivery approach for this project utilized Model Based Digital Delivery. A comprehensive 3D solids model was developed that also replaced 60% or more of the tradition 2D plans. This project's complications of a sophisticated staging plan and an even more sophisticated web of underground utilities provided new challenges that were better solved by way of the 3D model.

3D Solids Model:



Awards/Recognition:

The E. 138th street project was entered into Bentley's Year in Infrastructure for 2021 and was awarded as the winner in the bridge category edging out projects from China and Australia.



Articles:

https://informedinfrastructure.com/72813/nysdot-industrializes-east-138th-street-bridge-using-digital-twin/

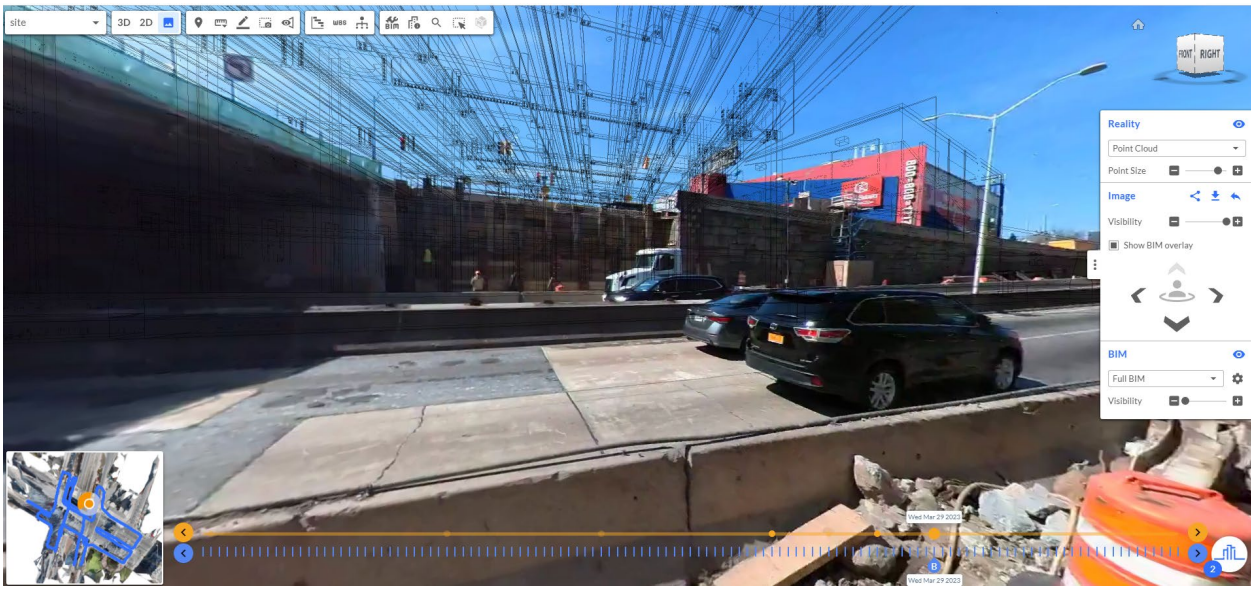
https://www.bridgeweb.com/bentley-systems/new-york-state-department-of-transportation-east-138th-street-over-the-major-de/15

https://blog.virtuosity.com/success-story-nysdot-industrializes-bridge-using-digital-twin

https://www.bentley.com/wp-content/uploads/BSY-050322-NYSDOT-138.pdf

Construction Photos:

Building Information Modeling/Reality Mesh Overlay





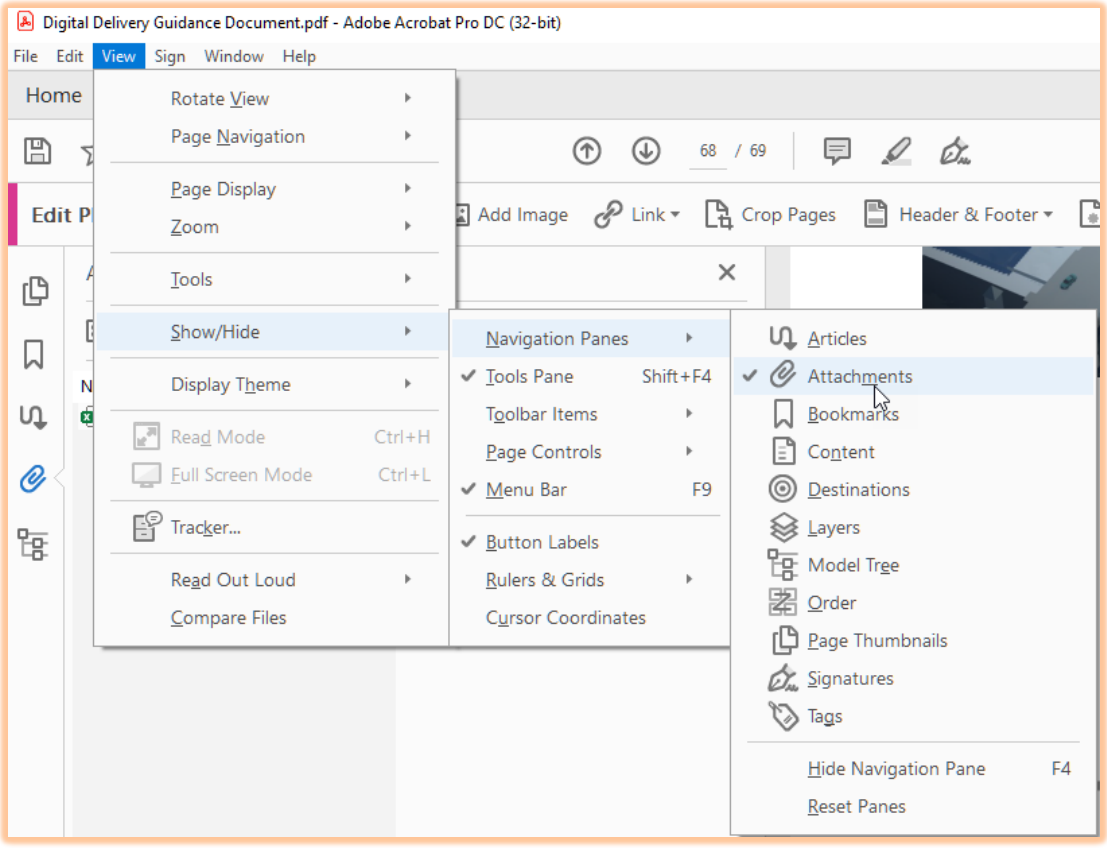



North
87
Maj Deegan
Expwy
Albany
U-HAUL

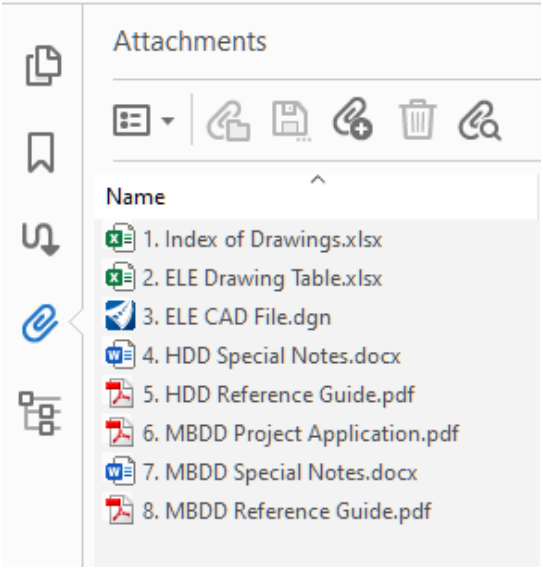
APPENDIX B: EMBEDDED DOCUMENTS

Embedded Document File Name	Format	DESCRIPTION
1. Index of Drawings	.XLSX	Index of drawings for HDD and MBDD projects
2. ELE Drawing Table	.XLSX	Electronic Files Identified as Plans Excel Table
3. ELE CAD File	.DGN	Electronic Files Identified as Plans CAD Drawing
4. HDD Special Notes	.DOCX	Hybrid Digital Delivery Special Notes
5. HDD Reference Guide	.PDF	Hybrid Digital Delivery Reference Guide
6. MBDD Project Application	.PDF	Model Based Digital Delivery Project Application
7. MBDD Special Notes	.DOCX	Model Based Digital Delivery Special Notes
8. MBDD Reference Guide	.PDF	Model Based Digital Delivery Reference Guide

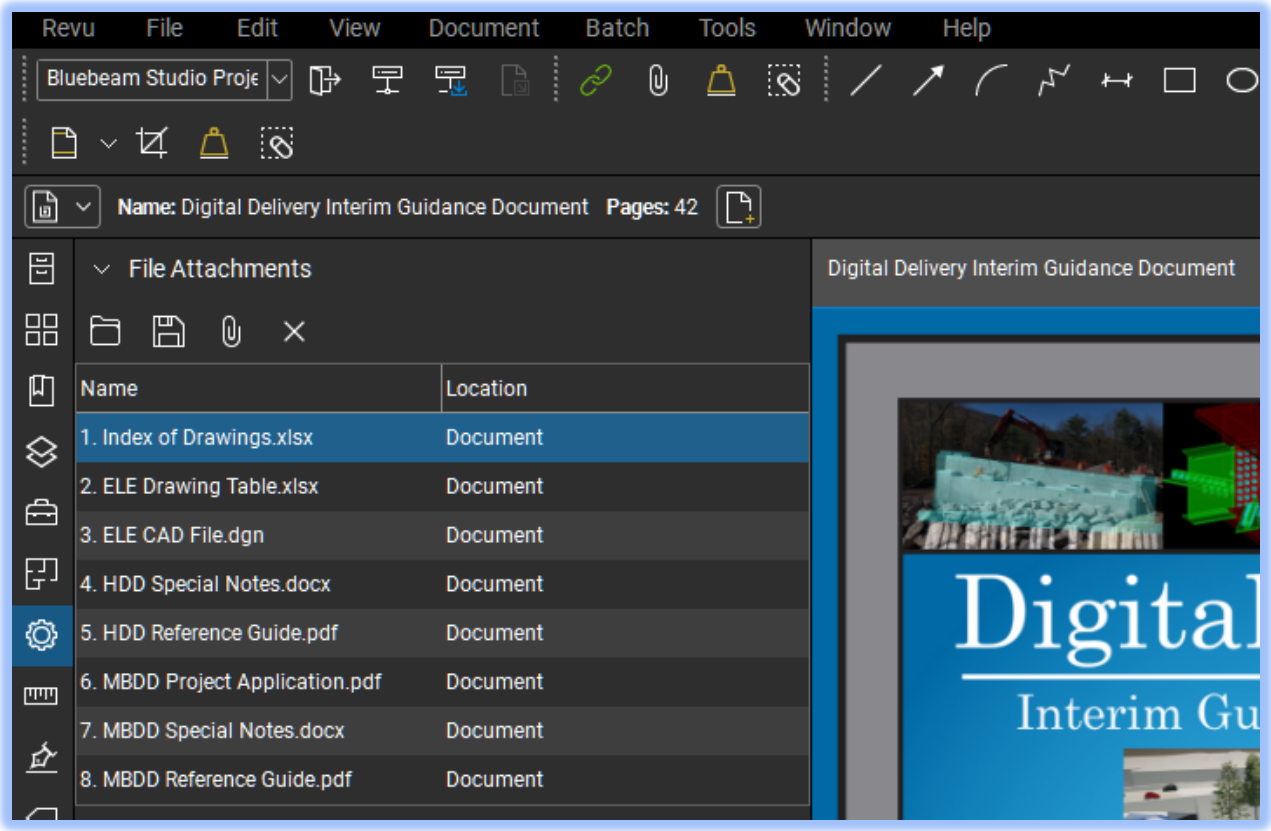
*Instructions for accessing embedded files within this document using **Adobe Acrobat**:*



1) Click “View”
2) Select “Show/Hide”
3) Select “Navigation Panes”
4) Click on “Attachment”
5) Select the paper clip icon on the left.
6) Select the document of interest.
7) User can open or save document(s).



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